

Roopsha Samanta

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Research Interests

I work at the intersection of formal methods and programming languages to develop algorithms and tools for assisting programmers in writing reliable programs. My research interests are in program synthesis, program verification, and concurrency. My current research agenda is centered around two themes—semantics-driven inductive program synthesis and formal reasoning about distributed systems.

Education

- 2013 **Doctor of Philosophy**, The University of Texas at Austin.
Dissertation: *Program Reliability through Algorithmic Design and Analysis*
Advisors: E. Allen Emerson and Vijay K. Garg
- 2003 **Master of Science**, The University of Texas at Austin.
Report: *Joint Space-time Interference Cancellation and Channel Shortening*
Advisor: Robert W. Heath, Jr.
- 2002 **Bachelor of Engineering**, University of Mumbai.

Professional Experience

- Aug. 2016 – current **Assistant Professor** *Department of Computer Science, Purdue University.*
- Jan. 2014 – June 2016 **Postdoctoral Researcher** *Institute of Science and Technology Austria.*
Host: Thomas A. Henzinger
- Fall 2009 **Research Intern** *Microsoft Research, Bangalore.*
- Summer 2005 **Research Intern** *Intel Labs, Santa Clara.*

Awards

- 2020 Purdue College of Science Team Award.
- 2019 NSF CAREER Award.
- 2019 Purdue Seed for Success Award.
- 2019 Purdue College of Science Team Award.
- 2019 Purdue Research Foundation Grant Award.

Publications

*In the author listings for publications first-authored, led, or co-led by me, my name is rendered in **boldface**.*

Peer-reviewed Journals and Conference Papers

- CAV 2020 N. Jaber, S. Jacobs, C. Wagner, M. Kulkarni, and **R. Samanta**. *Parameterized Verification of Systems with Global Synchronization and Guards*. In *Computer Aided Verification (CAV)*, 2020
- FMCAD 2020 X. Lin, H. Zhu, **R. Samanta**, and S. Jagannathan. *ART: Abstraction Refinement-Guided Training for Provably Correct Neural Networks*. In *Formal Methods in Computer Aided Design (FMCAD)*, 2020

