Stanly Samuel

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Research Summary

My research focuses on designing algorithms and building scalable tools in the domain of reactive synthesis using ideas from program verification, theory of infinite games, and logic. Broadly, my interests lie in the fine intersection between theory and practice, especially in the umbrella area of **algorithmic program synthesis**. More specifically, my research investigates efficient and scalable techniques for the automated synthesis of maximally permissive controllers for infinite state systems, using symbolic constraint solvers. Nowadays, I am also interested in neurosymbolic AI and applications of formal methods to blockchains and smart contracts

Education

Indian Institute of Science **Aug 2016 – 2023**
Ph.D. Candidate in Computer Science, ***Advisors:*** *Prof. Deepak D'Souza and Prof. K. V. Raghavan* ***CGPA:*** *7.5/10* *Bangalore, IN*

Mumbai University **Aug 2008 – May 2012**
Bachelors in Computer Engineering, ***Grade:*** *First Class with Distinction* *Mumbai, IN*

Relevant Projects

Towards Efficient Controller Synthesis Techniques for Logical LTL Games | *Python, Z3*

- Extension of our tool GenSys to support ω-regular specifications
- 46X improvement observed over the state of the art.

GenSys: a scalable fixed-point engine for maximal controller synthesis over infinite state spaces | *Python, Z3*

- A novel technique to synthesize correct by-construction strategies for infinite games, using ideas from Program Verification.
- The first scalable tool in this space which outperforms the current state-of-the-art by a good margin.
- Accepted in the tool demonstrations track at FSE 2021 [1]

Resilient Abstraction-Based Controller Design | *C++, CUDD BDD library, SCOTS*

- In collaboration with MPI-SWS, Germany.
- Realized the above idea as a proof of concept tool called RESCOT, implemented in C++ using the BDD library CUDD and extending SCOTS. Experiments gave desired results
- Accepted as a poster [2] and full paper [3].

Pointer Analysis Projects | *Java, IBM WALA*

- Interprocedural Null Dereference Analysis using the Iterative approach.
- Flow sensitive and Flow insensitive Intraprocedural May Points-to Analyses.

Record and Replay of Concurrent Programs in Java | *Java, Soot, Z3*

- A Record and Replay tool based on the PLDI' 13 paper 'CLAP:Recording Local Executions to Reproduce Concurrency Failures' was reimplemented.
- Record and Replay tools are fundamental to dynamic program analysis.

Publications

1. Samuel, S., D'Souza, D. & Komondoor, R. *GenSys: a scalable fixed-point engine for maximal controller synthesis over infinite state spaces* in *Proceedings of the 29th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering* (2021), 1585–1589.
2. Samuel, S. *et al. Resilient Abstraction-Based Controller Design* in *Proceedings of the 23rd International Conference on Hybrid Systems: Computation and Control* (Association for Computing Machinery, Sydney, New South Wales, Australia, 2020). ISBN: 9781450370189. https://doi.org/10.1145/3365365.3383467.
3. Samuel, S. *et al. Resilient abstraction-based controller design* in *2020 59th IEEE Conference on Decision and Control (CDC)* (2020), 2123–2129.
4. Raja, R. *et al. BNSynth: Bounded Boolean Functional Synthesis* 2022. https://arxiv.org/abs/2212.08170.
5. Samuel, S., D'Souza, D. & Komondoor, R. *Towards Efficient Controller Synthesis Techniques for Logical LTL Games* 2023. arXiv: 2306.02427 [cs.LO].

Mentoring

Boolean Function Synthesis using Graph Continuous Logic Networks **Jan 2020 – Present**

Student: *Ravi Raja,* ***Advisors:*** *Prof. Aditya Kanade, Prof. Chiranjib Bhattacharyya and Prof. Deepak D'Souza* *IISc, Bangalore*

- Finding the problem statement after extensive literature survey, with initial guidance from Dr. Sriram Rajamani from Microsoft Research
- Mentoring the student for Boolean Function Synthesis; analysed efficient methods to transform Verilog specifications into a format required by the Neural Network.
- Preliminary results using GCLN show promise. A scalable solution is underway.

