

RAHUL KUMAR

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EXPERIENCE

Caltech, Pasadena, CA

March 2015 – June 2015

Lecturer

CS119: Software Reliability and Analysis. The course covers topics such as software testing, engineering, analysis, model checking, and runtime verification. Created course syllabus, materials for spring term 2015 at Caltech.

Microsoft Research, Redmond, WA, India

March 2016 – Current

Senior Research Software Development Engineer

Verification technologies: researching new methods of doing incremental verification, verification for large code bases and enterprises, and designing a system that enables verification to be consumed as a service. The work aims to generalize the technologies used in Static Driver Verifier, produce new analysis methods for C/C++ code and enable large scale verification using Azure as the cloud technology provider.

JPL NASA, Pasadena, CA

Sep 2014 – March 2016

Systems & Software Engineering

Researching methods for software verification, program analysis, modelling techniques, and programming languages.

- Co-created the **K language**, which is a wide spectrum specification and programming language incorporating concepts from the object oriented, relational view, and imperative programming domains.
 - o Used by Europa team as a textual language for SysML models and constructs.
 - o Co-created the grammar, parser, and compiler for the K language.
 - o Integrated K with Z3 for automatic theorem proving and *contract* based reasoning of program properties.
 - o Provide ability to convert K to JSON for storing in a database.
- Created the **C4 code information and verification system**
 - o Use Clang (LLVM) as the front end parser for parsing C programs and saving them to databases such as MySQL, Elastic, and disk (files).
 - o Create schema for program representation, linkage, and access.
 - o Provide a structured library that enables accessing parts (or whole) C programs for analysis (implemented in Scala)
 - o Implemented multiple analysis using library and Scala

- Implement incremental and iterative verification using summaries and facts that are persistent over all invocations of the tool.
- Created **SVC audits** for Europa models. This tool is used by Europa team for performing checks on concept hierarchies in the Europa models that are written in SysML. Currently the tool is implemented as a MagicDraw plugin that computes the differences between the *inferred* and the *asserted* concept hierarchies of the Europa model. The output is directly integrated into the view models, which are translated as tables, which are used by the Europa modeling team for reviews, tracking, and correctness checking.

Microsoft Research India, Bangalore, India

Jan 2013 – Sep 2014

Senior Research and Software Development Engineer

www.mecr.org: Development lead for India's first online education portal that implements a blended learning system. Designed and led a team of 5 people for the development, evangelism, and support of www.mecr.org. Currently the platform is being used by 6 universities in India and is in its second semester pilot. We have over 5000 students registered and active on the service.

Root Causing Anomalous behavior in big data: worked on a new method for root causing anomalies in big data systems such as Bing. Worked directly inside the Bing system to implement root causing of alerts issued by Bing monitoring services for rise or drops in various KPIs that are measured continuously.

Verification technologies: researching new methods of doing incremental verification, verification for large code bases and enterprises, and designing a system that enables verification to be consumed as a service. The work aims to generalize the technologies used in Static Driver Verifier, produce new analysis methods for C/C++ code and enable large scale verification using Azure as the cloud technology provider.

Microsoft, Redmond, WA

Senior Software Development Engineer

2008 – 2012

Responsibilities:

- Research, design, and implement new techniques for static analysis and exhaustive verification of Windows device drivers. Breadth of work includes
 - Compiler modifications and compiler plugin development
 - Analysis engine algorithm research and development
 - Investigation of parallelization and distribution techniques

- Evaluate new technologies/techniques in research domain for applicability in improving existing software verification techniques
 - o Work with various Microsoft research teams around the world and evaluate their ideas for funneling into the product
- Co-create and contribute to long term verification strategy inside Windows
- Develop and maintain Static Driver Verifier (SDV) and SLAM (co-own) projects that are the *defacto* static analysis tools used in Windows for device driver analysis
- Ensure proper integration and existence with Windows Driver Kit (parent product with which SDV ships)
- Work with Kernel teams such as Windows Driver Framework (KMDF/UMDF) and provide consultation on verification, further development of framework, etc.

