Supporting Philosophers' Work through the Semantic Web: Ontological Issues

Michele Pasin, Enrico Motta
Knowledge Media Institute, Open University
m.pasin, e.motta @ {open.ac.uk}

Abstract. As the Semantic Web is increasingly becoming a reality, the availability of large quantities of structured data brings forward new challenges. In fact, when the content of resources is indexed, not just their status as a text document, an image or a video, it becomes important to have solid semantic models which avoid as much as possible the generation of ambiguities with relation to the resources' meaning. Within an educational context, we believe that only thanks to these models it is possible to organize and present resources in a dynamic and contextual manner. This can be achieved through a process of narrative pathway generation, that is, the active linking of resources into a learning path that contextualizes them with respect to one another. We are experimenting this approach in the PhiloSURFical tool, aimed at supporting philosophy students in understanding a text, by presenting them "maps" of relevant learning resources. An ontology describing the multiple aspects of the philosophical world plays a central role in this system. In this paper, we want to discuss some lessons-learned during the modelling process, which have been crystallized into a series of reusable patterns. We present three of these patterns, showing how they can support different context-based reasoning tasks and allow a formal conceptualization of ambiguities that are primarily philosophy-related but can be easily found in other domains too.

1. Introduction

The need to specify and separate the information about the context of usage of a learning resource, from the resource itself, is one of the main reasons behind the creation of various kinds of metadata schemas. In the past years, this work has focused around the notion of learning object (LO) [1], as the technology capable of guaranteeing interoperability to the rapidly growing number of Web-based educational applications. However, increasingly researchers are now arguing that LOs' metadata are not fine-grained enough to non-trivial composition of resources, e.g. when constructing a curriculum [2]. As a result, as attested by a series of workshops held worldwide [3], the e-Learning research community has begun looking at the potential for e-Learning of the emerging Semantic Web technologies. Our approach, in compliance with this new research direction, addresses the standard LOs' metadata limitation through the usage of ontologies in order to represent the knowledge used in the metadata.

In the PhiloSURFical tool[1] this approach is realized through the formalization of a humanistic discipline, philosophy. An ontology to describe and organize *theories*, *schools of thought*, *arguments*, *problems* and their relations to other philosophical concepts will allow the annotation of the learning material, and, subsequently, its dynamic reorganization with a degree of accuracy and flexibility well beyond the one provided by standard LOs metadata. The aim of this paper is to present some ontological lessons-learned which emerged as fundamental in supporting these functionalities. Under this respect, the modelling patterns we are presenting are quite different from the patterns discussed in other works such as [4], where the focus is more on the architectural issues involved in the ontology creation process. In particular, the patterns we are describing in the next sections represent some modelling decisions that are meant to guide the *interpretation* of philosophical texts, so to have formal models that are *applicable* for providing non-trivial navigation mechanisms. We believe that such a modelling can have a significance that goes beyond the specific domain of philosophy and can be reusable within more generic areas of interest.

In the following sections, we will first describe the pedagogical perspective motivating our work (section 2.1) and the functionalities of the PhiloSURFical tool used to test bed our assumptions (section 2.2). In the second part of the paper, we will instead give an overview of the approach taken in constructing the ontology (section 3.1) and present three important modelling patterns which emerged during the work: one about a natural language ambiguity regarding events, schools of thought and actors (section 3.2), one regarding the multiple view-types we identified in the domain (section 3.3) and one regarding the subtleties involving the representation of problem areas (section 3.4). Finally, in the conclusion we sum up the scope and contribution of this work.

2. Learning through discovery of relevant resources

2.1. Constructive Learning in Philosophy

It is nowadays common-sense knowledge that for a student to *really* understand something, it is necessary an *active* style of learning, not just, for example, a passive reading and remembering of what is read. In educational theory, this thesis (and others related to it) is one of the central tenets of doctrines such as constructivism and situated cognition [5]. Their importance and academic relevance, beyond the various and inevitable debates, is widely acknowledged. According to this position, students are usually advised to engage directly with a subject matter (e.g. an author's text), in order to obtain their own understanding and actively "construct" a meaning out of it.

