Joshua Clune

Curriculum Vitae

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Education

Carnegie Mellon University, Pursuing PhD in Computer Science — Sept 2021 – Present

Advisor: Jeremy Avigad

Carnegie Mellon University, B.S. in Computer Science — Sept 2017 – May 2021

Additional major in Philosophy, GPA: 3.86/4

Research Projects

Lean Hammer — Jan 2024 - Present

Collaborators: Jeremy Avigad, Haniel Barbosa, Sean Welleck, Yicheng Qian, and Thomas Zhu

- Developing a tactic to translate Lean goals to TPTP and SMT-LIB formats and subsequently reconstruct proofs found by external automatic theorem provers

Duper: An Automatic Theorem Prover for Dependent Type Theory — June 2022 - Sept 2024

Collaborators: Jeremy Avigad, Alexander Bentkamp, and Yicheng Qian

- Developed an automatic proof-producing superposition theorem prover in Lean 4
- Extended the prover to perform higher-order reasoning and handle problems which include dependent types
- Published in ITP 2024. `https://doi.org/10.4230/LIPIcs.ITP.2024.10`

A Formalized Reduction of Keller's Conjecture — Sept 2021 - Sept 2022

Advisor: Jeremy Avigad

- Formalized the connection between Keller graphs and Keller's original conjecture on cube tilings in Lean 3
- Produced the first verified proof that Keller's conjecture is false in eight dimensions
- Published in CPP 2023. `https://doi.org/10.1145/3573105.3575669`

A Polymorphic Logical Framework — Sept 2020 - July 2021

Advisor: Karl Crary

- Developed an extension to the LF logical framework that includes polymorphic types
- Main goals included proving identity expansion and cut elimination, and then formalizing said proofs in Coq

Program Equivalence for Assisted Grading of Functional Programs — May 2019 - Nov 2020

Collaborators: Umut Acar, Ruben Martins, and Vijay Ramamurthy

- Developed a provably sound technique for expressing the equivalence of functional programs with SMT formulas
- Implemented the technique to cluster thousands of Standard ML homework submissions from an introductory functional programming course
- Published in OOPSLA 2020. `https://doi.org/10.1145/3428239`

Professional Experience

Applied Scientist Intern - Amazon — June 2023 - Sept 2023

Mentor: Leonardo de Moura

- Created a package for creating and reasoning about CNF formulas in Lean 4
- Implemented a fully verified LRAT checker to support verified reasoning about the unsatisfiability of CNF formulas directly in Lean

Software Engineering Intern - Bloomberg L.P. Sept 2016 - Aug 2017, June - Aug 2018
Mentor: Stephen Csukas

- Created a Bloomberg Terminal function to help sales representatives monitor how effectively their customers engaged in various workflows, both at the aggregate level to discover widespread trends and the individual level for closer monitoring
- Created a Bloomberg Terminal function to display specific Terminal user information while simultaneously running internal checks to ascertain the consistency of the displayed data

General Coding Intern - Readorium June 2016 - Aug 2016
Mentor: David Isecke

- Migrated Readorium's main product from Flash to HTML5
- Developed a system of recording user transactions used to identify bugs and validate security features

Teaching

Logic and Mechanized Reasoning Jan 2024 - May 2024
Instructors: Jeremy Avigad and Marijn Heule

- Served as a TA; Filled in as a lecturer and assisted in assignment and exam development

Constructive Logic Sept 2022 - Dec 2022
Instructor: Karl Crary

- Served as a TA; Individually lead weekly recitations

Mathematical Concepts and Proofs Sept 2019 - Dec 2019
Instructor: John Mackey

- Served as a TA; Lead recitations twice a week; Gave two supplemental lectures

Mathematical Foundations for Computer Science Sept 2018 - Dec 2018
Instructor: John Mackey

- Served as a TA; Lead recitations twice a week

Skills

Experience with: Interactive Theorem Proving, Automatic Theorem Proving, Formal Methods, Program Analysis

Languages: Lean, Standard ML, OCaml, C, Python, JavaScript, C++, SQL, Bash

Publications/Awards

- Joshua Clune, Yicheng Qian, Alexander Bentkamp, and Jeremy Avigad. Duper: A Proof-Producing Superposition Theorem Prover for Dependent Type Theory. In 15th International Conference on Interactive Theorem Proving (ITP 2024). Leibniz International Proceedings in Informatics (LIPIcs), Volume 309, pp. 10:1-10:20, Schloss Dagstuhl – Leibniz-Zentrum für Informatik (2024) `https://doi.org/10.4230/LIPIcs.ITP.2024.10`
- Joshua Clune. A Formalized Reduction of Keller's Conjecture. Proc. ACM SIGPLAN International Conference on Certified Programs and Proofs. January 2023, Pages 90-101, `https://doi.org/10.1145/3573105.3575669`
- Joshua Clune, Vijay Ramamurthy, Ruben Martins, and Umut A. Acar. 2020. Program Equivalence for Assisted Grading of Functional Programs. Proc. ACM Program. Lang. 4, OOPSLA, Article 171 (November 2020), 29 pages. `https://doi.org/10.1145/3428239`
- Honorable Mention for 2021 CRA Outstanding Undergraduate Researcher Award