

# WonderWeb Deliverable D18

## Ontology Library (*final*)

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\*Part of this work has been done in cooperation with partners inside and outside the WonderWeb project. In particular Sections 5, 6, and 10 has been done in collaboration with Luc Schneider of the Department of Philosophy of the University of Geneva; Sections 7 and 8 in collaboration with Pierre Grenon of the IFOMIS institute of Leipzig; and Section in collaboration with Peter Mika, Marta Sabou of the Vrije Universiteit of Amsterdam, and Daniel Oberle of the Institute AIFB of the University of Karlsruhe.

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# 1 Introduction

## 1.1 The Role of Foundational Ontologies

Ontologies are the basic infrastructure for the Semantic Web. Everybody agrees on this, as the very idea of the Semantic Web hinges on the possibility to use shared vocabularies for describing resource content and capabilities, whose semantics is described in a (reasonably) unambiguous and machine-processable form. Describing this semantics, i.e. what is sometimes called the *intended meaning* of vocabulary terms, is exactly the job ontologies do for the Semantic Web.

But what *kinds* of ontologies do we need? This is still an open issue. In most practical applications, ontologies appear as simple taxonomic structures of primitive or composite terms together with associated definitions. These are the so-called *lightweight* ontologies, used to represent semantic relationships among terms in order to facilitate *content-based access* to the (Web) data produced by a given community. In this case, the *intended meaning* of primitive terms is more or less known in advance by the members of such community. Hence, in this case, the role of ontologies is more that of supporting *terminological services* (inferences based on relationships among terms – usually just taxonomic relationships) rather than explaining or defining their intended meaning.

On the other hand, however, the need to establishing precise agreements as to the meaning of terms becomes crucial as soon as a community of users evolves, or multicultural and multilingual communities need to exchange data and services. As recently reported by the *Harvard Business Review*<sup>1</sup>, this problem may have been “one of the main reasons that so many online market makers have foundered. The transactions they had viewed as simple and routine actually involved *many subtle distinctions in terminology and meaning*”.

To capture (or at least approximate) such subtle distinctions we need an explicit representation of the so-called *ontological commitments* about the meaning of terms, in order to remove terminological and conceptual ambiguities. A rigorous logical axiomatisation seems to be unavoidable in this case, as it accounts not only for the relationships between terms, but – most importantly – for the formal structure of the domain to be represented. This allows one to use axiomatic ontologies not only to facilitate *meaning negotiation* among agents, but also to clarify and model the negotiation process itself, and in general the structure of interaction.

We should immediately note that building axiomatic ontologies for these purposes may be extremely hard, both conceptually and computationally. However, this job only needs to be undertaken *once*, before the interaction process starts. The quality of meaning negotiation may drastically affect the *trust* in a service offered by the Semantic Web, but not the computational performance of the service itself. Thus, for example, a product procurement process involving multiple agents with distributed lightweight ontologies may be carried out in an efficient way by using simple terminological services, but the risk of *semantic mismatch* can be minimized only if the agents rely on explicit, axiomatised ontologies, which serve to ensure mutual compatibility of the respective models in such a way as to check the extent of real agreement.

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<sup>1</sup>October 2001.

Axiomatic ontologies come in different forms and can have different levels of generality, but a special relevance is enjoyed by the so-called *foundational ontologies*, which address very general domains. One of the goals of the WONDERWEB project is the development of a *library* of such foundational ontologies, systematically related to each other in a way that makes the rationales and alternatives underlying different ontological choices as explicit as possible. Hopefully, this library will allow different Semantic Web applications to commit to foundational ontologies according to their own needs and preferences, relying on the chosen modules (and their relationships with the rest of the library) for making explicit the underlying ontological assumptions and their formal consequences.

Foundational ontologies are ultimately devoted to facilitate mutual understanding and inter-operability among people and machines. This includes understanding the *reasons for non-interoperability*, which may in some cases be much more important than implementing an integrated (but unpredictable and conceptually imperfect) system relying on a generic shared “semantics”. In conclusion, we see the role and nature of foundational ontologies (and axiomatic ontologies in general) as complementary to that of lightweight ontologies: the latter can be built semi-automatically, e.g. by exploiting machine learning techniques; the former require more painful human labour, which can gain immense benefit from the results and methodologies of disciplines such as philosophy, linguistics, and cognitive science.

## 1.2 The WonderWeb Foundational Ontologies Library

Having motivated the role of foundational ontologies, let us describe the library we have developed within the WONDERWEB project: its philosophy, its structure, and its development approach.

### 1.2.1 Philosophy

We strongly believe it’s important to have *a library* of foundational ontologies, reflecting different commitments and purposes, rather than a single monolithic module. Indeed, we believe that the most important challenge for the Semantic Web is not so much the agreement on a monolithic set of ontological categories, but rather the careful isolation of the fundamental ontological options and their formal relationships. In our view, each module in this library should be described in terms of such fundamental options. Rationales and alternatives underlying the different ontological choices should be made as explicit as possible, in order to form a network of different but systematically related modules which the various Semantic Web applications can commit to, according to their ontological assumptions.

In short, the main goals of the WONDERWEB Foundational Ontologies Library (WFOL, see Figure 1) are to serve as:

- a starting point for building new ontologies. One of the most important and critical questions when starting a new ontology is determining what things there are in the domain to be modeled. Adopting a high level view provides an enormous jump start in answering this question;

- a reference point for easy and rigorous comparisons among different ontological approaches;
- a common framework for analyzing, harmonizing and integrating existing ontologies and metadata standards (by manually mapping existing categories into the categories assumed by some module(s) in the library).

In addition, we intend the library to be:

- *minimal* – as opposed to other comprehensive ontology efforts, we intend the library to be as general as possible, including only the most reusable and widely applicable upper-level categories;
- *rigorous* – where possible, the ontologies in the libraries will be characterized by means of rich axiomatisations, and the formal consequences (theorems) of such characterizations will be explored in detail;
- *extensively researched* – each module in the library will be added only after careful evaluation by experts and consultation with canonical works. The basis for ontological choices will be documented and referenced.

### 1.2.2 Structure

The basic structure of our library is depicted in Figure 1. Modules are organized along two dimensions: *vision*, corresponding to the basic ontological choices made, and *specificity*, according to the level of generality. Note that the actual implementation of this library as a single software service is out of the scope of this project. However, this document can be seen as a high-level specification for such implementation. In general, from the software engineering point of view, a foundational ontologies library can be seen as:

1. A collection of ontology modules, including:
  - a collection of machine-readable ontologies (encoded e.g. as KIF files), corresponding to the different ontology modules (see Appendix A, B for the KIF versions of DOLCE and OCHRE and Appendix C for an extended KIF version of DOLCE in order to introduce new concept indispensable for representing web services (see Section 12))<sup>2</sup>);
  - an informal presentation of the basic ontological choices adopted for each module (Sections 3, 5, 7);
  - a presentation of the logical axiomatisation adopted for each module, including a discussion on the motivations and consequences (i.e., theorems) of single axioms (Sections 4, 6, 8).
2. A specification of differences and similarities existing among modules, including:

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<sup>2</sup>The KIF version of the third module (BFO) is still not available.

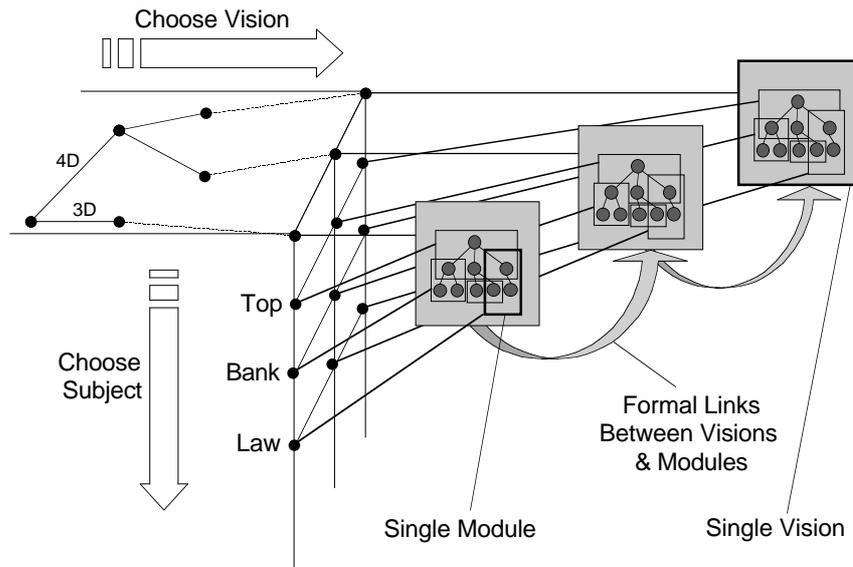


Figure 1: The WonderWeb Foundational Ontologies Library. The tree to the left describes a “roadmap” of ontological choices. Grey squares to the right correspond to ontologies (possibly) developed according to such choices. In turn, these are organized in modules according to domain specificity.

- an informal discussion on the differences between the ontological choices adopted;
  - a logical specification of the formal links (i.e., syntactic and semantic correspondences) existing between the various modules (in Section 10 the formal links between OCHRE and DOLCE are described in detail).
3. A mapping between ontology modules and natural language lexicons such as WordNet (see Section 11 for the mapping between DOLCE and WORDNET and Appendix D for an implementation of these mappings in KIF).

### 1.2.3 Development Approach

Developing foundational ontologies is not simple at all. We decided to describe first a core set of key ontological assumptions, focusing on the needs of other projects we were involved in, and reflecting our own choices and intuitions (see also the WONDERWEB Deliverable D15, that presents a first “roadmap” of various ontological options and the general methodology adopted). This was the origin of DOLCE, whose acronym (Descriptive Ontology for Linguistic and Cognitive Engineering) reflects what we have called a *cognitive bias*. Since its first development, DOLCE was *not* intended as a candidate for a “universal” standard ontology, but rather as a *reference module*, to be adopted as a starting point for comparing and elucidating the relationships with other future modules of the library. Indeed, the public availability of DOLCE - since its first release - stimulated

other research groups working on formal ontology to make their own ontologies available in the library as independent modules, although linked to DOLCE according to the WONDERWEB philosophy.

It is important to remark that, to reach the objective of extending the library with external contributions, a substantial allocation of resources on both sides (the library developer and the interested contributors) was required, in order to understand the different choices, compare them, and harmonise the documentation. Given the available resources, we succeeded in introducing two external modules besides DOLCE: OCHRE and BFO. The first one is an ontology independently developed by Luc Schneider, currently at the University of Geneve; the latter is being adopted by the IFOMIS research lab at the University of Leipzig for developing formal ontologies in the biomedical area. Further contacts for extending the library are in progress.

A final note concerns the logical language adopted for the various modules. The WONDERWEB project is committed to develop a layered language architecture for representing ontologies in the Semantic Web, based on existing standards such as RDF and OWL. The latter is intended to be used as a language for representing and querying ontologies on the Web, and has been carefully designed in order to offer the best possible tradeoff between expressivity and computational efficiency, while guaranteeing at the same time important logical properties such as inferential completeness. The result is a layered logical language allowing for different degrees of expressivity, which is however much less expressive than first-order logic. Using such a language for specifying foundational ontologies would be non-sensical: because of their very goals and nature, these ontologies need an expressive language, in order to suitably characterize their intended models. On the other hand, as we have noted above, their computational requirements are less stringent, since they only need to be accessed for meaning negotiation, not for terminological services where the intended meaning of terms is already agreed upon. The strategy we have devised to solve this expressivity problem is the following:

1. Describe a foundational ontology on paper, using a full first-order logic with modality;
2. Isolate the part of the axiomatization that can be expressed in OWL, and implement it;
3. Add the remaining part in the form of KIF<sup>3</sup> comments attached to OWL concepts.

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<sup>3</sup>Indeed, we are considering the new language CL ([cl.tamu.edu](http://cl.tamu.edu)), which is an extension of KIF.

## 2 Design Options and Ontological Choices

Before addressing specific issues about domain of discourse, basic categories, and their relations<sup>4</sup>, it may be important to clarify the general attitude towards ontological analysis, or – in other words – the motivations and the constraints that drive our *conceptualization* of reality. It comes to no surprise that the design options for building foundational ontologies reflect the main categorical distinctions discussed in philosophy. However, among all the philosophical stands and distinctions, foundational ontologists seem particularly interested in two general attitudes: a) *descriptive* vs. *revisionary*, and b) *multiplicative* vs. *reductionist*.

(a) A descriptive ontology aims at capturing the ontological stands that shape natural language and human cognition. It is based on the assumption that the *surface structure* of natural language and the so-called commonsense have ontological relevance. As a consequence, the categories refer to cognitive artifacts more or less depending on human perception, cultural imprints and social conventions. Under this approach, there are no major restrictions on the postulation of ontological categories because overall philosophical or scientific paradigms are neglected. This attitude stands in contrast to the revisionary approach. The revisionist considers linguistic and cognitive issues at the level of secondary sources (if considered at all), and does not hesitate to paraphrase linguistic expressions (or to re-interpret cognitive phenomena) when their ontological assumptions are not defensible on scientific grounds.

The following example should make this contraposition clear. Commonsense distinguishes between *things* (*spatial objects* like houses and computers) and *events* (*temporal objects* like bank transfers and computer repairs). In the wake of relativity theory, however, time is viewed as another dimension of objects on a par with the traditional spatial dimensions. Considering the consequences of this scientific theory (or theories), some philosophers and computer scientists have come to believe that the commonsense distinction between things that are and things that happen should be abandoned in favor of a unified viewpoint. According to these revisionist researchers, *everything* extends in space *and* time, and the distinction between things and events is an (ontologically irrelevant) historical and cognitive accident. This example shows that a revisionary ontology is committed to capture the *intrinsic nature* of the world by providing structures that are independent from the conceptualizing agents.

Classic examples of descriptive ontologies are [85] and [74].

(b) In designing ontologies, one has to model a considerable amount of concepts. These concepts form a wide taxonomy and are often intertwined in several ways. Since the complexity of the resulting system is quite high, there are considerable advantages in limiting the actual primitives to a small subset of the concepts. If this is possible, then many notions can be reconstructed in terms of the chosen primitives. A reductionist ontologist takes this view as a major guideline; he aims at describing a great number of ontological concepts with the smallest number of primitives. On the other hand, a multiplicative ontologist points at reaching a very expressive system without bothering

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<sup>4</sup>See [34].

about the complexity of the ontology. Indeed, the aim is to provide a reliable account of reality despite of the large number of basic concepts needed.

A clear example of this dichotomy is seen in the attitude towards co-localized entities. A multiplicative ontology allows for different entities to be *co-localized* in the same space-time. These entities are *assumed* to be different because they have incompatible *essential* properties. This case is often presented through the problem of the vase and the clay it is made of. It seems natural to assume that the vase ceases to exist when a radical change in shape occurs (for instance, when it breaks in peaces). Instead, the amount of clay is not altered by such events. According to the multiplicativist, these observations show that there must be different (yet related) entities that are co-localized: the vase is *constituted* by an amount of clay, but it is not an amount of clay.<sup>5</sup> Indeed, when a vase-master shapes a particular amount of clay, new properties are instantiated, and this justifies the *emergence* of a new entity that we call a vase. This solution is opposed by the reductionists, which provide a different answer to this issue. They postulate that each space-time location contains at most one object. Incompatible essential properties (like those that distinguish the vase from the clay) are regarded as byproducts of the different viewpoints one can assume about spatio-temporal entities. The vase and the clay are surely different, reductionists claim, although not as entities but as views of the same spatio-temporal object.

Before concluding these general remarks on ontological analysis, we give the gist of another issue that highlights the (sometimes subtle) relationships between formalization and conceptualization.

The problem of representing time and modality is an old and ever recurrent quandary in artificial intelligence. Basically, two approaches are possible: either one includes modal and temporal operators in the formal system from the very beginning, or reproduces modal reasoning into a first-order language adding time and world (or situation) parameters to the predicates. In the first case one can translate the expression “It is possible that John is ill” in a literal fashion. In the other approach, one has to rephrase the expression before translating it into the formalism. For instance, one can take the above expression to be equivalent to “There is a world in which John is ill”. This latter sentence can be translated literally.

Although these options are generally well known to the practitioner, their consequences are sometimes not recognized. Bending for one or the other approach often determines a preference in the dichotomies actualism/possibilism and presentism/eternalism. Actualism claims that only what is real exists, while possibilism admits *possibilia* (situations or worlds) as well. Similarly, presentism assumes that only what is present exists, while for an eternalist the past, the present and the future are all existing.

The decision to allow quantification over instants or worlds is a decision faced by the possibilism and eternalism approaches. On the other side, actualism and presentism go hand in hand with the use of primitive modalities.

In the next paragraphs we present the most relevant options underlying the organization of an ontology. These are particularly important to clarify the commitments behind

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<sup>5</sup>One of the purposes of the OntoClean methodology [47] is to help the user evaluating ontological choices of this type.

foundational ontologies and their basic categories. The following section outlines the ontological modules of the library. In this part, we resume the main theoretical choices discussed so far and show the ontological positions taken by the three ontologies DOLCE<sup>6</sup>, BFO<sup>7</sup>, and OCHRE<sup>8</sup>.

## 2.1 Universals, Particulars and Individual Properties

The ontological distinction between *universals* and *particulars* can be characterized by means of the primitive relation of *instantiation*: particulars are entities that *cannot* have instances; universals are entities that *can* have instances<sup>9</sup>. In linguistic, ‘proper nouns’ are normally considered to refer to particulars, while ‘common nouns’ to universals. For example, ‘Varenne’, the Italian racehorse, is an instance of ‘horse’, but it cannot be instantiated itself.

This characterization of the concept of universal is still vague since it does not clarify whether sets, predicates, and abstracts should be included among the universals. Let us consider why these entities are problematic.

Sets are extensional entities, i.e. fully determined by their extension, and the *membership* relation inherits this property: an element is a member of a set if it is in the extension of that set. The relation of instantiation is more generic and usually taken to be non-extensional. For example, the universals ‘three-angled polygon’ and ‘three-sided polygon’ are considered to be different although they have exactly the same instances, that is, they isolate the same sets.

Predicates are sometimes closed with respect to the logical connectives, i.e. if *P* and *Q* are predicates, also ‘*P* and *Q*’, ‘*P* or *Q*’, and ‘*not P*’ are predicates. This seems awkward for universals. For example, one would probably include *table* and *pumpkin* among the universals, but not predicates like ‘*table or pumpkin*’ or ‘*not table*’.

Finally, if abstracts are entities non extended in space-time (see also the next section), then they can differ from universals in many aspects. After all, not all abstracts seem to be universals (like numbers or sets). Furthermore, sometimes universals are taken to be localized in space-time since they are associated to the spatio-temporal locations of their instances<sup>10</sup>. More radically, universals can be rejected as in the *trope theory* [9]. Tropes do not have instances, they are properties/qualities of specific material entities and depend ontologically on them. In trope theory, it is possible to speak of the ‘whiteness’ of this specific piece of paper, while the universal ‘white’ does not exist. Note that tropes are often taken to be localized in the space-time of (the surface of) the material entities they depend on, that is, they cannot be considered as abstracts in the usual way. Related to this arguments, two further options have to be highlighted: objects can be seen as

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<sup>6</sup><http://www.loa-cnr.it/DOLCE.html>

<sup>7</sup><http://ontology.buffalo.edu/bfo/>

<sup>8</sup><http://www.ifomis.uni-leipzig.de/Research/pubs/forthcoming/ki2003epaper.pdf>

<sup>9</sup>Properties and relations are usually considered as universals.

<sup>10</sup>In this case, the location of a universal is the sum of the locations of its instances and, according to this philosophical stand, every universal is ‘wholly present’ in each instance. This thesis is controversial. The difficulty of understanding how there can be a class of entities extended in space-time but not behaving like particulars, remains unsolved.

bearers (or *substrates* - using a well-known Aristotelian category) of their properties or as aggregations of their properties. In the first case, objects are the result of a substratum (whatever this is claimed to be, i.e. *rough matter*) coming with peculiar qualities at a certain time; in the second, objects are individuated by different qualities considered in a certain spatial location at a certain time.

## 2.2 Abstract and Concrete Entities

We have mentioned that *abstracts entities* exist neither in space nor in time, i.e. they are not localized. On the other hand, *concrete entities* (or *concretes*) are defined as entities that exist at least in time. Mathematical objects (like numbers and sets) are examples of abstracts, while ordinary objects (like cars, books, etc.) or events (like the 2000 Olympic Games) are examples of concrete entities. This characterization immediately raises a question: how is it possible that abstracts exist without existing at any time? Is it better to say that these are eternal and immutable, i.e., they exist at all times without changing? From an ontological point of view the answer is not trivial, and perhaps a weaker characterization is preferable. An alternative definition is based on the ‘causal criterion’: abstracts possess no causal power while concretes do. This second definition, although similar to the first, is quite different: if abstracts are ‘timeless’ entities, as in the first definition, then they cannot be involved in causal relations; vice versa it is possible to individuate entities localized in time and space (like ‘the centre of mass of the solar system’ see [60]) that lack any causal power. In what follows, we focus on the first characterization of abstracts.<sup>11</sup>

## 2.3 3D vs. 4D

A fundamental ontological choice deals with the notion of change. What does it mean for an entity to change? This question raises the problem of variation in time and the related issue of the identity of the objects of experience.

In general a 3D option claims that objects are: a) extended in a three-dimensional space; b) wholly present at each instant of their life; c) changing entities, in the sense that at different times they can instantiate different properties (indeed, one could say *When I was out in the balcony my hands were colder than now*). On the contrary a four-dimensional perspective states that objects are: a) space-time worms; b) only partially present at each instant; c) changing entities, in the sense that at different phases they can have different properties (*My hands during the time spent out in the balcony, were colder than now*).

In the two following subsections we illustrate some specific arguments linked to this issue.

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<sup>11</sup>The sense of abstractness introduced here is different from the one used in trope theory. Here concrete entities are ‘material’ (such as cars, tables, etc.), while tropes are properties or qualities of these entities (possibly with a spatio-temporal location).

## 2.4 Endurants and Perdurants

Classically, *endurants* (also called *continuants*) are characterized as entities that are ‘in time’, they are ‘wholly’ present (all their proper parts are present) at any time of their existence. On the other hand, *perdurants* (also called *occurrents*) are entities that ‘happen in time’, they extend in time by accumulating different ‘temporal parts’, so that, at any time  $t$  at which they exist, only their temporal parts at  $t$  are present.<sup>12</sup> For example, the book you are holding now can be considered an endurant because (now) it is wholly present, while “your reading of this book” is a perdurant because, your “reading” of the previous section is not present now. Note that it is possible to distinguish between ‘ordinary objects’ (like the book) and ‘events or process’ (like ‘the reading of the book’) even when the domain contains perdurants only. In this latter case, one relies on properties that lie outside spatio-temporal aspects. Indeed, one can assume that four-dimensional entities do not need to have different spatio-temporal locations. A person and its life (both taken to be 4D entities) share the same space-time region but differ on other properties since, for instance, color, race, beliefs and the like make sense for person only.

Endurants and perdurants can be characterized in a different way. Something is an endurant if (i) it exists at more than one moment and (ii) its parts can be determined only relatively to something else (for instance time)[49]. In other words, the distinction is based on the different nature of the parthood relation: endurants need a time-indexed parthood, while perdurants do not. Indeed, a statement like “this keyboard is part of my computer” is incomplete unless you specify a particular time, while “my youth is part of my life” does not require such a specification.<sup>13</sup>

## 2.5 Co-localized entities

No matter what one decides about the ontological status of space and time, one has the option to include spatially and temporally co-located objects. It is quite natural to admit temporally co-localized objects (like you and the book you are reading) as well as spatially co-localized objects (somebody else can sit in the chair when I get up), while it is more problematic to justify the existence of spatio-temporally co-localized objects. Our natural language provides several compelling examples like a hole and the region of space it occupies, a statue and the clay it is made of, a person and its body. In other terms, in including (or excluding) spatio-temporally co-located objects, one answers major questions like: are there holes, or only *holed objects*? Are there statues or only *statue-shaped stuff*?

This subject is extremely complex and involves rather difficult issues like identity through time, material constitution, essentiality, modality, etc. This is not the place for a detailed discussion of these issues. Nevertheless, we try to make explicit the positions of the ontologies in the library with respect to co-localization of entities. We distinguish be-

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<sup>12</sup>Time-snapshots of perdurants (i.e., perdurants that are present only for an instant, and which lack proper temporal parts) are a limit case in this distinction.

<sup>13</sup>If the domain of quantification contains both ‘objects’ and ‘events’, without reducing one kind of elements to the other, the *participation* relation, stating that objects participates in events, becomes fundamental. For example, a person may participate in a discussion and a sword in a battle. This relation does not depend on the characterization of objects. It is crucial also in a four dimensionalist position where objects and events, although both 4D entities, are kept distinct.

tween entities that are spatially co-localized with ‘material entities’ –for example statues, persons, etc. – and entities that are dependent on ‘material entities’ although *not* spatially co-localized with them –for example holes, places, spots, shadows, etc. (see [13]) for a detailed treatment).

## 3 DOLCE: a Descriptive Ontology for Linguistic and Cognitive Engineering

### 3.1 Basic assumptions

The first module of our foundational ontologies library is a Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE). According to the vision introduced above, we do *not* intend DOLCE as a candidate for a “universal” standard ontology. Rather, it is intended to act as starting point for comparing and elucidating the relationships with other future modules of the library, and also for clarifying the hidden assumptions underlying existing ontologies or linguistic resources such as WordNet.

As reflected by its acronym, DOLCE has a clear *cognitive bias*, in the sense that it aims at capturing the ontological categories underlying natural language and human common-sense. We believe that such bias is very important for the Semantic Web (especially if we recognize its intrinsic social nature [15]). We do not commit to a strictly referentialist metaphysics related to the intrinsic nature of the world: rather, the categories we introduce here are thought of as cognitive artifacts ultimately depending on human perception, cultural imprints and social conventions (a sort of “cognitive” metaphysics). We draw inspiration here from Searle’s notion of “deep background” [74], which represents the set of skills, tendencies and habits shared by humans because of their peculiar biological make up, and their evolved ability to interact with their ecological niches. The consequences of this approach are that our categories are at the so-called *mesoscopic* level [79], and they do not claim any special robustness against the state of the art in scientific knowledge: they are just *descriptive* notions that assist in making *already formed* conceptualizations explicit. They do not provide therefore a *prescriptive* (or “revisionary” [85]) framework to conceptualize entities. In other words, our categories describe entities in an *ex post* way, reflecting more or less the surface structures of language and cognition.

DOLCE is an ontology of *particulars*, in the sense that its domain of discourse is restricted to them. The fundamental ontological distinction between *universals* and *particulars* can be informally understood by taking the relation of *instantiation* as a primitive: particulars are entities which have no instances<sup>14</sup>; universals are entities that can have instances. Properties and relations (corresponding to predicates in a logical language) are usually considered as universals. We take the ontology of universals as formally separated from that of particulars. Of course, universals *do* appear in an ontology of particulars, insofar they are used to organize and characterize them: simply, since they are not in the domain of discourse, they are not themselves subject to being organized and characterized (e.g., by means of *metaproperties*). An ontology of unary universals has been presented in [46]. In this paper, we shall occasionally use notions (e.g., rigidity) taken from such work in our meta-language.

A basic choice we make in DOLCE is the so-called *multiplicative approach*: different entities can be *co-located* in the same space-time. The reason why we *assume* they are different is because we *ascribe* to them incompatible essential properties. The classical

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<sup>14</sup>More exactly, we should say that they *can’t* have instances. This coincides with saying that they have no instances, since we include *possibilia* (possible instances) in our domain.

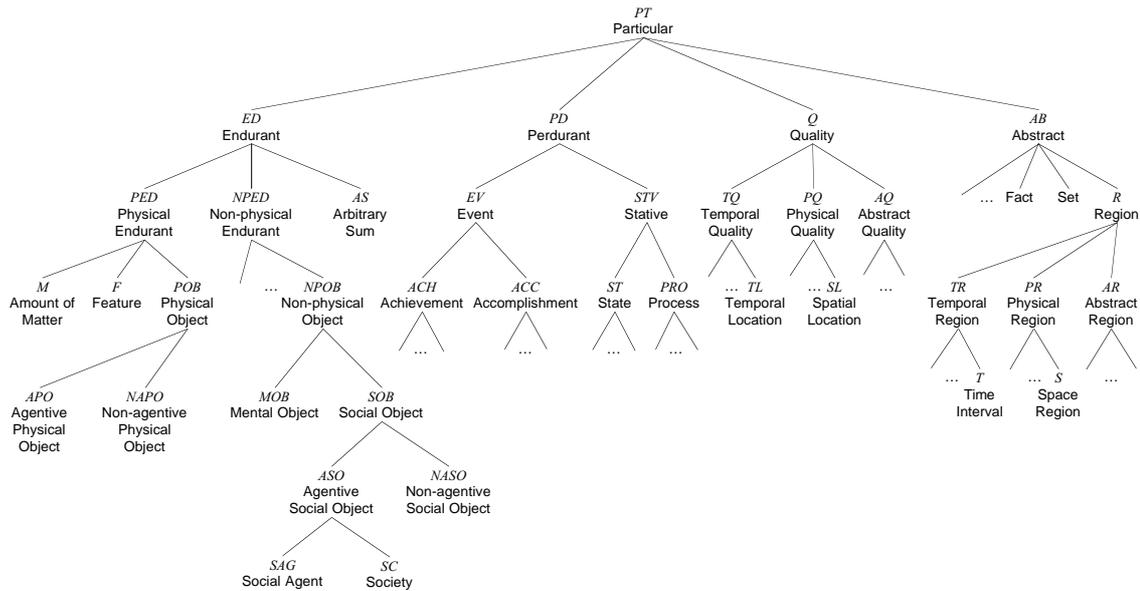


Figure 2: Taxonomy of DOLCE basic categories.

example is that of the vase and the amount of clay: necessarily, the vase does not survive a radical change in shape or topology, while, necessarily, the amount of clay does. Therefore the two things must be different, yet co-located: as we shall see, we say that the vase is *constituted* by an amount of clay, but it is not an amount of clay<sup>15</sup>. Certain properties a particular amount of clay happened to have when it was shaped by the vase-master are considered as essential for the *emergence* of a new entity. In language and cognition, we refer to this new entity as a genuine different thing: for instance, we say that a vase has a handle, but not that a piece of clay has a handle.

A similar multiplicative attitude concerns the introduction of categories which in principle could be reduced to others. For instance, suppose we want to explore whether or not having points in addition to regions (or vice versa) in one's ontology. It seems safe to assume the existence of both kind of entities, in order to study their formal relationships (and possibly their mutual reducibility), rather than committing on just one kind of entity in advance. Hence, when in doubt, we prefer to introduce new categories, since it is easy to explain their general behavior, while keeping at the same time the conceptual tools needed to account for their specific characteristics.

### 3.2 Basic categories

The taxonomy of the most basic categories of particulars assumed in DOLCE is depicted in Figure 2. They are considered as *rigid* properties, according to the OntoClean methodology that stresses the importance of focusing on these properties first. Some examples of “leaf” categories instances are illustrated in Table 1.

<sup>15</sup>One of the purposes of the OntoClean methodology [47, 48] is to help the user evaluating ontological choices like this one.

“Leaf” Basic Category	Examples
Abstract Quality	<i>the value of an asset</i>
Abstract Region	<i>the conventional value of 1 Euro</i>
Accomplishment	<i>a conference, an ascent, a performance</i>
Achievement	<i>reaching the summit of K2, a departure, a death</i>
Agentive Physical Object	<i>a human person (as opposed to legal person)</i>
Amount of Matter	<i>some air, some gold, some cement</i>
Arbitrary Sum	<i>my left foot and my car</i>
Feature	<i>a hole, a gulf, an opening, a boundary</i>
Mental Object	<i>a percept, a sense datum</i>
Non-agentive Physical Object	<i>a hammer, a house, a computer, a human body</i>
Non-agentive Social Object	<i>a law, an economic system, a currency, an asset</i>
Physical Quality	<i>the weight of a pen, the color of an apple</i>
Physical Region	<i>the physical space, an area in the color spectrum, 80Kg</i>
Process	<i>running, writing</i>
Social Agent	<i>a (legal) person, a contractant</i>
Society	<i>Fiat, Apple, the Bank of Italy</i>
State	<i>being sitting, being open, being happy, being red</i>
Temporal Quality	<i>the duration of World War I, the starting time of the 2000 Olympics</i>
Temporal Region	<i>the time axis, 22 june 2002, one second</i>

Table 1: Examples of “leaf” basic categories.

### 3.2.1 Endurants and Perdurants

DOLCE is based on a fundamental distinction between *enduring* and *perduring* entities, i.e. between what philosophers usually call *continuants* and *occurrents* [76], a distinction still strongly debated both in the philosophical literature [89] and within ontology standardization initiatives<sup>16</sup>. Again, we must emphasise that this distinction is motivated by our cognitive bias, and we do not commit to the fact that both these kinds of entity “do really exist”.

Classically, the difference between enduring and perduring entities (which we shall also call *endurants* and *perdurants*) is related to their behavior in time. Endurants are *wholly* present (i.e., all their proper parts are present) at any time they are present. Perdurants, on the other hand, just extend in time by accumulating different temporal parts, so that, at any time they are present, they are only *partially* present, in the sense that some of their proper temporal parts (e.g., their previous or future phases) may be not present. E.g., the piece of paper you are reading now is wholly present, while some temporal parts of your reading are not present any more. Philosophers say that endurants are entities that *are in time*, while lacking however temporal parts (so to speak, all their parts flow with them in time). Perdurants, on the other hand, are entities that *happen in time*, and can

<sup>16</sup>See for instance the extensive debate about the “3D” vs. the “4D” approach at [suo.ieee.org](http://suo.ieee.org), or the SNAP/SPAN opposition sketched in BFO

have temporal parts (all their parts are fixed in time)<sup>17</sup>.

Hence endurants and perdurants can be characterised by whether or not they can exhibit change in time. Endurants can “genuinely” change in time, in the sense that the very same endurant as a whole can have incompatible properties at different times; perdurants cannot change in this sense, since none of their parts keeps its identity in time. To see this, suppose that an endurant say “this paper” has a property at a time  $t$  “it’s white”, and a different, incompatible property at time  $t'$  “it’s yellow”: in both cases we refer to the whole object, without picking up any particular part of it. On the other hand, when we say that a perdurant “running a race” has a property at  $t$  “running fast” (say during the first five minutes) and an incompatible property at  $t'$  “running slow” (say toward the end of the race) there are always two different parts exhibiting the two properties.

Another way of characterizing endurants and perdurants – quite illuminating for our purposes – has been proposed recently by Katherine Hawley: something is an endurant iff (i) it exists at more than one moment and (ii) statements about what parts it has must be made relative to some time or other [49]. In other words, the distinction is based on the different nature of the parthood relation when applied to the two categories: endurants need a time-indexed parthood, while perdurants do not. Indeed, a statement like “this keyboard is part of my computer” is incomplete unless you specify a particular time, while “my youth is part of my life” does not require such specification.

In DOLCE, the main relation between endurants and perdurants is that of *participation*: an endurant “lives” in time by *participating* in some perdurant(s). For example, a person, which is an endurant, may participate in a discussion, which is a perdurant. A person’s life is also a perdurant, in which a person participates throughout its all duration.

In the following, we shall take the term *occurrence* as synonym of *perdurant*. We prefer this choice to the more common *occurrent*, which we reserve for denoting a type (a *universal*), whose instances are occurrences (*particulars*).

### 3.2.2 Qualities and quality regions

Qualities can be seen as the basic entities we can perceive or measure: shapes, colors, sizes, sounds, smells, as well as weights, lengths, electrical charges... ‘Quality’ is often used as a synonym of ‘property’, but this is not the case in DOLCE: qualities are particulars, properties are universals. Qualities *inhere* to entities: every entity (including qualities themselves) comes with certain qualities, which exist as long as the entity exists.<sup>18</sup> Within a certain ontology, we assume that these qualities belong to a finite set of *quality types* (like color, size, smell, etc., corresponding to the “leaves” of the quality taxonomy shown in Figure 2), and are characteristic for (*inhere in*) specific individuals: no two particulars can have the same quality, and each quality is *specifically constantly dependent* (see below) on the entity it inheres in: at any time, a quality can’t be present

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<sup>17</sup>Time-snapshots of perdurants (i.e., in our time structure, perdurants whose temporal location is atomic, and which lack therefore proper temporal parts) are a limit case in this distinction. We consider them as perdurants since we assume that their temporal location is fixed (a time-snapshot at a different time would be a different time-snapshot).

<sup>18</sup>We do not consider, for the time being, the possibility of a quality that intermittently inheres to something (for instance, an object that ceases to have a color while becoming transparent).

1. *This rose is red.*
2. *Red is a color.*
3. *This rose has a color.*
4. *The color of this rose turned to brown in one week.*
5. *The rose's color is changing.*
6. *Red is opposite to green and close to brown.*

Table 2: Some linguistic examples motivating the introduction of individual qualities.

unless the entity it inheres in is also present. So we distinguish between a quality (e.g., the color of a specific rose), and its “value” (e.g., a particular shade of red). The latter is called *quale*, and describes the position of an individual quality within a certain *conceptual space* (called here *quality space*) [39]. So when we say that two roses have (exactly) the same color, we mean that their color qualities, which are distinct, have the same position in the color space, that is they have the same *color quale*.

This distinction between qualities and qualia is inspired by [40] and the so-called *trope theory* [9] (with some differences that are not discussed here<sup>19</sup>). Its intuitive rationale is mainly due to the fact that natural language – in certain constructs – often seems to make a similar distinction (Table 2). For instance, in cases 4 and 5 of Table 2, we are not speaking of a certain shade of red, but of something else that keeps its identity while its ‘value’ changes.

On the other hand, in case 6 we are not speaking of qualities, but rather of regions within quality spaces. The specific shade of red of our rose – its color quale – is therefore a point (or an atom, mereologically speaking) in the color space.<sup>20</sup>

Each quality type has an associated quality space with a specific structure. For example, lengths are usually associated to a metric linear space, and colors to a topological 2D space. The structure of these spaces reflects our perceptual and cognitive bias: this is another important reason for taking the notion of “quale”, as used in philosophy of mind, to designate quality regions, which roughly correspond to qualitative sensorial experiences of humans<sup>21</sup>.

In this approach, we can explain the relation existing between ‘red’ intended as an adjective (as in “this rose is red”) and ‘red’ intended as a noun (as in “red is a color”): the rose is red because its color is located in the red region within the color space (more exactly, its color quale is a part of that region). Moreover, we can explain the difference between “this rose is red” and “the color of this rose is red” by interpreting “red” as synonymous of *red-thing* in the first case, and of *red-color* in the latter case (Figure 3).

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<sup>19</sup>An important difference is that standard trope theories explain a qualitative change in terms of a substitution of tropes (an old trope disappears and a new one is created). We assume instead that qualities persist in time during a qualitative change (note however that they are not endurants, since the parthood relation is not defined for them).

<sup>20</sup>The possibility of talking of qualia as particulars rather than reified properties is another advantage of our approach.

<sup>21</sup>We also allow for non-sensorial “qualia” such as “a 1 Euro value” (fixed by social conventions and independent from perception)

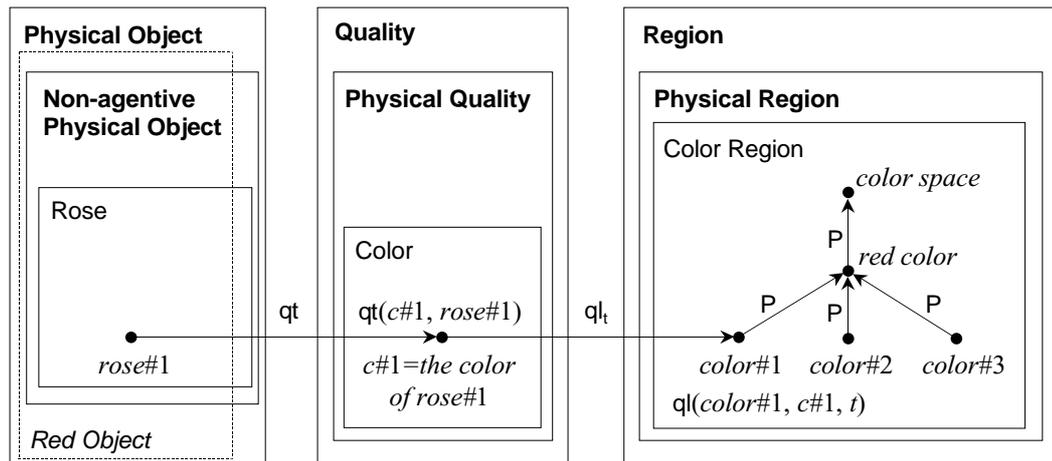


Figure 3: Qualities and quality regions.

**Space and time locations as special qualities.** In our ontology, space and time locations are considered as individual qualities like colors, weights, etc. Their corresponding qualia are called *spatial (temporal) regions*. For example, the spatial location of a physical object belongs to the quality type *space*, and its quale is a region in the geometric space. Similarly for the temporal location of an occurrence, whose quale is a region in the temporal space. This allows an homogeneous approach that remains neutral about the properties of the geometric/temporal space adopted (for instance, one is free to adopt linear, branching, or even circular time).

**Direct and indirect qualities.** We distinguish in DOLCE two kinds of quality inherence: *direct* and *indirect* inherence. The main reason for this choice comes from the symmetric behavior of perdurants and endurants with respect to their temporal and spatial locations: perdurants have a well-defined temporal location, while their spatial location seems to come indirectly from the spatial location of their participants; similarly, most endurants (what we call *physical endurants*, see below) have a clear spatial location, while their temporal location comes indirectly from the that of the perdurants they participate in.

Another argument for this distinction concerns complex qualities like colors, which – according to Gardenfors – exhibit multiple *dimensions* (hue, luminosity, etc.). We model this case by assuming that such dimensions are qualities of qualities: the quality *color of rose#1* has a specific hue that directly inheres to it, and indirectly inheres to *rose#1*.

**Parts of qualities.** As a final comment, we must observe that no parthood relation (neither temporal nor atemporal) is defined for qualities in the DOLCE ontology. This seems to us a safe choice, since apparently we do not need to reason about parts of qualities (while we certainly do need to reason on parts of quality regions). So we do not have to commit on a single kind of parthood relationship for them (maybe some of them need a temporal parthood, while others do not). Since no parthood is defined, qualities are neither endurants nor perdurants, although their persistence conditions may be similar, in certain cases, to those of endurants or perdurants.

### 3.2.3 Abstract entities

The main characteristic of abstract entities is that they do not have spatial nor temporal qualities, and they are not qualities themselves. The only class of abstract entities we consider in the present version of DOLCE is that of *quality regions* (or simply *regions*). *Quality spaces* are special kinds of quality regions, being mereological sums of all the regions related to a certain quality type. The other examples of abstract entities reported in Figure 2 (sets and facts) are only indicative.

## 3.3 Basic relations

According to the general methodology introduced in [34], before discussing the DOLCE *backbone* properties, we have first to introduce a set of *basic primitive relations*, suitable to characterize our ontological commitments as neutrally as possible. We believe that these relations should be, as much as possible,

- general enough to be applied to multiple domains;
- such that they do not rest on questionable ontological assumptions about the ontological nature of their arguments;
- sufficiently intuitive and well studied in the philosophical literature;
- hold as soon as their relata are given, without mediating additional entities.

In the past, we adopted the term *formal relation* (as opposite to *material relation*) for a relation that can be applied to *all* possible domains. Recently, however, [25] proposed a different notion of formal relation: “A relation is *formal* if it holds as soon as its relata are given. Formal relations are called equivalently *immediate relations*, since they hold of their relata without mediating additional individuals”<sup>22</sup>. The notion of *basic primitive relation* proposed above combines together the two notions. Roughly, a basic primitive relation is an immediate relation that spans multiple application domains.

The axioms constraining the arguments of primitive relations and functions are reported in Table 3, and summarized in Figure 4.

### 3.3.1 Parthood and Temporary Parthood

The endurants/perdurants distinction introduced in the previous section provides evidence for the general necessity of having two kinds of parthood relations: a-temporal and time-indexed parthood. The latter will hold for endurants, since for them it is necessary to know *when* a specific parthood relationship holds. Consider for instance the classical example of Tibbles the cat [76]: Tail is part of Tibbles before the cut but not after it. Formally, we can write  $P(\text{Tail}, \text{Tibbles}, \text{before}(\text{cut}))$  and  $\neg P(\text{Tail}, \text{Tibbles}, \text{after}(\text{cut}))$ . Atemporal

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<sup>22</sup>The notion of ‘immediate relation’ seems to be equivalent to what Johansson called *ground relation* [54]. According to Johansson, a ground relation “is derivable from its relata”. We understand that the very existence of the arguments is *sufficient* to conclude whether the relation holds or not. This notion seems also equivalent to that of “internal relation”.

<b>Parthood:</b> “ <i>x is part of y</i> ” $P(x,y) \rightarrow (AB(x) \vee PD(x)) \wedge (AB(y) \vee PD(y))$
<b>Temporary Parthood:</b> “ <i>x is part of y during t</i> ” $P(x,y,t) \rightarrow (ED(x) \wedge ED(y) \wedge T(t))$
<b>Constitution:</b> “ <i>x constitutes y during t</i> ” $K(x,y,t) \rightarrow ((ED(x) \vee PD(x)) \wedge (ED(y) \vee PD(y)) \wedge T(t))$
<b>Participation:</b> “ <i>x participates in y during t</i> ” $PC(x,y,t) \rightarrow (ED(x) \wedge PD(y) \wedge T(t))$
<b>Quality:</b> “ <i>x is a quality of y</i> ” $qt(x,y) \rightarrow (Q(x) \wedge (Q(y) \vee ED(y) \vee PD(y)))$
<b>Quale:</b> “ <i>x is the quale of y (during t)</i> ” $ql(x,y) \rightarrow (TR(x) \wedge TQ(y))$ $ql(x,y,t) \rightarrow ((PR(x) \vee AR(x)) \wedge (PQ(y) \vee AQ(y)) \wedge T(t))$

Table 3: Qualities and quality regions.

parthood, on the other hand, will be used for entities which do not properly change in time (occurrences and abstracts). In the present version, parthood will not be defined for qualities.

With respect to time-indexed parthood, two useful notions can be defined. We shall say that an endurant is *mereologically constant* iff all its parts remains the same during its life, and *mereologically invariant* iff they remain the same across all possible worlds. For example, we usually take ordinary material objects as mereologically variable, because during their life they can lose or gain parts. On the other hand, amounts of matter are taken as mereologically invariant (all their parts are *essential parts*).

### 3.3.2 Dependence and Spatial Dependence

There are basically two approaches to characterizing the notion of ontological dependence:

- non-modal accounts (cf. [33] and [76], pp. 310-318);
- modal accounts (cf. [76]).

Non-modal approaches treat the dependence relation as a quasi-mereological primitive whose formal properties are characterized by axioms. However, as Simons has justly observed, such axiomatizations cannot rule out non-intended interpretations that are purely topological in nature. The only way to save them is actually to link them with modal accounts.

In a modal approach, dependence of an entity  $x$  on an entity  $y$  might be defined as follows:  $x$  depends on  $y$  iff, necessarily,  $y$  is present whenever  $x$  is present. Such a definition seems to be in harmony both with commonsense intuition as well as philosophical tradition (Aristotle, Husserl), despite the fact that there are some cases where, as Kit Fine has shown, this characterization is vacuous. Indeed, according to the definition, everything is

trivially dependent on necessarily existing or always present objects. However, Simons has shown that it is possible to exclude such vacuous examples and while this move might be philosophically dubious, it makes perfect sense in an engineering approach to ontologies of everyday contingent objects.

Our concept of dependence involves the notion of presence in time as well as modality. We mainly use two variants of dependence, adapted from [86]: *specific* and *generic constant dependence*. The former is defined both for particulars and properties, while the latter only for properties. A particular  $x$  is *specifically constantly dependent* on another particular  $y$  iff, at any time  $t$ ,  $x$  can't be present at  $t$  unless  $y$  is also present at  $t$ . For example, a person might be specifically constantly dependent on its brain. This notion is naturally extended to properties by defining that a property  $\phi$  is specifically constantly dependent on a property  $\psi$  iff every  $\phi$ er is specifically constantly dependent on a  $\psi$ er. A property  $\phi$  is *generically constantly dependent* on a property  $\psi$  iff, for any instance  $x$  of  $\phi$ , at any time  $t$ ,  $x$  can't be present at  $t$ , unless a certain instance  $y$  of  $\psi$  is also present at  $t$ . For example, a person might be generically constantly dependent on having a heart.

We define spatial dependence as a particular kind of dependence which is grounded not only in time (presence), but also in space. The definitions are as above with the further requirement that  $y$  has to be spatially co-localised with  $x$  in addition of being co-present. This notion is defined both for endurants and perdurants.

### 3.3.3 Constitution

Constitution has been extensively discussed in the philosophical literature:

- Doepke (cit. in [76] p.238) “ $x$  constitutes  $y$  at time  $t$  iff  $x$  could be a substratum of  $y$ 's destruction”;
- Simons (cit. in [76] p.239) “When  $x$  constitutes  $y$ , there are certain properties of  $x$  which are *accidental* to  $x$ , but essential to  $y$ . (...) Where the essential properties concern the type and disposition of parts, this is often a case of composition, but in other cases, such as that of body/person, it is not.”

Constitution is not Identity – Consider the following classical example. I buy a portion of clay (LUMPL) at 9am. At 2pm I made a statue (GOLIATH) out of LUMPL and I put GOLIATH on a table. At 3pm I replace the left hand of GOLIATH with a new one and I throw the old hand in the dustbin. There are three reasons to support the claim that LUMPL is not GOLIATH:

(i) *Difference in histories.*

LUMPL is present at 9am, but GOLIATH is not [87].

(ii) *Difference in persistence conditions.*

At 3pm GOLIATH is wholly present on the table, but LUMPL is not wholly present on the table (a statue can undergo replacements of certain parts, but not an amount (portion) of matter, i.e. all parts of LUMPL are essential but not all parts of GOLIATH are essential [87]. LUMPL can survive a change of shape, GOLIATH not.

(iii) *Difference in essential relational properties*

It is metaphysically possible for LUMPL, but not for GOLIATH, to exist in the absence of an artworld or an artist or anybody's intentions [5].

### 3.3.4 Participation

The usual intuition about participation is that there are endurants "involved" in an occurrence. Linguistics has extensively investigated the relation between occurrences and their participants in order to classify verbs and verbal expressions. Fillmore's Case Grammar [29] and its developments (Construction Grammar, FrameNet) is one of the best attempts at building a systematic model of language-oriented participants. On the other hand, the first systematic investigation goes back at least to Aristotle, that defined four "causes" (aitiai), expressing the initiator, the destination, the instrument, and the substrate or host of an event. Sowa further specified subsets of aitiai on the basis of properties borrowed from linguistics (cfr. [84]).

In an ontology based on a strict distinction between endurants and perdurants, participation cannot be simply parthood; the participating endurants are not parts of the occurrences: only occurrences can be parts of other occurrences. Moreover, the primitive participation we introduce is time-indexed, in order to account for the varieties of participation in time (temporary participation, constant participation).

### 3.3.5 Quality inherence and quality value

Finally, three primitive relations are introduced in order to account for qualities: a generalized (direct or indirect) primitive relation<sup>23</sup>, holding between a quality and what it inheres to, and two kinds of "quale" relations (time-indexed and atemporal), holding between a quality and its quale, according to whether the entity to which the quality inheres can change in time or not.

## 3.4 Further distinctions

Let us discuss in the following some further distinctions we make within our basic categories, defined with the help of the relations introduced in the previous section.

### 3.4.1 Physical and non-physical endurants

Within endurants, we distinguish between *physical* and *non-physical endurants*, according to whether they have direct spatial qualities. Within physical endurants, we distinguish between *amounts of matter*, *objects*, and *features*. This distinction is mainly based on the notion of unity we have discussed and formalized in [34]<sup>24</sup>. In principle, the general

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<sup>23</sup>Direct inherence can be easily defined in terms of indirect inherence. The viceversa seem to be more problematic, since it would involve a recursive definition.

<sup>24</sup>In this preliminary report, such formalization has not been included in the axiomatization presented below.

structure of such distinction is supposed to hold also for non-physical endurants: nevertheless, we direct fully exploit it only for physical endurants, since the characteristics of non-physical features have not been considered yet.

**Amounts of matter.** The common trait of *amounts of matter* is that they are endurants with no unity (according to [34], none of them is an essential whole). Amounts of matter – “stuffs” referred to by mass nouns like “gold”, “iron”, “wood”, “sand”, “meat”, etc. – are mereologically invariant, in the sense that they change their identity when they change some parts.

**Objects.** The main characteristic of objects is that they are endurants with unity. However, they have no *common* unity criterion, since different subtypes of objects may have different unity criteria. Differently from aggregates, (most) objects change some of their parts while keeping their identity, they can have therefore *temporary parts*. Often objects (indeed, all endurants) are ontologically independent from occurrences (discussed below). However, if we admit that every object has a life, it is hard to exclude a mutual specific constant dependence between the two. Nevertheless, we may still use the notion of dependence to (weakly) characterize objects as being not specifically constantly dependent *on other objects*.

**Features.** Typical examples of features are “parasitic entities” such as holes, boundaries, surfaces, or stains, which are generically constantly dependent on physical objects<sup>25</sup> (their hosts). All features are essential wholes, but, as in the case of objects, no common unity criterion may exist for all of them. However, typical features have a topological unity, as they are singular entities. Some features may be *relevant parts* of their host, like a bump or an edge, or *places* like a hole in a piece of cheese, the underneath of a table, the front of a house, which are not parts of their host.

It may be interesting to note that we do not consider body parts like heads or hands as features: the reason is that we assume that a hand can be detached from its host (differently from a hole or a bump), and we assume that in this case it retains its identity. Should we reject this assumption, then body parts would be features.

### 3.4.2 Non-physical endurants and the agentive/non-agentive distinction

Within Physical Objects, a special place have those those to which we ascribe *intentions*, *beliefs*, and *desires*. These are called *Agentive*, as opposite to *Non-agentive*. Intentionality is understood here as the capability of heading for/dealing with objects or states of the world<sup>26</sup>. This is an important area of ontological investigation we haven't properly explored yet, so our suggestions are really very preliminary.

In general, we assume that agentive objects are *constituted* by non-agentive objects: a person is constituted by an organism, a robot is constituted by some machinery, and so on.

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<sup>25</sup>We may think that features are specifically constantly dependent on their host, but an example like “a whirlpool” is very critical in this sense. Notice that we are not considering as features entities that are dependent on mental-objects.

<sup>26</sup>See for example [74].

Among non-agentive physical objects we have for example houses, body organs, pieces of wood, etc.

Non-physical Objects are divided into *Social Objects and Mental Objects* according to whether or not they are generically dependent a community of agents. A private experience, for instance, is an example of a mental object.

Social Objects are further divided into *Agentive* and *Non-agentive*. Examples of Agentive Social Objects are *social agents* like “the president of United States”: we may think that the latter, besides depending generically on a community of US citizens, depends also generically on “George Bush *qua* legal person” (since the president can be substituted), which in turn depends specifically on “George Bush *qua* human being”. Social agents are *not* constituted by agentive physical objects (although they depend on them), while they can constitute *societies*, like the CNR, Mercedes-Benz, etc. Examples of *Non-Agentive Social Objects* are laws, norms, shares, peace treaties ecc., which are generically dependent on societies.

### 3.4.3 Kinds of perdurants

Perdurants (also called occurrences) comprise what are variously called events, processes, phenomena, activities and states. They can have temporal parts or spatial parts. For instance, the first movement of (an execution of) a symphony is a temporal part of it. On the other side, the play performed by the left side of the orchestra is a spatial part. In both cases, these parts are occurrences themselves. We assume that objects cannot be parts of occurrences, but rather they *participate* in them.

In DOLCE we distinguish among different kinds of occurrences mainly on the basis of two notions, both extensively discussed in the linguistic and philosophic literature: *homeomericity* and *cumulativity*. The former is discussed for instance in [11]; the latter has been introduced in [40], pp. 49-51, and refined in [69].

Intuitively, we say that an occurrence is homeomeric if and only if all its temporal parts are described *by the very expression* used for the whole occurrence. Every temporal part of the occurrence “John sitting here” is still described by “John sitting here”. But if we consider “a walk from *Ponte dei Sospiri* in Venice to *Piazza S. Marco*”, there are no parts of such an event which constitute a walk from these two places. In linguistic as well as in philosophical terminology, the notion of the *homeomericity* of an occurrence is often introduced with respect to a property characteristic of (or *exemplified by*) the occurrence itself. If such property holds for all the temporal parts of the occurrence, then the occurrence is homeomeric. In our axiomatization, this presupposes a finite list of occurrence-types (*occurrences*) which have to be declared in advance.

An occurrence-type is *stative* or *eventive* according to whether it holds of the mereological sum of two of its instances, *i.e.* if it is *cumulative* or not. A *sitting* occurrence is stative since the sum of two sittings is still a sitting occurrence. Within stative occurrences, we distinguish between *states* and *processes* according to homeomericity: *sitting* is classified as a state but *running* is classified as a process, since there are (very short) temporal parts of a running that are not themselves runnings.

Finally, eventive occurrences (*events*) are called *achievements* if they are atomic, otherwise they are *accomplishments*.

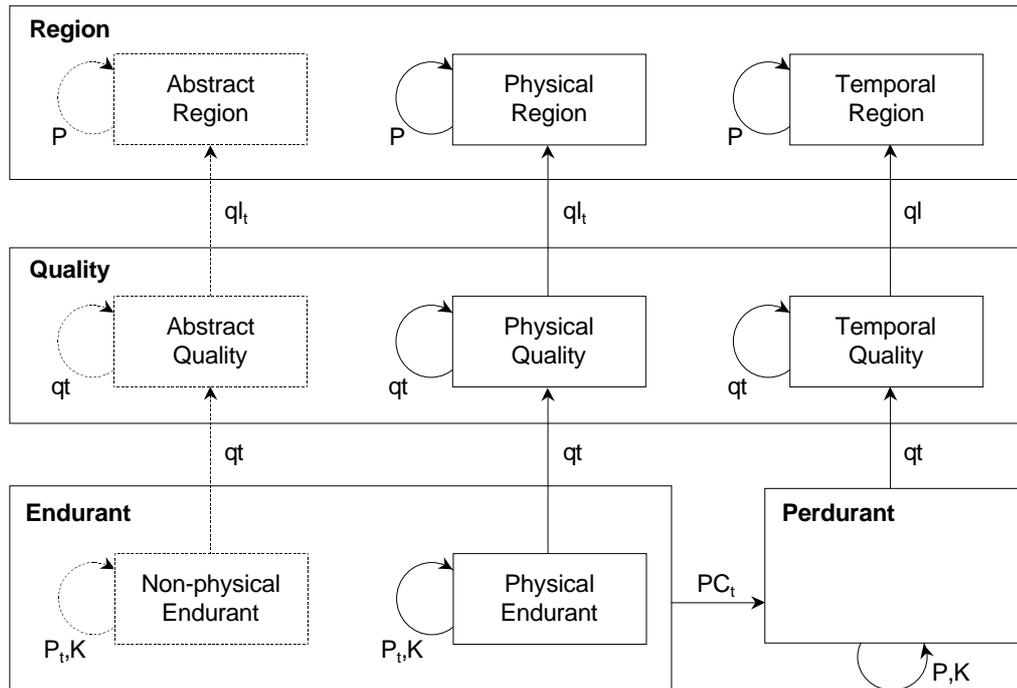


Figure 4: Primitive relations between basic categories (the dotted lines to the left indicate that we are less confident with what concerns non-physical endurants).

### 3.4.4 Kinds of quality

We assume that qualities belong to disjoint quality types according to kinds of entity they directly inhere to. That is, *temporal qualities* are those that directly inhere to perdurants, *physical qualities* those that directly inhere to physical endurants, and *abstract qualities* those that directly inhere to non-physical perdurants (Figure 4). We are aware that, unfortunately, this terminology is very problematic: for instance, it should be clear that abstract qualities are *not* abstracts, since they have a temporal location. Better suggestions are welcome.

## 4 DOLCE's Formal Characterization

### 4.1 Notation and introductory notes

**Notation.** In the following, we shall adopt the conventions below for variable and constant symbols:

- *Constants denoting Particulars:*  $a, b, c, \dots$
- *Variables ranging on Particulars:*  $x, y, z, \dots$
- *Constants denoting Universals:*  $T, R, Q \dots$
- *Variables ranging on Universals:*  $\phi, \psi, \rho, \dots$

**Modality and Time.** In this module we shall adopt the simplest quantified modal logic, namely S5 plus the Barcan Formula [52]. This means that we assume a *possibilist* view including in the domain of quantification all *possibilia* – all possible entities – independently of their actual existence [57] and that we quantify over a constant domain in every possible world (recall that all axioms and theorems are necessarily true even if the necessity box  $\Box$  is not present in front of the formulas). In addition we assume an *eternalist* view of time including in the domain of quantification all past, present and future entities/intervals.

**Universals.** In some cases we shall quantify over properties, and hence one might believe we have to adopt a second-order logic. However, for our purpose, we need to quantify only over a finite list of predicates, those that are explicitly introduced in the present theory or in any theory that specializes (commits to) the present one. We follow therefore the strategy proposed by the Common Logic working group<sup>27</sup>, which is to view, under suitable conditions, a second-order axiom (or definition) as syntactic sugar for a finite list of first-order axioms (definitions). Formally:

- all variables  $\phi, \psi, \rho$  range on a finite set ( $\Pi$ ) of explicitly introduced universals;
- the subclass of  $\Pi$ , that corresponds to the categories introduced in Figure 2, is called  $\Pi_X$  and it is identified by means of the (meta) predicate  $X : X(\phi)$  iff  $\phi \in \Pi_X$ ;
- existential quantifiers on universals,  $\exists\phi(\phi(x))$ , correspond to  $\bigvee_{\psi \in \Pi}(\psi(x))$ ;
- universal quantifiers on universals,  $\forall\phi(\phi(x))$ , correspond to  $\bigwedge_{\psi \in \Pi}(\psi(x))$ .

More explicitly, in DOLCE we consider:

$$\Pi_X = \{PT, AB, R, TR, T, PR, S, AR, Q, TQ, TL, PQ, SL, AQ, ED, PED, M, F, POB, APO, NAPO, NPED, NPOB, MOB, SOB, ASO, SAG, SC, NASO, AS, PD, EV, ACH, ACC, STV, ST, PRO\}$$

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<sup>27</sup>See cl.tamu.edu.

We can introduce some useful notions regarding universals:

- (Dd1)  $RG(\phi) \triangleq \Box \forall x(\phi(x) \rightarrow \Box \phi(x))$  ( *$\phi$  is Rigid*)  
(Dd2)  $NEP(\phi) \triangleq \Box \exists x(\phi(x))$  ( *$\phi$  is Non-Empty*)  
(Dd3)  $DJ(\phi, \psi) \triangleq \Box \neg \exists x(\phi(x) \wedge \psi(x))$  ( *$\phi$  and  $\psi$  are Disjoint*)  
(Dd4)  $SB(\phi, \psi) \triangleq \Box \forall x(\psi(x) \rightarrow \phi(x))$  ( *$\phi$  Subsumes  $\psi$* )  
(Dd5)  $EQ(\phi, \psi) \triangleq SB(\phi, \psi) \wedge SB(\psi, \phi)$  ( *$\phi$  and  $\psi$  are Equal*)  
(Dd6)  $PSB(\phi, \psi) \triangleq SB(\phi, \psi) \wedge \neg SB(\psi, \phi)$  ( *$\phi$  Properly Subsumes  $\psi$* )  
(Dd7)  $L(\phi) \triangleq \Box \forall \psi(SB(\phi, \psi) \rightarrow EQ(\phi, \psi))$  ( *$\phi$  is a Leaf*)  
(Dd8)  $SBL(\phi, \psi) \triangleq SB(\phi, \psi) \wedge L(\psi)$  ( *$\psi$  is a Leaf Subsumed by  $\phi$* )  
(Dd9)  $PSBL(\phi, \psi) \triangleq PSB(\phi, \psi) \wedge L(\psi)$  ( *$\psi$  is a Leaf Properly Subsumed by  $\phi$* )  
(Dd10)  $L_X(\phi) \triangleq X(\phi) \wedge \Box \forall \psi(SB(\phi, \psi) \wedge X(\psi)) \rightarrow EQ(\phi, \psi)$  ( *$\phi$  is a Leaf in  $\Pi_X$* )  
(Dd11)  $SBL_X(\phi, \psi) \triangleq SB(\phi, \psi) \wedge L_X(\psi)$   
(Dd12)  $PSBL_X(\phi, \psi) \triangleq PSB(\phi, \psi) \wedge L_X(\psi)$   
(Dd13)  $PT(\psi, \phi_1, \dots, \phi_n) \triangleq \psi \neq \phi_1 \wedge DJ(\phi_i, \phi_j)$  for  $1 \leq i \neq j \leq n \wedge \Box \forall x(\psi(x) \leftrightarrow (\phi_1(x) \vee \dots \vee \phi_n(x)))$  ( *$(\phi_1, \dots, \phi_n)$  is a non-trivial Partition of  $\psi$* )

In  $\Pi$  we consider only non-empty universals, and all the predicates in  $\Pi_X$  are rigid, i.e.:

$$\forall \phi(NEP(\phi))$$

$$\forall \phi((\phi) \rightarrow RG(\phi))$$

and all the “taxonomic” constraints depicted in Figure 2 have to be considered as PT (except for the universals for which the categories they subsume are not completely specified in the Figure for which we have only a subsumption constraint), i.e. for example:

$$PT(PT, AB, Q, ED, PD), PT(R, TR, PR, AR), PT(ED, PED, NPED, AS), \dots$$

$$SB(AB, R), SB(TQ, TL), SB(PQ, SL), \dots$$

## 4.2 Definitions

### 4.2.1 Mereological Definitions

- (Dd14)  $PP(x, y) \triangleq P(x, y) \wedge \neg P(y, x)$  (*Proper Part*)  
(Dd15)  $O(x, y) \triangleq \exists z(P(z, x) \wedge P(z, y))$  (*Overlap*)  
(Dd16)  $At(x) \triangleq \neg \exists y(PP(y, x))$  (*Atom*)  
(Dd17)  $AtP(x, y) \triangleq P(x, y) \wedge At(x)$  (*Atomic Part*)  
(Dd18)  $x + y \triangleq \iota z \forall w(O(w, z) \leftrightarrow (O(w, x) \vee O(w, y)))$  (*Binary Sum*)

- (Dd19)  $\sigma x\phi(x) \triangleq \iota z\forall y(O(y,z) \leftrightarrow \exists w(\phi(w) \wedge O(y,w)))$ <sup>28</sup> (Sum of  $\phi$ 's)
- (Dd20)  $PP(x,y,t) \triangleq P(x,y,t) \wedge \neg P(y,x,t)$  (Temporary Proper Part)
- (Dd21)  $O(x,y,t) \triangleq \exists z(P(z,x,t) \wedge P(z,y,t))$  (Temporary Overlap)
- (Dd22)  $At(x,t) \triangleq \neg\exists y(PP(y,x,t))$  (Temporary Atom)
- (Dd23)  $AtP(x,y,t) \triangleq P(x,y,t) \wedge At(x,t)$  (Temporary Atomic Part)
- (Dd24)  $x \equiv_t y \triangleq P(x,y,t) \wedge P(y,x,t)$  (Coincidence)
- (Dd25)  $CP(x,y) \triangleq \exists t(PRE(y,t)) \wedge \forall t(PRE(y,t) \rightarrow P(x,y,t))$  (Constant Part)
- (Dd26)  $x +_{te} y \triangleq \iota z\forall w,t(O(w,z,t) \leftrightarrow (O(w,x,t) \vee O(w,y,t)))$
- (Dd27)  $\sigma_{te}x\phi(x) \triangleq \iota z\forall y,t(O(y,z,t) \leftrightarrow \exists w(\phi(w) \wedge O(y,w,t)))$ <sup>29</sup>

#### 4.2.2 Quality

- (Dd28)  $dqt(x,y) \triangleq qt(x,y) \wedge \neg\exists z(qt(x,z) \wedge qt(z,y))$  (Direct Quality)
- (Dd29)  $qt(\phi,x,y) \triangleq qt(x,y) \wedge \phi(x) \wedge SBL_X(Q,\phi)$  (Quality of type  $\phi$ )

#### 4.2.3 Temporal and Spatial Quale

- (Dd30)  $ql_{T,PD}(t,x) \triangleq PD(x) \wedge \exists z(qt(TL,z,x) \wedge ql(t,z))$
- (Dd31)  $ql_{T,ED}(t,x) \triangleq ED(x) \wedge t\sigma t'(\exists y(PC(x,y,t')))$
- (Dd32)  $ql_{T,TQ}(t,x) \triangleq TQ(x) \wedge \exists z(qt(x,z) \wedge ql_{T,PD}(t,z))$
- (Dd33)  $ql_{T,PQ\vee AQ}(t,x) \triangleq (PQ(x) \vee AQ(x)) \wedge \exists z(qt(x,z) \wedge ql_{T,ED}(t,z))$
- (Dd34)  $ql_{T,Q}(t,x) \triangleq ql_{T,TQ}(t,x) \vee ql_{T,PQ\vee AQ}(t,x)$
- (Dd35)  $ql_T(t,x) \triangleq ql_{T,ED}(t,x) \vee ql_{T,PD}(t,x) \vee ql_{T,Q}(t,x)$  (Temporal Quale)
- (Dd36)  $ql_{S,PED}(s,x,t) \triangleq PED(x) \wedge \exists z(qt(SL,z,x) \wedge ql(s,z,t))$
- (Dd37)  $ql_{S,PQ}(s,x,t) \triangleq PQ(x) \wedge \exists z(qt(x,z) \wedge ql_{S,PED}(s,z,t))$
- (Dd38)  $ql_{S,PD}(s,x,t) \triangleq PD(x) \wedge \exists z(mppc(z,x) \wedge ql_{S,PED}(s,z,t))$
- (Dd39)  $ql_S(s,x,t) \triangleq ql_{S,PED}(s,x,t) \vee ql_{S,PQ}(s,x,t) \vee ql_{S,PD}(s,x,t)$  (Spatial Quale)

*Note* – The *temporal quale* relation is not defined on abstract entities. The *spatial quale* relation is not defined on non-physical endurants, abstract qualities, non-physical perdurants (i.e. perdurants that have only non-physical participants)<sup>30</sup>, or abstract entities.

*Note* – One can generalize the quale relations to include all temporal and physical qualities.

<sup>28</sup>In general, property  $\phi$  might not belong to  $\Pi$ . However, it is assumed that  $\phi$  is a property definable in the language of DOLCE. In addition, note that, in this formalism, the *iota* operator is interpreted as a relation. For instance, one can restate definition of fusion as follows:  $\sigma(x,\phi) \triangleq \forall y(O(y,x) \leftrightarrow \exists z(\phi(z) \wedge O(y,z)))$ .

<sup>29</sup>This definition may be problematic if  $\phi$  depends on time. However, in the following, we apply it only to atemporal properties.

<sup>30</sup>In order to generalize the spatial quale relation in the case of non-physical entities we need a relation that specify (for each temporal interval) the physical endurant on which a non-physical endurant depends.

#### 4.2.4 Being present

$$(Dd40) \text{ PRE}(x, t) \triangleq \exists t'(\text{ql}_T(t', x) \wedge \text{P}(t, t')) \quad (\text{Being Present at } t)$$

$$(Dd41) \text{ PRE}(x, s, t) \triangleq \text{PRE}(x, t) \wedge \exists s'(\text{ql}_S(s', x, t) \wedge \text{P}(s, s')) \quad (\text{Being Present in } s \text{ at } t)$$

#### 4.2.5 Inclusion and Coincidence

$$(Dd42) x \subseteq_T y \triangleq \exists t, t'(\text{ql}_T(t, x) \wedge \text{ql}_T(t', y) \wedge \text{P}(t, t')) \quad (\text{Temporal Inclusion})$$

$$(Dd43) x \subset_T y \triangleq \exists t, t'(\text{ql}_T(t, x) \wedge \text{ql}_T(t', y) \wedge \text{PP}(t, t')) \quad (\text{Proper Temporal Inclusion})$$

$$(Dd44) x \subseteq_S \langle y, t \rangle \triangleq \exists s, s'(\text{ql}_S(s, x, t) \wedge \text{ql}_S(s', y, t) \wedge \text{P}(s, s')) \quad (\text{Temporary Spatial Inclusion})$$

$$(Dd45) x \subset_S \langle y, t \rangle \triangleq \exists s, s'(\text{ql}_S(s, x, t) \wedge \text{ql}_S(s', y, t) \wedge \text{PP}(s, s')) \quad (\text{Temp. Proper Sp. Inclusion})$$

$$(Dd46) x \subseteq_{ST} y \triangleq \exists t(\text{PRE}(x, t)) \wedge \forall t(\text{PRE}(x, t) \rightarrow x \subseteq_S \langle y, t \rangle) \quad (\text{Spatio-temporal Inclusion})$$

$$(Dd47) x \subseteq_{ST} \langle y, t \rangle \triangleq \text{PRE}(x, t) \wedge \forall t'(\text{AtP}(t', t) \rightarrow x \subseteq_S \langle y, t' \rangle) \quad (\text{Spatio-temp. Incl. during } t)$$

$$(Dd48) x \approx_T y \triangleq (x \subseteq_T y \wedge y \subseteq_T x) \quad (\text{Temporal Coincidence})$$

$$(Dd49) x \approx_S \langle y, t \rangle \triangleq (x \subseteq_S \langle y, t \rangle \wedge y \subseteq_S \langle x, t \rangle) \quad (\text{Temporary Spatial Coincidence})$$

$$(Dd50) x \approx_{ST} y \triangleq (x \subseteq_{ST} y \wedge y \subseteq_{ST} x) \quad (\text{Spatio-temporal Coincidence})$$

$$(Dd51) x \approx_{ST} \langle y, t \rangle \triangleq \text{PRE}(x, t) \wedge \forall t'(\text{AtP}(t', t) \rightarrow x \approx_S \langle y, t' \rangle) \quad (\text{Spatio-temp. Coincidence dur. } t)$$

$$(Dd52) x \circ_T y \triangleq \exists t, t'(\text{ql}_T(t, x) \wedge \text{ql}_T(t', y) \wedge \text{O}(t, t')) \quad (\text{Temporal Overlap})$$

$$(Dd53) x \circ_S \langle y, t \rangle \triangleq \exists s, s'(\text{ql}_S(s, x, t) \wedge \text{ql}_S(s', y, t) \wedge \text{O}(s, s')) \quad (\text{Temporary Spatial Overlap})$$

#### 4.2.6 Perdurant

$$(Dd54) P_T(x, y) \triangleq PD(x) \wedge P(x, y) \wedge \forall z((P(z, y) \wedge z \subseteq_T x) \rightarrow P(z, x)) \quad (\text{Temporal Part})$$

$$(Dd55) P_S(x, y) \triangleq PD(x) \wedge P(x, y) \wedge x \approx_T y \quad (\text{Spatial Part})$$

$$(Dd56) \text{NEP}_S(\phi) \triangleq \text{SB}(PD, \phi) \wedge \square \exists x, y(\phi(x) \wedge \phi(y) \wedge \neg P(x, y) \wedge \neg P(y, x)) \quad (\phi \text{ is Strongly Non-Empty})$$

$$(Dd57) \text{CM}(\phi) \triangleq \text{SB}(PD, \phi) \wedge \square \forall x, y((\phi(x) \wedge \phi(y)) \rightarrow \phi(x_y)) \quad (\phi \text{ is Cumulative})$$

$$(Dd58) \text{CM}^\sim(\phi) \triangleq \text{SB}(PD, \phi) \wedge \square \forall x, y((\phi(x) \wedge \phi(y) \wedge \neg P(x, y) \wedge \neg P(y, x)) \rightarrow \neg \phi(x_y)) \quad (\phi \text{ is Anti-Cumulative})$$

$$(Dd59) \text{HOM}(\phi) \triangleq \text{SB}(PD, \phi) \wedge \square \forall x, y((\phi(x) \wedge P_T(y, x)) \rightarrow \phi(y)) \quad (\phi \text{ is Homeomorous})$$

$$(Dd60) \text{HOM}^\sim(\phi) \triangleq \text{SB}(PD, \phi) \wedge \square \forall x(\phi(x) \rightarrow \exists y(P_T(y, x) \wedge \neg \phi(y))) \quad (\phi \text{ is Anti-Homeom.})$$

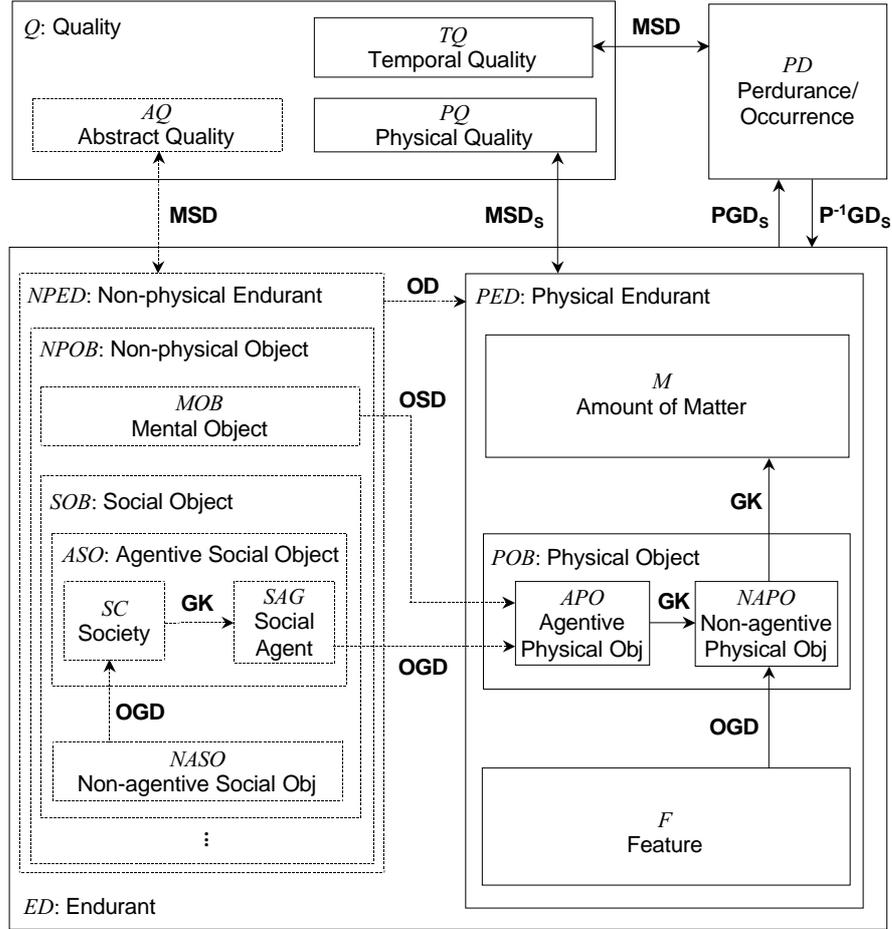


Figure 5: Constitution/(Spatial)Dependence relations between basic categories.

$$(Dd61) \quad AT(\phi) \triangleq SB(PD, \phi) \wedge \Box \forall x(\phi(x) \rightarrow At(x)) \quad (\phi \text{ is Atomic})$$

$$(Dd62) \quad AT^{\sim}(\phi) \triangleq SB(PD, \phi) \wedge \Box \forall x(\phi(x) \rightarrow \neg At(x)) \quad (\phi \text{ is Anti-Atomic})$$

#### 4.2.7 Participation

$$(Dd63) \quad PC_C(x, y) \triangleq \exists t(PRE(y, t)) \wedge \forall t(PRE(y, t) \rightarrow PC(x, y, t)) \quad (Const. Participation)$$

$$(Dd64) \quad PC_T(x, y, t) \triangleq PD(y) \wedge \forall z((P(z, y) \wedge PRE(z, t)) \rightarrow PC(x, z, t)) \quad (Temporary Total Participation)$$

$$(Dd65) \quad PC_T(x, y) \triangleq \exists t(ql_T(t, y) \wedge PC_T(x, y, t)) \quad (Total Participation)$$

$$(Dd66) \quad mpc(x, y) \triangleq x = \sigma_{tz}(PC_T(z, y)) \quad (Maximal Participant)$$

$$(Dd67) \quad mppc(x, y) \triangleq x = \sigma_{tz}(PC_T(z, y) \wedge PED(z)) \quad (Maximal Physical Participant)$$

$$(Dd68) \quad lf(x, y) \triangleq x = \sigma_z(PC_T(y, z)) \quad (Life)$$

#### 4.2.8 Dependence

(see Figure 5 for a summary of dependence relations between the basic categories)

- (Dd69)  $SD(x, y) \triangleq \Box(\exists t(PRE(x, t)) \wedge \forall t(PRE(x, t) \rightarrow PRE(y, t)))$  (*Specific Const. Dep.*)
- (Dd70)  $SD(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box \forall x(\phi(x) \rightarrow \exists y(\psi(y) \wedge SD(x, y)))$  (*Specific Const. Dep.*)
- (Dd71)  $GD(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box(\forall x(\phi(x) \rightarrow \exists t(PRE(x, t)) \wedge \forall x, t((\phi(x) \wedge At(t) \wedge PRE(x, t)) \rightarrow \exists y(\psi(y) \wedge PRE(y, t))))$  (*Generic Const. Dep.*)
- (Dd72)  $D(\phi, \psi) \triangleq SD(\phi, \psi) \vee GD(\phi, \psi)$  (*Constant Dependence*)
- (Dd73)  $OD(\phi, \psi) \triangleq D(\phi, \psi) \wedge \neg D(\psi, \phi)$  (*One-sided Constant Dependence*)
- (Dd74)  $OSD(\phi, \psi) \triangleq SD(\phi, \psi) \wedge \neg D(\psi, \phi)$  (*One-sided Specific Constant Dependence*)
- (Dd75)  $OGD(\phi, \psi) \triangleq GD(\phi, \psi) \wedge \neg D(\psi, \phi)$  (*One-sided Generic Constant Dependence*)
- (Dd76)  $MSD(\phi, \psi) \triangleq SD(\phi, \psi) \wedge SD(\psi, \phi)$  (*Mutual Specific Constant Dependence*)
- (Dd77)  $MGD(\phi, \psi) \triangleq GD(\phi, \psi) \wedge GD(\psi, \phi)$  (*Mutual Generic Constant Dependence*)

*Note* – Regions are not present in time and then the definition of dependence does not make sense for these entities.

#### 4.2.9 Spatial Dependence

(see Figure 5 for a summary of spatial dependence relations between the basic categories)

- (Dd78)  $SD_S(x, y) \triangleq \Box(\exists t, s(PRE(x, s, t)) \wedge \forall s, t(PRE(x, s, t) \rightarrow PRE(y, s, t)))$  (*Specific Spatial Dependence*)
- (Dd79)  $PSD_S(x, y) \triangleq \Box(\exists t, s(PRE(x, s, t)) \wedge \forall s, t(PRE(x, s, t) \rightarrow \exists s'(PP(s', s) \wedge PRE(y, s', t))))$  (*Partial Specific Spatial Dependence*)
- (Dd80)  $P^{-1}SD_S(x, y) \triangleq \Box(\exists t, s(PRE(x, s, t)) \wedge \forall s, t(PRE(x, s, t) \rightarrow \exists s'(PP(s, s') \wedge PRE(y, s', t))))$  (*Inverse Partial Specific Spatial Dependence*)
- (Dd81)  $SD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box \forall x(\phi(x) \rightarrow \exists y(\psi(y) \wedge SD_S(x, y)))$
- (Dd82)  $PSD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box \forall x(\phi(x) \rightarrow \exists y(\psi(y) \wedge PSD_S(x, y)))$
- (Dd83)  $P^{-1}SD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box \forall x(\phi(x) \rightarrow \exists y(\psi(y) \wedge P^{-1}SD_S(x, y)))$
- (Dd84)  $GD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box(\forall x(\phi(x) \rightarrow \exists t, s(PRE(x, s, t)) \wedge \forall x, s, t((\phi(x) \wedge At(t) \wedge PRE(x, s, t)) \rightarrow \exists y(\psi(y) \wedge PRE(y, s, t))))$  (*Generic Spatial Dependence*)
- (Dd85)  $PGD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box(\forall x(\phi(x) \rightarrow \exists t, s(PRE(x, s, t)) \wedge \forall x, s, t((\phi(x) \wedge At(t) \wedge PRE(x, s, t)) \rightarrow \exists y, s'(\psi(y) \wedge PP(s', s) \wedge PRE(y, s', t))))$  (*Partial Generic Spatial Dependence*)
- (Dd86)  $P^{-1}GD_S(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box(\forall x(\phi(x) \rightarrow \exists t, s(PRE(x, s, t)) \wedge \forall x, s, t((\phi(x) \wedge At(t) \wedge PRE(x, s, t)) \rightarrow \exists y, s'(\psi(y) \wedge PP(s, s') \wedge PRE(y, s', t))))$  (*Inverse Partial Generic Spatial Dependence*)
- (Dd87)  $DGD_S(\phi, \psi) \triangleq GD_S(\phi, \psi) \wedge \neg \exists \rho(GD_S(\phi, \rho) \wedge GD_S(\rho, \psi))$  (*Direct Generic Spatial Dependence*)
- (Dd88)  $SDt_S(x, y, t) \triangleq SD_S(x, y) \wedge PRE(x, t)$  (*Temporary Specific Spatial Dependence*)

(Dd89)  $GDt_S(x, y, t) \triangleq \exists \phi, \psi (\phi(x) \wedge \psi(y) \wedge GD_S(\phi, \psi) \wedge x \approx_S < y, t >)$   
(*Temporary Generic Spatial Dependence*)

(Dd90)  $DGDt_S(x, y, t) \triangleq \exists \phi, \psi (\phi(x) \wedge \psi(y) \wedge DGD_S(\phi, \psi) \wedge x \approx_S < y, t >)$   
(*Temporary Direct Spatial Dependence*)

(Dd91)  $OSD_S(\phi, \psi) \triangleq SD_S(\phi, \psi) \wedge \neg D(\psi, \phi)$  (*One-sided Specific Spatial Dependence*)

(Dd92)  $OGD_S(\phi, \psi) \triangleq GD_S(\phi, \psi) \wedge \neg D(\psi, \phi)$  (*One-sided Generic Spatial Dependence*)

(Dd93)  $MSD_S(\phi, \psi) \triangleq SD_S(\phi, \psi) \wedge SD_S(\psi, \phi)$  (*Mutual Specific Spatial Dependence*)

(Dd94)  $MGD_S(\phi, \psi) \triangleq GD_S(\phi, \psi) \wedge GD_S(\psi, \phi)$  (*Mutual Generic Spatial Dependence*)

*Note* – Supposing that  $DGD_S(\phi, \psi)$  does not mean that there could not be another  $\rho$  such that  $DGD_S(\rho, \psi)$ . That is we do not exclude at the moment the possibility that there are might be two different properties which are generically directly spatially dependent on a given property. If we allow this, we have no proper stratification with respect to spatial dependence, in the sense that there is no total order between the strata. In order to guarantee the latter, we would need axioms like the following (an analogue argument is valid for constitution):

$$\begin{aligned} (DGD_S(\phi, \psi) \wedge DGD_S(\rho, \psi)) &\rightarrow \rho = \phi \\ (DGD_S(\phi, \psi) \wedge DGD_S(\phi, \rho)) &\rightarrow \rho = \psi \end{aligned}$$

#### 4.2.10 Constitution

(see Figure 5 for a summary of constitution relations between the basic categories))

(Dd95)  $DK(x, y, t) \triangleq K(x, y, t) \wedge \neg \exists z (K(x, z, t) \wedge K(z, y, t))$  (*Direct Constitution*)

(Dd96)  $SK(x, y) \triangleq \Box (\exists t (PRE(x, t)) \wedge \forall t (PRE(x, t) \rightarrow K(y, x, t)))$   
(*x is Constantly Specifically Constituted by y*)

(Dd97)  $SK(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box \forall x (\phi(x) \rightarrow \exists y (\psi(y) \wedge SK(x, y)))$   
(*ϕ is Constantly Specifically Constituted by ψ*)

(Dd98)  $GK(\phi, \psi) \triangleq DJ(\phi, \psi) \wedge \Box (\forall x (\phi(x) \rightarrow \exists t (PRE(x, t)) \wedge \forall x, t ((\phi(x) \wedge At(t) \wedge PRE(x, t)) \rightarrow \exists y (\psi(y) \wedge K(y, x, t))))$   
(*ϕ is Constantly Generically Constituted by ψ*)

(Dd99)  $K(\phi, \psi) \triangleq SK(\phi, \psi) \vee GK(\phi, \psi)$  (*ϕ is Constituted by ψ*)

(Dd100)  $OSK(\phi, \psi) \triangleq SK(\phi, \psi) \wedge \neg K(\psi, \phi)$  (*ϕ is One-sided Cons. Specif. Const. by ψ*)

(Dd101)  $OGK(\phi, \psi) \triangleq GK(\phi, \psi) \wedge \neg K(\psi, \phi)$  (*ϕ is One-sided Cons. Gen. Const. by ψ*)

(Dd102)  $MSK(\phi, \psi) \triangleq SK(\phi, \psi) \wedge SK(\psi, \phi)$  (*Mutual Specific Constitution*)

(Dd103)  $MGK(\phi, \psi) \triangleq GK(\phi, \psi) \wedge GK(\psi, \phi)$  (*Mutual Generic Constitution*)

## 4.3 Characterization of primitive relations

### 4.3.1 Parthood

We shall adopt for the atemporal parthood the axioms of atomic General Extensional Mereology (GEM), and the classical definitions of overlap, proper part, atom, etc.

#### *Argument Restrictions*

$$(Ad1) \ P(x, y) \rightarrow (AB(x) \vee PD(x)) \wedge (AB(y) \vee PD(y))$$

$$(Ad2) \ P(x, y) \rightarrow (PD(x) \leftrightarrow PD(y))$$

$$(Ad3) \ P(x, y) \rightarrow (AB(x) \leftrightarrow AB(y))$$

$$(Ad4) \ (P(x, y) \wedge SB(R, \phi) \wedge X(\phi)) \rightarrow (\phi(x) \leftrightarrow \phi(y))$$

#### *Ground Axioms*

$$(Ad5) \ (AB(x) \vee PD(x)) \rightarrow P(x, x)$$

$$(Ad6) \ (P(x, y) \wedge P(y, x)) \rightarrow x = y$$

$$(Ad7) \ (P(x, y) \wedge P(y, z)) \rightarrow P(x, z)$$

$$(Ad8) \ ((AB(x) \vee PD(x)) \wedge \neg P(x, y)) \rightarrow \exists z(P(z, x) \wedge \neg O(z, y))$$

$$(Ad9) \ (\exists x\phi(x) \wedge (\forall x(\phi(x) \rightarrow AB(x)) \vee \forall x(\phi(x) \rightarrow PD(x)))) \rightarrow \exists y(y = \sigma x\phi(x))$$

### 4.3.2 Temporary Parthood

We drop antisymmetry and we slightly modify the axioms for P by introducing the *infinite sum* defined in (D27).

#### *Argument restrictions*

$$(Ad10) \ P(x, y, t) \rightarrow (ED(x) \wedge ED(y) \wedge T(t))$$

$$(Ad11) \ P(x, y, t) \rightarrow (PED(x) \leftrightarrow PED(y))$$

$$(Ad12) \ P(x, y, t) \rightarrow (NPED(x) \leftrightarrow NPED(y))$$

#### *Ground Axioms*

$$(Ad13) \ (P(x, y, t) \wedge P(y, z, t)) \rightarrow P(x, z, t)$$

$$(Ad14) \ (ED(x) \wedge ED(y) \wedge PRE(x, t) \wedge PRE(y, t) \wedge \neg P(x, y, t)) \rightarrow \exists z(P(z, x, t) \wedge \neg O(z, y, t))$$

$$(Ad15) \ (\exists x\phi(x) \wedge \forall x(\phi(x) \rightarrow ED(x))) \rightarrow \exists y(y = \sigma_{te}x\phi(x))$$

#### *Links With Other Primitives*

$$(Ad16) \ (ED(x) \wedge PRE(x, t)) \rightarrow P(x, x, t)$$

$$(Ad17) \ P(x, y, t) \rightarrow (PRE(x, t) \wedge PRE(y, t))$$

$$(Ad18) \ P(x, y, t) \rightarrow \forall t'(P(t', t) \rightarrow P(x, y, t'))$$

$$(Ad19) \ (PED(x) \wedge P(x, y, t)) \rightarrow x \subseteq_S < y, t >$$

#### *Debatable axiom*

$$(AP=) (CP(x,y) \wedge CP(y,x)) \rightarrow x = y$$

*Note* – With the introduction of (Ad15) we are accepting the existence of intermittent objects. Consider for example the sum of two objects that are temporally extended in disjoint intervals. In this case we have a theorem like  $PRE(c_1 + c_2, t) \leftrightarrow (PRE(c_1, t) \vee PRE(c_2, t))$ . Alternatively, we could define a different sum of temporally co-extensional endurants. (cf. [76] and [87]).

*Note* – The unicity of the product is guaranteed only introducing (AP=).

*Note* – We can alternatively consider  $P(x,y,t)$  defined only on temporal atoms, by substituting (Ad18) with  $P(x,y,t) \rightarrow At(t)$ .

*Note* – It may be interesting to study the cases where the law of substitution restricted to coincident entities is valid. In other words, we may want to study the circumstances where taken a temporary  $n + 1$ -ary relation between particulars,  $Rel(x_1, \dots, x_n, t)$ , then  $(Rel(x_1, \dots, x_n, t) \wedge x_1 \equiv_t y_1 \wedge \dots \wedge x_n \equiv_t y_n) \rightarrow Rel(y_1, \dots, y_n, t)$  holds.

*Note* – Clearly, extensionality does not hold in this case. That is, having the same parts does not imply being the same. Nevertheless, we have still to decide whether or not having the same proper parts means being coincident:  $P(x,y,t) \leftrightarrow \forall z (PP(z,x,t) \rightarrow P(z,y,t))$ .

### 4.3.3 Constitution

#### *Argument restrictions*

$$(Ad20) K(x,y,t) \rightarrow ((ED(x) \vee PD(x)) \wedge (ED(y) \vee PD(y)) \wedge T(t))$$

$$(Ad21) K(x,y,t) \rightarrow (PED(x) \leftrightarrow PED(y))$$

$$(Ad22) K(x,y,t) \rightarrow (NPED(x) \leftrightarrow NPED(y))$$

$$(Ad23) K(x,y,t) \rightarrow (PD(x) \leftrightarrow PD(y))$$

#### *Ground Axioms*

$$(Ad24) K(x,y,t) \rightarrow \neg K(y,x,t)$$

$$(Ad25) (K(x,y,t) \wedge K(y,z,t)) \rightarrow K(x,z,t)$$

#### *Links with other Primitives*

$$(Ad26) K(x,y,t) \rightarrow (PRE(x,t) \wedge PRE(y,t))$$

$$(Ad27) K(x,y,t) \leftrightarrow \forall t' (P(t',t) \rightarrow K(x,y,t'))$$

$$(Ad28) (K(x,y,t) \wedge PED(x)) \rightarrow x \approx_S \langle y, t \rangle$$

$$(Ad29) (K(x,y,t) \wedge P(y',y,t)) \rightarrow \exists x' (P(x',x,t) \wedge K(x',y',t))$$

#### *Links between Categories*

$$(Ad30) GK(NAPO, M)$$

$$(Ad31) GK(APO, NAPO)$$

$$(Ad32) GK(SC, SAG)$$

#### *General Properties*

$$(Td1) \neg K(x,x,t)$$

- (Td2)  $SK(\phi, \psi) \rightarrow SD(\phi, \psi)$   
 (Td3)  $GK(\phi, \psi) \rightarrow GD(\phi, \psi)$   
 (Td4)  $(SK(\phi, \psi) \wedge SK(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow SK(\phi, \rho)$   
 (Td5)  $(GK(\phi, \psi) \wedge GK(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow GK(\phi, \rho)$

*Debatable Axioms*

- (??)  $SK(x, y) \rightarrow \neg D(y, x)$   
 (??)  $SK(\phi, \psi) \rightarrow \neg D(\psi, \phi)$   
 (??)  $GK(\phi, \psi) \rightarrow \neg D(\psi, \phi)$   
 (??)  $K(x, y, t) \rightarrow (AtP(z, x, t) \leftrightarrow AtP(z, y, t))$

*Note* – This last axiom is strong but it is also very informative on the distinction between spatial dependence and constitution.

#### 4.3.4 Participation

*Argument restrictions*

- (Ad33)  $PC(x, y, t) \rightarrow (ED(x) \wedge PD(y) \wedge T(t))$

*Existential Axioms*

- (Ad34)  $(PD(x) \wedge PRE(x, t)) \rightarrow \exists y(PC(y, x, t))$   
 (Ad35)  $ED(x) \rightarrow \exists y, t(PC(x, y, t))$

*Links with other Primitives*

- (Ad36)  $PC(x, y, t) \rightarrow (PRE(x, t) \wedge PRE(y, t))$   
 (Ad37)  $PC(x, y, t) \leftrightarrow \forall t'(P(t', t) \rightarrow PC(x, y, t'))$

*Ground Properties*

- (Td6)  $\neg PC(x, x, t)$   
 (Td7)  $PC(x, y, t) \rightarrow \neg PC(y, x, t)$

*Note* - We consider also non-physical endurants as participants.

#### 4.3.5 Quality

*Argument restrictions*

- (Ad38)  $qt(x, y) \rightarrow (Q(x) \wedge (Q(y) \vee ED(y) \vee PD(y)))$   
 (Ad39)  $qt(x, y) \rightarrow (TQ(x) \leftrightarrow (TQ(y) \vee PD(y)))$   
 (Ad40)  $qt(x, y) \rightarrow (PQ(x) \leftrightarrow (PQ(y) \vee PED(y)))$   
 (Ad41)  $qt(x, y) \rightarrow (AQ(x) \leftrightarrow (AQ(y) \vee NPED(y)))$

*Ground Axioms*

- (Ad42)  $(qt(x, y) \wedge qt(y, z)) \rightarrow qt(x, z)$

$$(Ad43) \quad (dqt(x, y) \wedge dqt(x, y')) \rightarrow y = y'$$

$$(Ad44) \quad (qt(\phi, x, y) \wedge qt(\phi, x', y)) \rightarrow x = x'$$

$$(Ad45) \quad (qt(\phi, x, y) \wedge qt(\psi, y, z)) \rightarrow DJ(\phi, \psi)$$

#### *Existential Axioms*

$$(Ad46) \quad TQ(x) \rightarrow \exists!y(qt(x, y) \wedge PD(y))$$

$$(Ad47) \quad PQ(x) \rightarrow \exists!y(qt(x, y) \wedge PED(y))$$

$$(Ad48) \quad AQ(x) \rightarrow \exists!y(qt(x, y) \wedge NPED(y))$$

$$(Ad49) \quad PD(x) \rightarrow \exists y(qt(TL, y, x))$$

$$(Ad50) \quad PED(x) \rightarrow \exists y(qt(SL, y, x))$$

$$(Ad51) \quad NPED(x) \rightarrow \exists \phi, y(SBL(AQ, \phi) \wedge qt(\phi, y, x))$$

#### *Ground Properties*

$$(Td8) \quad \neg qt(x, x)$$

*Note* – Maybe it is interesting to make explicit, for each kind of entities, which are the types of quality they necessarily possess.

### **4.3.6 Quale**

#### **Immediate Quale**

##### *Argument restrictions*

$$(Ad52) \quad ql(x, y) \rightarrow (TR(x) \wedge TQ(y))$$

$$(Ad53) \quad (ql(x, y) \wedge TL(y)) \rightarrow T(x)$$

##### *Ground Axioms*

$$(Ad54) \quad (ql(x, y) \wedge ql(x', y)) \rightarrow x = x'$$

##### *Existential Axioms*

$$(Ad55) \quad TQ(x) \rightarrow \exists y(ql(y, x))$$

$$(Ad56) \quad (L_X(\phi) \wedge \phi(x) \wedge \phi(y) \wedge ql(r, x) \wedge ql(r', y)) \rightarrow \exists \psi(L_X(\psi) \wedge \psi(r) \wedge \psi(r'))$$

$$(Ad57) \quad (L_X(\phi) \wedge \phi(x) \wedge \neg \phi(y) \wedge ql(r, x) \wedge ql(r', y)) \rightarrow \neg \exists \psi(L_X(\psi) \wedge \psi(r) \wedge \psi(r'))$$

#### **Temporary Quale**

##### *Argument restrictions*

$$(Ad58) \quad ql(x, y, t) \rightarrow ((PR(x) \vee AR(x)) \wedge (PQ(y) \vee AQ(y)) \wedge T(t))$$

$$(Ad59) \quad ql(x, y, t) \rightarrow (PR(x) \leftrightarrow PQ(y))$$

$$(Ad60) \quad ql(x, y, t) \rightarrow (AR(x) \leftrightarrow AQ(y))$$

$$(Ad61) \quad (ql(x, y, t) \wedge SL(y)) \rightarrow S(x)$$

##### *Existential Axioms*

$$(Ad62) \quad ((PQ(x) \vee AQ(x)) \wedge PRE(x, t)) \rightarrow \exists y(ql(y, x, t))$$

$$(Ad63) (L_X(\phi) \wedge \phi(x) \wedge \phi(y) \wedge ql(r, x, t) \wedge ql(r', y, t)) \rightarrow \exists \psi(L_X(\psi) \wedge \psi(r) \wedge \psi(r'))$$

$$(Ad64) (L_X(\phi) \wedge \phi(x) \wedge \neg\phi(y) \wedge ql(r, x, t) \wedge ql(r', y, t)) \rightarrow \neg\exists \psi(L_X(\psi) \wedge \psi(r) \wedge \psi(r'))$$

*Links with other Primitives*

$$(Ad65) ql(x, y, t) \rightarrow PRE(y, t)$$

$$(Ad66) ql(x, y, t) \leftrightarrow \forall t'(P(t', t) \rightarrow ql(x, y, t'))$$

### 4.3.7 Dependence and Spatial Dependence

*Links between Categories*

$$(Ad67) MSD(TQ, PD)$$

$$(Ad68) MSD_S(PQ, PED)$$

$$(Ad69) MSD(AQ, NPED)$$

$$(Ad70) OGD(F, NAPO)$$

$$(Ad71) OSD(MOB, APO)$$

$$(Ad72) OGD(SAG, APO)$$

$$(Ad73) OGD(NASO, SC)$$

$$(Ad74) OD(NPED, PED)$$

*General Properties*

$$(Td9) (SD(\phi, \psi) \wedge SD(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow SD(\phi, \rho)$$

$$(Td10) (GD(\phi, \psi) \wedge GD(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow GD(\phi, \rho)$$

$$(Td11) (SD(\phi, \psi) \wedge GD(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow GD(\phi, \rho)$$

$$(Td12) (GD(\phi, \psi) \wedge SD(\psi, \rho) \wedge DJ(\phi, \rho)) \rightarrow GD(\phi, \rho)$$

$$(Td13) SD_S(\phi, \psi) \rightarrow SD(\phi, \psi)$$

$$(Td14) GD_S(\phi, \psi) \rightarrow GD(\phi, \psi)$$

### 4.3.8 Being Present

*Argument restrictions*

$$(Td15) (ED(x) \vee PD(x) \vee Q(x)) \rightarrow \exists t(PRE(x, t))$$

$$(Td16) ((PED(x) \vee PQ(x)) \wedge PRE(x, t)) \rightarrow \exists s(PRE(s, x, t))$$

*Ground Axioms*

$$(Td17) (PRE(x, t) \wedge P(t', t)) \rightarrow PRE(x, t')$$

$$(Td18) PRE(s, x, t) \rightarrow PRE(x, t)$$

## 4.4 Characterization of Categories

In order to resume all the properties of categories, we shall report in this section also some axioms or theorems introduced in the previous sections. We shall mark these axioms/theorems with an asterisk.

### 4.4.1 Region

$$(Ad4)^* (P(x, y) \wedge SB(R, \phi) \wedge X(\phi)) \rightarrow (\phi(x) \leftrightarrow \phi(y))$$

$$(Ad59)^* ql(x, y, t) \rightarrow (PR(x) \leftrightarrow PQ(y))$$

$$(Ad60)^* ql(x, y, t) \rightarrow (AR(x) \leftrightarrow AQ(y))$$

$$(Ad62)^* ((PQ(x) \vee AQ(x)) \wedge PRE(x, t)) \rightarrow \exists y(ql(y, x, t))$$

*Debatable Axioms*

$$(??) \exists x(R(x) \rightarrow \neg \exists y, t(ql(x, y, t)))$$

$$(??) \Box \forall x, t(R(x) \rightarrow \exists y(ql(x, y, t)))$$

### 4.4.2 Quality

$$(Ad38)^* qt(x, y) \rightarrow (Q(x) \wedge (Q(y) \vee ED(y) \vee PD(y)))$$

$$(Ad39)^* qt(x, y) \rightarrow (TQ(x) \leftrightarrow (TQ(y) \vee PD(y)))$$

$$(Ad40)^* qt(x, y) \rightarrow (PQ(x) \leftrightarrow (PQ(y) \vee PED(y)))$$

$$(Ad41)^* qt(x, y) \rightarrow (AQ(x) \leftrightarrow (AQ(y) \vee NPED(y)))$$

$$(Ad46)^* TQ(x) \rightarrow \exists! y(qt(x, y) \wedge PD(y))$$

$$(Ad47)^* PQ(x) \rightarrow \exists! y(qt(x, y) \wedge PED(y))$$

$$(Ad48)^* AQ(x) \rightarrow \exists! y(qt(x, y) \wedge NPED(y))$$

$$(Ad67)^* MSD(TQ, PD)$$

$$(Ad68)^* MSD_S(PQ, PED)$$

$$(Ad69)^* MSD(AQ, NPED)$$

$$(Td15)^* (ED(x) \vee PD(x) \vee Q(x)) \rightarrow \exists t(PRE(x, t))$$

### 4.4.3 Perdurant

$$(Ad2)^* P(x, y) \rightarrow (PD(x) \leftrightarrow PD(y))$$

$$(Ad39)^* qt(x, y) \rightarrow (TQ(x) \leftrightarrow (TQ(y) \vee PD(y)))$$

$$(Ad46)^* TQ(x) \rightarrow \exists! y(qt(x, y) \wedge PD(y))$$

$$(Ad49)^* PD(x) \rightarrow \exists y(qt(TL, y, x))$$

$$(Ad34)^* (PD(x) \wedge PRE(x, t)) \rightarrow \exists y(PC(y, x, t))$$

$$(Td15)^* (ED(x) \vee PD(x) \vee Q(x)) \rightarrow \exists t(PRE(x, t))$$

*Conditions on Perdurant's Leaves*

$$(Ad75) \text{ PSBL}(ACH, \phi) \rightarrow (\text{NEP}_S(\phi) \wedge \text{CM}^{\sim}(\phi) \wedge \text{AT}(\phi))$$

$$(Ad76) \text{ PSBL}(ACC, \phi) \rightarrow (\text{NEP}_S(\phi) \wedge \text{CM}^{\sim}(\phi) \wedge \text{AT}^{\sim}(\phi))$$

$$(Ad77) \text{ PSBL}(ST, \phi) \rightarrow (\text{NEP}_S(\phi) \wedge \text{CM}(\phi) \wedge \text{HOM}(\phi))$$

$$(Ad78) \text{ PSBL}(PRO, \phi) \rightarrow (\text{NEP}_S(\phi) \wedge \text{CM}(\phi) \wedge \text{HOM}^{\sim}(\phi))$$

*Existential Axioms*

$$(Ad79) \exists \phi(\text{PSBL}(ACH, \phi))$$

$$(Ad80) \exists \phi(\text{PSBL}(ACC, \phi))$$

$$(Ad81) \exists \phi(\text{PSBL}(ST, \phi))$$

$$(Ad82) \exists \phi(\text{PSBL}(PRO, \phi))$$

*Debatable Axioms*

$$(??) (\text{PD}(x) \wedge \text{PD}(y) \wedge x \subseteq_T y) \rightarrow \exists z(z \approx_T x \wedge z \subseteq_{ST} y)$$

**4.4.4 Endurant**

$$(Ad35)^* \text{ED}(x) \rightarrow \exists y, t(\text{PC}(x, y, t))$$

$$(Td15)^* (\text{ED}(x) \vee \text{PD}(x) \vee \text{Q}(x)) \rightarrow \exists t(\text{PRE}(x, t))$$

**Physical endurant**

$$(Ad11)^* \text{P}(x, y, t) \rightarrow (\text{PED}(x) \leftrightarrow \text{PED}(y))$$

$$(Ad21)^* \text{K}(x, y, t) \rightarrow (\text{PED}(x) \leftrightarrow \text{PED}(y))$$

$$(Ad40)^* \text{qt}(x, y) \rightarrow (\text{PQ}(x) \leftrightarrow (\text{PQ}(y) \vee \text{PED}(y)))$$

$$(Ad47)^* \text{PQ}(x) \rightarrow \exists !y(\text{qt}(x, y) \wedge \text{PED}(y))$$

$$(Ad50)^* \text{PED}(x) \rightarrow \exists y(\text{qt}(SL, y, x))$$

$$(Ad68)^* \text{MSD}_S(\text{PQ}, \text{PED})$$

$$(Ad74)^* \text{OD}(\text{NPED}, \text{PED})$$

*Debatable Axioms*

$$(??) (\text{PED}(x) \wedge \text{PED}(y) \wedge \Box(x \approx_{ST} y)) \rightarrow x = y$$

**Amount of Matter**

$$(Ad30)^* \text{GK}(\text{NAPO}, M)$$

### **Physical Object**

(Ad32)\*  $GK(SC, SAG)$

(Ad30)\*  $GK(NAPO, M)$

(Ad70)\*  $OGD(F, NAPO)$

(Ad71)\*  $OSD(MOB, APO)$

(Ad72)\*  $OGD(SAG, APO)$

### **Feature**

(Ad70)\*  $OGD(F, NAPO)$

### **Non-physical Endurant**

(Ad12)\*  $P(x, y, t) \rightarrow (NPED(x) \leftrightarrow NPED(y))$

(Ad22)\*  $K(x, y, t) \rightarrow (NPED(x) \leftrightarrow NPED(y))$

(Ad41)\*  $qt(x, y) \rightarrow (AQ(x) \leftrightarrow (AQ(y) \vee NPED(y)))$

(Ad48)\*  $AQ(x) \rightarrow \exists!y(qt(x, y) \wedge NPED(y))$

(Ad51)\*  $NPED(x) \rightarrow \exists\phi, y(SBL(AQ, \phi) \wedge qt(\phi, y, x))$

(Ad74)\*  $OD(NPED, PED)$

### **Mental Object**

(Ad71)\*  $OSD(MOB, APO)$

### **Social Object**

(Ad73)\*  $OGD(NASO, SC)$

(Ad32)\*  $GK(SC, SAG)$

(Ad71)\*  $OSD(MOB, APO)$

(Ad72)\*  $OGD(SAG, APO)$

## 4.5 Glossary of Basic Categories

<i>AB</i>	Abstract
<i>ACC</i>	Accomplishment
<i>ACH</i>	Achievement
<i>APO</i>	Agentive Physical Object
<i>AQ</i>	Abstract Quality
<i>AR</i>	Abstract Region
<i>AS</i>	Arbitrary Sum
<i>ASO</i>	Agentive Social Object
<i>ED</i>	Endurant
<i>EV</i>	Event
<i>F</i>	Feature
<i>M</i>	Amount of Matter
<i>MOB</i>	Mental Object
<i>NAPO</i>	Non-agentive Physical Object
<i>NASO</i>	Non-agentive Social Object
<i>NPED</i>	Non-physical Endurant
<i>NPOB</i>	Non-physical Object
<i>PD</i>	Perdurant, Occurrence
<i>PED</i>	Physical Endurant
<i>POB</i>	Physical Object
<i>PQ</i>	Physical Quality
<i>PR</i>	Physical Region
<i>PRO</i>	Process
<i>PT</i>	Particular
<i>Q</i>	Quality
<i>R</i>	Region
<i>S</i>	Space Region
<i>SAG</i>	Social Agent
<i>SC</i>	Society
<i>SL</i>	Spatial Location
<i>SOB</i>	Social Object
<i>ST</i>	State
<i>STV</i>	Stative
<i>T</i>	Time Interval
<i>TL</i>	Temporal Location
<i>TQ</i>	Temporal Quality
<i>TR</i>	Temporal Region

Abstract	<i>AB</i>
Abstract Quality	<i>AQ</i>
Abstract Region	<i>AR</i>
Accomplishment	<i>ACC</i>
Achievement	<i>ACH</i>
Agentive Physical Object	<i>APO</i>
Agentive Social Object	<i>ASO</i>
Amount of Matter	<i>M</i>
Arbitrary Sum	<i>AS</i>
Endurant	<i>ED</i>
Event	<i>EV</i>
Feature	<i>F</i>
Mental Object	<i>MOB</i>
Non-agentive Physical Object	<i>NAPO</i>
Non-agentive Social Object	<i>NASO</i>
Non-physical Endurant	<i>NPED</i>
Non-physical Object	<i>NPOB</i>
Particular	<i>PT</i>
Perdurant, Occurrence	<i>PD</i>
Physical Endurant	<i>PED</i>
Physical Object	<i>POB</i>
Physical Quality	<i>PQ</i>
Physical Region	<i>PR</i>
Process	<i>PRO</i>
Quality	<i>Q</i>
Region	<i>R</i>
Social Agent	<i>SAG</i>
Social Object	<i>SOB</i>
Society	<i>SC</i>
Space Region	<i>S</i>
Spatial Location	<i>SL</i>
State	<i>ST</i>
Stative	<i>STV</i>
Temporal Location	<i>TL</i>
Temporal Quality	<i>TQ</i>
Temporal Region	<i>TR</i>
Time Interval	<i>T</i>

## 5 OCHRE: the Object-Centered High-level Reference Ontology

OCHRE is the second module in the WonderWeb library. It has been developed by Luc Schneider at the Department of Philosophy of the University of Geneva. This ontology differs from the previous because it is based on different set of assumptions. In particular, it presents a revisionary view with respect to the standard notion of commonsense.

**Revisionary Commonsensism.** Any foundational ontology used in distributed AI applications involving human-computer interaction has to take into account the naive conceptualisation shared by humans with regard to their every-day environment. Unfortunately, the problem with commonsense is that it is a moving target, and we share Casati's [10] scepticism with respect to any attempt to read off an ontological commitment from the observable (linguistic or else) human behaviour. That is why we feel uneasy about the phrase "cognitive bias", since it is not clear whether human cognition grants any kind of representational advantage to one ontological category over another (e.g. to "things" over "events"). On the other hand, however, theoretical studies of translation suggest that the interpretation of an alien speaker's utterances only works on the assumption that the interpreter and the interpretee share the greatest possible common background of beliefs about their common environment [20, 22, 21, 23, 24]. These shared assumptions are without doubt part of the conventional implicatures underlying human conversation [44].

Although Quine [72, pp. 29-45] has famously voiced some caution regarding a possible indeterminacy of translation, a lack of empirical constraints for matching the vocabularies of different languages. In a critical appraisal of Quine's behaviourist account of interpretation, Horwich [51, pp. 199-202] has shown that in practice such indeterminacies may actually be marginal. Thus, there is room for assuming the existence of a common human conceptual framework regarding the environment of every-day life. Of course, there is no guarantee that this "naive metaphysics" is true. But in the absence of any reason for a generalised doubt, there is some methodological legitimacy to adopt a "second naiveté" (Putnam [71, pp. 488-489]), a "natural ontological attitude" (A. Fine [30]), with respect to human perception and conceptualisation of reality.

Revisionism comes in at the stage of making "naive metaphysics" explicit. Indeed, while it should be rather unproblematic to gather a collection of distinctions between various material or concrete kinds of entities from colloquial usage, this is far from being so easy with respect to formal categories like "object", "event", "attribute", "being part of", "being connected to", and so on. The latter are mere generalisations and belong already to a specialised discourse which is not part of every-day linguistic practice. To a large extent, "naive metaphysics" is a matter of extrapolation – and extrapolation can be guided by quite different criteria. In particular, revisionist metaphysics is characterised by a strict economy of basic formal categories. As such, revisionist metaphysics is not directed against commonsense or, at least, no more than against a certain traditional, if not "Aristotelian", wording of the latter. So there is no contradiction in pursuing a descriptive approach while trying to keep the number of terms to a minimum.

## 5.1 Basic Assumptions

The Object-Centered High-level Reference ontology (OCHRE) has been developed within the above framework and aims at combining descriptive adequacy for commonsense with formal economy in the basic categories and their axiomatisation.

**Particularism.** OCHRE is an ontology of particulars, even more so than DOLCE, because it does not include universals, i.e. repeatable properties, in its domain. With “particulars”, we mean here the concrete individuals, whether physical, mental or social, which we regard to be composed out of simple (atomic) individual features, i.e. non-repeatable properties and relations. Nevertheless, the domain of OCHRE is left sufficiently unspecified to allow for user-specified extensions. Other theories can be plugged into OCHRE; a desirable addition could be elementary set theory as well as an apparatus for representing meta-knowledge.

**Object-Centered Approach.** OCHRE is an object-centered ontology in the sense that certain bundles of tropes, namely those exhibiting spatial and temporal features as well as their enduring cores, are granted a privileged ontological status over other particulars. Especially the “event” category is considered to be derived from the concept of “object”, inasmuch occurrences as state-transitions are conceived of as successions of objects.

**Extensionalism.** OCHRE is decidedly extensionalist in two respects. On the one hand, we adopt extensionalism regarding parthood, which means that particulars with the same parts are considered to be the same. On the other hand, we adopt extensionalism with respect to spatial extent, insofar as no two spatial objects can be coincident. Thus, OCHRE rejects the multiplicative approach; instead of multiplying spatial objects having the same parts or the same spatial extension, we prefer to speak of spatial objects having various qualitative aspects or “guises”. A statue and the material it is made of are not two coincident objects, but two facets of the same impenetrable object.

## 5.2 Basic Categories

The crucial ontological choice in foundational ontology pertains to the basic ontological categories. There is a widespread consensus amongst ontologists that the denizens of reality fall into three main categories: *objects* (like quarks, tables, stones, insurance companies and solar systems), *attributes* or particular properties and relations (like the various colour hues on a soap bubble, the mass and velocity of a bullet, your intelligence and your relatedness to your parents) as well as *events* and *processes* (like runnings, hugs, bank transfers, perceptions, and thinkings).

### 5.2.1 Tropes

Attributes can be regarded either as *repeatables* or as *non-repeatables* (Armstrong [3, p. 31]). Repeatables, also called *universals*, apply to more than one case; by contrast,

non-repeatables, commonly referred to as *tropes* (Williams [90]; Campbell [9]), are single characteristics of individuals. OCHRE endorses the view of Williams, Campbell, and Denkel that the building blocks of reality, the atoms of mereology, are non-repeatables. Note however, that not every non-repeatable has to be atomic: as we shall see, some non-repeatable properties (like colours) may be regarded as composite. In the context of this report, the term *trope* will denote atomic non-repeatables only.

### 5.2.2 Thin and Thick Objects

Considerations of formal economy have lead us to adopt the so-called *qualitative account* of objects, according to which the latter are regarded as bundles of properties and relations. The qualitative account enjoys a certain popularity among ontologists, as e.g. Williams ([90]), Campbell ([9]), Denkel ([26]), and Simons ([77]), because it avoids the problematic idea of objects as unscrutable blobs which attributes somehow adhere to. Nevertheless it is also true that objects are more than mere sums of their properties. A descriptively adequate ontology has to account for the completeness, independence, and spatio-temporal bulk that objects enjoy in contrast to arbitrary agglomerations of attributes (Denkel [26], pp. 16–17).

