3. Ontological models of philosophy: a review

3.1 Introduction

In this chapter we review the existing attempts to formalize knowledge domains related to the philosophical one. We are particularly interested in the modeling of *abstract entities*, (e.g., *theories, schools of thought, concepts* etc.) for two main reasons:

1) as we will see in the next chapter, such entities constitute a fundamental portion of what philosophers deal with in their work;
2) while in the case of other knowledge domains there is already some research literature that focuses on the representation of the domain through semantic technologies, there is instead not much material regarding attempts to model 'ideas'.

The chapter is organized in two sections: in the first one we discuss the very few models which have been explicitly created with the purpose of representing the philosophical domain; in the second one, instead, we review ontologies or formal representations whose scope happen to overlap with the philosophical one, thus providing interesting hints for our specific research purpose.

3.2 Models entirely devoted to philosophy as a domain

In this sub-section we review research enterprises that have explicitly aimed at representing through formal methods the philosophical domain (or part of it). By reading the literature, we identified only three projects specifically aimed at this purpose. At the time of writing, only one of them has yielded tangible results (i.e. one or more ontologies) which we could build on or compare with our own work. Nevertheless, also the other two are presented because we believe that, in the near future, they are likely to provide other relevant results and research directions.

3.2.1 The Indiana Philosophy project (InPhilo)

The most important attempt to systematically formalize the philosophical domain is the one carried out in the work of Niepert and colleagues (Niepert et al., 2007), as part of a larger project (InPhilo) aimed at building a dynamic ontological-backbone for the online version of the Stanford Encyclopedia of Philosophy (SEP) (SEP, 2009).

As claimed by Niepert and colleagues, one of the most important ideas underlying this work can be located in the difference between a *static* ontology and a *dynamic* one:

> To be useful, an ontology for the domain of philosophy cannot be treated as a static object - it must reflect new scholarship as the SEP changes. We have developed a system for combining automatic methods and continuous (expert) feedback from the

> authors and editors of the encyclopedia that can be used to train and refine the automatic methods. In this way, a moderate amount of concentrated initial expert effort can be bootstrapped by a mixture of automatic methods and distributed human effort into a more sophisticated representation of the subject matter of the encyclopedia. In our approach, the ontology gets updated each time new material gets published in the SEP, and it is thus a "dynamic ontology".

Accordingly, the authors' approach starts with the construction of a 'hand-built' formal ontology, for then focusing on the definition of suitable information retrieval and extraction techniques for the periodic 'population' and update of the ontology. We will examine in more details the first phase of this approach, as it is the most related to our research.

The InPhilo ontology contains four basic categories: `thinker`, `document`, `organization` and `idea`. `Thinker` is mainly used to classify persons' roles in the philosophical world (e.g., *scientist*, *philosopher* etc.). `Document` and `organization` are quite self-explicative and, say the authors, the hierarchies departing from them have been mostly derived from other standard ontologies (such as AKT (AKT, 2002)). Finally, the `idea` branch is where the most important contributions have to be done:

> "The most difficult technical issues arise in deriving the significant semantic relationships between philosophical terms used in the SEP entries, and this structure is mostly represented by the *Idea* subontology. While numerous ontologies already exist in the public domain for many physical and abstract neighborhoods of the world, little progress has been made towards creating ontologies of ideas (and virtually nothing for philosophical ideas)."

We agree with the authors' thoughts. The domain of 'ideas' has been traditionally neglected by the knowledge representation community. Whether this is related to the difficulties in 'pinpointing' such abstract and fluid concepts would bring over, or to the lack of business interest in the enterprise, is difficult to say.

However, for that regards how to represent 'ideas' in the ontology, it is worth noting that the people in the InPhilo project have taken an alternative route, compared to modeling choices we opted for (cfr. chapter 5). In fact, while we attempted to derive a classification of ideas based on the most 'agreed-on' and basic *idea-types,* they decided to base their taxonomy on *topical* relationships (i.e. according to a principle of 'semantic relevance' of ideas):

> "[..] we believe it is better to organize idea-keywords according to inheritance relationships found in their contents rather than by their kinds. We have therefore created (and partially populated) an *Idea* subontology which groups ideas according to semantic relevance. On this scheme, the semantic space of philosophy divides along the standard sub-specializations of philosophy: *metaphysics, ethics, logic, philosophy of mind*, etc.*"*

It is possible to see a portion of the InPhilo taxonomy in the figure below (fig. 3-1). Notice how the highest layer of the ontology corresponds to some widely agreed categories used in the editorial organization of the SEP. Similarly, also the other concepts are inspired by the broad issues SEP-related philosophers considered as fundamental in the practice of a specific philosophical discipline.

