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Crisscross ontology: Mapping concept dynamics, competing argument and multiperspectival knowledge in philosophy

ABSTRACT: *Knowledge is one of humanity's highest achievements. But the formal representation of cultural and in particular philosophical knowledge still poses great difficulties to information science due to the inherently complex, contextual, indeterminate and contested nature of these disciplines' concepts and knowledge statements. Moreover, while we are seeing rapid technological development and the adoption of machine learning and semantic technologies in all sectors of society, philosophy has not yet risen to the challenge of properly relating to and adequately integrating them. This paper has two aims: First, it argues that we need a potent response to precisely this double challenge and to tackle it from a cross-disciplinary perspective involving philosophy, computational ontology, knowledge graphs, linguistics, lexicology, disagreement research and argumentation theory. Second, the paper also outlines a research agenda for finally opening up and making philosophy's multiperspectival knowledge contents available to the strongest models of formal knowledge representation: computational ontologies. Our aim is to achieve this, however, without compromising on the computational strengths of ontology nor imposing false stability and consistency on the knowledge base itself.*

KEYWORDS: *Crisscross knowledge, multiperspectivism, computational ontology, philosophy, Ludwig Wittgenstein.*

1. Introduction

While knowledge representation has become very capable of representing knowledge characterized by stability, precision, coherence and consistency, it remains a challenge to adequately map knowledge that is characterized by concept dynamics, vagueness, and multiperspectivism, as well as competing and contentious knowledge claims. The first kind of knowledge we call "jigsaw puzzle" knowledge since it is composed of individual stable pieces of knowledge that fit

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neatly together, often in predetermined formats, each in its own proper place; the second, borrowing a phrase from one of the most important and influential thinkers of all times, the Austrian-British philosopher Ludwig Wittgenstein (1889–1951), we call “crisscross” knowledge. Wittgenstein paid thorough attention to crisscross knowledge and made it a central topic of his later philosophy, which culminated in the posthumously published *magnum opus*, *Philosophical Investigations* (Wittgenstein 1953)[1]. Here, as elsewhere, Wittgenstein demonstrates how the cultural sector and philosophy in particular are necessarily fields of crisscross approaches[2].

With the key distinction between “jigsaw puzzle” and “crisscross” knowledge in mind, we contend that not only the vision of the Semantic Web,[3] which aspires to link generally agreed upon knowledge, but also a much more ambitious vision of a “Web of *meaning*” proper, can become a reality only when knowledge representation is able to fully integrate crisscross content into computational ontologies and knowledge graphs. In terms of philosophical practice, it is only then that philosophy can become a discipline fundamentally supported by digital practices, itself further developing and inspiring these practices in turn. Such deep engagement with some of the most powerful tools in current digital technology may also benefit the discipline of philosophy by, for example, opening up new ways of conceptualisations, testing philosophical intuitions and helping widespread dissemination. This strong intertwining of philosophical contents and computational ontologies is currently something that has not been achieved – but it is something that can and should become a reality. Reaching this objective is on the horizon today, if we only manage to integrate what, following Wittgenstein, we may term an authentically philosophical “crisscross” approach to knowledge, concepts and meaning-making, with the powerful systems of computational ontologies and knowledge graphs. However, this will not only require philosophers to begin taking the potentials of computational ontology seriously, but also that the latter takes into account the fact that knowledge statements can be marked by “messy”[4] concept dynamics, contextuality, vagueness, and multiperspectivism, as well as by contentiousness and even contradiction.

1 Wittgenstein terms the philosophical procedure of his *Investigations* “crisscross”; the term broadly refers to approaching the same point over and over again but from different perspectives or directions, see Wittgenstein 1953, Preface. On the contrast of “crisscross” to “jigsaw puzzle” knowledge see further: Pichler 2016.

