

# AJITHA RAJAN

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## EDUCATION

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**Ph.D.** in Computer Science, University of Minnesota, Minneapolis.

*Graduation Date:* July 2009

Advisor: Dr. Mats P.E. Heimdahl.

Thesis title: *Coverage Metrics for Requirements-Based Testing.*

The dissertation focuses on resolving research issues related to software validation. Defines coverage metrics directly over formal high-level requirements that provide objective adequacy measures for software validation testing. Also, provides an approach and framework for automatically generating test cases directly from requirements.

**Master of Science** in Computer Engineering, University of Minnesota.

*Graduation Date:* April 2007

**BTech** (Bachelors in Technology) in Information Technology, Sri Venkateswara College of Engineering, University of Madras, India.

*Graduation Date:* May 2002.

## RESEARCH EXPERIENCE

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**Dec 2015 – Present. Lecturer (UK term for Asst. Professor)**, School of Informatics, University of Edinburgh, UK.

Working on techniques for automating and optimising test executions, measuring quality of software tests, and more recently in integrating machine learning techniques into software engineering tasks.

**Dec 2012 – Nov 2015. Chancellor's Fellow**, School of Informatics, University of Edinburgh.

Diversified research into automated test execution and optimisations for execution time and energy.

**Jan 2011 – Nov 2012.** (*inclusive of a 6 month Maternity Leave*)

**Post Doctorate**, Department of Computer Science, University of Oxford, UK.

Currently working on an approach for formally verifying software changes and updates in continuously evolving software systems.

**Oct 2008 – Dec 2010.** (*inclusive of a 6 month Maternity Leave*)

**Post Doctorate**, Laboratoire d'Informatique de Grenoble (LIG), Grenoble, France.

Defined coverage metrics over finite state machines and Lustre language in the SCADE 6

synchronous modeling language from Esterel Technologies. Also, formally specified test oracles and generated tests for home automation systems implemented using service-oriented architecture.

**Jun 2004 – July 2008. Research Assistant**, Department of Computer Science and Engineering, University of Minnesota, Minneapolis.

Worked on several projects in collaboration with Rockwell Collins Inc. (NASA contract NCC-01001), NASA Ames Research Center (Cooperative Agreement NNA06CB21A), NASA IV&V Facility (Contract NNG-05CB16C). Primary contribution in these projects has been providing formal verification and validation capabilities.

## CAREER BREAKS

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Apr 2012 – Oct 2012 Maternity Leave

Dec 2009 – Jun 2010 Maternity Leave

## RESEARCH AND POSTGRADUATE SUPERVISION

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Postdoctoral Researcher Adel Nourredine (2014–2015).

Current PhD Students Panagiotis Stratis<sup>1</sup> (2015–now), Vanya Yaneva (2015–now), Chao Peng (2017–now), Sefa Akca (started in June 2018).

Masters Students Kostas Kyrimis (2018), Bowen Du (2018), Nourah Aloboud (2017), Yao Wang (2017), Bothinah Almutairi (2017), Jivan Virdee (2016), Xinyu Wang (2016), Boris Penev (2016), Panagiotis Stratis (2014).

## PEER-REVIEWED PUBLICATIONS

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Panagiotis Stratis, Vanya Yaneva, **Ajitha Rajan**. Assessing the Effect of Data Transformations on Test Suite Compilation. *In proceedings of ESEM 2018*. To Appear in October 2018.

Panagiotis Stratis, **Ajitha Rajan**. Speeding up Test Execution with Increased Cache Locality. Accepted in STVR Journal. DOI: 10.1002/stvr.1671. To Appear in August 2018 - Volume 28, Issue 5.

Vanya Yaneva, **Ajitha Rajan**, Christophe Dubach. Compiler-Assisted Test Acceleration on GPUs for Embedded Software. In proceedings of ISSTA 2017. July 2017.

Vanya Yaneva, **Ajitha Rajan**, Christophe Dubach. ParTeCL: Parallel Testing Using OpenCL. In proceedings of ISSTA 2017 Demonstrations. July 2017.

