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Shambwaditya "Sam" Saha

Professional Summary

Research Scientist advancing AI reasoning and general intelligence with a focus on interpretability, safety, and alignment. Specializing in neuro-symbolic AI, integrating formal methods, mathematical logic, and program synthesis to design systems capable of robust reasoning, cross-domain generalization, and solving open-ended problems.

Employment

May 2023 - Oct 2025 **Research Scientist**, *Software Engineering Institute (SEI)*, Carnegie Mellon University

Research Projects:

- Automating formal methods from natural-language specifications using agentic AI.
- Detecting unhandled error conditions in real-world codebases using agentic AI.
- Generating interpretable models, like Decision Trees, using Large Language Models.
- Extracting state machines from programs using Large Language Models.
- LLM assisted heterogeneous computing programming.

Aug 2020 - Sep 2021 **Postdoctoral Researcher**, *Tufts University*, under Prof. Jeff Foster

Synthesizing programs using type inferencing, symbolic solving, and genetic programming.

June 2020 - Aug 2020 **Research Internship**, *Runtime Verification*, Urbana, Illinois

Verification of Solidity bytecode for smart contracts used in the Ethereum Blockchain.

Education

2012 - 2019 **Integrated PhD, Computer Science**, *University of Illinois at Urbana-Champaign*

Advisor: Prof. Madhusudan Parthasarathy

Thesis: Learning Frameworks for Program Synthesis.

Research Projects:

- **Specification Mining:** Generating precise contracts for C# programs.
- **Precondition Synthesis:** Synthesized preconditions to prevent failures in C# programs.
- **Invariant Synthesis:** Verified GPU and heap programs by synthesizing loop invariants.
- **Program Synthesis:** Developed a synthesis engine that solved SyGuS benchmarks.
- **Network Synthesis:** Automated SDN configuration changes to enforce policy updates.

2009 - 2011 **Master of Science, Computer Science**, *Chennai Mathematical Institute*, India

Advisor: Prof. K. Narayan Kumar

Thesis: A Survey of Automata and Logics Over Infinite Graphs.

Publications

FACCT 2025 **Towards Compositional Assurance of Large Cyber-Physical Systems** Gabriel A. Moreno, Mark Klein, Shambwaditya Saha, Farzaneh Derakhshan, Limin Jia *Proceedings of the 1st Workshop on Formal Arguments for Cps Certification*

OOPSLA 2021 **Synthesizing Contracts Correct Modulo a Test Generator.*** Angello Astorga, Shambwaditya Saha, Ahmad Dinkins, Felica Wang, P. Madhusudan, and Tao Xie. *ACM SIGPLAN International Conference on Object-Oriented Programming, Systems, Languages, and Applications, 2021.*

JAR 2020 **A Learning-Based Approach to Synthesizing Invariants for Incomplete Verification Engines.** Daniel Neider, P. Madhusudan, Shambwaditya Saha, Pranav Garg, and Daejun Park. *Journal of Automated Reasoning, Volume 64, 2020.*

PLDI 2019 **Learning Stateful Preconditions Modulo a Test Generator.*** Angello Astorga, P. Madhusudan, Shambwaditya Saha, Shiyu Wang, and Tao Xie. *40th ACM SIGPLAN Conference on Programming Language Design and Implementation, 2019.*

SAS 2019 **Sorcar: Property-Driven Algorithms for Learning Conjunctive Invariants.** Daniel Neider, Shambwaditya Saha, Pranav Garg, and P. Madhusudan. *26th International Static Analysis Symposium, 2019.*

TOCL 2018 **Compositional Synthesis of Piece-Wise Functions by Learning Classifiers.*** Daniel Neider, Shambwaditya Saha, and P. Madhusudan. *ACM Transactions on Computational Logic, Volume 19, 2018*

CSL 2018 **A Decidable Fragment of Second Order Logic With Applications to Synthesis.*** P. Madhusudan, Umang Mathur, Shambwaditya Saha, and Mahesh Viswanathan. *27th EACSL Annual Conference on Computer Science Logic, 2018.*

TACAS 2018 **Invariant Synthesis for Incomplete Verification Engines.** Daniel Neider, Pranav Garg, P. Madhusudan, Shambwaditya Saha, and Daejun Park. *24th International Conference on Tools and Algorithms for the Construction and Analysis of Systems, 2018.*

TACAS 2016 **Synthesizing Piece-Wise Functions by Learning Classifiers.*** Daniel Neider, Shambwaditya Saha, and P. Madhusudan. *22nd International Conference on Tools and Algorithms for the Construction and Analysis of Systems, 2016.*

CAV 2015 **Alchemist: Learning Guarded Affine Functions.*** Shambwaditya Saha, Pranav Garg, and P. Madhusudan. *27th International Conference on Computer Aided Verification, 2015.*

SOSR 2015 **NetGen: Synthesizing Data-plane Configurations for Network Policies.*** Shambwaditya Saha, Santhosh Prabhu, and P. Madhusudan. *1st ACM SIGCOMM Symposium on Software Defined Networking Research, 2015.*

DSSE 2015 **Syntax-Guided Synthesis.*** Rajeev Alur, Rastislav Bodik, Eric Dallal, Dana Fisman, Pranav Garg, Garvit Juniwal, Hadas Kress-Gazit, P. Madhusudan, Milo M. K. Martin, Mukund Raghothaman, Shambwaditya Saha, Sanjit A. Seshia, Rishabh Singh, Armando Solar-Lezama, Emina Torlak, and Abhishek Udupa. *Dependable Software Systems Engineering, NATO Science for Peace and Security Series, D: Information, Communication Security, 2015.*

* First Author or Equal Contribution

Academic Service

Reviewer **Use of LLMs for Program Analysis and Generation Track**, *Hawaii International Conference on System Sciences*, 2024.

Teaching

CS477 **Formal Software Development Methods**, *University of Illinois at Urbana Champaign*

Mentored students on mathematical models and methods for software specification and verification using formal logics, deductive verification, abstract interpretation, and testing.

CS126 **Software Design Studio**, *University of Illinois at Urbana Champaign*

Coached 20 students to improve their coding style by reviewing their coding assignments and giving them critical feedback on design, documentation, testing, and debugging.

CS498 **Data Visualization**, *Part of Data Mining Specialization at Coursera*, offered by UIUC

Mentored students on the concepts and tools and helped them with their final projects.

Talks

Specification Mining, *Software Engineering Institute*, 2023

Program Synthesis, *MathWorks*, 2020

Program Synthesis, *GE Research*, 2020

Network Synthesis, *Excape PI Meeting*, 2017

Network Synthesis, *Midwest Verification Week*, 2015

Alchemist: Learning Guarded Affine Functions, *CAV*, 2015

NetGen: Synthesizing Data-plane Configurations for Network Policies, *SOSR*, 2015

NetGen: Synthesizing Data-plane Configurations for Network Policies, *Excape PI Meeting*, 2015