2 Wittgenstein’s writings are available open access online. See Ludwig Wittgenstein, *Wittgenstein Source Bergen Nachlass Edition*, in: Wittgenstein Source (http://wittgensteinsource.org), 2015-, and L. Wittgenstein, *Interactive Dynamic Presentation (IDP) of Ludwig Wittgenstein’s philosophical Nachlass* (http://wittgensteinonline.no/); both editions are provided by the Wittgenstein Archives at the University of Bergen under the direction of A. Pichler.

3 Berners-Lee, Hendler, and Lassila 2001.

4 Barsalou 2017.

2. Philosophical knowledge

Philosophical knowledge typically exhibits a strong dynamic dimension in both its methods, concepts and contents, as well as in interpreters' multifaceted approaches towards them. In particular, philosophical content is often characterized by deep conceptual changes over time, be that at the hand of the original author or by secondary interpretive acts of scholarship. This is only natural since philosophy is to a large extent precisely about negotiating concepts and addressing disagreement through argument.

The works of Ludwig Wittgenstein exhibit one of the most dramatic examples of such shifts in thought in the development of a single philosophical corpus. This can be seen when Wittgenstein critiques and ultimately rejects in his later works, especially his *Investigations* (Wittgenstein 1953), fundamental philosophical claims he had put forth in his early work, the *Tractatus logico-philosophicus*[5]. Here, and throughout the mass of unpublished writing he left behind, Wittgenstein exposes the dynamic nature of language and the richness of argumentative forms in greater detail than any other philosopher, before or since. He does so, moreover, in a manner that serves as a performative engagement with that very diversity of form. He is an example of a thinker who is his own best critic, hardly ever resting content with a stated view and never finalizing his way of philosophically carving up the world.

One can thus take Wittgenstein's philosophical oeuvre as a test case, a model for the necessity and potential of ontologies to meet the challenges of conceptually complex and dynamic knowledge bases. For, to engage with such a philosophical oeuvre on this point is to confront the question at the heart of the issue at hand: How are we, in a knowledge representation context, to account for knowledge statements that are inherently conflicting, dynamic, and multiperspectival in form, while at the same time remaining true to their nature and leaving them *undistorted* by formal representation?

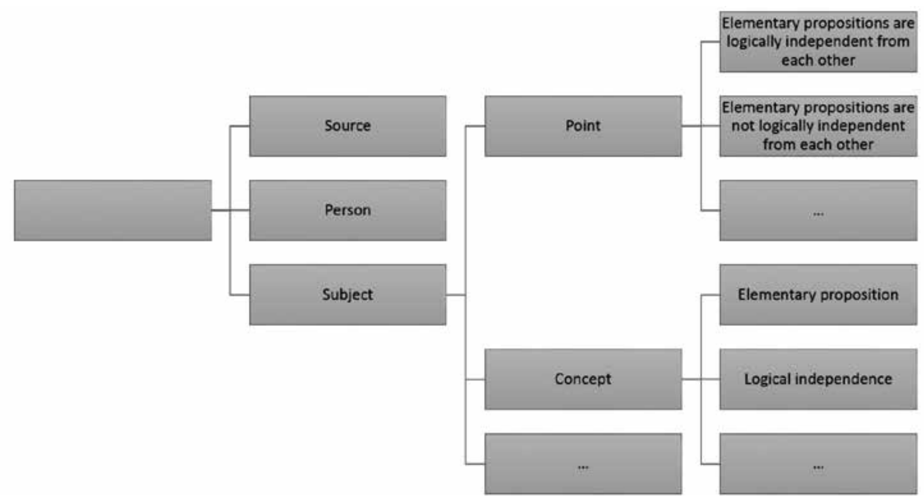
3. Towards a Wittgenstein ontology

Developing a computational ontology for the Wittgenstein domain seems thus a natural proof of concept for this field of research. The Wittgenstein Archives at the University of Bergen (WAB) has already produced the most general class structure for a comprehensive Wittgenstein ontology and come far in richly populating the first two of the top classes – *Source* and *Person*[6]. But philosophy ontologies need as their nodes not only named entities such as documents and persons, but also and most importantly, what is our central focus here, namely content instances, subjects. Subjects include first of all (1) concepts, then also (2) claims – we call the

