HARISHANKAR VISHWANATHAN

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My research interests are in static analysis and program synthesis. My current focus is in developing static analyses to help secure kernel extension technologies, specifically the eBPF subsystem in the Linux kernel.

EDUCATION

Rutgers University Jan 2021 – Dec 2025 (Expected)
Ph.D. in Computer Science GPA 3.9/4.0

University of California, Irvine ***(transferred to Rutgers)*** Sep 2019 – Dec 2020
Ph.D. in Computer Science GPA 4.0/4.0

University at Buffalo ***(transferred to UC Irvine)*** Jan 2019 – Jul 2019
Ph.D. in Computer Science and Engineering GPA 3.59/4.0

University at Buffalo Aug 2014 – Feb 2016
M.S. in Computer Science and Engineering GPA 3.63/4.0

University of Mumbai Jul 2009 – Jun 2013
B.E. in Electronics and Telecommunication Engineering First Class

EXPERIENCE

Research Assistant, Rutgers University ***(advised by Dr. Srinivas Narayana)*** Jan 2021 – Present
Developing and improving static analyses for eBPF

- Verifying the correctness of the eBPF verifier's abstract interpretation algorithms for the domain of tristate numbers
  - The eBPF verifier's abstract interpretation uses multiple abstract domains to over-approximate all possible values a program variable can take across all executions of an eBPF program; I analysed the domain of tristate numbers.
  - Proved the soundness and optimal precision of existing algorithms for tristate number addition and subtraction
  - Developed a new algorithm for abstract multiplication which is provably sound, empirically faster, and more precise than the prior algorithm.
- Verifying the soundness of the eBPF verifier's entire value tracking analysis
  - The eBPF verifier uses one abstract domain (e.g. interval) to update the other (e.g. tristate); I analysed the soundness of this refinement.
  - Built a tool, Agni, that synthesizes proof-of-concept eBPF programs when the soundness checks fail. Agni reduces false positives generated by the soundness analysis, and directly manifests soundness bugs in the eBPF verifier.

Research Assistant, University of California, Irvine ***(advised by Dr. Anton Burtsev)*** Sep 2019 – Dec 2020
Designing fast hash tables to utilize the high bandwidth provided by modern memory (DRAM) subsystems (applied specifically to counting nucleotide sequences of length k, a process called k-mer counting).

- Built a parallel parser for FASTQ files (a format used for storing nucleotide sequence data) into compact binary representation of sequences of length k.
- Built the cross-core communication framework with SPSC queues using B-Queue, a fast lock-free queue, to insert the parsed k-mer sequences into partitioned hash tables in parallel.
- Built the cache-aware, prefetched, linear-probing, partitioned hash table for counting k-mers. Optimized for performance by tweaking hashing functions, hashing schemes, and buckets to prefetch. Benchmarked existing k-mer counters' performance for comparison.

Research Assistant, University at Buffalo ***(advised by Dr. Steven Y. Ko)*** Jan 2019 – Jul 2019
Developing richer runtimes for trusted applications written for the ARM TrustZone trusted execution environment.

- Exploratory research on memory management in trusted operating systems, specifically OP-TEE, and on runtime systems and interfaces for garbage collection algorithms.
- The idea was to allow automated memory management of Trusted Applications in the Secure World by leveraging the help of a Garbage Collector running partly in the Normal World.

Software Engineer, FactSet Research Systems Inc. Mar 2016 – Jan 2019

Content Collection Services

- Helped build and maintain the ETF Analytics platform, which provides analytics information on exchange-traded funds, including a suite of data collection tools, ingestion jobs, an Analytics Calculation Engine, and front-end applications to help QC of the processes and data.
- Led the efforts to successfully transition the team's development workflow using Git and Jenkins for continuous integration.

Content and Technology Solutions

- Helped build and maintain part of the Open:Factset infrastructure at DataExchange, where different vendors with diverse data sets are integrated and made available to clients. Built the vendor-integration process by modelling vendor data, establishing vendor-specific schemas and parsing methods.
- Wrote a REST service for the vendor-integration process, with the goal of supporting vendor self-integration.

Independent Researcher, University at Buffalo *(advised by Dr. Dimitrios Koutsonikolas & Dr. Varun Chandola)* Jun 2015 – Aug 2015

Modelling information propagation in Twitter

- Collected data from the Twitter API to build a sub-graph of the Twitter network and studied the impact of different parameters (no. of followers, no. of retweets, no. followed) on the diffusion of tweets in Twitter.
- Surveyed literature related to the structure of the Twitter network and message propagation on Twitter and other social networks.
- The eventual goal was to build a simulator for Twitter which simulates network formation and information propagation.

Software Development Intern, Toshiba Machine Fall 2014

GUI Development

- Developed part of the software for the touch-controlled GUI of the HMI of injection moulding machines, using FLTK toolkit.
- Wrote part of the code for navigation using the keyboard.

PUBLICATIONS

1. **Verifying the Verifier: eBPF Range Analysis Verification** Jul 2023
   Harishankar Vishwanathan, Matan Shachnai, Srinivas Narayana, and Santosh Nagarakatte.
   International Conference on Computer Aided Verification (CAV 2023)
2. **Sound, Precise, and Fast Abstract Interpretation with Tristate Numbers** Apr 2022
   Harishankar Vishwanathan, Matan Shachnai, Srinivas Narayana, and Santosh Nagarakatte.
   International Symposium on Code Generation and Optimization (CGO 2022)
3. **Poster: Partitioning Garbage Collection Between the Secure and Normal Worlds for Trusted Applications.** Jun 2019
   Harishankar Vishwanathan, Chang Min Park, Sidharth Kumar Mishra, Karthik Dantu, Steven Y. Ko, Lukasz Ziarek.
   International Conference on Mobile Systems, Applications, and Service (MobiSys 2019)

AWARDS

- **Distinguished Paper Award** – International Symposium on Code Generation and Optimization (CGO 2022).
- **Travel/Conference Grant** – International Conference on Mobile Systems, Applications, and Service (MobiSys 2019).

TEACHING

CS 416/518 Operating Systems, Rutgers University Sep 2023 – Dec 2023

ICS 143A Operating Systems, University of California, Irvine Sep 2020 – Dec 2020

ICS 238P Operating Systems, University of California, Irvine Apr 2020 – Jun 2020

ICS 33 Intermediate Programming, University of California, Irvine Jan 2020 – Mar 2020

- Developed the programming assignment for implementing a shell using the Unix system call interface

CSE 486/586 Distributed Systems, University at Buffalo Sep 2019 – Dec 2019

SKILLS

Languages: C, C++, Java, Python, SQL, Bash, HTML, CSS, JavaScript