Charles Babu M

Curriculum Vitae

Research Interests

· To design techniques and build tools to formally verify software systems.
· Static Analysis, Model-checking, Programming Languages, and Machine Learning
· Verification of Industrial Systems

Education

2021–2024 **Ph.D. in Computer Science**, *CEA List, University Paris-Saclay,*.

2015–2017 **M.Sc. in Theoretical Computer Science**, *Chennai Mathematical Institute, India*.

2010–2014 **B.Tech. in Computer Science and Engineering**, *Rajiv Gandhi University of Knowledge Technologies, Nuzvid, India*.

Some Graduate Courses

Mathematical Logic, Graduate Logic, Proofs and Types, Concurrency Theory, Model-checking and Systems Verification, Software Verification using SMT Solvers, Logic Automata and Games, Topics in Verification, Machine Learning.

PhD Thesis

Title *Self-adaption For Adversarial Code Analysis*

Advisors Sebastien Bardin (CEA), Matthieu Lemerre (CEA), Jean-Yves Marion (CEA)

Abstract Several major classes of analyses are to be performed on code (E.g., C-code, assembly, machine code, etc.) to find software errors or security vulnerabilities. These analyses suffer from false alarms which is a major issue for the industrial adoption of software verification at scale. Our long-term goal is to leverage recent advances in software verification, security analysis, and artificial intelligence, in order to propose efficient semantic tools and techniques for software safety and security investigations.

Current Work *Improving Static Analysis Precision by Viewing Program Refinement as a Search Problem* (Under submission at POPL 2024)

Abstract Imprecision is a very common phenomenon in static analyses that results in false alarms when used for program verification. In the last two decades, static analysis gave rise to refinement techniques to improve precision through various forms of sensitivity. Yet, prior attempts to automatically improve precision are either specialized to particular domains or based on syntactic rules and heuristics that are tedious to design and prone to path explosion.

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In this work, we view the problem of improving precision through the lens of search as an optimization problem and propose a new generic refinement techniques to automatically improve precision. This provides us with a strategy that guarantees finding the most precise refinement while minimizing the program size. We further study the source of inefficiencies of the search problem (i.e., the size of the search space, the size of each refinement, and the time needed to analyze each refinement) and provide adequate solutions to each. Finally, we provide a first implementation of the method, demonstrating both its feasibility and potential over standard software verification benchmarks.

Master's Thesis

Title *Improving Precision of Loop Acceleration for C Programs*

Supervisor Prof. Mandayam Srivas (CMI)

Abstract The transitive closure of Linear Programs with finite monoid transformations is Presburger definable. We develop techniques to verify this class of counter systems using SMT solvers. We implement our technique in Veriabs, a portfolio software verifier, improving the precision of the tool.

Research Experiences

Aug'18 – present **Chennai Mathematical Institute.** (Research assistant)

Project: 2LS: Disjunctive Invariant Synthesis using Max-Strategy Iteration.

Max-strategy iteration (Max-SI) accelerate fixpoint computation without a need for widening operators on template linear constraint domains. We develop techniques to synthesize disjunctive invariants using Max-SI and classical completeness properties of abstract interpretation. We implement our techniques in 2LS tool.

Supervised by Prof. Mandayam Srivas, Peter Schrammel (Diffblue, Oxford).

Aug'17 – Jul'18 **Chennai Mathematical Institute & Tata Research Development and Design Center (Pune, India)** Research assistant.

Project: Acceleration in Symbolic Model-Checking

We develop exact acceleration and abstract acceleration techniques for linear counter systems. We implement our techniques in Veriabs, to improve the precision of the tool.
(Gold in ReachSafety Category in both SV-Comp 2019, 2020)

Supervised by Prof. Mandayam Srivas, Prof. Praveen M (CMI)

May'16 – Aug'16 **Tata Research Development and Design Center (Pune, India).** Intern.

Project: Improving Precision of Abstract Loop Acceleration for C Programs.

Achievements

2019, 2020 **Received Gold in Software Verification Comptetition in ReachSafety in 2019 and 2020**.

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2015 **Selected to CMI through the national entrance exam to pursue master's in Theoretical Computer Science**.

2017-2020 **Recipient of TCS-Research scholarship**.

Publications

1. Improving Static Analysis Precision by Viewing Program Refinement as a Search Problem

POPL-2024 Charles Babu M, Sébsatien Bardin, Matthieu Lemerre, Jean-Yves Marion (**Under Review**)

2. VeriAbs: Verification by Abstraction and Test Generation.

TACAS-2020 M Afzal, A Chauhan, Supratik Chakraborty, B Chimdyalwar, P Darke, A Gupta, S Kumar, Charles Babu M, D Unadkat, and Venkatesh R (**Tool Paper**)

3. VeriAbs: Verification by Abstraction and Test Generation.

ASV-2023 M Afzal, A Chauhan, Supratik Chakraborty, B Chimdyalwar, P Darke, A Gupta, S Kumar, Charles Babu M, D Unadkat, and Venkatesh R (**SVComp: Book Chapter**)

Technical Skills

PL Ocaml, Rust, Haskell, Java (Intermediate), Python (Intermediate)

Technologies Linux, Git, Docker, PostgreSQL, TypeScript, React

Relevant Talks

March 2022 **2022 Annual Meeting of the WG "Formal Methods for Security" Fréjus (France)**, *Talk Details*.

June 2021 **Loria (LORIA (Laboratoire Lorrain de Recherche en Informatique et ses Applications))**, (Online).

Dec 6-8, 2017 **The Second Indian SAT+SMT School - Infosys Mysore**, *Improving Precision of Loop Acceleration for C Programs*, Student talk.

2017 **Tata Research Development and Design Center (Pune, India)**, *Improving Precision of Loop Acceleration for C Programs*, Research talk.

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