

Charles Babu M

Curriculum Vitae

Research Interests

- To design techniques and build tools to formally verify software systems
- Static Analysis, Model-checking, Theorem Proving, Symbolic Execution, and Applications of SAT/SMT solving

Education and Experience

- 2021 – 2024 **Ph.D. in Computer Science**, *CEA List, University of Lorraine*.
- 2017 – 2020 **Research Assistant**, *Chennai Mathematical Institute, India & Tata Research Development and Design Center, India*.
- 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*.
- 2008 – 2010 **Mi.Bi.P.C. 2-year Pre University Course**, *Rajiv Gandhi University of Knowledge Technologies, Nuzvid, India*.

Some Graduate Courses

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

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.
- Project I *Trace Partitioning as an Optimization Problem*

Abstract Imprecision is a 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 are either specialized to particular domains or based on syntactic rules and heuristics that are tedious to design and prone to path explosion.

In this work, we solve this old problem of improving precision through the lens of search optimization 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.

Project II *Structural Abstract Interpretation*

Abstract "Structural abstract interpretation" is a crossing between structural analysis and abstract interpretation, where the idea is to combine the advantages of the "denotational style of abstract interpretation" (analysis based on structured code, allowing in particular to save in memory, but which does not manage the unstructured control-flow) and the "abstract interpretation based on chaotic iteration" (makes it possible in particular to manage loops non-natural). The goal of this work is synergize the two approaches with different trade-offs into a single simple framework.

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 – **Chennai Mathematical Institute.** (Research assistant)

Jun'20 **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 – **Chennai Mathematical Institute & Tata Research Development and Design Center (Pune, India)** Research assistant.

Jul'18

Project: Acceleration in Symbolic Model-Checking

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

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)

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

Aug'16 Project: Improving Precision of Abstract Loop Acceleration for C Programs.

Achievements

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

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

Publications

1. **Trace Partitioning as an Optimization Problem**

SAS-2023 Charles Babu M, Matthieu Lemerre, Sébastien Bardin, Jean-Yves Marion

2. **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**)

3. **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

Technical Skills

PL Ocaml, Rust, Haskell, Python, Java (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.