Boris Penev, **Ajitha Rajan**. Sensitivity of Application Performance to Resource Availability. *In proceedings of ValueTools 2016*. October 2016.

Panagiotis Stratis, **Ajitha Rajan**. Test Case Permutation to Improve Execution Time. *In proceedings of ASE 2016*. September 2016.

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<sup>1</sup>Panos received a bronze medal in the ACM Student Research Competition held at ICSE 2016

**Ajitha Rajan** , Adel Nouredine, Panagiotis Stratis. A Study on the Influence of Software and Hardware Features on Program Energy. *In proceedings of ESEM 2016*. September 2016.

Gregory Gay, **Ajitha Rajan** , Matt Staats, Michael Whalen, Mats Heimdahl. The Effect of Program and Model Structure on the Effectiveness of MC/DC Test Adequacy Coverage. *TOSEM Journal*. Volume 25, Issue 3. August 2016.

**Ajitha Rajan**, Daniel Kroening. Measuring Change Impact on Program Behaviour. *Validation of Evolving Software*. 2015. Pages 125 - 145. Springer International Publishing.

Adel Nouredine, **Ajitha Rajan**. Optimising Energy Consumption of Design Patterns. *In proceedings of the 37th IEEE/ACM International Conference on Software Engineering, ICSE 2015*, pages 623 - 626, May 2015, Florence, Italy.

**Ajitha Rajan**, Subodh Sharma, Peter Schrammel, Daniel Kroening. Accelerated Test Execution using GPUs. *In proceedings of the 29th IEEE/ACM International Conference on Automated Software Engineering, ASE 2014*, pages 97 - 102, September 2014, Vasteras, Sweden.

Virginia Papailiopolou, **Ajitha Rajan**, Ioannis Parissis. Structural Test Coverage Criteria for Integration Testing of LUSTRE/SCADE Programs. *In proceedings of the 16th International Workshop on Formal Methods for Industrial Critical Systems FMICS 2011*, Pages 85-101, July 2011.

**Ajitha Rajan**, Lydie du Bousquet, Yves Ledru, German Vega, Jean-Luc Richier. Assertion-based test oracles for home automation systems. *In Proceedings of the 7th International Workshop on Model-Based Methodologies for Pervasive and Embedded Software, MOMPES 10*, Antwerp, Belgium, Sep. 2010.

Matt Staats, Michael Whalen, **Ajitha Rajan**, and Mats Heimdahl. Coverage Metrics for Requirements-Based Testing: Evaluation of Effectiveness. *Second NASA Formal Methods Symposium*, Washington D.C., USA, April 2010.

Lydie Du Bousquet, **Ajitha Rajan**, Catherine Oriat, Jean-Luc Richier, and German Vega. Service Specification and Validation in the Context of the Home. *In proceedings of the 10th International Conference on Feature Interactions (ICFI 2009)*, Lisbon, Portugal. Jun 2009.

(\*) Matt Staats, Weijia Deng, **Ajitha Rajan**, Mats Heimdahl, Kurt Woodham. Reqs-Cov: A Tool for Measuring Test-Adequacy over Requirements. *In Proceedings of the 23rd IEEE/ACM International Conference on Automated Software Engineering, ASE 2008* , pages 499 - 500, L'Aquila, Italy, Sep 2008.

(\*) **Ajitha Rajan**, Michael Whalen, Matt Staats and Mats Heimdahl. Requirements Coverage as an Adequacy Measure for Conformance Testing. *In Proceedings of the 10th International Conference on Formal Engineering Methods(ICFEM 2008)*, pages 86 - 104, Kitakyushu, Japan, Oct 2008. *Acceptance Rate 32% (62 Submitted, 10 Accepted)*

(\*) **Ajitha Rajan**, Michael Whalen and Mats Heimdahl. The Effect of Program and Model Structure on MC/DC Test Adequacy Coverage. *In Proceedings of the 22nd IEEE International Conference on Software Engineering (ICSE 2008)*, pages 161-170, Leipzig, Germany, May 2008. *Awarded ACM Distinguished Paper. Acceptance Rate 15% (371 Submitted, 56 Accepted)*

Mats P.E. Heimdahl, Michael W. Whalen, **Ajitha Rajan**, and Matt Staats. On MC/DC and Implementation Structure: An Empirical Study. *Proceedings of the 27<sup>th</sup> IEEE Digital Avionics Systems Conference – DASC 2008*. Oct 26-30, 2008. *Awarded Best Paper in the software track*.

