

# Mukund Ragothaman

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## Research Interests

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My research is at the intersection of programming languages and software engineering. I draw on techniques from machine learning and formal methods to solve problems in program synthesis, verification, and static analysis. My goal is to build theoretically well-understood, rigorously evaluated, and practically useful tools to help programmers create better software with less effort.

## Education

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### 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

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### University of Pennsylvania

*Postdoctoral Researcher*

Advisor: Mayur Naik

By combining probabilistic and logical reasoning techniques, I am reducing false alarm rates, incorporating user feedback, and improving the usability of static analysis tools [PLDI18, MLP18, TR18b].

Philadelphia, PA

May, 2017–Present

### 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

### Microsoft Corporation

*Software Development Engineer Intern*

Manager: Bill Ramsey

I developed a prototype Visual Studio plugin for SCOPE, a SQL-like language used internally at Microsoft.

Redmond, WA

May–July, 2009

## Teaching

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### CIS 500, Software Foundations

University of Pennsylvania

Graduate

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

University of Pennsylvania

Undergraduate

Fall 2011

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

## Publications

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Drafts.....

- [TR18a] Rajeev Alur, Dana Fisman, Konstantinos Mamouras, Mukund Raghothaman, and Caleb Stanford. Streamable regular transductions. Tech. rep. In submission. 2018. CoRR: abs/1807.03865.
- [TR18b] Mukund Raghothaman, Richard Zhang, Xujie Si, Kihong Heo, and Mayur Naik. Difflog: Learning Datalog programs by continuous optimization. In submission. 2018.
- [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.

Conference papers.....

- [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.
- [NIPS18] 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 (Spotlight; to appear)*. 2018.
- [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.....

- [DSSE15] Rajeev Alur, Rastislav Bodik, Eric Dallal, 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.....

- [TR14] Mukund Raghothaman and Abhishek Udupa. Language to specify syntax-guided synthesis problems. Tech. rep. 2014. CoRR: abs/1405.5590.

## Software

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### **Bingo**

*Interactive system for ranking static analysis alarms [PLDI18, MLP18]*

### **CODE2INV**

*System to automatically synthesize loop invariants by reinforcement learning [NIPS18]*

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

### **Difflog**

*System to learn Datalog queries from input-output relations using numerical optimization [TR18b, MLP18]*

### **SyGuS**

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

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

### **SWIM**

*Natural language code search [ICSE16]*

## **StreamQRE and DReX**

*Domain-specific languages for easy, efficient stream processing [TR18a, Ths17, PLDI17, ESOP16, POPL15, LICS14]*  
<https://bitbucket.org/strexp/drex>

## **Awards**

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1. Second place in SyGuS competition 2014 for the stochastic SyGuS solver `stoch`.
2. Honourable mention at the ACM ICPC Asia Regionals, 2009, held at IIT Kanpur.
3. National Talent Search Scholarship, 2004, by the National Council for Educational Research and Training.

## **Service**

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<b>IBM PL Day 2018</b>	Selection Committee Member (Upcoming)
<b>CAV 2017</b>	Artifact Evaluation Committee Member
<b>CAV 2016</b>	Artifact Evaluation Committee Member
<b>POPL 2016</b>	Artifact Evaluation Committee Member
<b>PLDI 2016</b>	External Review Committee Member