5 Wittgenstein 1922.

6 http://wab.uib.no/cost-a32_philospace/wittgenstein.owl; for a semantic faceted search and browsing application see http://wab.uib.no/sfb/. For brief presentations of the ontology see Pichler, and Zöllner-Weber 2013; Addis, Brock, and Pichler 2015.

latter "points" since each philosophical claim indeed makes a philosophical point. Subjects include further (3) arguments and (4) debates. It is with modelling and populating the third top class, the *Subject* class with the above mentioned four subgroups and the relations both within these groups and between them, that the real challenges begin.



Wittgenstein ontology: Source, Person and Subject – the real challenge begins with the Subject class

4. Ontological restrictions

While the field of Digital Humanities has begun to occupy a central role in the creation and exchange of knowledge, to successfully map the rich multifaceted contents of cultural and humanities resources still presents enormous conceptual challenges, which are not satisfactorily tackled by standard approaches. Information science's most powerful instrument for knowledge mapping, computational ontology, typically presupposes that the domain to be mapped is stable and consistent, and that its contents are universally agreed upon and shared within the domain in question, ideally formalizable and organizable in linear and hierarchical pathways[7]. Thus, we see computational ontologies having the greatest impact today in areas where canonical knowledge is key, such as in the domains of anatomy[8] and functional genomics[9]. And even where ontologies have successfully touched on the humanities, these tend to be in areas with a high level of

7 Berners-Lee, *et al.* 2001, and Gruber 1993.
8 Cf. Rosse and Mejino 2003.
9 Cf. Smith, Köhler, and Kumar 2004.

empirical content, such as archaeology and cultural inheritance, which provide standards of coherence that are foreign to many humanities fields[10]. Strong coherence, consistency, universality and stability oriented approaches soon become inadequate when dealing with theoretical humanities proper, and in particular with philosophy, which paradigmatically embodies the dynamism, open-endedness, vagueness, implicitness, context-dependency and multiperspectivism of human thought in general.

In distinction to the broadly universalist conceptualizations employed in the empirical sciences, cultural and humanistic concepts are thoroughly characterized by what Wittgenstein termed "family resemblance": Often, our usages of a concept have no one stable core and no single defining feature in common, with the unity of the concept consisting rather in "a complicated network of similarities overlapping and criss-crossing"[11]. Rather than upon something like an eternal and immutable essence, *family resemblance networks of meaning* are built upon and sustained by pragmatic patterns of connecting usage and are thus deeply embedded in dynamic cultural practices that vary from place to place and evolve over time. This open-ended structure of human concept use and, in turn, of human knowledge poses a challenge to standard ontology methods that needs to be tackled if we want to make the contents of something like philosophy fully available to computational knowledge representation that is usable by both humans and machines. How, then, can we advance the field and allow complex and dynamic philosophical contents to be represented in formal, computational models?

In traditional approaches, concept definitions are typically only found in an ontology's metadata and so they are only reluctantly open to revision – and even then, at the risk of invalidating lower-level mappings. Moreover, much ontology construction starts from a middle-out approach, detailing a conceptual domain downwards in a top-down fashion as well as abstracting it upwards by adding upper-level concepts and defining a set of top-level categories considered to be authoritative for the domain in question. In this way the domain is broken down into classes and subclasses into which all its relevant concepts and objects are thought to fit. However, it is important not to overlook the crucial fact that such a procedure, even if conceived of as yielding a sufficiently exhaustive and definite picture of the domain in question, formalizes a particular classification scheme and demands in turn that any contentious concepts either conform to the standard or remain outside the model. It is important to note that such a picture of the domain may not be an exhaustive representation of the reality it purports to model but is a model built from a *particular cognitive perspective*. Thus, any concept that is left out of the model for reasons of not conforming are not necessarily disposable as such for an adequate representation of the domain in question. In modelling philosophical concepts, we must