- PACMPL (POPL) 2020 S. An, S. Misailovic, R. Singh and **R. Samanta**. *Augmented Example-based Synthesis using Relational Perturbation Properties*. In Proceedings of the ACM on Programming Languages (PACMPL), Issue POPL, 2020
- SAS 2019 Q. Hu, R. Samanta, R. Singh, and L. D'Antoni. *Direct Manipulation for Imperative Programs*. In Static Analysis Symposium (SAS), 2019
- PLDI 2019 D. M. Perry, D. Kim, **R. Samanta**, and X. Zhang. *SemCluster: Clustering of Imperative Programming Assignments Based on Quantitative Semantic Features*. In Programming Language Design and Implementation (PLDI)2019
- FMSD 2017 P. Černý, E. M. Clarke, T. A. Henzinger, A. Radhakrishna, L. Ryzhyk, **R. Samanta** and T. Tarrach. *From Non-preemptive to Preemptive Scheduling using Synchronization Synthesis*. In Formal Methods in System Design (FMSD), 2017
- CAV 2016 L. D'Antoni, **R. Samanta** and R. Singh. *Qlose: Program Repair with Quantitative Objectives*. In Computer Aided Verification (CAV), 2016
- VMCAI 2016 T. A. Henzinger, J. Otop and R. Samanta. *Lipschitz-Robustness of Timed I/O Systems*. In Verification, Model Checking and Abstract Interpretation (VMCAI), 2016.
- CAV 2015 P. Černý, E. M. Clarke, T. A. Henzinger, A. Radhakrishna, L. Ryzhyk, **R. Samanta** and T. Tarrach. *From Non-preemptive to Preemptive Scheduling using Synchronization Synthesis*. In Computer Aided Verification (CAV), 2015. **Runner-up in the CAV 2015 Artifact Evaluation.**
- POPL 2015 A. Gupta, T. A. Henzinger, A. Radhakrishna, T. Tarrach and **R. Samanta**. *Succinct Representation of Concurrent Trace Sets*. In Principles of Programming Languages, 2015. **Approved by the POPL 2015 Artifact Evaluation Committee.**
- FSTTCS 2014 T. A. Henzinger, J. Otop and **R. Samanta**. *Lipschitz-Robustness of Finite-State Transducers*. In Foundations of Software Technology and Theoretical Computer Science (FSTTCS), 2014.
- SAS 2014 **R. Samanta**, O. Olivo and E. A. Emerson. *Cost-aware Program Repair*. In Static Analysis Symposium (SAS), 2014.
- ATVA 2013 **R. Samanta**, J. V. Deshmukh and S. Chaudhuri. *Robustness Analysis of String Transducers*. In Automated Technology for Verification and Analysis (ATVA), 2013.
- VMCAI 2013 **R. Samanta**, J. V. Deshmukh and S. Chaudhuri. *Robustness Analysis of Networked Systems*. In Verification, Model Checking and Abstract Interpretation (VMCAI), 2013.
- ATVA 2011¹ E. A. Emerson and **R. Samanta**. *An Algorithmic Framework for Synthesis of Concurrent Programs*. In Automated Technology for Verification and Analysis (ATVA), 2011.
- FMCAD 2008 **R. Samanta** J. V. Deshmukh and E. A. Emerson. *Automatic Generation of Local Repairs for Boolean Programs*. In Formal Methods in Computer Aided Design (FMCAD), 2008.
- VT 2007 **R. Samanta**, R. W. Heath, Jr., and B. L. Evans. *Joint Interference Cancellation and Channel Shortening for Multi-User MIMO Systems*. IEEE Transactions on Vehicular Technology, vol. 56, pp. 652-660, 2007.
- ACHA 2007 B. Mondal, R. Samanta, and R. W. Heath, Jr. *On the Voronoi Tessellations of a Sphere by an Equiangular Unit Norm Frame*. Applied and Computational Harmonic Analysis, vol. 23, pp. 254-258, 2007.
- Asilomar 2005 **R. Samanta** and R. W. Heath, Jr. *Codebook Adaptation for Quantized MIMO Beamforming Systems*. In IEEE Asilomar Conference on Signals, Systems, and Computers, 2005.
- WNCMC 2005 B. Mondal, R. Samanta and R. W. Heath, Jr. *Frame Theoretic Quantization of Limited Feedback MIMO Beamforming Systems*. In Wireless Networks, Communications and Mobile Computing, 2005.
- Asilomar 2003 **R. Samanta**, R. W. Heath, Jr. and B. L. Evans. *Joint Space-Time Interference Cancellation and Channel Shortening*. In IEEE Asilomar Conference on Signals, Systems, and Computers (invited), 2003.

Peer-reviewed Workshops

SYNT 2012 **R. Samanta.** *Towards Algorithmic Synthesis of Synchronization for Shared-Memory Concurrent Programs.* In Workshop on Synthesis (SYNT)

Patents

[1] N. Himayat, R. Samanta, and S. Talwar. *Link Performance Prediction Presence of Co-channel Interference.* US Patent 7,697,906. 2010.

Tutorials

POPL 2015 A. Radhakrishna and R. Samanta. *Trace-based Synchronization Synthesis for Concurrent Programs.* In Principles of Programming Languages (POPL), 2016.

Teaching

Spring 2019, 2020, 2021 *Reasoning About Programs.* Introductory graduate course on program verification and synthesis. Purdue CS.

Fall 2018, 2019, 2020 *Software Engineering I.* Required undergraduate course in Software Engineering Track. Purdue CS.

Spring 2017 *Programming Languages.* Required undergraduate course in Programming Languages Track. Purdue CS.

Fall 2016, 2017 *Computer-Aided Program Reasoning.* Graduate seminar on program verification and synthesis. Purdue CS.