However, this picture is quite a simplified one. While an active style of learning is relatively easy to foster in “natural”, everyday situations (for example, when learning how to ride a bike or how to speak a language), this is not the case for the more artificial, “academic” learning. The learning and teaching of philosophy, for instance, is a very delicate matter: philosophy, as other subjects such as theoretical physics, mathematics and logic, deals only with abstractions, that is, in Laudrillard terms, “descriptions of the world” [6]. As a consequence of this, its learning cannot be situated in a natural context, but it’s intrinsically de-situated and linked to other

[1] A prototype of the tool is available at http://philosurfical.open.ac.uk

processes of second-order nature. This de-contextualized learning is also necessarily *mediated*: philosophy students do not engage directly with the world, but they act on *descriptions of the world*. Precisely, with the descriptions emerging from the teacher's world. In such an academic and abstract context, what are the ideal students' activities, to the end of a successful learning experience, and what are the best methods and situations to support them, is undoubtedly the object of much debate [7].

But even if a general agreement on this matter will hardly be reached, we can still define some requirements to achieve: for example, in the same specific case of philosophy, following a recent discussion on the topic we agree that the three most important skills to develop in a student must be (a) analysis, (b) argument and (c) interpretation [8]. As the author remarks, the "three skills are interwoven as analysis requires interpretation, and argument depends on the prior abilities to analyse and interpret correctly other philosophical positions".

With the PhiloSURFical tool we aim especially at supporting the (a) analysis and (c) interpretation skills development, through an environment which allow constructing advanced strategies to present annotated resources to the user, in the form of browsing facilities and narrative generation (figure 1). The active involvement of the student in a process of semi-structured navigation (the structure being provided by the ontology) guarantees her engagement with the subject matter in a "constructivist" manner.

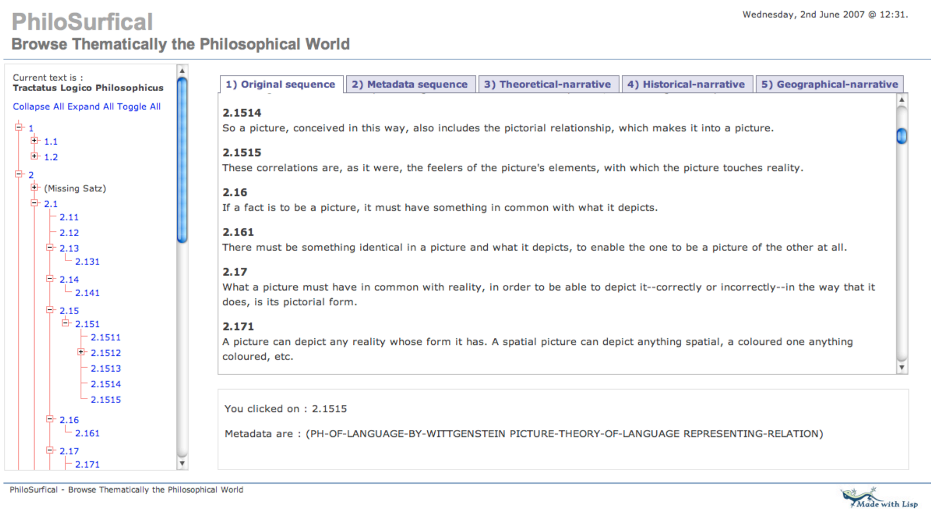

Figure 1. Screenshot of the PhiloSURFical application

2.2. The PhiloSURFical tool

The PhiloSURFical's tool functionalities, and in general, the envisaged context of usage which has been guiding the ontology engineering process is the following: the semantic model should support the *reconstruction* of the history of ideas, by relying on structured information about the practical domain and the theoretical domain of thinkers. Our approach takes the notion of a *learning pathway* as a "system of specially stored and organized narrative elements which the computer retrieves and assembles according to some expressed form of narration" [9] and attempts to transpose it within the specific scenario made up of philosophical entities.

For example, within an educational scenario where young philosophers try to understand domain notions (in a wide sense, comprising ideas and events), these functionalities will exist in the form of mechanisms for *contextual navigation* and linking of relevant resources. As a result, we expect such a service to facilitate the discovery of (related) unknown resources, which can be used by students and scholars during the process of answering difficult problems.

