

PhD from JHU, fall 2022

Supervised by **Emily Riehl**

Interested in: *machine learning, formal & higher category theory, and homotopy type theory.*

— Work Experience —

- 2026– **Principal Research Engineer**
TOPOS RESEARCH UK
- 2024–2026 **Assoc. Director of Research**
SYMBOLICA AI
Initial role: Research Software Engineer
- 2022–2024 **Quantitative Technologist**
RADIX TRADING B.V.
- 2016–2022 **Teaching Assistant**
JOHNS HOPKINS

— Education —

- July 2022 **PhD in Mathematics**
JOHNS HOPKINS, DISSERTATION
Towards the theory of proof-relevant categories
- Spring 2020 **Programme Associate**
MATHEMATICAL SCIENCES RESEARCH INSTITUTE
Higher Categories and Categorification
- 2018 **Masters Degree**
JOHNS HOPKINS, M.A. MATH.
Completed written qualifying exams and oral speciality exam
- 2016–2018 **Principle Fulbright Scholar**
JOHNS HOPKINS
Selected & funded to pursue PhD in Math., transferred from George Washington University
- 2015–2016 **Principle Fulbright Scholar**
GEORGE WASHINGTON UNIVERSITY
Graduate coursework
- 2015 **Masters Degree**
UNIV. CAPE TOWN, M.SC. MATH., WITH DISTINCTION
Dissertation: “On the local and global properties of information manifolds”
- 2014–2015 **Research Group**
UNIV. CAPE TOWN, INFORMATION GEOMETRY
Quantum Gravity and Strings Laboratory
- 2014 **Honours Degree**
UNIV. CAPE TOWN, PURE MATH., FIRST CLASS
- 2011–2013 **Bachelor of Science**
UNIV. CAPE TOWN, DEGREE WITH DISTINCTION
Majors: Pure Math., Applied Math., and Astrophysics, each with distinction

— Teaching Experience —

See my **website** for details, including my role as sole instructor, my role in administrating the online homework system, and my work as a course development assistant and the products thereof.

- 2018–2021 **Head T.A. & WeBWork administrator**
JOHNS HOPKINS
Calculus III & ODE (twice & thrice, resp.) and online homework system
- Spring 2019 **Course development**
JOHNS HOPKINS
Introduction to Proofs, assisted Prof. Riehl in course development
- Fall 2017 **Sole Instructor**
JOHNS HOPKINS
Introduction to Calculus
- Jan. 2017 **Primary Instructor**
JOHNS HOPKINS
Interession Course: Recreational Math. for All
- 2017–‘19, ‘21 **DRP Mentor**
JOHNS HOPKINS
Mentored projects in: General Topology, Braid Group Representations, Category Theory, Homotopy Type Theory
- Oct. 2014 **Invited Instructor**
UNIV. CAPE TOWN
Introduction to Group Theory
- 2014–2021 **Teaching Assistant**
Real Analysis, Introductory Abstract Algebra, Linear Algebra, Differential Equations, Calculus Sequence, String Theory

— Teaching Award —

- April 2021 **William Kelso Morrill Award**
EXCELLENCE IN MATHEMATICS
For love of teaching, love of mathematics, and concern for students, nominated by undergraduates & selected by the department.

—Papers—

■ **Regular Calculi I: Graphical Regular Logic**

([arXiv 2109.14123](#))

joint with B. Fong & D. I. Spivak, on the novel structure of regular calculi and their use as an ergonomic & graphical syntax for regular logic.

■ **A common misinterpretation of Isbell's obstruction to monoidal strictification**

([arXiv 2106.03652](#))

which shows that the widely disseminated obstruction to strictifying the associator is shown to be under-specified as stated, and the truth is more subtle.

■ **Bi-representations and bi-initial objects are not so different** ([link](#))

joint with L. Moser, on 2-categorical and double-categorical theorems characterising when pseudo-functors into Cat are representable, with applications to bi-adjunctions and 2-dimensional limits. Cahiers de Topologie et Géométrie Différentielle Catégoriques, LXIII-3.