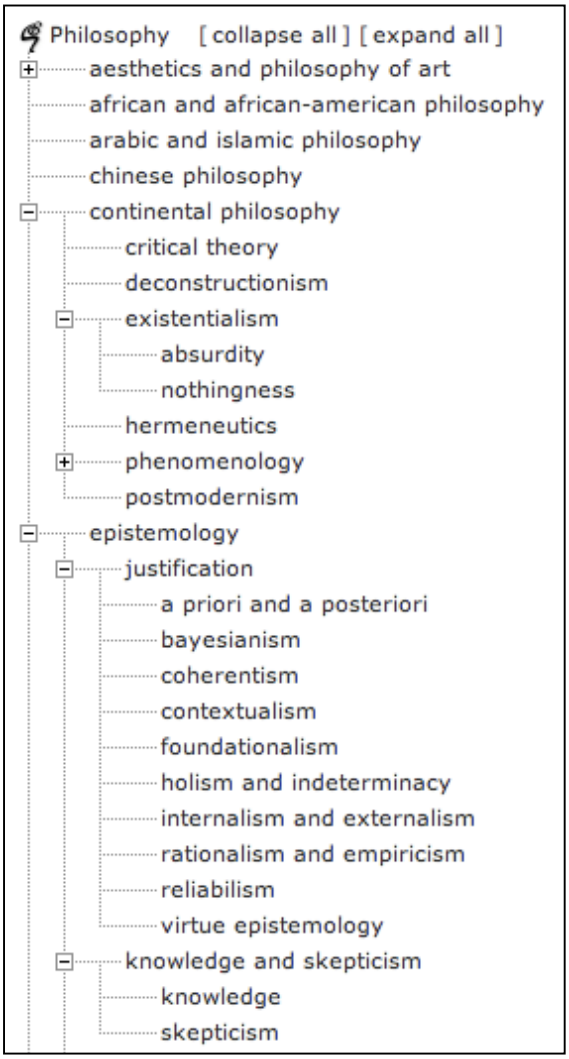

Figure 3-1 - Extract from the InPhilo taxonomy of philosophical concepts

In general, compared to our approach, it is fair to say that this work is less focused on the building of a complete and 'ontologically sound' knowledge model and more targeted at finding useful information extraction techniques, which could benefit from the vast expert-reviewed SEP. In order to build a working 'knowledge-management system' suited to the SEP needs, the authors have chosen to opt for a formal representation of philosophical concepts which is more resembling of a *topic map* than of a carefully structured ontology. For example, as we can see in the figure above, the class 'knowledge' is considered as being a subclass of 'knowledge and skepticism'; in our ontology, instead,

these two topics could be treated as instances of `problem-area` which deal with specific instances of `concept` and `view` (i.e., “knowledge” and “skepticism”), as explained in section 5.5.

As a consequence, we see our work and theirs as essentially *complementary:* for example, we could easily integrate the concept-map above in our ontology, as it were, so to say, the SEP-specific view on the field.

We will discover more about this and other functionalities of our ontology in the next chapter. In particular, let us mention that the mechanism by which different *views* on the philosophical world can coexist in the same ontology relies on the `interpretation` class (see section 4.1.5.4).

3.2.2 Discovery project

The notion of a ‘dynamic ontology’ we have just introduced, and the associated thesis claiming the need of dynamic ontologies *especially* in humanities’ oriented digital applications are not completely novel ideas. In fact, in the context of the Hypernietzsche project (D'Iorio, 2003), such strategies had already been advocated as potentially successful:

> “From a cognitive point of view, HyperNietzsche can be understood as an example of an ‘Dynamic Ontology’. Everybody knows what a descriptive or static ontology is. It is something such as a photograph, which represents the objects of a field of study and their relations at a given moment. [...] The problem is that science has this strange characteristic, that it growths. Now, what I call dynamic ontology is able to create a ›standardized terminology and classification system‹, but it is also capable of expressing the changes which the objects of study and their relations undergo due

> to the growth of knowledge. That which is for a formal ontology a final achievement, is merely the point of departure for a dynamic ontology."

However, in HyperNietzsche this idea did not seem to go too far. In fact, even if the system's implementation made use of a combination of static and dynamic HTML pages, the overall architecture did not benefit from the usage of any ontology-based technologies. This is not the case instead of the Discovery project (Discovery, 2008), which started as a continuation and improvement on HyperNietzsche's ideas.

In fact, the Discovery Project "aims at the creation of a federation of interoperable web sites designed to aid humanities scholars working on digital collections". Mainly, the content of the Discovery federation is related to ancient and modern philosophy, benefitting from a number of specialized partners providing digital contents and metadata about them. In particular, the main platform used for the interchange of resources is Talia (Barbera et al., 2008,Nucci et al., 2007), a Semantic Web application tailored to the creation and publishing of philosophy-related material.

From the ontological point of view, the authors plan to use a 'network' of ontologies. It is worth quoting the entire passage stating their intentions:

> To organize information and support the semantic enrichment of the content provided by partners with different needs, it was decided not to develop a common ontology for the whole project. Instead, we defined only a very broad *structural ontology,* which contains only some general concepts and relations to link documents, and each Discovery content partner will develop its own *domain ontology* for the specific needs of each archive.

Unfortunately, at the time of writing there is still no publicly available ontology for the philosophical domain. The reason that made us cite this work, despite the lack of concrete results, is its very ambitious purpose. In fact, given the vast scope of the project, we envisage that in order to maintain interoperability among such large network of *specialized* philosophical ontologies, Discovery's authors will soon or later have to tackle some of the modeling problems presented in chapter 5.

In conclusion, at this stage of the project we can just stress its fundamental importance with regards to the employment of semantic technologies in philosophy (and more generally, in the humanities).

3.2.3 PhiloNet project

PhiloNet is a joint project between various italian institutions (Bentivogli et al., 2002) with the main goal of developing "tools for semantic concordances" of philosophical texts. As the authors explain:

> We use the term semantic concordance to refer to the set of text passages in which a concept occurs. Concepts are expressed in texts through words and, therefore, to build semantic concordances two lexical semantic issues must be dealt with: polysemy (when a given word expresses different concepts) and synonymy (when different words express the same concept).