Research Group

Current Graduate Students

Fall 2021 – Caleb Helbling (Purdue CS)
Fall 2020 – Yongwei Yuan (Purdue CS)
Research project: MANTIS: *Semantics-Guided Inductive Program Synthesis.*

Fall 2018 – Christopher Wagner (Purdue CS)
Research project: DISCOVER[I]: *Component-based Parameterized Reasoning for Distributed Systems.*

Spr. 2017 – Nouraldin Jaber (Purdue ECE). Co-supervisor: Milind Kulkarni.
Research project: DISCOVER[I]: *Component-based Parameterized Reasoning for Distributed Systems.*

Graduated Students

Spr. 2017 – Fall 2018 David Perry (M.S., Purdue CS). Co-supervisor: Xiangyu Zhang.
Research project: MANTIS: *Semantics-Guided Inductive Program Synthesis.* (Paper: PLDI 2019)

Past Graduate Student Supervision

Fall 2017 – Fall 2020 Xuankang Lin (Purdue CS). Co-supervisor: Suresh Jagannathan.
Research project: *Reliable AI.* (Paper: FMCAD 2020)

Summer 2019 Marcel Moosbrugger (Intern from TU, Wien, GoBoiler Internship Program).
Research project: *Reliable AI.*

Fall 2017 – Spr. 2019 Shengwei An (Purdue CS).
Research project: MANTIS: *Semantics-Guided Inductive Program Synthesis.* (Paper: POPL 2020)

Past Undergraduate Student Supervision

Spr. 2019 – Spr. 2020 Arya Barve (Purdue CS).

- Research project: DISCOVER[I]: *Component-based Parameterized Reasoning for Distributed Systems*.
- Summer 2019 Yugesh Kothari (Intern from IIT, Kanpur).
 Research project: *Abstraction-guided Program Repair*.
- Spr. 2018 Austin Horning (Purdue CS).
 Research project: *Data-driven Repair of Web Applications*.
- Sum. 2017 Mohan Sai Teja Dantam (Intern from IIT, Bombay).
 Research project: MANTIS: *Semantics-Guided Inductive Program Synthesis*.

Funding

- co-PI *HACCLE: High-Assurance Compositional Cryptography: Languages and Environments*. IARPA Homomorphic Encryption Computing Techniques with Overhead Reduction Award. Milind Kulkarni, Tiark Rompf, Roopsha Samanta, Hemanta Maji, Aniket Kate, Christina Garman, Benjamin Delaware, and Jeremiah Blocki. My amount: \$123,838. Award period: Jun. 6, 2019 — May 31, 2020.
- PI *Collaborative Research: Verification Mentoring Workshop at Computer Aided Verification 2019-2021*. #1905108 NSF CCF Award. Roopsha Samanta and Loris D’Antoni (UW Madison). My amount: \$66,800. Award period: May 1, 2019 — Apr. 30, 2022.
- PI *CAREER: Robustness of Inductive Reasoning Engines*. #1846327 NSF CCF Award. My amount: \$580,000. Award period: Mar. 1, 2019 — Feb. 29, 2024.
- co-PI *Formal Methods for Robust Machine Learning*. Purdue Integrative Data Science Initiative Award. Jennifer Neville, Dan Goldwasser, Bruno Ribeiro, Roopsha Samanta, and Tiark Rompf. My amount: \$8,097. Award period: June 1 2018 — May 31 2020.
- PI *Data Driven Program Repair*. Purdue Research Foundation Award. My amount: \$30,144 (1 graduate student). Award period: June 1 2018 — Sep 14 2019.