10 Bruseker, Carboni, and Guillem 2017.
11 Wittgenstein 1953, §§66-67.

encounter and challenge the underlying assumption that any given particular cognitive perspective can serve as *the* correct representation of reality. This is a core undertaking in philosophy and one that is clearly at odds with current practices in computational ontology construction. This fact is readily revealed when we consider how, even at the most basic level, any attempt at ontology design is already embedded within a semantic framework that communicates and codifies a set of particular priorities belonging to it, whereas our aim in philosophy is to bring together competing claims to reveal and develop the dialectics between these claims.

It is in philosophy that we thoroughly acknowledge that knowledge itself, like the various languages in which we express it, is in a continual state of development. Rarely is it achieved once and for all with no possibility for further contention or advancement. In this sense, the challenge of creating an ontology that embraces and accommodates the dynamic nature of a given knowledge base cannot be adequately met with an approach which is exclusively geared towards canonization of knowledge and turns a blind eye to the limitations the ontology might have at lower levels due to context specificities. Moreover, an approach that proceeds solely top-down will be in danger of neglecting the fact that over the course of the development of a given knowledge base a concept will typically take on very different meanings and thus imply views and statements that stand in significant logical tension to each other due to its advancement.

5. Stock-taking

Philosophical subjects are characterized by deep disagreement, contestation and debate as well as non-shared conceptualization. Moreover, it is not only the case that different scholars have differing and contrasting uses of concepts and interpretations of Wittgenstein – even Wittgenstein himself *had conflicting views*. Standard approaches to ontology modelling do not manage to extract and map from philosophy that part of the discipline which is the truly philosophical one, that is, the part characterized by conceptual dynamics, multiperspectival interpretations, contentious claims and competing arguments – in short, "crisscross" knowledge. To adequately respond to such knowledge, we need knowledge representation itself to become capable of proceeding *crisscross*. Ontology building needs to aspire not only at coherence, consistency, universality and stability, but also address concept dynamics, open-endedness, vagueness, context-dependency, multi-perspectivism and contentiousness.

This implies that knowledge representation must make room for mapping *not only* the *shared*, but also the *non-shared*: the developments, tensions, contradictions and contentiousness themselves that are embedded within knowledge. This can only be achieved by an approach which strongly proceeds bottom-up and maps the domain's concept meanings, knowledge claims and argumentative landscapes as they are at work in their specific contexts. Only by adopting such an approach can one avoid constructing false cohesion and unity, while at the same time also remain faithful to the need of framing the endeavour within the most general applicable overall structures and explicating them, thus serving the interoperability of diverse humanities-based ontologies and the extension of work that has already been undertaken[12]. Providing for the possibility of such an approach is the basic requirement for bridging the current gap between philosophy and information science.

Our task consists in, to put it as briefly as possible, developing a model of doing computational ontology that permits the integration of dynamic concepts, non-shared conceptualization, knowledge about knowledge, competing claims, contested arguments and ongoing debate into formal knowledge representation. In order to provide for adequate modelling of the dynamic and contentious contents of the humanities, we need first of all to revisit and revise the idea of computational ontology from a truly humanistic viewpoint and to design novel approaches to ontology design, so that these can fully integrate humanities and philosophy contents while at the same time still retain the traditional strengths and assets of ontology work such as formal precision, cognitive economy, maximum interoperability and explanatory power, as well as permitting standard querying and inference tasks.