Relevant Coursework

- Program Analysis and Verification
- Formal Methods in Software Engineering
- Automata Theory and Computability
- Topics in Program Analysis
- Principles of Programming
- Programming Languages Design and Implementation
- Mathematical Logic and Theorem Proving
- Program Synthesis meets Machine Learning

Experience

Veridise Inc., University of Texas at Austin **Aug 2022 – Nov 2022**

Research and Development Engineer Intern, ***Mentors:*** *Benjamin Mariano, Andreea Buterchi* *Remote*

- Worked with Prof. Isil Dillig's group on OrCa, Veridise's automated fuzzing tool that uses temporal logic for smart contracts.
- Designed the visitor architecture for Veridise's proprietary specification language, V.
- Made OrCa's Oracle robust by writing exhaustive tests in Linear Temporal Logic, using the Google test framework. I was also involved in implementing various features for the Oracle and the V specification language from the discovered bugs.
- Designed CI/CD using Docker and GitHub Actions, for OrCa.
- Won the Ethereum India hackathon 2022 (representing Veridise) for our tool ETHGuard, which was a responsive VSCode plugin for detecting smart contract bugs at runtime. The tool sacrificed formal guarantees for efficiency by using machine learning.

Max Planck Institute for Software Systems **Sep 2019 – Nov 2019**

Research Intern, ***Advisors:*** *Daniel Neider, Anne-Kathrin Schmuck and Kaushik Mallik* *Kaiserslautern, DE*

- Worked with Prof. Rupak Majumdar's Rigorous Software Engineering (RSE) group in the domain of correct-by-construction controller synthesis
- Formulated and solved the problem Resilient *Abstraction-Based Controller Design* that applied reactive synthesis techniques to the domain of cyber-physical systems to synthesize resilient controllers.
- This work has been accepted for full paper presentation at the 59th Conference on Decision and Control (CDC), 2020 [3].

Indian Institute of Science **Jan 2018 – May 2021**

Teaching Assistant *Bangalore, IN*

- Mathematical Logic and Theorem Proving, **Jan 2021 – May 2021**
- Program Analysis and Verification, **Aug 2018 – Dec 2018**
- Formal Methods in Software Engineering, **Jan 2018 – April 2018**

St. Francis Institute of Technology **July 2013 – June 2014**

Lecturer *Mumbai, IN*

- Subjects taught: Mobile Computing and Theoretical Computer Science for fourth year and second year engineeering students respectively.

Xavier Institute of Engineering **Jan 2013 – May 2013**
Lecturer *Mumbai, IN*

- Subjects taught: Internet Programming and Software Engineering for second year and third year students engineeering respectively.

Stanly Classes, Gnostopedia, Bit Brothers **Aug 2012 – July 2017**
Founder, Web Engineer, Trainer *Mumbai, IN*

- All the ventures, explorations, informal teaching experiences et. al. that I have been a part of. Please visit stanlysamuel.com for more details.

Academic Honors and Awards

- Awarded ACM SIGSOFT CAPS award to attend ESEC/FSE 2021.
- Awarded Cisco Ph.D. Fellowship for the year 2020-2021 (awarded to 6 people).
- Awarded Ph.D. Fellowship by Ministry of Human Resource Development (MHRD), Government of India for the duration 2016 - 2022.
- All India Rank 311 in GATE CS 2016 (out of 108495 candidates).

Service

- Reviewer for CDC 2023
- Sub reviewer for FSTTCS 2022
- Artifact Evaluation Committee for CAV 2022, 2023
- Artifact Evaluation Committee for PLDI 2022, 2023
- Artifact Evaluation Committee for SAS 2021
- ACM Member, September 2021 - August 2022
- Internal Quality Assurance Committee, Xavier Institute of Engineering, Mumbai, June 2021 - May 2022

Technical Skills

Languages: Python, Java, C, C++, C#
Solvers: Z3, CVC4
Verifiers: Alloy, VCC, Boogie, SPIN

