

Mukund Raghothaman

941 Bloom Walk SAL 308 – Los Angeles, CA 90089

+1 (302) 438 2978 • +1 (213) 821-0853 • raghotha@usc.edu
r-mukund.github.io

Research Interests

Program synthesis, formal verification, probabilistic methods in static analysis, programming abstractions for stream processing

Education

University of Pennsylvania

Ph.D. in Computer Science

Thesis: *Regular Programming over Data Streams*

Advisor: Rajeev Alur

Philadelphia, PA

September, 2010–May, 2017

Indian Institute of Technology Guwahati

Bachelor of Technology in Computer Science

Thesis: *State Reachability in Counter Automata*

Advisor: Purandar Bhaduri

Guwahati, India

August, 2006–May, 2010

Experience

University of Southern California

Assistant Professor

Department of Computer Science

Los Angeles, CA

August, 2019–Present

University of Pennsylvania

Postdoctoral Researcher

Advisor: Mayur Naik

I combined probabilistic and logical reasoning techniques to reduce false alarm rates, incorporating user feedback, and improving the usability of static analysis tools [PLDI18, MLP18, PLDI19, IJCAI19].

Philadelphia, PA

May, 2017–August, 2019

École Polytechnique Fédérale de Lausanne

Visiting Researcher

Advisor: Viktor Kuncak

I worked on using patterns derived from code corpora and developed probabilistic enumeration techniques to improve the state of the art in program synthesis algorithms [TR17].

Lausanne, Switzerland

September–December, 2016

Microsoft Research Ltd.

Research Intern

Advisor: Youssef Hamadi, Yi Wei

I developed an algorithm to extract API usage idioms from open-source C# projects and a program synthesizer to answer natural language API-related queries [ICSE16].

Cambridge, UK

June–August, 2013, June–August, 2014

Teaching

CSCI 599, An Introduction to Programming Languages

Graduate / Undergraduate

University of Southern California

Fall 2020

CSCI 699, Computer-Aided Verification
Graduate

University of Southern California
Spring 2020, Spring 2021

CIS 700, Software Analysis and Testing
Graduate

University of Pennsylvania
Fall 2018

Guest lecture on program synthesis.

CIS 400, Senior Design Project
Undergraduate

University of Pennsylvania
Fall 2018

Mentoring a group of four seniors to integrate continuous program reasoning tools into repository hosting services such as GitHub.

CIS 500, Software Foundations
Graduate

University of Pennsylvania
Spring 2012

Teaching assistant. Helped with updating and creating new pedagogical material, homework assignments and exams, and conducted office hours.

CIS 262, Automata, Computability, and Complexity
Undergraduate

University of Pennsylvania
Fall 2011

Teaching assistant. Conducted office hours, prepared solutions to assignments and exams, and graded them.

Ph.D. Students

1. Nathaniel Sands. Fall 2020–Present.
2. Yifei Huang. Joining Summer 2021.
3. Amirmohammad Nazari. Joining Fall 2021.

Publications

Drafts

- [TR20b] Hyunsu Kim, Mukund Raghothaman, and Kihong Heo. Synthesizing Bayesian Alarm Ranking Systems for Static Analysis. In submission. 2020.
- [TR20a] Aalok Thakkar, Aaditya Naik, Nathaniel Sands, Mukund Raghothaman, Mayur Naik, and Rajeev Alur. Example-Guided Synthesis of Relational Queries. In submission. 2020.

Conference Papers

- [AAAI21] Jonathan Mendelson, Aaditya Naik, Mayur Naik, and Mukund Raghothaman. GenSynth: Synthesizing Datalog Programs Without Language Bias. In: *Proceedings of the 35th AAAI Conference on Artificial Intelligence*. To appear. 2021.
- [ICSE2021] Jingbo Wang, Chungha Sung, Mukund Raghothaman, and Chao Wang. Provably Sound Synthesis of Side-Channel Analyzers from Data. In: *Proceedings of the 43rd International Conference on Software Engineering*. To appear. 2021.
- [POPL20] Mukund Raghothaman, Jonathan Mendelson, David Zhao, Mayur Naik, and Bernhard Scholz. Provenance-Guided Synthesis Of Datalog Programs. In: *Proceedings of the 47th ACM SIGPLAN Symposium on Principles of Programming Languages*. POPL. ACM, 2020.
- [PLDI19] Kihong Heo, Mukund Raghothaman, Xujie Si, and Mayur Naik. Continuous Program Reasoning via Differential Bayesian Inference. In: *Proceedings of the 40th ACM SIGPLAN Conference on Programming Language Design and Implementation*. PLDI. SIGPLAN Distinguished Paper Award. ACM, 2019, pp. 561–575.