What we should be after is a model and theory of ontology that, first of all, departs from the "shared conceptualizations" approach on the concept level by addressing and integrating polysemy, vagueness, context dependency and the family resemblance and other crisscross aspects of concepts. "Family resemblance" implies that the concept's meanings have no stable core and no one defining feature in common and that the unity of the concept consists rather in nothing but "a complicated network of similarities overlapping and crisscrossing"[13], sustained by pragmatic patterns of use that are deeply embedded in concrete cultural practices. Secondly, we also need an ontology that, on the level of claims, can handle disagreement and contradiction between points made, and, on the level of argument, permits one to model the fact that the alleged relations between philosophical arguments themselves are often contentious and can thus become the subject of further argument down the road. The challenge, then, is to make explicit and processable both the "blurring" and "messy" dimensions of concept meanings as well as the disagreement and contradiction between and about knowledge claims.

12 E.g. in the SKOS and CIDOC CRM environments; see *SKOS Core Guide W3C Working Draft 2 November 2005*, ed. A. Miles and D. Brickley, www.w3.org/TR/2005/WD-swbp-skos-core-guide-20051102 and *Definition of the CIDOC Conceptual Reference Model. ICOM. Produced by the ICOM/CIDOC Documentation Standards Group, Continued by the CIDOC CRM Special Interest Group*, *Version 6.2.4, November 2018,* http://www.cidoc-crm.org/sites/default/files/2018-10-26%23CIDOC%20CRM_v6.2.4_esIP.pdf.

13 Wittgenstein 1953, §§66-67.

6. Crisscross ontology

In order to adequately deal with the challenges identified, we think that work on at least three levels is needed:

I – Revisiting computational ontology: How to conceive of and organize computational ontology so that it can adequately take on the contents of culture, the humanities and philosophy?

II – Concept and point mining and modelling: How to identify and adequately map the dynamic landscape of philosophy concepts and knowledge claims ("points")?

III – Argument mining and modelling: How to adequately represent philosophy's debates and arguments and open the representation for further enrichment by both humans and computers?

6.1 Revisiting ontology

We need to develop a model of doing computational ontology that permits mapping crisscross features of concepts, non-shared conceptualizations and contradiction of viewpoints, while at the same time remaining able to support query requests and inferencing. On the representation side, the computational ontology must capture the above-mentioned particularities of concepts; further, contradiction, tension and other relations between points; then also relations such as attack and support between arguments, and, finally, the chaining of arguments into greater debates. Concrete scenarios for point modelling could include that a point instance has properties that represent: free prose representations of the point, possibly language-tagged to accommodate different translations; concepts mentioned in the point (e.g. witt:philosophy), with links to further concepts; other points that the point opposes or supports; a temporal restriction (context) of a point's validity; a spatial (source) restriction (context) of a point's validity; a person (author) restriction (context) of a point's validity; other properties for source, URL, when the point was retrieved, etc. Crosscutting concerns that apply to all of the main subclasses of Subject can include additional validity constraints, in particular: *who* it is that uses a concept, states a point or makes an argument, at *what* time and in *which* context (e.g., from which perspective and/or as part of which debate).

On the reasoning side, the computational ontology must be able to answer salient questions about, e.g., consistency, opposition, subsumption and other relations between concepts and their features; real and apparent explicit and implicit ("hidden") contradictions and overlap between points and maximal consistent subsets of points; supporting, contradicting and independent arguments, etc.

The envisaged ontology can take as a starting point contemporary standards in computational ontology, such as OWL2, RDF with named graphs, description logics, rule languages, reasoning engines, etc. To increase precision and achieve openness, existing semantic vocabularies and knowledge bases should be employed whenever possible. The ontology can, for example, use terms from *SKOS* as a starting point for modelling concepts and use entries in *Wikidata* and *WordNet* to disambiguate and link concepts. *Wikidata* is language-neutral and allows labelling of its concepts in any language, and the English *WordNet* is interlinked with word nets for other languages which can help prepare for multilinguality.

The ontology should also be properly organised into sub-ontologies for concepts, points and arguments which are precisely interrelated.

