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Prof. Igor Farkaš
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Comenius University in Bratislava

Vienna, July 3, 2018

Subject: Assessment of Dr. Martin Homola's Habilitation Thesis

Dear Prof. Farkaš,

In what follows, I will provide a review of the cumulative habilitation thesis of Martin Homola and will comment on the scientific track record of the candidate.

Relationship to the Applicant. I have worked together with Martin Homola and his colleagues in several bi-lateral projects between TU Wien and Comenius University, which have been very productive but did not lead to any publication which are co-authored by myself and the candidate. We have also conversed at different international scientific events. Apart from these meetings, I have not had any relationship with the candidate that could influence my assessment of the thesis.

Research Context. Martin Homola's research is situated in the field of Knowledge Representation and Reasoning (KRR). KRR is a central aspect of Artificial Intelligence which aims at representing information about the world in a form that a computer system can utilize to solve complex tasks. Key aspects of KRR are therefore formal languages (to describe the domain of interest) as well as deduction principles in order derive conclusions from the described knowledge base. Consequently, KRR has its roots in formal logic, but is also concerned with algorithm design and complexity analysis. A wide variety of KRR formalisms has been developed over the last decades in order to handle several applications, including, for instance, the Semantic Web.

Although many KRR formalisms are rooted in classical logic, it soon became apparent that classical reasoning is not appropriate in many situations. In particular, knowledge can be stored in a distributed way which may lead to contradicting information that needs to be handled accordingly. Likewise, since knowledge is not a static concept but evolves over time (whereby some knowledge may be given up in the light of new information), the monotonicity principle of logic cannot be preserved. All this calls for particularly tailored formal

approaches that go beyond classical logic.

While Machine Learning has played a dominant role in AI within the last years, we recently see a trend back to logical approaches which are able to explain decision made by a computer. I thus rate KRR as an integral part of AI in particular, and Computer Science in general.

Contents of the Thesis. Martin Homola's thesis falls into the field of KRR and addresses several problems that come with heterogenous and dynamic knowledge bases. The thesis is cumulative and contains in total 15 research papers. In the introductory part, after a quick overview of the structure, Dr. Homola first gives a general introduction to KRR and its basic principles. Then, six research areas are introduced and associated to the papers of the thesis. These areas are as follows.

1. Dynamic Logic Programming, a generalization of logic programming where rules have different preferences in order to cope with potential inconsistencies. Martin Homola analysed a particular class of programs (acyclic programs) and showed that on this class different semantics from the literature coincide. The first paper in the thesis is devoted to this topic.

2. Distributed Ontologies. Ontologies play a central role in KRR for conceptualization. When multiple ontologies have to be taken into account, several problems as discussed above arise. Papers 2–4 are on this topic.

3. Contextual Knowledge. Knowledge may not me universally valid, but only in some particular situation or location. Martin Homola co-invented the concept of Contextualized Knowledge Repositories which incorporates metainformation on top of particular KRR formalisms, namely description logics SROIQ and ALC. Papers 5–7 of the thesis present some of his research in this field. These papers are also concerned with proof calculi and complexity analysis.

4. Hybrid Systems integrate knowledge and (closed-world) rules for reasoning. This type of heterogeneity is particularly challenging since conceptually different semantics have to be unified. Among the several approaches in the literature multi-context systems and hybrid MKNF play an important rule. Homola and colleagues have analysed and compared these approaches in Paper 8 of the thesis.

5. Metamodelling is a method to overcome expressivity limitations of standards ontology languages like OWL or RDF. Martin Homola has contributed to this research stream in several publications, among them Papers 9–12.

6. Defeasible Reasoning formalizes knowledge via two type of rules, strict and defeasible rules. The latter can be blocked by contrary evidence while strict rules always have to be applied. Hence, this popular formalism constitutes another materialization of heterogeneity in knowledge representation. In particular, defeasible logic programs are one of the key formalisms in argumentation. In certain situations their outcomes

might be counterintuitive in the sense that some natural desiderata are not met. Homola and colleagues have proposed a novel form of conflict resolution for such formalisms. Their results are contained in the final papers 13–15 of the thesis.

All these areas are of high relevance and constitute fundamental research questions in KRR.

My overall evaluation of the thesis is positive. At first glance, it might look a bit strange to include such a high number of papers in the thesis. On the other hand, they reflect well the candidate's broad research agenda and nicely fit the overall topic of the thesis. The introductory part could have been presented in a better way. In particular, I missed a more general discussion of the concept of heterogeneity besides its concrete materializations along the topics (1)–(6) mentioned above. Besides that, this part was a good read; several examples nicely illustrate the introduced concepts and make the research questions treated in the papers easily accessible. Martin Homola demonstrates here his capabilities to present complex formal concepts in an appealing and general manner.

All papers have been published in international journals and proceedings of international scientific events. Three articles appeared in prestigious journals (Journal of Logic and Computation, Journal of Web Semantics, Journal of Applied Artificial Intelligence), the other papers appeared in proceedings of international conferences and workshops. All of them have high reputation; however, the KR'16 paper is the only one in a top-class conference.

Overall Assessment. The habilitation thesis comprehensively represents the broad scientific skills of the candidate. The candidate also clearly demonstrated that he can work autonomously (as shown by the single-authored publication in the thesis) and is also able to guide younger colleagues and students (for some of the papers in the thesis, Martin Homola is the most senior among the authors). The overall publication record of Martin Homola is very good, but not outstanding. He is well known in the community and has served as co-organizer of several international events. In conclusion, Dr. Homola has clearly documented his scientific qualification in the area of KRR and is therefore sufficiently qualified to be awarded a habilitation degree.

I therefore recommend the commission to accept the habilitation request by Dr. Homola.

Yours faithfully,

Stefan Woltran