**Ajitha Rajan** and Mats Heimdahl. Challenges in Automated Testing Beyond Test Case Generation. *Workshop on State-space Exploration for Automated Testing (SSEAT 2008, co-located with ISSTA08)*, Seattle, USA, July 2008.

**Ajitha Rajan** and Mats Heimdahl. Assessing Requirements Quality Through Requirements Coverage. *The Sixth NASA Langley Formal Methods Workshop*, Virginia, USA, May 2008.

**Ajitha Rajan**, Michael Whalen and Mats Heimdahl. Model Validation Using Automatically Generated Requirements-Based Tests. *In Proceedings of the 10<sup>th</sup> IEEE High Assurance Systems Engineering Symposium (HASE 2007)*, pages 95-104, Dallas, USA, November 2007. *Acceptance Rate 33% (100 Submitted, 33 Accepted)*

Renee Bryce, **Ajitha Rajan** and Mats Heimdahl. Interaction Testing in Model-Based Development: Effect on Model Coverage. *In Proceedings of the 13<sup>th</sup> Asia Pacific Conference on Software Engineering (APSEC 2006)*, pages 259-268, Bangalore, India, Dec 2006. *Acceptance Rate 25% (230 Submitted, 59 Accepted)*

Michael Whalen, **Ajitha Rajan**, Mats Heimdahl and Steven Miller. Coverage Metrics for Requirements-Based Testing. *In Proceedings of the ACM/SIGSOFT International Symposium on Software Testing and Analysis , (ISSTA 2006)*, pages 25-36, Portland, USA, July, 2006. *Acceptance Rate 24% (82 Submitted, 20 Accepted)*

## BOOKS AND JOURNALS

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(\*) Panagiotis Stratis, **Ajitha Rajan**. Speeding up Test Execution with Increased Cache Locality. Accepted in STVR Journal - May 2018. To Appear in August 2018 – Volume 28, Issue 5.

(\*) **Ajitha Rajan**, Matt Staats, Gregory Gay, Michael Whalen and Mats Heimdahl. The Effect of Program and Model Structure on MC/DC Test Adequacy Coverage. *ACM Transactions on Software Engineering and Methodology (TOSEM)*. Colume 25, Issue 3, pages 1–34. July 2016.

*Author of chapter* in the book, *Validation of Evolving Software*, published by Springer in August 2015. ISBN 978-3-319-10623-6.

(\*) *Co-ordinator and editor* of the CESAR Project Book. CESAR is a European funded project from ARTEMIS Joint Undertaking. The book was published by Springer International in May 2013.

## OTHER PUBLICATIONS

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Panagiotis Stratis, **Ajitha Rajan**. Reordering Tests for Faster Test Suite Execution. In ICSE 2018 Posters Track. May 2018.

Pamela Farries, **Ajitha Rajan**. PINCETTE - Validating Changes and Upgrades in Networked Software. *ERCIM News 2012*(88).

**Ajitha Rajan**. Automated Requirements-Based Test Case Generation, *Foundations of Software Engineering (FSE 2006)*, Portland, Oregon, Nov 2006.

**Ajitha Rajan**. Coverage Metrics to Measure Adequacy of Black-Box Test Suites. *In Proceedings of the 21<sup>st</sup> IEEE/ACM International Conference on Automated Software Engineering, ASE 2006 (Doctoral Symposium)*, pages 335-338, Tokyo, Japan, Sep 2006.