- [IJCAI19] Xujie Si, Mukund Raghothaman, Kihong Heo, and Mayur Naik. Synthesizing Datalog Programs By Numerical Relaxation. In: *Proceedings of the 28th International Joint Conference on Artificial Intelligence*. IJCAI. International Joint Conferences on Artificial Intelligence Organization, 2019, pp. 6117–6124.
- [PLDI18] Mukund Raghothaman, Sulekha Kulkarni, Kihong Heo, and Mayur Naik. User-Guided Program Reasoning Using Bayesian Inference. In: *Proceedings of the 39th ACM SIGPLAN Conference on Programming Language Design and Implementation*. PLDI. ACM, 2018, pp. 722–735.
- [MLP18] Mukund Raghothaman, Sulekha Kulkarni, Richard Zhang, Xujie Si, Kihong Heo, Woosuk Lee, and Mayur Naik. Beyond Deductive Methods in Program Analysis. In: *Machine Learning for Programming*. 2018.
- [NeurIPS18] Xujie Si, Hanjun Dai, Mukund Raghothaman, Mayur Naik, and Le Song. Learning Loop Invariants for Program Verification. In: *Advances in Neural Information Processing Systems 31*. NeurIPS (Spotlight). 2018, pp. 7762–7773.
- [PLDI17] Konstantinos Mamouras, Mukund Raghothaman, Rajeev Alur, Zachary Ives, and Sanjeev Khanna. StreamQRE: Modular Specification and Efficient Evaluation of Quantitative Queries Over Streaming Data. In: *Proceedings of the 38th ACM SIGPLAN Conference on Programming Language Design and Implementation*. PLDI. ACM, 2017, pp. 693–708.
- [ESOP16] Rajeev Alur, Dana Fisman, and Mukund Raghothaman. Regular Programming for Quantitative Properties of Data Streams. In: *Programming Languages and Systems: 25th European Symposium on Programming*. ESOP. Springer, 2016, pp. 15–40.
- [ICSE16] Mukund Raghothaman, Yi Wei, and Youssef Hamadi. SWIM: Synthesizing What I Mean. Code Search and Idiomatic Snippet Synthesis. In: *Proceedings of the 38th International Conference on Software Engineering*. ICSE. ACM, 2016, pp. 357–367.
- [POPL15] Rajeev Alur, Loris D’Antoni, and Mukund Raghothaman. DReX: A Declarative Language for Efficiently Evaluating Regular String Transformations. In: *Proceedings of the 42nd Annual Symposium on Principles of Programming Languages*. POPL. ACM, 2015, pp. 125–137.
- [CAV15] Rajeev Alur, Mukund Raghothaman, Christos Stergiou, Stavros Tripakis, and Abhishek Udupa. Automatic Completion of Distributed Protocols With Symmetry. In: *Proceedings of the 27th International Conference on Computer Aided Verification*. CAV. Springer, 2015, pp. 395–412.
- [LICS14] Rajeev Alur, Adam Freilich, and Mukund Raghothaman. Regular Combinators for String Transformations. In: *Proceedings of the Joint Meeting of the 23rd Annual Conference on Computer Science Logic and the 29th Annual Symposium on Logic in Computer Science*. CSL-LICS. ACM, 2014, 9:1–9:10.
- [HVC14] Rajeev Alur, Milo Martin, Mukund Raghothaman, Christos Stergiou, Stavros Tripakis, and Abhishek Udupa. Synthesizing Finite-State Protocols from Scenarios and Requirements. In: *Hardware and Software: Verification and Testing: Proceedings of the 10th International Haifa Verification Conference*. HVC. Springer, 2014, pp. 75–91.
- [FMCAD13] Rajeev Alur, Rastislav Bodik, Garvit Juniwal, Milo Martin, Mukund Raghothaman, Sanjit Seshia, Rishabh Singh, Armando Solar-Lezama, Emina Torlak, and Abhishek Udupa. Syntax-Guided Synthesis. In: *Formal Methods in Computer-Aided Design*. FMCAD. Extended version published as [DSSE15]. IEEE, 2013, pp. 1–8.
- [LICS13] Rajeev Alur, Loris D’Antoni, Jyotirmoy Deshmukh, Mukund Raghothaman, and Yifei Yuan. Regular Functions and Cost Register Automata. In: *Proceedings of the 28th Annual Symposium on Logic in Computer Science*. LICS. IEEE, 2013, pp. 13–22.

