Ramana Nagasamudram

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Research summary and interests

Computer programs evolve constantly. It's challenging to obtain strong guarantees that code revisions preserve intended behaviors, especially in the absence of precise specifications. My research addresses this problem by developing tools and techniques for verifying relations like equivalence between programs.

Formal methods · program analysis · proof assistants and auto-active verifiers · relational verification

Education

Ph.D. in Computer Science, Stevens Institute of Technology, Hoboken, NJ — Aug 2019-present
Thesis: *Auto-active relational verification and alignment completeness*
Advisor: Dave Naumann

M.S. in Computer Science, Stevens Institute of Technology, Hoboken, NJ — Aug 2017-May 2019

B.S. in Mechanical Engineering, University at Buffalo, Buffalo, NY — Aug 2012-May 2016
Minor in Mathematics

Research projects and related publications

Practical relational verification of heap-manipulating programs

- Built an auto-active tool for verifying relational properties of object-based programs (≈ 12k LOC OCaml).
- Verified 14 benchmark problems on compiler optimizations, security, and representation independence.
- Qualitatively evaluated amenability of the tool to SMT-based automation, shedding light on scalability.

WhyRel: A Prototype for Relational Verification (research abstract)
Ramana Nagasamudram
International Symposium on Formal Methods (FM), Doctoral Symposium 2021
🏆 *Best presentation award*

A Relational Program Logic with Data Abstraction and Dynamic Framing
Anindya Banerjee, **Ramana Nagasamudram**, David A. Naumann, Mohammad Nikouei
ACM Transactions on Programming Languages and Systems (TOPLAS) 2022

The WhyRel Prototype for Modular Relational Verification of Pointer Programs
Ramana Nagasamudram, Anindya Banerjee, David A. Naumann
International Conf. on Tools and Algorithms for the Construction and Analysis of Systems (TACAS) 2023
★ *Best paper nomination; invited to the International Journal on Software Tools for Technology Transfer*

Foundational verification of C programs using the Verified Software Toolchain

- Funded by Siemens for one academic year (Aug 2021-May 2022) to build certified applications.
- Wrote machine-checked correctness proofs of a C library for distributed systems (≈ 20k LOC Coq).
- Conducted a two day internal workshop at Siemens on interactive theorem proving and C verification.

Verifying a C Implementation of Derecho's Coordination Mechanism using VST and Coq
Ramana Nagasamudram, Lennart Beringer, Ken Birman, Mae Milano, David A. Naumann
NASA Formal Methods Symposium (NFM) 2024

Alignments in relational program verification

- Collaborately developed alignment completeness, a theoretical tool for judging relational program logics.
- Spearheaded the design of the first alignment complete relational logic for simulation properties.

Alignment Completeness for Relational Hoare Logics
Ramana Nagasamudram, David A. Naumann
IEEE Logic in Computer Science (LICS) 2021

An Algebra of Alignment for Relational Verification
Timos Antonopoulos, Eric Koskinen, Ton Chanh Le, **Ramana Nagasamudram**, David A. Naumann, Minh Ngo
ACM SIGPLAN Symposium on Principles of Programming Languages (POPL) 2023

Alignment Complete Relational Hoare Logics for Some and All
Ramana Nagasamudram, Anindya Banerjee, David A. Naumann
In submission, 2024

Assistantships and additional experience

Teaching Assistant, Stevens Institute of Technology, Hoboken, NJ — Aug 2018–May 2024

- TA'd graduate level computer science courses ranging from 8 to 249 students for a total of three years.
- Held two–hour weekly office hours and separate one–on–one tutoring sessions.
- Formulated and graded quizzes/assignments weekly; lectured when instructor was unavailable.

Programming Languages	Feb–May 2024, Aug–Dec 2023, Aug–Dec 2022
Algorithmic Complexity	Feb–May 2023
Type Systems for Programming Languages	Feb–May 2019
Algorithms, Design and Implementation	Aug–Dec 2018

Graduate Research Assistant, Stevens Institute of Technology, Hoboken, NJ
With Dave Naumann — May–Aug 2019

- Formalized an imperative language with objects in Coq as first steps towards mechanizing region logic.

With Jeffrey Nickerson — Aug 2017–May 2019

- Developed an automated tool in Python to rank 3D models for use in an online design competition.

Senior Analyst, CapGemini, Bengaluru, India — Jan–Aug 2017

- Maintained a legacy Java application that converts between 3D CAD formats.

Academic service

Artifact Evaluation Committee: POPL 2023, ICFP 2023, ICFP 2024
Sub–reviewer: POPL 2023, ECOOP 2024
Student Volunteer: POPL 2021

Funding Awards

Fellowship for High Assurance, Siemens Corporate Research — Aug 2021–May 2022
Provost Doctoral Fellowship, Stevens Institute of Technology — Aug 2019–May 2020

Additional education

Oregon Programming Languages Summer School, University of Oregon — Jun 2019
Summer School on Formal Techniques, SRI International — Jun 2022

Skills

Programming Languages: OCaml, C, Scheme, Haskell, Python, LaTeX
Formal verification: Coq, Verified Software Toolchain (VST), Why3, Isabelle/HOL

Open–source software artifacts

WhyRel (GitHub), BiKAT (Zenodo), VerifiedSST (Zenodo)