KAKI RYAN

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EDUCATION

University of North Carolina at Chapel Hill *Expected May 2025*
Ph.D in Computer Science
Research Focus: Formal Verification, Hardware Security
Relevant courses: Cryptography, Systems Security, Computer Architecture, Logical Foundations

University of North Carolina at Chapel Hill *May 2021*
M.S. in Computer Science & Mathematics
Relevant courses: Parallel Computing, Computational Photography, Programming Languages, Advanced Operating Systems

University of North Carolina at Chapel Hill *May 2020*
B.S. in Computer Science & Mathematics
Relevant courses: Digital Logic, Compilers, Operating Systems, Intro to Machine Learning, 2-D Graphics, Internet Services and Protocols, Algorithms and Analysis, Real Analysis, Differential Equations, Elements of Algebra and Number Theory

HONORS AND RECOGNITIONS

2022 Tanner Award for Excellence in Undergraduate Teaching by Graduate Teaching Assistants ($5000)
2021 John M. Glotzer Graduate Teaching Assistant Award ($500)
2021 Selected to attend GREPSEC V
2018 Robert E. Bryan Fellowship ($2,500)

PUBLICATIONS

SEIF: Augmented Symbolic Execution for Information Flow in Hardware Designs
Nominated for Best Paper.
Kaki Ryan, Matthew Gregoire, and Cynthia Sturton.
Hardware and Architectural Support for Security and Privacy (HASP), October 2023.

Countering the Path Explosion Problem in the Symbolic Execution of Hardware Designs
Kaki Ryan and Cynthia Sturton.
Formal Methods in Computer Aided Design (FMCAD), 2023.

Special Session: CAD for Hardware Security - Promising Directions for Automation of Security Assurance
Sohrab Aftabjahani, Mark Tehranipoor, Farimah Farahmandi, Bulbul Ahmed, Ryan Kastner, Francesco Restuccia, Andres Meza, **K. Ryan**, Nicole Fern, Jasper Van Woudenberg, Rajesh Velegalati, Cees-Bart Breunesse, Cynthia Sturton, Calvin Deutschbein
VLSI Test Symposium (VTS), 2023

REFEREED POSTERS

Symbolic Execution + the Security Verification of Hardware Designs
Kaki Ryan and Cynthia Sturton. CRA-WP Grad Cohort for Women, 2023.

Countering the Path Explosion Problem in the Symbolic Execution of Hardware Designs
Kaki Ryan and Cynthis Sturton. Design Automation Conference (**DAC**), 2023.

RESEARCH PROJECTS

Symbolic Execution for the Security Verification of Hardware August 2020 - Present
UNC Hardware Security Group

Developed a symbolic execution engine for hardware designs implemented in the Verilog Hardware Description Language (HDL) at the Register Transfer Level (RTL) without requiring translation to a software simulation of the design.

My dissertation research is focused on leveraging this symbolic execution workflow for 1) finding security vulnerabilities in hardware designs, and 2) designing hardware-oriented optimizations and search strategies for countering path explosion.

Hardware Security and Information Flow August 2022 - Present
UNC Hardware Security Group

Working with researchers at UNC, UC San Diego, and Intel to use information flow tracking to mine for vulnerabilities in hardware designs. Our aim is to efficiently extract information flow properties from symbolic execution of hardware.

Parser for SystemVerilog Assertions January 2022 - December 2022
UNC Hardware Security Group

Mentored an undergraduate researcher in the design and implementation of a parser for SystemVerilog assertions to be used as part of a front-end for a hardware security verification tool-chain.

Symbolic Execution in Coq January 2021 - August 2022
UNC Hardware Security Group

Worked towards specifying formal proofs in Coq of three properties of symbolic execution laid out in the seminal paper (King 77).

Voting Rights Data Institute Summer Fellowship May 2018 - August 2018
Metric Geometry and Gerrymandering Group

Used census data and GIS shapefiles to compile data-rich population graphs. Developed R Shiny application to calculate and interpret ecological inference. Generate districting plans with a Markov chain Monte Carlo algorithm.

