Quo Vadis, CS? – On the (non)-Impact of Conceptual Structures on the Semantic Web
(Position Paper)

Sebastian Rudolph, Markus Krötzsch, and Pascal Hitzler
Institute AIFB, Universität Karlsruhe (TH), Germany
{rudolph,kroetzsch,hitzler}@aifb.uni-karlsruhe.de

Abstract. Conceptual Structures is a field of research which shares abstract concepts and interests with recent work on knowledge representation for the Semantic Web. However, while the latter is an area of research and development which is rapidly expanding in recent years, the former fails to participate in these developments on a large scale. In this paper, we attempt to stimulate the Conceptual Structures community to catch the Semantic Web train.

1 Status Quo

It is a fact that mainstream Semantic Web (SW) developments currently happen with only little impact from the Conceptual Structures (CS) community. This is a curious development as Semantic Web knowledge representation is closely related to CS research. While CS certainly profits from the SW hype – as do many areas in computer science – we believe that the full potential for the transfer and use of CS methods and technologies is not given enough credit by the community.

With this somewhat provocative position paper, we intend to stimulate a controversial discussion about the possible future of Conceptual Structures as the changed situation might require to reconsider former pessimistic attitudes towards the Semantic Web as depicted in [1]. We first give a very brief history of Conceptual Structures and Semantic Web. We then analyse the two main paradigms for the CS community, namely Conceptual Graphs (CGs) and Formal Concept Analysis (FCA) in terms of their relationship to SW research. For each of the paradigms, we will give general research directions which we think would help to leverage CS for the SW.

We will substantiate some of our statements and claims by literature references, but there is too much work which is important for this position paper to explicitly refer to it all. The resulting selection is obviously very subjective.

Conceptual Structures is a term introduced by John Sowa in his 1984 book on the topic [2]. His work stimulated an interdisciplinary research community with interests in the relations between artificial intelligent knowledge representation, mathematical logic, philosophy and linguistics, manifesting itself in the annual International Conference on Conceptual Structures [3] which runs since 1993 after some workshops in the years before.

1 See http://www.conceptualstructures.org

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The field basically comprises two interacting research communities, one of which focuses on conceptual graphs as introduced in [2], while the other comes from a tradition spawned by Rudolf Wille’s work in 1982 on restructuring lattice theory [3], which led to the establishment of Formal Concept Analysis [4] as a mathematical theory and which recently finds applications in Computer Science, especially in data mining [5].

While the CS community mainly focuses on the above-mentioned areas, it also has strong mathematical and philosophical undercurrents, and also ever since has been involved in Computer Science applications, witnessed by a considerable number of implemented systems and application studies.

Semantic Web, in contrast, is a relatively new research area spawned by Tim Berners-Lee, inventor of the World Wide Web and director of the World Wide Web Consortium (W3C) [6]. Its main idea is to bring meaning to web data for intelligent processing. This is achieved by utilising knowledge representation languages for describing so-called ontologies, which model domains of interest in a logic-based, declarative and machine-processable way. Ontology representation languages which have been standardised by the W3C are the Resource Description Framework RDF(S) [2] and the Web Ontology Language OWL [3], both of which have concept hierarchies as their basic internal structure. While RDFS is a straightforward language which features only a simple use of inheritance for inferencing, OWL is a full-blown Description Logic (DL) [7], and as such a powerful knowledge representation language.

Semantic Web research in the last few years was driven by the W3C and by influential funding agencies such as DARPA and the European Commission. Specialised annual conferences, like the International Semantic Web Conference feature several hundred participants each year, and Semantic Web publications are present in all major conferences and journals in Artificial Intelligence, Knowledge Management, and other fields. Influential software companies like IBM, Oracle and SAP are currently starting to enter the market with products based on the underlying Semantic Technologies.

2 Quo Vadis, CG?

Both being historically founded in semantic networks, CGs and DLs share a conceptually very similar view on how to represent knowledge, as reported by Tim Berners-Lee [4]. It is thus surprising that the participation of the CG community in mainstream Semantic Web research is very limited.

While CGs have been used in some Semantic Web applications (see e.g. the Corese Semantic Web Factory [5] or [8]), such work is rarely presented at mainstream Semantic Web events and has had next to no impact on standardisation efforts. So, while CGs are the more historic approach, DLs overtook and got standardised. Considering the high impact in research and development of SW methods and technologies, it is promising to utilise the close conceptual relationship between CGs and SW languages, and to utilise

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2 http://www.w3.org/RDF/
3 http://www.w3.org/2004/OWL/
4 http://www.w3.org/DesignIssues/CG.html
5 http://www-sop.inria.fr/acacia/corese/