Accomplishments:

- Successfully integrated SDV into the Windows Phone development environment
 - o Introduced Windows Phone to SDV, provided education and consultation for usage and deployment of SDV
 - o Provided tools for creating a static analysis baseline for Windows Phone drivers and consulted with them on how to fix defects discovered by SDV
- Successfully developed and released first version of SDV integrated with Visual Studio for driver development
- Successfully developed and released SLAM2 with version 2.1 of SDV during Windows 7 timeframe. This resulted in the discovery of hundreds of defects in device drivers
- Created new algorithms in SLAM2 for global pointer analysis, forward/backward analysis of defect traces, predicate abstraction, and high level algorithm for orchestrating verification
- Increased scalability and performance of SDV with improved SLAM2 verification engine to verify larger drivers
- Successfully filed patent application for SLAM2 techniques

Microsoft, Redmond, WA

Software Development Intern

June 2006 – Sep 2006

- Design and implement prototype of SLAM2, with an improved CEGAR loop for performing verification of small C programs

- Implemented new abstraction and path validation techniques in SLAM that rely on weakest precondition as opposed to strongest postcondition. Developed various tools for testing and development of new verification engine
- SLAM2 eventually shipped with Windows 7!

Brigham Young University, Provo, UT

Graduate Teaching Assistant

Jan 2004 – Aug 2008

Worked as a graduate assistant during MS and PhD.

Masaryk University, Brno, Czech Republic

Visiting Research Assistant

Aug 2004 – Dec 2004

Worked in the capacity of a visiting researcher at the Parallel and Distributed Systems Engineering Lab (ParaDiSe) with Lubos Brim on exchanging ideas in distributed verification algorithms.

Microsoft, Redmond, WA

Software Development Engineer in Test Intern

May 2001 – Aug 2001

- Developed system integration test cases and suites for testing the LDAP services in Windows Server
- Implemented a network object discovery protocol by extending the COM XML parser and writing a matching algorithm for matching existing network objects to required objects for tests specified in XML files.

Novell, Provo, UT

Software Test Lead

1999 – 2000

- Developed test plans, test suites, automation software, and individual test cases for products being developed on the Novell Directory Services (NDS) platform
- Provided weekly quality reports, defect reports, analysis, and plans for maturing respective products and enabling their completion.

