

# Rishabh Singh

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## Research Interests

Neural program synthesis and reasoning. Combining neural and symbolic techniques for achieving human-like programming skills.

## Employment

- 2/2018– Present **Research Scientist**, *Google Brain*, Google, Mountain View, CA.  
Neural architectures for program synthesis and program reasoning.
- 9/2016– 1/2018 **Researcher**, *Cognition Group*, Microsoft Research, Redmond, WA.  
Neural architectures for program synthesis and program reasoning.
- 7/2014– 8/2016 **Researcher**, *RiSE Group*, Microsoft Research, Redmond, WA.  
Program synthesis techniques for data wrangling and program repair.
- 5/2012– 8/2012 **Research Intern**, *Dr. Sumit Gulwani*, Microsoft Research, Redmond, WA.  
Using machine learning to rank string transformation programs in FlashFill.
- 5/2011– 8/2011 **Research Intern**, *Dr. Sumit Gulwani*, Microsoft Research, Redmond, WA.  
Learning lookup transformations using input-output examples.
- 5/2010– 8/2010 **Research Intern**, *Dr. Sumit Gulwani*, Microsoft Research, Redmond, WA.  
Semantic entity manipulations using input-output examples.
- 6/2009– 8/2009 **Research Intern**, *Dr. Dimitra Giannakopoulou and Dr. Corina Păsăreanu*, NASA Ames Research Center, Mountain View, CA.  
Using May and Must abstractions for learning component interfaces.
- 12/2007– 1/2008 **Intern**, *Prof. Andrey Rybalchenko*, Max Planck Institute of Software Systems, Saarbrücken, Germany.  
Demand Driven Abstraction Refinement.
- 5/2007– 7/2007 **Intern**, *Prof. Thomas Henzinger and Dr. Andrey Rybalchenko*, Ecole Polytechnique Federal de Lausanne, Lausanne, Switzerland.  
Lazy Abstraction Heuristics in ARMC.

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## Education

2008–2014 **PhD, Computer Science**, *Massachusetts Institute of Technology*, MA.

advisors: Prof. Armando Solar-Lezama and Dr. Sumit Gulwani

thesis: Accessible programming using program synthesis, Awarded *George M. Sprowls Award* for best PhD thesis in Computer Science, MIT

2008–2010 **MS, Computer Science**, *Massachusetts Institute of Technology*, MA.

advisor: Prof. Armando Solar-Lezama

gpa: 5.0/5.0

thesis: Storyboard Programming of Data Structure Manipulations, Awarded *William A. Martin Memorial Thesis Award* for outstanding master thesis

2004–2008 **BTech(H), Computer Science**, *IIT Kharagpur*, WB, India.

gpa: 9.60/10.0

honors: Ranked 1<sup>st</sup> (68) in the Department of Computer Science (*Institute Silver Medal*) and 2<sup>nd</sup> (750) in the Institute (*Bigyan Sinha Memorial Award*)

2004 **CBSE AISSCE**, *Kendriya Vidyalaya ONGC*, Dehradun, UK, India.

honors: Ranked 1<sup>st</sup> in India (97.6%), Awarded to be *Prime Minister's guest* at Republic Day Parade, New Delhi

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## Publications

ICLR 2020 Vincent J. Hellendoorn, Charles Sutton, Rishabh Singh, Petros Maniatis, David Bieber. **Global Relational Models of Source Code** 8<sup>th</sup> International Conference on Learning Representations, 2020

POPL 2020 Shengwei An, Rishabh Singh, Sasa Misailovic, Roopsha Samanta. **Augmented Example-based Synthesis using Relational Perturbation Properties**. 47<sup>th</sup> SIGPLAN Symposium on Principles of Programming Languages, 2020

ESOP 2020 Rong Pan, Qinheping Hu, Rishabh Singh, and Loris D'Antoni. **Solving Program Sketches with Large Integer Values**. 29<sup>th</sup> European Symposium on Programming, 2020

NeurIPS 2019 Hanjun Dai, Yujia Li, Chenglong Wang, Rishabh Singh, Po-Sen Huang, Pushmeet Kohli. **Learning Transferable Graph Exploration**. 33<sup>rd</sup> Annual Conference on Neural Information Processing Systems, 2019

ICLR 2019 Marko Vasic, Aditya Kanade, Petros Maniatis, David Bieber, Rishabh Singh. **Neural Program Repair by Jointly Learning to Localize and Repair** 7<sup>th</sup> International Conference on Learning Representations, 2019

