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FRANCE

EDUCATION

PhD **University of Colorado Boulder**, August 2008 – December 2014

Advisors: Dr. Bor-Yuh Evan Chang and Dr. Sriram Sankaranarayanan

École Normale Supérieure, July 2013 – December 2014

Advisor: Dr. Xavier Rival

Research: *Parametric Heap Abstraction for Dynamic Language Libraries*MS **University of Colorado Boulder**, Computer Engineering, 3.91

2013

BS **University of the Pacific**, Computer Engineering, 3.64 GPA, 3.95 Engineering GPA

2005

Senior Project: *Design and Construction of the Eidolon Video Game Console*

CURRENT RESEARCH PROJECTS

Parametric Heap Abstraction for Dynamic Language Libraries

2012-present

Dynamic languages have many language features that make them difficult to statically analyze. We are developing new abstractions and invariant generation algorithms to automatically and modularly verify programs that manipulate maps, dictionaries, hashes, strings and heaps. We are drawing on previous work in separation logic-based analyses to reason precisely about data and containers. This work focuses on the abstraction of open objects and callbacks that frequently occur in dynamic language libraries.

The codirection of this work began in 2012. In 2013 Arlen Cox was awarded the Chateaubriand Fellowship to continue to pursue this work in France.

(advised by Xavier Rival and Bor-Yuh Evan Chang; in collaboration with Sriram Sankaranarayanan)

PAST RESEARCH PROJECTS AND EXPERIENCE

Automated Verification of Quantized Digital Filters

2010-2011

Digital filters are part of most electronic devices today. To lower the manufacturing cost, engineers simplify designs produced by design tools by quantizing them to use fixed-point arithmetics. However, there are no guarantees that the quantized designs do not have flaws that break the filters. We are developing techniques for efficiently verifying quantized filters to ensure that they have not been broken by the quantization process. We use cutting edge word-level model checking techniques.

(with Bor-Yuh Evan Chang and Sriram Sankaranarayanan)

Microsoft Research (Cambridge, UK)

2011

Diagnosing and Refining Abstractions for Heap Analysis

We extended the SLAYER separation logic-based heap analysis tool to generate counterexamples when a memory safety proof failed. We used the counterexample generation functionality along with the structure of the failed proof to automatically determine where in an analysis abstraction lost vital information. From this we developed a simple automatic refinement scheme – the first for a separation logic-based analysis.

(with Josh Berdine, Samin Ishtiaq and Christoph Wintersteiger)

ioSemantics (Littleton, CO, USA)

2011

Automated Analysis of Business Logic COBOL programs make up some of the largest code bases in the world. We studied automatic path enumeration techniques for COBOL programs. We use satisfiability-modulo-theories (SMT) solvers to model the behavior of the program and automatically locate correlated branches. This analysis is now being developed into a commercial project.

(with Steve Bucuvalas and Aaron Bradley)

IIMC (Incremental Inductive Model Checker)

2010

IIMC is a state-of-the-art hardware model checker that uses the incremental inductive algorithm IC3. Because IC3 is a satisfiability-based model checker, we explored the conversion of expression directed acyclic graphs into conjunctive normal form. We evaluated the traditional Tseitin transform along with more modern and efficient technology mapping and heuristic approaches to determine if they benefited the IC3 algorithm. We found that they did not produce significantly better results.

(with Aaron Bradley)

REFEREED PUBLICATIONS

Arlen Cox, Bor-Yuh Evan Chang, Xavier Rival. Automatic Analysis of Open Objects in Dynamic Language Programs. In *Proceedings of Static Analysis Symposium*, September 2014.

Arlen Cox, Bor-Yuh Evan Chang, Sriram Sankaranarayanan. QUICr: A Reusable Library for Parametric Abstraction of Sets and Numbers. In *Proceedings of Computer Aided Verification*, July 2014.

Arlen Cox, Bor-Yuh Evan Chang, Sriram Sankaranarayanan. QUIC Graphs: Relational Invariant Generation for Containers. In *Proceedings of European Conference on Object-Oriented Programming*, July, 2013.

Arlen Cox, Sriram Sankaranarayanan, Bor-Yuh Evan Chang. A Bit Too Precise? Verification of Quantized Digital Filters. In *Software Tools for Technology Transfer*, April, 2014.

Josh Berdine, **Arlen Cox**, Samin Ishtiaq, Christoph M. Wintersteiger. Diagnosing Abstraction Failure in Separation Logic-based Analyses. In *Proceedings of Computer Aided Verification*, July, 2012.

Arlen Cox, Sriram Sankaranarayanan, Bor-Yuh Evan Chang. A Bit Too Precise? Bounded Verification of Quantized Digital Filters. In *Proceedings of Tools and Algorithms for the Construction and Analysis of Systems*, March, 2013.

TECHNICAL REPORTS

Josh Berdine, **Arlen Cox**, Samin Ishtiaq, Christoph M. Wintersteiger. Diagnosing Abstraction Failure in Separation Logic-based Analyses. no. MSR-TR-2012-44, April, 2012.

PRESENTATIONS

HOO: Automatic Analysis of Open Objects in Dynamic Language Programs. September 13, 2014
Static Analysis Symposium. Munich, Germany.