In order to detect these semantic concordances, the authors intend to employ a representation of philosophical knowledge analogous to the one of Wordnet (Fellbaum, 1998). More precisely:

> For our purposes we propose to manually annotate philosophical texts with synsets selected from an extension of the generic WordNet called PhiloNet (which is specialized for the philosophical domain, see below), and to build a user interface that given a synset/concept permits to access all the passages in which the concept is used.

Although the authors provide some interesting examples of a 'philosophical synset' (i.e. the various interpretations of the concept of 'reason'), these appear more as a proof of concept, than as a thorough investigation of how to build a complex network of philosophical 'synsets'.

In conclusion, since we did not find any evidence of further results for this project, we must consider it only just as another interesting approach in need of further improvement.

3.3 Models partially devoted to philosophy as a domain

In this second sub-section we review existing ontologies or other formal models whose scope is not explicitly devoted to the representation of the philosophical domain, but still it can be related to it.

Before going further, we must underline the fact that philosophy is a very vast domain. Not surprisingly, in fact, the task of representing it through formal languages will involve the description of a vast range of entity-types, such as *people*, *events*, *physical objects, ideas* etc. (cfr. section 5.2).

However, since there are a large number of existing ontologies that model *most of* those *types* of entities, in the following analysis we decided to focus on a specific *type* only, the *least represented*. That is, we give an account only of formal models of *ideas.* In fact, this is the specific topic where less material is available and, consequently, where our research contributions will have more relevance.

For that regards our modeling choices in the rest of the cases (i.e. *people, events, etc.)*, they will be discussed directly in chapter 5, when presenting the ontology.

In the following sections we are going to review five well-known ontologies: Cyc, Dolce, Wordnet, Sumo and Cidoc-crm.

3.3.1 Cyc

It is worth starting our analysis of Cyc's (Lenat and Guha, 1990) modeling of *ideas* with the generic design pattern Cyc uses to represent *information objects* (see fig. 3-2). This modeling pattern relies on three basic categories of things that contain information:

1. an `Information-BearingThing` (IBT) is the physical embodiment of some abstract information object (ex. a book, a magazine),
2. an `Abstract Information Structure` (AIS) is the specific coding system used to represent the information (ex. a natural language or a formal one)

3. the `Propositional Information Thing` (PIT) is the abstract 'content' of the encoding.

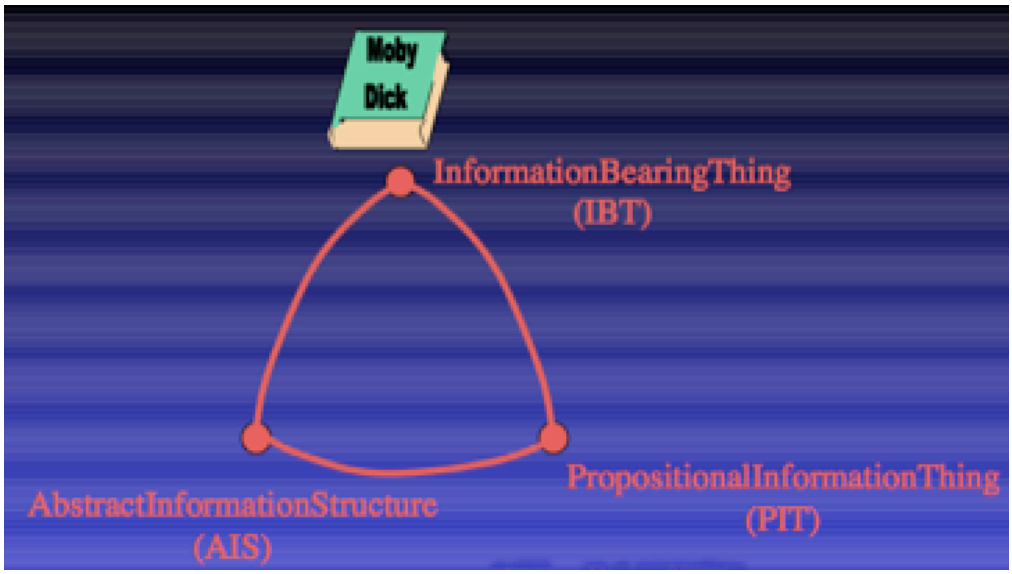

Figure 3-2 - Modeling Information Objects in Cyc (Lenat, 1990)

In the ontology, these categories are subsumed by various super-classes, as we can see in figure 3-3. Notoriously, Cyc is a very complex model where it is difficult to define a main hierarchy structure. However, for the purpose of highlighting the classes referring to 'abstract ideas' (especially, philosophical ones), let us refer to the class `Intangible` (the collection of things that are not physical) as a common ancestor for all of them.

Two other important classes on this branch are `AspatialThing`, defined as the collection of all things with no spatial extent or location, and `InformationStore`, a concrete or abstract repository of information.

Also, `Proposition` inherits from both of these classes; this is defined as an abstract propositional thing that has some truth value in some context or 'world'. A `proposition`, specify the authors, can be represented by a sentence in some

formal or natural language, but it is not assumed to be intrinsically linguistic. In fact, `propositions` are normally viewed as extra-linguistic, intensional entities, which can be grouped within a `Propositional Information Thing` (PIT).