■ **2-limits and 2-terminal objects are too different** ([link](#))

joint with L. Moser, on the failure of all theorems of the form “a 2-dimensional limit is a 2-dimensional terminal object in a 2-dimensional slice category of cones”. Appl. Categor. Struct. 2022

—Computer Science—

Prior to commencing graduate studies in mathematics, i organised, competed in, and taught the following:

■ 2011-2014 **Algorithm Circle**

THEORETICAL C.S. ORGANISATION, UNIV. CAPE TOWN
Lecturer (2011-2014), Vice Chairman (2012, 2014), Chairman (2013) for an organisation that gave free & open, weekly lectures on topics in theoretical computer science (data structures, complexity theory, programming language theory, cryptography) and helped attendees prepare for programming contests.

■ Dec. 2012 **Top 10 in Southern Africa**

GOOGLE APP DEVELOPER CHALLENGE

Designed and implemented a website allowing for the easy, intuitive and visual organisation of free-form data into graphs and networks conveying relations and interconnections. Written in Python, Javascript, and using D3.js.

■ 2011 & 2012 **Haskell Course**

UNIVERSITY OF CAPE TOWN

Organised and gave a free & open Haskell programming language course.

In the period 2011-present, i have contributed code to several open-source projects, including:

■ **MikeOS**, a 16bit real-mode operating system written in x86 assembly

■ **DoomRetro**, a modern source port of ID Software's DOOM (II) game engine written in C using SDL2

■ **tiny-menu.el**, an Emacs minor mode to display interactive menus for quick actions written in Emacs Lisp

In the period 2016-present, i have created several medium-to-large projects of my own, including:

■ **ctak** [C], a line-mode interface for the game of Tak, complete with a computer opponent. This project was designed to learn about neural networks, adversarial tree search, & buildroot for cross-compiling and embedded computing on a Raspberry PI

■ **srchr** [Rust], a parallelised keyboard layout optimiser. This project exploits symmetries in “pre-layouts” to reduce the search space, which it explores by way of a genetic algorithm in order to optimise layouts given certain n-gram distributions and a customisable loss function as input. Includes schematics for custom keyboard pcbs

■ **Art-deco clock** [AVR C, OpenSCAD], a 3D-printed art-deco clock using an ATTiny24, RTC chip, and two OLED displays

■ **siege-mode.el** [elisp], an Emacs minor mode to surround the region with smart delimiters interactively

■ **msr** [C], a public-key signature verification tool using curve Ed25519, libsodium, GNU argp, and compatible with OpenBSD's signify

■ **ZiRC** [Zig], a project to learn the Zig programming language and the basics of 3D rendering by building a featureful raycaster engine

— Notable Service —

- 2019 **Primary organiser**
2019 CATEGORY THEORY OCTOBERFEST ([website](#))
hosted at Johns Hopkins
- 2018 **Chapter representative**
DIRECTED READING PROGRAM (DRP)
Represented the JHU DRP chapter at the Directed Reading Programme Network & Workshop, MIT
- 2017-2019 **Co-organiser**
DIRECTED READING PROGRAM (DRP), JOHNS HOPKINS
Individual pairing of undergraduates with graduates for independent studies ([website](#)). Mentor & co-organiser (2017-2019), primary organiser (2018-2019)
- 2015 **Organiser**
MATHS POSTGRAD. TEA PARTY, UNIV. CAPE TOWN
Founder of a biweekly meeting of graduates, comprising peer lectures and discussions over tea
- 2011-2015 **Various roles**
ALGORITHM CIRCLE – THEORETICAL COMP. SCI. CLUB, UNIV. CAPE TOWN
Free and open lectures, and competition prep. Lecturer (2011-2015), Vice-chairman (2012, 2014), Chairman (2013)
- 2011 & 2012 **Organiser**
HASKELL PROGRAMMING COURSE, UNIV. CAPE TOWN
Organised and gave a free and open Haskell language programming course

— Talks —

See my [website](#) for slides.

