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Professional Summary

I am a postdoctoral researcher at the University of Klagenfurt, working on the project EX3 (EXplain and EXploit Knowledge EXtracted to Improve ASP Performance) under the supervision of Professor Tarzariol Alice. I did my PhD at KULeuven University in the Knowledge Representation and Reasoning group, under the supervision of Professor Marc Denecker. The main topic of my research is the proper treatment of partial functions in Knowledge Representation. Building on this, I worked on the relations of partial functions and types (sorts) in logic and applied these techniques to the decision modeling languages. On this journey, I also get to work on epistemic logic.

Research Positions

2025 - Present | **University of Klagenfurt (Institut für Artificial Intelligence und Cybersecurity)**, Klagenfurt, Austria
Postdoctoral Researcher

Education

2021 - 2025 | **KU Leuven**, Leuven, Belgium
PhD in Computer Science, Knowledge Representation

2020 - 2021 | **KU Leuven**, Leuven, Belgium
Predoctoral training in Computer Science, Knowledge Representation

2018 - 2019 | **Faculty of Science**, University of Kragujevac, Serbia
M.S. in Computer Science

2013 - 2018 | **Faculty of Science**, University of Kragujevac, Serbia
B.S. in Computer Science

2009 - 2013 | **Prva Kragujevačka Gimnazija**, Kragujevac, Serbia
High School Diploma in Natural Sciences

Summer schools

2024 | **ESSLLI**, Leuven, Belgium
35th European Summer School in Logic, Language and Information

2022 | **ESSLLI**, Galway, Ireland
33th European Summer School in Logic, Language and Information

2021 | **MGS21**, In Cyberspace
Midlands Graduate School in the Foundations of Computing Science

Professional Experience

10/2018 - 8/2019 | **Technomedia d.o.o**
Software Engineer

Reverse engineering of the connection API for obsolete peripheral devices such as cameras and tag readers.

07/2017 - 9/2017 | **DM Dokumenten Management GmbH**
Software Engineer Intern
Designed and implemented a setup and configuration application for Lobotalk client and server.

04/2016 - 04/2017 | **Neutrinos IT/AI Justice Association**
Software Engineer Intern
Developing a private and secure self-hosted cloud solution.

Publications

1. **Markovic D.**, & Denecker M., (2024). Order-Sorted Intensional Logic: Expressing Subtyping Polymorphism with Typing Assertions and Quantification over Concepts. In **Proceedings 40th International Conference on Logic Programming** (ICLP 2024).
2. **Markovic D.**, & Denecker M., (2024). Solving "Greeting a Customer with Unknown Data" Challenge with Epistemic DMN. In **Proceedings of International Joint Conference on Rules and Reasoning 2024** (RuleML+RR 2024).
3. **Markovic D.**, & Bogaerts B., & Passmore. G., (2024). Modeling and verifying simple vehicle controller, such as the Triton unmanned aircraft systems of the US Navy: using Imandra system and first-order logic. In **book Demystifying Artificial Intelligence Symbolic, Data-Driven, Statistical and Ethical AI, Chapter 4 Reasoning with first-order logic. Published by De Gruyter (p. 136)** (2024).
4. **Markovic D.**, & Vandevelde S., Vanbesien L., & Vennekens J., & Denecker M., (2024). An epistemic logic for modeling decisions in the context of incomplete knowledge. In **Proceedings of the 39th ACM/SIGAPP Symposium on Applied Computing** (SAC 2024).
5. **Markovic D.**, & Bruynooghe M., & Denecker M., (2023). Towards Systematic Treatment of Partial Functions in Knowledge Representation. In **Logics in Artificial Intelligence - European Conference on Logics in Artificial Intelligence 2023, part of Lecture Notes in Computer Science** (JELIA 2023).
6. **Markovic D.**, & Vandevelde S., & Vennekens J., & Denecker M., (2022). On the Semantics of "null" in DMN: Undefined is not Unknown. In **Proceedings of International Joint Conference on Rules and Reasoning 2022** (RuleML+RR 2022).