The PhiloSURFical application is being prototyped with Wittgenstein's Tractatus Logico Philosophicus [10] and it allows the navigation of a semantically enhanced version of the text. By relying on an ontology created to describe the philosophical domain at various levels of abstraction, users can benefit from multiple perspectives on the text and on related resources. For example, they can reorganize the same text according to the relevance of a single metadata, e.g. the concept of "logical-independence" (tab 2 – metadata based sequence); they can query the knowledge base or other repositories in the Semantic Web, such as the DBpedia [11], by choosing an object of interest (i.e. a topic) and using it to trigger a *theoretical narrative* (i.e. meta-historical, tab 3), a *historical narrative* (tab 4), or a *geographical* one (tab 5).

This is achieved by using simultaneously the knowledge encoded in the ontology, an initial knowledge base of resources and metadata built by a philosophy teacher, and the SPARQL [12] query language to gather information from other sources in the SW.

However, the *perspectives* mentioned above are only grouping a larger set of possible "narratives" that can be derived from an appropriate metadata description of the domain. The division into *theoretical*, *historical* and *geographical* seemed to us a valid initial breakdown of the domain's features, which also generic users' would easily grasp. In the table below, for example, we show other generic narratives existing within the meta-historical narrative (table 1).

Theoretical Narrative	**Ontology classes mainly involved**	**Example**
Disambiguation	Concept	Visualization of the concept of "god", as defined by different competing conceptions
Contrast	View	Visualization of competing theories, the problems involved and the supporting arguments
Resolution	Problem, Argument	Visualization of the path from the birth of a problem, and its solution
Analogy	Concept, View	Visualization of concepts that play similar roles in different theories
Causation	View, Problem	Visualization of a chain of problem-theory-problem etc.

Table 1. Theoretical narratives

As the complete formalization of these "narratives" in the form of SW-queries is still an ongoing work, and the PhiloSURFical prototype has not been evaluated yet, we will not discuss more these aspects, but instead focus on the analysis of some aspects of the ontology. Remarkably, we soon realized how the latter constitutes the primary source for the creation of interesting and valuable narratives. In fact, as we will see in the next section, the philosophical domain conceals various ambiguities and implicit assumptions that have to be made explicit and formalized. Only by doing so, Semantic Web agents can perform reasoning tasks that offer a valuable alternative to more classic types of search.

3. Engineering Philosophical Knowledge

3.1. Overview: an event-centred design

The specific approach used to realize this system has at its centre the decision to employ the CIDOC Conceptual Reference Model [13] as a starting point for our formalizations. The CRM ontology was originally an attempt of the CIDOC Committee of the International Council of Museums (ICOM) to achieve semantic interoperability for museum data. Since 1996, the formal model has improved considerably till becoming in 2006 an ISO standard. It is now (version 4.2 [14]) in a very stable form, and contains 75 classes and 108 properties, both arranged in multiple is-A hierarchies. The choice of using the CRM was motivated by two reasons. Firstly, for its widely recognized status as a standard for interpreting cultural heritage data. In fact, by reusing and extending an existing and internationally recognized ontology, we will give our tool's users more chances to benefit from the emerging Semantic Web infrastructure.

