SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Artificial Intelligence Lab

has the honor to invite you to the public defence of the PhD thesis of

ir. Linde Vanbesien

to obtain the degree of Doctor of Sciences

Joint PhD with KU Leuven

Title of the PhD thesis:

Algebraic Formalizations of Constructive Knowledge

Supervisors:

Prof. dr. Marc Denecker (KU Leuven)

Prof. dr. Bart Bogarts (VUB)

The defence will take place on

Monday, October 27, 2025 at 5 p.m. in Auditorium D, C300 Celestijnenlaan 300 3001 Heverlee

The defence can be followed through a live stream:
https://livestream.kuleuven.be/?pin=854112

Members of the jury

Em. prof. dr. Lucie Vandewalle (KU Leuven, chair)
Prof. dr. Frank Piessens (KU Leuven, secretary)
Prof. dr. Geraint Wiggins (VUB)
Prof. dr. Bas Ketsman (VUB)
Prof. dr. Joost Vennekens (KU Leuven)
Prof. dr. Jesse Heyninck (Open Universiteit, NL)
Prof. dr. Angelos Charalambidis (Harokopio University, GR)

Curriculum vitae

In 2018 and 2020, Linde respectively obtained her B.Sc. and M.Sc. degree in engineering science in the field of Computer Science at KU Leuven. Afterwards, she started working towards a PhD in Engineering Science at KRR (Knowledge Representation and Reasoning), a sub-group of the DTAI-research group at the Computer Science Department at KU Leuven. In 2023 this transitioned into a joint doctoral program with VUB, where she works towards a PhD in Science at the AILab (Artificial Intelligence Lab).

Abstract of the PhD research

Knowledge representation aims to represent knowledge in an unambiguous way. The most basic type of knowledge is made up of simple, clear facts, such as '8 is a natural number' or '8 is an even number'. Slightly more complex pieces of knowledge are formulated by composite propositions that express relations between different concepts in our discourse. For example, the proposition 'a natural number is either even or odd' connects the notions of 'natural numbers', 'even' and 'odd'. We use knowledge to build our understanding of the world, and to reason about the reality.

Oftentimes knowledge has a constructive nature, it describes how to construct entities. For instance, no-one has stored the infinite set of even natural numbers somewhere in their memory, nevertheless, most people could enumerate them, provided time is not a limiting factor. Specifically, we know that 0 is an even natural number, and that if x is an even natural number, then so is $x+2$. These two simple rules form a complete recipe to construct the intended set. This recipe also allows us to deduce that 3 is not an even natural number, neither is π, Belgium or the Dalai Lama. In mathematics, this type of constructive knowledge is usually referred to as inductive or recursive definitions. Interestingly, similar constructive processes are found in a plethora of other applications as well. For example, if we have a database of people and their parents, we can easily determine someone's ancestors. Specifically, your ancestors consist of your parents and all of their ancestors. Consequently, the ancestor-relation is constructed in function of a parameter-concept, i.e., the parent-relation. Different databases for the parent-relation will produce different ancestor-relations without requiring changes to the definition. In summary, constructive knowledge describes how to build new notions upon existing concepts, introducing flexibility and reusability while enabling us to capture concepts that are too large or abstract to describe otherwise.

This thesis aims to investigate and formalize these types of constructive knowledge using mathematical frameworks and theories that abstract away the details of specific examples and applications by focusing on what unites them, i.e., their underlying construction processes. This work clarifies and elaborates on existing tools and proposed solutions, allowing us to obtain new insights in the matter. Additionally, it refines and improves existing ideas, extending their applicability. The work has practical value in logic, artificial intelligence, and beyond.