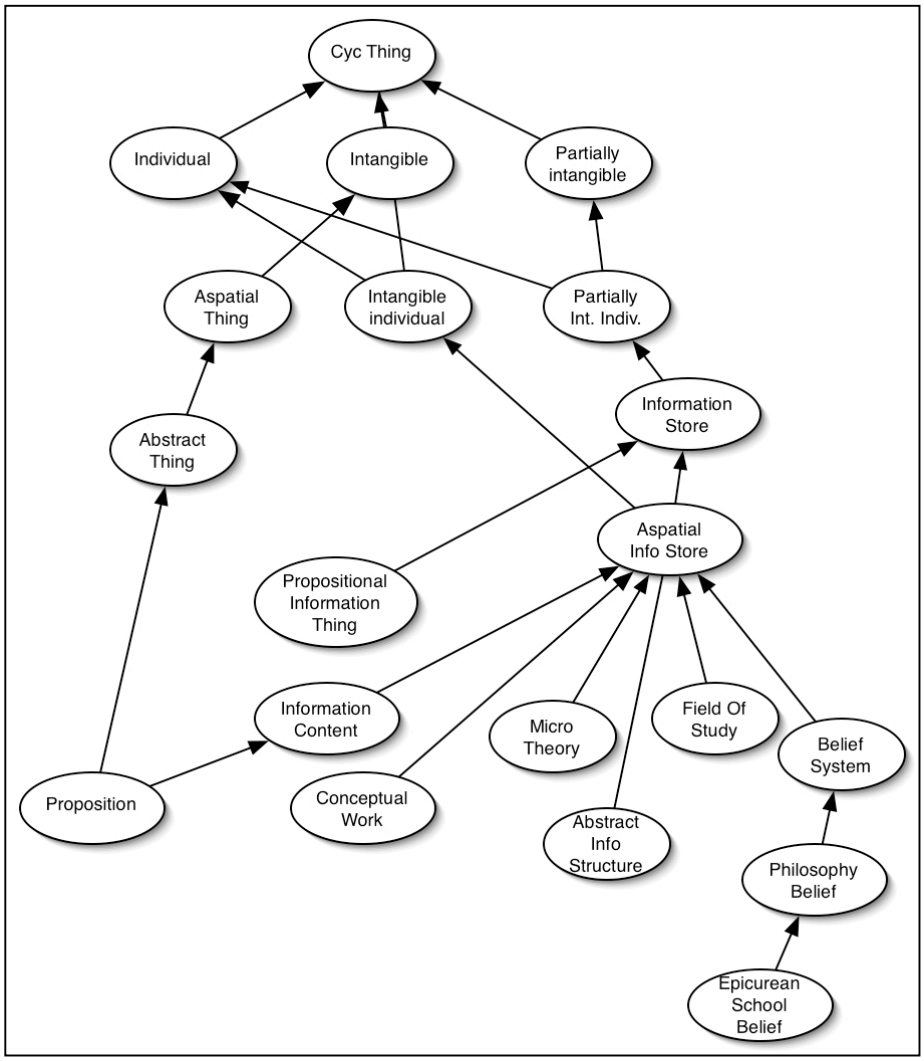

Figure 3-3 - Partial reproduction of Cyc intangible branch (the arrows represent isA relations)

Another quite interesting construct in Cyc is the one of a `Microtheory`. Essentially, through this class it is possible to 'say' that a set of formally defined sentences constitutes a 'theory'. Each `microtheory` serves to group a set of assertions that together share some common assumptions. That is, by separating out a set of assertions from the rest of the ontology, this mechanism

allows the specification of different 'discourse contexts' for other assertions. In other words, it is a generic functionality for creating *abstractions* at different levels of granularity.

As for the classes which are closer to the philosophical domain, it is possible to find some of them on the branch departing from `Aspatial Information Store`. Specifically, let us underline the following ones:

- `Conceptual Work` (CW) serves to represent the reification of famous artifacts as conceptual objects (e.g., the 'Hamlet' or the 'Monnalisa').
- `Field of Study` is defined as a particular area of study, with its own distinctive set of theories, hypotheses, and problems (e.g., 'humanities' or 'artificial intelligence').
- `Belief System` is defined as "an ideology (systems of belief) in terms of which an agent characterizes (i.e., makes sense of) the world'. Quite interestingly, this class subsumes different types of belief systems, such as `Political Beliefs`, `Religious Beliefs` and `Philosophy Beliefs`. As instances of the latter, it possible to find various philosophical ideas: for example, *MilesianSchoolBeliefs*, *Phenomenology*, *EpicureanSchoolBelief*, *Marxism* and so on.

In conclusion, Cyc's model contains various elements which can be reused when developing a specific ontology for philosophy. More precisely, `beliefSystem` and `philosophy-belief` can be translated, in our ontology, into subtypes of `view` (section 5.5.5). The class `conceptualWork` is the equivalent of our `work` (section 5.4.5). Finally, `field-of-study` is a class we are using too, although our formalization of it is quite different (see section 5.5.2).

Nonetheless, Cyc leaves out many other types of philosophical ideas we need to represent. For example, the distinction between a *philosophy* and a *school of thought* (cf. section 5.5.5.3) or the definition of a *philosophical-problem* in the context of a philosophy (cf. section 5.5.3). In general, Cyc does not provide the right granularity for mapping out the various elements taking part in the 'history of philosophical thought'.

Moreover, mainly because of the quite ambitious intended scope of the Cyc project (which was the codification of human being's 'common sense' knowledge), the resulting ontology has reached such a level of complexity that it would easily become quite troublesome for a person to extract or replicate a 'working' portion of it.

Therefore, for that regards the construction of a formal model of philosophical ideas, we believe that there is a lot of space for an improvement of Cyc's facilities.