PAPERS

- RAHUL KUMAR, CHETAN BANSAL, JAKOB LICHTENBERG. STATIC ANALYSIS USING THE CLOUD. IFMCLOUD 2016, REYKJAVIK, ICELAND.
- KUMAR, R., BALL, T., LICHTENBERG, J., DEISINGER, N., UPRETI, A., & BANSAL, C. CLOUDSDV ENABLING STATIC DRIVER VERIFIER USING MICROSOFT AZURE. IN INTERNATIONAL CONFERENCE ON INTEGRATED FORMAL METHODS (PP. 523-536), 2016, JUNE. SPRINGER INTERNATIONAL PUBLISHING.
- M. BROJ, K. HAVELUND, AND R. KUMAR. TOWARDS A UNIFIED VIEW OF MODELING AND PROGRAMMING. ISOLA 2016, CORFU, GREECE.
- M. BROJ, K. HAVELUND, R. KUMAR, AND B. STEFFEN. TOWARDS A UNIFIED VIEW OF MODELING AND PROGRAMMING (TRACK SUMMARY). ISOLA 2016, CORFU, GREECE.
- K. HAVELUND, R. KUMAR, C. DELP AND B. CLEMENT. *K: A WIDE SPECTRUM LANGUAGE FOR MODELING, PROGRAMMING, AND ANALYSIS*. MODELSWARD 2016 4TH INTERNATIONAL CONFERENCE ON MODEL-DRIVEN ENGINEERING AND SOFTWARE DEVELOPMENT. 19-21 FEBRUARY 2016 - ROME, ITALY.
- K. HAVELUND AND R. KUMAR. *VERIFIED CHANGE*. SUBMITTED TO FOMAC: TRANSACTIONS ON FOUNDATIONS FOR MASTERING CHANGE (EDITED BY BERNHARD STEFFEN). UNDER REVIEW. FIRST ISSUE CONTAINING SUBMISSIONS FROM THE EDITORIAL BOARD. SUBMITTED 2015.
- CYRILLE VALENTIN ARTHO, KLAUS HAVELUND, RAHUL KUMAR AND YORIYUKI YAMAGATA. DOMAIN SPECIFIC LANGUAGES WITH SCALA, TO APPEAR IN ICFEM2015, PARIS, FRANCE, NOVEMBER 2015.
- VARUN TULSIAN, ADITYA KANADE, RAHUL KUMAR, AKASH LAL, AND ADITYA V. NORI. MUX: ALGORITHM SELECTION FOR SOFTWARE MODEL CHECKERS, IN MINING SOFTWARE REPOSITORIES (MSR), ACM, MAY 2014.
- ANDREW CROSS, B. ASHOK, SRINATH BALA, EDWARD CUTRELL, NAREN DATHA, AND RAHUL KUMAR (MICROSOFT RESEARCH INDIA), VIRAJ KUMAR (PES UNIVERSITY), MADHUSUDAN PARTHASARATHY (UNIVERSITY OF ILLINOIS AT URBANA CHAMPAIGN), AND SIDDHARTH PRAKASH, SRIRAM RAJAMANI, SATISH SANGAMESWARAN, DEEPIKA SHARMA, AND WILLIAM THIES (MICROSOFT RESEARCH INDIA). ONLINE LEARNING VERSUS BLENDED LEARNING: AN EXPLORATORY STUDY. LEARNING AT SCALE 2014. MARCH 2014.

- RANJITA BHAGWAN, RAHUL KUMAR, RAMACHANDRAN RAMJEE, GEORGE VARGHESE, SURJYAKANTA MOHAPATRA, HEMANTH MANOHARAN, AND PIYUSH SHAH, ADTRIBUTOR: REVENUE DEBUGGING IN ADVERTISING SYSTEMS, IN SYMPOSIUM ON NETWORKED SYSTEMS DESIGN AND IMPLEMENTATION (NSDI), USENIX, APRIL 2014
- RAHUL KUMAR AND ADITYA V. NORI. THE ECONOMICS OF STATIC ANALYSIS TOOLS. IN ESEC-FSE '13: FOUNDATIONS OF SOFTWARE ENGINEERING (INDUSTRIAL TRACK), AUGUST 2013
- AWS ALBARGHOUSHI, RAHUL KUMAR, ADITYA V. NORI AND SRIRAM K. RAJAMANI, *PARALLELIZING TOP-DOWN INTERPROCEDURAL ANALYSES*. PLDI '12
- THOMAS BALL, ELLA BOUNIMOVA, RAHUL KUMAR, AND VLADIMIR LEVIN. *SLAM2: STATIC DRIVER VERIFICATION WITH UNDER 4% FALSE ALARMS*. FMCAD 2010
- THOMAS BALL, ELLA BOUNIMOVA, VLADIMIR LEVIN, JAKOB LICHTENBERG, MARINA POLISHCHUK, AND RAHUL KUMAR. *THE STATIC DRIVER VERIFIER RESEARCH PLATFORM*. COMPUTER AIDED VERIFICATION - CAV, PP. 119-122, 2010.
- RAHUL KUMAR AND ERIC MERCER. *IMPROVING LIVE SEQUENCE CHART TO AUTOMATA TRANSLATION FOR VERIFICATION*. ELECTRONIC COMMUNICATION OF THE EUROPEAN ASSOCIATION OF SOFTWARE SCIENCE AND TECHNOLOGY - ECEASST, VOL. 10.
- RAHUL KUMAR AND ERIC MERCER. *VERIFYING COMMUNICATION PROTOCOLS USING LIVE SEQUENCE CHARTS*. ELECTRONIC NOTES IN THEORETICAL COMPUTER SCIENCE - ENTCS, VOL. 250, NO. 2, PP. 33-48, 2009.
- RAHUL KUMAR, ERIC MERCER, AND ANNETTE BUNKER. *IMPROVING LIVE SEQUENCE CHART TO TEMPORAL LOGIC TRANSLATION*. *ELECTRONIC NOTES IN THEORETICAL COMPUTER SCIENCE - ENTCS, VOL. 250, NO. 1, PP. 137-152, 2009*.
- RAHUL KUMAR AND ERIC MERCER. *LOAD BALANCING PARALLEL EXPLICIT STATE MODEL CHECKING*. ELECTRONIC NOTES IN THEORETICAL COMPUTER SCIENCE - ENTCS, VOL. 128, NO. 3, PP. 19-34, 2005.
- MICHAEL JONES, ERIC MERCER, TONGLAGA BAO, RAHUL KUMAR, AND PETER LAMBORN. *BENCHMARKING EXPLICIT STATE PARALLEL MODEL CHECKERS*. ELECTRONIC NOTES IN THEORETICAL COMPUTER SCIENCE - ENTCS , VOL. 89, NO. 1, PP. 84-98, 2003.

