Ali Hajiabadi

Computer Science PhD Candidate
National University of Singapore (NUS)

Contact Information

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Research Interests

Systems Security, Hardware/Software Co-design, Computer Architecture, Optimizing Compilers, Formal Methods, Trusted Execution Environments, Confidential Computing for Heterogeneous Systems, Secure Architectures and Software, Microarchitectural Attacks and Side Channels, Machine Learning Security and Privacy

Education

AUG. 2019 - Present	Doctor of Philosophy in Computer Science **National University of Singapore (NUS)**, Singapore Thesis: *"Non-speculative and Non-deterministic Processing for Efficient and Secure Modern CPUs"* Advisor: Dr. Trevor E. CARLSON
2014 - 2019	Bachelor of Science in Computer Engineering **Sharif University of Technology**, Tehran, Iran Thesis: *"High Concurrency Latency Tolerant Register Files for GPUs"* Advisor: Prof. Hamid SARBAZI-AZAD
2009 - 2013	Diploma in Physics and Mathematics Discipline **Shahid Beheshti High School**, Birjand, Iran *Affiliated with the National Organization for the Development of Exceptional Talents (NODET)*

Honors & Awards

OCT. 2023	Recipient of SoC RESEARCH INCENTIVE AWARD from School of Computing, NUS (S$ 2,500 award).
JAN. 2022	Recipient of STUDENT TRAVEL AWARD from ASPLOS'22 conference.
AUG. 2021	Recipient of RESEARCH ACHIEVEMENT AWARD from School of Computing, NUS.
MAR. 2020	Invited talk and travel grant for the 2nd Young Architect Workshop at ASPLOS'20, Switzerland.
FEB. 2019	Recipient of PRESIDENT'S GRADUATE FELLOWSHIP, the most prestigious doctoral fellowship at National University of Singapore (NUS).
SEP. 2014	Ranked **164th** in Iranian National University Entrance Exam among more than 250,000 students.
2006/2009	Recognized as talented student in entry exam of NODET for middle school and high school.

Research Experience

AUG. 2019 - PRESENT	Graduate Research Assistant at NATIONAL UNIVERSITY OF SINGAPORE, Singapore *NUS Computer Architecture Group* *Advisor:* Prof. Trevor E. CARLSON My current research spans around HW/SW co-design to build secure and efficient general-purpose processors. My focus is on microarchitectural attacks, including speculation-based attacks and power analysis attacks.
JUL. 2016 - JUN. 2019	Research Assistant at SHARIF UNIVERSITY OF TECHNOLOGY, Tehran, Iran *High Performance Computer Architectures and Networks (HPCAN) Lab* *Advisor:* Prof. Hamid SARBAZI-AZAD Focus of my research has been on latency tolerant register files for GPUs through HW/SW cooperative register prefetching. I contributed to an ASPLOS'18 paper and an ACM TOCS paper. In collaboration with *Institute for Research in Fundamental Sciences (IPM), EPFL*, and *ETH Zürich*.
SUMMER 2018	Research Intern at NATIONAL UNIVERSITY OF SINGAPORE, Singapore *Advisor:* Prof. Trevor E. CARLSON As a visiting research assistant, I investigated the potentials of out-of-order commit in modern processors and explored implementations (simulation+compiler) to enable efficient out-of-order commit.

In-Progress Work

Yun Chen*, **Ali Hajiabadi***, Romain Poussier, Andreas Diavastos, Shivam Bhasin, Trevor E. Carlson
Mitigating Power Attacks through Fine-Grained Instruction Reordering.
*Joint first-authors with equal contribution.
▶ *Proposing a novel criticality-aware and non-deterministic instruction scheduling for out-of-order processors to resist power analysis attacks.*
arXiv Paper