Following Strawson [85, pp. 16–17, 39], the basic difference between objects and other entities is that the former can be singled out on their own, while the latter have to be individuated relatively to some object. Objects enjoy ontological priority over other particulars since they constitute a framework of reference that serves as a basis for identification of all other entities. However, the thesis that objects form the basic framework of reference may seem to be undermined by the fact that objects change. Objects apparently lose and gain parts, move around, and exhibit incompatible properties and relations over time. A solution favoured by many ontologists, e.g. Quine ([72], p. 171), Heller ([50]), and Armstrong ([3], pp. 99–107), is to regard objects as space-time worms: incompatible facts just pertain to different phases of such four-dimensional entities. This approach is elegant, but rejects the intuitive distinction between objects and processes.

Alternatively, one can stick to the intuition of objects as three-dimensional entities and temporalise the *assertions* about objects instead. Formal relations, like parthood, have to receive an additional temporal parameter. This approach has been defended, amongst many others, by Simons ([76], chap. 5), and has been adopted by Masolo et al. ([62]). However, temporalisation makes reasoning about formal relations like parthood more difficult.

The problem of change emphasises an ambiguity of the naive concept of object. Varying the terminology of Armstrong ([3], pp. 123–126) and developing intuitions from Simons ([77]) and Denkel ([26], p. 108), one has to distinguish between an evanescent whole, the *thick object*, and a core of enduring characteristics, the *thin object*. Thick objects have spatio-temporal bulk and undergo change. More precisely: change consists in the succession of temporary aggregations of tropes shaped by relations of spatial connection. Thin objects as the enduring cores of thick objects constitute the ultimate referential framework, the ontological backbone of reality. Successions of thick objects are held together by thin objects common to all elements in these chains, such as for example by bundles of essential functions in the case of artifacts or organisms.

Our approach to the problem of change is akin to the stage theory proposed by Sider ([75], pp. 1-10, pp. 188-208), Hawley ([49], chap. 2), and Denkel ([26], pp. 101-109), with the main difference that thick objects are founded on thin objects. Successive incompatible states of affairs bear on consecutive thick objects that share the same thin object as a common core. The exchange of colour-tropes in a ripening tomato just pertains to different evanescent wholes centered around the bundle of core characteristics, amongst them the tomato's DNA. That one speaks of the same object through change is grounded in the existence of thin objects. Every temporal attribution of properties and relations to a thin object amounts to the atemporal attribution of these attributes to succeeding thick objects as its stages.

### 5.2.3 Haecceities, Properties, Guises and Relations

Since a thick object may contain other thick objects as parts, it is necessary to determine whether a trope or a thin object is associated with that thick object or one of its thick parts. For example, one would like to distinguish the weight of a body and the weight of its right arm. Such distinctions can be done through the relation of *direct parthood*, of which we will say more later. In the words of Williams ([90], p. 6), direct parts are *fine* or *abstract* parts, as opposed to *gross* or *concrete* parts, of thick objects.

A thin object that is a direct part of a thick object is called an *haecceity* of the latter. A direct part which does not overlap with an haecceity is called a *property* of the thick object. Every property of a thick object is supposed to be founded or dependent on exactly one haecceity of that thick object.

We have said that a thick object has at least one haecceity. It seems counterintuitive that a thick object may have more than one haecceity, but this is the case for most everyday objects such as artifacts (or organisms) and the amount of material they are made of. Common-sense allows for numerically distinct objects to be spatially and temporally co-located, *orcoincident*, e.g., a terracotta statue and the clay it is made of, or a person and her body. Some ontologists, like Simons ([76], chap. 6), assume such entities to be distinct physical objects of which one (e.g. the clay) *constitutes* the other (e.g. the statue).

In OCHRE, there is no need to allow for *constitution* as an additional non-extensional composition. Indeed, thick objects cannot be co-located, since they have spatial bulk and thus compete for space. Instead, we consider coincident entities to be *direct parts* of the same thick object. Thick objects may have more than one essence, each of which has its own periphery of dependent tropes. The mereological sum of a thin object and all the properties founded on it represents a qualitative aspect of the thick object, which we call a *guise*, after Castañeda ([14]). A particular thick object that we identify as a terracotta statue made of clay contains two sub-bundles of tropes, namely the statue and the amount of clay, each centered on a particular thin object: the functions of the artifact and the chemical characteristics of the material. These trope bundles are *fine* or *abstract* parts of the same thick object and represent different aspects of the latter.

## 5.2.4 Eventualities

A descriptively adequate ontology has to acknowledge the intuitive distinction between objects and processes, or, as the philosophical jargon has it, between *endurants* and *perdurants*. Endurants have no phases and are present as a whole at each instant they are present at all. Perdurants, on the contrary, consist of different phases at different times (Lewis [59, p. 202]). However, taking this distinction for granted does not mean that its terms have both to be considered as primitive.

According to the intuitive definition of endurants, tropes, as well as thin and thick objects, turn out to be endurants. Thin objects are wholly present in each of the thick objects they are part of, and the same trivially applies to tropes, i.e. to atoms. And since thick objects have no temporal parts, they too are endurants. In OCHRE, only a subclass of perdurants is envisaged, namely successions of thick objects and arbitrary sums of such successions, called *eventualities*.

The basic eventualities are events as changes or state-transitions: for example, the change of a tomato's colour from green to red amounts to the succession of a red tomato-stage to a green one. The change of a memory cell from 0 to 1 is the succession of a charged cell-stage to an uncharged one. The definition implies that there are no instantaneous events, which is consistent with the doctrine that perdurants have at least two distinct temporal parts. The instantaneous left and right boundaries of eventualities are endurants, namely thick objects. Hence the *events* that represent the beginning and the ending of an eventuality cannot be instantaneous and always have to involve at least two object-stages.

*Eventualities* are arbitrary mereological sums of events; they can be recursively characterised with single events as a base case. We call *process* any eventuality which is not a single event or state-transition.

## 5.3 Basic Relations

Obviously, OCHRE has also to acknowledge *formal properties* and *formal relations* that are the subject matter of any foundational ontology, such as *object*, *trope*, *parthood*, *dependence*, or *similarity*. References to formal properties and relations are made through the respective predicates. Formal relations apply to their relata directly, without any further mediating ties (Smith and Murray [82], pp. 50-51). This is just a consequence of their being the top-level categories of reality. In other words, the nexus between a formal property and its instances, in particular that between a formal relation and its relata, is ontologically unanalysable.

### 5.3.1 Parthood

*Mereology*, the formal theory of parthood, has grown out of early-20th-century mathematical research into a calculus of individuals capturing relations between set-theoretical *urelemente* (Leonard and Goodman [56]). There are several systems of mereology of different strength. In OCHRE, we have adopted the so-called *Closure Mereology (CM)* that amounts to a Boolean algebra without a null element (Simons [76, chap. 1]; Casati and Varzi [12, chap. 3]). More precisely, OCHRE is based on the atomistic version of CM.

Parthood between particulars is supposed to be extensionally defined over a domain of least elements, so-called *atoms*, and closed under the operations of binary sum and product. The atoms of mereology are all basic non-repeatables, i.e. tropes: the latter are the building blocks of reality. Sameness, i.e. identity between particulars, is conceived of simply as mutual parthood. In other words, parthood is partial identity (Armstrong [3, p. 17] ; Lewis [58, pp. 81–82]). Furthermore, there is a unique parthood relation between particulars, which does not exclude that additional subdomains of individuals (like sets) require the introduction of different concepts of parthood. All in all, this formal account of parthood has the advantage of a clear algebraic approach and a great conceptual unity.

### 5.3.2 Foundation

Intuitively, foundation can be understood in terms of identification: a particular  $x$  is founded on an individual  $y$  if, and only if, in order to identify  $x$ , one has to single out  $y$  first (Strawson ([85], pp. 16–17). In a certain sense, the entities on which something is founded are part of its very definition or identity (Fine [31], p. 275). Formally, foundation can be characterised as a reflexive and transitive relation which satisfies the following conditions (Fine [33, 32]; Simons [76, pp. 310-318]):

1. wholes are founded on their parts;
2. if something is founded on the atomic parts of something else, it is founded on the latter as a whole.

Thin objects, the haecceities of thick objects, are accounted for as bundles of atoms (or tropes) which are self-founded, i.e. founded only on their parts. Every thin object is an integral whole, i.e. a whole whose atomic parts held together by foundation relations. Using a term of Roman Ingarden [53, vol. 1], thin objects are autonomous in the sense that they contain all their determinations, all that is needed to explain them.

### 5.3.3 Similarity, Exact Similarity, Comparability

Similarity is a reflexive, symmetric and intransitive relation defined over atoms (i.e. tropes); it can be conceived of as connection or immediate neighbourhood in a relational “quality space”. Two atoms (tropes) are exactly similar if and only if they are similar to the same tropes. Thus, exact similarity is like qualitative identity, coincidence in a relational “quality space”. Comparability, finally, is the transitive closure of the similarity relation. These basic relations between tropes can be used to define resemblance relations between complex particulars. The most interesting case is exact resemblance, which holds between two complex particulars if and only if their atomic parts can be matched together one-to-one in pairs of exactly similar tropes.

### 5.3.4 Connection and Anteriority

Thick objects are nodes in a comprehensive grid of spatial and temporal relations. The formal ontological theory of spatial and temporal relations is called *topology*; topology

constraints mereology and both together constitute the formal-ontological framework of *mereotopology* (Casati and Varzi [12, chap. 4]).

The first primitive of topology is *spatial connection*, a symmetric and intransitive relation that is reflexive in all cases it applies at all. Its underlying intuition is that of immediate neighborhood in space. E.g., France is connected to Germany and Germany to Poland, but France is not connected to Poland. A thick object is enclosed in another if, and only if, everything which is connected to the first is also connected to the second. A heart is contained in a chest, a fish in a lake, and so on. The principle of monotonicity (Casati and Varzi [12, p. 54]) states that parthood between thick objects implies spatial enclosure, but not vice-versa. Since a heart is part of a chest, it is also enclosed in the latter. However, a fish is enclosed in, but is not part of a lake.

Thick objects do not only exhibit spatial relations, but also temporal ones. The theory of temporal order used in OCHRE is the one proposed by Russell [73] and Chisholm [17]: accepting the relation of anteriority qua complete precedence as a primitive, one easily defines the relations of immediate anteriority and simultaneity. This theory is only weakly axiomatised on purpose: indeed, the question whether thick objects are instantaneous or temporally extended is left undecided. The important issue about thick objects is that they have no temporal parts. This is ensured by the principle of mereo-topological invariance, i.e. the stipulation that connection implies simultaneity. Capturing the intuition behind Chisholm's account of *entia successiva* ([16, pp. 97–104]), a three-dimensionalist version of stage theory, this axiom states that thick objects are frozen in time: change consists in the succession of snap-shot like three-dimensional entities.

A further important postulate is that coincidence, namely mutual spatial enclosure, implies sameness. In other words: distinct thick objects cannot be co-located, they compete for space. Thus there is no need to distinguish between a thick object and the region in which it is located. Indeed, a thick object can be seen as a qualitatively enriched spatio-temporal region.

The principle of mereo-topological invariance together with the assumption that non-coincidence yields distinctness, may seem rather strong. In fact, any mereo-topological change implies a change of parts too, by the extensionality of parthood. Now, it is not *that* counterintuitive that any movement is accompanied by some qualitative change: kinetic energy is transformed into position energy with loss of some kinetic energy in form of heat through friction, the gravitational attraction between physical objects changes, and so on. Hence, the account of change in OCHRE may well be in harmony with a more or less scientific preconception of the world.

### 5.3.5 Relational Precedence

Non-repeatable relations (e.g. marriages, or kinships) have been often defined as multiply dependent attributes (Simons [78], Mulligan and Smith [66]). Accordingly, a property of a thick object that is founded on haecceities of other thick objects is called a *relational property* in OCHRE. Relational properties are material properties in contrast to formal relations like parthood and foundation. (We remind the reader that formal relations are not represented by particulars; they correspond to sets of tuples.)

But multiple foundedness is not sufficient to account for relations; the relata stand

in a certain order of precedence, which is not simply part of the essence of a relational property, but is a formal relation *sui generis*. We assume that the relata of a relational property are strictly ordered by precedence. This means that there are no reflexive relational properties. Apparent reflexivity of material properties is just a linguistic phenomenon: a predicate may correspond to a disjunction between a material property and sameness. Symmetry occurs on the level of types or classes, in case the relata are always recombined by an exactly similar relational property with reverse order of precedence.

## 5.4 Derived Relations

### 5.4.1 Direct Parthood

Traditionally, the peculiar formal relation between objects and their characteristics has been called *inherence* and the authors of DOLCE follow this usage (Masolo et al. [62]). In OCHRE, however, it is not necessary to provide for inherence as an additional primitive; in fact, the relation between (thin or thick) objects and their attributes can be accounted for in terms of foundation and parthood.

A part of a thick object which is not itself a thick object is called a *thin part*. A thin part which does not overlap with any of the (proper) thick parts of a thick object is called a *direct part*. We have already mentioned how the concept of *haecceity* and that of *property* can be defined using direct parthood.

Every atom (trope) is a direct part of some thick object. In other words, there are no homeless tropes. Furthermore, no two comparable tropes may be both direct parts of the same thick object. Thus a physical object-stage cannot have more than one mass or kinetic energy. Also, every thick object has to contain at least one haecceity: as we have seen, many thick objects have more than one haecceity. Finally every property is founded on exactly one haecceity of the *same* thick object. Since haecceities qua thin objects are self-founded, properties are one-sidedly founded on haecceities.

### 5.4.2 Succession

Successive thick objects that are stages of the same thin object stand in a peculiar relation of loose identity: they are not identical, but everything that is true of them is also true, in a temporal sense, of the common thin object. This idea of stage-successions is directly related to Chisholm's [16, pp. 97–104] account of change in terms of consecutive entities. We say that a thick object  $x$  is the *successor* of some thick object  $y$  *with respect to* a thin object  $z$  iff  $y$  is immediately anterior to  $x$ , and  $z$  is a common haecceity of  $x$  and  $y$ . In order to exclude that thin objects have instantaneous lives, we postulate that for each thin object  $x$  there are at least two thick objects that are in succession with respect to  $x$ . By extensionality of parthood, there must be at least one atomic part that is not shared between distinct stages of a thin object. Hence there cannot be successive stages with exactly the same proper parts: things change constantly.

### 5.4.3 Participation

In DOLCE, the relation between perdurants and the (thin) objects involved in them is called *participation* and considered to be a primitive. OCHRE's particular account of perdurants in terms of endurants allows for participation to be defined as a special case of parthood. Indeed, a thin object  $x$  *participates in* a eventuality  $y$ , if and only if there is an event which is part of  $y$ , such that  $x$  is the common haecceity of the succeeding thick objects that constitute this event.

## 6 OCHRE's Formal Characterization

### 6.1 Mereology - Theory of Parts and Wholes

#### 6.1.1 Definitions of Mereology

- (Do1)  $SA(x, y) \triangleq P(x, y) \wedge P(y, x)$  (*sameness*)  
 (Do2)  $PP(x, y) \triangleq P(x, y) \wedge \neg SA(x, y)$  (*proper parthood*)  
 (Do3)  $O(x, y) \triangleq \exists z(P(z, x) \wedge P(z, y))$  (*overlap*)  
 (Do4)  $U(x, y) \triangleq \exists z(P(x, z) \wedge P(y, z))$  (*underlap*)  
 (Do5)  $At(x) \triangleq PT(x) \wedge \neg \exists y(PP(y, x))$  (*atom*)  
 (Do6)  $AtP(x, y) \triangleq P(x, y) \wedge At(x)$  (*atomic parthood*)  
 (Do7)  $Cx(x) \triangleq PT(x) \wedge \neg At(x)$  (*complex*)  
 (Do8)  $SM(x, y, z) \triangleq \forall w(P(w, x) \leftrightarrow (P(w, y) \vee P(w, z)))$  (*sum*)  
 (Do9)  $PR(x, y, z) \triangleq \forall w(P(w, x) \leftrightarrow (P(w, y) \wedge P(w, z)))$  (*product*)  
 (Do10)  $DF(x, y, z) \triangleq \forall w(P(w, x) \leftrightarrow (P(w, y) \wedge \neg O(w, z)))$  (*difference*)  
 (Do11)  $UN(x) \triangleq \forall y(P(y, x))$  (*universe*)

#### 6.1.2 Axioms of Mereology

- (Ao1)  $P(x, y) \rightarrow (PT(x) \wedge PT(y))$  (*parthood*)  
 (Ao2)  $PT(x) \rightarrow P(x, x)$  (*reflexivity*)  
 (Ao3)  $((P(x, y) \wedge P(y, z)) \rightarrow P(x, z))$  (*transitivity*)  
 (Ao4)  $SA(x, y) \leftrightarrow (PT(x) \wedge PT(y) \wedge x = y)$  (*sameness is particular-identity*)  
 (Ao5)  $\exists y(AtP(y, x))$  (*atomicity*)  
 (Ao6)  $(PT(x) \wedge PT(y) \wedge \forall z(AtP(z, x) \rightarrow AtP(z, y))) \rightarrow P(x, y)$  (*extensionality*)  
 (Ao7)  $U(x, y) \rightarrow \exists z(SM(z, x, y))$  (*existence of sum*)  
 (Ao8)  $(SM(x, z, w) \wedge SM(y, z, w)) \rightarrow SA(x, y)$  (*uniqueness of sum*)  
 (Ao9)  $O(x, y) \rightarrow \exists z(PR(z, x, y))$  (*existence of product*)  
 (Ao10)  $(PR(x, z, w) \wedge PR(y, z, w)) \rightarrow SA(x, y)$  (*uniqueness of product*)  
 (Ao11)  $\exists x(UN(x))$  (*existence of universe*)  
 (Ao12)  $(UN(x) \wedge UN(y)) \rightarrow SA(x, y)$  (*uniqueness of universe*)

### 6.2 Theory of Foundations

#### 6.2.1 Definitions of the Theory of Foundations

- (Do12)  $SF(x, y) \triangleq F(x, y) \wedge \neg P(y, x)$  (*strong foundation*)  
 (Do13)  $OF(x, y) \triangleq F(x, y) \wedge \neg F(y, x)$  (*one-sided foundation*)

- (Do14)  $MF(x, y) \triangleq F(x, y) \wedge F(y, x)$  (*mutual foundation*)  
(Do15)  $TH(x) \triangleq Cx(x) \wedge \forall y(F(x, y) \rightarrow P(y, x))$  (*thin object*)  
(Do16)  $IW(x) \triangleq Cx(x) \wedge \forall y, z((AtP(y, x) \wedge AtP(z, x)) \rightarrow (F(y, z) \vee F(z, y)))$  (*integral whole*)

### 6.2.2 Axioms of the Theory of Foundations

- (Ao13)  $F(x, y) \rightarrow (PT(x) \wedge PT(y))$  (*restriction*)  
(Ao14)  $PT(x) \rightarrow F(x, x)$  (*reflexivity*)  
(Ao15)  $(F(x, y) \wedge F(y, z)) \rightarrow F(x, z)$  (*transitivity*)  
(Ao16)  $P(y, x) \rightarrow F(x, y)$  (*wholes are founded on their parts*)  
(Ao17)  $(AtP(z, y) \rightarrow F(x, z)) \rightarrow F(x, y)$  (*foundation on a whole*)  
(Ao18)  $\exists x(TH(x))$  (*existence of thin objects*)  
(Ao19)  $TH(x) \rightarrow IW(x)$  (*thin objects are integral wholes*)

## 6.3 Theory of Similarity

### 6.3.1 Definitions of the Theory of Similarity

- (Do17)  $ES(x, y) \triangleq \forall z(SI(x, z) \leftrightarrow SI(y, z))$  (*exact similarity*)  
(Do18)  $RS(x, y) \triangleq Cx(x) \wedge Cx(y) \wedge \exists z, w(AtP(z, x) \wedge AtP(w, y) \wedge ES(z, w))$  (*resemblance*)  
(Do19)  $CR(x, y) \triangleq Cx(x) \wedge Cx(y) \wedge \forall z(AtP(z, x) \rightarrow \exists w(AtP(w, y) \wedge ES(z, w)))$  (*complete resemblance*)  
(Do20)  $ER(x, y) \triangleq CR(x, y) \wedge CR(y, x)$  (*exact resemblance*)

### 6.3.2 Axioms of the Theory of Similarity

- (Ao20)  $SI(x, y) \rightarrow (At(x) \wedge At(y))$  (*similarity*)  
(Ao21)  $At(x) \rightarrow SI(x, x)$  (*reflexivity*)  
(Ao22)  $SI(x, y) \rightarrow SI(y, x)$  (*symmetry*)  
(Ao23)  $CM(x, y) \rightarrow (At(x) \wedge At(y))$  (*comparability*)  
(Ao24)  $CM(x, y) \rightarrow CM(y, x)$  (*symmetry*)  
(Ao25)  $(CM(x, y) \wedge CM(y, z)) \rightarrow CM(x, z)$  (*transitivity*)  
(Ao26)  $SI(x, y) \rightarrow CM(y, x)$  (*similarity implies comparability*)

## 6.4 Topology - Theory of Space and Time

### 6.4.1 Definitions of Topology

- (Do21)  $TK(x) \triangleq \exists y(C(x,y))$  *(thick object)*  
 (Do22)  $TKP(x,y) \triangleq TK(x) \wedge TK(y) \wedge P(x,y)$  *(thick parthood)*  
 (Do23)  $E(x,y) \triangleq \forall z(C(z,x) \rightarrow C(z,y))$  *(enclosure)*  
 (Do24)  $Cl(x,y) \triangleq E(x,y) \wedge E(y,x)$  *(coincidence)*  
 (Do25)  $IA(x,y) \triangleq A(x,y) \wedge \neg \exists z(A(x,z) \wedge A(z,y))$  *(immediate anteriority)*  
 (Do26)  $TO(x,y) \triangleq \neg A(x,z) \wedge \neg A(y,x)$  *(temporal overlap)*  
 (Do27)  $SL(x,y) \triangleq \forall z(TO(x,z) \leftrightarrow TO(y,z))$  *(simultaneity)*

### 6.4.2 Axioms of Topology

- (Ao27)  $C(x,y) \rightarrow (Cx(x) \wedge Cx(y) \wedge \neg TH(x) \wedge \neg TH(y))$  *(connection)*  
 (Ao28)  $TK(x) \rightarrow C(x,x)$  *(reflexivity)*  
 (Ao29)  $C(x,y) \rightarrow C(y,x)$  *(symmetry)*  
 (Ao30)  $A(x,y) \rightarrow (TK(x) \wedge TK(y))$  *(anteriority)*  
 (Ao31)  $\neg A(x,x)$  *(irreflexivity)*  
 (Ao32)  $(A(x,y) \wedge A(y,z)) \rightarrow A(x,z)$  *(transitivity)*  
 (Ao33)  $TK(x) \rightarrow \exists y(A(x,y) \vee A(y,x))$  *(temporal order)*  
 (Ao34)  $\exists x(TK(x))$  *(existence of thick objects)*  
 (Ao35)  $C(x,y) \rightarrow SL(x,y)$  *(mereo-topological invariance)*  
 (Ao36)  $TKP(x,y) \rightarrow E(x,y)$  *(monotonicity)*  
 (Ao37)  $(TK(x) \wedge TK(y) \wedge Cl(x,y)) \rightarrow x = y$  *(extensionality)*

## 6.5 Theory of Properties

### 6.5.1 Definitions of the Theory of Properties

- (Do28)  $THP(x,y) \triangleq P(x,y) \wedge TK(y) \wedge \neg TK(x)$  *(thin parthood)*  
 (Do29)  $DP(x,y) \triangleq THP(x,y) \wedge \neg \exists z(THP(z,y) \wedge \neg z = y \wedge O(z,x))$  *(direct parthood)*  
 (Do30)  $H(x,y) \triangleq TH(x) \wedge DP(x,y)$  *(haecceity)*  
 (Do31)  $Prop(x,y) \triangleq DP(x,y) \wedge \forall z(H(z,y) \rightarrow \neg O(z,x))$  *(property)*  
 (Do32)  $IProp(x,y) \triangleq Prop(x,y) \wedge IW(x)$  *(integral property)*  
 (Do33)  $G(x,y,z) \triangleq DP(x,y) \wedge H(z,y) \wedge \forall w(P(w,x) \leftrightarrow (w = z \vee (Prop(w,y) \wedge F(w,z))))$  *(guise)*

## 6.5.2 Axioms of the Theory of Properties

- (Ao38)  $At(x) \rightarrow \exists y(DP(x, y))$  *(tropes are direct parts of thick objects)*  
(Ao39)  $(DP(y, x) \wedge DP(z, x) \wedge CM(y, z)) \rightarrow SA(y, z)$  *(comparable direct parts)*  
(Ao40)  $TK(x) \rightarrow \exists y(H(y, x))$  *(existence of haecceities)*  
(Ao41)  $(H(x, y) \wedge H(x, z) \wedge SL(y, z)) \rightarrow SA(y, z)$  *(unicity of simultaneous stages)*  
(Ao42)  $Prop(x, y) \rightarrow \exists z(H(z, y) \wedge F(x, z))$  *(property foundation: 1)*  
(Ao43)  $(Prop(x, y) \wedge H(z, y) \wedge H(w, y) \wedge F(x, z) \wedge F(x, w)) \rightarrow SA(z, w)$  *(prop. found.: 2)*

## 6.5.3 Theorems of the Theory of Properties

- (To1)  $(G(x, y, z) \wedge G(x', y, z)) \rightarrow SA(x, x')$

## 6.6 Theory of Eventualities

### 6.6.1 Definitions of the Theory of Eventualities

- (Do34)  $SC(x, y, z) \triangleq IA(y, x) \wedge H(z, x) \wedge H(z, y)$  *(succession)*  
(Do35)  $EV(x, y) \triangleq \exists w, z(SM(x, w, z) \wedge SC(y, w, z))$  *(event in)*  
(Do36)  $E(x) \triangleq \exists y(EV(x, y))$  *(event)*  
(Do37)  $PRO(x) \triangleq ETY(x) \wedge \neg E(x)$  *(process)*  
(Do38)  $lf(x, y) \triangleq ETY(x) \wedge TH(y) \wedge \forall z(P(z, x) \leftrightarrow EV(z, y))$  *(life)*  
(Do39)  $PC(x, y) \triangleq TH(x) \wedge ETY(y) \wedge \exists z(EV(z, x) \wedge P(z, y))$  *(participation)*

### 6.6.2 Axioms of the Theory of Eventualities

- (Ao44)  $(SC(z, x, y) \wedge SC(w, x, y)) \rightarrow z = w$  *(unicity on the left)*  
(Ao45)  $(SC(x, y, z) \wedge SC(x, y, w)) \rightarrow z = w$  *(unicity on the right)*  
(Ao46)  $TH(x) \rightarrow \exists y, z(TK(y) \wedge TK(z) \wedge SC(y, z, x))$  *(thin objects as haecceities)*  
(Ao47)  $E(x) \rightarrow ETY(x)$  *(eventuality: 1)*  
(Ao48)  $(E(x) \wedge ETY(y) \wedge SM(z, x, y)) \rightarrow ETY(z)$  *(eventuality: 2)*

## 6.7 Theory of Relational Properties

### 6.7.1 Definitions of the Theory of Relational Properties

- (Do40)  $RPO(x, y) \triangleq Prop(x, y) \wedge \exists z, w(H(z, w) \wedge \neg H(z, y) \wedge \neg w = y \wedge F(x, z))$   
(Do41)  $RL(x, y) \triangleq \exists z(RPO(y, z) \wedge \exists w(H(x, w) \wedge F(y, x)))$  *(relatum)*

### 6.7.2 Axioms of the Theory of Relational Properties

- (Ao49)  $PC(x, y, z) \rightarrow (RL(x, z) \wedge RL(y, z))$  *(precedence)*
- (Ao50)  $\neg PC(x, x, y)$  *(irreflexivity)*
- (Ao51)  $(PC(x, y, w) \wedge PC(y, z, w)) \rightarrow PC(x, z, w)$  *(transitivity)*
- (Ao52)  $(RL(x, z) \wedge RL(y, z)) \rightarrow (PC(x, y, z) \vee PC(y, x, z))$  *(order of precedence)*

## 7 BFO: Basic Formal Ontology

BFO is the third module of the WonderWeb Ontology. It has been developed at the IFOMIS institute in Leipzig.

### 7.1 Introduction and preliminaries

BFO is a foundational ontology that aims at reconciling the so-called three-dimensionalist and four-dimensionalist views (a bi-ontological theory, so to speak). Such a theory can however be stripped down of its meta-ontological flavor. The result is the underlying bi-categorical ontology, which is in essence a form of non-eliminativistic three dimensionalism. Generally speaking, continuants are here seen as persisting entities that are self-identical through time and that participate in occurrents of various sorts. The treatment of three dimensional entities finds its roots in a neo-Aristotelian metaphysics of substances [80].

Although the differences and similarities between BFO and DOLCE will be discussed in a later section, it is instructive to anticipate a few remarks on the baroque attitude of BFO's theory of universals and the modal realism of DOLCE. These remarks will drive the first part of our presentation.

#### 7.1.1 Universals

At the present stage, BFO adopts the structural vocabulary introduced for the characterization of DOLCE as it concerns universals, without fussing about the modal interpretation.

In particular, we present BFO as an ontology of particulars and add glosses on a number of predicates that corresponds to formal universals recognized by BFO.

The BFO's native formal approach consists in introducing nominals for so-called genuine formal universals; using the instantiation relation for monadic universals (properties as they are called by most people) and some relational variant for the other universals.

#### 7.1.2 Temporality

BFO has two components. A *Snap* ontology of endurants which is reproduced at each moment of time and is used to characterize static views of the world. This view is motivated by an underlying presentist metaphysics of time (if something exists, it exists at the present time). No temporal consideration is germane to the *Snap* ontology in this very elementary sense.

*Snap* requires a temporal logic of a certain grade if we want to use it in temporal contexts. There are two devices in BFO in order to handle temporality. The first one—probably not the most manageable one—consists in using diachronic relations, which hold between entities in temporally-different *Snap* views. This allows us to account for a large number of features, but it does not furnish an ontology of temporal entities in itself. Rather, and this is the second device of BFO, the theory contains a temporal component: the *Span* ontology. This is an ontology of happenings and occurrents and, more generally, of entities which persist in time by perduring (these are entities which have temporal

parts). Trans-ontological *Snap* considerations provide a useful device for characterizing *Span* entities. Indeed, an entity across different *Snap* instances corresponds to changes in a *Snap* entity. For example, a movement is a change in location, a discoloration is a change in the color trope of a material object, and so on. The interdependency and complementarity of the *Snap* and *Span* components is BFO's message in a nutshell.

In the bi-categorical context, we disregard meta-ontological devices (ontologies, the relation of being a constituent of an ontology, and the like), thus the predicates of BFO receive an additional temporal parameter, namely, the moment or period of time at (during) which they obtain. This brings the formal characterization close to that of DOLCE since the latter introduces both non temporally qualified and temporally qualified predicates – although not quite for the same reasons.

One drawback, as far as BFO is concerned, might be that certain categorial – or pseudo-categorial as argued in (Grenon, 2003b) – claims will be temporally qualified as well. This relates to DOLCE's treatment of universals according to which a category includes all its possibilia as members. BFO differs on this aspect; categories have a number of instances at a time in the *Snap* case and they encompass all of their actual (past, present, future) instances in the *Span* case.

In this regard, note that at the moment the list of rigid categories in BFO is not definite. Nonetheless, it is remarkable that the parameterization of certain statements of categorial membership is primarily related to granularity (and not to time).

### 7.1.3 Granularity

*Snap* ontologies are allegedly sensitive to the level of granularity at which their constituents are revealed. It is in this spirit that, taking account of the granularity paradigm, the categories of substance and aggregate of substances are relative to an ontology (we should better talk of pseudo-categories for this very reason). A number of reservations concerning this paradigm can be raised. Nevertheless, note that the actual characterization falls short of doing justice to the underlying intuitions. A possible way out could be to introduce granularity parameters on a par with temporal parameters. However, this is inadequate from the realist standpoint of BFO (what are these parameters? in the temporal case the answer is simple: they are temporal regions). Perhaps, on this issue it is advisable to follow the formal treatment of granularity used in CYC.

After this preliminary discussion, in the following pages we sketch the BFO theory. A more convoluted explication and justification of the formalization can be found in [41]. Here, we draw attention to some salient similarities (with certain qualifications) and dissimilarities between BFO and DOLCE.

## 7.2 BFO in a nutshell

The entities considered here are all particulars. Particulars are either endurants (*Snap*) or perdurants (*Span*).

### 7.2.1 *Snap*

*Snap* entities are most importantly divided into *substantial entities* (which are the bearer of properties and change, e.g., material objects, organs, portions of the atmosphere, but also organisations and other agents), *tropes* (which are the latter's qualities, functions, powers, dispositions, and other entities inhering in substantial entities, e.g., headaches, colour of a tomato, temperature of a body, tendency toward decomposition of the tomato, contracts –a document on which is written a contract is itself a substantial entity), and *spatial regions* (which are pure space regions). Here, we do not treat the so-called 'quasi entities', although the absence of a formal distinction does not prevent BFO to take these under its scope.

The category of substantial entities is the most direct indicator of the neo-Aristotelian stand that BFO is committed to. In the world, these are entities that preserve their identity through time, are subjected to (more or less continuous) change, and are the bearers of a number of qualities and assimilated entities. Among substantial entities, the salient category is that of *maximally strongly connected* substantial entities with bona fide boundaries, e.g., a body, a tomato, a ball and so on.

Qualities and assimilated –*Snap* dependent entities or tropes– are particular entities (the instances of property universals) that depend for their existence on substantial entities. The colour of this tomato depends on this tomato and it is no other entity's colour. Another tomato may have a colour-trope of the exact same hue, etc. Colours of tomatoes may be qualitatively identical, they are as numerically distinct one from the other as their respective bearers are numerically distinct one from the other. Tropes are of various kinds which are best distinguished on modal basis although we do not introduce this aspect in the formalization. Among the relevant sub-kind of tropes we find: states or conditions, functions, powers, dispositions, and liabilities.<sup>31</sup> Tropes are divided in monadic (dependent upon a single entity, e.g., colours) and polyadic or relational (dependent upon more than one entity, e.g., contracts). The relation between a trope and its bearer is called *inherence* (this is a relation between particulars) which is also a form of specific dependence.

The metaphysic of space is substantivalist in the sense that *spatial regions* are entities in their own right. These are distinct from substantial entities and may be the location of substantial entities as well as of tropes (in first approximation, a trope of a substance is co-located with its bearer). We assume that spatial regions are (exactly) located at themselves. On the contrary, substantial entities – and their tropes – may be located at different regions at different times. However, at any time at which they exist they have a single spatial location. We leave open whether at each time a spatial region needs to be the location of a substantial entity (BFO supports both variants).

Also, the present formalization remains agnostic as concerns cross-categorical *sums* of *Snap* entities. Rather, the existence of sums of two entities within each of the three mean species of *Snap* entities is explicitly introduced. Characteristically, sums remain in these species (cumulativity closure) and their parts as well (dissectivity closure).

*Snap* entities are said to exist at a time. Indeed they may exist (and usually exist) at more than one time. Their existence needs to be continuous (a property left out in the present formalization). It is open, however, whether there are instantaneous *Snap* entities.

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<sup>31</sup>At this level BFO does not draw a sharp distinction between the physical and the social.

As already mentioned, *Snap* is in itself not sensitive to time. Inherence, spatial location and other spatial relations are forms of co-existence. An interesting and genuinely diachronic relation that one could add to BFO is the *genidentity* relation (the such-as-to-have-come-forth-from relation). For example, this cake on the table is genidentical to the mereological sum of all pieces of cakes in the plates of the participants of the upcoming diner.

### 7.2.2 *Span*

*Span* entities are divided mainly into *processual entities* (which are happenings or occurring entities, changes of various kinds in substantial entities, e.g., raising of temperature, acquisition of a social status, movements, activities, etc.), *temporal regions* (the whole of time and all of its parts), and *spatio-temporal regions* (four dimensional regions of space-time, i.e., the whole locational substratum for occurrents its parts). These sub-kinds of *Span* entities are disjoint. Like spatial regions, temporal regions are not parts of space-time. It is remarkable that there is nothing analogous to tropes (*Snap* dependent entities) in *Span*, that is, there are no entities that are qualities of processes.

Analogously to the case of substantial entities, processual entities are divided according to their topological properties. *Processes* are the self-connected processuals. For instance, baking a cake, falling down, scratching your nose are processes. More generally, processuals have a temporal and a spatiotemporal extent and do not change their locations in time or space-time.

Time is given entirely in a *canonical Span* ontology, BFO takes the whole of *time* to be an entity in its own right and any of its parts is a temporal region (these can be extended or instantaneous). Similarly, space-time is an entity in BFO and its parts are the spatio-temporal regions (these may be of various dimensions). Inforamlly, BFO regards time as a continuum, in the spirit of [8], and space-time as a four-dimensional manifold. Temporal and spatio-temporal regions are substrata of locations for every *Span* entity (and for *Span* entities only! Recall that *Snap* entities are considered to exist in time, not to be located in it). A regions is located in itself in the corresponding dimension and every *Span* entity has a unique location both in time and space-time (as already observed for processes).

The existence of cross-categorical *sums* among *Span* entities is left open, while the existence of sums of two entities within the sub-kinds of *Span* entities is explicitly introduced. Sums remain in these species (cumulativity closure) and their parts as well (dissectivity closure).

*Span* entities are perdurants, thus they have temporal parts. A temporal slice is a temporal part located at an instant of time. Temporal parts are more generally spatio-temporal parts, those which are carved up only in the temporal dimension. They are sometimes called phases. Processual entities are said to occur at a time when they have a temporal slice which is located at this time.

### 7.2.3 *Snap–Span* and *Span–Snap*

Although in the meta-ontological framework the relation between a *snap* entity and a moment of time at which it exists is definable, here it is taken as a primitive relation. From

this, we may define *existence during* a period of time (a quite weak notion). We can then proceed by adding a temporal argument to spatial location and inherence. For instance, Wojtyla exists now, it has been existing all throughout 2003, because at any instant of time during that year, Wojtyla was existing. During that year (at each and every instant), his papehood was inhering in him and he has been located at many spatial locations.

Additional native primitive terms of BFO are non-temporalized predicates for the relation of *participation* and *realization* (they obtain at a given moment of time). In this context, we can introduce participation in relation to an extended processual which has to occur at the time at which its participants exist and during which the more basic synchronic relation obtains. Wojtyla realises his papehood when he acts according to his status. He participates in many other processual entities which have nothing to do with his papehood. Additional variants, such as the *complete participation* (when an entity participates to the whole of the processual in question) can be defined. The *life of* a substantial is the sum of the processual entities it is a complete participant of.

In many cases, the realization of a trope is just a part of its own life. Here we assume this is also part of the life of its bearer. Other forms of participation, beside realization, could be added but their conditions are not easily stated (think of intentional relations). On the other hand, it is difficult to define the notion of life for tropes, since in many cases tropes exist without being realized, and it is unclear the relationship between the life of a trope and that of its bearer. It may be useful to introduce two categories of tropes: those who have realizations as proper parts of their life (e.g., functions) and those whose lives coincide with their realization (an example could be a condition or a state). Of course, one can go on defining a number of sub-kinds of processuals, for instance *functionings* (the processes in which a function is realized – assuming that no single function is realized as a disconnected processual entity).

## 8 Formal Characterization of BFO

In keeping with the modular framework of BFO, following [41] I take *Snap* and *Span* entities as primitive notions. We can always introduce the term ‘Entity’ as applying to entities of any of the kinds used here. Since this is only a partial rendition of BFO (most importantly not including universals), I leave it open whether *Snap* and *Span* form partitions of this putative Entity, i.e., whether there are any other kinds of entities. Here, the instances of *Snap* and *Span* are all particulars.

(Ab1)  $DJ(Snap, Span)$

(Ab2)  $PT(Span, PRS, TR, STR)$

(Ab3)  $PT(Snap, SR, SBL, TRP)$

### 8.1 *Span* Entities

Material in this section is based on or adapted from [41, 43].

**Primitives relations and constants.** On *Span* entities we assume the following primitives:

- *Parthood*:  $P(x, y)$  means that  $x$  is a *part* of  $y$ .
- *Boundary For*:  $B(x, y)$  means that  $x$  is a *bona fide boundary* for  $y$ ;  $x$  is not necessarily the whole boundary of  $y$ , but any part of it (contrast with *Boundary Of* to be defined). A bona fide boundary for an entity is to be understood as a partial external delineation of that entity. Boundaries are lower dimensional entities (e.g., a section of a sphere is a boundary for a ball; a section of a circle is one for a disk; a point for a line). Bona fide boundaries are not all parts of the entities they bound, this is the case for closed entities (it is definitional for them)
- *Fiat Boundary For*:  $FB(x, y)$  means that  $x$  is a *fiat boundary for*  $y$ ;  $FB$  is the fiat counterpart of  $B$ . Fiat boundaries are parts of the entities they are fiat boundaries for. A fiat boundary is for instance the delineation between two component parts of an entity (they are typically regarded as the products of convention).
- *Specific Dependence*:  $SD(x, y)$  means that  $x$  is *specifically dependent* on  $y$ . Specific dependence is defined by (Smith, 1997) modally and  $SD(x, y)$  means that  $x$  and  $y$  do not overlap and  $x$  is such that it necessitates the existence of  $y$  in order to exist. Notice in particular that specific dependence is then not a form of parthood. Here, without a modal language, I am taking dependence as primitive.
- *Time*: the constant time designates an individual: the whole of time.
- *Temporal Location*:  $L_T(x, t)$  means that  $t$  is the temporal region at which  $x$  is (uniquely) located. (It is exact temporal location.)
- *Space-time*: The term spacetime designates an individual: the whole of space-time.
- *Spatio-temporal Location*:  $L_{ST}(x, st)$  means that  $st$  is the spatio-temporal region at which  $x$  is (uniquely) located. (It is exact spatio-temporal location.)

### 8.1.1 Parthood

Material in this section is based on or adapted from [76, 80, 83].

**Definitions.** We introduce the classical mereological definitions.

- (Db1)  $PP(x, y) \triangleq P(x, y) \wedge \neg P(y, x)$  (*Proper Part*)  
 (Db2)  $O(x, y) \triangleq \exists z(P(z, x) \wedge P(z, y))$  (*Overlap*)  
 (Db3)  $FUS(y, x[\phi(x)]) \triangleq \forall z(O(z, y) \leftrightarrow \exists w(\phi(w) \wedge O(z, w)))$  (*Fusion*)  
 (Db4)  $SM(x, y, z) \triangleq FUS(x, w[P(w, y) \vee P(w, z)])$  (*Sum*)  
 (Db5)  $DF(x, y, z) \triangleq FUS(x, w[P(w, y) \wedge \neg O(w, z)])$  (*Difference*)  
 (Db6)  $CMP(x, y) \triangleq FUS(x, z[\neg O(z, y)])$  (*Complement*)

#### Axioms

- (Ab4)  $P(x, y) \rightarrow (Span(x) \wedge Span(y))$   
 (Ab5)  $(P(x, y) \wedge TR(y)) \rightarrow TR(x)$   
 (Ab6)  $(P(x, y) \wedge STR(y)) \rightarrow STR(x)$   
 (Ab7)  $(P(x, y) \wedge PRS(y)) \rightarrow PRS(x)$   
 (Ab8)  $Span(x) \rightarrow P(x, x)$   
 (Ab9)  $(P(x, y) \wedge P(y, z)) \rightarrow P(x, z)$   
 (Ab10)  $(P(x, y) \wedge P(y, x)) \rightarrow x = y$   
 (Ab11)  $(FUS(y, x[\phi(x)]) \wedge FUS(y', x[\phi(x)])) \rightarrow y = y'$   
 (Ab12)  $(TR(x) \wedge TR(y)) \rightarrow \exists z(SM(z, x, y))$   
 (Ab13)  $(STR(x) \wedge STR(y)) \rightarrow \exists z(SM(z, x, y))$   
 (Ab14)  $(PRS(x) \wedge PRS(y)) \rightarrow \exists z(SM(z, x, y))$   
 (Ab15)  $(TR(x) \wedge TR(y) \wedge SM(z, x, y)) \rightarrow TR(z)$   
 (Ab16)  $(STR(x) \wedge STR(y) \wedge SM(z, x, y)) \rightarrow STR(z)$   
 (Ab17)  $(PRS(x) \wedge PRS(y) \wedge SM(z, x, y)) \rightarrow PRS(z)$

### 8.1.2 Topology

Material in this section is based on or adapted from [81, 83]

#### Definitions

- *Internal Part*:  $IP(x, y)$  means that  $x$  is a part of  $y$  and no *boundary for* (B)  $x$  overlaps with  $y$ .
- *Fiat Internal Part*:  $FIP(x, y)$  means that  $x$  is a *fiat part* of  $y$ .
- *Boundary*:  $Bd(x)$  means that  $x$  is a boundary of an entity (at least one).

- *Fiat Boundary*:  $\text{FBd}(x)$  means that  $x$  is a *fiat boundary* of some entity.
- *Boundary Of*:  $\text{BO}(x, y)$  means that  $x$  is the complete (bona fide) boundary of  $y$ . The boundary of an entity is the fusion of all entities which are (bona fide) boundaries for this entity. The boundary of an entity is therefore a boundary for ( $\text{B}(x, y)$ ) that entity.
- *Fiat Boundary Of*:  $\text{FBO}(x, y)$  as in the case of  $\text{BO}(x, y)$ .
- *Closure*:  $\text{CL}(x, y)$  means that  $x$  is the *closure* of  $y$ . The closure of an entity is the sum of this entity with its boundary.
- *Interior*:  $\text{INT}(x, y)$  means that  $x$  is the *interior* of  $y$ . The interior of an entity is the difference between this entity and its closure.
- *Weak Connected*:  $\text{WC}(x)$  means that  $x$  is *weakly connected*, i.e.,  $x$  is such that any two entities it is the sum of are such that their closures overlap. This is [83]'s Connected.
- *Mildly Connected*:  $\text{MC}(x)$  means that  $x$  is *mildly connected*, i.e.,  $x$  is such that any two entities it is the sum of are such that one overlaps with the closure of the other or vice versa. This is [83]'s Connected\*.
- *Strongly Connected*:  $\text{SC}(x)$  means that  $x$  is *strongly connected*, i.e., its interior is mildly connected.
- *Connection*:  $\text{C}(x, y)$  means that  $x$  is *connected* to  $y$ , i.e.,  $x$  and  $y$  overlap or  $x$  overlaps with the closure of  $y$  or  $y$  overlaps with the closure of  $x$ .
- *External Connection*:  $\text{EC}(x, y)$  means that  $x$  is connected to  $y$  but they do not overlap.
- *Closed*:  $\text{CLS}(x)$  means that  $x$  is *closed*, i.e., it is its own closure. A bona fide boundary - in particular, the boundary of this entity - for closed entity is a part of this entity.

$$\text{(Db7)} \quad \text{IP}(x, y) \triangleq \text{P}(x, y) \wedge \forall z(\text{B}(z, y) \rightarrow \neg \text{O}(z, x)) \quad (\text{Internal Parthood})$$

$$\text{(Db8)} \quad \text{FIP}(x, y) \triangleq \text{P}(x, y) \wedge \forall z(\text{FB}(z, y) \rightarrow \neg \text{O}(x, y)) \quad (\text{Fiat Internal Parthood})$$

$$\text{(Db9)} \quad \text{Bd}(x) \triangleq \exists y \text{B}(x, y) \quad (\text{Boundary})$$

$$\text{(Db10)} \quad \text{FBd}(x) \triangleq \exists y \text{FB}(x, y) \quad (\text{Fiat Boundary})$$

$$\text{(Db11)} \quad \text{BO}(x, y) \triangleq \text{FUS}(x, z[\text{B}(z, y)]) \quad (\text{Boundary Of})$$

$$\text{(Db12)} \quad \text{FBO}(x, y) \triangleq \text{FUS}(x, z[\text{FB}(z, y)]) \quad (\text{Fiat Boundary Of})$$

$$\text{(Db13)} \quad \text{CL}(x, y) \triangleq \forall z(\text{BO}(z, x) \rightarrow \text{SM}(x, y, z)) \quad (\text{Closure})$$

$$\text{(Db14)} \quad \text{INT}(x, y) \triangleq \forall z(\text{CL}(z, y) \rightarrow \text{DF}(x, y, z)) \quad (\text{Interior})$$

$$\text{(Db15)} \quad \text{WC}(x) \triangleq \forall y, z, c_y, c_z((\text{SM}(x, y, z) \wedge \text{CL}(c_y, y) \wedge \text{CL}(c_z, z)) \rightarrow \text{O}(c_y, c_z)) \quad (\text{Weak Connected})$$

$$\text{(Db16)} \quad \text{MC}(x) \triangleq \forall y, z, c_y, c_z((\text{SM}(x, y, z) \wedge \text{CL}(c_y, y) \wedge \text{CL}(c_z, z)) \rightarrow (\text{O}(c_y, z) \vee \text{O}(c_z, y))) \quad (\text{Mild Connected})$$

$$\text{(Db17)} \quad \text{SC}(x) \triangleq \forall y(\text{INT}(y, x) \rightarrow \text{MC}(y)) \quad (\text{Strong Connected})$$

- (Db18)  $C(x,y) \triangleq O(x,y) \vee \forall c_x, c_y ((CL(c_x, x) \wedge CL(c_y, y)) \rightarrow (O(c_x, y) \vee O(c_y, x)))$   
(*Connection*)
- (Db19)  $EC(x,y) \triangleq C(x,y) \wedge \neg O(x,y)$  (*External Connection*)
- (Db20)  $CLS(x) \triangleq CL(x,x)$  (*Closed*)

### Axioms

- (Ab18)  $B(x,y) \rightarrow (Span(x) \wedge Span(y))$
- (Ab19)  $(B(x,y) \wedge TR(y)) \rightarrow TR(x)$
- (Ab20)  $(B(x,y) \wedge STR(y)) \rightarrow STR(x)$
- (Ab21)  $(B(x,y) \wedge PRS(y)) \rightarrow PRS(x)$
- (Ab22)  $(P(x,y) \wedge B(y,z)) \rightarrow B(x,z)$
- (Ab23)  $FB(x,y) \rightarrow P(x,y)$
- (Ab24)  $(P(x,y) \wedge FB(y,z)) \rightarrow FB(x,z)$
- (Ab25)  $CL(x,y) \rightarrow P(y,x)$
- (Ab26)  $(CL(x,y) \wedge CL(z,x)) \rightarrow P(z,x)$
- (Ab27)  $(SM(x,y,z) \wedge CL(c_x, x) \wedge CL(c_y, y) \wedge CL(c_z, z) \wedge SM(x', c_y, c_z)) \rightarrow c_x = x'$
- (Ab28)  $(SM(x,y,z) \wedge SC(x)) \rightarrow FC(y,z)$
- (Ab29)  $(Bd(x) \wedge FCn(x)) \rightarrow \exists y, z (FCn(y) \wedge B(x,y) \wedge IP(z,y))$

### Theorems

- (Tb1)  $BO(x,y) \rightarrow B(x,y)$
- (Tb2)  $(CLS(x) \wedge B(y,x)) \rightarrow P(y,x)$

The following are held to be theorem by [83]:

- (Tb3)  $(B(x,y) \wedge B(y,z)) \rightarrow B(x,z)$
- (Tb4)  $(B(x,y) \wedge CMP(z,y)) \rightarrow B(x,z)$
- (Tb5)  $\neg(EC(x,y) \wedge CLS(x) \wedge CLS(y))$
- (Tb6)  $(FB(x,y) \wedge FB(y,z)) \rightarrow FB(x,z)$

### 8.1.3 Dependence

Material in this section is based on or adapted from [80, 81].

#### Definitions

- (Db21)  $MSD(x,y) \triangleq SD(x,y) \wedge SD(y,x)$  (*Mutual Specific Dependence*)
- (Db22)  $OSD(x,y) \triangleq SD(x,y) \wedge \neg SD(y,x)$  (*One-side Specific Dependence*)

## Axioms

(Ab30)  $SD(x, y) \rightarrow (Span(x) \wedge Span(y))$

(Ab31)  $SD(x, y) \rightarrow \neg O(x, y)$

### 8.1.4 Time and Space-time

#### Definitions

- *Temporal Region*:  $TR(x)$  means that  $x$  is a region of time, i.e. a part of time which may be extended or instantaneous (a time instant), connected to various degrees or scattered.
- *Temporal Instant*:  $TI(x)$  means that  $x$  is an instant of time, i.e. a maximally strongly connected boundary of a temporal region.
- *Spatio-temporal Region*:  $STR(x)$  means that  $x$  is a region of space-time, i.e. a part of space-time.

(Db23)  $TR(x) \triangleq P(x, \text{time})$  (*Temporal Region*)

(Db24)  $TI(x) \triangleq \exists y (TR(y) \wedge B(x, y) \wedge SC(x) \wedge \forall z ((B(z, y) \wedge SC(z)) \rightarrow x = z))$   
(*Temporal Instant*)

(Db25)  $STR(x) \triangleq P(x, \text{spacetime})$  (*Spatio-temporal Region*)

#### Axioms

(Ab32)  $Span(\text{time})$

(Ab33)  $Span(\text{spacetime})$

(Ab34)  $SD(\text{spacetime}, \text{time})$

### 8.1.5 Temporal Location

#### Definitions

- *Temporal Location at an Instant*:  $ll_{\top}(x, t)$  means that  $x$  is temporally located at  $t$  and that  $t$  is an instant of time.
- *Temporal Co-location*:  $CoL_{\top}(x, y)$  means that  $x$  and  $y$  are located at the same temporal region.
- *Temporal Subsumption*:  $SbL_{\top}(x, y)$  means that  $x$  temporally subsumes  $y$ , i.e., the temporal location of  $y$  is a part of the temporal location of  $x$ .
- *Temporal Part*:  $TP(x, y)$  means that  $x$  is a *temporal part* of  $y$ , i.e.,  $x$  is a part of  $y$  such that all parts of  $y$  temporally co-located with  $x$  are parts of  $x$ . (It is trivial to introduce a ternary relation indicating the time of location of  $x$ ).
- *Temporal Slice*:  $TS(x, y)$  means that  $x$  is a *temporal slice* of  $y$ , i.e.,  $x$  is an instantaneous temporal part of  $y$ .

- *Processual*:  $PRS(x)$  means that  $x$  is a *processual*, i.e., an happening, an occurrent (not a temporal or spatiotemporal region).
- *Process*:  $PRO(x)$  means that  $x$  is a *process*, i.e., a maximally strongly connected occurrent (processual).
- *Event*:  $EV(x)$  means that  $x$  is an *event*, i.e., a temporal slice of a processual.
- *Bona Fide Event*:  $BFEV(x)$  means that  $x$  is a *bona fide event*, i.e., a maximally strongly connected boundary of an occurrent.

- (Db26)  $IL_{\top}(x, t) \triangleq (L_{\top}(x, t) \wedge TI(t))$  (Temporal Location at a Instant)
- (Db27)  $CoL_{\top}(x, y) \triangleq \exists t(L_{\top}(x, t) \wedge L_{\top}(y, t))$  (Temporal Co-localization)
- (Db28)  $SbL_{\top}(x, y) \triangleq \forall t_x, t_y((L_{\top}(x, t_x) \wedge L_{\top}(y, t_y)) \rightarrow P(t_y, t_x))$  (Temporal Subsumption)
- (Db29)  $TP(x, y) \triangleq P(x, y) \wedge \forall z((P(z, y) \wedge CoL_{\top}(z, x)) \rightarrow P(z, x))$  (Temporal Part)
- (Db30)  $TS(x, y) \triangleq TP(x, y) \wedge \exists t(IL_{\top}(x, t))$  (Temporal Slice)
- (Db31)  $OCC(x, t) \triangleq \neg TR(x) \wedge \neg STR(x) \wedge \exists y(TS(y, x) \wedge IL_{\top}(y, t))$   
(Occurrence at an instant)
- (Db32)  $PRS(x) \triangleq \exists t(OCC(x, t))$  (Processual)
- (Db33)  $PRO(x) \triangleq PRS(x) \wedge SC(x) \wedge \forall y((P(x, y) \wedge SC(y)) \rightarrow x = y)$  (Process)
- (Db34)  $EV(x) \triangleq \exists y(PRS(y) \wedge TS(x, y))$  (Event)
- (Db35)  $BFEV(x) \triangleq \exists y(PRS(y) \wedge TS(x, y) \wedge B(x, y))$  (Bona-fide Event)

### Axioms

- (Ab35)  $L_{\top}(x, t) \rightarrow (Span(x) \wedge TR(t))$
- (Ab36)  $(L_{\top}(x, t) \wedge L_{\top}(x, t')) \rightarrow t = t'$
- (Ab37)  $Span(x) \rightarrow \exists t(L_{\top}(x, t))$
- (Ab38)  $Span(x) \rightarrow \exists y(TP(y, x))$
- (Ab39)  $TR(t) \rightarrow L_{\top}(t, t)$
- (Ab40)  $L_{\top}(spacetime, time)$
- (Ab41)  $(PRO(x) \wedge PRO(y) \wedge P(x, y)) \rightarrow x = y$

### Theorems

- (Tb7)  $TP(x, y) \rightarrow SbL_{\top}(y, x)$

## 8.1.6 Spatio-Temporal Location

### Definitions

- *Spatio-temporal Part*:  $STP(x, y)$  means that  $x$  is a *spatio-temporal part* of  $y$ , i.e.,  $x$  is a part of  $y$  such that all parts of  $y$  spatiotemporally co-located with  $x$  are parts of  $x$ .

- *Spatio-temporal Co-location*:  $\text{CoL}_{\text{ST}}(x, y)$  means that  $x$  and  $y$  are located at the same spatio-temporal region.

(Db36)  $\text{STP}(x, y) \triangleq \text{P}(x, y) \wedge \forall z((\text{P}(z, y) \wedge \text{CoL}_{\text{ST}}(z, x)) \rightarrow \text{P}(z, x))$  (*Spatio-temp. Part*)

(Db37)  $\text{CoL}_{\text{ST}}(x, y) \triangleq \exists st(\text{L}_{\text{ST}}(x, st) \wedge \text{L}_{\text{ST}}(y, st))$  (*Spatio-temporal Co-location*)

### Axioms

(Ab42)  $\text{L}_{\text{ST}}(x, st) \rightarrow (\text{Span}(x) \wedge \text{STR}(st))$

(Ab43)  $(\text{L}_{\text{ST}}(x, st) \wedge \text{L}_{\text{ST}}(x, st')) \rightarrow st = st'$

(Ab44)  $\text{Span}(x) \rightarrow \exists st(\text{L}_{\text{ST}}(x, st))$

(Ab45)  $\text{Span}(x) \rightarrow \exists y(\text{STP}(y, x))$

(Ab46)  $\text{STR}(x) \rightarrow \text{L}_{\text{ST}}(x, x)$

(Ab47)  $(\text{TR}(x) \wedge \text{STP}(y, x)) \rightarrow x = y$

(Ab48)  $(\text{L}_{\text{ST}}(x, st) \wedge \text{L}_{\text{T}}(x, t)) \rightarrow \text{L}_{\text{T}}(st, t)$

(Ab49)  $(\text{L}_{\text{ST}}(x, st) \wedge \text{L}_{\text{T}}(st, t)) \rightarrow \text{L}_{\text{T}}(x, t)$

## 8.2 Snap Entities

**Primitives relations and constants.** On *Snap* entities we assume the following primitives:

- *Instantaneous Existence*:  $\text{EX}_t(x, t)$  means that  $x$  exists at the temporal instant  $t$ .
- *Instantaneous Parthood*:  $\text{P}_t(x, y, t)$  means that  $x$  is a *part* of  $y$  at the temporal instant  $t$ .
- *Instantaneous Boundary For*:  $\text{B}_t(x, y, t)$  means that  $x$  is a *bona fide boundary* for  $y$  at the temporal instant  $t$ ;  $x$  is not necessarily the whole boundary of  $y$  at  $t$ , but any part of it.
- *Instantaneous Fiat Boundary For*:  $\text{FB}_t(x, y, t)$  means that  $x$  is a *fiat boundary* for  $y$  at the temporal instant  $t$ ;  $\text{FB}$  is the fiat counterpart of  $\text{B}$ .
- *Instantaneous Specific Dependence*:  $\text{SD}_t(x, y, t)$  means that  $x$  is *specifically dependent* on  $y$  at the temporal instant  $t$ .
- *Instantaneous Inherence*:  $\text{IH}_t(x, y, t)$  means that at the instant of time  $t$ ,  $x$  (directly) *inheres* in  $y$ .  $x$  is a trope of which  $y$  is a substantial. Inherence is a form of specific dependence.
- *Space*: the constant space designates an individual: the whole of space.
- *Instantaneous Spatial Location*:  $\text{L}_S(x, s, t)$  means that  $s$  is the spatial region at which  $x$  is (uniquely) located at the temporal instant  $t$ . (It is exact spatial location.)

## 8.2.1 Instantaneous Existence

### Axioms

$$(Ab50) \text{EX}_t(x, t) \rightarrow (\text{Snap}(x) \wedge \text{TI}(t))$$

$$(Ab51) \text{Snap}(x) \rightarrow \exists t(\text{EX}_t(x, t))$$

## 8.2.2 Instantaneous Parthood

### Definitions

$$(Db38) \text{PP}_t(x, y, t) \triangleq \text{P}_t(x, y, t) \wedge \neg \text{P}_t(y, x, t) \quad (\text{Instantaneous Proper Part})$$

$$(Db39) \text{O}_t(x, y, t) \triangleq \exists z(\text{P}_t(z, x, t) \wedge \text{P}_t(z, y, t)) \quad (\text{Instantaneous Overlap})$$

$$(Db40) \text{FUS}_t(y, x[\phi(x)], t) \triangleq \forall z(\text{O}_t(z, y, t) \leftrightarrow \exists w(\phi(w) \wedge \text{O}_t(z, w, t))) \quad (\text{Inst. Fusion})$$

$$(Db41) \text{SM}_t(x, y, z, t) \triangleq \text{FUS}_t(x, w[\text{P}_t(w, y, t) \vee \text{P}_t(w, z, t)], t) \quad (\text{Instantaneous Sum})$$

$$(Db42) \text{DF}_t(x, y, z, t) \triangleq \text{FUS}_t(x, w[\text{P}_t(w, y, t) \wedge \neg \text{O}_t(w, z, t)], t) \quad (\text{Instantaneous Difference})$$

$$(Db43) \text{PD}_t(x, y, z, t) \triangleq \text{FUS}_t(x, w[\text{P}_t(w, y, t) \wedge \text{P}_t(w, z, t)], t) \quad (\text{Instantaneous Product})$$

$$(Db44) \text{CMP}_t(x, y, t) \triangleq \text{FUS}_t(x, z[\neg \text{O}_t(z, y, t)], t) \quad (\text{Instantaneous Complement})$$

### Axioms

$$(Ab52) \text{P}_t(x, y, t) \rightarrow (\text{EX}_t(x, t) \wedge \text{EX}_t(y, t))$$

$$(Ab53) (\text{P}_t(x, y, t) \wedge \text{SR}(y)) \rightarrow \text{SR}(x)^{32}$$

$$(Ab54) (\text{P}_t(x, y, t) \wedge \text{SBL}(y)) \rightarrow \text{SBL}(x)$$

$$(Ab55) (\text{P}_t(x, y, t) \wedge \text{TRP}(y)) \rightarrow \text{TRP}(x)$$

$$(Ab56) \text{EX}_t(x, t) \rightarrow \text{P}_t(x, x, t)$$

$$(Ab57) (\text{P}_t(x, y, t) \wedge \text{P}_t(y, z, t)) \rightarrow \text{P}_t(x, z, t)$$

$$(Ab58) (\text{P}_t(x, y, t) \wedge \text{P}_t(y, x, t)) \rightarrow x = y$$

$$(Ab59) (\text{FUS}_t(y, x[\phi(x)], t) \wedge \text{FUS}_t(y', x[\phi(x)], t)) \rightarrow y = y'$$

$$(Ab60) (\text{EX}_t(x, t) \wedge \text{EX}_t(y, t) \wedge \text{SR}(x) \wedge \text{SR}(y)) \rightarrow \exists z(\text{SM}(z, x, y, t))$$

$$(Ab61) (\text{EX}_t(x, t) \wedge \text{EX}_t(y, t) \wedge \text{SBL}(x) \wedge \text{SBL}(y)) \rightarrow \exists z(\text{SM}(z, x, y, t))$$

$$(Ab62) (\text{EX}_t(x, t) \wedge \text{EX}_t(y, t) \wedge \text{TRP}(x) \wedge \text{TRP}(y)) \rightarrow \exists z(\text{SM}(z, x, y, t))$$

$$(Ab63) (\text{SR}(x) \wedge \text{SR}(y) \wedge \text{SM}(z, x, y, t)) \rightarrow \text{SR}(z)$$

$$(Ab64) (\text{SBL}(x) \wedge \text{SBL}(y) \wedge \text{SM}(z, x, y, t)) \rightarrow \text{SBL}(z)$$

$$(Ab65) (\text{TRP}(x) \wedge \text{TRP}(y) \wedge \text{SM}(z, x, y, t)) \rightarrow \text{TRP}(z)$$

### Theorems

$$(Tb8) \text{P}_t(x, y, t) \rightarrow (\text{Snap}(x) \wedge \text{Snap}(y) \wedge \text{TI}(t))$$

---

<sup>32</sup>Defining spatial regions as in (Db66), from the transitivity of instantaneous parthood this ‘‘axiom’’ follows. We prefer to indicate this formula here as an axiom in order to be more explicit.

### 8.2.3 Instantaneous Topology

**Definitions.** The informal description of the notions introduced in this section is analogous to that in the section of (non-instantaneous) topology.

$$(Db45) \quad IP_t(x, y, t) \triangleq P_t(x, y, t) \wedge \forall z (B_t(z, y, t) \rightarrow \neg O_t(z, x, t)) \quad (\text{Inst. Internal Parthood})$$

$$(Db46) \quad FIP_t(x, y, t) \triangleq P_t(x, y, t) \wedge \forall z (FB_t(z, y, t) \rightarrow \neg O_t(x, y, t)) \\ (\text{Inst. Fiat Internal Parthood})$$

$$(Db47) \quad Bd_t(x, t) \triangleq \exists y B_t(x, y, t) \quad (\text{Inst. Boundary})$$

$$(Db48) \quad FBd_t(x, t) \triangleq \exists y FB_t(x, y, t) \quad (\text{Inst. Fiat Boundary})$$

$$(Db49) \quad BO_t(x, y, t) \triangleq FUS_t(x, z[B(z, y, t)], t) \quad (\text{Inst. Boundary Of})$$

$$(Db50) \quad CL_t(x, y, t) \triangleq \forall z (BO_t(z, x, t) \rightarrow SM_t(x, y, z, t)) \quad (\text{Inst. Closure})$$

$$(Db51) \quad INT_t(x, y, t) \triangleq \forall z (CL_t(z, y, t) \rightarrow DF_t(x, y, z, t)) \quad (\text{Inst. Interior})$$

$$(Db52) \quad WC_t(x, t) \triangleq \forall y, z, c_y, c_z ((SM_t(x, y, z, t) \wedge CL_t(c_y, y, t) \wedge CL_t(c_z, z, t)) \rightarrow O_t(c_x, c_y, t)) \\ (\text{Inst. Weak Connection})$$

$$(Db53) \quad MC_t(x, t) \triangleq \forall y, z, c_y, c_z ((SM_t(x, y, z, t) \wedge CL_t(c_y, y, t) \wedge CL_t(c_z, z, t)) \rightarrow \\ (O_t(c_y, z, t) \vee O_t(c_z, y, t))) \quad (\text{Inst. Mild Connection})$$

$$(Db54) \quad SC(x, t) \triangleq \forall y (INT_t(y, x, t) \rightarrow MC_t(y, t)) \quad (\text{Inst. Strong Connection})$$

$$(Db55) \quad C_t(x, y, t) \triangleq O_t(x, y, t) \vee \forall c_x, c_y ((CL_t(c_x, x, t) \wedge CL_t(c_y, y, t)) \rightarrow \\ (O_t(c_x, y, t) \vee O_t(c_y, x, t))) \quad (\text{Inst. Connection})$$

$$(Db56) \quad EC_t(x, y, t) \triangleq C_t(x, y, t) \wedge \neg O_t(x, y, t) \quad (\text{Inst. External Connection})$$

$$(Db57) \quad CLS_t(x, t) \triangleq CL_t(x, x, t) \quad (\text{Inst. Closed})$$

$$(Db58) \quad SBC_t(x, t) \triangleq SBL(x) \wedge SC_t(x, t) \wedge \forall y ((P_t(x, y, t) \wedge SC_t(y, t)) \rightarrow x = y) \\ (\text{Inst. Substance})$$

$$(Db59) \quad SBC(x) \triangleq \forall t (EX_t(x, t) \rightarrow SBC_t(x, t)) \quad (\text{Substance})$$

#### Axioms

$$(Ab66) \quad B_t(x, y, t) \rightarrow (EX_t(x, t) \wedge EX_t(y, t))$$

$$(Ab67) \quad (B_t(x, y, t) \wedge SR(y)) \rightarrow SR(x)$$

$$(Ab68) \quad (B_t(x, y, t) \wedge SBL(y)) \rightarrow SBL(x)$$

$$(Ab69) \quad (B_t(x, y, t) \wedge TRP(y)) \rightarrow TRP(x)$$

$$(Ab70) \quad (P_t(x, y, t) \wedge B_t(y, z, t)) \rightarrow B_t(x, z, t)$$

$$(Ab71) \quad FB_t(x, y, t) \rightarrow P_t(x, y, t)$$

$$(Ab72) \quad (P_t(x, y, t) \wedge FB_t(y, z, t)) \rightarrow FB_t(x, z, t)$$

$$(Ab73) \quad CL_t(x, y, t) \rightarrow P_t(y, x, t)$$

$$(Ab74) \quad (CL_t(x, y, t) \wedge CL_t(z, x, t)) \rightarrow P(z, x, t)$$

$$(Ab75) \quad (SM_t(x, y, z, t) \wedge SC_t(x, t)) \rightarrow FC_t(y, z, t)$$

$$(Ab76) \quad (SM_t(x, y, z, t) \wedge CL_t(c_x, x, t) \wedge CL_t(c_y, y, t) \wedge CL_t(c_z, z, t) \wedge SM_t(x', c_y, c_z, t)) \rightarrow_{c_x = x'}$$

$$(Ab77) \quad BO_t(x, y, t) \rightarrow B_t(x, y, t)$$

$$(Ab78) \quad (Bd_t(x, t) \wedge FCn_t(x, t)) \rightarrow \exists y, z (FCn_t(y, t) \wedge B_t(x, y, t) \wedge IP_t(z, y, t))$$

### Theorems

$$(Tb9) \quad B_t(x, y, t) \rightarrow (Snap(x) \wedge Snap(y) \wedge TI(t))$$

$$(Tb10) \quad BO_t(x, y, t) \rightarrow B_t(x, y, t)$$

$$(Tb11) \quad (CLS_t(x, t) \wedge B_t(x, y, t)) \rightarrow P_t(x, y, t)$$

Possible theorems in view of adaptation from [83]:

$$(Tb12) \quad (B_t(x, y, t) \wedge B_t(y, z, t)) \rightarrow B_t(x, z, t)$$

$$(Tb13) \quad (B_t(x, y, t) \wedge CMP_t(z, y, t)) \rightarrow B_t(x, z, t)$$

$$(Tb14) \quad \neg(EC_t(x, y, t) \wedge CLS_t(x, t) \wedge CLS_t(y, t))$$

$$(Tb15) \quad (FB_t(x, y, t) \wedge FB_t(y, z, t)) \rightarrow FB_t(x, z, t)$$

### 8.2.4 Instantaneous Dependence

Temporalized variant for dependence relations.

#### Definitions

- *Substance at an Instant*:  $SBC_t(x, t)$  means that, at  $t$ ,  $x$  is a *substance*, i.e. it is a maximally strongly connected substantial entity. It has a bona fide boundary.
- *Substance*:  $SBC(x)$  means that  $x$  is a substance at every time instant at which it exists.

$$(Db60) \quad MSD_t(x, y, t) \triangleq SD_t(x, y, t) \wedge SD_t(y, x, t) \quad (\text{Mutual Inst. Specific Dep.})$$

$$(Db61) \quad OSD_t(x, y, t) \triangleq SD_t(x, y, t) \wedge \neg SD_t(y, x, t) \quad (\text{One-side Inst. Specific Dep.})$$

$$(Db62) \quad SBC_t(x, t) \triangleq SBL(x) \wedge SC_t(x, t) \wedge \forall y ((P_t(x, y, t) \wedge SC_t(y, t)) \rightarrow x = y) \quad (\text{Substance at an Instant})$$

$$(Db63) \quad SBC(x) \triangleq \forall t (EX_t(x, t) \rightarrow SBC_t(x, t)) \quad (\text{Substance})$$

#### Axioms

$$(Ab79) \quad SD_t(x, y, t) \rightarrow (EX_t(x, t) \wedge EX_t(y, t))$$

$$(Ab80) \quad SD_t(x, y, t) \rightarrow \neg O_t(x, y, t)$$

$$(Ab81) \quad SR(x) \rightarrow \neg \exists y, t (SD_t(x, y, t))$$

$$(Ab82) \quad SBL(x) \rightarrow \neg \exists y, t (SD_t(x, y, t))$$

## Theorems

$$(Tb16) \quad (SBC(x) \wedge SBC(y) \wedge P_t(x, y, t)) \rightarrow x = y$$

### 8.2.5 Instantaneous Inherence

#### Definitions

- *Monadic Trope*:  $MTRP(x)$  means that  $x$  is a *monadic trope*, i.e., it is specifically dependent on at most on one substantial entity.
- *Relational Trope*:  $RTRP(x)$  means that  $x$  is a *relational trope*, i.e., it is specifically dependent on at least two substantial entities.

$$(Db64) \quad MTRP(x) \triangleq TRP(x) \wedge \forall y, z, t ((IH_t(x, y, t) \wedge IH_t(x, z, t)) \rightarrow y = z) \quad (\text{Monadic Trope})$$

$$(Db65) \quad RTRP(x) \triangleq TRP(x) \wedge \forall t (EX_t(x, t) \rightarrow \exists y, z (IH_t(x, y, t) \wedge IH_t(x, z, t) \wedge \neg y = z)) \quad (\text{Relational Trope})$$

#### Axioms

$$(Ab83) \quad IH_t(x, y, t) \rightarrow (TRP(x) \wedge SBL(y) \wedge TI(t))$$

$$(Ab84) \quad IH_t(x, y, t) \rightarrow SD_t(x, y, t)$$

$$(Ab85) \quad (SBC(x) \wedge EX_t(x, t)) \rightarrow \exists y (IH_t(y, x, t))$$

$$(Ab86) \quad (TRP(x) \wedge EX_t(x, t)) \rightarrow \exists y (IH_t(x, y, t))$$

$$(Ab87) \quad (MTRP(x) \wedge IH_t(x, y, t) \wedge IH_t(x, y', t')) \rightarrow y = y'$$

$$(Ab88) \quad (RTRP(x) \wedge \forall y_1, y_2, y_3, t ((IH_t(x, y_1, t) \wedge IH_t(x, y_2, t) \wedge IH_t(x, y_3, t)) \rightarrow (y_1 = y_2 \vee y_2 = y_3 \vee y_1 = y_3))) \rightarrow \forall z_1, z_2, z_3, z_4, t, t' ((IH_t(x, z_1, t) \wedge IH_t(x, z_2, t) \wedge IH_t(x, z_3, t') \wedge IH_t(x, z_4, t') \wedge \neg z_1 = z_2 \wedge \neg z_3 = z_4) \rightarrow ((z_1 = z_3 \wedge z_2 = z_4) \vee (z_1 = z_4 \vee z_2 = z_3)))$$

## Theorems

$$(Tb17) \quad IH_t(x, y, t) \rightarrow (EX_t(x, t) \wedge EX_t(y, t))$$

### 8.2.6 Space

#### Definitions

- *SpatialRegion*:  $SR(x)$  means that  $x$  is a *spatial region*, i.e., a part of space.

$$(Db66) \quad SR(x) \triangleq Snap(x) \wedge \forall t (EX_t(x, t) \rightarrow P(x, \text{space}, t)) \quad (\text{Spatial Region})$$

#### Axioms

$$(Ab89) \quad TI(t) \rightarrow EX_t(\text{space}, t)$$

## Theorems

(Tb18)  $Snap(\text{space})$

### 8.2.7 Instantaneous Spatial Location

#### Definitions

- *Instantaneous Spatial Subsumtion*:  $SbL_S(x, y, t)$  means that  $x$  spatially subsumes  $y$  at  $t$ , i.e., at  $t$ , the spatial location of  $x$  is a part of the spatial location of  $y$ .
- *Occupies*:  $OC_t(x, y, t)$  means that  $x$  occupies  $y$  at  $t$ , i.e., (i)  $x$  and  $y$  (which are both substantial entities) do not overlap at  $t$  and neither do their respective locations, but (ii) at  $t$ , the location of  $x$  is an internal part of the location of the sum of the  $x$  and  $y$ .
- *Site*:  $Site_t(x, t)$  means that  $x$  is a site at  $t$ , i.e., it is a substantial entity occupied at  $y$  by a substance.

(Db67)  $SbL_S(x, y, t) \triangleq \forall s_x, s_y ((L_S(x, s_x, t) \wedge L_S(y, s_y, t)) \rightarrow P_t(s_x, s_y, t))$   
(Spat. Subsumtion)

(Db68)  $OC_t(x, y, t) \triangleq \forall s_x, s_y (SBL(x) \wedge SBL(y) \wedge EX_t(x, t) \wedge EX_t(y, t) \wedge \neg O(x, y, t) \wedge L_S(x, s_x, t) \wedge L_S(y, s_y, t) \wedge SM_t(s_x, s_y)) \rightarrow (\neg O_t(s_x, s_y) \wedge IP_t(s_x, s_y))$   
(Occupies)

(Db69)  $Site_t(x, t) \triangleq \exists y (SBC(y) \wedge OC_t(y, x, t))$   
(Site)

#### Axioms

(Ab90)  $L_S(x, s, t) \rightarrow (Snap(x) \wedge SR(s) \wedge TI(t))$

(Ab91)  $L_S(x, s, t) \rightarrow (EX_t(x, t) \wedge EX_t(s, t))$

(Ab92)  $(L_S(x, s, t) \wedge L_S(x, s', t)) \rightarrow s = s'$

(Ab93)  $(Snap(x) \wedge EX_t(x, t)) \rightarrow \exists s (L_S(x, s, t))$

(Ab94)  $SR(x) \rightarrow \exists t (L_S(x, x, t))$

(Ab95)  $(TRP(x) \wedge FUS_t(y, z [IH_t(x, z, t)], t) \wedge L_S(y, s, t)) \rightarrow L_S(x, s, t)$

### 8.3 Relations between *Snap* and *Span* entities

Material in this section is partially based on or adapted from [42, 41, 43].

**Primitives relations.** The most fundamental form of participation is between a *Snap* entity and a temporal slice of a process (an event) - [42]:

- *Participation*:  $PC_{ss}(x, y, t)$  means that  $x$  is a substantial which participates in the event  $y$  at  $t$ .
- *Realization*:  $RZ_{ss}(x, y, t)$  means that  $x$  is in a process of realization in the event  $y$  at  $t$ .
- *Dependence*:  $SD_{ss}(x, y, t)$  means that  $x$  is dependent on the event  $y$  at  $t$ .

### Definitions

(Db70)  $TPC_t(x, y, t) \triangleq \exists z(TS(z, y) \wedge PC_{ss}(x, z, t))$  (Temporal Participation)

(Db71)  $CPC(x, y) \triangleq \forall t(OCC(y, t) \rightarrow TPC_t(x, y, t))$  (Complete Participation)

(Db72)  $LF(x, y) \triangleq FUS(x, z[CPC(y, z)])$  (Life)

(Db73)  $EvL_S(x, s_x, t) \triangleq FUS(s_x, s[\exists y(PC_t(y, x, t) \wedge L_S(y, s, t))], t)$  (Spat. Loc. of Events)

### Axioms

(Ab96)  $SD_{ss}(x, y, t) \rightarrow (Snap(x) \wedge EV(y) \wedge TI(t))$

(Ab97)  $SD_{ss}(x, y, t) \rightarrow (EX_t(x, t) \wedge IL_T(y, t))$

(Ab98)  $PC_{ss}(x, y, t) \rightarrow SD_{ss}(x, y, t)$

(Ab99)  $PC_{ss}(x, y, t) \rightarrow SBL(x)$

(Ab100)  $RZ_{ss}(x, y, t) \rightarrow \exists z(IH_t(x, z, t) \wedge PC_{ss}(z, y, t))$

(Ab101)  $(RZ_{ss}(x, y, t) \wedge IH_t(x, z, t)) \rightarrow PC_{ss}(z, y, t)$

## 9 Comparing the Basic Modules: A Case Study

In this section, we aim at comparing the ontologies in the library through an example. The example is stated as follows.

“A statue of clay exists for a period of time going from  $t_1$  to  $t_2$ . Between  $t_2$  and  $t_3$ , the statue is crashed and so ceases to exist although the clay is still there.”

### 9.1 The statue and the clay in DOLCE

This example is represented in DOLCE assuming that there is a *perdurant*, the crashing (*crash*), that lasts during all the period of time (from  $t_1$  to  $t_3$ ), and two *endurants*, the statue (*statue*) and the clay (*clay*), which are participants in the perdurant. More precisely, the crashing is an *accomplishment* (*ACC*), the statue is a *non-agentive physical object* (*NAPO*), and the clay is an *amount of matter* (*M*). Since in DOLCE one can represent temporal location explicitly using the category of *time intervals* (*T*), we have (Figure 6 illustrates the formal constraints between these entities):<sup>33</sup>

$$\begin{aligned} & ACC(crash) \wedge NAPO(statue) \wedge M(clay) \wedge T(t_1) \wedge T(t_2) \wedge T(t_3) \\ & PRE(crash, t_1 + t_2 + t_3) \wedge PC(statue, crash, t_1 + t_2) \wedge PC(clay, crash, t_1 + t_2 + t_3) \end{aligned}$$

From this, it follows that:

$$PRE(statue, t_1 + t_2) \wedge PRE(clay, t_1 + t_2 + t_3)$$

During its life, the statue is composed of the clay and so these are spatio-temporally co-localized:

$$DK(statue, clay, t_1 + t_2) \wedge statue \subseteq_{ST} clay$$

All these constraints are based on the temporal (*TL*) and spatial (*SL*) locations of the perdurant and endurants. In DOLCE, endurants have only direct spatial qualities and perdurants only temporal qualities. The temporal regions of endurant and the spatial regions of perdurants are inherited by means of the participation relation (the first conjunct below introduces these regions):

$$\begin{aligned} & TL(tl) \wedge SL(sl_c) \wedge SL(sl_s) \wedge S(s_1) \wedge S(s_2) \\ & qt(tl, crash) \wedge qt(sl_c, clay) \wedge qt(sl_s, statue) \\ & ql(t_1 + t_2 + t_3, tl) \wedge ql(s_1, sl_s, t_1 + t_2) \wedge ql(s_1, sl_c, t_1 + t_2) \wedge ql(s_2, sl_c, t_3) \end{aligned}$$

### 9.2 The statue and the clay in OCHRE

Since OCHRE is an object-centered ontology, the main elements in the example, namely the statue and the clay, are both introduced as *thin* objects:

<sup>33</sup>For the sake of simplicity, here we use maximal temporal indices only, i.e., we write  $PC(x, y, t_1 + t_2)$  without  $PC(x, y, t_1) \wedge PC(x, y, t_2)$  although the latter is formally required by the axioms of DOLCE.

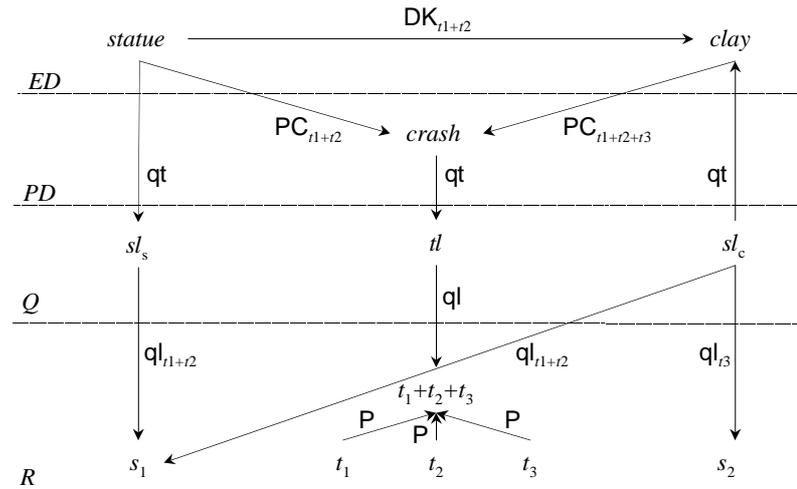


Figure 6: The statue and the clay in DOLCE: formal constraints constraints between the entities in the domain. The temporal index indicates the time interval at which the relation is valid.

$$TH(statue) \wedge TH(clay)$$

Recall that in OCHRE the parthood relation is extensional and that thin objects are *integral wholes*, thus each of these two objects have atomic proper parts that we dub “*essential tropes*”. Let us assume that each object has two essential tropes (Figure 7 illustrates the mereo-topological and spatio-temporal constraints):<sup>34</sup>

- the mass and the volume are essential to the clay:

$$TR(mass) \wedge TR(vol) \wedge AtP(mass, clay) \wedge AtP(vol, clay)$$

- the form and the color are essential to the statue:

$$TR(form) \wedge TR(color) \wedge AtP(form, statue) \wedge AtP(color, statue)$$

In OCHRE, one has to model time through temporal relations over *thick objects*. These objects are *stages* of thin objects. The temporal relation we need in this example is the relation of *immediate anteriority* (IA). We need at least three thick objects, say  $s_1, s_2$  and  $s_3$  (where  $s_i$  is related time  $t_i$ ):

$$TK(s_1) \wedge TK(s_2) \wedge TK(s_3)$$

$$H(statue, s_1) \wedge H(statue, s_2) \wedge H(clay, s_1) \wedge H(clay, s_2) \wedge H(clay, s_3)$$

$$IA(s_1, s_2) \wedge IA(s_2, s_3)$$

The fact that the *statue* is composed of the *clay* in the period from  $t_1$  to  $t_2$  can be represented as follows:

$$H(statue, s_1) \wedge H(statue, s_2) \wedge H(clay, s_1) \wedge H(clay, s_2) \wedge IA(s_1, s_2)$$

<sup>34</sup>For the sake of simplicity, we assume that all the tropes are simple (or atomic) although in general tropes like the color can be decomposed in different “dimensions”.

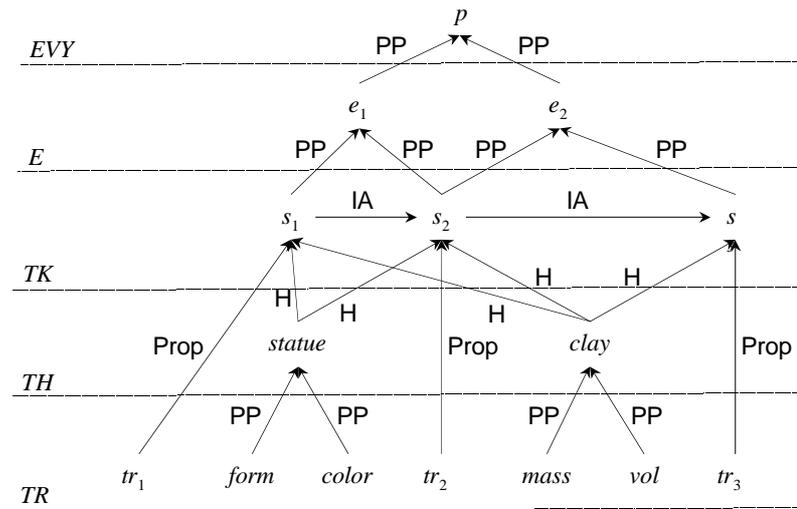


Figure 7: The statue and the clay in OCHRE: constraints on Mereology and Space-time.

That is, the relationship between the statue and the clay is not captured through the *connection* relation.<sup>35</sup> Instead, they are considered haecceities of the same thick object.

From the definition of H, all the essential tropes of the clay and of the statue are parts of  $s_1$  and  $s_2$ . Therefore, to distinguish these two stages (and to distinguish  $s_3$  from the thin object *clay*), we need additional tropes here called  $tr_1, tr_2, tr_3$ . These new tropes are *direct parts* of the thick objects (stages) and are not part of the thin objects themselves ( $tr_i$  is a *property* of  $s_i$ ):

$$TR(tr_1) \wedge TR(tr_2) \wedge TR(tr_3) \\ P(tr_1, s_1) \wedge P(tr_2, s_2) \wedge P(tr_3, s_3)$$

At this point, we look at the constraints for the *foundation* relation. For this, recall that:

- thin objects are founded on their parts only (see (Ao16));
- properties are founded on exactly one thin object (see (Ao42) and (Ao43));
- thick objects are founded on at least one thin object;
- thin objects are integral wholes, thus one of the two essential tropes we stated has to be founded on the other (see (Do16) and (Ao19)).

These constraints are captured by the following expressions (Figure 8 illustrates the constraints on the foundation primitive):

$$F(statue, form) \wedge F(statue, color) \wedge F(clay, mass) \wedge F(clay, vol) \\ F(tr_1, clay) \wedge F(tr_2, clay) \wedge F(tr_3, clay) \\ F(s_1, statue) \wedge F(s_2, statue, color) \wedge F(s_1, clay) \wedge F(s_2, clay) \wedge F(s_3, clay)$$

<sup>35</sup>Remember that the *connection* relation is defined only on thick objects.

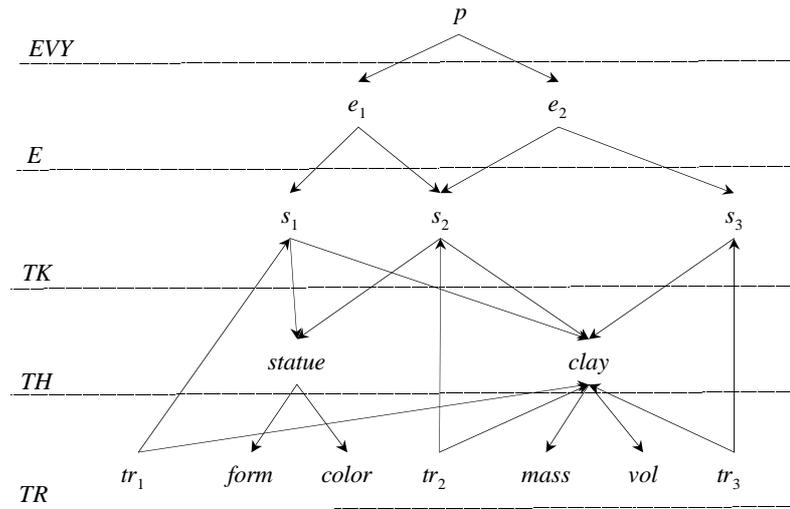


Figure 8: The statue and the clay in OCHRE: constraints on the foundation relation.

$$F(\text{color}, \text{form}) \wedge F(\text{vol}, \text{mass})$$

Note that the tropes  $tr_1$ ,  $tr_2$  and  $tr_3$  are *properties* of the thick objects  $s_1$ ,  $s_2$  and  $s_3$ , respectively. We have assumed that they are founded on the thin object *clay*. Thus, by (Do33), we have direct parts  $g_1$ ,  $g_2$  and  $g_3$  which are *guises* of the thick objects  $s_1$ ,  $s_2$  and  $s_3$ , respectively. Since no trope is founded on the statue, the statue forms a guise on its own:

$$SM(g_1, \text{clay}, tr_1) \wedge SM(g_2, \text{clay}, tr_2) \wedge SM(g_3, \text{clay}, tr_3)$$

$$G(g_1, \text{clay}, s_1) \wedge G(g_2, \text{clay}, s_2) \wedge G(g_3, \text{clay}, s_3)$$

$$G(\text{statue}, \text{statue}, s_1) \wedge G(\text{statue}, \text{statue}, s_2) \wedge G(\text{statue}, \text{statue}, s_3)$$

Thin objects are founded on their own parts. This explains why the thin object *statue* is not founded on the thin object *clay*.

Finally, the example we are dealing with is formalized using two events  $e_1, e_2$ :

$$SM(e_1, s_1, s_2) \wedge EV(e_1, \text{statue}) \wedge EV(e_1, \text{clay})$$

$$SM(e_2, s_2, s_3) \wedge EV(e_2, \text{clay})$$

and three *eventualities* ( $e_1, e_2$  and  $p$  such that  $SM(p, e_1, e_2)$ ). It follows that:

$$PC(\text{statue}, e_1) \wedge PC(\text{clay}, e_1) \wedge PC(\text{clay}, e_2) \wedge PC(\text{statue}, p) \wedge PC(\text{clay}, p)$$

### 9.3 The statue and the clay in BFO

At this stage of the formalization of BFO, we cannot provide a detailed description of the statue/clay example since it involves the notion of quasi-entity (a notion not formalized yet) and the more general meta-ontological framework (which is left out in this presentation). Nonetheless, we can give a few informal intuitions that drive BFO approach to this problem.

In BFO, a statue is simply a quasi-substance. In particular, it is an element of an ontology of art or social reality. It is consistent in BFO to think of a statue as capable of changing its parts (e.g., replacement of hands).

On the other hand, the ontology in which the clay is to be found is one of physical reality. What can be said about the clay before and after the crashing is that the first is genidentical to the aggregates of the detached parts. In a physical ontology, severing a piece of clay looks like a case of separation (creates two new substances). If you remove a part of the clay or replace it, the clay has changed (mereological change, maybe even morphological).

The formalization of these intuitions in the framework of BFO can be done in different ways and the issue is under discussion.

## 10 Comparing the Basic Modules: Formal Links

In this section we provide an explicit example of the connections among modules in the library. Here we focalize to the link from OCHRE to DOLCE. This example intends (i) to clarify what we intend for *semantic links* and (ii) to show the level of formal complexity they may require. Note that our procedure uses standard set theory. We do not believe the use of set theory is an exception restricted to the particular modules we are dealing with in this section. Although one can consider problematic the application of set theory, since it is much stronger than the formalisms *description logic* can represent, it should be noticed that set theory is applied only to construct formal structures and it is not required in the actual formula translation.

In our view, this kind of semantic links should form a special *translation module* in the library. This module should collect the formulas of a specific ontology and their translations into another ontology.

Our general task is the definition of a translation operator from OCHRE formulas into the DOLCE language. We indicate this operator with  $\Phi$ . Note that the inverse operator is not considered here.

Important differences between DOLCE and OCHRE make the translation particularly relevant. 1) As we know, DOLCE follows a *multiplicativist* approach, while OCHRE is a *revisionist* ontology. Indeed, OCHRE is based on a small number of basic categories and relations in comparison with DOLCE. This fact does not imply that OCHRE has a smaller number of entities in the domain of quantification. Rather, the modest structure at the level of categories and relations forces OCHRE to state strong existential conditions. 2) On the other hand, DOLCE considers a wider domain of quantification than OCHRE. For example, OCHRE does not include *abstract* entities. 3) The distinctions DOLCE introduces are more specific than those in OCHRE. For example, OCHRE does not distinguish *agentive* vs. *non-agentive* entities.

In other words, the DOLCE taxonomy is more inclusive and deeper than the taxonomy of OCHRE. For this reason, only a fragment of DOLCE is “expressible” in terms of the OCHRE language.

Technically speaking, we define:

- (i) two kinds of structures indicated with  $O$  and  $\mathcal{D}$  that are *associated*, respectively, with OCHRE and with a fragment of DOLCE;
- (ii) the operator  $\Phi : O \rightarrow \mathcal{D}$  mapping  $O$ -structures into  $\mathcal{D}$ -structures.

**Definition of OCHRE structures.** An OCHRE structure  $O$  is an ordered tuple

$$\langle PT, P, F, C, A, SI, CM \rangle$$

where:

- $PT$  is a non-empty set of “particulars”;
- $P$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *parthood* relation;

- $F$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *foundation* relation;
- $Sl$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *similarity* relation;
- $CM$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *comparability* relation;
- $C$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *connection* relation;
- $A$  is a binary relation on  $PT \times PT$  satisfying the OCHRE axioms on the *anteriority* relation.

In what follows we use all the definitions introduced in OCHRE. In particular, we often refer to the three subsets of  $PT$  corresponding to *tropes*, *thin objects*, and *thick objects*. These are:<sup>36</sup>

- $TR = \{x : x \in PT \wedge TR(x)\}$ ;
- $TH = \{x : x \in PT \wedge TH(x)\}$ ;
- $TK = \{x : x \in PT \wedge TK(x)\}$ .

As we will see, an OCHRE structure can be translated into DOLCE using only a subset of the DOLCE categories. This fact allows us to simplify the axiomatization of DOLCE considered in this section by disregarding the irrelevant distinctions: the new axioms are indicated by Aod while others are ignored. The changes are indicated below.

**Definition of DOLCE structures.** A DOLCE structure  $\mathcal{D}$  is an ordered tuple<sup>37</sup>

$$\langle ED, PD, Q, T, R, P^{(2)}, P^{(3)}, K, PC, qt, ql \rangle$$

where:

- $ED$  is a non-empty set of “endurants”;
- $PD$  is a non-empty set of “perdurants”;
- $Q$  is a non-empty set of “qualities”;
- $T$  is a non-empty set of “time intervals”;
- $R$  is a non-empty set of “space regions”;
- $P^{(2)}$  is a binary relation on  $(PD \cup T \cup R) \times (PD \cup T \cup R)$  satisfying the following DOLCE axioms on the *parthood* relation: (Ad1), (Ad2), (Ad5)–(Ad8)<sup>38</sup>. Instead of (Ad3) we consider the following two axioms:

<sup>36</sup>We use the same constant identifier for a set and its corresponding predicate since there is no danger of confusion.

<sup>37</sup>In DOLCE, *parthood* and *temporary parthood* are indicated with the same symbol because they differ in the number of arguments. In the structure we differentiate this two relations indicating the number of arguments. When the number of arguments is clear from the context, we drop the arity index.

<sup>38</sup>We take  $AB = T \cup R$ . In addition, we do not consider the DOLCE axiom for fusion (Ad9) because OCHRE does not include this operator.

$$(Aod1) P(x, y) \rightarrow (T(x) \leftrightarrow T(y))$$

$$(Aod2) P(x, y) \rightarrow (R(x) \leftrightarrow R(y))$$

- $P^{(3)}$  is a ternary relation on  $ED \times ED \times T$  satisfying the following DOLCE axioms on the *temporary parthood* relation: (Ad10), (Ad13), and (Ad16)–(Ad18);
- $K$  is a binary relation on  $ED \times ED^{39}$  satisfying the following DOLCE axioms on the *composition* relation: (Ad24)–(Ad27). In addition, instead of axiom (Ad20) we consider:

$$(Aod3) K(x, y, t) \rightarrow (ED(x) \wedge ED(y) \wedge T(t))$$

- $PC$  is a binary relation on  $ED \times PD$  satisfying the following DOLCE axioms on the *participation* relation: (Ad33)–(Ad37);
- $qt$  is a binary relation on  $Q \times ED^{40}$  satisfying the following DOLCE axioms on the *quality* relation: (Ad43)–(Ad44). In addition, instead of axioms (Ad38)–(Ad41) we consider:

$$(Aod4) qt(x, y) \rightarrow (Q(x) \wedge ED(y));$$

and instead of axioms (Ad46)–(Ad48) we consider:

$$(Aod5) Q(x) \rightarrow \exists y(qt(x, y));$$

- $ql$  is a ternary relation on  $R \times Q \times T$  satisfying the following DOLCE axioms on the *temporary quale* relation: (Ad65)–(Ad66). In addition, instead of (Ad58)–(Ad61) we consider:

$$(Aod6) ql(x, y, t) \rightarrow (R(x) \wedge Q(y) \wedge T(t));$$

and instead of (Ad62) we consider:

$$(Aod7) (Q(x) \wedge PRE(x, t)) \rightarrow \exists r(ql(r, x, t));$$

As for OCHRE, in what follows, we use all the definitions introduced in DOLCE.

**Definition of the operator  $\Phi$ .** Given an OCHRE structure  $O = \langle PT, P, F, C, A, SI, CM \rangle$  we define the DOLCE structure associated with  $O$

$$\Phi(O) = \langle ED, PD, Q, T, R, P^{(2)}, P^{(3)}, K, PC, qt, ql \rangle$$

in the following way:

$$(Dod1) ED = TH$$

$$(Dod2) PD = \wp(TK) \text{ where } \wp(TK) \text{ is the power set of } TK$$

Let  $T_{At}$  be the set of *atomic time intervals* defined as the maximal set of *simultaneously thick* objects:

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<sup>39</sup>We consider *composition* only between endurants. It is not clear to which extent it is possible to introduce composition between perdurants in OCHRE.

<sup>40</sup>We consider here qualities of endurants only.

(Dod3)  $T_{At} = \{|tk|_T : tk \in TK\}$ , where we put  $|tk|_T = \{tk' : SL(tk', tk)\}$

(Dod4)  $T = \wp(T_{At})$

(Dod5)  $Q = \{|tr, th|_Q : tr \in TR \wedge th \in TH \wedge IN(tr, th)\}$ , where

$$IN(tr, th) \triangleq tr \in TR \wedge th \in TH \wedge (P(tr, th) \vee \exists tk (\text{Prop}(tr, tk) \wedge H(th, tk)))$$

$$|tr, th|_Q = \{tr' : IN(tr', th) \wedge CM(tr', tr)\}$$

thus, a quality is the maximal set of *comparable* tropes that are in the relation  $IN$  with a thin object.

An atomic region is an element of  $R_{At}$  and it corresponds to a maximal set of similar tropes:

(Dod6)  $R_{At} = \{|tr|_R : tr \in TR\}$  and  $|tr|_R = \{tr' \in TR : SI(tr', tr)\}$

Using  $R_{At}$  we define regions in our structure as the elements of the following set:

(Dod7)  $R = \{||tr|_R| : |tr|_R \in R_{At}\}$ , where  $||tr|_R| \subseteq \{|tr'|_R \in R_{At} : CM(tr', tr)\}$

i.e. regions are sets of *comparable* atomic regions.

(Dod8)  $P^{(2)} = \{(x, y) : (x, y \in T \vee x, y \in R \vee x, y \in PD) \wedge x \subseteq y\}$

(Dod9)  $P^{(3)} = \{(x, y, t) : x, y \in ED \wedge t \in T \wedge \forall t_{at} \in t (P_{At}(x, y, t_{at}))\}$

where  $P_{At}$  is defined only on atomic time intervals by:

(Dod10)  $P_{At} = \{(x, y, t) : x, y \in ED \wedge t \in T_{At} \wedge \exists tk_x, tk_y \in t (H(x, tk_x) \wedge H(y, tk_y) \wedge P(tk_x, tk_y))\}$

(Dod11)  $K = \{(x, y, t) : x, y \in ED \wedge t \in T \wedge \forall t_{at} \in t (K_{At}(x, y, t_{at}))\}$

where  $K_{At}$  is defined only on atomic time intervals by:

(Dod12)  $K_{At} = \{(x, y, t) : x, y \in ED \wedge t \in T_{At} \wedge \exists tk \in t (H(x, tk) \wedge H(y, tk) \wedge \forall g_x, g_y ((G(g_x, tk, x) \wedge G(g_y, tk, y)) \rightarrow PP(g_x, g_y)))\}$

(Dod13)  $PC = \{(x, y, t) : x \in ED \wedge y \in PD \wedge t \in T \wedge \forall t_{at} \in t (PC_{At}(x, y, t_{at}))\}$

where  $PC_{At}$  is defined only on atomic time intervals by:

(Dod14)  $PC_{At} = \{(x, y, t) : x \in ED \wedge y \in PD \wedge t \in T_{At} \wedge \exists tk \in (t \cap y) (H(x, tk))\}$

(Dod15)  $qt = \{(|tr, th|_Q, th) : |tr, th|_Q \in Q \wedge th \in ED\}$

(Dod16)  $ql = \{(r, q, t) : r \in R \wedge q \in Q \wedge t \in T \wedge r = \{r_{at} : t_{at} \in t \wedge ql_{At}(r_{at}, q, t_{at})\}\}$

where  $ql_{At}$  is defined only on atomic time intervals by:

(Dod17)  $ql_{At} = \{(r, |tr, th|_Q, t) : r_{at} \in R_{At} \wedge |tr, th|_Q \in Q \wedge t \in T_{At} \wedge \exists tr', tk (tr' \in (|tr, th|_Q \cap r) \wedge tk \in t \wedge P(tr', tk) \wedge H(th, tk))\}$

(Dod1) states that endurants correspond to thin objects.

For the sake of simplicity, here we take perdurants to be any set of thick objects (Dod2). This means that we admit instantaneous perdurants (corresponding to singletons) and non-convex perdurants (corresponding to non-convex sets of elements in  $TK$ , where convexity is relative to the *anteriority* relation). Adding temporal or cardinal constraints on the sets in  $\wp(TK)$ , it is possible to limit  $PD$ . However, we do not consider this aspect. As in the case of perdurants, we admit non-convex and instantaneous time

intervals (Dod4); in particular, *atomic time intervals* are defined as the the maximal set of *simultaneous* thick objects (Dod3).

Quality are maximal sets of *comparable* tropes that are in the relation IN with a thin object (Dod5). Note that we consider qualities of thin objects only. It is not clear whether one can define qualities of qualities (properties of properties) or temporal qualities (qualities of thick objects). Also, we will consider physical and abstract regions only. The regions are defined as sets of comparable atomic regions (Dod7), where atomic regions are maximal sets of similar tropes of OCHRE (Dod6).

The relation of *being present* is not considered in  $\mathcal{D}$ , but it is very useful in the proofs. We introduce the PRE relation via the  $\text{PRE}_{\text{At}}$  relation defined only on atomic temporal intervals:

$$\text{(Dod18) } \text{PRE}_{\text{At}} = \{(x, t) : (x \in ED \wedge \exists tk \in t(\text{H}(x, tk))) \vee (x \in PD \wedge \exists tk \in x \cap t) \vee (x = |tr, th|_Q \in Q \wedge \exists tk \in t, \exists tr' \in |tr, th|_Q(\text{H}(th, tk) \wedge \text{P}(tr', tk)))\}$$

$$\text{(Dod19) } \text{PRE} = \{(x, t) : \forall t_{\text{at}} \in t(\text{PRE}_{\text{At}}(x, t_{\text{at}}))\}$$

**Main theorem.** *If  $O$  is an OCHRE structure, then  $\Phi(O)$  is a DOLCE structure.*

*Proof.* In the following we will consider only relations based on atomic temporal intervals ( $\text{P}_{\text{At}}, \text{K}_{\text{At}}, \text{PC}_{\text{At}}, \text{q}_{\text{At}}$ ); the general result follows directly from the definition of the correspondent non atomic version.

### Parthood

*Argument restrictions*

(Ad1), (Aod1), (Aod2) Directly from the definition (Dod8) and from the fact that  $AB = T \cup R$ .

*Ground axioms*

(Ad5)–(Ad8) Directly from the definitons (Dod8), (Dod4), (Dod7), and the properties of the  $\subseteq$  relation.

### Temporary Parthood

*Argument restrictions*

(Ad10) Directly from the definition of temporary parthood (Dod9).

*Ground axioms*

(Ad13) From  $\text{P}_{\text{At}}(x, y, t)$ ,  $\text{P}_{\text{At}}(y, z, t)$ , and (Dod10), we have

$$\exists tk_x, tk_y, tk'_y, tk_z \in t(\text{H}(x, tk_x) \wedge \text{H}(y, tk_y) \wedge \text{H}(y, tk'_y) \wedge \text{H}(z, tk_z) \wedge \text{P}(tk_x, tk_y) \wedge \text{P}(tk'_y, tk_z)).$$

By (Ao3) and (Ao41),  $\exists tk_x, tk_y, tk_z \in t(\text{H}(x, tk_x) \wedge \text{H}(y, tk_y) \wedge \text{H}(z, tk_z) \wedge \text{P}(tk_x, tk_y) \wedge \text{P}(tk_y, tk_z))$ . By (Ao3) again,  $\exists tk_x, tk_z \in t(\text{H}(x, tk_x) \wedge \text{H}(z, tk_z) \wedge \text{P}(tk_x, tk_z))$ , i.e.,  $\text{P}_{\text{At}}(x, z, t)$ .

*Links with other primitives*

(Ad16) From  $x \in ED \wedge \text{PRE}_{\text{At}}(x, t)$ , (Dod18), and (Ao1), we obtain  $\exists tk \in t(H(x, tk) \wedge P(tk, tk))$ . By (Dod10),  $\text{P}_{\text{At}}(x, x, t)$ .

(Ad17) From  $x, y \in ED \wedge \text{P}_{\text{At}}(x, y, t)$  and (Dod10),  $\exists tk_x, tk_y \in t(H(x, tk_x) \wedge H(y, tk_y) \wedge P(tk_x, tk_y))$ . We get  $\text{PRE}_{\text{At}}(x, t) \wedge \text{PRE}_{\text{At}}(y, t)$  using (Dod18).

(Ad18) Directly from (Dod9), (Dod4), and (Dod8).

### Constitution

#### Argument restrictions

(Aod3) Directly from (Dod11).

#### Ground axioms

(Ad24) From  $\text{K}_{\text{At}}(x, y, t)$  and (Dod12)

$$\exists tk \in t(H(x, tk) \wedge H(y, tk) \wedge \forall g_x, g_y((G(g_x, tk, x) \wedge G(g_y, tk, y)) \rightarrow \text{PP}(g_x, g_y))).$$

By the antisimmetry of PP,

$$\exists tk \in t(H(x, tk) \wedge H(y, tk) \wedge \forall g_x, g_y((G(g_x, tk, x) \wedge G(g_y, tk, y)) \rightarrow \neg \text{PP}(g_y, g_x))).$$

By (Dod12), we conclude that  $\neg \text{K}_{\text{At}}(y, x, t)$ .

(Ad25) From  $\text{K}_{\text{At}}(x, y, t) \wedge \text{K}_{\text{At}}(y, z, t)$  and (Dod12),  $\exists tk \in t(H(x, tk) \wedge H(y, tk) \wedge \forall g_x, g_y((G(g_x, tk, x) \wedge G(g_y, tk, y)) \rightarrow \text{PP}(g_x, g_y))) \wedge$

$$\exists tk' \in t(H(y, tk') \wedge H(z, tk') \wedge \forall g'_y, g'_z((G(g'_y, tk', y) \wedge G(g'_z, tk', z)) \rightarrow \text{PP}(g'_y, g'_z)))$$

Now, we can use (Ao41) to get

$$\begin{aligned} \exists tk \in t(H(x, tk) \wedge H(y, tk) \wedge H(z, tk) \wedge \\ \forall g_x, g_y((G(g_x, tk, x) \wedge G(g_y, tk, y)) \rightarrow \text{PP}(g_x, g_y)) \wedge \\ \forall g'_y, g'_z((G(g'_y, tk, y) \wedge G(g'_z, tk, z)) \rightarrow \text{PP}(g'_y, g'_z))) \end{aligned}$$

By (To1),

$$\begin{aligned} \exists tk \in t(H(x, tk) \wedge H(y, tk) \wedge H(z, tk) \wedge \\ \forall g_x, g_y, g_z((G(g_x, tk, x) \wedge G(g_y, tk, y) \wedge G(g_y, tk, z)) \rightarrow (\text{PP}(g_x, g_y) \wedge \text{PP}(g_y, g_z)))) \end{aligned}$$

Since PP is transitive, we get

$$\exists tk \in t(H(x, tk) \wedge H(z, tk) \wedge \forall g_x, g_z((G(g_x, tk, x) \wedge G(g_z, tk, z)) \rightarrow \text{PP}(g_x, g_z)))$$

thus,  $\text{K}_{\text{At}}(x, z, t)$  from (Dod12).

#### Links with other primitives

(Ad26) From  $\text{K}_{\text{At}}(x, y, t)$  and (Dod12), we get  $\exists tk \in t(H(x, tk) \wedge H(y, tk))$ . By (Dod18), we conclude that  $\text{PRE}_{\text{At}}(x, t) \wedge \text{PRE}_{\text{At}}(y, t)$ .

(Ad27) Directly from (Dod11), (Dod8), and (Dod4).

### Participation

#### Argument restrictions

(Ad33) Directly from (Dod13).

#### Existential axioms

(Ad34) From  $x \in PD \wedge \text{PRE}_{\text{At}}(x, t)$  and (Dod18), one gets  $\exists tk \in t \cap x$ . By (Ao40) and (Dod2), this gives  $\exists y \in ED, \exists tk \in t \cap x(H(y, tk))$ . Applying (Dod14),  $\exists y(\text{PC}_{\text{At}}(y, x, t))$  holds.

(Ad35) From  $x \in ED$ , (Ao46) and (Dod1),  $\exists tk(H(x, tk))$ . Taking  $t = |tk|_T$  and  $y = \{tk\}$ , one obtains  $\exists tk, y, t(tk \in t \cap y \wedge H(x, tk))$ . From this and (Dod14),  $\exists y, t(PC_{At}(x, y, t))$ .

*Links with other primitives*

(Ad36) From  $PC_{At}(x, y, t)$  and (Dod14),  $x \in ED \wedge y \in PD \wedge \exists tk(tk \in y \cap t \wedge H(x, tk))$ . By (Dod18),  $PRE_{At}(x, t) \wedge PRE_{At}(y, t)$ .

(Ad37) Directly from (Dod13), (Dod8), and (Dod4).

## Quality

*Argument restrictions*

(Aod4) Directly from (Dod15).

*Ground axioms*<sup>41</sup>

(Ad43) From  $qt(|tr, th|_Q, y) \wedge qt(|tr, th|_Q, y')$  and (Dod15),  $th = y \wedge th = y'$ . Thus,  $y = y'$ .

(Ad44) We can rewrite the hypothesis as:

$qt(|tr, th|_Q, y) \wedge qt(|tr', th'|_Q, y) \wedge CM(tr, tr')$ . By (Dod15),  
 $qt(|tr, th|_Q, y) \wedge qt(|tr', th'|_Q, y) \wedge CM(tr, tr')$ . From (Ao24), (Ao25) and (Dod5), we conclude that  $|tr, th|_Q = |tr', th'|_Q$ .

*Existential axioms*

(Aod5) Directly from (Dod5) and (Do15).

## Temporary quale

*Argument restrictions*

(Aod6) Directly from (Dod16)).

*Existential axioms*

(Ad62) From  $(Q(x) \wedge PRE_{At}(x, t))$  and (Dod18),

$(x = |tr, th|_Q \wedge \exists tk \in t, \exists tr' \in |tr, th|_Q(H(th, tk) \wedge P(tr', tk)))$ .

Let  $r = |tr'|_R$ , then

$\exists r \in R_{At}(\exists tk \in t, \exists tr' \in |tr, th|_Q \cap r(H(th, tk) \wedge P(tr', tk)))$  and, by (Dod17),  $\exists r(ql_{At}(r, x, t))$ .

*Links with other primitives*

(Ad65) From  $ql_{At}(r, |tr, th|_Q, t)$  and (Dod17),

$\exists tk \in t, \exists tr' \in |tr, th|_Q \cap r(H(th, tk) \wedge P(tr', tk))$ .

That is,  $\exists tk \in t, \exists tr' \in |tr, th|_Q(H(th, tk) \wedge P(tr', tk))$ . Using (Dod18), one concludes that  $PRE_{At}(|tr, th|_Q, t)$ .

(Ad66) Directly from (Dod16), (Dod8), and (Dod4).

□Main theorem

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<sup>41</sup>Note that considering only qualities of endurants  $qt$  and  $dqt$  coincide.

Note that in the definition of DOLCE structures we do not have considered (Ad14), for the relation  $P^{(3)}$ . This because, OCHRE structures have to be strengthened in order to prove this axiom via  $\Phi$ .

**Definition of  $P^{(3)}$ -extensional DOLCE structures.** A  $P^{(3)}$ -extensional DOLCE structure is a DOLCE structure with the additional axiom (Ad14).

**Definition of  $TK$ -extensional OCHRE structures.** A  $TK$ -extensional OCHRE structure is an OCHRE structure with the following additional axiom:

$$(Aod8) \quad (TK(x) \wedge TK(y) \wedge \neg P(x, y)) \rightarrow \exists z (TK(z) \wedge P(z, x) \wedge \neg O(z, y))$$

**Theorem.** *If  $O$  is a  $TK$ -extensional structure, then  $\Phi(O)$  is a  $P^{(3)}$ -extensional DOLCE structure.*

*Proof.* We need to prove only (Ad14):

(Ad14) From  $x, y \in ED \wedge PRE_{At}(x, t) \wedge PRE_{At}(y, t) \wedge \neg P_{At}(x, y, t)$ , (Dod10), and (Dod18),  
 $\exists tk_x, tk_y \in t (H(x, tk_x) \wedge H(y, tk_y) \wedge \neg P(tk_x, tk_y))$ . By (Aod8),  $\exists tk_x, tk_y \in t, \exists tk_z (H(x, tk_x) \wedge$   
 $H(y, tk_y) \wedge P(tk_z, tk_x) \wedge \neg O(tk_z, tk_y))$

Thus,  $\exists tk_x, tk_y, tk_z \in t (H(x, tk_x) \wedge H(y, tk_y) \wedge P(tk_z, tk_x) \wedge \neg O(tk_z, tk_y))$

and, by (Ao40),  $\exists tk_x, tk_y, tk_z \in t, z \in ED (H(x, tk_x) \wedge H(y, tk_y) \wedge H(z, tk_z) \wedge P(tk_z, tk_x) \wedge$   
 $\neg O(tk_y, tk_z))$

From this and (Dod10),  $\exists z \in ED (P_{At}(z, x, t) \wedge \neg O_{At}(z, y, t))$

□Theorem

## 11 The Link with Natural Language

In the last years, lexicographers, lexical semanticists and ontologists have been joining forces to build innovative systems for integrating ontological knowledge with lexica and semantic resources in general.

Although autonomously developed, lexica manifest a natural disposition to be informed by axiomatic ontologies: both kinds of resources are built with similar relations (hyponymy/subsumption, meronymy/parthood, etc.), attempt to represent concepts (synsets/ontological categories), and capture relevant aspects of human semantic and world knowledge. In particular, from the viewpoint of applications, the “alliance” between ontologies and lexica can improve the infrastructures of the emerging Semantic Web, supplying lexical coverage to formalized conceptual distinctions. Important examples of this interaction are the recent works on the conceptual analysis of WORDNET (one of the first lexical knowledge bases), and the wide use of upper ontologies in innovative international projects like EUROWORDNET<sup>42</sup>, SIMPLE, Balkanet<sup>43</sup>, DWDSnet<sup>44</sup>

The best-known and most frequently used lexicon in the NLP community is WORDNET [27], as we said above, one of the first resources available in the field. WORDNETS’ building blocks are sets of cognitively synonymous English words from the four major syntactic classes. The synsets are interlinked by conceptual-semantic relations, forming a tight network. The conceptual-semantic relations differ somewhat according to the part of speech category of the synsets members.

In the next paragraph we present an overview of the alignment we performed between DOLCE foundational ontology and WORDNET 1.6, focused on the their top level structure (for the WORDNET top hierarchy see Table 4).

### 11.1 Mapping WORDNET into DOLCE

In the recent years, we developed a methodology for testing the ontological adequacy of taxonomic links called OntoClean [47, 48], which was used as a tool for a first systematic analysis of WORDNET’s upper level taxonomy of nouns [35]. OntoClean was based on an ontology of properties (unary *universals*), characterized by means of meta-properties. DOLCE, in this sense, has to be seen as a complement of OntoClean, being a reference ontology which exploit the distinctions identified by OntoClean.

We adopt some preliminary assumptions in order to convert WORDNET’s databases into a workable knowledge base.

In order to work with named concepts, we normalized the way synsets are referred to lexemes in WORDNET, thus obtaining one distinct name for each synset: if a synset had a unique noun phrase, this was used as concept name; if that noun phrase was polysemous, the concept name was numbered (e.g. window\_1). If a synset had more than one synonymous noun phrase, the concept name linked them together with a dummy character (e.g. Equine\$Equid).