3.3.2 Dolce

Dolce (Gangemi et al., 2002) treats extensively the domain of conceptual entities, which are subsumed under the category `Non-physical-object`. A first broad distinction is made between `Social-objects` and `Mental-objects`, according to whether or not they are generically dependent on a community of agents. Among the first ones, we would like to highlight the importance of `non-agentive-social-objects`, and, among them, `Descriptions`, `Information-objects` and `Concepts` (see fig. 3-4). These are mainly treated in Dolce's DnS

(Descriptions and Situations) module (Gangemi et al., 2005). Let us consider each one of them separately:

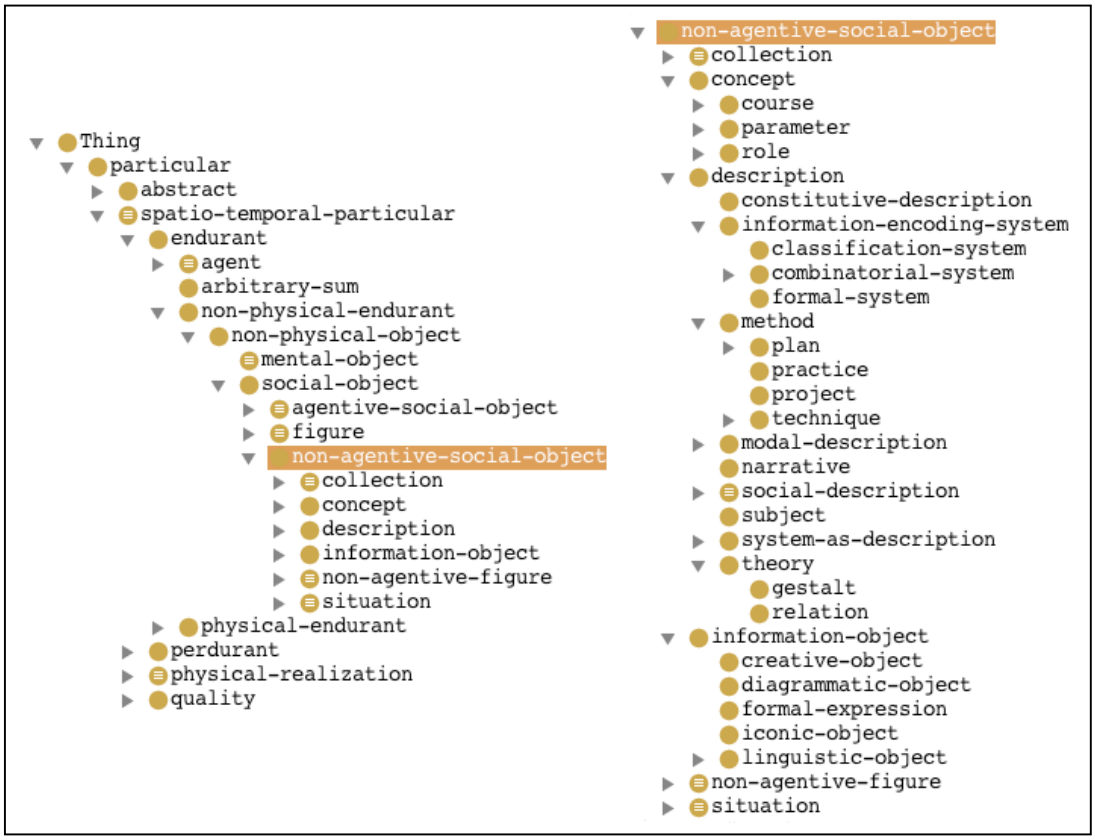

Fig. 3-4 - Dolce's propositional contents

- A `Description` is defined as "a social object which represents a conceptualization (e.g., a mental object or state), hence it is generically dependent on some `agent` and communicable. Descriptions define or use `concepts` or `figures`, are expressed by an `information object` and can be satisfied by `situations`." Examples of descriptions can be *regulations*, *laws*, *projects*, *plots*, *techniques*, *codes* and *theories*.
- `Information-objects` are defined as the `social objects` which are "realized by some entity. They are ordered (expressed according to) by some system for information encoding. Consequently, they are dependent from an encoding

as well as from a concrete realization. They can express a `description` (the ontological equivalent of a meaning/conceptualization), can be about any `entity`, and can be interpreted by an `agent`.".

- A `Concept` is defined as "a non-physical object that is defined by a `description`, and whose function is classifying entities from a ground ontology in order to build `situations` that can satisfy s".

First of all, let us underline how similar Dolce's triadic *information-objects* modeling pattern is to the one previously presented in Cyc (section 3.3.1). The major difference is that while in Dolce the `information-object` is an abstract entity (whose corresponding physical entity, e.g., the actual book of 'Hamlet', is categorized as a `Physical-realization`) Cyc's `Information-Bearing-Thing` is already a physical entity. Without delving further into knowledge representation issues which are not essential to our purposes, let us just remind the reader that we integrated Dolce's IOs design pattern in our ontology. We will thus say more about it later (cfr. section 5.4).

Secondly, let us highlight some of the subclasses of `Description` that are relevant to the philosophical domain. These are the following ones:

1. `Method`, which is defined as a "description that contains a specification to do, realize, behave, etc. Subclasses are plan, technique, practice, project, etc.". As we will see, `method` is one of the main types composing the `philosophical-idea` branch in our ontology (see section 5.5.4).
2. `Narrative`, defined as a "description expressed by a text, and ordered by additional semiotic codes (narratological structures)". This entity, in our

ontology, is related to the information-object design pattern introduced above (see sections 5.4.2 and 5.4.5).