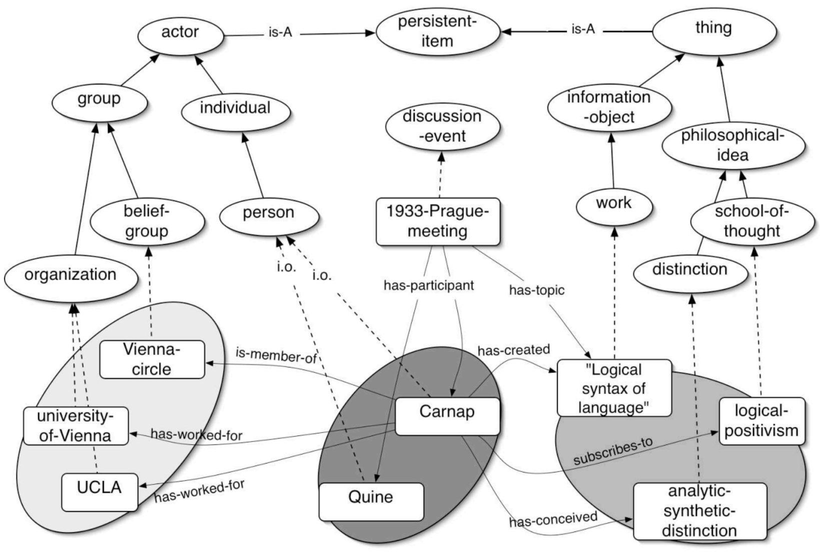

Figure 2. Reasoning with philosophical events

Secondly, for its extensive event-centered design. This design rationale, in fact, appeared to be appropriate also when trying to organize the history of philosophy: even if it is common to see it as an *history of ideas,* stressing the importance of the *theoretical* (i.e. meta-historical) dimension, we believe this cannot be examined without an adequate consideration of the *historical* dimension. That is, a history of the events related (directly or indirectly) to these ideas. In figure 2 we can see an example of an event-centered representation in the PhiloSURFical ontology. The persistent-item class, which is one of the five classes composing CIDOC's top layer (together with time-specification, dimension, place and temporal-entity) subsumes thing and actor. The two branches of the ontology departing from them can have various instances, which are related by taking part (in various ways) to the same event. This kind of modelling, in the context of the PhiloSURFical tool, is extremely useful because of the multiple navigational pathways it can support (e.g. we could move to another event having the same topic, or to another topic treated during the same event, etc.)

From the implementation point of view, the ontology has been prototyped by using the Operational Conceptual Modelling Language (OCML) [15], which provides rich support for both specification and reference. Import/export mechanisms from OCML to other languages, such as OWL and Ontolingua, ensure symbol-level interoperability.

At the time of writing, the ontology[2] counts 348 classes, partly integrated from other relevant semantic models and partly identified through various knowledge acquisition techniques (formal and informal). In the next sections we will present three ontological issues we encountered during the modelling process, together with the solutions we contrived in order to solve them. As in the example above, the derived modelling patterns aim at taking advantage of the multiple meanings a philosophical entity (e.g. an idea, a text or an event) can have, by making these meanings explicit and employable when building novel exploration mechanisms. In other words, according to our approach "ambiguities are good" because, if properly identified, they let us explore the domain in different and interesting ways.

3.2. Pattern #1: is rationalism a school of thought or an event?

The first pattern origins from the fact that in our everyday language we refer to belief groups, intellectual movements and schools of thought ambiguously, often using the same word.

According to CIDOC, Period (which is a direct subclass of Temporal-entity) should subsume prehistoric or historic periods, or even artistic styles. This is motivated by the fact that "it is the social or physical coherence of these phenomena that identify a Period and not the associated spatio-temporal bounds" [14]. This seemed to apply quite neatly also to *cultural* and *philosophical periods*, thus we have added Intellectual-movement and its subclass Philosophical-movement to the hierarchy. So, for example, we can describe the "enlightenment movement" in the following way (note that the temporal relations are specified here as slots, but are usually inferred whenever the appropriate time specifications of the other periods were provided)[3]:

```
(def-instance enlightenment intellectual-movement
((has-time-specification 18th-century)
 (overlaps-in-time-with scientific-revolution renaissance)
 (meets-in-time-with French-revolution American-revolution romanticism)
 (overlaps-with Age-of-Reason neo-classical-art)
 (took-place-at Germany France  Britain  Spain)
 (has-related-group-of-people enlightenment-group-of-people)
 (is-typified-by enlightenment-conception)))
```

The last two properties in the previous example have a special importance. Periods, in fact, appear to be tightly connected to the abstract ideas defining them and

[2] The latest version of the ontology can be found online at http://philosurfical.open.ac.uk/ontology/.

