

# Zachary Tatlock

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## EDUCATION

University of California, San Diego

Ph.D., Computer Science & Engineering, Autumn 2014

Thesis: *Reducing the Costs of Proof Assistant Based Formal Verification*

Advisor: Sorin Lerner

Purdue University, West Lafayette, IN

B.S., Computer Science (Honors), Spring 2007

B.S., Mathematics, Spring 2007

Advisor: Suresh Jagannathan

## EMPLOYMENT

University of Washington, Seattle

Paul G. Allen School of Computer Science & Engineering

Associate Professor, Autumn 2019 – Present

Assistant Professor, Autumn 2013 – Autumn 2019

OctoML, Seattle, WA

Compilers Liaison, Autumn 2019 – Present

Microsoft Research India, Bengaluru, India

Graduate Research Intern, Summer 2010

## PUBLICATIONS

*Refereed Conference and Journal Papers*

### **Fast and Extensible Equality Saturation**

Max Willsey, Chandrakana Nandi, Yisu Remy Wang, Oliver Flatt, Pavel Panchekha, Zachary Tatlock

Principles of Programming Languages (POPL) 2021

### **Synthesizing Structured CAD Models with Equality Saturation and Inverse Transformations**

Chandrakana Nandi, Max Willsey, Adam Anderson, James R. Wilcox,

Eva Darulova, Dan Grossman, Zachary Tatlock

Programming Language Design and Implementation (PLDI) 2020

### **Carpentry Compiler**

Chenming Wu, Haisen Zhao, Chandrakana Nandi, Jeffrey I. Lipton, Zachary Tatlock, Adriana Schulz

ACM Transactions on Graphics (SIGGRAPH ASIA) 2019

### **Modular Verification of Web Page Layout**

Pavel Panchekha, Michael D. Ernst, Zachary Tatlock, Shoaib Kamil

Object-Oriented Programming, Systems, Languages & Applications (OOPSLA) 2019

**Theia: Automatically Generating Correct Program State Visualizations**

Josh Pollock, Jared Roesch, Doug Woos, Zachary Tatlock  
ACM SIGPLAN Symposium on SPLASH-E 2019

**QED at Large: A Survey of Engineering of Formally Verified Software**

Talia Ringer, Karl Palmskog, Ilya Sergey, Milos Gligoric, Zachary Tatlock  
Foundations and Trends in Programming Languages (FTPL) 2019

**Icing: Supporting Fast-Math Style Optimizations in a Verified Compiler**

Heiko Becker, Eva Darulova, Magnus O. Myreen, Zachary Tatlock  
Computer-Aided Verification (CAV) 2019

**Teaching Rigorous Distributed Systems With Efficient Model Checking**

Ellis Michael, Doug Woos, Thomas E. Anderson, Michael D. Ernst, Zachary Tatlock  
European Conference on Computer Systems (EuroSys) 2019

**Sinking Point: Dynamic Precision Tracking for Floating-Point**

Bill Zorn, Dan Grossman, Zachary Tatlock  
Conference for Next Generation Arithmetic (CoNGA) 2019

**Functional Programming for Compiling and Decompiling Computer-aided Design**

Chandrakana Nandi, James R. Wilcox, Pavel Panchekha, Taylor Blau, Dan Grossman, Zachary Tatlock  
International Conference on Functional Programming (ICFP) 2018

**Verifying that Web Pages have Accessible Layout**

Pavel Panchekha, Adam T. Geller, Michael D. Ernst, Zachary Tatlock, Shoaib Kamil  
Programming Language Design and Implementation (PLDI) 2018

**Finding Root Causes of Floating Point Error**

Alex Sanchez-Stern, Pavel Panchekha, Sorin Lerner, Zachary Tatlock  
Programming Language Design and Implementation (PLDI) 2018

**Programming and Proving with Distributed Protocols**

Ilya Sergey, James R. Wilcox, Zachary Tatlock  
Principles of Programming Languages (POPL) 2018

