

Naorin Hossain

Computer Science PhD Candidate * Princeton University
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Education

Ph.D. Candidate, Department of Computer Science, Princeton University, Princeton, New Jersey

- Thesis topic: Formal and applied methods for security and correctness verification in computer hardware
- Advisor: Professor Margaret Martonosi
- Expected graduation date: May 2023

Princeton University, The Graduate School, Princeton, New Jersey

- M.A. Computer Science
- Degree awarded: May 2021

Rutgers University, School of Engineering, New Brunswick, New Jersey

- B.S. Electrical and Computer Engineering, Computer Science
- Honors: *summa cum laude* (GPA: 3.97)
- Graduation date: May 2018

Honors & Awards

Rutgers University

- Matthew Leydt Society – Top 2% of academic achievers 2018
- John B. Smith Award – Graduated from ECE department with a GPA >3.95 2018
- ECE Departmental Service Award 2018
- Honor's Academy 2014-2018
- Presidential Scholar 2014-2018
- Dean's List 2014-2018
- Rutgers Academic Excellence Award 2016
- Eta Kappa Nu (HKN) membership 2016

Academic Research Experience

Princeton University

September 2018 – Present

Advisor: **Professor Margaret Martonosi**

- Leveraging hardware performance data and machine learning techniques for detection and localization of anomalous activity targeting availability on a heterogeneous System-on-a-Chip (SoC)
- Designing empirical testing methodology for validating and verifying a transistency model specification using formally synthesized enhanced litmus tests
- Developed a framework for formally specifying transistency models and using the models to synthesize suites of enhanced litmus tests
- Defined a transistency model for x86 processors and synthesized enhanced litmus tests that can be used for empirical testing on x86 processors to validate and verify the model
- Applied CheckMate tool to an Intel Sandy Bridge-like microarchitectural specification written in Alloy to synthesize TLB exploits

Advisor: *Professor Ulrich Kremer*

- Investigated swarming strategies and potential tradeoffs for autonomous, battery-operated underwater gliders to cooperatively navigate and achieve desired goals
- Built and tested a simulation environment for a leader-follower strategy using optical communication technologies – specifically LED color detection using a camera and OpenCV

Publications

- **Naorin Hossain**, Caroline Trippel, and Margaret Martonosi, “TransForm: Formally Specifying Transistency Models and Synthesizing Enhanced Litmus Tests”, *47th International Symposium on Computer Architecture (ISCA)*, May-June 2020.

Selected Talks and Presentations

- “TransForm: Formally Specifying Transistency Models and Synthesizing Enhanced Litmus Tests”
 - *ISCA '22*, conference poster, June 2022
 - *Languages, Systems, and Data Seminar at UC Santa Cruz*, invited talk, January 2021
 - *IBM Workshop on the Future of Computing Architectures (FOCA)*, invited talk, October 2020.
 - *Princeton University*, General Exam, September 2020
 - *ISCA '20*, conference talk, June 2020
- “Security Verification of Virtual Memory Implementations with CheckMate”, *Intel Side Channel Academic Program Workshop 2020*, September-October 2020
- “CheckMate: Automated Synthesis of Hardware Exploits and Security Litmus Tests”, *Intel Side Channel Academic Program Workshop 2019*, June 2019

Work Experience

Research Intern, IBM, Yorktown Heights, NY

May 2022 – August 2022

- Anomalous activity detection for domain-specific heterogeneous SoCs
 - Hardware counters and semi-supervised machine learning models for detecting anomalous activity resulting in compromised system availability
 - DoS attack detection in representative implementation of SoC for communication subsystem in connected autonomous vehicles
 - **Patent submitted for this work.**
- Localizing detected anomalous activity in domain-specific heterogeneous SoCs
 - Explainable machine learning techniques to extract impacted SoC locations based on hardware counter data used for detection

Research Intern, IBM, Yorktown Heights, NY

May 2021 – August 2021

- Explored heterogeneous SoC anomalous activity detection and mitigation for EPOCHS
 - EPOCHS: agile methodology for designing and implementing domain-specific SoCs for real-time cognitive decision engines in connected autonomous vehicles
 - Anomalous activity detection: collected hardware performance data for analysis with machine learning techniques to detect compromised system availability
- Developed microbenchmark tests for reporting accelerator performance on EPOCHS FPGA prototype