[3] OCML has a simple frame-like syntax, with sequences of *slot-name* and *slot-values*.

to the group of people that often carries the same name. The slots *has-related-group-of-people* and *is-typified-by* specifically serve this purpose. This issue is better understood is we just consider how often this feature of intellectual events generates ambiguities, since in natural-language expressions it is not clear what entity we are referring to. For example, let us consider the following three statements:

"Throughout history, the attacks of rationalism against empiricism has diminished"

"Descartes was one of the founders of modern rationalism

"This theory is clearly a new and re-shaped rationalism"

At a first examination, all three sentences refer to "rationalism". However, at a deeper ontological analysis, we came to the conclusion that in a) "rationalism" is the label referencing to a group of people, in b) we are meaning an event, while in c) we are probably referring to an abstract idea.

A modelling pattern (figure 3) involving actors, periods and views (a type of abstract philosophical idea, as we shall see later, expressing a standpoint) attempts to tidy things up. The ambiguity of a term such as "rationalism" can be clarified, since the semantic model keeps the three different ways to intend the concept into a consistent representation. By doing so, we are providing a context of usage for such ambiguous concepts, and a direct way to navigate coherently among entities that are ontologically quite distinct (i.e. from temporal-entity to actor and propositional-content, which belong to separate branches of the ontology). Moreover, such a context-specification could be used for by a reasoner to derive inferences from incomplete or inconsistent data sources, or for performing information extraction.

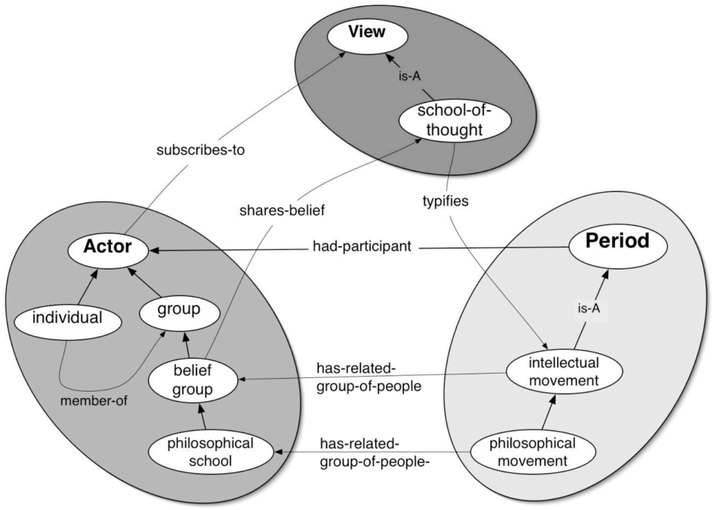

Figure 3. The actor-event-view modelling pattern

3.3. Pattern #2: not all views are theories!

The second pattern is related to the fact that people often employ the term "theory" in a loose manner, over-classifying views with different characteristics.

In our ontology, view has been defined as a generic class referring to philosophical ideas expressing a viewpoint. That is, propositions picturing a perspective on the world in the form of more or less structured interpretations of things and events. Examples of view are "solipsism", "theory of evolution by natural selection", "philosophy of Plato" or "a name has a meaning only in the context of a proposition" (i.e. Frege's context principle). Because of their "categorical" attitude, views usually *define* concepts and, in general, create the context for the definition of other meanings too (e.g. problem-areas, problems, methods etc.). A number of properties connect views to the other philosophical-ideas: e.g. views can *use* other ideas, *tackle* problems, *influence* and *support/contrast* each other, *be-supported* by arguments. However, the feature we want to highlight here is how views can have different granularities: from our analysis of the literature, we identified four of them. This classification is mainly related to the degree of generality they exhibit, and the level of complexity they have. So, we can have (as shown in figure 4):