**CEuf: Minimizing the Coq Extraction TCB**

Eric Mullen, Stuart Pernsteiner, James R. Wilcox, Zachary Tatlock, Dan Grossman  
Certified Programs and Proofs (CPP) 2018

**Automatic Formal Verification for EPICS**

Jonathan Jacky, Stefani Banerian, Michael D. Ernst, Calvin Loncaric,  
Stuart Pernsteiner, Zachary Tatlock, Emina Torlak  
International Conference on Accelerator and Large Experimental Control Systems (ICALEPCS) 2017

**SpaceSearch: A Library for Building and Verifying Solver-aided Tools**

Konstantin Weitz, Steven Lyubomirsky, Stefan Heule, Emina Torlak, Michael D. Ernst, Zachary Tatlock  
International Conference on Functional Programming (ICFP) 2017

**Programming Language Tools and Techniques for 3D Printing**

Chandrakana Nandi, Anat Caspi, Dan Grossman, Zachary Tatlock  
Summit on Advances in Programming Languages (SNAPL) 2017

**Programming Language Abstractions for Modularly Verified Distributed Systems**

James R. Wilcox, Ilya Sergey, Zachary Tatlock  
Summit on Advances in Programming Languages (SNAPL) 2017

**Scalable Verification of Border Gateway Protocol Configurations with an SMT Solver**

Konstantin Weitz, Doug Woos, Emina Torlak, Michael D. Ernst, Arvind Krishnamurthy, Zachary Tatlock  
Object-Oriented Programming, Systems, Languages & Applications (OOPSLA) 2016

**Investigating Safety of a Radiotherapy Machine Using System Models with Pluggable Checkers**

Stuart Pernsteiner, Calvin Loncaric, Emina Torlak, Zachary Tatlock,  
Xi Wang, Michael D. Ernst, Jonathan Jacky  
Computer-Aided Verification (CAV) 2016

**Toward a Standard Benchmark Format and Suite for Floating-Point Analysis**

Nasrine Damouche, Matthieu Martel, Pavel Panchekha, Chen Qiu, Alex Sanchez-Stern, Zachary Tatlock  
Numerical Software Verification (NSV) 2016

**Verified Peephole Optimizations for CompCert**

Eric Mullen, Daryl Zuniga, Zachary Tatlock, Dan Grossman  
Programming Language Design and Implementation (PLDI) 2016

**Planning for Change in a Formal Verification of the Raft Consensus Protocol**

Doug Woos, James R. Wilcox, Steve Anton, Zachary Tatlock, Michael D. Ernst, Thomas E. Anderson  
Certified Programs and Proofs (CPP) 2016

**Automatically Improving Accuracy for Floating Point Expressions**

Pavel Panchekha, Alex Sanchez-Stern, James R. Wilcox, Zachary Tatlock  
Programming Language Design and Implementation (PLDI) 2015  
*Distinguished Paper Award*

**Verdi: A Framework for Implementing and Formally Verifying Distributed Systems**

James R. Wilcox, Doug Woos, Pavel Panchekha, Zachary Tatlock,  
Xi Wang, Michael D. Ernst, Thomas E. Anderson  
Programming Language Design and Implementation (PLDI) 2015

**Toward a Dependability Case Language and Workflow for a Radiation Therapy System**

Michael D. Ernst, Dan Grossman, Jonathan Jacky, Calvin Loncaric,  
Stuart Pernsteiner, Zachary Tatlock, Emina Torlak, Xi Wang  
Summit on Advances in Programming Languages (SNAPL) 2015

**RoboFlow: A Flow-based Visual Programming Language for Mobile Manipulation Tasks**

Sonya Alexandrova, Zachary Tatlock, Maya Cakmak  
International Conference on Robotics and Automation (ICRA) 2015

**Jitk: A Trustworthy In-Kernel Interpreter Infrastructure**

Xi Wang, David Lazar, Nikolai Zeldovich, Adam Chlipala, Zachary Tatlock  
Operating Systems Design and Implementation (OSDI) 2014

