Saswat Padhi

Curriculum Vitae • Last modified on October 6, 2024

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Interests

I am a backend generalist, primarily interested in low-level systems software. I hold a doctorate degree with a specialization in software analysis, synthesis and verification. More recently, my work has been focused on performance and reliability analyses of software systems in the industry.

Education

University of California, Los Angeles Sep 2014 – Jun 2020
(UCLA) *Los Angeles, CA*

- Philosophiae Doctor (Ph.D.), Computer Science · CGPA: 3.8/4.0
- *Specialization:* Programming Languages & Software Systems
- *Dissertation:* Data-Driven Learning of Invariants and Specifications
- *Advisor:* Professor Todd Millstein

Indian Institute of Technology, Bombay Aug 2010 – Apr 2014
(IIT-B) *Mumbai, India*

- Bachelor of Technology (B.Tech.), Computer Science and Engineering with Honors · CPI: 8.9/10.0
- *Undergraduate Thesis:* Lazy Static Slicing of Functional Programs
- *Advisors:* Professor Amitabha Sanyal, Professor Uday Khedker

D.A.V. Public School, Pokhariput 2004 – 2009
(DAV-Pkt) *Bhubaneswar, India*

- 2009 All India Senior School Certification Examination in Science · 96.0 %
- 2007 All India Secondary School Examination · 98.0 %

Employment

Google LLC Sep 2022 – Present
Senior Software Engineer *San Jose, CA*

- *Team:* ChromeOS Performance & ChromeOS Virtualization
- Performance measurement, analysis and improvement across browser and OS layers
- Designed a technique to predict performance metrics from device hardware specifications
- Resulting paper, *Predicting UX on Laptops from Hardware Specifications* (NeurIPS-MLSys 2023)

Amazon Inc. Aug 2020 – Sep 2022
Applied Scientist II *Boston, MA*

- *Team:* Automated Reasoning Group (ARG)
- Led the *inductive proofs* project: built compiler support for certifying safety of `C` code with loops
- Collaborated with AWS IoT team on formal analysis of their events monitoring systems
- Resulting paper, *Automated Analyses of IoT Event Monitoring Systems* (CAV 2023)
- Resulting patent, `US 12093160 B1`, granted in 2024
- Mentored 4 PhD interns; interviewed 30+ applied science and software engineering candidates

Microsoft Corp. · Oct 2017 – Aug 2018

(Part-Time) Research Software Development Engineer · *Remote (US)*

- *Team:* Research in Software Engineering (RiSE) group
- Worked on identifying data frames within spreadsheets and synthesizing formulas for data cells
- Resulting patent, US 12039257 B2, granted in 2024

Visiting Positions

Princeton University · Apr 2019 – Jun 2019

Visiting Research Collaborator · *Princeton, NJ*

- Collaboration with Prof. David Walker's team in the Programming Languages group
- Worked on extending my prior work on invariant synthesis to recursive data types
- Resulting paper, *Data-Driven Inference of Representation Invariants* (PLDI 2020)

Microsoft Research Lab - India · Sep 2018 – Mar 2019

Ph.D. Research Intern · *Bengaluru, India*

- Systems Research group, collaborating with Dr. Rahul Sharma
- Worked on optimizing my prior work on invariant synthesis with insights from machine learning
- Resulting paper, *Overfitting in Synthesis: Theory and Practice* (at CAV 2019)

Microsoft Research · Jun 2017 – Jun 2018

Ph.D. Research Intern · *Redmond, WA*

- Research in Software Engineering (RiSE) group, with Dr. Ben Zorn and Dr. Rishabh Singh
- Developed a neural (CNN-based) approach for identifying tables (data frames) in Excel sheets

Microsoft · Jun 2016 – Dec 2016

Ph.D. Research Intern · *Redmond, WA*

- Program Synthesis using Examples (PROSE) group, with Dr. Sumit Gulwani
- Worked on program synthesis techniques for pattern-based profiling of large-scale datasets
- Resulting paper, *FlashProfile: A Framework for Synthesizing Data Profiles* (OOPSLA 2018)

Google Inc. · May 2013 – Jul 2013

Summer Intern · *Mountain View, CA*

- Technical Infrastructure (TI) group, reporting to Smeeta Jalan
- Worked on test automation for Google's Borg and Omega cluster-management systems

Technische Universität Braunschweig (TU-Br) · May 2012 – Jul 2012

Summer Research Intern · *Braunschweig, Germany*

- Institut für Informationssysteme (IFIS), advised by Prof. Dr. Wolf-Tilo Balke
- Worked on a comparative analysis of bibliometric vs semantic measures for estimating topical similarity of scientific publications (primarily the PubMed corpus)