UNDERGRADUATE STUDENTS MENTORED

Jayden Rogers June 2023 - Present
NC A&T *UNC-Intel REU Summer 2023*

Jesse Wei November 2022 - May 2023
UNC Chapel Hill

Maurille Beheton UNC-Intel REU Summer 2022
Shaw University

Moshe Ikechukwu B.S. December 2022
UNC Chapel Hill

INVITED TALKS AND PRESENTATIONS

1. "Bringing Symbolic Execution to the Security Verification of Hardware Designs," Systems Seminar at UNC. October 2023.
2. "SEIF: Augmented Symbolic Execution for Information Flow in Hardware Designs," Workshop Presentation at HASP. October 2023.
3. "Sylvia: Countering the Path Explosion Problem in the Symbolic Execution of Hardware Designs," Conference Talk at FMCAD. October 2023.
4. "User Authentication," Guest lecture in Computer Security Concepts Course. September 2023
5. "Sylvia: Countering the Path Explosion Problem in the Symbolic Execution of Hardware Designs," Research presentation at Intel Scalable Assurance Cluster Fall Workshop. September 2023.
6. "Bringing Symbolic Execution to the Security Verification of Hardware Designs," Invited talk at Workshop on Computer Architecture Research with RISC-V (CARRV). June 2023.
7. "Understanding Information Flow through Static and Symbolic Analysis," Research presentation at Semi-Conductor Corporation (SRC) Hardware Security Annual Review. June 2023.
8. "Three Strategies for Falsifying Information Flow Paths Using Static and Symbolic Analysis," Lightning talk at Women in Security and Cryptography Workshop (WISC). June 2023.
9. "Understanding Information Flow through Static and Symbolic Analysis," Research presentation at Intel Scalable Assurance Cluster Spring Workshop. May 2023.
10. "Formal Verification + Operating Systems," Guest lecture in Advanced Operating Systems. March 2023.
11. "Piecewise Composition: A new strategy for tackling path explosion," Systems Seminar at UNC. January 2023.
12. "Modes of Operation and Encryption," Guest lecture in Computer Security Concepts course. September 2022.
13. "Hardware Security at UNC," invited talk at UNC Black in Tech Research Fair. March 2022.
14. "Intro to Recursion," Guest lecture in CS1 course at UNC. December 2021.
15. "Intro to git!," Invited talk at HACK110 Hackathon at UNC. December 2021.
16. "Peer Teaching Summit," Student panelist at SIGCSE. March 2019.
17. "University discussion of using Undergraduate Learning Assistants (ULAs)," invited panelist. March 2019.

TEACHING

UNC Chapel Hill Summer 2021, Summer 2022
Graduate Instructor *Chapel Hill, NC*

- **COMP 110: Intro to Programming**

  Solo instructor of record for a 40-student section of CS1 course taught in Python. Daily programming assignments and weekly readings on algorithmic bias.

- **COMP 210: Data Structures**

  Solo instructor of record for a 40-student section of data structures taught in Java. Developed new assignments and weekly quizzes. The course project required each student to conduct research on a notable computer scientist from a historically underrepresented background.

UNC Chapel Hill August 2020 - December 2022
Graduate Teaching Assistant *Chapel Hill, NC*

- **COMP 110: Intro to Programming**

  Manage operations of introductory programming course and transition to Python. Develop online course materials, assessments and projects. Give guest lectures on selected topics. Incorporate readings about the ethics and social implications of algorithmic bias into the curriculum and lead group discussions

- **COMP 435: Computer Security Principles**

  Reorganized six hands-on and investigation-driven lab assignments. Each lab included programming tasks and conceptual components. Held weekly reviews going over problems and concepts from class. Held daily office hours.

UNC Chapel Hill August 2017 - May 2020
Undergraduate Teaching Assistant *Chapel Hill, NC*

- **COMP 110: Intro to Programming**

  Covered concepts such as loops, recursion, functions and call stacks, and OOP. Taught in TypeScript and Python. Held one-on-one office hours with hundreds of students. Led grading and code review for 600+ students per semester.