**Automating Formal Proofs for Reactive Systems**

Daniel Ricketts, Valentin Robert, Dongseok Jang, Zachary Tatlock, Sorin Lerner  
Programming Language Design and Implementation (PLDI) 2014

**SafeDispatch: Securing C++ Virtual Calls from Memory Corruption Attacks**

Dongseok Jang, Zachary Tatlock, Sorin Lerner  
Network and Distributed System Security (NDSS) 2014

**Establishing Browser Security Guarantees through Formal Shim Verification**

Dongseok Jang, Zachary Tatlock, Sorin Lerner  
USENIX Security Symposium 2012

**Equality Saturation: A New Approach to Optimization**

Ross Tate, Michael Stepp, Zachary Tatlock, Sorin Lerner  
Logical Methods in Computer Science (LMCS) 2011

**Bringing Extensibility to Verified Compilers**

Zachary Tatlock, Sorin Lerner  
Programming Language Design and Implementation (PLDI) 2010

**Proving Optimizations Correct using Parameterized Program Equivalence**

Sudipta Kundu, Zachary Tatlock, Sorin Lerner  
Programming Language Design and Implementation (PLDI) 2009

**Equality Saturation: A New Approach to Optimization**

Ross Tate, Michael Stepp, Zachary Tatlock, Sorin Lerner  
Principles of Programming Languages (POPL) 2009

**Deep Typechecking and Refactoring**

Zachary Tatlock, Chris Tucker, David Shuffelton, Ranjit Jhala, Sorin Lerner  
Object-Oriented Programming, Systems, Languages & Applications (OOPSLA) 2008

*Workshops, Invited Papers, Short Papers, Extended Abstracts, and Book Chapters*

**The Essence of Program Semantics Visualizers: A Three-Axis Model**

Josh Pollock, Grace Oh, Eunice Jun, Philip J. Guo, Zachary Tatlock  
Workshop on Evaluation and Usability of Programming Languages and Tools (PLATEAU) 2020

**Towards Numerical Assistants**

Pavel Panchekha, Zachary Tatlock  
Numerical Software Verification (NSV) 2020

**Toward Multi-Precision, Multi-Format Numerics**

David Thien, Bill Zorn, Pavel Panchekha, Zachary Tatlock  
Software Correctness for HPC Applications (CORRECTNESS) 2019

### **Combining Tools for Optimization and Analysis of Floating-Point Computations**

Heiko Becker, Pavel Panchekha, Eva Darulova, Zachary Tatlock  
Formal Methods (FM) Short Paper 2018

### **Software Verification with ITPs Should Use Binary Code Extraction to Reduce the TCB**

Ramana Kumar, Eric Mullen, Zachary Tatlock, Magnus O. Myreen  
Interactive Theorem Proving Short Paper (ITP) 2018

### **Relay: a New IR for Machine Learning Frameworks**

Jared Roesch, Steven Lyubomirsky, Logan Weber, Josh Pollock,  
Marisa Kirisame, Tianqi Chen, Zachary Tatlock  
Machine Learning and Programming Languages (MAPL) 2018

### **Verification of Implementations of Distributed Systems Under Churn**

Ryan Doenges, James R. Wilcox, Doug Woos, Zachary Tatlock, Karl Palmskog  
Workshop on Coq for Programming Languages (CoqPL) 2017

### **Formal Semantics and Automated Verification for the Border Gateway Protocol**

Konstantin Weitz, Doug Woos, Emina Torlak, Michael D. Ernst, Arvind Krishnamurthy, Zachary Tatlock  
ACM SIGCOMM Workshop on Networking and Programming Languages (NetPL) 2016

### **Visual Robot Programming for Generalizable Mobile Manipulation Tasks**

Sonya Alexandrova, Zachary Tatlock, Maya Cakmak  
Human Robot Interaction Extended Abstracts (HRI) 2015

