# What's happening in Semantic Web
## ... and what FCA could have to do with it

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The Semantic Web [27] is gaining momentum. Driven by over 10 years of focused project funding in the US and the EU, Semantic Web Technologies are now entering application areas in industry, academia, government, and the open Web.

The Semantic Web is based on the idea of describing the meaning – or semantics – of data on the Web using metadata – data that describes other data – in the form of ontologies, which are represented using logic-based knowledge-representation languages [26]. Central to the transfer of Semantic Web into practice is the Linked Open Data effort [7], which has already resulted in the publication, on the Web, of billions of pieces of information using ontology languages. This provides the basic data needed for establishing intelligent system applications on the Web in the tradition of Semantic Web Technologies.

Despite considerable success and progress, the field of Semantic Web Technologies still requires considerable conceptual advances in order to come to its full potential [23, 24, 29]. Below, we briefly list some research challenges where Formal Concept Analysis (FCA) could contribute as a method, and list some of the past FCA-related work on these issues.[1]

## 1 Ontology Generation

Semantic Web applications require knowledge represented in the form of ontologies. However, the generation of such ontologies is a formidable modeling task which requires both ontology modeling expertise, profound domain knowledge, and an understanding of technical application requirements. Any automated or semi-automated tools which make ontology generation simpler and less costly are therefore highly desirable to have.

Automated or semi-automated generation of ontologies has been studied to a considerable extent, and some of this work uses FCA as a main component [9–11, 21, 31, 50]. More recently, FCA has also found application for refining, completing, and improving ontologies [3, 4, 6, 13, 19, 20, 38, 40–42, 46–48]. Indeed, it turns out that FCA is indeed used as an ontology engineering component in recent application-driven work [5, 8, 16, 17, 30, 32, 37].

[1] We do not claim completeness with respect to FCA-based work in Semantic Web, and we may in particular miss early work – indeed Semantic Web as a field is not clearly defined, so it is sometimes a matter of judgement or opinion whether a paper is actually a Semantic Web paper.

## 2 Ontology Merging and Alignment

Ontology Alignment [15] refers to the process of merging two or more ontologies in order to create a larger ontology for use in applications. Tools for realizing alignments are based on a variety of techniques, and their performances differ substantially depending on the task at hand (see, e.g., the evaluation in [28]). FCA has been introduced early on as a method for ontology merging [12, 18, 35, 43, 44, 49].

## 3 Ontology-based Interfaces

Some work has investigated the use of FCA for interfaces, e.g. for the purpose of browsing data with underlying ontologies [11, 14, 45]. It seems that work related to this has, so far, only be very preliminary, so there might be further potential in this, in particular when considering the rapid expansion and rising popularity of Linked Data: To date, navigating these datasets is a tedious task, and better interfaces would have significant potential.

## 4 Ontology Cleansing

Usability of Linked Data is significantly hampered by the fact that it is still very *raw* data in the sense that it contains many mistakes and omissions, and cannot distinguish between different points of view [24]. In order to leverage logic-based methods mediated by ontology reasoning, data would be required to be of high modeling quality.

How to bridge this data quality gap is currently an open problem. Application of traditional methods from data mining and machine learning is limited, since the output of such methods is also, usually, prone to mistakes and errors (often measured by probabilistic confidence levels). FCA as an alternative *data clustering method* may have the potential to approach this problem, perhaps in an interactive manner akin to exploration-based completion of ontologies as performed in [40]. However, there seems to be no current work on this issue.

## 5 Ontology Language Development

Ontology languages currently being used are constantly being improved and revised in incremental standardization processes, e.g. through the World Wide Web Consortium (W3C). Such revisions of languages are driven both by theoretical investigations and by applicability concerns. The current situation regarding ontology languages is far from stable: While main paradigms seem to be agreed upon [26, 33, 36], the paradigms and their interactions are still being investigated (see, e.g., [34]) with respect to foundations and practice.

There has been some work which can be understood as dealing with the question whether FCA can be used to analyze or improve knowledge representation languages [1, 2, 22, 25]. However, this line of investigation has not been systematically investigated yet.

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