SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Artificial Intelligence Lab
has the honor to invite you to the public defense of the PhD thesis of

Simon Marynissen

to obtain the degree of Doctor of Sciences

Joint PhD with KU Leuven

Title of the PhD thesis:
Advances in Justification Theory

Promotors:
Prof. dr. Marc Denecker (KU Leuven)
Prof. dr. Bart Bogaerts (VUB)

The defense will take place on
Monday, January 31, 2022 at 17h00 in auditorium Jozef Heuts (00.215), Landbouwinstituut Hoofdgebouw (331-01), Kasteelpark Arenberg 20, 3001 Heverlee

The defense can be followed through a live stream:
https://livestream.kuleuven.be/?pin=123982.

Members of the jury

Prof. dr. Robert Puers (KU Leuven, chair)
Prof. dr. Geraint Wiggins (VUB)
Prof. dr. ir. Gerda Janssens (KULeuven)
Prof. dr. ir. Bart Jacobs (KULeuven, secretary)
Prof. dr. Pedro Cabalar (University of Corunna, Spain)
Prof. dr. Panagiotis Rondigiannos (National and Kapodistrian University of Athens)

Curriculum vitae

Simon Marynissen studied mathematics at the KU Leuven. His master thesis was titled 'Anosov rational forms of Lie algebras associated with graphs' and was supervised by Jonas Deré. He graduated magna cum laude in July 2017.
In September 2017, he joined the DTAI (Declarative Languages and Artificial Intelligence) research group of the departement of Computer Science of the KU Leuven to research knowledge representation and reasoning, supervised by Marc Denecker. After a year, his PhD became jointly supervised by Bart Bogaerts at the Vrije Universiteit Brussel. His last paper won the IJCAI distinguished paper award.

Abstract of the PhD research

To practice knowledge representation, it is paramount that knowledge representation languages have formal semantics. However, since there are numerous different languages all with a formalisation, it is valuable to have unifying frameworks that can capture the semantics of families of languages and logics. One such framework is justification theory, in which the semantics are defined by the use of explanations, called justifications in our terminology. Intuitively, a justification is a graph that explains the truth values of certain facts. However this introduces a potential problem: the justification status of a fact and its negation can be inconsistent. So, for justification semantics to be well-defined, these statuses should be opposite. Such semantics are called consistent.
In the first part of this thesis we prove that the main semantics of justification theory are in fact consistent. Moreover, we prove useful results for justifications, such as the ability to compose together justifications. An other issue with justification semantics is that there are different flavours of justifications, which could result in distinct semantics. We show that these two seemingly unrelated issues are actually deeply connected.
After that, we establish a connection between justification theory and game theory, which allows for justifications to be seen as strategies in a two-player game. This connection provides a resolution of the two issues in justification theory by providing a general condition on the semantics in case the system is finite.
Justification theory is not the only unifying framework for semantics of non-monotonic logics. Another well-known framework is approximation fixpoint theory (AFT), which is more algebraic in nature. We establish a connection between justification theory and AFT. The notion of ultimate semantics of AFT can be transferred into the realm of justification semantics. This allows for justification semantics to capture more semantics than previously.
As the final topic of this thesis, we look into the nesting of justifications, which can be used to define modular semantics. In previous definitions of nesting, a significant amount of information is lost because a compression operation is used. We provide an alternative and more general definition without this disadvantage. This allows for more intuitive modular semantics based on justifications. We prove that this is equivalent to the compression for tree-like justifications and in special cases for graph-like justifications. We investigate the consistency of both approaches as well and as an added bonus we solve the consistency for tree-like justifications.
In summary, this thesis gathers a number of advances in justification theory and illustrates them with examples.