### **Peek: A Formally Verified Peephole Optimization Framework for x86**

Eric Mullen, Zachary Tatlock, Dan Grossman  
Workshop on Coq for Programming Languages (CoqPL) 2015

### **Parameterized Program Equivalence Checking** (Chapter 8, Pages 123 - 145)

Sudipta Kundu, Sorin Lerner, and Rajesh K. Gupta  
High-Level Verification: Methods and Tools for Verification of System-Level Designs, Springer 2011

## STUDENTS

### *Current Graduate Students*

1. Amy Zhu
  - Joined Summer 2020, co-advised with Adriana Schulz
  - Rewrite Synthesis, PL for Knitting
2. Gus Smith
  - Joined Autumn 2018, co-advised with Luis Ceze
  - Hardware Software Co-design for ML Accelerators
3. Steven Lyubomirsky
  - Joined Autumn 2016
  - Dynamic Tensor Rematerialization, ML Compiler Design (TVM Relay)

4. Chandrakana Nandi

- Joined Autumn 2015, co-advised with Dan Grossman
- Rewrite Synthesis, PL for 3D Printing and Carpentry

5. Jared Roesch

- Joined Autumn 2015
- ML Compiler Design (TVM Relay), Chief Architect at OctoML

6. Bill Zorn

- Joined Autumn 2014, co-advised with Dan Grossman
- Floating-point Accuracy, Number Systems Analysis Tools

*Current Undergraduate Students*

7. Andrew Liu

- Joined Summer 2020
- Custom Numeric Datatypes for ML Training

8. Brett Saiki

- Joined Winter 2019
- Floating-point Accuracy, Mixed-precision Optimization

9. Mike He

- Joined Winter 2019
- Dynamic Tensor Rematerialization, ML Compiler Design (TVM Relay)

10. Adam Anderson

- Joined Summer 2017 (HS)
- Rewrite Synthesis, PL for 3D Printing

*Current High School Students*

11. Grace Oh

- Joined Summer 2020
- Program State Visualization, CS Education

*Graduated Ph.D. Students*

12. Pavel Panchekha

- Ph.D. 2019 → Assistant Professor at Utah
- Thesis: *Automated Reasoning for Web Page Layout*
- Co-advised with Michael D. Ernst

13. James Wilcox

- ABD 2019 → CTO at Certora

14. Doug Woos

- Ph.D. 2019 → Lecturer at Brown University
- Thesis: *A Step-through Debugger for Distributed Systems*
- Co-advised with Michael D. Ernst and Thomas Anderson

15. Stuart Pernsteiner

- Ph.D. 2018 → Galois Inc.
- Thesis: *Practical Verification of Safety-Critical Systems*
- Co-advised with Michael D. Ernst

16. Eric Mullen

- Ph.D. 2018 → Google
- Thesis: *Pushing the Limits of Compiler Verification*
- Co-advised with Dan Grossman

17. Konstantin Weitz

- Ph.D. 2017 → Google
- Thesis: *Formal Semantics and Scalable Verification for the Border Gateway Protocol using Proof Assistants and SMT Solvers*
- Co-advised with Michael D. Ernst

*Graduated M.S. Students*

18. Marisa Kirisame

- B.S. 2019, M.S. 2020 → Ph.D. Student at Utah
- Thesis: *Building Flexible Deep Learning Systems*

19. Logan Weber

- B.S. 2019, M.S. 2020 → Ph.D. Student at MIT
- Thesis: *Living Life on the Low-power Edge: Tiny Models on Tiny Devices*

20. Alex Sanchez-Stern

- B.S. 2014, M.S. 2015 → Ph.D. Student at UCSD
- Thesis: *Algebraic Simplification for the Herbie Project*

*Graduated B.S. Students*

21. Altan Haan

- B.S. 2020 → OctoML
- Thesis: *Simulating Dynamic Tensor Rematerialization*

22. Josh Pollock

- B.S. 2020 → Ph.D. Student at MIT
- Thesis: *Sidewinder: Designing Correct Program State Visualizations*

