Aangeboden projecten: Details project

A categorical approach to homogeneous ordered vector spaces (John van de Wetering)
Master Logic
4 Nov 2022

1.1 Proposal
Thesis project proposal

1.2 Project Title
A categorical approach to homogeneous ordered vector spaces

1.3 Project Description

A foundational result in Quantum Foundations is the Koecher-Vinberg theorem, which states that any ordered vector space which is self-dual (meaning that it's order is completely defined by a positive-definite inner product), and homogeneous (that it is 'maximally symmetric' in a suitable way), must be the state space of a Jordan algebra. Since Jordan algebras are very close to standard quantum systems, this gives a way to (almost) characterise quantum systems from abstract order-theoretic grounds. Koecher in the 1960's built a rich theory of homogeneous ordered vector spaces, and such spaces have seen use in other applied fields as well (like in convex optimisation). However, such systems are usually considered in isolation. But one thing that modern quantum information theory has made clear is that compositionality is very important: they way different systems interact with each other.
In this project we will try to construct categories of homogeneous cones that have suitable tensor products (i.e. monoidal categories). Such tensor products model the ways system compose together to form larger systems. Either we will be able to construct such categories, and these will form interesting foils to constrast with standard quantum theory, or there will be barriers to constructing such tensor products, in which case this gives insight into why physical systems are quantum and not just general homogeneous vector spaces.

Prerequisites: Strong mathematical background. Knowledge on category theory and/or operator algebras would be useful, but is not required.
Interested students can check out the Wikipedia pages
https://en.wikipedia.org/wiki/Koecher%E2%80%93Vinberg_theorem
https://en.wikipedia.org/wiki/Symmetric_cone
And they might want to read about the project of Reconstructing Quantum Theory, in which this project fits, such as in this paper:
https://journals.aps.org/pra/abstract/10.1103/PhysRevA.84.012311

1.4 Work environment

The student will meet regularly with the supervisor. Pending available space, the student will be given an office to work from.

1.5 Expectations

Perform research and finish the project with writing a thesis.

Duration

- MSc Information Studies and MSc Logic: 6 months

- MSc Software Engineering: 3 months

- MSc Computational Science: 8 months

1.10 Programmes
Master Logic (6 months)

1.11 Project Contact
John van de Wetering (j.m.m.vandewetering@uva.nl, IVI)

1.12 Number of Students
1

2. Research Tags

Please choose a maximum of three individual tags.
Note: it is not possible to submit the form if more than 3 research tags are selected

2.1 Amsterdam Machine Learning Lab

2.2 Computational Science Lab

2.3 Computer Vision

2.4 Digital Interactions Lab

2.5 Intelligent Data Engineering Lab

2.6 Information Retrieval Lab

2.7 Language Technology Lab

2.8 Multimedia Analytics Lab Amsterdam

2.9 Quantitative Healthcare Analysis

2.10 Theory of Computer Science Quantum computing

2.11 Complex Cyber Infrastructure

2.12 Security by Design

2.13 Multiscale Networked Systems

2.14 Parallel Computing Systems

2.15 Socially Intelligent Artificial Systems

2.16 Video and Image Sense Lab

2.17 Natural Language Processing & Digital Humanities

2.18 Theoretical Computer Science (ILLC)

2.19 Formal Semantics and Philosophical Logic

3.1 Imported project id

3.2 Copied project id