6.2 Concept and point mining and modelling

Our working hypothesis is that content nodes can be formed of concepts and points, and that the mining and modelling can thus proceed along two sub-activities: *Concept* mining and modelling, and *Point* mining and modelling. Wittgenstein domain candidates for instances of Subject > Concept are for example concepts such as "understanding", "logical independence", "philosophy", "requirement", "logical analysis". Wittgenstein domain candidates for instances of Subject > Point are all statements from and about Wittgenstein's philosophy, e.g. "Philosophy requires logical analysis".

Semantic feature analysis seems to address concepts' inherently dynamic nature and thus form an adequate approach to modelling concepts. With it, each concept can be broken down into an open-ended set of semantic features that coincide, overlap, or are even opposed. "Understanding", for example, can be broken down into features such as linguistic and/or non-linguistic, transitive and/or non-transitive, mental and/or non-mental, episodic and/or punctual, and so forth, as the mapping of the knowledge base demands; any single occurrence of "understanding" can in theory display a different set of features, in variable configurations. Looking at the concept of "understanding" as a whole we find indeed that "[semantic] features … overlap and criss-cross"[14].

At the same time, there will also be a great number of other concepts which share with "understanding" much of the same features or family resemblances, and this again goes on to show how concepts are related to each other. Prototype theory may therefore provide another adequate modelling approach, such that prototypes for understanding will include "Understanding a sentence", "Understanding a gesture", "Understanding a melody", etc. Each of the concrete feature bundles and each of the prototypes will be associated with sources that exemplify that specific feature or prototype. The semantic features and prototype approaches may turn out to be very valuable when it comes to prepare for the challenges that multilingual rendering poses: It will often prove impossible to find a perfectly matching term in another language, but circumscribing the semantic field in question by semantic features and prototypes will help to explicate and address such difficulties rather than avoid them.

14 Wittgenstein 1953, §67.

Points are of varying nature and can be descriptive, normative, about the right policy, etc. They can state something about the world, language, thought, or also about philosophy itself. Moreover, any given point found in a philosophical oeuvre need not be the philosopher's own and need not even be assumed for the sake of argument to be true. Moreover, one point can contradict another. While such contradiction is not unique to Wittgenstein and can be observed in many other oeuvres (e.g. F. de Saussure)[15], many preeminent examples of this are found in Wittgenstein's philosophy. For it is not only in the course of his philosophical development but also at one and the same time that Wittgenstein presents statements that directly contradict one another. "Philosophy requires logical analysis" is defended by the early, but contradicted by the later Wittgenstein. Examples of logical tension within a single work can be found in the *Investigations* itself, where Wittgenstein notes both that "what is hidden is of no interest to us"[16] and, shortly thereafter, that "the aspects of things that are most important for us are hidden because of their simplicity and familiarity"[17].

In terms of the scholarly literature, what this means is that diverging but equally legitimate knowledge claims can in such cases be derived from one and the same point statement and source. With top-down approaches there is clearly a danger that the finegrade differentiations and developments of such concepts, and the tensions and even contradictions between them, will in the end either go unnoticed or remain underrepresented. This is particularly the case when the top-down approach is fundamentally based on the belief that formal knowledge representations must aim at consistency in order to properly represent the knowledge base in question. On the contrary, the beauty and power of human knowledge is that it rarely abides by such restrictions, and hence attempts by machines to represent it in terms of neat and consistent systems generally do a disservice to both the human and the machine.