- ICLR 2019 Richard Shin, Neel Kant, Kavi Gupta, Chris Bender, Brandon Trabucco, Rishabh Singh, Dawn Song. **Synthetic Datasets for Neural Program Synthesis** 7<sup>th</sup> International Conference on Learning Representations, 2019
- SAS 2019 Qinheping Hu, Roopsha Samanta, Rishabh Singh, Loris D'Antoni. **Direct Manipulation for Imperative Programs** 26<sup>th</sup> Static Analysis Symposium, 2019
- NeurIPS 2018 Xin Zhang, Armando Solar-Lezama, Rishabh Singh. **Interpreting Neural Network Judgments via Minimal, Stable, and Symbolic Corrections.** 33<sup>rd</sup> Annual Conference on Neural Information Processing Systems, 2018
- CACM 2018 Rajeev Alur, Rishabh Singh, Dana Fisman, Armando Solar-Lezama. **Search-based Program Synthesis.** [Communications of the ACM](#), 2018
- ICML 2018 Abhinav Verma, Vijayaraghavan Murali, Rishabh Singh, Pushmeet Kohli, and Swarat Chaudhuri. **Programmatically Interpretable Reinforcement Learning.** 35<sup>th</sup> International Conference on Machine Learning, 2018
- PLDI 2018 Ke Wang, Rishabh Singh, and Zhendong Su. **Search, Align, and Repair: Data-driven Feedback Generation for Introductory Programming Exercises** . 39<sup>th</sup> Conference on Programming Language Design and Implementation, Seattle, WA, 2013
- ICLR 2018 Ke Wang, Zhendong Su, and Rishabh Singh. **Dynamic Neural Program Embeddings for Program Repair** 6<sup>th</sup> International Conference on Learning Representations, 2018
- ICLR 2018 Rudy Bunel, Matthew Hausknecht, Jacob Devlin, Rishabh Singh, and Pushmeet Kohli. **Leveraging Grammar and Reinforcement Learning for Neural Program Synthesis** 6<sup>th</sup> International Conference on Learning Representations, 2018
- ICSE 2018 Sahil Bhatia, Pushmeet Kohli, and Rishabh Singh. **Neuro-Symbolic Program Repair for Correcting Introductory Programming Assignments.** 40<sup>th</sup> International Conference on Software Engineering, 2018
- POPL 2018 Jeevana Inala and Rishabh Singh. **WebRelate: Integrating Web Data with Spreadsheets using Examples.** 45<sup>th</sup> SIGPLAN Symposium on Principles of Programming Languages, 2018
- POPL 2018 Xinyu Wang, Isil Dillig, and Rishabh Singh. **Program Synthesis using Abstraction Refinement.** 45<sup>th</sup> SIGPLAN Symposium on Principles of Programming Languages, 2018
- NIPS 2017 Jacob Devlin, Rudy Bunel, Rishabh Singh, Matthew Hausknecht, and Pushmeet Kohli. **Neural Program Meta-induction.** 31<sup>st</sup> Annual Conference on Neural Information Processing Systems, 2017
- SNAPL 2017 Rishabh Singh and Pushmeet Kohli. **Artificial Programming.** 2<sup>nd</sup> Summit on Advances in Programming Languages, 2017