Honors and Awards

2020	*ACM SIGPLAN Distinguished Paper* award at the 41st PLDI Conference for "*Data-Driven Inference of Representation Invariants*" paper
2020	*Outstanding Research in Computer Science* award from UCLA
2019 – 2020	*Dissertation-Year Fellowship* from UCLA

2018	Gold medal at the 8th *Federated Logic Conference (FLoC)* in London, UK for multiple consecutive victories in the annual SyGuS Competition
2017, 2018	Winner of the annual *Syntax-Guided Synthesis (SyGuS) Competition*
2017 – 2019	*Ph.D. Fellowship* from Microsoft Research
2013	Winner of the *Prezi Scale Contest* hosted by HackerRank
2010 – 2014	FIITJEE Scholarship for achieving *All-India Rank 43 in IIT-JEE*
2008	*Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship* from the Department of Science and Technology, Government of India
2008, 2007	Selected (top 25 across India) in the Indian National Astronomy Olympiad (INAO)
2007	*National Talent Search Examination (NTSE) Scholarship* from the National Council of Education Research and Training (NCERT), India
2007	*Double gold medal* from the University of New South Wales (UNSW), Australia for Maths and CS in the International Assessment for Indian Schools (IAIS)
2005	Silver medal (All-India Rank 2) in the National Science Olympiad (NSO), India

Patent Grants and Applications

IoT Event detector correctness verification.
Vaibhav Sharma, Andrew Gacek, Michael Whalen, *Saswat Padhi*, Andrew Apicelli, Raveesh Yadav, Samuel Bayless, Roman Pruzhanskiy, Rajat Gupta, Harshil Shah, Fernando Dias Pauer, Ankush Das, Dhivashini Jaganathan

- 2024 Grant: US 12093160 B1
- A technique for verifying correctness of AWS IoT event detectors that models the event detectors as finite state machines and correctness properties as LTL constraints on them.
- Deployed as an analyzer in AWS IoT Events production service since December 2021.

Systems, methods, and computer-readable media for improved table identification using a neural network.
Ben Zorn, Marc Brockschmidt, Pallavi Choudhury, Alex Polozov, Rishabh Singh, *Saswat Padhi*

- 2024 Grant: US 12039257 B2
- A neural algorithm, based on convolutional neural networks (CNNs), for identifying regions of tabular data (also called *data frames*) within Excel spreadsheets.
- Initially implemented as a Microsoft Excel add-on.

Record profiling for dataset sampling.
Daniel Simmons, Kevin Grealish, Sumit Gulwani, Ranvijay Kumar, Kevin Ellis, *Saswat Padhi*

- 2020 Grant: US 10846298 B2
- An algorithm for sampling small, representative subsets of strings from very large datasets based on the *syntactic profiles* of the records in the dataset.
- Implemented in the `Matching.Text` library, publicly available as part of Microsoft PROSE SDK.

Syntactic profiling of alphanumeric strings.
Sumit Gulwani, Prateek Jain, Daniel Perelman, *Saswat Padhi*, Alex Polozov

- 2021 Grant: US 11210327 B2 · 2019 Grant: US 10394874 B2
- An algorithm for generating a *syntactic profile* for a collection of strings: a set of *RegExp* like patterns, each of which describes the structure of a subset of strings.
- Implemented in the `Matching.Text` library, publicly available as part of Microsoft PROSE SDK.

Publications

Journal Articles

1. **FlashProfile: A Framework for Synthesizing Data Profiles**. *OOPSLA 2018*
   Saswat Padhi, Prateek Jain, Daniel Perelman, Alex Polozov, Sumit Gulwani, Todd Millstein.
   In the proceedings of the ACM on Programming Languages (PACMPL) Vol. 2, Object-Oriented Programming, Systems and Applications issue, Article 150, 2018. 28 pages.
   DOI: 10.1145/3276520

Conference Proceedings

1. **Data-Driven Inference of Representation Invariants**. *PLDI 2020*
   Anders Miltner, *Saswat Padhi*, Todd Millstein, David Walker.
   In the proceedings of the 41st ACM SIGPLAN Conference on Programming Language Design and Implementation, London, UK, June 15–20, 2020. 19 pages.
   DOI: 10.1145/3395638 **(ACM SIGPLAN Distinguished Paper)**

2. **Overfitting in Synthesis: Theory and Practice**. *CAV 2019*
   Saswat Padhi, Todd Millstein, Aditya Nori, Rahul Sharma.
   In the proceedings of the 31st International Conference on Computer Aided Verification, Part I, New York City, NY, USA, July 15-18, 2019. 19 pages.
   DOI: 10.1007/978-3-030-25540-4_17

3. **A Static Slicing Method for Functional Programs and Its Incremental Version**. *CC 2019*
   Prasanna Kumar K., Amitabha Sanyal, Amey Karkare, *Saswat Padhi*.
   In the proceedings of the 28th International Conference on Compiler Construction, Washington, DC, USA, February 16–17, 2019. 12 pages.
   DOI: 10.1145/3302516.3307345