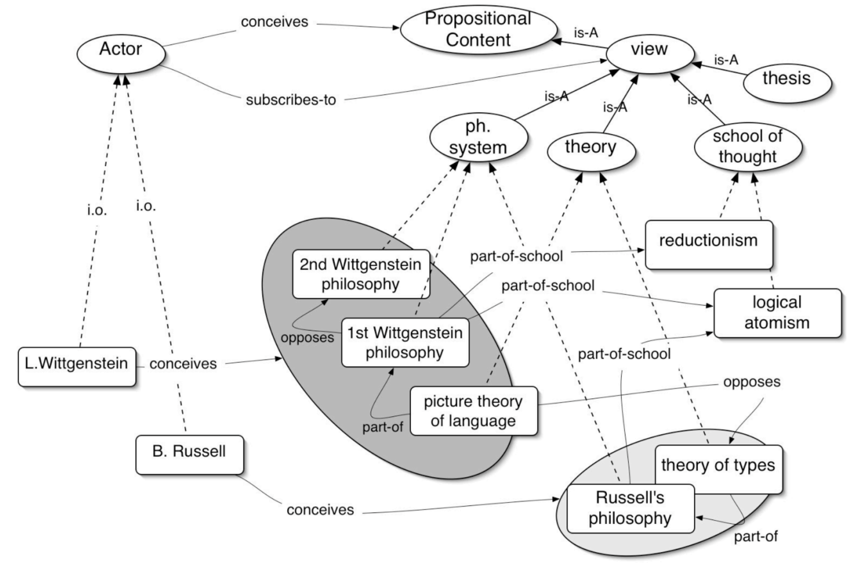

Figure 4. The view-types instantiation

- Thesis: is the least structured view, as sometimes it consists only of a standpoint in the form of a statement (i.e. an assertion). So, for example, in the context of Wittgenstein's “picture theory of language”, a thesis can be the "independence of the state of things".

- Theory: is a systemic conceptual construction with a coherent and organic architecture. A theory explains a specific phenomenon (or a class of phenomena) and typically answers to an already existing problem. Examples can be Darwin’s “theory of evolution” or Quine’s “verification theory

- Philosophical-system: it might appear as a theory, at first sight, but it differs from it essentially for its generality. That is, because it spans over various problem-area, while a theory is usually confined to one problem-area only. As a consequence, theories are usually *part-of* philosophical systems. We can therefore define a system as the set of a person’s views that are consistently connected to each other, in such a way to form a unity (in a way, this class refers to what is normally called the "philosophy" of a thinker).

- School-of-thought: this class refers to the set of theory-types, or generic standpoints, which in the history of thought have acquired a particular significance and, seemingly, a life on their own. They correspond to widely known conceptions, or standardized intellectual trends that hint at typical ways to answer a problem (or a set of problems). Examples are “pacifism”, “animism”, “expansionism”, "empiricism" or "monism". A school-of-thought, compared to the other views, is not as formalized and specific as a theory, and not as general and systematic as a philosophical-system.

3.4. Pattern #3: “problematic” problem-areas

The third pattern we are presenting wants to provide a way of expressing the distinctive features of fields of study. As we will see, the difficulty here arises from the fact that we can interpret them in two different ways: a generic one (e.g. the field of “physics”) and a specific one (e.g. “Newtonian physics”). The pattern models the relations between them.

Our starting point is a problem-centred approach, that is, the decision to see the activity of philosophers as essentially an ongoing process of specifying and giving solutions to problems. Consequently, we consider any recognized area of study, of whatever type or dimensions, as a problem-area. In its simplest version, a problem-area is composed by a set of problems linked by different relational schemas, but in general, tying around a main theme. This theme, in our ontology, can be represented through a problem (*has-central-problem* property) or thanks to a thesis functioning as a criterion (*has-criteria* property). For example, “psychology”, when treated as a problem-area, can gather problems tied to the “mind-definition” problem, to the problem of “relating human behaviour to brain activities”, or to the thesis that "brain and mind can be investigated with the methods of natural sciences".

Other features of problem-areas are that they can be *related-to* each other (e.g. “mathematics” and “philosophy of mathematics”) and that they can be organized into simple hierarchies (e.g. “internet-ethics” is a sub-area of “ethics”). However, we realized soon that "psychology" has a role and significance in our world that goes beyond a mere problem area. In a similar fashion, "ethics" or "cognitive science" would not be properly characterized only as instances of problem-area, for they also refer to theories or methods which have become intrinsically related to the definition of the area.

Moreover, if we consider the history of thought, the topic and description of problem areas have always been subject of many debates: different views aspire at having the ultimate vision about what the central issues to look at are, or the right methods to take. In this respect, problem-areas are not very different from other ideas that can be *defined* by multiple views. For example, we can just consider how different was the sense given to “philosophy of language” by the first philosophy of Wittgenstein and the second one.