- [ICALP13] Rajeev Alur and Mukund Raghothaman. Decision Problems for Additive Regular Functions. In: *Proceedings of the 40th International Colloquium on Automata, Languages, and Programming, Part II. ICALP*. Springer, 2013, pp. 37–48.

Journal Papers

- [TCS20] Rajeev Alur, Dana Fisman, Konstantinos Mamouras, Mukund Raghothaman, and Caleb Stanford. Streamable Regular Transductions. In: vol. 807. Elsevier, 2020, pp. 15–41.
- [DSSE15] Rajeev Alur, Rastislav Bodik, Eric Dallah, Dana Fisman, Pranav Garg, Garvit Juniwal, Hadas Kress-Gazit, Madhusudan Parthasarathy, Milo Martin, Mukund Raghothaman, Shambwaditya Saha, Sanjit Seshia, Rishabh Singh, Armando Solar-Lezama, Emina Torlak, and Abhishek Udupa. Syntax-Guided Synthesis. In: *Dependable Software Systems Engineering*. IOS Press, 2015, pp. 1–25.

Theses

- [Ths17] Mukund Raghothaman. Regular Programming over Data Streams. PhD thesis. University of Pennsylvania, 2017.

Technical Reports

- [TR17] Manos Koukoutos, Mukund Raghothaman, Etienne Kneuss, and Viktor Kuncak. On Repair with Probabilistic Attribute Grammars. Tech. rep. In submission. 2017. CoRR: abs/1707.04148.
- [TR14] Mukund Raghothaman and Abhishek Udupa. Language to Specify Syntax-Guided Synthesis Problems. Tech. rep. 2014. CoRR: abs/1405.5590.

Invited Talks

Precise Program Reasoning Using Probabilistic Methods

Workshop on Declarative Program Analysis

June 2019

Software

Bingo, Drake

Interactive systems for prioritizing static analysis alarms by confidence and relevance [PLDI18, MLP18, PLDI19]

<https://github.com/difflog-project/bingo>

CODE2INV

System to automatically synthesize loop invariants by reinforcement learning [NeurIPS18]

<https://github.com/PL-ML/code2inv>

Difflog [IJCAI19], Prosynth [POPL20]

Systems to learn Datalog queries from input-output examples

<https://github.com/petablox/difflog>, <https://github.com/petablox/pop12020-artifact>

SyGuS

Interchange format for syntax-guided synthesis problems [FMCAD13, TR14]

<https://github.com/rishabhs/syguS-comp14>

SWIM

Natural language code search [ICSE16]

StreamQRE

Domain-specific language for easy, efficient stream processing [TCS20, Ths17, PLDI17, ESOP16]

<http://www.cis.upenn.edu/~rmukund/StreamQRE.html>

DReX

Highly expressive DSL for string transformations supporting fast, one-pass evaluation [Ths17, POPL15, LICS14]

<https://bitbucket.org/strexp/drex>

Awards

1. SIGPLAN Distinguished Paper Award at PLDI 2019 for paper describing Drake.
2. Second place in SyGuS competition 2014 for the stochastic SyGuS solver STOCH.
3. Honourable mention at the ACM ICPC Asia Regionals, 2009, held at IIT Kanpur.
4. National Talent Search Scholarship, 2004, by the National Council for Educational Research and Training.

Service

OOPSLA 2020	External Review Committee Member
SYNT 2020	Program Committee Member
CAV 2020	Program Committee Member
PLDI 2020	Program Committee Member
SYNT 2019	Program Committee Member
IBM PL Day 2018	Selection Committee Member
CAV 2017	Artifact Evaluation Committee Member
CAV 2016	Artifact Evaluation Committee Member
POPL 2016	Artifact Evaluation Committee Member
PLDI 2016	External Review Committee Member