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<sup>42</sup><http://www.illc.uva.nl/EuroWordNet/>

<sup>43</sup><http://www.ceid.upatras.gr/Balkanet/>

<sup>44</sup><http://www.dwdsnet.com/>

Comparing WORDNET's unique beginners with DOLCE's ontological categories, it becomes evident that some notions are very heterogeneous: for example, Entity looks like a "catch-all" class containing concepts hardly classifiable elsewhere, like Anticipation, Imaginary\_Place, Inessential, etc. Such synsets have only a few children and these have been already excluded in our analysis.

Some examples of our merging work are sketched in Table 5. Some problems encountered for each category are discussed below.

### 11.1.1 Endurants

Entity is a very confused synset. A lot of its hyponyms have to be "rejected": in fact there are roles (Causal\_Agent, Subject\_4), unclear synsets (Location<sup>45</sup>.) and so on. This Unique Beginner maps partly to our Amount of Matter and partly to our Physical Object category. Some hyponyms of Physical\_Object are mapped to our top concept feature.

By removing roles like Arrangement and Straggle, Group\$grouping appears to include Agentive Social Object (social group, ethnic group), Non-agentive Social Object (circuit), Agentive Physical Object (citizenry) and Non-agentive Physical Object (biological group, kingdom; collection).

Possession\_1 is a role, and it includes both roles and types. In our opinion, the synsets marked as types (Asset, Liability, etc.) should be moved towards lower levels of the ontology, since their meanings seem to deal more with a specific domain - the economic one - than with a set of general concepts. This means that the remainder branch has also to be eliminated from the top level, because of its overall anti-rigidity (the peculiarity of roles).

### 11.1.2 Perdurants

Event\_1, Phenomenon\_1, State\_1 and Act\_1 are the Unique Beginners (top nodes) of those branches of WORDNET denoting perdurants. In particular, the hyponyms of State\_1 seem to fit well with our state category, as the children of Process (a subordinate of Phenomenon). For the time being, we restrict the mapping of our accomplishment category to the homonymous synset of WORDNET. Event\_1 is too heterogeneous to be clearly partitioned in terms of our approach: to a great extent, however, its hyponyms could be added to lower levels of the taxonomy of occurrences.

### 11.1.3 Qualities and Abstracts

ABSTRACTION\_1 is the most heterogeneous Unique Beginner: it contains abstracts such as Set\_5, quality regions such as Chromatic\_Color, qualities (mostly from the synset Attribute) and a hybrid concept (Relation\_1) that contains social objects, concrete entities (as Substance\_4<sup>46</sup>), and even meta-level categories. Each child synset has been mapped appropriately.

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<sup>45</sup>Referring to Location, we find roles (There, Here, Home, Base, Whereabouts), instances (Earth), and geometric concepts like Line, Point, etc.)

<sup>46</sup>"The stuff of which an object consists".

Psychological\_feature contains both mental objects (Cognition<sup>47</sup>) and events (Feeling\_1). We consider Motivation as a material role, so to be added to lower levels of the taxonomy of mental objects.

The classification of qualities deals mainly with adjectives. This alignment focuses on the WORDNET database of nouns; nevertheless our treatment of qualities foreshadows a semantic organization of the database of adjectives too, which is a current desideratum in the WORDNET community.

The final results of our mapping are sketched in Table 5. As one can see, a substantial taxonomy rearrangement has been performed. The application of the explicit distinctions of DOLCE helped clarifying the meaning of WORDNET senses. We believe that strong (and explicit) ontological distinctions should also help reducing the risk of classification mistakes in the ontology development process, and simplifying the update and maintenance process. This work, recently named ONTOWORDNET, is still ongoing: we are further refining our methodology and extending the conceptual analysis of the hierarchic levels of WORDNET taxonomy.

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<sup>47</sup>“The psychological result of perception, and learning and reasoning”.

<p><b>Abstraction_1</b>  Attribute  Color  Chromatic_Color  Measure\$Quantity\$Amount\$Quantum  Relation_1  Set_5  Space_1  Time_1</p> <p><b>Act\$Human_Action\$Human_Activity</b>  Action_1  Activity_1  Forfeit\$Forfeiture\$Sacrifice</p> <p><b>Entity\$Something</b>  Anticipation  Causal_Agent\$Cause\$Causal_Agency  Cell_1  Inessential\$Nonessential  Life_Form\$Organism\$Being\$...  Object\$Physical_Object  Artifact\$Artefact  Edge_3  Skin_4  Opening_3  Excavation\$. . .  Building_Material  Mass_5  Cement_2  Bricks_and_Mortar  Lath_and_Plaster  Body_Of_Water\$Water  Land\$Dry_Land\$Earth\$. . .  Location  Natural_Object  Blackbody_Full_Radiator  Body_5  Universe\$Existence\$Nature\$. . .  Paring\$Paring</p>	<p>Film  Part\$Portion  Body_Part  Substance\$Matter  Body_Substance  Chemical_Element  Food\$Nutrient  Part\$Piece  Subject\$Content\$Depicted_Object</p> <p><b>Event_1</b>  Fall_3  Happening\$Occurrence\$Natural_Event  Case\$Instance  Time\$Clip  Might-Have-Been</p> <p><b>Group\$Grouping</b>  Arrangement_2  Biological_Group  Citizenry\$People</p> <p><b>Phenomenon_1</b>  Consequence\$Effect\$Outcome. . .  Levitation  Luck\$Fortune</p> <p><b>Possession_1</b>  Asset  Liability\$Financial_Obligation\$. . .  Own_Right  Territory\$Dominion\$. . .  Transferred_Property\$. . .</p> <p><b>Psychological_Feature</b>  Cognition\$Knowledge  Structure  Feeling_1  Motivation\$Motive\$Need</p> <p><b>State_1</b>  Action\$Activity\$Activeness  Being\$Beingness\$Existence  Condition\$status  Damnation\$Eternal_Damnation</p>
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Table 4: WORDNET's Top Level.

<p><b>Endurant</b></p> <p><b>Physical Endurant</b></p> <p><b>Amount of matter</b></p> <ul style="list-style-type: none"> <li>body_substance</li> <li>chemical_element</li> <li>mixture</li> <li>compound\$chemical_compound</li> <li>mass_5</li> <li>fluid_1</li> </ul> <p><b>Physical Object</b></p> <p><b>Agentive Physical Object</b></p> <ul style="list-style-type: none"> <li>life_form\$organism\$being\$. . .</li> <li>citizenry</li> <li>sainthood</li> <li>ethnic_group</li> </ul> <p><b>Non-agentive Physical Object</b></p> <ul style="list-style-type: none"> <li>body_of_water\$water</li> <li>land\$dry_land\$earth\$. . .</li> <li>body\$organic_structure</li> <li>artifact\$artefact</li> <li>biological_group</li> <li>kingdom</li> <li>collection</li> <li>blackbody\$full_radiator</li> <li>body_5</li> <li>universe\$existence\$nature\$creation</li> </ul> <p><b>Feature</b></p> <ul style="list-style-type: none"> <li>edge_3</li> <li>skin_4</li> <li>paring\$parings</li> <li>opening_3</li> <li>excavation\$hole_in_the_ground</li> </ul> <p><b>Non-physical Endurant</b></p> <p><b>Mental Object</b></p> <ul style="list-style-type: none"> <li>cognition</li> <li>motivation</li> </ul> <p><b>Social Object</b></p> <p><b>Non-agentive Social Object</b></p> <ul style="list-style-type: none"> <li>rule\$prescript</li> <li>law</li> <li>circuit_5</li> </ul> <p><b>Agentive Social Object</b></p> <ul style="list-style-type: none"> <li>social_group</li> </ul>	<p><b>Perdurant</b></p> <p><b>Eventive</b></p> <p><b>Accomplishment</b></p> <ul style="list-style-type: none"> <li>accomplishment\$achievement</li> </ul> <p><b>Stative</b></p> <p><b>State</b></p> <ul style="list-style-type: none"> <li>condition\$status</li> <li>cognitive_state</li> <li>existence</li> <li>death_4</li> <li>degree</li> <li>medium_4</li> <li>relationship_1</li> <li>relationship_2</li> <li>conflict</li> </ul> <p><b>Process</b></p> <ul style="list-style-type: none"> <li>decrement_2</li> <li>increment</li> <li>shaping</li> <li>activity_1</li> <li>chelation</li> <li>execution</li> <li>activity_1</li> </ul> <p><b>Quality</b></p> <p><b>Physical Quality</b></p> <ul style="list-style-type: none"> <li>position\$place</li> <li>chromatic_color</li> </ul> <p><b>Temporal Quality</b></p> <ul style="list-style-type: none"> <li>time_interval\$interval</li> </ul> <p><b>Abstract</b></p> <p><b>Quality Region</b></p> <ul style="list-style-type: none"> <li>space_1</li> <li>time_1</li> <li>time_interval\$interval</li> <li>chromatic_color</li> </ul> <p><b>Set</b></p> <ul style="list-style-type: none"> <li>set_5</li> </ul> <p><b>Proposition</b></p> <ul style="list-style-type: none"> <li>statement_1</li> <li>symbol</li> </ul>
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Table 5: Mapping WORDNET into DOLCE.

## 12 A core Ontology of Services

This section has been developed in cooperation with Peter Mika, Marta Sabou of the Vrije Universiteit of Amsterdam, and Daniel Oberle of the Institute AIFB of the University of Karlsruhe.

### 12.1 Introduction

This Technical Report covers original work by the authors on an Ontology of Services and Service Descriptions. This work has been initiated within the European WonderWeb project [1].

The WonderWeb architecture envisages a tight integration between web-based KR languages, ontology learning and manipulation tools, foundational ontologies and ontology building methodologies.

WonderWeb also provides an infrastructure that facilitates plug'n'play engineering of ontology-based modules and, thus, the development and maintenance of comprehensive Semantic Web applications, an infrastructure which is called *Application Server for the Semantic Web (ASSW)* [68]. It facilitates re-use of existing modules, e.g. ontology stores, editors, and inference engines, combines means to coordinate the information flow between such modules, to define dependencies, to broadcast events between different modules and to translate between ontology-based data formats. Since software modules come as black boxes of code, descriptions need to be attached to them in order to facilitate their discovery. As a result, the ASSW features a registry that stores descriptions of the module and its API. Such descriptions adhere to an ontology which is not only used for module and API discovery, but also for manual classification, connectivity and implementation tasks. An Application Server for the Semantic Web can therefore be considered as *semantic middleware*. Additionally, there exists the possibility to offer a module's functionality by another paradigm. E.g., the module might not only be represented as one object revealing a particular API, but its functionality may also be accessible as separate web services. This is achieved by translating a module's ontological API description into corresponding web service descriptions.

Existing conceptualizations of web services, such as the Web Services Architecture (WSA) [6] are informal and thus cannot avoid ambiguities even in the very definition of web services (see Section 12.7). Ontologies for the descriptions of web services, in particular DAML-S [19] and its successor OWL-S, attempt to cater for both worlds, but make no distinction as to what are general aspects of services and what are the notions specific to software or web services in particular. As a result, confusion arises as to the nature of objects comprising and processed by web services (see Section 12.6).

Therefore, the initiative was taken within the project to create an Ontology of Services using the DOLCE foundational ontology, which has been also developed within the project. The resulting "upper ontology" of services based on well-founded principles is expected to influence (support) the design of more specific ontologies, such as the one designed for the description of software modules in the ASSW use case. It was also confirmed that the Ontology of Services would help in clearing up otherwise fuzzy definitions of concepts related to web services and in pointing out inconsistencies or ambiguities in

conceptualizations such as the WSA document.

The Ontology of Services is thus part of a layered architecture of ontologies developed within WonderWeb (cf. Figure 9). On the one hand, it is an extension (module) to the DOLCE foundational ontology [63]. In particular, it makes extensive use of the Ontology of Descriptions (also called Descriptions & Situations or D&S) available in the extended version of DOLCE, called DOLCE+ [36] (see also Section 12.4). On the other hand, the Ontology of Services generalizes notions of existing conceptualizations of web services or web service descriptions such as the DAML-S [19], the Web Services Architecture [6] or the Ontology of Software Modules used within the ASSW [67]. More specifically, the Ontology of Services covers all kinds of services, with information services as a special case. At the bottom layer of the architecture we find domain-level ontologies. An example of such an ontology is the ontology of Semantic Web tools, which provides descriptions directly processed by the ASSW.

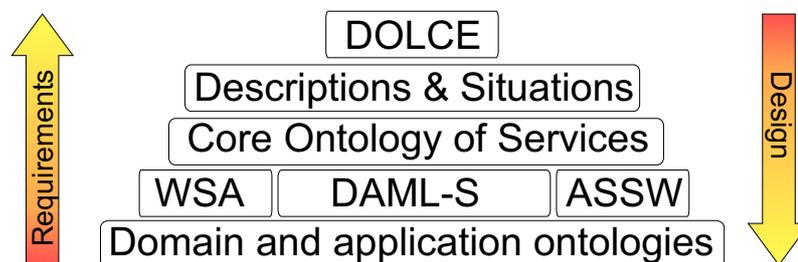


Figure 9: Ontology stacking in WonderWeb.

Our method was a combination of a bottom-up and a top-down approach. On the one hand, ontologies in the lower layers provided representation requirements for the higher layers, which abstracted their concepts and relationships. On the other hand, the upper layers provided design guidelines to the lower layers.

In the following, we will use the example of a typical (but hypothetical) web-based flight booking service to illustrate some of the notions introduced.

## 12.2 Motivation

We share the motivation of the DAML coalition that descriptions of (web) services should be formulated according to an ontology in order to support the automation of service related task.

While DAML-S defines service related concepts in relation to each other, it lacks the formal semantics to relate these concepts to the basic categories of philosophy, linguistics or human cognition. Typically for a domain ontology, there is no firm class or property hierarchy (most classes and properties are direct subclasses of the top level concept) and several relations take *Thing* as their domain or range. Part of the missing semantics is in the text of the document, while some are left to the reader or future work to decide.

We believe that this situation is not satisfactory: the level of commitment in DAML-S will need to be raised if it is to support the complex tasks put forward by the coalition (for

a description of these tasks, see [19, 6]). Further axiomatization through alignment to a foundational ontology will help to exclude terminological and conceptual ambiguities due to unintended interpretations. This capacity will be critical if DAML-S is to be employed on a global scale, where the meaning of descriptions will need to be constantly negotiated.

Axiomatization is not without dangers of its own: it may lead to the creation of an overly restrictive, rigid ontology which would require a commitment that is difficult to achieve on a global scale (see [88] for an analysis of the contradiction between the formality, sharing scope and stability of knowledge). However, we believe that this danger is mitigated by the design of DOLCE. While extensively researched and formalized, DOLCE is created with minimality in mind and includes only the most reusable and widely applicable upper-level categories [63]. DOLCE also calls for a careful isolation of the fundamental ontological options and their formal relationships and is built with modularization in mind. This means that DOLCE can avoid to become a single, monolithic upper-ontology that would be rejected by its users.

Note that DOLCE also allows us to observe minimality. In fact, our ontology is chiefly a combination of basic DOLCE and two extensions (an Ontology of Descriptions and an Ontology of Planning). To these existing ontologies less than 10 new concepts and 5 new properties were needed to be added to get to the core Ontology of Services.

### 12.3 Methodology

For the engineering of the Ontology of Services, we have chosen to follow a variation of ONIONS, the Ontologic Integration of Naive Sources methodology [38]. ONIONS has been successfully applied in the past for various developments (e.g. an ontology of fishery services for the FAO of the UN). The methodology consists of the five steps shown below, which result in a new module (domain-specific extension) to a given foundational ontology (FO). Foundational ontologies such as DOLCE are explicitly designed as upper-level frameworks for analyzing, harmonizing and integrating existing ontologies and metadata standards [63].

1. **Re-engineering.** In the re-engineering phase, the sources are acquired and transformed in a uniform representation (data format).
2. **Integration.** In this step the sources are integrated in a logical sense. For example, distinctions between classes and instances are made, data types are harmonized etc.
3. **Alignment.** During alignment, concepts and relationships of the sources are characterized in terms of the concepts and relationships of a Foundational Ontology (FO). For example, at this stage classes described in the source ontologies are defined as subclasses of the most specific superclass available in the FO.
4. **Merging.** In the last step, concepts described in various sources are merged when they carry the same meaning with respect to the application scenario.

The sources in our case were the WSA document, DAML-S, parts of the Common Information Model (CIM) and the Ontology of Software Modules used within the ASSW.

Instead of direct alignment to the DOLCE foundational ontology, we decided to develop a Core Ontology of Services based on D&S (which is an extension to DOLCE) and aligned the sources to this ontology. This two-stage alignment is a common technique when the conceptual gap between the source ontologies and the foundational ontology is large. Also, formulated at a more generic level, one may expect the core ontology to be reusable later in other scenarios (e.g. our Ontology of Services may be reused for descriptions of purely commercial services. However, our sources are geared specifically towards information services, which means that the resulting ontology may lack some of the notions necessary for the matching and retrieval of commercial service offerings).

The remaining sections of this technical report is organized as follows. The Ontology of Descriptions (D&S) is introduced in Section 12.4. The Core Ontology of Services is presented in Section 12.5. Experiences with the alignment of the WSA document, DAML-S, and the Application Server's ontology are discussed in Sections 12.7 to 12.9, respectively.

## 12.4 Descriptions as entities

### 12.4.1 Motivation

Foundational ontologies in WonderWeb are ontologies that contain a specification of domain-independent concepts and relations based on formal principles derived from linguistics, philosophy, and mathematics. Formal principles are needed to allow an explicit comparison between alternative ontologies. Examples of formal principles are spatio-temporal localization, topological closure, heterogeneity of parts, dependency on the intention of agents, etc. We refer to [63] for a detailed explanation.

While formalizing the principles governing physical objects or events is (quite) straightforward, intuition comes to odds when an ontology needs to be extended with *non-physical objects*, such as social institutions, organizations, plans, regulations, narratives, mental contents, schedules, parameters, diagnoses, etc. In fact, important fields of investigation have negated an ontological primitiveness to non-physical objects [65], because they are taken to have meaning only in combination with some other entity, i.e. their intended meaning results from a statement. For example, a norm, a plan, or a social role are to be represented as a (set of) statement(s), not as concepts. This position is documented by the almost exclusive attention dedicated by many important theoretical frameworks (BDI agent model, theory of trust, situation calculus, formal context analysis), to states of affairs, facts, beliefs, viewpoints, contexts, whose logical representation is set at the level of theories or models, not at the level of concepts or relations.

On the other hand, recent work (e.g. [65]) addresses non-physical objects as first-order entities that can change, or that can be manipulated similarly to physical entities. This means that many relations and axioms that are valid for physical entities can be used for non-physical ones as well.

Here we support the position by which non-physical entities can be represented both as theories/models and as concepts with explicit reification rules, and we share the following motivations:

1. Technology and society are full of reifications, for example when we divide human

experience into social, cultural, educational, political, religious, legal, economic, industrial, scientific or technological experiences

2. In realistic domains, specially in socially-intensive applications (e.g. law, finance, business, politics), a significant amount of terms convey concepts related to non-physical entities, and such concepts seem to be tightly interrelated
3. Interrelations between theories are notoriously difficult to be manipulated, then it would be an advantage to represent non-physical objects as instances of concepts instead of models satisfying some theory
4. For many domains of application, we are faced with partial theories and partial models that are explicated and/or used at various detail levels. Partiality and granularity are two more reasons to have some theories and models manipulated as first-order entities
5. Natural languages are able to reify whatever fragment of (usually informal) theories and models by simply creating or reusing a noun. Once linguistically reified, a theory or a model (either formal or informal) enters a life-cycle that allows agents to communicate even in presence of partial (or even no) information about the reified theory or model. The Web contains plenty of examples of such creatures: catalog subjects or topics, references to distributed resources, unstructured or semi-structured (but explicitly referenced) contents, such as plans, methods, regulations, formats, profiles, etc., and even linguistic elements and texts (taken independently from a particular physical encoding) can be considered a further example
6. Recent (still) unpublished work by one of the authors reports that more 25% of WordNet (v1.6) noun synsets [28] can be formalised as non-physical object classes

In general, we feel entitled to say that representing ontological (reified) contexts is a difficult alternative to avoid, when so much domain-oriented and linguistic categorisations involve reification. However, we also want to provide an explicit account of the contextual nature of non-physical entities and thus aim for a reification that accounts to some extent for the partial and hybrid structure of such entities.

From the logical viewpoint, any reification of theories and models provides a first order representation. From the ontological engineering viewpoint, a straightforward reification is not enough, since the elements resulting from reification must be framed within an ontology, possibly built according to a foundational ontology.

#### **12.4.2 An Ontology of Descriptions and Situations**

The Descriptions and Situations ontology (D&S) [37] is an attempt to define a theory that supports a first-order manipulation of theories and models, independently from the particular foundational ontology it is plugged in.

In general, D&S commits only to a widespread and very ancient ontological distinction between *flux*, or an unstructured world or context, and *logos*, or an intentionality. D&S is neutral with respect to realism issues, such as whether we conceive a structure

because it is in the flux, or because it is in our intentionality [64]. D&S as a representation mechanism makes no pretense in either direction. Hence, a flux can have as many inherent structure (parts, boundaries, qualities, etc.) as one might want to believe in or might claim to have discovered, but without a logos, a flux would have no description of that structure.

When logos is applied to the description of the flux, some *structure* emerges (this reflects the cognitive structuring cognitive process [55]). The emerging structure is not necessarily equivalent to the actual structure.

Due to its neutrality with respect to realism, D&S can generalize the flux/logos distinction, in order to obtain an epistemological layering. Epistemological layering consists of assuming that any logical structure  $L_i$  (either formal or capable of being at least partly formalised) is built upon a flux-like structure that it describes according to a more abstract, logos-like theory  $T_i$  (either formal or capable of being at least partly formalised).

In other words,  $T_i$  describes what kind of ontological commitment  $L_i$  is supposed to have within the epistemological layer that is shared by the encoder of an ontology.

Epistemological layering reflects the so-called *figure-ground* shifting cognitive process [55]. Moreover, most assumption-makings in any domain of interest apply epistemological layering (several names have been used to refer to flux-like structures: tacit knowledge, context, substrate, etc.).

D&S implements reification rules for any  $T_i$ , called a *description*, and a basic framework for any  $L_i$ , called a *situation*<sup>48</sup>, and for their elements.

Flux-like structures are not reified in D&S, but they result to be the structures that include all the (ground) logical dependencies of the components of a situation  $S$  classified within an ontology  $O$ , plus any additional elements that could be part of the ground context of  $S$  according to some encoder of  $O$ , but that are not inside  $O$ . A flux-like structure is called a *state of affairs* (SOA) in D&S.

### 12.4.3 Implementing the Ontology of Descriptions in DOLCE

DOLCE [63] has four top categories: enduring (including object- and substance-like entities), perdurant (event- and state-like entities), quality (individual attributes), and abstracts (mainly conceptual “regions” for structuring attributes).

Within DOLCE, D&S is plugged in as follows. A situation is a (new) top category, a description is a non-physical enduring. Description is disjoint from situation. A description may be satisfied by a SOA. The satisfaction relation is reified in D&S as a first-order *referenced-by* relation. A description satisfied by a SOA is an *s-description*. A SOA satisfying a description is a situation.<sup>49</sup>

Concerning the reification of the elements of a theory, the descriptions that reify a selection rule on DOLCE regions (e.g. speed limit or visibility) are called *parameters*, the descriptions that reify a functional property of DOLCE endurants (e.g. citizen or

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<sup>48</sup>We are keeping these names for the historical reasons. Other intuitive names have been proposed so far, e.g. representation, conceptualisation, or schema for description, and setting, Gestalt, or configuration for situation.

<sup>49</sup>A situation can satisfy a (s-)description in many ways, so that we can build a taxonomy of satisfaction (referenced by) relations.

judge) are called *functional roles*, and the descriptions that reify sequences of DOLCE perdurants (e.g. schedule or pathway) are called *courses*.

In D&S for DOLCE, descriptions have only other descriptions as parts. S-descriptions have courses, functional roles, and parameters as components. (See Fig. 10.) Between such components some relations hold: *modality-target* holding between functional roles and courses, and *requisite-for* holding between parameters and either functional roles or courses. Modality-target reifies the modal dependence between a functional property, and a sequence, while requisite-for reifies the logical dependence between a selection rule and either functional properties or sequences.

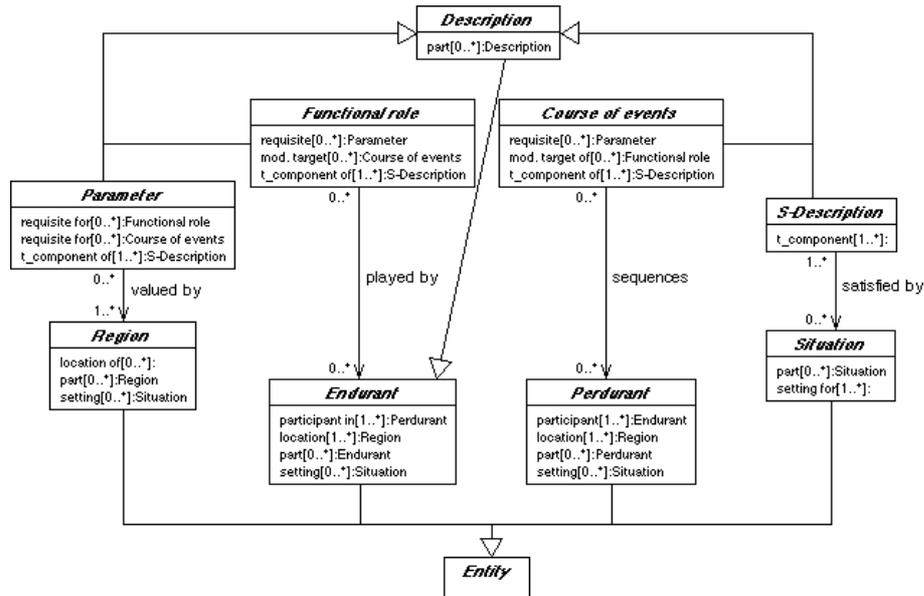


Figure 10: The DOLCE-Lite+ Library

Situations and s-descriptions are systematically related. The basic relation is *selects*, and it reifies the instantiation relation between an individual in a model and a concept in a theory. Within DOLCE, *selects* relates components of an (s-) description to instances of DOLCE categories. Intuitively, *selects*(x,y) binds an individual y classified in a DOLCE category to a situation s that is referenced (satisfies) the s-description d that has x as a component. In particular: parameters are *valued-by* regions, f-roles *play* endurants, and courses *sequence* perdurants.

Examples of descriptions and situations include:

- A clinical condition (situation) has an associated diagnosis (s-description) made by some agent.
- A case in point (situation) is constrained by a certain norm (s-description)
- A murder (situation) has been reported by a witness (functional role) in a testimony (s-description)
- Information science as a topic (s-description) references the manipulation of data structures (situation), both as a pure or applied science (parent s-descriptions)

- A person (endurant) plays the role of judge (functional role) in the context of a constitutive Law (s-description)
- 40kmph (region) is the value for a speed limit (parameter) in the context of an accident (state of affairs) described as a speed excess case (situation) in an area covered by traffic Law (s-description)

D&S results to be a theory of ontological contexts because it is capable to describe various notions of context (physical and non-physical situations, topics, provisions, plans, assessments, beliefs, etc.) as first-order entities.

## 12.5 The Core Ontology of Services

The core ontology of services consists of a repeated application of the Ontology of Descriptions (D&S).

D&S provides reification rules for the properties by which varieties of the three basic categories of DOLCE (regions, endurants and perdurants) are defined. Such reified rules are called parameters, roles and courses. Containers of such reified rules are called "descriptions" D&S is a design pattern, for modelling non-physical contexts such as views, theories, beliefs, norms etc. An important distinction is made in D&S between (the components of) descriptions (the reified rules) and (components of) a particular model, also called state-of-affairs (SOA): elements of a SOA (regions, endurants and perdurants) may play the parameters, roles and courses of a description, in which case the SOA is understood as a situation (case) for a particular description. However, the same SOA may be interpreted according to other, alternative descriptions. This captures an important feature of contexts, namely that multiple overlapping (or alternative) contexts may match the same world or model. For more information on D&S, we refer the reader to Section 12.4.

Service descriptions as non-physical contexts are ideally suited as applications of D&S. Descriptions of services can be considered as views from various perspectives on a series of activities that constitute the service for the various parties involved. In other words, service descriptions exhibit the same distinction between what is offered, expected or planned (descriptions, theories) and the elements that consist a particular model of the world.

Currently, we have considered five frequently occurring contexts regarding services, where each is a separate description of the same service in the D&S sense. More views may be added in the future when needs arise. Figure 11 shows their interrelationships.

1. **Service Offering (Description).** The Service Offering is the viewpoint of the legal entity providing the service. Much like commercial advertisements, the service offering may not describe entirely how the service will be carried out. This can also be considered as a proposal for a contract (agreement) for a service.
2. **Service Requirements (Description).** This is the counterpart of the offering in that it comprises the expectations of the requestor of the service. Requirements are often flexible, concerning only a subset of the tasks, roles and parameters of service activities (but might also contain others).

3. **Service Agreement (Description).** Once an agreement is reached between the provider and the requestor of the service, their joint understanding regarding the service may be described in a Service Agreement. Agreement means an understanding of the service as providing some value to the requestor, which may or may not be the same as the originally offered functionality of the service (in an extreme case, even doing nothing can be a service: consider the NOP command of machine language.)<sup>50</sup>
4. **Service Assessment (Description).** Typically, when an agreement is reached measures are taken to monitor, assess and control the execution of the service provided. Assessment concerns matching the service activities against the agreement.<sup>51</sup> Service assessment may be executed by a third party and may also involve aspects not even mentioned in the above three descriptions, e.g. the cleanliness of a hotel room may be checked by looking for dust on the TV sets. In the web services area, assessment is of particular concern to those interested in the management of web services.<sup>52</sup>
5. **Service Activities Description.** This is a description of the social conventions regarding the execution of a service, whether a written code of practice (ISO) or unwritten norm. This view is the basis for legal action once a service deviates from the norms in ways not foreseen in the agreement.

### 12.5.1 The Service Offering Description

In the following, we detail the structure of a Service Offering Description (see Figure 12). All other views are similar in nature.

The *Service Offering Description* is an S-Description, more precisely a Promise which has at least a single Service Task as temporary component.<sup>53</sup> A Task in DOLCE+ is a Course, which has only other tasks as temporary components and sequences at least one activity. A Task can also have a Situation as its precondition or postcondition, which may or may not relate to (elements of) a situation for the description in which the Task is defined.<sup>54</sup>

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<sup>50</sup>Independently from the fact that it may be described, similarly to WSA we believe that in general an agreement (written or unwritten) between provider and requestor is necessary to talk of a service. Spam, or a dolphin saving someone in the middle of the ocean is not considered a service, no matter how useful it proves afterwards.

<sup>51</sup>In an ideal world such a function would be meaningless. In reality, contracts are incomplete, since it is difficult to imagine all possible outcomes flowing from the agreement. Also, violations and the resulting penalties are often accepted rather than adhering to the contract (a kind of control strategy).

<sup>52</sup>The WSA document, for example, stresses the manageability of web services as this is a key feature to companies interested in providing management platforms for web services. The CIM standard was also developed for creating a common format for exchanging information between management systems (Software designed to manage the IT assets of companies, including both their software and hardware environment).

<sup>53</sup>In the following, all categories and relations not printed in Italics are defined in DOLCE+, see Section 12.4.

<sup>54</sup>We decided not to give different names to elements of the offering such as Service Offering Task. Unity criteria is given by the structure, i.e. the entire description.

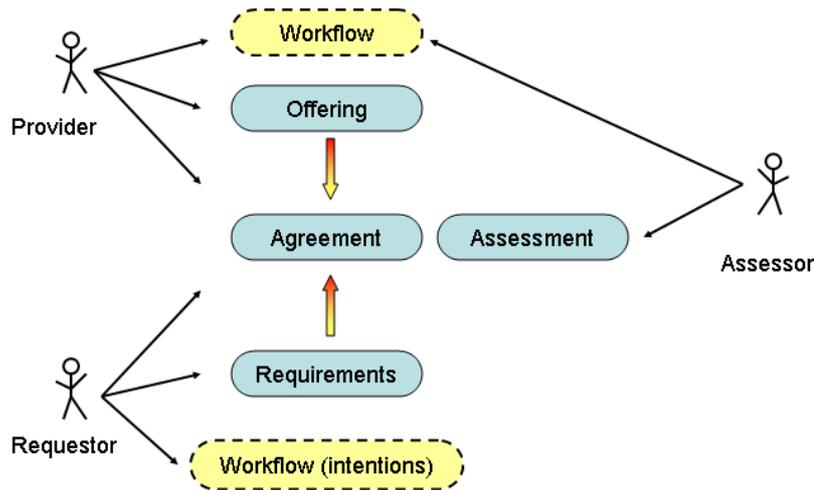


Figure 11: Relationships between the various views on a service.

We further define two disjoint subclasses of Task, *Service Task* and *Computational Task*. Service Tasks sequence only Service Activities and have only Service Tasks as temporary components. Similar statements hold for Computational Tasks. As we will see, the emergent distinction is that between tasks which require computational execution and work with information objects and tasks which involve physical objects.

A number of concepts from the Ontology of Planning are likely to be useful conjunction with the Core Ontology of Services. These include the division of tasks into elementary and complex tasks, and the construction of complex tasks from elementary ones. This part of the ontology is not detailed here, but can be consulted at <http://www.isib.cnr.it/infor/ontology/DOLCE.html>.

The chief difference between tasks and activities is that of between a plan and a particular execution of the plan: a plan represents possible sequences of execution. Examples of Computational Task are the reservation of a flight and the collection of payment, both in the sense of a transaction in an information system, even if it may be implemented in a number of ways. A Service Task can be flying the passenger (some passenger, not a particular one) to some destination. Again, this may be carried out in several ways.

In our ontology we also define a number of roles that are most commonly found in service descriptions. Two common agentive roles are introduced, namely *Requestor* and *Provider*. These are described as subclasses of the legally-constructed-person notion imported from a legal extension of DOLCE (Legally constructed persons are agentive functional roles played by socially constructed persons). In agreement with WSA, we conceive them as legal entities so that they can enter into agreement regarding a service. Examples are a passenger role (requestor of the booking service) and the role of the travel agency (provider of the service). We also conceive a third kind of agent role, namely that of the *Executor*. This can be used for modelling delegation.

Roles that are played by instruments of activities are called Instrumentality Roles in DOLCE-Lite+. *Input* and *Output* are examples of such roles. *Computational Input* and *Computational Output* are kinds of input and output that are played only by information objects and only have exploitation within Computational Tasks.

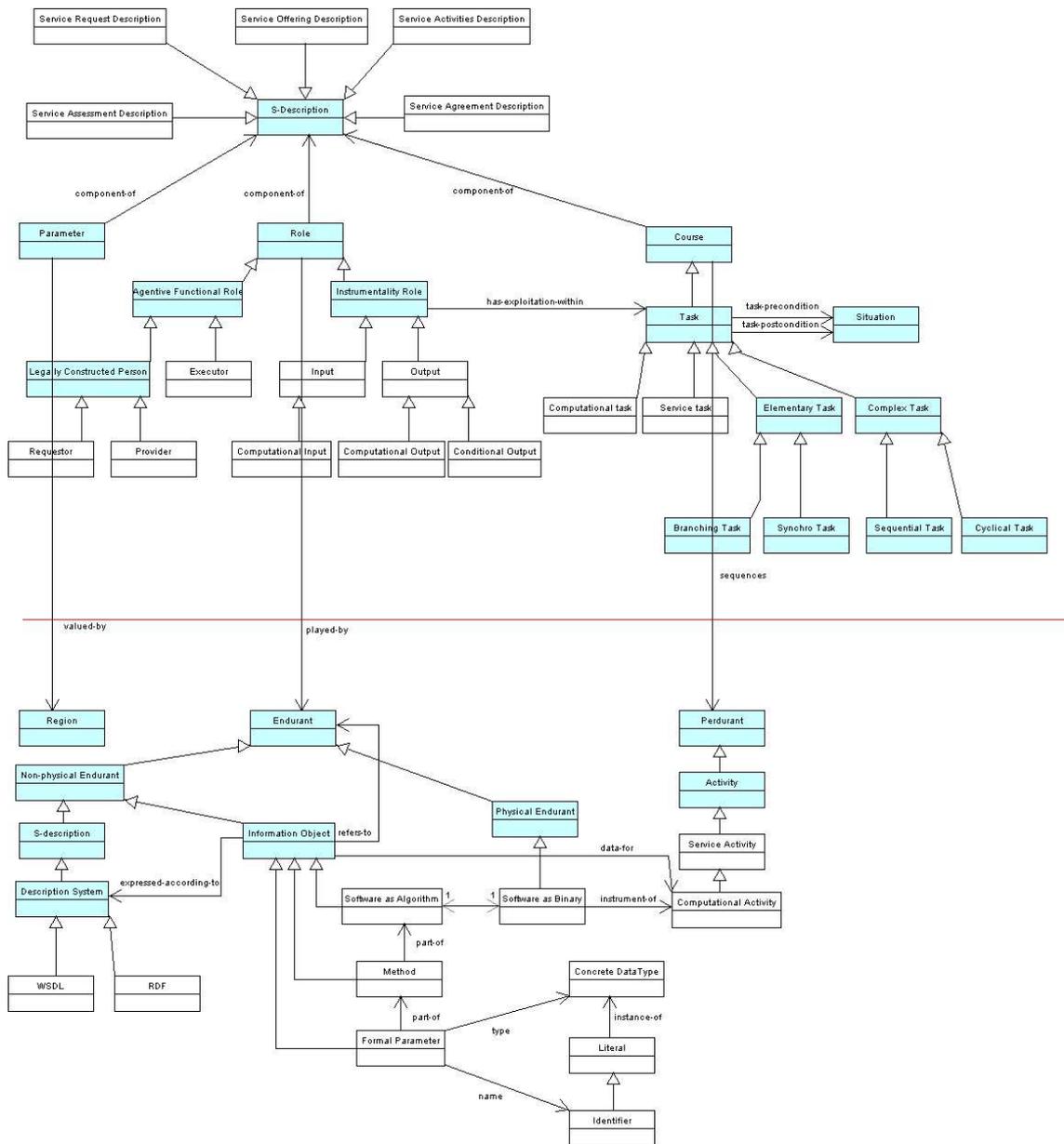


Figure 12: UML diagram of the Service Offering Description.

### 12.5.2 Service Situations

Our Service Offering Description introduced above stipulates the existence of a number entities in situations that satisfy the description. We also add some elements which may be useful in describing the settings of service executions.

A *Service Activity* is kind of Activity (a perdurant in DOLCE). A *Computational Activity* is a special kind of Service Activity which has only information objects or binary software as participants (Computational activity is another name for software as a perdurant). An example of a Service Activity would be flying Joe, a particular passenger, to his destination. An example of a Computational Activity would be the execution of the procedure that reserves a particular seat for a particular passenger.

Information Object is a non-physical endurant in DOLCE, which may be expressed according to a Description System. Examples of Description Systems are RDF or WSDL. As described in 12.6, *Software as Algorithm* is an information object, while *Software as Binary* represents its physical counterpart (more specifically, Software as Binary is said to be the instrument of a Computational Activity, while information objects are *data-for* the Computational Activity).

Assuming a procedural programming paradigm as common in the web services literature, Software as Algorithm is modelled as set of *Methods*. Methods in turn may have a number of *Parameters* as parts. Methods and Parameters are necessarily identified by names. Parameters must also have exactly one type.

We further introduce the minimal notions necessary for modelling information representation, partly based on earlier work on an ontology of communication and interpretation [37]. See Fig. 13 for an illustration.

In this example, Joe is a physical agent, but has a representation counterpart, namely the information object that is used to reference (identify) Joe in the software. The information object represents a meaning, an S-Description which may involve the entity in question. A Literal may extrinsically represent that information object, in which case the literal is said to be the name of the entity.

### 12.5.3 Axiomatization

$$\begin{aligned} & \text{Service\_Offering\_Description}(x) \rightarrow \text{promise}(x) \\ & \forall x. \text{Service\_Offering\_Description}(x) \rightarrow \\ & \exists y. \text{temporary\_component}(x, y) \wedge \text{Service\_Task}(y) \\ & \text{Service\_Requestor}(x) \rightarrow \text{Legally\_Constructed\_Person}(x) \\ & \text{Service\_Provider}(x) \rightarrow \text{Legally\_Constructed\_Person}(x) \\ & \text{Service\_Executor}(x) \rightarrow \text{agent\_role}(x) \end{aligned}$$

$$\begin{aligned} & \text{Service\_Input}(x) \rightarrow \text{non\_agentive\_functional\_role}(x) \\ & \text{Computational\_Input}(x) \rightarrow \text{Service\_Input}(x) \\ & \forall x, y. \text{Computational\_Input}(x) \wedge \text{played\_by}(x, y) \rightarrow \text{Information\_Object}(y) \\ & \forall x, y. \text{Computational\_Input}(x) \wedge \text{has\_exploitation\_within}(x, y) \rightarrow \\ & \text{Computational\_Task}(y) \end{aligned}$$

$$\text{Service\_Out put}(x) \rightarrow \text{non\_agentive\_functional\_role}(x)$$

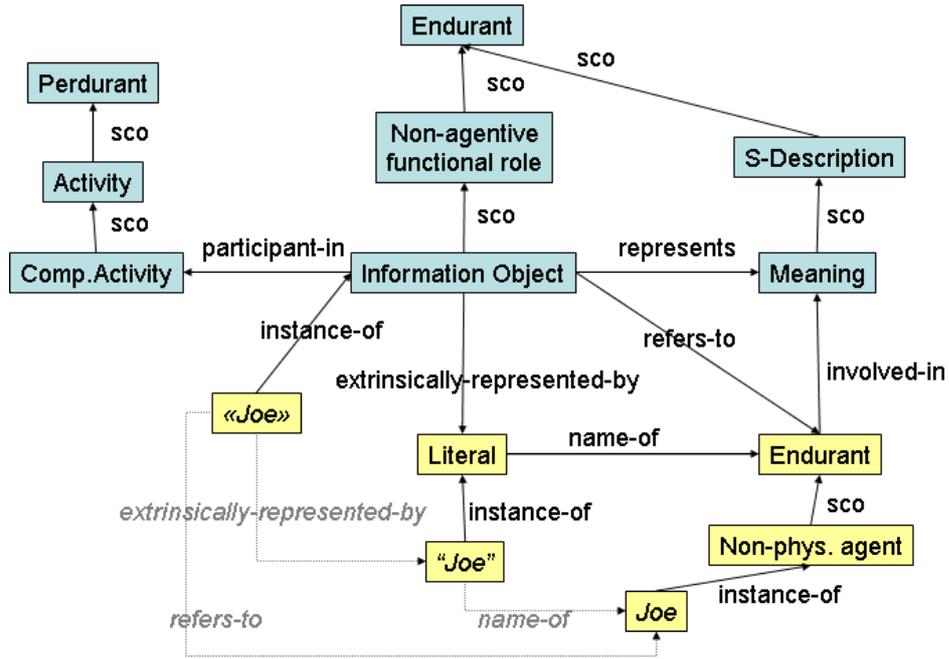


Figure 13: Modelling information representation.

$Computational\_Output(x) \rightarrow Service\_Output(x)$   
 $\forall x, y. Computational\_Output(x) \wedge played\_by(x, y) \rightarrow Information\_Object(y)$   
 $\forall x, y. Computational\_Output(x) \wedge has\_exploitation\_within(x, y) \rightarrow$   
 $Computational\_Task(y)$

$Conditional\_Output(x) \rightarrow Service\_Output(x)$

$Computational\_Task(x) \rightarrow Task(x)$

$\forall x, y. Computational\_Task(x) \wedge sequences(x, y) \rightarrow Computational\_Activity(y)$   
 $\forall x, y. Computational\_Task(x) \wedge temporary\_component(x, y) \rightarrow Computational\_Task(y)$   
 $Service\_Task(x) \rightarrow Task(x)$   
 $\forall x, y. Service\_Task(x) \wedge sequences(x, y) \rightarrow Service\_Activity(y)$   
 $\forall x, y. Service\_Task(x) \wedge temporary\_component(x, y) \rightarrow Service\_Task(y)$

$Service\_Activity(x) \rightarrow Activity(x)$   
 $Computational\_Activity(x) \rightarrow Activity(x)$   
 $\forall x, y. Computational\_Activity(x) \wedge participant(x, y) \rightarrow$   
 $Information\_Object(y) \vee Software\_As\_Binary(y)$

$\neg(Computational\_Activity(x) \wedge Service\_Activity(x))$   
 $\neg(Computational\_Task(x) \wedge Service\_Task(x))$

$Software\_as\_Algorithm(x) \rightarrow Information\_Object(x)$   
 $Software\_as\_Binary(x) \rightarrow Physical\_Endurant(x)$

$Literal(x) \rightarrow Concrete\_Datatype(x)$   
 $Identifier(x) \rightarrow Literal(x)$

$Method(x) \rightarrow Information\_Object(x)$   
 $\forall x, y. Method(x) \wedge name(x, y) \rightarrow Identifier(y) \wedge \nexists zy \neq z \wedge name(x, z) \wedge Identifier(z)$

$Formal\_Parameter(x) \rightarrow Information\_Object(x)$   
 $\forall x, y. Formal\_Parameter(x) \wedge name(x, y) \rightarrow Identifier(y) \wedge \neg \exists zy \neq z \wedge name(x, z) \wedge Identifier(z)$   
 $\forall x, y. Formal\_Parameter(x) \wedge name(x, y) \rightarrow Concrete\_Datatype(y) \wedge \neg \exists zy \neq z \wedge name(x, z) \wedge Concrete\_Datatype(z)$

$type(x, y) \rightarrow Property(x, y)$   
 $type(x, y) \rightarrow Formal\_Parameter(x)$   
 $type(x, y) \rightarrow Concrete\_Datatype(y)$   
 $type\_of(x, y) \rightarrow Property(x, y)$   
 $type\_of(x, y) \rightarrow Concrete\_Datatype(x)$   
 $type\_of(x, y) \rightarrow Formal\_Parameter(y)$   
 $type(x, y) \leftrightarrow type\_of(y, x)$

$extrinsically\_represented\_by(x, y) \rightarrow extrinsic\_relation(x, y)$   
 $extrinsically\_represented\_by(x, y) \rightarrow Information\_Object(x)$   
 $extrinsically\_represented\_by(x, y) \rightarrow Literal(y)$   
 $extrinsically\_represents(x, y) \rightarrow extrinsic\_relation(x, y)$   
 $extrinsically\_represents(x, y) \rightarrow Literal(x)$   
 $extrinsically\_represents(x, y) \rightarrow Information\_Object(y)$   
 $extrinsically\_represents(x, y) \leftrightarrow extrinsically\_represented\_by(y, x)$

$name\_of(x, y) \rightarrow extrinsic\_relation(x, y)$   
 $name\_of(x, y) \rightarrow Literal(x)$   
 $name\_of(x, y) \rightarrow Endurant(y)$   
 $name(x, y) \rightarrow extrinsic\_relation(x, y)$   
 $name(x, y) \rightarrow Endurant(x)$   
 $name(x, y) \rightarrow Literal(y)$   
 $name(x, y) \leftrightarrow name\_of(y, x)$

$data\_for(x, y) \rightarrow used\_in(x, y)$   
 $data\_for(x, y) \rightarrow Information\_Object(x)$   
 $data\_for(x, y) \rightarrow Computational\_Activity(y)$   
 $data(x, y) \rightarrow situation\_of\_use\_of(x, y)$   
 $data(x, y) \rightarrow Computational\_Activity(x)$   
 $data(x, y) \rightarrow Information\_Object(y)$   
 $data(x, y) \leftrightarrow data\_for(y, x)$

$task\_input(i, t) \leftrightarrow Task(t) \wedge Input(i) \wedge modality\_target(i, t)$

$$task\_output(o,t) \leftrightarrow Task(t) \wedge Output(i) \wedge modality\_target(o,t)$$
$$NameOf(x,y) \leftrightarrow Literal(x) \wedge Entity(y) \wedge \exists z,w. Information\_Object(z) \wedge Meaning(w) \wedge extrinsically\_represents(x,z) \wedge represents(z,w) \wedge involves(w,y) \wedge refers\_to(z,y)$$
$$input\_for(io,a) \leftrightarrow Information\_Object(io) \wedge Activity(a) \wedge \exists d,t,r. Serve\_Offering-Description(d) \wedge Agentive\_Functional\_Role(r) \wedge Task(t) \wedge Input(r) \wedge task\_input(r,t) \wedge sequences(t,a)$$
$$requestor\_in(e,a) \leftrightarrow Endurant(e) \wedge Service\_Requestor(a) \wedge plays(e,a) \wedge participant\_in(e,a)$$
$$provider\_in(e,a) \leftrightarrow Endurant(e) \wedge Service\_Provider(a) \wedge plays(e,a) \wedge participant\_in(e,a)$$
$$sequences(t,a) \wedge part(a,b) \rightarrow sequences(t,b)$$
$$participant\_in(e,p) \wedge setting(p,s) \rightarrow setting(e,s)$$

## 12.6 Defining web services: On the border of Infolandia

The greatest obstacle in conceptualizing web services seems to be the name itself, which is severely overloaded in meaning. Here are just some of the various definitions found in the literature:

1. A web service is a software system identified by a URI, whose public interfaces and bindings are defined and described using XML. Its definition can be discovered by other software systems. These systems may then interact with the web service in a manner prescribed by its definition, using XML based messages conveyed by internet protocols [6].
2. A web service is viewed as an abstract notion that must be implemented by a concrete agent. The agent is the physical entity (a piece of software) that sends and receives messages, while the service is the abstract set of functionality that is provided. To illustrate this distinction, you might implement a particular web service using one agent one day (perhaps written in one programming language), and a different agent the next day (perhaps written in a different programming language). Although the agent may have changed, the web service remains the same (also from [6], although in clear contradiction to the previous def.)
3. A service is an active program or a software component in a given environment that provides and manages access to a resource that is essential for the function of other entities in the environment. A web service is a service that abides by a specific framework to offer its services. The framework provides the means to describe and discover the service, audit its service offering, and integrate the service with other

services to offer higher-level services.<sup>55</sup>

4. Loosely speaking, a web service is a piece of functionality (an object, a component, an application, a database call) that can be invoked over a network using a predefined syntax.<sup>56</sup>
5. First of all, we start with an application that you want others to use. That is, you have a piece of software that initiates or accepts business transactions, provides or updates enterprise information, or perhaps manages the very systems and processes that make your business run. You may want to make this accessible to people in other parts of your organization, or a business partner, or a supplier, or a customer. We're really thinking here about software-to-software communication rather than the person-sitting-at-a-browser-talking-to-server-software situation, though it turns out that web services can be used there as well.<sup>57</sup>
6. Among the most important Web resources are those that provide services. By "service" we mean Web sites that do not merely provide static information but allow one to effect some action or change in the world, such as the sale of a product or the control of a physical device. The Semantic Web should enable users to locate, select, employ, compose, and monitor Web-based services automatically... Any Web-accessible program/sensor/device that is declared as a service will be regarded as a service. DAML-S does not preclude declaring simple, static Web pages to be services. But our primary motivation in defining DAML-S has been to support more complex tasks like those described above. [19]

These definitions call one of the following (or both, as in the case of WSA) a web service:

1. An information system, invokeable using particular technologies such as XML, i.e. accessible through the Web. This is often confused with the functionality attributed to the service, even though functionality of a tool is contingent on usefulness in a particular situation.<sup>58</sup>
2. Some functionality (service) provided and a task to be fulfilled. This task is external to the software, e.g. a business transaction.
3. An interface to a software or heterogeneous system, which makes it web accessible. Having a publicly available description of a service is often considered a requirement to call it a web service. As a consequence, this view often goes as far as equating the web service to (the description of) an interface.

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<sup>55</sup>cf. <http://www.informit.com> under "Web Development", "Web services".

<sup>56</sup>cf. <http://www.informit.com>, Article "Web Services Part 3: What Are Web Services" by Alex Nghiem.

<sup>57</sup>cf. <http://searchwebservices.techtarget.com>, definition of web services

<sup>58</sup>Similar phenomena exist with real world objects: a hammer becomes a "tool" instead of an artifact when it is in the hands of someone who knows how to use it. Otherwise, it's an amount of matter.

We have to separate these concepts in order to modularize our descriptions of services. It seems that at the heart of the entanglement between software, functionality and interfaces lies a disregard to the fact that web services exist on the boundary of the world inside an information system (Infolandia) and the outside world:

*The scope of “Web services” as that term is used by this working group is somewhat different. It encompasses not only the Web and REST Web services whose purpose is to create, retrieve, update, and delete information resources but extends the scope to consider services that perform an arbitrarily complex set of operations on resources that may not be “on the Web.” Although the distinctions here are murky and controversial, a “web service” invocation may lead to services being performed by people, physical objects being moved around (e.g. books delivered). [6]*

Thus web services carry out computational activities to *support* a service. But can we call the software a service? We believe that is not the case: usefulness, which is an essential property of a service, arises from the entire process involving real world as well as computational activities. In the case of a flight booking service, the customer of the service values the fact that as a result of the service, he will be able to transport himself to one place or another. The fact that part of the execution involves an interaction between the travel agent and the customer through an information system (e.g. a WWW site) is a mere implementation aspect from the customer point of view. This is not to say that there cannot exist services which concern purely information objects, e.g. the transformation of some data from one from to another. Most services offered via the Web, however, will not be pure information services.

The curious positioning of web services holds a particular challenge for ontological modelling. Descriptions of web services are, in fact, descriptions of two parallel worlds. In Infolandia, the world consist of software manipulating (representations of) information objects. Activities are sequenced by computational processes. Meantime in the real world passengers and airplanes are flying to their destinations. The connection between these worlds is simply that some of the information objects in Infolandia are symbols of (or identifiers for) real world objects. Also, computational activities comprise part of the service execution in the real world. For example, a booking needs to be entered by the travel agent into an information system, so that the airline would know which passengers to allow on the plane.

Since software stands in between the information and the real world, it stretches the categories of foundational ontologies.<sup>59</sup> Upon close inspection, it seems that the term software is also heavily inflicted by polysemy and refers to at least four different concepts:

1. An algorithm. An algorithm is like a tune in music, distinct from its notations or executions. Algorithm is an endurant in DOLCE terms.
2. The encoding of an algorithm in some kind of representation, e.g. binary or Java code. Encoding can be either in mind, on paper or any other form. This is software as information object, which is also an endurant.

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<sup>59</sup>The problem is similar to modelling communication, which occurs in three layers: 1) meaning 2) symbols, expressions 3) physical signals transmitted through a channel. The first two aspects are logical, while the last one is physical, yet part of the same process.

3. Static implementation of software, which is a file on someone's computer with the executable code. Different from the previous category in that it's a directly exploitable form. This kind of software is a perdurant or 4D object<sup>60</sup>.
4. The running system, which is the result of an execution. This is the form of software which manifests itself in the form electrical signals rising and dropping, the screen flickering and sound coming out the machine. This form of software is a physical perdurant or 4D object.

The first two items represent software as a product, while the latter two refer to the process nature of software.<sup>61</sup> The two seem just as inseparable as the wave and particle nature of light: without hardware in the physical world, no software would exist. In other words, perdurancy mutually depends on endurancy: for each state of a perdurant (software), there is a state of an endurant (hardware) reflecting that perdurant. Nevertheless, when we want to separate the two aspects of software in our descriptions, we will talk about Software-as-Perdurant and Software-as-Endurant.

## 12.7 Alignment of the Web Services Architecture

The Web Services Architecture (WSA) document is a work of the similarly named working group of the W3C, whose membership is almost exclusively comprised by industry representatives. The document is an effort by the W3C to create a conceptual framework of web services based, which matches the requirements collected in [4]. The document is also input to other web services related activities at the W3C, namely the XML Protocol Working Group (responsible, among others, for SOAP), the Web Services Description Working Group (working on WSDL) and the Web Services Choreography Working Group (working on service composition). The WSA is still a work in progress<sup>62</sup>, which means that our comments may be outdated.

In general, the document shows a great deal of confusion over the definition of a web service (see also Section 12.6). The current defines the web service as a software system and requires that web services are identified by a URI and their public interfaces and bindings are defined and described using XML. However, the authors themselves express doubts whether it's truly required for a web service to have a public description. The notion of binding is left undefined. Mentioning XML as base technology is also somewhat awkward, considering that it only concerns representation (ASCII or Unicode is then also a requirement).<sup>63</sup>

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<sup>60</sup>Strictly speaking software is a 4D object: while someone can sit on a chair at a certain point in time, it is not possible to make sense of software at a given point in time. 4D objects are not yet covered by DOLCE.

<sup>61</sup>Similar bipolar effect characterizes the difference between service and product in the commercial world. Products can be viewed as a service: if someone buys a house for lifetime rental, what he actually buys is the right to live there for the end of his life.

<sup>62</sup>W3C Working Draft of May 14, 2003

<sup>63</sup>The intention of the definition is to stress the interoperability requirements for web services. The document tries to be neutral with regard to more web-service-specific protocols.

Only one section later, in contradiction with the earlier definition, a web service is called an abstract notion that is implemented by an agent (a software). While it's not explained what this abstract notion is, the document notes that the purpose of a web service is to provide some functionality on behalf of its owner.<sup>64</sup> Further, in Section 1.6.2, the document returns to the original definition, when doubts are expressed in the comments whether the web service is the external code or an interface to some external code.

Besides notes on the architecture, the document also provides a collection of "Core Concepts and Relationships". Unfortunately, this is only available in text and pictures. (For that reason, we did not perform the actual physical alignment.)

Here we go through the major concepts, skipping features of the entire architecture, acts and concepts related to the management of web services.

Skipped: authentication, choreography description language, correlation, discovery, discovery service, feature, identifier, intermediary, life cycle, management capability, management configuration, management event, manager, manageable element, manageability interface, management metric, message exchange pattern, message header, message description language, message identifier, reliable messaging, representation, resource, SOAP, WSDL.

**Agent** A program, i.e. a software acting on behalf of a legal entity. A deployed element, i.e. physical.  
sameAs SoftwareAsEndurant and it plays computational agent role

**Choreography** A choreography is a set of possible interactions between a set of services. A choreography is thus another description, which operates on the union of the regions, endurants and perdurants referenced by the individual service descriptions. A choreography expresses only possible interactions, and therefore it is distinct from a composite service, i.e. a possible realization of interacting services.

**Deployed element** Deployed element is the collective name for physical objects. Agents, services and descriptions are mentioned as kinds of deployed elements. Deployed element is introduced also as a unit of manageability.

**Legal entity** Same as our definition.

**Message** A "unit of interaction between agents".  
Message is a functional role in communication played exclusively by information objects. (Pigeons carrying letters seem to be excluded )

**Message Sender, Message Receiver** Conceived as kinds of agents.  
We model sender and receiver as functional roles in communication.

**Service** Again a new definition, emphasizing the process nature of a service and the agreement needed: "A service is a set of actions that form a coherent whole from

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<sup>64</sup>"The provider entity is the legal entity that provides an appropriate agent to implement a particular service." How does one determine whether an agent is appropriate before an agreement is reached over the service? General feeling is that the industry community thinks of a web service as an extra interface to an existing line-of-business system, i.e. functionality is engrained.

the point of view of service providers and service requesters.”

If we disregard the universal, objectivist view of a service, this seems to be close to the set of tasks performed by a service or the entire description.

**Service Description** A “set of documents” that describe the interface to and semantics of a service.

If set of documents is meant in a representation-independent way, its akin to an information object representing the service (offering) description.

**Service Provider, Service Requester** Conceived as kinds of agents.

We model providers and requesters as functional roles in some description of a service.

**Service Semantics** “The semantics of a service is the contract between the service provider and the service requester that expresses the effect of invoking the service.”

Clearly, this is the Service Agreement Description.

**Service Task** “A service task is a unit of activity associated with a service. It is denoted by a pair: a goal and an action; the goal denotes the intended effect of the task and the action denotes the process by which the goal is achieved.”

Matches the DOLCE notion of a task.

## 12.8 Alignment of DAML-S

DAML-S divides information about a web service into three kinds of descriptions: profiles, processes and groundings. The reason behind this separation are the different functions these descriptions are designed to support. Profiles are primarily intended for discovery and matching of service offerings and requests, therefore profiles contain metadata about the service (classification, ratings, source) as well as inputs, outputs, preconditions and effects of the entire service. Process descriptions, on the other hand, support the composition of web services by describing the IOPEs of individual atomic services that may be identified within the service and valid sequences of executions. Lastly, grounding concerns the information necessary to invoke a web service over the internet. (All three kinds of descriptions are meant for machine processing.)

The goal of all modularizations is a separation of concerns. Given some division of concerns, a modularization is optimal if it reduces the need for links between modules in order to attend to those concerns (overlapping or cross-cutting concerns are problematic as there is a need to duplicate information, see the difficulty of maintaining consistency between IOPEs in the process and the profile). This suggests that related information, which is expected to be used in conjunction with the same concern, should be allocated to the same module. Without a history of usage of web services, it is not known at this point how the information available in web service descriptions would be used and therefore it is difficult to tell if the divisions in DAML-S are indeed the optimal ones.

Our ontology suggests one important dimension for modularization: the distinction between elements of the description (a plan) and a situation (its execution). However, we

leave further modularization dependent on future use cases for our descriptions (on the technical side, we are also waiting for a more versatile modularization mechanism than namespaces).

Although the definition of a service is ambiguous even in the natural text description of DAML-S, for the sake of argument we considered an *daml-s:Service* as a Service Offering Description, which has the *ServiceProfile* and *ServiceModel* (also Service Offering Descriptions) as parts. Actors in the *ServiceProfile* are aligned as Agentive Functional Roles. The *ServiceModel* concept was aligned to our Service Task concept, while the individual control constructs were mapped to task components provided by the Ontology of Plans.

In the Core Ontology of Services, the notions of Inputs and Outputs were modelled as Non-Agentive Functional Roles and not as relations in DAML-S. Nevertheless, alignment was possible by means of a composed relationship. On the other hand, the notion of preconditions and effects are inherited from the Ontology of Plans (task-precondition and task-postcondition) where they are modelled as Situations.

As it was not related to the focus of work, we omitted the alignment of the particular grounding ontology for WSDL [18]. Nevertheless, the notion of *Software* is present in the Core Ontology of Services as *Information Object* that can be expressed according to any number description systems.<sup>65</sup> WSDL could be considered as such a description system and modelled to the extent required to express groundings.

To the observer, our ontology might seem to be more verbose than DAML-S. In fact, we decompose many of the relationships in DAML-S, such as the link between endurants and their representation in information systems. We also decompose the grounding relation of DAML-S between processes and software implementations. Our goal in these decompositions is to find semantically distinct building blocks of these relationships and thus reconstruct semantics. In effect, DAML-S relationships may be easily recomposed from these blocks. For example, we may introduce a composed relationship between information objects and tasks, which says that if an information object *plays* input and that input *has exploitation within* a given task, we might say that such an information object is *input-for* that task, mimicking the similar relationship in DAML-S.

### 12.8.1 Illustrated example

In this Section we show how the semantics of the Congo example of DAML-S could be represented by our Core Ontology of Services. For the purposes of this demonstration, we shortened the example to the part described in [61].

We begin with the Service Offering Description proposed by Congo Inc., called CongoBuyOffering. CongoBuyOffering has a number of functional roles and tasks as parts.

$$\begin{aligned} \text{CongoBuyOffering}(x) &\rightarrow \text{Service\_Offering\_Description}(x) \\ \text{CongoCustomer}(x) &\rightarrow \text{Service\_Requestor}(x) \\ \forall x, y. \text{CongoCustomer}(x) \wedge \text{temporary\_component\_of}(x, y) &\rightarrow \text{CongoBuyOffering}(y) \\ \text{CongoProvider}(x) &\rightarrow \text{Service\_Provider}(x) \end{aligned}$$


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<sup>65</sup>An alternative, more refined representation we considered was to model *Software* as an S-Description, in the sense of an abstract algorithm.

$$\forall x, y. \text{CongoProvider}(x) \wedge \text{temporary\_component\_of}(x, y) \rightarrow \text{CongoBuyOffering}(y)$$

In all situations, CongoInc necessarily plays the role of the provider (a role restriction).

$$\text{agentive\_physical\_object}(\text{CongoInc})$$

$$\forall x, y. \text{CongoProvider}(x) \wedge \text{played\_by}(x, y) \rightarrow y = \text{CongoInc}$$

LocateBook and BuyBook are elementary computational tasks.

$$\text{LocateBook}(x) \rightarrow \text{Computational\_Task}(x)$$

$$\text{LocateBook}(x) \rightarrow \text{elementary\_task}(x)$$

$$\text{BuyBook}(x) \rightarrow \text{Computational\_Task}(x)$$

$$\text{BuyBook}(x) \rightarrow \text{elementary\_task}(x)$$

ExpandedCongoBuy is a complex service task, which has LocateBook and BuyBook as parts and is itself a temporary component of the offering. It is inferred that LocateBook and BuyBook are also temporary components.

$$\text{ExpandedCongoBuy}(x) \rightarrow \text{Service\_Task}(x)$$

$$\text{ExpandedCongoBuy}(x) \rightarrow \text{complex\_Task}(x)$$

$$\forall x, y. \text{LocateBook}(x) \wedge \text{part\_of}(x, y) \rightarrow \text{ExpandedCongoBuy}(y)$$

$$\forall x, y. \text{BuyBook}(x) \wedge \text{part\_of}(x, y) \rightarrow \text{ExpandedCongoBuy}(y)$$

$$\forall x, y. \text{ExpandedCongoBuy}(x) \wedge \text{temporary\_component\_of}(x, y) \rightarrow \text{CongoBuyOffering}(y)$$

BookToLocate is a computational input to LocateBook. DescriptionOutput and CatalogueBookOutput are conditional computational outputs of LocateBook.

$$\text{BookToLocate}(x) \rightarrow \text{Computational\_Input}(x)$$

$$\forall x, y. \text{BookToLocate}(x) \wedge \text{modality\_target}(x, y) \rightarrow \text{LocateBook}(y)$$

$$\text{DescriptionOutput}(x) \rightarrow \text{Conditional\_Output}(x)$$

$$\text{DescriptionOutput}(x) \rightarrow \text{Computational\_Output}(x)$$

$$\text{CatalogueBookOutput}(x) \rightarrow \text{Conditional\_Output}(x)$$

$$\text{CatalogueBookOutput}(x) \rightarrow \text{Computational\_Output}(x)$$

$$\forall x, y. \text{DescriptionOutput}(x) \wedge \text{modality\_target}(x, y) \rightarrow \text{LocateBook}(y)$$

$$\forall x, y. \text{CatalogueBookOutput}(x) \wedge \text{modality\_target}(x, y) \rightarrow \text{LocateBook}(y)$$

BookToLocate is played by information objects in RDF that reference a book (Role playing can be similarly restricted for the outputs of BookToLocate).

$$\text{BookDescription}(x) \rightarrow \text{Information\_Object}(x)$$

$$\text{language}(\text{RDF})$$

$$\forall x, y. \text{BookDescription}(x) \wedge \text{expressed\_according\_to}(x, y) \rightarrow y = \text{RDF}$$

$$\text{Book}(x) \rightarrow \text{Physical\_Endurant}(x)$$

$$\forall x, y. \text{BookDescription}(x) \wedge \text{refers\_to}(x, y) \rightarrow \text{Book}(y)$$

$$\forall x, y. \text{BookToLocate}(x) \wedge \text{played\_by}(x, y) \rightarrow \text{BookDescription}(y)$$

Next, we model an actual sale of a book. We show that this can be understood as a situation for the above description by mapping between elements of the setting and the service offering description. Note that this implies, for example, that CongoInc is necessarily participating in this sale as the provider.

*Situation(CongoSale)*  
*CongoBuyOffering(cbo)*  
*satisfies(CongoSale, cbo)*

Joe is a CongoInc customer, who participates in the activity.

*natural\_person(Joe)*  
*CongoCustomer(cc)*  
*plays(Joe, cc)*  
*participant\_in(Joe, BuyingWinnieThePooh)*

BookObject is an information object (document), which refers to WinnieThePooh, a book that the customer would like to find.

*Book(WinnieThePooh)*  
*Literal("WinnieThePooh")*  
*name\_of(WinnieThePooh, "WinnieThePooh")*  
*part\_of(WinnieThePooh, CongoSale)*  
*BookDescription(BookObject)*  
*refers\_to(BookObject, WinnieThePooh)*  
*BookToLocate(WinnieThePooh)*  
*plays(BookObject, WinnieThePooh)*  
*part(BookObject, CongoSale)*

BuyingWinnieThePooh is the actual activity that is performed in this sale according to the task description. LocatingWinnieThePooh is a computational part of the activity that is carried out to locate the book. The BookObject is data for this activity.

*Service\_Activity(BuyingWinnieThePooh)*  
*Computational\_Activity(LocatingWinnieThePooh)*  
*part\_of(LocatingWinnieThePooh, BuyingWinnieThePooh)*  
*setting(BuyingWinnieThePooh, CongoSale)*  
*ExpandedCongoBuy(ecb)*  
*sequences(ecb, BuyingWinnieThePooh)*  
*data\_for(BookObject, LocatingWinnieThePooh)*

We don't capture that Joe provides the information object, i.e. the book to locate. We do capture that the information object references a book, and we could capture as a precondition that Joe wants book. We could also describe the effect: Joe has a book.

## 12.9 Alignment of the Application Server's ontology

### 12.9.1 Original Ontology

The Application Server for the Semantic Web uses an ontology for software module and API discovery, manual classification of software modules and for implementation tasks [68]. During its design we tried to stay as close as possible to DAML-S (cf. Section 12.8) for it is an accepted standard that has been investigated for a long time and has a sound basis [67].

Although DAML-S serves as a good starting point for our ontology, the main difficulty was in the type of software entities to be described. While DAML-S describes web services, our goal is to describe software modules and their APIs. As a result some parts of DAML-S were not reusable. In the Appendix we present all the subontologies in DAML-S in comparison to ours before the alignment. What we will achieve in the next subsection is the alignment from the generic level, represented by DOLCE, D&S and the Core Ontology of Services, to the intermediate and domain level.

The *Implementation* subontology is primarily used to facilitate component discovery for the client and of particular importance as it introduces several new concepts. Its terminology is shown below.

**Software Module** Speaking in terms of the object-oriented paradigm, a software module is an object revealing an Application Programming Interface (API). A software module fulfills complex computational tasks. Examples: ontology store, inference engine.

**Component** Software module that is deployed to the Application Server for the Semantic Web <sup>66</sup>.

**System Component** Component providing functionality for the Application Server for the Semantic Web itself, e.g. the registry.

**Functional Component** Component that is of interest to the client and can be discovered. Ontology-related software modules become functional components by making them deployable, e.g. RDF stores.

**External Module** An external module cannot be deployed directly as it may be programmed in a different language, live on a different computing platform, etc. It equals a functional component from a client perspective. This is achieved by having a proxy component deployed that relays communication to the external module.

**Proxy Component** Special type of functional component that manages the communication to an external module. Examples are proxy components for inference engines, like FaCT.

**Interceptor** Software that monitors requests and modifies them. Examples: transaction or semantic interoperation interceptor.

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<sup>66</sup>We use the word deployment as the process of registering, possibly initializing and starting a component to the Microkernel.

**Surrogate** Software embedded in the client application. It offers the same API as a particular component and relays communication to it. Meant for ease of use in the ASSW scenario, similar to stubs in CORBA.

### 12.9.2 Aligning the taxonomy

In a first step, we strive to align the terminology in the subsection above. Figure 14 sketches an overview before we detail the concept's axioms in the following paragraphs.

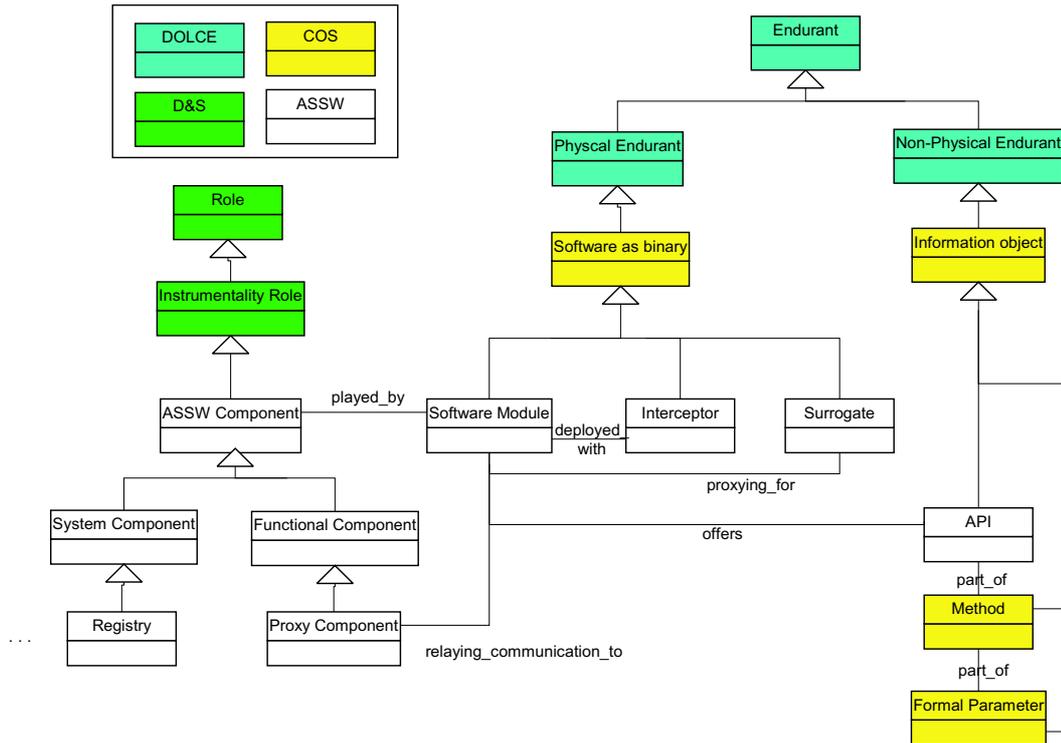


Figure 14: Alignment of the ASSW's concepts

Software Module, Interceptor and Surrogate become subconcepts of Software-as-binary. A Software module offers an API which in turn is subconcept of Information Object. An API consists of Methods and a Method may have Formal Parameters. Software Modules are deployed with an Interceptor and Surrogates proxy for Software Modules on the client side.

$Software\_Module(x) \rightarrow Software\_as\_binary(x)$

$Interceptor(x) \rightarrow Software\_as\_binary(x)$

$Surrogate(x) \rightarrow Software\_as\_binary(x)$

$API(x) \rightarrow Information\_object(x)$

$offers(x,y) \rightarrow Software\_Module(x)$

$offers(x,y) \rightarrow API(y)$

$deployed\_with(x,y) \rightarrow Software\_Module(x)$

$deployed\_with(x,y) \rightarrow Interceptor(y)$

$proxying\_for(x,y) \rightarrow Surrogate(x)$   
 $proxying\_for(x,y) \rightarrow Software\_Module(y)$

While the conceptualization above is quite generic, Software Modules can become Components in the Application Server for the Semantic Web setting (formalizing the specializations of Component is straightforward). This behavior shows a clear contextual nature and, thus, we model an ASSW Component as a role played by a Software Module. The most prominent example for that is an Ontology Store Software Module which is a first order entity but can be both the registry (i.e. a System Component) and a Functional Component within the Application Server.

$ASSW\_Component(x) \rightarrow Instrumentality\_Role(x)$   
 $\forall x,y.ASSW\_Component(x) \wedge played\_by(x,y) \rightarrow Software\_Module(y)$   
 $Functional\_Component(x) \rightarrow ASSW\_Component(x)$   
 $Proxy\_Component(x) \rightarrow Functional\_Component(x)$   
 $System\_Component(x) \rightarrow ASSW\_Component(x)$   
 $Registry(x) \rightarrow System\_Component(x)$

...

Note that we do not list all specializations of System Component here (Registry, Association Management, Component Loader, Cascading Component, etc.). Note also, that there is no need to model External Modules. It is enough to formalize Proxy Component as a role that relays communication to a Software Module.

$relaying\_communication\_to(x,y) \rightarrow Proxy\_Component(x)$   
 $relaying\_communication\_to(x,y) \rightarrow Software\_Module(y)$

### 12.9.3 API Descriptions

After aligning the terminology we would like to capture the intuition that is common in both DAML-S and ASSW, namely that there are semantic descriptions of software (describing functionality or tasks) and syntactic descriptions of software (describing parts of software as an object). Hence we come up with a new kind of description in the D&S sense, called APIDescription (cf. Figure 15).

In fact, we formalize a whole hierarchy of APIDescriptions as domain knowledge. E.g., in the Semantic Web domain, StoreAPIDescription along subconcepts like RDF-StoreAPIDescription or OntologyStoreAPIDescription. What is common to all APIDescriptions is that there has to be a role ASSW Component played by Software Module and the ASSW Component has exploitation within at least one Computational Task. The last relation is refined for specializations of APIDescriptions, e.g. in an RDFStoreAPIDescription the role of a Functional Component has exploitation within a StoreTriple Computational Task etc.

$StoreAPIDescription(x) \rightarrow APIDescription(x)$   
 $RDFStoreAPIDescription(x) \rightarrow StoreAPIDescription(x)$   
 $OntologyStoreAPIDescription(x) \rightarrow StoreAPIDescription(x)$

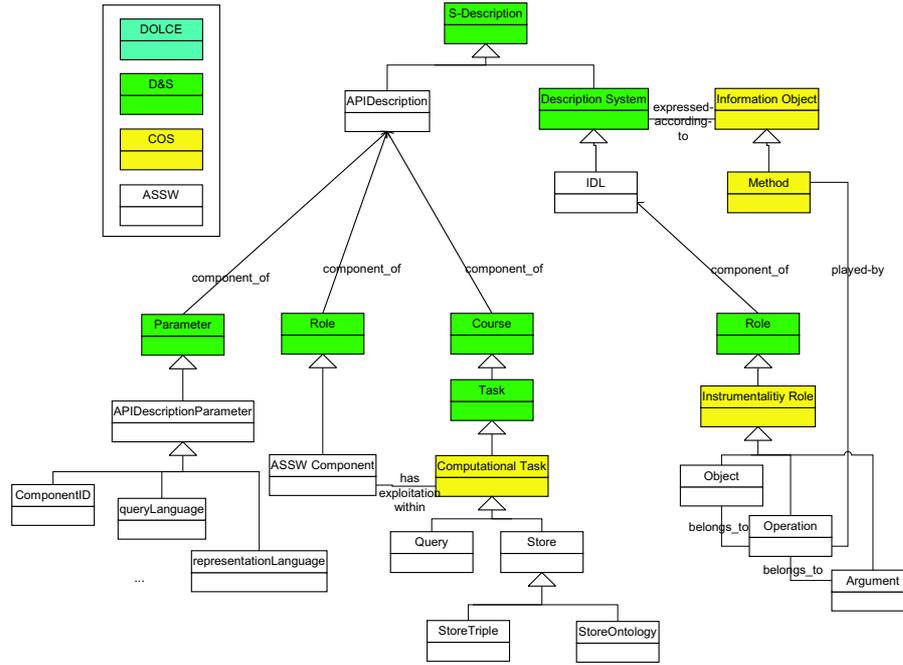


Figure 15: API Description

...

$$\forall x.APIDescription(x) \rightarrow$$

$$\exists y,z,t.component\_of(x,y) \wedge ASSW\_Component(y) \wedge played\_by(y,z) \wedge$$

$$SoftwareModule(z) \wedge has\_exploitation\_within(y,t) \wedge computational\_task(t)$$

...

$$\forall x.RDFStoreAPIDescription(x) \rightarrow$$

$$\exists y,z,t.component\_of(x,y) \wedge Functional\_Component(y) \wedge played\_by(y,z) \wedge$$

$$SoftwareModule(z) \wedge has\_exploitation\_within(y,t) \wedge StoreTriple(t)$$

...

**Roles.** The new roles introduced in the subsection above are relevant for the API Description. So-called ASSW Components and specializations are played by Software Modules (cf. Figure 14). Every ASSW Component has exploitation within a Computational Task.

**Courses.** As depicted in Figure 15 we use Computational Task which is part of the Core Ontology of Services and subconcept of DOLCE's Course. We define new, domain dependent, specializations thereof. In the example, we come up with Semantic Web related Computational Task like StoreTriple or StoreOntology. They become components of the API Description and have exploitation within the ASSW Component role which are ultimately played by Software Modules.

$$Store(x) \rightarrow computational\_task(x)$$

$$StoreTriple(x) \rightarrow Store(x)$$

$StoreOntology(x) \rightarrow Store(x)$

...

$Query(x) \rightarrow computational\_task(x)$

The other way around, it is important to model which Method fulfills the Computational Tasks mentioned above. Therefore we have to define a new relation 'fulfills' between Information Object and Computational Task independent of the APIDescription.

$fulfills(x,y) \rightarrow Information\_Object(x)$

$fulfills(x,y) \rightarrow Computational\_Task(x)$

**Parameters.** When a Software Module is deployed to the Application Server for the Semantic Web, it automatically gains several attributes, most prominently a ComponentID. Such properties do not belong to the software module but show a clear context dependency. Hence, we model them as new parameters that are component of the APIDescription (cf. Figure 15).

$ComponentID(x) \rightarrow APIDescriptionParameter(x)$

$\forall x.ComponentID(x) \rightarrow \exists y.APIDescription(y) \wedge component\_of(y,x)$

...

In addition, specializations of the APIDescription may have several domain-dependent properties. E.g., an StoreAPIDescription may have a parameter representationLanguage or queryLanguage. [70] gives a nice overview of different Semantic Web software modules and their characteristics. Such relations have to be axiomatized accordingly, e.g.

$queryLanguage(x) \rightarrow APIDescriptionParameter(x)$

$\forall x.queryLanguage(x) \rightarrow \exists y.StoreAPIDescription(y) \wedge component\_of(y,x)$

...

Figure 15 sketches the newly introduced parameter called APIDescriptionParameter which can be component of APIDescriptions only. Note that an APIDescription is not expected to have a certain number of parameters as component. They are optional altogether.

#### 12.9.4 IDL Descriptions

For the syntactic descriptions of software we come up with a new kind of description called IDLDescription. For this purpose we formalized the terminology of IDL (Interface Description Language [45]), viz. Object, Operation, Argument etc., as instrumentality roles. The idea is that such roles are played by information objects, e.g. Object is played by Software Module and Operation is played by Method.

The general idea is already featured in the Core Ontology of Services where Description Systems are introduced as subconcept of D&S's description. Information Objects, which are non physical Endurants, are expressed according to such a Description System. Examples would be RDF or the aforementioned IDL.

$IDLDescription(x) \rightarrow APIDescription(x)$   
 $\forall x.IDLDescription(x) \rightarrow \exists y.component\_of(x,y) \wedge Object(y)$   
 $\forall x.IDLDescription(x) \rightarrow \exists y.component\_of(x,y) \wedge Operation(y)$   
 $\forall x.IDLDescription(x) \rightarrow \exists y.component\_of(x,y) \wedge Parameter(y)$   
 ...  
 $\forall x.Object(x) \rightarrow \exists y.played\_by(x,y) \wedge Software\_Module(y)$   
 $\forall x.Operation(x) \rightarrow \exists y.played\_by(x,y) \wedge Method(y)$   
 $\forall x.Argument(x) \rightarrow \exists y.played\_by(x,y) \wedge Formal\_Parameter(y)$   
 ...

### 12.9.5 Example

Last but not least, the example in Figure 16 shows both an APIDescription and an IDLDescription of a KAON Ontology Store which is part of the KAON Tool suite [7]. For the sake of brevity, we limit ourselves to one Method 'AddStatement' which is part of the KAONOntologyStore Software Module and fulfills the task of storing a triple.

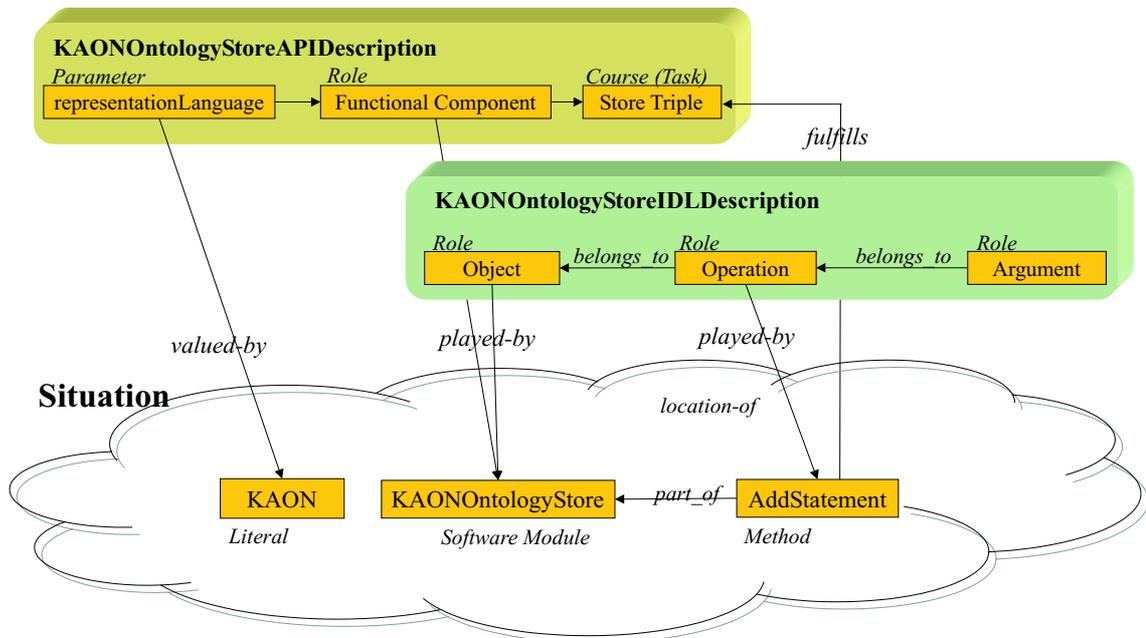


Figure 16: KAON Ontology Store Example

In our context, the KAONOntologyStoreAPIDescription plays the role of a functional component deployed to the Application Server. The description features several parameters, such as representationLanguage and the ComponentID. Furthermore, the Functional Component has exploitation within the StoreTriple task.

The KAONOntologyIDLDescription consists only of roles: Object is played by the KAONOntologyStore Software Module, Operation is played by the AddStatement Method, Argument played by a Formal Parameter and so on.

Note that an APIDescription is expected to have several Tasks, like StoreTriple, Query, Retrieve and so on. The same holds for IDLDescription which should feature one Object

role related to a multitude of Operation roles.

## Appendix

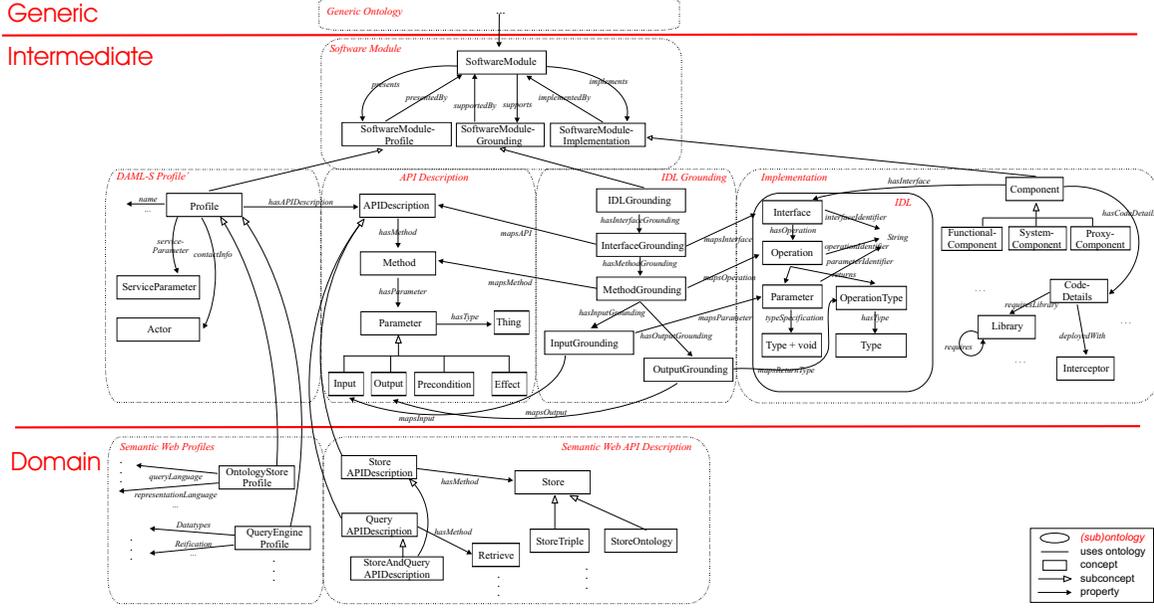


Figure 17: Application Server ontology overview before alignment

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## 13 APPENDIX A: KIF version of DOLCE

```
;;; DOLCE (V2.1) in KIF (text format)
;;; 31 December 03

;THIS IS A TRANSLATION IN KIF (ACCORDING TO THE KIF-DRAFT
;PROPOSED TO THE AMERICAN NATIONAL STANDARD NCITS.T2/98-004
;http://logic.stanford.edu/kif/dpans.html) OF DOLCE V2.1

;For comments on this version, please contact:
;borgo@loa-cnr.it

;REVIEW INFO
;CHANGES - COMMENTS

;(D13) changed WORD into WORLD - Typo
;(NA3)-(NA9) have been dropped - These occur already
;somewhere else
;(NA10)-(NA12) are left as comments - These are guaranteed
;by def. (ND5)
;(NA13) has been dropped -It follows from (NA14) and (D2)

; Basic functions and relations
; new non-rigid universals introduced in specialized
; theories or in new versions of DOLCE need to be added in
; this definition as new disjunction clauses of
; form (= ?f )
; (ND1): universals
(defrelation UNIVERSAL (?f) :=
  (or (X ?f)))

; new rigid universals introduced in new versions of DOLCE
; (or by the user) need to be added in this definition
; (ND2) rigid universals
(defrelation X (?f) :=
  (or (= ?f ALL) (= ?f AB) (= ?f R) (= ?f TR) (=
?f T) (= ?f PR) (= ?f S) (= ?f AR)
(= ?f Q) (= ?f TQ) (= ?f TL) (= ?f PQ) (= ?f SL)
(= ?f AQ) (= ?f ED) (= ?f M) (= ?f
PED) (= ?f F) (= ?f POB) (= ?f APO) (= ?f NAPO)
(= ?f NPED) (= ?f NPOB) (= ?f MOB)
(= ?f SOB) (= ?f ASO) (= ?f SAG) (= ?f SC) (= ?f
NASO) (= ?f AS) (= ?f PD) (= ?f
EV) (= ?f ACH) (= ?f ACC) (= ?f STV) (= ?f ST) (= ?f PRO))))

; there are no particulars in this version of DOLCE, any
; particular has to be added in this definition, the def.
; will have form : (or (= ?x ) (= ?x ))
; (ND3) particulars
(defrelation PARTICULAR(?x) :=
  )

; there are no named worlds in this version of DOLCE, any
; world has to be added in this definition, the def. Will
; have form : (or (= ?w ) (= ?w ))
; (ND4) worlds
(defrelation WORLD(?w) :=
  )

; (ND5) accessibility relation on worlds
(defrelation WLDR(?w ?v) :=
  (and (WORLD ?w) (WORLD ?v)))

; (ND6) Parthood
(defrelation P (?w ?x ?y) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y)))
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```

; (ND7) Temporal Parthood
(defrelation P (?w ?x ?y ?t) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y) (PARTICULAR ?t)))

; (ND8) Constitution
(defrelation K (?w ?x ?y ?t) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y) (PARTICULAR ?t)))

; (ND9) Participation
(defrelation PC (?w ?x ?y ?t) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y) (PARTICULAR ?t)))

; (ND10) Quality
(defrelation qt (?w ?x ?y) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y)))

; (ND11) Quale
(defrelation ql (?w ?x ?y) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y)))

; (ND12) Quale (temporal)
(defrelation ql (?w ?x ?y ?t) :=>
  (and (WORLD ?w) (PARTICULAR ?x) (PARTICULAR ?y) (PARTICULAR ?t)))

;*****

; (NA1) NEW AXIOM: total domain
(forall (?x)
  (or (PARTICULAR ?x) (UNIVERSAL ?x) (WORLD ?x)))

; (NA2) partition of the domain
(forall (?x)
  (and (<=> (PARTICULAR ?x)
    (and (not (UNIVERSAL ?x)) (not (WORLD ?x))))
    (<=> (UNIVERSAL ?x)
    (and (not (PARTICULAR ?x)) (not (WORLD ?x))))
    (<=> (WORLD ?x)
    (and (not (PARTICULAR ?x)) (not (UNIVERSAL ?x)))))))

; Formal Characterization
;PRINCIPLES USED IN THE TRANSLATION IN KIF:
;Modal operators of possibility and necessity are translated in the standard
; way, see for instance p516 of Handbook of Logic in AI and Logic Prog. Vol.4;
;The indeces of relations are included prefixing
a dot (we preserve the capital or
; lower case distinction)
;These are the only predicates (with their arity)
that do not have possible worlds
; as arguments:
; X_1,PARTICULAR_1,UNIVERSAL_1, =_2

;No need for Barcan formulas, the domain of particulars turns out to be unique
; in the translation

;WLDR is an equivalence relation (from corrispondence theory, this implies
; that WLDR is a relation for S5). The axioms (NA10)-(NA12) are not necessary
; because of our definition of WLDR.
; (NA10)
;(forall (?w0) (=> (WORLD ?w0) (WLDR ?w0 ?w0)))
; (NA11)
;(forall (?w0 ?w1)
;  (=> (and (WLDR ?w0 ?w1) (WORLD ?w0) (WORLD ?w1))
;      (WLDR ?w1 ?w0)))
; (NA12)
;(forall (?w0 ?w1 ?w2)

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```

;   (=> (and (WLDR ?w0 ?w1)
;           (WLDR ?w1 ?w2)
;           (WORLD ?w0)
;           (WORLD ?w1)
;           (WORLD ?w2))
;       (WLDR ?w0 ?w2)))

; ***THE UNIVERSALS ARE NECESSARILY NON-EMPTY***-- axiom
; (NA14) -- axiom
(forall (?w ?f) (=> (and (UNIVERSAL ?f) (WORLD ?w))
                    (NEP ?w ?f)))

; (NA15) -- axiom
(forall (?w ?f) (=> (and (UNIVERSAL ?f) (WORLD ?w))
                    (or (not (X ?f)) (RG ?w ?f)))))

; (NA16) Instances of PT -- axiom
(forall (?w0) (=> (WORLD ?w0)
                  (and (PT ?w0 ALL ED PD Q AB)
                       (PT ?w0 ED PED NPED AS)
                       (PT ?w0 PED M F POB)
                       (PT ?w0 POB APO NAPO)
                       (PT ?w0 NPOB MOB SOB)
                       (PT ?w0 SOB ASO NASO)
                       (PT ?w0 ASO SAG SC)
                       (PT ?w0 PD EV STV)
                       (PT ?w0 EV ACH ACC)
                       (PT ?w0 STV ST PRO)
                       (PT ?w0 Q TQ PQ AQ)
                       (PT ?w0 R TR PR AR)))))

; (NA17) Instances of SB -- axiom
(forall (?w0)
  (=> (WORLD ?w0)
      (and (SB ?w0 ALL ED) (SB ?w0 ALL PD) (SB ?w0 ALL Q) (SB ?w0 ALL AB)
           (SB ?w0 ED PED) (SB ?w0 ED NPED) (SB ?w0 ED AS)
           (SB ?w0 PED M) (SB ?w0 PED F) (SB ?w0 PED POB)
           (SB ?w0 POB APO) (SB ?w0 POB NAPO)
           (SB ?w0 NPED NPOB)
           (SB ?w0 NPOB MOB) (SB ?w0 NPOB SOB)
           (SB ?w0 SOB ASO) (SB ?w0 SOB NASO)
           (SB ?w0 ASO SAG) (SB ?w0 ASO SC)
           (SB ?w0 PD EV) (SB ?w0 PD STV)
           (SB ?w0 EV ACH) (SB ?w0 EV ACC)
           (SB ?w0 STV ST) (SB ?w0 STV PRO)
           (SB ?w0 Q TQ) (SB ?w0 Q PQ) (SB ?w0 Q AQ)
           (SB ?w0 TQ TL)
           (SB ?w0 PQ SL)
           (SB ?w0 AB FACT) (SB ?w0 AB SET) (SB ?w0 AB R)
           (SB ?w0 R TR) (SB ?w0 R PR) (SB ?w0 R AR)
           (SB ?w0 TR T)
           (SB ?w0 PR S)))))

; (NA18) Existence of sum
(forall (?w0 ?x ?y)
  (=> (and (PARTICULAR ?x) (PARTICULAR ?y) (WORLD ?w0))
      (exists (?z)
        (and (PARTICULAR ?z) (+ ?w0 ?x ?y ?z)))))

; (NA19) Existence of sigma
(forall (?w0 ?f)
  (=> (and (UNIVERSAL ?f) (WORLD ?w0))
      (exists (?z)
        (and (PARTICULAR ?z) (sigma ?w0 ?f ?z)))))

; (NA20) Existence of sum.t

```

```

(forall (?w0 ?x ?y)
  (=) (and (PARTICULAR ?x) (PARTICULAR ?y) (WORLD ?w0))
    (exists (?z)
      (and (PARTICULAR ?z) (+.t ?w0 ?x ?y ?z))))

; (NA21) Existence of sigma.t
(forall (?w0 ?f)
  (=) (and (UNIVERSAL ?f) (WORLD ?w0))
    (exists (?z)
      (and (PARTICULAR ?z) (sigma.t ?w0 ?f ?z))))

; this could be added in the def. of UNIVERSAL
;(forall (@f)
;  (<=> (UNIVERSAL @f)
;    (exists (?g @h) (and (UNIVERSAL ?g)
;      (or (UNIVERSAL @h) (= @h (listof)))
;      (= @f (listof ?g @h))))))

; this could be added in the def. of PARTICULAR
;(forall (@x)
;  (<=> (PARTICULAR @x)
;    (exists (?y @z) (and (PARTICULAR ?y)
;      (or (PARTICULAR @z) (= @z (listof)))
;      (= @x (listof ?y @z))))))

;*****
;(D1) RG: Rigid Universal
(defrelation RG (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (forall (?w ?x)
      (=) (and (WLDR ?w0 ?w) (WORLD ?w) (PARTICULAR ?x))
        (=) (?f ?w ?x)
          (forall (?u)
            (=) (and (WLDR ?w ?u) (WORLD ?u))
              (?f ?u ?x))))))

;(D2) NEP: Non-Empty Universal
(defrelation NEP (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (forall (?w)
      (=) (and (WLDR ?w0 ?w) (WORLD ?w))
        (exists (?y)
          (and (PARTICULAR ?y) (?f ?w ?y))))))

;(D3) DJ: Disjoint Universals
(defrelation DJ (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (WORLD ?w0)
    (forall (?w ?x)
      (=) (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x))
        (not (and (?f ?w ?x) (?g ?w ?x))))))

;(D4) SB: Subsumption
(defrelation SB (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (WORLD ?w0)
    (forall (?w ?x)
      (=) (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x))
        (or (not (?g ?w ?x)) (?f ?w ?x))))))

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```

;(D5) EQ: Equal Universals
(defrelation EQ (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (SB ?w0 ?f ?g) (SB ?w0 ?g ?f)))

;(D6) PSB: Properly Subsuming
(defrelation PSB (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (SB ?w0 ?f ?g)
    (not (SB ?w0 ?f ?g))))

;(D7) L: Leaf Universal
(defrelation L (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (forall (?w ?g)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (UNIVERSAL ?g))
        (or (not (?SB ?w0 ?f ?g)) (EQ ?w0 ?f ?g)))))))

;(D8) SBL: Leaf Subsumed by
(defrelation SBL (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (SB ?w0 ?f ?g) (L ?w0 ?g)))

;(D9) PSBL: Leaf Properly Subsumed by
(defrelation PSBL (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (PSB ?w0 ?f ?g) (L ?w0 ?g)))

;(D10) L__: Leaf in the set X
(defrelation L.X (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (X ?f)
    (forall (?w ?g)
      (=> (and (WLDR ?w0 ?w) (WORLD ?w) (UNIVERSAL ?g))
        (=> (and (?SB ?w ?f ?g) (X ?g))
          (EQ ?w ?f ?g)))))))

;(D11) SBL__
(defrelation SBL.X (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (SB ?w0 ?f ?g) (L.X ?w0 ?g)))

;(D12) PSBL__
(defrelation PSBL.X (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f) (UNIVERSAL ?g) (WORLD ?w0) (PSB ?w0 ?f ?g) (L.X ?w0 ?g)))

; Definition (D13) is left for expressivity. In practice it becomes superfluous
; since the user needs to give a list of the n-tuple satisfying relation PT in
; axiom (NA17)
;(D13) PT: Partition
(defrelation PT (?w0 ?f @g) :=
  (and (UNIVERSAL ?f)
    (UNIVERSAL @g)
    (WORLD ?w0)
    (not (item ?f @g))
    (forall (?h ?k)
      (and (=> (and (UNIVERSAL ?h)
        (UNIVERSAL ?k)
        (item ?h @g)
        (item ?k @g)
        (/= ?h ?k))
        (DJ ?w0 ?h ?k))
      (forall (?w ?x)
        (=> (and (WLDR ?w0 ?w)
          (WORLD ?w)
          (PARTICULAR ?x))
          (<=> (?f ?w ?x)
            (exists (?h))))))))

```

```

                                (and (UNIVERSAL ?h)
                                    (item ?h @g)
                                    (?h ?w ?x)))))))))

; Mereological Definitions
;(D14) PP: Proper Part
(defrelation PP (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (P ?w0 ?x ?y)
        (not (P ?w0 ?y ?x))))

;(D15) O: Overlap
(defrelation O (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (exists (?z) (and (PARTICULAR ?z)
                          (P ?w0 ?z ?x)
                          (P ?w0 ?z ?y)))))

;(D16) At: Atom
(defrelation At (?w0 ?x) :=
  (and (PARTICULAR ?x)
        (WORLD ?w0)
        (not (exists (?y) (and (PARTICULAR ?y)
                                (PP ?w0 ?y ?x))))))

;(D17) AtP: Atomic Part
(defrelation AtP (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (P ?w0 ?x ?y)
        (At ?w0 ?x)))

;(D18) __ Binary Sum
(defrelation + (?w0 ?x ?y ?z) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?z)
        (WORLD ?w0)
        (forall (?u)
          (=> (PARTICULAR ?u)
              (<=> (O ?w0 ?u ?z)
                  (or (O ?w0 ?u ?x) (O ?w0 ?u ?y))))))
        (forall (?z1)
          (=> (and (PARTICULAR ?z1)
                  (forall (?u)
                    (=> (PARTICULAR ?u)
                        (<=> (O ?w0 ?u ?z1)
                            (or (O ?w0 ?u ?x) (O ?w0 ?u ?y))))))
              (= ?z1 ?z))))))

;(D19) (general) Sum
; Note: the rendition in KIF is weaker than the corresponding definition in
;modal FOL; here ?f has to be one of the universal introduced explicitly.
;[A possible way out: use string-variables (@f) to code Boolean
;combinations of universals.]
(defrelation sigma (?w0 ?f ?z) :=
  (and (PARTICULAR ?z)
        (UNIVERSAL ?f)
        (WORLD ?w0)
        (forall (?y)
          (=> (PARTICULAR ?y)
              (<=> (O ?w0 ?y ?z)
                  (exists (?v)
                    (sigma ?w0 ?f ?v))))))

```

```

                                (and (PARTICULAR ?v)
                                    (?f ?w0 ?v)
                                    (O ?w0 ?y ?v))))))
(forall (?z1)
  (=> (PARTICULAR ?z1)
    (exists (?y)
      (and (PARTICULAR ?y)
        (=> (<=> (O ?w0 ?y ?z1)
          (exists (?v)
            (and (PARTICULAR ?v)
              (?f ?w0 ?v)
              (O ?w0 ?y ?v))))))
        (= ?z1 ?z))))))

;(D20) PP: Temporary Proper Part
(defrelation PP (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (P ?w0 ?x ?y ?t)
    (not (P ?w0 ?y ?x ?t))))

;(D21) O: Temporary Overlap
(defrelation O (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (exists (?z) (and (PARTICULAR ?z)
      (P ?w0 ?z ?x ?t)
      (P ?w0 ?z ?y ?t)))))

;(D22) At: Temporary Atom
(defrelation At (?w0 ?x ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (not (exists (?y)
      (and (PARTICULAR ?y) (PP ?w0 ?y ?x ?t))))))

;(D23) AtP: Temporary Atomic Part
(defrelation AtP (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (P ?w0 ?x ?y ?t)
    (At ?w0 ?x ?t)))

;(D24) Coincidence
(defrelation =.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (P ?w0 ?x ?y ?t)
    (P ?w0 ?y ?x ?t)))

;(D25) CP: Constant Part
(defrelation CP (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (WORLD ?w0)
    (exists (?t)
      (and (PARTICULAR ?t) (PRE ?w0 ?y ?t))))
  (forall (?t)
    (=> (and (PARTICULAR ?t) (PRE ?w0 ?y ?t)))))

```

```

(P ?w0 ?x ?y ?t))))

;(D26)
(defrelation +.t (?w0 ?x ?y ?z) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?z)
        (WORLD ?w0)
        (forall (?u ?t)
          (=> (and (PARTICULAR ?u) (PARTICULAR ?t))
              (<=> (O ?w0 ?u ?z ?t)
                  (or (O ?w0 ?u ?x ?t) (O ?w0 ?u ?y ?t))))))
        (forall (?z1 ?t)
          (=> (and (PARTICULAR ?z1)
                  (PARTICULAR ?t)
                  (forall (?u)
                    (=> (PARTICULAR ?u)
                        (<=> (O ?w0 ?u ?z1 ?t)
                            (or (O ?w0 ?u ?x ?t) (O ?w0 ?u ?y ?t))))))
              (= ?z1 ?z))))))

;(D27)
; NOTE: this rendition includes only the listed universal, for instance,
; no Boolean combination of universals is included [see also comment on (D19)]
(defrelation sigma.t (?w0 ?f ?z) :=
  (and (PARTICULAR ?z)
        (UNIVERSAL ?f)
        (WORLD ?w0)
        (forall (?y ?t)
          (=> (and (PARTICULAR ?y) (PARTICULAR ?t))
              (<=> (O ?w0 ?y ?z ?t)
                  (exists (?v)
                    (and (PARTICULAR ?v)
                        (?f ?w0 ?v)
                        (O ?w0 ?y ?v ?t))))))
        (forall (?z1 ?t)
          (=> (and (PARTICULAR ?z1) (PARTICULAR ?t))
              (exists (?y)
                (and (PARTICULAR ?y)
                    (=> (<=> (O ?w0 ?y ?z1 ?t)
                            (exists (?v)
                              (and (PARTICULAR ?v)
                                    (?f ?w0 ?v)
                                    (O ?w0 ?y ?v ?t))))))
                    (= ?z1 ?z)))))))))

; Quality
;(D28) dqt: Direct Quality
(defrelation dqt (?w0 ?x ?y) :=
  (and (WORLD ?w0)
        (PARTICULAR ?x)
        (PARTICULAR ?y)
        (qt ?w0 ?x ?y)
        (not (exists (?z)
          (and (PARTICULAR ?z)
              (qt ?w0 ?x ?z)
              (qt ?w0 ?z ?y))))))

;(D29) qt: Quality of type
(defrelation qtf (?w0 ?f ?x ?y) :=
  (and (UNIVERSAL ?f)
        (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (qt ?w0 ?x ?y)
        (?f ?w0 ?x)
        (SBL.X ?w0 Q ?f)))

```

```

; Temporal and Spatial Quale
;(D30) ql_T,PD
(defrelation ql.T.PD (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)
        (PARTICULAR ?x)
        (WORLD ?w0)
        (PD ?w0 ?x)
        (exists (?z) (and (PARTICULAR ?z)
                          (qtf ?w0 TL ?z ?x)
                          (ql ?w0 ?t ?z))))))

;(D31) ql_T,ED
(defrelation ql.T.ED (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)
        (PARTICULAR ?x)
        (WORLD ?w0)
        (ED ?w0 ?x)
        (forall (?u)
          (=> (PARTICULAR ?u)
              (<=> (O ?w0 ?u ?t)
                  (exists (?v ?y)
                    (and (PARTICULAR ?v)
                        (PARTICULAR ?y)
                        (PC ?w0 ?x ?y ?v)
                        (O ?w0 ?u ?v)))))))
        (forall (?t1)
          (=> (PARTICULAR ?t1)
              (exists (?u)
                (and (PARTICULAR ?u)
                    (=> (<=> (O ?w0 ?u ?t1)
                            (exists (?v ?y)
                              (and (PARTICULAR ?v)
                                  (PARTICULAR ?y)
                                  (PC ?w0 ?x ?y ?v)
                                  (O ?w0 ?u ?v))))))
                    (= ?t1 ?t))))))))))

;(D32) ql_T,TQ
(defrelation ql.T.TQ (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)
        (PARTICULAR ?x)
        (WORLD ?w0)
        (TQ ?w0 ?x)
        (exists (?z) (and (PARTICULAR ?z)
                          (qt ?w0 ?x ?z)
                          (ql.T.PD ?w0 ?t ?z))))))

;(D33) ql_T,PQ_or_AQ
(defrelation ql.T.PQAQ (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)
        (PARTICULAR ?x)
        (WORLD ?w0)
        (or (PQ ?w0 ?x) (AQ ?w0 ?x))
        (exists (?z) (and (PARTICULAR ?z)
                          (qt ?w0 ?x ?z)
                          (ql.T.ED ?w0 ?t ?z))))))

;(D34) ql_T,Q
(defrelation ql.T.Q (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)
        (PARTICULAR ?x)
        (WORLD ?w0)
        (or (ql.T.TQ ?w0 ?t ?x)
            (ql.T.PQAQ ?w0 ?t ?x))))

;(D35) ql_T: Temporal Quale
(defrelation ql.T (?w0 ?t ?x) :=
  (and (PARTICULAR ?t)

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(PARTICULAR ?x)
(WORLD ?w0)
(or (ql.T.ED ?w0 ?t ?x)
    (ql.T.PD ?w0 ?t ?x)
    (ql.T.Q ?w0 ?t ?x)))

;(D36) ql_S,PED
(defrelation ql.S.PED (?w0 ?s ?x ?t) :=
  (and (PARTICULAR ?s)
        (PARTICULAR ?x)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PED ?w0 ?x)
        (exists (?z) (and (PARTICULAR ?z)
                          (qtf ?w0 SL ?z ?x)
                          (ql ?w0 ?s ?z ?t)))))

;(D37) ql_S,PQ
(defrelation ql.S.PQ (?s ?x ?t) :=
  (and (PARTICULAR ?s)
        (PARTICULAR ?x)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PQ ?w0 ?x)
        (exists (?z) (and (PARTICULAR ?z)
                          (qt ?w0 ?x ?z)
                          (ql.S.PED ?w0 ?s ?z ?t)))))

;(D38) ql_S,PD
(defrelation ql.S.PD (?w0 ?s ?x ?t) :=
  (and (PARTICULAR ?s)
        (PARTICULAR ?x)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PD ?w0 ?x)
        (exists (?z) (and (PARTICULAR ?z)
                          (mppc ?w0 ?z ?x)
                          (ql.S.PED ?w0 ?s ?z ?t)))))

;(D39) ql_S: Spatial Quale
(defrelation ql.S (?w0 ?s ?x ?t) :=
  (and (PARTICULAR ?s)
        (PARTICULAR ?x)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (or (ql.S.PED ?w0 ?s ?x ?t)
            (ql.S.PQ ?w0 ?s ?x ?t)
            (ql.S.PD ?w0 ?s ?x ?t))))

;Being present
;(D40) PRE: Being Present at
(defrelation PRE (?w0 ?x ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?u) (and (PARTICULAR ?u)
                          (ql.T ?w0 ?u ?x)
                          (P ?w0 ?t ?u)))))

;(D41) PRE: Being Present in at
(defrelation PRE (?w0 ?x ?s ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?s)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PRE ?w0 ?x ?t)
        (exists (?u) (and (PARTICULAR ?u)
                          (ql.S ?w0 ?u ?x ?t)

```

```

(P ?w0 ?s ?u))))))

; Inclusion and Coincidence
;(D42) Temporal Inclusion
(defrelation incl.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (exists (?t ?u) (and (PARTICULAR ?t)
                              (PARTICULAR ?u)
                              (ql.T ?w0 ?t ?x)
                              (ql.T ?w0 ?u ?y)
                              (P ?w0 ?t ?u))))))

;(D43) Proper Temporal Inclusion
(defrelation sincl.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (exists (?t ?u) (and (PARTICULAR ?t)
                              (PARTICULAR ?u)
                              (ql.T ?w0 ?t ?x)
                              (ql.T ?w0 ?u ?y)
                              (PP ?w0 ?t ?u))))))

;(D44) Temporary Spatial Inclusion
(defrelation incl.S.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?s ?r) (and (PARTICULAR ?s)
                              (PARTICULAR ?r)
                              (ql.S ?w0 ?s ?x ?t)
                              (ql.S ?w0 ?r ?y ?t)
                              (P ?w0 ?s ?r))))))

;(D45) Temp. Proper Sp. Inclusion
(defrelation sincl.S.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?s ?r) (and (PARTICULAR ?s)
                              (PARTICULAR ?r)
                              (ql.S ?w0 ?s ?x ?t)
                              (ql.S ?w0 ?r ?y ?t)
                              (PP ?w0 ?s ?r))))))

;(D46) Spatio-temporal Inclusion
(defrelation incl.S.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (exists (?t) (and (PARTICULAR ?t) (PRE ?w0 ?x ?t)))
        (forall (?t) (=> (and (PARTICULAR ?t) (PRE ?w0 ?x ?t))
                          (incl.S.t ?w0 ?x ?y ?t))))))

;(D47) Spatio-temp. Incl. during
(defrelation incl.S.T.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PRE ?w0 ?x ?t)
        (forall (?u) (=> (and (PARTICULAR ?u) (AtP ?w0 ?u ?t))
                          (incl.S.t ?w0 ?x ?y ?u))))))

```

```
;(D48) Temporal Coincidence
(defrelation ~.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (incl.T ?w0 ?x ?y)
        (incl.T ?w0 ?y ?x)))

;(D49) Temporary Spatial Coincidence
(defrelation ~.S.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (incl.S.t ?w0 ?x ?y ?t)
        (incl.S.t ?w0 ?y ?x ?t)))

;(D50) Spatio-temporal Coincidence
(defrelation ~.S.T (?w0 ?x ?y) :=
  (and (WORLD ?w0)
        (PARTICULAR ?x)
        (PARTICULAR ?y)
        (incl.S.T ?w0 ?x ?y)
        (incl.S.T ?w0 ?y ?x)))

;(D51) Spatio-temp. Coincidence during
(defrelation ~.S.T.t (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (PRE ?w0 ?x ?t)
        (forall (?u) (=> (and (PARTICULAR ?u) (AtP ?w0 ?u ?t))
                          (~.S.t ?w0 ?x ?y ?u)))))

;(D52) O_T: Temporal Overlap
(defrelation O.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (exists (?t ?u) (and (PARTICULAR ?t)
                              (PARTICULAR ?u)
                              (ql.T ?w0 ?t ?x)
                              (ql.T ?w0 ?u ?y)
                              (O ?w0 ?t ?u)))))

;(D53) O_S,t: Temporary Spatial Overlap
(defrelation O.S.t (?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?s ?r) (and (PARTICULAR ?s)
                              (PARTICULAR ?r)
                              (ql.S ?w0 ?s ?x ?t)
                              (ql.S ?w0 ?r ?y ?t)
                              (O ?w0 ?s ?r)))))

; Perdurant
;(D54) P_T: Temporal Part
(defrelation P.T (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (PD ?w0 ?x)
        (P ?w0 ?x ?y)
        (forall (?z) (=> (and (PARTICULAR ?z)
                              (P ?w0 ?z ?y)))))
```

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        (incl.T ?w0 ?z ?x))
      (P ?w0 ?z ?x))))))

;(D55) P_S: Spatial Part
(defrelation P.S (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (WORLD ?w0)
        (PD ?w0 ?x)
        (P ?w0 ?x ?y)
        (~.T ?w0 ?x ?y)))

;(D56) NEP_S: Strongly Non-Empty
(defrelation NEP.S (?w0 ?f) :=
  (and (UNIVERSAL ?f)
        (WORLD ?w0)
        (SB ?w0 PD ?f)
        (forall (?w) (=> (and (WLDR ?w0 ?w) (WORLD ?w))
                          (exists (?x ?y)
                                   (and (PARTICULAR ?x)
                                        (PARTICULAR ?y)
                                        (?f ?w ?x)
                                        (?f ?w ?y)
                                        (not (P ?w ?x ?y))
                                        (not (P ?w ?y ?x))))))))))

;(D57) CM: Cumulative
(defrelation CM (?w0 ?f) :=
  (and (UNIVERSAL ?f)
        (WORLD ?w0)
        (SB ?w0 PD ?f)
        (forall (?w ?x ?y ?z)
              (=> (and (WLDR ?w0 ?w)
                      (WORLD ?w)
                      (PARTICULAR ?x)
                      (PARTICULAR ?y)
                      (PARTICULAR ?z)
                      (+ ?w ?x ?y ?z)
                      (?f ?w ?x)
                      (?f ?w ?y))
                  (?f ?w ?z))))))

;(D58) CM: Anti-Cumulative
(defrelation CM~ (?w0 ?f) :=
  (and (UNIVERSAL ?f)
        (WORLD ?w0)
        (SB ?w0 PD ?f)
        (forall (?w ?x ?y ?z)
              (=> (and (WLDR ?w0 ?w)
                      (WORLD ?w)
                      (PARTICULAR ?x)
                      (PARTICULAR ?y)
                      (PARTICULAR ?z)
                      (+ ?w ?x ?y ?z)
                      (?f ?w ?x)
                      (?f ?w ?y)
                      (not (P ?w ?x ?y))
                      (not (P ?w ?y ?x)))
                  (not (?f ?w ?z))))))

;(D59) HOM: Homeomorous
(defrelation HOM (?w0 ?f) :=
  (and (UNIVERSAL ?f)
        (WORLD ?w0)
        (SB ?w0 PD ?f)
        (forall (?w ?x ?y) (=> (and (WLDR ?w0 ?w)
                                   (WORLD ?w)
                                   (PARTICULAR ?x)

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(PARTICULAR ?y)
(?f ?w ?x)
(P.T ?w ?y ?x))
(?f ?w ?y))))))

;(D60) HOM: Anti-Homeom.
(defrelation HOM~ (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (SB ?w0 PD ?f)
    (forall (?w ?x)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x)
        (?f ?w ?x))
      (exists (?y)
        (and (PARTICULAR ?y)
          (P.T ?w ?y ?x)
          (not (?f ?w ?y))))))))))

;(D61) AT: Atomic
(defrelation AT (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (SB ?w0 PD ?f)
    (forall (?w ?x) (=> (and (WLDR ?w0 ?w)
      (WORLD ?w)
      (PARTICULAR ?x)
      (?f ?w ?x))
    (At ?w ?x))))))

;(D62) AT: Anti-Atomic
(defrelation AT~ (?w0 ?f) :=
  (and (UNIVERSAL ?f)
    (WORLD ?w0)
    (SB ?w0 PD ?f)
    (forall (?w ?x) (=> (and (WLDR ?w0 ?w)
      (WORLD ?w)
      (PARTICULAR ?x)
      (?f ?w ?x))
    (not (At ?w ?x))))))

;Participation
;(D63) PC_C: Constant Participation
(defrelation PC.C (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (WORLD ?w0)
    (exists (?t) (and (PARTICULAR ?t) (PRE ?w0 ?y ?t)))
    (forall (?t) (=> (and (PARTICULAR ?t)
      (PRE ?w0 ?y ?t))
    (PC ?w0 ?x ?y ?t))))))