Professional Service

- Co-Founder and Steering Committee member Workshop on Design and Analysis of Robust Systems (DARS). 2016—
- General Chair Machine Programming Symposium (MAPS). Co-located with PLDI 2021
- Co-Chair Programming Language Design and Implementation (PLDI)-Artifact Evaluation. 2019
 Workshop on Design and Analysis of Robust Systems (DARS). Co-located with CAV 2017, CPSWeek 2016
- Publicity Chair Computer Aided Verification (CAV). 2016
- Program Committee Computer-Aided Verification (CAV). 2021, 2019, 2018, 2017
 Programming Language Design and Implementation (PLDI). 2021
 Principles of Programming Languages (POPL). 2020
 Programming Language Design and Implementation (PLDI) External Review Committee. 2019
 Object-oriented Programming, Systems, Languages, and Applications (OOPSLA). 2018
 Formal Methods in Computer Aided Design (FMCAD). 2017
 Verification, Model Checking and Abstract Interpretation (VMCAI). 2017, 2016
 Workshop on Synthesis (SYNT) 2018, 2017, 2016
- Journal Reviewer ACM Transactions on Programming Languages and Systems (TOPLAS)
 Formal Methods in System Design (FMSD)
 IEEE Transactions on Communications
 IEEE Transactions on Signal Processing
 IEEE Transactions on Vehicular Technology

- Conference Reviewer Programming Language Design and Implementation (PLDI). 2016
 Formal Modeling and Analysis of Timed Systems (FORMATS). 2015
 Foundations of Software Science and Computation Structures (FOSSACS). 2013
 Tools and Algorithms for the Construction and Analysis of Systems (TACAS). 2013
 Automated Technology for Verification and Analysis (ATVA). 2012, 2007,
 International Conference On Principles Of Distributed Systems (OPODIS). 2012
 Computer Aided Verification (CAV). 2009
 Formal Methods for Computer Aided Design (FMCAD). 2008
- Book Reviewer Handbook of Model Checking. Editors: E. M. Clarke, Thomas A. Henzinger and
 Helmut Veith. Springer 2018,
 Introduction to Lattice Theory with Computer Science Applications. Vijay K. Garg.
 Wiley & Sons 2015
- Proposal Reviewer NSF Computing and Communication Foundations Panels. 2018, 2017

Outreach

- Steering Committee Verification Mentoring Workshop (VMW). 2020—
- Chair Verification Mentoring Workshop (VMW). CAV 2020
- Committee Member Verification Mentoring Workshop (VMW). CAV 2021
 Student Research Competition. POPL 2018
- Panelist Purdue CAREER Workshop Panel. 2019
 Programming Languages Mentoring Workshop (PLMW). POPL 2017, PLDI 2017
 CERIAS Symposium Panel on “Formal Methods and Secure Architecture”. 2017
- Presentations Recruitment Talk for Purdue CS graduate program and GoBoiler internship program
 for students at Masaryk University, Czech Republic. 2018
 CS591. *Research Seminar for Graduate Students*. 2020, 2019, 2017, 2016
 CS397. *Topics in Computer Sciences (Honors)*. 2019, 2017, 2016
 CS197. *Topics in Computer Sciences (Honors)*. 2021, 2019, 2018, 2017
 SCI195. *Global Science Leadership Seminar*. 2017
 Service Learning. *Outreach course, MAGIC (Mentors for Aspiring Girls in Computing)*
section, 2017
- Other Women in CS: Female faculty and graduate students meetup to discuss “Academia as
 a Future Career Path”. 2018, 2016

Presentations

Invited Talks

- MANTIS: Semantics-Guided Inductive Program Synthesis*
- Dec. 2020 First NeurIPS Workshop on Computer-Assisted Programming (CAP) (**Keynote**)
- Nov. 2020 CODE MESH V
- Computer-aided Concurrent Programming*
- Sep. 2018 Invited talk highlighting advances in synchronization synthesis for concurrent programs
 over the last four decades at Papers We Love (PWL) Conference, St. Louis, USA
- Formal Methods Research: The What, The Why and the How*
- Jun. 2017 Invited talk on overview of research in formal methods for students attending the
 Programming Languages Mentoring Workshop (PLMW) at Programming Languages
 Design and Implementation (PLDI), Barcelona, Spain
- Program Distances for Repair and More!*
- May 2017 Invited Junior Researcher Presentation at Summit oN Advances in Programming
 Languages (SNAPL), Asilomar, USA