- **COMP 290: Tools for Computer Science**

  1-hour pilot course for majors to introduce fundamental tools: shell, vim, make, git.

- **COMP 211: Systems Fundamentals**

  Aided in pilot of a new core systems programming course taught in C; emphasis on representation, memory management, and software engineering tools.

INDUSTRY EXPERIENCE

Cisco Systems, Inc. Summer 2019
Summer Software Engineering Intern *Research Triangle Park, NC*

Developed MEAN stack application to automate Google Lighthouse audits, measure performance of Cisco.com and its microsites. Project deployed into production.

Viyb Health Summer 2018
Front-End Development Intern *Chapel Hill, NC*

Created user-friendly web platform for a mental health start-up using HTML and CSS. Collaborate with back-end developers to improve usability.

National Alliance on Mental Illness (NAMI) Summer 2017
Education Intern *Arlington, VA*

Wrote selections on diversity and inclusion for program manual to be distributed to trainers at NAMI affiliates nationwide.

UNIVERSITY AND DEPARTMENT SERVICE

University Post-Baccalaureate Teaching Awards Committee July 2022 - Present
Graduate Student Member

Review the portfolios and select the recipients of the University Distinguished Teaching Awards for Post-Baccalaureate Instruction.

UNC Intel REU Program May 2022 - Present
Graduate Student Research Mentor

During summer 2022 I served as a research mentor for one student, leading them in a project that involved building a testing framework onto one of our group's existing tool chains. Collaborating with UNC staff and Intel partners to create an engaging and inclusive program for students.

UNC Computer Science Undergraduate Admissions Committee May 2022 - Present
Graduate Student Member

Provide student insight and experiences during the development of new departmental admission processes and procedures. Read applications and provide input during the decision making process.

UNC Computer Science Diversity and Inclusion Committee January 2022 - Present
Graduate Student Member

Create, develop, and assess DEI practices with the department. Member of community engagement subcommittee focused on outreach to K-12 students and surrounding schools.

UNC 3C Fellows January 2022 - Present
Cohort 2

Develop new curriculum for UNC's undergraduate computer science program focused on the intersection of computing and racism, identity, discrimination, equity, and bias. Implement new departmental policies to foster a more inclusive and equitable culture.

UNC Undergrad Curriculum Committee April 2019 - January 2023
Student Member

Serve as a liaison between students and faculty in the computer science department. Provide input and feedback on current course offerings and topics covered.

STUDENT ORGANIZATIONS

UNC Graduate Women in Computer Science August 2022 - Present
President

Revitalized the organization post-covid to serve as a space for women in the department to connect and find community. Additional activities include community outreach, mentorship, networking with alumni, and a semesterly speaker series.

UNC Computer Science Students Association August 2022 - Present
Student Officer

Collaborate with other officers to represent the interests of UNC Computer Science graduate students to the faculty. Advocate for curriculum and cultural changes. Plan social events.

UNC Student Safety and Security Committee August 2022 - Present
Graduate Student Member

Represent the safety and security interests of UNC Chapel Hill graduate students. Responsible for maintaining and appropriating the Student Safety and Security Fee to campus organizations and university departments to promote student safety at UNC.

TOPICS Club September 2021 - Present
Graduate Student Mentor

"Talking Over Papers in Computer Science." Graduate mentor for undergraduate women's reading group. Help select papers to read and provide advice, encouragement, and a place to talk.

Mental Health Ambassadors September 2018
Carolina Center for Public Service

Prepare and deliver presentations to various organizations and audiences on campus about different aspects of mental health to fight stigma. Mental health first aid certified. Bryan Fellowship project.

TECHNICAL STRENGTHS

Computer Languages	Python, Java, TypeScript, MATLAB, C, Verilog, Scala, Assembly
Tools	LaTeX, Vim, Bash, Git, Jupyter notebooks, SQL, Coq, JasperGold