Mats Heimdahl, Michael Whalen, **Ajitha Rajan** and Steven Miller. Testing Strategies for Model-Based Development. NASA Technical Report. 2006. Document ID: 20060018336; Report Number: NASA CR-2006-214307.

## INVITED TALKS

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Compiler Optimisations for Test Executions. Dagstuhl Seminar on Testing and Verification of Compilers, Dagstuhl, Germany. Dec 2017.

Improving Energy Efficiency of Software Development and Testing. University of California, San Diego, April 2016.

Challenges in Measuring Software Quality. Microsoft Research, Cambridge, August 2013.

Coverage Metrics for Requirements-Based Testing. VERIMAG Research Lab, Grenoble, France, Mar 2008.

Coverage Metrics for Requirements-Based Testing. LIG Research Lab, Grenoble, France, Mar 2008.

Model Validation in Model-Based Development. NASA Software Assurance Symposium (SAS 07), West Virginia, Sep 2007.

Introduction to Model Checking and Lustre Translator Framework. NASA Independent Verification and Validation Facility, West Virginia. Jan 2007.

## AWARDS

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Huawei Innovation Research Program Open 2018 Award. *“Smart Contracts: Testing and Analysis of Safety and Correctness”*. Application has been selected, agreement is being processed.

SICSA PECE Grant in August 2016.

GCHQ Equipment Grant in March 2015. *“Accelerated security testing using GPUs”*.

EPSRC First Grant, July 2014 to Jan 2016. *“Verifying Changes: How Much Will it Cost”*.

Chancellor’s Fellowship, Dec 2012 to 2017, School of Informatics, University of Edinburgh, UK

Best paper award (software track): 27<sup>th</sup> IEEE Digital Avionics Systems Conference (DASC 2008), October 26-30, 2008. *“On MC/DC and Implementation Structure: An Empirical Study”* with Michael W. Whalen, Mats P.E. Heimdahl, and Matt Staats.

ACM Distinguished Paper Award. 22<sup>nd</sup> IEEE International Conference on Software Engineering. Leipzig, Germany, May, 2008. *“The Effect of Program and Model Structure on MC/DC Test Adequacy Coverage”* with Mats P.E. Heimdahl and Michael W. Whalen.

Graduate School Fellowship. University of Minnesota, Sep 2002 - May 2003.

## OTHER ACCOMPLISHMENTS

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Selected to present research at Honeywell Nobel Initiative Conference at the University of Minnesota, Oct 2007.

Nominated for University of Minnesota Doctoral Dissertation Fellowship 2007-2008.

## PROFESSIONAL SERVICE

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*PC Member* for International Conference on Software Engineering (ICSE 2019).

*PC Member* for European Conference on Object-Oriented Programming (ECOOP 2019).

*Journal reviewer* of Formal Methods in System Design (2018).

*Associate editor* of IET Software Journal (2017 – now).

*Journal reviewer* of Transaction on Software Engineering (2017). Journal of Systems and Software (2016), Transaction on Software Engineering and Methodology (2012 –2013).

*PC Member* for Formal Methods in Computer-Aided Design (FMCAD 2017).

*PC Member* for 2015, 2016 Grace Hopper Celebration of Women in Computing, Productization track.

*PC Member* for 37th ACM/IEEE International Conference on Software Engineering - ACM Student Research Competition, ICSE 2015 SRC.

*PC Member* for 8th India Software Engineering Conference, ISEC 2015.

*Publicity Chair* for 26th IEEE/ACM International Conference on Automated Software Engineering, ASE 2011.

*PC Member* for 25th IEEE/ACM International Conference on Automated Software Engineering, ASE 2010.

*PC Member* for 24th IEEE/ACM International Conference on Automated Software Engineering, ASE 2009.

*PC Member* for International Conference for Software Testing (ICST 2008), for Student Paper Track.

*PC Member* for Graduate Student Research Symposium (GSRS 2007) held at University of California, Irvine.