Joshua Chen

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I am interested in the theory and semantics of dependent and homotopy type theory, as well as its applications to the foundations of mathematics and proof assistants.

Research & Work

2017–present

University of Bonn,
University of Innsbruck

Alternative logical foundations in Isabelle

Presently, I build dependently-typed logical foundations and related infrastructure and tools for the Isabelle proof assistant.

2017–2018

Fraunhofer Institute for Intelligent Analysis and Information Systems

Machine learning and NLP for Copernicus EMS

I worked in the Knowledge Discovery group of the Fraunhofer IAIS, applying probabilistic models to analyze and classify topics in tweet corpora. I implemented targeted topic models in Java and also used Python for natural language processing of Twitter and Facebook data. This work was part of the European Union's E2mC project—a pilot project using publicly-available social media data to support its Copernicus emergency management service.

2015

The Australian National University

Enumeration and visualization of planar trivalent graphs

I developed and implemented algorithms in Scala to enumerate and automatically draw certain classes of planar graphs. This was part of research in quantum algebra investigating subfactors and planar algebras. Code incorporated into the repository at `https://bitbucket.org/scottmorrison/toolkit/`.

2013–2014

The Australian National University

Temperley-Lieb categories and skein modules

Final year Honours research thesis in category theory, quantum algebra, and applications to low-dimensional topological invariants.
Available online at `arXiv:1502.06845 [math.QA]`.

Nov 2012–Jan 2013

The Australian National University

Integer houses in cyclotomic fields

Selective international undergraduate research program. I investigated questions concerning the dimensions of objects in fusion categories with the aid of Wolfram Mathematica.

Preprints & Theses

Isabelle/Spartan — A Dependent Type Theory Framework for Isabelle

Feb 2020. `arXiv:2002.09282 [cs.LO]`

In this paper I introduce Isabelle/Spartan, an implementation of a core intensional dependent type theory with cumulative universes as an object logic in the Isabelle proof assistant. I demonstrate how Isabelle's simple type theoretic logical framework infrastructure is able to support the development and subsequent use of a proof environment based on dependent type theory in a manner familiar to users of "natively" dependently-typed systems like Coq and Agda.

An Implementation of Homotopy Type Theory in Isabelle/Pure

Masters thesis. Sep 2018. `arXiv:1911.00399 [cs.LO]`

This thesis presents an implementation of a fragment of "book HoTT" as an object logic for the interactive proof assistant Isabelle. It also gives a mathematical description of the underlying theory of the Isabelle/Pure logical framework, and discusses various issues and design decisions that arise when attempting to encode intensional dependent type theory with universes inside a simple type-theoretic logical foundation.

The Temperley-Lieb categories and skein modules

Bachelors thesis. May 2014. `arXiv:1502.06845 [math.QA]`

The theory of diagrammatic Temperley-Lieb categories is developed in order to construct examples of spherical fusion categories. These are then used to provide a more direct construction of Turaev-Viro skein modules for n-holed disks via their spines.

Selected Talks

2019	*Dependent Types in Isabelle* 4th Prague Inter-Reasoning Workshop, Czech Technical University, Prague
2019	*Isabelle/HoTT* Seminar talk, Chair for Logic and Verification, Technische Universität München, Munich
2019	*Hybrid and alternative logics in Isabelle* Doctoral program, Conference on Intelligent Computer Mathematics, Prague
2014	*What is Mathematics?* Outreach talk, ANU Open Day 2014, Canberra
2014	*An Introduction to Topological Quantum Field Theory* Australian Mathematical Sciences Student Conference, Newcastle
2014	*The Temperley-Lieb categories and Turaev-Viro skein modules* ANU MSI Honours Conference, Canberra

Teaching Assistance

2017–2018	Machine Learning (University of Bonn)
2017	Data Mining and Knowledge Discovery (University of Bonn)
2015	Engineering Mathematics 1B (University of Canterbury)
2014	Mathematics and Applications 1 (Australian National University)
2014	Mathematics and Applications 1 (University of Canterbury)
2013	Discrete Mathematics (University of Canterbury)

Awards

2013	ANU Mathematical Sciences Institute Honours Scholarship
2012	ANU Summer Research Scholarship
2011	University of Canterbury Peter Bryant Prize for Pure Mathematics
2010	University of Canterbury Dux Scholarship

Education

Masters in Mathematics
Oct 2015–Sep 2018

University of Bonn
Advisor: Prof. Dr. Peter Koepke
German GPA 1.9

B.Sc. (Honours) Mathematics
Jun 2013–Jul 2014

The Australian National University
Advisor: Assoc. Prof. Scott Morrison
First Class Honours (GPA 80%)

B.Sc. Mathematics
Feb 2010–Dec 2012

University of Canterbury
Dean's Congratulations (GPA 8.64/9)