Points will always contain at least one concept. Since concepts in turn can be modelled in terms of semantic features, it will often be possible to model tensions and contradictions between points in terms of opposition between concepts' features. Moreover, what on the surface looks like one and the same point, may, thanks to further analysis, actually turn out to be multiple point "homonyms". "Understanding is not a mental process" will for example need to be analyzed into at least the following two different points: "Understanding is not a process" and "Understanding is not mental", respectively. "Process" and "mental" will again be concepts that can be found among the instances of the Subject > Concept class. Note that "mental" is both a semantic feature and a concept, as will be the case with many concepts / semantic features of the Wittgenstein Subject domain. Another example would be Wittgenstein's claim in *Tractatus*, that there is a "Sprache, die allein ich verstehe"[18]. Depending on how we read the claim, the point can be about a language that only *I* understand, or alternatively, the *only* language that I understand.

15 See Godel 1957, and Cosenza 2016.
16 Wittgenstein 1953, §126.
17 Wittgenstein 1953, §129.
18 Wittgenstein 1922, 5.62.

In philosophy and the humanities, we find many such ambiguous points; explicating their ambiguity will help resolve debates, and some of the apparent contradictions may in this way turn out not to be real contradictions. Other contradictions may disappear by limiting concepts' and points' validity to individual sources, persons and other subdomains. At the same time, philosophy and the humanities do of course also contain *real* contradictions, and it will be exciting to research our ontology's capacity to derive from it not only the explicit, but also the *hidden* contradictions. This brings to the fore how technology can actively participate in the development of the humanities from inside the discipline rather than acting merely as an external aid for dissemination.

Content nodes mining and modelling also needs to address the perspective of multilingual usage of the resulting ontology, as the particularities of term translation at the concept level often have far reaching effects on the levels of argument and debate.

6.3 Argument mining and modelling

Finally, the ontology has also to address and capture disagreement and contentiousness in debate and argument. In order to model multiple viewpoints and, moreover, not only tolerate, but even facilitate and guide disagreement, we need first to understand better disagreement's nature and see to what extent existing research[19] is applicable to philosophy. Continuing with the above Wittgensteinian example, the point "Philosophy requires logical analysis" contradicts (at least on the surface) the point "Philosophy does not require logical analysis". A minimum set of the concepts composing these points will include "logical analysis", "requirement" and "philosophy" – note that these concepts are themselves open to further modelling as *features* and/or *prototypes*. As a consequence, a reasonable approach to be applied to points seems to model them as *graphs*; the graph representation permits breaking the overall domain's complex and vast network of relationships down into smaller content units that in turn allow one to expose, process and navigate the knowledge in manageable ways.

Further, since our domain requires that both concepts and points be allowed to take on any number of attributes, and each point be permitted to become the subject of another point – recursively so, and on several levels simultaneously: i.e., *crisscross* – it is also a consequence for our ontology, that concepts and points shall both be allowed to develop their own sub-ontologies within the overarching general domain ontology. Finally, it also seems reasonable to assume that one will be able to merge graphs for different points which use the same concepts and are non-contradictory into larger graphs which, consequently, can represent an actual viewpoint within the specific domain. This we could call a *perspective*. Perspectives can be organized in the subclass Subject > Perspective; they can be scalable and be more broadly or more narrowly conceived (e.g. all non-contradictory statements of a specific author in a specific book vs. all non-contradictory statements within a specific community).

19 For disagreement research see for example Chalmers 2011.

Most important, however, is to see that philosophy is not merely characterized by disagreement, but more so by *patterns of disagreement and agreement* in *debate*. Mining and modelling a specific philosopher domain's arguments will have to address three areas: first, the applicability of general argumentation taxonomies and schemes[20] to this domain (empirical vs. normative argument; modus ponens syllogism vs. reductio ad absurdum, etc.); second, the viability of classifying the philosopher's arguments *point*-wise (argument against the notion of private language, for example; argument against the notion of a logically perfect language; argument for use approach to meaning; etc.); third, the possibility of classifying scholarship arguments in terms of debates (with regard to Wittgenstein, for example, the debate about resolute readings of Wittgenstein's oeuvre *as a whole*; debate about linguistic idealism / logical positivist / … interpretations of Wittgenstein; and so forth). It makes sense that, just as *Concept*, *Point* and *Perspective*, also *Debate* and *Argument* become subclasses of *Subject* – Subject > Argument and Subject > Debate – and offer in the ontology entry points to the domain specific debates and arguments, in terms of the concepts, points and perspectives which operate there.