;(D64) PC_T: Temporary Total Particip.
(defrelation PC.T (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (WORLD ?w0)
    (PD ?w0 ?y)
    (forall (?z)
      (=> (and (PARTICULAR ?z)
        (P ?w0 ?z ?y)
        (PRE ?w0 ?z ?t))
      (PC ?w0 ?x ?z ?t))))))

;(D65) PC_T: Total Participation
(defrelation PC.T (?w0 ?x ?y) :=

```

```

(and (PARTICULAR ?x)
(PARTICULAR ?y)
(WORLD ?w0)
(exists (?t) (and (PARTICULAR ?t)
(q1.T ?w0 ?t ?y)
(PC.T ?w0 ?x ?y ?t))))))

;(D66) mpc: Maximal Participant
(defrelation mpc (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
(PARTICULAR ?y)
(WORLD ?w0)
(forall (?z ?t)
  (=> (and (PARTICULAR ?z) (PARTICULAR ?t))
(<=> (O ?w0 ?z ?x ?t)
(exists (?v)
  (and (PARTICULAR ?v)
(PC.T ?w0 ?v ?y ?t)
(O ?w0 ?z ?v ?t)))))))
(forall (?z ?x1 ?t)
  (=> (and (PARTICULAR ?z)
(PARTICULAR ?x1)
(PARTICULAR ?t)
(<=> (O ?w0 ?z ?x1 ?t)
(exists (?v)
  (and (PARTICULAR ?v)
(PC.T ?w0 ?v ?y ?t)
(O ?w0 ?z ?v ?t))))))
(= ?x1 ?x))))))

;(D67) mppc: Maximal Physical Participant
(defrelation mppc (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
(PARTICULAR ?y)
(WORLD ?w0)
(forall (?z ?t)
  (=> (and (PARTICULAR ?z) (PARTICULAR ?t))
(<=> (O ?w0 ?z ?x ?t)
(exists (?v)
  (and (PARTICULAR ?v)
(PC.T ?w0 ?v ?y ?t)
(PED ?w0 ?z)
(O ?w0 ?z ?v ?t)))))))
(forall (?z ?x1 ?t)
  (=> (and (PARTICULAR ?z)
(PARTICULAR ?x1)
(PARTICULAR ?t)
(<=> (O ?w0 ?z ?x1 ?t)
(exists (?v)
  (and (PARTICULAR ?v)
(PC.T ?w0 ?v ?y ?t)
(PED ?w0 ?z)
(O ?w0 ?z ?v ?t))))))
(= ?x1 ?x))))))

;(D68) lf: Life
(defrelation lf (?w0 ?x ?y) :=
  (and (PARTICULAR ?x)
(PARTICULAR ?y)
(WORLD ?w0)
(forall (?z)
  (=> (PARTICULAR ?z)
(<=> (O ?w0 ?z ?x)
(exists (?v)
  (and (PARTICULAR ?v)
(PC.T ?w0 ?y ?v)
(O ?w0 ?z ?v)))))))
(forall (?z ?u)

```

```

(=> (and (PARTICULAR ?z) (PARTICULAR ?u)
        (<=> (O ?w0 ?z ?u)
            (exists (?v)
              (and (PARTICULAR ?v)
                    (P.C.T ?w0 ?y ?v)
                    (O ?w0 ?z ?v))))))
    (= ?u ?x))))))

; Dependence
;(D69) SD: Specific Constant Dep.
(defrelation SD (?w0 ?x ?y) :=
  (or (and (PARTICULAR ?x)
           (PARTICULAR ?y)
           (WORLD ?w0)
           (forall (?w)
             (=> (and (WLDR ?w0 ?w) (WORLD ?w))
                 (and (exists (?t)
                       (and (PARTICULAR ?t) (PRE ?w ?x ?t)))
                       (forall (?t)
                         (=> (and (PARTICULAR ?t) (PRE ?w ?x ?t))
                             (PRE ?w ?y ?t))))))))))
      (and (UNIVERSAL ?x)
            (UNIVERSAL ?y)
            (WORLD ?w0)
            (DJ ?w0 ?x ?y)
            (forall (?w ?x1)
              (=> (and (WLDR ?w0 ?w)
                      (WORLD ?w)
                      (PARTICULAR ?x1)
                      (?x ?w ?x1))
                  (exists (?y1) (and (PARTICULAR ?y1)
                                      (?y ?w ?y1)
                                      (SD ?w ?x1 ?y1))))))))))

;(D70) SD: Specific Const. Dep.
;included in def (D69)

;(D71) GD: Generic Const. Dep.
(defrelation GD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (DJ ?w0 ?f ?g)
        (forall (?w ?x ?t)
          (=> (and (WLDR ?w0 ?w)
                  (WORLD ?w)
                  (PARTICULAR ?x)
                  (PARTICULAR ?t)
                  (?f ?w ?x))
              (and (exists (?t1)
                    (and (PARTICULAR ?t1) (PRE ?w ?x ?t1)))
                    (=> (and (At ?w ?t) (PRE ?w ?x ?t))
                        (exists (?y)
                          (and (PARTICULAR ?y)
                                (?g ?w ?y)
                                (PRE ?w ?y ?t))))))))))

;(D72) D: Constant Dependence
(defrelation D (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (or (SD ?w0 ?f ?g) (GD ?w0 ?f ?g))))

;(D73) OD: One-sided Constant Dependence
(defrelation OD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)

```

```

(WORLD ?w0)
(D ?w0 ?f ?g)
(not (D ?w0 ?g ?f)))

;(D74) OSD: One-sided Specific Constant Dependence
(defrelation OSD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SD ?w0 ?f ?g)
        (not (D ?w0 ?g ?f))))

;(D75) OGD: One-sided Generic Constant Dependence
(defrelation OGD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GD ?w0 ?f ?g)
        (not (D ?w0 ?g ?f))))

;(D76) MSD: Mutual Specific Constant Dependence
(defrelation MSD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SD ?w0 ?f ?g)
        (SD ?w0 ?g ?f)))

;(D77) MGD: Mutual Generic Constant Dependence
(defrelation MGD (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GD ?w0 ?f ?g)
        (GD ?w0 ?g ?f)))

; Spatial Dependence
;(D78) SD_S: Specific Spatial Dependence
(defrelation SD.S (?w0 ?x ?y) :=
  (or (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (forall (?w)
            (=> (and (WLDR ?w0 ?w) (WORLD ?w))
                (and (exists (?t ?s)
                    (and (PARTICULAR ?t)
                        (PARTICULAR ?s)
                        (PRE ?w ?x ?s ?t))))
                (forall (?t ?s)
                    (=> (and (PARTICULAR ?t)
                        (PARTICULAR ?s)
                        (PRE ?w ?x ?s ?t))
                        (PRE ?w ?y ?s ?t))))))))
      (and (WORLD ?w0)
            (UNIVERSAL ?x)
            (UNIVERSAL ?y)
            (DJ ?w0 ?x ?y)
            (forall (?w ?x1)
             (=> (and (WLDR ?w0 ?w)
                    (WORLD ?w)
                    (PARTICULAR ?x1)
                    (?x ?w ?x))
                (exists (?y1)
                    (and (PARTICULAR ?y1)
                        (?y ?w ?y1)
                        (SD.S ?w ?x1 ?y1))))))))))

;(D79) PSD_S: Partial Specific Spatial Dependence

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(defrelation PSD.S (?w0 ?x ?y) :=
  (or (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (forall (?w)
      (=> (and (WLDR ?w0 ?w) (WORLD ?w))
        (and (exists (?t ?s)
          (and (PARTICULAR ?t)
            (PARTICULAR ?s)
            (PRE ?w ?x ?s ?t)))
        (forall (?t ?s)
          (=> (and (PARTICULAR ?t)
            (PARTICULAR ?s)
            (PRE ?w ?x ?s ?t)))
          (exists (?r)
            (and (PARTICULAR ?r)
              (PP ?w ?r ?s)
              (PRE ?w ?y ?r ?t))))))))))
  (and (WORLD ?w0)
    (UNIVERSAL ?x)
    (UNIVERSAL ?y)
    (DJ ?w0 ?x ?y)
    (forall (?w ?x1)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x1)
        (?x ?w ?x1))
      (exists (?y1)
        (and (PARTICULAR ?y1)
          (?y ?w ?y1)
          (PSD.S ?w ?x1 ?y1))))))))

;(D80) P-1SD_S: Inverse Partial Specific Spatial Dependence
(defrelation P1SD.S (?w0 ?x ?y) :=
  (or (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (forall (?w)
      (=> (and (WLDR ?w0 ?w) (WORLD ?w))
        (and (exists (?t ?s)
          (and (PARTICULAR ?t)
            (PARTICULAR ?s)
            (PRE ?w ?x ?s ?t)))
        (forall (?t ?s)
          (=> (and (PARTICULAR ?t)
            (PARTICULAR ?s)
            (PRE ?w ?x ?s ?t)))
          (exists (?r)
            (and (PARTICULAR ?r)
              (PP ?w ?s ?r)
              (PRE ?w ?y ?r ?t))))))))))
  (and (WORLD ?w0)
    (UNIVERSAL ?x)
    (UNIVERSAL ?y)
    (DJ ?w0 ?x ?y)
    (forall (?w ?x1)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x1)
        (?x ?w ?x1))
      (exists (?y1)
        (and (PARTICULAR ?y1)
          (?y ?w ?y1)
          (P1SD.S ?w ?x1 ?y1))))))))

;(D81) SD_S
;included in def (D78)

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;(D82) PSD_S
;included in def (D79)

;(D83) P-1SD_S
;included in def (D80)

;(D84) GD_S: Generic Spatial Dependence
(defrelation GD.S (?w0 ?f ?g) :=
  (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (DJ ?w0 ?f ?g)
    (forall (?w ?x ?s ?t)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x)
        (PARTICULAR ?t)
        (PARTICULAR ?s)
        (?f ?w ?x))
        (and (exists (?t1 ?s1)
          (and (PARTICULAR ?t1)
            (PARTICULAR ?s1)
            (PRE ?w ?x ?s1 ?t1)))
          (=> (and (At ?w ?t) (PRE ?w ?x ?s ?t))
            (exists (?y)
              (and (PARTICULAR ?y)
                (?g ?w ?y)
                (PRE ?w ?y ?s ?t))))))))))

;(D85) PGD_S: Partial Generic Spatial Dependence
(defrelation PGD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (WORLD ?w0)
    (DJ ?w0 ?f ?g)
    (forall (?w ?x ?s ?t)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x)
        (PARTICULAR ?s)
        (PARTICULAR ?t)
        (?f ?w ?x))
        (and (exists (?s1 ?t1)
          (and (PRE ?w ?x ?s1 ?t1)
            (PARTICULAR ?s1)
            (PARTICULAR ?t1))
          (=> (and (At ?w ?t) (PRE ?w ?x ?s ?t))
            (exists (?y ?u)
              (and (PARTICULAR ?y)
                (PARTICULAR ?u)
                (?g ?w ?y)
                (PP ?w ?u ?s)
                (PRE ?w ?y ?u ?t))))))))))

;(D86) P-1GD_S: Inverse Partial Generic Spatial Dependence
(defrelation P1GD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (WORLD ?w0)
    (DJ ?w0 ?f ?g)
    (forall (?w ?x ?s ?t)
      (=> (and (WLDR ?w0 ?w)
        (WORLD ?w)
        (PARTICULAR ?x)
        (PARTICULAR ?s)
        (PARTICULAR ?t)
        (?f ?w ?x))
        (and (exists (?t1 ?s1)

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        (and (PARTICULAR ?t1)
              (PARTICULAR ?s1)
              (PRE ?w ?x ?s1 ?t1))
(=> (and (At ?w ?t) (PRE ?w ?x ?t))
     (exists (?y ?u)
          (and (PARTICULAR ?y)
                (PARTICULAR ?u)
                (?g ?w ?y)
                (PP ?w ?s ?u)
                (PRE ?w ?y ?u ?t)))))))))

;(D87) DGD_S: Direct Generic Spatial Dependence
(defrelation DGD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GD.S ?w0 ?f ?g)
        (not (exists (?h) (and (UNIVERSAL ?h)
                                (GD.S ?w0 ?f ?h)
                                (GD.S ?w0 ?h ?g))))))

;(D88) Sdt_S: Temporary Specific Spatial Dependence
(defrelation SDt.S (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (SD.S ?w0 ?x ?y)
        (PRE ?w0 ?x ?t)))

;(D89) GDt_S: Temp. Gen. Sp. Dep.
(defrelation GDt.S (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?f ?g) (and (UNIVERSAL ?f)
                                (UNIVERSAL ?g)
                                (?f ?w0 ?x)
                                (?g ?w0 ?y)
                                (GD.S ?w0 ?f ?g)
                                (~.S.t ?w0 ?x ?y ?t))))))

;(D90) DGDt_S: Temp. Direct Sp. Dep.
(defrelation DGDt.S (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (exists (?f ?g) (and (UNIVERSAL ?f)
                                (UNIVERSAL ?g)
                                (?f ?w0 ?x)
                                (?g ?w0 ?y)
                                (DGD.S ?w0 ?f ?g)
                                (~.S.t ?w0 ?x ?y ?t))))))

;(D91) OSD_S: One-sided Specific Spatial Dependence
(defrelation OSD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SD.S ?w0 ?f ?g)
        (not (D ?w0 ?g ?f))))

;(D92) OGD_S: One-sided Generic Spatial Dependence
(defrelation OGD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)

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(WORLD ?w0)
(GD.S ?w0 ?f ?g)
(not (D ?w0 ?g ?f)))

;(D93) MSD_S: Mutual Specific Spatial Dependence
(defrelation MSD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SD.S ?w0 ?f ?g)
        (SD.S ?w0 ?g ?f)))

;(D94) MGD_S: Mutual Generic Spatial Dependence
(defrelation MGD.S (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GD.S ?w0 ?f ?g)
        (GD.S ?w0 ?g ?f)))

; Constitution
;(D95) DK: Direct Constitution
(defrelation DK (?w0 ?x ?y ?t) :=
  (and (PARTICULAR ?x)
        (PARTICULAR ?y)
        (PARTICULAR ?t)
        (WORLD ?w0)
        (K ?w0 ?x ?y ?t)
        (not (exists (?z) (and (PARTICULAR ?z)
                               (K ?w0 ?x ?z ?t)
                               (K ?w0 ?z ?y ?t)))))))

;(D96) SK: Constantly Specifically Constituted by
(defrelation SK (?w0 ?x ?y) :=
  (or (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (forall (?w)
            (=> (and (WLDR ?w0 ?w) (WORLD ?w))
                (and (exists (?t)
                    (and (PARTICULAR ?t) (PRE ?w ?x ?t))
                        (forall (?t)
                         (=> (and (PARTICULAR ?t)
                                (PRE ?w ?x ?t))
                            (K ?w ?y ?x ?t))))))))))
      (and (UNIVERSAL ?x)
            (UNIVERSAL ?y)
            (WORLD ?w0)
            (DJ ?w0 ?f ?g)
            (forall (?w ?x1)
             (=> (and (WLDR ?w0 ?w)
                    (WORLD ?w)
                    (PARTICULAR ?x1)
                    (?f ?w ?x1))
                (exists (?y1)
                 (and (PARTICULAR ?y1)
                     (?y ?w ?y1)
                     (SK ?w ?x1 ?y1))))))))))

;(D97) SK: Constantly Specifically Constituted by
;included in def (D96)

;(D98) GK: Constantly Generically Constituted by
(defrelation GK (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (DJ ?w0 ?f ?g)

```

```

(forall (?w ?x ?t)
  (=> (and (WLDR ?w0 ?w)
          (WORLD ?w)
          (PARTICULAR ?x)
          (PARTICULAR ?t)
          (?f ?w ?x))
      (and (exists (?t1)
            (and (PARTICULAR ?t1) (PRE ?w ?x ?t1)))
          (=> (and (At ?w ?t) (PRE ?w ?x ?t))
              (exists (?y)
                (and (PARTICULAR ?y)
                     (?g ?w ?y)
                     (K ?w ?y ?x ?t))))))))))

;(D99) K_Constituted by
(defrelation K (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (or (SK ?w0 ?f ?g) (GK ?w0 ?f ?g))))

;(D100) OSK: One-sided Cons. Specif. Const. by
(defrelation OSK (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SK ?w0 ?f ?g)
        (not (K ?w0 ?g ?f))))

;(D101) OGK: One-sided Cons. Generic. Const. by
(defrelation OGK (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GK ?w0 ?f ?g)
        (not (K ?w0 ?g ?f))))

;(D102) MSK: Mutual Specific Constitution
(defrelation MSK (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (SK ?w0 ?f ?g)
        (SK ?w0 ?g ?f)))

;(D103) MGK: Mutual Generic Constitution
(defrelation MSK (?w0 ?f ?g) :=
  (and (UNIVERSAL ?f)
        (UNIVERSAL ?g)
        (WORLD ?w0)
        (GK ?w0 ?f ?g)
        (GK ?w0 ?g ?f)))

; Characterization of functions and relations
; Parthood
; Argument Restrictions
;(A1)
(forall (?w0 ?x ?y)
  (=> (and (P ?w0 ?x ?y)
          (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y))
      (and (or (AB ?w0 ?x) (PD ?w0 ?x))
            (or (AB ?w0 ?y) (PD ?w0 ?y))))))

;(A2)
(forall (?w0 ?x ?y)
  (=> (and (P ?w0 ?x ?y)

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```
(WORLD ?w0)
(PARTICULAR ?x)
(PARTICULAR ?y)
(<=> (PD ?w0 ?x) (PD ?w0 ?y))))

;(A3)
(forall (?w0 ?x ?y)
  (=> (and (P ?w0 ?x ?y)
    (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y))
    (<=> (AB ?w0 ?x)
      (AB ?w0 ?y))))

;(A4)
(forall (?w0 ?x ?y ?f)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (UNIVERSAL ?f)
    (P ?w0 ?x ?y)
    (SB ?w0 R ?f)
    (X ?f))
    (<=> (?f ?w0 ?x) (?f ?w0 ?y))))

; Ground Axioms
;(A5)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (or (AB ?w0 ?x) (PD ?w0 ?x))
    (P ?w0 ?x ?x))))

;(A6)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (P ?w0 ?x ?y)
    (P ?w0 ?y ?x))
    (= ?x ?y)))

;(A7)
(forall (?w0 ?x ?y ?z)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?z)
    (P ?w0 ?x ?y)
    (P ?w0 ?y ?z))
    (P ?w0 ?x ?z)))

;(A8)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (or (AB ?w0 ?x) (PD ?w0 ?x))
    (not (P ?w0 ?x ?y)))
    (exists (?z)
      (and (PARTICULAR ?x)
        (P ?w0 ?z ?x)
        (not (O ?w0 ?z ?y))))))

;(A9)
; Note: this version in KIF consider only the universal explicitly listed
;[see comment on (D19)]
(forall (?w0 ?f)
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(=> (and (WORLD ?w0)
        (UNIVERSAL ?f)
        (exists (?x)
          (and (PARTICULAR ?x) (?f ?w0 ?x)))
        (or (forall (?x)
            (=> (and (PARTICULAR ?x) (?f ?w0 ?x))
                (AB ?w0 ?x)))
            (forall (?x)
              (=> (and (PARTICULAR ?x) (?f ?w0 ?x))
                  (PD ?w0 ?x))))))
    (exists (?y)
      (and (PARTICULAR ?y) (sigma ?w0 ?f ?y))))

; Temporary Parthood
; Argument restrictions
;(A10)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y)
          (PARTICULAR ?t)
          (P ?w0 ?x ?y ?t))
      (and (ED ?w0 ?x) (ED ?w0 ?y) (T ?w0 ?t))))

;(A11)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y)
          (PARTICULAR ?t)
          (P ?w0 ?x ?y ?t))
      (<=> (PED ?w0 ?x) (PED ?w0 ?y))))

;(A12)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y)
          (PARTICULAR ?t)
          (P ?w0 ?x ?y ?t))
      (<=> (NPED ?w0 ?x) (NPED ?w0 ?y))))

; Ground Axioms
;(A13)
(forall (?w0 ?x ?y ?z ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y)
          (PARTICULAR ?z)
          (PARTICULAR ?t)
          (P ?w0 ?x ?y ?t)
          (P ?w0 ?y ?z ?t))
      (P ?w0 ?x ?z ?t)))

;(A14)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?y)
          (PARTICULAR ?t)
          (ED ?w0 ?x)
          (ED ?w0 ?y)
          (PRE ?w0 ?x ?t)
          (PRE ?w0 ?y ?t)
          (not (P ?w0 ?x ?y ?t)))
      (exists (?z)
        (and (PARTICULAR ?z)
              (P ?w0 ?z ?x ?t))))

```

```
(not (O ?w0 ?z ?y ?t))))))

;(A15)
:[see comment on (D19)]
(forall (?w0 ?f)
  (=> (and (WORLD ?w0)
           (UNIVERSAL ?f)
           (exists (?x)
             (and (PARTICULAR ?x) (?f ?w0 ?x)))
             (forall (?x)
               (=> (and (PARTICULAR ?x) (?f ?w0 ?x))
                 (ED ?w0 ?x))))
       (exists (?y)
         (and (PARTICULAR ?y) (sigma.t ?w0 ?f ?y))))))

; Links With Other Primitives
;(A16)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?t)
           (ED ?w0 ?x)
           (PRE ?w0 ?x ?t))
      (P ?w0 ?x ?x ?t)))

;(A17)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (P ?w0 ?x ?y ?t))
      (and (PRE ?w0 ?x ?t) (PRE ?w0 ?y ?t))))

;(A18)
(forall (?w0 ?x ?y ?t ?u)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (PARTICULAR ?u)
           (P ?w0 ?x ?y ?t)
           (P ?w0 ?u ?t))
      (P ?w0 ?x ?y ?u)))

;(A19)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (PED ?w0 ?x)
           (P ?w0 ?x ?y ?t))
      (incl.S.t ?w0 ?x ?y ?t)))

; Constitution
; Argument restrictions
;(A20)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (and (or (ED ?w0 ?x) (PD ?w0 ?x))
            (or (ED ?w0 ?y) (PD ?w0 ?y))
            (T ?w0 ?t))))
```

```
;(A21)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (<=> (PED ?w0 ?x) (PED ?w0 ?y))))

;(A22)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (<=> (NPED ?w0 ?x) (NPED ?w0 ?y))))

;(A23)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (<=> (PD ?w0 ?x) (PD ?w0 ?y))))

; Ground Axioms
;(A24)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (not (K ?w0 ?y ?x ?t))))

;(A25)
(forall (?w0 ?x ?y ?z ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?z)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t)
           (K ?w0 ?y ?z ?t))
      (K ?w0 ?x ?z ?t)))

; Links with other Primitives
;(A26)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t))
      (and (PRE ?w0 ?x ?t) (PRE ?w0 ?y ?t))))

;(A27)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t))
      (<=> (K ?w0 ?x ?y ?t)
           (forall (?u)
              (=> (and (PARTICULAR ?u) (P ?w0 ?u ?t))
                  (K ?w0 ?x ?y ?u))))))
```

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;(A28)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (PED ?w0 ?x)
           (K ?w0 ?x ?y ?t))
      (~.S.t ?w0 ?x ?y ?t)))

;(A29)
(forall (?w0 ?x ?y ?y1 ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?y1)
           (PARTICULAR ?t)
           (K ?w0 ?x ?y ?t)
           (P ?w0 ?y1 ?y ?t))
      (exists (?x1)
        (and (PARTICULAR ?x1)
              (P ?w0 ?x1 ?x ?t)
              (K ?w0 ?x1 ?y1 ?t)))))

; Links between Categories
;(A30)
(forall (?w0) (=> (WORLD ?w0) (GK ?w0 NAPO M)))

;(A31)
(forall (?w0) (=> (WORLD ?w0) (GK ?w0 APO NAPO)))

;(A32)
(forall (?w0) (=> (WORLD ?w0) (GK ?w0 SC SAG)))

; Participation
; Argument restrictions
;(A33)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (PC ?w0 ?x ?y ?t))
      (and (ED ?w0 ?x) (PD ?w0 ?y) (T ?w0 ?t))))

; Existential Axioms
;(a34)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?t)
           (PD ?w0 ?x)
           (PRE ?w0 ?x ?t))
      (exists (?y)
        (and (PARTICULAR ?y) (PC ?w0 ?y ?x ?t)))))

;(a35)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (ED ?w0 ?x))
      (exists (?y ?t)
        (and (PARTICULAR ?y) (PARTICULAR ?t) (PC ?w0 ?x ?y ?t)))))

; Links with other Primitives
;(a36)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
```

```
(PARTICULAR ?y)
(PARTICULAR ?t)
(PC ?w0 ?x ?y ?t))
(and (PRE ?w0 ?x ?t) (PRE ?w0 ?y ?t))))

;(a37)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t))
    (<=> (PC ?w0 ?x ?y ?t)
      (forall (?u)
        (=> (and (PARTICULAR ?u) (P ?w0 ?u ?t))
          (PC ?w0 ?x ?y ?u)))))))

; Quality
; Argument restrictions:
;(a38)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (qt ?w0 ?x ?y))
    (and (Q ?w0 ?x)
      (or (Q ?w0 ?y) (ED ?w0 ?y) (PD ?w0 ?y))))))

;(a39)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (qt ?w0 ?x ?y))
    (<=> (TQ ?w0 ?x)
      (or (TQ ?w0 ?y) (PD ?w0 ?y))))))

;(a40)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (qt ?w0 ?x ?y))
    (<=> (PQ ?w0 ?x)
      (or (PQ ?w0 ?y) (PED ?w0 ?y))))))

;(a41)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (qt ?w0 ?x ?y))
    (<=> (AQ ?w0 ?x)
      (or (AQ ?w0 ?y) (NPED ?w0 ?y))))))

; Ground Axioms:
;(a42)
(forall (?w0 ?x ?y ?z)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?z)
    (qt ?w0 ?x ?y)
    (qt ?w0 ?y ?z))
    (qt ?w0 ?x ?z)))

;(a43)
(forall (?w0 ?x ?y ?z)
  (=> (and (WORLD ?w0)
```

```
(PARTICULAR ?x)
(PARTICULAR ?y)
(PARTICULAR ?z)
(qt ?w0 ?x ?y)
(qt ?w0 ?x ?z)
(= ?y ?z)))

;(a44)
(forall (?w0 ?f ?x ?y ?z)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?z)
    (qtf ?w0 ?f ?x ?y)
    (qtf ?w0 ?f ?z ?y))
    (= ?x ?z)))

;(a45)
(forall (?w0 ?f ?g ?x ?y ?z)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?z)
    (qtf ?w0 ?f ?x ?y)
    (qtf ?w0 ?g ?y ?z))
    (DJ ?w0 ?f ?g))))

; Existential Axioms:
;(a46)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (TQ ?w0 ?x))
    (exists (?y)
      (and (PARTICULAR ?y)
        (qt ?w0 ?x ?y)
        (PD ?w0 ?y)
        (forall (?z)
          (=> (and (PARTICULAR ?z)
            (qt ?w0 ?x ?z)
            (PD ?w0 ?z))
            (= ?z ?y))))))))

;(a47)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (PQ ?w0 ?x))
    (exists (?y)
      (and (PARTICULAR ?y)
        (qt ?w0 ?x ?y)
        (PED ?w0 ?y)
        (forall (?z)
          (=> (and (PARTICULAR ?z)
            (qt ?w0 ?x ?z)
            (PED ?w0 ?z))
            (= ?z ?y))))))))

;(a48)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (AQ ?w0 ?x))
    (exists (?y)
      (and (PARTICULAR ?y)
        (qt ?w0 ?x ?y)
        (NPED ?w0 ?y)
        (forall (?z)
          (=> (and (PARTICULAR ?z)
            (qt ?w0 ?x ?z)
            (NPED ?w0 ?z))
```

```
(= ?z ?y))))))

;(a49)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (PD ?w0 ?x)
    (exists (?y)
      (and (PARTICULAR ?y) (qtf ?w0 TL ?y ?x))))))

;(a50)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (PED ?w0 ?x)
    (exists (?y)
      (and (PARTICULAR ?y) (qtf ?w0 SL ?y ?x))))))

;(a51)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (NPED ?w0 ?x)
    (exists (?f ?y)
      (and (PARTICULAR ?y)
        (UNIVERSAL ?f)
        (SBL ?w0 AQ ?f)
        (qtf ?w0 ?f ?y ?x))))))

; Quale
; Immediate Quale
; Argument restrictions:
;(A52)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (ql ?w0 ?x ?y)
    (and (TR ?w0 ?x) (TQ ?w0 ?y))))))

;(A53)
(forall (?w0 ?x ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (ql ?w0 ?x ?y)
    (TL ?w0 ?y)
    (T ?w0 ?x))))))

; Basic Axioms:
;(A54)
(forall (?w0 ?x ?x1 ?y)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?x1)
    (PARTICULAR ?y)
    (ql ?w0 ?x ?y)
    (ql ?w0 ?x1 ?y)
    (= ?x ?x1))))))

; Existential Axioms:
;(A55)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (TQ ?w0 ?x)
    (exists (?y)
      (and (PARTICULAR ?y) (ql ?w0 ?y ?x))))))

;(A56)
(forall (?w0 ?f ?x ?y ?r ?r1)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (PARTICULAR ?x)
```

```
(PARTICULAR ?y)
(PARTICULAR ?r)
(PARTICULAR ?r1)
(L.X ?w0 ?f)
(?f ?w0 ?x)
(?f ?w0 ?y)
(ql ?w0 ?r ?x)
(ql ?w0 ?r1 ?y)
(exists (?g)
  (and (UNIVERSAL ?g)
        (L.X ?w0 ?g)
        (?g ?w0 ?r)
        (?g ?w0 ?r1))))

;(A57)
(forall (?w0 ?f ?x ?y ?r ?r1)
  (=> (and (WORLD ?w0)
           (UNIVERSAL ?f)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?r)
           (PARTICULAR ?r1)
           (L.X ?w0 ?f)
           (?f ?w0 ?x)
           (not (?f ?w0 ?y))
           (ql ?w0 ?r ?x)
           (ql ?w0 ?r1 ?y))
      (not (exists (?g)
                  (and (UNIVERSAL ?g)
                        (L.X ?w0 ?g)
                        (?g ?w0 ?r)
                        (?g ?w0 ?r1)))))))

; Temporary Quale
; Argument restrictions:
;(A58)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (ql ?w0 ?x ?y ?t))
      (and (or (PR ?w0 ?x) (AR ?w0 ?x))
            (or (PQ ?w0 ?y) (AQ ?w0 ?y))
            (T ?w0 ?t))))

;(A59)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (ql ?w0 ?x ?y ?t))
      (<=> (PR ?w0 ?x) (PQ ?w0 ?y))))

;(A60)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
           (PARTICULAR ?y)
           (PARTICULAR ?t)
           (ql ?w0 ?x ?y ?t))
      (<=> (AR ?w0 ?x) (AQ ?w0 ?y))))

;(A61)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
           (PARTICULAR ?x)
```

```
(PARTICULAR ?y)
(PARTICULAR ?t)
(ql ?w0 ?x ?y ?t)
(SL ?w0 ?y)
(S ?w0 ?x)))

; Existential Axioms:
;(A62)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (or (PQ ?w0 ?x) (AQ ?w0 ?x))
    (PRE ?w0 ?x ?t))
    (exists (?y)
      (and (PARTICULAR ?y) (ql ?w0 ?y ?x ?t))))))

;(A63)
(forall (?w0 ?f ?x ?y ?r ?r1 ?t)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?r)
    (PARTICULAR ?r1)
    (PARTICULAR ?t)
    (L.X ?w0 ?f)
    (?f ?w0 ?x)
    (?f ?w0 ?y)
    (ql ?w0 ?r ?x ?t)
    (ql ?w0 ?r1 ?y ?t))
    (exists (?g)
      (and (UNIVERSAL ?g)
        (L.X ?w0 ?g)
        (?g ?w0 ?r)
        (?g ?w0 ?r1))))))

;(A64)
(forall (?w0 ?f ?x ?y ?r ?r1 ?t)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?r)
    (PARTICULAR ?r1)
    (PARTICULAR ?t)
    (L.X ?w0 ?f)
    (?f ?w0 ?x)
    (not (?f ?w0 ?y))
    (ql ?w0 ?r ?x ?t)
    (ql ?w0 ?r1 ?y ?t))
    (not (exists (?g)
      (and (UNIVERSAL ?g)
        (L.X ?w0 ?g)
        (?g ?w0 ?r)
        (?g ?w0 ?r1))))))

; Link with Parthood and extension:
;(A65)
(forall (?w0 ?x ?y ?t)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)
    (PARTICULAR ?y)
    (PARTICULAR ?t)
    (ql ?w0 ?x ?y ?t))
    (PRE ?w0 ?y ?t)))

;(A66)
(forall (?w0 ?x ?y ?t)
```

```

(=> (and (WORLD ?w0)
         (PARTICULAR ?x)
         (PARTICULAR ?y)
         (PARTICULAR ?t))
 (<=> (ql ?w0 ?x ?y ?t)
      (forall (?u)
        (=> (and (PARTICULAR ?u) (P ?w0 ?u ?t))
            (ql ?w0 ?x ?y ?u))))))

; Dependence and Spatial Dependence
; Links between categories
;(A67)
(forall (?w0) (=> (WORLD ?w0) (MSD ?w0 TQ PD)))

;(A68)
(forall (?w0) (=> (WORLD ?w0) (MSD.S ?w0 PQ PED)))

;(A69)
(forall (?w0) (=> (WORLD ?w0) (MSD ?w0 AQ NPED)))

;(A70)
(forall (?w0) (=> (WORLD ?w0) (OGD ?w0 F NAPO)))

;(A71)
(forall (?w0) (=> (WORLD ?w0) (OSD ?w0 MOB APO)))

;(A72)
(forall (?w0) (=> (WORLD ?w0) (OGD ?w0 SAG APO)))

;(A73)
(forall (?w0) (=> (WORLD ?w0) (OGD ?w0 NASO SC)))

;(A74)
(forall (?w0) (=> (WORLD ?w0) (OD ?w0 NPED PED)))

; Characterization of Categories
; Perdurant
; Conditions on Perdurant's Leaves
;(A75)
(forall (?w0 ?f)
  (=> (and (WORLD ?w0)
          (UNIVERSAL ?f)
          (PSBL ?w0 ACH ?f))
      (and (NEP.S ?w0 ?f) (CM~ ?w0 ?f) (AT ?w0 ?f))))

;(A76)
(forall (?w0 ?f)
  (=> (and (WORLD ?w0)
          (UNIVERSAL ?f)
          (PSBL ?w0 ACC ?f))
      (and (NEP.S ?w0 ?f) (CM~ ?w0 ?f) (AT~ ?w0 ?f))))

;(A77)
(forall (?w0 ?f)
  (=> (and (WORLD ?w0)
          (UNIVERSAL ?f)
          (PSBL ?w0 ST ?f))
      (and (NEP.S ?w0 ?f) (CM ?w0 ?f) (HOM ?w0 ?f))))

;(A78)
(forall (?w0 ?f)
  (=> (and (WORLD ?w0)
          (UNIVERSAL ?f)
          (PSBL ?w0 PRO ?f))
      (and (NEP.S ?w0 ?f) (CM ?w0 ?f) (HOM~ ?w0 ?f))))

; Existential Axioms
;(A79)

```

```

(forall (?w0)
  (=> (WORLD ?w0)
    (exists (?f) (and (UNIVERSAL ?f) (PSBL ?w0 ACH ?f)))))

;(A80)
(forall (?w0)
  (=> (WORLD ?w0)
    (exists (?f) (and (UNIVERSAL ?f) (PSBL ?w0 ACC ?f)))))

;(A81)
(forall (?w0)
  (=> (WORLD ?w0)
    (exists (?f) (and (UNIVERSAL ?f) (PSBL ?w0 ST ?f)))))

;(A82)
(forall (?w0)
  (=> (WORLD ?w0)
    (exists (?f) (and (UNIVERSAL ?f) (PSBL ?w0 PRO ?f)))))
; =====
; THEOREMS
; General Properties
; (T1)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (PARTICULAR ?t))
    (not (K ?w0 ?x ?x ?t))))

; (T2)
(forall (?w0 ?f ?g)
  (=> (and (WORLD ?w0) (UNIVERSAL ?f) (UNIVERSAL ?g) (SK ?w0 ?f ?g))
    (SD ?w0 ?f ?g)))

; (T3)
(forall (?w0 ?f ?g)
  (=> (and (WORLD ?w0) (UNIVERSAL ?f) (UNIVERSAL ?g) (GK ?w0 ?f ?g))
    (GD ?w0 ?f ?g)))

; (T4)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (SK ?w0 ?f ?g)
    (SK ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (SK ?w0 ?f ?h)))

; (T5)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (GK ?w0 ?f ?g)
    (GK ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (GK ?w0 ?f ?h)))

; Ground Properties
; (T6)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0) (PARTICULAR ?x) (PARTICULAR ?t))
    (not (PC ?w0 ?x ?x ?t))))

; (T7)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0)
    (PARTICULAR ?x)

```

```
(PARTICULAR ?y)
(PARTICULAR ?t)
(PC ?w0 ?x ?y ?t))
(not (PC ?w0 ?y ?x ?t))))

; (T8)
(forall (?w0 ?x)
  (=> (and (WORLD ?w0) (PARTICULAR ?x))
    (not (qt ?w0 ?x ?x))))

; General properties
; (T9)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (SD ?w0 ?f ?g)
    (SD ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (SD ?w0 ?f ?h)))

; (T10)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (GD ?w0 ?f ?g)
    (GD ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (GD ?w0 ?f ?h)))

; (T11)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (SD ?w0 ?f ?g)
    (GD ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (GD ?w0 ?f ?h)))

; (T12)
(forall (?w0 ?f ?g ?h)
  (=> (and (WORLD ?w0)
    (UNIVERSAL ?f)
    (UNIVERSAL ?g)
    (UNIVERSAL ?h)
    (GD ?w0 ?f ?g)
    (SD ?w0 ?g ?h)
    (DJ ?w0 ?f ?h))
    (GD ?w0 ?f ?h)))

; (T13)
(forall (?w0 ?f ?g)
  (=> (and (WORLD ?w0) (UNIVERSAL ?f) (UNIVERSAL ?g) (SD.S ?w0 ?f ?g))
    (SD ?w0 ?f ?g)))

; (T14)
(forall (?w0 ?f ?g)
  (=> (and (WORLD ?w0) (UNIVERSAL ?f) (UNIVERSAL ?g) (GD.S ?w0 ?f ?g))
    (GD ?w0 ?f ?g)))

; Being Present
; (T15)
(forall (?w0 ?x)
```

```
(=> (and (WORLD ?w0)
        (PARTICULAR ?x)
        (or (ED ?w0 ?x) (PD ?w0 ?x) (Q ?w0 ?x)))
    (exists (?t)
      (and (PARTICULAR ?t) (PRE ?w0 ?x ?t))))

; (T16)
(forall (?w0 ?x ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?t)
          (or (PED ?w0 ?x) (PQ ?w0 ?x))
          (PRE ?w0 ?x ?t))
      (exists (?s)
        (and (PARTICULAR ?s) (PRE ?w0 ?s ?x ?t)))))

; (T17)
(forall (?w0 ?x ?t ?t1)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?t)
          (PARTICULAR ?t1)
          (PRE ?w0 ?x ?t)
          (P ?w0 ?t1 ?t))
      (PRE ?w0 ?x ?t1)))

; (T18)
(forall (?w0 ?x ?s ?t)
  (=> (and (WORLD ?w0)
          (PARTICULAR ?x)
          (PARTICULAR ?s)
          (PARTICULAR ?t)
          (PRE ?w0 ?s ?x ?t))
      (PRE ?w0 ?x ?t)))
```

## 14 APPENDIX B: KIF version of OCHRE

```
=====
; THE OBJECT-CENTRED HIGH-LEVEL REFERENCE ONTOLOGY
; (OCHRE)
;
; Translation in the Knowledge Interchange Format (KIF)
; (American National Standard NCITS.T2/98-004)
; (http://logic.stanford.edu/kif/dpans.html)
;
; in the framework of
; EC IST Project 2001-33052
; WONDERWEB: ONTOLOGY INFRASTRUCTURE FOR THE SEMANTIC WEB
;
; version: 2.1
; date: December 13, 2003
; author: Luc Schneider
; institute: Department of Philosophy, University of Geneva
; e-mail: schneil3@etu.unige.ch
=====

;=====
; THE DOMAIN
;=====

; Existence of particulars
(exists (?x)
  (particular ?x))

;=====
; MEREOLGY - THEORY OF PARTS AND WHOLEES
;=====

; DEFINITIONS OF MEREOLGY
;=====

; ----Sameness----
(defrelation same (?x ?y) :=
  (and
    (part_of ?x ?y)
    (part_of ?y ?x)))

; ----Proper parthood----
(defrelation proper_part_of (?x ?y) :=
  (and
    (part_of ?x ?y)
    (not
      (same ?x ?y))))

; ----Overlap----
(defrelation overlap (?x ?y) :=
  (exists (?z)
    (and
      (part_of ?z ?x)
      (part_of ?z ?y))))

; ----Underlap----
(defrelation underlap (?x ?y) :=
  (exists (?z)
    (and
      (part_of ?x ?z)
      (part_of ?y ?z))))

; ----Atom----
(defrelation atom (?x) :=
  (and
    (particular ?x)
    (not
```

```
(exists (?y)
  (proper_part_of ?y ?x))))

; ----Atomic part----
(defrelation atomic_part_of (?x ?y) :=
  (and
    (atom ?x)
    (part_of ?x ?y)))

; ----Complex----
(defrelation complex (?x) :=
  (and
    (particular ?x)
    (not
      (atom ?x))))

; ----Sum----
(defrelation sum (?x ?y ?z) :=
  (forall (?w)
    (<=>
      (part_of ?w ?x)
      (or
        (part_of ?w ?y)
        (part_of ?w ?z)))))

; ----Product----
(defrelation product (?x ?y ?z) :=
  (forall (?w)
    (<=>
      (part_of ?w ?x)
      (and
        (part_of ?w ?y)
        (part_of ?w ?z)))))

; ----Difference----
(defrelation difference (?x ?y ?z) :=
  (forall (?w)
    (<=>
      (part_of ?w ?x)
      (and
        (part_of ?w ?y)
        (not
          (overlap ?w ?z))))))

; ----Universe----
(defrelation universe (?x) :=
  (forall (?y)
    (part_of ?y ?x)))

; AXIOMS OF MEREOLOGY
;=====

; ----Parthood----
(forall (?x ?y)
  (=>
    (part_of ?x ?y)
    (and
      (particular ?x)
      (particular ?y))))

; ----Reflexivity of parthood----
(forall (?x)
  (=>
    (particular ?x)
    (part_of ?x ?x)))

; ----Transitivity of parthood----
```

```
(forall (?x ?y ?z)
  (=>
    (and
      (part_of ?x ?y)
      (part_of ?y ?z))
    (part_of ?x ?z)))

; ----Sameness implies identity of particulars----
(forall (?x ?y)
  (<=>
    (same ?x ?y)
    (and
      (particular ?x)
      (particular ?y)
      (= ?x ?y))))

; ----Atomicity----
(forall (?x)
  (=>
    (particular ?x)
    (exists (?y)
      (atomic_part_of ?y ?x))))

; ----Extensionality----
(forall (?x ?y)
  (=>
    (and
      (particular ?x)
      (particular ?y)
      (forall (?z)
        (=>
          (atomic_part_of ?z ?x)
          (atomic_part_of ?z ?y))))
    (part_of ?x ?y)))

; ----Existence of sum----
(forall (?x ?y)
  (=>
    (underlap ?x ?y)
    (exists (?w)
      (sum ?w ?x ?y))))

; ----Uniqueness of sum----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (sum ?x ?z ?w)
      (sum ?y ?z ?w)
      (same ?x ?y))))

; ----Existence of product----
(forall (?x ?y)
  (=>
    (overlap ?x ?y)
    (exists (?w)
      (product ?w ?x ?y))))

; ----Uniqueness of product----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (product ?x ?z ?w)
      (product ?y ?z ?w)
      (same ?x ?y))))

; ----Existence of universe----
(exists (?x)
  (universe ?x))
```

```

; ----Uniqueness of universe----
(forall (?x ?y)
  (=>
    (and
      (universe ?x)
      (universe ?y))
    (same ?x ?y)))

;=====
; THE THEORY OF FOUNDATIONS
;=====

; DEFINITIONS OF THE THEORY OF FOUNDATIONS
;=====

; ----Strong foundation----
(defrelation strongly_founded_on (?x ?y) :=
  (and
    (founded_on ?x ?y)
    (not
      (part_of ?y ?x))))

; ----One-sided foundation----
(defrelation one-sidedly_founded_on (?x ?y) :=
  (and
    (founded_on ?x ?y)
    (not
      (founded_on ?y ?x))))

; ----Mutual foundation----
(defrelation mutually_founded_on (?x ?y) :=
  (and
    (founded_on ?x ?y)
    (founded_on ?y ?x)))

; ----Thin object----
(defrelation thin_object (?x) :=
  (and
    (complex ?x)
    (forall (?y)
      (=>
        (founded_on ?x ?y)
        (part_of ?y ?x)))))

; ----Integral whole----
(defrelation integral_wole (?x) :=
  (and
    (complex ?x)
    (forall (?y ?z)
      (=>
        (and
          (atomic_part_of ?y ?x)
          (atomic_part_of ?z ?x))
        (or
          (founded_on ?y ?z)
          (founded_on ?z ?y))))))

; AXIOMS OF THE THEORY OF FOUNDATIONS
;=====

; ----Foundation----
(forall (?x ?y)
  (=>
    (founded_on ?x ?y)
    (and
      (particular ?x)

```

```
(particular ?y)))

; ----Reflexivity of foundation----
(forall (?x)
  (=>
    (particular ?x)
    (founded_on ?x ?x)))

; ----Transitivity of foundation----
(forall (?x ?y ?z)
  (=>
    (and
      (founded_on ?x ?y)
      (founded_on ?y ?z))
    (founded_on ?x ?z)))

; ----Wholes are founded on their parts----
(forall (?x ?y)
  (=>
    (part_of ?y ?x)
    (founded_on ?x ?y)))

; ----Something is founded on a whole,
; if it is founded on all its atomic parts.----
(forall (?x ?y)
  (=>
    (forall (?z)
      (=>
        (atomic_part_of ?z ?y)
        (founded_on ?x ?z)))
    (founded_on ?x ?y)))

; ----Existence of thin objects----
(exists (?x)
  (thin_object ?x))

; ----Thin objects are integral wholes.----
(forall (?x)
  (=>
    (thin_object ?x)
    (integral_whole ?x)))

;=====
; THE THEORY OF SIMILARITY
;=====

; DEFINITIONS OF THE THEORY OF SIMILARITY
;=====

; ----Exact similarity----
(defrelation exactly_similar (?x ?y) :=
  (forall (?z)
    (<=>
      (similar ?x ?z)
      (similar ?y ?z))))

; ----Resemblance----
(defrelation resembles (?x ?y) :=
  (and
    (complex ?x)
    (complex ?y)
    (exists (?z ?w)
      (and
        (atomic_part_of ?z ?x)
        (atomic_part_of ?w ?y)
        (exactly_similar ?z ?w)))))

; ----Complete resemblance----
```

```
(defrelation completely_resembles (?x ?y) :=
  (and
    (complex ?x)
    (complex ?y)
    (forall (?z)
      (=>
        (atomic_part_of ?z ?x)
        (exists (?w)
          (and
            (atomic_part_of ?w ?y)
            (exactly_similar ?z ?w)))))))

; ----Exact resemblance----
(defrelation exactly_resembles (?x ?y) :=
  (and
    (completely_resembles ?x ?y)
    (completely_resembles ?y ?x)))

; AXIOMS OF THE THEORY OF SIMILARITY
;=====

; ----Similarity----
(forall (?x ?y)
  (=>
    (similar ?x ?y)
    (and
      (atom ?x)
      (atom ?y))))

; ----Reflexivity of similarity----
(forall (?x)
  (=>
    (atom ?x)
    (similar ?x ?x)))

; ----Symmetry of similarity----
(forall (?x ?y)
  (=>
    (similar ?x ?y)
    (similar ?y ?x)))

; ----Comparability----
(forall (?x ?y)
  (=>
    (comparable ?x ?y)
    (and
      (atom ?x)
      (atom ?y))))

; ----Symmetry of comparability----
(forall (?x ?y)
  (=>
    (comparable ?x ?y)
    (comparable ?y ?x)))

; ----Transitivity of comparability----
(forall (?x ?y ?z)
  (=>
    (and
      (comparable ?x ?y)
      (comparable ?y ?z))
    (comparable ?x ?z)))

; ----Similarity implies comparability----
(forall (?x ?y)
  (=>
    (similar ?x ?y)
```

```
(comparable ?x ?y))

;=====
; TOPOLOGY - THE THEORY OF SPACE AND TIME
;=====

; DEFINITIONS OF TOPOLOGY
;=====

; ----Thick object----
(defrelation thick_object (?x) :=
  (exists (?y)
    (connected ?x ?y)))

; ----Thick parthood----
(defrelation thick_part_of (?x ?y) :=
  (and
    (thick_object ?x)
    (thick_object ?y)
    (part_of ?x ?y)))

; ----Enclosure----
(defrelation enclosed (?x ?y) :=
  (forall (?z)
    (=>
      (connected ?x ?z)
      (connected ?y ?z))))

; ----Coincidence----
(defrelation coincident (?x ?y) :=
  (and
    (enclosed ?x ?y)
    (enclosed ?y ?x)))

; ----Immediate anteriority----
(defrelation immediately_anterior (?x ?y) :=
  (and
    (anterior ?x ?y)
    (not
      (exists (?z)
        (and
          (anterior ?x ?z)
          (anterior ?z ?y))))))

; ----Temporal overlap----
(defrelation temporally_overlaps (?x ?y) :=
  (and
    (not
      (anterior ?x ?y))
    (not
      (anterior ?y ?x))))

; ----Simultaneity----
(defrelation simultaneous (?x ?y) :=
  (forall (?z)
    (<=>
      (temporally_overlaps ?x ?z)
      (temporally_overlaps ?y ?z))))

; B - AXIOMS OF TOPOLOGY
;=====

; ----Connection----
(forall (?x ?y)
  (=>
    (connected ?x ?y)
    (and
      (complex ?x)
```

```
(complex ?y)
(not
  (thin_object ?x))
(not
  (thin_object ?y))))

; ----Reflexivity of connection----
(forall (?x)
  (=>
    (thick_object ?x)
    (connected ?x ?x)))

; ----Symmetry of connection----
(forall (?x ?y)
  (=>
    (connected ?x ?y)
    (connected ?y ?x)))

; ----Anteriority----
(forall (?x ?y)
  (=>
    (anterior ?x ?y)
    (and
      (thick_object ?x)
      (thick_object ?y))))

; ----Irreflexivity of anteriority----
(forall (?x)
  (not
    (anterior ?x ?x)))

; ----Transitivity of anteriority----
(forall (?x ?y ?z)
  (=>
    (and
      (anterior ?x ?y)
      (anterior ?y ?z))
    (anterior ?x ?z)))

; ----Temporal order----
(forall (?x)
  (=>
    (thick_object ?x)
    (exists (?y)
      (or
        (anterior ?x ?y)
        (anterior ?y ?x)))))

; ----Existence of thick objects----
(exists (?x)
  (thick_object ?x))

; ----Mereotopological invariance----
(forall (?x ?y)
  (=>
    (connected ?x ?y)
    (simultaneous ?x ?y)))

; ----Monotonicity----
(forall (?x ?y)
  (=>
    (thick_part_of ?x ?y)
    (enclosed ?x ?y)))

; ----Extensionality----
(forall (?x ?y)
  (=>
```

```
(coincident ?x ?y)
(same ?x ?y))

;=====
; THE THEORY OF PROPERTIES
;=====

;=====
; DEFINITIONS OF THE THEORY OF PROPERTIES
;=====

; ----Thin parthood----
; A part of a thick object which is not itself
; a thick object is called a thin part.
(defrelation thin_part_of (?x ?y) :=
  (and
    (part_of ?x ?y)
    (thick_object ?y)
    (not
      (thick_object ?x))))

; ----Direct parthood----
; A thin part which does not overlap with any
; of the (proper) thick parts of a thick object
; is called a direct part.
(defrelation direct_part_of (?x ?y) :=
  (and
    (thin_part_of ?x ?y)
    (not
      (exists (?z)
        (and
          (thick_part ?z ?y)
          (not
            (same ?z ?y))
          (overlaps ?x ?z)))))))

; ----Haecceity----
; A thin object that is a direct part of a thick
; object is called an haecceity of that thick object.
(defrelation haecceity (?x ?y) :=
  (and
    (thin_object ?x)
    (direct_part_of ?x ?y)))

; ----Property----
; A direct part of a thick object that does not
; overlap with an haecceity is called a property.
(defrelation property (?x ?y) :=
  (and
    (direct_part_of ?x ?y)
    (forall (?z)
      (=>
        (haecceity ?z ?y)
        (not
          (overlaps ?x ?z)))))))

; ----Integral property----
; Complex properties that form integral wholes,
; e.g., colours (composed of saturations, hues
; and brightnesses), are called integral properties.
(defrelation integral_property (?x ?y) :=
  (and
    (property ?x ?y)
    (integral_whole ?x)))

; ----Guisse or facet----
; A direct part containing an haecceity and all
; the properties founded on the latter is called
```

```
; a guise or facet.
; E.g. the statue and the clay are not distinct
; thick objects, but guises, hence thin parts,
; of the same thick object.
(defrelation guise (?x ?y ?z) :=
  (and
    (direct_part_of ?x ?y)
    (haecceity ?z ?y)
    (forall (?w)
      (<=>
        (part_of ?w ?x)
        (or
          (same ?w ?z)
          (and
            (property ?w ?y)
            (founded_on ?w ?z)))))))

;=====
; AXIOMS OF THE THEORY OF PROPERTIES
;=====

; ----Tropes are direct parts of thick objects.----
(forall (?x)
  (=>
    (atom ?x)
    (exists (?y)
      (direct_part_of ?x ?y))))

; ----Comparable direct parts----
(forall (?x ?y ?z)
  (=>
    (and
      (comparable ?x ?y)
      (direct_part_of ?x ?z)
      (direct_part_of ?y ?z))
    (same ?x ?y)))

; ----Existence of haecceities----
(forall (?x)
  (=>
    (thick_object ?x)
    (exists (?y)
      (haecceity ?y ?x))))

; ----Unicity of simultaneous stages----
(forall (?x ?y ?z)
  (=>
    (and
      (haecceity ?x ?y)
      (haecceity ?x ?z)
      (simultaneous ?y ?z))
    (same ?y ?z)))

; ----Property foundation: 1----
(forall (?x ?y)
  (=>
    (property ?x ?y)
    (exists (?z)
      (and
        (haecceity ?z ?y)
        (founded_on ?x ?z))))))

; ----Property foundation: 2----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (property ?x ?y)
```

```
(haecceity ?z ?y)
(haecceity ?w ?y)
(founded_on ?x ?z)
(founded_on ?x ?w))
(same ?z ?w)))

;=====
; THE THEORY OF RELATIONAL PROPERTIES
;=====

;=====
; DEFINITIONS OF THE THEORY OF RELATIONAL PROPERTIES
;=====

; ----Relational property----
(defrelation relational_property (?x ?y) :=
  (and
    (property ?x ?y)
    (exists (?z ?w)
      (and
        (haecceity ?z ?w)
        (not
          (haecceity ?z ?y))
        (not
          (same ?w ?y))
        (founded_on ?x ?z))))))

; ----Relatum----
(defrelation relatum (?x ?y) :=
  (and
    (exists (?z)
      (relational_property ?y ?z))
    (exists (?w)
      (haecceity ?x ?w))
    (founded_on ?y ?x)))

;=====
; B - AXIOMS OF THE THEORY OF RELATIONAL PROPERTIES
;=====

; ----Precedence----
(defrelation precedes (?x ?y ?z) :=>
  (and
    (relatum ?x ?z)
    (relatum ?y ?z)))

; ----Irreflexivity of precedence----
(forall (?x ?y)
  (not
    (precedes ?x ?x ?y)))

; ---- Transitivity of precedence----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (precedes ?x ?y ?w)
      (precedes ?y ?z ?w))
    (precedes ?x ?z ?w)))

; ----Order of precedence----
(forall (?x ?y ?z)
  (=>
    (and
      (relatum ?x ?z)
      (relatum ?y ?z))
    (or
      (precedes ?x ?y ?z)
```

```
(precedes ?y ?x ?z)))

;=====
; THE THEORY OF EVENTUALITIES
;=====

;=====
; DEFINITIONS OF THE THEORY OF EVENTUALITIES
;=====

; ----Succession----
(defrelation succeeds (?x ?y ?z) :=
  (and
    (immediately_anterior ?y ?x)
    (haecceity ?z ?x)
    (haecceity ?z ?y)))

; ----Event in----
(defrelation event_in (?x ?y) :=
  (exists (?z ?w)
    (and
      (succeeds ?z ?w ?y)
      (sum ?x ?z ?w))))

; ----Event----
(defrelation event (?x) :=
  (exists (?y)
    (event_in ?x ?y)))

; ----Process----
(defrelation process (?x) :=
  (and
    (eventuality ?x)
    (not
      (event ?x))))

; ----Life----
(defrelation life (?x ?y) :=
  (and
    (eventuality ?x)
    (thin_object ?y)
    (forall (?z)
      (<=>
        (part_of ?z ?x)
        (event_in ?z ?y))))))

; ----Participation----
(defrelation participates (?x ?y) :=
  (and
    (thin_object ?x)
    (eventuality ?y)
    (exists (?z)
      (and
        (event_in ?z ?x)
        (part_of ?z ?y)))))

;=====
; AXIOMS OF THE THEORY OF EVENTUALITIES
;=====

; ----Succession: unicity on the left----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (succeeds ?z ?x ?y)
      (succeeds ?w ?x ?y)
      (same ?z ?w))))
```

```
; ----Succession: unicity on the right----
(forall (?x ?y ?z ?w)
  (=>
    (and
      (succeeds ?x ?y ?z)
      (succeeds ?x ?y ?w))
      (same ?z ?w)))

; ----Thin objects as haecceities----
(forall (?x)
  (=>
    (thin_object ?x)
    (exists (?y ?z)
      (and
        (thick_object ?y)
        (thick_object ?z)
        (succeeds ?y ?z ?x)))))

; ----Eventuality: 1----
(forall (?x)
  (=>
    (event ?x)
    (eventuality ?x)))

; ----Eventuality: 2----
(forall (?x ?y ?z)
  (=>
    (and
      (event ?x)
      (eventuality ?y)
      (sum ?z ?x ?y))
      (eventuality ?z)))
```

## 15 APPENDIX C: DOLCE-Lite-Plus

### Scope of DOLCE-Lite+

The “lite” versions of DOLCE are simplified translations of DOLCE2.0 into various logical languages. They are maintained for several reasons:

1. allowing the implementation of DOLCE-based ontologies in languages that are less expressive than FOL. In particular, DOLCE-Lite does not make use of S5 modalities and of some temporally-indexed relations. Modal operators are not heavily exploited in DOLCE, then the consequences are not very harmful for most uses. Temporal indexing is partly supported by ‘composing’ originally indexed relations with temporal location relations. Even this support is not provided for description logic versions of DOLCE-Lite like DAML+OIL, OWL-DL, etc.
2. allowing a description-logic-like naming policy for DOLCE signature. In many cases, different names are adopted for relations that have the same name but different arities in the FOL version, or for relations that have polymorphic domains
3. allowing extensions of DOLCE that do not have a detailed axiomatization yet, and modularizing them
4. taking benefit of the services of certain implemented languages -specially the classification services provided by description logics- in order to support domain applications

In this report, we describe the current structure of the DOLCE-Lite+ ontology library, and we briefly summarize the content of the extensions, their purpose and applications in realistic domains.

As an appendix, we include the code for the library in two languages: a dialect of KIF3.0 (PL), and DAML+OIL. The first one contains a complete code for the library, including the WordNet alignment modules. The second one contains the library (according to available constructs of DAML+OIL) without the WordNet code, since it is very simple and takes much space. DOLCE-Lite+KIF is currently used in some applications that need deep inferences, which can only be provided by expressive, logic-programming-like languages. DOLCE-Lite+DAML is currently used in Semantic Web applications, for example in the Core Ontology for Services (COS), extensively described in section xxx. The extensions to DOLCE presented in the library are work in progress, and although some of them have been tested in realistic applications, they should be taken cautiously from the viewpoint of rigorous formal ontology.

### Structure of DOLCE-Lite+

Currently, DOLCE-Lite+ is designed as follows (fig:library):

1. The “*Top*” module contains only the topmost distinctions of the signature. Among unary relations, the topmost classes are “entity” (aka “particular”), “formal-property”, and “universal”. The instances of “universal” are subclasses of “entity” or “formal-property”. “Formal-property” is used to implement so-called “meta-properties”, such as those defined in the Onto-Clean methodology [48]. “Entity” is the topmost class for individuals. Among binary relations, “immediate-relation” and “mediated-relation” are those holding between entities. An “immediate-relation” is a relation that holds without additional mediating individuals. In logical terms, it is a non-composed relation. A “mediated-relation” holds through other mediating individuals. Logically, it is a relation that composes other relations. For example, a “temporary-participation” relation is a participation relation (holding between objects and events) composed with a mereological relation, because a “part” relation allows to talk of the participation of an object to part of an event. Other relations are present for reasons related to the features of implemented logics, rather than for ontological completeness. For example, “entity-to-constant-relation” allows to link so-called “abstract data” i.e. entities, individuals of a domain that exist ‘outside’ the information service that uses the ontology (e.g. dogs, walkings, thoughts, colors, etc.), with so-called “concrete data” i.e. individuals of a domain existing ‘inside’ the information service that uses the ontology (e.g. integers, strings, etc.).
2. The “DOLCE” module contains the ‘lite’ version of DOLCE2.0, with some customization due to the application experiences carried out so far. Among classes, the basic taxonomy is the same as DOLCE2.0. Among binary relations, the following branches are currently characterized:
  - Identity. Total order, ontological identity.
  - Part. Mereology is characterized in both atemporal (for any entity) and temporalized (only for endurants) ways. Proper-part and component (qualified proper part) relations are introduced.
  - Constitution. Member relations are considered constituencies (see section on DOLCE).
  - Connection. Both weak (no common boundary) and strong (common boundary) relations are characterized. Succession relations are also introduced as primitives, and in both direct and indirect form.
  - Attribution. Inherence of qualities in entities, and representation of qualities within abstract regions are both characterized.
  - Participation. Participation of endurants in perdurants is characterized both as atemporal, and temporalized. Mereological varieties of participation (complete, temporary, constant) are defined. An attempts to characterize “functional” participation is presented in a lower module.

- Localization. This is the branching that goes farthest from DOLCE2.0, since we have tried to capture some naive notions of location by means of mediated relations. "Generic-location" has been introduced to catch both "exact" and "approximate" localizations. Exact ones hold between entities and regions. Approximate ones hold between entities (regions are mediating individuals related through mereological relations. Approximate localization relations are defined in a lower module
  - Dependency. Both specific and generic dependence are characterized. Some subrelations are defined for different domains.
3. The "*Descriptions*" module contains the larger and most peculiar extension to DOLCE. It is described in a dedicated section below. Unary and binary relations are highly interrelated, since the module implements the so-called theory of "descriptions and situations" ([37]) in the form of a "design pattern" that can be applied to many domains without important modifications. The basic classes are: "description", furtherly distinguished into "c-description" (concept description) and "s-description" (situation description), and "situation". S-descriptions have c-descriptions as components. C-descriptions have different functions and are distinguished into "courses", "roles", and "parameters". Each c-description 'describes' the way an entity is found in a situation. The structure of c-descriptions that are components of an s-description constitutes a set of partial rules that can be employed to 'recognize' a situation. This machinery allows to talk of the descriptions we use to perceive, to create, to regulate, etc. any kind of state of affairs. The basic binary relations are: "satisfied-by", holding between s-descriptions and situations; "selects", holding between c-descriptions and entities in a state of affairs; "setting-for", holding between situations and entities in a state of affairs. Other relations allow to add structure to the c-descriptions within a same s-description. Other classes and relations are defined to (minimally) introduce important types of descriptions and roles, such as plans, norms, techniques, systems, social roles, organizations, agents vs. patients, etc. Another important distinction introduced here is that between physical and "functional" endurants. Functionality (as represented through roles) creates a kind of 'layering' in the ontology, since the same amount of matter can be seen as such (e.g. a piece of clay), or as a physical object (a statue), or as functionally-viewed matter (clay used for its therapeutical properties), or as a functional object (a memorial statue). These four views can be considered four different entities, although they are co-located and bear certain dependencies.
  4. The "*Communication*" module contains a simple sketch of a communication theory by using the theory of descriptions (indeed, the two theories are interrelated, since descriptions depend on some intentional agent and on her communication practices). The theory characterised here is composed of some basic semiotic notions ("expression", "meaning", "context", "represents", "interpretant", etc.), and of Jakobson's theory of communicative functions ("encoder", "decoder", "message", "channel", "context", "code"). The theory has been used to characterize P2P communication.
  5. The "*Extrinsic*" module contains some relations to link entities with concrete data like strings and numbers.
  6. The "*Modalities*" module contains the characterization of modal relations as they are treated by legal theorists such as Hohfeld and L. Allen. It is far than complete, but it shows how the theory of descriptions can be used to represent modal notions at first order. Modalities is built around the four basic notions of "right", "power", "privilege", and "immunity", with their converses.
  7. The "*Time Topology*" module contains an adaptation of J. Allen's temporal relations to DOLCE-Lite+. Temporal relations hold here between perdurants, and are "mediated" relations, since they need a mediating time interval (that is the universe of discourse in the original Allen's theory). Mereotopological relations are used to define temporal relations.
  8. The "*Places*" module contains the definition of several "approximate" localization relation (see above). It also contains some classes to distinguishes physical and non-physical (e.g. "political") geographical entities, geographical features, etc.
  9. The "*Functional Participation*" module contains functionally-viewed participation relations, such as "performs", "used-in", "target-of", "consequence-of", etc. Such relations constrain participation within the scope of an s-description: an event is participated by an object according to an s-description and its components. The module also contains the definition of some further classes of perdurants, such as "activity" and "phenomenon", which stand on intentionality as a differential criterion.
  10. The "*Plans*" module contains an attempt to characterize planning concepts according to the theory of descriptions. Plans are taken to be a kind of "method" (an s-description), whose peculiar components are "tasks" that provide instructions to execute actions. Goals are considered both as s-descriptions ("goal-descriptions") and expected goal-situations that satisfy goal-descriptions. Pre- and post-conditions are also characterized. A typical algebra of tasks (case, branching, synchronization, concurrency, cycling, etc.) is characterized with the help of succession relations. Tasks are distinguished from the executed actions; consequently, the status of a procedure (e.g. "started") belongs to a different class from the status of a task (e.g. "accepted"). Moreover, some classes are defined to talk of plan *representation*: flow charts, join and fork nodes, etc.
  11. The "*Systems*" module contains very few classes to get some basic meanings of "system" and "artifact".
  12. The "*WNATOP*" module contains some classes needed to make a preliminary alignment of the WordNet nouns taxonomy. It also shows some domain-oriented examples of application of DOLCE-Lite+ classes.
  13. The "*WNAT*" module contains the 809 classes corresponding to the so-called "synsets" from WordNet 1.6 [28] that have been aligned to DOLCE-Lite+. This alignment has allowed the use of WordNet as a plugin to DOLCE. Some experiments seem very encouraging [2], but much refinement is still needed to get a sound ontological organization of the entire WordNet.

14. The "Services" module contains a preliminary alignment of the DAML-S ontology into DOLCE-Lite+. It is not only an alignment, since the scope of a core ontology of services is wider than the DAML-S one.
15. Various other modules are being built or maintained, notably for the *legal* domain, for the *biomedical* domain, for *banking* and *finance*, etc.

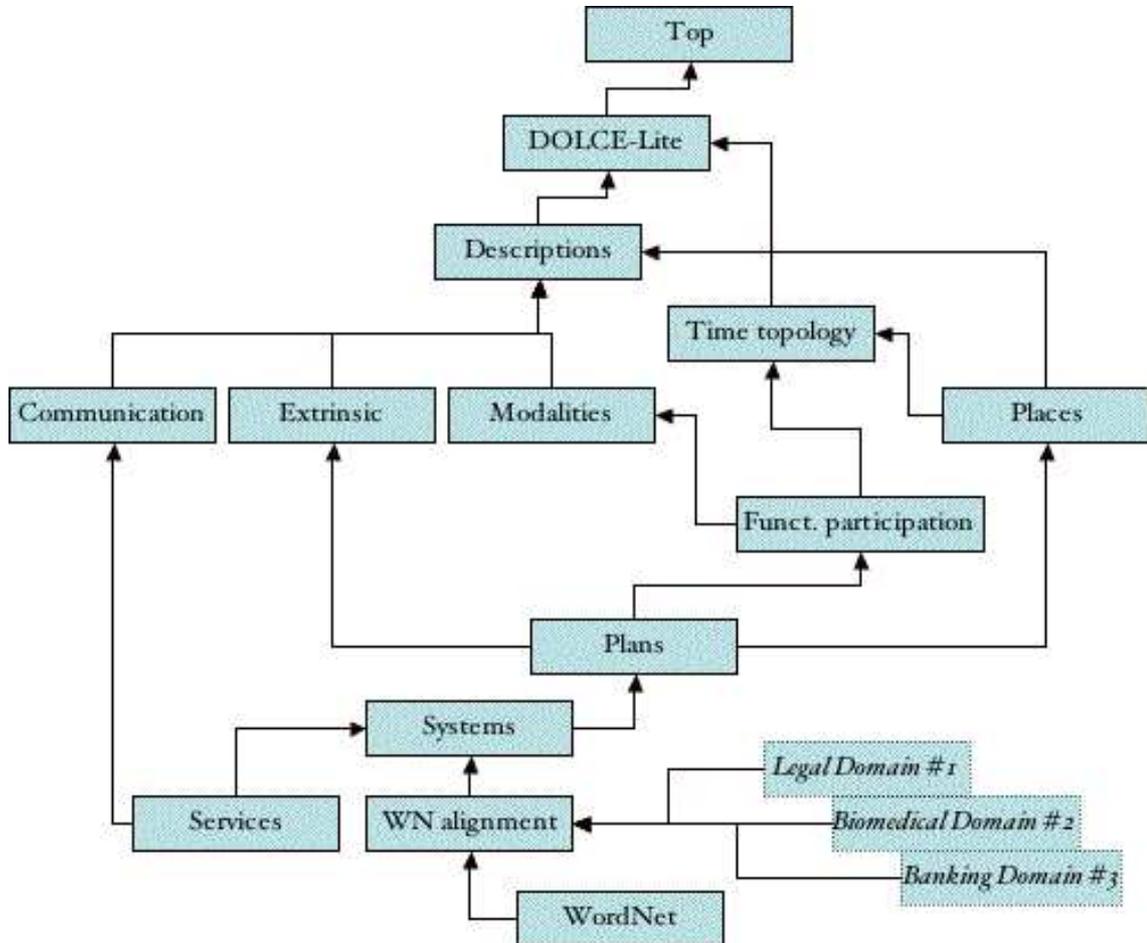


Figure 18: The DOLCE-Lite+ Library

## KIF version of DOLCE-Lite+ (PL dialect)

```
(DEFMODULE "TOP"
  :INCLUDES ())

(IN-MODULE "TOP")

(DEFCONCEPT UNIVERSAL (?SELF)
  :=> (CONCEPT ?SELF))

(DEFCONCEPT ENTITY (?SELF)
  :AXIOMS (UNIVERSAL ENTITY))

(DEFRELATION FORMAL-PROPERTY (?SELF))

(DEFRELATION EXTRINSIC-RELATION (?A ?B)
  :AXIOMS (SYMMETRIC EXTRINSIC-RELATION))

(DEFRELATION IMMEDIATE-RELATION (?A ?B)
  :AXIOMS (AND (SYMMETRIC IMMEDIATE-RELATION)
    (DOCUMENTATION IMMEDIATE-RELATION "A relation that holds without
    additional mediating individuals. In logical terms, a non-composed
    relation.")))

(DEFRELATION META-RELATION (?A ?B)
  :AXIOMS (SYMMETRIC META-RELATION))

(DEFRELATION TERNARY-META-RELATION (?A ?B ?C))

(DEFRELATION ENTITY-TO-CONSTANT-RELATION (?A ?B))

(DEFRELATION CONSTANT-TO-ENTITY-RELATION (?A ?B)
  :AXIOMS (INVERSE CONSTANT-TO-ENTITY-RELATION ENTITY-TO-CONSTANT-RELATION))

(DEFRELATION TERNARY-CONCEPTUAL-RELATION (?A ?B ?C))

(DEFRELATION CONCEPT-TO-ENTITY-RELATION (?A ?B))

(DEFRELATION ENTITY-TO-CONCEPT-RELATION (?A ?B)
  :AXIOMS (INVERSE ENTITY-TO-CONCEPT-RELATION CONCEPT-TO-ENTITY-RELATION))

(DEFRELATION RELATION-TO-ENTITY-RELATION (?A ?B))

(DEFRELATION ENTITY-TO-RELATION-RELATION (?A ?B)
  :AXIOMS (INVERSE ENTITY-TO-RELATION-RELATION RELATION-TO-ENTITY-RELATION))

(DEFRELATION MEDIATED-RELATION (?A ?B)
  :<=> (EXISTS (?C)
    (AND (IMMEDIATE-RELATION ?A ?C) (IMMEDIATE-RELATION ?C ?B))))
  :AXIOMS (AND (SYMMETRIC MEDIATED-RELATION)
    (DOCUMENTATION MEDIATED-RELATION "A relation that composes other
    relations. For example, a participation relation
    composed with a representation relation.")))

(DEFRELATION MEDIATED-EXTRINSIC-RELATION (?A ?B)
  :<=> (EXISTS (?C)
    (AND (EXTRINSIC-RELATION ?A ?C) (EXTRINSIC-RELATION ?C ?B))))
  :AXIOMS (SYMMETRIC MEDIATED-RELATION))

(DEFRELATION HYBRID-RELATION (?A ?B)
  :<=> (EXISTS (?C)
    (AND (IMMEDIATE-RELATION ?A ?C) (ENTITY-TO-CONSTANT-RELATION ?C ?B))))

(DEFRELATION INVERSE-HYBRID-RELATION (?A ?B)
  :AXIOMS (INVERSE INVERSE-HYBRID-RELATION HYBRID-RELATION))

(DEFRELATION HYBRID-MEDIATED-RELATION (?A ?B)
  :<=> (EXISTS (?C)
```

```
(AND (MEDIATED-RELATION ?A ?C) (ENTITY-TO-CONSTANT-RELATION ?C ?B))))

(DEFRELATION INVERSE-HYBRID-MEDIATED-RELATION (?A ?B)
:AXIOMS (INVERSE INVERSE-HYBRID-MEDIATED-RELATION HYBRID-MEDIATED-RELATION))

(ASSERT (= (INVERSE CONSTANT-TO-ENTITY-RELATION) ENTITY-TO-CONSTANT-RELATION))

(ASSERT (= (INVERSE ENTITY-TO-CONCEPT-RELATION) CONCEPT-TO-ENTITY-RELATION))

(ASSERT (= (INVERSE ENTITY-TO-RELATION-RELATION) RELATION-TO-ENTITY-RELATION))

(ASSERT (= (INVERSE INVERSE-HYBRID-RELATION) HYBRID-RELATION))

(ASSERT (= (INVERSE INVERSE-HYBRID-MEDIATED-RELATION) HYBRID-MEDIATED-RELATION))

(ASSERT (forall (?a ?b)
  (=>> (EXTRINSIC-RELATION ?a ?b)
    (LITERAL ?b))))

(ASSERT (forall (?a ?b)
  (=>> (EXTRINSIC-RELATION ?a ?b)
    (LITERAL ?a))))

(ASSERT (forall (?a ?b)
  (=>> (IMMEDIATE-RELATION ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (IMMEDIATE-RELATION ?a ?b)
    (ENTITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (ENTITY-TO-CONSTANT-RELATION ?a ?b)
    (LITERAL ?b))))

(ASSERT (forall (?a ?b)
  (=>> (ENTITY-TO-CONSTANT-RELATION ?a ?b)
    (ENTITY ?a))))

(ASSERT (forall (?a ?b ?c)
  (=>> (and (TERNARY-CONCEPTUAL-RELATION ?a ?b ?c)
    (ENTITY ?a)
    (ENTITY ?b))
    (ENTITY ?c))))

(ASSERT (forall (?a ?b)
  (=>> (META-RELATION ?a ?b)
    (RELATION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (META-RELATION ?a ?b)
    (RELATION ?a))))

(ASSERT (forall (?a ?b)
  (=>> (CONCEPT-TO-ENTITY-RELATION ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (RELATION-TO-ENTITY-RELATION ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (RELATION-TO-ENTITY-RELATION ?a ?b)
    (RELATION ?a))))

(ASSERT (forall (?a ?b)
  (=>> (exists (?c)
    (and (MEDIATED-RELATION ?a ?c)
```

```
(IMMEDIATE-RELATION ?c ?b)))
(MEDIATED-RELATION ?a ?b)))

(ASSERT (forall (?a ?b)
  (=> (exists (?c)
    (and (IMMEDIATE-RELATION ?a ?c)
      (MEDIATED-RELATION ?c ?b)))
    (MEDIATED-RELATION ?a ?b))))

(ASSERT (BINARY-RELATION CONSTANT-TO-ENTITY-RELATION))

(ASSERT (BINARY-RELATION ENTITY-TO-CONCEPT-RELATION))

(ASSERT (BINARY-RELATION ENTITY-TO-RELATION-RELATION))

(ASSERT (BINARY-RELATION INVERSE-HYBRID-RELATION))

(ASSERT (BINARY-RELATION INVERSE-HYBRID-MEDIATED-RELATION))

(DEFMODULE "TOP/DOLCE"
  :INCLUDES ("TOP")
  :SHADOW (FEATURE MEMBER-OF ABSTRACT SET))

(IN-MODULE "TOP/DOLCE")

(DEFCONCEPT FEATURE (?SELF)
  :=> (PHYSICAL-ENDURANT ?SELF)
  :AXIOMS (DOCUMENTATION FEATURE "Features are 'parasitic entities',
that exist insofar their host exists.
Typical examples of features are holes, bumps, boundaries, or spots
of color. Features may be relevant
parts of their host, like a bump or an edge, or dependent regions
like a hole in a piece of cheese,
the underneath of a table, the front of a house, or the shadow of a
tree, which are not parts of their host.
All features are essential wholes, but no common unity criterion may
exist for all of them. However, typical
features have a topological unity, as they are singular entities.")

(DEFCONCEPT ABSTRACT (?SELF)
  :=> (ENTITY ?SELF)
  :AXIOMS (DOCUMENTATION ABSTRACT
  "The main characteristic of abstract entities is that
they do not have spatial nor temporal qualities, and they are not qualities
themselves.
The only class of abstract entities we consider in the present version of the
upper
ontology is that of quality regions (or simply regions). Quality spaces are
special
kinds of quality regions, being mereological sums of all the regions related to
a certain
quality type. The other examples of abstract entities (sets and facts) are only
indicative.")

(DEFCONCEPT SET (?SELF)
  :=> (ABSTRACT ?SELF))

(DEFRELATION IDENTITY-C (?A ?B)
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (AND (REFLEXIVE IDENTITY-C) (SYMMETRIC IDENTITY-C)
    (TRANSITIVE IDENTITY-C)
    (DOCUMENTATION IDENTITY-C "Any pair of individuals are ontologically
identical if they are identical to themselves. This is the non-extrinsic TBox
version
```

of the 'identity' relation. A total order: reflexive, symmetric, and transitive.  
Being ontologically identical does not imply being notionally identical.")))

```
(DEFRELATION DIFFERENT-P (?A ?B)
  :<=> (AND (IMMEDIATE-RELATION ?A ?B) (NOT (IDENTITY-C ?A ?B)))
  :AXIOMS (AND (IRREFLEXIVE DIFFERENT-P) (SYMMETRIC DIFFERENT-P)))

(DEFRELATION PART (?A ?B)
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (AND (REFLEXIVE PART) (TRANSITIVE PART)
    (DOCUMENTATION PART
      "The most generic part relation. A partial order (reflexive,
asymmetric, and transitive)."))))

(DEFRELATION PART-OF (?A ?B)
  :<=> (PART ?B ?A))

(DEFRELATION ATOM ((?A ENTITY))
  :<=> (NOT (EXISTS ?X (AND (ENTITY ?X) (PROPER-PART ?A ?X)))))

(DEFRELATION TEMPORARY-PART (?A ?B)
  :<=> (AND (PART ?A ?B) (ENDURANT ?A) (ENDURANT ?B)
    (PARTLY-COMPRESSENT-WITH ?A ?B))
  :AXIOMS (DOCUMENTATION TEMPORARY-PART
    "Being part at time t. It holds for endurants only. This is important
to model parts that can change or be lost over time without affecting the
identity of the whole. In FOL, this is expressed as a ternary relation, but in
DLs
we only can reason with binary relations, then only the necessary axiom of
compresence
is represented here."))

(DEFRELATION TEMPORARY-PART-OF (?A ?B)
  :<=> (TEMPORARY-PART ?B ?A))

(DEFRELATION PROPER-PART (?A ?B)
  :<=> (AND (PART ?A ?B) (NOT (IDENTITY-C ?A ?B)))
  :AXIOMS (AND (IRREFLEXIVE PROPER-PART) (ANTISYMMETRIC PROPER-PART)
    (TRANSITIVE PROPER-PART)
    (DOCUMENTATION PROPER-PART
      "The proper part relation: irreflexive, antisymmetric,
and transitive.")))

(DEFRELATION PROPER-PART-OF (?A ?B)
  :<=> (PROPER-PART ?B ?A))

(DEFRELATION OVERLAPS (?A ?B)
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C) (AND (PART ?A ?C) (PART-OF ?C ?B))))
  :AXIOMS (AND (SYMMETRIC OVERLAPS)
    (DOCUMENTATION OVERLAPS
      "Mereological overlap: having a common part.")))

(DEFRELATION SIBLING-PART (?A ?B)
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C) (AND (PART-OF ?A ?C) (PART ?C ?B))))
  :AXIOMS (AND (SYMMETRIC SIBLING-PART)
    (DOCUMENTATION SIBLING-PART
      "Mereological sibling: having a common whole"))))

(DEFRELATION TEMPORARY-PROPER-PART (?A ?B)
  :<=> (AND (PROPER-PART ?A ?B) (ENDURANT ?A) (ENDURANT ?B)
    (PARTLY-COMPRESSENT-WITH ?A ?B))
  :AXIOMS (DOCUMENTATION TEMPORARY-PROPER-PART
    "Being proper part at time t. It holds for endurants
only. This is important to model proper parts that can change or be lost over
time
without affecting the identity of the whole."))
```

```
(DEFRELATION TEMPORARY-PROPER-PART-OF (?A ?B)
 :<=> (TEMPORARY-PROPER-PART ?B ?A))

(DEFRELATION COMPONENT (?A ?B)
 :=> (PROPER-PART ?A ?B)
 :AXIOMS (AND (IRREFLEXIVE COMPONENT) (ANTISYMMETRIC COMPONENT)))

(DEFRELATION COMPONENT-OF (?A ?B)
 :<=> (COMPONENT ?B ?A))

(DEFRELATION TEMPORARY-COMPONENT (?A ?B)
 :<=> (AND (COMPONENT ?A ?B) (ENDURANT ?A) (ENDURANT ?B)
         (PARTLY-COMPRESSENT-WITH ?A ?B))
 :AXIOMS (DOCUMENTATION TEMPORARY-COMPONENT
          "Being component at time t. It holds for endurants
          only. This is important to model components that can change or be lost over time
          without affecting the identity of the whole."))

(DEFRELATION TEMPORARY-COMPONENT-OF (?A ?B)
 :<=> (TEMPORARY-COMPONENT ?B ?A))

(DEFRELATION CONSTITUENT (?A ?B)
 :=> (IMMEDIATE-RELATION ?A ?B)
 :AXIOMS (DOCUMENTATION CONSTITUENT
          "'Constituent' should depend on some layering of
          the ontology. For example, scientific granularities or ontological 'strata' are
          typical layerings. A constituent is a part belonging to a lower layer. Since
          layering is actually a partition of the ontology, constituents are not properly
          classified as parts, although this kinship can be intuitive for common sense.
          Example of constituents are the entities constituting a setting (a situation),
          the entities constituting a collection, etc."))

(DEFRELATION CONSTITUENT-OF (?A ?B)
 :<=> (CONSTITUENT ?B ?A))

(DEFRELATION HAS-MEMBER (?A ?B)
 :=> (CONSTITUENT ?A ?B)
 :AXIOMS (DOCUMENTATION HAS-MEMBER
          "Being a constituent in a countable collection, for
          example: member of a society, bacterium in a colony, etc."))

(DEFRELATION MEMBER-OF (?A ?B)
 :<=> (HAS-MEMBER ?B ?A))

(DEFRELATION WEAK-CONNECTION (?A ?B)
 :=> (IMMEDIATE-RELATION ?A ?B)
 :AXIOMS (AND (SYMMETRIC WEAK-CONNECTION)
         (DOCUMENTATION WEAK-CONNECTION
          "The basic connection, not requiring a common boundary.")))

(DEFRELATION BOUNDARY-OF (?A ?B)
 :=> (PROPER-PART-OF ?A ?B)
 :AXIOMS (DOCUMENTATION BOUNDARY-OF
          "A boundary here is taken to be a part (mereological treatment).
          Consequently, in the case of endurants, (reified) boundaries are features."))

(DEFRELATION BOUNDARY (?A ?B)
 :<=> (BOUNDARY-OF ?B ?A)
 :AXIOMS (SINGLE-VALUED BOUNDARY))

(DEFRELATION STRONG-CONNECTION (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C ?D)
          (AND (BOUNDARY ?A ?C) (OVERLAPS ?C ?D) (BOUNDARY-OF ?D ?B))))
 :AXIOMS (AND (SYMMETRIC STRONG-CONNECTION)
         (DOCUMENTATION STRONG-CONNECTION
          "By strong connection here we mean a connection between
```

```
two entities that share a boundary.")))

(DEFRELATION T-SUCCESSOR (?A ?B)
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (DOCUMENTATION T-SUCCESSOR "To be understood as 'entity x
has successor y'. Succession does not exclude connection, but it excludes
overlapping
(see rules files). It can be direct or indirect, and assumes a choice (temporal,
spatial, abstract, etc. Cf. the cognitive 'path' schema."))

(DEFRELATION T-PREDECESSOR (?A ?B)
  :<=> (T-SUCCESSOR ?B ?A)
  :AXIOMS (DOCUMENTATION T-PREDECESSOR "To be understood as 'entity x
has predecessor y'.")

(DEFRELATION DIRECT-SUCCESSOR (?A ?B)
  :=> (T-SUCCESSOR ?A ?B)
  :AXIOMS (DOCUMENTATION DIRECT-SUCCESSOR "Anti-transitive succession."))

(DEFRELATION DIRECT-PREDECESSOR (?A ?B)
  :<=> (DIRECT-SUCCESSOR ?B ?A)
  :AXIOMS (DOCUMENTATION DIRECT-PREDECESSOR "To be understood as 'entity x
has predecessor y'.")

(DEFRELATION INDIRECT-SUCCESSOR (?A ?B)
  :<=> (AND (T-SUCCESSOR ?A ?B)
    (EXISTS (?C) (AND (DIRECT-SUCCESSOR ?A ?C) (DIRECT-SUCCESSOR ?C ?B))))
  :AXIOMS (DOCUMENTATION INDIRECT-SUCCESSOR "Transitive succession."))

(DEFRELATION INDIRECT-PREDECESSOR (?A ?B)
  :<=> (INDIRECT-SUCCESSOR ?B ?A))

(DEFRELATION INHERENT-IN (?A ?B)
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (DOCUMENTATION INHERENT-IN
    "The immediate relation holding for qualities
and entities."))

(DEFRELATION HAS-QUALITY (?A ?B)
  :<=> (INHERENT-IN ?B ?A))

(DEFRELATION T-INHERENT-IN (?A ?B)
  :<=> (AND (INHERENT-IN ?A ?B)
    (EXISTS (?C)
      (AND (Q-LOCATION ?A ?C) (TEMPORAL-REGION ?C) (EXACT-LOCATION-OF ?C ?B)
        (TEMPORAL-REGION ?C))))
  :AXIOMS (DOCUMENTATION T-INHERENT-IN
    "The immediate relation holding for qualities
and entities at time t."))

(DEFRELATION HAS-T-QUALITY (?A ?B)
  :<=> (T-INHERENT-IN ?B ?A))

(DEFRELATION Q-LOCATION (?A ?B)
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (DOCUMENTATION Q-LOCATION "The immediate relation holding for
qualities and regions. See 'generic location' branching for the
various mediated relations that embed q-location."))

(DEFRELATION Q-LOCATION-OF (?A ?B)
  :<=> (Q-LOCATION ?B ?A))

(DEFRELATION HAS-QUALE (?A ?B)
  :=> (Q-LOCATION ?A ?B))

(DEFRELATION QUALE-OF (?A ?B)
  :<=> (HAS-QUALE ?B ?A))
```

```
(DEFRELATION HOST (?A ?B)
:=> (IMMEDIATE-RELATION ?A ?B)
:AXIOMS (DOCUMENTATION HOST
"The immediate relation holding for features and entities."))

(DEFRELATION HOST-OF (?A ?B)
:<=> (HOST ?B ?A))

(DEFRELATION PARTICIPANT (?A ?B)
:=> (IMMEDIATE-RELATION ?A ?B)
:AXIOMS (DOCUMENTATION PARTICIPANT
"The immediate relation holding between endurants and perdurants."))

(DEFRELATION PARTICIPANT-IN (?A ?B)
:<=> (PARTICIPANT ?B ?A))

(DEFRELATION COMPLETE-PARTICIPANT (?A ?B)
:<=> (AND (PARTICIPANT ?A ?B)
(FORALL (?C) (=) (PART ?B ?C) (PARTICIPANT ?A ?C))))
:AXIOMS (DOCUMENTATION COMPLETE-PARTICIPANT
"x participates in y with all its parts."))

(DEFRELATION COMPLETE-PARTICIPANT-IN (?A ?B)
:<=> (COMPLETE-PARTICIPANT ?B ?A))

(DEFRELATION TEMPORARY-PARTICIPANT (?A ?B)
:<=> (AND (PARTICIPANT ?A ?B)
(EXISTS (?C) (AND (PART ?A ?C) (PARTICIPANT ?C ?B)))))
:AXIOMS (DOCUMENTATION TEMPORARY-PARTICIPANT
"x participates in some of y's parts."))

(DEFRELATION TEMPORARY-PARTICIPANT-IN (?A ?B)
:<=> (TEMPORARY-PARTICIPANT ?B ?A))

(DEFRELATION TOTAL-PARTICIPANT (?A ?B)
:<=> (AND (PARTICIPANT ?A ?B)
(FORALL (?C) (=) (PART ?A ?C) (PARTICIPANT ?C ?B))))
:AXIOMS (DOCUMENTATION TOTAL-PARTICIPANT "x participates in all y's parts."))

(DEFRELATION TOTAL-PARTICIPANT-IN (?A ?B)
:<=> (TOTAL-PARTICIPANT ?B ?A))

(DEFRELATION GENERIC-LOCATION (?A ?B)
:=> (MEDIATED-RELATION ?A ?B)
:AXIOMS (DOCUMENTATION GENERIC-LOCATION "The most generic mediated (indirect)
location relation. This is meant to support naive localization, between
any kinds of entities. Generic location is primarily branched into
'exact' location, ranging on regions, and 'approximate' location,
ranging on non-regions."))

(DEFRELATION GENERIC-LOCATION-OF (?A ?B)
:<=> (GENERIC-LOCATION ?B ?A))

(DEFRELATION EXACT-LOCATION (?A ?B)
:<=> (AND (GENERIC-LOCATION ?A ?B) (REGION ?B)
(EXISTS (?C) (AND (HAS-QUALITY ?A ?C) (Q-LOCATION ?C ?B)))))
:AXIOMS (DOCUMENTATION EXACT-LOCATION
"Location relation bounded to regions and defined analytically
through the
composition of inherence and q-location."))

(DEFRELATION EXACT-LOCATION-OF (?A ?B)
:<=> (EXACT-LOCATION ?B ?A))

(DEFRELATION PHYSICAL-LOCATION (?A ?B)
:<=> (AND (EXACT-LOCATION ?A ?B) (PHYSICAL-ENDURANT ?A) (PHYSICAL-REGION ?B))
:AXIOMS (DOCUMENTATION PHYSICAL-LOCATION
"Analytical location holding between physical endurants and physical
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```
regions."))

(DEFRELATION PHYSICAL-LOCATION-OF (?A ?B)
 :<=> (PHYSICAL-LOCATION ?B ?A))

(DEFRELATION SPATIAL-LOCATION (?A ?B)
 :<=> (AND (PHYSICAL-LOCATION ?A ?B) (PHYSICAL-ENDURANT ?A) (SPACE-REGION ?B))
 :AXIOMS (DOCUMENTATION SPATIAL-LOCATION
 "Analytical location holding between physical endurants and spatial
 regions."))

(DEFRELATION SPATIAL-LOCATION-OF (?A ?B)
 :<=> (SPATIAL-LOCATION ?B ?A))

(DEFRELATION P-SPATIAL-LOCATION (?A ?B)
 :<=> (AND (EXACT-LOCATION ?A ?B) (PERDURANT ?A) (SPACE-REGION ?B)
 (EXISTS (?C)
 (AND (PARTICIPANT ?A ?C) (PHYSICAL-ENDURANT ?C)
 (SPATIAL-LOCATION ?C ?B))))
 :AXIOMS (DOCUMENTATION P-SPATIAL-LOCATION
 "Analytical indirect location holding between perdurants and space
 regions."))

(DEFRELATION P-SPATIAL-LOCATION-OF (?A ?B)
 :<=> (P-SPATIAL-LOCATION ?B ?A))

(DEFRELATION TEMPORAL-LOCATION (?A ?B)
 :<=> (AND (EXACT-LOCATION ?A ?B) (PERDURANT ?A) (TEMPORAL-REGION ?B))
 :AXIOMS (DOCUMENTATION TEMPORAL-LOCATION
 "Analytical location holding between physical perdurants and temporal
 regions."))

(DEFRELATION TEMPORAL-LOCATION-OF (?A ?B)
 :<=> (TEMPORAL-LOCATION ?B ?A))

(DEFRELATION DURATION (?A ?B)
 :=> (TEMPORAL-LOCATION ?A ?B))

(DEFRELATION DURATION-OF (?A ?B)
 :<=> (DURATION ?B ?A))

(DEFRELATION E-TEMPORAL-LOCATION (?A ?B)
 :<=> (AND (EXACT-LOCATION ?A ?B) (ENDURANT ?A) (TEMPORAL-REGION ?B)
 (EXISTS (?C)
 (AND (PARTICIPANT-IN ?A ?C) (PERDURANT ?C) (TEMPORAL-LOCATION ?C ?B))))
 :AXIOMS (DOCUMENTATION E-TEMPORAL-LOCATION
 "Analytical indirect location holding between endurants and temporal
 regions."))

(DEFRELATION E-TEMPORAL-LOCATION-OF (?A ?B)
 :<=> (E-TEMPORAL-LOCATION ?B ?A))

(DEFRELATION ABSTRACT-LOCATION (?A ?B)
 :<=> (AND (EXACT-LOCATION ?A ?B) (NON-PHYSICAL-ENDURANT ?A)
 (ABSTRACT-REGION ?B))
 :AXIOMS (DOCUMENTATION ABSTRACT-LOCATION "Analytical location holding between
 non-physical endurants and abstract regions."))

(DEFRELATION ABSTRACT-LOCATION-OF (?A ?B)
 :<=> (ABSTRACT-LOCATION ?B ?A))

(DEFRELATION DEPEND-ON-SPATIAL-LOCATION (?A ?B)
 :<=> (AND (EXACT-LOCATION ?A ?B) (NON-PHYSICAL-ENDURANT ?A) (SPACE-REGION ?B)
 (EXISTS (?C)
 (AND (PHYSICALLY-DEPENDS-ON ?A ?C) (NON-PHYSICAL-ENDURANT ?A)
 (PHYSICAL-ENDURANT ?C) (SPATIAL-LOCATION ?C ?B) (SPACE-REGION ?B))))
 :AXIOMS (DOCUMENTATION DEPEND-ON-SPATIAL-LOCATION
 "Analytical indirect location holding between non-physical endurants
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```
and space regions."))

(DEFRELATION DEPEND-ON-SPATIAL-LOCATION-OF (?A ?B)
 :<=> (DEPEND-ON-SPATIAL-LOCATION ?B ?A))

(DEFRELATION PRESENT-AT (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C)
 (AND (E-TEMPORAL-LOCATION ?A ?C) (ENDURANT ?A) (TIME-INTERVAL ?C)
 (PART ?C ?B) (TIME-INTERVAL ?B))))))
:AXIOMS (DOCUMENTATION PRESENT-AT
 "Presence is axiomatized as being temporally located in a part of
one's life."))

(DEFRELATION TIME-OF-PRESENCE-OF (?A ?B)
 :<=> (PRESENT-AT ?B ?A))

(DEFRELATION PARTLY-COMPRESNT-WITH (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C) (AND (PRESENT-AT ?A ?C) (PRESENT-AT ?B ?C))))))
:AXIOMS (SYMMETRIC PARTLY-COMPRESNT-WITH))

(DEFRELATION Q-PRESENT-AT (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C ?D)
 (AND (INHERENT-IN ?A ?C) (PHYSICAL-QUALITY ?A) (PHYSICAL-ENDURANT ?C)
 (E-TEMPORAL-LOCATION ?C ?D) (TIME-INTERVAL ?D) (PART ?D ?B)
 (TIME-INTERVAL ?B))))))
:AXIOMS (DOCUMENTATION Q-PRESENT-AT
 "Presence of a physical quality when inheres in an endurant."))

(DEFRELATION TIME-OF-Q-PRESENCE-OF (?A ?B)
 :<=> (Q-PRESENT-AT ?B ?A))

(DEFRELATION HAPPENS-AT (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C)
 (AND (TEMPORAL-LOCATION ?A ?C) (PERDURANT ?A) (TIME-INTERVAL ?C)
 (PART ?C ?B) (TIME-INTERVAL ?B))))))
:AXIOMS (DOCUMENTATION HAPPENS-AT
 "Perdurant presence (happening) is axiomatized as being temporally
located at a point in one's life."))

(DEFRELATION TIME-OF-HAPPENING-OF (?A ?B)
 :<=> (HAPPENS-AT ?B ?A))

(DEFRELATION SPECIFICALLY-CONSTANTLY-DEPENDENT-ON (?A ?B)
 :=> (IMMEDIATE-RELATION ?A ?B)
:AXIOMS (DOCUMENTATION SPECIFICALLY-CONSTANTLY-DEPENDENT-ON
 "The constant dependence between two individuals. Taken here as
primitive."))

(DEFRELATION SPECIFIC-CONSTANT-DEPEND-ON-OF (?A ?B)
 :<=> (SPECIFICALLY-CONSTANTLY-DEPENDENT-ON ?B ?A))

(DEFRELATION GENERICALLY-DEPENDS-ON (?A ?B)
 :<=> (AND (IMMEDIATE-RELATION ?A ?B)
 (EXISTS (?P) (AND (SUPERRELATION ?P ENTITY) (INSTANCE-OF ?B ?P))))))
:AXIOMS (DOCUMENTATION GENERICALLY-DEPENDS-ON
 "The dependence on an individual of a given type."))

(DEFRELATION GENERIC-DEPEND-ON-OF (?A ?B)
 :<=> (GENERICALLY-DEPENDS-ON ?B ?A))

(DEFRELATION E-DEPENDS-ON (?A ?B)
 :<=> (AND (SPECIFICALLY-CONSTANTLY-DEPENDENT-ON ?A ?B) (ENDURANT ?A)
 (ENDURANT ?B))
:AXIOMS (DOCUMENTATION E-DEPENDS-ON "Specific dependence between endurants.
```

The only constraint given here is temporal co-occurrence (correlation), but an interesting form of dependence should include some causality context.")

```
(DEFRELATION E-DEPEND-ON-OF (?A ?B)
 :<=> (E-DEPENDS-ON ?B ?A))

(DEFRELATION PHYSICALLY-DEPENDS-ON (?A ?B)
 :<=> (AND (E-DEPENDS-ON ?A ?B) (NON-PHYSICAL-ENDURANT ?A)
        (PHYSICAL-ENDURANT ?B))
 :AXIOMS (DOCUMENTATION PHYSICALLY-DEPENDS-ON
          "Specific dependence of non-physical on physical endurants."))

(DEFRELATION PHYSICAL-DEPEND-ON-OF (?A ?B)
 :<=> (PHYSICALLY-DEPENDS-ON ?B ?A))

(DEFRELATION DESCRIPTIVELY-DEPENDS-ON (?A ?B)
 :<=> (AND (E-DEPENDS-ON ?A ?B) (ENDURANT ?A) (NON-PHYSICAL-ENDURANT ?B))
 :AXIOMS (DOCUMENTATION DESCRIPTIVELY-DEPENDS-ON
          "Specific dependence of endurants on non-physical endurants."))

(DEFRELATION DESCRIPTIVE-DEPEND-ON-OF (?A ?B)
 :<=> (DESCRIPTIVELY-DEPENDS-ON ?B ?A))

(DEFRELATION TEMPORARILY-DEPENDS-ON (?A ?B)
 :=> (AND (E-DEPENDS-ON ?A ?B) (PARTLY-COMPRESNT-WITH ?A ?B))
 :AXIOMS (DOCUMENTATION TEMPORARILY-DEPENDS-ON
          "Specific, but temporary dependence between
          endurants."))

(DEFRELATION TEMPORARY-DEPEND-ON-OF (?A ?B)
 :<=> (TEMPORARILY-DEPENDS-ON ?B ?A))

(DEFRELATION P-DEPENDS-ON (?A ?B)
 :<=> (AND (IMMEDIATE-RELATION ?A ?B) (PERDURANT ?A) (PERDURANT ?B)
        (FORALL ?Z
          (=> (AND (TIME-INTERVAL ?Z) (HAPPENS-AT ?A ?Z) (NOT (PART ?A ?B)))
              (HAPPENS-AT ?B ?Z))))
 :AXIOMS (DOCUMENTATION P-DEPENDS-ON "Primitive dependence between perdurants.
The only constraint given here is temporal co-occurrence (correlation),
but an interesting form of dependence should include some causality
context."))

(DEFRELATION P-DEPEND-ON-OF (?A ?B)
 :<=> (P-DEPENDS-ON ?B ?A))

(DEFCONCEPT ENDURANT (?SELF)
 :=> (ENTITY ?SELF)
 :AXIOMS (DOCUMENTATION ENDURANT "The main characteristic of endurants is
that all of them are independent essential wholes. This does not mean that the
corresponding property (being an endurant) carries proper unity, since there is
no common unity criterion for endurants. Endurants can 'genuinely' change in
time,
in the sense that the very same endurant as a whole can have incompatible
properties
at different times. To see this, suppose that an endurant say 'this paper' has a
property at a time t 'it's white', and a different, incompatible property at
time t'
'it's yellow': in both cases we refer to the whole object, without picking up
any
particular part of it. Within endurants, we distinguish between physical and
non-physical
endurants, according to whether they have direct spatial qualities. Within
physical
endurants, we distinguish between amounts of matter, objects, and features. "))

(DEFCONCEPT ARBITRARY-SUM (?SELF)
 :=> (ENDURANT ?SELF))
```

```
(DEFCONCEPT PHYSICAL-ENDURANT (?SELF)
  :=> (ENDURANT ?SELF))

(DEFCONCEPT AMOUNT-OF-MATTER (?SELF)
  :=> (PHYSICAL-ENDURANT ?SELF)
  :AXIOMS (DOCUMENTATION AMOUNT-OF-MATTER
    "The common trait of amounts of matter is that they
    are endurants with no unity (according to Gangemi et a. 2001 none of them is an
    essential
    whole). Amounts of matter - 'stuffs' referred to by mass nouns like 'gold',
    'iron', 'wood',
    'sand', 'meat', etc. - are mereologically invariant, in the sense that they
    change their
    identity when they change some parts."))

(DEFCONCEPT RELEVANT-PART (?SELF)
  :=> (FEATURE ?SELF))

(DEFCONCEPT DEPENDENT-PLACE (?SELF)
  :=> (FEATURE ?SELF))

(DEFCONCEPT PHYSICAL-OBJECT (?SELF)
  :=> (PHYSICAL-ENDURANT ?SELF)
  :AXIOMS (DOCUMENTATION PHYSICAL-OBJECT
    " The main characteristic of physical objects is that
    they are endurants with unity. However, they have no common unity criterion,
    since
    different subtypes of objects may have different unity criteria. Differently
    from
    aggregates, (most) physical objects change some of their parts while keeping
    their
    identity, they can have therefore temporary parts. Often physical objects
    (indeed,
    all endurants) are ontologically independent from occurrences (discussed below).
    However, if we admit that every object has a life, it is hard to exclude a
    mutual
    specific constant dependence between the two. Nevertheless, we may still use the
    notion of dependence to (weakly) characterize objects as being not specifically
    constantly dependent on other objects."))

(DEFCONCEPT AGENTIVE-PHYSICAL-OBJECT (?SELF)
  :=> (PHYSICAL-OBJECT ?SELF)
  :AXIOMS (DOCUMENTATION AGENTIVE-PHYSICAL-OBJECT
    " Within Physical objects, a special place have
    those to which we ascribe intentions, beliefs, and desires. These are called
    Agentive,
    as opposite to Non-agentive. Intentionality is understood here as the capability
    of
    heading for/dealing with objects or states of the world. This is an important
    area
    of ontological investigation we haven't properly explored yet, so our
    suggestions are
    really very preliminary.
    In general, we assume that agentive objects are constituted by non-agentive
    objects:
    a person is constituted by an organism, a robot is constituted by some
    machinery, and
    so on. Among non-agentive physical objects we have for example houses, body
    organs,
    pieces of wood, etc. ")

(DEFCONCEPT NATURAL-PERSON (?SELF)
  :=> (AGENTIVE-PHYSICAL-OBJECT ?SELF)
  :AXIOMS (DOCUMENTATION NATURAL-PERSON "A person ontologically dependent on
    an organism"))

(DEFCONCEPT NON-AGENTIVE-PHYSICAL-OBJECT (?SELF)
```

```
:=> (PHYSICAL-OBJECT ?SELF)
:AXIOMS (DOCUMENTATION NON-AGENTIVE-PHYSICAL-OBJECT
        " Within Physical objects, a special place have those
those to which we ascribe intentions, beliefs, and desires. These are called
Agentive,
as opposite to Non-agentive. Intentionality is understood here as the capability
of
heading for/dealing with objects or states of the world. This is an important
area
of ontological investigation we haven't properly explored yet, so our
suggestions are
really very preliminary.
A possible modelling of case roles has been started within the descriptions
plugin
(see file: descriptions.lisp) that could be embedded within basic DOLCE.
In general, we assume that agentive objects are constituted by non-agentive
objects: a
person is constituted by an organism, a robot is constituted by some machinery,
and so on.
Among non-agentive physical objects we have for example houses, body organs,
pieces of wood,
etc. ")

(DEFCONCEPT UNITARY-COLLECTION (?SELF)
 :=> (NON-AGENTIVE-PHYSICAL-OBJECT ?SELF)
 :AXIOMS (DOCUMENTATION UNITARY-COLLECTION
         "A non-agentive physical object constituted by
members of definite kinds."))

(DEFCONCEPT NON-PHYSICAL-ENDURANT (?SELF)
 :=> (ENDURANT ?SELF)
 :AXIOMS (DOCUMENTATION NON-PHYSICAL-ENDURANT
         "An endurant having only abstract qualities.
Its temporal or spatial qualities are inherited by the physical endurants it
depends on."))

(DEFCONCEPT QUALITY (?SELF)
 :=> (ENTITY ?SELF)
 :AXIOMS (DOCUMENTATION QUALITY
         " Qualities can be seen as the basic entities we can
perceive or measure: shapes, colors, sizes, sounds, smells, as well as weights,
lengths,
electrical charges... 'Quality' is often used as a synonymous of 'property', but
this is
not the case in this upper ontology: qualities are particulars, properties are
universals.
Qualities inhere to entities: every entity (including qualities themselves)
comes with
certain qualities, which exist as long as the entity exists."))

(DEFCONCEPT TEMPORAL-QUALITY (?SELF)
 :=> (QUALITY ?SELF)
 :AXIOMS (DOCUMENTATION TEMPORAL-QUALITY
         "A quality inherent only in perdurants."))

(DEFCONCEPT PHYSICAL-QUALITY (?SELF)
 :=> (QUALITY ?SELF)
 :AXIOMS (DOCUMENTATION PHYSICAL-QUALITY
         "A quality inherent only in physical endurants."))

(DEFCONCEPT ABSTRACT-QUALITY (?SELF)
 :=> (QUALITY ?SELF)
 :AXIOMS (DOCUMENTATION ABSTRACT-QUALITY
         "A quality inherent only in non-physical endurants."))

(DEFCONCEPT TEMPORAL-LOCATION-Q (?SELF)
 :=> (TEMPORAL-QUALITY ?SELF))
```

```
(DEFCONCEPT SPATIAL-LOCATION-Q (?SELF)
  :=> (PHYSICAL-QUALITY ?SELF))

(DEFCONCEPT REGION (?SELF)
  :=> (ABSTRACT ?SELF)
  :AXIOMS (DOCUMENTATION REGION
    "We distinguish between a quality (e.g., the color
of a specific rose), and its value (e.g., a particular shade of red). The latter
is called quale, and describes the position of an individual quality within a
certain
conceptual space (called here quality space) Gardenfors (2000). So when we say
that
two roses have (exactly) the same color, we mean that their color qualities,
which
are distinct, have the same position in the color space, that is they have the
same
color quale."))

(DEFCONCEPT TEMPORAL-REGION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (DOCUMENTATION TEMPORAL-REGION
    "A region at which only temporal qualities can be
directly located. It assumes a metrics for time."))

(DEFCONCEPT PHYSICAL-REGION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (DOCUMENTATION PHYSICAL-REGION
    "A region at which only physical qualities can be
directly located. It assumes some metrics for physical properties."))

(DEFCONCEPT ABSTRACT-REGION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (DOCUMENTATION ABSTRACT-REGION
    "A region at which only abstract qualities can be
directly located. It assumes some metrics for abstract (neither physical nor
temporal) properties."))

(DEFCONCEPT TIME-INTERVAL (?SELF)
  :=> (TEMPORAL-REGION ?SELF))

(DEFCONCEPT SPACE-REGION (?SELF)
  :=> (PHYSICAL-REGION ?SELF))

(DEFCONCEPT SPATIO-TEMPORAL-REGION (?SELF)
  :=> (SPACE-REGION ?SELF))

(DEFCONCEPT QUALE (?SELF)
  :<=> (AND (REGION ?SELF) (NOT (EXISTS (?A) (PROPER-PART ?SELF ?A)))))

(DEFCONCEPT PERDURANT (?SELF)
  :=> (ENTITY ?SELF)
  :AXIOMS (DOCUMENTATION PERDURANT
    "Perdurants (also called occurrences) comprise what are
variously called events, processes, phenomena, activities and states. They can
have
temporal parts or spatial parts. For instance, the first movement of (an
execution of)
a symphony is a temporal part of it. On the other side, the play performed by
the left
side of the orchestra is a spatial part. In both cases, these parts are
occurrences
themselves. We assume that objects cannot be parts of occurrences, but rather
they
participate in them. Perdurants extend in time by accumulating different
temporal parts,
so that, at any time they are present, they are only partially present, in the
sense that
some of their proper temporal parts (e.g., their previous or future phases) may
```

be not present. E.g., the piece of paper you are reading now is wholly present, while some temporal parts of your reading are not present any more. Philosophers say that endurants are entities that are in time, while lacking however temporal parts (so to speak, all their parts flow with them in time). Perdurants, on the other hand, are entities that happen in time, and can have temporal parts (all their parts are fixed in time).")

```
(DEFCONCEPT EVENT (?SELF)
  => (PERDURANT ?SELF)
  :AXIOMS (DOCUMENTATION EVENT
    "An occurrence-type is stative or eventive according
to whether it holds of the mereological sum of two of its instances, i.e. if it
is
cumulative or not. A sitting occurrence is stative since the sum of two sittings
is still a sitting occurrence."))
```

```
(DEFCONCEPT STATIVE (?SELF)
  => (PERDURANT ?SELF)
  :AXIOMS (DOCUMENTATION STATIVE
    "An occurrence-type is stative or eventive according
to whether it holds of the mereological sum of two of its instances, i.e. if it
is
cumulative or not. A sitting occurrence is stative since the sum of two sittings
is still a sitting occurrence."))
```

```
(DEFCONCEPT STATE (?SELF)
  => (STATIVE ?SELF)
  :AXIOMS (DOCUMENTATION STATE
    "Within stative occurrences, we distinguish between
states and processes according to homeomericity: sitting is classified as a
state
but running is classified as a process, since there are (very short) temporal
parts
of a running that are not themselves runnings."))
```

```
(DEFCONCEPT PROCESS (?SELF)
  => (STATIVE ?SELF)
  :AXIOMS (DOCUMENTATION PROCESS
    "Within stative occurrences, we distinguish between
states and processes according to homeomericity: sitting is classified as a
state
but running is classified as a process, since there are (very short) temporal
parts
of a running that are not themselves runnings."))
```

```
(DEFCONCEPT ACHIEVEMENT (?SELF)
  => (EVENT ?SELF)
  :AXIOMS (DOCUMENTATION ACHIEVEMENT
    "Eventive occurrences (events) are called achievements
if they are atomic, otherwise they are accomplishments."))
```

```
(DEFCONCEPT ACCOMPLISHMENT (?SELF)
  => (EVENT ?SELF)
  :AXIOMS (DOCUMENTATION ACCOMPLISHMENT "An Occurrence that contains its
result as a boundary. It does include aborted, suspended, misperformed
accomplishments,
and does NOT include processes that have a result that wasn't intended as their
achievement.
This disclaimer leads to the conclusion that the accomplishment/process
distinction is
dependent on intentionality. (Cf. The F-Perdurant plugin to DOLCE).
Eventive occurrences (events) are called achievements
if they are atomic, otherwise they are accomplishments."))
```

```
(DEFCONCEPT FACT (?SELF)
  :=> (ABSTRACT ?SELF))

(DEFCONCEPT SITUATION (?SELF)
  :=> (ENTITY ?SELF)
  :AXIOMS (DOCUMENTATION SITUATION
    "Support for settings (situations, episodes, states of affairs).
    This results to be a new category in DOLCE, but it could be equivalently
    modelled
    as a special complex perdurant defined through its relations to qualities,
    regions, and endurants.
    In fact, a perdurant should be the only mandatory component of a setting.
    See also documentation for 'S-Description'.
    As a disjoint category, a situation is generically dependent on a description
    made by some agent.
    Two descriptions of a same situation are possible, otherwise we would result in
    a solipsistic
    ontology.
    A situation has a unity criterion -the intentionality of the describing agent-
    and is (pseudo-)
    extensional, since its constituents are invariant to a description. The
    difference with physical
    endurants is extensionality; in fact, the unity criterion for situations creates
    a view on the
    constituents of a situation, but if a situation loses a constituent, it is no
    more the same situation.
    This double dependence (on constituents and on descriptions) is characteristic
    of an 'interactionist'
    assumption: (pseudo-) extensionally speaking, the reality is always the same,
    but a particular cut is
    given on it by an observer -but not necessarily a 'unique' cut.
    Consequently, situation is a *generically constantly dependent* property, but a
    *specifically
    constantly constituted* property.
    Notice that these metaproperties are compatible with a special kind of perdurant
    as well as of
    endurant, but not with a special kind of region."))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF ENDURANT PERDURANT QUALITY REGION
  SITUATION)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF NON-PHYSICAL-ENDURANT
  PHYSICAL-ENDURANT ARBITRARY-SUM)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF PHYSICAL-OBJECT FEATURE
  AMOUNT-OF-MATTER)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF AGENTIVE-PHYSICAL-OBJECT
  NON-AGENTIVE-PHYSICAL-OBJECT)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF ABSTRACT-QUALITY TEMPORAL-QUALITY
  PHYSICAL-QUALITY)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF ABSTRACT-REGION TEMPORAL-REGION
  PHYSICAL-REGION)))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-PART ?a ?b)
  (ENDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-PART ?a ?b)
  (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-PROPER-PART ?a ?b)
  (ENDURANT ?b))))
```

```
(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-PROPER-PART ?a ?b)
    (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-COMPONENT ?a ?b)
    (ENDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORARY-COMPONENT ?a ?b)
    (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (INHERENT-IN ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (INHERENT-IN ?a ?b)
    (QUALITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (T-INHERENT-IN ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (T-INHERENT-IN ?a ?b)
    (QUALITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (Q-LOCATION ?a ?b)
    (REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (Q-LOCATION ?a ?b)
    (QUALITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (HAS-QUALE ?a ?b)
    (QUALE ?b))))

(ASSERT (forall (?a ?b)
  (=>> (HAS-QUALE ?a ?b)
    (QUALITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (HOST ?a ?b)
    (ENTITY ?b))))

(ASSERT (forall (?a ?b)
  (=>> (HOST ?a ?b)
    (FEATURE ?a))))

(ASSERT (forall (?a ?b)
  (=>> (PARTICIPANT ?a ?b)
    (ENDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (PARTICIPANT ?a ?b)
    (PERDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (EXACT-LOCATION ?a ?b)
    (REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (EXACT-LOCATION ?a ?b)
    (ENTITY ?a))))
```

```
(ASSERT (forall (?a ?b)
  (=>> (PHYSICAL-LOCATION ?a ?b)
        (PHYSICAL-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (PHYSICAL-LOCATION ?a ?b)
        (PHYSICAL-ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (SPATIAL-LOCATION ?a ?b)
        (SPACE-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (SPATIAL-LOCATION ?a ?b)
        (PHYSICAL-ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (P-SPATIAL-LOCATION ?a ?b)
        (SPACE-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (P-SPATIAL-LOCATION ?a ?b)
        (PERDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORAL-LOCATION ?a ?b)
        (TEMPORAL-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (TEMPORAL-LOCATION ?a ?b)
        (PERDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (DURATION ?a ?b)
        (PERDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (E-TEMPORAL-LOCATION ?a ?b)
        (TEMPORAL-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (E-TEMPORAL-LOCATION ?a ?b)
        (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (ABSTRACT-LOCATION ?a ?b)
        (ABSTRACT-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (ABSTRACT-LOCATION ?a ?b)
        (NON-PHYSICAL-ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (DEPEND-ON-SPATIAL-LOCATION ?a ?b)
        (SPACE-REGION ?b))))

(ASSERT (forall (?a ?b)
  (=>> (DEPEND-ON-SPATIAL-LOCATION ?a ?b)
        (NON-PHYSICAL-ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (PRESENT-AT ?a ?b)
        (TIME-INTERVAL ?b))))

(ASSERT (forall (?a ?b)
  (=>> (PRESENT-AT ?a ?b)
        (ENDURANT ?a))))
```

```
(ASSERT (forall (?a ?b)
  (=>> (PARTLY-COMPONENT-WITH ?a ?b)
    (ENDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (PARTLY-COMPONENT-WITH ?a ?b)
    (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (Q-PRESENT-AT ?a ?b)
    (TIME-INTERVAL ?b))))

(ASSERT (forall (?a ?b)
  (=>> (Q-PRESENT-AT ?a ?b)
    (PHYSICAL-QUALITY ?a))))

(ASSERT (forall (?a ?b)
  (=>> (HAPPENS-AT ?a ?b)
    (TIME-INTERVAL ?b))))

(ASSERT (forall (?a ?b)
  (=>> (HAPPENS-AT ?a ?b)
    (PERDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (E-DEPENDS-ON ?a ?b)
    (ENDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (E-DEPENDS-ON ?a ?b)
    (ENDURANT ?a))))

(ASSERT (forall (?a ?b)
  (=>> (P-DEPENDS-ON ?a ?b)
    (PERDURANT ?b))))

(ASSERT (forall (?a ?b)
  (=>> (P-DEPENDS-ON ?a ?b)
    (PERDURANT ?a))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PERDURANT ?a)
      (PARTICIPANT-IN ?self ?a)))
    (ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (PARTICIPANT-IN ?self ?b))
    (ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (ENDURANT ?c)
      (PART ?self ?c)))
    (ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (ENDURANT ?d)
      (PART-OF ?self ?d)))
    (ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (ENDURANT ?e)
      (CONSTITUENT ?self ?e)))
    (ENDURANT ?self))))
```

```
(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PHYSICAL-ENDURANT ?a)
      (PART ?self ?a)))
    (PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (PHYSICAL-ENDURANT ?b)
      (PART-OF ?self ?b)))
    (PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PHYSICAL-ENDURANT ?c)
      (CONSTITUENT ?self ?c)))
    (PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (PHYSICAL-QUALITY ?d)
      (HAS-QUALITY ?self ?d)))
    (PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?e)
    (and (HAS-QUALITY ?self ?e)
      (PHYSICAL-QUALITY ?e)))
    (PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (NON-PHYSICAL-ENDURANT ?a)
      (PART ?self ?a)))
    (NON-PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (NON-PHYSICAL-ENDURANT ?b)
      (CONSTITUENT ?self ?b)))
    (NON-PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (ABSTRACT-QUALITY ?c)
      (HAS-QUALITY ?self ?c)))
    (NON-PHYSICAL-ENDURANT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (INHERENT-IN ?self ?a)
      (ENTITY ?a)))
    (QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (REGION ?b)
      (Q-LOCATION ?self ?b)))
    (QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (QUALITY ?c)
      (HAS-QUALITY ?self ?c)))
    (QUALITY ?self))))

(ASSERT (forall (?self)
```

```
(<= (forall (?a)
      (<= (TEMPORAL-REGION ?a)
          (Q-LOCATION ?self ?a)))
    (TEMPORAL-QUALITY ?self)))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (TEMPORAL-QUALITY ?b)
        (HAS-QUALITY ?self ?b)))
    (TEMPORAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PERDURANT ?c)
        (INHERENT-IN ?self ?c)))
    (TEMPORAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (exists (?d)
    (and (INHERENT-IN ?self ?d)
          (PERDURANT ?d)))
    (TEMPORAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PHYSICAL-REGION ?a)
        (Q-LOCATION ?self ?a)))
    (PHYSICAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (PHYSICAL-QUALITY ?b)
        (HAS-QUALITY ?self ?b)))
    (PHYSICAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PHYSICAL-ENDURANT ?c)
        (INHERENT-IN ?self ?c)))
    (PHYSICAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (exists (?d)
    (and (INHERENT-IN ?self ?d)
          (PHYSICAL-ENDURANT ?d)))
    (PHYSICAL-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (ABSTRACT-REGION ?a)
        (Q-LOCATION ?self ?a)))
    (ABSTRACT-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (ABSTRACT-QUALITY ?b)
        (HAS-QUALITY ?self ?b)))
    (ABSTRACT-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (NON-PHYSICAL-ENDURANT ?c)
        (INHERENT-IN ?self ?c)))
    (ABSTRACT-QUALITY ?self))))

(ASSERT (forall (?self)
  (<= (exists (?d)
    (and (INHERENT-IN ?self ?d)
```

```
(NON-PHYSICAL-ENDURANT ?d))
(ABSTRACT-QUALITY ?self)))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (REGION ?a)
      (PART ?self ?a)))
    (REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (REGION ?b)
      (PART-OF ?self ?b)))
    (REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (QUALITY ?c)
      (Q-LOCATION-OF ?self ?c)))
    (REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (TEMPORAL-REGION ?a)
      (PART ?self ?a)))
    (TEMPORAL-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (TEMPORAL-QUALITY ?b)
      (Q-LOCATION-OF ?self ?b)))
    (TEMPORAL-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PHYSICAL-REGION ?a)
      (PART ?self ?a)))
    (PHYSICAL-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (PHYSICAL-QUALITY ?b)
      (Q-LOCATION-OF ?self ?b)))
    (PHYSICAL-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (ABSTRACT-REGION ?a)
      (PART ?self ?a)))
    (ABSTRACT-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (ABSTRACT-QUALITY ?b)
      (Q-LOCATION-OF ?self ?b)))
    (ABSTRACT-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (SPACE-REGION ?a)
      (PART ?self ?a)))
    (SPACE-REGION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (SPATIAL-LOCATION-Q ?b)
      (Q-LOCATION-OF ?self ?b)))
    (SPACE-REGION ?self))))
```

```
(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (PARTICIPANT ?self ?a)
      (ENDURANT ?a)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (HAS-QUALITY ?self ?b)
      (TEMPORAL-LOCATION-Q ?b)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (ENDURANT ?c)
      (PARTICIPANT ?self ?c)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (TEMPORAL-QUALITY ?d)
      (HAS-QUALITY ?self ?d)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (PERDURANT ?e)
      (PART ?self ?e)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?f)
    (<= (PERDURANT ?f)
      (PART-OF ?self ?f)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?g)
    (<= (PERDURANT ?g)
      (CONSTITUENT ?self ?g)))
    (PERDURANT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (not (HAS-QUALITY ?self ?a))
      TRUE))
    (ABSTRACT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (HOST ?self ?a))
    (FEATURE ?self))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS"
  :INCLUDES ("DOLCE")
  :SHADOW (DESCRIPTION METHOD))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS")

(DEFCONCEPT DESCRIPTION (?SELF)
  :=> (NON-PHYSICAL-ENDURANT ?SELF)
  :AXIOMS (AND
    (DOCUMENTATION DESCRIPTION
```