3. `Subject`, defined as a "domain of knowledge, typically expressed by one term, related to other subjects in a partial order hierarchy and with some topological properties; e.g., biology, sport, politics.". For that regards this entity, we are proposing a more complex model which keeps into account features such as subjects' *level of generality* and their *relationship to authors' conceptions* (see section 5.5.2).
4. `Theory`, which according to the authors is "used in a wide cultural sense: a theory about something, expressed in a rather systematic way, but not necessarily public (although communicable in principle). An axiomatic theory is not a theory in this sense, although we can expect an axiomatic theory to be the formal representation of a generic theory." In our work we extended this class by proposing a formalization of various types of *philosophical* theories (described in section 5.5.5).

In conclusion, analogously as what happened with Cyc's classifications, we acknowledged that there are numerous hints to be drawn here. However, once again it also clearly appears that we need more *ad-hoc* classes in order to describe thoroughly what a philosophy is, or how it relates to other viewpoints. In fact, let us remind the reader that one of the most important purposes of Dolce's `social-objects` formalizations has been the modeling of entities and processes typical of the 'legal' domain, as attested, for example, in (Gangemi et al., 2003). Accordingly, we can presume that the classes mentioned above have

been conceived, or more likely, subsequently refined, according to the needs of a very specific application domain.

In conclusion, also Dolce's analysis confirms the need of a more specialized 'philosophical' ontology.

3.3.3 Wordnet

It is interesting to see how a lexical database such as Wordnet (Fellbaum, 1998) categorizes the philosophical concepts we aim to capture with the ontology. Wordnet is considered to be mostly a 'lexical resource', not an ontology. In fact, from the ontological point of view, many are the problems which can be highlighted in Wordnet (Gangemi et al., 2002).

Nonetheless, given its widespread usage and richness of concepts, we thought it was worth an analysis here.

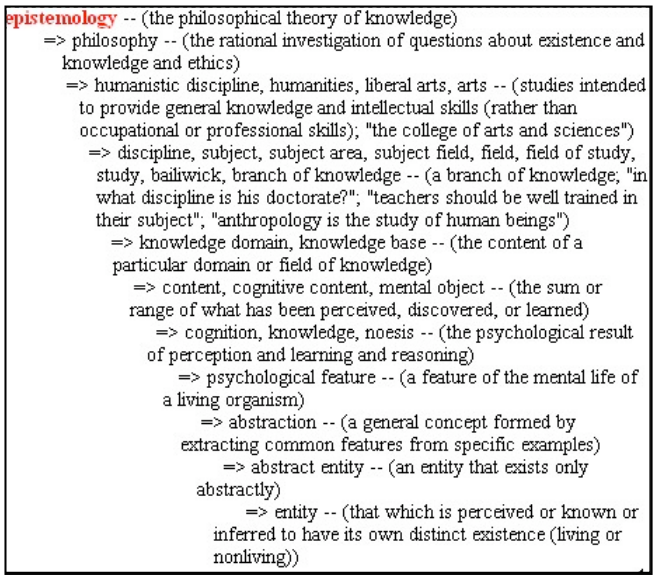

Figure 3-5 - Philosophical concepts in Wordnet: 'Humanistic discipline' branch

In most cases, the abstract notions we are investigating can be found under `HumanisticDiscipline` (see gif. 3-5), which in the hierarchy is a subclass of, respectively, `AbstractEntity` — `PsychologicalFeature` — `CognitiveContent` — `KnowledgeDomain` - `Discipline` (for example, here you can find “ethics” or “epistemology”).

Alternatively, other philosophy-related concepts (entities such as “rationalism” or “idealism”) can be found under `PhilosophicalDoctrine` (see gif. 3-6), which is in the branch starting from `AbstractEntity` — `PsychologicalFeature` - `CognitiveContent` — `Belief` - `Doctrine` .

As expected, this organization is very minimal: *doctrines* and *disciplines* are definitely not enough for creating a working formal model of philosophy. However, Wordnet’s *synsets* about philosophical concepts can be very useful if taken as a set of instances to test our ontology with.

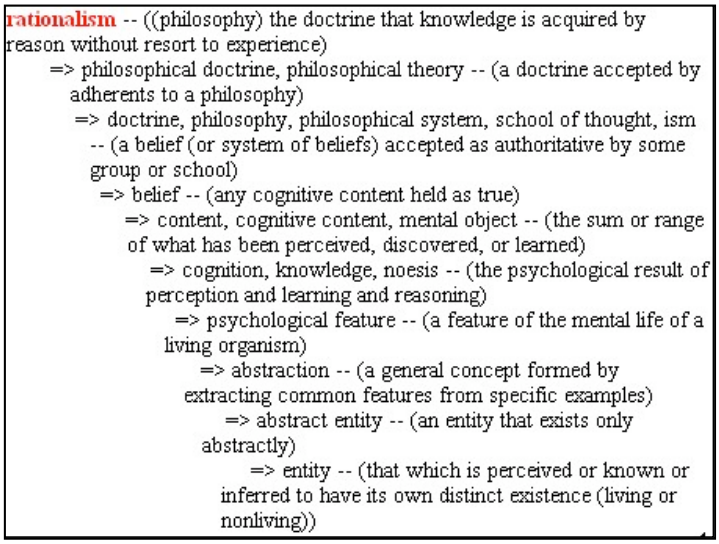

Figure 3-6 - Philosophical concepts in Wordnet: ‘Philosophical doctrine’ branch

3.3.4 Sumo

The Suggested Upper Merged Ontology (SUMO) (Niles and Pease, 2001) gathers all the abstract contents which can be related to philosophers' ideas under the class `proposition` (see fig. 3-7).