Arguments can be modelled in terms of points and argument operators; the latter are typically researched in argumentation theory and can at least partly be derived from preexisting argument modelling. As concepts and points can be limited to specific contexts, such as individual sources and persons, so too can arguments be restricted – e.g. one can limit their validity to specific sources and persons. A further question is how to aptly model the logical relations, first among points, then among points and arguments, and finally among arguments. It is possible to apply logical labels such as "implies" and "contradicts", and also argumentative labels such as "is pro" and "is contra" for relations among points, as well as argumentative labels such as "is valid" for properties of and "is refuted by" for relations between arguments. This will explicate the logical and argumentative relations for points and arguments in the subject area – surely often only as they are *perpectivized* from one scholar's or school's point of view – such that it will become possible to pursue argumentative threads in the ontology, or to study the different paths and levels in the arguments' movements depending on the scholar or interpretation one wants to focus on, or to investigate the argumentative weight (support) a certain claim or argument has in the domain (or a specific part of the domain, respectively).

It would be misleading to suggest that argument mining will be capable of automatically extracting, without human expert support, from a natural language philosophy corpus its arguments and the relations between them. But having the ontology produce a web of all the domain's arguments and their relations as they are identified and labeled by the human expert can be achievable. Investment in research and development might yield tools for semi-automatic identification and labeling of arguments as well as the relations both within and between them. This

20 See for example Toulmin 1958; Walton 1989, 1996.

should include an online platform with substantial user involvement where this research task will be largely outsourced – always with the continuously growing ontology as the backbone for user driven identification, phrasing and labeling not only of concepts and points, but precisely also arguments and the relations between them.

7. Conclusion

In this paper we identified a double challenge: On the one hand, while we are seeing rapid technological development and adoption of machine learning and semantic technologies in all areas of society, philosophy and the humanities more generally have not yet risen to the challenge of properly relating to and adequately integrating them. On the other hand, philosophy as well as culture and the humanities more generally have a wealth of knowledge – "crisscross knowledge" – that at present remains inadequately assimilated and generally underutilized by knowledge representation platforms. This situation has arisen due to a mismatch between what the first have to offer and what the latter is able to take on. We thus need to develop the research and methodology required to meet this double challenge and bridge the gap. With a focus on the most multiperspectival discipline of all, philosophy, a model can be created for how to digitally map crisscross knowledge within the computational ontology environment. This will help information science to develop the computational models required for adequately representing and exploiting the knowledge from the humanities and cultural sphere. The central question becomes: *How can we advance computational ontology development in the humanities, while at the same time allowing for extremely complex and dynamic, crisscross contents to be represented in formal, computational models?* We have not yet provided a detailed, settled answer to this question here, but have aimed to show that we need to develop a *new* formalised computational ontology model that permits us to represent and reason over multiperspectivism, contentiousness, conceptual vagueness and family resemblance, thus taking account of constrained concept validity, non-shared conceptualization and contradiction between viewpoints. At the same time, such an ontology must retain the traditional strengths and assets of computational ontology, including formal precision, cognitive economy, maximum interoperability and explanatory power, as well as permitting standard querying and inference tasks. The specific recommendations outlined above – such as organizing the philosophical Subject class via the subclasses of Concept, Point, Argument and Debate, further modelling concepts according to semantic feature analysis and/or prototype theory, points as graphs, arguments as composites of points connected by argumentative operators, and debates as arrangements of arguments – are based on our conviction that the oeuvre of the British-Austrian philosopher Ludwig Wittgenstein can serve as a proof of concept and deliver a viable model for how to adequately computationally map the dynamism of human knowledge in general. It is thus here that we wish to start.

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