"A non-physical enduring, generically dependent on some communication act (and indirectly on some agentive physical object participating in that act)."))

```
(DEFCONCEPT METHOD (?SELF)
  :=> (S-DESCRIPTION ?SELF))
```

```
(DEFCONCEPT S-DESCRIPTION (?SELF)
  :=> (DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION S-DESCRIPTION "A situation can be modelled as:
- a [complex] perdurant
- a perdurant token
- a description (proposition)
- a new compound category (?fact).
As a perdurant, it seems quite natural, but, is 'Brutus stabbed Caesar' an instance of a perdurant? In a sense yes, but if we want to talk of the veridicity of it? Truth values are attached to propositions, not to instances of concepts ... But if we classify a proposition or fact as a description concerning a perdurant ...
Then we could have situation-descriptions (propositions), and situation-perdurants (facts), and propositions can be true (adequate, used, accepted, adopted, executed) of corresponding facts. Do we need a new category that contains facts, or the existence of descriptions referencing interrelated perdurants, enduring, qualities and regions is sufficient to account for facts?
In a minimal solution, a concept named 's-description' is created, with the intended meaning of a description that encompasses (kind of 'references') at least one perdurant with at least one enduring with at least one quality and region. This also entails that *all* contexts depend on descriptions, since the entities in a situation are modelled only because a description encompasses them (see documentation about situations).
It is still possible to incorporate a new hybrid category called Situation (or State-of-Affairs or Episode), automatically generated by constructing the dependency graph that focuses on an S-Description and may even result from the transitive closure of the encompasses, participant, and inherence relationships. BTW, this hybrid category, although easily constructable as a Universal, has a still unclear ontological status as a particular. Is it a 4D or 3.5D entity? A tentative preliminary such category is introduced in the file: Situations.lisp.))
```

```
(DEFCONCEPT C-DESCRIPTION (?SELF)
  :=> (DESCRIPTION ?SELF))
```

```
(DEFCONCEPT FUNCTIONAL-ROLE (?SELF)
  :=> (C-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION FUNCTIONAL-ROLE
  "A description that refers to (in particular, it is 'played by') enduring, as a component of some s-description. Functional roles are the descriptive counterpart of enduring, and, as enduring participate in perdurants, they usually have attitudes towards descriptions of perdurants. This relation is named 'modality target', because it actually reifies at first order a typology of modal relations.))
```

```
(DEFCONCEPT COURSE (?SELF)
  :=> (C-DESCRIPTION ?SELF))
```

```
(DEFCONCEPT PARAMETER (?SELF)
```

```
:=> (C-DESCRIPTION ?SELF))

(DEFRELATION REFERENCES ((?A DESCRIPTION) (?B ENTITY))
  :=> (IMMEDIATE-RELATION ?A ?B)
  :AXIOMS (DOCUMENTATION REFERENCES "A relation holding between descriptions
and entities whatsoever (thus including descriptions themselves).
An intuition for the references relation could be that a description adds
information to an entity. In fact, descriptions depend on a communication
setting.
In most cases, this is the characteristic relation that provides a (functional)
unity criterion to objects, events, etc.
For example, cars are objects and not mere aggregates because there is a
project, a design, a social value, a functional structure, a
personal emotional structure, etc. attached to them. This attachment
can be represented by means of 'descriptions' that 'reference' cars.
The most obvious application is for situations, which do not exist
without a description, although they still are extensional entities:
a situation without a part is no more the same situation, but a
situation is not a mere aggregate, since it has references to a description
as its unity criterion.
Adding information to an entity can also be thought as an intentional solution
to a holistic stance. Defenders of this view -within different frameworks- are
Kant, Brentano, Husserl, Gestalt psychologists, Merleau-Ponty ...
References is distinguished according to the kinds of descriptions and
referenced
ground entities: referencing between s-descriptions and situations is called
'SATISFIED-BY', while referencing between s-description components and situation
constituents is called 'SELECTS'.
Other kinds of referencing relations can be defined, e.g. 'MODALITY-TARGET' is
bound to functional roles and courses, 'REQUISITE-FOR' is bound to parameters
and either functional roles or courses, 'REPRESENTS' is bound to information
objects
and the meaning in which they are involved, 'REALIZED-BY' is bound to
information objects
and physical representations that are involved in them, etc.))

(DEFRELATION REFERENCED-BY (?A ?B)
  :<=> (REFERENCES ?B ?A))

(DEFRELATION SATISFIED-BY (?A ?B)
  :<=> (AND (REFERENCES ?A ?B) (S-DESCRIPTION ?A) (SITUATION ?B))
  :AXIOMS (DOCUMENTATION SATISFIED-BY
    "The referencing relation between s-descriptions and
situations. It can be understood as a reification of the 'satisfiability'
relation
of formal semantics that holds between theories and models.
A theory is reified as a description, thus acquiring a life-cycle: a theory can
be
changed, versioned, discussed, issued, etc. 'Theory' can be a 'potential'
theory in the sense that most conceptualizations that could be formalized, could
also
be reified, e.g. plans, norms, stories, projects, diagnoses, methods, etc. No
position is taken on the extensionality of s-descriptions. For example, if a
theory
is required to be reified in fine detail, if it changes an axiom, it could be
considered no more the same theory. On the other hand, if theories are reified
without such a strong assumption, axioms can be changed just like non-essential
parts of physical objects, with the theory preserving its identity.
In case a theory is considered extensional, it might be considered a member of
a class of 'theory changing history'.
A model is reified as situation, thus the class of models that can satisfy a
theory
are reified as a situation type (class). Situations depend on s-descriptions,
but
not vice-versa (constructivist stance).
Components of s-descriptions 'select' constituents of situations.")

(DEFRELATION SATISFIES (?A ?B)
```

```
:<=> (SATISFIED-BY ?B ?A))

(DEFRELATION SELECTS (?A ?B)
 :<=> (AND (REFERENCES ?A ?B) (C-DESCRIPTION ?A)
         (OR (ENDURANT ?B) (PERDURANT ?B) (REGION ?B))))
:AXIOMS (DOCUMENTATION SELECTS
 "The referencing relation between components of
 s-descriptions and constituents of situations. It can be understood as a
 reification of the 'satisfiability' relation of formal semantics that holds
 between elements of theories and elements of models.")

(DEFRELATION SELECTED-BY (?A ?B)
 :<=> (SELECTS ?B ?A))

(DEFRELATION PLAYS (?A ?B)
 :<=> (AND (SELECTED-BY ?A ?B) (ENDURANT ?A) (FUNCTIONAL-ROLE ?B)))

(DEFRELATION PLAYED-BY (?A ?B)
 :<=> (PLAYS ?B ?A))

(DEFRELATION SEQUENCES (?A ?B)
 :<=> (AND (SELECTED-BY ?A ?B) (PERDURANT ?B) (COURSE ?A)))

(DEFRELATION SEQUENCED-BY (?A ?B)
 :<=> (SEQUENCES ?B ?A))

(DEFRELATION VALUE-FOR (?A ?B)
 :<=> (AND (SELECTED-BY ?A ?B) (REGION ?A) (PARAMETER ?B)))

(DEFRELATION VALUED-BY (?A ?B)
 :<=> (VALUE-FOR ?B ?A))

(DEFRELATION MODALITY-TARGET (?A ?B)
 :<=> (AND (REFERENCES ?A ?B) (COURSE ?A) (FUNCTIONAL-ROLE ?B)))

(DEFRELATION MODALITY-TARGET-OF (?A ?B)
 :<=> (MODALITY-TARGET ?B ?A))

(DEFRELATION REQUISITE-FOR (?A ?B)
 :<=> (AND (REFERENCES ?A ?B) (PARAMETER ?A)
         (OR (COURSE ?B) (FUNCTIONAL-ROLE ?B))))

(DEFRELATION HAS-REQUISITE (?A ?B)
 :<=> (REQUISITE-FOR ?B ?A))

(DEFRELATION FUNCTIONALLY-DEPENDS-ON (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (FUNCTIONAL-ROLE ?A) (FUNCTIONAL-ROLE ?B)
         (E-DEPENDS-ON ?A ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT-OF ?A ?C) (S-DESCRIPTION ?C)
               (TEMPORARY-COMPONENT ?C ?B))))
:AXIOMS (DOCUMENTATION FUNCTIONALLY-DEPENDS-ON
 "The dependence between two functional
 roles within the same s-description. This provides an ordering of
 functional roles (a 'functional structure'), whose intuition is
 'superordination'.")

(DEFRELATION FUNCTIONAL-DEPEND-ON-OF (?A ?B)
 :<=> (FUNCTIONALLY-DEPENDS-ON ?B ?A))

(DEFRELATION PARAMETRICALLY-DEPENDS-ON (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (PARAMETER ?A) (PARAMETER ?B)
         (E-DEPENDS-ON ?A ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT-OF ?A ?C) (S-DESCRIPTION ?C)
               (TEMPORARY-COMPONENT ?C ?B))))
:AXIOMS (DOCUMENTATION PARAMETRICALLY-DEPENDS-ON
 "The dependence between two parameters
```

within the same s-description. This provides an ordering of parameters that helps combining regions according to a certain view."))

```
(DEFRELATION PARAMETRICAL-DEPEND-ON-OF (?A ?B)
 :<=> (PARAMETRICALLY-DEPENDS-ON ?B ?A))
```

```
(DEFRELATION ENCOMPASSES (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (S-DESCRIPTION ?A) (ENTITY ?B)
 (EXISTS (?C)
 (AND (TEMPORARY-COMPONENT ?A ?C) (C-DESCRIPTION ?C) (SELECTS ?C ?B))))
 :AXIOMS (DOCUMENTATION ENCOMPASSES "A double composition may be needed here
 for linking s-descriptions and situation components, since many
 possible components could be available in the setting. The first
 one constrains encompasses through setting components, the second
 one constrains encompasses through description components.
 On the other hand, here we only implement the second composition, since
 we suggest that situations emerge out of states of affairs because an
 s-description references it, then encompassed entities only require
 a relation to s-description components."))
```

```
(DEFRELATION ENCOMPASSED-BY (?A ?B)
 :<=> (ENCOMPASSES ?B ?A))
```

```
(DEFRELATION EXPECTS (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (S-DESCRIPTION ?A) (PERDURANT ?B)
 (EXISTS (?C)
 (AND (TEMPORARY-COMPONENT ?A ?C) (COURSE ?C) (SEQUENCES ?C ?B))))))
```

```
(DEFRELATION EXPECTED-BY (?A ?B)
 :<=> (EXPECTS ?B ?A))
```

```
(DEFRELATION INVOLVES (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (S-DESCRIPTION ?A) (ENDURANT ?B)
 (EXISTS (?C)
 (AND (TEMPORARY-COMPONENT ?A ?C) (FUNCTIONAL-ROLE ?C)
 (PLAYED-BY ?C ?B))))))
```

```
(DEFRELATION INVOLVED-IN (?A ?B)
 :<=> (INVOLVES ?B ?A))
```

```
(DEFRELATION ADMITS (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (S-DESCRIPTION ?A) (REGION ?B)
 (EXISTS (?C)
 (AND (TEMPORARY-COMPONENT ?A ?C) (PARAMETER ?C) (VALUED-BY ?C ?B))))))
```

```
(DEFRELATION ADMITTED-BY (?A ?B)
 :<=> (ADMITS ?B ?A))
```

```
(DEFRELATION PARAMETRIZED-BY (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (PARAMETER ?B)
 (EXISTS (?C) (AND (EXACT-LOCATION ?A ?C) (VALUE-FOR ?C ?B))))))
```

```
(DEFRELATION PARAMETRIZES (?A ?B)
 :<=> (PARAMETRIZED-BY ?B ?A))
```

```
(DEFRELATION INDIRECTLY-PLAYS ((?A ENDURANT) (?B ENDURANT))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (PLAYS ?C ?D) (FUNCTIONAL-ROLE ?C)
 (FUNCTIONAL-ROLE ?D) (PLAYED-BY ?D ?B))))
 :AXIOMS (DOCUMENTATION INDIRECTLY-PLAYS
 "A relation for endurants associated by means of two
 interplaying functional roles. For example, a device like a watch can play a
 non-agentive
 role like 'instrumentality', but an instrumentality role could play an agentive
 role
 like 'machine' (in a wide sense of agentivity), that is played by some agentive
 device."))
```

```
(DEFRELATION INDIRECTLY-PLAYED-BY (?A ?B)
 :<=> (INDIRECTLY-PLAYS ?B ?A))

(DEFRELATION REFINES ((?A S-DESCRIPTION) (?B S-DESCRIPTION))
 :=> (REFERENCES ?A ?B)
 :AXIOMS (DOCUMENTATION REFINES
          "A relation between s-descriptions, representing a granularity
          refinement. The refined one has at least one component that is expanded in the
          refining one."))

(DEFRELATION REFINED-BY (?A ?B)
 :<=> (REFINES ?B ?A))

(DEFRELATION EXPANDS ((?A C-DESCRIPTION) (?B C-DESCRIPTION))
 :=> (REFERENCES ?A ?B)
 :AXIOMS (DOCUMENTATION EXPANDS
          "A relation between c-descriptions, representing a granularity
          refinement. An expanded c-description does *not* imply that its s-description
          refines another
          s-description of the simple description."))

(DEFRELATION EXPANDED-BY (?A ?B)
 :<=> (EXPANDS ?B ?A))

(DEFRELATION SPECIALIZES ((?A DESCRIPTION) (?B DESCRIPTION))
 :=> (IMMEDIATE-RELATION ?A ?B)
 :AXIOMS (DOCUMENTATION SPECIALIZES
          "A partial order relation that holds between descriptions. It
          supports
          the association between a description and another description featuring
          the same properties of the former, with possible additional ones."))

(DEFRELATION SPECIALIZED-BY (?A ?B)
 :<=> (SPECIALIZES ?B ?A))

(DEFCONCEPT INTERNAL-DESCRIPTION (?SELF)
 :<=> (AND (S-DESCRIPTION ?SELF)
          (= (CARDINALITY (SETOFALL ?A (PHYSICALLY-DEPENDS-ON ?SELF ?A))) 1))
 :AXIOMS (AND
          (DOCUMENTATION INTERNAL-DESCRIPTION
           "Internal descriptions are dependent on an intentional agent.")))

(DEFCONCEPT SOCIAL-DESCRIPTION (?SELF)
 :<=> (AND (S-DESCRIPTION ?SELF)
          (>= (CARDINALITY (SETOFALL ?A (PHYSICALLY-DEPENDS-ON ?SELF ?A))) 2))
 :AXIOMS (AND
          (DOCUMENTATION SOCIAL-DESCRIPTION
           "Examples of Social Descriptions are laws, norms,
           shares, peace treaties ecc., which are generically dependent on societies.
           Social
           descriptions are dependent on a community of agents.")))

(DEFRELATION SOCIAL-OBJECT (?SELF)
 :<=> (OR (SOCIAL-DESCRIPTION ?SELF) (SOCIAL-ROLE ?SELF) (SOCIAL-AGENT ?SELF))
 :AXIOMS (DOCUMENTATION SOCIAL-OBJECT
          "A catch-all class for entities from the social world.
          It includes agentive and non-agentive social roles, and social descriptions."))

(DEFCONCEPT FUNCTIONALLY-VIEWED-MATTER (?SELF)
 :<=> (AND (AMOUNT-OF-MATTER ?SELF)
          (EXISTS (?A) (AND (PLAYS ?SELF ?A) (FUNCTIONAL-ROLE ?A))))))

(DEFCONCEPT AGENTIVE-FUNCTIONAL-OBJECT (?SELF)
 :<=> (AND (AGENTIVE-PHYSICAL-OBJECT ?SELF)
          (EXISTS (?A) (AND (PLAYS ?SELF ?A) (FUNCTIONAL-ROLE ?A))))))

(DEFCONCEPT NON-AGENTIVE-FUNCTIONAL-OBJECT (?SELF)
```

```
:<=> (AND (NON-AGENTIVE-PHYSICAL-OBJECT ?SELF)
          (EXISTS (?A) (AND (PLAYS ?SELF ?A) (FUNCTIONAL-ROLE ?A))))))

(DEFRELATION SETTING-FOR (?A ?B)
  :<=> (AND (CONSTITUENT ?A ?B) (SITUATION ?A)
           (OR (ENDURANT ?B) (PERDURANT ?B) (REGION ?B))))

(DEFRELATION SETTING (?A ?B)
  :<=> (SETTING-FOR ?B ?A))

(DEFRELATION EXPECTED-SETTING-FOR ((?A SITUATION) (?B C-DESCRIPTION))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
           (EXISTS (?C)
            (AND (SATISFIES ?A ?C) (S-DESCRIPTION ?C)
                 (TEMPORARY-COMPONENT ?C ?B))))
  :AXIOMS (DOCUMENTATION EXPECTED-SETTING-FOR
           "A double composition is needed here
for linking situations and s-descriptions components, since many
possible constituents could be available in the situation."))

(DEFRELATION EXPECTED-SETTING (?A ?B)
  :<=> (EXPECTED-SETTING-FOR ?B ?A))

(DEFCONCEPT AGENTIVE-FUNCTIONAL-ROLE (?SELF)
  :=> (FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION AGENTIVE-FUNCTIONAL-ROLE
           "Agent is a role played by some object
that intentionally carries out a process or event, or bears a state.
By intentional agent we mean here any object oriented to achieve a given
state of the world. Intentionality can be either external or internal.
A cognitive agent has an explicit representation for goals, intentions, and
beliefs.
Intentionality and representation-explicitness are addressed by the theory
of 'Modalities' in D\&S, which is still under development and will be enhanced
by ontologies of agents currently being examined.
The perdurant carried out can be partly present even in absence of it or of
its whole (other agents can realize it).
Examples of Agentive Functional Roles are social agents like
'the president of United States': we may think that the latter, besides
depending generically on a
community of US citizens, depends also generically on 'George Bush qua legal
person' (since the
president can be substituted), which in turn depends specifically on 'George
Bush qua human being'.
Social agents are not constituted by agentive physical objects (although they
depend on them), while
they can constitute societies or organizations, like the Italian Government,
Mercedes-Benz, etc.
Agentive-functional-role is a low-level role for agentivity, meaning that it is
played
by physical agents or by other agentive functional roles.
In this theory there is a related functional role called 'Agent-Role' that is a
generalized
'case' role for attributing intentionality."))

(DEFCONCEPT SOCIAL-ROLE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (AND
           (DOCUMENTATION SOCIAL-ROLE
            "A role created and maintained by a society.")))

(DEFCONCEPT SOCIAL-AGENT (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (AND
           (DOCUMENTATION SOCIAL-AGENT
            "An agentive role created and maintained by a society.")))

(DEFCONCEPT SOCIALLY-CONSTRUCTED-PERSON (?SELF))
```

```
:=> (SOCIAL-AGENT ?SELF)
:AXIOMS (DOCUMENTATION SOCIALLY-CONSTRUCTED-PERSON
        "A person which is constructed by
other previously existing persons (socially constructed or born).")

(DEFCONCEPT SOCIAL-UNIT (?SELF)
 :=> (SOCIAL-AGENT ?SELF))

(DEFCONCEPT NON-AGENTIVE-FUNCTIONAL-ROLE (?SELF)
 :=> (FUNCTIONAL-ROLE ?SELF)
 :AXIOMS (AND
          (DOCUMENTATION NON-AGENTIVE-FUNCTIONAL-ROLE
           " A non-agentive functional role is the specification of
a function without an (internal or external) intention
(e.g. 'container', 'burnt area', etc)."))

(DEFCONCEPT REGULATION (?SELF)
 :=> (S-DESCRIPTION ?SELF))

(DEFCONCEPT OBLIGATION (?SELF)
 :=> (S-DESCRIPTION ?SELF))

(DEFCONCEPT COMMITMENT (?SELF)
 :=> (OBLIGATION ?SELF))

(DEFCONCEPT SCRIPT (?SELF)
 :=> (S-DESCRIPTION ?SELF))

(DEFCONCEPT TECHNIQUE (?SELF)
 :=> (METHOD ?SELF))

(DEFCONCEPT PROJECT (?SELF)
 :=> (METHOD ?SELF))

(DEFCONCEPT CONTRACT (?SELF)
 :=> (REGULATION ?SELF))

(DEFCONCEPT NORM (?SELF)
 :=> (REGULATION ?SELF))

(DEFCONCEPT PROMISE (?SELF)
 :=> (COMMITMENT ?SELF))

(DEFCONCEPT LIFE-CYCLE (?SELF)
 :=> (COURSE ?SELF))

(DEFCONCEPT INDICATOR (?SELF)
 :=> (PARAMETER ?SELF))

(DEFRELATION REPRESENTS ((?A DESCRIPTION) (?B INFORMATION-OBJECT))
 :=> (REFERENCES ?A ?B)
 :AXIOMS (DOCUMENTATION REPRESENTS
          "A relation between information objects that are
used as representations (signs) and the content they represent. Information
objects
are 'systemic' objects created by the system of rules of the semiotic code. For
the representation between the physical implementation of information objects
(physical representations) and information objects, the 'realized-by' relation
is used.")

(DEFCONCEPT INFORMATION-OBJECT (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFRELATION REPRESENTED-BY (?A ?B)
 :<=> (REPRESENTS ?B ?A))

(DEFRELATION REALIZED-BY ((?A INFORMATION-OBJECT) (?B PHYSICAL-ENDURANT))
 :=> (AND (MEDIATED-RELATION ?A ?B))
```

```
(EXISTS (?C ?D)
  (AND (EXPRESSED-ACCORDING-TO ?A ?C) (SATISFIED-BY ?C ?D)
    (DESCRIPTION-SYSTEM ?C) (SETTING-FOR ?D ?B))))
:AXIOMS (DOCUMENTATION REALIZED-BY
  "A physical representation (p. enduring, p. perdurant,
or p. quality) realizes a description according to a system of rules. This is a
subrelation of 'references' because it does not only means that a description
may
add information to an entity (the intended meaning of 'references'), but
(differential
condition) when that entity is a 'realization' of a description, this entity is
supposed to
conventionally represent a position in a system of rules, allowing interpreters
to
perceive an expression.
On the other hand, this is a subclass of references, and not a new immediate
relation, because (similarity condition) a physical representation is an entity
that
contains additional information provided by its communication value according to
a
system of rules.")

(DEFRELATION REALIZES (?A ?B)
  :<=> (REALIZED-BY ?B ?A))

(DEFRELATION PHYSICALLY-REPRESENTS ((?A PHYSICAL-ENDURANT) (?B DESCRIPTION))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C) (AND (REALIZES ?A ?C) (REPRESENTS ?C ?B)))))

(DEFRELATION PHYSICALLY-REPRESENTED-BY (?A ?B)
  :<=> (PHYSICALLY-REPRESENTS ?B ?A))

(DEFRELATION EXPRESSED-ACCORDING-TO ((?A INFORMATION-OBJECT)
  (?B DESCRIPTION-SYSTEM))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C)
      (AND (PLAYS ?A ?C) (FUNCTIONAL-ROLE ?C)
        (TEMPORARY-COMPONENT-OF ?C ?B)))))

(DEFCONCEPT DESCRIPTION-SYSTEM (?SELF)
  :=> (INFORMATION-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION DESCRIPTION-SYSTEM "These provide roles
and operations to create valid information objects
(e.g. grammars, codes, templates)."))

(DEFRELATION EXPRESSION-MEANS-FOR (?A ?B)
  :<=> (EXPRESSED-ACCORDING-TO ?B ?A))

(DEFRELATION LEXICALIZES (?A ?B)
  :<=> (AND (REPRESENTS ?A ?B) (TERM ?A)))

(DEFRELATION LEXICALIZED-BY (?A ?B)
  :<=> (LEXICALIZES ?B ?A))

(DEFRELATION Q-REPRESENTS ((?A REGION) (?B INFORMATION-OBJECT))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (EXPRESSED-ACCORDING-TO ?A ?C) (TEMPORARY-COMPONENT ?C ?D)
        (DESCRIPTION-SYSTEM ?C) (PARAMETER ?D) (VALUED-BY ?D ?B))))
  :AXIOMS (DOCUMENTATION Q-REPRESENTS
    "This relation supports the representation of
conceptual regions by information objects. It is defined as a composed
relation: an information object is expressed according to a description system
that maps a quality space. In other words, this means that a representation
of conceptual regions within quality spaces requires an explicit
conceptualization
of the dimensions operating in the quality space. In still other words, a
quality space can be mapped to a theory, which can be reified as a special
```

```
kind of 'Description-System'.))

(DEFRELATION Q-REPRESENTED-BY (?A ?B)
 :<=> (Q-REPRESENTS ?B ?A))

(DEFRELATION Q-REALIZED-BY ((?A REGION) (?B PHYSICAL-ENDURANT))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
          (EXISTS (?C) (AND (Q-REPRESENTED-BY ?A ?C) (REALIZED-BY ?C ?B)))))

(DEFRELATION Q-REALIZES (?A ?B)
 :<=> (Q-REALIZED-BY ?B ?A))

(DEFRELATION METAPHORICALLY-PLAYS (?A ?B)
 :=> (PLAYS ?A ?B))

(DEFRELATION METAPHORICALLY-PLAYED-BY (?A ?B)
 :<=> (METAPHORICALLY-PLAYS ?B ?A))

(DEFCONCEPT LINGUISTIC-OBJECT (?SELF)
 :=> (INFORMATION-OBJECT ?SELF))

(DEFCONCEPT DIAGRAMMATIC-OBJECT (?SELF)
 :=> (INFORMATION-OBJECT ?SELF))

(DEFCONCEPT ICONIC-OBJECT (?SELF)
 :=> (INFORMATION-OBJECT ?SELF))

(DEFCONCEPT TEXT (?SELF)
 :=> (LINGUISTIC-OBJECT ?SELF)
 :AXIOMS (DOCUMENTATION TEXT
          "A complex linguistic object, expressed according to a language and
          still independent from a particular physical support."))

(DEFCONCEPT FORMAL-EXPRESSION (?SELF)
 :=> (LINGUISTIC-OBJECT ?SELF))

(DEFCONCEPT AXIOM (?SELF)
 :=> (FORMAL-EXPRESSION ?SELF))

(DEFCONCEPT PREDICATE-NAME (?SELF)
 :=> (FORMAL-EXPRESSION ?SELF))

(DEFCONCEPT LOGICAL-OPERATOR (?SELF)
 :=> (FORMAL-EXPRESSION ?SELF))

(DEFCONCEPT FORMAL-SYSTEM (?SELF)
 :=> (FORMAL-EXPRESSION ?SELF))

(DEFCONCEPT AXIOMATIZATION (?SELF)
 :=> (FORMAL-SYSTEM ?SELF))

(DEFCONCEPT DOCUMENT (?SELF)
 :=> (TEXT ?SELF)
 :AXIOMS (DOCUMENTATION DOCUMENT
          "A formatted text, still independent from a *physical* document."))

(DEFCONCEPT STYLESHEET (?SELF)
 :=> (DESCRIPTION-SYSTEM ?SELF))

(DEFCONCEPT STATEMENT (?SELF)
 :=> (LINGUISTIC-OBJECT ?SELF))

(DEFCONCEPT TERM (?SELF)
 :=> (LINGUISTIC-OBJECT ?SELF))

(DEFCONCEPT PROPER-NOUN (?SELF)
 :=> (LINGUISTIC-OBJECT ?SELF))
```

```
(DEFCONCEPT MEASUREMENT-UNIT (?SELF)
  :=> (INFORMATION-OBJECT ?SELF))

(DEFCONCEPT INFORMATION-COLLECTION (?SELF)
  :=> (INFORMATION-OBJECT ?SELF)
  :AXIOMS (AND
    (DOCUMENTATION INFORMATION-COLLECTION
      "An information object constituted by
members of definite, complex kinds of information objects.")))

(DEFCONCEPT LITERATURE (?SELF)
  :=> (INFORMATION-COLLECTION ?SELF))

(DEFCONCEPT INFORMATION-DESCRIPTION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION INFORMATION-DESCRIPTION "An information description is
an s-description that involves information objects.
They can be divided into 1) formal descriptions,
which provide roles and operations to define formal
descriptions (e.g. theories), 2) description systems,
which provide roles and operations to create valid
information objects (e.g. grammars), and
3) classes of descriptions, which are contexts of (ev.
ordered) lists of information objects, and
4) informal descriptions, which provide roles
and operations to define informal descriptions (e.g.
narratives)."))

(DEFCONCEPT FORMAL-DESCRIPTION (?SELF)
  :=> (INFORMATION-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION FORMAL-DESCRIPTION "These provide roles
and operations to define formal descriptions (e.g.
theories)."))

(DEFCONCEPT CLASS-OF-DESCRIPTIONS (?SELF)
  :=> (INFORMATION-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION CLASS-OF-DESCRIPTIONS "These provide contexts
of (ev. ordered) lists of information objects, e.g
terminologies, subjects, knowledge domains."))

(DEFCONCEPT INFORMAL-DESCRIPTION (?SELF)
  :=> (INFORMATION-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION INFORMAL-DESCRIPTION "These provide roles
and operations to define informal descriptions (e.g.
narratives)."))

(DEFCONCEPT THEORY (?SELF)
  :=> (FORMAL-DESCRIPTION ?SELF))

(DEFCONCEPT TERMINOLOGY (?SELF)
  :=> (CLASS-OF-DESCRIPTIONS ?SELF))

(DEFCONCEPT CLASSIFICATION (?SELF)
  :=> (CLASS-OF-DESCRIPTIONS ?SELF))

(DEFCONCEPT TOPIC (?SELF)
  :=> (CLASS-OF-DESCRIPTIONS ?SELF)
  :AXIOMS (DOCUMENTATION TOPIC "Any reified knowledge domain,
informally referred. Intuitively, a formal description
is the formal counterpart of a topic, while an
informal description is its informal counterpart.
Subjects or topics are often 'opaque', meaning that no related list
of information objects is provided (e.g. in flat catalogues).
On the other hand, any subject, together with the contents
derivable from a referred information collection, constitutes
such a list."))

(DEFCONCEPT SEMIOTIC-CODE (?SELF)
```

```
:=> (DESCRIPTION-SYSTEM ?SELF))

(DEFCONCEPT LANGUAGE (?SELF)
 :=> (SEMIOTIC-CODE ?SELF))

(DEFCONCEPT GRAMMAR (?SELF)
 :=> (DESCRIPTION-SYSTEM ?SELF))

(DEFCONCEPT DOCUMENT-TEMPLATE (?SELF)
 :=> (DESCRIPTION-SYSTEM ?SELF))

(DEFCONCEPT NARRATIVE (?SELF)
 :=> (INFORMAL-DESCRIPTION ?SELF))

(DEFRELATION D-CONSTITUENT (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (ENDURANT ?A) (FUNCTIONAL-ROLE ?B)
          (EXISTS (?C) (AND (CONSTITUENT ?A ?C) (ENDURANT ?C) (PLAYS ?C ?B))))
 :AXIOMS (DOCUMENTATION D-CONSTITUENT "Relation for dealing with constitution
when functional roles are considered instead of physical endurants."))

(DEFRELATION D-CONSTITUENT-OF (?A ?B)
 :<=> (D-CONSTITUENT ?B ?A))

(DEFRELATION REGULATES (?A ?B)
 :<=> (AND (SATISFIED-BY ?A ?B) (REGULATION ?A)))

(DEFRELATION REGULATED-BY (?A ?B)
 :<=> (REGULATES ?B ?A))

(DEFRELATION CONSTRAINS (?A ?B)
 :<=> (AND (EXPECTS ?A ?B) (REGULATION ?A) (PERDURANT ?B)))

(DEFRELATION CONSTRAINED-BY (?A ?B)
 :<=> (CONSTRAINS ?B ?A))

(DEFCONCEPT CASE-SYSTEM (?SELF)
 :<=> (AND (S-DESCRIPTION ?SELF)
          (EXISTS (?A) (AND (TEMPORARY-COMPONENT ?SELF ?A) (CASE-ROLE ?A))))))

(DEFCONCEPT CASE-ROLE (?SELF)
 :=> (FUNCTIONAL-ROLE ?SELF)
 :AXIOMS (DOCUMENTATION CASE-ROLE "Case roles are functional roles that are
constituent of the case system of descriptions. The case system goes
back at least to Aristotle's 'aitiai', and has been proposed in various forms
by Port Royal's grammarians and recently by Charles Fillmore, Roger Shank,
Ray Jackendoff, John Sowa, etc. The case system can be used on top of
functional descriptions to distinguish forms of behaviour. They can
also be used to specialize the 'participation' relation.
Case roles constitute a partition. This is untenable without the notion of
description, since participants can change through time: for example, an
object can be an agent for part of an activity, and then become a patient.
By using descriptions, we can simply state that for one part of an activity,
the object *plays* the role of agent, and for another part, it plays the
role of patient.
The case system will be connected to rest of D&S as soon as possible. The main
issue is that the agentive/non-agentive distinction, which is 'attached'
to roles, can be overruled by a role in the case system. In other words, an
'agentive-functional-role' can play roles other than 'agent-role' in the case
system."))

(DEFCONCEPT SUBSTRATE-ROLE (?SELF)
 :=> (CASE-ROLE ?SELF)
 :AXIOMS (DOCUMENTATION SUBSTRATE-ROLE "Substrate is a role played by some
endurant that carries out a process or event, or bears a state, without
doing it intentionally. Another condition is that no part of the perdurant
can exist if the endurant (or its whole) playing the substrate-role does not
exist.
On the contrary, an agent-role provides intentionality, and the perdurant
```

carried out can be partly present even in absence of it or of its whole  
(other agent-roles can realize it."))

```
(DEFCONCEPT AGENT-ROLE (?SELF)
  :=> (CASE-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION AGENT-ROLE
    "Agent-role is here a placeholder within the
    case system (cf. Fillmore, Minsky). It is used to define so-called 'functional'
    participant relations, but in DAML+OIL version there is no trace of that use
    (due to lack of expressivity).
    We expect to build a linkage between the case system and the
    agentive/non-agentive
    functional roles currently defined in the theory. This is currently under
    investigation.
    The main issue is that the agentive/non-agentive distinction, which is
    'attached'
    to roles, can be overruled by a role in the case system. In other words, an
    'agentive-functional-role' can play roles other than 'agent-role' in the case
    system."))
```

```
(DEFCONCEPT PATIENT-ROLE (?SELF)
  :=> (CASE-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION PATIENT-ROLE "Patient is a role played by some
    enduring that participates in a perdurant without carrying it out, either
    without doing it intentionally but being affected by it, or by having a
    'passive' intentionality."))
```

```
(DEFCONCEPT INSTRUMENTALITY-ROLE (?SELF)
  :=> (CASE-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION INSTRUMENTALITY-ROLE
    "Instrumentality is a role played by
    some enduring that participates in a perdurant. It can carry out parts of or
    even
    the whole perdurant, but only if there is something playing agent- or
    substrate-role
    that bootstraps the perdurant. It can bear only external intentionality,
    although there can be a compresent internal intentionality. This deals with
    the complexity of 'delegation'."))
```

```
(DEFCONCEPT TARGET-ROLE (?SELF)
  :=> (PATIENT-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION TARGET-ROLE ""))
```

```
(DEFCONCEPT CONSEQUENCE-ROLE (?SELF)
  :=> (CASE-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION CONSEQUENCE-ROLE "Consequence is a role played by
    some enduring that participates in a perdurant. The role-player does not
    carry out the perdurant, and comes into being only when the perdurant
    or a functional part of it (its 'prerequisite') has been completed."))
```

```
(DEFCONCEPT DEVICE-ROLE (?SELF)
  :=> (AND (INSTRUMENTALITY-ROLE ?SELF)
    (FORALL (?A) (= (PLAYED-BY ?SELF ?A) (PHYSICAL-OBJECT ?A))))
  :AXIOMS (DOCUMENTATION DEVICE-ROLE ""))
```

```
(DEFCONCEPT RESOURCE-ROLE (?SELF)
  :=> (AND (INSTRUMENTALITY-ROLE ?SELF)
    (FORALL (?A) (= (PLAYED-BY ?SELF ?A) (AMOUNT-OF-MATTER ?A))))
  :AXIOMS (DOCUMENTATION RESOURCE-ROLE ""))
```

```
(DEFCONCEPT ARTIFACT-ROLE (?SELF)
  :=> (CONSEQUENCE-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION ARTIFACT-ROLE
    "An artifact role is a kind of consequence
    role motivated by an intentional activity."))
```

```
(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF C-DESCRIPTION S-DESCRIPTION)))
```

```
(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF PARAMETER FUNCTIONAL-ROLE COURSE)))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF AGENTIVE-FUNCTIONAL-ROLE
NON-AGENTIVE-FUNCTIONAL-ROLE)))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (DESCRIPTION ?a)
      (TEMPORARY-PART ?self ?a)))
    (DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (DESCRIPTION ?b)
      (COMPONENT ?self ?b)))
    (DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (DESCRIPTION ?c)
      (REFERENCED-BY ?self ?c)))
    (DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (DESCRIPTION ?d)
      (SPECIALIZED-BY ?self ?d)))
    (DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (SITUATION ?a)
      (SATISFIED-BY ?self ?a)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (ENTITY ?b)
      (ENCOMPASSES ?self ?b)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (REGION ?c)
      (ADMITS ?self ?c)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (PERDURANT ?d)
      (EXPECTS ?self ?d)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (ENDURANT ?e)
      (INVOLVES ?self ?e)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?f)
    (<= (or (FUNCTIONAL-ROLE ?f)
      (COURSE ?f)
      (PARAMETER ?f))
      (TEMPORARY-COMPONENT ?self ?f)))
    (S-DESCRIPTION ?self))))

(ASSERT (forall (?self)
```

```
(<= (exists (?g)
      (and (TEMPORARY-COMPONENT ?self ?g)
            (or (FUNCTIONAL-ROLE ?g)
                (COURSE ?g)
                (PARAMETER ?g))))
     (S-DESCRIPTION ?self)))

(ASSERT (forall (?self)
         (<= (exists (?a)
               (and (TEMPORARY-COMPONENT-OF ?self ?a)
                     (S-DESCRIPTION ?a)))
              (C-DESCRIPTION ?self))))

(ASSERT (forall (?self)
         (<= (forall (?b)
               (<= (or (ENDURANT ?b)
                       (PERDURANT ?b)
                       (REGION ?b)
                       (SELECTS ?self ?b)))
                  (C-DESCRIPTION ?self))))

(ASSERT (forall (?self)
         (<= (forall (?c)
               (<= (C-DESCRIPTION ?c)
                   (EXPANDS ?self ?c)))
              (C-DESCRIPTION ?self))))

(ASSERT (forall (?self)
         (<= (exists (?a)
               (and (TEMPORARY-COMPONENT-OF ?self ?a)
                     (S-DESCRIPTION ?a)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (forall (?b)
               (<= (ENDURANT ?b)
                   (PLAYED-BY ?self ?b)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (forall (?c)
               (<= (COURSE ?c)
                   (MODALITY-TARGET ?self ?c)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (forall (?d)
               (<= (PARAMETER ?d)
                   (HAS-REQUISITE ?self ?d)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (forall (?e)
               (<= (FUNCTIONAL-ROLE ?e)
                   (EXPANDS ?self ?e)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (exists (?f)
               (and (GENERALLY-DEPENDS-ON ?self ?f)
                     (ENDURANT ?f)))
              (FUNCTIONAL-ROLE ?self))))

(ASSERT (forall (?self)
         (<= (exists (?a)
               (and (TEMPORARY-COMPONENT-OF ?self ?a)
                     (S-DESCRIPTION ?a)))
              (COURSE ?self))))
```

```
(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (PERDURANT ?b)
      (SEQUENCES ?self ?b)))
    (COURSE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (FUNCTIONAL-ROLE ?c)
      (MODALITY-TARGET-OF ?self ?c)))
    (COURSE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (PARAMETER ?d)
      (HAS-REQUISITE ?self ?d)))
    (COURSE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (COURSE ?e)
      (EXPANDS ?self ?e)))
    (COURSE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?f)
    (<= (COURSE ?f)
      (PART ?self ?f)))
    (COURSE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT-OF ?self ?a)
      (S-DESCRIPTION ?a)))
    (PARAMETER ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (REGION ?b)
      (VALUED-BY ?self ?b)))
    (PARAMETER ?self))))

(ASSERT (forall (?self)
  (<= (exists (?c)
    (and (VALUED-BY ?self ?c)
      (REGION ?c)))
    (PARAMETER ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (or (FUNCTIONAL-ROLE ?d)
      (COURSE ?d))
      (REQUISITE-FOR ?self ?d)))
    (PARAMETER ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (PART ?self ?a)
      (PROMISE ?a)))
    (CONTRACT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (PLAYS ?self ?a)
      (SEMIOTIC-CODE ?a)))
    (CODE ?self))))
```

```
(ASSERT (forall (?self)
  (<= (exists (?b)
    (EXPRESSED-ACCORDING-TO ?self ?b))
    (INFORMATION-OBJECT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (EXPRESSED-ACCORDING-TO ?self ?a)
      (LANGUAGE ?a)))
    (TEXT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (PART ?self ?a)
      (AXIOM ?a)))
    (AXIOMATIZATION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?v06)
    (and (= (CARDINALITY (kappa (?a) (HAS-MEMBER ?self ?a))) ?v06)
      (>= ?v06 2)))
    (INFORMATION-COLLECTION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (INVOLVES ?self ?a)
      (INFORMATION-OBJECT ?a)))
    (INFORMATION-DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT ?self ?a)
      (FORMAL-EXPRESSION ?a)))
    (THEORY ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (DOCUMENT ?b)
      (EXPRESSION-MEANS-FOR ?self ?b)))
    (DOCUMENT-TEMPLATE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (REPRESENTED-BY ?self ?a)
      (TEXT ?a)))
    (NARRATIVE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (S-DESCRIPTION ?a)
      (SATISFIES ?self ?a)))
    (SITUATION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (SATISFIES ?self ?b)
      (S-DESCRIPTION ?b)))
    (SITUATION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (SETTING-FOR ?self ?b)
      (or (ENDURANT ?b)
        (PERDURANT ?b)
        (REGION ?b))))
    (SITUATION ?self))))

(ASSERT (forall (?self)
```

```
(<= (exists (?d)
      (and (GENERALLY-DEPENDS-ON ?self ?d)
            (S-DESCRIPTION ?d)))
    (SITUATION ?self)))

(ASSERT (forall (?self)
  (<= (forall (?e)
      (<= (SITUATION ?e)
          (PART ?self ?e)))
      (SITUATION ?self))))

(ASSERT (forall (?self)
  (<= (and (not (SUBSTRATE-ROLE ?self))
            (not (PATIENT-ROLE ?self))
            (not (INSTRUMENTALITY-ROLE ?self))
            (not (CONSEQUENCE-ROLE ?self)))
      (AGENT-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (and (not (SUBSTRATE-ROLE ?self))
            (not (PATIENT-ROLE ?self))
            (not (INSTRUMENTALITY-ROLE ?self))
            (not (AGENT-ROLE ?self)))
      (CONSEQUENCE-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (and (not (SUBSTRATE-ROLE ?self))
            (not (PATIENT-ROLE ?self))
            (not (CONSEQUENCE-ROLE ?self))
            (not (AGENT-ROLE ?self)))
      (INSTRUMENTALITY-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (and (not (SUBSTRATE-ROLE ?self))
            (not (INSTRUMENTALITY-ROLE ?self))
            (not (CONSEQUENCE-ROLE ?self))
            (not (AGENT-ROLE ?self)))
      (PATIENT-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (and (not (PATIENT-ROLE ?self))
            (not (INSTRUMENTALITY-ROLE ?self))
            (not (CONSEQUENCE-ROLE ?self))
            (not (AGENT-ROLE ?self)))
      (SUBSTRATE-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
      (and (TEMPORARY-COMPONENT-OF ?self ?a)
            (CASE-SYSTEM ?a)))
      (CASE-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
      (and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
            (or (AGENT-ROLE ?a)
                (SUBSTRATE-ROLE ?a))))
      (PATIENT-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
      (and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
            (or (AGENT-ROLE ?a)
                (SUBSTRATE-ROLE ?a))))
      (INSTRUMENTALITY-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
      (and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
            (or (AGENT-ROLE ?a)
                (SUBSTRATE-ROLE ?a))))
      (INSTRUMENTALITY-ROLE ?self))))
```

```
(and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
      (or (AGENT-ROLE ?a)
           (SUBSTRATE-ROLE ?a))))
(CONSEQUENCE-ROLE ?self)))

(ASSERT (forall (?self)
             (<= (exists (?a)
                    (and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
                          (AGENT-ROLE ?a)))
                  (TARGET-ROLE ?self))))

(ASSERT (forall (?self)
             (<= (exists (?a)
                    (and (FUNCTIONALLY-DEPENDS-ON ?self ?a)
                          (AGENT-ROLE ?a)))
                  (ARTIFACT-ROLE ?self))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION"
  :INCLUDES ("DESCRIPTIONS")
  :SHADOW (COMMUNICATION CODE))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION")

(DEFCONCEPT COMMUNICATION (?SELF)
  :=> (ACCOMPLISHMENT ?SELF)
  :AXIOMS (DOCUMENTATION COMMUNICATION "Here communication is taken in a rather
wide sense, being possible as an (intentional) activity as well as a
phenomenon."))

(DEFCONCEPT SEMIOTIC-ROLE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION SEMIOTIC-ROLE
           "A semiotic role is played within a communication
setting by a description that participates in a communication (act). They
are used to fill the universe of the so-called 'interpretation function'.
Two of them are equivalent to two communication functions (message and
context)."))

(DEFCONCEPT EXPRESSION (?SELF)
  :=> (SEMIOTIC-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION EXPRESSION "Expressions are played by information
objects and are semiotic roles. They are used to fill the first domain of the
so-called 'interpretation function'.
It may be equivalent to the 'message' communication role, but since
communication
theory and semiotic theories are different, it is more correct to say that
a message plays an expression role."))

(DEFCONCEPT S-CONTEXT (?SELF)
  :=> (SEMIOTIC-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION S-CONTEXT "S-Contexts are played by S-Descriptions
and are semiotic roles. They are used to fill the second domain of the
so-called 'interpretation function'.
It may be equivalent to the 'context' communication role,, but since
communication
theory and semiotic theories are different, it is more correct to say that
a c-context plays an s-context."))

(DEFCONCEPT MEANING (?SELF)
  :=> (SEMIOTIC-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION MEANING "Meanings are played by descriptions
whatsoever and are semiotic roles. They are used to fill the range of the
so-called 'interpretation function'.
It is not equivalent to any communication function.
```

Descriptions playing meaning have different natures according to the situation referenced by S-Contexts. In other words, meanings are just what ontology is supposed to explicit, thus they cannot be thematized within the same ontology that describes them (both used and mentioned).")

```
(DEFRELATION INTERPRETATION (?A ?B ?C)
  :<=> (AND (TERNARY-CONCEPTUAL-RELATION ?A ?B ?C) (EXPRESSION ?A)
          (S-CONTEXT ?B) (MEANING ?C))
  :AXIOMS (AND (SINGLE-VALUED INTERPRETATION)
              (DOCUMENTATION INTERPRETATION
               "The basic interpretation function of semiotics
               states that, given an information object and a context (either descriptive or
               physical - a situation), a description results.
               There is some inherent recursivity here, since information objects and
               descriptive
               contexts are descriptions as well. The recursion is weakened by the fact that:
               1) information objects are a partition within descriptions, and are dependent on
               some physical entity;
               2) descriptive contexts are a superclass of semiotic contexts.")))
```

```
(DEFRELATION INTERPRETANT (?A ?B)
  :<=> (AND (FUNCTIONAL-DEPEND-ON-OF ?A ?B)
          (EXISTS ?Y (AND (S-CONTEXT ?Y) (INTERPRETATION ?A ?Y ?B))))
  :AXIOMS (DOCUMENTATION INTERPRETANT
           "A meaning is the interpretant of an expression
           when there is an s-context for the interpretation function of that expression.
           A same s-description (semiotic interpretation) is required."))
```

```
(DEFRELATION INTERPRETANT-OF (?A ?B)
  :<=> (INTERPRETANT ?B ?A))
```

```
(DEFCONCEPT COMMUNICATION-METHOD (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION COMMUNICATION-METHOD
           "Jakobson defined six functions of communication
           that are compatible with Shannon's theory of information. They are the
           'message',
           here covered by 'Message-Role', the context, covered here by 'C-Context',
           the code, covered by 'Code', plus 'Channel', 'Encoder', and
           'Decoder', which are introduced below.
           Message-Role, C-Context, and Code can also be viewed as playing a semiotic role
           (Expression, S-Context, Semiotic-Code).
           For a communication method, we also need other components that are not specified
           in Jakobson's theory: 'Communication-Turns' governing the sequence of a
           communication
           process, and 'Communication-Parameters', governing the values that participants
           and events of a communication should have in order for the communication to be
           successful (i.e. for the communication method to be satisfied).")
```

```
(DEFCONCEPT COMMUNICATION-SITUATION (?SELF)
  :<=> (AND (SITUATION ?SELF)
          (EXISTS (?A) (AND (SATISFIES ?SELF ?A) (COMMUNICATION-METHOD ?A)))
          (EXISTS (?B) (AND (SETTING-FOR ?SELF ?B) (INFORMATION-OBJECT ?B)))
          (EXISTS (?C) (AND (SETTING-FOR ?SELF ?C) (COMMUNICATION ?C)))
          (EXISTS (?D) (AND (SETTING-FOR ?SELF ?D) (SOCIAL-AGENT ?D)))))
```

```
(DEFCONCEPT COMMUNICATION-TURNS (?SELF)
  :=> (COURSE ?SELF))
```

```
(DEFCONCEPT COMMUNICATION-PARAMETER (?SELF)
  :=> (PARAMETER ?SELF))
```

```
(DEFCONCEPT AGENTIVE-COMMUNICATION-ROLE (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION AGENTIVE-COMMUNICATION-ROLE
           "The set of agentive roles in Jakobson's theory of
           communication."))
```

```
(DEFCONCEPT NON-AGENTIVE-COMMUNICATION-ROLE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (DOCUMENTATION NON-AGENTIVE-COMMUNICATION-ROLE
    "The set of non-agentive roles in Jakobson's theory of
    communication."))

(DEFCONCEPT ENCODER (?SELF)
  :=> (AGENTIVE-COMMUNICATION-ROLE ?SELF))

(DEFCONCEPT DECODER (?SELF)
  :=> (AGENTIVE-COMMUNICATION-ROLE ?SELF))

(DEFCONCEPT CHANNEL-ROLE (?SELF)
  :=> (NON-AGENTIVE-COMMUNICATION-ROLE ?SELF))

(DEFCONCEPT MESSAGE-ROLE (?SELF)
  :=> (NON-AGENTIVE-COMMUNICATION-ROLE ?SELF))

(DEFCONCEPT CODE-ROLE (?SELF)
  :=> (NON-AGENTIVE-COMMUNICATION-ROLE ?SELF))

(DEFCONCEPT C-CONTEXT (?SELF)
  :=> (NON-AGENTIVE-COMMUNICATION-ROLE ?SELF))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (DESCRIPTION ?a)
      (PLAYED-BY ?self ?a)))
    (MEANING ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (S-DESCRIPTION ?a)
      (PLAYED-BY ?self ?a)))
    (S-CONTEXT ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (INFORMATION-OBJECT ?a)
      (PLAYED-BY ?self ?a)))
    (EXPRESSION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (PLAYS ?self ?a)
      (S-CONTEXT ?a)))
    (TOPIC ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (SEQUENCED-BY ?self ?a)
      (COMMUNICATION-TURNS ?a)))
    (COMMUNICATION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT-OF ?self ?a)
      (COMMUNICATION-METHOD ?a)))
    (COMMUNICATION-TURNS ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT ?self ?a)
      (MESSAGE-ROLE ?a)))
    (COMMUNICATION-METHOD ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
```

```
(and (TEMPORARY-COMPONENT ?self ?b)
      (CHANNEL-ROLE ?b)))
(COMMUNICATION-METHOD ?self)))

(ASSERT (forall (?self)
  (<= (exists (?c)
    (and (TEMPORARY-COMPONENT ?self ?c)
          (CODE-ROLE ?c)))
      (COMMUNICATION-METHOD ?self))))

(ASSERT (forall (?self)
  (<= (exists (?d)
    (and (TEMPORARY-COMPONENT ?self ?d)
          (AGENTIVE-COMMUNICATION-ROLE ?d)))
      (COMMUNICATION-METHOD ?self))))

(ASSERT (forall (?self)
  (<= (exists (?e)
    (and (GENERICALLY-DEPENDS-ON ?self ?e)
          (COMMUNICATION ?e)))
      (DESCRIPTION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (SOCIAL-AGENT ?a)
        (PLAYED-BY ?self ?a)))
      (AGENTIVE-COMMUNICATION-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT-OF ?self ?a)
          (COMMUNICATION-METHOD ?a)))
      (AGENTIVE-COMMUNICATION-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT-OF ?self ?a)
          (COMMUNICATION-METHOD ?a)))
      (NON-AGENTIVE-COMMUNICATION-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PHYSICAL-ENDURANT ?a)
        (PLAYED-BY ?self ?a)))
      (CHANNEL-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (INFORMATION-OBJECT ?a)
        (PLAYED-BY ?self ?a)))
      (MESSAGE-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (PLAYS ?self ?b)
          (EXPRESSION ?b)))
      (MESSAGE-ROLE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (S-DESCRIPTION ?a)
        (PLAYED-BY ?self ?a)))
      (C-CONTEXT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (PLAYS ?self ?b)
          (S-CONTEXT ?b))))
```

```
(C-CONTEXT ?self)))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (DESCRIPTION-SYSTEM ?a)
      (PLAYED-BY ?self ?a)))
    (CODE-ROLE ?self))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/EXTRINSIC"
  :INCLUDES ("DESCRIPTIONS"))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/EXTRINSIC")

(DEFRELATION NUMEROSITY (?A ?B)
  :=> (ENTITY-TO-CONSTANT-RELATION ?A ?B)
  :AXIOMS (SINGLE-VALUED NUMEROSITY))

(DEFRELATION NUMEROSITY-OF (?A ?B)
  :<=> (NUMEROSITY ?B ?A))

(DEFRELATION COUNTED-BY ((?A REGION) (?B NUMBER))
  :=> (ENTITY-TO-CONSTANT-RELATION ?A ?B)
  :AXIOMS (SINGLE-VALUED COUNTED-BY))

(DEFRELATION COUNTS (?A ?B)
  :<=> (COUNTED-BY ?B ?A))

(DEFRELATION HAS-INFORMAL-DESCRIPTION ((?A ENTITY) (?B STRING))
  :=> (ENTITY-TO-CONSTANT-RELATION ?A ?B))

(DEFRELATION INFORMAL-DESCRIPTION-OF (?A ?B)
  :<=> (HAS-INFORMAL-DESCRIPTION ?B ?A))

(DEFRELATION TITLE ((?A INFORMATION-OBJECT) (?B STRING))
  :=> (ENTITY-TO-CONSTANT-RELATION ?A ?B))

(DEFRELATION TITLE-OF (?A ?B)
  :<=> (TITLE ?B ?A))

(DEFRELATION UNIT (?A ?B))

(DEFRELATION UNIT-OF (?A ?B)
  :<=> (UNIT ?B ?A))

(DEFRELATION UNIVERSAL-TIME ((?A TEMPORAL-REGION) (?B NUMBER))
  :=> (ENTITY-TO-CONSTANT-RELATION ?A ?B))

(DEFRELATION UNIVERSAL-TIME-OF (?A ?B)
  :<=> (UNIVERSAL-TIME ?B ?A))

(DEFRELATION TIME-VALUE ((?A PERDURANT) (?B NUMBER))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C) (AND (TEMPORAL-LOCATION ?A ?C) (UNIVERSAL-TIME ?C ?B)))))

(DEFRELATION TIME-VALUE-OF (?A ?B)
  :<=> (TIME-VALUE ?B ?A))

(ASSERT (forall (?a ?b)
  (=>> (NUMEROSITY ?a ?b)
    (NUMBER ?b))))

(ASSERT (forall (?a ?b)
  (=>> (UNIT ?a ?b)
    (MEASUREMENT-UNIT ?b))))
```

```
(ASSERT TRUE)

(DEFMODULE "TOP/DOLCE/T-TOPOLOGY"
  :INCLUDES ("DOLCE"))

(IN-MODULE "TOP/DOLCE/T-TOPOLOGY")

(DEFRELATION MERETOPOLOGICAL-ASSOCIATION (?A ?B)
  :<=> (AND (MEDIATED-RELATION ?A ?B) (ENTITY ?A) (ENTITY ?B)
    (OR (PART ?A ?B) (PROPER-PART ?A ?B) (PART ?B ?A) (PROPER-PART ?B ?A)
      (OVERLAPS ?A ?B) (STRONG-CONNECTION ?A ?B) (WEAK-CONNECTION ?A ?B)
      (DIRECT-SUCCESSOR ?A ?B) (DIRECT-SUCCESSOR ?B ?A)))
  :AXIOMS (SYMMETRIC MERETOPOLOGICAL-ASSOCIATION))

(DEFRELATION TEMPORAL-RELATION ((?A PERDURANT) (?B PERDURANT))
  :<=> (AND (MEDIATED-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (TEMPORAL-LOCATION ?A ?C) (MERETOPOLOGICAL-ASSOCIATION ?C ?D)
        (TEMPORAL-REGION ?C) (TEMPORAL-REGION ?D)
        (TEMPORAL-LOCATION-OF ?D ?B))))
  :AXIOMS (SYMMETRIC TEMPORAL-RELATION))

(DEFRELATION TEMPORAL-CONNECTION (?A ?B)
  :<=> (AND (TEMPORAL-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (TEMPORAL-LOCATION ?A ?C) (WEAK-CONNECTION ?C ?D)
        (TEMPORAL-REGION ?C) (TEMPORAL-REGION ?D)
        (TEMPORAL-LOCATION-OF ?D ?B))))
  :AXIOMS (SYMMETRIC TEMPORAL-CONNECTION))

(DEFRELATION TEMPORALLY-CONTAINS (?A ?B)
  :<=> (AND (TEMPORAL-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (TEMPORAL-LOCATION ?A ?C) (PROPER-PART ?C ?D)
        (TEMPORAL-REGION ?C) (TEMPORAL-REGION ?D)
        (TEMPORAL-LOCATION-OF ?D ?B))))
  :AXIOMS (SYMMETRIC TEMPORALLY-CONTAINS))

(DEFRELATION TEMPORALLY-CONTAINED-IN (?A ?B)
  :<=> (TEMPORALLY-CONTAINS ?B ?A))

(DEFRELATION PRECEDES (?A ?B)
  :<=> (AND (TEMPORAL-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (TEMPORAL-LOCATION ?A ?C) (DIRECT-SUCCESSOR ?C ?D)
        (TEMPORAL-REGION ?C) (TEMPORAL-REGION ?D)
        (TEMPORAL-LOCATION-OF ?D ?B))))
  :AXIOMS (SYMMETRIC PRECEDES))

(DEFRELATION FOLLOWS (?A ?B)
  :<=> (PRECEDES ?B ?A))

(DEFRELATION CO-OCCURS (?A ?B)
  :<=> (AND (TEMPORAL-RELATION ?A ?B)
    (EXISTS (?C ?D)
      (AND (TEMPORAL-LOCATION ?A ?C) (IDENTITY-C ?C ?D) (TEMPORAL-REGION ?C)
        (TEMPORAL-REGION ?D) (TEMPORAL-LOCATION-OF ?D ?B))))
  :AXIOMS (SYMMETRIC CO-OCCURS))

(DEFRELATION MEETS (?A ?B)
  :<=> (AND (TEMPORAL-CONNECTION ?A ?B) (PRECEDES ?A ?B)))

(DEFRELATION MET-BY (?A ?B)
  :<=> (MEETS ?B ?A))
```

```

(DEFRELATION STARTS (?A ?B)
 :=> (AND (TEMPORALLY-CONTAINED-IN ?A ?B)
         (EXISTS (?C) (AND (PRECEDES ?A ?C) (PART-OF ?C ?B)))))

(DEFRELATION STARTED-BY (?A ?B)
 :<=> (STARTS ?B ?A))

(DEFRELATION CONCLUDES (?A ?B)
 :=> (AND (TEMPORALLY-CONTAINED-IN ?A ?B)
         (EXISTS (?C) (AND (FOLLOWS ?A ?C) (PART-OF ?C ?B)))))

(DEFRELATION CONCLUDED-BY (?A ?B)
 :<=> (CONCLUDES ?B ?A))

(DEFRELATION TEMPORAL-INTERSECTION (?A ?B)
 :<=> (AND (TEMPORAL-RELATION ?A ?B)
         (EXISTS (?C ?D ?E)
          (AND (TEMPORAL-LOCATION ?A ?C) (OVERLAPS ?C ?D) (TEMPORAL-REGION ?C)
                (TEMPORAL-REGION ?D) (DIRECT-SUCCESSOR ?D ?E) (TEMPORAL-REGION ?E)
                (TEMPORAL-LOCATION-OF ?E ?B))))
 :AXIOMS (SYMMETRIC TEMPORAL-INTERSECTION))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/MODALITIES"
 :INCLUDES ("DESCRIPTIONS"))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/MODALITIES")

(DEFCONCEPT MODAL-DESCRIPTION (?SELF)
 :<=> (AND (S-DESCRIPTION ?SELF)
         (EXISTS (?A)
          (AND (TEMPORARY-COMPONENT ?SELF ?A)
                (AND (FUNCTIONAL-ROLE ?A)
                     (EXISTS (?B) (AND (MODALITY-TARGET ?A ?B) (COURSE ?B)))))))
 :AXIOMS (AND
         (DOCUMENTATION MODAL-DESCRIPTION
          "A modal description is any part of a
description that has a unity criterion consisting in the specification
of a right, power, duty, etc. Notice that modal descriptions can
appear in conventionalized s-descriptions as well as in idiosyncratic
assessments, narratives, promises, etc.")))

(DEFCONCEPT RIGHT (?SELF)
 :<=> (AND (MODAL-DESCRIPTION ?SELF)
         (EXISTS (?A)
          (AND (TEMPORARY-COMPONENT ?SELF ?A)
                (AND (FUNCTIONAL-ROLE ?A)
                     (EXISTS (?B) (AND (HAS-RIGHT-ON ?A ?B) (COURSE ?B)))))))

(DEFCONCEPT NON-RIGHT (?SELF)
 :<=> (AND (MODAL-DESCRIPTION ?SELF)
         (EXISTS (?A)
          (AND (TEMPORARY-COMPONENT ?SELF ?A)
                (AND (FUNCTIONAL-ROLE ?A)
                     (EXISTS (?B) (AND (HAS-NOT-RIGHT-ON ?A ?B) (COURSE ?B)))))))

(DEFCONCEPT POWER (?SELF)
 :<=> (AND (MODAL-DESCRIPTION ?SELF)
         (EXISTS (?A)
          (AND (TEMPORARY-COMPONENT ?SELF ?A)
                (AND (FUNCTIONAL-ROLE ?A)
                     (EXISTS (?B) (AND (HAS-POWER-ON ?A ?B) (COURSE ?B)))))))

(DEFCONCEPT DISABILITY (?SELF)
 :<=> (AND (MODAL-DESCRIPTION ?SELF)

```

```
(EXISTS (?A)
  (AND (TEMPORARY-COMPONENT ?SELF ?A)
    (AND (FUNCTIONAL-ROLE ?A)
      (EXISTS (?B) (AND (HAS-DISABILITY-TO ?A ?B) (COURSE ?B))))))))

(DEFCONCEPT PRIVILEGE (?SELF)
  :<=> (AND (MODAL-DESCRIPTION ?SELF)
    (EXISTS (?A)
      (AND (TEMPORARY-COMPONENT ?SELF ?A)
        (AND (FUNCTIONAL-ROLE ?A)
          (EXISTS (?B) (AND (HAS-PRIVILEGE-OF ?A ?B) (COURSE ?B))))))))))

(DEFCONCEPT DUTY (?SELF)
  :<=> (AND (MODAL-DESCRIPTION ?SELF)
    (EXISTS (?A)
      (AND (TEMPORARY-COMPONENT ?SELF ?A)
        (AND (FUNCTIONAL-ROLE ?A)
          (EXISTS (?B) (AND (HAS-DUTY-OF ?A ?B) (COURSE ?B))))))))))

(DEFCONCEPT IMMUNITY (?SELF)
  :<=> (AND (MODAL-DESCRIPTION ?SELF)
    (EXISTS (?A)
      (AND (TEMPORARY-COMPONENT ?SELF ?A)
        (AND (FUNCTIONAL-ROLE ?A)
          (EXISTS (?B) (AND (HAS-IMMUNITY-OF ?A ?B) (COURSE ?B))))))))))

(DEFCONCEPT LIABILITY (?SELF)
  :<=> (AND (MODAL-DESCRIPTION ?SELF)
    (EXISTS (?A)
      (AND (TEMPORARY-COMPONENT ?SELF ?A)
        (AND (FUNCTIONAL-ROLE ?A)
          (EXISTS (?B) (AND (HAS-LIABILITY-TO ?A ?B) (COURSE ?B))))))))))

(DEFRELATION LEGAL-MODALITY-TARGET (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION LEGAL-MODALITY-TARGET-OF (?A ?B)
  :<=> (LEGAL-MODALITY-TARGET ?B ?A))

(DEFRELATION HAS-POWER-ON (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION POWER-TARGET-OF (?A ?B)
  :<=> (HAS-POWER-ON ?B ?A))

(DEFRELATION HAS-DISABILITY-TO (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION DISABILITY-TARGET-OF (?A ?B)
  :<=> (HAS-DISABILITY-TO ?B ?A))

(DEFRELATION HAS-PRIVILEGE-OF (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION PRIVILEGE-TARGET-OF (?A ?B)
  :<=> (HAS-PRIVILEGE-OF ?B ?A))

(DEFRELATION HAS-DUTY-OF (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION DUTY-TARGET-OF (?A ?B)
  :<=> (HAS-DUTY-OF ?B ?A))

(DEFRELATION HAS-RIGHT-ON (?A ?B)
  :=> (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION RIGHT-TARGET-OF (?A ?B)
  :<=> (HAS-RIGHT-ON ?B ?A))
```

```
(DEFRELATION HAS-NOT-RIGHT-ON (?A ?B)
  => (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION NOT-RIGHT-TARGET-OF (?A ?B)
  <=> (HAS-NOT-RIGHT-ON ?B ?A))

(DEFRELATION HAS-IMMUNITY-OF (?A ?B)
  => (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION IMMUNITY-TARGET-OF (?A ?B)
  <=> (HAS-IMMUNITY-OF ?B ?A))

(DEFRELATION HAS-LIABILITY-TO (?A ?B)
  => (LEGAL-MODALITY-TARGET ?A ?B))

(DEFRELATION LIABILITY-TARGET-OF (?A ?B)
  <=> (HAS-LIABILITY-TO ?B ?A))

(DEFRELATION HAS-BDI-ON (?A ?B)
  => (MODALITY-TARGET ?A ?B))

(DEFRELATION BDI-TARGET-OF (?A ?B)
  <=> (HAS-BDI-ON ?B ?A))

(DEFRELATION SUBJECTED-TO (?A ?B)
  => (MODALITY-TARGET ?A ?B))

(DEFRELATION SUBJECT-TARGET-OF (?A ?B)
  <=> (SUBJECTED-TO ?B ?A))

(DEFRELATION HAS-EXPLOITATION-WITHIN (?A ?B)
  => (MODALITY-TARGET ?A ?B))

(DEFRELATION USE-TARGET-OF (?A ?B)
  <=> (HAS-EXPLOITATION-WITHIN ?B ?A))

(DEFRELATION CONSEQUENT-WITHIN (?A ?B)
  => (MODALITY-TARGET ?A ?B))

(DEFRELATION CONSEQUENCE-TARGET-OF (?A ?B)
  <=> (CONSEQUENT-WITHIN ?B ?A))

(ASSERT (forall (?self)
  (<= (exists (?c ?d ?e)
    (and (TEMPORARY-PART-OF ?self ?c)
      (S-DESCRIPTION ?c)
      (TEMPORARY-COMPONENT ?self ?d)
      (TEMPORARY-COMPONENT ?self ?e)
      (FUNCTIONAL-ROLE ?d)
      (COURSE ?e)
      (MODALITY-TARGET ?d ?e)))
    (MODAL-DESCRIPTION ?self))))))

(ASSERT (forall (?a ?b)
  (<= (COURSE ?b)
    (HAS-BDI-ON ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (AGENT-ROLE ?a)
    (HAS-BDI-ON ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (COURSE ?b)
    (SUBJECTED-TO ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (PATIENT-ROLE ?a)
```

```
(SUBJECTED-TO ?a ?b)))

(ASSERT (forall (?a ?b)
  (<= (COURSE ?b)
    (HAS-EXPLOITATION-WITHIN ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (INSTRUMENTALITY-ROLE ?a)
    (HAS-EXPLOITATION-WITHIN ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (COURSE ?b)
    (CONSEQUENT-WITHIN ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (CONSEQUENCE-ROLE ?a)
    (CONSEQUENT-WITHIN ?a ?b))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-DUTY-OF ?x ?y))
    (HAS-PRIVILEGE-OF ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-PRIVILEGE-OF ?x ?y))
    (HAS-DUTY-OF ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-LIABILITY-TO ?x ?y))
    (HAS-IMMUNITY-OF ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-IMMUNITY-OF ?x ?y))
    (HAS-LIABILITY-TO ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-DISABILITY-TO ?x ?y))
    (HAS-POWER-ON ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (forall (?z)
    (<= (HAS-LIABILITY-TO ?z ?y)
      (and (MODALITY-TARGET ?z ?y)
        (AGENT-ROLE ?z))))
    (HAS-POWER-ON ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-POWER-ON ?x ?y))
    (HAS-DISABILITY-TO ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (forall (?z)
    (<= (HAS-IMMUNITY-OF ?z ?y)
      (and (MODALITY-TARGET ?z ?y)
        (AGENT-ROLE ?z))))
    (HAS-DISABILITY-TO ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (not (HAS-NOT-RIGHT-ON ?x ?y))
    (HAS-RIGHT-ON ?x ?y))))

(ASSERT (forall (?x ?y)
  (<= (forall (?z)
    (<= (HAS-DUTY-OF ?z ?y)
      (and (MODALITY-TARGET ?z ?y)
        (AGENT-ROLE ?z))))
    (HAS-RIGHT-ON ?x ?y))))

(ASSERT (forall (?x ?y)
```

```
(<= (not (HAS-RIGHT-ON ?x ?y))
     (HAS-NOT-RIGHT-ON ?x ?y)))

(ASSERT (forall (?x ?y)
          (<= (forall (?z ?a)
              (<= (HAS-PRIVILEGE-OF ?z ?y)
                  (and (MODALITY-TARGET ?z ?y)
                      (AGENT-ROLE ?z))))
              (HAS-NOT-RIGHT-ON ?x ?y))))))

(DEFMODULE "TOP/DOLCE/T-TOPOLOGY/PLACES"
  :INCLUDES ("T-TOPOLOGY" "DESCRIPTIONS"))

(IN-MODULE "TOP/DOLCE/T-TOPOLOGY/PLACES")

(DEFRELATION APPROXIMATE-LOCATION (?A ?B)
  :=> (GENERIC-LOCATION ?A ?B))

(DEFRELATION APPROXIMATE-LOCATION-OF (?A ?B)
  :=<=> (APPROXIMATE-LOCATION ?B ?A))

(DEFRELATION PLACE (?A ?B)
  :=<=> (AND (APPROXIMATE-LOCATION ?A ?B) (PHYSICAL-ENDURANT ?A)
            (PHYSICAL-ENDURANT ?B)
            (EXISTS (?C ?D)
              (AND (SPATIAL-LOCATION ?A ?C) (SPACE-REGION ?C)
                  (MEREOTOPOLOGICAL-ASSOCIATION ?C ?D) (SPACE-REGION ?D)
                  (SPATIAL-LOCATION-OF ?D ?B))))))

(DEFRELATION PLACE-OF (?A ?B)
  :=<=> (PLACE ?B ?A))

(DEFRELATION SITUATION-PLACE (?A ?B)
  :=<=> (AND (APPROXIMATE-LOCATION ?A ?B) (SETTING-FOR ?A ?B) (SITUATION ?A)
            (ENDURANT ?B)))

(DEFRELATION SITUATION-PLACE-OF (?A ?B)
  :=<=> (SITUATION-PLACE ?B ?A))

(DEFRELATION MATERIAL-PLACE (?A ?B)
  :=<=> (AND (APPROXIMATE-LOCATION ?A ?B) (ENDURANT ?A) (PHYSICAL-ENDURANT ?B)
            (EXISTS (?C ?D)
              (AND (EXACT-LOCATION ?A ?C) (SPACE-REGION ?C)
                  (MEREOTOPOLOGICAL-ASSOCIATION ?C ?D) (SPACE-REGION ?D)
                  (SPATIAL-LOCATION-OF ?D ?B))))))

(DEFRELATION MATERIAL-PLACE-OF (?A ?B)
  :=<=> (MATERIAL-PLACE ?B ?A))

(DEFRELATION FIAT-PLACE (?A ?B)
  :=<=> (AND (APPROXIMATE-LOCATION ?A ?B) (ENDURANT ?A)
            (NON-PHYSICAL-ENDURANT ?B)
            (EXISTS (?C ?D)
              (AND (EXACT-LOCATION ?A ?C) (SPACE-REGION ?C)
                  (MEREOTOPOLOGICAL-ASSOCIATION ?C ?D) (SPACE-REGION ?D)
                  (DEPEND-ON-SPATIAL-LOCATION-OF ?D ?B))))))

(DEFRELATION FIAT-PLACE-OF (?A ?B)
  :=<=> (FIAT-PLACE ?B ?A))

(DEFRELATION GEOGRAPHIC-PART-OF (?A ?B)
  :=<=> (AND (FIAT-PLACE ?A ?B) (POLITICAL-GEOGRAPHIC-OBJECT ?A)
            (POLITICAL-GEOGRAPHIC-OBJECT ?B)))
```

```
(DEFRELATION GEOGRAPHIC-PART (?A ?B)
 :<=> (GEOGRAPHIC-PART-OF ?B ?A))

(DEFRELATION PARTICIPANT-PLACE (?A ?B)
 :<=> (AND (GENERIC-LOCATION ?A ?B) (PERDURANT ?A) (ENDURANT ?B)
 (EXISTS (?C)
 (AND (PARTICIPANT ?A ?C) (APPROXIMATE-LOCATION ?C ?B) (ENDURANT ?C))))))

(DEFRELATION PARTICIPANT-PLACE-OF (?A ?B)
 :<=> (PARTICIPANT-PLACE ?B ?A))

(DEFRELATION ORIGIN (?A ?B)
 :=> (PLACE ?A ?B))

(DEFRELATION ORIGIN-OF (?A ?B)
 :<=> (ORIGIN ?B ?A))

(DEFRELATION DESCRIPTIVE-ORIGIN (?A ?B)
 :=> (FIAT-PLACE ?A ?B))

(DEFRELATION DESCRIPTIVE-ORIGIN-OF (?A ?B)
 :<=> (DESCRIPTIVE-ORIGIN ?B ?A))

(DEFCONCEPT PHYSICAL-PLACE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF))

(DEFCONCEPT GEOGRAPHICAL-OBJECT (?SELF)
 :=> (PHYSICAL-PLACE ?SELF))

(DEFCONCEPT NON-PHYSICAL-PLACE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT GEOGRAPHICAL-ROLE (?SELF)
 :=> (NON-PHYSICAL-PLACE ?SELF))

(DEFCONCEPT POLITICAL-GEOGRAPHIC-OBJECT (?SELF)
 :=> (GEOGRAPHICAL-ROLE ?SELF))

(DEFCONCEPT COUNTRY (?SELF)
 :=> (POLITICAL-GEOGRAPHIC-OBJECT ?SELF))

(ASSERT (forall (?self)
 (<= (exists (?a)
 (and (PHYSICALLY-DEPENDS-ON ?self ?a)
 (PHYSICAL-OBJECT ?a)))
 (NON-PHYSICAL-PLACE ?self))))))

(ASSERT (forall (?self)
 (<= (exists (?a)
 (and (PHYSICALLY-DEPENDS-ON ?self ?a)
 (GEOGRAPHICAL-OBJECT ?a)))
 (POLITICAL-GEOGRAPHIC-OBJECT ?self))))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/MODALITIES/F-PARTICIPATION"
 :INCLUDES ("MODALITIES" "T-TOPOLOGY")
 :SHADOW (ACTION))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/MODALITIES/F-PARTICIPATION")

(DEFCONCEPT ACTION (?SELF)
 :=> (ACCOMPLISHMENT ?SELF)
 :AXIOMS (AND
 (DOCUMENTATION ACTION "A Perdurant that exemplifies the
 intentionality of an agent.
```

Could it be aborted, incomplete, mislead, while remaining a (potential) accomplishment?  
The point here is that having a result depends on a method, then an action remains an action under incomplete results. As a matter of fact, if we neutralize intentionality, a purely topological, post-hoc view is at odds with the notion of incomplete accomplishments.")))

```
(DEFRELATION FUNCTIONAL-PARTICIPANT (?A ?B)
 :<=> (AND (PARTICIPANT ?A ?B)
          (EXISTS (?C ?D)
            (AND (SEQUENCED-BY ?A ?C) (MODALITY-TARGET-OF ?C ?D)
                 (PLAYED-BY ?D ?B))))
 :AXIOMS (DOCUMENTATION FUNCTIONAL-PARTICIPANT
          "This relation constrains participation within the
          scope of an s-description: an event is participated by an object according to
          an s-description and its components."))
```

```
(DEFRELATION FUNCTIONAL-PARTICIPANT-IN (?A ?B)
 :<=> (FUNCTIONAL-PARTICIPANT ?B ?A))
```

```
(DEFRELATION PERFORMS (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
          (EXISTS (?C ?D)
            (AND (PLAYS ?A ?C) (AGENTIVE-FUNCTIONAL-ROLE ?C) (HAS-BDI-ON ?C ?D)
                 (SEQUENCES ?D ?B))))))
```

```
(DEFRELATION PERFORMED-BY (?A ?B)
 :<=> (PERFORMS ?B ?A))
```

```
(DEFRELATION AGENT-IN (?A ?B)
 :<=> (PERFORMS ?A ?B))
```

```
(DEFRELATION HAS-AGENT (?A ?B)
 :<=> (PERFORMED-BY ?A ?B))
```

```
(DEFRELATION PRESCRIBES (?A ?B)
 :=> (PERFORMS ?A ?B))
```

```
(DEFRELATION PRESCRIBED-BY (?A ?B)
 :<=> (PRESCRIBES ?B ?A))
```

```
(DEFRELATION PATIENT-OF (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
          (EXISTS (?C ?D)
            (AND (PLAYS ?A ?C) (PATIENT-ROLE ?C) (SUBJECTED-TO ?C ?D)
                 (SEQUENCES ?D ?B))))))
```

```
(DEFRELATION PATIENT (?A ?B)
 :<=> (PATIENT-OF ?B ?A))
```

```
(DEFRELATION TARGET-OF (?A ?B)
 :<=> (AND (PATIENT-OF ?A ?B)
          (EXISTS (?C ?D)
            (AND (PLAYS ?A ?C) (TARGET-ROLE ?C) (SUBJECTED-TO ?C ?D)
                 (SEQUENCES ?D ?B))))))
```

```
(DEFRELATION HAS-TARGET (?A ?B)
 :<=> (TARGET-OF ?B ?A))
```

```
(DEFRELATION GENERIC-TARGET-OF (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
          (EXISTS (?C ?D)
            (AND (PLAYS ?A ?C) (TARGET-ROLE ?C) (TEMPORARY-COMPONENT-OF ?C ?D)
                 (S-DESCRIPTION ?D) (EXPECTS ?D ?B) (ACTIVITY ?B))))))
```

```
(DEFRELATION GENERIC-TARGET (?A ?B)
```

```
:<=> (GENERIC-TARGET-OF ?B ?A))

(DEFRELATION THEME (?A ?B)
 :=> (PATIENT ?A ?B))

(DEFRELATION THEME-OF (?A ?B)
 :<=> (THEME ?B ?A))

(DEFRELATION USED-IN (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (INSTRUMENTALITY-ROLE ?C)
 (HAS-EXPLOITATION-WITHIN ?C ?D) (SEQUENCES ?D ?B))))))

(DEFRELATION SITUATION-OF-USE-OF (?A ?B)
 :<=> (USED-IN ?B ?A))

(DEFRELATION INSTRUMENT-OF (?A ?B)
 :<=> (AND (USED-IN ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (DEVICE-ROLE ?C) (HAS-EXPLOITATION-WITHIN ?C ?D)
 (SEQUENCES ?D ?B))))))

(DEFRELATION INSTRUMENT (?A ?B)
 :<=> (INSTRUMENT-OF ?B ?A))

(DEFRELATION RESOURCE-FOR (?A ?B)
 :<=> (AND (USED-IN ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (RESOURCE-ROLE ?C) (HAS-EXPLOITATION-WITHIN ?C ?D)
 (SEQUENCES ?D ?B))))))

(DEFRELATION RESOURCE (?A ?B)
 :<=> (RESOURCE-FOR ?B ?A))

(DEFRELATION CONSEQUENCE-OF (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (CONSEQUENCE-ROLE ?C) (CONSEQUENT-WITHIN ?C ?D)
 (SEQUENCES ?D ?B))))))

(DEFRELATION CONSEQUENCE (?A ?B)
 :<=> (CONSEQUENCE-OF ?B ?A))

(DEFRELATION PRODUCT-OF (?A ?B)
 :<=> (AND (FUNCTIONAL-PARTICIPANT-IN ?A ?B)
 (EXISTS (?C ?D)
 (AND (PLAYS ?A ?C) (ARTIFACT-ROLE ?C) (CONSEQUENT-WITHIN ?C ?D)
 (SEQUENCES ?D ?B))))))

(DEFRELATION PRODUCT (?A ?B)
 :<=> (CONSEQUENCE-OF ?B ?A))

(DEFRELATION SUBSTRATE-OF (?A ?B)
 :<=> (AND (TOTAL-PARTICIPANT-IN ?A ?B) (FUNCTIONAL-PARTICIPANT-IN ?A ?B)))

(DEFRELATION SUBSTRATE (?A ?B)
 :<=> (SUBSTRATE-OF ?B ?A))

(DEFRELATION HAS-STATE (?A ?B)
 :<=> (AND (SUBSTRATE-OF ?A ?B) (STATE ?B)))

(DEFRELATION STATE-OF (?A ?B)
 :<=> (HAS-STATE ?B ?A))

(DEFRELATION CO-PARTICIPATES-WITH (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
 (EXISTS (?C) (AND (PARTICIPANT-IN ?A ?C) (PARTICIPANT ?C ?B))))))
```

```
(DEFRELATION REFERENCE-THEME (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
           (EXISTS (?C) (AND (PERFORMS ?A ?C) (THEME ?C ?B))))))

(DEFRELATION REFERENCE-THEME-OF (?A ?B)
 :<=> (REFERENCE-THEME ?B ?A))

(DEFRELATION MAKES (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
           (EXISTS (?C) (AND (PERFORMS ?A ?C) (ACTIVITY ?C) (CONSEQUENCE ?C ?B))))))

(DEFRELATION MADE-BY (?A ?B)
 :<=> (MAKES ?B ?A))

(DEFRELATION RULES ((?A SOCIALLY-CONSTRUCTED-PERSON) (?B FUNCTIONAL-ROLE))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
           (EXISTS (?C ?D)
             (AND (PERFORMS ?A ?C) (ACTIVITY ?C) (EXPECTED-BY ?C ?D) (ACTIVITY ?C)
                  (REGULATION ?D) (INVOLVES ?D ?B) (REGULATION ?D))))))

(DEFRELATION RULED-BY (?A ?B)
 :<=> (RULES ?B ?A))

(DEFRELATION RESULT-OF (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (ACTIVITY ?B)
           (EXISTS (?C ?D)
             (AND (SEQUENCED-BY ?A ?C) (T-PREDECESSOR ?C ?D) (SEQUENCES ?D ?B))))
           (EXISTS (?E)
             (AND (PARTICIPANT ?A ?E) (PARTICIPANT-IN ?E ?B) (ACTIVITY ?B))))
 :AXIOMS (DOCUMENTATION RESULT-OF
          "A perdurant p1 results from another one p2 if they
          are sequenced within a same course, if a same endurant participates in
          both perdurants, and if p1 follows p2."))

(DEFRELATION RESULT (?A ?B)
 :<=> (RESULT-OF ?B ?A))

(DEFRELATION USES (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B)
           (EXISTS (?C) (AND (PERFORMS ?A ?C) (SITUATION-OF-USE-OF ?C ?B))))))

(DEFRELATION USED-BY (?A ?B)
 :<=> (USES ?B ?A))

(DEFCONCEPT ACTIVITY (?SELF)
 :=> (ACTION ?SELF)
 :AXIOMS (AND
           (DOCUMENTATION ACTIVITY
            "In dependency terms, an activity is an action that
            is generically constantly dependent on a conventional, shared description
            (course) adopted
            by participants. Intuitively, activities are complex actions that are at least
            partly conventionally planned.")))

(DEFCONCEPT PHENOMENON (?SELF)
 :=> (ACCOMPLISHMENT ?SELF)
 :AXIOMS (AND
           (DOCUMENTATION PHENOMENON
            "A phenomenon seems an accomplishment when some
            intentionality puts boundaries on it (although it is not claimed to be
            inherently
            intentional). On the other hand, a purely physical phenomenon does not seem to
            have
            inherent boundaries either ... and also for biological processes as well as
            economic processes this seems to be disputable. If the boundary hypothesis is
            discarded, phenomenon should migrate under process.")))
```

```
(DEFCONCEPT PHYSICAL-PHENOMENON (?SELF)
  :=> (PHENOMENON ?SELF))

(DEFCONCEPT FLUX (?SELF)
  :=> (PROCESS ?SELF)
  :AXIOMS (AND
    (DOCUMENTATION FLUX
      "Fluxes are processes that (also) contain accomplishments
as constituents. In other words, fluxes emerge out of accomplishments.")))

(DEFCONCEPT RECONSTRUCTED-FLUX (?SELF)
  :<=> (AND (FLUX ?SELF)
    (FORALL (?A) (=> (HAS-MEMBER ?SELF ?A) (ACCOMPLISHMENT ?A))))
  :AXIOMS (AND
    (DOCUMENTATION RECONSTRUCTED-FLUX
      "Reconstructed fluxes are fluxes that only contain
accomplishments as members.")))

(DEFCONCEPT COGNITIVE-STATE (?SELF)
  :=> (STATE ?SELF))

(DEFCONCEPT COGNITIVE-EVENT (?SELF)
  :=> (EVENT ?SELF))

(ASSERT (forall (?a ?b)
  (= >> (THEME ?a ?b)
    (INFORMATION-OBJECT ?b))))

(ASSERT (forall (?self)
  (<= (exists (?a ?b)
    (and (PARTICIPANT ?self ?a)
      (SOCIAL-AGENT ?a)
      (GENERICALLY-DEPENDS-ON ?self ?b)
      (COGNITIVE-STATE ?b)))
    (ACTION ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a ?b)
    (and (SEQUENCED-BY ?self ?a)
      (COURSE ?a)
      (GENERICALLY-DEPENDS-ON ?self ?b)
      (COURSE ?b)))
    (ACTIVITY ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (SUBSTRATE ?self ?a)
      (NATURAL-PERSON ?a)))
    (COGNITIVE-STATE ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (SUBSTRATE ?self ?a)
      (NATURAL-PERSON ?a)))
    (COGNITIVE-EVENT ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (CONSTITUENT ?self ?a)
      (ACCOMPLISHMENT ?a)))
    (FLUX ?self))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS"
  :INCLUDES ("DOCUMENTS" "PLACES")
  :SHADOW (GOAL PLAN))
```

```
(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS")

(DEFCONCEPT GOAL (?SELF)
  :<=> (AND (S-DESCRIPTION ?SELF)
    (EXISTS (?D ?A ?B)
      (AND (S-DESCRIPTION ?D) (PART ?D ?SELF) (TEMPORARY-COMPONENT ?SELF ?A)
        (TEMPORARY-COMPONENT ?SELF ?B) (AGENT-ROLE ?A) (TASK ?B)
        (HAS-BDI-ON ?A ?B))))
  :AXIOMS (DOCUMENTATION GOAL
    "A goal is constructed here as a situation description
that references a certain setting (a goal state). A goal has at least one agent
(role)
as component, and agents have a BDI on a goal task when a goal is
instantiated."))

(DEFCONCEPT PLAN (?SELF)
  :=> (METHOD ?SELF)
  :AXIOMS (DOCUMENTATION PLAN "A generic plan is a method for executing or
performing a procedure or a stage of a procedure.
If the postcondition is a desired one, this is a goal-state and is referenced
by a goal."))

(DEFCONCEPT PATH (?SELF)
  :=> (COURSE ?SELF))

(DEFCONCEPT TASK (?SELF)
  :=> (COURSE ?SELF))

(DEFCONCEPT SCHEDULE (?SELF)
  :<=> (AND (TASK ?SELF)
    (EXISTS (?A ?B)
      (AND (HAS-REQUISITE ?SELF ?A) (PARAMETER ?A) (VALUED-BY ?A ?B)
        (TIME-INTERVAL ?B))))))

(DEFCONCEPT PLAN-INFORMATION (?SELF)
  :<=> (AND (INFORMATION-OBJECT ?SELF)
    (EXISTS (?A) (AND (REPRESENTS ?SELF ?A) (PLAN ?A))))
  :AXIOMS (DOCUMENTATION PLAN-INFORMATION
    "Documents, models, or diagrams that present
the information about a plan."))

(DEFCONCEPT GOAL-STATE (?SELF)
  :<=> (AND (SITUATION ?SELF)
    (EXISTS (?A ?E ?F)
      (AND (SATISFIES ?SELF ?G) (GOAL ?G) (SETTING-FOR ?SELF ?E) (AGENT ?E)
        (SETTING-FOR ?SELF ?A)
        (OR
          (AND (PERDURANT ?A)
            (EXISTS (?B)
              (AND (RESULT-OF ?A ?B) (ACTIVITY ?B) (EXPECTED-BY ?B ?G))))
          (AND (ENDURANT ?A)
            (EXISTS (?C)
              (AND (CONSEQUENCE-OF ?A ?C) (ACTIVITY ?C) (EXPECTED-BY ?C ?G))))
          (AND (REGION ?A) (ADMITTED-BY ?A ?G))))))
  :AXIOMS (DOCUMENTATION GOAL-STATE
    "A goal state is instantiated when it is referenced
by a goal (description) that is adopted by some enduring playing an agent role,
and executing a task from the goal description, on which it has a BDI."))

(DEFRELATION AGENT (?SELF)
  :<=> (AND
    (OR (AGENTIVE-PHYSICAL-OBJECT ?SELF) (AGENTIVE-FUNCTIONAL-ROLE ?SELF))
    (EXISTS (?A ?B)
      (AND (PARTICIPANT-IN ?SELF ?A) (ACTIVITY ?A) (SEQUENCED-BY ?A ?B)
        (TASK ?B))))))
```

```
(DEFRELATION METHOD-OF (?A ?B)
 :<=> (AND (EXPECTS ?A ?B) (METHOD ?A) (ACTIVITY ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT ?A ?C) (TASK ?C) (SEQUENCES ?C ?B))))))

(DEFRELATION HAS-METHOD (?A ?B)
 :<=> (METHOD-OF ?B ?A))

(DEFRELATION QUANTITATIVELY-ADMITS (?A ?B)
 :<=> (AND (HYBRID-MEDIATED-RELATION ?A ?B)
         (EXISTS (?C) (AND (ADMITS ?A ?C) (COUNTED-BY ?C ?B))))))

(DEFRELATION QUANTITATIVELY-ADMITTED-BY (?A ?B)
 :<=> (QUANTITATIVELY-ADMITS ?B ?A))

(DEFRELATION ENVISAGES (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (S-DESCRIPTION ?A) (PERDURANT ?B)
         (EXISTS (?C)
          (AND (WEAK-CONNECTION ?A ?C) (S-DESCRIPTION ?C) (EXPECTS ?C ?B))))))

(DEFRELATION ENVISAGED-BY (?A ?B)
 :<=> (ENVISAGES ?B ?A))

(DEFRELATION EXPLOITS (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (METHOD ?A) (ENDURANT ?B)
         (EXISTS (?C)
          (AND (METHOD-OF ?A ?C) (ACTIVITY ?C) (SITUATION-OF-USE-OF ?C ?B))))))

(DEFRELATION EXPLOITED-BY (?A ?B)
 :<=> (EXPLOITS ?B ?A))

(DEFRELATION SIBLING-TASK ((?A TASK) (?B TASK))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT-OF ?A ?C) (PLAN ?C)
               (TEMPORARY-COMPONENT ?C ?B))))))
:AXIOMS (AND (SYMMETRIC SIBLING-TASK)
          (DOCUMENTATION SIBLING-TASK "Two tasks contained in the same
plan."))

(DEFRELATION PRECONDITION ((?A S-DESCRIPTION) (?B SITUATION))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C)
          (AND (SATISFIED-BY ?A ?C) (SITUATION ?C) (DIRECT-PREDECESSOR ?C ?B))))))
:AXIOMS (DOCUMENTATION PRECONDITION
        "A situation is a pre-condition of the execution
of a method (and of its tasks) when it is a predecessor (however succession is
interpreted, although temporal interpretation is the usual one) of that
execution,
and is constituted by a subset of the individuals that constitute the execution
situation.
For example, a surgical guideline describes how to carry out a heart transplant:
its (expected) execution situation is constituted by the perdurants, durants,
and regions described by the guideline, while its pre-condition situation might
be
only constituted by the heart to be removed, the one to be transplanted, their
anatomical and morphological environment, the physiological functions in which
they
participates, and some physiological values.
But the devices used during the transplantation and the surgeon might (or might
not)
be external to the pre-condition situation.
This definition does not cover the possibility of a pre-condition having
constituents that are not involved in the description. This is a difficult
issue. A
possible solution is that such pre-conditions are actually referenced by other
s-descriptions that -for instance- 'control' the feasibility of a procedure, or
```

'analyze' a set of events under an independent unity criterion. If this solution is applicable, such pre-conditions would be 'hybrid' situations requiring the 'pairing' of two or more related descriptions."))

```
(DEFRELATION PRECONDITION-OF (?A ?B)
 :<=> (PRECONDITION ?B ?A))
```

```
(DEFRELATION POSTCONDITION ((?A S-DESCRIPTION) (?B SITUATION))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C)
          (AND (SATISFIED-BY ?A ?C) (SITUATION ?C) (DIRECT-SUCCESSOR ?C ?B))))
 :AXIOMS (DOCUMENTATION POSTCONDITION
```

"A situation is a post-condition of the execution of a method (and of its tasks) when it is a successor (however succession is interpreted, although temporal interpretation is the usual one) of that execution, and is constituted by a subset of the individuals that constitute the execution situation. For example, a surgical guideline describes how to carry out a heart transplant: its (expected) execution situation is constituted by the perdurants, endurants, and regions described by the guideline, while its post-condition situation might be only constituted by the transplanted heart, its anatomical and morphological environment, the physiological functions in which it participates, and some physiological values. But the devices used during the transplantation and the surgeon can be external to the post-condition situation. This definition does not cover the possibility of a post-condition having constituents that are not involved in the description. This is a difficult issue. A possible solution is that such post-conditions are actually referenced by other s-descriptions that -for instance- 'control' the outcome of a procedure, or 'reconstruct' a set of events under an independent unity criterion. If this solution is applicable, such post-conditions would be 'hybrid' situations requiring the 'pairing' of two or more related descriptions."))

```
(DEFRELATION POSTCONDITION-OF (?A ?B)
 :<=> (POSTCONDITION ?B ?A))
```

```
(DEFRELATION TASK-PRECONDITION ((?A TASK) (?B SITUATION))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT-OF ?A ?C) (METHOD ?C) (PRECONDITION ?C ?B))))))
```

```
(DEFRELATION TASK-PRECONDITION-OF (?A ?B)
 :<=> (TASK-PRECONDITION ?B ?A))
```

```
(DEFRELATION TASK-POSTCONDITION ((?A TASK) (?B SITUATION))
 :<=> (AND (MEDIATED-RELATION ?A ?B)
         (EXISTS (?C)
          (AND (TEMPORARY-COMPONENT-OF ?A ?C) (METHOD ?C)
              (POSTCONDITION ?C ?B))))))
```

```
(DEFRELATION TASK-POSTCONDITION-OF (?A ?B)
 :<=> (TASK-POSTCONDITION ?B ?A))
```

```
(DEFRELATION EXIT-CONDITION (?A ?B)
 :=> (TASK-POSTCONDITION ?A ?B))
```

```
(DEFRELATION EXIT-CONDITION-OF (?A ?B)
 :<=> (EXIT-CONDITION ?B ?A))
```

```
(DEFRELATION REPETITION-INTERVAL (?A ?B)
 :<=> (AND (MEDIATED-RELATION ?A ?B) (TASK ?A) (TIME-INTERVAL ?B)
         (EXISTS (?C)
          (AND (HAS-REQUISITE ?A ?C) (PARAMETER ?C) (VALUED-BY ?C ?B))))))
```

```
(DEFRELATION REPETITION-INTERVAL-OF (?A ?B)
 :<=> (REPETITION-INTERVAL ?B ?A))

(DEFRELATION FIRST-TASK-OF ((?A TASK) (?B PLAN))
 :<=> (AND (TEMPORARY-COMPONENT-OF ?A ?B)
 (NOT
 (EXISTS ?W
 (AND (TASK ?W) (TEMPORARY-COMPONENT-OF ?W ?B)
 (DIRECT-PREDECESSOR ?A ?W))))))

(DEFRELATION FIRST-TASK (?A ?B)
 :<=> (FIRST-TASK-OF ?B ?A))

(DEFRELATION LAST-TASK-OF ((?A TASK) (?B PLAN))
 :<=> (AND (TEMPORARY-COMPONENT-OF ?A ?B)
 (NOT
 (EXISTS ?W
 (AND (TASK ?W) (TEMPORARY-COMPONENT-OF ?W ?B)
 (DIRECT-SUCCESSOR ?A ?W))))))

(DEFRELATION LAST-TASK (?A ?B)
 :<=> (LAST-TASK-OF ?B ?A))

(DEFRELATION ITERATED-FOR ((?A TASK) (?B INTEGER))
 :<=> (AND (ENTITY-TO-CONSTANT-RELATION ?A ?B)
 (EXISTS (?C ?D)
 (AND (HAS-REQUISITE ?A ?C) (PARAMETER ?C) (VALUED-BY ?C ?D)
 (REGION ?D) (COUNTED-BY ?D ?B))))
 :AXIOMS (SINGLE-VALUED ITERATED-FOR))

(DEFRELATION ITERATION-VALUE-OF (?A ?B)
 :<=> (ITERATED-FOR ?B ?A))

(DEFCONCEPT ELEMENTARY-TASK (?SELF)
 :<=> (AND (TASK ?SELF)
 (NOT (EXISTS (?A) (AND (TASK ?A) (COMPONENT ?SELF ?A)))))
 :AXIOMS (DOCUMENTATION ELEMENTARY-TASK "An atomic task.))

(DEFCONCEPT COMPLEX-TASK (?SELF)
 :<=> (AND (TASK ?SELF) (EXISTS (?A) (AND (TASK ?A) (COMPONENT ?SELF ?A)))))

(DEFCONCEPT SEQUENTIAL-TASK (?SELF)
 :<=> (AND (COMPLEX-TASK ?SELF)
 (NOT
 (EXISTS (?A)
 (AND (OR (BRANCHING-TASK ?A) (SYNCHRO-TASK ?A) (CYCLICAL-TASK ?A))
 (COMPONENT ?SELF ?A)))))
 :AXIOMS (DOCUMENTATION SEQUENTIAL-TASK
 "A task that does not contain branchings
 nor synchronizations, nor cycles.))

(DEFCONCEPT SYNCHRO-TASK (?SELF)
 :<=> (AND (ELEMENTARY-TASK ?SELF)
 (>= (CARDINALITY (SETOFALL ?A (DIRECT-PREDECESSOR ?SELF ?A))) 2))
 :AXIOMS (DOCUMENTATION SYNCHRO-TASK
 "A task that synchronizes a set of tasks.))

(DEFCONCEPT BRANCHING-TASK (?SELF)
 :<=> (AND (ELEMENTARY-TASK ?SELF)
 (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2))
 :AXIOMS (DOCUMENTATION BRANCHING-TASK
 "A task that subdivides in a set of tasks.))

(DEFCONCEPT CASE-TASK (?SELF)
 :<=> (AND (BRANCHING-TASK ?SELF)
 (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2)
 (FORALL (?B ?C)
```

```

(=>
  (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B)
        (SEQUENCES ?A ?C)))
(PRECEDES ?B ?C))
:AXIOMS (DOCUMENTATION CASE-TASK
  "A task branched to a set of tasks that are not
executable concurrently (at a time).")

(DEFCONCEPT ALTERNATE-TASK (?SELF)
  :<=> (AND (CASE-TASK ?SELF)
    (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A)) 2))
  :AXIOMS (DOCUMENTATION ALTERNATE-TASK
  "A case task branched to exactly 2 tasks not executable in
parallel."))

(DEFCONCEPT CONCURRENT-TASK (?SELF)
  :<=> (AND (BRANCHING-TASK ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2)
    (FORALL (?B ?C)
      (=>
        (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B) (SEQUENCES ?A ?C))
        (TEMPORAL-INTERSECTION ?B ?C))))
  :AXIOMS (DOCUMENTATION CONCURRENT-TASK
  "A branching task to a set of tasks executable concurrently.")

(DEFCONCEPT PARALLEL-TASK (?SELF)
  :<=> (AND (BRANCHING-TASK ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2)
    (FORALL (?B ?C)
      (=>
        (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B) (SEQUENCES ?A ?C))
        (CO-OCCURS ?B ?C))))))

(DEFCONCEPT ANY-ORDER-TASK (?SELF)
  :<=> (AND (BRANCHING-TASK ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2)
    (FORALL (?B ?C)
      (=>
        (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B) (SEQUENCES ?A ?C))
        (TEMPORAL-RELATION ?B ?C))))))

(DEFCONCEPT PARTLY-CONCURRENT-TASK (?SELF)
  :<=> (AND (BRANCHING-TASK ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 3)
    (FORALL (?B ?C)
      (=>
        (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B) (SEQUENCES ?A ?C))
        (AND (TEMPORAL-INTERSECTION ?B ?C)
          (EXISTS (?D ?E)
            (AND (ACTIVITY ?D) (ACTIVITY ?E) (SEQUENCES ?A ?D)
              (SEQUENCES ?A ?E) (PRECEDES ?D ?E))))))))
  :AXIOMS (DOCUMENTATION PARTLY-CONCURRENT-TASK
  "A branching task to a set of tasks, some of which are executable
concurrently."))

(DEFCONCEPT PARTLY-PARALLEL-TASK (?SELF)
  :<=> (AND (BRANCHING-TASK ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 3)
    (FORALL (?B ?C)
      (=>
        (AND (ACTIVITY ?B) (ACTIVITY ?C) (SEQUENCES ?A ?B) (SEQUENCES ?A ?C))
        (AND (CO-OCCURS ?B ?C)
          (EXISTS (?D ?E)
            (AND (ACTIVITY ?D) (ACTIVITY ?E) (SEQUENCES ?A ?D)
              (SEQUENCES ?A ?E) (NOT (CO-OCCURS ?D ?E))))))))))
  :AXIOMS (DOCUMENTATION PARTLY-CONCURRENT-TASK
  "A branching task to a set of tasks, some of which are executable
in parallel."))