Research Intern, Microsoft, Redmond, WA

June 2020 – August 2020

- CHERI + memory versioning: explored novel design for efficient temporal safety on CHERI systems
 - CHERI: replaces integer pointers with capabilities equipped with permission and bounds information, inherently offering spatial memory safety
 - Memory versioning for temporal safety: reduces frequency of full memory sweeps required for capability revocation when freeing memory by $2^n \times$, where n is the number of version bits
 - Formal security analysis: proposed a formal hardware-software contract for secure speculation on CHERI + memory versioning systems and presented a mathematical model of the system

Applications Engineer I Intern, Hamamatsu Photonics, Bridgewater Township, NJ *June 2018 – August 2018*

- Vein imaging demo software: developed MFC application with capability to display image(s) from board level scientific camera, view histogram data of 12-bit grayscale pixel values, adjust contrast of image, and print image
- Wireless oscilloscope: high level design for wireless oscilloscope – analog input from Multi-Pixel Photon Counter (MPPC) module to digital output on Android application

Software Developer Intern, IBM, San Jose, CA

June 2017 – August 2017

- Information Management System (IMS) API Developer (Java):
 - Developed models, controllers, and handlers for new wizard used to add/edit fields in transaction messages for updated version of existing application, IMS Explorer for Development (E4D)
 - Developed refresh functionality for catalog connection and navigation tool for upcoming version of IMS E4D

IT Intern, Verizon, Warren, NJ

June 2016 – August 2016

- Mobile Content Solutions QA Developer: enhanced user interface, added several features, and fixed security vulnerabilities for existing in-house testing automation web application; developed an algorithm for automating input parameter generation
- Intern Hackathon: developed a suite of Alexa skills for the Amazon Echo involving various health assessments using Javascript

IT Intern, NYC School Construction Authority, Long Island City, NY

June 2015 – August 2015

- Business Analyst: documented user stories and translated them into use cases for development
- Front End UI Developer: developed one of the user stories using standard web programming languages (Javascript/Angular.JS)

Teaching and Mentoring Experience

Undergraduate Independent Work Mentor, Princeton University

February 2020 – May 2020

- Mentored Princeton undergraduate student Vinicius Wagner alongside Professor Margaret Martonosi
- Advised Vinicius on development of an automated debugging tool for use with axiomatic relational models, particularly those written with the relational modeling DSL Alloy

Assistantship in Instruction, Princeton University

February 2019 – May 2019

- Designed and graded assignments, projects, and exams in COS 375 Computer Architecture & Organization course with Professor Margaret Martonosi

Assistantship in Instruction, Princeton University

September 2018 – January 2019

- Taught precepts, graded assignments and exams, and assisted students in COS 126 Computer Science: An Interdisciplinary Approach course with Professor Robert Sedgewick

Computer Science Grader, Rutgers University

September 2016 – December 2016

- Assisted with facilitating and reviewing course projects as well as grading exams for CS 431 Software Engineering course with Professor Alex Borgida

Mathematics Grader, Rutgers University January 2016 – May 2018

- Reviewed MATLAB-based assignments for Math 250: Introduction to Linear Algebra with Professor Lasantha Goonetilleke

Leadership Experience

Eta Kappa Nu (HKN) – Electrical and Computer Engineering Honor Society

- Former President of Rutgers University (Gamma Epsilon) chapter: Led weekly E-Board meetings and monthly general body meetings; collaborated with other organizations such as IEEE to organize joint events; organized and participated in mentorship and middle school outreach programs; communicated with industry professionals to organize professional events for students; several events to assist ECE students such as Tutoring Night

Skills

Computer Skills

- **Programming Languages:** Alloy, Bash, C, C++, Coq, Java, Javascript (Angular.JS, jQuery), JSP, MATLAB, MIPS, MySQL, Python, R, Racket, SystemVerilog, Verilog
- **Software:** Alloy Analyzer, Canopy, Eclipse, GTKWave, MATLAB, Microsoft Visual Studio, PSpice, QEMU, Quartus II/ModelSim, QtSpim
- **Operating Systems:** Linux-based OS (Ubuntu, Fedora, Kali), Windows

Languages

- English (*fluent*), Bengali (*intermediate*), French (*novice*)