Invited Seminars

- MANTIS: Semantics-Guided Inductive Program Synthesis*
Jan. 2021 Microsoft PROSE Team
Dec. 2020 University of California at San Diego
- Discover[i]: Component-based Parameterized Reasoning for Distributed Systems*
Nov. 2018 University of Washington, Washington, USA
Nov. 2018 Microsoft Research, Redmond, USA
- Trace-based Synchronization Synthesis for Concurrent Programs*
Nov. 2017 University of Illinois at Urbana-Champaign, Urbana, USA
- Computer-aided Programming for Concurrency and Beyond*
Mar. 2016 Georgia Institute of Technology, Atlanta, USA
Mar. 2016 Purdue University, West Lafayette, USA
Feb. 2016 Simon Fraser University, Burnaby, Canada
Sep. 2015 Microsoft Research, Cambridge, UK
Jul. 2015 Samsung Research America, Mountain View, USA
Jul. 2015 University of California, Berkeley, USA
June 2015 Northeastern University, Boston, USA
- Lipschitz Robustness of I/O Systems*
Jun. 2015 Max Planck Institute for Software Systems, Kaiserslautern, Germany
- Succinct Representation of Concurrent Trace Sets*
May 2015 University of Oxford, Oxford, UK
Feb. 2015 Vienna University of Technology, Vienna, Austria
- Robustness Analysis of Networked Systems*
Jan. 2013 Institute of Science and Technology Austria
Jan. 2013 Vienna University of Technology
- ### Conference Talks
- Augmented Example-Based Synthesis using Relational Perturbation Properties*
Jan. 2020 Principles of Programming Languages (POPL), New Orleans, USA
- Qlose: Program repair with Quantitative Objectives*
Jul. 2016 Computer Aided Verification (CAV), Toronto, Canada
- From Non-preemptive to Preemptive Scheduling using Synchronization Synthesis*
Jul. 2015 Computer Aided Verification (CAV), San Francisco, USA
- Succinct Representation of Concurrent Trace Sets*
Jan. 2015 Principles of Programming Languages (POPL), Mumbai, India
- Lipschitz Robustness of Finite-State Transducers*
Dec. 2014 Foundations of Software Technology and Theoretical Computer Science (FSTTCS), New Delhi, India
- Cost-aware Program Repair*
Sep. 2014 Static Analysis Symposium (SAS)
- Robustness Analysis of String Transducers*
Oct. 2013 Automated Technology for Verification and Analysis (ATVA), Hanoi, Vietnam
- An Algorithmic Framework for Synthesis of Concurrent Programs*

Oct. 2011 Automated Technology for Verification and Analysis (ATVA), Taipei, Taiwan
Automatic Generation of Local Repairs for Boolean Programs

Nov. 2008 Formal Methods in Computer Aided Design (FMCAD)

Talks at Workshops and Meetings

Discover[i]:Component-based Parameterized Reasoning for Distributed Systems

Sep. 2019 PurPL Fest and Midwest Programming Languages Summit, Purdue University, West Lafayette, USA

Logic-based Repair of Neural Networks

Aug. 2018 IDSI Deep Learning Workshop, Purdue University, West Lafayette, USA

Qlose: Program repair with Quantitative Objectives

Dec. 2016 Midwest Programming Languages Summit, University of Chicago, Chicago, USA

Towards Computer-aided Concurrent Programming

Jun. 2015 Annual Expeditions in Computer Augmented Program Engineering (ExCAPE) meeting, Massachusetts Institute of Technology, Boston, USA

Robustness Analysis of Transducers

May 2014 Alpine Verification Meeting, Frejus, France

Synchronization Synthesis for Shared-Memory Concurrent Programs

Jan. 2013 Principles of Programming Languages (POPL) Student Talk, Rome, Italy

Towards Algorithmic Synthesis of Synchronization for Shared-Memory Concurrent Programs

Jul. 2012 Workshop on Synthesis (SYNT), colocated with CAV, Berkeley, USA

Apr. 2012 Dagstuhl Seminar on Software Synthesis, Wadern, Germany