THESIS

- RAHUL KUMAR. USING LIVE SEQUENCE CHARTS FOR FORMAL VERIFICATION OF SYSTEMS, BRIGHAM YOUNG UNIVERSITY, PROVO, UT. DECEMBER 2008.
- RAHUL KUMAR. LOAD BALANCING PARALLEL EXPLICIT STATE MODEL CHECKING, BRIGHAM YOUNG UNIVERSITY, PROVO, UT, JUNE 2004.

TECHNICAL REPORTS

- MADHUSUDAN PARTHASARATHY, SIDDHARTH PRAKASH, SRIRAM RAJAMANI, WILLIAM THIES. MASSIVELY EMPOWERED CLASSROOM: ENHANCING TECHNICAL EDUCATION IN INDIA.
- RAHUL KUMAR, MICHAEL JONES, JOHN LESUER, AND ERIC MERCER. EXPLORING DYNAMIC PARTITIONING SCHEMES IN HOPPER. COMPUTER SCIENCE DEPARTMENT, BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH, SEPTEMBER 2003.
- RAHUL KUMAR AND ERIC MERCER. VERIFYING TEMPORAL AND EPISTEMIC PROPERTIES OF MULTI-AGENT SYSTEMS USING LIVE SEQUENCE CHARTS. COMPUTER SCIENCE DEPARTMENT, BRIGHAM YOUNG UNIVERSITY, PROVO, UTAH, SEPTEMBER 2008.

EDUCATION

Brigham Young University, Provo, UT

Ph.D. in Computer Science

2008

Dissertation: Using Live Sequence Charts for Formal Verification of Systems

Advisor: Eric G Mercer

Brigham Young University, Provo, UT

M.S. in Computer Science

2004

Thesis: Load Balancing Parallel Explicit State Model Checking

Advisor: Eric G Mercer

Brigham Young University, Provo, UT

B.S. in Computer Engineering

2002

AWARDS

Patent US8402444 B2	
Various Technology Transfer Awards	2010 - 2012
Engineering Excellence Award for SLAM2 and SDV	2009
Doctoral Fellowship, <i>Brigham Young University</i>	2003 – 2007
Doctorate Scholarship, <i>Masaryk University</i>	2004
Academic Scholarships, <i>Brigham Young University</i>	1998 – 2002

TEACHING EXPERIENCE

Brigham Young University, Provo, UT

Various teaching and assistantship positions

1999 – 2008

Computer Science Department

Developed syllabus and lectures, delivered lectures, and managed grading along with other teaching functions. Specific courses: Data Structures and Programming, Introduction to Operating Systems, Program analysis and Model Checking.

REFERENCES AVAILABLE UPON REQUEST