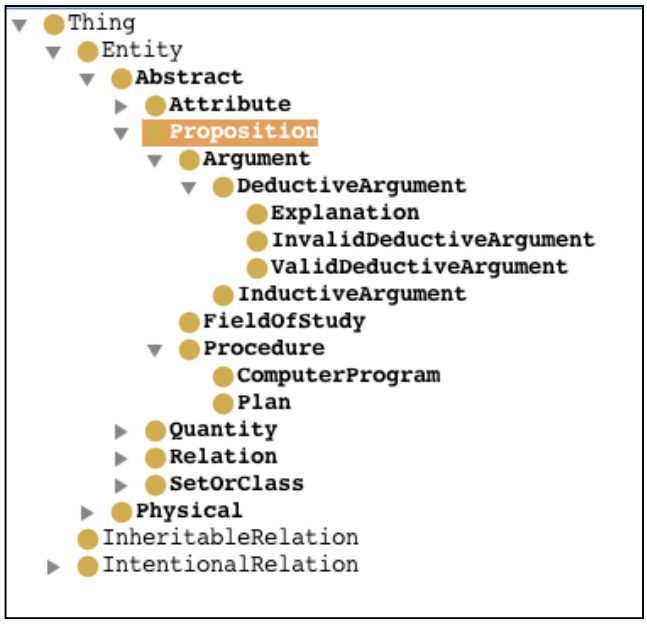

Figure 3-7 - Abstract entities in SUMO

It is worth reporting the entire definition of this class:

> Propositions are Abstract entities that express a complete thought or a set of such thoughts. As an example,the formula '(instance Yojo Cat)' expresses the Proposition that the entity named Yojo is an element of the Class of Cats. Note that propositions are not restricted to the content expressed by individual sentences of a Language. They may encompass the content expressed by theories, books, and even whole libraries. It is important to distinguish Propositions from the ContentBearingObjects that express them. A Proposition is a piece of information, e.g., that the cat is on the mat, but a ContentBearingObject is an Object that represents this information. A Proposition is an abstraction that may have multiple representations: strings, sounds, icons, etc. For example, the Proposition that the cat is on the mat is represented

> here as a string of graphical characters displayed on a monitor and/or printed on paper, but it can be represented by a sequence of sounds or by some non-latin alphabet or by some cryptographic form.

Essentially, SUMO characterizes `Propositions` in a way comparable to DOLCE's `Descriptions` or CYC's `Propositional Information Thing`. However, the classes originating from SUMO's `Proposition` are much less than those ones originating from the equivalent classes in the other two ontologies. In the paper, this is explained by the authors as follows:

> "The concept of Proposition corresponds to the notion of semantics or informational content. However, the SUMO places no size or restriction on this content. Although some 'Propositions' are expressed by single sentences, other 'Propositions' are expressed by entire books or even libraries of books. This is a broader notion than is used in many ontologies, but it does not seem to be possible to make a principled distinction between the abstract content expressed by one sentence and the abstract content expressed by larger units of discourse."

Therefore, according to SUMO we cannot draw any distinction regarding different types of ideas. Only in three cases there seems to be cogent evidence so to support the creation of subclasses, that is:

1. `Argument`, i.e. `Propositions` with the "form of a deductive or inductive argument, i.e. a set of premises which, it is claimed, imply a conclusion". We also treat arguments as types of philosophical ideas in section 5.5.1.
2. `FieldOfStudy`, defined as "an academic or applied discipline with recognized experts and with a core of accepted theory or practice". Importantly, the

authors also underline that, being a subclass of `Proposition`, `FieldOfStudy` must be intended as "a body of abstract, informational content, with varying degrees of certainty attached to each element of this content". In other words, although it is strictly related to various entities which are not abstract, `FieldOfStudy` is totally abstract. Our ontology models this feature using a specific pattern which is presented in section 5.5.2.

3. `Procedure`, i.e. any sequence-dependent specification. For example, *ComputerPrograms*, *finite-state machines*, *cooking recipes*, *musical scores*, *conference schedules*, *driving directions*, and the *scripts* of plays and movies. In our ontology, this class is called instead `method` (cf. section 5.5.4).

In conclusion, also in SUMO we could not find an adequate treatment of philosophical ideas. Of the three types of `Proposition` the authors highlight, two of them have already been mentioned in the ontologies previously analyzed (`FieldOfStudy` and `Procedure`). We take this as an implicit confirmation of their importance. For that regards the remaining class (`Argument`) we too believe it can be seen as a well-defined type of abstract entities; in fact, we have created an analogous class in the PhiloSurfical ontology (cfr. section 5.5.1).

3.3.5 CIDOC-CRM

The CIDOC-CRM model (Crofts et al., 2005) organizes all the abstract entities under the `ConceptualObject` class (see fig. 3-8), which is defined as comprising "non-material products of our minds and information produced by humans with

or without using technical devices that have become objects of a discourse about their identity, circumstances of creation and historical implications".