```

```
(DEFCONCEPT PARTLY-ANY-ORDER-TASK (?SELF)
 :<=> (AND (CASE-TASK ?SELF) (NOT (ALTERNATE-TASK ?SELF)))
 :AXIOMS (DOCUMENTATION PARTLY-CONCURRENT-TASK
 "A branching task to a set of tasks, some of which are not executable
 concurrently."))

(DEFCONCEPT CYCLICAL-TASK (?SELF)
 :<=> (AND (COMPLEX-TASK ?SELF)
 (EXISTS (?A)
 (AND (COMPLEX-TASK ?A) (DIRECT-SUCCESSOR ?SELF ?A)
 (IDENTITY-C ?SELF ?A))))
 :AXIOMS (DOCUMENTATION CYCLICAL-TASK "A cyclical task."))

(DEFCONCEPT CYCLE-FOR (?SELF)
 :<=> (AND (CYCLICAL-TASK ?SELF)
 (FORALL (?A) (=> (ITERATED-FOR ?SELF ?A) (INTEGER ?A)))
 (EXISTS (?A) (AND (ITERATED-FOR ?SELF ?A) (INTEGER ?A)))))

(DEFCONCEPT CYCLE-UNTIL (?SELF)
 :=> (CYCLICAL-TASK ?SELF)
 :AXIOMS (DOCUMENTATION CYCLE-UNTIL
 "A cyclical task, which iterates until a certain condition
 becomes true. It can be repeated after a certain interval."))

(DEFCONCEPT PLANNING-ACTIVITY (?SELF)
 :=> (ACTIVITY ?SELF))

(DEFCONCEPT INFORMATION-GATHERING (?SELF)
 :=> (ACTIVITY ?SELF))

(DEFCONCEPT DECISION-ACTIVITY (?SELF)
 :=> (PLANNING-ACTIVITY ?SELF))

(DEFCONCEPT ASSESSMENT-QUALITY (?SELF)
 :=> (ABSTRACT-QUALITY ?SELF))

(DEFCONCEPT PLAN-ASSESSMENT-QUALITY (?SELF)
 :<=> (AND (ASSESSMENT-QUALITY ?SELF)
 (EXISTS (?A) (AND (INHERENT-IN ?SELF ?A) (PLAN ?A)))))

(DEFCONCEPT PROCEDURAL-QUALITY (?SELF)
 :<=> (AND (TEMPORAL-QUALITY ?SELF)
 (EXISTS (?A) (AND (T-INHERENT-IN ?SELF ?A) (ACTIVITY ?A)))))

(DEFCONCEPT DIAGRAM (?SELF)
 :=> (DIAGRAMMATIC-OBJECT ?SELF))

(DEFCONCEPT DIAGRAM-COMPONENT (?SELF)
 :<=> (AND (DIAGRAMMATIC-OBJECT ?SELF)
 (EXISTS (?A) (AND (COMPONENT-OF ?SELF ?A) (DIAGRAM ?A)))))

(DEFCONCEPT FLOW-CHART (?SELF)
 :=> (DIAGRAM ?SELF))

(DEFCONCEPT FLOW-CHART-COMPONENT (?SELF)
 :<=> (AND (DIAGRAM-COMPONENT ?SELF)
 (EXISTS (?A) (AND (COMPONENT-OF ?SELF ?A) (FLOW-CHART ?A)))))

(DEFCONCEPT FLOW-CHART-NODE (?SELF)
 :=> (FLOW-CHART-COMPONENT ?SELF))

(DEFCONCEPT SIMPLE-NODE (?SELF)
 :=> (FLOW-CHART-NODE ?SELF))

(DEFCONCEPT FORK-NODE (?SELF)
 :<=> (AND (FLOW-CHART-NODE ?SELF)
 (>= (CARDINALITY (SETOFALL ?A (DIRECT-SUCCESSOR ?SELF ?A))) 2)))
```

```
(DEFCONCEPT JOIN-NODE (?SELF)
  :<=> (AND (FLOW-CHART-NODE ?SELF)
    (>= (CARDINALITY (SETOFALL ?A (DIRECT-PREDECESSOR ?SELF ?A))) 2)))

(DEFCONCEPT CYCLE-NODE (?SELF)
  :=> (FLOW-CHART-NODE ?SELF))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (PHENOMENON ?a)
      (SEQUENCES ?self ?a)))
    (PATH ?self))))

(ASSERT (forall (?self)
  (<= (and (forall (?a)
    (<= (ACTIVITY ?a)
      (SEQUENCES ?self ?a)))
    (forall (?b)
      (<= (TASK ?b)
        (T-SUCCESSOR ?self ?b))))
    (TASK ?self))))

(ASSERT (forall (?self)
  (<= (not (ELEMENTARY-TASK ?self))
    (COMPLEX-TASK ?self))))

(ASSERT (forall (?self)
  (<= (not (COMPLEX-TASK ?self))
    (ELEMENTARY-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (TASK ?b)
      (TEMPORARY-COMPONENT ?self ?b)))
    (TASK ?self))))

(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (TEMPORARY-COMPONENT ?self ?a)
      (TASK ?a)))
    (PLAN ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (TEMPORARY-COMPONENT ?self ?b)
      (FUNCTIONAL-ROLE ?b)))
    (PLAN ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PERDURANT ?c)
      (ENVISAGES ?self ?c)))
    (PLAN ?self))))

(ASSERT (forall (?self)
  (<= (forall (?d)
    (<= (INFORMATION-OBJECT ?d)
      (REPRESENTED-BY ?self ?d)))
    (PLAN ?self))))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (AUTHORED-BY ?self ?b))
    (PLAN-INFORMATION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PERDURANT ?c)
      (ENVISAGES ?self ?c)))
    (PLAN ?self))))
```

```
(<= (STRING ?c)
      (TITLE ?self ?c)))
(PLAN-INFORMATION ?self)))

(ASSERT (forall (?self)
  (<= (exists (?d)
    (and (PRESENT-AT ?self ?d)
          (TIME-INTERVAL ?d)))
    (PLAN-INFORMATION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (STRING ?e)
          (HAS-INFORMAL-DESCRIPTION ?self ?e)))
    (PLAN-INFORMATION ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PLANNING-ACTIVITY ?c)
          (SEQUENCES ?self ?c)))
    (SYNCHRO-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (PLANNING-ACTIVITY ?c)
          (SEQUENCES ?self ?c)))
    (BRANCHING-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (DECISION-ACTIVITY ?b)
          (SEQUENCES ?self ?b)))
    (CASE-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?f)
    (<= (ACTIVITY ?f)
          (SEQUENCES ?self ?f)))
    (CYCLICAL-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (TIME-INTERVAL ?a)
          (REPETITION-INTERVAL ?self ?a)))
    (CYCLE-UNTIL ?self))))

(ASSERT (forall (?self)
  (<= (forall (?c)
    (<= (TIME-INTERVAL ?c)
          (REPETITION-INTERVAL ?self ?c)))
    (CYCLE-FOR ?self))))

(ASSERT (MUTUALLY-DISJOINT-COLLECTION (SETOF CYCLE-NODE SIMPLE-NODE FORK-NODE
JOIN-NODE)))

(ASSERT (forall (?self)
  (<= (exists (?b)
    (and (INDIRECT-PREDECESSOR ?self ?b)
          (FORK-NODE ?b)))
    (JOIN-NODE ?self))))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (FLOW-CHART-COMPONENT ?b)
          (T-SUCCESSOR ?self ?b)))
    (FLOW-CHART-COMPONENT ?self))))

(ASSERT (forall (?self)
```

```
(<= (forall (?b)
      (<= (JOIN-NODE ?b)
          (REPRESENTED-BY ?self ?b)))
    (SYNCHRO-TASK ?self)))

(ASSERT (forall (?self)
  (<= (forall (?b)
    (<= (FORK-NODE ?b)
        (REPRESENTED-BY ?self ?b)))
      (BRANCHING-TASK ?self))))

(ASSERT (forall (?self)
  (<= (forall (?e)
    (<= (CYCLE-NODE ?e)
        (REPRESENTED-BY ?self ?e)))
      (CYCLICAL-TASK ?self))))

(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS"
  :INCLUDES ("PLANS"))

(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS")

(DEFRELATION SYSTEM-AS-ARTIFACT (?SELF)
  :<=> (AND (NON-AGENTIVE-PHYSICAL-OBJECT ?SELF)
    (EXISTS (?B) (AND (INVOLVED-IN ?SELF ?B) (OR (PLAN ?B) (PROJECT ?B)))))
  :AXIOMS (DOCUMENTATION SYSTEM-AS-ARTIFACT
    "A physical object playing the role of
    artifact, i.e., produced through an execution of a plan that makes
    a project materialized. There is a inherent circularity here, since
    being produced implies executing a plan that contains a functional role
    for being an artifact. It is the primitive notion of transforming by
    making that is lacking, but even having that one, how to anchor it
    to some other notion? The only possibility seems to have descriptions
    for changing (evolution) scenarios, but how to distinguish between
    different changes, i.e. between non-artifactual and artifactual changes?
    Here comes the notion of 'function': an artifactual change is one that
    provides a function not available before. But what is such a function?
    It seems the possibility (a task) for acting in some way, not previously
    available (plannable). Within non intentional systems, there is no
    difference btw functional or not (unless imposed by intentionality).
    But within intentional systems, what are these ways in general is not
    clear, since they are determined by the interaction btw intentional
    agents and their environments ... at the end there seems to be a hardcore
    constituted by agent's euphoric/disphoric attitude, since any plan
    satisfaction can only be bounded to agents, and agents have no shared,
    pre-defined way to be satisfied. The closure of rationalism seems to
    rely on the standardization of satisfaction (an ontology of satisfaction?
    quality assessment for one's or a standard identification life?).
    Making artefactuality dependent on life models is a hard choice,
    although practicable. Currently, we simply put an 'artifact-role' as
    primitive in the ontology.")

(DEFRELATION MATERIAL-ARTIFACT (?SELF)
  :<=> (AND (NON-AGENTIVE-PHYSICAL-OBJECT ?SELF)
    (EXISTS (?B) (AND (INVOLVED-IN ?SELF ?B) (PROJECT ?B)))))

(DEFRELATION MATERIAL-REPRESENTATION-ARTIFACT (?SELF)
  :<=> (AND (MATERIAL-ARTIFACT ?SELF)
    (EXISTS (?A) (AND (REALIZES ?SELF ?A) (INFORMATION-OBJECT ?A)))))

(DEFRELATION SYSTEM-AS-DESCRIPTION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (DOCUMENTATION SYSTEM-AS-DESCRIPTION
    "A description of a system-as-situation.
```

This is provided for cognitive reconstructions of states of affairs:  
historical, ecological, environmental, sociological, economical, etc."))

```
(DEFRELATION SYSTEM-AS-SITUATION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (DOCUMENTATION SYSTEM-AS-SITUATION
    "A system with the intended meaning of
    a state of affairs described through appropriate intentional constraints.
    This is provided for some cognitive reconstructions of states of affairs
    that describe a 'systemic' context: historical, ecological, environmental,
    sociological, economical, political, etc."))
```

```
(ASSERT (forall (?self)
  (<= (forall (?a)
    (<= (SYSTEM-AS-SITUATION ?a)
      (SATISFIED-BY ?self ?a)))
    (SYSTEM-AS-DESCRIPTION ?self))))
```

```
(ASSERT (forall (?self)
  (<= (exists (?a)
    (and (SATISFIES ?self ?a)
      (SYSTEM-AS-DESCRIPTION ?a)))
    (SYSTEM-AS-SITUATION ?self))))
```

```
(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS/WNATOP"
  :INCLUDES ("SYSTEMS"))
```

```
(IN-MODULE
"TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS/WNATOP")
```

```
(DEFCONCEPT PHYSICAL-BODY (?SELF)
  :=> (NON-AGENTIVE-PHYSICAL-OBJECT ?SELF))
```

```
(DEFCONCEPT BIOLOGICAL-OBJECT (?SELF)
  :=> (PHYSICAL-BODY ?SELF))
```

```
(DEFCONCEPT CHEMICAL-OBJECT (?SELF)
  :=> (PHYSICAL-BODY ?SELF))
```

```
(DEFCONCEPT AGENTIVE-GROUP (?SELF)
  :=> (AGENTIVE-PHYSICAL-OBJECT ?SELF))
```

```
(DEFCONCEPT GEOGRAPHICAL-FEATURE (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (DOCUMENTATION GEOGRAPHICAL-FEATURE
    "These can be either dependent places
    (e.g. bays) or relevant parts (e.g. peaks). In a rigorous geological
    sense, I suspect that every geographical physical object is a feature.
    On the other hand, rivers, lakes, mountains, etc. are hardly features
    for common sense, then -in the spirit of DOLCE- it seems appropriate
    to follow the common sense in general, and reserve the feature meaning
    to less mundane entities and domain-oriented geological entries."))
```

```
(DEFCONCEPT AGENTIVE-TEMPORAL-ROLE (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF))
```

```
(DEFCONCEPT LEGAL-POSSESSION-ENTITY (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))
```

```
(DEFCONCEPT CAUSAL-ROLE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))
```

```
(DEFCONCEPT NON-AGENTIVE-TEMPORAL-ROLE (?SELF)
```

```
:=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT SUBSTANCE-ROLE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT COMMERCE-ROLE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT FEATURE-ROLE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT QUALITATIVE-ROLE (?SELF)
 :=> (NON-AGENTIVE-FUNCTIONAL-ROLE ?SELF))

(DEFCONCEPT CREATIVE-OBJECT (?SELF)
 :=> (INFORMATION-OBJECT ?SELF))

(DEFCONCEPT I-TOPIC (?SELF)
 :=> (TOPIC ?SELF))

(DEFCONCEPT |WN-Subject| (?SELF)
 :=> (TOPIC ?SELF))

(DEFCONCEPT |WN-Word| (?SELF)
 :=> (TERM ?SELF))

(DEFRELATION SUBJECT (?A ?B))

(DEFRELATION SUBJECT-OF (?A ?B)
 :<=> (SUBJECT ?B ?A))

(DEFRELATION HAS-I-TOPIC (?A ?B))

(DEFRELATION I-TOPIC-OF (?A ?B)
 :<=> (HAS-I-TOPIC ?B ?A))

(DEFRELATION WORD (?A ?B))

(DEFRELATION SENSE (?A ?B)
 :<=> (WORD ?B ?A))

(DEFRELATION D-PART-OF (?A ?B)
 :=> (PART-OF ?A ?B))

(DEFRELATION D-PART (?A ?B)
 :<=> (D-PART-OF ?B ?A))

(ASSERT (forall (?a ?b)
  (<= (|WN-Subject| ?b)
    (SUBJECT ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (I-TOPIC ?b)
    (HAS-I-TOPIC ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (|WN-Word| ?b)
    (WORD ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (I-TOPIC ?b)
    (D-PART-OF ?a ?b))))

(ASSERT (forall (?a ?b)
  (<= (I-TOPIC ?a)
    (D-PART-OF ?a ?b))))
```

## 16 APPENDIX D: WORDNET-DOLCE alignment

```
(DEFMODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS/WNATOP/WNAT"  
  :INCLUDES ("WNATOP")  
  :SHADOW (SETTING ISSUE SUBSTRATE WORLD ATOM))  
  
(IN-MODULE "TOP/DOLCE/DESCRIPTIONS/COMMUNICATION/DOCUMENTS/PLANS/SYSTEMS/WNATOP/WNAT")  
  
(IN-DIALECT :KIF)  
  
(DEFCONCEPT SETTING (?SELF)  
  :=> (NON-PHYSICAL-PLACE ?SELF)  
  :AXIOMS (AND (SUBJECT SETTING LOCATIONS)  
    (DOCUMENTATION SETTING  
      "the physical position of something; 'he changed the setting on the thermostat'")  
    (HAS-I-TOPIC SETTING |Factotum|) (WORD SETTING |setting|)))  
(DEFCONCEPT ISSUE (?SELF)  
  :=> (QUALITATIVE-ROLE ?SELF)  
  :AXIOMS (AND (SUBJECT ISSUE COGNITION)  
    (DOCUMENTATION ISSUE  
      "an important question that is in dispute and must be settled; 'the issue could be settled by  
      requiring public education for everyone'; 'politicians never discuss the real issues'")  
    (HAS-I-TOPIC ISSUE |Factotum|) (WORD ISSUE |issue|)))  
(DEFCONCEPT SUBSTRATE (?SELF)  
  :=> (SUBSTANCE-ROLE ?SELF)  
  :AXIOMS (AND (SUBJECT SUBSTRATE SUBSTANCES)  
    (DOCUMENTATION SUBSTRATE  
      "the substance acted upon by an enzyme or ferment")  
    (HAS-I-TOPIC SUBSTRATE |Chemistry|) (WORD SUBSTRATE |substrate|)))  
(DEFCONCEPT WORLD (?SELF)  
  :=> (QUALITATIVE-ROLE ?SELF)  
  :AXIOMS (AND (SUBJECT WORLD OBJECTS)  
    (DOCUMENTATION WORLD  
      "a part of the earth that can be considered separately; 'the outdoor world'; 'the world of insects'")  
    (HAS-I-TOPIC WORLD |Earth|) (WORD WORLD |world|)))  
(DEFCONCEPT ATOM (?SELF)  
  :=> (CHEMICAL-OBJECT ?SELF)  
  :AXIOMS (AND (SUBJECT ATOM SUBSTANCES)  
    (DOCUMENTATION ATOM  
      "(physics and chemistry) the smallest component of an element having the chemical  
      properties of the element")  
    (HAS-I-TOPIC ATOM |Chemistry|) (HAS-I-TOPIC ATOM |Physics|)  
    (WORD ATOM |atom|)))  
(DEFCONCEPT ANTIQUITY_1 (?SELF)  
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)  
  :AXIOMS (AND (SUBJECT ANTIQUITY_1 ARTIFACTS)  
    (DOCUMENTATION ANTIQUITY_1 "an artifact surviving from the past")  
    (HAS-I-TOPIC ANTIQUITY_1 |Archaeology|)  
    (WORD ANTIQUITY_1 |antiquity|)))  
(DEFCONCEPT GRAVE$TOMB (?SELF)  
  :=> (NON-PHYSICAL-PLACE ?SELF)  
  :AXIOMS (AND (SUBJECT GRAVE$TOMB ARTIFACTS)  
    (DOCUMENTATION GRAVE$TOMB  
      "a place for the burial of a corpse (especially beneath the ground and marked by a tombstone);  
      'he put flowers on his mother's grave'")  
    (HAS-I-TOPIC GRAVE$TOMB |Archaeology|)  
    (HAS-I-TOPIC GRAVE$TOMB |Religion|) (WORD GRAVE$TOMB |grave|)  
    (WORD GRAVE$TOMB |tomb|)))  
(DEFCONCEPT SUBJECT$CONTENT$DEPICTED_OBJECT (?SELF)  
  :=> (FUNCTIONAL-ROLE ?SELF)  
  :AXIOMS (AND (SUBJECT SUBJECT$CONTENT$DEPICTED_OBJECT ARTIFACTS)  
    (DOCUMENTATION SUBJECT$CONTENT$DEPICTED_OBJECT  
      "something (a person or object or scene) selected by an artist or photographer for graphic  
      representation; 'a moving picture of a train is more dramatic than a still picture of the same subject'")  
    (HAS-I-TOPIC SUBJECT$CONTENT$DEPICTED_OBJECT |Photography|)  
    (WORD SUBJECT$CONTENT$DEPICTED_OBJECT |subject|)  
    (WORD SUBJECT$CONTENT$DEPICTED_OBJECT |content|)  
    (WORD SUBJECT$CONTENT$DEPICTED_OBJECT |depicted object|)))
```

```
(DEFCONCEPT EXPRESSIVE_STYLE$STYLE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT EXPRESSIVE_STYLE$STYLE COMMUNICATION)
(DOCUMENTATION EXPRESSIVE_STYLE$STYLE
"a way of expressing something (in language or art or music etc.) that is characteristic of a
particular person or group of people or period; 'all the reporters were expected to adopt the
style of the newspaper'")
(HAS-I-TOPIC EXPRESSIVE_STYLE$STYLE |Art|)
(HAS-I-TOPIC EXPRESSIVE_STYLE$STYLE |Linguistics|)
(WORD EXPRESSIVE_STYLE$STYLE |expressive style|)
(WORD EXPRESSIVE_STYLE$STYLE |style|)))

(DEFCONCEPT SHOW_2 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT SHOW_2 COMMUNICATION)
(DOCUMENTATION SHOW_2
"a public exhibition or entertainment; 'they wanted to see some of the shows on Broadway'")
(HAS-I-TOPIC SHOW_2 |Art|) (HAS-I-TOPIC SHOW_2 |Telecommunication|)
(WORD SHOW_2 |show|)))

(DEFCONCEPT ART_COLLECTION (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT ART_COLLECTION GROUPS)
(DOCUMENTATION ART_COLLECTION "a collection of art works")
(HAS-I-TOPIC ART_COLLECTION |Art|)
(WORD ART_COLLECTION |art collection|)))

(DEFCONCEPT ENSEMBLE$TOUT_ENSEMBLE (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT ENSEMBLE$TOUT_ENSEMBLE GROUPS)
(DOCUMENTATION ENSEMBLE$TOUT_ENSEMBLE
"an assemblage of parts or details (as in a work of art) considered as forming a whole")
(HAS-I-TOPIC ENSEMBLE$TOUT_ENSEMBLE |Art|)
(WORD ENSEMBLE$TOUT_ENSEMBLE |ensemble|)
(WORD ENSEMBLE$TOUT_ENSEMBLE |tout ensemble|)))

(DEFCONCEPT EXHIBITION$EXPOSITION$EXPO (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT EXHIBITION$EXPOSITION$EXPO GROUPS)
(DOCUMENTATION EXHIBITION$EXPOSITION$EXPO
"a collection of things (goods or works of art etc.) for public display")
(HAS-I-TOPIC EXHIBITION$EXPOSITION$EXPO |Art|)
(HAS-I-TOPIC EXHIBITION$EXPOSITION$EXPO |Tourism|)
(WORD EXHIBITION$EXPOSITION$EXPO |exhibition|)
(WORD EXHIBITION$EXPOSITION$EXPO |exposition|)
(WORD EXHIBITION$EXPOSITION$EXPO |expo|)))

(DEFCONCEPT REPERTOIRE (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT REPERTOIRE GROUPS)
(DOCUMENTATION REPERTOIRE
"a collection of works that an artist or company can perform")
(HAS-I-TOPIC REPERTOIRE |Art|) (WORD REPERTOIRE |repertoire|)))

(DEFCONCEPT DEEP_SPACE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT DEEP_SPACE LOCATIONS)
(DOCUMENTATION DEEP_SPACE
"any region in space outside the solar system")
(HAS-I-TOPIC DEEP_SPACE |Astrology|)
(HAS-I-TOPIC DEEP_SPACE |Astronomy|) (WORD DEEP_SPACE |deep_space|)))

(DEFCONCEPT INTERGALACTIC_SPACE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT INTERGALACTIC_SPACE LOCATIONS)
(DOCUMENTATION INTERGALACTIC_SPACE
"the space between galaxies; 'the Milky Way travels through intergalactic space'")
(HAS-I-TOPIC INTERGALACTIC_SPACE |Astrology|)
(HAS-I-TOPIC INTERGALACTIC_SPACE |Astronomy|)
(WORD INTERGALACTIC_SPACE |intergalactic_space|)))

(DEFCONCEPT INTERPLANETARY_SPACE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT INTERPLANETARY_SPACE LOCATIONS)
(DOCUMENTATION INTERPLANETARY_SPACE
"the part of outer space within the solar system")
```

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(HAS-I-TOPIC INTERPLANETARY_SPACE |Astrology|)
(HAS-I-TOPIC INTERPLANETARY_SPACE |Astronomy|)
(WORD INTERPLANETARY_SPACE |interplanetary_space|))
(DEFCONCEPT INTERSTELLAR_SPACE (?SELF)
  => (REGION ?SELF)
  :AXIOMS (AND (SUBJECT INTERSTELLAR_SPACE LOCATIONS)
    (DOCUMENTATION INTERSTELLAR_SPACE "the space between stars")
    (HAS-I-TOPIC INTERSTELLAR_SPACE |Astrology|)
    (HAS-I-TOPIC INTERSTELLAR_SPACE |Astronomy|)
    (WORD INTERSTELLAR_SPACE |interstellar_space|)))
(DEFCONCEPT OUTER_SPACE$SPACE (?SELF)
  => (REGION ?SELF)
  :AXIOMS (AND (SUBJECT OUTER_SPACE$SPACE LOCATIONS)
    (DOCUMENTATION OUTER_SPACE$SPACE
      "any region in space outside the Earth's atmosphere; 'the astronauts walked in space
      without a tether'")
    (HAS-I-TOPIC OUTER_SPACE$SPACE |Astrology|)
    (WORD OUTER_SPACE$SPACE |outer_space|)
    (WORD OUTER_SPACE$SPACE |space|)))
(DEFCONCEPT SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
  (?SELF)
  => (REGION ?SELF)
  :AXIOMS (AND
    (SUBJECT SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      LOCATIONS)
    (DOCUMENTATION SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      "one of 12 equal areas into which the zodiac is divided")
    (HAS-I-TOPIC SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      |Astrology|)
    (HAS-I-TOPIC SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      |Astronomy|)
    (WORD SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      |sign_of_the_zodiac|)
    (WORD SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE |sign|)
    (WORD SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      |mansion|)
    (WORD SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE |house|)
    (WORD SIGN_OF_THE_ZODIAC$SIGN$MANSION$HOUSE$PLANETARY_HOUSE
      |planetary_house|)))
(DEFCONCEPT MEDIUM_6 (?SELF)
  => (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT MEDIUM_6 SUBSTANCES)
    (DOCUMENTATION MEDIUM_6
      "a liquid with which pigment is mixed by a painter")
    (HAS-I-TOPIC MEDIUM_6 |Painting|) (WORD MEDIUM_6 |medium|)))
(DEFCONCEPT STAMP_COLLECTION (?SELF)
  => (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT STAMP_COLLECTION GROUPS)
    (DOCUMENTATION STAMP_COLLECTION "a collection of stamps")
    (HAS-I-TOPIC STAMP_COLLECTION |Philately|)
    (WORD STAMP_COLLECTION |stamp collection|)))
(DEFCONCEPT ANACHRONISM_1 (?SELF)
  => (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT ANACHRONISM_1 ARTIFACTS)
    (DOCUMENTATION ANACHRONISM_1
      "an artifact that belongs to another time")
    (HAS-I-TOPIC ANACHRONISM_1 |History|)
    (WORD ANACHRONISM_1 |anachronism|)))
(DEFCONCEPT HISTORY_2 (?SELF)
  => (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT HISTORY_2 COGNITION)
    (DOCUMENTATION HISTORY_2
      "all that is remembered of the past as preserved in writing; a body of knowledge: 'the dawn
      of recorded history'; 'from the beginning of history'")
    (HAS-I-TOPIC HISTORY_2 |History|)
    (HAS-I-TOPIC HISTORY_2 |Psychology|) (WORD HISTORY_2 |history|)))
(DEFCONCEPT VICTORIANA (?SELF)
  => (UNITARY-COLLECTION ?SELF)
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:AXIOMS (AND (SUBJECT VICTORIANA GROUPS)
  (DOCUMENTATION VICTORIANA
    "collection of materials of or characteristic of the Victorian era")
  (HAS-I-TOPIC VICTORIANA |History|) (WORD VICTORIANA |Victoriana|)))
(DEFCONCEPT LANGUAGE$LINGUISTIC_COMMUNICATION (?SELF)
  :=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT LANGUAGE$LINGUISTIC_COMMUNICATION COMMUNICATION)
  (DOCUMENTATION LANGUAGE$LINGUISTIC_COMMUNICATION
    "a systematic means of communicating by the use of sounds or conventional symbols;
    'he taught foreign languages'; 'the language introduced is standard throughout the text';
    'the speed with which a program can be executed depends on the
    language in which it is written'")
  (HAS-I-TOPIC LANGUAGE$LINGUISTIC_COMMUNICATION |Linguistics|)
  (WORD LANGUAGE$LINGUISTIC_COMMUNICATION |language|)
  (WORD LANGUAGE$LINGUISTIC_COMMUNICATION |linguistic communication|)))
(DEFCONCEPT LANGUAGE_UNIT$LINGUISTIC_UNIT (?SELF)
  :=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT LANGUAGE_UNIT$LINGUISTIC_UNIT COMMUNICATION)
  (DOCUMENTATION LANGUAGE_UNIT$LINGUISTIC_UNIT
    "one of the natural units into which linguistic messages can be analyzed")
  (HAS-I-TOPIC LANGUAGE_UNIT$LINGUISTIC_UNIT |Linguistics|)
  (WORD LANGUAGE_UNIT$LINGUISTIC_UNIT |language unit|)
  (WORD LANGUAGE_UNIT$LINGUISTIC_UNIT |linguistic unit|)))
(DEFCONCEPT PHYLUM_2 (?SELF)
  :=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT PHYLUM_2 GROUPS)
  (DOCUMENTATION PHYLUM_2
    "(linguistics) a large group of languages that are historically related")
  (HAS-I-TOPIC PHYLUM_2 |Linguistics|) (WORD PHYLUM_2 |phylum|)))
(DEFCONCEPT SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE (?SELF)
  :=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE COGNITION)
  (DOCUMENTATION SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE
    "the grammatical arrangement of words in sentences")
  (HAS-I-TOPIC SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE |Grammar|)
  (WORD SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE |syntax|)
  (WORD SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE
    |sentence structure|)
  (WORD SYNTAX$SENTENCE_STRUCTURE$PHRASE_STRUCTURE |phrase structure|)))
(DEFCONCEPT LEXIS (?SELF)
  :=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT LEXIS COGNITION)
  (DOCUMENTATION LEXIS
    "all of the words in a language; all word forms having meaning or grammatical function")
  (HAS-I-TOPIC LEXIS |Linguistics|) (WORD LEXIS |lexis|)))
(DEFCONCEPT LINGUISTIC_RELATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT LINGUISTIC_RELATION RELATIONS)
  (DOCUMENTATION LINGUISTIC_RELATION
    "a relation between linguistic forms or constituents")
  (HAS-I-TOPIC LINGUISTIC_RELATION |Linguistics|)
  (WORD LINGUISTIC_RELATION |linguistic relation|)))
(DEFCONCEPT PARALANGUAGE$PARALINGUISTIC_COMMUNICATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND
  (SUBJECT PARALANGUAGE$PARALINGUISTIC_COMMUNICATION COMMUNICATION)
  (DOCUMENTATION PARALANGUAGE$PARALINGUISTIC_COMMUNICATION
    "the use of manner of speaking to communicate particular meanings")
  (HAS-I-TOPIC PARALANGUAGE$PARALINGUISTIC_COMMUNICATION
    |Linguistics|)
  (HAS-I-TOPIC PARALANGUAGE$PARALINGUISTIC_COMMUNICATION
    |Telecommunication|)
  (WORD PARALANGUAGE$PARALINGUISTIC_COMMUNICATION |paralanguage|)
  (WORD PARALANGUAGE$PARALINGUISTIC_COMMUNICATION
    |paralinguistic communication|)))
(DEFCONCEPT RULE$LINGUISTIC_RULE (?SELF)
  :=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT RULE$LINGUISTIC_RULE COMMUNICATION)

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(DOCUMENTATION RULE$LINGUISTIC_RULE
  "a rule describing (or prescribing) a linguistic practice")
(HAS-I-TOPIC RULE$LINGUISTIC_RULE |Linguistics|)
(WORD RULE$LINGUISTIC_RULE |rule|)
(WORD RULE$LINGUISTIC_RULE |linguistic rule|))
(DEFCONCEPT VOCABULARY$LEXICON$MENTAL_LEXICON (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT VOCABULARY$LEXICON$MENTAL_LEXICON COGNITION)
    (DOCUMENTATION VOCABULARY$LEXICON$MENTAL_LEXICON
      "a language user's knowledge of words")
    (HAS-I-TOPIC VOCABULARY$LEXICON$MENTAL_LEXICON |Linguistics|)
    (WORD VOCABULARY$LEXICON$MENTAL_LEXICON |vocabulary|)
    (WORD VOCABULARY$LEXICON$MENTAL_LEXICON |lexicon|)
    (WORD VOCABULARY$LEXICON$MENTAL_LEXICON |mental lexicon|)))
(DEFCONCEPT IMAGINARY_PLACE (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT IMAGINARY_PLACE LOCATIONS)
    (DOCUMENTATION IMAGINARY_PLACE
      "a place said to exist in religious or fictional writings")
    (HAS-I-TOPIC IMAGINARY_PLACE |Literature|)
    (HAS-I-TOPIC IMAGINARY_PLACE |Mythology|)
    (WORD IMAGINARY_PLACE |imaginary_place|)))
(DEFCONCEPT THEME$MOTIF (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT THEME$MOTIF COGNITION)
    (DOCUMENTATION THEME$MOTIF
      "a unifying idea that is a recurrent element in a literary or artistic work;
      'it was the usual 'boy gets girl' theme'")
    (HAS-I-TOPIC THEME$MOTIF |Literature|) (WORD THEME$MOTIF |theme|)
    (WORD THEME$MOTIF |motif|)))
(DEFCONCEPT JUDAICA (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT JUDAICA GROUPS)
    (DOCUMENTATION JUDAICA
      "historical and literary materials relating to Judaism")
    (HAS-I-TOPIC JUDAICA |Literature|) (WORD JUDAICA |Judaica|)))
(DEFCONCEPT LIBRARY_3 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT LIBRARY_3 GROUPS)
    (DOCUMENTATION LIBRARY_3
      "a collection of literary documents or records kept for reference or borrowing")
    (HAS-I-TOPIC LIBRARY_3 |Literature|) (WORD LIBRARY_3 |library|)))
(DEFCONCEPT ANTECEDENT_2 (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ANTECEDENT_2 EVENTS)
    (DOCUMENTATION ANTECEDENT_2
      "a preceding occurrence or cause or event")
    (HAS-I-TOPIC ANTECEDENT_2 |Philosophy|)
    (WORD ANTECEDENT_2 |antecedent|)))
(DEFCONCEPT ELEMENT_4 (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT ELEMENT_4 SUBSTANCES)
    (DOCUMENTATION ELEMENT_4
      "one of four substances thought in ancient and medieval cosmology to constitute
      the physical universe; 'the alchemists believed that there were four elements'")
    (HAS-I-TOPIC ELEMENT_4 |Philosophy|) (WORD ELEMENT_4 |element|)))
(DEFCONCEPT ABSOLUTE (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ABSOLUTE COGNITION)
    (DOCUMENTATION ABSOLUTE
      "something that is conceived to be absolute; something that does not depends on anything
      else and is beyond human control; 'no mortal being can influence the absolute'")
    (HAS-I-TOPIC ABSOLUTE |Philosophy|) (WORD ABSOLUTE |absolute|)))
(DEFCONCEPT LOGICAL_RELATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT LOGICAL_RELATION RELATIONS)
    (DOCUMENTATION LOGICAL_RELATION
      "a relation between logical propositions")

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        (HAS-I-TOPIC LOGICAL_RELATION |Mathematics|)
        (HAS-I-TOPIC LOGICAL_RELATION |Philosophy|)
        (WORD LOGICAL_RELATION |logical_relation|))
(DEFCONCEPT COIN_COLLECTION_2 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT COIN_COLLECTION_2 GROUPS)
    (DOCUMENTATION COIN_COLLECTION_2 "a collection of coins")
    (HAS-I-TOPIC COIN_COLLECTION_2 |Numismatics|)
    (WORD COIN_COLLECTION_2 |coin collection|)))
(DEFCONCEPT PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT (?SELF)
  :=> (COGNITIVE-EVENT ?SELF)
  :AXIOMS (AND
    (SUBJECT PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      COGNITION)
    (DOCUMENTATION
      PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      "the performance of some composite cognitive activity; an operation that affects mental contents;
        'the process of thinking'; 'the act of remembering'")
    (HAS-I-TOPIC
      PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |Psychology|)
    (WORD PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |process|)
    (WORD PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |cognitive process|)
    (WORD PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |operation|)
    (WORD PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |cognitive operation|)
    (WORD PROCESS$COGNITIVE_PROCESS$OPERATION$COGNITIVE_OPERATION$ACT
      |act|)))
(DEFCONCEPT PROCESS$UNCONSCIOUS_PROCESS (?SELF)
  :=> (COGNITIVE-EVENT ?SELF)
  :AXIOMS (AND (SUBJECT PROCESS$UNCONSCIOUS_PROCESS COGNITION)
    (DOCUMENTATION PROCESS$UNCONSCIOUS_PROCESS
      "a mental process that you are not directly aware of; 'the process of denial'")
    (HAS-I-TOPIC PROCESS$UNCONSCIOUS_PROCESS |Psychology|)
    (WORD PROCESS$UNCONSCIOUS_PROCESS |process|)
    (WORD PROCESS$UNCONSCIOUS_PROCESS |unconscious process|)))
(DEFCONCEPT BEHAVIOR$BEHAVIOUR$CONDUCT (?SELF)
  :=> (COURSE ?SELF)
  :AXIOMS (AND (SUBJECT BEHAVIOR$BEHAVIOUR$CONDUCT ACTS)
    (DOCUMENTATION BEHAVIOR$BEHAVIOUR$CONDUCT
      "manner of acting or conducting oneself")
    (HAS-I-TOPIC BEHAVIOR$BEHAVIOUR$CONDUCT |Psychology|)
    (WORD BEHAVIOR$BEHAVIOUR$CONDUCT |behavior|)
    (WORD BEHAVIOR$BEHAVIOUR$CONDUCT |behaviour|)
    (WORD BEHAVIOR$BEHAVIOUR$CONDUCT |conduct|)))
(DEFCONCEPT BEHAVIOR$BEHAVIOUR_1 (?SELF)
  :=> (COURSE ?SELF)
  :AXIOMS (AND (SUBJECT BEHAVIOR$BEHAVIOUR_1 ACTS)
    (DOCUMENTATION BEHAVIOR$BEHAVIOUR_1
      "(psychology) the aggregate of the responses or reactions or movements made
        by an organism in any situation")
    (HAS-I-TOPIC BEHAVIOR$BEHAVIOUR_1 |Psychology|)
    (WORD BEHAVIOR$BEHAVIOUR_1 |behavior|)
    (WORD BEHAVIOR$BEHAVIOUR_1 |behaviour|)))
(DEFCONCEPT COGNITIVE_FACTOR (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT COGNITIVE_FACTOR COGNITION)
    (DOCUMENTATION COGNITIVE_FACTOR
      "something immaterial (as a circumstance or influence) that contributes to producing a result")
    (HAS-I-TOPIC COGNITIVE_FACTOR |Psychology|)
    (WORD COGNITIVE_FACTOR |cognitive factor|)))
(DEFCONCEPT VOICE_4 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT VOICE_4 COMMUNICATION)
    (DOCUMENTATION VOICE_4

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"something suggestive of speech in being a medium of expression;
'the wee small voice of conscience'; 'the voice of experience'; 'he said his voices told him to do it'"
(HAS-I-TOPIC VOICE_4 |Psychology|) (WORD VOICE_4 |voice|))
(DEFCONCEPT CLIMATE$MOOD (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT CLIMATE$MOOD STATES)
(DOCUMENTATION CLIMATE$MOOD
"the prevailing psychological state; 'the climate of opinion';
'the national mood had changed radically since the last election'")
(HAS-I-TOPIC CLIMATE$MOOD |Psychology|)
(WORD CLIMATE$MOOD |climate|) (WORD CLIMATE$MOOD |mood|)))
(DEFCONCEPT ATTITUDE$MENTAL_ATTITUDE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT ATTITUDE$MENTAL_ATTITUDE COGNITION)
(DOCUMENTATION ATTITUDE$MENTAL_ATTITUDE
"a complex mental orientation involving beliefs and feelings and values and dispositions
to act in certain ways; 'he had the attitude that work was fun'")
(HAS-I-TOPIC ATTITUDE$MENTAL_ATTITUDE |Psychology|)
(WORD ATTITUDE$MENTAL_ATTITUDE |attitude|)
(WORD ATTITUDE$MENTAL_ATTITUDE |mental attitude|)))
(DEFCONCEPT CHEMISTRY$INTERPERSONAL_CHEMISTRY (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT CHEMISTRY$INTERPERSONAL_CHEMISTRY RELATIONS)
(DOCUMENTATION CHEMISTRY$INTERPERSONAL_CHEMISTRY
"the way two individuals relate to each other; 'their chemistry was wrong from the beginning
-- they hated each other'")
(HAS-I-TOPIC CHEMISTRY$INTERPERSONAL_CHEMISTRY |Psychology|)
(WORD CHEMISTRY$INTERPERSONAL_CHEMISTRY |chemistry|)
(WORD CHEMISTRY$INTERPERSONAL_CHEMISTRY |interpersonal_chemistry|)))
(DEFCONCEPT MIND$HEAD$BRAIN$PSYCHE$NOUS (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT MIND$HEAD$BRAIN$PSYCHE$NOUS COGNITION)
(DOCUMENTATION MIND$HEAD$BRAIN$PSYCHE$NOUS
"that which is responsible for one's thoughts and feelings; the seat of the faculty of reason;
'his mind wandered'; 'I couldn't get his words out of my head'")
(HAS-I-TOPIC MIND$HEAD$BRAIN$PSYCHE$NOUS |Psychology|)
(WORD MIND$HEAD$BRAIN$PSYCHE$NOUS |mind|)
(WORD MIND$HEAD$BRAIN$PSYCHE$NOUS |head|)
(WORD MIND$HEAD$BRAIN$PSYCHE$NOUS |brain|)
(WORD MIND$HEAD$BRAIN$PSYCHE$NOUS |psyche|)
(WORD MIND$HEAD$BRAIN$PSYCHE$NOUS |nous|)))
(DEFCONCEPT PERCEPTION_2 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT PERCEPTION_2 COGNITION)
(DOCUMENTATION PERCEPTION_2
"knowledge gained by perceiving; 'a man admired for the depth of his perception'")
(HAS-I-TOPIC PERCEPTION_2 |Psychology|)
(WORD PERCEPTION_2 |perception|)))
(DEFCONCEPT COGNITIVE_STATE$STATE_OF_MIND (?SELF)
:=> (COGNITIVE-STATE ?SELF)
:AXIOMS (AND (SUBJECT COGNITIVE_STATE$STATE_OF_MIND COGNITION)
(DOCUMENTATION COGNITIVE_STATE$STATE_OF_MIND
"the state of a person's cognitive processes")
(HAS-I-TOPIC COGNITIVE_STATE$STATE_OF_MIND |Psychology|)
(WORD COGNITIVE_STATE$STATE_OF_MIND |cognitive state|)
(WORD COGNITIVE_STATE$STATE_OF_MIND |state of mind|)))
(DEFCONCEPT PSYCHOLOGICAL_STATE$MENTAL_STATE (?SELF)
:=> (STATE ?SELF)
:AXIOMS (AND (SUBJECT PSYCHOLOGICAL_STATE$MENTAL_STATE STATES)
(DOCUMENTATION PSYCHOLOGICAL_STATE$MENTAL_STATE
"a mental condition in which the qualities of a state are relatively constant even though
the state itself may be dynamic; 'a manic state'")
(HAS-I-TOPIC PSYCHOLOGICAL_STATE$MENTAL_STATE |Psychology|)
(WORD PSYCHOLOGICAL_STATE$MENTAL_STATE |psychological_state|)
(WORD PSYCHOLOGICAL_STATE$MENTAL_STATE |mental_state|)))
(DEFCONCEPT CONGREGATION$FOLD$FAITHFUL (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT CONGREGATION$FOLD$FAITHFUL GROUPS)

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(DOCUMENTATION CONGREGATION$FOLD$FAITHFUL
"a group of people who adhere to a common faith and habitually attend a given church")
(HAS-I-TOPIC CONGREGATION$FOLD$FAITHFUL |Religion|)
(WORD CONGREGATION$FOLD$FAITHFUL |congregation|)
(WORD CONGREGATION$FOLD$FAITHFUL |fold|)
(WORD CONGREGATION$FOLD$FAITHFUL |faithful|))
(DEFCONCEPT SAINTHOOD (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT SAINTHOOD GROUPS)
(DOCUMENTATION SAINTHOOD "saints collectively")
(HAS-I-TOPIC SAINTHOOD |Religion|) (WORD SAINTHOOD |sainthood|)))
(DEFCONCEPT WISE_MEN$MAGI (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT WISE_MEN$MAGI GROUPS)
(DOCUMENTATION WISE_MEN$MAGI
"(New Testament) the sages who visited Jesus and Mary and Joseph shortly after Jesus was born;
according to the Gospel of Matthew they were guided by a star and brought gifts of gold
and frankincense and myrrh; because there were three gifts it is usually
assumed that there were three of them")
(HAS-I-TOPIC WISE_MEN$MAGI |Religion|)
(WORD WISE_MEN$MAGI |Wise_Men|) (WORD WISE_MEN$MAGI |Magi|)))
(DEFCONCEPT DESTINY$FATE_2 (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT DESTINY$FATE_2 PERSONS)
(DOCUMENTATION DESTINY$FATE_2
"the ultimate agency that predetermines the course of events (often personified as a woman);
'we are helpless in the face of Destiny'"
(HAS-I-TOPIC DESTINY$FATE_2 |Religion|)
(WORD DESTINY$FATE_2 |Destiny|) (WORD DESTINY$FATE_2 |Fate|)))
(DEFCONCEPT FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE PERSONS)
(DOCUMENTATION FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE
"a self-caused agent that is the cause of all things; 'God is the first cause'"
(HAS-I-TOPIC FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE |Religion|)
(WORD FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE |first_cause|)
(WORD FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE |prime_mover|)
(WORD FIRST_CAUSE$PRIME_MOVER$PRIMUM_MOBILE |primum_mobile|)))
(DEFCONCEPT SUPERNATURAL$OCCULT (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT SUPERNATURAL$OCCULT PERSONS)
(DOCUMENTATION SUPERNATURAL$OCCULT
"supernatural forces and events and beings collectively;
'She doesn't believe in the supernatural'"
(HAS-I-TOPIC SUPERNATURAL$OCCULT |Religion|)
(WORD SUPERNATURAL$OCCULT |supernatural|)
(WORD SUPERNATURAL$OCCULT |occult|)))
(DEFCONCEPT PHILOSOPHER_S_STONE (?SELF)
:=> (AMOUNT-OF-MATTER ?SELF)
:AXIOMS (AND (SUBJECT PHILOSOPHER_S_STONE SUBSTANCES)
(DOCUMENTATION PHILOSOPHER_S_STONE
"a hypothetical substance that the alchemists believed to be capable of
changing other metals into gold")
(HAS-I-TOPIC PHILOSOPHER_S_STONE |Mythology|)
(WORD PHILOSOPHER_S_STONE |philosopher's_stone|)))
(DEFCONCEPT FALL_3 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT FALL_3 EVENTS)
(DOCUMENTATION FALL_3
"the lapse of mankind into sinfulness because of the sin of Adam and Eve;
'women have been blamed ever since the Fall'"
(HAS-I-TOPIC FALL_3 |Religion|) (WORD FALL_3 |Fall|)))
(DEFCONCEPT MIRACLE_1 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT MIRACLE_1 EVENTS)
(DOCUMENTATION MIRACLE_1
"a marvellous event manifesting a supernatural act of God")
(HAS-I-TOPIC MIRACLE_1 |Religion|) (WORD MIRACLE_1 |miracle|)))
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(DEFCONCEPT HOLY_PLACE$SANCTUM$HOLY (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HOLY_PLACE$SANCTUM$HOLY LOCATIONS)
(DOCUMENTATION HOLY_PLACE$SANCTUM$HOLY
"a sacred place of pilgrimage")
(HAS-I-TOPIC HOLY_PLACE$SANCTUM$HOLY |Religion|)
(WORD HOLY_PLACE$SANCTUM$HOLY |holy_place|)
(WORD HOLY_PLACE$SANCTUM$HOLY |sanctum|)
(WORD HOLY_PLACE$SANCTUM$HOLY |holy|)))

(DEFCONCEPT OMNIPOTENCE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT OMNIPOTENCE STATES)
(DOCUMENTATION OMNIPOTENCE
"the state of being omnipotent; having unlimited power")
(HAS-I-TOPIC OMNIPOTENCE |Religion|)
(WORD OMNIPOTENCE |omnipotence|)))

(DEFCONCEPT OMNISCIENCE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT OMNISCIENCE STATES)
(DOCUMENTATION OMNISCIENCE
"the state of being omniscient; having infinite knowledge")
(HAS-I-TOPIC OMNISCIENCE |Religion|)
(WORD OMNISCIENCE |omniscience|)))

(DEFCONCEPT PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND
(SUBJECT
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
COMMUNICATION)
(DOCUMENTATION
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
"communication by paranormal means")
(HAS-I-TOPIC
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
|Occultism|)
(WORD
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
|psychic communication|)
(WORD
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
|psychical communication|)
(WORD
PSYCHIC_COMMUNICATION$PSYCHICAL_COMMUNICATION$
ANOMALOUS_COMMUNICATION
|anomalous communication|)))

(DEFCONCEPT WORKS$DEEDS (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT WORKS$DEEDS ACTS)
(DOCUMENTATION WORKS$DEEDS
"performance of moral or religious acts; 'salvation by deeds' or 'the reward for good works'")
(HAS-I-TOPIC WORKS$DEEDS |Religion|) (WORD WORKS$DEEDS |works|)
(WORD WORKS$DEEDS |deeds|)))

(DEFCONCEPT SPIRITUAL_BEING$SUPERNATURAL_BEING (?SELF)
:=> (SOCIALLY-CONSTRUCTED-PERSON ?SELF)
:AXIOMS (AND (SUBJECT SPIRITUAL_BEING$SUPERNATURAL_BEING PERSONS)
(DOCUMENTATION SPIRITUAL_BEING$SUPERNATURAL_BEING
"an incorporeal being with powers to affect the course of human events")
(HAS-I-TOPIC SPIRITUAL_BEING$SUPERNATURAL_BEING |Religion|)
(WORD SPIRITUAL_BEING$SUPERNATURAL_BEING |spiritual_being|)
(WORD SPIRITUAL_BEING$SUPERNATURAL_BEING |supernatural_being|)))

(DEFCONCEPT DAMNATION$ETERNAL_DAMNATION (?SELF)
:=> (STATE ?SELF)
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:AXIOMS (AND (SUBJECT DAMNATION$ETERNAL_DAMNATION STATES)
  (DOCUMENTATION DAMNATION$ETERNAL_DAMNATION
    "the state of being condemned to eternal punishment in Hell")
  (HAS-I-TOPIC DAMNATION$ETERNAL_DAMNATION |Religion|)
  (WORD DAMNATION$ETERNAL_DAMNATION |damnation|)
  (WORD DAMNATION$ETERNAL_DAMNATION |eternal_damnation|)))
(DEFCONCEPT GRACE$STATE_OF_GRACE (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT GRACE$STATE_OF_GRACE STATES)
    (DOCUMENTATION GRACE$STATE_OF_GRACE
      "a state of sanctification by God")
    (HAS-I-TOPIC GRACE$STATE_OF_GRACE |Religion|)
    (WORD GRACE$STATE_OF_GRACE |grace|)
    (WORD GRACE$STATE_OF_GRACE |state_of_grace|)))
(DEFCONCEPT MYTHOLOGY_2 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT MYTHOLOGY_2 GROUPS)
    (DOCUMENTATION MYTHOLOGY_2
      "myths collectively; the body of stories associated with a culture or institution or person")
    (HAS-I-TOPIC MYTHOLOGY_2 |Mythology|) (WORD MYTHOLOGY_2 |mythology|)))
(DEFCONCEPT RATE_2 (?SELF)
  :=> (PHYSICAL-REGION ?SELF)
  :AXIOMS (AND (SUBJECT RATE_2 TIME)
    (DOCUMENTATION RATE_2
      "a magnitude or frequency relative to a time unit; 'they traveled at a rate of 55 miles per hour';
      'the rate of change was faster than expected'")
    (HAS-I-TOPIC RATE_2 |Metrology|) (WORD RATE_2 |rate|)))
(DEFCONCEPT MEASURE$QUANTITY$AMOUNT$QUANTUM (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT MEASURE$QUANTITY$AMOUNT$QUANTUM TOPS)
    (DOCUMENTATION MEASURE$QUANTITY$AMOUNT$QUANTUM
      "how much there is of something that you can measure")
    (HAS-I-TOPIC MEASURE$QUANTITY$AMOUNT$QUANTUM |Metrology|)
    (WORD MEASURE$QUANTITY$AMOUNT$QUANTUM |measure|)
    (WORD MEASURE$QUANTITY$AMOUNT$QUANTUM |quantity|)
    (WORD MEASURE$QUANTITY$AMOUNT$QUANTUM |amount|)
    (WORD MEASURE$QUANTITY$AMOUNT$QUANTUM |quantum|)))
(DEFCONCEPT RATIO_WN (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT RATIO_WN RELATIONS)
    (DOCUMENTATION RATIO_WN
      "the relative magnitudes of two quantities (usually expressed as a quotient)")
    (HAS-I-TOPIC RATIO_WN |Metrology|) (WORD RATIO_WN |ratio|)))
(DEFCONCEPT SCALE_3 (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT SCALE_3 RELATIONS)
    (DOCUMENTATION SCALE_3
      "relative magnitude; 'they entertained on a grand scale'")
    (HAS-I-TOPIC SCALE_3 |Metrology|) (WORD SCALE_3 |scale|)))
(DEFCONCEPT TEMPORAL_RELATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT TEMPORAL_RELATION RELATIONS)
    (DOCUMENTATION TEMPORAL_RELATION "a relation involving time")
    (HAS-I-TOPIC TEMPORAL_RELATION |Metrology|)
    (WORD TEMPORAL_RELATION |temporal_relation|)))
(DEFCONCEPT HUNK$LUMP (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT HUNK$LUMP OBJECTS)
    (DOCUMENTATION HUNK$LUMP
      "a large piece of something without definite shape; 'a hunk of bread' or 'a lump of coal'")
    (HAS-I-TOPIC HUNK$LUMP |Metrology|) (WORD HUNK$LUMP |hunk|)
    (WORD HUNK$LUMP |lump|)))
(DEFCONCEPT PEOPLE_1 (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT PEOPLE_1 GROUPS)
    (DOCUMENTATION PEOPLE_1
      "(plural) any group of human beings (men or women or children) collectively; 'old people';
      'there were at least 200 people in the audience'")
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        (HAS-I-TOPIC PEOPLE_1 |Person|) (WORD PEOPLE_1 |people|)))
(DEFCONCEPT OPERATOR$MANIPULATOR (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT OPERATOR$MANIPULATOR PERSONS)
(DOCUMENTATION OPERATOR$MANIPULATOR
"an agent that operates some apparatus or machine; 'the operator of the switchboard'")
(HAS-I-TOPIC OPERATOR$MANIPULATOR |Person|)
(WORD OPERATOR$MANIPULATOR |operator|)
(WORD OPERATOR$MANIPULATOR |manipulator|)))
(DEFCONCEPT PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL (?SELF)
:=> (SOCIALLY-CONSTRUCTED-PERSON ?SELF)
:AXIOMS (AND
(SUBJECT PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL TOPS)
(DOCUMENTATION PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
"a human being; 'there was too much for one person to do'")
(HAS-I-TOPIC PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
|Biology|)
(HAS-I-TOPIC PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
|Person|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL |person|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
|individual|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
|someone|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL
|somebody|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL |mortal|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL |human|)
(WORD PERSON$INDIVIDUAL$SOMEONE$SOMEBODY$MORTAL$HUMAN$SOUL |soul|)))
(DEFCONCEPT TIME_1 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT TIME_1 TOPS)
(DOCUMENTATION TIME_1
"the continuum of experience in which events pass from the future through the present to the past")
(HAS-I-TOPIC TIME_1 |Time_Period|) (WORD TIME_1 |time|)))
(DEFCONCEPT GOAL$END (?SELF)
:=> (GOAL ?SELF)
:AXIOMS (AND (SUBJECT GOAL$END COGNITION)
(DOCUMENTATION GOAL$END
"the state of affairs that a plan is intended to achieve and that (when achieved)
terminates behavior intended to achieve it; 'the ends justify the means'")
(HAS-I-TOPIC GOAL$END |Factotum|) (WORD GOAL$END |goal|)
(WORD GOAL$END |end|)))
(DEFCONCEPT PLAN$PROGRAM$PROGRAMME (?SELF)
:=> (PLAN ?SELF)
:AXIOMS (AND (SUBJECT PLAN$PROGRAM$PROGRAMME COGNITION)
(DOCUMENTATION PLAN$PROGRAM$PROGRAMME
"a series of steps to be carried out or goals to be accomplished; 'they drew up a six-step plan';
'they discussed plans for a new bond issue'")
(HAS-I-TOPIC PLAN$PROGRAM$PROGRAMME |Factotum|)
(WORD PLAN$PROGRAM$PROGRAMME |plan|)
(WORD PLAN$PROGRAM$PROGRAMME |program|)
(WORD PLAN$PROGRAM$PROGRAMME |programme|)))
(DEFCONCEPT QUALITY$CHARACTER$LINEAMENT (?SELF)
:=> (ABSTRACT-REGION ?SELF)
:AXIOMS (AND (SUBJECT QUALITY$CHARACTER$LINEAMENT COGNITION)
(DOCUMENTATION QUALITY$CHARACTER$LINEAMENT
"a characteristic property that defines the apparent individual nature of something;
'each town has a quality all its own'; 'the radical character of our demands'")
(HAS-I-TOPIC QUALITY$CHARACTER$LINEAMENT |Factotum|)
(WORD QUALITY$CHARACTER$LINEAMENT |quality|)
(WORD QUALITY$CHARACTER$LINEAMENT |character|)
(WORD QUALITY$CHARACTER$LINEAMENT |lineament|)))
(DEFCONCEPT CONGREGATION (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT CONGREGATION GROUPS)
(DOCUMENTATION CONGREGATION
"an assemblage of people or animals or things collected together;

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'a congregation of children pleaded for his autograph'; 'a great congregation of birds flew over'")
(HAS-I-TOPIC CONGREGATION |Factotum|)
(WORD CONGREGATION |congregation|)))
(DEFCONCEPT GATHERING$ASSEMBLAGE (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT GATHERING$ASSEMBLAGE GROUPS)
(DOCUMENTATION GATHERING$ASSEMBLAGE
"a group of persons together in one place")
(HAS-I-TOPIC GATHERING$ASSEMBLAGE |Factotum|)
(WORD GATHERING$ASSEMBLAGE |gathering|)
(WORD GATHERING$ASSEMBLAGE |assemblage|)))
(DEFCONCEPT PROCESSION (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT PROCESSION GROUPS)
(DOCUMENTATION PROCESSION
"a collection of things moving ahead in an orderly manner")
(HAS-I-TOPIC PROCESSION |Factotum|) (WORD PROCESSION |procession|)))
(DEFCONCEPT SET$CIRCLE$BAND$LOT (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT SET$CIRCLE$BAND$LOT GROUPS)
(DOCUMENTATION SET$CIRCLE$BAND$LOT
"an unofficial association of people or groups; 'the smart set goes there';
'they were an angry lot'")
(HAS-I-TOPIC SET$CIRCLE$BAND$LOT |Factotum|)
(WORD SET$CIRCLE$BAND$LOT |set|) (WORD SET$CIRCLE$BAND$LOT |circle|)
(WORD SET$CIRCLE$BAND$LOT |band|) (WORD SET$CIRCLE$BAND$LOT |lot|)))
(DEFCONCEPT TENANTRY (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT TENANTRY GROUPS)
(DOCUMENTATION TENANTRY
"tenants of an estate considered as a group")
(HAS-I-TOPIC TENANTRY |Factotum|) (WORD TENANTRY |tenantry|)))
(DEFCONCEPT WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$
HUMAN_BEINGS$HUMANS$MANKIND$MAN (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND
(SUBJECT
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
GROUPS)
(DOCUMENTATION
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
"all of the inhabitants of the earth; 'all the world loves a lover'")
(HAS-I-TOPIC
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|Factotum|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|world|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|human race|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|humanity|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|humankind|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|human beings|)
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(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|humans|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|mankind|)
(WORD
WORLD$HUMAN_RACE$HUMANITY$HUMANKIND$HUMAN_BEINGS$
HUMANS$MANKIND$MAN
|man|))
(DEFCONCEPT DEUS_EX_MACHINA (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT DEUS_EX_MACHINA PERSONS)
(DOCUMENTATION DEUS_EX_MACHINA
"any active agent who appears unexpectedly to solve and insoluble difficulty")
(HAS-I-TOPIC DEUS_EX_MACHINA |Factotum|)
(WORD DEUS_EX_MACHINA |deus_ex_machina|)))
(DEFCONCEPT FORCE_2 (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT FORCE_2 GROUPS)
(DOCUMENTATION FORCE_2
"a group of people having the power of effective action;
'he joined forces with a band of adventurers'")
(HAS-I-TOPIC FORCE_2 |Factotum|) (WORD FORCE_2 |force|)))
(DEFCONCEPT NATURE_3 (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT NATURE_3 PERSONS)
(DOCUMENTATION NATURE_3
"a causal agent creating and controlling things in the universe;
'nature has seen to it that men are stronger than women'")
(HAS-I-TOPIC NATURE_3 |Factotum|) (WORD NATURE_3 |nature|)))
(DEFCONCEPT POWER$FORCE (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT POWER$FORCE PERSONS)
(DOCUMENTATION POWER$FORCE
"one possessing or exercising power or influence or authority:
'the mysterious presence of an evil power'; 'may the force be with you'; 'the forces of evil'")
(HAS-I-TOPIC POWER$FORCE |Factotum|) (WORD POWER$FORCE |power|)
(WORD POWER$FORCE |force|)))
(DEFCONCEPT PRODUCER_1 (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT PRODUCER_1 EVENTS)
(DOCUMENTATION PRODUCER_1
"something that produces; 'Maine is a leading producer of potatoes' or
'this microorganism is a producer of disease'")
(HAS-I-TOPIC PRODUCER_1 |Factotum|) (WORD PRODUCER_1 |producer|)))
(DEFCONCEPT AEROSPACE (?SELF)
:=> (AMOUNT-OF-MATTER ?SELF)
:AXIOMS (AND (SUBJECT AEROSPACE LOCATIONS)
(DOCUMENTATION AEROSPACE
"the atmosphere and outer space considered as a whole")
(HAS-I-TOPIC AEROSPACE |Factotum|) (WORD AEROSPACE |aerospace|)))
(DEFCONCEPT IONOSPHERE (?SELF)
:=> (AMOUNT-OF-MATTER ?SELF)
:AXIOMS (AND (SUBJECT IONOSPHERE LOCATIONS)
(DOCUMENTATION IONOSPHERE
"the outer region of the Earth's atmosphere; contains a high concentration of free electrons")
(HAS-I-TOPIC IONOSPHERE |Factotum|) (WORD IONOSPHERE |ionosphere|)))
(DEFCONCEPT MASS_5 (?SELF)
:=> (AMOUNT-OF-MATTER ?SELF)
:AXIOMS (AND (SUBJECT MASS_5 OBJECTS)
(DOCUMENTATION MASS_5
"a large body of matter without definite shape; 'a huge ice mass'")
(HAS-I-TOPIC MASS_5 |Factotum|) (WORD MASS_5 |mass|)))
(DEFCONCEPT BACKLOG (?SELF)
:=> (ARBITRARY-SUM ?SELF)
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:AXIOMS (AND (SUBJECT BACKLOG GROUPS)
  (DOCUMENTATION BACKLOG
    "an accumulation of jobs not done or materials not processed that are yet to be dealt with;
    'a large backlog of orders'")
  (HAS-I-TOPIC BACKLOG |Factotum|) (WORD BACKLOG |backlog|)))
(DEFCONCEPT CONTENT_1 (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT CONTENT_1 GROUPS)
    (DOCUMENTATION CONTENT_1
      "everything that is included in a collection; 'he emptied the contents of his pockets';
      'the two groups were similar in content'")
    (HAS-I-TOPIC CONTENT_1 |Factotum|) (WORD CONTENT_1 |content|)))
(DEFCONCEPT DATA$INFORMATION (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT DATA$INFORMATION GROUPS)
    (DOCUMENTATION DATA$INFORMATION
      "a collection of facts from which conclusions may be drawn; 'statistical data'")
    (HAS-I-TOPIC DATA$INFORMATION |Factotum|)
    (WORD DATA$INFORMATION |data|) (WORD DATA$INFORMATION |information|)))
(DEFCONCEPT PILE$HEAP$MOUND (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT PILE$HEAP$MOUND GROUPS)
    (DOCUMENTATION PILE$HEAP$MOUND
      "a collection of objects laid on top of each other")
    (HAS-I-TOPIC PILE$HEAP$MOUND |Factotum|)
    (WORD PILE$HEAP$MOUND |pile|) (WORD PILE$HEAP$MOUND |heap|)
    (WORD PILE$HEAP$MOUND |mound|)))
(DEFCONCEPT STRAGGLE (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT STRAGGLE GROUPS)
    (DOCUMENTATION STRAGGLE
      "a wandering or disorderly grouping (of things or persons); 'a straggle of outbuildings';
      'a straggle of followers'")
    (HAS-I-TOPIC STRAGGLE |Factotum|) (WORD STRAGGLE |straggle|)))
(DEFCONCEPT SUM$SUM_TOTAL (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT SUM$SUM_TOTAL GROUPS)
    (DOCUMENTATION SUM$SUM_TOTAL
      "the final aggregate; 'the sum of all our troubles did not equal the misery they suffered'")
    (HAS-I-TOPIC SUM$SUM_TOTAL |Factotum|) (WORD SUM$SUM_TOTAL |sum|)
    (WORD SUM$SUM_TOTAL |sum total|)))
(DEFCONCEPT AGENT_1 (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT AGENT_1 OBJECTS)
    (DOCUMENTATION AGENT_1
      "an active and efficient cause; capable of producing a certain effect;
      'their research uncovered new disease agents'")
    (HAS-I-TOPIC AGENT_1 |Factotum|) (WORD AGENT_1 |agent|)))
(DEFCONCEPT CATALYST (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT CATALYST PERSONS)
    (DOCUMENTATION CATALYST
      "something that causes an important event to happen;
      'the invasion acted as a catalyst to unite the country'")
    (HAS-I-TOPIC CATALYST |Factotum|) (WORD CATALYST |catalyst|)))
(DEFCONCEPT DANGER_3 (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT DANGER_3 STATES)
    (DOCUMENTATION DANGER_3
      "a cause of pain or injury or loss; 'he feared the dangers of traveling by air'")
    (HAS-I-TOPIC DANGER_3 |Factotum|) (WORD DANGER_3 |danger|)))
(DEFCONCEPT ENGINE_2 (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ENGINE_2 PHENOMENA)
    (DOCUMENTATION ENGINE_2
      "something used to achieve a purpose: 'an engine of change'")
    (HAS-I-TOPIC ENGINE_2 |Factotum|) (WORD ENGINE_2 |engine|)))
(DEFCONCEPT ETIOLOGY$AETIOLOGY_2 (?SELF)

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:=> (CAUSAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT ETIOLOGY$AETIOLOGY_2 EVENTS)
  (DOCUMENTATION ETIOLOGY$AETIOLOGY_2 "the cause of a disease")
  (HAS-I-TOPIC ETIOLOGY$AETIOLOGY_2 |Factotum|)
  (WORD ETIOLOGY$AETIOLOGY_2 |etiology|)
  (WORD ETIOLOGY$AETIOLOGY_2 |aetiology|)))
(DEFCONCEPT FEELING_1 (?SELF)
:=> (COGNITIVE-EVENT ?SELF)
:AXIOMS (AND (SUBJECT FEELING_1 TOPS)
  (DOCUMENTATION FEELING_1
    "the psychological feature of experiencing affective and emotional states;
    'he had a feeling of euphoria'")
  (HAS-I-TOPIC FEELING_1 |Factotum|) (WORD FEELING_1 |feeling|)))
(DEFCONCEPT MOTIVATION$MOTIVE$NEED (?SELF)
:=> (COGNITIVE-EVENT ?SELF)
:AXIOMS (AND (SUBJECT MOTIVATION$MOTIVE$NEED TOPS)
  (DOCUMENTATION MOTIVATION$MOTIVE$NEED
    "the psychological feature that arouses an organism to action; the reason for the action;
    'we did not understand his motivation'; 'he acted with the best of motives'")
  (HAS-I-TOPIC MOTIVATION$MOTIVE$NEED |Factotum|)
  (WORD MOTIVATION$MOTIVE$NEED |motivation|)
  (WORD MOTIVATION$MOTIVE$NEED |motive|)
  (WORD MOTIVATION$MOTIVE$NEED |need|)))
(DEFCONCEPT ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY ACTS)
  (DOCUMENTATION ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY
    "earnest and conscientious activity intended to do or accomplish something;
    'made an effort to cover all the reading material'; 'wished him luck in his endeavor';
    'she gave it a good try'")
  (HAS-I-TOPIC ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |Factotum|)
  (WORD ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |attempt|)
  (WORD ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |effort|)
  (WORD ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |endeavor|)
  (WORD ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |endeavour|)
  (WORD ATTEMPT$EFFORT$ENDEAVOR$ENDEAVOUR$TRY |try|)))
(DEFCONCEPT CONTINUANCE$CONTINUATION (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT CONTINUANCE$CONTINUATION ACTS)
  (DOCUMENTATION CONTINUANCE$CONTINUATION
    "the act of continuing or resuming an activity")
  (HAS-I-TOPIC CONTINUANCE$CONTINUATION |Factotum|)
  (WORD CONTINUANCE$CONTINUATION |continuance|)
  (WORD CONTINUANCE$CONTINUATION |continuation|)))
(DEFCONCEPT OCCUPATION (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT OCCUPATION ACTS)
  (DOCUMENTATION OCCUPATION
    "any activity that occupies a person's attention;
    'he missed the bell in his occupation with the computer game'")
  (HAS-I-TOPIC OCCUPATION |Factotum|) (WORD OCCUPATION |occupation|)))
(DEFCONCEPT ROUTINE$MODUS_OPERANDI (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT ROUTINE$MODUS_OPERANDI ACTS)
  (DOCUMENTATION ROUTINE$MODUS_OPERANDI
    "an unvarying or habitual method of procedure")
  (HAS-I-TOPIC ROUTINE$MODUS_OPERANDI |Factotum|)
  (WORD ROUTINE$MODUS_OPERANDI |routine|)
  (WORD ROUTINE$MODUS_OPERANDI |modus operandi|)))
(DEFCONCEPT USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND
  (SUBJECT USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE ACTS)
  (DOCUMENTATION USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
    "the act of using; 'the steps were worn from years of use'")
  (HAS-I-TOPIC USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
    |Factotum|)
  (WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE |use|)

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(WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE |usage|)
(WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
 |utilization|)
(WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
 |utilisation|)
(WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
 |employment|)
(WORD USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE
 |exercise|))
(DEFCONCEPT ACCIDENT$FORTUITY$CHANCE_EVENT (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT ACCIDENT$FORTUITY$CHANCE_EVENT EVENTS)
 (DOCUMENTATION ACCIDENT$FORTUITY$CHANCE_EVENT
 "anything that happens by chance without an apparent cause")
 (HAS-I-TOPIC ACCIDENT$FORTUITY$CHANCE_EVENT |Factotum|)
 (WORD ACCIDENT$FORTUITY$CHANCE_EVENT |accident|)
 (WORD ACCIDENT$FORTUITY$CHANCE_EVENT |fortuity|)
 (WORD ACCIDENT$FORTUITY$CHANCE_EVENT |chance event|)))
(DEFCONCEPT ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE EVENTS)
 (DOCUMENTATION ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE
 "an event or situation that happens at the same time as or in connection with another")
 (HAS-I-TOPIC ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE |Factotum|)
 (WORD ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE |accompaniment|)
 (WORD ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE |concomitant|)
 (WORD ACCOMPANIMENT$CONCOMITANT$CO-OCCURRENCE |co-occurrence|)))
(DEFCONCEPT ACT$HUMAN_ACTION$HUMAN_ACTIVITY (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT ACT$HUMAN_ACTION$HUMAN_ACTIVITY TOPS)
 (DOCUMENTATION ACT$HUMAN_ACTION$HUMAN_ACTIVITY
 "something that people do or cause to happen")
 (HAS-I-TOPIC ACT$HUMAN_ACTION$HUMAN_ACTIVITY |Factotum|)
 (WORD ACT$HUMAN_ACTION$HUMAN_ACTIVITY |act|)
 (WORD ACT$HUMAN_ACTION$HUMAN_ACTIVITY |human action|)
 (WORD ACT$HUMAN_ACTION$HUMAN_ACTIVITY |human activity|)))
(DEFCONCEPT APPEARANCE_3 (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT APPEARANCE_3 EVENTS)
 (DOCUMENTATION APPEARANCE_3 "the event of coming into sight")
 (HAS-I-TOPIC APPEARANCE_3 |Factotum|)
 (WORD APPEARANCE_3 |appearance|)))
(DEFCONCEPT AVALANCHE_1 (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT AVALANCHE_1 EVENTS)
 (DOCUMENTATION AVALANCHE_1
 "a sudden appearance of an overwhelming number of things;
 'the program brought an avalanche of mail'")
 (HAS-I-TOPIC AVALANCHE_1 |Factotum|) (WORD AVALANCHE_1 |avalanche|)))
(DEFCONCEPT BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN EVENTS)
 (DOCUMENTATION BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN
 "a sudden happening that brings very good fortune")
 (HAS-I-TOPIC BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN |Factotum|)
 (WORD BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN |boom|)
 (WORD BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN |bonanza|)
 (WORD BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN |goldmine|)
 (WORD BOOM$BONANZA$GOLDMINE$MANNA_FROM_HEAVEN |manna from heaven|)))
(DEFCONCEPT CASE$INSTANCE$EXAMPLE (?SELF)
 :=> (EVENT ?SELF)
 :AXIOMS (AND (SUBJECT CASE$INSTANCE$EXAMPLE EVENTS)
 (DOCUMENTATION CASE$INSTANCE$EXAMPLE
 "an occurrence of something; 'it was a case of bad judgment';
 'another instance occurred yesterday'; 'but there is always the famous example of the Smiths'")
 (HAS-I-TOPIC CASE$INSTANCE$EXAMPLE |Factotum|)
 (WORD CASE$INSTANCE$EXAMPLE |case|)
 (WORD CASE$INSTANCE$EXAMPLE |instance|))
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(WORD CASE$INSTANCE$EXAMPLE |example|))
(DEFCONCEPT CASUS_BELLI (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CASUS_BELLI EVENTS)
(DOCUMENTATION CASUS_BELLI
"an event used to justify starting a war")
(HAS-I-TOPIC CASUS_BELLI |Factotum|)
(WORD CASUS_BELLI |casus belli|)))
(DEFCONCEPT CHANGE$ALTERATION$MODIFICATION (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CHANGE$ALTERATION$MODIFICATION EVENTS)
(DOCUMENTATION CHANGE$ALTERATION$MODIFICATION
"an event that occurs when something passes from one state or phase to another:
'the change was intended to increase sales'; 'this storm is certainly a change for the worse'")
(HAS-I-TOPIC CHANGE$ALTERATION$MODIFICATION |Factotum|)
(WORD CHANGE$ALTERATION$MODIFICATION |change|)
(WORD CHANGE$ALTERATION$MODIFICATION |alteration|)
(WORD CHANGE$ALTERATION$MODIFICATION |modification|)))
(DEFCONCEPT CONTACT$IMPINGING$STRIKING (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CONTACT$IMPINGING$STRIKING EVENTS)
(DOCUMENTATION CONTACT$IMPINGING$STRIKING
"the physical coming together of two or more things;
'contact with the pier scraped paint from the hull'")
(HAS-I-TOPIC CONTACT$IMPINGING$STRIKING |Factotum|)
(WORD CONTACT$IMPINGING$STRIKING |contact|)
(WORD CONTACT$IMPINGING$STRIKING |impinging|)
(WORD CONTACT$IMPINGING$STRIKING |striking|)))
(DEFCONCEPT CONVERGENCE (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CONVERGENCE EVENTS)
(DOCUMENTATION CONVERGENCE
"the occurrence of two or more things coming together")
(HAS-I-TOPIC CONVERGENCE |Factotum|)
(WORD CONVERGENCE |convergence|)))
(DEFCONCEPT DESTINY$FATE_1 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT DESTINY$FATE_1 EVENTS)
(DOCUMENTATION DESTINY$FATE_1
"an event (or course of events) that will inevitably happen in the future")
(HAS-I-TOPIC DESTINY$FATE_1 |Factotum|)
(WORD DESTINY$FATE_1 |destiny|) (WORD DESTINY$FATE_1 |fate|)))
(DEFCONCEPT DISAPPEARANCE (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT DISAPPEARANCE EVENTS)
(DOCUMENTATION DISAPPEARANCE "the event of passing out of sight")
(HAS-I-TOPIC DISAPPEARANCE |Factotum|)
(WORD DISAPPEARANCE |disappearance|)))
(DEFCONCEPT DISCHARGE (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT DISCHARGE EVENTS)
(DOCUMENTATION DISCHARGE "the sudden giving off of energy")
(HAS-I-TOPIC DISCHARGE |Factotum|) (WORD DISCHARGE |discharge|)))
(DEFCONCEPT EMERGENCE$EGRESS$ISSUE (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT EMERGENCE$EGRESS$ISSUE EVENTS)
(DOCUMENTATION EMERGENCE$EGRESS$ISSUE
"the becoming visible; 'not a day's difference between the emergence of the
andrenas and the opening of the willow catkins'")
(HAS-I-TOPIC EMERGENCE$EGRESS$ISSUE |Factotum|)
(WORD EMERGENCE$EGRESS$ISSUE |emergence|)
(WORD EMERGENCE$EGRESS$ISSUE |egress|)
(WORD EMERGENCE$EGRESS$ISSUE |issue|)))
(DEFCONCEPT EMERGENCE$OUTGROWTH$GROWTH (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT EMERGENCE$OUTGROWTH$GROWTH EVENTS)
(DOCUMENTATION EMERGENCE$OUTGROWTH$GROWTH
"the gradual beginning or coming forth; 'figurines presage the emergence of sculpture in Greece'"))
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        (HAS-I-TOPIC EMERGENCE$OUTGROWTH$GROWTH |Factotum|)
        (WORD EMERGENCE$OUTGROWTH$GROWTH |emergence|)
        (WORD EMERGENCE$OUTGROWTH$GROWTH |outgrowth|)
        (WORD EMERGENCE$OUTGROWTH$GROWTH |growth|))
(DEFCONCEPT ENDING$CONCLUSION (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT ENDING$CONCLUSION EVENTS)
    (DOCUMENTATION ENDING$CONCLUSION
      "an event whose occurrence ends something; 'his death marked the ending of an era'")
    (HAS-I-TOPIC ENDING$CONCLUSION |Factotum|)
    (WORD ENDING$CONCLUSION |ending|)
    (WORD ENDING$CONCLUSION |conclusion|)))
(DEFCONCEPT EPISODE_2 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT EPISODE_2 EVENTS)
    (DOCUMENTATION EPISODE_2
      "a happening that is distinctive in a series of related events")
    (HAS-I-TOPIC EPISODE_2 |Factotum|) (WORD EPISODE_2 |episode|))
(DEFCONCEPT EVENTUALITY$CONTINGENCY (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT EVENTUALITY$CONTINGENCY EVENTS)
    (DOCUMENTATION EVENTUALITY$CONTINGENCY
      "a possible event or occurrence or result")
    (HAS-I-TOPIC EVENTUALITY$CONTINGENCY |Factotum|)
    (WORD EVENTUALITY$CONTINGENCY |eventuality|)
    (WORD EVENTUALITY$CONTINGENCY |contingency|)))
(DEFCONCEPT EXPERIENCE_3 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT EXPERIENCE_3 EVENTS)
    (DOCUMENTATION EXPERIENCE_3
      "an event as apprehended; 'a surprising experience';
      'that painful experience certainly got our attention'")
    (HAS-I-TOPIC EXPERIENCE_3 |Factotum|)
    (WORD EXPERIENCE_3 |experience|))
(DEFCONCEPT FAILURE_3 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT FAILURE_3 EVENTS)
    (DOCUMENTATION FAILURE_3
      "an event that does not accomplish its intended purpose")
    (HAS-I-TOPIC FAILURE_3 |Factotum|) (WORD FAILURE_3 |failure|))
(DEFCONCEPT FIRE_2 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT FIRE_2 EVENTS)
    (DOCUMENTATION FIRE_2
      "the event of something burning (often destructive); 'they lost everything in the fire'")
    (HAS-I-TOPIC FIRE_2 |Factotum|) (WORD FIRE_2 |fire|))
(DEFCONCEPT FLASH_2 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT FLASH_2 EVENTS)
    (DOCUMENTATION FLASH_2 "a sudden intense burst of radiant energy")
    (HAS-I-TOPIC FLASH_2 |Factotum|) (WORD FLASH_2 |flash|))
(DEFCONCEPT INCIDENT_1 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT INCIDENT_1 EVENTS)
    (DOCUMENTATION INCIDENT_1 "a single distinct event")
    (HAS-I-TOPIC INCIDENT_1 |Factotum|) (WORD INCIDENT_1 |incident|))
(DEFCONCEPT INTERRUPTION$BREAK$ABRUPT_CHANGE (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT INTERRUPTION$BREAK$ABRUPT_CHANGE EVENTS)
    (DOCUMENTATION INTERRUPTION$BREAK$ABRUPT_CHANGE
      "some occurrence that interrupts; 'the telephone is an annoying interruption';
      'there was a break in the action when a player was hurt'")
    (HAS-I-TOPIC INTERRUPTION$BREAK$ABRUPT_CHANGE |Factotum|)
    (WORD INTERRUPTION$BREAK$ABRUPT_CHANGE |interruption|)
    (WORD INTERRUPTION$BREAK$ABRUPT_CHANGE |break|)
    (WORD INTERRUPTION$BREAK$ABRUPT_CHANGE |abrupt change|))
(DEFCONCEPT JUNCTURE$OCCASION (?SELF)
  :=> (EVENT ?SELF)

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:AXIOMS (AND (SUBJECT JUNCTURE$OCCASION EVENTS)
  (DOCUMENTATION JUNCTURE$OCCASION
    "an event that occurs at a critical time; 'at such junctures he always had an impulse to leave';
    'it was needed only on special occasions'")
  (HAS-I-TOPIC JUNCTURE$OCCASION |Factotum|)
  (WORD JUNCTURE$OCCASION |juncture|)
  (WORD JUNCTURE$OCCASION |occasion|)))
(DEFCONCEPT MIGHT-HAVE-BEEN (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT MIGHT-HAVE-BEEN EVENTS)
    (DOCUMENTATION MIGHT-HAVE-BEEN
      "an event that could have occurred but never did")
    (HAS-I-TOPIC MIGHT-HAVE-BEEN |Factotum|)
    (WORD MIGHT-HAVE-BEEN |might-have-been|)))
(DEFCONCEPT MIRACLE_2 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT MIRACLE_2 EVENTS)
    (DOCUMENTATION MIRACLE_2 "any amazing or wonderful occurrence")
    (HAS-I-TOPIC MIRACLE_2 |Factotum|) (WORD MIRACLE_2 |miracle|)))
(DEFCONCEPT MOVEMENT$MOTION (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT MOVEMENT$MOTION EVENTS)
    (DOCUMENTATION MOVEMENT$MOTION
      "a natural event that involves a change in the position or location of something")
    (HAS-I-TOPIC MOVEMENT$MOTION |Factotum|)
    (WORD MOVEMENT$MOTION |movement|) (WORD MOVEMENT$MOTION |motion|)))
(DEFCONCEPT NEWS_EVENT (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT NEWS_EVENT EVENTS)
    (DOCUMENTATION NEWS_EVENT "a newsworthy event")
    (HAS-I-TOPIC NEWS_EVENT |Factotum|) (WORD NEWS_EVENT |news event|)))
(DEFCONCEPT NONEVENT (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT NONEVENT EVENTS)
    (DOCUMENTATION NONEVENT
      "an anticipated event that turns out to be far less significant than was expected")
    (HAS-I-TOPIC NONEVENT |Factotum|) (WORD NONEVENT |nonevent|)))
(DEFCONCEPT OUTBREAK (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT OUTBREAK EVENTS)
    (DOCUMENTATION OUTBREAK
      "a sudden violent spontaneous occurrence of an undesirable condition")
    (HAS-I-TOPIC OUTBREAK |Factotum|) (WORD OUTBREAK |outbreak|)))
(DEFCONCEPT OUTBURST$BURST$FLARE-UP (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT OUTBURST$BURST$FLARE-UP EVENTS)
    (DOCUMENTATION OUTBURST$BURST$FLARE-UP
      "a sudden violent happening; 'an outburst of heavy rain'; 'a burst of lightning'")
    (HAS-I-TOPIC OUTBURST$BURST$FLARE-UP |Factotum|)
    (WORD OUTBURST$BURST$FLARE-UP |outburst|)
    (WORD OUTBURST$BURST$FLARE-UP |burst|)
    (WORD OUTBURST$BURST$FLARE-UP |flare-up|)))
(DEFCONCEPT PERIODIC_EVENT$RECURRENT_EVENT (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT PERIODIC_EVENT$RECURRENT_EVENT EVENTS)
    (DOCUMENTATION PERIODIC_EVENT$RECURRENT_EVENT
      "an event that recurs at intervals")
    (HAS-I-TOPIC PERIODIC_EVENT$RECURRENT_EVENT |Factotum|)
    (WORD PERIODIC_EVENT$RECURRENT_EVENT |periodic event|)
    (WORD PERIODIC_EVENT$RECURRENT_EVENT |recurrent event|)))
(DEFCONCEPT PHENOMENON_1 (?SELF)
  :=> (EVENT ?SELF)
  :AXIOMS (AND (SUBJECT PHENOMENON_1 TOPS)
    (DOCUMENTATION PHENOMENON_1
      "any state or process known through the senses rather than by intuition or reasoning")
    (HAS-I-TOPIC PHENOMENON_1 |Factotum|)
    (WORD PHENOMENON_1 |phenomenon|)))
(DEFCONCEPT PRELIMINARY$OVERTURE$PRELUDE (?SELF)
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:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT PRELIMINARY$OVERTURE$PRELUDE EVENTS)
  (DOCUMENTATION PRELIMINARY$OVERTURE$PRELUDE
    "something that serves as a preceding event or introduces what follows;
      'training is a necessary preliminary to employment'; 'drinks were the overture to dinner'")
  (HAS-I-TOPIC PRELIMINARY$OVERTURE$PRELUDE |Factotum|)
  (WORD PRELIMINARY$OVERTURE$PRELUDE |preliminary|)
  (WORD PRELIMINARY$OVERTURE$PRELUDE |overture|)
  (WORD PRELIMINARY$OVERTURE$PRELUDE |prelude|)))
(DEFCONCEPT REVERSE$REVERSAL$SETBACK$BLOW (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT REVERSE$REVERSAL$SETBACK$BLOW EVENTS)
  (DOCUMENTATION REVERSE$REVERSAL$SETBACK$BLOW
    "an unfortunate happening that hinders or impedes; something that is thwarting or frustrating")
  (HAS-I-TOPIC REVERSE$REVERSAL$SETBACK$BLOW |Factotum|)
  (WORD REVERSE$REVERSAL$SETBACK$BLOW |reverse|)
  (WORD REVERSE$REVERSAL$SETBACK$BLOW |reversal|)
  (WORD REVERSE$REVERSAL$SETBACK$BLOW |setback|)
  (WORD REVERSE$REVERSAL$SETBACK$BLOW |blow|)))
(DEFCONCEPT SOUND_2 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT SOUND_2 EVENTS)
  (DOCUMENTATION SOUND_2
    "the sudden occurrence of an audible event; 'the sound awakened them'")
  (HAS-I-TOPIC SOUND_2 |Factotum|) (WORD SOUND_2 |sound|)))
(DEFCONCEPT START (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT START EVENTS)
  (DOCUMENTATION START
    "the beginning of anything; 'it was off to a good start'")
  (HAS-I-TOPIC START |Factotum|) (WORD START |start|)))
(DEFCONCEPT SUCCESS_2 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT SUCCESS_2 EVENTS)
  (DOCUMENTATION SUCCESS_2
    "an event that accomplishes its intended purpose; 'let's call heads a success and tails a failure';
      'the election was a remarkable success for Republicans'")
  (HAS-I-TOPIC SUCCESS_2 |Factotum|) (WORD SUCCESS_2 |success|)))
(DEFCONCEPT THING_8 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT THING_8 EVENTS)
  (DOCUMENTATION THING_8
    "an event: 'a funny thing happened on the way to the...'"")
  (HAS-I-TOPIC THING_8 |Factotum|) (WORD THING_8 |thing|)))
(DEFCONCEPT TROUBLE_1 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT TROUBLE_1 EVENTS)
  (DOCUMENTATION TROUBLE_1
    "an event causing distress or pain; 'what is the trouble?'; 'heart trouble'")
  (HAS-I-TOPIC TROUBLE_1 |Factotum|) (WORD TROUBLE_1 |trouble|)))
(DEFCONCEPT UNION_2 (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT UNION_2 EVENTS)
  (DOCUMENTATION UNION_2
    "the occurrence of a uniting of separate parts; 'lightning produced an unusual union of the metals'")
  (HAS-I-TOPIC UNION_2 |Factotum|) (WORD UNION_2 |union|)))
(DEFCONCEPT WONDER$MARVEL (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT WONDER$MARVEL EVENTS)
  (DOCUMENTATION WONDER$MARVEL
    "something that causes feelings of wonder; 'the wonders of modern science'")
  (HAS-I-TOPIC WONDER$MARVEL |Factotum|) (WORD WONDER$MARVEL |wonder|)
  (WORD WONDER$MARVEL |marvel|)))
(DEFCONCEPT FEATURE$CHARACTERISTIC (?SELF)
:=> (FEATURE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT FEATURE$CHARACTERISTIC COGNITION)
  (DOCUMENTATION FEATURE$CHARACTERISTIC
    "a prominent aspect of something; 'the map showed roads and other features';
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'generosity is one of his best characteristics'")
(HAS-I-TOPIC FEATURE$CHARACTERISTIC |Factotum|)
(WORD FEATURE$CHARACTERISTIC |feature|)
(WORD FEATURE$CHARACTERISTIC |characteristic|))
(DEFCONCEPT PART$SECTION$DIVISION (?SELF)
:=> (FEATURE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT PART$SECTION$DIVISION COGNITION)
(DOCUMENTATION PART$SECTION$DIVISION
"one of the portions into which something is regarded as divided and which together
constitute a whole: 'the written part of the exam'; 'the finance section of the company';
'the BBC's engineering division'")
(HAS-I-TOPIC PART$SECTION$DIVISION |Factotum|)
(WORD PART$SECTION$DIVISION |part|)
(WORD PART$SECTION$DIVISION |section|)
(WORD PART$SECTION$DIVISION |division|)))
(DEFCONCEPT AIR_3 (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT AIR_3 LOCATIONS)
(DOCUMENTATION AIR_3
"the region above the ground; 'her hand stopped in mid air'; 'the hanged man danced on air'")
(HAS-I-TOPIC AIR_3 |Factotum|) (WORD AIR_3 |air|)))
(DEFCONCEPT BELT_3 (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT BELT_3 LOCATIONS)
(DOCUMENTATION BELT_3
"an elongated region where a specific condition is found; 'a belt of high pressure'")
(HAS-I-TOPIC BELT_3 |Factotum|) (WORD BELT_3 |belt|)))
(DEFCONCEPT BOTTOM (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT BOTTOM LOCATIONS)
(DOCUMENTATION BOTTOM
"the lowest part of anything; 'they started at the bottom of the hill'")
(HAS-I-TOPIC BOTTOM |Factotum|) (WORD BOTTOM |bottom|)))
(DEFCONCEPT BOUNDARY$EDGE$BOUND (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT BOUNDARY$EDGE$BOUND SHAPES)
(DOCUMENTATION BOUNDARY$EDGE$BOUND
"a line determining the limits of an area")
(HAS-I-TOPIC BOUNDARY$EDGE$BOUND |Factotum|)
(WORD BOUNDARY$EDGE$BOUND |boundary|)
(WORD BOUNDARY$EDGE$BOUND |edge|) (WORD BOUNDARY$EDGE$BOUND |bound|)))
(DEFCONCEPT CENTERLINE$CENTER_LINE (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT CENTERLINE$CENTER_LINE SHAPES)
(DOCUMENTATION CENTERLINE$CENTER_LINE
"a line that bisects a plane figure")
(HAS-I-TOPIC CENTERLINE$CENTER_LINE |Factotum|)
(WORD CENTERLINE$CENTER_LINE |centerline|)
(WORD CENTERLINE$CENTER_LINE |center_line|)))
(DEFCONCEPT CONNECTION$CONNEXION$LINK (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT CONNECTION$CONNEXION$LINK SHAPES)
(DOCUMENTATION CONNECTION$CONNEXION$LINK "a connecting shape")
(HAS-I-TOPIC CONNECTION$CONNEXION$LINK |Factotum|)
(WORD CONNECTION$CONNEXION$LINK |connection|)
(WORD CONNECTION$CONNEXION$LINK |connexion|)
(WORD CONNECTION$CONNEXION$LINK |link|)))
(DEFCONCEPT CORNER_5 (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT CORNER_5 OBJECTS)
(DOCUMENTATION CORNER_5
"a projecting part that is corner-shaped; 'he knocked off the corners'")
(HAS-I-TOPIC CORNER_5 |Factotum|) (WORD CORNER_5 |corner|)))
(DEFCONCEPT ENCLOSURE (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT ENCLOSURE ARTIFACTS)
(DOCUMENTATION ENCLOSURE
"a space that has been enclosed for some purpose")
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(HAS-I-TOPIC ENCLOSURE |Factotum|) (WORD ENCLOSURE |enclosure|))
(DEFCONCEPT EXTREMITY_2 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT EXTREMITY_2 LOCATIONS)
    (DOCUMENTATION EXTREMITY_2
      "the outermost or farthest region or point")
    (HAS-I-TOPIC EXTREMITY_2 |Factotum|) (WORD EXTREMITY_2 |extremity|)))
(DEFCONCEPT FRAGMENT (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT FRAGMENT OBJECTS)
    (DOCUMENTATION FRAGMENT
      "a piece broken off of something else; 'a fragment of rock'")
    (HAS-I-TOPIC FRAGMENT |Factotum|) (WORD FRAGMENT |fragment|)))
(DEFCONCEPT HEAD_8 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT HEAD_8 OBJECTS)
    (DOCUMENTATION HEAD_8
      "a rounded compact mass; 'the head of a comet'")
    (HAS-I-TOPIC HEAD_8 |Factotum|) (WORD HEAD_8 |head|)))
(DEFCONCEPT HERE (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT HERE LOCATIONS)
    (DOCUMENTATION HERE
      "the present location; this place; 'where do we go from here?'" )
    (HAS-I-TOPIC HERE |Factotum|) (WORD HERE |here|)))
(DEFCONCEPT INSIDE$INTERIOR_2 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT INSIDE$INTERIOR_2 LOCATIONS)
    (DOCUMENTATION INSIDE$INTERIOR_2
      "the region that is inside of something")
    (HAS-I-TOPIC INSIDE$INTERIOR_2 |Factotum|)
    (WORD INSIDE$INTERIOR_2 |inside|)
    (WORD INSIDE$INTERIOR_2 |interior|)))
(DEFCONCEPT LAYER_3 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT LAYER_3 LOCATIONS)
    (DOCUMENTATION LAYER_3
      "a relatively thin sheetlike expanse or region lying over or under another")
    (HAS-I-TOPIC LAYER_3 |Factotum|) (WORD LAYER_3 |layer|)))
(DEFCONCEPT NUB$STUB (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT NUB$STUB OBJECTS)
    (DOCUMENTATION NUB$STUB
      "a small piece; 'a nub of coal' or 'a stub of a pencil'")
    (HAS-I-TOPIC NUB$STUB |Factotum|) (WORD NUB$STUB |nub|)
    (WORD NUB$STUB |stub|)))
(DEFCONCEPT OPENING_3 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT OPENING_3 ARTIFACTS)
    (DOCUMENTATION OPENING_3
      "a vacant or unobstructed space; 'they left a small opening for the cat at the bottom of the door'")
    (HAS-I-TOPIC OPENING_3 |Factotum|) (WORD OPENING_3 |opening|)))
(DEFCONCEPT OUTSIDE$EXTERIOR_2 (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT OUTSIDE$EXTERIOR_2 LOCATIONS)
    (DOCUMENTATION OUTSIDE$EXTERIOR_2
      "the region that is outside of something")
    (HAS-I-TOPIC OUTSIDE$EXTERIOR_2 |Factotum|)
    (WORD OUTSIDE$EXTERIOR_2 |outside|)
    (WORD OUTSIDE$EXTERIOR_2 |exterior|)))
(DEFCONCEPT PART$PORTION (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT PART$PORTION ARTIFACTS)
    (DOCUMENTATION PART$PORTION
      "something less than the whole of a human artifact: 'the rear part of the house';
      'glue the two parts together'")
    (HAS-I-TOPIC PART$PORTION |Factotum|) (WORD PART$PORTION |part|)
    (WORD PART$PORTION |portion|)))
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(DEFCONCEPT PERIMETER (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT PERIMETER SHAPES)
    (DOCUMENTATION PERIMETER "a line enclosing a plane areas")
    (HAS-I-TOPIC PERIMETER |Factotum|) (WORD PERIMETER |perimeter|)))
(DEFCONCEPT RADIUS_2 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT RADIUS_2 LOCATIONS)
    (DOCUMENTATION RADIUS_2
      "a circular region whose area is indicated by the length of its radius;
      'they located it within a radius of 2 miles'")
    (HAS-I-TOPIC RADIUS_2 |Factotum|) (WORD RADIUS_2 |radius|)))
(DEFCONCEPT SIDE_7 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SIDE_7 LOCATIONS)
    (DOCUMENTATION SIDE_7
      "a place within a region identified relative to a center or reference location;
      'they always sat on the right side of the church'; 'he never left my side'")
    (HAS-I-TOPIC SIDE_7 |Factotum|) (WORD SIDE_7 |side|)))
(DEFCONCEPT SLICE_2 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SLICE_2 OBJECTS)
    (DOCUMENTATION SLICE_2 "a thin flat piece cut off of some object")
    (HAS-I-TOPIC SLICE_2 |Factotum|) (WORD SLICE_2 |slice|)))
(DEFCONCEPT SPACE_4 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SPACE_4 SHAPES)
    (DOCUMENTATION SPACE_4
      "an empty area (usually bounded in some way between things);
      'the architect left space in front of the building'; 'they stopped at an open space in the jungle';
      'the space between his teeth'")
    (HAS-I-TOPIC SPACE_4 |Factotum|) (WORD SPACE_4 |space|)))
(DEFCONCEPT STRIP_2 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT STRIP_2 OBJECTS)
    (DOCUMENTATION STRIP_2
      "a relatively long narrow piece of something; 'he felt a flat strip of muscle'")
    (HAS-I-TOPIC STRIP_2 |Factotum|) (WORD STRIP_2 |strip|)))
(DEFCONCEPT SURFACE_1 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SURFACE_1 ARTIFACTS)
    (DOCUMENTATION SURFACE_1
      "the outer boundary of an object or a material layer constituting or resembling such a boundary;
      'there is a special cleaner for these surfaces';
      'the cloth had a pattern of red dots on a white surface'")
    (HAS-I-TOPIC SURFACE_1 |Factotum|) (WORD SURFACE_1 |surface|)))
(DEFCONCEPT THERE (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT THERE LOCATIONS)
    (DOCUMENTATION THERE
      "a location other than here; that place; 'you can take it from there'")
    (HAS-I-TOPIC THERE |Factotum|) (WORD THERE |there|)))
(DEFCONCEPT TOP_4 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT TOP_4 LOCATIONS)
    (DOCUMENTATION TOP_4
      "the upper part of anything; 'the mower cuts off the tops of the grass';
      'the title should be written at the top of the first page'")
    (HAS-I-TOPIC TOP_4 |Factotum|) (WORD TOP_4 |top|)))
(DEFCONCEPT VACUUM$VACUITY_1 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT VACUUM$VACUITY_1 LOCATIONS)
    (DOCUMENTATION VACUUM$VACUITY_1 "a region empty of matter")
    (HAS-I-TOPIC VACUUM$VACUITY_1 |Factotum|)
    (WORD VACUUM$VACUITY_1 |vacuum|) (WORD VACUUM$VACUITY_1 |vacuity|)))
(DEFCONCEPT WHEREABOUTS (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT WHEREABOUTS LOCATIONS)
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(DOCUMENTATION WHEREABOUTS
  "the general location where something is;
  'I questioned him about his whereabouts on the night of the crime'"
  (HAS-I-TOPIC WHEREABOUTS |Factotum|)
  (WORD WHEREABOUTS |whereabouts|))
(DEFCONCEPT ARTICLE_1 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT ARTICLE_1 TOPS)
    (DOCUMENTATION ARTICLE_1
      "one of a class of artifacts; 'an article of clothing'"
      (HAS-I-TOPIC ARTICLE_1 |Factotum|) (WORD ARTICLE_1 |article|)))
(DEFCONCEPT BLOCK_1 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT BLOCK_1 ARTIFACTS)
    (DOCUMENTATION BLOCK_1
      "a solid piece of something (usually having flat rectangular sides);
      'the pyramids were built with large stone blocks'"
      (HAS-I-TOPIC BLOCK_1 |Factotum|) (WORD BLOCK_1 |block|)))
(DEFCONCEPT CONE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT CONE ARTIFACTS)
    (DOCUMENTATION CONE "any cone-shaped artifact"
      (HAS-I-TOPIC CONE |Factotum|) (WORD CONE |cone|)))
(DEFCONCEPT COVERING_2 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT COVERING_2 ARTIFACTS)
    (DOCUMENTATION COVERING_2
      "an artifact that protects or shelters or conceals"
      (HAS-I-TOPIC COVERING_2 |Factotum|) (WORD COVERING_2 |covering|)))
(DEFCONCEPT CREATION_3 (?SELF)
  :=> (CREATIVE-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT CREATION_3 ARTIFACTS)
    (DOCUMENTATION CREATION_3
      "something that has been brought into existence by someone"
      (HAS-I-TOPIC CREATION_3 |Factotum|) (WORD CREATION_3 |creation|)))
(DEFCONCEPT DECKER (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT DECKER ARTIFACTS)
    (DOCUMENTATION DECKER
      "(often used in combination) something constructed with multiple levels;
      'they rode in a double-decker bus'"
      (HAS-I-TOPIC DECKER |Factotum|) (WORD DECKER |decker|)))
(DEFCONCEPT DECORATION$ORNAMENT$ORNAMENTATION (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT DECORATION$ORNAMENT$ORNAMENTATION ARTIFACTS)
    (DOCUMENTATION DECORATION$ORNAMENT$ORNAMENTATION
      "something used to beautify"
      (HAS-I-TOPIC DECORATION$ORNAMENT$ORNAMENTATION |Factotum|)
      (WORD DECORATION$ORNAMENT$ORNAMENTATION |decoration|)
      (WORD DECORATION$ORNAMENT$ORNAMENTATION |ornament|)
      (WORD DECORATION$ORNAMENT$ORNAMENTATION |ornamentation|)))
(DEFCONCEPT FIXTURE (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT FIXTURE ARTIFACTS)
    (DOCUMENTATION FIXTURE
      "a object firmly fixed in place (especially in a household)"
      (HAS-I-TOPIC FIXTURE |Factotum|) (WORD FIXTURE |fixture|)))
(DEFCONCEPT FLOAT_1 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT FLOAT_1 ARTIFACTS)
    (DOCUMENTATION FLOAT_1
      "something that remains on the surface of a liquid"
      (HAS-I-TOPIC FLOAT_1 |Factotum|) (WORD FLOAT_1 |float|)))
(DEFCONCEPT INSERT$INSET (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT INSERT$INSET ARTIFACTS)
    (DOCUMENTATION INSERT$INSET "something inserted or to be inserted"
      (HAS-I-TOPIC INSERT$INSET |Factotum|) (WORD INSERT$INSET |insert|))
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        (WORD INSERT$INSET |inset|)))
(DEFCONCEPT INSTRUMENTALITY$INSTRUMENTATION (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT INSTRUMENTALITY$INSTRUMENTATION ARTIFACTS)
    (DOCUMENTATION INSTRUMENTALITY$INSTRUMENTATION
      "an artifact (or system of artifacts) that is instrumental in accomplishing some end")
    (HAS-I-TOPIC INSTRUMENTALITY$INSTRUMENTATION |Factotum|)
    (WORD INSTRUMENTALITY$INSTRUMENTATION |instrumentality|)
    (WORD INSTRUMENTALITY$INSTRUMENTATION |instrumentation|)))
(DEFCONCEPT LINE_2 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT LINE_2 ARTIFACTS)
    (DOCUMENTATION LINE_2 "something long and thin and flexible")
    (HAS-I-TOPIC LINE_2 |Factotum|) (WORD LINE_2 |line|)))
(DEFCONCEPT MARKER_1 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT MARKER_1 ARTIFACTS)
    (DOCUMENTATION MARKER_1
      "some conspicuous object used to distinguish or mark something;
      'the buoys were markers for the channel'")
    (HAS-I-TOPIC MARKER_1 |Factotum|) (WORD MARKER_1 |marker|)))
(DEFCONCEPT SHEET$FLAT_SOLID (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT SHEET$FLAT_SOLID ARTIFACTS)
    (DOCUMENTATION SHEET$FLAT_SOLID
      "a flat man-made object that is thin relative to its length and width")
    (HAS-I-TOPIC SHEET$FLAT_SOLID |Factotum|)
    (WORD SHEET$FLAT_SOLID |sheet|) (WORD SHEET$FLAT_SOLID |flat solid|)))
(DEFCONCEPT SPHERE_1 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT SPHERE_1 ARTIFACTS)
    (DOCUMENTATION SPHERE_1 "any spherically shaped artifact")
    (HAS-I-TOPIC SPHERE_1 |Factotum|) (WORD SPHERE_1 |sphere|)))
(DEFCONCEPT SQUARE_2 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT SQUARE_2 ARTIFACTS)
    (DOCUMENTATION SQUARE_2
      "any object having a shape similar to a plane geometric figure with four equal
      sides and four right angles; 'a chessboard has 64 squares'")
    (HAS-I-TOPIC SQUARE_2 |Factotum|) (WORD SQUARE_2 |square|)))
(DEFCONCEPT STRIP$SLIP (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT STRIP$SLIP ARTIFACTS)
    (DOCUMENTATION STRIP$SLIP "a narrow flat piece of material")
    (HAS-I-TOPIC STRIP$SLIP |Factotum|) (WORD STRIP$SLIP |strip|)
    (WORD STRIP$SLIP |slip|)))
(DEFCONCEPT STRUCTURE$CONSTRUCTION (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT STRUCTURE$CONSTRUCTION ARTIFACTS)
    (DOCUMENTATION STRUCTURE$CONSTRUCTION
      "a thing constructed; a complex construction or entity; 'the structure consisted of a
      series of arches'; 'she wore her hair in an amazing construction of whirls and ribbons'")
    (HAS-I-TOPIC STRUCTURE$CONSTRUCTION |Factotum|)
    (WORD STRUCTURE$CONSTRUCTION |structure|)
    (WORD STRUCTURE$CONSTRUCTION |construction|)))
(DEFCONCEPT THING_2 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT THING_2 ARTIFACTS)
    (DOCUMENTATION THING_2 "an artifact; 'how does this thing work?'" )
    (HAS-I-TOPIC THING_2 |Factotum|) (WORD THING_2 |thing|)))
(DEFCONCEPT UNIT$BUILDING_BLOCK (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT UNIT$BUILDING_BLOCK OBJECTS)
    (DOCUMENTATION UNIT$BUILDING_BLOCK
      "a single undivided natural entity occurring in the composition of something else;
      'units of nucleic acids'")
    (HAS-I-TOPIC UNIT$BUILDING_BLOCK |Factotum|)
    (WORD UNIT$BUILDING_BLOCK |unit|))

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(WORD UNIT$BUILDING_BLOCK |building_block|))
(DEFCONCEPT WEIGHT_1 (?SELF)
  => (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT WEIGHT_1 ARTIFACTS)
    (DOCUMENTATION WEIGHT_1 "an artifact that is heavy")
    (HAS-I-TOPIC WEIGHT_1 |Factotum|) (WORD WEIGHT_1 |weight|)))
(DEFCONCEPT WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES (?SELF)
  => (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND
    (SUBJECT WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES ARTIFACTS)
    (DOCUMENTATION WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES
      "miscellaneous unspecified artifacts; 'the trunk was full of stuff'")
    (HAS-I-TOPIC WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES
      |Factotum|)
    (WORD WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES
      |whatchamacallit|)
    (WORD WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES |stuff|)
    (WORD WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES |whatsis|)
    (WORD WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES |sundry|)
    (WORD WHATCHAMACALLIT$STUFF$WHATSIS$SUNDRY$SUNDRIES |sundries|)))
(DEFCONCEPT IMAGINARY_BEING$IMAGINARY_CREATURE (?SELF)
  => (FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT IMAGINARY_BEING$IMAGINARY_CREATURE PERSONS)
    (DOCUMENTATION IMAGINARY_BEING$IMAGINARY_CREATURE
      "a creature of the imagination")
    (HAS-I-TOPIC IMAGINARY_BEING$IMAGINARY_CREATURE |Factotum|)
    (WORD IMAGINARY_BEING$IMAGINARY_CREATURE |imaginary_being|)
    (WORD IMAGINARY_BEING$IMAGINARY_CREATURE |imaginary_creature|)))
(DEFCONCEPT AGGLOMERATION (?SELF)
  => (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT AGGLOMERATION GROUPS)
    (DOCUMENTATION AGGLOMERATION "a jumbled collection or mass")
    (HAS-I-TOPIC AGGLOMERATION |Factotum|)
    (WORD AGGLOMERATION |agglomeration|)))
(DEFCONCEPT FILM (?SELF)
  => (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT FILM ARTIFACTS)
    (DOCUMENTATION FILM
      "a thin coating or layer; 'the table was covered with a film of dust'")
    (HAS-I-TOPIC FILM |Factotum|) (WORD FILM |film|)))
(DEFCONCEPT MATERIAL$STUFF (?SELF)
  => (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT MATERIAL$STUFF SUBSTANCES)
    (DOCUMENTATION MATERIAL$STUFF
      "the tangible substance that goes into the makeup of a physical object;
      'coal is a hard black material'; 'wheat is the stuff they use to make bread'")
    (HAS-I-TOPIC MATERIAL$STUFF |Factotum|)
    (WORD MATERIAL$STUFF |material|) (WORD MATERIAL$STUFF |stuff|)))
(DEFCONCEPT SAMPLE_2 (?SELF)
  => (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT SAMPLE_2 OBJECTS)
    (DOCUMENTATION SAMPLE_2
      "all or part of a natural object that is collected and preserved as an example of its class")
    (HAS-I-TOPIC SAMPLE_2 |Factotum|) (WORD SAMPLE_2 |sample|)))
(DEFCONCEPT ABUTMENT_2 (?SELF)
  => (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT ABUTMENT_2 LOCATIONS)
    (DOCUMENTATION ABUTMENT_2
      "point of contact between two objects or parts")
    (HAS-I-TOPIC ABUTMENT_2 |Factotum|) (WORD ABUTMENT_2 |abutment|)))
(DEFCONCEPT BACK$REAR (?SELF)
  => (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT BACK$REAR LOCATIONS)
    (DOCUMENTATION BACK$REAR
      "the part of something that is furthest from the normal viewer:
      'he stood at the back of the stage'; 'it was hidden in the rear of the store'")
    (HAS-I-TOPIC BACK$REAR |Factotum|) (WORD BACK$REAR |back|)
    (WORD BACK$REAR |rear|)))
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(DEFCONCEPT CROSSING_3 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CROSSING_3 LOCATIONS)
    (DOCUMENTATION CROSSING_3
      "a point where two lines (paths or arcs etc.) intersect")
    (HAS-I-TOPIC CROSSING_3 |Factotum|) (WORD CROSSING_3 |crossing|)))
(DEFCONCEPT DEPTH_3 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT DEPTH_3 LOCATIONS)
    (DOCUMENTATION DEPTH_3
      "(usually plural) the deepest and most remote part; 'from the depths of darkest Africa';
      'signals received from the depths of space'")
    (HAS-I-TOPIC DEPTH_3 |Factotum|) (WORD DEPTH_3 |depth|)))
(DEFCONCEPT END_7 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT END_7 LOCATIONS)
    (DOCUMENTATION END_7
      "one of two places from which people are communicating to each other;
      'the phone rang at the other end' or 'both ends wrote at the same time'")
    (HAS-I-TOPIC END_7 |Factotum|) (WORD END_7 |end|)))
(DEFCONCEPT FOCUS$FOCAL_POINT (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT FOCUS$FOCAL_POINT PHENOMENA)
    (DOCUMENTATION FOCUS$FOCAL_POINT
      "a point of convergence of light (or other radiation) or a point from which it diverges")
    (HAS-I-TOPIC FOCUS$FOCAL_POINT |Factotum|)
    (WORD FOCUS$FOCAL_POINT |focus|)
    (WORD FOCUS$FOCAL_POINT |focal_point|)))
(DEFCONCEPT FOCUS_3 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT FOCUS_3 LOCATIONS)
    (DOCUMENTATION FOCUS_3
      "a fixed reference point on the concave side of a conic section")
    (HAS-I-TOPIC FOCUS_3 |Factotum|) (WORD FOCUS_3 |focus|)))
(DEFCONCEPT FRONT_3 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT FRONT_3 LOCATIONS)
    (DOCUMENTATION FRONT_3
      "the part of something that is nearest to the normal viewer;
      'he walked to the front of the stage'")
    (HAS-I-TOPIC FRONT_3 |Factotum|) (WORD FRONT_3 |front|)))
(DEFCONCEPT HILUM (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT HILUM PLANTS)
    (DOCUMENTATION HILUM
      "the scar on certain seeds marking its point of attachment to the funicle")
    (HAS-I-TOPIC HILUM |Factotum|) (WORD HILUM |hilum|)))
(DEFCONCEPT LEFT_2 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT LEFT_2 LOCATIONS)
    (DOCUMENTATION LEFT_2
      "location near or direction toward the left side; i.e. the side to the north when a
      person or object faces east: 'she stood on the left'")
    (HAS-I-TOPIC LEFT_2 |Factotum|) (WORD LEFT_2 |left|)))
(DEFCONCEPT LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION LOCATIONS)
    (DOCUMENTATION LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION
      "a mathematical value toward which a function goes as the independent
      variable approaches infinity")
    (HAS-I-TOPIC LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION |Factotum|)
    (WORD LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION |limit|)
    (WORD LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION |limit_point|)
    (WORD LIMIT$LIMIT_POINT$POINT_OF_ACCUMULATION
      |point_of_accumulation|)))
(DEFCONCEPT LINE_8 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT LINE_8 LOCATIONS)
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(DOCUMENTATION LINE_8
  "a spatial location defined by a real or imaginary unidimensional extent")
(HAS-I-TOPIC LINE_8 |Factotum|) (WORD LINE_8 |line|))
(DEFCONCEPT MCBURNEY_S_POINT (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT MCBURNEY_S_POINT BODY_AS_SUBJECT)
    (DOCUMENTATION MCBURNEY_S_POINT
      "a point one third of the way along a line drawn from the hip to the umbilicus;
      the point of maximum sensitivity in acute appendicitis")
    (HAS-I-TOPIC MCBURNEY_S_POINT |Factotum|)
    (WORD MCBURNEY_S_POINT |McBurney's point|)))
(DEFCONCEPT PARHELION$MOCK_SUN$SUNDOG (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT PARHELION$MOCK_SUN$SUNDOG PHENOMENA)
    (DOCUMENTATION PARHELION$MOCK_SUN$SUNDOG
      "a bright spot on the parhelic circle; caused by diffraction by ice crystals")
    (HAS-I-TOPIC PARHELION$MOCK_SUN$SUNDOG |Factotum|)
    (WORD PARHELION$MOCK_SUN$SUNDOG |parhelion|)
    (WORD PARHELION$MOCK_SUN$SUNDOG |mock_sun|)
    (WORD PARHELION$MOCK_SUN$SUNDOG |sundog|)))
(DEFCONCEPT PEAK$CROWN$CREST$TOP$TIP$SUMMIT (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT PEAK$CROWN$CREST$TOP$TIP$SUMMIT LOCATIONS)
    (DOCUMENTATION PEAK$CROWN$CREST$TOP$TIP$SUMMIT
      "the top point of a mountain or hill; 'the view from the peak was magnificent';
      'they clambered to the summit of Monadnock'")
    (HAS-I-TOPIC PEAK$CROWN$CREST$TOP$TIP$SUMMIT |Factotum|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |peak|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |crown|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |crest|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |top|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |tip|)
    (WORD PEAK$CROWN$CREST$TOP$TIP$SUMMIT |summit|)))
(DEFCONCEPT RIGHT_3 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT RIGHT_3 LOCATIONS)
    (DOCUMENTATION RIGHT_3
      "location near or direction toward the right side; i.e. the side to the south when a
      person or object faces east: 'he stood on the right'")
    (HAS-I-TOPIC RIGHT_3 |Factotum|) (WORD RIGHT_3 |right|)))
(DEFCONCEPT SCOUR (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SCOUR LOCATIONS)
    (DOCUMENTATION SCOUR
      "a place that is scoured (especially by running water)")
    (HAS-I-TOPIC SCOUR |Factotum|) (WORD SCOUR |scour|)))
(DEFCONCEPT SUNSPOT$MACULA (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SUNSPOT$MACULA PHENOMENA)
    (DOCUMENTATION SUNSPOT$MACULA
      "a cooler darker spot appearing periodically on the surface of the sun;
      associated with a strong magnetic field")
    (HAS-I-TOPIC SUNSPOT$MACULA |Factotum|)
    (WORD SUNSPOT$MACULA |sunspot|) (WORD SUNSPOT$MACULA |macula|)))
(DEFCONCEPT MARE$MARIA (?SELF)
  :=> (GEOGRAPHICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT MARE$MARIA OBJECTS)
    (DOCUMENTATION MARE$MARIA
      "a dark region of considerable extent on the surface of the moon")
    (HAS-I-TOPIC MARE$MARIA |Factotum|) (WORD MARE$MARIA |mare|)
    (WORD MARE$MARIA |maria|)))
(DEFCONCEPT TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$
  MANDATE$COLONY (?SELF)
  :=> (GEOGRAPHICAL-ROLE ?SELF)
  :AXIOMS (AND
    (SUBJECT
      TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
      POSSESSION)
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(DOCUMENTATION
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
"a territorial possession controlled by a ruling state")
(HAS-I-TOPIC
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|Factotum|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|territory|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|dominion|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|territorial_dominion|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|province|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|mandate|)
(WORD
TERRITORY$DOMINION$TERRITORIAL_DOMINION$PROVINCE$MANDATE$COLONY
|colony|)))
(DEFCONCEPT CLASSIFICATION$CATEGORIZATION (?SELF)
:=> (INFORMATION-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT CLASSIFICATION$CATEGORIZATION GROUPS)
(DOCUMENTATION CLASSIFICATION$CATEGORIZATION
"a group of people or things arranged by class or category")
(HAS-I-TOPIC CLASSIFICATION$CATEGORIZATION |Factotum|)
(WORD CLASSIFICATION$CATEGORIZATION |classification|)
(WORD CLASSIFICATION$CATEGORIZATION |categorization|)))
(DEFCONCEPT AUDITORY_COMMUNICATION (?SELF)
:=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT AUDITORY_COMMUNICATION COMMUNICATION)
(DOCUMENTATION AUDITORY_COMMUNICATION
"communication that relies on hearing")
(HAS-I-TOPIC AUDITORY_COMMUNICATION |Factotum|)
(WORD AUDITORY_COMMUNICATION |auditory communication|)))
(DEFCONCEPT SIGN_1 (?SELF)
:=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT SIGN_1 COMMUNICATION)
(DOCUMENTATION SIGN_1
"a public display of a (usually written) message; 'he posted signs in all the shop windows'"
(HAS-I-TOPIC SIGN_1 |Factotum|) (WORD SIGN_1 |sign|)))
(DEFCONCEPT SIGNAL$SIGNALING$SIGN (?SELF)
:=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT SIGNAL$SIGNALING$SIGN COMMUNICATION)
(DOCUMENTATION SIGNAL$SIGNALING$SIGN
"any communication that encodes a message; 'signals from the boat suddenly stopped'")
(HAS-I-TOPIC SIGNAL$SIGNALING$SIGN |Factotum|)
(WORD SIGNAL$SIGNALING$SIGN |signal|)
(WORD SIGNAL$SIGNALING$SIGN |signaling|)
(WORD SIGNAL$SIGNALING$SIGN |sign|)))
(DEFCONCEPT VISUAL_COMMUNICATION (?SELF)
:=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT VISUAL_COMMUNICATION COMMUNICATION)
(DOCUMENTATION VISUAL_COMMUNICATION
"communication that relies on vision")
(HAS-I-TOPIC VISUAL_COMMUNICATION |Factotum|)
(WORD VISUAL_COMMUNICATION |visual communication|)))
(DEFCONCEPT WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE (?SELF)
:=> (INFORMATION-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE COMMUNICATION)
(DOCUMENTATION WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE
"communication by means of written symbols")
(HAS-I-TOPIC WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE |Factotum|)
(WORD WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE
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|written communication|)
(WORD WRITTEN_COMMUNICATION$WRITTEN_LANGUAGE |written language|))
(DEFCONCEPT OWN_RIGHT (?SELF)
:=> (LEGAL-POSSESSION-ENTITY ?SELF)
:AXIOMS (AND (SUBJECT OWN_RIGHT POSSESSION)
(DOCUMENTATION OWN_RIGHT
"by title vested in oneself or by virtue of qualifications one has achieved;
'a peer of the realm in his own right'; 'a leading sports figure in his own right';
'a fine opera in its own right'")
(HAS-I-TOPIC OWN_RIGHT |Factotum|) (WORD OWN_RIGHT |own_right|)))
(DEFCONCEPT ADDRESS_3 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT ADDRESS_3 LOCATIONS)
(DOCUMENTATION ADDRESS_3
"the place where a person or organization can be found or communicated with")
(HAS-I-TOPIC ADDRESS_3 |Factotum|) (WORD ADDRESS_3 |address|))
(DEFCONCEPT BASE$HOME (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT BASE$HOME LOCATIONS)
(DOCUMENTATION BASE$HOME
"the place where you are stationed and from which missions start and end")
(HAS-I-TOPIC BASE$HOME |Factotum|) (WORD BASE$HOME |base|)
(WORD BASE$HOME |home|)))
(DEFCONCEPT BEGINNING$ORIGIN$ROOT$SOURCE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT BEGINNING$ORIGIN$ROOT$SOURCE LOCATIONS)
(DOCUMENTATION BEGINNING$ORIGIN$ROOT$SOURCE
"the place where something begins, where it springs into being;
'the Italian beginning of the Renaissance'; 'Jupiter was the origin of the radiation';
'Pittsburgh is the source of the Ohio River'; 'communism's Russian root'")
(HAS-I-TOPIC BEGINNING$ORIGIN$ROOT$SOURCE |Factotum|)
(WORD BEGINNING$ORIGIN$ROOT$SOURCE |beginning|)
(WORD BEGINNING$ORIGIN$ROOT$SOURCE |origin|)
(WORD BEGINNING$ORIGIN$ROOT$SOURCE |root|)
(WORD BEGINNING$ORIGIN$ROOT$SOURCE |source|))
(DEFCONCEPT BIRTHPLACE$PLACE_OF_BIRTH (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT BIRTHPLACE$PLACE_OF_BIRTH LOCATIONS)
(DOCUMENTATION BIRTHPLACE$PLACE_OF_BIRTH
"the place where someone was born")
(HAS-I-TOPIC BIRTHPLACE$PLACE_OF_BIRTH |Factotum|)
(WORD BIRTHPLACE$PLACE_OF_BIRTH |birthplace|)
(WORD BIRTHPLACE$PLACE_OF_BIRTH |place_of_birth|))
(DEFCONCEPT BLACK_HOLE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT BLACK_HOLE OBJECTS)
(DOCUMENTATION BLACK_HOLE
"a region of space resulting from the collapse of a star; extremely high gravitational field")
(HAS-I-TOPIC BLACK_HOLE |Factotum|) (WORD BLACK_HOLE |black_hole|))
(DEFCONCEPT DESTINATION$GOAL (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT DESTINATION$GOAL LOCATIONS)
(DOCUMENTATION DESTINATION$GOAL
"place where something (e.g., a journey or race) ends")
(HAS-I-TOPIC DESTINATION$GOAL |Factotum|)
(WORD DESTINATION$GOAL |destination|) (WORD DESTINATION$GOAL |goal|))
(DEFCONCEPT DISTANCE_2 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT DISTANCE_2 LOCATIONS)
(DOCUMENTATION DISTANCE_2
"a distant region; 'I could see it in the distance'")
(HAS-I-TOPIC DISTANCE_2 |Factotum|) (WORD DISTANCE_2 |distance|))
(DEFCONCEPT EARTH_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT EARTH_1 LOCATIONS)
(DOCUMENTATION EARTH_1
"the abode of mortals (as contrasted with heaven or hell); 'it was hell on earth'")
(HAS-I-TOPIC EARTH_1 |Factotum|) (WORD EARTH_1 |Earth|))
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(DEFCONCEPT EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND
  (SUBJECT EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    LOCATIONS)
  (DOCUMENTATION EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$
    SHANGRI-LA
    "any place of complete bliss and delight and peace")
  (HAS-I-TOPIC EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |Factotum|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA |eden|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |paradise|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |nirvana|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |heaven|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |promised_land|)
  (WORD EDEN$PARADISE$NIRVANA$HEAVEN$PROMISED_LAND$SHANGRI-LA
    |Shangri-la|)))
(DEFCONCEPT FIELD_5 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT FIELD_5 LOCATIONS)
  (DOCUMENTATION FIELD_5
    "somewhere (away from a studio or office or library or laboratory) where practical
    work is done or data is collected; 'anthropologists do much of their work in the field'")
  (HAS-I-TOPIC FIELD_5 |Factotum|) (WORD FIELD_5 |field|)))
(DEFCONCEPT HALF-MAST (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HALF-MAST LOCATIONS)
  (DOCUMENTATION HALF-MAST
    "a position some distance below the top of the mast to which a flag is lowered in
    mourning or to signal distress")
  (HAS-I-TOPIC HALF-MAST |Factotum|) (WORD HALF-MAST |half-mast|)))
(DEFCONCEPT HELL$HELL_ON_EARTH$THE_PIT$INFERNO (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HELL$HELL_ON_EARTH$THE_PIT$INFERNO LOCATIONS)
  (DOCUMENTATION HELL$HELL_ON_EARTH$THE_PIT$INFERNO
    "any place of pain and turmoil: 'the hell of battle'; 'the inferno of the engine room';
    'when you're alone Christmas is the pits';")
  (HAS-I-TOPIC HELL$HELL_ON_EARTH$THE_PIT$INFERNO |Factotum|)
  (WORD HELL$HELL_ON_EARTH$THE_PIT$INFERNO |hell|)
  (WORD HELL$HELL_ON_EARTH$THE_PIT$INFERNO |hell_on_earth|)
  (WORD HELL$HELL_ON_EARTH$THE_PIT$INFERNO |the_pits|)
  (WORD HELL$HELL_ON_EARTH$THE_PIT$INFERNO |inferno|)))
(DEFCONCEPT HIDING_PLACE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HIDING_PLACE LOCATIONS)
  (DOCUMENTATION HIDING_PLACE
    "a place suitable for hiding something (such as yourself)")
  (HAS-I-TOPIC HIDING_PLACE |Factotum|)
  (WORD HIDING_PLACE |hiding_place|)))
(DEFCONCEPT HIGH$HEIGHTS (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HIGH$HEIGHTS LOCATIONS)
  (DOCUMENTATION HIGH$HEIGHTS
    "a high place; 'they stood on high and observed the countryside' or 'he doesn't like heights'")
  (HAS-I-TOPIC HIGH$HEIGHTS |Factotum|) (WORD HIGH$HEIGHTS |high|)
  (WORD HIGH$HEIGHTS |heights|)))
(DEFCONCEPT HOME_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT HOME_1 LOCATIONS)
  (DOCUMENTATION HOME_1
    "the country or state or city where you live; 'Canadian tariffs enabled United States
    lumber companies to raise prices at home'; 'his home is New Jersey'")
  (HAS-I-TOPIC HOME_1 |Factotum|) (WORD HOME_1 |home|)))
(DEFCONCEPT LANDMARK_2 (?SELF)
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:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT LANDMARK_2 LOCATIONS)
  (DOCUMENTATION LANDMARK_2
    "the position of a prominent or well-known object in a particular landscape;
    'the church steeple provided a convenient landmark'")
  (HAS-I-TOPIC LANDMARK_2 |Factotum|) (WORD LANDMARK_2 |landmark|)))
(DEFCONCEPT LIE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT LIE LOCATIONS)
  (DOCUMENTATION LIE
    "position or manner in which something is situated")
  (HAS-I-TOPIC LIE |Factotum|) (WORD LIE |lie|)))
(DEFCONCEPT MECCA_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT MECCA_1 LOCATIONS)
  (DOCUMENTATION MECCA_1
    "a place that attracts many visitors; 'New York is a mecca for young artists'")
  (HAS-I-TOPIC MECCA_1 |Factotum|) (WORD MECCA_1 |mecca|)))
(DEFCONCEPT MIDAIR (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT MIDAIR LOCATIONS)
  (DOCUMENTATION MIDAIR
    "some point in the air; above ground level; 'the planes collided in midair'")
  (HAS-I-TOPIC MIDAIR |Factotum|) (WORD MIDAIR |midair|)))
(DEFCONCEPT NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE STATES)
  (DOCUMENTATION NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE
    "a wild primitive state untouched by civilization; 'he lived in the wild';
    'they tried to preserve nature as they found it'")
  (HAS-I-TOPIC NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE |Factotum|)
  (WORD NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE |nature|)
  (WORD NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE |wild|)
  (WORD NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE |natural_state|)
  (WORD NATURE$WILD$NATURAL_STATE$STATE_OF_NATURE |state_of_nature|)))
(DEFCONCEPT NEIGHBOR$NEIGHBOUR_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT NEIGHBOR$NEIGHBOUR_1 OBJECTS)
  (DOCUMENTATION NEIGHBOR$NEIGHBOUR_1
    "a nearby object of the same kind; 'Fort Worth is a neighbor of Dallas';
    'what is the closest neighbor to the Earth?'" )
  (HAS-I-TOPIC NEIGHBOR$NEIGHBOUR_1 |Factotum|)
  (WORD NEIGHBOR$NEIGHBOUR_1 |neighbor|)
  (WORD NEIGHBOR$NEIGHBOUR_1 |neighbour|)))
(DEFCONCEPT NESTING_PLACE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT NESTING_PLACE LOCATIONS)
  (DOCUMENTATION NESTING_PLACE "a place suitable for nesting")
  (HAS-I-TOPIC NESTING_PLACE |Factotum|)
  (WORD NESTING_PLACE |nesting_place|)))
(DEFCONCEPT OVERLOOK (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT OVERLOOK LOCATIONS)
  (DOCUMENTATION OVERLOOK "a high place affording a good view")
  (HAS-I-TOPIC OVERLOOK |Factotum|) (WORD OVERLOOK |overlook|)))
(DEFCONCEPT PITCH_3 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT PITCH_3 LOCATIONS)
  (DOCUMENTATION PITCH_3
    "(British) a vendor's position (especially on the sidewalk); 'he was employed to see that
    his paper's news pitches were not trespassed upon by rival vendors'")
  (HAS-I-TOPIC PITCH_3 |Factotum|) (WORD PITCH_3 |pitch|)))
(DEFCONCEPT POLLING_PLACE$POLLING_STATION (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT POLLING_PLACE$POLLING_STATION LOCATIONS)
  (DOCUMENTATION POLLING_PLACE$POLLING_STATION
    "a place where voters go to cast their votes in an election")
  (HAS-I-TOPIC POLLING_PLACE$POLLING_STATION |Factotum|))
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(WORD POLLING_PLACE$POLLING_STATION |polling_place|)
(WORD POLLING_PLACE$POLLING_STATION |polling_station|))
(DEFCONCEPT POOL$PUDDLE_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT POOL$PUDDLE_1 LOCATIONS)
(DOCUMENTATION POOL$PUDDLE_1
"something resembling a pool of liquid; 'he stood in a pool of light'; 'his chair sat in
a puddle of books and magazines'")
(HAS-I-TOPIC POOL$PUDDLE_1 |Factotum|) (WORD POOL$PUDDLE_1 |pool|)
(WORD POOL$PUDDLE_1 |puddle|)))
(DEFCONCEPT POSITION_2 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT POSITION_2 LOCATIONS)
(DOCUMENTATION POSITION_2
"the appropriate or customary location; 'the cars were in position'")
(HAS-I-TOPIC POSITION_2 |Factotum|) (WORD POSITION_2 |position|)))
(DEFCONCEPT POST$STATION (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT POST$STATION LOCATIONS)
(DOCUMENTATION POST$STATION
"the position where something or someone (as a guard or sentry) stands or is assigned
to stand: 'a sentry station'")
(HAS-I-TOPIC POST$STATION |Factotum|) (WORD POST$STATION |post|)
(WORD POST$STATION |station|)))
(DEFCONCEPT RENDEZVOUS_2 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT RENDEZVOUS_2 LOCATIONS)
(DOCUMENTATION RENDEZVOUS_2
"a place where people meet; 'he was waiting for them at the rendezvous'")
(HAS-I-TOPIC RENDEZVOUS_2 |Factotum|)
(WORD RENDEZVOUS_2 |rendezvous|)))
(DEFCONCEPT SHOWPLACE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT SHOWPLACE LOCATIONS)
(DOCUMENTATION SHOWPLACE
"a place that is frequently exhibited and visited for its historical interest or natural beauty")
(HAS-I-TOPIC SHOWPLACE |Factotum|) (WORD SHOWPLACE |showplace|)))
(DEFCONCEPT SITE$LAND_SITE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT SITE$LAND_SITE LOCATIONS)
(DOCUMENTATION SITE$LAND_SITE
"the piece of land on which something is located (or is to be located): 'a good site for the school'")
(HAS-I-TOPIC SITE$LAND_SITE |Factotum|) (WORD SITE$LAND_SITE |site|)
(WORD SITE$LAND_SITE |land_site|)))
(DEFCONCEPT SITE$SITUATION (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT SITE$SITUATION LOCATIONS)
(DOCUMENTATION SITE$SITUATION
"physical position in relation to the surroundings")
(HAS-I-TOPIC SITE$SITUATION |Factotum|) (WORD SITE$SITUATION |site|)
(WORD SITE$SITUATION |situation|)))
(DEFCONCEPT SOLITUDE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT SOLITUDE LOCATIONS)
(DOCUMENTATION SOLITUDE "a solitary place")
(HAS-I-TOPIC SOLITUDE |Factotum|) (WORD SOLITUDE |solitude|)))
(DEFCONCEPT STAND_5 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT STAND_5 LOCATIONS)
(DOCUMENTATION STAND_5
"the position where a thing or person stands")
(HAS-I-TOPIC STAND_5 |Factotum|) (WORD STAND_5 |stand|)))
(DEFCONCEPT STOP_2 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT STOP_2 LOCATIONS)
(DOCUMENTATION STOP_2
"a spot where something halts or pauses; 'his next stop is Atlanta'")
(HAS-I-TOPIC STOP_2 |Factotum|) (WORD STOP_2 |stop|)))
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(DEFCONCEPT TARGET$TARGET_AREA (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT TARGET$TARGET_AREA LOCATIONS)
(DOCUMENTATION TARGET$TARGET_AREA
"the location of the target that is to be hit")
(HAS-I-TOPIC TARGET$TARGET_AREA |Factotum|)
(WORD TARGET$TARGET_AREA |target|)
(WORD TARGET$TARGET_AREA |target_area|)))

