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RESEARCH INTERESTS

Formal methods

- SMT Solvers - Developed the Heuristic Theorem Prover which was entered in SMT-Comp '05 and SMT-Comp '06. In SMT-Comp'06 the tool won 2nd and 3rd place finish in two divisions. The key idea I introduced was using symmetry breaking to improve the performance of an SMT solver. I view this as a first step towards being able to use knowledge about the problem domain to improve SMT performance.
- Developing a formal framework for a C static analysis tool using the Coq theorem prover (PhD thesis).
 - Verification of complex integrity conditions for recursive data structures.
 - Targeting memory leaks, dangling pointer references, and array reference errors
 - A tool based on this research would have likely found the Heart bleed bug.
 - Experimenting with verifying a simplified version of the DPLL SAT solver program written in C in order to demonstrate the framework on a non-trivial program. It incorporates many complex data structures with complex invariants.
- Developing a Python/Tk/Tcl based IDE for the Coq theorem prover (CoqPIE). This IDE introduces many innovations to improve proof development productivity such as caching outputs for quick browsing and tools to assist in replaying theorems.

Medical Informatics and Data Science

Computerized medical records provide many opportunities to improve patient care.

- Challenges:
 - Data cleaning – Often information is either missing, incorrectly entered or may even be no way to systemize important patient information
 - Large data – Highly optimized algorithms are needed to analyze data due to its size
 - Privacy – HIPAA requires medical institutions to maintain privacy of patient data yet researchers need to gain access to produce meaningful studies
- Projects
 - Clinical profiles – This project aims to produce statistical summaries of patient data that can be made publicly available. This data will enable researchers to perform some studies on these patient populations without needing to gain permission to access the medical records (using Python, Numpy and Pandas). This project is part of NCATS translator, a multi-institution collaboration aimed creating uniform tools to integrate data from different sources.
 - Machine learning – I'm involved in efforts to use machine learning to detect relationships in medical data and to predict the effectiveness of different treatments (using Python and sklearn).
 - (Personal project) Analyzing stock market statistics using the boosted decision trees, neural networks with Tensorflow and SkLearn—makes short term predictions
 - Web development
 - Javascript, php and SQL
 - Deployed one web app on AWS
 - Experience interfacing web app to Epic medical records DB

EDUCATION

- PhD.** Computer Science, The Johns Hopkins University, (Sept 2010-Feb 2018).
Advisor: Scott Smith
- MS,** Computer Science, The University of Illinois, (Sept 1986-June 1992)
- BS,** Computer Science, The University of Michigan,(Sept 1983-Aug 1985)

POSITIONS

- SiFive** (Oct 2019-May 2020) Staff Software Engineer (Formal methods)
Part of the team developing the Kami/ProcKami formally verified Risc V processor using the Coq theorem prover (Open source code available here: <https://github.com/sifive/RiscvSpecFormal>)
- Johns Hopkins Medical Center** (May 2016-May 2019) Software Engineer/
Biomedical data scientist
- Developing yourgiftgives.com and Denim website, a website for monitoring the use of patient genetic data
 - Developing clinical profile infrastructure to summarize medical record databases
 - Researching machine learning with medical records
- Naval Research Lab Intern** (July 2012-Sept 2012)
- Helped out with a static analysis tool for finding security holes in C programs
- NetApp** (Sunnyvale, CA, Sept 2006-April 2009) Software Engineer (MTS 4)
- Kernel level development on the DataFort including work on its CIFS, FTP, TFTP, HTTP proxies, VRRP protocol and command interpreter
 - Developed source code documentation (HLD and LLD) and a test suite (ATE) for an EAL4 Common Criteria government certification
- Synopsys/Systems Sciences** (Mountain View, CA, March 1997-August 2003)
Staff Software Engineer
- Developed many improvements to the Vera kernel (C language)
 - Developed performance enhancements that doubled the speed of Vera
 - Co-developed a UI for Vera (using C++ and MFS Foundation libraries)
 - Added a window for displaying analog signals in SimWave (a tool for displaying the output of hardware simulations) C language+Motif/X Windows libraries
- Meta Software/Avant!** (Sunnyvale, CA, Oct 1994-March 1997)
Codeveloped a tool for viewing the results of HSPICE simulations (C++/Galaxy windows galaxy windows library)
- HDL Systems** (October 1992-October 1994) Software Engineer
- Developed a Verilog to VHDL translator
 - Developed SoftSim, a tool for viewing the signal waveforms of a Verilog simulation. The tool was customized with specialized views for the MIPS RS3000 processor

BUSINESS

- Roe Mobile Development** (<http://www.roemobiledevelopment.com>), Feb 2009-present
Formed a small company to develop mobile applications.
- Developed the application Smart Recorder (an audio recorder/transcription app) on multiple platforms
 - iOS and Mac, Windows 8 Desktop and Windows 8 Phone
 - Managed the development of an Android version
 - iOS version has been installed on over 1,000,000 devices and has over 40,000 active users
 iOS version has extensive functionality giving me experience with many aspects of the iOS eco system