In order to catch these subtle differences, we defined the class field-of-study as a problem-area that has been socially and historically recognized as separate from the others (and from being a mere agglomerate of problems). In the ontology, this is reflected by the fact that a field-of-study is not just specified by a criteria, but is *defined-by* a view. It is also characterized by the fact that it collects not only problems, but also ways to solve or tackle them (i.e. theories and methods). The distinguishing properties are therefore *defined-by-view*, *has-exemplar-theory* and *has-methodology*.

Finally, a last tricky issue regarding fields of study must be addressed (see figure 5). This does not emerge when treating relatively isolated entities such as “phrenology”, but it clearly is an issue if we consider, say, “physics”. In our everyday language, and also in the organization of academic programs, we usually refer to “physics”, “psychology” or “philosophy of mind” as *generic* fields of study. What this means, is not really clear. In fact, when we delve into them (or even more, if we ask for clarifications to a practitioner), we discover quickly that there are *many* “physics”, “psychologies” and “philosophies”, at least as many as the views defining them. From our ontological perspective, these would all be separate instance-candidates of the field-of-study class. However, we also need to represent the fact that they are all part of a more generic (and probably *emptier*, for that regards its meaning) type of field of study.

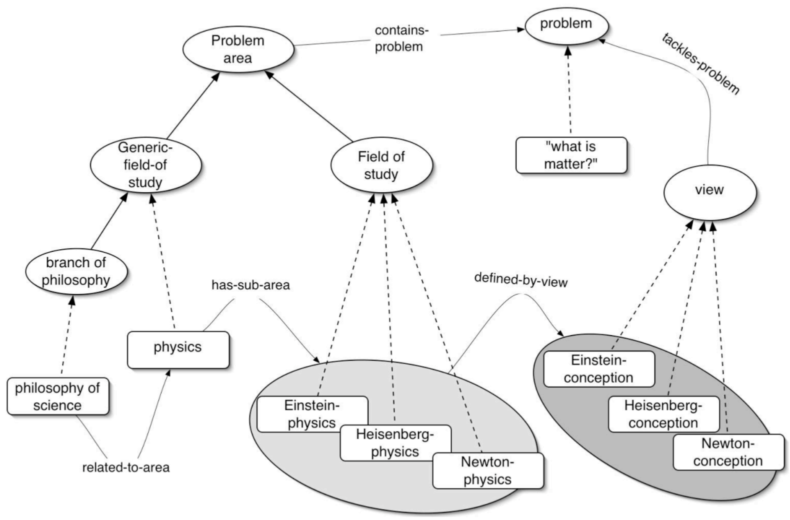

Figure 5. Problem areas and fields of study

Our solution to this problem consists in the creation of a generic-field-of-study class, which has no defining view but the views defining the specific fields-of-study that are claimed to be part of it. In other words, we are formalizing the fact that generic fields of study such as “physics” or “philosophy” can be defined only *extensionally*. So:

```
(def-class generic-Field-of-study (Problem-area) ?GF
((defined-by-view :type
        (SetOfAll ?V (and (has-sub-area ?GF ?F)
                          (defined-by-view ?F ?V))))))
```

In the formula, the variables ?GF, ?V and ?F refer respectively to generic-field-of-study, view and field-of-study. Therefore, doing so we can maintain the interoperability between specific thinkers’ definitions of classic problem areas, and the generic but useful ways to refer to them. In figure 5 we give a graphical overview of this modelling pattern, highlighting the important relationships among the classes involved.

4. Conclusion

In this article we have presented three important modelling patterns that emerged during our work with the PhiloSURFical tool. This is an application built to support students in understanding a philosophical text, through contextual navigation mechanisms based on Semantic Web technologies. The application is being prototyped with the Tractatus-Logico Philosophicus written by Wittgenstein, using a philosophical ontology we created and instantiated with the relevant data. The ontology modelling process has demonstrated to be crucial to the aim of providing valuable and non-naïve navigation mechanisms. In the paper we show how the usage of solid modelling schemas can serve to solve ambiguities in the philosophical domain, and possibly to tidy up poorly or wrongly structured data in the quickly improving Semantic Web.

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