- 2021/11/11 **Topology Seminar**
UNIVERSITY OF VIRGINIA
Structures for witnessed composition, an approach to higher categories
- Sept. 2021 **Category Theory 20→21**
Representation presentation: to present a representative, 2-representative theorem
- 2021/08/10 **Topos Institute**
BERKELEY
Invitation to the next dimension: 2D doesn't mean double the work, only twice as much
- 2021/07/16 **Applied Cat. Theory 2021**
UNIVERSITY OF CAMBRIDGE
Graphical Regular Logic: the complete 2D picture
- 2020/10/14 **Category Theory Seminar**
JOHNS HOPKINS (ONLINE, OPEN TO PUBLIC)
2-lessons from Australian Category Theory: Mates and Doctrinal Adjunction

- 2020/09/11 **Category Theory Seminar**
JOHNS HOPKINS (ONLINE, OPEN TO PUBLIC)
BI DOUBLING categories we'll see/ MULTIPLE morphisms acting weakly/ Two out of the four/ Have laws rather poor/ But the last is coherent VIRTUALLY!
- 2019/11/05 **Category Theory Seminar**
JOHNS HOPKINS
Within and not without: an apology for internal languages (2 parts)
- 2019/09/17 **Category Theory Seminar**
JOHNS HOPKINS
Induction & construction: the pointless theory of localic topoi
- 2019/06/15 **Types 2019**
OSLO
Towards proof relevant category theory, as modelled by globular T-categories
- 2019/06/06 **HoTT-UF Project**
CAS OSLO
What is proof relevant category theory?
- 2019/04/02 **School and Workshop on Univalent Mathematics**
UNIVERSITY OF BIRMINGHAM
The univalence axiom, a brief & incomplete tour
- 2019/02/19 **Category Theory Seminar**
JOHNS HOPKINS
Polynomial functors, a degree of generality
- 2019/02/10 **Johns Hopkins Mathematics Tournament**
AUDIENCE OF HIGH-SCHOOL STUDENTS
Fractions: ratio of two integers or universal machine?
- 2018/11/30 **University Seminar**
GEORGE WASHINGTON UNIV.
Homotopy Type Theory, the confluence of logic and space
- 2018/11/08 **Category Theory Seminar**
JOHNS HOPKINS
What is an LCC?
- 2018/09/20 **Oral Speciality Exam**
JOHNS HOPKINS
Type Theory and Categories, the unbearable likeness of being
- 2017/12/05 **Graduate Topics Course**
JOHNS HOPKINS
'Rings Modules and Algebras in Infinite Loop Space Theory' at a glance
- 2017/11/15 **Graduate Topics Course**
JOHNS HOPKINS
What do we mean when we say spectra?

■ 2017/11/30 **University Seminar**

GEORGE WASHINGTON UNIV.

An Intuitive Description of Toposes, Toposes as a Description of Intuitionism

■ 2017/10/12 **Category Theory Seminar**

JOHNS HOPKINS

All good things must come to an end

■ 2017/04/09 **Graduate Topics Course**

JOHNS HOPKINS

The Calculus of Fractions and Homotopy Theory

■ 2016/12/12 **Category Theory Seminar**

JOHNS HOPKINS

A monad is just ...(with an eye to universal algebra)

— **Conferences Attended** —

- 2021 CT 20→21 online, Genoa
- 2021 ACT 2021 online, Cambridge
- 2019 Category Theory Octoberfest, JHU
- 2019 Homotopy Type Theory, CMU
- 2019 Category Theory, Edinburgh
- 2019 Types, Oslo
- 2019 HoTT-UF Project, CAS Oslo
- 2019 Summer School on Higher Topos Theory and Univalent Foundations, Leeds
- 2019 School and Workshop on Univalent Mathematics, Birmingham
- 2018 Vladimir Voevodsky Memorial Conference, IAS
- 2018 Category Theory Octoberfest, CUNY
- 2018 Directed Reading Programme Network & Workshop, MIT
- 2017 Category Theory Octoberfest, CMU
- 2017 Category Theory 2017, UBC

— **Competencies** —

- Comfortable in Python (incl. torch) & Haskell, with experience in Agda, C, Common Lisp, Coq, L^AT_EX, Python, Rust, and Zig
- English (fluent), Hebrew (intermediate), Dutch (intermediate)

— **Personal Pursuits** —

- **Electronics & 3D printing** Various projects leveraging micro-controllers and custom circuitry
- **Cellular automata** Exploration of rule sets and pattern engineering
- **Esoteric Programming Languages** Authored and implemented several languages ([url](#))
- **Fractal Art** Exploration of the media of iterated function systems, chaotic maps and attractors, and epicyclic generators
- **Digital Music** Leveraged trackers and other platforms to create a variety of compositions

References available upon request