Talks / Workshops

- **Towards Efficient Controller Synthesis Techniques for Logical LTL Games**
  - IST Austria, Klostenburg (upcoming), Sep 2023
  - MPI-SWS, Kaiserslautern (upcoming), Sep 2023
  - ASE, Luxembourg (upcoming), Sep 2023
  - NASA Ames Research Center (online), July 2023
- Selected for the 41st Marktoberdorf Summer School on Safety and Security through Formal Verification, Marktoberdorf, August 2023
- Selected for the first Summer school on Neurosymbolic Programming at California Institute of Technology in Pasadena, California USA, July 2022
- **GenSys: A Scalable Fixed-Point Engine for Maximal Controller Synthesis over Infinite State Spaces**
  - ESEC/FSE, Aug 2021
  - SERI, July 2021
- **Lecture: Model Based Projection**, MLTP Course, CSA IISc, May 2021.
- **Automata Logic and Games: A Research Perspective**, Xavier Institute of Engineering, Mumbai, Dec 2020.
- **Resilient Abstraction Based Controller Design**
  - ARCS 2021 Short paper presentation, Feb 2021.
  - Workshop on Research Highlights in Programming Languages FSTTCS, Dec 2020
  - CDC, Paper presentation, Dec 2020
  - HSCC, Poster presentation, April 2020.
  - MPI-SWS, End of Internship Talk, Dec 2019.
- **Music programming using Chuck**
  - MIT, Pune, Dec 2019 (Invited Talk)

    - CSA Open Day, Mar 2018
- **Declarative programming using Alloy**
    - MIT, Pune, Dec 2019 (Invited Talk)
    - 6th Undergraduate Summer School, CSA, IISc, July 2018
    - 5th Undergraduate Summer School, CSA, IISc, July 2017
    - CSA Open Day, Mar 2017
- **Proof Techniques Refresher Course**, Aug 2017, 2018 and 2019, CSA, IISc.
- Selected for "ACM's Winter School in Software Engineering" at Tata Research Development and Design Centre (TRDDC) , Pune, December 2017.
- Selected for First Indian SAT+SMT workshop" at Tata Institute of Fundamental Research (TIFR), Mumbai, December 2016.

Relevant Leadership / Extracurricular Experience

Network Seminar Series, Centre for Networked Intelligence **Jan 2021 - July 2021**

Co-convener *IISc, Bangalore*

- Pioneered the Network Seminar Series (cni.iisc.ac.in/networks-seminar), sponsored by Cisco.
- Overhauled the previous website by making independent design decisions, as per seminar requirements.
- Designed and marketed social media content resulting in a 2X increase in audience attendance.
- Hosted the seminar series talks by coordinating with the respective speakers on a weekly basis.

CSA Writing Team **June 2020 - July 2021**

Founder, Editor-In-Chief *IISc, Bangalore*

- Founded the official writing team for my department.
- Created the website (csa-iisc.github.io/csa-writing-team) as per blog requirements, in Jekyll.
- Led and guided a team of 8 students to publish a series of blog posts.
- Interviewed eminent researchers as part of CSA's golden jubilee celebrations.
- Marketed the posts digitally resulting in >12,000 views on Quora (csaiisc.quora.com)

CSA Student Welfare Committee **August 2020 – present**

Member *IISc, Bangalore*

- Handled issues concerning the mental health of students.

CSA Webteam **August 2016 – July 2019**

Member *IISc, Bangalore*

- Brainstormed on the design decisions involving the overhaul of the department website.

CSA Open Day **Jan 2017, 2018, 2019, 2020**

Digital Marketer *IISc, Bangalore*

- Handled digital marketing on Facebook raising the likes from 100 to 2,800 over 3 years resulting in larger organic reach and converted footfall.

Rhythmica, IISc **Aug 2018 – July 2019**

Co-Convener *IISc, Bangalore*

- Handled digital marketing on Facebook raising the likes from 100 to 2,400 over 3 years resulting in larger organic reach and converted footfall.
- Led the team responsible for logo redesign.

Student's Council, IISc **Apr 2018 – July 2018**

Member of Security Committee *IISc, Bangalore*

- Conducted polls regarding the safety of students on campus and proposed solutions to the authorities.

References

- Deepak D'Souza, Professor, Indian Institute of Science, Bangalore, India
- Raghavan Komondoor, Associate Professor, Indian Institute of Science, Bangalore, India
- Daniel Neider, Professor, TU Dortmund, Dortmund, Germany
- Anne-Kathrin Schmuck, Research Group Leader, Max Planck Institute for Software Systems, Kaiserslautern, Germany