(DEFCONCEPT VANISHING_POINT_2 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT VANISHING_POINT_2 LOCATIONS)
(DOCUMENTATION VANISHING_POINT_2
"the point beyond which something disappears or ceases to exist")
(HAS-I-TOPIC VANISHING_POINT_2 |Factotum|)
(WORD VANISHING_POINT_2 |vanishing_point|)))

(DEFCONCEPT VANTAGE (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT VANTAGE LOCATIONS)
(DOCUMENTATION VANTAGE
"place or situation affording some advantage (especially a comprehensive view
or commanding perspective)")
(HAS-I-TOPIC VANTAGE |Factotum|) (WORD VANTAGE |vantage|)))

(DEFCONCEPT WORKPLACE$WORK (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT WORKPLACE$WORK ARTIFACTS)
(DOCUMENTATION WORKPLACE$WORK
"a place where work is done; 'he arrived at work early today'")
(HAS-I-TOPIC WORKPLACE$WORK |Factotum|)
(WORD WORKPLACE$WORK |workplace|) (WORD WORKPLACE$WORK |work|)))

(DEFCONCEPT ZONE_1 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT ZONE_1 LOCATIONS)
(DOCUMENTATION ZONE_1
"an area or region distinguished from adjacent parts by a distinctive feature or characteristic")
(HAS-I-TOPIC ZONE_1 |Factotum|) (WORD ZONE_1 |zone|)))

(DEFCONCEPT OLD_WIVES__TALE (?SELF)
:=> (NARRATIVE ?SELF)
:AXIOMS (AND (SUBJECT OLD_WIVES__TALE COGNITION)
(DOCUMENTATION OLD_WIVES__TALE
"a bit of lore passed on by word of mouth")
(HAS-I-TOPIC OLD_WIVES__TALE |Factotum|)
(WORD OLD_WIVES__TALE |old wives' tale|)))

(DEFCONCEPT COMMON_DENOMINATOR_1 (?SELF)
:=> (PARAMETER ?SELF)
:AXIOMS (AND (SUBJECT COMMON_DENOMINATOR_1 ATTRIBUTES)
(DOCUMENTATION COMMON_DENOMINATOR_1
"an attribute that is common to all members of a category")
(HAS-I-TOPIC COMMON_DENOMINATOR_1 |Factotum|)
(WORD COMMON_DENOMINATOR_1 |common denominator|)))

(DEFCONCEPT PARAMETER_2 (?SELF)
:=> (PARAMETER ?SELF)
:AXIOMS (AND (SUBJECT PARAMETER_2 EVENTS)
(DOCUMENTATION PARAMETER_2
"any factor that defines a system and determines (or limits) its performance")
(HAS-I-TOPIC PARAMETER_2 |Factotum|) (WORD PARAMETER_2 |parameter|)))

(DEFCONCEPT ANTICIPATION (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT ANTICIPATION OBJECTS)
(DOCUMENTATION ANTICIPATION
"some early entity whose type or style anticipates a later one;
'there were many anticipations of Darwinian theory'; 'the hour glass was an anticipation of the clock'")
(HAS-I-TOPIC ANTICIPATION |Factotum|)
(WORD ANTICIPATION |anticipation|)))

(DEFCONCEPT CATCH_5 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT CATCH_5 OBJECTS)
(DOCUMENTATION CATCH_5
"anything that is caught (especially if it is worth catching); 'he shared his catch with the others'"))
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        (HAS-I-TOPIC CATCH_5 |Factotum|) (WORD CATCH_5 |catch|))
(DEFCONCEPT COAGULATION_FACTOR (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT COAGULATION_FACTOR SUBSTANCES)
    (DOCUMENTATION COAGULATION_FACTOR
      "any of the factors in the blood whose actions are essential for blood coagulation")
    (HAS-I-TOPIC COAGULATION_FACTOR |Factotum|)
    (WORD COAGULATION_FACTOR |coagulation_factor|)))
(DEFCONCEPT DETAIL$PARTICULAR$ITEM (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT DETAIL$PARTICULAR$ITEM RELATIONS)
    (DOCUMENTATION DETAIL$PARTICULAR$ITEM
      "a small part that can be considered separately from the whole; 'it was perfect in all details'")
    (HAS-I-TOPIC DETAIL$PARTICULAR$ITEM |Factotum|)
    (WORD DETAIL$PARTICULAR$ITEM |detail|)
    (WORD DETAIL$PARTICULAR$ITEM |particular|)
    (WORD DETAIL$PARTICULAR$ITEM |item|)))
(DEFCONCEPT DRAW$LOT (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT DRAW$LOT ARTIFACTS)
    (DOCUMENTATION DRAW$LOT
      "anything (straws or pebbles etc.) taken or chosen at random;
      'the luck of the draw' or 'they drew lots for it'")
    (HAS-I-TOPIC DRAW$LOT |Factotum|) (WORD DRAW$LOT |draw|)
    (WORD DRAW$LOT |lot|)))
(DEFCONCEPT EQUIVALENT (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT EQUIVALENT COGNITION)
    (DOCUMENTATION EQUIVALENT
      "a person or thing equal to another in value or measure or force or effect or significance etc:
      'send two dollars or the equivalent in stamps'")
    (HAS-I-TOPIC EQUIVALENT |Factotum|) (WORD EQUIVALENT |equivalent|)))
(DEFCONCEPT FINDING_2 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT FINDING_2 OBJECTS)
    (DOCUMENTATION FINDING_2
      "something that is found; 'the findings in the gastrointestinal tract indicate that he died
      several hours after dinner'; 'an area rich in archaeological findings'")
    (HAS-I-TOPIC FINDING_2 |Factotum|) (WORD FINDING_2 |finding|)))
(DEFCONCEPT GROWTH_2 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT GROWTH_2 OBJECTS)
    (DOCUMENTATION GROWTH_2
      "something grown or growing; 'a growth of hair'")
    (HAS-I-TOPIC GROWTH_2 |Factotum|) (WORD GROWTH_2 |growth|)))
(DEFCONCEPT INESSENTIAL$NONESSENTIAL (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT INESSENTIAL$NONESSENTIAL OBJECTS)
    (DOCUMENTATION INESSENTIAL$NONESSENTIAL
      "anything that is not essential; 'they discarded all their inessentials'")
    (HAS-I-TOPIC INESSENTIAL$NONESSENTIAL |Factotum|)
    (WORD INESSENTIAL$NONESSENTIAL |inessential|)
    (WORD INESSENTIAL$NONESSENTIAL |nonessential|)))
(DEFCONCEPT ITEM (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ITEM ARTIFACTS)
    (DOCUMENTATION ITEM
      "an individual unit; especially when included in a list or collection;
      'they reduced the price on many items'")
    (HAS-I-TOPIC ITEM |Factotum|) (WORD ITEM |item|)))
(DEFCONCEPT ITEM$POINT (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ITEM$POINT COMMUNICATION)
    (DOCUMENTATION ITEM$POINT
      "a distinct part that can be specified separately in a group of things that could
      be enumerated on a list; 'he noticed an item in the New York Times'; 'she had
      several items on her shopping list'; 'the main point on the agenda was taken up first'")
    (HAS-I-TOPIC ITEM$POINT |Factotum|) (WORD ITEM$POINT |item|)

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(WORD ITEM$POINT |point|))
(DEFCONCEPT KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
  MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND
  (SUBJECT
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    COGNITION)
  (DOCUMENTATION
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    "the choicest or most essential or most vital part of some idea or experience:
      'the gist of the prosecutor's argument'; 'the nub of the story'")
  (HAS-I-TOPIC
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |Factotum|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |kernel|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |substance|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |core|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |center|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |essence|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |gist|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |heart|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |inwardness|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |marrow|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |meat|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |nub|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
    MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
    |pith|)
  (WORD
    KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
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        MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
        |sum|)
    (WORD
        KERNEL$SUBSTANCE$CORE$CENTER$ESSENCE$GIST$HEART$INWARDNESS$
        MARROW$MEAT$NUB$PITH$SUM$NITTY-GRITTY
        |nitty-gritty|))
(DEFCONCEPT MEMBER_3 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT MEMBER_3 RELATIONS)
    (DOCUMENTATION MEMBER_3
      "anything that belongs to a set or class: 'snakes are members of the class Reptilia';
      'members of the opposite sex'")
    (HAS-I-TOPIC MEMBER_3 |Factotum|) (WORD MEMBER_3 |member|))
(DEFCONCEPT NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND
    (SUBJECT NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      OBJECTS)
    (DOCUMENTATION NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      "anything indispensable; 'food and shelter are necessities of life'; 'the essentials of the good life';
      'allow farmers to buy their requirements under favorable conditions';
      'a place where the requisites of water fuel and fodder can be obtained'")
    (HAS-I-TOPIC NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |Factotum|)
    (WORD NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |necessity|)
    (WORD NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |essential|)
    (WORD NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |requirement|)
    (WORD NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |requisite|)
    (WORD NECESSITY$ESSENTIAL$REQUIREMENT$REQUISITE$NECESSARY
      |necessary|))
(DEFCONCEPT OBJECT_1 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT OBJECT_1 COGNITION)
    (DOCUMENTATION OBJECT_1
      "the focus of cognitions or feelings; 'objects of thought'; 'the object of my affection'")
    (HAS-I-TOPIC OBJECT_1 |Factotum|) (WORD OBJECT_1 |object|))
(DEFCONCEPT PARING$PARINGS (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT PARING$PARINGS FOOD)
    (DOCUMENTATION PARING$PARINGS
      "a part that is pared or cut off; especially skin or peel")
    (HAS-I-TOPIC PARING$PARINGS |Factotum|)
    (WORD PARING$PARINGS |paring|) (WORD PARING$PARINGS |parings|))
(DEFCONCEPT PLACE_1 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT PLACE_1 COGNITION)
    (DOCUMENTATION PLACE_1
      "an abstract mental location; 'he has a special place in my thoughts'; 'a place in my heart';
      'a political system with no place for the less prominent groups'")
    (HAS-I-TOPIC PLACE_1 |Factotum|) (WORD PLACE_1 |place|))
(DEFCONCEPT PLACE_5 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT PLACE_5 STATES)
    (DOCUMENTATION PLACE_5
      "proper or appropriate position or location; 'a woman's place is no longer in the kitchen'")
    (HAS-I-TOPIC PLACE_5 |Factotum|) (WORD PLACE_5 |place|))
(DEFCONCEPT REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST RELATIONS)
    (DOCUMENTATION REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST
      "something left after other parts have been taken away; 'there was no remainder';
      'he threw away the rest'")
    (HAS-I-TOPIC REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |Factotum|)
    (WORD REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |remainder|)

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(WORD REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |residual|)
(WORD REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |residue|)
(WORD REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |residuum|)
(WORD REMAINDER$RESIDUAL$RESIDUE$RESIDUUM$REST |rest|))
(DEFCONCEPT REMAINS (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT REMAINS OBJECTS)
(DOCUMENTATION REMAINS
"any object that is left unused or still extant; 'I threw out the remains of my dinner'")
(HAS-I-TOPIC REMAINS |Factotum|) (WORD REMAINS |remains|)))
(DEFCONCEPT RIBBON$THREAD (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT RIBBON$THREAD OBJECTS)
(DOCUMENTATION RIBBON$THREAD
"any long object resembling a thin line; 'a mere ribbon of land';
'the lighted ribbon of traffic'; 'from the air the road was a gray thread';
'a thread of smoke climbed upward'")
(HAS-I-TOPIC RIBBON$THREAD |Factotum|) (WORD RIBBON$THREAD |ribbon|)
(WORD RIBBON$THREAD |thread|))
(DEFCONCEPT SUBPART (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT SUBPART RELATIONS)
(DOCUMENTATION SUBPART "a part of a part")
(HAS-I-TOPIC SUBPART |Factotum|) (WORD SUBPART |subpart|)))
(DEFCONCEPT TEACHER (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT TEACHER COGNITION)
(DOCUMENTATION TEACHER
"a personified abstraction that teaches; 'books were his teachers' or
'experience is a demanding teacher'")
(HAS-I-TOPIC TEACHER |Factotum|) (WORD TEACHER |teacher|)))
(DEFCONCEPT THEOREM_1 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT THEOREM_1 COGNITION)
(DOCUMENTATION THEOREM_1 "an idea accepted as a demonstrable truth")
(HAS-I-TOPIC THEOREM_1 |Factotum|) (WORD THEOREM_1 |theorem|)))
(DEFCONCEPT THING_3 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT THING_3 ARTIFACTS)
(DOCUMENTATION THING_3
"an entity that is not named specifically; 'I couldn't tell what the thing was'")
(HAS-I-TOPIC THING_3 |Factotum|) (WORD THING_3 |thing|)))
(DEFCONCEPT THING_5 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT THING_5 COGNITION)
(DOCUMENTATION THING_5
"a special abstraction; 'a thing of the spirit'; 'things of the heart'")
(HAS-I-TOPIC THING_5 |Factotum|) (WORD THING_5 |thing|)))
(DEFCONCEPT TRANSFERRED_PROPERTY$TRANSFERRED_POSSESSION (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT TRANSFERRED_PROPERTY$
TRANSFERRED_POSSESSION POSSESSION)
(DOCUMENTATION TRANSFERRED_PROPERTY$TRANSFERRED_POSSESSION
"a possession whose ownership changes or lapses")
(HAS-I-TOPIC TRANSFERRED_PROPERTY$TRANSFERRED_POSSESSION |Factotum|)
(WORD TRANSFERRED_PROPERTY$TRANSFERRED_POSSESSION
|transferred_property|)
(WORD TRANSFERRED_PROPERTY$TRANSFERRED_POSSESSION
|transferred_possession|)))
(DEFCONCEPT TREASURE_2 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT TREASURE_2 POSSESSION)
(DOCUMENTATION TREASURE_2
"any possession that is highly valued by its owner;
'the children returned from the seashore with their shells and other treasures'")
(HAS-I-TOPIC TREASURE_2 |Factotum|) (WORD TREASURE_2 |treasure|)))
(DEFCONCEPT UNIT_2 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)

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:AXIOMS (AND (SUBJECT UNIT_2 RELATIONS)
  (DOCUMENTATION UNIT_2
    "an individual or group or structure or other entity regarded as a structural or functional
      constituent of a whole; 'the reduced the number of units and installations';
      'the word is a basic linguistic unit'")
    (HAS-I-TOPIC UNIT_2 |Factotum|) (WORD UNIT_2 |unit|)))
(DEFCONCEPT UNKNOWN_QUANTITY (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT UNKNOWN_QUANTITY EVENTS)
  (DOCUMENTATION UNKNOWN_QUANTITY
    "a factor in a given situation whose bearing and importance is not apparent;
      'I don't know what the new man will do; he's still an unknown quantity'")
    (HAS-I-TOPIC UNKNOWN_QUANTITY |Factotum|)
    (WORD UNKNOWN_QUANTITY |unknown quantity|)))
(DEFCONCEPT VAGABOND_1 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT VAGABOND_1 OBJECTS)
  (DOCUMENTATION VAGABOND_1
    "anything that resembles a vagabond in having no fixed place;
      'pirate ships were vagabonds of the sea'")
    (HAS-I-TOPIC VAGABOND_1 |Factotum|) (WORD VAGABOND_1 |vagabond|)))
(DEFCONCEPT VARIABLE_2 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT VARIABLE_2 OBJECTS)
  (DOCUMENTATION VARIABLE_2
    "something that is likely to vary; something that is subject to variation;
      'the weather is one variable to be considered'")
    (HAS-I-TOPIC VARIABLE_2 |Factotum|) (WORD VARIABLE_2 |variable|)))
(DEFCONCEPT WALL_3 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT WALL_3 OBJECTS)
  (DOCUMENTATION WALL_3
    "anything that suggests a wall in structure or effect; 'a wall of water';
      'a wall of smoke'; 'a wall of prejudice'")
    (HAS-I-TOPIC WALL_3 |Factotum|) (WORD WALL_3 |wall|)))
(DEFCONCEPT WHITE_ELEPHANT_2 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT WHITE_ELEPHANT_2 POSSESSION)
  (DOCUMENTATION WHITE_ELEPHANT_2
    "a valuable possession whole upkeep is expensive")
    (HAS-I-TOPIC WHITE_ELEPHANT_2 |Factotum|)
    (WORD WHITE_ELEPHANT_2 |white_elephant|)))
(DEFCONCEPT WHOLE (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT WHOLE COGNITION)
  (DOCUMENTATION WHOLE
    "all of something including all its component elements or parts; 'Europe as a whole';
      'the whole of American literature'")
    (HAS-I-TOPIC WHOLE |Factotum|) (WORD WHOLE |whole|)))
(DEFCONCEPT ANGULAR_SHAPE$ANGULARITY (?SELF)
  :=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT ANGULAR_SHAPE$ANGULARITY SHAPES)
  (DOCUMENTATION ANGULAR_SHAPE$ANGULARITY
    "a shape having one or more sharp angles")
    (HAS-I-TOPIC ANGULAR_SHAPE$ANGULARITY |Factotum|)
    (WORD ANGULAR_SHAPE$ANGULARITY |angular_shape|)
    (WORD ANGULAR_SHAPE$ANGULARITY |angularity|)))
(DEFCONCEPT BLOB (?SELF)
  :=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT BLOB SHAPES)
  (DOCUMENTATION BLOB "an indistinct shapeless form")
    (HAS-I-TOPIC BLOB |Factotum|) (WORD BLOB |blob|)))
(DEFCONCEPT CIRCLE_2 (?SELF)
  :=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT CIRCLE_2 SHAPES)
  (DOCUMENTATION CIRCLE_2
    "something approximating the shape of a circle; 'the chairs were arranged in a circle'")
    (HAS-I-TOPIC CIRCLE_2 |Factotum|) (WORD CIRCLE_2 |circle|)))

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(DEFCONCEPT COLUMN$TOWER$PILLAR (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT COLUMN$TOWER$PILLAR SHAPES)
(DOCUMENTATION COLUMN$TOWER$PILLAR
"anything tall and thin approximating the shape of a column or tower;
'the test tube held a column of white powder'; 'a tower of dust rose above the horizon';
'a thin pillar of smoke betrayed their campsite'")
(HAS-I-TOPIC COLUMN$TOWER$PILLAR |Factotum|)
(WORD COLUMN$TOWER$PILLAR |column|)
(WORD COLUMN$TOWER$PILLAR |tower|)
(WORD COLUMN$TOWER$PILLAR |pillar|)))

(DEFCONCEPT CURVE (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT CURVE COMMUNICATION)
(DOCUMENTATION CURVE "a line on a graph representing data")
(HAS-I-TOPIC CURVE |Factotum|) (WORD CURVE |curve|)))

(DEFCONCEPT DISTORTED_SHAPE$DISTORTION (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT DISTORTED_SHAPE$DISTORTION SHAPES)
(DOCUMENTATION DISTORTED_SHAPE$DISTORTION
"a shape resulting from distortion")
(HAS-I-TOPIC DISTORTED_SHAPE$DISTORTION |Factotum|)
(WORD DISTORTED_SHAPE$DISTORTION |distorted_shape|)
(WORD DISTORTED_SHAPE$DISTORTION |distortion|)))

(DEFCONCEPT FIGURE_6 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT FIGURE_6 SHAPES)
(DOCUMENTATION FIGURE_6
"a combination of points and lines and planes that form a visible palpable shape")
(HAS-I-TOPIC FIGURE_6 |Factotum|) (WORD FIGURE_6 |figure|)))

(DEFCONCEPT FLARE_2 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT FLARE_2 SHAPES)
(DOCUMENTATION FLARE_2
"a shape that spreads outward; 'the skirt had a wide flare'")
(HAS-I-TOPIC FLARE_2 |Factotum|) (WORD FLARE_2 |flare|)))

(DEFCONCEPT INHERITANCE$HERITAGE_2 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT INHERITANCE$HERITAGE_2 ATTRIBUTES)
(DOCUMENTATION INHERITANCE$HERITAGE_2
"any attribute that passes from parent to offspring")
(HAS-I-TOPIC INHERITANCE$HERITAGE_2 |Factotum|)
(WORD INHERITANCE$HERITAGE_2 |inheritance|)
(WORD INHERITANCE$HERITAGE_2 |heritage|)))

(DEFCONCEPT MOON_1 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT MOON_1 OBJECTS)
(DOCUMENTATION MOON_1
"any object resembling a moon; 'he made a moon lamp that he used as a night light';
'the clock had a moon that showed various phases'")
(HAS-I-TOPIC MOON_1 |Factotum|) (WORD MOON_1 |moon|)))

(DEFCONCEPT PERSONALITY_1 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT PERSONALITY_1 ATTRIBUTES)
(DOCUMENTATION PERSONALITY_1
"the complex of all the attributes--behavioral, temperamental, emotional and mental
--that characterize a unique individual; 'their different reactions reflected their very
different personalities'; 'it is his nature to help others'")
(HAS-I-TOPIC PERSONALITY_1 |Factotum|)
(WORD PERSONALITY_1 |personality|)))

(DEFCONCEPT QUALITY_1 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT QUALITY_1 ATTRIBUTES)
(DOCUMENTATION QUALITY_1
"an essential and distinguishing attribute of something or someone;
'the quality of mercy is not strained'--Shakespeare")
(HAS-I-TOPIC QUALITY_1 |Factotum|) (WORD QUALITY_1 |quality|)))

(DEFCONCEPT ROUND_SHAPE (?SELF)
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:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT ROUND_SHAPE SHAPES)
  (DOCUMENTATION ROUND_SHAPE
    "a shape that is curved and without sharp angles")
  (HAS-I-TOPIC ROUND_SHAPE |Factotum|)
  (WORD ROUND_SHAPE |round_shape|))
(DEFCONCEPT SHAPELESSNESS_2 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT SHAPELESSNESS_2 SHAPES)
  (DOCUMENTATION SHAPELESSNESS_2
    "an amorphous or indefinite shape; 'a shapeless mass'")
  (HAS-I-TOPIC SHAPELESSNESS_2 |Factotum|)
  (WORD SHAPELESSNESS_2 |shapelessness|))
(DEFCONCEPT SOLID_1 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT SOLID_1 SHAPES)
  (DOCUMENTATION SOLID_1 "a three-dimensional shape")
  (HAS-I-TOPIC SOLID_1 |Factotum|) (WORD SOLID_1 |solid|))
(DEFCONCEPT THING_4 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT THING_4 ATTRIBUTES)
  (DOCUMENTATION THING_4
    "any attribute or quality considered as having its own existence: 'the thing I like about her is ...'")
  (HAS-I-TOPIC THING_4 |Factotum|) (WORD THING_4 |thing|))
(DEFCONCEPT TRAIT (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT TRAIT ATTRIBUTES)
  (DOCUMENTATION TRAIT
    "a distinguishing feature of one's personal nature")
  (HAS-I-TOPIC TRAIT |Factotum|) (WORD TRAIT |trait|))
(DEFCONCEPT WEB_3 (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT WEB_3 OBJECTS)
  (DOCUMENTATION WEB_3
    "an intricate network suggesting something that was formed by weaving or interweaving;
    'the trees cast a delicate web of shadows over the lawn'")
  (HAS-I-TOPIC WEB_3 |Factotum|) (WORD WEB_3 |web|))
(DEFCONCEPT BALDNESS$HAIRLESSNESS$PHALACROSIS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT BALDNESS$HAIRLESSNESS$PHALACROSIS STATES)
  (DOCUMENTATION BALDNESS$HAIRLESSNESS$PHALACROSIS
    "the condition of having no hair (especially on the top of the head)")
  (HAS-I-TOPIC BALDNESS$HAIRLESSNESS$PHALACROSIS |Factotum|)
  (WORD BALDNESS$HAIRLESSNESS$PHALACROSIS |baldness|)
  (WORD BALDNESS$HAIRLESSNESS$PHALACROSIS |hairlessness|)
  (WORD BALDNESS$HAIRLESSNESS$PHALACROSIS |phalacrosis|))
(DEFCONCEPT CELIBACY (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT CELIBACY STATES)
  (DOCUMENTATION CELIBACY
    "an unmarried status (as because of religious vows)")
  (HAS-I-TOPIC CELIBACY |Factotum|) (WORD CELIBACY |celibacy|))
(DEFCONCEPT COMFORT$COMFORTABLENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT COMFORT$COMFORTABLENESS STATES)
  (DOCUMENTATION COMFORT$COMFORTABLENESS
    "a state of being relaxed and feeling no pain; 'he is a man who enjoys his comfort';
    'she longed for the comfortableness of her armchair'")
  (HAS-I-TOPIC COMFORT$COMFORTABLENESS |Factotum|)
  (WORD COMFORT$COMFORTABLENESS |comfort|)
  (WORD COMFORT$COMFORTABLENESS |comfortableness|))
(DEFCONCEPT CONDITION_WN (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT CONDITION_WN STATES)
  (DOCUMENTATION CONDITION_WN
    "a mode of being or form of existence of a person or things: 'the human condition'")
  (HAS-I-TOPIC CONDITION_WN |Factotum|)
  (WORD CONDITION_WN |condition|))
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(DEFCONCEPT DISCOMFORT$UNCOMFORTABLENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT DISCOMFORT$UNCOMFORTABLENESS STATES)
(DOCUMENTATION DISCOMFORT$UNCOMFORTABLENESS
"the state of being tense and feeling pain")
(HAS-I-TOPIC DISCOMFORT$UNCOMFORTABLENESS |Factotum|)
(WORD DISCOMFORT$UNCOMFORTABLENESS |discomfort|)
(WORD DISCOMFORT$UNCOMFORTABLENESS |uncomfortableness|)))
(DEFCONCEPT DRYNESS$WATERLESSNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT DRYNESS$WATERLESSNESS STATES)
(DOCUMENTATION DRYNESS$WATERLESSNESS
"the condition of not containing or being covered by a liquid (especially water)")
(HAS-I-TOPIC DRYNESS$WATERLESSNESS |Factotum|)
(WORD DRYNESS$WATERLESSNESS |dryness|)
(WORD DRYNESS$WATERLESSNESS |waterlessness|)))
(DEFCONCEPT EMPTINESS_2 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT EMPTINESS_2 STATES)
(DOCUMENTATION EMPTINESS_2 "the state of containing nothing")
(HAS-I-TOPIC EMPTINESS_2 |Factotum|) (WORD EMPTINESS_2 |emptiness|)))
(DEFCONCEPT ENNOBLEMENT_2 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT ENNOBLEMENT_2 STATES)
(DOCUMENTATION ENNOBLEMENT_2 "the state of being noble")
(HAS-I-TOPIC ENNOBLEMENT_2 |Factotum|)
(WORD ENNOBLEMENT_2 |ennoblement|)))
(DEFCONCEPT FULLNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT FULLNESS STATES)
(DOCUMENTATION FULLNESS "the condition of being filled to capacity")
(HAS-I-TOPIC FULLNESS |Factotum|) (WORD FULLNESS |fullness|)))
(DEFCONCEPT GUILT$GUILTYNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT GUILT$GUILTYNESS STATES)
(DOCUMENTATION GUILT$GUILTYNESS
"the state of having committed an offense")
(HAS-I-TOPIC GUILT$GUILTYNESS |Factotum|)
(WORD GUILT$GUILTYNESS |guilt|) (WORD GUILT$GUILTYNESS |guiltiness|)))
(DEFCONCEPT HOPEFULNESS_2 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT HOPEFULNESS_2 STATES)
(DOCUMENTATION HOPEFULNESS_2 "full of hope")
(HAS-I-TOPIC HOPEFULNESS_2 |Factotum|)
(WORD HOPEFULNESS_2 |hopefulness|)))
(DEFCONCEPT ILLUMINATION (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT ILLUMINATION STATES)
(DOCUMENTATION ILLUMINATION
"the degree of visibility of your environment")
(HAS-I-TOPIC ILLUMINATION |Factotum|)
(WORD ILLUMINATION |illumination|)))
(DEFCONCEPT IMMATURITY$IMMATURENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT IMMATURITY$IMMATURENESS STATES)
(DOCUMENTATION IMMATURITY$IMMATURENESS
"not having reached maturity")
(HAS-I-TOPIC IMMATURITY$IMMATURENESS |Factotum|)
(WORD IMMATURITY$IMMATURENESS |immaturity|)
(WORD IMMATURITY$IMMATURENESS |immatureness|)))
(DEFCONCEPT IMMINENCE$IMMINENCY$IMPENDENCE$IMPENDENCY$FORTHCOMINGNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND
(SUBJECT IMMINENCE$IMMINENCY$IMPENDENCE$IMPENDENCY$FORTHCOMINGNESS
STATES)
(DOCUMENTATION
IMMINENCE$IMMINENCY$IMPENDENCE$IMPENDENCY$FORTHCOMINGNESS
"the state of being imminent and liable to happen soon")

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(HAS-I-TOPIC
IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|Factotum|)
(WORD IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|imminence|)
(WORD IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|imminency|)
(WORD IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|impedence|)
(WORD IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|impedency|)
(WORD IMMINENCE$IMMINENCY$IMPEDENCE$IMPEDENCY$FORTHCOMINGNESS
|forthcomingness|))
(DEFCONCEPT IMPERFECTION$IMPERFECTNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT IMPERFECTION$IMPERFECTNESS STATES)
(DOCUMENTATION IMPERFECTION$IMPERFECTNESS
"the state or an instance of being imperfect")
(HAS-I-TOPIC IMPERFECTION$IMPERFECTNESS |Factotum|)
(WORD IMPERFECTION$IMPERFECTNESS |imperfection|)
(WORD IMPERFECTION$IMPERFECTNESS |imperfectness|)))
(DEFCONCEPT IMPURITY$IMPURENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT IMPURITY$IMPURENESS STATES)
(DOCUMENTATION IMPURITY$IMPURENESS "the condition of being impure")
(HAS-I-TOPIC IMPURITY$IMPURENESS |Factotum|)
(WORD IMPURITY$IMPURENESS |impurity|)
(WORD IMPURITY$IMPURENESS |impureness|)))
(DEFCONCEPT INNOCENCE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT INNOCENCE STATES)
(DOCUMENTATION INNOCENCE
"a state or condition of being innocent of a specific crime or offense;
'the trial established his innocence'")
(HAS-I-TOPIC INNOCENCE |Factotum|) (WORD INNOCENCE |innocence|)))
(DEFCONCEPT INTEGRITY$UNITY$WHOLENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT INTEGRITY$UNITY$WHOLENESS STATES)
(DOCUMENTATION INTEGRITY$UNITY$WHOLENESS
"an unbroken or unbroken completeness or totality")
(HAS-I-TOPIC INTEGRITY$UNITY$WHOLENESS |Factotum|)
(WORD INTEGRITY$UNITY$WHOLENESS |integrity|)
(WORD INTEGRITY$UNITY$WHOLENESS |unity|)
(WORD INTEGRITY$UNITY$WHOLENESS |wholeness|)))
(DEFCONCEPT MATURITY$MATURITY$MATURENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT MATURITY$MATURITY$MATURENESS STATES)
(DOCUMENTATION MATURITY$MATURITY$MATURENESS
"state of being mature; full development")
(HAS-I-TOPIC MATURITY$MATURITY$MATURENESS |Factotum|)
(WORD MATURITY$MATURITY$MATURENESS |maturity|)
(WORD MATURITY$MATURITY$MATURENESS |matureness|)))
(DEFCONCEPT NOISE_CONDITIONS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT NOISE_CONDITIONS STATES)
(DOCUMENTATION NOISE_CONDITIONS
"the condition of being noisy (as in a communication channel)")
(HAS-I-TOPIC NOISE_CONDITIONS |Factotum|)
(WORD NOISE_CONDITIONS |noise_conditions|)))
(DEFCONCEPT PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA STATES)
(DOCUMENTATION PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA
"the state of being without a flaw or defect")
(HAS-I-TOPIC PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA |Factotum|)
(WORD PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA |perfection|)
(WORD PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA |flawlessness|)
(WORD PERFECTION$FLAWLESSNESS$NE_PLUS_ULTRA |ne_plus_ultra|)))

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(DEFCONCEPT POLARIZATION (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT POLARIZATION STATES)
(DOCUMENTATION POLARIZATION
"the condition of having or giving polarity")
(HAS-I-TOPIC POLARIZATION |Factotum|)
(WORD POLARIZATION |polarization|)))
(DEFCONCEPT PROPERTY_WN (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT PROPERTY_WN ATTRIBUTES)
(DOCUMENTATION PROPERTY_WN
"a basic or essential attribute shared by all members of a class;
'a study of the physical properties of atomic particles'")
(HAS-I-TOPIC PROPERTY_WN |Factotum|) (WORD PROPERTY_WN |property|)))
(DEFCONCEPT PURITY$PURENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT PURITY$PURENESS STATES)
(DOCUMENTATION PURITY$PURENESS
"being undiluted or unmixed with extraneous material")
(HAS-I-TOPIC PURITY$PURENESS |Factotum|)
(WORD PURITY$PURENESS |purity|) (WORD PURITY$PURENESS |pureness|)))
(DEFCONCEPT PURITY$SINLESSNESS$INNOCENCE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT PURITY$SINLESSNESS$INNOCENCE STATES)
(DOCUMENTATION PURITY$SINLESSNESS$INNOCENCE
"the state of being free from sin or moral wrong; lacking a knowledge of evil")
(HAS-I-TOPIC PURITY$SINLESSNESS$INNOCENCE |Factotum|)
(WORD PURITY$SINLESSNESS$INNOCENCE |purity|)
(WORD PURITY$SINLESSNESS$INNOCENCE |sinlessness|)
(WORD PURITY$SINLESSNESS$INNOCENCE |innocence|)))
(DEFCONCEPT READING$METER_READING_2 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT READING$METER_READING_2 COGNITION)
(DOCUMENTATION READING$METER_READING_2
"the data presented to a user by a meter or similar instrument;
'he could not believe the meter reading'")
(HAS-I-TOPIC READING$METER_READING_2 |Factotum|)
(WORD READING$METER_READING_2 |reading|)
(WORD READING$METER_READING_2 |meter reading|)))
(DEFCONCEPT SILENCE (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT SILENCE STATES)
(DOCUMENTATION SILENCE
"the state of being silent (as when no one is speaking); 'there was a shocked silence':
'he gestured for silence'")
(HAS-I-TOPIC SILENCE |Factotum|) (WORD SILENCE |silence|)))
(DEFCONCEPT SKILLFULNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT SKILLFULNESS COGNITION)
(DOCUMENTATION SKILLFULNESS
"the state of being cognitively skillful")
(HAS-I-TOPIC SKILLFULNESS |Factotum|)
(WORD SKILLFULNESS |skillfulness|)))
(DEFCONCEPT SPACE_1 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT SPACE_1 TOPS)
(DOCUMENTATION SPACE_1
"the unlimited 3-dimensional expanse in which everything is located;
'they tested his ability to locate objects in space'")
(HAS-I-TOPIC SPACE_1 |Factotum|) (WORD SPACE_1 |space|)))
(DEFCONCEPT SUSCEPTIBILITY$SUSCEPTIBLENESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT SUSCEPTIBILITY$SUSCEPTIBLENESS STATES)
(DOCUMENTATION SUSCEPTIBILITY$SUSCEPTIBLENESS
"the state of being susceptible; easily affected")
(HAS-I-TOPIC SUSCEPTIBILITY$SUSCEPTIBLENESS |Factotum|)
(WORD SUSCEPTIBILITY$SUSCEPTIBLENESS |susceptibility|)
(WORD SUSCEPTIBILITY$SUSCEPTIBLENESS |susceptible|)))
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(DEFCONCEPT TENSION$TENSITY$TENSENESS$TAUTNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT TENSION$TENSITY$TENSENESS$TAUTNESS STATES)
(DOCUMENTATION TENSION$TENSITY$TENSENESS$TAUTNESS
"the physical condition of being stretched or strained; 'it places great tension on the leg muscles';
'he could feel the tenseness of her body'; 'the violinist adjusted the tension of the strings'")
(HAS-I-TOPIC TENSION$TENSITY$TENSENESS$TAUTNESS |Factotum|)
(WORD TENSION$TENSITY$TENSENESS$TAUTNESS |tension|)
(WORD TENSION$TENSITY$TENSENESS$TAUTNESS |tensity|)
(WORD TENSION$TENSITY$TENSENESS$TAUTNESS |tenseness|)
(WORD TENSION$TENSITY$TENSENESS$TAUTNESS |tautness|)))
(DEFCONCEPT UNSUSCEPTIBILITY$IMMUNITY (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT UNSUSCEPTIBILITY$IMMUNITY STATES)
(DOCUMENTATION UNSUSCEPTIBILITY$IMMUNITY
"the state of not being susceptible: 'unsusceptibility to rust'; 'immunity to disease'")
(HAS-I-TOPIC UNSUSCEPTIBILITY$IMMUNITY |Factotum|)
(WORD UNSUSCEPTIBILITY$IMMUNITY |unsusceptibility|)
(WORD UNSUSCEPTIBILITY$IMMUNITY |immunity|)))
(DEFCONCEPT WETNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT WETNESS STATES)
(DOCUMENTATION WETNESS
"the condition of containing or being covered by a liquid (especially water);
'he confirmed the wetness of the paint'")
(HAS-I-TOPIC WETNESS |Factotum|) (WORD WETNESS |wetness|)))
(DEFCONCEPT ABILITY$POWER (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT ABILITY$POWER COGNITION)
(DOCUMENTATION ABILITY$POWER
"possession of the qualities (especially mental qualities) required to do
something or get something done; 'danger heightened his powers of discrimination'")
(HAS-I-TOPIC ABILITY$POWER |Factotum|)
(WORD ABILITY$POWER |ability|) (WORD ABILITY$POWER |power|)))
(DEFCONCEPT ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND
(SUBJECT ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY COGNITION)
(DOCUMENTATION ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
"personal knowledge or information about someone or something")
(HAS-I-TOPIC ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
|Factotum|)
(WORD ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
|acquaintance|)
(WORD ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
|familiarity|)
(WORD ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
|conversance|)
(WORD ACQUAINTANCE$FAMILIARITY$CONVERSANCE$CONVERSANCY
|conversancy|)))
(DEFCONCEPT AFFINITY$KINSHIP (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT AFFINITY$KINSHIP RELATIONS)
(DOCUMENTATION AFFINITY$KINSHIP
"a close connection marked by community of interests or similarity in nature or character:
'found a natural affinity with the immigrants'; 'felt a deep kinship with the other students';
'anthropology's kinship with the humanities'")
(HAS-I-TOPIC AFFINITY$KINSHIP |Factotum|)
(WORD AFFINITY$KINSHIP |affinity|) (WORD AFFINITY$KINSHIP |kinship|)))
(DEFCONCEPT ANA_1 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT ANA_1 GROUPS)
(DOCUMENTATION ANA_1
"a collection of anecdotes about a person or place")
(HAS-I-TOPIC ANA_1 |Factotum|) (WORD ANA_1 |ana|)))
(DEFCONCEPT APOLOGY_1 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT APOLOGY_1 COGNITION)
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        (DOCUMENTATION APOLOGY_1
         "a poor example; 'it was an apology for a meal'")
        (HAS-I-TOPIC APOLOGY_1 |Factotum|) (WORD APOLOGY_1 |apology|))
(DEFCONCEPT ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT ARRANGEMENT$ORGANIZATION$ORGANISATION$
              SYSTEM COGNITION)
            (DOCUMENTATION ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM
             "an organized structure for arranging or classifying; 'he changed the arrangement of the topics';
              'the facts were familiar but it was in the organization of them that he was original';
              'he tried to understand their system of classification'")
            (HAS-I-TOPIC ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM
             |Factotum|)
            (WORD ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM |arrangement|)
            (WORD ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM |organization|)
            (WORD ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM |organisation|)
            (WORD ARRANGEMENT$ORGANIZATION$ORGANISATION$SYSTEM |system|)))
(DEFCONCEPT ARRANGEMENT_2 (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT ARRANGEMENT_2 GROUPS)
            (DOCUMENTATION ARRANGEMENT_2
             "an orderly grouping (of things or persons)")
            (HAS-I-TOPIC ARRANGEMENT_2 |Factotum|)
            (WORD ARRANGEMENT_2 |arrangement|)))
(DEFCONCEPT CAUSALITY (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT CAUSALITY RELATIONS)
            (DOCUMENTATION CAUSALITY "the relation between causes and effects")
            (HAS-I-TOPIC CAUSALITY |Factotum|) (WORD CAUSALITY |causality|)))
(DEFCONCEPT CHANGE_8 (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT CHANGE_8 RELATIONS)
            (DOCUMENTATION CHANGE_8
             "a relational difference between states; especially between states before and after some event:
              'he attributed the change to their marriage'")
            (HAS-I-TOPIC CHANGE_8 |Factotum|) (WORD CHANGE_8 |change|)))
(DEFCONCEPT CHEERFULNESS$CHEER (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT CHEERFULNESS$CHEER ATTRIBUTES)
            (DOCUMENTATION CHEERFULNESS$CHEER
             "the quality of being cheerful and dispelling gloom; 'flowers added a note of cheerfulness
              to the drab room'")
            (HAS-I-TOPIC CHEERFULNESS$CHEER |Factotum|)
            (WORD CHEERFULNESS$CHEER |cheerfulness|)
            (WORD CHEERFULNESS$CHEER |cheer|)))
(DEFCONCEPT CLASS$CATEGORY$FAMILY (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT CLASS$CATEGORY$FAMILY GROUPS)
            (DOCUMENTATION CLASS$CATEGORY$FAMILY
             "a collection of things sharing a common attribute; 'there are two classes of detergents'")
            (HAS-I-TOPIC CLASS$CATEGORY$FAMILY |Factotum|)
            (WORD CLASS$CATEGORY$FAMILY |class|)
            (WORD CLASS$CATEGORY$FAMILY |category|)
            (WORD CLASS$CATEGORY$FAMILY |family|)))
(DEFCONCEPT COMPARISON (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT COMPARISON RELATIONS)
            (DOCUMENTATION COMPARISON
             "relation based on similarities and differences")
            (HAS-I-TOPIC COMPARISON |Factotum|) (WORD COMPARISON |comparison|)))
(DEFCONCEPT CONNECTION$CONNEXION$CONNECTEDNESS (?SELF)
 :=> (S-DESCRIPTION ?SELF)
 :AXIOMS (AND (SUBJECT CONNECTION$CONNEXION$CONNECTEDNESS RELATIONS)
            (DOCUMENTATION CONNECTION$CONNEXION$CONNECTEDNESS
             "a relation between things or events (as in the case of one causing the other or
              sharing features with it); 'there was a connection between eating that pickle and having
              that nightmare'")
            (HAS-I-TOPIC CONNECTION$CONNEXION$CONNECTEDNESS |Factotum|)

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(WORD CONNECTION$CONNECTION$CONNECTEDNESS |connection|)
(WORD CONNECTION$CONNECTION$CONNECTEDNESS |connexion|)
(WORD CONNECTION$CONNECTION$CONNECTEDNESS |connectedness|))
(DEFCONCEPT CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT COGNITION)
(DOCUMENTATION CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT
"the sum or range of what has been perceived, discovered, or learned")
(HAS-I-TOPIC CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT |Factotum|)
(WORD CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT |content|)
(WORD CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT |cognitive content|)
(WORD CONTENT$COGNITIVE_CONTENT$MENTAL_OBJECT |mental object|)))
(DEFCONCEPT CONTROL_5 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT CONTROL_5 RELATIONS)
(DOCUMENTATION CONTROL_5
"a relation of constraint of one entity (thing or person or group) by another;
'measures for the control of disease'; 'they instituted controls over drinking on campus'")
(HAS-I-TOPIC CONTROL_5 |Factotum|) (WORD CONTROL_5 |control|)))
(DEFCONCEPT COURSE_1 (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT COURSE_1 ACTS)
(DOCUMENTATION COURSE_1
"a mode of action; 'if you persist in that course you will surely fail'")
(HAS-I-TOPIC COURSE_1 |Factotum|) (WORD COURSE_1 |course|)))
(DEFCONCEPT ETHOS (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT ETHOS ATTRIBUTES)
(DOCUMENTATION ETHOS
"the distinctive spirit of a people or an era; 'the Greek ethos'")
(HAS-I-TOPIC ETHOS |Factotum|) (WORD ETHOS |ethos|)))
(DEFCONCEPT EXCEPTION_1 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT EXCEPTION_1 COGNITION)
(DOCUMENTATION EXCEPTION_1
"an instance that does not conform to a rule or generalization; 'all her children were brilliant;
the only exception was her last child'; 'an exception tests the rule'")
(HAS-I-TOPIC EXCEPTION_1 |Factotum|) (WORD EXCEPTION_1 |exception|)))
(DEFCONCEPT FOUNDATION_2 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT FOUNDATION_2 RELATIONS)
(DOCUMENTATION FOUNDATION_2
"the basis on which something is grounded; 'there is little foundation for his objections'")
(HAS-I-TOPIC FOUNDATION_2 |Factotum|)
(WORD FOUNDATION_2 |foundation|)))
(DEFCONCEPT FUNCTION_2 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT FUNCTION_2 RELATIONS)
(DOCUMENTATION FUNCTION_2
"a relation such that one thing is dependent on another; 'height is a function of age';
'price is a function of supply and demand'")
(HAS-I-TOPIC FUNCTION_2 |Factotum|) (WORD FUNCTION_2 |function|)))
(DEFCONCEPT HYPOTHESIS$POSSIBILITY$THEORY (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT HYPOTHESIS$POSSIBILITY$THEORY COGNITION)
(DOCUMENTATION HYPOTHESIS$POSSIBILITY$THEORY
"a concept that is not yet verified but that if true would explain certain facts or phenomena;
'he proposed a fresh theory of alkalis that later was accepted in chemical practices'")
(HAS-I-TOPIC HYPOTHESIS$POSSIBILITY$THEORY |Factotum|)
(WORD HYPOTHESIS$POSSIBILITY$THEORY |hypothesis|)
(WORD HYPOTHESIS$POSSIBILITY$THEORY |possibility|)
(WORD HYPOTHESIS$POSSIBILITY$THEORY |theory|)))
(DEFCONCEPT INABILITY (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT INABILITY COGNITION)
(DOCUMENTATION INABILITY
"lack of ability (especially mental ability) to do something")
(HAS-I-TOPIC INABILITY |Factotum|) (WORD INABILITY |inability|)))
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(DEFCONCEPT INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND
(SUBJECT INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS RELATIONS)
(DOCUMENTATION INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS
"mutual or reciprocal relation or relatedness: 'interrelationships of animal structure and function'")
(HAS-I-TOPIC INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS
|Factotum|)
(WORD INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS
|interrelation|)
(WORD INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS
|interrelationship|)
(WORD INTERRELATION$INTERRELATIONSHIP$INTERRELATEDNESS
|interrelatedness|)))
(DEFCONCEPT LAW$LAW_OF_NATURE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT LAW$LAW_OF_NATURE COGNITION)
(DOCUMENTATION LAW$LAW_OF_NATURE
"a generalization based on recurring facts or events (in science or mathematics etc):
'the laws of thermodynamics")
(HAS-I-TOPIC LAW$LAW_OF_NATURE |Factotum|)
(WORD LAW$LAW_OF_NATURE |law|)
(WORD LAW$LAW_OF_NATURE |law of nature|)))
(DEFCONCEPT LAW$NATURAL_LAW (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT LAW$NATURAL_LAW COGNITION)
(DOCUMENTATION LAW$NATURAL_LAW
"a rule or body of rules of conduct inherent in human nature and essential to or
binding upon human society")
(HAS-I-TOPIC LAW$NATURAL_LAW |Factotum|)
(WORD LAW$NATURAL_LAW |law|) (WORD LAW$NATURAL_LAW |natural law|)))
(DEFCONCEPT MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT MESSAGE$CONTENT$SUBJECT_MATTER$
SUBSTANCE COMMUNICATION)
(DOCUMENTATION MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE
"what a communication that is about something is about")
(HAS-I-TOPIC MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE |Factotum|)
(WORD MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE |message|)
(WORD MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE |content|)
(WORD MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE |subject matter|)
(WORD MESSAGE$CONTENT$SUBJECT_MATTER$SUBSTANCE |substance|)))
(DEFCONCEPT MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$
WORD_STRUCTURE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND
(SUBJECT
MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$WORD_STRUCTURE
COGNITION)
(DOCUMENTATION
MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$WORD_STRUCTURE
"the admissible arrangement of sounds in words")
(HAS-I-TOPIC
MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$WORD_STRUCTURE
|Factotum|)
(WORD MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$
WORD_STRUCTURE
|morphology|)
(WORD MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$
WORD_STRUCTURE
|sound structure|)
(WORD MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$
WORD_STRUCTURE
|syllable structure|)
(WORD MORPHOLOGY$SOUND_STRUCTURE$SYLLABLE_STRUCTURE$
WORD_STRUCTURE
|word structure|)))
(DEFCONCEPT OPPOSITION$OPPOSITENESS (?SELF)
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:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT OPPOSITION$OPPOSITENESS RELATIONS)
  (DOCUMENTATION OPPOSITION$OPPOSITENESS
    "the relation between opposed entities")
  (HAS-I-TOPIC OPPOSITION$OPPOSITENESS |Factotum|)
  (WORD OPPOSITION$OPPOSITENESS |opposition|)
  (WORD OPPOSITION$OPPOSITENESS |oppositeness|)))
(DEFCONCEPT POSITION$SPATIAL_RELATION (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT POSITION$SPATIAL_RELATION ATTRIBUTES)
  (DOCUMENTATION POSITION$SPATIAL_RELATION
    "the spatial property of a place where or way in which something is situated;
    'the position of the hands on the clock'; 'he specified the spatial relations of
    every piece of furniture on the stage'")
  (HAS-I-TOPIC POSITION$SPATIAL_RELATION |Factotum|)
  (WORD POSITION$SPATIAL_RELATION |position|)
  (WORD POSITION$SPATIAL_RELATION |spatial relation|)))
(DEFCONCEPT PRACTICE$PATTERN (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT PRACTICE$PATTERN ACTS)
  (DOCUMENTATION PRACTICE$PATTERN
    "a customary way of operation or behavior; 'it is their practice to give annual raises';
    'they changed their dietary pattern'")
  (HAS-I-TOPIC PRACTICE$PATTERN |Factotum|)
  (WORD PRACTICE$PATTERN |practice|) (WORD PRACTICE$PATTERN |pattern|)))
(DEFCONCEPT PROFESSIONAL_RELATION (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT PROFESSIONAL_RELATION RELATIONS)
  (DOCUMENTATION PROFESSIONAL_RELATION
    "the relation that exists when one person requests and is granted professional
    help from a qualified source")
  (HAS-I-TOPIC PROFESSIONAL_RELATION |Factotum|)
  (WORD PROFESSIONAL_RELATION |professional_relation|)))
(DEFCONCEPT PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE COGNITION)
  (DOCUMENTATION PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE
    "knowledge that is available to anyone")
  (HAS-I-TOPIC PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE |Factotum|)
  (WORD PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE |public knowledge|)
  (WORD PUBLIC_KNOWLEDGE$GENERAL_KNOWLEDGE |general knowledge|)))
(DEFCONCEPT QUINTESSENCE_1 (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT QUINTESSENCE_1 COGNITION)
  (DOCUMENTATION QUINTESSENCE_1
    "the most typical example or representative of a type")
  (HAS-I-TOPIC QUINTESSENCE_1 |Factotum|)
  (WORD QUINTESSENCE_1 |quintessence|)))
(DEFCONCEPT RECIPROCALITY$RECIPROCITY (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT RECIPROCALITY$RECIPROCITY RELATIONS)
  (DOCUMENTATION RECIPROCALITY$RECIPROCITY
    "a relation of mutual dependence or action or influence")
  (HAS-I-TOPIC RECIPROCALITY$RECIPROCITY |Factotum|)
  (WORD RECIPROCALITY$RECIPROCITY |reciprocality|)
  (WORD RECIPROCALITY$RECIPROCITY |reciprocity|)))
(DEFCONCEPT RELATIONS$DEALINGS (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT RELATIONS$DEALINGS RELATIONS)
  (DOCUMENTATION RELATIONS$DEALINGS
    "mutual dealings or connections or communications among persons or groups")
  (HAS-I-TOPIC RELATIONS$DEALINGS |Factotum|)
  (WORD RELATIONS$DEALINGS |relations|)
  (WORD RELATIONS$DEALINGS |dealings|)))
(DEFCONCEPT RELATIONSHIP$HUMAN_RELATIONSHIP (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT RELATIONSHIP$HUMAN_RELATIONSHIP RELATIONS)
  (DOCUMENTATION RELATIONSHIP$HUMAN_RELATIONSHIP
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        ('relationship' is often used where 'relation' would serve (as in 'the relationship
        between inflation and unemployment') preferred usage of 'relationship' is for human
        relations or states of relatedness; 'the relationship between mothers and children'")
        (HAS-I-TOPIC RELATIONSHIP$HUMAN_RELATIONSHIP |Factotum|)
        (WORD RELATIONSHIP$HUMAN_RELATIONSHIP |relationship|)
        (WORD RELATIONSHIP$HUMAN_RELATIONSHIP |human_relationship|)))
(DEFCONCEPT RULE$REGULATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT RULE$REGULATION COGNITION)
    (DOCUMENTATION RULE$REGULATION
      "a principle or condition that customarily governs behavior; 'it was his rule to take
      a walk before breakfast'; 'short haircuts were the regulation'")
    (HAS-I-TOPIC RULE$REGULATION |Factotum|)
    (WORD RULE$REGULATION |rule|) (WORD RULE$REGULATION |regulation|)))
(DEFCONCEPT SPECIMEN_2 (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT SPECIMEN_2 COGNITION)
    (DOCUMENTATION SPECIMEN_2
      "an example regarded as typical of its class")
    (HAS-I-TOPIC SPECIMEN_2 |Factotum|) (WORD SPECIMEN_2 |specimen|)))
(DEFCONCEPT STANDARD_OF_LIVING$STANDARD_OF_LIFE (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT STANDARD_OF_LIVING$STANDARD_OF_LIFE STATES)
    (DOCUMENTATION STANDARD_OF_LIVING$STANDARD_OF_LIFE
      "a level of material comfort in terms of goods and services available to someone")
    (HAS-I-TOPIC STANDARD_OF_LIVING$STANDARD_OF_LIFE |Factotum|)
    (WORD STANDARD_OF_LIVING$STANDARD_OF_LIFE |standard_of_living|)
    (WORD STANDARD_OF_LIVING$STANDARD_OF_LIFE |standard_of_life|)))
(DEFCONCEPT TIP-OFF (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT TIP-OFF COGNITION)
    (DOCUMENTATION TIP-OFF
      "inside information that something is going to happen")
    (HAS-I-TOPIC TIP-OFF |Factotum|) (WORD TIP-OFF |tip-off|)))
(DEFCONCEPT UNCHEERFULNESS (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT UNCHEERFULNESS ATTRIBUTES)
    (DOCUMENTATION UNCHEERFULNESS
      "not conducive to cheer or good spirits")
    (HAS-I-TOPIC UNCHEERFULNESS |Factotum|)
    (WORD UNCHEERFULNESS |uncheerfulness|)))
(DEFCONCEPT UNCONNECTEDNESS (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT UNCONNECTEDNESS RELATIONS)
    (DOCUMENTATION UNCONNECTEDNESS
      "the lack of a connection between things")
    (HAS-I-TOPIC UNCONNECTEDNESS |Factotum|)
    (WORD UNCONNECTEDNESS |unconnectedness|)))
(DEFCONCEPT ABNORMALITY$ABNORMALCY (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ABNORMALITY$ABNORMALCY STATES)
    (DOCUMENTATION ABNORMALITY$ABNORMALCY "an abnormal condition")
    (HAS-I-TOPIC ABNORMALITY$ABNORMALCY |Factotum|)
    (WORD ABNORMALITY$ABNORMALCY |abnormality|)
    (WORD ABNORMALITY$ABNORMALCY |abnormalcy|)))
(DEFCONCEPT ACTION$ACTIVITY$ACTIVENESS (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ACTION$ACTIVITY$ACTIVENESS STATES)
    (DOCUMENTATION ACTION$ACTIVITY$ACTIVENESS
      "the state of being active; 'his sphere of activity'; 'he is out of action'")
    (HAS-I-TOPIC ACTION$ACTIVITY$ACTIVENESS |Factotum|)
    (WORD ACTION$ACTIVITY$ACTIVENESS |action|)
    (WORD ACTION$ACTIVITY$ACTIVENESS |activity|)
    (WORD ACTION$ACTIVITY$ACTIVENESS |activeness|)))
(DEFCONCEPT ATMOSPHERE$AMBIANCE$AMBIENCE (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ATMOSPHERE$AMBIANCE$AMBIENCE STATES)
    (DOCUMENTATION ATMOSPHERE$AMBIANCE$AMBIENCE

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"a particular environment or surrounding influence; 'there was an atmosphere of excitement'"
(HAS-I-TOPIC ATMOSPHERE$AMBIANCE$AMBIENCE |Factotum|)
(WORD ATMOSPHERE$AMBIANCE$AMBIENCE |atmosphere|)
(WORD ATMOSPHERE$AMBIANCE$AMBIENCE |ambiance|)
(WORD ATMOSPHERE$AMBIANCE$AMBIENCE |ambiance|))
(DEFCONCEPT BACKGROUND$BACKGROUND_KNOWLEDGE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT BACKGROUND$BACKGROUND_KNOWLEDGE COGNITION)
(DOCUMENTATION BACKGROUND$BACKGROUND_KNOWLEDGE
"information that is essential to understanding a situation or problem;
'the embassy filled him in on the background of the incident'")
(HAS-I-TOPIC BACKGROUND$BACKGROUND_KNOWLEDGE |Factotum|)
(WORD BACKGROUND$BACKGROUND_KNOWLEDGE |background|)
(WORD BACKGROUND$BACKGROUND_KNOWLEDGE |background knowledge|))
(DEFCONCEPT BEING$BEINGNESS$EXISTENCE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT BEING$BEINGNESS$EXISTENCE STATES)
(DOCUMENTATION BEING$BEINGNESS$EXISTENCE
"the state or fact of existing: 'a point of view gradually coming into being';
'laws in existence for centuries'")
(HAS-I-TOPIC BEING$BEINGNESS$EXISTENCE |Factotum|)
(WORD BEING$BEINGNESS$EXISTENCE |being|)
(WORD BEING$BEINGNESS$EXISTENCE |beingness|)
(WORD BEING$BEINGNESS$EXISTENCE |existence|))
(DEFCONCEPT CHANGE_1 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CHANGE_1 ACTS)
(DOCUMENTATION CHANGE_1
"the act of changing something; 'the change of government had no impact on the economy';
'his change on abortion cost him the election'")
(HAS-I-TOPIC CHANGE_1 |Factotum|) (WORD CHANGE_1 |change|))
(DEFCONCEPT CIRCUMSTANCE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CIRCUMSTANCE STATES)
(DOCUMENTATION CIRCUMSTANCE
"a condition that accompanies or influences some event or activity")
(HAS-I-TOPIC CIRCUMSTANCE |Factotum|)
(WORD CIRCUMSTANCE |circumstance|))
(DEFCONCEPT CIRCUMSTANCE$CONDITION$CONSIDERATION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CIRCUMSTANCE$CONDITION$CONSIDERATION COGNITION)
(DOCUMENTATION CIRCUMSTANCE$CONDITION$CONSIDERATION
"information that should be kept in mind when making a decision; 'another consideration
is the time it would take'")
(HAS-I-TOPIC CIRCUMSTANCE$CONDITION$CONSIDERATION |Factotum|)
(WORD CIRCUMSTANCE$CONDITION$CONSIDERATION |circumstance|)
(WORD CIRCUMSTANCE$CONDITION$CONSIDERATION |condition|)
(WORD CIRCUMSTANCE$CONDITION$CONSIDERATION |consideration|))
(DEFCONCEPT CONDITIONALITY (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CONDITIONALITY STATES)
(DOCUMENTATION CONDITIONALITY "the state of being conditional")
(HAS-I-TOPIC CONDITIONALITY |Factotum|)
(WORD CONDITIONALITY |conditionality|))
(DEFCONCEPT CONFIGURATION$CONSTELLATION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CONFIGURATION$CONSTELLATION COGNITION)
(DOCUMENTATION CONFIGURATION$CONSTELLATION
"an arrangement of parts or elements; 'the outcome depends on the configuration of
influences at the time'")
(HAS-I-TOPIC CONFIGURATION$CONSTELLATION |Factotum|)
(WORD CONFIGURATION$CONSTELLATION |configuration|)
(WORD CONFIGURATION$CONSTELLATION |constellation|))
(DEFCONCEPT CONFLICT_4 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CONFLICT_4 STATES)
(DOCUMENTATION CONFLICT_4
"a state of opposition between persons or ideas or interests; 'his conflict of interest
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        made him ineligible for the post'; 'a conflict of loyalties'")
        (HAS-I-TOPIC CONFLICT_4 |Factotum|) (WORD CONFLICT_4 |conflict|))
(DEFCONCEPT CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND
        (SUBJECT CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT PHENOMENA)
        (DOCUMENTATION CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT
        "a phenomenon that follows and is caused by some previous phenomenon; 'the magnetic
        effect was greater when the rod was lengthwise'; 'his decision had depressing
        consequences for business'")
        (HAS-I-TOPIC CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT
        |Factotum|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |consequence|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |effect|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |outcome|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |result|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |issue|)
        (WORD CONSEQUENCE$EFFECT$OUTCOME$RESULT$ISSUE$UPSHOT |upshot|)))
(DEFCONCEPT DANGER_2 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DANGER_2 STATES)
        (DOCUMENTATION DANGER_2
        "the condition of being susceptible to harm or injury; 'you are in no danger';
        'there was widespread danger of disease'")
        (HAS-I-TOPIC DANGER_2 |Factotum|) (WORD DANGER_2 |danger|)))
(DEFCONCEPT DEAD_LETTER$NON-ISSUE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DEAD_LETTER$NON-ISSUE STATES)
        (DOCUMENTATION DEAD_LETTER$NON-ISSUE
        "the state of something that has outlived its relevance")
        (HAS-I-TOPIC DEAD_LETTER$NON-ISSUE |Factotum|)
        (WORD DEAD_LETTER$NON-ISSUE |dead_letter|)
        (WORD DEAD_LETTER$NON-ISSUE |non-issue|)))
(DEFCONCEPT DECLINE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DECLINE STATES)
        (DOCUMENTATION DECLINE
        "a condition inferior to an earlier condition")
        (HAS-I-TOPIC DECLINE |Factotum|) (WORD DECLINE |decline|)))
(DEFCONCEPT DEGREE$LEVEL$STAGE$POINT (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DEGREE$LEVEL$STAGE$POINT STATES)
        (DOCUMENTATION DEGREE$LEVEL$STAGE$POINT
        "a specific identifiable position in a continuum or series or especially in a process;
        'a remarkable degree of frankness'; 'at what stage are the social sciences?")
        (HAS-I-TOPIC DEGREE$LEVEL$STAGE$POINT |Factotum|)
        (WORD DEGREE$LEVEL$STAGE$POINT |degree|)
        (WORD DEGREE$LEVEL$STAGE$POINT |level|)
        (WORD DEGREE$LEVEL$STAGE$POINT |stage|)
        (WORD DEGREE$LEVEL$STAGE$POINT |point|)))
(DEFCONCEPT DEPENDENCE$DEPENDANCE$DEPENDENCY (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DEPENDENCE$DEPENDANCE$DEPENDENCY STATES)
        (DOCUMENTATION DEPENDENCE$DEPENDANCE$DEPENDENCY
        "lack of independence or self-sufficiency")
        (HAS-I-TOPIC DEPENDENCE$DEPENDANCE$DEPENDENCY |Factotum|)
        (WORD DEPENDENCE$DEPENDANCE$DEPENDENCY |dependence|)
        (WORD DEPENDENCE$DEPENDANCE$DEPENDENCY |dependance|)
        (WORD DEPENDENCE$DEPENDANCE$DEPENDENCY |dependency|)))
(DEFCONCEPT DESPAIR$DESPERATION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DESPAIR$DESPERATION STATES)
        (DOCUMENTATION DESPAIR$DESPERATION
        "a state in which everything seems wrong and will turn out badly;
        'they were rescued from despair at the last minute'")
        (HAS-I-TOPIC DESPAIR$DESPERATION |Factotum|)
        (WORD DESPAIR$DESPERATION |despair|)
        (WORD DESPAIR$DESPERATION |desperation|)))

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(DEFCONCEPT DIFFICULTY_2 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DIFFICULTY_2 STATES)
(DOCUMENTATION DIFFICULTY_2
"a situation or condition almost beyond one's ability to deal with and requiring
great effort to bear or overcome: 'grappling with financial difficulties'")
(HAS-I-TOPIC DIFFICULTY_2 |Factotum|)
(WORD DIFFICULTY_2 |difficulty|)))
(DEFCONCEPT DISORDER (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DISORDER STATES)
(DOCUMENTATION DISORDER
"a disturbance of the peace or of public order")
(HAS-I-TOPIC DISORDER |Factotum|) (WORD DISORDER |disorder|)))
(DEFCONCEPT DISORDERLINESS$DISORDER (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DISORDERLINESS$DISORDER STATES)
(DOCUMENTATION DISORDERLINESS$DISORDER
"a condition in which things are not in their expected places: 'the files are in complete disorder'")
(HAS-I-TOPIC DISORDERLINESS$DISORDER |Factotum|)
(WORD DISORDERLINESS$DISORDER |disorderliness|)
(WORD DISORDERLINESS$DISORDER |disorder|)))
(DEFCONCEPT DOMINANCE$ASCENDANCE$ASCENDENCE$ASCENDANCY$
ASCENDENCY$CONTROL (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND
(SUBJECT
DOMINANCE$ASCENDANCE$ASCENDENCE$ASCENDANCY$ASCENDENCY$CONTROL
STATES)
(DOCUMENTATION
DOMINANCE$ASCENDANCE$ASCENDENCE$ASCENDANCY$ASCENDENCY$CONTROL
"the state that exists when one person or group has power over another;
'her apparent dominance of her husband was really her attempt to make him pay attention to her'")
(HAS-I-TOPIC
DOMINANCE$ASCENDANCE$ASCENDENCE$ASCENDANCY$
ASCENDENCY$CONTROL
|Factotum|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|dominance|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|ascendance|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|ascendence|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|ascendancy|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|ascendency|)
(WORD DOMINANCE$ASCENDANCE$ASCENDENCE$
ASCENDANCY$ASCENDENCY$CONTROL
|control|)))
(DEFCONCEPT DYSTOPIA (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT DYSTOPIA STATES)
(DOCUMENTATION DYSTOPIA
"state in which the condition of life is extremely bad as from deprivation or oppression or terror")
(HAS-I-TOPIC DYSTOPIA |Factotum|) (WORD DYSTOPIA |dystopia|)))
(DEFCONCEPT END$DESTRUCTION$DEATH (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT END$DESTRUCTION$DEATH STATES)
(DOCUMENTATION END$DESTRUCTION$DEATH
"a final state; 'he came to a bad end'; 'the so-called glorious experiment came
to an inglorious end'")
(HAS-I-TOPIC END$DESTRUCTION$DEATH |Factotum|)

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        (WORD END$DESTRUCTION$DEATH |end|)
        (WORD END$DESTRUCTION$DEATH |destruction|)
        (WORD END$DESTRUCTION$DEATH |death|))
(DEFCONCEPT ENVIRONMENTAL_CONDITION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ENVIRONMENTAL_CONDITION STATES)
    (DOCUMENTATION ENVIRONMENTAL_CONDITION
      "the state of the environment")
    (HAS-I-TOPIC ENVIRONMENTAL_CONDITION |Factotum|)
    (WORD ENVIRONMENTAL_CONDITION |environmental_condition|)))
(DEFCONCEPT EVIDENCE$GROUNDS (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT EVIDENCE$GROUNDS COGNITION)
    (DOCUMENTATION EVIDENCE$GROUNDS
      "your basis for belief or disbelief; knowledge on which to base belief;
      'the evidence that smoking causes lung cancer is very compelling'")
    (HAS-I-TOPIC EVIDENCE$GROUNDS |Factotum|)
    (WORD EVIDENCE$GROUNDS |evidence|) (WORD EVIDENCE$GROUNDS |grounds|)))
(DEFCONCEPT FACT_1 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT FACT_1 COGNITION)
    (DOCUMENTATION FACT_1
      "a piece of information about circumstances that exist or events that have occurred;
      'first you must collect all the facts of the case'")
    (HAS-I-TOPIC FACT_1 |Factotum|) (WORD FACT_1 |fact|)))
(DEFCONCEPT FACT_2 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT FACT_2 COGNITION)
    (DOCUMENTATION FACT_2
      "a concept whose truth can be proved; 'scientific hypotheses are not facts'")
    (HAS-I-TOPIC FACT_2 |Factotum|) (WORD FACT_2 |fact|)))
(DEFCONCEPT FORM$SHAPE$PATTERN (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT FORM$SHAPE$PATTERN COGNITION)
    (DOCUMENTATION FORM$SHAPE$PATTERN
      "a perceptual structure; 'the composition presents problems for students of musical form';
      'a visual pattern must include not only objects but the spaces between them'")
    (HAS-I-TOPIC FORM$SHAPE$PATTERN |Factotum|)
    (WORD FORM$SHAPE$PATTERN |form|) (WORD FORM$SHAPE$PATTERN |shape|)
    (WORD FORM$SHAPE$PATTERN |pattern|)))
(DEFCONCEPT FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND
    (SUBJECT FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION STATES)
    (DOCUMENTATION FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION
      "your overall circumstances or condition in life (including everything that happens to you);
      'whatever my fortune may be'; 'deserved a better fate'; 'has a happy lot'; 'the luck of the Irish';
      'a victim of circumstances'; 'success that was her portion'")
    (HAS-I-TOPIC FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION
      |Factotum|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |fortune|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |destiny|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |fate|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |luck|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |lot|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION
      |circumstances|)
    (WORD FORTUNE$DESTINY$FATE$LUCK$LOT$CIRCUMSTANCES$PORTION |portion|)))
(DEFCONCEPT HAPPENING$OCCURRENCE$NATURAL_EVENT (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT HAPPENING$OCCURRENCE$NATURAL_EVENT EVENTS)
    (DOCUMENTATION HAPPENING$OCCURRENCE$NATURAL_EVENT
      "an event that happens")
    (HAS-I-TOPIC HAPPENING$OCCURRENCE$NATURAL_EVENT |Factotum|)
    (WORD HAPPENING$OCCURRENCE$NATURAL_EVENT |happening|)
    (WORD HAPPENING$OCCURRENCE$NATURAL_EVENT |occurrence|)
    (WORD HAPPENING$OCCURRENCE$NATURAL_EVENT |natural event|)))
(DEFCONCEPT HINDRANCE$INTERFERENCE$INTERFERING (?SELF)

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:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT HINDRANCE$INTERFERENCE$INTERFERING ACTS)
  (DOCUMENTATION HINDRANCE$INTERFERENCE$INTERFERING
    "the act of hindering or obstructing or impeding")
  (HAS-I-TOPIC HINDRANCE$INTERFERENCE$INTERFERING |Factotum|)
  (WORD HINDRANCE$INTERFERENCE$INTERFERING |hindrance|)
  (WORD HINDRANCE$INTERFERENCE$INTERFERING |interference|)
  (WORD HINDRANCE$INTERFERENCE$INTERFERING |interfering|))
(DEFCONCEPT HOSTILITY$ENMITY$ANTAGONISM (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT HOSTILITY$ENMITY$ANTAGONISM STATES)
  (DOCUMENTATION HOSTILITY$ENMITY$ANTAGONISM
    "a state of deep-seated ill-will")
  (HAS-I-TOPIC HOSTILITY$ENMITY$ANTAGONISM |Factotum|)
  (WORD HOSTILITY$ENMITY$ANTAGONISM |hostility|)
  (WORD HOSTILITY$ENMITY$ANTAGONISM |enmity|)
  (WORD HOSTILITY$ENMITY$ANTAGONISM |antagonism|))
(DEFCONCEPT IMPROVEMENT_2 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT IMPROVEMENT_2 STATES)
  (DOCUMENTATION IMPROVEMENT_2
    "a condition superior to an earlier condition: 'the new school represents a great improvement'")
  (HAS-I-TOPIC IMPROVEMENT_2 |Factotum|)
  (WORD IMPROVEMENT_2 |improvement|))
(DEFCONCEPT INACTION$INACTIVITY$INACTIVENESS (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT INACTION$INACTIVITY$INACTIVENESS STATES)
  (DOCUMENTATION INACTION$INACTIVITY$INACTIVENESS
    "the state of being inactive")
  (HAS-I-TOPIC INACTION$INACTIVITY$INACTIVENESS |Factotum|)
  (WORD INACTION$INACTIVITY$INACTIVENESS |inaction|)
  (WORD INACTION$INACTIVITY$INACTIVENESS |inactivity|)
  (WORD INACTION$INACTIVITY$INACTIVENESS |inactiveness|))
(DEFCONCEPT INACTIVITY (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT INACTIVITY ACTS)
  (DOCUMENTATION INACTIVITY "being inactive")
  (HAS-I-TOPIC INACTIVITY |Factotum|) (WORD INACTIVITY |inactivity|))
(DEFCONCEPT MEDIUM_4 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT MEDIUM_4 STATES)
  (DOCUMENTATION MEDIUM_4
    "a state that is intermediate between extremes; a middle position; 'a happy medium'")
  (HAS-I-TOPIC MEDIUM_4 |Factotum|) (WORD MEDIUM_4 |medium|))
(DEFCONCEPT MODEL$EXAMPLE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT MODEL$EXAMPLE COGNITION)
  (DOCUMENTATION MODEL$EXAMPLE
    "a representative form or pattern; 'I profited from his example'")
  (HAS-I-TOPIC MODEL$EXAMPLE |Factotum|) (WORD MODEL$EXAMPLE |model|)
  (WORD MODEL$EXAMPLE |example|))
(DEFCONCEPT MOTION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT MOTION STATES)
  (DOCUMENTATION MOTION
    "a state of change; 'they were in a state of steady motion'")
  (HAS-I-TOPIC MOTION |Factotum|) (WORD MOTION |motion|))
(DEFCONCEPT NEED$DEMAND (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT NEED$DEMAND STATES)
  (DOCUMENTATION NEED$DEMAND
    "a condition requiring relief; 'she satisfied his need for affection';
    'God has no need of men to accomplish His work'; 'there is a demand for jobs'")
  (HAS-I-TOPIC NEED$DEMAND |Factotum|) (WORD NEED$DEMAND |need|)
  (WORD NEED$DEMAND |demand|))
(DEFCONCEPT NONACCOMPLISHMENT$NONACHIEVEMENT (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT NONACCOMPLISHMENT$NONACHIEVEMENT ACTS)
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(DOCUMENTATION NONACCOMPLISHMENT$NONACHIEVEMENT
  "an act that does not achieve its intended goal")
(HAS-I-TOPIC NONACCOMPLISHMENT$NONACHIEVEMENT |Factotum|)
(WORD NONACCOMPLISHMENT$NONACHIEVEMENT |nonaccomplishment|)
(WORD NONACCOMPLISHMENT$NONACHIEVEMENT |nonachievement|))
(DEFCONCEPT NONBEING (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT NONBEING STATES)
    (DOCUMENTATION NONBEING "the state of not being")
    (HAS-I-TOPIC NONBEING |Factotum|) (WORD NONBEING |nonbeing|)))
(DEFCONCEPT NORMALITY$NORMALCY (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT NORMALITY$NORMALCY STATES)
    (DOCUMENTATION NORMALITY$NORMALCY "conformity with the norm")
    (HAS-I-TOPIC NORMALITY$NORMALCY |Factotum|)
    (WORD NORMALITY$NORMALCY |normality|)
    (WORD NORMALITY$NORMALCY |normalcy|)))
(DEFCONCEPT ORDER_3 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ORDER_3 STATES)
    (DOCUMENTATION ORDER_3
      "established customary state esp. of society; 'order ruled in the streets'; 'law and order'")
    (HAS-I-TOPIC ORDER_3 |Factotum|) (WORD ORDER_3 |order|)))
(DEFCONCEPT ORDERLINESS$ORDER (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ORDERLINESS$ORDER STATES)
    (DOCUMENTATION ORDERLINESS$ORDER
      "a condition of regular or proper arrangement: 'he put his desk in order';
      'put the chessmen in order'")
    (HAS-I-TOPIC ORDERLINESS$ORDER |Factotum|)
    (WORD ORDERLINESS$ORDER |orderliness|)
    (WORD ORDERLINESS$ORDER |order|)))
(DEFCONCEPT ORDINARY_4 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT ORDINARY_4 STATES)
    (DOCUMENTATION ORDINARY_4
      "the expected or commonplace condition or situation: 'not out of the ordinary'")
    (HAS-I-TOPIC ORDINARY_4 |Factotum|) (WORD ORDINARY_4 |ordinary|)))
(DEFCONCEPT PRECEDENT$CASE_IN_POINT (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT PRECEDENT$CASE_IN_POINT COGNITION)
    (DOCUMENTATION PRECEDENT$CASE_IN_POINT
      "an example that is used to justify similar occurrences at a later time")
    (HAS-I-TOPIC PRECEDENT$CASE_IN_POINT |Factotum|)
    (WORD PRECEDENT$CASE_IN_POINT |precedent|)
    (WORD PRECEDENT$CASE_IN_POINT |case in point|)))
(DEFCONCEPT REINSTATEMENT_2 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT REINSTATEMENT_2 STATES)
    (DOCUMENTATION REINSTATEMENT_2
      "the condition of being reinstated; 'her reinstatement to her former office followed quickly'")
    (HAS-I-TOPIC REINSTATEMENT_2 |Factotum|)
    (WORD REINSTATEMENT_2 |reinstatement|)))
(DEFCONCEPT RELATIONSHIP_1 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT RELATIONSHIP_1 STATES)
    (DOCUMENTATION RELATIONSHIP_1
      "a state of connectedness between people (especially an emotional connection);
      'he didn't want his wife to know of the relationship'")
    (HAS-I-TOPIC RELATIONSHIP_1 |Factotum|)
    (WORD RELATIONSHIP_1 |relationship|)))
(DEFCONCEPT RELATIONSHIP_2 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT RELATIONSHIP_2 STATES)
    (DOCUMENTATION RELATIONSHIP_2
      "a state involving mutual dealings between people or parties or countries")
    (HAS-I-TOPIC RELATIONSHIP_2 |Factotum|)
    (WORD RELATIONSHIP_2 |relationship|)))

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(DEFCONCEPT REPAIR (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT REPAIR STATES)
    (DOCUMENTATION REPAIR
      "a formal way of referring to the condition of something; 'the building was in good repair'")
    (HAS-I-TOPIC REPAIR |Factotum|) (WORD REPAIR |repair|)))
(DEFCONCEPT RESISTANCE$OPPOSITION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT RESISTANCE$OPPOSITION ACTS)
    (DOCUMENTATION RESISTANCE$OPPOSITION
      "the action of opposing something that you disapprove or disagree with;
      'he encountered a general feeling of resistance from many citizens';
      'despite opposition from the newspapers he went ahead'")
    (HAS-I-TOPIC RESISTANCE$OPPOSITION |Factotum|)
    (WORD RESISTANCE$OPPOSITION |resistance|)
    (WORD RESISTANCE$OPPOSITION |opposition|)))
(DEFCONCEPT SAFETY_2 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT SAFETY_2 STATES)
    (DOCUMENTATION SAFETY_2
      "the state of being safe; 'the safety of the children'")
    (HAS-I-TOPIC SAFETY_2 |Factotum|) (WORD SAFETY_2 |safety|)))
(DEFCONCEPT SITUATION$POSITION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT SITUATION$POSITION STATES)
    (DOCUMENTATION SITUATION$POSITION
      "a condition or position in which you find yourself: 'the unpleasant situation (or position)
      of having to choose between two evils'; 'found herself in a very fortunate situation'")
    (HAS-I-TOPIC SITUATION$POSITION |Factotum|)
    (WORD SITUATION$POSITION |situation|)
    (WORD SITUATION$POSITION |position|)))
(DEFCONCEPT SITUATION$STATE_OF_AFFAIRS (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT SITUATION$STATE_OF_AFFAIRS STATES)
    (DOCUMENTATION SITUATION$STATE_OF_AFFAIRS
      "the general state of things; the combination of circumstances at a given time;
      'the present international situation is dangerous'; 'wondered how such a state of
      affairs had come about'; 'eternal truths will be neither true nor eternal unless they
      have fresh meaning for every new social situation'- Franklin D.Roosevelt")
    (HAS-I-TOPIC SITUATION$STATE_OF_AFFAIRS |Factotum|)
    (WORD SITUATION$STATE_OF_AFFAIRS |situation|)
    (WORD SITUATION$STATE_OF_AFFAIRS |state_of_affairs|)))
(DEFCONCEPT SOUNDNESS (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT SOUNDNESS STATES)
    (DOCUMENTATION SOUNDNESS
      "a state or condition free from damage or decay")
    (HAS-I-TOPIC SOUNDNESS |Factotum|) (WORD SOUNDNESS |soundness|)))
(DEFCONCEPT STIMULATION$STIMULUS$STIMULANT$INPUT (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT STIMULATION$STIMULUS$STIMULANT$INPUT COGNITION)
    (DOCUMENTATION STIMULATION$STIMULUS$STIMULANT$INPUT
      "any stimulating information or event; acts to arouse action")
    (HAS-I-TOPIC STIMULATION$STIMULUS$STIMULANT$INPUT |Factotum|)
    (WORD STIMULATION$STIMULUS$STIMULANT$INPUT |stimulation|)
    (WORD STIMULATION$STIMULUS$STIMULANT$INPUT |stimulus|)
    (WORD STIMULATION$STIMULUS$STIMULANT$INPUT |stimulant|)
    (WORD STIMULATION$STIMULUS$STIMULANT$INPUT |input|)))
(DEFCONCEPT SUPPORT_2 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT SUPPORT_2 ACTS)
    (DOCUMENTATION SUPPORT_2
      "the activity of providing for or maintaining by supplying with money or necessities;
      'his support kept the family together'; 'they gave him emotional support during difficult times'")
    (HAS-I-TOPIC SUPPORT_2 |Factotum|) (WORD SUPPORT_2 |support|)))
(DEFCONCEPT TEMPORARY_STATE (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT TEMPORARY_STATE STATES)

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(DOCUMENTATION TEMPORARY_STATE
  "a state that continues for a limited time")
(HAS-I-TOPIC TEMPORARY_STATE |Factotum|)
(WORD TEMPORARY_STATE |temporary_state|))
(DEFCONCEPT UNSOUNDNESS (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT UNSOUNDNESS STATES)
    (DOCUMENTATION UNSOUNDNESS "a condition of damage or decay")
    (HAS-I-TOPIC UNSOUNDNESS |Factotum|)
    (WORD UNSOUNDNESS |unsoundness|)))
(DEFCONCEPT UTOPIA (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT UTOPIA STATES)
    (DOCUMENTATION UTOPIA
      "ideally perfect state; especially in its social and political and moral aspects")
    (HAS-I-TOPIC UTOPIA |Factotum|) (WORD UTOPIA |utopia|)))
(DEFCONCEPT VARIATION$VARIANCE (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT VARIATION$VARIANCE ACTS)
    (DOCUMENTATION VARIATION$VARIANCE
      "an activity that varies from a norm or standard; 'any variation in his routine was
      immediately reported'")
    (HAS-I-TOPIC VARIATION$VARIANCE |Factotum|)
    (WORD VARIATION$VARIANCE |variation|)
    (WORD VARIATION$VARIANCE |variance|)))
(DEFCONCEPT WAY_6 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT WAY_6 STATES)
    (DOCUMENTATION WAY_6
      "the condition of things generally; 'that's the way it is' or 'I felt the same way'")
    (HAS-I-TOPIC WAY_6 |Factotum|) (WORD WAY_6 |way|)))
(DEFCONCEPT ORGANIZATION$ORGANISATION_2 (?SELF)
  :=> (SOCIAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ORGANIZATION$ORGANISATION_2 GROUPS)
    (DOCUMENTATION ORGANIZATION$ORGANISATION_2
      "a group of people who work together")
    (HAS-I-TOPIC ORGANIZATION$ORGANISATION_2 |Factotum|)
    (WORD ORGANIZATION$ORGANISATION_2 |organization|)
    (WORD ORGANIZATION$ORGANISATION_2 |organisation|)))
(DEFCONCEPT SUBGROUP_2 (?SELF)
  :=> (SOCIAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SUBGROUP_2 GROUPS)
    (DOCUMENTATION SUBGROUP_2
      "a distinct and often subordinate group within a group")
    (HAS-I-TOPIC SUBGROUP_2 |Factotum|) (WORD SUBGROUP_2 |subgroup|)))
(DEFCONCEPT ROLE_WN (?SELF)
  :=> (SOCIALLY-CONSTRUCTED-PERSON ?SELF)
  :AXIOMS (AND (SUBJECT ROLE_WN ACTS)
    (DOCUMENTATION ROLE_WN
      "normal or customary activity; 'what is your role on the team?'" )
    (HAS-I-TOPIC ROLE_WN |Factotum|) (WORD ROLE_WN |role|)))
(DEFCONCEPT DEATH_4 (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT DEATH_4 STATES)
    (DOCUMENTATION DEATH_4
      "the absence of life or state of being dead; 'he seemed more content in death than
      he had ever been in life'")
    (HAS-I-TOPIC DEATH_4 |Factotum|) (WORD DEATH_4 |death|)))
(DEFCONCEPT DISHABILLE$DESHABILLE (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT DISHABILLE$DESHABILLE STATES)
    (DOCUMENTATION DISHABILLE$DESHABILLE
      "the state of being carelessly or partially dressed")
    (HAS-I-TOPIC DISHABILLE$DESHABILLE |Factotum|)
    (WORD DISHABILLE$DESHABILLE |dishabille|)
    (WORD DISHABILLE$DESHABILLE |deshabille|)))
(DEFCONCEPT FREEDOM (?SELF)
  :=> (STATE ?SELF)
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:AXIOMS (AND (SUBJECT FREEDOM STATES)
  (DOCUMENTATION FREEDOM
    "the condition of being free; the power to act or speak or think without externally imposed restraints")
  (HAS-I-TOPIC FREEDOM |Factotum|) (WORD FREEDOM |freedom|))
(DEFCONCEPT HOMELESSNESS (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT HOMELESSNESS STATES)
    (DOCUMENTATION HOMELESSNESS
      "the state or condition of having no home (especially the state of living in the streets)")
    (HAS-I-TOPIC HOMELESSNESS |Factotum|)
    (WORD HOMELESSNESS |homelessness|))
(DEFCONCEPT HYALINIZATION (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT HYALINIZATION STATES)
    (DOCUMENTATION HYALINIZATION
      "the state of being hyaline or having become hyaline: 'the patient's arterioles showed
      marked hyalinization'")
    (HAS-I-TOPIC HYALINIZATION |Factotum|)
    (WORD HYALINIZATION |hyalinization|))
(DEFCONCEPT MOTIONLESSNESS$STILLNESS (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT MOTIONLESSNESS$STILLNESS STATES)
    (DOCUMENTATION MOTIONLESSNESS$STILLNESS
      "a state of no motion or movement")
    (HAS-I-TOPIC MOTIONLESSNESS$STILLNESS |Factotum|)
    (WORD MOTIONLESSNESS$STILLNESS |motionlessness|)
    (WORD MOTIONLESSNESS$STILLNESS |stillness|))
(DEFCONCEPT NAKEDNESS$NUDITY$NUDENESS (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT NAKEDNESS$NUDITY$NUDENESS STATES)
    (DOCUMENTATION NAKEDNESS$NUDITY$NUDENESS
      "the state of being without clothing or covering of any kind")
    (HAS-I-TOPIC NAKEDNESS$NUDITY$NUDENESS |Factotum|)
    (WORD NAKEDNESS$NUDITY$NUDENESS |nakedness|)
    (WORD NAKEDNESS$NUDITY$NUDENESS |nudity|)
    (WORD NAKEDNESS$NUDITY$NUDENESS |nudeness|))
(DEFCONCEPT REPRESENTATION$DELEGACY$AGENCY (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT REPRESENTATION$DELEGACY$AGENCY STATES)
    (DOCUMENTATION REPRESENTATION$DELEGACY$AGENCY
      "the state of serving as an official and authorized delegate or agent")
    (HAS-I-TOPIC REPRESENTATION$DELEGACY$AGENCY |Factotum|)
    (WORD REPRESENTATION$DELEGACY$AGENCY |representation|)
    (WORD REPRESENTATION$DELEGACY$AGENCY |delegacy|)
    (WORD REPRESENTATION$DELEGACY$AGENCY |agency|))
(DEFCONCEPT SERRATION_3 (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT SERRATION_3 STATES)
    (DOCUMENTATION SERRATION_3
      "the condition of being serrated; 'the serrations of a city skyline'")
    (HAS-I-TOPIC SERRATION_3 |Factotum|) (WORD SERRATION_3 |serration|))
(DEFCONCEPT TILTH (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT TILTH STATES)
    (DOCUMENTATION TILTH
      "the state of aggregation of soil and its condition for supporting plant growth")
    (HAS-I-TOPIC TILTH |Factotum|) (WORD TILTH |tilth|))
(DEFCONCEPT UNION_4 (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT UNION_4 STATES)
    (DOCUMENTATION UNION_4
      "the state of being united; 'there is strength in union'")
    (HAS-I-TOPIC UNION_4 |Factotum|) (WORD UNION_4 |union|))
(DEFCONCEPT VACUOLIZATION$VACUOLATION (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT VACUOLIZATION$VACUOLATION STATES)
    (DOCUMENTATION VACUOLIZATION$VACUOLATION
      "the state of having become filled with vacuoles")
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        (HAS-I-TOPIC VACUOLIZATION$VACUOLATION |Factotum|)
        (WORD VACUOLIZATION$VACUOLATION |vacuolization|)
        (WORD VACUOLIZATION$VACUOLATION |vacuolation|))
(DEFCONCEPT VIRGINITY (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT VIRGINITY STATES)
    (DOCUMENTATION VIRGINITY
      "the condition or quality of being a virgin")
    (HAS-I-TOPIC VIRGINITY |Factotum|) (WORD VIRGINITY |virginity|)))
(DEFCONCEPT DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$
  FIELD_OF_STUDY$
  STUDY$BRANCH_OF_KNOWLEDGE (?SELF)
  :=> (TOPIC ?SELF)
  :AXIOMS (AND
    (SUBJECT
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$
      FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      COGNITION)
    (DOCUMENTATION
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$
      FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      "a branch of knowledge; 'in what discipline is his doctorate?';
      'teachers should be well trained in their subject';
      'anthropology is the study of human beings'")
    (HAS-I-TOPIC
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      |Factotum|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      |discipline|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      |subject|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$STUDY$
      BRANCH_OF_KNOWLEDGE
      |subject area|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$
      STUDY$BRANCH_OF_KNOWLEDGE
      |subject field|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$
      STUDY$BRANCH_OF_KNOWLEDGE
      |field|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$
      STUDY$BRANCH_OF_KNOWLEDGE
      |field of study|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$
      STUDY$BRANCH_OF_KNOWLEDGE
      |study|)
    (WORD
      DISCIPLINE$SUBJECT$SUBJECT_AREA$SUBJECT_FIELD$FIELD$FIELD_OF_STUDY$
      STUDY$BRANCH_OF_KNOWLEDGE
      |branch of knowledge|)))
(DEFCONCEPT DOMAIN$REGION$REALM (?SELF)
  :=> (TOPIC ?SELF)
  :AXIOMS (AND (SUBJECT DOMAIN$REGION$REALM COGNITION)
    (DOCUMENTATION DOMAIN$REGION$REALM
      "a knowledge domain that you are interested in or are communicating about;
      'it was a limited domain of discourse'; 'here we enter the region of opinion';z

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'the realm of the occult'")
(HAS-I-TOPIC DOMAIN$REGION$REALM |Factotum|)
(WORD DOMAIN$REGION$REALM |domain|)
(WORD DOMAIN$REGION$REALM |region|)
(WORD DOMAIN$REGION$REALM |realm|))
(DEFCONCEPT LORE$TRADITIONAL_KNOWLEDGE (?SELF)
:=> (TOPIC ?SELF)
:AXIOMS (AND (SUBJECT LORE$TRADITIONAL_KNOWLEDGE COGNITION)
(DOCUMENTATION LORE$TRADITIONAL_KNOWLEDGE
"knowledge gained through tradition or anecdote: 'early peoples passed on
plant and animal lore through legend'")
(HAS-I-TOPIC LORE$TRADITIONAL_KNOWLEDGE |Factotum|)
(WORD LORE$TRADITIONAL_KNOWLEDGE |lore|)
(WORD LORE$TRADITIONAL_KNOWLEDGE |traditional knowledge|)))
(DEFCONCEPT METAKNOWLEDGE (?SELF)
:=> (TOPIC ?SELF)
:AXIOMS (AND (SUBJECT METAKNOWLEDGE COGNITION)
(DOCUMENTATION METAKNOWLEDGE "knowledge about knowledge")
(HAS-I-TOPIC METAKNOWLEDGE |Factotum|)
(WORD METAKNOWLEDGE |metaknowledge|)))
(DEFCONCEPT SCIENCE$SCIENTIFIC_KNOWLEDGE (?SELF)
:=> (TOPIC ?SELF)
:AXIOMS (AND (SUBJECT SCIENCE$SCIENTIFIC_KNOWLEDGE COGNITION)
(DOCUMENTATION SCIENCE$SCIENTIFIC_KNOWLEDGE
"any domain of knowledge accumulated by systematic study and organized by
general principles; 'mathematics is important for science'")
(HAS-I-TOPIC SCIENCE$SCIENTIFIC_KNOWLEDGE |Factotum|)
(WORD SCIENCE$SCIENTIFIC_KNOWLEDGE |science|)
(WORD SCIENCE$SCIENTIFIC_KNOWLEDGE |scientific knowledge|)))
(DEFCONCEPT TOPIC$SUBJECT$ISSUE$MATTER (?SELF)
:=> (TOPIC ?SELF)
:AXIOMS (AND (SUBJECT TOPIC$SUBJECT$ISSUE$MATTER COGNITION)
(DOCUMENTATION TOPIC$SUBJECT$ISSUE$MATTER
"some situation or event that is thought about; 'he kept drifting off the topic';
'he had been thinking about the subject for several years'; 'it is a matter for the police'")
(HAS-I-TOPIC TOPIC$SUBJECT$ISSUE$MATTER |Factotum|)
(WORD TOPIC$SUBJECT$ISSUE$MATTER |topic|)
(WORD TOPIC$SUBJECT$ISSUE$MATTER |subject|)
(WORD TOPIC$SUBJECT$ISSUE$MATTER |issue|)
(WORD TOPIC$SUBJECT$ISSUE$MATTER |matter|)))
(DEFCONCEPT UNIVERSE$UNIVERSE_OF_DISCOURSE (?SELF)
:=> (TOPIC ?SELF)
:AXIOMS (AND (SUBJECT UNIVERSE$UNIVERSE_OF_DISCOURSE COGNITION)
(DOCUMENTATION UNIVERSE$UNIVERSE_OF_DISCOURSE
"everything stated or assumed in a given discussion")
(HAS-I-TOPIC UNIVERSE$UNIVERSE_OF_DISCOURSE |Factotum|)
(WORD UNIVERSE$UNIVERSE_OF_DISCOURSE |universe|)
(WORD UNIVERSE$UNIVERSE_OF_DISCOURSE |universe of discourse|)))
(DEFCONCEPT CUTTING (?SELF)
:=> (SUBSTANCE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT CUTTING OBJECTS)
(DOCUMENTATION CUTTING
"a piece cut off from the main part of something")
(HAS-I-TOPIC CUTTING |Factotum|) (WORD CUTTING |cutting|)))
(DEFCONCEPT EMANATION (?SELF)
:=> (SUBSTANCE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT EMANATION SUBSTANCES)
(DOCUMENTATION EMANATION "something that is produced by emanation")
(HAS-I-TOPIC EMANATION |Factotum|) (WORD EMANATION |emanation|)))
(DEFCONCEPT POUNDER (?SELF)
:=> (SUBSTANCE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT POUNDER OBJECTS)
(DOCUMENTATION POUNDER
"something weighing a given number of pounds; 'the fisherman caught a 10-pounder'
or 'their linemen are all 300-pounders'")
(HAS-I-TOPIC POUNDER |Factotum|) (WORD POUNDER |pounder|)))
(DEFCONCEPT SAMPLE_1 (?SELF)
:=> (SUBSTANCE-ROLE ?SELF)
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:AXIOMS (AND (SUBJECT SAMPLE_1 COGNITION)
  (DOCUMENTATION SAMPLE_1
    "a small part of something intended as representative of the whole")
  (HAS-I-TOPIC SAMPLE_1 |Factotum|) (WORD SAMPLE_1 |sample|)))
(DEFCONCEPT SHINER_2 (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SHINER_2 OBJECTS)
    (DOCUMENTATION SHINER_2 "something that shines")
    (HAS-I-TOPIC SHINER_2 |Factotum|) (WORD SHINER_2 |shiner|)))
(DEFCONCEPT SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$
    OOZE SUBSTANCES)
    (DOCUMENTATION SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE
      "any thick messy substance")
    (HAS-I-TOPIC SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |Factotum|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |sludge|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |slime|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |goo|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |gook|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |guck|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |gunk|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |muck|)
    (WORD SLUDGE$SLIME$GOO$GOOK$GUCK$GUNK$MUCK$OOZE |ooze|)))
(DEFCONCEPT SUBSTANCE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SUBSTANCE RELATIONS)
    (DOCUMENTATION SUBSTANCE "the stuff of which an object consists")
    (HAS-I-TOPIC SUBSTANCE |Factotum|) (WORD SUBSTANCE |substance|)))
(DEFCONCEPT THEORY_2 (?SELF)
  :=> (THEORY ?SELF)
  :AXIOMS (AND (SUBJECT THEORY_2 COGNITION)
    (DOCUMENTATION THEORY_2
      "an organized system of accepted knowledge that applies in a variety of circumstances
        to explain a specific set of phenomena; 'true in fact and theory'")
    (HAS-I-TOPIC THEORY_2 |Factotum|) (WORD THEORY_2 |theory|)))
(DEFCONCEPT ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$
  POTPOURRI$MOTLEY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND
    (SUBJECT
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      GROUPS)
    (DOCUMENTATION
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      "a collection containing a variety of sorts of things; 'a great assortment of cars was on display';
        'he had a variety of disorders'")
    (HAS-I-TOPIC
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |Factotum|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |assortment|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |mixture|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |miscellany|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |miscellanea|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |variety|)
    (WORD
      ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
      |potpourri|)
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(WORD
  ASSORTMENT$MIXTURE$MISCELLANY$MISCELLANEA$VARIETY$POTPOURRI$MOTLEY
  |motley|)))
(DEFCONCEPT BATCH (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BATCH GROUPS)
    (DOCUMENTATION BATCH
      "all the loaves of bread baked at the same time")
    (HAS-I-TOPIC BATCH |Factotum|) (WORD BATCH |batch|)))
(DEFCONCEPT BATCH$CLUTCH (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BATCH$CLUTCH GROUPS)
    (DOCUMENTATION BATCH$CLUTCH
      "a collection of things or persons to be handled together")
    (HAS-I-TOPIC BATCH$CLUTCH |Factotum|) (WORD BATCH$CLUTCH |batch|)
    (WORD BATCH$CLUTCH |clutch|)))
(DEFCONCEPT BATTERY_1 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BATTERY_1 GROUPS)
    (DOCUMENTATION BATTERY_1
      "a collection of related things intended for use together: 'took a battery of achievement tests'")
    (HAS-I-TOPIC BATTERY_1 |Factotum|) (WORD BATTERY_1 |battery|)))
(DEFCONCEPT BLOCK_3 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BLOCK_3 GROUPS)
    (DOCUMENTATION BLOCK_3
      "a number or quantity of related things dealt with as a unit; 'he reserved a large block of seats';
      'he held a large block of the company's stock'")
    (HAS-I-TOPIC BLOCK_3 |Factotum|) (WORD BLOCK_3 |block|)))
(DEFCONCEPT BOTTLE_COLLECTION_3 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BOTTLE_COLLECTION_3 GROUPS)
    (DOCUMENTATION BOTTLE_COLLECTION_3
      "a collection of bottles: 'her bottle collection is arranged on glass shelves in the wondow'")
    (HAS-I-TOPIC BOTTLE_COLLECTION_3 |Factotum|)
    (WORD BOTTLE_COLLECTION_3 |bottle collection|)))
(DEFCONCEPT BUNCH$LOT$CABOODLE (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BUNCH$LOT$CABOODLE GROUPS)
    (DOCUMENTATION BUNCH$LOT$CABOODLE
      "any collection in its entirety; 'she bought the whole caboodle'")
    (HAS-I-TOPIC BUNCH$LOT$CABOODLE |Factotum|)
    (WORD BUNCH$LOT$CABOODLE |bunch|) (WORD BUNCH$LOT$CABOODLE |lot|)
    (WORD BUNCH$LOT$CABOODLE |caboodle|)))
(DEFCONCEPT COMBINATION_2 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT COMBINATION_2 GROUPS)
    (DOCUMENTATION COMBINATION_2
      "a collection of things that have been combined; an assemblage of separate parts or qualities")
    (HAS-I-TOPIC COMBINATION_2 |Factotum|)
    (WORD COMBINATION_2 |combination|)))
(DEFCONCEPT CORPUS_2 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT CORPUS_2 GROUPS)
    (DOCUMENTATION CORPUS_2
      "a collection of writings; 'he edited the Hemingway corpus'")
    (HAS-I-TOPIC CORPUS_2 |Factotum|) (WORD CORPUS_2 |corpus|)))
(DEFCONCEPT GALAXY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT GALAXY GROUPS)
    (DOCUMENTATION GALAXY
      "a splendid assemblage (especially of famous people)")
    (HAS-I-TOPIC GALAXY |Factotum|) (WORD GALAXY |galaxy|)))
(DEFCONCEPT GIMMICKRY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT GIMMICKRY GROUPS)
    (DOCUMENTATION GIMMICKRY "a collection of gimmicks")
    (HAS-I-TOPIC GIMMICKRY |Factotum|) (WORD GIMMICKRY |gimmickry|)))

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(DEFCONCEPT MASS_4 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT MASS_4 GROUPS)
    (DOCUMENTATION MASS_4
      "an ill-structured collection of similar things (objects or people)")
    (HAS-I-TOPIC MASS_4 |Factotum|) (WORD MASS_4 |mass|)))
(DEFCONCEPT PACK_4 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT PACK_4 GROUPS)
    (DOCUMENTATION PACK_4 "a complete collection of similar things")
    (HAS-I-TOPIC PACK_4 |Factotum|) (WORD PACK_4 |pack|)))
(DEFCONCEPT REPERTORY$REPERTOIRE (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT REPERTORY$REPERTOIRE GROUPS)
    (DOCUMENTATION REPERTORY$REPERTOIRE
      "the entire range of skills or aptitudes or devices used in a particular field or occupation:
      'the repertory of the supposed feats of mesmerism'; 'has a large repertory of dialects and characters'")
    (HAS-I-TOPIC REPERTORY$REPERTOIRE |Factotum|)
    (WORD REPERTORY$REPERTOIRE |repertory|)
    (WORD REPERTORY$REPERTOIRE |repertoire|)))
(DEFCONCEPT ROGUE_S_GALLERY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT ROGUE_S_GALLERY GROUPS)
    (DOCUMENTATION ROGUE_S_GALLERY
      "a collection of pictures of criminals")
    (HAS-I-TOPIC ROGUE_S_GALLERY |Factotum|)
    (WORD ROGUE_S_GALLERY |rogue's_gallery|)))
(DEFCONCEPT SET_4 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT SET_4 GROUPS)
    (DOCUMENTATION SET_4
      "a group of things of the same kind that belong together and are so used: 'a set of books';
      'a set of golf clubs'")
    (HAS-I-TOPIC SET_4 |Factotum|) (WORD SET_4 |set|)))
(DEFCONCEPT STATUARY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT STATUARY GROUPS)
    (DOCUMENTATION STATUARY "statues collectively")
    (HAS-I-TOPIC STATUARY |Factotum|) (WORD STATUARY |statuary|)))
(DEFCONCEPT STRING_2 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT STRING_2 ARTIFACTS)
    (DOCUMENTATION STRING_2
      "a collection of objects threaded on a single strand")
    (HAS-I-TOPIC STRING_2 |Factotum|) (WORD STRING_2 |string|)))
(DEFCONCEPT SYSTEM_4 (?SELF)
  :=> (SYSTEM-AS-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT SYSTEM_4 GROUPS)
    (DOCUMENTATION SYSTEM_4
      "a group of independent but interrelated elements comprising a unified whole;
      'a vast system of production and distribution and consumption keep the country going'")
    (HAS-I-TOPIC SYSTEM_4 |Factotum|) (WORD SYSTEM_4 |system|)))
(DEFCONCEPT TREASURE_1 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT TREASURE_1 GROUPS)
    (DOCUMENTATION TREASURE_1
      "a collection of precious things; 'the trunk held all her meager treasures'")
    (HAS-I-TOPIC TREASURE_1 |Factotum|) (WORD TREASURE_1 |treasure|)))
(DEFCONCEPT TREASURE_TROVE (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT TREASURE_TROVE GROUPS)
    (DOCUMENTATION TREASURE_TROVE
      "any collection of valuables that is discovered; 'her book was a treasure trove of new
      ideas' or 'mother's attic was a treasure trove when we were looking for antiques'")
    (HAS-I-TOPIC TREASURE_TROVE |Factotum|)
    (WORD TREASURE_TROVE |treasure_trove|)))
(DEFCONCEPT UNIVERSE$COSMOS (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)

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:AXIOMS (AND (SUBJECT UNIVERSE$COSMOS GROUPS)
  (DOCUMENTATION UNIVERSE$COSMOS
    "the whole collection of existing things")
  (HAS-I-TOPIC UNIVERSE$COSMOS |Factotum|)
  (WORD UNIVERSE$COSMOS |universe|) (WORD UNIVERSE$COSMOS |cosmos|)))
(DEFCONCEPT PLAYTHING$TOY (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT PLAYTHING$TOY ARTIFACTS)
    (DOCUMENTATION PLAYTHING$TOY
      "an artifact designed to be played with")
    (HAS-I-TOPIC PLAYTHING$TOY |Play|) (WORD PLAYTHING$TOY |plaything|)
    (WORD PLAYTHING$TOY |toy|)))
(DEFCONCEPT HAND$DEAL (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT HAND$DEAL GROUPS)
    (DOCUMENTATION HAND$DEAL
      "the cards held in a card game by a given player at any given time; 'I didn't hold a good
      hand all evening'; 'he kept trying to see my hand'")
    (HAS-I-TOPIC HAND$DEAL |Card|) (WORD HAND$DEAL |hand|)
    (WORD HAND$DEAL |deal|)))
(DEFCONCEPT TURN$PLAY (?SELF)
  :=> (COURSE ?SELF)
  :AXIOMS (AND (SUBJECT TURN$PLAY ACTS)
    (DOCUMENTATION TURN$PLAY
      "the activity of doing something in an agreed succession; 'it is my turn' or 'it is still my play'")
    (HAS-I-TOPIC TURN$PLAY |Sport|) (WORD TURN$PLAY |turn|)
    (WORD TURN$PLAY |play|)))
(DEFCONCEPT LEAD_4 (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT LEAD_4 LOCATIONS)
    (DOCUMENTATION LEAD_4
      "(baseball) the position taken by a base runner preparing to advance to the next base;
      'he took a long lead off first'")
    (HAS-I-TOPIC LEAD_4 |Baseball|) (WORD LEAD_4 |lead|)))
(DEFCONCEPT HOLE_2 (?SELF)
  :=> (QUALITATIVE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT HOLE_2 ARTIFACTS)
    (DOCUMENTATION HOLE_2
      "one unit of play from tee to green on a golf course; 'he played 18 holes'")
    (HAS-I-TOPIC HOLE_2 |Golf|) (WORD HOLE_2 |hole|)))
(DEFCONCEPT DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT DEFENSE$DEFENCE$DEFENSE_TEAM$
    DEFENSE_LAWYERS GROUPS)
    (DOCUMENTATION DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS
      "the defendant and his legal advisors collectively; 'the defense called for a mistrial'")
    (HAS-I-TOPIC DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS |Law|)
    (WORD DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS |defense|)
    (WORD DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS |defence|)
    (WORD DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS |defense team|)
    (WORD DEFENSE$DEFENCE$DEFENSE_TEAM$DEFENSE_LAWYERS
      |defense lawyers|)))
(DEFCONCEPT PROSECUTION_2 (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT PROSECUTION_2 GROUPS)
    (DOCUMENTATION PROSECUTION_2
      "the lawyers acting for the state to put the case against the defendant")
    (HAS-I-TOPIC PROSECUTION_2 |Law|) (WORD PROSECUTION_2 |prosecution|)))
(DEFCONCEPT BERTILLON_SYSTEM (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT BERTILLON_SYSTEM ACTS)
    (DOCUMENTATION BERTILLON_SYSTEM
      "a system or procedure for identifying persons")
    (HAS-I-TOPIC BERTILLON_SYSTEM |Law|)
    (WORD BERTILLON_SYSTEM |Bertillon system|)))
(DEFCONCEPT LAW$JURISPRUDENCE (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT LAW$JURISPRUDENCE GROUPS)
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(DOCUMENTATION LAW$JURISPRUDENCE
  "the collection of rules imposed by authority; 'civilization presupposes respect for the law'"
  (HAS-I-TOPIC LAW$JURISPRUDENCE |Law|) (WORD LAW$JURISPRUDENCE |law|)
  (WORD LAW$JURISPRUDENCE |jurisprudence|)))
(DEFCONCEPT RIGHT_2 (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT RIGHT_2 ATTRIBUTES)
    (DOCUMENTATION RIGHT_2
      "an abstract idea of that which is due to a person or governmental body by law
      or tradition or nature: 'they are endowed by their Creator with certain unalienable Rights,
      that among these are Life, Liberty and the pursuit of Happiness'; 'Certain rights can never
      be granted to the government but must be kept in the hands of the people'-
      Eleanor Roosevelt; 'it is his right to say what he pleases'"
      (HAS-I-TOPIC RIGHT_2 |Law|) (WORD RIGHT_2 |right|)))
(DEFCONCEPT ORGANIZED_CRIME$GANGLAND$GANGDOM (?SELF)
  :=> (SOCIAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ORGANIZED_CRIME$GANGLAND$GANGDOM GROUPS)
    (DOCUMENTATION ORGANIZED_CRIME$GANGLAND$GANGDOM
      "underworld organizations")
    (HAS-I-TOPIC ORGANIZED_CRIME$GANGLAND$GANGDOM |Law|)
    (HAS-I-TOPIC ORGANIZED_CRIME$GANGLAND$GANGDOM |Sociology|)
    (WORD ORGANIZED_CRIME$GANGLAND$GANGDOM |organized crime|)
    (WORD ORGANIZED_CRIME$GANGLAND$GANGDOM |gangland|)
    (WORD ORGANIZED_CRIME$GANGLAND$GANGDOM |gangdom|)))
(DEFCONCEPT CIRCUIT (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT CIRCUIT GROUPS)
    (DOCUMENTATION CIRCUIT
      "(law) one of the twelve groups of states in the U.S. that is covered by a particular
      circuit court of appeals")
    (HAS-I-TOPIC CIRCUIT |Law|) (WORD CIRCUIT |circuit|)))
(DEFCONCEPT COMMODITY$GOODS (?SELF)
  :=> (COMMERCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT COMMODITY$GOODS ARTIFACTS)
    (DOCUMENTATION COMMODITY$GOODS "articles of commerce")
    (HAS-I-TOPIC COMMODITY$GOODS |Commerce|)
    (WORD COMMODITY$GOODS |commodity|) (WORD COMMODITY$GOODS |goods|)))
(DEFCONCEPT EXPORT (?SELF)
  :=> (COMMERCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT EXPORT ARTIFACTS)
    (DOCUMENTATION EXPORT "goods or services sold to a foreign country")
    (HAS-I-TOPIC EXPORT |Commerce|) (WORD EXPORT |export|)))
(DEFCONCEPT IMPORT_1 (?SELF)
  :=> (COMMERCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT IMPORT_1 ARTIFACTS)
    (DOCUMENTATION IMPORT_1
      "goods or services bought from a foreign country")
    (HAS-I-TOPIC IMPORT_1 |Commerce|) (WORD IMPORT_1 |import|)))
(DEFCONCEPT LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
  BUSINESS_LINE$
  LINE_OF_BUSINESS (?SELF)
  :=> (COMMERCE-ROLE ?SELF)
  :AXIOMS (AND
    (SUBJECT
      LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
      BUSINESS_LINE$LINE_OF_BUSINESS
      ARTIFACTS)
    (DOCUMENTATION
      LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
      BUSINESS_LINE$LINE_OF_BUSINESS
      "a particular kind of product; 'a nice line of shoes'"
      (HAS-I-TOPIC
        LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
        BUSINESS_LINE$LINE_OF_BUSINESS
        |Commerce|)
      (WORD
        LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
        BUSINESS_LINE$LINE_OF_BUSINESS
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|line|)
(WORD
LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
BUSINESS_LINE$LINE_OF_BUSINESS
|product line|)
(WORD
LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
BUSINESS_LINE$LINE_OF_BUSINESS
|line of products|)
(WORD
LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
BUSINESS_LINE$LINE_OF_BUSINESS
|line of merchandise|)
(WORD
LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
BUSINESS_LINE$LINE_OF_BUSINESS
|business line|)
(WORD
LINE$PRODUCT_LINE$LINE_OF_PRODUCTS$LINE_OF_MERCHANDISE$
BUSINESS_LINE$LINE_OF_BUSINESS
|line of business|))
(DEFCONCEPT MERCHANDISE$WARES$PRODUCT (?SELF)
:=> (COMMERCE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT MERCHANDISE$WARES$PRODUCT ARTIFACTS)
(Documentation MERCHANDISE$WARES$PRODUCT
"commodities offered for sale; 'good business depends on having good merchandise';
'that store offers a variety of products'")
(HAS-I-TOPIC MERCHANDISE$WARES$PRODUCT |Commerce|)
(WORD MERCHANDISE$WARES$PRODUCT |merchandise|)
(WORD MERCHANDISE$WARES$PRODUCT |wares|)
(WORD MERCHANDISE$WARES$PRODUCT |product|)))
(DEFCONCEPT CONSUMER_GOODS (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT CONSUMER_GOODS ARTIFACTS)
(Documentation CONSUMER_GOODS
"goods (as food or clothing) intended for direct use or consumption")
(HAS-I-TOPIC CONSUMER_GOODS |Commerce|)
(WORD CONSUMER_GOODS |consumer goods|)))
(DEFCONCEPT DRYGOODS$SOFT_GOODS (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT DRYGOODS$SOFT_GOODS ARTIFACTS)
(Documentation DRYGOODS$SOFT_GOODS
"textiles or clothing and related merchandise")
(HAS-I-TOPIC DRYGOODS$SOFT_GOODS |Commerce|)
(WORD DRYGOODS$SOFT_GOODS |drygoods|)
(WORD DRYGOODS$SOFT_GOODS |soft goods|)))
(DEFCONCEPT BASIC$STAPLE (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT BASIC$STAPLE ARTIFACTS)
(Documentation BASIC$STAPLE
"(usually plural) a necessary commodity for which demand is constant")
(HAS-I-TOPIC BASIC$STAPLE |Commerce|) (WORD BASIC$STAPLE |basic|)
(WORD BASIC$STAPLE |staple|)))
(DEFCONCEPT ENTRANT_1 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT ENTRANT_1 ARTIFACTS)
(Documentation ENTRANT_1
"a commodity that enters competition with established merchandise; 'a well publicized
entrant is the pocket computer'")
(HAS-I-TOPIC ENTRANT_1 |Commerce|) (WORD ENTRANT_1 |entrant|)))
(DEFCONCEPT MIDDLING (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT MIDDLING ARTIFACTS)
(Documentation MIDDLING
"any commodity of intermediate quality or size (especially when coarse particles of
ground wheat are mixed with bran)")
(HAS-I-TOPIC MIDDLING |Commerce|) (WORD MIDDLING |middling|)))
(DEFCONCEPT TOP_OF_THE_LINE (?SELF)
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:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT TOP_OF_THE_LINE ARTIFACTS)
  (DOCUMENTATION TOP_OF_THE_LINE
    "the best (most expensive) in a given line of merchandise")
  (HAS-I-TOPIC TOP_OF_THE_LINE |Commerce|)
  (WORD TOP_OF_THE_LINE |top of the line|)))
(DEFCONCEPT SALE_3 (?SELF)
:=> (STATE ?SELF)
:AXIOMS (AND (SUBJECT SALE_3 STATES)
  (DOCUMENTATION SALE_3
    "the state of being purchasable; offered or exhibited for selling; 'vitamin C is on sale
    at most pharmacies'; 'the new line of cars will soon be on sale'")
  (HAS-I-TOPIC SALE_3 |Commerce|) (WORD SALE_3 |sale|)))
(DEFCONCEPT JOB_LOT (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT JOB_LOT GROUPS)
  (DOCUMENTATION JOB_LOT
    "a miscellaneous collection of things sold together")
  (HAS-I-TOPIC JOB_LOT |Commerce|) (WORD JOB_LOT |job lot|)))
(DEFCONCEPT PACKAGE$BUNDLE$PACKET$PARCEL (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT PACKAGE$BUNDLE$PACKET$PARCEL GROUPS)
  (DOCUMENTATION PACKAGE$BUNDLE$PACKET$PARCEL
    "a collection of things wrapped or boxed together")
  (HAS-I-TOPIC PACKAGE$BUNDLE$PACKET$PARCEL |Commerce|)
  (WORD PACKAGE$BUNDLE$PACKET$PARCEL |package|)
  (WORD PACKAGE$BUNDLE$PACKET$PARCEL |bundle|)
  (WORD PACKAGE$BUNDLE$PACKET$PARCEL |packet|)
  (WORD PACKAGE$BUNDLE$PACKET$PARCEL |parcel|)))
(DEFCONCEPT SUM$TOTAL$TOTALITY$AGGREGATE (?SELF)
:=> (ARBITRARY-SUM ?SELF)
:AXIOMS (AND (SUBJECT SUM$TOTAL$TOTALITY$AGGREGATE ARTIFACTS)
  (DOCUMENTATION SUM$TOTAL$TOTALITY$AGGREGATE "the whole")
  (HAS-I-TOPIC SUM$TOTAL$TOTALITY$AGGREGATE |Economy|)
  (WORD SUM$TOTAL$TOTALITY$AGGREGATE |sum|)
  (WORD SUM$TOTAL$TOTALITY$AGGREGATE |total|)
  (WORD SUM$TOTAL$TOTALITY$AGGREGATE |totality|)
  (WORD SUM$TOTAL$TOTALITY$AGGREGATE |aggregate|)))
(DEFCONCEPT CRASH$COLLAPSE (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CRASH$COLLAPSE EVENTS)
  (DOCUMENTATION CRASH$COLLAPSE
    "a sudden large decline of business or the prices of stocks (especially one that causes
    additional failures)")
  (HAS-I-TOPIC CRASH$COLLAPSE |Exchange|)
  (WORD CRASH$COLLAPSE |crash|) (WORD CRASH$COLLAPSE |collapse|)))
(DEFCONCEPT DOCUMENT_2 (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT DOCUMENT_2 POSSESSION)
  (DOCUMENTATION DOCUMENT_2
    "a written account of ownership or obligation")
  (HAS-I-TOPIC DOCUMENT_2 |Administration|)
  (HAS-I-TOPIC DOCUMENT_2 |Economy|) (WORD DOCUMENT_2 |document|)))
(DEFCONCEPT FACILITY$INSTALLATION (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT FACILITY$INSTALLATION ARTIFACTS)
  (DOCUMENTATION FACILITY$INSTALLATION
    "something created to provide a particular service; 'the assembly plant is an enormous facility'")
  (HAS-I-TOPIC FACILITY$INSTALLATION |Economy|)
  (WORD FACILITY$INSTALLATION |facility|)
  (WORD FACILITY$INSTALLATION |installation|)))
(DEFCONCEPT ASSET (?SELF)
:=> (FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT ASSET POSSESSION)
  (DOCUMENTATION ASSET "anything of material value or usefulness")
  (HAS-I-TOPIC ASSET |Economy|) (WORD ASSET |asset|)))
(DEFCONCEPT LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$
PECUNIARY_OBLIGATION (?SELF)
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:=> (LEGAL-POSSESSION-ENTITY ?SELF)
:AXIOMS (AND
  (SUBJECT
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    POSSESSION)
  (DOCUMENTATION
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    "possession that is owed to someone else")
  (HAS-I-TOPIC
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    |Economy|)
  (WORD
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    |liability|)
  (WORD
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    |financial_obligation|)
  (WORD
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    |indebtedness|)
  (WORD
    LIABILITY$FINANCIAL_OBLIGATION$INDEBTEDNESS$PECUNIARY_OBLIGATION
    |pecuniary_obligation|)))
(DEFCONCEPT OWNERSHIP_1 (?SELF)
:=> (LEGAL-POSSESSION-ENTITY ?SELF)
:AXIOMS (AND (SUBJECT OWNERSHIP_1 POSSESSION)
  (DOCUMENTATION OWNERSHIP_1
    "possession with the right to transfer possession to others")
  (HAS-I-TOPIC OWNERSHIP_1 |Economy|) (WORD OWNERSHIP_1 |ownership|)))
(DEFCONCEPT PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION (?SELF)
:=> (LEGAL-POSSESSION-ENTITY ?SELF)
:AXIOMS (AND
  (SUBJECT PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION POSSESSION)
  (DOCUMENTATION PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION
    "any tangible possession that is owned by someone; 'that hat is my property'")
  (HAS-I-TOPIC PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION
    |Economy|)
  (WORD PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION |property|)
  (WORD PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION |belongings|)
  (WORD PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION |holding|)
  (WORD PROPERTY$BELONGINGS$HOLDING$MATERIAL_POSSESSION
    |material_possession|)))
(DEFCONCEPT RECEIVERSHIP_3 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT RECEIVERSHIP_3 STATES)
  (DOCUMENTATION RECEIVERSHIP_3
    "the state of property that is in the hands of a receiver; 'the business is in receivership'")
  (HAS-I-TOPIC RECEIVERSHIP_3 |Economy|)
  (WORD RECEIVERSHIP_3 |receivership|)))
(DEFCONCEPT BUSINESS_RELATION (?SELF)
:=> (S-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT BUSINESS_RELATION RELATIONS)
  (DOCUMENTATION BUSINESS_RELATION
    "a relation between different business enterprises")
  (HAS-I-TOPIC BUSINESS_RELATION |Economy|)
  (WORD BUSINESS_RELATION |business_relation|)))
(DEFCONCEPT FINANCIAL_CONDITION$ECONOMIC_CONDITION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT FINANCIAL_CONDITION$ECONOMIC_CONDITION STATES)
  (DOCUMENTATION FINANCIAL_CONDITION$ECONOMIC_CONDITION
    "the condition of finances")
  (HAS-I-TOPIC FINANCIAL_CONDITION$ECONOMIC_CONDITION |Economy|)
  (WORD FINANCIAL_CONDITION$ECONOMIC_CONDITION |financial_condition|)
  (WORD FINANCIAL_CONDITION$ECONOMIC_CONDITION |economic_condition|)))
(DEFCONCEPT OWNERSHIP_2 (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT OWNERSHIP_2 STATES)
  (DOCUMENTATION OWNERSHIP_2 "the state or fact of being an owner")

