

# Saket Upadhyay

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## Personal Profile

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As a Ph.D. candidate in the University of Virginia's Computer Science department, my work centers on exploring low-level software security through compiler-based techniques. My research investigates how compilers can be leveraged to enforce granular security policies and how memory objects influence hardware-level behavior and system security. My expertise spans LLVM instrumentation, debuggers, and low-level programming language constructs, with a focus on using compiler infrastructure to analyze, monitor, and instrument programs, to inform enforcement systems. I also have a strong background in cybersecurity, particularly in threat intelligence, malware analysis, and reverse engineering. I am committed to academic research and to broadening access to STEM education for individuals from diverse backgrounds.

## Education

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### University of Virginia

Ph.D. in Computer Science

Virginia, USA

Aug 2022 - Current

- GPA 3.8/4
- Graduate Student Representative '25-26, '26-27
- International Student Citizen Leaders Fellowship '24-25
- Steering committee member in Computer Architecture Student Association (CASA) '23-24
- Teaching Assistant: Compilers CS4620, Network Security and Privacy CS6501/ECE6502

### Vellore Institute of Technology

B.Tech in Computer Science

Bhopal, India

May 2018 - May 2022

- CGPA 8.5/10
- Established and led the student research and development group in the cybersecurity department.
- Conducted cybersecurity workshops for high school students and faculty training, including live demonstrations of security concepts.

## Publications

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### CONFERENCE PROCEEDINGS

*Shiny Objects: Object-Centric Characterization of Chromium.* Saket Upadhyay, Ashish Venkat

ACM SIGMETRICS 2026, 2026, Ann Arbor, MI, USA

*Special Session: Detecting and Defending Vulnerabilities in Heterogeneous and Monolithic Systems: Current Strategies and Future Directions.*

Venkat Nitin Patnala, Sai Manoj Pudukotai Dinakarao, Guru Venkataramani, Jie Chen, Milos Doroslovacki, Fan Yao, Hongyu Fang, Meron Demissiea, Todd Austin, Lauren Biernacki, Saket Upadhyay, Arnabjyoti Kalita, Ashish Venkat

2024 International Conference on Compilers, Architecture, and Synthesis for Embedded Systems (CASES), 2024, Raleigh, NC, USA

*PACE: Platform for Android Malware Classification and Performance Evaluation.* Ajit Kumar, Vinti Agarwal, Shishir K. Shandilya, Andrii Shalaginov, Saket Upadhyay, Bhawna Yadav

2019 IEEE International Conference on Big Data (Big Data), 2019, Los Angeles, CA, USA

### JOURNAL ARTICLES

*Modified Firefly Optimization Algorithm-Based IDS for Nature-Inspired Cybersecurity.* Shishir Kumar Shandilya, Bong Jun Choi, Ajit Kumar, Saket Upadhyay

Processes 11.3 (2023). 2023

*AI-assisted Computer Network Operations testbed for Nature-Inspired Cyber Security based adaptive defense simulation and analysis.* Shishir Kumar Shandilya, Saket Upadhyay, Ajit Kumar, Atulya K. Nagar

Future Generation Computer Systems 127 (Feb. 2022) pp. 297–308. 2022

*PACER: Platform for Android Malware Classification, Performance Evaluation and Threat Reporting.* Ajit Kumar, Vinti Agarwal, Shishir Kumar Shandilya, Andrii Shalaginov, Saket Upadhyay, Bhawna Yadav

Future Internet 12.4 (Apr. 2020) p. 66. 2020

### BOOK CHAPTERS

*Nature-Inspired Malware and Anomaly Detection in Android-Based Systems.* Saket Upadhyay

Advances in Nature-Inspired Cyber Security and Resilience, 2022

### ARCHIVE

*FuzzDistill: Intelligent Fuzzing Target Selection using Compile-Time Analysis and Machine Learning.* Saket Upadhyay

arXiv, 2024

# Projects

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## Compartmentalization and Privilege Management

DARPA, University of Virginia

2024 – Present

- Designed and implemented LLVM compiler passes to automate software compartmentalization, using annotations from other collaborators.
- Developed compiler passes for verification of a multi-stage, multi-collaborator compartmentalization pipeline, to ensure correctness of access policies.
- Investigating and designing strategies for efficient compression of access matrices to optimize resource usage.
- Developed an instrumentation pass to inform gate-call placements for hardware enforcement by other collaborators.

## Object-Centric Characterization of Large-Scale Software Systems

University of Virginia

August 2023 – Present

- Developed a scalable, low-overhead instrumentation design for object lifetime profiling.
- Investigated the memory management strategies employed within the Chromium web browser.
- Implemented a compiler pass to instrument object tracking gadgets, enabling collection of object-level runtime data.
- Designed a framework for processing raw trace data and generating comprehensive lifetime analysis reports, supporting in-depth performance investigations.

