



Alex Sanchez-Stern

Curriculum Vitae

Publications

- December 2023 **Passport: Improving Automated Formal Verification Using Identifiers**, *TOPLAS 2023*
- May 2023 **Proofster: Automated Formal Verification**, *ICSE 2023 Demo Track*
- December 2022 **Data Driven Lemma Synthesis for Interactive Proofs**, *OOPSLA2022*
- June 2021 **Scooter & Sidecar: a domain-specific approach to writing secure migrations**, *PLDI 2021*
- June 2020 **Generating Correctness Proofs with Neural Networks**, *MAPL 2020*
- January 2020 **REPLica: REPL Instrumentation for Coq Analysis**, *CPP 2020*
- June 2018 **Finding Root Causes of Floating Point Error**, *PLDI 2018*
- July 2016 **Towards a Standard Benchmark Format and Suite for Floating-Point Analysis**, *NSV 2016*
- June 2015 **Automatically Improving Accuracy for Floating Point Expressions**, *PLDI 2015*, Distinguished Paper Award

Awards

- 2015 Marygates Research Scholarship
- 2015 Distinguished Paper – PLDI 2015

Service

- 2024 PLDI PC
- 2023 OOPSLA ERC
- 2021 AIPLANS Committee
- 2020-2021 ACM Mentorship Program Mentor
- 2019-2020 ICFP Artifact Evaluation Committee
- 2018-2019 POPL Student Volunteer Captain

Education

- 2018–2021 **Doctor of Philosophy, Computer Science**, *University of California, San Diego*

- 2016–2018 **Candidate of Philosophy, Computer Science**, *University of California, San Diego*
- 2015–2016 **Masters of Science, Computer Science**, *The University of Washington*
Honors
- 2012–2015 **Bachelors of Science, Computer Science**, *The University of Washington*
Honors

PhD Thesis

- Title *Hybrid-Neural Synthesis of Machine-Checkable Software Correctness Proofs*
- Supervisor Professor Sorin Lerner
- Description The correctness of large software artifacts has important impact on many aspects of the modern world. Machine-checkable software correctness proofs provide a guarantee that a piece of software adheres to some logical specification, however producing such proofs is labor-intensive, taking in some cases 23 person-years of highly skilled labor to prove properties of 10,000 line programs. This thesis work uses a hybrid-approach of machine learning and proof assistant search procedures to produce proofs of correctness for a large variety of software automatically or semi-automatically.

Masters Thesis

- Title *Dynamic Analysis of Floating Point Errors with Herbgrind*
- Supervisor Professor Zachary Tatlock
- Description Numerical computation using floating point numbers is notoriously difficult to reason about, even in idealized environments. This thesis presents the development of a tool which can analyze the runtime behavior of programs written in a variety of environments and languages, and extract inaccurate floating point computation for improvement.

Bachelors Thesis

- Title *Algebraic Simplification for the Herbie Project*
- Supervisor Professor Zachary Tatlock
- Description The ability to simplify arbitrary mathematical expressions is extremely useful in many applications, including the Herbie numerical synthesis tool, but is exponential in general. This thesis presents a set of data structures and heuristics that allow thousands of expressions to be simplified every second.

Experience

Vocational

September 2021–Present **Postdoctoral Researcher**, UNIVERSITY OF MASSACHUSETTS, AMHERST, Amherst, MA

Worked on an extension to the TacTok proof synthesis tool with co-authors at UMass Amherst and University of Illinois, Urbana Champagne. Also advised a new PhD student in her studies, worked on a masters students project on localization of errors in flakey tests, and extended thesis work with reinforcement learning concepts.

- Co-PI on a DARPA-PEARLS proposal.
- Submitted a paper to PLDI in my first three months, on inferring helper lemmas for Coq proofs.
- Now have 3 papers published during the postdoc with 3 more in the pipeline.

September 2016–June 2021 **Research Assistant**, UNIVERSITY OF CALIFORNIA, SAN DIEGO, San Diego
Continued work begun at the University of Washington on the Herbgrind project for automatically diagnosing the causes of floating-point error in large numerical software, and began work on neural synthesis of machine-checkable proofs of program correctness.

Detailed achievements:

- Worked with collaborators at UCSD to produce Proverbot9001, a tool for neural proof synthesis.
 - Implemented in Python using PyTorch and Rust
 - Can find proofs for almost a quarter of all theorem statements in CompCert (a verified C compiler).
 - Published and presented as “Generating Correctness Proofs with Neural Networks” at MAPL 2020
 - Pre-print of the paper available at <http://proverbot9001.ucsd.edu/papers/proverbot9001.pdf>
 - Talk is available as part of MAPL proceedings at <https://youtu.be/rwBbYh0AnPo?t=11540>
- Worked with Collaborators in the Systems & Security groups to produce Scooter, a tool to make data migrations safer.
- Worked with collaborators at the UW as well as Sorin Lerner at UCSD to complete work on the Herbgrind tool and paper.
 - Implemented in 20,000 lines of code (C, python, and bash scripts).
 - Analyses programs up to 50,000 lines of code.
 - Published and presented “Finding Root Causes of Floating Point Error” at PLDI 2018
 - Pre-print of the paper available at <http://herbgrind.ucsd.edu/herbgrind-pldi18.pdf>
 - Talk slides available at <http://herbgrind.ucsd.edu/pldi18-talk/>
 - Talk video available at https://www.youtube.com/watch?time_continue=1&v=bFL6PaPrz8Y
- Continuing maintenance of the Herbie project with collaborators at the UW.

- December 2013– **Research Assistant**, UNIVERSITY OF WASHINGTON, Seattle
 September 2016 Worked with another research assistant to develop the Herbie system for automatically improving the accuracy of floating point code
- Detailed achievements:
- Worked with Pavel Panchekha and Zachary Tatlock in developing the high level design of the system over the course of two years.
 - Worked closely with Pavel Panchekha to write the implementation of the system, including specifically:
 - Independently developing the algebraic simplification system
 - Writing the top level code which controls the various subsystems
 - Developed the experimental loop variant of Herbie to continue the work described in the paper.
 - Authored a paper on our work together with Pavel Panchekha, Zachary Tatlock, and James Wilcox.
 - Our paper was published at the Programming Languages Design and Implementation 2015 conference.
 - Paper and talk available at <http://herbie.uwplse.org/pldi15.html>
 - Authored a second paper with Pavel Panchekha, Zachary Tatlock, Chen Qiu, and international collaborators Nasrine Damouche and Matthieu Martel on a new format and benchmark suite for cross-tool floating point benchmarks.
 - Began work on a third project, Herbgrind, which I continued at UCSD
- June 2013– **College Tech**, SEATTLE SCHOOLS DISTRICT, Seattle
 September 2013 Maintained existing educational and teacher machines, and set up and installed new machines, at a variety of schools in the Seattle Schools District.
- September 2011– **Assistant Operations Engineer**, CASA LATINA, Seattle
 2011–January 2013 Wrote tests and data aggregation and display code for the Machete job registration system, under James Carter.
- July 2011– **Intern**, BENSUSSEN DEUTSCH & ASSOCIATES, INC, Woodinville
 September 2011 Performed market research, handled product returns, and managed product testing.