- ICLR 2017 Emilio Parisotto, Abdel-rahman Mohamed, Rishabh Singh, Lihong Li, Dengyong Zhou, and Pushmeet Kohli. **Neuro-symbolic Program Synthesis**. 5<sup>th</sup> International Conference on Learning Representations, 2017
- ICML 2017 Jacob Devlin, Jonathan Uesato, Surya Bhupatiraju, Rishabh Singh, Abdel-rahman Mohamed, and Pushmeet Kohli. **RobustFill: Neural Program Learning under Noisy I/O**. 34<sup>th</sup> International Conference on Machine Learning, 2017
- ASE 2017 Patrice Godefroid, Hila Peleg, and Rishabh Singh. **Learn&Fuzz: Machine Learning for Input Fuzzings**. 32<sup>nd</sup> IEEE/ACM International Conference on Automated Software Engineering, 2017
- OOPSLA2017 Xinyu Wang, Isil Dillig, and Rishabh Singh. **Synthesis of Data Completion Scripts using Finite Tree Automata**. 32<sup>nd</sup> International Conference on Object-Oriented Programming, Systems, Languages & Applications, 2017
- FSE 2017 Loris D'Antoni, Rishabh Singh, and Michael Vaughn. **NoFAQ: Synthesizing Command Repairs from Examples**. ACM SIGSOFT Symposium on the Foundations of Software Engineering, 2017
- NOW 2017 Sumit Gulwani, Oleksandr Polozov, and Rishabh Singh. **Program Synthesis**. Foundations and Trends in Programming Languages, 2017
- VLDB 2016 Rishabh Singh. **BlinkFill: Semi-supervised Programming By Example for Syntactic String Transformations**. 42<sup>nd</sup> International Conference on Very Large Databases, 2016
- OOPSLA2016 Xinyu Wang, Sumit Gulwani, and Rishabh Singh. **FIDEX: Filtering Spreadsheet Data using Examples**. 31<sup>st</sup> International Conference on Object-Oriented Programming, Systems, Languages & Applications, 2016
- CAV 2016 Loris D'Antoni, Roopsha Samanta, and Rishabh Singh. **Qlose: Program Repair with Quantitative Objectives**. 28<sup>th</sup> International Conference on Computer Aided Verification, Berkeley, CA, 2016
- CHI 2016 Parmit K. Chilana, Rishabh Singh, and Philip J. Guo. **Understanding Conversational Programmers: A Perspective from the Software Industry**. 34<sup>th</sup> International Conference on Human Factors in Computing Systems, 2016
- POPL 2016 Rishabh Singh, Sumit Gulwani, Armando Solar-Lezama. **Transforming Spreadsheet Data Types using Examples**. 43<sup>rd</sup> SIGPLAN Symposium on Principles of Programming Languages, 2016
- CAV 2015 Rishabh Singh and Sumit Gulwani. **Predicting a Correct Program in Programming by Example**. 27<sup>th</sup> International Conference on Computer Aided Verification, Berkeley, CA, 2015
- UIST 2015 Mikael Mayer, Gustavo Soares, Maxim Grechkin, Vu Le, Mark Marron, Oleksandr Polozov, Rishabh Singh, Benjamin Zorn, and Sumit Gulwani. **User Interaction Models for Disambiguation in Programming by Example**. 28<sup>th</sup> ACM User Interface Software and Technology Symposium, 2015

- TOCHI 2015 Elena L. Glassman, Jeremy Scott, Rishabh Singh, Philip J. Guo, and Robert C. Miller. **OverCode: Visualizing Variation in Student Solutions to Programming Problems at Scale.**
- VMCAI 2014 Rohit Singh, Rishabh Singh, Zhilei Xu, Rebecca Krosnick, Armando Solar-Lezama. **Modular Synthesis of Sketches using Models.** 15<sup>th</sup> International Conference on Verification, Model Checking, and Abstract Interpretation, San Diego, CA, 2014
- FMCAD 2013 Rajeev Alur, Rastislav Bodik, Garvit Juniwal, Milo Martin, Mukund Raghothaman, Sanjit Seshia, Rishabh Singh, Armando Solar-Lezama, Emina Torlak, Abhishek Udupa. **Syntax-Guided Synthesis.** 13<sup>th</sup> International Conference on Formal Methods in Computer-Aided Design, Portland, OR, 2013 (Invited Paper)
- PLDI 2013 Rishabh Singh, Sumit Gulwani, Armando Solar-Lezama. **Automated Feedback Generation for Introductory Programming Assignments.** 34<sup>th</sup> Conference on Programming Language Design and Implementation, Seattle, WA, 2013
- CACM 2012 Sumit Gulwani, William Harris, Rishabh Singh. **Spreadsheet Data Manipulation Using Examples.** [CACM Research Highlight](#), August 2012
- CAV 2012 Rishabh Singh, Sumit Gulwani. **Synthesizing Number Transformations from Input-Output Examples.** 24<sup>th</sup> International Conference on Computer Aided Verification, Berkeley, CA, 2012
- CAV 2012 Rishabh Singh, Armando Solar-Lezama. **SPT: Storyboard Programming Tool.** 24<sup>th</sup> International Conference on Computer Aided Verification, Berkeley, CA, 2012 (Tool Paper)
- VLDB 2012 Rishabh Singh, Sumit Gulwani. **Learning Semantic String Transformations from Examples.** 38<sup>th</sup> International Conference on Very Large Databases, Istanbul, Turkey, 2012
- FSE 2011 Rishabh Singh, Armando Solar-Lezama. **Synthesizing data-structure manipulations using Storyboards.** 8<sup>th</sup> joint meeting of the European Software Engineering Conference and the ACM SIGSOFT Symposium on the Foundations of Software Engineering, Szeged, Hungary, 2011
- CAV 2010 Rishabh Singh, Dimitra Giannakopoulou, Corina Pasareanu. **Learning Component Interfaces with May and Must Abstractions.** 22<sup>nd</sup> International Conference on Computer Aided Verification, Edinburgh, Scotland, UK, 2010
- ICSE 2009 Derek Rayside, Zev Benjamin, Rishabh Singh, Joseph P. Near, Aleksandar Milicevic, Daniel Jackson. **Equality and Hashing for (almost) Free: Generating Implementations from Abstraction Functions.** 31<sup>st</sup> International Conference on Software Engineering, Vancouver, Canada, 2009
- SPIN 2009 Andrey Rybalchenko, Rishabh Singh. **Subsumer-first: Steering Symbolic Reachability Analysis.** 16<sup>th</sup> International SPIN Workshop on Model Checking of Software, Grenoble, France, 2009