4. **Data-Driven Precondition Inference with Learned Features**. *PLDI 2016*
   Saswat Padhi, Rahul Sharma, Todd Millstein.
   In the proceedings of the 37th ACM SIGPLAN Conference on Programming Language Design and Implementation, Santa Barbara, CA, USA, June 13–17, 2016. 19 pages.
   DOI: 10.1145/2908080.2908099

Workshop Papers

1. **Predicting User Experience on Laptops from Hardware Specifications**. *NeurIPS 2023*
   Saswat Padhi, Sunil Bhasin, Udaya Kiran Ammu, Alex Bergman, Allan Knies. *ML4Sys*
   In the proceedings of the 2023 Workshop on Machine Learning for Systems at the Conference on Neural Information Processing Systems, New Orleans, LA, USA, December 16, 2023. 9 pages.
   (Invited for Oral Spotlight Presentation)

2. **OASIS: ILP-Guided Synthesis of Loop Invariants**. *NeurIPS 2020*
   Sahil Bhatia, *Saswat Padhi*, Nagarajan Natarajan, Rahul Sharma, Prateek Jain. *CAP*
   In the proceedings of the 2020 Workshop on Computer-Assisted Programming at the Conference on Neural Information Processing Systems (Virtual), December 12, 2020. 5 pages.

Industrial Experience Papers

1. **Automated Analyses of IoT Event Monitoring Systems**. *CAV 2023*
   Andrew Apicellii, Sam Bayless, Ankush Das, Andrew Gacek, Dhiva Jaganathan, *Saswat Padhi*, Vaibhav Sharma, Michael W. Whalen, Raveesh Yadav.
   In the proceedings of the 35th International Conference on Computer Aided Verification, Part I, Paris, France, July 17-22, 2023. 13 pages.
   DOI: 10.1007/978-3-031-37706-8_2

Theses

1. **Data-Driven Learning of Invariants and Specifications**.　　　*Doctoral Dissertation 2020*
   Saswat Padhi.

   Supervised by Prof. Todd Millstein, Department of Computer Science, University of California, Los Angeles, CA. ProQuest ID: Padhi_ucla_0031D_19057. 157 pages.
   DOI: https://escholarship.org/uc/item/3k89r896

Technical Reports

1. **The SyGuS Language Standard Version 2.1**.　　　*SYNT 2021*
   Saswat Padhi, Elizabeth Polgreen, Mukund Raghothaman, Andrew Reynolds, Abhishek Udupa.

   Discussed at the 2021 Workshop on Synthesis at the 33rd International Conference on Computer Aided Verification, Los Angeles, CA, USA, July 19, 2023. 36 pages.

2. **SyGuS-Comp 2018: Result and Analysis**.　　　*SYNT 2018*
   Rajeev Alur, Dana Fisman, *Saswat Padhi*, Rishabh Singh, Abhishek Udupa.

   Discussed at the 2018 Workshop on Synthesis at the 8th Federated Logic Conference (FLoC), Oxford, UK, July 18, 2018. 18 pages.

Invited Presentations

Data-Driven Precondition Inference
- Sep 2020: Amazon Web Services, Inc. (Virtual)
- Jan 2017: Microsoft Research Lab, Bengaluru, India.
- Jun 2016: 37th ACM SIGPLAN PLDI Conference, Santa Barbara, CA, USA.
- May 2016: University of California at Berkeley, CA, USA.
- May 2016: Software Lunch Talk, Stanford University, CA, USA.
- Dec 2015: 15th SoCal PLS Workshop, Pomona College, CA, USA.

Synthesizing Pattern-Based Data Profiles
- Nov 2018: 18th ACM SIGPLAN SPLASH-OOPSLA Conference, Boston, MA, USA.
- Oct 2018: Microsoft Research Lab, Bengaluru, India.
- Dec 2016: Microsoft Research, Redmond, WA, USA.

Overfitting in Program Synthesis
- Jul 2019: 31st CAV Conference, New York City, NY, USA.

ML-Based User Experience Prediction
- Dec 2023: ML4Sys Workshop at 37th NeurIPS Conference, New Orleans, LA, USA.