## Intelligent Fuzzing Target Selection via Compile-Time Analysis and Machine Learning

University of Virginia

August 2024 – December 2024

- Designed and implemented a modular, open-source infrastructure for feature extraction, model training, and prediction for fuzzing target selection using compile-time analysis and machine learning.
- Achieved a PoC accuracy of 86% in identifying optimal fuzzing targets, demonstrating the effectiveness of the approach.
- Developed an LLVM compiler pass for efficient extraction of function-level and basic block features.
- Designed a Python framework to evaluate and train over ten ML algorithms, to find optimal approach for target selection.
- Created Python-based back-end APIs and a web front-end to visualize results.
- Project repository available at: <https://github.com/Saket-Upadhyay/FuzzDistill>

# Teaching

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## CS6501/ECE6502 Network Security and Privacy

University of Virginia

Graduate Teaching Assistant

Spring 2024 / Spring 2025

- Delivered a guest lecture on "Leveraging Compilers for Static Software Profiling," exploring binary security techniques through compiler modifications, enhancing student understanding of low-level analysis. [llvm-obfuscation-edu]
- Graded assignments and projects.
- Conducted office hours.

## CS4620 Compilers

University of Virginia

Graduate Teaching Assistant

Fall 2023 / Fall 2024

- Modernized the teaching compiler's (tipc) optimizer by integrating a new pass manager within LLVM 15+.
- Implemented opaque pointers within the tipc's CodeGen routine.
- Successfully migrated the tipc's codebase from LLVM14 to LLVM17.
- Delivered an 'explainer lecture' to explain project details, code sections, and deliverable expectations.
- Graded assignments and projects.
- Conducted office hours.

# Work Experience

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## University of Virginia

Charlottesville, VA

Research Assistant

Aug 2022 - Current

- Low-level software and hardware security research with Dr. Ashish Venkat.
- **Technical Skills:** C++, Linux/Windows VMs, Linux tools, LLVM, LLVM IR, Python, x86 assembly, \*nix scripting, Git, software build systems (CMake, ninja, makefiles), development on HPC clusters, data analysis, research documentation (ATE).

## Uptycs

Bangalore, India (Remote)

Security Research Intern

Jul 2021 - Jan 2022

- Collaborated with a small team to expand the existing threat intelligence database that enables cloud-native application protection platform (CNAPP) and extended detection and response (XDR) solutions.
- Wrote and validated YARA rules for new malware families for the XDR platform.
- Validated detection rules for CNAPP and XDR deployment (development).
- Learned advanced malware reverse engineering and AV evasion techniques from renowned and experienced malware researchers.
- Gave a talk on 'Automating malware process scanning with Python3' in PyCode2021 Conference.
- **Technical Skills:** C++, Linux/Windows VMs, Linux tools, YARA, Python, x86 assembly, Scripting, Git., Debuggers, IDA Pro, Ghidra
- **Soft Skills:** Teamwork, Time Management, Communication, Presentation skills.

# Skills

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	x86, ARM, Operating Systems (Threads, Process Control, Memory/Resource Management, Virtual Memory), Compilers (AST, Grammars, State Machines, Optimizations), LLVM, Bash/Shell Scripting, Security Testing, Reverse Engineering (GDB, Ghidra, IDA Pro, x32dbg, LLDB), Threat Analysis, Threat Models (OWASP, MITRE Att&ck).
<b>Core</b>	C, C++, Python, x86 and ARM Assembly.
<b>Programming</b>	*nix systems, L <sup>A</sup> T <sub>E</sub> X, Microsoft Office, Git, Adobe Creative Cloud suite (Photoshop, PremierePro, Aftereffects, Lightroom)

# Achievements

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2024	<b>International Student Citizen Leaders Fellowship</b> , UVA	USA
2021	<b>1st Runner-up</b> , HackDSC Hackathon, Google DSC	India
2020	<b>Winner</b> , Ultimate Secure Code Tournament	Global
2020	<b>Winner</b> , TrendMicro Cloud Security CTF	Global
2020	<b>Winner</b> , DEFCON 28 Secure Code Tournament	USA
2019	<b>Best Paper Award</b> , IEEE International Conference on Big Data 2019	USA

# Interests

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Motorcycles, Cooking, Mountain biking, Hiking, Swimming, Community Service.

# Languages

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<b>English</b>	Full professional proficiency (ILR level 4)
<b>Hindi</b>	Native proficiency (ILR level 5)
<b>Marathi, Gujarati, Punjabi</b>	Elementary proficiency (ILR level 1)
<b>Russian, Dutch</b>	(ILR level 0)

\* ILR = Interagency Language Roundtable scale.