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## Awards

**George M. Sprowls Award** for outstanding PhD thesis in Computer Science, MIT, 2014

**Microsoft Research PhD Fellowship**, Microsoft Research, 2012-2014

**CACM Research Highlight** for FlashFill, CACM, 2012

**William A. Martin Memorial Thesis Award** for outstanding Master's thesis in Computer Science, MIT, 2010

**Institute Silver Medal** for best academic performance in the Department of Computer Science and Engineering, IIT Kharagpur, 2008

**Bigyan Sinha Memorial Prize** for securing 2<sup>nd</sup> position in the Institute, IIT Kharagpur, 2008

**Prime Minister's** guest at Republic Day Parade, Rajpath New Delhi, 2005 for securing 1<sup>st</sup> position in AISSCE CBSE 2004

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## Interns Supervised

- 2017 Matej Balog, Cambridge University
- 2017 Chenglong Wang, University of Washington
- 2017 Konstantin Bottinger, Fraunhofer Research Institute
- 2017 Robert Bowden, Harvard
- 2017 Ke Wang, UC Davis
- 2017 Saswat Anand, UCLA
- 2017 Qinheping Hu, Wisconsin
- 2016 Emilio Parisotto, CMU
- 2016 Jeevana Priya Inala, MIT
- 2016 Hila Peleg, Technion
- 2016 Ke Wang, UC Davis
- 2015 Dana Drachler-Cohen, Technion
- 2015 John Feser, Rice
- 2015 Thorsten Tarrach, IST Austria
- 2015 Xinyu Wang, UT Austin

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## Service

- Program Committee POPL 2017, PLDI 2017, ICML 2017, ISEC 2017
- Reviewer ICML 2017, NIPS 2017
- Co-organizer PLOOC 2015, ASSES 2015, CHESE 2016, Dagstuhl seminar on Inductive Programming 2017

SyGuS- Co-organizing the first Syntax-Guided Synthesis Competition (SyGuS-COMP  
COMP 2014) at FLOC 2014 with Rajeev Alur, Dana Fisman, and Armando Solar-  
Lezama.

External EMSOFT 2009, ESOP 2010, POPL 2011, VMCAI 2011, TACAS 2011, SAS  
Reviewer 2011, SAS 2013

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## Selected Press

### AutoGrader

MIT News Automatically grading programming homework.  
<http://web.mit.edu/newsoffice/2013/automatically-grading-programming-homework-0603.html>

MIT CSAIL The Auto Grader.  
Spotlight <http://www.csail.mit.edu/node/1886>

### FlashFill

MIT News Excel Programming for Nonprogrammers.  
<http://web.mit.edu/newsoffice/2012/excel-programming-for-nonprogrammers-0508.html>

Microsoft Flash Fill gives Excel a smart change.  
Research <http://research.microsoft.com/en-us/news/features/flashfill-020613.aspx>

CNN Money ...Excel 2013's coolest new feature that should have been available years ago...  
<http://cnnmoneytech.tumblr.com/post/27346588168/excel-2013s-coolest-new-feature-that-should-have-been?iid=EL>

Ars Technica ...One of the shock-and-awe features of the Excel 2013 demo was the "flash fill" feature...

ZDNet ...One of the more useful features in Flash Fill...

Times Of ...The most notable feature in Excel...  
India

<http://timesofindia.indiatimes.com/tech/itslideshow/15015129.cms>

Wired ...Excel is now a lot easier for people who aren't spreadsheet pros.  
<http://www.wired.com/gadgetlab/2012/07/first-look-at-microsoft-office-2013-and-office-365-going-to-the-cloud/2/>