Yunkai Zhang

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Education

Imperial College London *London, UK*
MEng in Computing (Computer Science) *Sept 2022 – present*

- Current Grade: First Class Honours
- *Modules*: Formalising Mathematics, Type Systems, Seminar in Effect Handlers, Concurrent Programming
- *Awards*: 2022-23 Computing Entrance Scholarship (10/250+)

Research Experience

Proof Engineer Intern (Industrial Placement) *Paris, France*
Formal Land *Apr 2025 – Sept 2025*
Supervisor: Dr Guillaume Claret

- Developed Garden, an open-source Rocq framework for formally verifying zero-knowledge circuits.
- Structured the translation of blake3 hash function AIR (originally written in Plonky3, a cryptographic toolkit written in Rust for STARK-based zkVMs) into Rocq specification
- Formulated the formalisation of finite field skeleton in Rocq, and designed various monadic primitives for effectful operations.
- Formally verified the soundness and correctness of the blake3 hash function using number theory and customised reasoning tools, covering 1k+ lines of Rust code in the original implementation.
- Collaborated with an international team of researchers and engineers from other organisations to communicate about ongoing developments in zero-knowledge proof systems and formal verification.

Projects

Seminar in Computational Effects and Effect Handlers *Imperial College London*
Coursework Project for *Computing Research Collective (CRC)* *Autumn 2024*
Supervisor: Omar Tahir

- Participated in research-intensive seminar led by PhD student, engaging with primary literature in computational effects and handlers.
- Studied foundational literature including Moggi's "Notions of Computation and Monads," Bauer's categorical tutorials, and additional research papers on higher order effects, algebraic effects, and temporal logic.
- Authored systematic literature review synthesizing the research trajectory of mathematical foundations for effects, analyzing theoretical developments across multiple seminal papers.
- Presented critical analysis of "Modular Models of Monoids with Operations," examining a possible mathematical framework for higher-order effect systems with better expressivity and modularity.

Category Theory in Lean 4 *Imperial College London*
Coursework and beyond for *Formalising Mathematics** *Spring 2025*
Supervisor: Dr Bhavik Mehta

- Formalised several small projects in category theory using Lean 4, including
  - (co)algebras of endofunctors, and the proof of Lambek's Lemma
  - factorisation categories, their characterisation in terms of initial and terminal objects, and their equivalent form as iterated comma categories
  - monads, monad composition via distributive laws, and several instances of such monads
- Contributed several merged pull requests to mathlib4.

Talks

Category Theory Meets Computing: A Story of Computational Effects *London, UK*
Talk delivered at Imperial College Mathematics Student Colloquium *Feb 2025*

- Targeted undergraduate students from department of mathematics, introducing how category theory can be used by computer scientists through the lens of computational effects.

Rust 101   *London, UK*
2-session workshop at Department of Computing Society (DocSoc)   *Autumn 2024*
- Introduced the basics of Rust programming language, including immutability, ownership, and borrowing.
- Guided students through hands-on exercises and live-coding sessions to reinforce learning.
- Provided an overview of benefits, origins, and innovations the language and its ecosystem, including Cargo, crates.io, and Rust documentation.

Teaching Experience

Undergraduate Teaching Assistant (Maths Tutor)   *London, UK*
Imperial College London   *Sept 2024 – present*
Personal Maths Tutor (PMT) for first-year computing students
- Responsible for leading weekly small-group tutorial sessions, marking and providing feedback on tutorial sheets
- Illustrated the structure and system of natural deduction and formal proofs using proof assistants.
- *Relevant Modules*: Discrete Mathematics, Logic, Reasoning about Programs, Graph & Algorithms

Teaching Assistant in Computer Science   *London, UK*
David Game College   *Jan 2025 – Apr 2025*
Teaching Placement in High School for module *Communicating CS in Schools*
- Taught Python programming and functional programming concepts to high school students
- Delivered lessons on theoretical computer science: Turing machines, finite state machines, regular expressions, context-free grammars, and complexity
- Conducted live Haskell coding demonstrations for advanced/extension work
- Provided individualized student support and assisted with coursework across multiple classes

Academic Development

Oregon Programming Languages Summer School   *University of Oregon, US*
Awarded OPLSS 2025 Fellowship   *June 2025 – July 2025*
- Studied several advanced topics in programming languages, including Martin-Löf Type Theory, Proof Theory, Effect and Handlers, and Metaprogramming.
- Participated in student-led discussions including Separation Logic, Categorical Semantics, Agda & Introduction to HoTT.
- Undertook fellowship responsibilities for collaboratively taking notes for <u>Introduction to Logical Foundations</u> and <u>Introduction to Type Theories</u> lectures.

Midlands Graduate School in the Foundations of Computer Science   *University of Sheffield, UK*
MGS 2025   *Apr 2025*
- *Courses*: Coalgebra, Linear Logic, Category Theory, Curry-Howard Correspondence, Proof-theoretic Semantics, Linear Logic, Refinement Types in Haskell

Skills

Preferred Languages: Rocq/Coq, Lean 4, Haskell, OCaml, Rust, C, C++, Java, Kotlin, Python

Languages with Experience in: Agda, Prolog, SQL, JavaScript, HTML/CSS, Bash

Frameworks: Z3, Dafny, Zero Knowledge Circuits, Parser Combinators, Lean EDSL

Tools: Git, CI/CD (GitLab / GitHub Actions), Docker, LaTeX, Typst, VSCode

Natural Languages: English (fluent, TOEFL: 117/120), Mandarin (native), Japanese (beginner)

Other: Competitive Programming, Public Transport Systems, Piano