23. Taylor Blau
  - B.S. 2020 → GitHub
  - PL for 3D Printing
24. David Thien
  - B.S. 2019 → Ph.D. Student at UCSD
  - Floating-point Accuracy, Mixed-precision optimization
25. Jifan Zhang
  - B.S. 2019 → M.S. Student at UW with Kevin Jamieson
  - ML Compiler Design (TVM Relay)
26. Melissa Hovik
  - B.S. 2018 → M.S. Student and Instructor at UW
  - PL for 3D Printing
27. Chen Qiu
  - B.S. 2018 → M.S. Student at UW → Facebook
  - Floating-point Accuracy, Random Numerical Testing
28. Justin Adsuara
  - B.S. 2018 → Hilton Hotels
  - Formally Verified Serialization for Distributed Systems
29. Adam Geller
  - B.S. 2018 → Ph.D. Student at UBC
  - CSS Formalization in SMT, Web Page Layout Verification
30. Paul Curry
  - B.S. 2018 → Xnor.ai → Apple
  - PL for 3D Printing
31. Ryan Doenges
  - B.S. 2017 → Ph.D. Student at Cornell
  - Formal Verification of Distributed Systems under Churn
32. Luke Nelson
  - Co-advised with Xi Wang
  - B.S. 2017 → Ph.D. Student at UW
  - Formally Verified, Self-hosted eBPF JIT Compilation
33. Miranda Edwards
  - B.S. 2017 → Cisco Meraki
  - Formally Verified Distributed Systems



34. Keith Simmons

- B.S. 2017 → Microsoft
- Formally Verified Distributed Systems

35. Steve Anton

- B.S. 2017 → Google
- Formally Verified Distributed Systems

36. Seth Pendergrass

- B.S. 2016 → Microsoft
- PL for 3D Printing

37. Daryl Zuniga

- B.S. 2015 → Microsoft
- Formal Verification of Peephole Optimizations in CompCert

### *Graduated High School Students*

38. Juliet Oh

- H.S. 2016 → B.A. in Computer Science at Princeton University
- PL for 3D Printing

## TEACHING

### *Instructor*

- Spring 2020 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Winter 2020 – UW CSE 341: Programming Languages (Undergraduate)
- Spring 2019 – UW CSE P505: Concepts of Programming Languages (Professional Masters)
- Winter 2019 – UW CSE 341: Programming Languages (Undergraduate)
- Autumn 2018 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Spring 2018 – UW CSE 331: Software Design and Implementation (Undergraduate)
- Winter 2018 – UW CSE 341: Programming Languages (Undergraduate)
- Autumn 2017 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Spring 2017 – UW CSE 599Z: Accurate Computing (Graduate)
- Winter 2017 – UW CSE 331: Software Design and Implementation (Undergraduate)
- Autumn 2016 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Spring 2016 – UW CSE 599W: Systems Verification (Graduate)
- Winter 2016 – UW CSE 331: Software Design and Implementation (Undergraduate)

- Autumn 2015 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Spring 2015 – UW CSE 341: Programming Languages (Undergraduate)
- Winter 2015 – UW CSE 505: Concepts of Programming Languages (Graduate)
- Spring 2014 – UW CSE 341: Programming Languages (Undergraduate)
- Winter 2014 – UW CSE 506: Proof Assistants (Graduate)
- Autumn 2013 – UW CSE 505: Concepts of Programming Languages (Graduate)

### *Teaching Assistant*

- Autumn 2012 – UCSD CSE 231: Advanced Compiler Design (Graduate)
- Winter 2012 – UCSD CSE 130: Programming Languages (Undergraduate)
- Autumn 2011 – UCSD CSE 231: Advanced Compiler Design (Graduate)
- Spring 2011 – UCSD CSE 231: Advanced Compiler Design (Graduate)
- Spring 2007 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Fall 2006 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Spring 2006 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Fall 2005 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Spring 2005 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Fall 2004 – Purdue CS 180: Intro Java Programming (Undergraduate, Head Lab TA)
- Spring 2004 – Purdue CS 180: Intro Java Programming (Undergraduate, Lab TA)

