Joshua Clune

Curriculum Vitae

jclune@andrew.cmu.edu | (201) - 218 - 7654 | joshclune.github.io/ | Pittsburgh, PA

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

LeanHammer — Jan 2024 - Present

Many collaborators

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

QuerySMT: Hint-Based SMT Proof Reconstruction — Jan 2024 - Present

Advisors: Jeremy Avigad and Haniel Barbosa

- Developed a new "hint-based" approach to reconstructing SMT proofs
- Implemented the approach as a Lean tactic which leverages cvc5 to discover standalone proof scripts

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

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

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 technique for expressing the equivalence of functional programs with SMT formulas
- Implemented the technique to cluster Standard ML homework submissions from an introductory course

Professional Experience

Research Intern - Microsoft — May 2025 - Aug 2025

Mentors: Michael Naehrig, Jonathan Protzenko, Son Ho

- Contributed to the formal verification of a Rust ML-KEM implementation using Aeneas and Lean
- Developed proof automation for the Aeneas toolchain to streamline the verification of cryptographic code

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 verified LRAT checker to support reasoning about the unsatisfiability of CNF formulas in Lean

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

- Created a Terminal function to help monitor how customers engaged in various workflows
- Created a Terminal function to ascertain the consistency of user data across

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

- Henrik Böving, Siddharth Bhat, Luisa Cicolini, Alex Keizer, Léon Frenot, Abdalrhman Mohamed, Léo Stefanesco, Harun Khan, **Joshua Clune**, Clark Barrett, and Tobias Grosser. 2025. Interactive Bitvector Reasoning using Verified Bit-Blasting. Proc. ACM Program. Lang. 9, OOPSLA2, Article 389 (October 2025), 27 pages. https://doi.org/10.1145/3763167
- Yicheng Qian, **Joshua Clune**, Clark Barrett, Jeremy Avigad. 2025. Lean-Auto: An Interface Between Lean 4 and Automated Theorem Provers. In: Piskac, R., Rakamarić, Z. (eds) Computer Aided Verification. CAV 2025. Lecture Notes in Computer Science, vol 15933. Springer, Cham. https://doi.org/10.1007/978-3-031-98682-6_10
- **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