For that regards the subtypes of `ConceptualObject` (see fig. 3-8), we should remember that (at least initially) most of them have been created with the very specific purpose of providing support to the museum community (it is important to remember that CIDOC is an ISO standard for describing museum and cultural heritage resources). For example, in this branch we can find descriptors such as `Right`, `Appellation` and `Type`, which, unfortunately, are not very useful to our philosophical application domain.

Thus, the only interesting class from our point of view is the remaining `InformationObject`, which according to the authors comprises "identifiable immaterial items, such as a poems, jokes, data sets, images, texts, multimedia objects, procedural prescriptions, computer program code, algorithm or mathematical formulae, that have an objectively recognizable structure and are documented as single units".

This is clearly a quite broad scope for `InformationObject`. In particular, when analyzing its subclasses (which are `Design_or_procedure`, `Document`, `Linguistic_object` and `Visual_item`) it stroke us that that there is no distinction between information objects' *content*, *form* and *realization* (cfr. the previously discussed information-object modeling pattern of DOLCE and CYC).

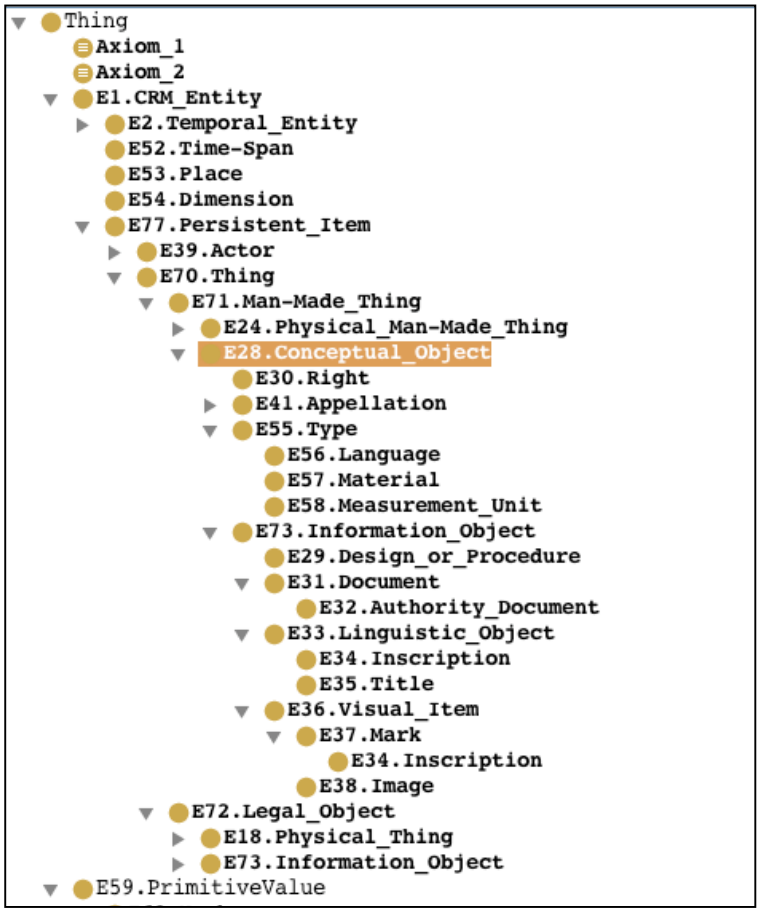

Figure 3-8 - Abstract entities in CIDOC

In conclusion, although we are aware of current work aimed at extending CIDOC precisely in this direction, the current official version (4.4.2) does not seem to provide any type of support for formalizing philosophical ideas. Moreover, the lack of an adequate representation of the different ways to conceptualize information objects' distinctive features makes CIDOC even less suitable to be used for the description of abstract entities in general.

Let us anticipate that, despite such problems, CIDOC provides many useful advantages which make it stand out if compared to the other ontologies previously treated. In fact, we eventually opted for CIDOC to provide the

foundational structure needed by our philosophical ontology. We will discuss such issues in more details in section 5.2.1.

3.4 Summary and gap analysis

In this chapter we analyzed various formal definitions (mainly ontologies) relevant to the task of representing the philosophical domain. Precisely, we investigated the formalization of *ideas*, that is, abstract entities representing 'sensible thoughts' at various levels of granularity and generality.

As a result, we reached two main conclusions.

Firstly, we identified a few classes across the ontologies which are well suited for modeling certain types of (philosophical) ideas. Subsequently, we will include these entities in our formalizations. In particular, the classes we are talking about are the following:

I. **information object**, intended as an abstract entity carrying information about a *form* and a *content;*
II. **field of study**, intended as a knowledge domain carrying some 'historical' features too;
III. **argument**, that is, the abstraction depicting the dialogical sequence of positions competing during a debate activity;
IV. **procedure** or **method**, intended as a pre-defined sequence of steps;
V. **theory**, **doctrine**, intended as an organized set of ideas;

VI. **proposition**, **description**, intended as a simple idea about something.

In chapter 5, we will take into consideration these and other related entities, so to further disclose their meaning and highlight their 'less apparent' senses. Also, we will attempt to derive a *map* of the relations among such entities, with the purpose of constructing a viable formal model of philosophical discourse and scholarship.

Finally, the second conclusion of this review is expressed by the thesis that *there is not any formal model of philosophical ideas (and of philosophy in general) which represents the domain in detail.* More precisely, *there is not any formal characterization of philosophy which supports mechanisms for the creation of 'digital narratives for learning'.*

Having stated a precise gap in the research literature, we now intend to provide a solution for it. In the next chapter we outline the principal characteristics of our approach.