Current work

1. **Markovic D.**, & Van den Eede R., & Denecker M., (2025). A Prudent Logic of Partial Functions. Under revision for the Journal Annals of Mathematics and Artificial Intelligence.
2. **Markovic D.**, & Denecker M., (2025). Partial function logic as a unifying framework of many sorted logics. In the writing phase, plan to submit to the Springer volume entitled Artificial Intelligence and Mathematics.

Teaching Experience

2021 - Present | **Modeling of Complex Systems**, KU Leuven
Professor: Prof. Marc Denecker
Teaching assistant for the master of Artificial Intelligence course Modeling of Complex Systems. Led 11 weeks of double exercise sessions (5 hours), created and graded project assignments, and the practical part of the exams. On average, 170 students are enrolled in the course each year. This course covers a variety of topics like first-order logic, inductive definitions, logic programming,

linear time calculus, temporal modal logics, refinement, expressivity results of first-order logic, conflict-driven clause learning, and algorithms for CTL and LTL model checking.

Programming languages

I have experience developing custom algorithms and software in C, C++, C#, Rust, and Python. I am also familiar with web development languages including HTML, CSS, JavaScript, and PHP. Additionally, I have limited hands-on experience with Haskell, MiniZinc, ASP, Prolog, ProB, and Event-B. I have extensive experience with IDP3 and IDP-Z3.

PhD Thesis abstract

Most of the knowledge representation formalisms assume that functions are total. In fact, in many applications, the domain of discourse is heterogeneous, consisting of multiple types of objects, resulting in basically all functions being partial. Furthermore, logic is often limited to the extensions of concepts (their value), while sometimes it is needed to talk about concepts themself (intensions). For example, counting chief positions in a company; counting extensions of chief positions (i.e., people behind them) is wrong, as different positions could be assigned to the same person.
Different applications and experiments of Knowledge Base systems show the requirement for partial functions and intensional concepts. Due to the lack of support for such language constructs, knowledge engineers developed different ways of getting around them. This thesis focuses on the systematic treatment of partial functions and intensional concepts, resulting in increased expressivity, compactness, and elegance of the language. Research of these topics led to the following three main scientific results:

1. A prudent logic of partial functions; We develop a base extension of three-valued predicate logic, in which partial function terms are guarded by domain expressions ensuring the well-definedness property despite the three-valued nature of the underlying logic. To tackle the verbosity of this core language, we propose different ways to increase convenience by using disambiguating annotations and non-commutative connectives. Furthermore, we present an extension of the logic with definitions allowing the declaration of partial functions rather than only constraining them.
   This approach resulted in a system with a refined distinction between meaningfulness and undefinedness. Namely, undefined sentences are often rejected on the grounds of having no meaning. However, we consider potentially undefined sentences ambiguous, and not necessary meaningless (e.g., the present king of France is bald); while the lack of meaning is reserved for the categorically undefined sentences (e.g., the present king of France is a prime number).
2. Order-Sorted Intensional Logic; Combining the idea of guards with the intensional logic in the context of order-sorted logic, we discover a logic suitable for expressing subtyping polymorphism. In this extremely expressive logic, it is possible to cast a variable to an appropriate type based on its application by using typing assertions and quantification over concepts (e.g., it is possible to express the sentence “An animal is producing a sound if it produces a sound characteristic for its species”).
   Motivated by the connection between partial functions and types, we investigated the foundations of types; when and why they are introduced, and how they differ from unary predicates. Types serve as domains for functions and predicates, grouping entities into homogeneous classes. However, when partial functions are involved, this approach can lead to complex and convoluted type structures. As a solution, we take the reverse approach: treating partial functions as the most primitive entity and formalizing types as unary total predicates. In this setup, the guarding relation of partial functions serves as the well-typing relation. We show that both many-sorted and order-sorted logic can be embedded within the logic of partial functions and that their expressivity goes beyond.

3. An epistemic logic for modeling decisions in the context of incomplete knowledge; When modeling decision processes, it is often the case that decisions are made with incomplete knowledge about the actual state of affairs. Initially, we tackle this incompleteness with partial functions and provide alternative semantics for Decision Modeling and Notation (DMN). Finally, we extend this approach to the epistemic context, as decisions are naturally made in an epistemic state of some agent.