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(HAS-I-TOPIC OWNERSHIP_2 |Economy|) (WORD OWNERSHIP_2 |ownership|)))
(DEFCONCEPT MARKET$MARKETPLACE (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT MARKET$MARKETPLACE ACTS)
(DOCUMENTATION MARKET$MARKETPLACE
"the world of commercial activity where goods and services are bought and sold;
'without competition there would be no market'; 'they were driven from the marketplace'")
(HAS-I-TOPIC MARKET$MARKETPLACE |Exchange|)
(WORD MARKET$MARKETPLACE |market|)
(WORD MARKET$MARKETPLACE |marketplace|)))
(DEFCONCEPT ENTERPRISE (?SELF)
:=> (ORGANIZATION$ORGANISATION_2 ?SELF)
:AXIOMS (AND (SUBJECT ENTERPRISE GROUPS)
(DOCUMENTATION ENTERPRISE
"an organization created for business ventures; 'a growing enterprise must have a bold leader'")
(HAS-I-TOPIC ENTERPRISE |Enterprise|) (WORD ENTERPRISE |enterprise|)))
(DEFCONCEPT EMPLOYMENT$EMPLOY (?SELF)
:=> (STATE ?SELF)
:AXIOMS (AND (SUBJECT EMPLOYMENT$EMPLOY STATES)
(DOCUMENTATION EMPLOYMENT$EMPLOY
"the state of being employed or having a job; 'they are looking for employment';
'he was in the employ of the city'")
(HAS-I-TOPIC EMPLOYMENT$EMPLOY |Enterprise|)
(WORD EMPLOYMENT$EMPLOY |employment|)
(WORD EMPLOYMENT$EMPLOY |employ|)))
(DEFCONCEPT UNEMPLOYMENT (?SELF)
:=> (STATE ?SELF)
:AXIOMS (AND (SUBJECT UNEMPLOYMENT STATES)
(DOCUMENTATION UNEMPLOYMENT
"the state of being unemployed or not having a job; 'unemployment is a serious social evil';
'the rate of unemployment is an indicator of the health of an economy'")
(HAS-I-TOPIC UNEMPLOYMENT |Enterprise|)
(WORD UNEMPLOYMENT |unemployment|)))
(DEFCONCEPT FLEET_3 (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT FLEET_3 GROUPS)
(DOCUMENTATION FLEET_3
"group of motor vehicles operating together under the same ownership")
(HAS-I-TOPIC FLEET_3 |Economy|) (HAS-I-TOPIC FLEET_3 |Military|)
(HAS-I-TOPIC FLEET_3 |Transport|) (WORD FLEET_3 |fleet|)))
(DEFCONCEPT FLEET_4 (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT FLEET_4 GROUPS)
(DOCUMENTATION FLEET_4
"group of aircraft operating together under the same ownership")
(HAS-I-TOPIC FLEET_4 |Economy|) (HAS-I-TOPIC FLEET_4 |Transport|)
(WORD FLEET_4 |fleet|)))
(DEFCONCEPT AUTOMATON$ROBOT$GOLEM (?SELF)
:=> (AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT AUTOMATON$ROBOT$GOLEM ARTIFACTS)
(DOCUMENTATION AUTOMATON$ROBOT$GOLEM
"a mechanism that can move automatically")
(HAS-I-TOPIC AUTOMATON$ROBOT$GOLEM |Industry|)
(HAS-I-TOPIC AUTOMATON$ROBOT$GOLEM |Mechanics|)
(WORD AUTOMATON$ROBOT$GOLEM |automaton|)
(WORD AUTOMATON$ROBOT$GOLEM |robot|)
(WORD AUTOMATON$ROBOT$GOLEM |golem|)))
(DEFCONCEPT EXCAVATION$HOLE_IN_THE_GROUND (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT EXCAVATION$HOLE_IN_THE_GROUND ARTIFACTS)
(DOCUMENTATION EXCAVATION$HOLE_IN_THE_GROUND
"a hole made by excavating")
(HAS-I-TOPIC EXCAVATION$HOLE_IN_THE_GROUND |Industry|)
(WORD EXCAVATION$HOLE_IN_THE_GROUND |excavation|)
(WORD EXCAVATION$HOLE_IN_THE_GROUND |hole in the ground|)))
(DEFCONCEPT PADDING$CUSHIONING (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT PADDING$CUSHIONING ARTIFACTS)
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(DOCUMENTATION PADDING$CUSHIONING
"soft or resilient material used to fill or give shape or protect or add comfort")
(HAS-I-TOPIC PADDING$CUSHIONING |Industry|)
(WORD PADDING$CUSHIONING |padding|)
(WORD PADDING$CUSHIONING |cushioning|))
(DEFCONCEPT FABRIC$CLOTH$MATERIAL$TEXTILE (?SELF)
:=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
:AXIOMS (AND (SUBJECT FABRIC$CLOTH$MATERIAL$TEXTILE ARTIFACTS)
(DOCUMENTATION FABRIC$CLOTH$MATERIAL$TEXTILE
"something made by weaving or felting or knitting or crocheting natural or synthetic fibers")
(HAS-I-TOPIC FABRIC$CLOTH$MATERIAL$TEXTILE |Industry|)
(WORD FABRIC$CLOTH$MATERIAL$TEXTILE |fabric|)
(WORD FABRIC$CLOTH$MATERIAL$TEXTILE |cloth|)
(WORD FABRIC$CLOTH$MATERIAL$TEXTILE |material|)
(WORD FABRIC$CLOTH$MATERIAL$TEXTILE |textile|)))
(DEFCONCEPT FIELD_4 (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT FIELD_4 LOCATIONS)
(DOCUMENTATION FIELD_4
"a region in which military operations are in progress; 'the army was in the field awaiting action'")
(HAS-I-TOPIC FIELD_4 |Military|) (WORD FIELD_4 |field|)))
(DEFCONCEPT MILITARY_POSITION$POSITION (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT MILITARY_POSITION$POSITION LOCATIONS)
(DOCUMENTATION MILITARY_POSITION$POSITION
"a point occupied by troops for tactical reasons")
(HAS-I-TOPIC MILITARY_POSITION$POSITION |Military|)
(WORD MILITARY_POSITION$POSITION |military_position|)
(WORD MILITARY_POSITION$POSITION |position|)))
(DEFCONCEPT READINESS$PREPAREDNESS (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT READINESS$PREPAREDNESS STATES)
(DOCUMENTATION READINESS$PREPAREDNESS
"the state of being ready or prepared for use or action (especially military action);
'putting them in readiness'")
(HAS-I-TOPIC READINESS$PREPAREDNESS |Military|)
(WORD READINESS$PREPAREDNESS |readiness|)
(WORD READINESS$PREPAREDNESS |preparedness|)))
(DEFCONCEPT AVIATION$AIR_POWER (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT AVIATION$AIR_POWER GROUPS)
(DOCUMENTATION AVIATION$AIR_POWER
"the aggregation of a country's military aircraft")
(HAS-I-TOPIC AVIATION$AIR_POWER |Military|)
(WORD AVIATION$AIR_POWER |aviation|)
(WORD AVIATION$AIR_POWER |air_power|)))
(DEFCONCEPT CONVOY_2 (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT CONVOY_2 GROUPS)
(DOCUMENTATION CONVOY_2
"a collection of merchant ships with an escort of warships")
(HAS-I-TOPIC CONVOY_2 |Military|) (WORD CONVOY_2 |convoy|)))
(DEFCONCEPT FLEET_1 (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT FLEET_1 GROUPS)
(DOCUMENTATION FLEET_1
"a group of warships organized as a tactical unit")
(HAS-I-TOPIC FLEET_1 |Military|) (WORD FLEET_1 |fleet|)))
(DEFCONCEPT CITIZENRY$PEOPLE (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT CITIZENRY$PEOPLE GROUPS)
(DOCUMENTATION CITIZENRY$PEOPLE
"the body of citizens of a state or country; 'the Spanish people'")
(HAS-I-TOPIC CITIZENRY$PEOPLE |Politics|)
(WORD CITIZENRY$PEOPLE |citizenry|) (WORD CITIZENRY$PEOPLE |people|)))
(DEFCONCEPT MOVEMENT$FRONT (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT MOVEMENT$FRONT GROUPS)
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(DOCUMENTATION MOVEMENT$FRONT
  "a group of people with a common ideology who try together to achieve certain general goals;
  'he was a charter member of the movement'; 'politicians have to respect a mass movement';
  'he led the national liberation front'")
(HAS-I-TOPIC MOVEMENT$FRONT |Politics|)
(WORD MOVEMENT$FRONT |movement|) (WORD MOVEMENT$FRONT |front|)))
(DEFCONCEPT NONALIGNMENT$NONALINEMENT (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT NONALIGNMENT$NONALINEMENT GROUPS)
    (DOCUMENTATION NONALIGNMENT$NONALINEMENT
      "people (or countries) who are not aligned with other people (or countries) in a pact or treaty")
    (HAS-I-TOPIC NONALIGNMENT$NONALINEMENT |Politics|)
    (WORD NONALIGNMENT$NONALINEMENT |nonalignment|)
    (WORD NONALIGNMENT$NONALINEMENT |nonalinement|)))
(DEFCONCEPT THIRD_WORLD (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT THIRD_WORLD GROUPS)
    (DOCUMENTATION THIRD_WORLD
      "underdeveloped and developing countries of Asia and Africa and Latin America collectively;
      neutral in the East-West alignment")
    (HAS-I-TOPIC THIRD_WORLD |Politics|)
    (WORD THIRD_WORLD |Third World|)))
(DEFCONCEPT MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE GROUPS)
    (DOCUMENTATION MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE
      "the common people generally; 'separate the warriors from the mass'; 'power to the people'")
    (HAS-I-TOPIC MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |Politics|)
    (WORD MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |multitude|)
    (WORD MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |masses|)
    (WORD MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |mass|)
    (WORD MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |hoi polloi|)
    (WORD MULTITUDE$MASSES$MASS$HOI_POLLOI$PEOPLE |people|)))
(DEFCONCEPT IRREDENTA$IRRIDENTA (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT IRREDENTA$IRRIDENTA LOCATIONS)
    (DOCUMENTATION IRREDENTA$IRRIDENTA
      "a region that is related ethnically or historically to one country but is controlled
      politically by another")
    (HAS-I-TOPIC IRREDENTA$IRRIDENTA |Politics|)
    (WORD IRREDENTA$IRRIDENTA |irredenta|)
    (WORD IRREDENTA$IRRIDENTA |irridenta|)))
(DEFCONCEPT POLLS (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT POLLS LOCATIONS)
    (DOCUMENTATION POLLS "the place where people vote")
    (HAS-I-TOPIC POLLS |Politics|) (WORD POLLS |polls|)))
(DEFCONCEPT POLITICAL_SYSTEM$FORM_OF_GOVERNMENT (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT POLITICAL_SYSTEM$FORM_OF_GOVERNMENT GROUPS)
    (DOCUMENTATION POLITICAL_SYSTEM$FORM_OF_GOVERNMENT
      "the members of a social organization who are in power")
    (HAS-I-TOPIC POLITICAL_SYSTEM$FORM_OF_GOVERNMENT |Anthropology|)
    (HAS-I-TOPIC POLITICAL_SYSTEM$FORM_OF_GOVERNMENT |Politics|)
    (HAS-I-TOPIC POLITICAL_SYSTEM$FORM_OF_GOVERNMENT |Sociology|)
    (WORD POLITICAL_SYSTEM$FORM_OF_GOVERNMENT |political_system|)
    (WORD POLITICAL_SYSTEM$FORM_OF_GOVERNMENT |form_of_government|)))
(DEFCONCEPT POLITICS$POLITICAL_RELATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT POLITICS$POLITICAL_RELATION RELATIONS)
    (DOCUMENTATION POLITICS$POLITICAL_RELATION
      "social relations involving authority or power")
    (HAS-I-TOPIC POLITICS$POLITICAL_RELATION |Politics|)
    (WORD POLITICS$POLITICAL_RELATION |politics|)
    (WORD POLITICS$POLITICAL_RELATION |political_relation|)))
(DEFCONCEPT OFFICE$POWER (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT OFFICE$POWER STATES)
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(DOCUMENTATION OFFICE$POWER
"(of a government or government official) holding an office means being in power;
'being in office already gives a candidate a great advantage'; 'during his first year in power'")
(HAS-I-TOPIC OFFICE$POWER |Politics|) (WORD OFFICE$POWER |office|)
(WORD OFFICE$POWER |power|))
(DEFCONCEPT FREE_WORLD (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT FREE_WORLD GROUPS)
(DOCUMENTATION FREE_WORLD "anti-Communist countries collectively")
(HAS-I-TOPIC FREE_WORLD |Politics|) (WORD FREE_WORLD |Free World|)))
(DEFCONCEPT EDITION_3 (?SELF)
:=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT EDITION_3 GROUPS)
(DOCUMENTATION EDITION_3
"all of the identical copies of something offered to the public at the same time;
'the first edition appeared in 1920' or 'it was too late for the morning edition' or
'they issued a limited edition of Bach recordings'")
(HAS-I-TOPIC EDITION_3 |Publishing|) (WORD EDITION_3 |edition|)))
(DEFCONCEPT INTEREST$INTEREST_GROUP (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT INTEREST$INTEREST_GROUP GROUPS)
(DOCUMENTATION INTEREST$INTEREST_GROUP
"(usually plural) a social group whose members control some field of activity
and who have common aims; 'the iron interests stepped up production'")
(HAS-I-TOPIC INTEREST$INTEREST_GROUP |Sociology|)
(WORD INTEREST$INTEREST_GROUP |interest|)
(WORD INTEREST$INTEREST_GROUP |interest group|)))
(DEFCONCEPT KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$
TRIBE GROUPS)
(DOCUMENTATION KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE
"group of people related by blood or marriage")
(HAS-I-TOPIC KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE
|Sociology|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE |kin|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE |kin group|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE
|kinship group|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE |kindred|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE |clan|)
(WORD KIN$KIN_GROUP$KINSHIP_GROUP$KINDRED$CLAN$TRIBE |tribe|)))
(DEFCONCEPT MINORITY_2 (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT MINORITY_2 GROUPS)
(DOCUMENTATION MINORITY_2
"a group of people who differ racially or politically from a larger group of which it is a part")
(HAS-I-TOPIC MINORITY_2 |Anthropology|)
(HAS-I-TOPIC MINORITY_2 |Sociology|) (WORD MINORITY_2 |minority|)))
(DEFCONCEPT SOCIETY (?SELF)
:=> (AGENTIVE-GROUP ?SELF)
:AXIOMS (AND (SUBJECT SOCIETY GROUPS)
(DOCUMENTATION SOCIETY
"an extended social group having a distinctive cultural and economic organization")
(HAS-I-TOPIC SOCIETY |Anthropology|)
(HAS-I-TOPIC SOCIETY |Sociology|) (WORD SOCIETY |society|)))
(DEFCONCEPT SOCIAL_EVENT (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT SOCIAL_EVENT EVENTS)
(DOCUMENTATION SOCIAL_EVENT
"an event characteristic of persons forming groups")
(HAS-I-TOPIC SOCIAL_EVENT |Sociology|)
(WORD SOCIAL_EVENT |social event|)))
(DEFCONCEPT PLATOON_3 (?SELF)
:=> (QUALITATIVE-ROLE ?SELF)
:AXIOMS (AND (SUBJECT PLATOON_3 GROUPS)
(DOCUMENTATION PLATOON_3
"a group of persons who are engaged in a common activity; 'platoons of tourists poured

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        out of the busses'; 'the defensive platoon of the football team'")
      (HAS-I-TOPIC PLATOON_3 |Sociology|) (WORD PLATOON_3 |platoon|)))
(DEFCONCEPT STATUS$POSITION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT STATUS$POSITION STATES)
    (DOCUMENTATION STATUS$POSITION
      "the relative position or standing of things or especially persons in a society: 'he had the
      status of a minor'; 'the novel attained the status of a classic'; 'atheists do not enjoy a
      favorable position in American life'")
      (HAS-I-TOPIC STATUS$POSITION |Sociology|)
      (WORD STATUS$POSITION |status|) (WORD STATUS$POSITION |position|)))
(DEFCONCEPT KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP RELATIONS)
    (DOCUMENTATION KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP
      "state of relatedness or connection by blood or marriage or adoption")
      (HAS-I-TOPIC KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP
        |Anthropology|)
      (HAS-I-TOPIC KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP |Sociology|)
      (WORD KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP |kinship|)
      (WORD KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP
        |family_relationship|)
      (WORD KINSHIP$FAMILY_RELATIONSHIP$RELATIONSHIP |relationship|)))
(DEFCONCEPT PRACTICE_3 (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT PRACTICE_3 COGNITION)
    (DOCUMENTATION PRACTICE_3
      "knowledge of how something is customarily done: 'it is not the local practice to wear shorts to dinner'")
      (HAS-I-TOPIC PRACTICE_3 |Sociology|) (WORD PRACTICE_3 |practice|)))
(DEFCONCEPT STRATIFICATION$SOCIAL_STRATIFICATION (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT STRATIFICATION$SOCIAL_STRATIFICATION STATES)
    (DOCUMENTATION STRATIFICATION$SOCIAL_STRATIFICATION
      "the condition of being arranged in social strata or classes")
      (HAS-I-TOPIC STRATIFICATION$SOCIAL_STRATIFICATION |Sociology|)
      (WORD STRATIFICATION$SOCIAL_STRATIFICATION |stratification|)
      (WORD STRATIFICATION$SOCIAL_STRATIFICATION |social_stratification|)))
(DEFCONCEPT WRONGDOING$MISCONDUCT (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT WRONGDOING$MISCONDUCT ACTS)
    (DOCUMENTATION WRONGDOING$MISCONDUCT
      "activity that transgresses moral or civil law; 'he denied any wrongdoing'")
      (HAS-I-TOPIC WRONGDOING$MISCONDUCT |Sociology|)
      (WORD WRONGDOING$MISCONDUCT |wrongdoing|)
      (WORD WRONGDOING$MISCONDUCT |misconduct|)))
(DEFCONCEPT MESSAGE (?SELF)
  :=> (INFORMATION-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT MESSAGE COMMUNICATION)
    (DOCUMENTATION MESSAGE
      "a communication (usually brief) that is written or spoken or signaled;
      'he sent a three-word message'")
      (HAS-I-TOPIC MESSAGE |Telecommunication|) (WORD MESSAGE |message|)))
(DEFCONCEPT MAIL_3 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT MAIL_3 GROUPS)
    (DOCUMENTATION MAIL_3
      "any particular collection of letters or packages that is delivered; 'your mail is on the table'")
      (HAS-I-TOPIC MAIL_3 |Post|) (WORD MAIL_3 |mail|)))
(DEFCONCEPT SERVICE_AREA (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT SERVICE_AREA LOCATIONS)
    (DOCUMENTATION SERVICE_AREA
      "place on a highway providing garage services and eating and toilet facilities")
      (HAS-I-TOPIC SERVICE_AREA |Tourism|)
      (WORD SERVICE_AREA |service_area|)))
(DEFCONCEPT TRAFFIC_2 (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT TRAFFIC_2 GROUPS)
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(DOCUMENTATION TRAFFIC_2
  "the aggregation of things (pedestrians or vehicles or messages) coming and going
  in a particular locality")
(HAS-I-TOPIC TRAFFIC_2 |Town_Planning|)
(HAS-I-TOPIC TRAFFIC_2 |Transport|) (WORD TRAFFIC_2 |traffic|))
(DEFCONCEPT WAY_2 (?SELF)
  :=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT WAY_2 ARTIFACTS)
    (DOCUMENTATION WAY_2
      "any road or path affording passage from one place to another; 'he said he was
      looking for the way out'")
    (HAS-I-TOPIC WAY_2 |Transport|) (WORD WAY_2 |way|)))
(DEFCONCEPT JUNCTION (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT JUNCTION ARTIFACTS)
    (DOCUMENTATION JUNCTION "the place where two things come together")
    (HAS-I-TOPIC JUNCTION |Transport|) (WORD JUNCTION |junction|))
(DEFCONCEPT PORT (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT PORT LOCATIONS)
    (DOCUMENTATION PORT
      "a place (seaport or airport) where people and merchandise can enter or leave a country")
    (HAS-I-TOPIC PORT |Geography|) (HAS-I-TOPIC PORT |Merchant_Navy|)
    (WORD PORT |port|))
(DEFCONCEPT STATION_2 (?SELF)
  :=> (NON-PHYSICAL-PLACE ?SELF)
  :AXIOMS (AND (SUBJECT STATION_2 LOCATIONS)
    (DOCUMENTATION STATION_2
      "(Navy) the location to which a ship or fleet is assigned for duty")
    (HAS-I-TOPIC STATION_2 |Merchant_Navy|) (WORD STATION_2 |station|))
(DEFCONCEPT BALLAST (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT BALLAST ARTIFACTS)
    (DOCUMENTATION BALLAST "used to stabilize a ship or airship")
    (HAS-I-TOPIC BALLAST |Transport|) (WORD BALLAST |ballast|))
(DEFCONCEPT ATMOSPHERE_1 (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT ATMOSPHERE_1 LOCATIONS)
    (DOCUMENTATION ATMOSPHERE_1
      "the mass of air surrounding the Earth; 'there was great heat as the comet entered the atmosphere'")
    (HAS-I-TOPIC ATMOSPHERE_1 |Astronomy|)
    (WORD ATMOSPHERE_1 |atmosphere|))
(DEFCONCEPT HELIOSPHERE (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT HELIOSPHERE LOCATIONS)
    (DOCUMENTATION HELIOSPHERE
      "the region inside the heliopause containing the sun and solar system")
    (HAS-I-TOPIC HELIOSPHERE |Astronomy|)
    (WORD HELIOSPHERE |heliosphere|))
(DEFCONCEPT CELESTIAL_POINT (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CELESTIAL_POINT LOCATIONS)
    (DOCUMENTATION CELESTIAL_POINT
      "a point in the heavens (on the celestial sphere)")
    (HAS-I-TOPIC CELESTIAL_POINT |Astronomy|)
    (WORD CELESTIAL_POINT |celestial_point|))
(DEFCONCEPT ASTERISM_1 (?SELF)
  :=> (GEOGRAPHICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT ASTERISM_1 OBJECTS)
    (DOCUMENTATION ASTERISM_1
      "(astronomy) a cluster of stars (or a small constellation)")
    (HAS-I-TOPIC ASTERISM_1 |Astronomy|) (WORD ASTERISM_1 |asterism|))
(DEFCONCEPT CONSTELLATION (?SELF)
  :=> (GEOGRAPHICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT CONSTELLATION OBJECTS)
    (DOCUMENTATION CONSTELLATION
      "a configuration of stars as seen from the earth")
    (HAS-I-TOPIC CONSTELLATION |Astronomy|)
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        (WORD CONSTELLATION |constellation|)))
(DEFCONCEPT ZODIAC_2 (?SELF)
  :=> (GEOGRAPHICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT ZODIAC_2 LOCATIONS)
    (DOCUMENTATION ZODIAC_2
      "a belt-shaped region in the heavens on either side to the ecliptic; divided into 12
      constellations or signs for astrological purposes")
    (HAS-I-TOPIC ZODIAC_2 |Astronomy|) (WORD ZODIAC_2 |zodiac|)))
(DEFCONCEPT CELESTIAL_BODY$HEAVENLY_BODY (?SELF)
  :=> (PHYSICAL-BODY ?SELF)
  :AXIOMS (AND (SUBJECT CELESTIAL_BODY$HEAVENLY_BODY OBJECTS)
    (DOCUMENTATION CELESTIAL_BODY$HEAVENLY_BODY
      "natural objects visible in the sky")
    (HAS-I-TOPIC CELESTIAL_BODY$HEAVENLY_BODY |Astronomy|)
    (WORD CELESTIAL_BODY$HEAVENLY_BODY |celestial_body|)
    (WORD CELESTIAL_BODY$HEAVENLY_BODY |heavenly_body|)))
(DEFCONCEPT UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$
  MACROCOSM (?SELF)
  :=> (PHYSICAL-BODY ?SELF)
  :AXIOMS (AND
    (SUBJECT UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$
      MACROCOSM
      OBJECTS)
    (DOCUMENTATION
      UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      "everything that exists anywhere; 'they study the evolution of the universe';
      'the biggest tree in existence'")
    (HAS-I-TOPIC
      UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |Astronomy|)
    (HAS-I-TOPIC
      UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |Physics|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |universe|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |existence|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |nature|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |creation|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |world|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |cosmos|)
    (WORD UNIVERSE$EXISTENCE$NATURE$CREATION$WORLD$COSMOS$MACROCOSM
      |macrocosm|)))
(DEFCONCEPT ANOMALY (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT ANOMALY LOCATIONS)
    (DOCUMENTATION ANOMALY
      "(astronomy) position of a planet as defined by its angular distance from its perihelion
      (as observed from the sun)")
    (HAS-I-TOPIC ANOMALY |Astronomy|) (WORD ANOMALY |anomaly|)))
(DEFCONCEPT MAGNITUDE_RELATION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT MAGNITUDE_RELATION RELATIONS)
    (DOCUMENTATION MAGNITUDE_RELATION "a relation between magnitudes")
    (HAS-I-TOPIC MAGNITUDE_RELATION |Astronomy|)
    (WORD MAGNITUDE_RELATION |magnitude_relation|)))
(DEFCONCEPT GALAXY$EXTRAGALACTIC_NEBULA (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT GALAXY$EXTRAGALACTIC_NEBULA GROUPS)
    (DOCUMENTATION GALAXY$EXTRAGALACTIC_NEBULA
      "(astronomy) a collection of star systems; any of the billions of systems each having many
      stars and nebulae and dust; 'extragalactic nebula' is a former name for 'galaxy'")
    (HAS-I-TOPIC GALAXY$EXTRAGALACTIC_NEBULA |Astronomy|)
    (WORD GALAXY$EXTRAGALACTIC_NEBULA |galaxy|))

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(WORD GALAXY$EXTRAGALACTIC_NEBULA |extragalactic nebula|))
(DEFCONCEPT OORT_CLOUD (?SELF)
  => (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT OORT_CLOUD GROUPS)
    (DOCUMENTATION OORT_CLOUD
      "(astronomy) a hypothetical huge collection of comets orbiting the sun far beyond the orbit
      of Pluto; perturbations (as by other stars) can upset a comet's orbit and may send
      it tumbling toward the sun")
      (HAS-I-TOPIC OORT_CLOUD |Astronomy|) (WORD OORT_CLOUD |Oort cloud|)))
(DEFCONCEPT SET_5 (?SELF)
  => (SET ?SELF)
  :AXIOMS (AND (SUBJECT SET_5 GROUPS)
    (DOCUMENTATION SET_5
      "an abstract collection of numbers or symbols; 'the set of prime numbers is infinite'"
      (HAS-I-TOPIC SET_5 |Mathematics|) (WORD SET_5 |set|)))
(DEFCONCEPT QUANTITY_2 (?SELF)
  => (ABSTRACT-REGION ?SELF)
  :AXIOMS (AND (SUBJECT QUANTITY_2 COGNITION)
    (DOCUMENTATION QUANTITY_2
      "something that has a magnitude and can be represented in mathematical expressions by a
      constant or a variable")
      (HAS-I-TOPIC QUANTITY_2 |Mathematics|) (WORD QUANTITY_2 |quantity|)))
(DEFCONCEPT CALCULATION$COMPUTATION (?SELF)
  => (COURSE ?SELF)
  :AXIOMS (AND (SUBJECT CALCULATION$COMPUTATION ACTS)
    (DOCUMENTATION CALCULATION$COMPUTATION
      "the procedure of calculating; determining something by mathematical or logical methods")
      (HAS-I-TOPIC CALCULATION$COMPUTATION |Mathematics|)
      (WORD CALCULATION$COMPUTATION |calculation|)
      (WORD CALCULATION$COMPUTATION |computation|)))
(DEFCONCEPT RULE$FORMULA (?SELF)
  => (COURSE ?SELF)
  :AXIOMS (AND (SUBJECT RULE$FORMULA COGNITION)
    (DOCUMENTATION RULE$FORMULA
      "(mathematics) a standard procedure for solving a class of problems; 'he determined the
      upper bound with Descartes' rule of signs'; 'he gave us a general formula for
      attacking polynomials'"
      (HAS-I-TOPIC RULE$FORMULA |Mathematics|) (WORD RULE$FORMULA |rule|)
      (WORD RULE$FORMULA |formula|)))
(DEFCONCEPT SEGMENT (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT SEGMENT OBJECTS)
    (DOCUMENTATION SEGMENT
      "one of the parts into which something naturally divides: 'a segment of an orange'"
      (HAS-I-TOPIC SEGMENT |Geometry|) (WORD SEGMENT |segment|)))
(DEFCONCEPT GEODESIC$GEODESIC_LINE (?SELF)
  => (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT GEODESIC$GEODESIC_LINE SHAPES)
    (DOCUMENTATION GEODESIC$GEODESIC_LINE
      "(mathematics) the shortest line between two points on a mathematically defined surface
      (as a straight line on a plane or a an arc of a great circle on a sphere)"
      (HAS-I-TOPIC GEODESIC$GEODESIC_LINE |Mathematics|)
      (WORD GEODESIC$GEODESIC_LINE |geodesic|)
      (WORD GEODESIC$GEODESIC_LINE |geodesic_line|)))
(DEFCONCEPT CENTER$CENTRE$MIDPOINT (?SELF)
  => (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CENTER$CENTRE$MIDPOINT LOCATIONS)
    (DOCUMENTATION CENTER$CENTRE$MIDPOINT
      "a point equidistant from the ends of a line or the extremities of a figure")
      (HAS-I-TOPIC CENTER$CENTRE$MIDPOINT |Geometry|)
      (WORD CENTER$CENTRE$MIDPOINT |center|)
      (WORD CENTER$CENTRE$MIDPOINT |centre|)
      (WORD CENTER$CENTRE$MIDPOINT |midpoint|)))
(DEFCONCEPT CORNER_1 (?SELF)
  => (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CORNER_1 LOCATIONS)
    (DOCUMENTATION CORNER_1
      "the point where two lines meet or intersect; 'the corners of a rectangle'"))
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                (HAS-I-TOPIC CORNER_1 |Geometry|) (WORD CORNER_1 |corner|)))
(DEFCONCEPT CORNER_4 (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CORNER_4 LOCATIONS)
    (DOCUMENTATION CORNER_4
      "the point where three areas or surfaces meet or intersect; 'the corners of a cube'")
    (HAS-I-TOPIC CORNER_4 |Geometry|) (WORD CORNER_4 |corner|)))
(DEFCONCEPT CURVE$CURVED_SHAPE (?SELF)
  :=> (QUALITY ?SELF)
  :AXIOMS (AND (SUBJECT CURVE$CURVED_SHAPE SHAPES)
    (DOCUMENTATION CURVE$CURVED_SHAPE
      "the trace of a point whose direction of motion changes")
    (HAS-I-TOPIC CURVE$CURVED_SHAPE |Geometry|)
    (WORD CURVE$CURVED_SHAPE |curve|)
    (WORD CURVE$CURVED_SHAPE |curved_shape|)))
(DEFCONCEPT STRAIGHT_LINE (?SELF)
  :=> (QUALITY ?SELF)
  :AXIOMS (AND (SUBJECT STRAIGHT_LINE SHAPES)
    (DOCUMENTATION STRAIGHT_LINE
      "a line traced by a point traveling in a constant direction; a line of zero curvature;
      'the shortest distance between two points is a straight line'")
    (HAS-I-TOPIC STRAIGHT_LINE |Geometry|)
    (WORD STRAIGHT_LINE |straight_line|)))
(DEFCONCEPT PLANE$SHEET (?SELF)
  :=> (QUALITY ?SELF)
  :AXIOMS (AND (SUBJECT PLANE$SHEET SHAPES)
    (DOCUMENTATION PLANE$SHEET
      "(mathematics) an unbounded two-dimensional shape; 'we will refer to the plane of the graph
      as the X-Y plane'; 'any line joining two points on a plane lies wholly on that plane'")
    (HAS-I-TOPIC PLANE$SHEET |Mathematics|) (WORD PLANE$SHEET |plane|)
    (WORD PLANE$SHEET |sheet|)))
(DEFCONCEPT MATHEMATICAL_RELATION (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT MATHEMATICAL_RELATION RELATIONS)
    (DOCUMENTATION MATHEMATICAL_RELATION
      "a relation between mathematical expressions (such as equality or inequality)")
    (HAS-I-TOPIC MATHEMATICAL_RELATION |Mathematics|)
    (WORD MATHEMATICAL_RELATION |mathematical_relation|)))
(DEFCONCEPT STATISTIC (?SELF)
  :=> (S-DESCRIPTION ?SELF)
  :AXIOMS (AND (SUBJECT STATISTIC COGNITION)
    (DOCUMENTATION STATISTIC
      "a datum that can be represented numerically")
    (HAS-I-TOPIC STATISTIC |Mathematics|) (WORD STATISTIC |statistic|)))
(DEFCONCEPT POPULATION$UNIVERSE (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT POPULATION$UNIVERSE COGNITION)
    (DOCUMENTATION POPULATION$UNIVERSE
      "(statistics) the entire aggregation of items from which samples can be drawn; 'it is an estimate
      of the mean of the population'")
    (HAS-I-TOPIC POPULATION$UNIVERSE |Statistics|)
    (WORD POPULATION$UNIVERSE |population|)
    (WORD POPULATION$UNIVERSE |universe|)))
(DEFCONCEPT FLUID_1 (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT FLUID_1 SUBSTANCES)
    (DOCUMENTATION FLUID_1
      "a continuous amorphous substance that tends to flow and to conform to the outline of its
      container: a liquid or a gas")
    (HAS-I-TOPIC FLUID_1 |Physics|) (WORD FLUID_1 |fluid|)))
(DEFCONCEPT MOLECULE (?SELF)
  :=> (CHEMICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT MOLECULE SUBSTANCES)
    (DOCUMENTATION MOLECULE
      "(physics and chemistry) the simplest structural unit of an element or compound")
    (HAS-I-TOPIC MOLECULE |Chemistry|) (HAS-I-TOPIC MOLECULE |Physics|)
    (WORD MOLECULE |molecule|)))
(DEFCONCEPT VOICE$VOCALIZATION (?SELF)

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:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT VOICE$VOCALIZATION COMMUNICATION)
  (DOCUMENTATION VOICE$VOCALIZATION
    "the sound made by the vibration of vocal folds modified by the resonance of the vocal tract;
    'a singer takes good care of his voice'; 'the giraffe cannot make any vocalizations'")
  (HAS-I-TOPIC VOICE$VOCALIZATION |Acoustics|)
  (WORD VOICE$VOCALIZATION |voice|)
  (WORD VOICE$VOCALIZATION |vocalization|)))
(DEFCONCEPT ELECTROPLATE (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT ELECTROPLATE ARTIFACTS)
  (DOCUMENTATION ELECTROPLATE
    "any artifact that has been plated with a thin coat of metal by electrolysis")
  (HAS-I-TOPIC ELECTROPLATE |Physics|)
  (WORD ELECTROPLATE |electroplate|)))
(DEFCONCEPT LIGAND (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT LIGAND SUBSTANCES)
  (DOCUMENTATION LIGAND
    "an atom or molecule or radical or ion that forms a complex around a central atom")
  (HAS-I-TOPIC LIGAND |Physics|) (WORD LIGAND |ligand|)))
(DEFCONCEPT BLIND_SPOT$OPTIC_DISC (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT BLIND_SPOT$OPTIC_DISC BODY_AS_SUBJECT)
  (DOCUMENTATION BLIND_SPOT$OPTIC_DISC
    "the point where the optic nerve enters the retina; not sensitive to light")
  (HAS-I-TOPIC BLIND_SPOT$OPTIC_DISC |Anatomy|)
  (HAS-I-TOPIC BLIND_SPOT$OPTIC_DISC |Optics|)
  (WORD BLIND_SPOT$OPTIC_DISC |blind spot|)
  (WORD BLIND_SPOT$OPTIC_DISC |optic disc|)))
(DEFCONCEPT BLACKBODY$FULL_RADIATOR (?SELF)
:=> (PHYSICAL-BODY ?SELF)
:AXIOMS (AND (SUBJECT BLACKBODY$FULL_RADIATOR OBJECTS)
  (DOCUMENTATION BLACKBODY$FULL_RADIATOR
    "a hypothetical object capable of absorbing all the electromagnetic radiation falling on it")
  (HAS-I-TOPIC BLACKBODY$FULL_RADIATOR |Physics|)
  (WORD BLACKBODY$FULL_RADIATOR |blackbody|)
  (WORD BLACKBODY$FULL_RADIATOR |full_radiator|)))
(DEFCONCEPT RADIATOR_3 (?SELF)
:=> (PHYSICAL-BODY ?SELF)
:AXIOMS (AND (SUBJECT RADIATOR_3 OBJECTS)
  (DOCUMENTATION RADIATOR_3 "any object that radiates energy")
  (HAS-I-TOPIC RADIATOR_3 |Physics|) (WORD RADIATOR_3 |radiator|)))
(DEFCONCEPT ASTIGMATISM$ASTIGMIA_1 (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT ASTIGMATISM$ASTIGMIA_1 STATES)
  (DOCUMENTATION ASTIGMATISM$ASTIGMIA_1
    "(optics) defect in an optical system in which light rays from a single point fail to converge in
    a single focal point")
  (HAS-I-TOPIC ASTIGMATISM$ASTIGMIA_1 |Optics|)
  (WORD ASTIGMATISM$ASTIGMIA_1 |astigmatism|)
  (WORD ASTIGMATISM$ASTIGMIA_1 |astigmia|)))
(DEFCONCEPT STIGMATISM (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT STIGMATISM STATES)
  (DOCUMENTATION STIGMATISM
    "(optics) condition of an optical system (as a lens) in which light rays from a single point
    converge in a single focal point")
  (HAS-I-TOPIC STIGMATISM |Optics|) (WORD STIGMATISM |stigmatism|)))
(DEFCONCEPT EYE_CONDITION (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT EYE_CONDITION STATES)
  (DOCUMENTATION EYE_CONDITION
    "the condition of the optical properties of the eye")
  (HAS-I-TOPIC EYE_CONDITION |Optics|)
  (WORD EYE_CONDITION |eye_condition|)))
(DEFCONCEPT ISOMERISM (?SELF)
:=> (STATE ?SELF)

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:AXIOMS (AND (SUBJECT ISOMERISM STATES)
  (DOCUMENTATION ISOMERISM
    "the state of being an isomer; the complex of chemical and physical phenomena
    characteristic of isomers")
  (HAS-I-TOPIC ISOMERISM |Chemistry|)
  (HAS-I-TOPIC ISOMERISM |Physics|) (WORD ISOMERISM |isomerism|)))
(DEFCONCEPT BIOLOGICAL_GROUP (?SELF)
  :=> (AGENTIVE-PHYSICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT BIOLOGICAL_GROUP GROUPS)
  (DOCUMENTATION BIOLOGICAL_GROUP "a group of plants or animals")
  (HAS-I-TOPIC BIOLOGICAL_GROUP |Biology|)
  (WORD BIOLOGICAL_GROUP |biological group|)))
(DEFCONCEPT LIFE_FORM$ORGANISM$BEING$LIVING_THING (?SELF)
  :=> (AGENTIVE-PHYSICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT LIFE_FORM$ORGANISM$BEING$LIVING_THING TOPS)
  (DOCUMENTATION LIFE_FORM$ORGANISM$BEING$LIVING_THING
    "any living entity")
  (HAS-I-TOPIC LIFE_FORM$ORGANISM$BEING$LIVING_THING |Biology|)
  (WORD LIFE_FORM$ORGANISM$BEING$LIVING_THING |life form|)
  (WORD LIFE_FORM$ORGANISM$BEING$LIVING_THING |organism|)
  (WORD LIFE_FORM$ORGANISM$BEING$LIVING_THING |being|)
  (WORD LIFE_FORM$ORGANISM$BEING$LIVING_THING |living thing|)))
(DEFCONCEPT VITAL_PRINCIPLE$LIFE_PRINCIPLE (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT VITAL_PRINCIPLE$LIFE_PRINCIPLE PERSONS)
  (DOCUMENTATION VITAL_PRINCIPLE$LIFE_PRINCIPLE
    "a hypothetical force to which the functions and qualities peculiar to living things are
    sometimes ascribed")
  (HAS-I-TOPIC VITAL_PRINCIPLE$LIFE_PRINCIPLE |Biology|)
  (WORD VITAL_PRINCIPLE$LIFE_PRINCIPLE |vital_principle|)
  (WORD VITAL_PRINCIPLE$LIFE_PRINCIPLE |life_principle|)))
(DEFCONCEPT FAUNA (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT FAUNA GROUPS)
  (DOCUMENTATION FAUNA "all the animal life in a particular region")
  (HAS-I-TOPIC FAUNA |Botany|) (HAS-I-TOPIC FAUNA |Zoology|)
  (WORD FAUNA |fauna|)))
(DEFCONCEPT VEGETATION$FLORA (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
:AXIOMS (AND (SUBJECT VEGETATION$FLORA GROUPS)
  (DOCUMENTATION VEGETATION$FLORA
    "all the plant life in a particular region")
  (HAS-I-TOPIC VEGETATION$FLORA |Botany|)
  (HAS-I-TOPIC VEGETATION$FLORA |Zoology|)
  (WORD VEGETATION$FLORA |vegetation|) (WORD VEGETATION$FLORA |flora|)))
(DEFCONCEPT BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE (?SELF)
  :=> (BIOLOGICAL-OBJECT ?SELF)
:AXIOMS (AND
  (SUBJECT BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE BODY_AS_SUBJECT)
  (DOCUMENTATION BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE
    "the entire physical structure of an organism (especially an animal or human being);
    'he felt as if his whole body were on fire'")
  (HAS-I-TOPIC BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE |Anatomy|)
  (WORD BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE |body|)
  (WORD BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE |organic structure|)
  (WORD BODY$ORGANIC_STRUCTURE$PHYSICAL_STRUCTURE
    |physical structure|)))
(DEFCONCEPT BODY_PART (?SELF)
  :=> (BIOLOGICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT BODY_PART BODY_AS_SUBJECT)
  (DOCUMENTATION BODY_PART
    "any part of an organism such as an organ or extremity")
  (HAS-I-TOPIC BODY_PART |Anatomy|) (WORD BODY_PART |body part|)))
(DEFCONCEPT CELL_1 (?SELF)
  :=> (BIOLOGICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT CELL_1 TOPS)
  (DOCUMENTATION CELL_1
    "the basic structural and functional unit of all organisms; cells may exist as independent
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        units of life (as in monads) or may form colonies or tissues as in higher plants and animals")
        (HAS-I-TOPIC CELL_1 |Biology|) (WORD CELL_1 |cell|)))
(DEFCONCEPT CREATION$CONCEPTION (?SELF)
:=> (EVENT ?SELF)
:AXIOMS (AND (SUBJECT CREATION$CONCEPTION EVENTS)
          (DOCUMENTATION CREATION$CONCEPTION
           "the event that occurred at the beginning of something; 'from its creation the plan
           was doomed to failure'")
          (HAS-I-TOPIC CREATION$CONCEPTION |Biology|)
          (WORD CREATION$CONCEPTION |creation|)
          (WORD CREATION$CONCEPTION |conception|)))
(DEFCONCEPT CORPUS_1 (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT CORPUS_1 BODY_AS_SUBJECT)
          (DOCUMENTATION CORPUS_1
           "the main part of an organ or other bodily structure")
          (HAS-I-TOPIC CORPUS_1 |Anatomy|) (WORD CORPUS_1 |corpus|)))
(DEFCONCEPT COVERING$NATURAL_COVERING$COVER (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT COVERING$NATURAL_COVERING$COVER OBJECTS)
          (DOCUMENTATION COVERING$NATURAL_COVERING$COVER
           "a natural object that covers or envelops; 'the fox was flushed from its cover'")
          (HAS-I-TOPIC COVERING$NATURAL_COVERING$COVER |Anatomy|)
          (WORD COVERING$NATURAL_COVERING$COVER |covering|)
          (WORD COVERING$NATURAL_COVERING$COVER |natural_covering|)
          (WORD COVERING$NATURAL_COVERING$COVER |cover|)))
(DEFCONCEPT ACICULA (?SELF)
:=> (FEATURE ?SELF)
:AXIOMS (AND (SUBJECT ACICULA OBJECTS)
          (DOCUMENTATION ACICULA
           "a needle-like part or structure of a plant or animal or crystal; as a spine or bristle or crystal")
          (HAS-I-TOPIC ACICULA |Biology|) (HAS-I-TOPIC ACICULA |Geology|)
          (WORD ACICULA |acicula|)))
(DEFCONCEPT PLANT_PART (?SELF)
:=> (BIOLOGICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT PLANT_PART PLANTS)
          (DOCUMENTATION PLANT_PART "any part of a plant or fungus")
          (HAS-I-TOPIC PLANT_PART |Botany|) (WORD PLANT_PART |plant_part|)))
(DEFCONCEPT BODY$DEAD_BODY (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT BODY$DEAD_BODY BODY_AS_SUBJECT)
          (DOCUMENTATION BODY$DEAD_BODY
           "body of a dead animal or person; 'they found the body in the lake'")
          (HAS-I-TOPIC BODY$DEAD_BODY |Anatomy|) (WORD BODY$DEAD_BODY |body|)
          (WORD BODY$DEAD_BODY |dead body|)))
(DEFCONCEPT MECHANISM_2 (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT MECHANISM_2 OBJECTS)
          (DOCUMENTATION MECHANISM_2
           "a natural object resembling a machine in structure and function; 'the mechanism of the ear'")
          (HAS-I-TOPIC MECHANISM_2 |Biology|) (WORD MECHANISM_2 |mechanism|)))
(DEFCONCEPT COCOON (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT COCOON ANIMALS)
          (DOCUMENTATION COCOON
           "silky envelope spun by the larvae of many insects to protect pupas and by spiders to protect eggs")
          (HAS-I-TOPIC COCOON |Zoology|) (WORD COCOON |cocoon|)))
(DEFCONCEPT NEST_5 (?SELF)
:=> (NON-AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT NEST_5 OBJECTS)
          (DOCUMENTATION NEST_5
           "a structure in which animals lay eggs or give birth to their young")
          (HAS-I-TOPIC NEST_5 |Zoology|) (WORD NEST_5 |nest|)))
(DEFCONCEPT BODY_SUBSTANCE (?SELF)
:=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
:AXIOMS (AND (SUBJECT BODY_SUBSTANCE BODY_AS_SUBJECT)
          (DOCUMENTATION BODY_SUBSTANCE "the substance of the body")
          (HAS-I-TOPIC BODY_SUBSTANCE |Anatomy|))
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(WORD BODY_SUBSTANCE |body substance|))
(DEFCONCEPT PROTOPLASM$LIVING_SUBSTANCE (?SELF)
:=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
:AXIOMS (AND (SUBJECT PROTOPLASM$LIVING_SUBSTANCE BODY_AS_SUBJECT)
(DOCUMENTATION PROTOPLASM$LIVING_SUBSTANCE
"the living substance of a cell")
(HAS-I-TOPIC PROTOPLASM$LIVING_SUBSTANCE |Biology|)
(WORD PROTOPLASM$LIVING_SUBSTANCE |protoplasm|)
(WORD PROTOPLASM$LIVING_SUBSTANCE |living substance|)))
(DEFCONCEPT LEAVEN$LEAVENING_2 (?SELF)
:=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
:AXIOMS (AND (SUBJECT LEAVEN$LEAVENING_2 SUBSTANCES)
(DOCUMENTATION LEAVEN$LEAVENING_2
"a substance used to produce fermentation in dough or a liquid")
(HAS-I-TOPIC LEAVEN$LEAVENING_2 |Botany|)
(HAS-I-TOPIC LEAVEN$LEAVENING_2 |Gastronomy|)
(WORD LEAVEN$LEAVENING_2 |leaven|)
(WORD LEAVEN$LEAVENING_2 |leavening|)))
(DEFCONCEPT NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND
(SUBJECT NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS
BODY_AS_SUBJECT)
(DOCUMENTATION NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS
"scar where the umbilical cord was attached")
(HAS-I-TOPIC NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS
|Anatomy|)
(WORD NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS |navel|)
(WORD NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS |umbilicus|)
(WORD NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS |bellybutton|)
(WORD NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS |omphalos|)
(WORD NAVEL$UMBILICUS$BELLYBUTTON$OMPHALOS$OMPHALUS |omphalus|)))
(DEFCONCEPT TRICHION$CRINION (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT TRICHION$CRINION LOCATIONS)
(DOCUMENTATION TRICHION$CRINION
"point where the hairline meets the midpoint of the forehead")
(HAS-I-TOPIC TRICHION$CRINION |Anatomy|)
(WORD TRICHION$CRINION |trichion|) (WORD TRICHION$CRINION |crinion|)))
(DEFCONCEPT BODY_5 (?SELF)
:=> (PHYSICAL-BODY ?SELF)
:AXIOMS (AND (SUBJECT BODY_5 OBJECTS)
(DOCUMENTATION BODY_5
"an individual 3-dimensional object that has mass and that is distinguishable from
other objects; 'heavenly body'")
(HAS-I-TOPIC BODY_5 |Anatomy|) (WORD BODY_5 |body|)))
(DEFCONCEPT TANGLE (?SELF)
:=> (PHYSICAL-BODY ?SELF)
:AXIOMS (AND (SUBJECT TANGLE OBJECTS)
(DOCUMENTATION TANGLE
"a twisted and tangled mass that is highly interwoven; 'they carved their way through
the tangle of vines'")
(HAS-I-TOPIC TANGLE |Zoology|) (WORD TANGLE |tangle|)))
(DEFCONCEPT NATURAL_SHAPE (?SELF)
:=> (QUALITY ?SELF)
:AXIOMS (AND (SUBJECT NATURAL_SHAPE SHAPES)
(DOCUMENTATION NATURAL_SHAPE
"a shape created by natural forces; not man-made")
(HAS-I-TOPIC NATURAL_SHAPE |Biology|)
(WORD NATURAL_SHAPE |natural_shape|)))
(DEFCONCEPT ATONICITY$ATONY$ATONIA$AMYOTONIA (?SELF)
:=> (REGION ?SELF)
:AXIOMS (AND (SUBJECT ATONICITY$ATONY$ATONIA$AMYOTONIA STATES)
(DOCUMENTATION ATONICITY$ATONY$ATONIA$AMYOTONIA
"lack of normal muscular tension or tonus")
(HAS-I-TOPIC ATONICITY$ATONY$ATONIA$AMYOTONIA |Physiology|)
(WORD ATONICITY$ATONY$ATONIA$AMYOTONIA |atonicity|)
(WORD ATONICITY$ATONY$ATONIA$AMYOTONIA |atony|))
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        (WORD ATONICITY$ATONY$ATONIA$AMYOTONIA |atonia|)
        (WORD ATONICITY$ATONY$ATONIA$AMYOTONIA |amyotonia|))
(DEFCONCEPT NICHE_1 (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT NICHE_1 STATES)
    (DOCUMENTATION NICHE_1
      "(ecology) the status of an organism within its environment and community
      (affecting its survival as a species)")
    (HAS-I-TOPIC NICHE_1 |Ecology|) (WORD NICHE_1 |niche|)))
(DEFCONCEPT TURGOR (?SELF)
  :=> (STATE ?SELF)
  :AXIOMS (AND (SUBJECT TURGOR STATES)
    (DOCUMENTATION TURGOR
      "(biology) the normal rigid state of fullness of a cell or blood vessel or capillary
      resulting from pressure of the contents against the wall or membrane")
    (HAS-I-TOPIC TURGOR |Biology|) (WORD TURGOR |turgor|)))
(DEFCONCEPT PHYSIOLOGICAL_STATE (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT PHYSIOLOGICAL_STATE STATES)
    (DOCUMENTATION PHYSIOLOGICAL_STATE
      "the condition of the body or bodily functions")
    (HAS-I-TOPIC PHYSIOLOGICAL_STATE |Physiology|)
    (WORD PHYSIOLOGICAL_STATE |physiological_state|)))
(DEFCONCEPT CULTURE_MEDIUM$MEDIUM (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT CULTURE_MEDIUM$MEDIUM SUBSTANCES)
    (DOCUMENTATION CULTURE_MEDIUM$MEDIUM
      "(bacteriology) a nutrient substance (solid or liquid) that is used to cultivate micro-organisms")
    (HAS-I-TOPIC CULTURE_MEDIUM$MEDIUM |Biology|)
    (WORD CULTURE_MEDIUM$MEDIUM |culture_medium|)
    (WORD CULTURE_MEDIUM$MEDIUM |medium|)))
(DEFCONCEPT MEDIUM_5 (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT MEDIUM_5 SUBSTANCES)
    (DOCUMENTATION MEDIUM_5
      "(biology) a substance in which specimens are preserved or displayed")
    (HAS-I-TOPIC MEDIUM_5 |Biology|) (WORD MEDIUM_5 |medium|)))
(DEFCONCEPT METABOLITE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT METABOLITE SUBSTANCES)
    (DOCUMENTATION METABOLITE
      "any substance involved in metabolism (either as a product of metabolism or as necessary
      for metabolism)")
    (HAS-I-TOPIC METABOLITE |Biology|) (WORD METABOLITE |metabolite|)))
(DEFCONCEPT BIOTA$BIOLOGY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT BIOTA$BIOLOGY GROUPS)
    (DOCUMENTATION BIOTA$BIOLOGY
      "all the plant and animal life of a particular region")
    (HAS-I-TOPIC BIOTA$BIOLOGY |Biology|) (WORD BIOTA$BIOLOGY |biota|)
    (WORD BIOTA$BIOLOGY |biology|)))
(DEFCONCEPT MENAGERIE (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT MENAGERIE GROUPS)
    (DOCUMENTATION MENAGERIE
      "a collection of live animals for study or display")
    (HAS-I-TOPIC MENAGERIE |Zoology|) (WORD MENAGERIE |menagerie|)))
(DEFCONCEPT CHEMICAL_ELEMENT$ELEMENT (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT CHEMICAL_ELEMENT$ELEMENT SUBSTANCES)
    (DOCUMENTATION CHEMICAL_ELEMENT$ELEMENT
      "any of the more than 100 known substances (of which 93 occur naturally) that cannot be
      separated into simpler substances and that singly or in combination constitute all matter")
    (HAS-I-TOPIC CHEMICAL_ELEMENT$ELEMENT |Chemistry|)
    (WORD CHEMICAL_ELEMENT$ELEMENT |chemical_element|)
    (WORD CHEMICAL_ELEMENT$ELEMENT |element|)))
(DEFCONCEPT COMPOUND$CHEMICAL_COMPOUND (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)

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:AXIOMS (AND (SUBJECT COMPOUND$CHEMICAL_COMPOUND SUBSTANCES)
  (DOCUMENTATION COMPOUND$CHEMICAL_COMPOUND
    "(chemistry) a substance formed by chemical union of two or more elements or ingredients
    in definite proportion by weight")
  (HAS-I-TOPIC COMPOUND$CHEMICAL_COMPOUND |Chemistry|)
  (WORD COMPOUND$CHEMICAL_COMPOUND |compound|)
  (WORD COMPOUND$CHEMICAL_COMPOUND |chemical_compound|)))
(DEFCONCEPT FLUID_2 (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT FLUID_2 SUBSTANCES)
    (DOCUMENTATION FLUID_2
      "a substance that is fluid at room temperature and pressure")
    (HAS-I-TOPIC FLUID_2 |Chemistry|) (WORD FLUID_2 |fluid|)))
(DEFCONCEPT AGENT_3 (?SELF)
  :=> (CAUSAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT AGENT_3 SUBSTANCES)
    (DOCUMENTATION AGENT_3
      "a substance that exerts some force or effect")
    (HAS-I-TOPIC AGENT_3 |Chemistry|) (WORD AGENT_3 |agent|)))
(DEFCONCEPT GROUP$RADICAL (?SELF)
  :=> (CHEMICAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT GROUP$RADICAL SUBSTANCES)
    (DOCUMENTATION GROUP$RADICAL
      "two or more atoms bound together as a single unit and forming part of a molecule")
    (HAS-I-TOPIC GROUP$RADICAL |Chemistry|) (WORD GROUP$RADICAL |group|)
    (WORD GROUP$RADICAL |radical|)))
(DEFCONCEPT CHEMICAL_IRRITANT (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT CHEMICAL_IRRITANT SUBSTANCES)
    (DOCUMENTATION CHEMICAL_IRRITANT "a substance producing irritation")
    (HAS-I-TOPIC CHEMICAL_IRRITANT |Chemistry|)
    (WORD CHEMICAL_IRRITANT |chemical_irritant|)))
(DEFCONCEPT FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL SUBSTANCES)
    (DOCUMENTATION FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL
      "a substance that can be burned to provide heat or power; 'more fuel is needed during the
      winter months'; 'they developed alternative fuels for aircraft'")
    (HAS-I-TOPIC FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL |Chemistry|)
    (WORD FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL |fuel|)
    (WORD FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL |combustible|)
    (WORD FUEL$COMBUSTIBLE$COMBUSTIBLE_MATERIAL |combustible_material|)))
(DEFCONCEPT POISON_2 (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT POISON_2 SUBSTANCES)
    (DOCUMENTATION POISON_2
      "any substance that causes injury or illness or death of a living organism")
    (HAS-I-TOPIC POISON_2 |Chemistry|) (HAS-I-TOPIC POISON_2 |Medicine|)
    (WORD POISON_2 |poison|)))
(DEFCONCEPT SOLID_2 (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT SOLID_2 SUBSTANCES)
    (DOCUMENTATION SOLID_2
      "a substance that is a solid at room temperature and pressure")
    (HAS-I-TOPIC SOLID_2 |Chemistry|) (WORD SOLID_2 |solid|)))
(DEFCONCEPT SATURATION_2 (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT SATURATION_2 STATES)
    (DOCUMENTATION SATURATION_2
      "(chemistry) the state in which a substance contains no multiple bonds and thus is
      incapable of undergoing additional reactions")
    (HAS-I-TOPIC SATURATION_2 |Chemistry|)
    (WORD SATURATION_2 |saturation|)))
(DEFCONCEPT ACTIVATOR (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ACTIVATOR SUBSTANCES)
    (DOCUMENTATION ACTIVATOR
      "any agency bringing about activation; (biology) a molecule that increases the activity of

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        an enzyme or a protein that increases the production of a gene product in DNA transcription")
      (HAS-I-TOPIC ACTIVATOR |Chemistry|) (WORD ACTIVATOR |activator|)))
(DEFCONCEPT ADULTERANT (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ADULTERANT SUBSTANCES)
    (DOCUMENTATION ADULTERANT
      "any substance that adulterates (lessens the purity or effectiveness of a substance);
      'it is necessary to remove the adulterants before use'")
    (HAS-I-TOPIC ADULTERANT |Chemistry|) (WORD ADULTERANT |adulterant|)))
(DEFCONCEPT CARCINOGEN (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT CARCINOGEN SUBSTANCES)
    (DOCUMENTATION CARCINOGEN "any substance that produces cancer")
    (HAS-I-TOPIC CARCINOGEN |Chemistry|) (WORD CARCINOGEN |carcinogen|)))
(DEFCONCEPT DENATURANT (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT DENATURANT SUBSTANCES)
    (DOCUMENTATION DENATURANT
      "any substance that serves as a denaturing agent")
    (HAS-I-TOPIC DENATURANT |Chemistry|) (WORD DENATURANT |denaturant|)))
(DEFCONCEPT FERMENT (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT FERMENT SUBSTANCES)
    (DOCUMENTATION FERMENT
      "a substance capable of bringing about fermentation")
    (HAS-I-TOPIC FERMENT |Chemistry|) (WORD FERMENT |ferment|)))
(DEFCONCEPT INHIBITOR (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT INHIBITOR SUBSTANCES)
    (DOCUMENTATION INHIBITOR
      "a substance that retards or stops an activity")
    (HAS-I-TOPIC INHIBITOR |Chemistry|) (WORD INHIBITOR |inhibitor|)))
(DEFCONCEPT MIXTURE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT MIXTURE SUBSTANCES)
    (DOCUMENTATION MIXTURE
      "(chemistry) a substance consisting of two or more substances mixed together (not in
      fixed proportions and not with chemical bonding)")
    (HAS-I-TOPIC MIXTURE |Chemistry|) (WORD MIXTURE |mixture|)))
(DEFCONCEPT PRECIPITANT (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT PRECIPITANT SUBSTANCES)
    (DOCUMENTATION PRECIPITANT
      "a substance that causes a precipitate to form")
    (HAS-I-TOPIC PRECIPITANT |Chemistry|)
    (WORD PRECIPITANT |precipitant|)))
(DEFCONCEPT REFRIGERANT (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT REFRIGERANT SUBSTANCES)
    (DOCUMENTATION REFRIGERANT
      "a substance used to provide cooling (as in a refrigerator)")
    (HAS-I-TOPIC REFRIGERANT |Chemistry|)
    (WORD REFRIGERANT |refrigerant|)))
(DEFCONCEPT RESIDUE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT RESIDUE SUBSTANCES)
    (DOCUMENTATION RESIDUE
      "matter that remains after something has been removed")
    (HAS-I-TOPIC RESIDUE |Chemistry|) (WORD RESIDUE |residue|)))
(DEFCONCEPT SOLUTE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SOLUTE SUBSTANCES)
    (DOCUMENTATION SOLUTE
      "the dissolved substance in a solution; the component of a solution that changes its state")
    (HAS-I-TOPIC SOLUTE |Chemistry|) (WORD SOLUTE |solute|)))
(DEFCONCEPT SOLVATE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SOLVATE SUBSTANCES)
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(DOCUMENTATION SOLVATE
  "a compound formed by solvation (the combination of solvent molecules with molecules or
  ions of the solute)")
(HAS-I-TOPIC SOLVATE |Chemistry|) (WORD SOLVATE |solvate|))
(DEFCONCEPT SYSTEM_5 (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT SYSTEM_5 SUBSTANCES)
    (DOCUMENTATION SYSTEM_5
      "(physical chemistry) a sample of matter in which substances in different phases are in
      equilibrium; 'in a static system oil cannot be replaced by water on a surface';
      'a system generating hydrogen peroxide'")
      (HAS-I-TOPIC SYSTEM_5 |Chemistry|) (WORD SYSTEM_5 |system|)))
(DEFCONCEPT VOLATILE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT VOLATILE SUBSTANCES)
    (DOCUMENTATION VOLATILE
      "a volatile substance; a substance that changes readily from solid or liquid to a vapor;
      'it was heated to evaporate the volatiles'")
      (HAS-I-TOPIC VOLATILE |Chemistry|) (WORD VOLATILE |volatile|))
(DEFCONCEPT KINGDOM_1 (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT KINGDOM_1 GROUPS)
    (DOCUMENTATION KINGDOM_1 "a basic group of natural objects")
    (HAS-I-TOPIC KINGDOM_1 |Chemistry|) (WORD KINGDOM_1 |kingdom|)))
(DEFCONCEPT POPULATION_1 (?SELF)
  :=> (AGENTIVE-GROUP ?SELF)
  :AXIOMS (AND (SUBJECT POPULATION_1 GROUPS)
    (DOCUMENTATION POPULATION_1
      "a group of organisms of the same species populating a given area;
      'they hired hunters to keep down the deer population'")
      (HAS-I-TOPIC POPULATION_1 |Geography|)
      (WORD POPULATION_1 |population|))
(DEFCONCEPT APPLETON_LAYER$F_LAYER$F_REGION (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT APPLETON_LAYER$F_LAYER$F_REGION LOCATIONS)
    (DOCUMENTATION APPLETON_LAYER$F_LAYER$F_REGION
      "the highest region of the ionosphere (from 90 to 600 miles up) that contains the
      highest concentration of free electrons and is most useful for long-range radio transmission")
      (HAS-I-TOPIC APPLETON_LAYER$F_LAYER$F_REGION |Geography|)
      (WORD APPLETON_LAYER$F_LAYER$F_REGION |Appleton_layer|)
      (WORD APPLETON_LAYER$F_LAYER$F_REGION |F_layer|)
      (WORD APPLETON_LAYER$F_LAYER$F_REGION |F_region|))
(DEFCONCEPT D-LAYER$D_REGION (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT D-LAYER$D_REGION LOCATIONS)
    (DOCUMENTATION D-LAYER$D_REGION
      "the lowest region of the ionosphere (35 to 50 miles up) that reflects low-frequency radio waves")
      (HAS-I-TOPIC D-LAYER$D_REGION |Geography|)
      (WORD D-LAYER$D_REGION |D-layer|) (WORD D-LAYER$D_REGION |D_region|))
(DEFCONCEPT HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND
    (SUBJECT HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      LOCATIONS)
    (DOCUMENTATION
      HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      "a region of the ionosphere (from 50 to 90 miles up) that reflects radio waves of medium length")
    (HAS-I-TOPIC
      HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      |Geography|)
    (WORD HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      |Heaviside_layer|)
    (WORD HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      |Kennelly-Heaviside_layer|)
    (WORD HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      |E_layer|)
    (WORD HEAVISIDE_LAYER$KENNELLY-HEAVISIDE_LAYER$E_LAYER$E_REGION
      |E_region|)))

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(DEFCONCEPT LAND$GROUND$SOIL (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT LAND$GROUND$SOIL OBJECTS)
    (DOCUMENTATION LAND$GROUND$SOIL
      "what plants grow in (especially with reference to its quality or use);
      'the land had never been plowed'; 'good agricultural soil'"
    (HAS-I-TOPIC LAND$GROUND$SOIL |Geography|)
    (WORD LAND$GROUND$SOIL |land|) (WORD LAND$GROUND$SOIL |ground|)
    (WORD LAND$GROUND$SOIL |soil|)))
(DEFCONCEPT ICE_1 (?SELF)
  :=> (AMOUNT-OF-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT ICE_1 OBJECTS)
    (DOCUMENTATION ICE_1 "the frozen part of a body of water")
    (HAS-I-TOPIC ICE_1 |Oceanography|) (WORD ICE_1 |ice|)))
(DEFCONCEPT BASE_5 (?SELF)
  :=> (FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT BASE_5 OBJECTS)
    (DOCUMENTATION BASE_5
      "the bottom or lowest part; 'the base of the mountain'"
    (HAS-I-TOPIC BASE_5 |Geography|) (WORD BASE_5 |base|)))
(DEFCONCEPT ENCLOSURE$NATURAL_ENCLOSURE (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT ENCLOSURE$NATURAL_ENCLOSURE OBJECTS)
    (DOCUMENTATION ENCLOSURE$NATURAL_ENCLOSURE
      "a naturally enclosed space")
    (HAS-I-TOPIC ENCLOSURE$NATURAL_ENCLOSURE |Earth|)
    (WORD ENCLOSURE$NATURAL_ENCLOSURE |enclosure|)
    (WORD ENCLOSURE$NATURAL_ENCLOSURE |natural_enclosure|)))
(DEFCONCEPT ANTIPODES (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT ANTIPODES LOCATIONS)
    (DOCUMENTATION ANTIPODES
      "any two places or regions on diametrically opposite sides of the Earth;
      'the North Pole and the South Pole are antipodes'"
    (HAS-I-TOPIC ANTIPODES |Geography|) (WORD ANTIPODES |antipodes|)))
(DEFCONCEPT CONFLUENCE$JUNCTION$MEETING (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT CONFLUENCE$JUNCTION$MEETING LOCATIONS)
    (DOCUMENTATION CONFLUENCE$JUNCTION$MEETING
      "a place where two things come together; 'Pittsburgh is located at the confluence
      of the Allegheny and Monongahela rivers'"
    (HAS-I-TOPIC CONFLUENCE$JUNCTION$MEETING |Geography|)
    (WORD CONFLUENCE$JUNCTION$MEETING |confluence|)
    (WORD CONFLUENCE$JUNCTION$MEETING |junction|)
    (WORD CONFLUENCE$JUNCTION$MEETING |meeting|)))
(DEFCONCEPT EPICENTER$EPICENTRE (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT EPICENTER$EPICENTRE LOCATIONS)
    (DOCUMENTATION EPICENTER$EPICENTRE
      "the point on the Earth's surface directly above the focus of an earthquake")
    (HAS-I-TOPIC EPICENTER$EPICENTRE |Geography|)
    (WORD EPICENTER$EPICENTRE |epicenter|)
    (WORD EPICENTER$EPICENTRE |epicentre|)))
(DEFCONCEPT MAGNETIC_POLE (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT MAGNETIC_POLE LOCATIONS)
    (DOCUMENTATION MAGNETIC_POLE
      "either of two points where the lines of force of the Earth's magnetic field are vertical")
    (HAS-I-TOPIC MAGNETIC_POLE |Geography|)
    (WORD MAGNETIC_POLE |magnetic_pole|)))
(DEFCONCEPT NORTH$NORTHLAND$SEPTENTRION (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT NORTH$NORTHLAND$SEPTENTRION LOCATIONS)
    (DOCUMENTATION NORTH$NORTHLAND$SEPTENTRION
      "any region lying in or toward the north")
    (HAS-I-TOPIC NORTH$NORTHLAND$SEPTENTRION |Geography|)
    (WORD NORTH$NORTHLAND$SEPTENTRION |North|)
    (WORD NORTH$NORTHLAND$SEPTENTRION |northland|))

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        (WORD NORTH$NORTHLAND$SEPTENTRION |septentrion|))
(DEFCONCEPT POLE_4 (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT POLE_4 LOCATIONS)
(DOCUMENTATION POLE_4
"one of two antipodal points where the Earth's axis of rotation intersects the Earth's surface")
(HAS-I-TOPIC POLE_4 |Geography|) (WORD POLE_4 |pole|)))
(DEFCONCEPT SOUTH$SOUTHLAND (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT SOUTH$SOUTHLAND LOCATIONS)
(DOCUMENTATION SOUTH$SOUTHLAND
"any region lying in or toward the south")
(HAS-I-TOPIC SOUTH$SOUTHLAND |Geography|)
(WORD SOUTH$SOUTHLAND |South|) (WORD SOUTH$SOUTHLAND |southland|)))
(DEFCONCEPT WEST$OCCIDENT (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT WEST$OCCIDENT LOCATIONS)
(DOCUMENTATION WEST$OCCIDENT
"the countries of (originally) Europe and (now including) North and South America")
(HAS-I-TOPIC WEST$OCCIDENT |Geography|) (WORD WEST$OCCIDENT |West|)
(WORD WEST$OCCIDENT |occident|)))
(DEFCONCEPT GEOLOGICAL_FORMATION$GEOLOGY$FORMATION (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT GEOLOGICAL_FORMATION$GEOLOGY$FORMATION OBJECTS)
(DOCUMENTATION GEOLOGICAL_FORMATION$GEOLOGY$FORMATION
"the geological features of the earth")
(HAS-I-TOPIC GEOLOGICAL_FORMATION$GEOLOGY$FORMATION |Geology|)
(WORD GEOLOGICAL_FORMATION$GEOLOGY$FORMATION |geological_formation|)
(WORD GEOLOGICAL_FORMATION$GEOLOGY$FORMATION |geology|)
(WORD GEOLOGICAL_FORMATION$GEOLOGY$FORMATION |formation|)))
(DEFCONCEPT PASS$MOUNTAIN_PASS$NOTCH (?SELF)
:=> (GEOGRAPHICAL-FEATURE ?SELF)
:AXIOMS (AND (SUBJECT PASS$MOUNTAIN_PASS$NOTCH OBJECTS)
(DOCUMENTATION PASS$MOUNTAIN_PASS$NOTCH
"the location in a range of mountains of a geological formation that is lower than
the surrounding peaks; 'we got through the pass before it started to snow'")
(HAS-I-TOPIC PASS$MOUNTAIN_PASS$NOTCH |Geology|)
(WORD PASS$MOUNTAIN_PASS$NOTCH |pass|)
(WORD PASS$MOUNTAIN_PASS$NOTCH |mountain_pass|)
(WORD PASS$MOUNTAIN_PASS$NOTCH |notch|)))
(DEFCONCEPT BODY_OF_WATER$WATER (?SELF)
:=> (GEOGRAPHICAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT BODY_OF_WATER$WATER OBJECTS)
(DOCUMENTATION BODY_OF_WATER$WATER
"the part of the earth's surface covered with water; 'they invaded our territorial waters'")
(HAS-I-TOPIC BODY_OF_WATER$WATER |Geography|)
(WORD BODY_OF_WATER$WATER |body_of_water|)
(WORD BODY_OF_WATER$WATER |water|)))
(DEFCONCEPT LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA (?SELF)
:=> (GEOGRAPHICAL-OBJECT ?SELF)
:AXIOMS (AND
(SUBJECT LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA
OBJECTS)
(DOCUMENTATION LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$
TERRA_FIRMA
"the solid part of the earth's surface; 'the plane turned away from the sea and
moved back over land'; 'the earth shook for several minutes'; 'he dropped the logs on the ground'")
(HAS-I-TOPIC LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA
|Geography|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA |land|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA
|dry_land|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA |earth|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA |ground|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA
|solid_ground|)
(WORD LAND$DRY_LAND$EARTH$GROUND$SOLID_GROUND$TERRA_FIRMA
|terra_firma|)))

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(DEFCONCEPT AREA$COUNTRY (?SELF)
:=> (GEOGRAPHICAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT AREA$COUNTRY LOCATIONS)
(DOCUMENTATION AREA$COUNTRY
"a particular geographical region of indefinite boundary (usually serving some special
purpose or distinguished by its people or culture or geography); 'it was a mountainous area'; 'Bible country'
(HAS-I-TOPIC AREA$COUNTRY |Geography|) (WORD AREA$COUNTRY |area|)
(WORD AREA$COUNTRY |country|)))
(DEFCONCEPT DOMAIN$DEMESNE$LAND (?SELF)
:=> (GEOGRAPHICAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT DOMAIN$DEMESNE$LAND LOCATIONS)
(DOCUMENTATION DOMAIN$DEMESNE$LAND
"territory over which rule or control is exercised; 'his domain extended into Europe';
'he made it the law of the land'")
(HAS-I-TOPIC DOMAIN$DEMESNE$LAND |Administration|)
(HAS-I-TOPIC DOMAIN$DEMESNE$LAND |Geography|)
(WORD DOMAIN$DEMESNE$LAND |domain|)
(WORD DOMAIN$DEMESNE$LAND |demesne|)
(WORD DOMAIN$DEMESNE$LAND |land|)))
(DEFCONCEPT FAR_EAST (?SELF)
:=> (GEOGRAPHICAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT FAR_EAST LOCATIONS)
(DOCUMENTATION FAR_EAST
"a popular expression for the countries of eastern Asia (usually including China
and Mongolia and Taiwan and Japan and Korea and Indochina and eastern Siberia)")
(HAS-I-TOPIC FAR_EAST |Geography|) (WORD FAR_EAST |Far_East|))
(DEFCONCEPT GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION (?SELF)
:=> (GEOGRAPHICAL-ROLE ?SELF)
:AXIOMS (AND
(SUBJECT
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
LOCATIONS)
(DOCUMENTATION
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
"a demarcated area of the Earth")
(HAS-I-TOPIC
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
|Geography|)
(WORD
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
|geographical_area|)
(WORD
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
|geographic_area|)
(WORD
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
|geographical_region|)
(WORD
GEOGRAPHICAL_AREA$GEOGRAPHIC_AREA$GEOGRAPHICAL_REGION$
GEOGRAPHIC_REGION
|geographic_region|)))
(DEFCONCEPT EXPANSE$EXTENT (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT EXPANSE$EXTENT OBJECTS)
(DOCUMENTATION EXPANSE$EXTENT
"a wide and open space or area as of surface or land or sky")
(HAS-I-TOPIC EXPANSE$EXTENT |Earth|) (WORD EXPANSE$EXTENT |expanses|)
(WORD EXPANSE$EXTENT |extent|)))
(DEFCONCEPT BACKWATER (?SELF)
:=> (NON-PHYSICAL-PLACE ?SELF)
:AXIOMS (AND (SUBJECT BACKWATER LOCATIONS)
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        (DOCUMENTATION BACKWATER
         "any backward region that is isolated from the world and resists progress")
        (HAS-I-TOPIC BACKWATER |Geography|) (WORD BACKWATER |backwater|))
(DEFCONCEPT BIOGEOGRAPHICAL_REGION (?SELF)
 :=> (NON-PHYSICAL-PLACE ?SELF)
 :AXIOMS (AND (SUBJECT BIOGEOGRAPHICAL_REGION LOCATIONS)
            (DOCUMENTATION BIOGEOGRAPHICAL_REGION
             "an area of the Earth determined by distribution of flora and fauna")
            (HAS-I-TOPIC BIOGEOGRAPHICAL_REGION |Geography|)
            (WORD BIOGEOGRAPHICAL_REGION |biogeographical_region|)))
(DEFCONCEPT OLD_WORLD (?SELF)
 :=> (NON-PHYSICAL-PLACE ?SELF)
 :AXIOMS (AND (SUBJECT OLD_WORLD LOCATIONS)
            (DOCUMENTATION OLD_WORLD
             "the regions of the world that were known to Europeans before the discovery of the Americas")
            (HAS-I-TOPIC OLD_WORLD |Geography|) (WORD OLD_WORLD |old_world|)))
(DEFCONCEPT UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA (?SELF)
 :=> (NON-PHYSICAL-PLACE ?SELF)
 :AXIOMS (AND (SUBJECT UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA LOCATIONS)
            (DOCUMENTATION UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA
             "an unknown and unexplored region; 'they came like angels out the unknown'")
            (HAS-I-TOPIC UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA |Geography|)
            (WORD UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA |unknown|)
            (WORD UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA |unknown_region|)
            (WORD UNKNOWN$UNKNOWN_REGION$TERRA_INCOGNITA |terra_incognita|)))
(DEFCONCEPT ROCK$STONE_1 (?SELF)
 :=> (PHYSICAL-BODY ?SELF)
 :AXIOMS (AND (SUBJECT ROCK$STONE_1 OBJECTS)
            (DOCUMENTATION ROCK$STONE_1
             "a lump of hard consolidated mineral matter; 'he threw a rock at me'")
            (HAS-I-TOPIC ROCK$STONE_1 |Geology|) (WORD ROCK$STONE_1 |rock|)
            (WORD ROCK$STONE_1 |stone|)))
(DEFCONCEPT SKI_CONDITIONS (?SELF)
 :=> (REGION ?SELF)
 :AXIOMS (AND (SUBJECT SKI_CONDITIONS STATES)
            (DOCUMENTATION SKI_CONDITIONS
             "the amount and state of snow for skiing")
            (HAS-I-TOPIC SKI_CONDITIONS |Meteorology|)
            (WORD SKI_CONDITIONS |ski_conditions|)))
(DEFCONCEPT WEATHER_CONDITIONS (?SELF)
 :=> (REGION ?SELF)
 :AXIOMS (AND (SUBJECT WEATHER_CONDITIONS STATES)
            (DOCUMENTATION WEATHER_CONDITIONS "the condition of the weather")
            (HAS-I-TOPIC WEATHER_CONDITIONS |Meteorology|)
            (WORD WEATHER_CONDITIONS |weather_conditions|)))
(DEFCONCEPT DRIFT_1 (?SELF)
 :=> (SUBSTANCE-ROLE ?SELF)
 :AXIOMS (AND (SUBJECT DRIFT_1 OBJECTS)
            (DOCUMENTATION DRIFT_1 "something heaped up by the wind or current")
            (HAS-I-TOPIC DRIFT_1 |Geography|) (HAS-I-TOPIC DRIFT_1 |Geology|)
            (WORD DRIFT_1 |drift|)))
(DEFCONCEPT SEDIMENT$DEPOSIT (?SELF)
 :=> (SUBSTANCE-ROLE ?SELF)
 :AXIOMS (AND (SUBJECT SEDIMENT$DEPOSIT OBJECTS)
            (DOCUMENTATION SEDIMENT$DEPOSIT
             "matter deposited by water or ice or wind")
            (HAS-I-TOPIC SEDIMENT$DEPOSIT |Geology|)
            (WORD SEDIMENT$DEPOSIT |sediment|) (WORD SEDIMENT$DEPOSIT |deposit|)))
(DEFCONCEPT BEDDING_MATERIAL$BEDDING$LITTER (?SELF)
 :=> (SUBSTANCE-ROLE ?SELF)
 :AXIOMS (AND (SUBJECT BEDDING_MATERIAL$BEDDING$LITTER ARTIFACTS)
            (DOCUMENTATION BEDDING_MATERIAL$BEDDING$LITTER
             "material used to provide a bed for animals")
            (HAS-I-TOPIC BEDDING_MATERIAL$BEDDING$LITTER |Agriculture|)
            (HAS-I-TOPIC BEDDING_MATERIAL$BEDDING$LITTER |Zootechnics|)
            (WORD BEDDING_MATERIAL$BEDDING$LITTER |bedding material|)
            (WORD BEDDING_MATERIAL$BEDDING$LITTER |bedding|)
            (WORD BEDDING_MATERIAL$BEDDING$LITTER |litter|)))

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(DEFCONCEPT FOOD$NUTRIENT (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT FOOD$NUTRIENT TOPS)
    (DOCUMENTATION FOOD$NUTRIENT
      "any substance that can be metabolized by an organism to give energy and build tissue")
    (HAS-I-TOPIC FOOD$NUTRIENT |Alimentation|)
    (WORD FOOD$NUTRIENT |food|) (WORD FOOD$NUTRIENT |nutrient|)))
(DEFCONCEPT GRINDING_2 (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT GRINDING_2 OBJECTS)
    (DOCUMENTATION GRINDING_2
      "matter resulting from the process of grinding; 'vegetable grindings clogged the drain'")
    (HAS-I-TOPIC GRINDING_2 |Gastronomy|) (WORD GRINDING_2 |grinding|)))
(DEFCONCEPT MACHINE_1 (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
  :AXIOMS (AND (SUBJECT MACHINE_1 ARTIFACTS)
    (DOCUMENTATION MACHINE_1
      "any mechanical or electrical device that transmits or modifies energy to perform or assist
      in the performance of human tasks")
    (HAS-I-TOPIC MACHINE_1 |Building_Industry|)
    (WORD MACHINE_1 |machine|)))
(DEFCONCEPT BRICKS_AND_MORTAR (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT BRICKS_AND_MORTAR SUBSTANCES)
    (DOCUMENTATION BRICKS_AND_MORTAR
      "building material consisting of bricks laid with mortar between them")
    (HAS-I-TOPIC BRICKS_AND_MORTAR |Building_Industry|)
    (WORD BRICKS_AND_MORTAR |bricks_and_mortar|)))
(DEFCONCEPT LATH_AND_PLASTER (?SELF)
  :=> (ARBITRARY-SUM ?SELF)
  :AXIOMS (AND (SUBJECT LATH_AND_PLASTER SUBSTANCES)
    (DOCUMENTATION LATH_AND_PLASTER
      "a building material consisting of thin strips of wood that provide a foundation for a coat of plaster")
    (HAS-I-TOPIC LATH_AND_PLASTER |Building_Industry|)
    (WORD LATH_AND_PLASTER |lath_and_plaster|)))
(DEFCONCEPT BUILDING_MATERIAL (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT BUILDING_MATERIAL SUBSTANCES)
    (DOCUMENTATION BUILDING_MATERIAL
      "material used for constructing buildings")
    (HAS-I-TOPIC BUILDING_MATERIAL |Building_Industry|)
    (WORD BUILDING_MATERIAL |building_material|)))
(DEFCONCEPT PAVING_MATERIAL (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)
  :AXIOMS (AND (SUBJECT PAVING_MATERIAL SUBSTANCES)
    (DOCUMENTATION PAVING_MATERIAL "material used for pavement")
    (HAS-I-TOPIC PAVING_MATERIAL |Building_Industry|)
    (WORD PAVING_MATERIAL |paving_material|)))
(DEFCONCEPT DISTRICT$TERRITORY (?SELF)
  :=> (GEOGRAPHICAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT DISTRICT$TERRITORY LOCATIONS)
    (DOCUMENTATION DISTRICT$TERRITORY
      "a region marked off for administrative or other purposes")
    (HAS-I-TOPIC DISTRICT$TERRITORY |Administration|)
    (HAS-I-TOPIC DISTRICT$TERRITORY |Town_Planning|)
    (WORD DISTRICT$TERRITORY |district|)
    (WORD DISTRICT$TERRITORY |territory|)))
(DEFCONCEPT LIBRARY$PROGRAM_LIBRARY (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT LIBRARY$PROGRAM_LIBRARY GROUPS)
    (DOCUMENTATION LIBRARY$PROGRAM_LIBRARY
      "(computing) a collection of standard programs and subroutines that are stored and
      available for immediate use")
    (HAS-I-TOPIC LIBRARY$PROGRAM_LIBRARY |Computer_Science|)
    (WORD LIBRARY$PROGRAM_LIBRARY |library|)
    (WORD LIBRARY$PROGRAM_LIBRARY |program library|)))
(DEFCONCEPT DRUG (?SELF)
  :=> (FUNCTIONALLY-VIEWED-MATTER ?SELF)

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:AXIOMS (AND (SUBJECT DRUG ARTIFACTS)
  (DOCUMENTATION DRUG
    "something that is used as a medicine or narcotic")
  (HAS-I-TOPIC DRUG |Pharmacy|) (WORD DRUG |drug|)))
(DEFCONCEPT FOCUS$NIDUS (?SELF)
  :=> (GEOGRAPHICAL-FEATURE ?SELF)
  :AXIOMS (AND (SUBJECT FOCUS$NIDUS STATES)
    (DOCUMENTATION FOCUS$NIDUS
      "a central point or locus of bacterial growth in an organism; 'the focus of infection'")
    (HAS-I-TOPIC FOCUS$NIDUS |Medicine|) (WORD FOCUS$NIDUS |focus|)
    (WORD FOCUS$NIDUS |nidus|)))
(DEFCONCEPT CURVATURE_2 (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT CURVATURE_2 STATES)
    (DOCUMENTATION CURVATURE_2
      "(medical) a curving or bending; often abnormal; 'curvature of the spine'")
    (HAS-I-TOPIC CURVATURE_2 |Medicine|) (WORD CURVATURE_2 |curvature|)))
(DEFCONCEPT SANITARY_CONDITION (?SELF)
  :=> (REGION ?SELF)
  :AXIOMS (AND (SUBJECT SANITARY_CONDITION STATES)
    (DOCUMENTATION SANITARY_CONDITION
      "the state of sanitation (clean or dirty)")
    (HAS-I-TOPIC SANITARY_CONDITION |Medicine|)
    (WORD SANITARY_CONDITION |sanitary_condition|)))
(DEFCONCEPT DISORDER$UPSET (?SELF)
  :=> (SITUATION ?SELF)
  :AXIOMS (AND (SUBJECT DISORDER$UPSET STATES)
    (DOCUMENTATION DISORDER$UPSET
      "a disturbance of normal functioning; 'the doctor prescribed some medicine for the disorder';
      'everyone gets stomach upsets from time to time'")
    (HAS-I-TOPIC DISORDER$UPSET |Medicine|)
    (WORD DISORDER$UPSET |disorder|) (WORD DISORDER$UPSET |upset|)))
(DEFCONCEPT ALLERGEN (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ALLERGEN SUBSTANCES)
    (DOCUMENTATION ALLERGEN "any substance that can cause an allergy")
    (HAS-I-TOPIC ALLERGEN |Medicine|) (WORD ALLERGEN |allergen|)))
(DEFCONCEPT ESSENCE (?SELF)
  :=> (SUBSTANCE-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ESSENCE SUBSTANCES)
    (DOCUMENTATION ESSENCE
      "any substance possessing to a high degree the predominant properties of a plant or drug
      or other natural product from which it is extracted")
    (HAS-I-TOPIC ESSENCE |Pharmacy|) (WORD ESSENCE |essence|)))
(DEFCONCEPT ARMAMENTARIUM (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT ARMAMENTARIUM GROUPS)
    (DOCUMENTATION ARMAMENTARIUM
      "the collection of equipment and methods used in the practice of medicine")
    (HAS-I-TOPIC ARMAMENTARIUM |Medicine|)
    (WORD ARMAMENTARIUM |armamentarium|)))
(DEFCONCEPT PHARMAPOEIA (?SELF)
  :=> (UNITARY-COLLECTION ?SELF)
  :AXIOMS (AND (SUBJECT PHARMAPOEIA ARTIFACTS)
    (DOCUMENTATION PHARMAPOEIA "a collection or stock of drugs")
    (HAS-I-TOPIC PHARMAPOEIA |Pharmacy|)
    (WORD PHARMAPOEIA |pharmacopoeia|)))
(DEFCONCEPT TAXONOMIC_GROUP$TAXON (?SELF)
  :=> (LIFE_FORM$ORGANISM$BEING$LIVING_THING ?SELF)
  :AXIOMS (AND (SUBJECT TAXONOMIC_GROUP$TAXON GROUPS)
    (DOCUMENTATION TAXONOMIC_GROUP$TAXON
      "animal or plant group having natural relations")
    (HAS-I-TOPIC TAXONOMIC_GROUP$TAXON |Biology|)))
(DEFCONCEPT DIVISION_8 (?SELF)
  :=> (LIFE_FORM$ORGANISM$BEING$LIVING_THING ?SELF))
(DEFCONCEPT ANIMAL_GROUP (?SELF)
  :=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
  :AXIOMS (AND (SUBJECT ANIMAL_GROUP GROUPS)

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(DOCUMENTATION ANIMAL_GROUP "a group of animals")
(HAS-I-TOPIC ANIMAL_GROUP |Zoology|))
(DEFCONCEPT GENERATION_1 (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT GENERATION_1 GROUPS)
(DOCUMENTATION GENERATION_1
"group of genetically related organisms constituting a single step in the line of descent")
(HAS-I-TOPIC GENERATION_1 |Biology|)))
(DEFCONCEPT DESCENDANTS$POSTERITY (?SELF)
:=> (AGENTIVE-FUNCTIONAL-ROLE ?SELF)
:AXIOMS (AND (SUBJECT DESCENDANTS$POSTERITY GROUPS)
(DOCUMENTATION DESCENDANTS$POSTERITY
"all of the offspring of a given progenitor; 'we must secure the benefits of freedom
for ourselves and our posterity'")
(HAS-I-TOPIC DESCENDANTS$POSTERITY |Biology|)))
(DEFCONCEPT POWER_TOOL (?SELF)
:=> (INSTRUMENTALITY-ROLE ?SELF)
:AXIOMS (AND (SUBJECT POWER_TOOL ARTIFACTS)
(DOCUMENTATION POWER_TOOL "a motor-driven tool")
(HAS-I-TOPIC POWER_TOOL |Building_Industry|)))
(DEFCONCEPT HOME_APPLIANCE$HOUSEHOLD_APPLIANCE (?SELF)
:=> (INSTRUMENTALITY-ROLE ?SELF)
:AXIOMS (AND (SUBJECT HOME_APPLIANCE$HOUSEHOLD_APPLIANCE ARTIFACTS)
(DOCUMENTATION HOME_APPLIANCE$HOUSEHOLD_APPLIANCE
"an appliance that does a particular job in the home")
(HAS-I-TOPIC HOME_APPLIANCE$HOUSEHOLD_APPLIANCE |Furniture|)))
(DEFCONCEPT AUTOPILOT$AUTOMATIC_PILOT (?SELF)
:=> (AGENTIVE-FUNCTIONAL-OBJECT ?SELF)
:AXIOMS (AND (SUBJECT AUTOPILOT$AUTOMATIC_PILOT ARTIFACTS)
(DOCUMENTATION AUTOPILOT$AUTOMATIC_PILOT
"automatically keeps ships or planes or spacecraft on a steady course")
(HAS-I-TOPIC AUTOPILOT$AUTOMATIC_PILOT |Transport|)
(WORD AUTOPILOT$AUTOMATIC_PILOT |autopilot|)
(WORD AUTOPILOT$AUTOMATIC_PILOT |automatic pilot|)))
(DEFCONCEPT TERMINOLOGY$NOMENCLATURE$LANGUAGE (?SELF)
:=> (INFORMATION-DESCRIPTION ?SELF)
:AXIOMS (AND (SUBJECT TERMINOLOGY$NOMENCLATURE$LANGUAGE COMMUNICATION)
(DOCUMENTATION TERMINOLOGY$NOMENCLATURE$LANGUAGE
"a system of words used in a particular discipline; 'legal terminology'; 'the language of sociology'")
(HAS-I-TOPIC TERMINOLOGY$NOMENCLATURE$LANGUAGE |Linguistics|)
(WORD TERMINOLOGY$NOMENCLATURE$LANGUAGE |terminology|)
(WORD TERMINOLOGY$NOMENCLATURE$LANGUAGE |nomenclature|)
(WORD TERMINOLOGY$NOMENCLATURE$LANGUAGE |language|)))
(DEFCONCEPT CONDITION$STATUS (?SELF)
:=> (SITUATION ?SELF)
:AXIOMS (AND (SUBJECT CONDITION$STATUS STATES)
(DOCUMENTATION CONDITION$STATUS
"a condition or state at a particular time: 'a condition (or state) of disrepair'; 'the current
status of the arms negotiations'")
(HAS-I-TOPIC CONDITION$STATUS |Factotum|)
(WORD CONDITION$STATUS |condition|) (WORD CONDITION$STATUS |status|)))
(DEFCONCEPT PHASE$STAGE (?SELF)
:=> (PARAMETER ?SELF)
:AXIOMS (AND (SUBJECT PHASE$STAGE TIME)
(DOCUMENTATION PHASE$STAGE
"any distinct time period in a sequence of events; 'we are in a transitional stage in which
many former ideas must be revised or rejected'")
(HAS-I-TOPIC PHASE$STAGE |Biology|)
(HAS-I-TOPIC PHASE$STAGE |Time_Period|) (WORD PHASE$STAGE |phase|)
(WORD PHASE$STAGE |stage|)))
(DEFCONCEPT CYCLE$RHYTHM$ROUND (?SELF)
:=> (COURSE ?SELF)
:AXIOMS (AND (SUBJECT CYCLE$RHYTHM$ROUND TIME)
(DOCUMENTATION CYCLE$RHYTHM$ROUND
"an interval during which a recurring sequence of events occurs; 'the neverending cycle
of the seasons'")
(HAS-I-TOPIC CYCLE$RHYTHM$ROUND |Time_Period|)
(WORD CYCLE$RHYTHM$ROUND |cycle|) (WORD CYCLE$RHYTHM$ROUND |rhythm|))
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(WORD CYCLE$RHYTHM$ROUND |round|))
(DEFCONCEPT REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD (?SELF)
:=> (PARAMETER ?SELF)
:AXIOMS (AND (SUBJECT REACTION_TIME$RESPONSE_TIME$LATENCY$
LATENT_PERIOD TIME)
(DOCUMENTATION REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
"the time that elapses between a stimulus and the response to it")
(HAS-I-TOPIC REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
|Chemistry|)
(HAS-I-TOPIC REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
|Time_Period|)
(WORD REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
|reaction_time|)
(WORD REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
|response_time|)
(WORD REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD |latency|)
(WORD REACTION_TIME$RESPONSE_TIME$LATENCY$LATENT_PERIOD
|latent_period|)))
(DEFCONCEPT CRAFT (?SELF)
:=> (VEHICLE_1 ?SELF)
:AXIOMS (AND (SUBJECT CRAFT ARTIFACTS)
(DOCUMENTATION CRAFT
"a vehicle designed for navigation in or on water or air or through outer space")
(HAS-I-TOPIC CRAFT |Transport|) (WORD CRAFT |craft|)))
(DEFCONCEPT EXPLOITATION$DEVELOPMENT (?SELF)
:=> (USE$USAGE$UTILIZATION$UTILISATION$EMPLOYMENT$EXERCISE ?SELF)
:AXIOMS (AND (SUBJECT EXPLOITATION$DEVELOPMENT ACTS)
(DOCUMENTATION EXPLOITATION$DEVELOPMENT
"the act of making some area of land or water more profitable or productive or useful:
'the development of Alaskan resources'; 'the exploitation of copper deposits'")
(HAS-I-TOPIC EXPLOITATION$DEVELOPMENT |Factotum|)
(WORD EXPLOITATION$DEVELOPMENT |exploitation|)
(WORD EXPLOITATION$DEVELOPMENT |development|)))
(DEFCONCEPT HARVEST$HARVESTING$HARVEST_HOME (?SELF)
:=> (GATHER$GATHERING_1 ?SELF)
:AXIOMS (AND (SUBJECT HARVEST$HARVESTING$HARVEST_HOME ACTS)
(DOCUMENTATION HARVEST$HARVESTING$HARVEST_HOME
"the gathering of a ripened crop")
(HAS-I-TOPIC HARVEST$HARVESTING$HARVEST_HOME |Factotum|)
(WORD HARVEST$HARVESTING$HARVEST_HOME |harvest|)
(WORD HARVEST$HARVESTING$HARVEST_HOME |harvesting|)
(WORD HARVEST$HARVESTING$HARVEST_HOME |harvest home|)))
(DEFCONCEPT DEVELOPMENT$EVOLUTION (?SELF)
:=> (PROCESS ?SELF)
:AXIOMS (AND (SUBJECT DEVELOPMENT$EVOLUTION PROCESSES)
(DOCUMENTATION DEVELOPMENT$EVOLUTION
"a process in which something passes by degrees to a more advanced or mature stage;
'the development of his ideas took many years'; 'the evolution of Greek civilization';
'the slow development of her skill as a writer'")
(HAS-I-TOPIC DEVELOPMENT$EVOLUTION |Factotum|)
(WORD DEVELOPMENT$EVOLUTION |development|)
(WORD DEVELOPMENT$EVOLUTION |evolution|)))
(DEFCONCEPT DEVICE_1 (?SELF)
:=> (INSTRUMENTALITY$INSTRUMENTATION ?SELF)
:AXIOMS (AND (SUBJECT DEVICE_1 ARTIFACTS)
(DOCUMENTATION DEVICE_1
"an instrumentality invented for a particular purpose; 'the device is small enough
to wear on your wrist'; 'a device intended to conserve water'")
(HAS-I-TOPIC DEVICE_1 |Factotum|) (WORD DEVICE_1 |device|)))
(DEFCONCEPT PROVISION$PROVIDING$SUPPLY$SUPPLYING (?SELF)
:=> (ACTIVITY_1 ?SELF)
:AXIOMS (AND (SUBJECT PROVISION$PROVIDING$SUPPLY$SUPPLYING ACTS)
(DOCUMENTATION PROVISION$PROVIDING$SUPPLY$SUPPLYING
"the activity of supplying or providing something")
(HAS-I-TOPIC PROVISION$PROVIDING$SUPPLY$SUPPLYING |Factotum|)
(WORD PROVISION$PROVIDING$SUPPLY$SUPPLYING |provision|)
(WORD PROVISION$PROVIDING$SUPPLY$SUPPLYING |providing|)
(WORD PROVISION$PROVIDING$SUPPLY$SUPPLYING |supply|))
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(WORD PROVISION$PROVIDING$SUPPLY$SUPPLYING |supplying|))
(DEFCONCEPT CONVEYANCE$TRANSPORT (?SELF)
:=> (INSTRUMENTALITY$INSTRUMENTATION ?SELF)
:AXIOMS (AND (SUBJECT CONVEYANCE$TRANSPORT ARTIFACTS)
(DOCUMENTATION CONVEYANCE$TRANSPORT
"something that serves as a means of transportation")
(HAS-I-TOPIC CONVEYANCE$TRANSPORT |Transport|)
(WORD CONVEYANCE$TRANSPORT |conveyance|)
(WORD CONVEYANCE$TRANSPORT |transport|)))
(DEFCONCEPT VEHICLE_1 (?SELF)
:=> (CONVEYANCE$TRANSPORT ?SELF)
:AXIOMS (AND (SUBJECT VEHICLE_1 ARTIFACTS)
(DOCUMENTATION VEHICLE_1
"a conveyance that transports people or objects")
(HAS-I-TOPIC VEHICLE_1 |Transport|) (WORD VEHICLE_1 |vehicle|)))
(DEFCONCEPT GATHER$GATHERING_1 (?SELF)
:=> (COLLECTION$COLLECTING$ASSEMBLING ?SELF)
:AXIOMS (AND (SUBJECT GATHER$GATHERING_1 ACTS)
(DOCUMENTATION GATHER$GATHERING_1 "the act of gathering something")
(HAS-I-TOPIC GATHER$GATHERING_1 |Factotum|)
(WORD GATHER$GATHERING_1 |gather|)
(WORD GATHER$GATHERING_1 |gathering|)))
(DEFCONCEPT EQUIPMENT (?SELF)
:=> (INSTRUMENTALITY$INSTRUMENTATION ?SELF)
:AXIOMS (AND (SUBJECT EQUIPMENT ARTIFACTS)
(DOCUMENTATION EQUIPMENT
"an artifact needed for an undertaking or to perform a service")
(HAS-I-TOPIC EQUIPMENT |Factotum|) (WORD EQUIPMENT |equipment|)))
(DEFCONCEPT TRANSACTION$DEALING$DEALINGS (?SELF)
:=> (GROUP_ACTION ?SELF)
:AXIOMS (AND (SUBJECT TRANSACTION$DEALING$DEALINGS ACTS)
(DOCUMENTATION TRANSACTION$DEALING$DEALINGS
"the act of transacting within or between groups (as carrying on commercial activities);
'no transactions are possible without him'; 'he has always been honest in his dealings with me'")
(HAS-I-TOPIC TRANSACTION$DEALING$DEALINGS |Economy|)
(WORD TRANSACTION$DEALING$DEALINGS |transaction|)
(WORD TRANSACTION$DEALING$DEALINGS |dealing|)
(WORD TRANSACTION$DEALING$DEALINGS |dealings|)))
(DEFCONCEPT DEMAND_3 (?SELF)
:=> (ECONOMIC_PROCESS ?SELF)
:AXIOMS (AND (SUBJECT DEMAND_3 PROCESSES)
(DOCUMENTATION DEMAND_3
"the ability and desire to purchase goods and services; 'the automobile reduced the
demand for buggywhips'; 'the demand exceeded the supply'")
(HAS-I-TOPIC DEMAND_3 |Economy|) (WORD DEMAND_3 |demand|)))
(DEFCONCEPT COMMERCE$COMMERCIALISM$MERCANTILISM (?SELF)
:=> (TRANSACTION$DEALING$DEALINGS ?SELF)
:AXIOMS (AND (SUBJECT COMMERCE$COMMERCIALISM$MERCANTILISM ACTS)
(DOCUMENTATION COMMERCE$COMMERCIALISM$MERCANTILISM
"transactions having the objective of supplying commodities")
(HAS-I-TOPIC COMMERCE$COMMERCIALISM$MERCANTILISM |Commerce|)
(WORD COMMERCE$COMMERCIALISM$MERCANTILISM |commerce|)
(WORD COMMERCE$COMMERCIALISM$MERCANTILISM |commercialism|)
(WORD COMMERCE$COMMERCIALISM$MERCANTILISM |mercantilism|)))
(DEFCONCEPT SUPPLY_1 (?SELF)
:=> (ECONOMIC_PROCESS ?SELF)
:AXIOMS (AND (SUBJECT SUPPLY_1 PROCESSES)
(DOCUMENTATION SUPPLY_1 "offering goods and services for sale")
(HAS-I-TOPIC SUPPLY_1 |Economy|) (WORD SUPPLY_1 |supply|)))
(DEFCONCEPT ECONOMIC_PROCESS (?SELF)
:=> (PROCESS ?SELF)
:AXIOMS (AND (SUBJECT ECONOMIC_PROCESS PROCESSES)
(DOCUMENTATION ECONOMIC_PROCESS
"any process affecting the production and development and management of material wealth")
(HAS-I-TOPIC ECONOMIC_PROCESS |Economy|)
(WORD ECONOMIC_PROCESS |economic_process|)))
(DEFCONCEPT COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS (?SELF)
:=> (COMMERCE$COMMERCIALISM$MERCANTILISM ?SELF)
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:AXIOMS (AND
(SUBJECT COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS ACTS)
(DOCUMENTATION COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS
 "the activity of providing goods and services involving financial and commercial
 and industrial aspects; 'computers are now widely used in business'")
(HAS-I-TOPIC COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS
 |Enterprise|)
(HAS-I-TOPIC COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS
 |Industry|)
(WORD COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS
 |commercial enterprise|)
(WORD COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS
 |business enterprise|)
(WORD COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS |business|)))
(DEFCONCEPT INDUSTRY$MANUFACTURE$MANUFACTURING (?SELF)
:=> (COMMERCIAL_ENTERPRISE$BUSINESS_ENTERPRISE$BUSINESS ?SELF)
:AXIOMS (AND (SUBJECT INDUSTRY$MANUFACTURE$MANUFACTURING ACTS)
(DOCUMENTATION INDUSTRY$MANUFACTURE$MANUFACTURING
 "the organized action of making of goods and services for sale; 'American industry i
 s making increased use of computers to control production'")
(HAS-I-TOPIC INDUSTRY$MANUFACTURE$MANUFACTURING |Enterprise|)
(HAS-I-TOPIC INDUSTRY$MANUFACTURE$MANUFACTURING |Industry|)
(WORD INDUSTRY$MANUFACTURE$MANUFACTURING |industry|)
(WORD INDUSTRY$MANUFACTURE$MANUFACTURING |manufacture|)
(WORD INDUSTRY$MANUFACTURE$MANUFACTURING |manufacturing|)))
(DEFCONCEPT FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY (?SELF)
:=> (PLANT$WORKS$INDUSTRIAL_PLANT ?SELF)
:AXIOMS (AND (SUBJECT FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY ARTIFACTS)
(DOCUMENTATION FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY
 "buildings with facilities for manufacturing")
(HAS-I-TOPIC FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY
 |Enterprise|)
(HAS-I-TOPIC FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY
 |Industry|)
(WORD FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY |factory|)
(WORD FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY |mill|)
(WORD FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY
 |manufacturing plant|)
(WORD FACTORY$MILL$MANUFACTURING_PLANT$MANUFACTORY |manufactory|)))
(DEFCONCEPT CORD_1 (?SELF)
:=> (LINE_2 ?SELF)
:AXIOMS (AND (SUBJECT CORD_1 ARTIFACTS)
(DOCUMENTATION CORD_1 "a line made of twisted fibers or threads")
(HAS-I-TOPIC CORD_1 |Factotum|) (WORD CORD_1 |cord|)))
(DEFCONCEPT DISAGREEMENT$DISSENSION (?SELF)
:=> (CONFLICT_4 ?SELF)
:AXIOMS (AND (SUBJECT DISAGREEMENT$DISSENSION STATES)
(DOCUMENTATION DISAGREEMENT$DISSENSION
 "a conflict of people's opinions or actions or characters")
(HAS-I-TOPIC DISAGREEMENT$DISSENSION |Factotum|)
(WORD DISAGREEMENT$DISSENSION |disagreement|)
(WORD DISAGREEMENT$DISSENSION |dissension|)))
(DEFCONCEPT ORGANIC_PROCESS$BIOLOGICAL_PROCESS (?SELF)
:=> (NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY ?SELF)
:AXIOMS (AND (SUBJECT ORGANIC_PROCESS$BIOLOGICAL_PROCESS PROCESSES)
(DOCUMENTATION ORGANIC_PROCESS$BIOLOGICAL_PROCESS
 "a process occurring in living organisms")
(HAS-I-TOPIC ORGANIC_PROCESS$BIOLOGICAL_PROCESS |Biology|)
(WORD ORGANIC_PROCESS$BIOLOGICAL_PROCESS |organic_process|)
(WORD ORGANIC_PROCESS$BIOLOGICAL_PROCESS |biological_process|)))
(DEFCONCEPT GROUP_ACTION (?SELF)
:=> (ACT$HUMAN_ACTION$HUMAN_ACTIVITY ?SELF)
:AXIOMS (AND (SUBJECT GROUP_ACTION ACTS)
(DOCUMENTATION GROUP_ACTION "action taken by a group of people")
(HAS-I-TOPIC GROUP_ACTION |Factotum|)
(WORD GROUP_ACTION |group action|)))
(DEFCONCEPT PLANT$WORKS$INDUSTRIAL_PLANT (?SELF)
:=> (BUILDING_COMPLEX$COMPLEX ?SELF)
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:AXIOMS (AND (SUBJECT PLANT$WORKS$INDUSTRIAL_PLANT ARTIFACTS)
  (DOCUMENTATION PLANT$WORKS$INDUSTRIAL_PLANT
    "buildings for carrying on industrial labor; 'they built a large plant to manufacture automobiles'")
  (HAS-I-TOPIC PLANT$WORKS$INDUSTRIAL_PLANT |Industry|)
  (WORD PLANT$WORKS$INDUSTRIAL_PLANT |plant|)
  (WORD PLANT$WORKS$INDUSTRIAL_PLANT |works|)
  (WORD PLANT$WORKS$INDUSTRIAL_PLANT |industrial plant|)))
(DEFCONCEPT ACTIVITY_1 (?SELF)
  :=> (ACT$HUMAN_ACTION$HUMAN_ACTIVITY ?SELF)
  :AXIOMS (AND (SUBJECT ACTIVITY_1 ACTS)
    (DOCUMENTATION ACTIVITY_1
      "any specific activity or pursuit; 'they avoided all recreational activity'")
    (HAS-I-TOPIC ACTIVITY_1 |Factotum|) (WORD ACTIVITY_1 |activity|)))
(DEFCONCEPT NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY (?SELF)
  :=> (PROCESS ?SELF)
  :AXIOMS (AND
    (SUBJECT NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY PROCESSES)
    (DOCUMENTATION NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY
      "a process existing in or produced by nature (rather than by the intent of human beings);
      'the action of natural forces'; 'volcanic activity'")
    (HAS-I-TOPIC NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY
      |Factotum|)
    (WORD NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY
      |natural_process|)
    (WORD NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY
      |natural_action|)
    (WORD NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY |action|)
    (WORD NATURAL_PROCESS$NATURAL_ACTION$ACTION$ACTIVITY |activity|)))
(DEFCONCEPT COLLECTION$COLLECTING$ASSEMBLING (?SELF)
  :=> (GROUPING ?SELF)
  :AXIOMS (AND (SUBJECT COLLECTION$COLLECTING$ASSEMBLING ACTS)
    (DOCUMENTATION COLLECTION$COLLECTING$ASSEMBLING
      "the act of gathering something together")
    (HAS-I-TOPIC COLLECTION$COLLECTING$ASSEMBLING |Factotum|)
    (WORD COLLECTION$COLLECTING$ASSEMBLING |collection|)
    (WORD COLLECTION$COLLECTING$ASSEMBLING |collecting|)
    (WORD COLLECTION$COLLECTING$ASSEMBLING |assembling|)))
(DEFCONCEPT GROUPING (?SELF)
  :=> (ACTIVITY_1 ?SELF)
  :AXIOMS (AND (SUBJECT GROUPING ACTS)
    (DOCUMENTATION GROUPING
      "the activity of putting things together in groups")
    (HAS-I-TOPIC GROUPING |Factotum|) (WORD GROUPING |grouping|)))
(DEFCONCEPT BUILDING_COMPLEX$COMPLEX (?SELF)
  :=> (STRUCTURE$CONSTRUCTION ?SELF)
  :AXIOMS (AND (SUBJECT BUILDING_COMPLEX$COMPLEX ARTIFACTS)
    (DOCUMENTATION BUILDING_COMPLEX$COMPLEX
      "a whole building made up of interconnected or related structures")
    (HAS-I-TOPIC BUILDING_COMPLEX$COMPLEX |Factotum|)
    (WORD BUILDING_COMPLEX$COMPLEX |building complex|)
    (WORD BUILDING_COMPLEX$COMPLEX |complex|)))
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