

# ZHOULAI FU, Ph.D.

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## RESEARCH INTERESTS & HIGHLIGHTS

### **Programming Language Theory**

- ◆ Satisfiability Solving (CAV'16)
- ◆ Static Analysis (ESOP'14)
- ◆ Abstract Interpretation (VMCAI'14)

### **Software Engineering**

- ◆ Search-based Testing (PLDI'17)
- ◆ Numerical Error Analysis (OOPSLA'15)
- ◆ Symbolic Execution (ICSE'15)

## EDUCATION

- INRIA and Université de Rennes 1, France, Ph.D. in Computer Science, obtained on 07/22/2013  
Thesis: Static analysis of numerical properties in the presence of pointers
- École Polytechnique, France, 2009 (the most prestigious institution in Science and Engineering in France. *Ingénieur polytechnicien* program)  
M.S. in Computer Science  
M.Eng. in Software Engineering

## PROFESSIONAL PREPARATION

University of California, Davis, California, USA

04/2014 – Present

### **Postdoc Scholar**

Established the equivalence between program correctness and unconstrained programming, which provides a unified approach for handling search-based testing, satisfiability solving, boundary value analysis, and exception detection. Studied numerical error analysis and symbolic execution.

IMDEA Software, Madrid, Spain

03 – 08/2013

### **PhD Research Visitor**

Devised a memory abstraction to overcome the inherent imprecision of the traditional “strong/weak updates” paradigm of programming language theory.

INRIA, Rennes, France

09/2009 – 02/2013

### **PhD Candidate**

Studied the theory of abstract interpretation. Implemented a new static numerical analysis for programs that manipulate pointers

École Polytechnique and École Normale Supérieure Paris, France; ETHZ, Switzerland

04 – 09/2008

### **Research Intern**

Studied static analysis of alias relationship for the object-oriented language Eiffel

## AWARDS & GRANTS

- NSF Grant CCF-1618158, “SHF: Small: Testing and Analysis for Reliable Numerical Software,” Co-Principal-Investigator with PI Zhendong Su, \$500,000, 2016 – 2019

- French Ministry of Research Ph.D. Allocation, 2009 – 2012
- France Télécom Grant Recipient, 2008 – 2009
- École Polytechnique Foundation Grant Recipient, 2005 – 2008

### **TEACHING & MENTORING**

- Instructor, UC Davis ECS50 (75 students): Computer Organization and Machine Dependent Programming, 2017
- Mentor for six Ph.D. candidates and two undergraduates, UC Davis, 02/2014 – present
- Speaker and organizer, Seminar Series: Software Foundations with Coq, Department of Computer Science, UC Davis, 2016
- Speaker, Seminar Series: Advanced Linear Algebra, École Polytechnique, France, 2005

### **SYNERGISTIC ACTIVITIES**

- NSF Panelist (National Science Foundation in the US), 2016 and 2017
- Program Committee for PLDI Artifact Evaluation 2017
- Program Committee for ISSTA Artifact Evaluation 2017
- Reviewer for ICSE, CAV, FSE, HVC and PSI, 2014 – 2017
- Invited talks given at Berkeley University, Stanford University, CEA Saclay France, VERIMAG Grenoble France, IMDEA Software Spain, 2013 – 2017

### **DEVELOPED TOOLS\***

- CoverMe: A coverage-based testing tool. Evaluated on Sun’s math library, CoverMe significantly outperformed the search-based software testing tool Austin (developed at the CREST team at UCL) and Google’s security-oriented fuzz tester AFL.
- XSat: A floating-point satisfiability solver. Evaluated on SMT-Competition 2015 benchmarks, XSat provided 100% consistent satisfiability results as MathSat and Microsoft’s Z3, an average speed-up of more than 700X over MathSat and 800X over Z3.
- BEA: The first algorithm to automate backward error analysis, which had been studied in a paper-and-pencil style by mathematicians for decades.
- NumP: A static numerical analyzer for Java. Evaluated on the DaCaPo benchmarks, NumP inferred arithmetic properties manifested in Java programs of more than 60K lines of code, a scalability beyond existing static analyzers.

\* Details on the tools are given in the publications. The tools are available upon request; we are looking into the process to share them online for academic/industry purposes.

### **LANGUAGES**

English (fluent), French (fluent), Chinese (native)

## **PUBLICATION LIST**

**[PLDI'17]** Zhoulai Fu and Zhendong Su, “Achieving High Coverage for Floating-Point Code via Unconstrained Programming.” In 38th ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI), 2017

**[CAV'16]** Zhoulai Fu and Zhendong Su, “XSat: A Fast Floating-Point Satisfiability Solver.” In 28th International Conference on Computer Aided Verification (CAV), 2016

**[CORR'16]** Zhoulai Fu and Zhendong Su, “Mathematical Execution: A Unified Approach for Testing Numerical Code.” CoRR abs/1610.01133, 2016

**[ICSE'15]** Ting Su, Zhoulai Fu, Geguang Pu, Jifeng He, and Zhendong Su. “Combining Symbolic Execution and Model Checking for Data Flow Testing.” In 37th International Conference on Software Engineering (ICSE), 2015

**[OOPSLA'15]** Zhoulai Fu, Zhaojun Bai, and Zhendong Su. “Automated Backward Error Analysis for Numerical Code.” In Proceedings of the 2015 ACM SIGPLAN International Conference on Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), 2015

**[ESOP'14]** Zhoulai Fu, “Targeted Update – Aggressive Memory Abstraction Beyond Common Sense and its Application on Static Numeric Analysis.” In 23rd European Symposium on Programming (ESOP), 2014

**[VMCAI'14]** Zhoulai Fu, “Modularly Combining Numeric Abstract Domains with Points-to Analysis, and a Scalable Static Numeric Analyzer for Java.” In 15th International Conference on Verification, Model Checking, and Abstract Interpretation (VMCAI), 2014