Professional Service

Organizing Committee Member
- 2019 – 2021 Syntax-Guided Synthesis Competition (SyGuS-Comp)

Program / Review Committee Member
- 2024 Workshop on Horn Clauses for Verification and Synthesis (HCVS)
  at the European Joint Conferences on Theory and Practice of Software (ETAPS)
- 2022 Workshop on Horn Clauses for Verification and Synthesis (HCVS)
  at the European Joint Conferences on Theory and Practice of Software (ETAPS)

- 2021 ACM SIGPLAN Conference on Programming Languages Design and Implementation (PLDI)
- 2020 ACM SIGPLAN Conference on Programming Languages Design and Implementation (PLDI)
- 2021 Workshop on Synthesis (SYNT)
   at the International Conference on Computer-Aided Verification (CAV)
- 2019 Workshop on Debugging Machine Learning Models (DebugML)
   at the International Conference on Learning Representations (ICLR)

Artifact Evaluation Committee Member

- 2020 ACM SIGPLAN Conference on Principles of Programming Languages (POPL)
- 2019 Static Analysis Symposium (SAS)
- 2019 Object-Oriented Programming, Systems, and Applications (OOPSLA) track
   of the ACM SIGPLAN Conference on Systems, Programming, Languages, and Applications:
   Software for Humanity (SPLASH)
- 2018 Object-Oriented Programming, Systems, and Applications (OOPSLA) track
   of the ACM SIGPLAN Conference on Systems, Programming, Languages, and Applications:
   Software for Humanity (SPLASH)

Invited External Reviewer

- 2024 Journal of Artificial Intelligence Research (JAIR)
- 2022 International Conference on Foundations of Software Science and Computation Structures
- 2021 IEEE Transactions on Software Engineering (TSE)
- 2019 International Conference on Computer-Aided Verification (CAV)
- 2019 ACM SIGSOFT India's Innovations in Software Engineering Conference (ISEC)

Mentoring Experience

- Tomoya Matsubara, intern at Google during doctoral study at Keio University, Japan.
   (Summer 2024) Investigating performance impact of ChromeOS kernel security flags.

- Dr. Akshay Utture, intern at AWS during doctoral study at UCLA. Now at Uber Inc.
   (Summer 2022) Proving memory-safety of the task queue implementation in the FreeRTOS kernel.

- Dr. Imtiaz Kareem, intern at AWS during doctoral study at Purdue University.
   (Summer 2021, co-mentored with Dr. Vaibhav Sharma) Type checking for AWS-internal DSLs.

- Long Pham, intern at AWS during doctoral study at CMU.
   (Summer 2021) Adding termination proofs to the C Bounded Model Checker (CBMC).

- Dr. Aalok Thakkar, intern at AWS during doctoral study at UPenn. Now at Aptos Labs.
   (Summer 2021) Adding history variables to the C Bounded Model Checker (CBMC).

- Pamina Georgiou, intern at AWS during doctoral study at TU-Wein.
   (Fall 2020) Proving correctness of AWS projects in C using the C Bounded Model Checker (CBMC).

- Adam Stein, undergrad at UCLA. Now Ph.D. candidate at UPenn.
   (2019 – 2020) Adding Bit Vector theory to the LoopInvGen synthesizer.

- Sahil Bhatia, Research Fellow at Microsoft. Now Ph.D. candidate at UC Berkeley.
   (2018 – 2019) Synthesizing loop invariants using integer linear programming (ILP).

- Brett Chalabian, M.S. student at UCLA. Now at Google.
   (2017 – 2019) Adding user-specified ad-hoc features in the LoopInvGen synthesizer.

- Zhouheng (Jeffrey) Sun, undergrad at UCLA. Now at Apple.
   (2017 – 2019) Adding higher-order features to the LoopInvGen synthesizer.

Teaching Experience

Programming Languages CS 131
Graduate Teaching Assistant *University of California, Los Angeles*

- Spring 2016 · Instructor: Prof. Todd Millstein
- Fall 2014 · Instructor: Prof. Todd Millstein

Abstractions and Paradigms in Programming CS 152
Undergraduate Teaching Assistant *Indian Institute of Technology, Bombay*

- Spring 2014 · Instructor: Prof. Amitabha Sanyal

Computer Programming and Utilization Fall 2011 · Fall 2013
Undergraduate Teaching Assistant *Indian Institute of Technology, Bombay*

- Fall 2013 · Instructor: Padma Shri Prof. Deepak B. Phatak
- Fall 2011 · Instructor: Padma Shri Prof. Deepak B. Phatak

Software Releases

pseudocode.js 2020 – Present
[https://github.com/SaswatPadhi/pseudocode.js] *MIT License*

- Current lead developer; originally authored by Tate Tian.
- A JavaScript library that accurately typesets LaTeX-style pseudocodes to HTML.

LoopInvGen 2016 – 2020
[https://github.com/SaswatPadhi/LoopInvGen] *MIT License*

- Lead developer; co-developed with Todd Millstein and Rahul Sharma.
- Infers necessary preconditions and sufficient loop invariants, fully automatically.
- Won SyGuS-Comp 2017, 2018. Second place in SyGuS-Comp 2019.

Personal Information

- Born in March, 1992.
- Citizen of the Republic of India.
- Married, and have one child.
- Languages spoken: Odiya (native), English (fluent), Hindi (fluent), Sanskrit (basic).