### *Summer School Courses*

- Verifying Distributed Systems Implementations in Coq  
DeepSpec Summer School 2018

## AWARDS AND NOMINATIONS

- UW FACET Mentorship Award 2020
- NSF CAREER Award 2018
- Facebook Research Award 2018
- PLDI Distinguished Paper Award 2015
- UW Distinguished Teaching Nomination 2015
- Google Faculty Research Award 2015
- NSF GRFP Honorable Mention 2007
- Purdue Undergraduate Teaching Assistant of the Year 2006
- Purdue ACM Humor Award 2004

## SERVICE

### *Reviewing*

- PLDI 2021 Program Committee
- ASPLOS 2021 Program Committee
- SCF 2020 External Reviewer
- OOPSLA 2020 External Review Committee
- PLDI 2020 External Program Committee
- ASPLOS 2020 Program Committee
- CPP 2019 Program Committee
- PLDI 2019 Program Committee
- ICFP 2019 External Review Committee
- ITP 2018 Program Committee
- TOPLAS 2018 Referee
- POPL 2018 Program Committee
- Onward! 2017 Program Committee
- ASPLOS 2017 External Reviewer
- POPL 2017 External Reviewer
- PLDI 2016 Program Committee
- PLDI 2016 Artifact Evaluation Committee co-Chair
- CPP 2016 Program Committee
- ASPLOS 2016 External Review Committee
- POPL 2016 External Review Committee
- CoqPL 2015 Program Committee
- POPL 2015 External Review Committee
- OOPSLA 2014 External Review Committee
- PLDI 2014 External Review Committee
- CC 2009 External Reviewer

## *Mentoring and Organizing*

- SRC JUMP: Applications Driving Architecture (ADA) Student Hackathon 2020
- FPTalks 2020: Co-Organizer
- SRC JUMP: Applications Driving Architecture (ADA) Student Hackathon 2019
- UW Verification in Practice 2019 Co-Organizer
- PLDI 2018 Programming Languages Mentoring Workshop (PLMW) Panelist
- PNW PLSE 2018 Organizer and Program Committee Chair
- POPL 2018 Programming Languages Mentoring Workshop (PLMW) Panelist
- UW NSF STARS Mentor 2017
- SPLASH 2017 Doctoral Symposium Program Committee
- POPL 2016 Student Research Competition Chair
- PLDI 2015 Student Research Competition Committee
- SPLASH 2015 Programming Languages Mentoring Workshop (PLMW) Co-Chair
- Inspirations at SPLASH 2014 Co-Organizer and Speaker

## GRANTS

- FMitF: Retargetable, Verifiable, Optimizable Computer-Aided Manufacturing  
Co-PI; NSF CCF-2019302; \$749,913; 2020 – 2023
- RTML: Automatic Synthesis of HW/SW Systems for General Neural-Networks  
Co-PI; DARPA; \$4,605,227; 2019 – 2022
- Knit Pattern Understanding for Garment Modeling, Modification, and Fabrication  
Co-PI; NSF CHS-1907337; \$500,000; 2019 – 2021
- FMitF: Formal Verification of Accessibility  
Co-PI; NSF CCF-1836813; \$738,125; 2019 – 2022
- Applications Driving Architectures (ADA) SRC JUMP Center  
Co-PI; Joint DARPA & SRC; \$1,375,000; 2018 – 2023
- Programming Languages Foundations for 3D Printing  
PI; NSF SHF-1813166; \$500,000; 2018 – 2021
- CAREER: Verifying Distributed Systems Implementations  
PI; NSF CCF-1749570; \$550,000; 2018 – 2023
- A Picture is Worth a Billion Bits: Adaptive Visualization of Big Data  
Co-PI; DARPA; \$7,855,225; 2015 – 2019