- Comprehensive use of many iOS audio packages both for recording/ playback and compression
 - Recording edit capability (trim/cut and paste segments)
 - Siri voice to text
 - Developed custom widgets (with custom gestures) for displaying audio waves
 - Lots of code to communicate with various web services using asynchronous protocols.
- Built a custom php based web server for a transcription service that used Amazon Mechanical Turks
- Developed many other iOS apps including Travel Diary, Census Wizard, The Nuclear Test, Word Quiz and Transylvania—all in the iTunes app store (at one time)
- Took on numerous small mobile development consulting contracts including the following:
 - Verizon through Toptal (June 2019) - developed Android code for displaying an H.264 video stream
 - TMSoft (Oct 2015-May 2016) – developed enhancements for both the iOS and Android White noise products
 - SalonSwipe through Toptal (Mar-Aug 2015) – developed a revamped user interface for a credit card processing iOS app
 - PostalPix through Toptal (Mar-Aug 2015) – developed a revamped user interface for an app that allows ordering of photos
 - Nimbot (May-Jul 2015) - developed webapp prototype for managing consent forms (php/javascript)
 - Zarquon through Toptal (Dec 2014-Jan 2015) – completed emoji keyboard app
 - Spensa Technologies through Toptal (Nov 2014-Mar 2015) – developed an iOS configuration tool for a bug trap device
 - Hopkins Medical Center (May 2012-Feb 2013) – Developed ipc3, a tool used by doctors for studies of patients with terminal cancer conditions
 - Independent Security Evaluators (Dec 2011-Apr 2012) – Data encryption projects
 - Thoratec (Feb-May 2011) – Drawing tool to illustrate the use of heart implants
 - Cryptite (Jun-Aug 2010) - developed custom bar code reading algorithm and iOS app for color coded barcodes using the OpenCV library
 - Hopkins Medical Center (Jun-July 2010) – Developed an iPad patient education app
 - Talking Tag (Feb-Jun 2010) – improved app that scans tag bar codes and stores associated information on a web server

PEER REVIEWED PUBLICATIONS

- Roe K, Vibhu J, Zhang X, Chute C, Epstein J, Matelsky J, Shpitser I, Feature engineering with clinical expert knowledge: A case study assessment of machine learning model complexity and performance, PLOS ONE (April 2020)
- Taylor CO, Lemke KW, Richards TM, Roe KD, He T, Arruda-Olson A, Carrell D, Denny JC, Hripcsak G, Kiryluk K, Kullo I, Larson EB, Peissig P, Walton N, Wei W, Ye Z, Chute CG, Weiner JP. Comorbidity Characterization Among eMERGE Institutions: A Pilot Evaluation of the Johns Hopkins ACG System. In AMIA Summits on Translational Science Proceedings, vol. 2019 (accepted).
- Kenneth Roe and Scott Smith, “Using the Coq Theorem Prover to Verify Complex Data Structure Invariants”, *MEMOCODE 2017*
- Kenneth Roe and Scott Smith, “CoqPIE: An IDE aimed at improving proof development productivity (rough diamond)”, *Interactive Theorem Proving*, 2016
- Peterson, John; Cleary, Alan; Roe, Ken, “Tool Demo - PyFRP: Function Reactive Programming in Python” *SPLASH-E 2015*

- Roe, Kenneth, "The Heuristic Theorem Prover: Yet Another SMT Modulo Theorem Prover", *18th International Conference on Computer Aided Verification (CAV)*, 2006
- Kim, Yong Se; and Roe, Kenneth D., "Conversions in Form Feature Recognition Using Convex Decomposition", *1992 ASME International Computers in Engineering Conf.*

CONFERENCE ABSTRACTS

- Roe KD, Vibhu J, Zhu R, Chee B, Matelsky J, Kinsey M, Epstein J, Zhang Z, Chute CG, Taylor CO. Reusable Clinical Profiles with Temporal Patterns for Machine Learning Applications. NorthEast Computational Health Summit. 2018. MIT-IBM Watson AI Lab, Cambridge, MA. April 27, 2018. (Poster presentation)

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TALKS

NJPLS Penn (May 2016)

Verifying programs with complex data structures using Coq

IDA, Bowie, MD (May 2014)

Using Coq to verify DPLL

UCSD and KESTREL INSTITUTE (June 2015)

Using Coq for Separation Logic and the need for a better IDE

IBM PL DAY (June 2010)

A Framework for describing recursive data structures

POSTER PRESENTATIONS/STUDENT RESEARCH COMPETITIONS

HCSS 2014, HCSS 2015, HCSS 2016

PLDI 2013, PLDI 2017

PATENTS

US Patent 9318110 Audio Transcription Generator and Editor

HONORS AND AWARDS

WWDC Scholarships (2015, 2016)

Apple awards 350 scholarships to attend the WWDC conference for free each year to full time students. I won scholarships in 2015 and 2016.

SMT-COMP '06

My HTP solver won 2nd place finish in QF_LRA, 3rd place finish in QF_UF and 5th place finishes in QF_IDL and QF_RDL divisions

TEACHING

TA, Android mobile development (Feb-May 2011)

TA, Declarative methods (Feb-May 2013)

More information is available at <http://www.cs.jhu.edu/~roe>.