JSAna with HOO: Automatically Verifying JavaScript Libraries without Client August 15, 2014
Code. FaceBook. London, U.K.

JSAna with HOO: Automatically Verifying JavaScript Libraries without Client Code. JSTools. Uppsala, Sweden.	July 28, 2014
QUICr: A Parametric Abstraction Domain for Sets of Numbers. Computer Aided Verification. Vienna, Austria.	July 22, 2014
HOO: Heap with Open Objects. Dagstuhl Seminar for Scripting Languages and Frameworks: Analysis and Verification. Wadem, Germany.	June 30, 2014
QUIC Graphs: Relational Invariant Generation for Containers (extended). Université Paris Diderot. Paris, France.	December 9, 2013
QUIC Graphs: Relational Invariant Generation for Containers (extended). Microsoft Research, Cambridge. Cambridge, UK.	September 13, 2013
QUIC Graphs: Relational Invariant Generation for Containers. European Conference for Object Oriented Programming. Montpellier, France.	July 4, 2013
Relational Invariants for Containers. Midwest Verification Day. Lawrence, KS.	September 21, 2012
Diagnosing Abstraction Failure in Separation Logic-based Analyses. Computer Aided Verification. Berkeley, CA.	July 10, 2012
A Bit Too Precise? Bounded Verification of Quantized Digital Filters. Short Talk. 5th International Workshop on Numerical Software Verification. Berkeley, CA.	July 8, 2012
A Bit Too Precise? Bounded Verification of Quantized Digital Filters. 18th International Conference on Tools and Algorithms for the Construction and Analysis of Systems. Tallinn, Estonia.	March 27, 2012
Bounded Verification of Quantized Digital Filters. Student Lightning Talk Finalist. 39th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages. Philadelphia, PA.	January 25, 2012
Counterexample Generation for Separation Logic. Z3 Special Interest Group. Cambridge, UK.	November 2, 2011

AWARDS

Chateaubriand Fellowship	2013-2014
Facebook Fellowship Finalist	2012

TEACHING EXPERIENCE

University of Colorado Boulder (Boulder, CO) Readings in Programming Languages , <i>Co-Instructor</i> Advanced graduate reading seminar on current research topics.	Spring 2012
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University of Colorado Boulder (Boulder, CO) Spring 2010
C Programming for EE/ECE, *Lead Recitation/Lab Instructor*
Introductory programming course on C and Matlab for electrical and computer engineering students.

University of Colorado Boulder (Boulder, CO) Fall 2008, Spring 2009, and Fall 2009
Computers as Components, *Recitation/Lab Instructor*
Introductory course to embedded systems and assembly language.

INDUSTRY EXPERIENCE

ioSemantics (Littleton, CO) Summer 2011
SMT-Based Program Analysis *Contractor*

- Developed unified framework for Satisfiability Modulo Theories solving.
- Translated framework into OSGI for project integration.
- Integrated framework, replacing existing SMT solver and improved run-time performance

LSI (Longmont, CO) June 2005–July 2008
Hard Disk Read Channel IC Design *IC Design Engineer*

- Created digital logic for a dynamic memory interface including refresh circuitry and multiple priority ordered ports.
- Wrote and tested an analog calibration routine.
- Developed a macro assembler for a custom processor.
- Improved analog calibration through new data acquisition techniques.

NVIDIA (Santa Clara, CA) June–December 2004
Mobile Graphics Processor Characterization and Bring-up *Hardware Intern*

- Designed a PCB used to accurately control temperature of GPU dies.
- Developed embedded system to control temperature of GPU dies.
- Correlated estimated critical path timings with maximum operational frequencies of graphics processors and prepared reports of this information.
- Characterized power consumption of mobile graphics processors.
- Measured various spread spectrum solutions and prepared an application note about suggested integrated solution.

NVIDIA (Santa Clara, CA) Spring 2003
Graphics Processor Performance Characterization *Performance Analysis Intern*

- Ran game-related performance benchmarks on latest graphics products.
- Analyzed performance results to determine problems and bottlenecks.
- Developed Perl scripts for automating benchmark runs.

PATENTS

Gabriele Gorla, Sau Yan Keith Li, **Arlen Cox**. Platform-independent system and method for controlling a temperature of an integrated circuit. US Patent #8026515. September, 2011.

RELEVANT COURSEWORK

Logic and Automata Theory. *Prof. Aaron Bradley*. Fall 2010.
Logic Synthesis of VLSI Systems. *Prof. Fabio Somenzi*. Spring 2010.

Linear Programming. *Prof. Sriram Sankaranarayanan.* Fall 2009.
Compiler Construction. *Prof. Jeremy Siek.* Fall 2009.
Special Topics in Verification and Debugging. *Prof. Fabio Somenzi.* Spring 2009.
Software Engineering Reusable Components. *Prof. Jeremy Siek.* Spring 2009.
Fundamentals of Programming Languages. *Prof. Bor-Yuh Evan Chang.* Spring 2009.
High Integrity Software Engineering. *Prof. Aaron Bradley.* Fall 2008.

CITIZENSHIP

United States of America