Peer-Reviewed Publications

DAC'24	**Ali Hajiabadi**, Archit Agarwal, Andreas Diavastos, Trevor E. Carlson Levioso: *Efficient Compiler-Informed Secure Speculation.* To appear in Proceedings of 61st ACM/IEEE Design Automation Conference (DAC 2024), June 2024. Acceptance rate: 337/1465 = 23.0% ▶ *Efficient and comprehensive mitigation for speculative execution attacks through compiler-informed hints about true branch dependencies to restrict execution of speculative instructions only if necessary.*
DAC'24	**Ali Hajiabadi**, Trevor E. Carlson Conjuring: *Leaking Control Flow via Speculative Fetch Attacks.* To appear in Proceedings of 61st ACM/IEEE Design Automation Conference (DAC 2024), June 2024. Acceptance rate: 337/1465 = 23.0% ▶ *Proposing a new and practical variant of speculative fetch attacks that enables unprivileged attackers to leak control flow information of victims, without requiring priming a side channel.*
HPCA'24	Yun Chen*, **Ali Hajiabadi***, Trevor E. Carlson GadgetSpinner: *A New Transient Execution Primitive using the Loop Stream Detector.* Proceedings of 30th IEEE International Symposium on High-Performance Computer Architecture (HPCA 2024), March 2024. Acceptance rate: 75/410 = 18.3% *Joint first-authors with equal contribution. ▶ *Analyzing and discovering vulnerabilities of the Loop Stream Detector (LSD) in Intel CPUs that enables cross-core transient execution attacks without requiring branch mistraning/poisoning.* Paper | Artifact
HPCA'24	Yun Chen, **Ali Hajiabadi**, Lingfeng Pei, Trevor E. Carlson PrefetchX: *Cross-Core Cache-Agnostic Prefetcher-Based Side-Channel Attacks.* Proceedings of 30th IEEE International Symposium on High-Performance Computer Architecture (HPCA 2024), March 2024. Acceptance rate: 75/410 = 18.3% ▶ *Extensive reverse-engineering of an undocumented Intel prefetcher, called XPT (an LLC miss predictor) that enables cross-core cache-agnostic side and covert channels.* Paper | Artifact
ICCAD'23	Arash Pashrashid, **Ali Hajiabadi**, Trevor E. Carlson HidFix: *Efficient Mitigation of Cache-based Spectre Attacks through Hidden Rollbacks.* Proceedings of 42nd IEEE/ACM International Conference on Computer-Aided Design (ICCAD 2023), November 2023. Acceptance rate: 172/768 = 22.4% ▶ *Co-designing detection and mitigation to defend cache-based Spectre with no performance overhead; extensive study of existing detection/mitigation combinations and proposing attacks to bypass them.* Paper
ICCAD'22	Arash Pashrashid, **Ali Hajiabadi**, Trevor E. Carlson *Fast, Robust and Accurate Detection of Cache-based Spectre Attack Phases.* Proceedings of 41st IEEE/ACM International Conference on Computer-Aided Design (ICCAD 2022), November 2022. Acceptance rate: 132/586 = 22.5% ▶ *(1) Demonstrating different attacks bypassing ML-based detectors for Spectre attacks; (2) proposing an efficient, accurate, robust, and timely mechanism to detect cache-based Spectre attack phases.* Paper | Github
ASPLOS'21	**Ali Hajiabadi**, Andreas Diavastos, Trevor E. Carlson Noreba: *A Compiler-Informed Non-speculative Out-of-Order Commit Processor.* Proceedings of 26th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2021). April 2021. Acceptance rate: 75/398 = 18.8% ▶ *A hardware/software co-design that compiler informs the hardware about true branch dependencies enabling safe and non-speculative out-of-order commit of instructions improving efficiency.* Paper | Extended Abstract | Short Slides | Short Talk | Slides | Full Talk

TOCS'21	Mohammad Sadrosadati, Amirhossein Mirhosseini, **Ali Hajiabadi**, Seyed Borna Ehsani, Hajar Falahati, Hamid Sarbazi-Azad, Mario Drumond, Babak Falsafi, Rachata Ausavarungnirun, Onur Mutlu *Highly Concurrent Latency-tolerant Register Files for GPUs.* In ACM Transactions on Computer Systems (TOCS), 2021. ▶ *A hardware/software co-operative design for register prefetching in GPUs. The compiler constructs the prefetch sets and ensures minimal register bank conflicts via register renumbering.* arXiv Paper
CGO'21	Harish Patil, Alexander Isaev, Wim Heirman, Alen Sabu, **Ali Hajiabadi**, Trevor E. Carlson *ELFies: Executable Region Checkpoints for Performance Analysis and Simulation.* Proceedings of 19th IEEE International Symposium on Code Generation and Optimization (CGO 2021), March 2021. Acceptance rate: 31/89 = 34.8% ▶ *Proposing a set of tools to generate checkpoint executables of the regions of interest of applications, called ELFies. ELFies run natively and can be used for detailed analysis in other tools and simulators.* Paper	Github

TEACHING EXPERIENCE

▶ **National University of Singapore, Singapore**

SPRING 2020 and SPRING 2021	**Teaching Assistant**, Tutorial Instructor *Course*: CS2106 Introduction to Operating Systems *Instructor*: Prof. Djordje Jevdjic

▶ **Sharif University of Technology, Tehran, Iran**

SPRING 2017	**Teaching Assistant**, Assignments/Projects Assistant *Course*: CE323 Computer Architecture *Instructor*: Prof. Hamid Sarbazi-Azad
FALL 2017 and FALL 2018	**Teaching Assistant**, Tutorial Instructor, Assignments/Projects Assistant *Course*: CE453 Real-Time Systems *Instructor*: Prof. Amirhossein Jahangir

SERVICES

Nov. 2023	**Heavy Shadow PC member** at 19th European Conference on Computer Systems (EuroSys 2024).
OCT. 2022	**Shadow PC member** at 18th European Conference on Computer Systems (EuroSys 2023).
MAR. 2022	**Mentor in the Meet-a-Senior-Student program** at 27th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2022), Lausanne.
JUN. 2021	**Student Volunteer** at 42nd International Conference on Programming Language Design and Implementation (PLDI 2021), Virtual.

RESEARCH MENTORING

2021 - PRESENT	Arash Pashrashid, PhD Student at NUS Advised by Trevor E. Carlson
2020 - PRESENT	Yun Chen, PhD Student at NUS Advised by Trevor E. Carlson
2021 - 2023	Archit Agarwal, Research Assistant at NUS
2020 - 2021	Vernon Pang, Undergraduate Student at NUS

TALKS

AUG. 2021	NOREBA: **A Compiler-Informed Non-speculative Out-of-Order Commit Processor** *Computing Research Week, School of Computing (NUS)*, Virtual.
APR. 2021	NOREBA: **A Compiler-Informed Non-speculative Out-of-Order Commit Processor** *International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2021)*, Virtual.
FEB. 2021	**Accelerating HPC applications with Out-of-Order Commit Processors** *Free and Open source Software Developers' European Meeting (FOSDEM 2021), HPC, Big Data, and Data Science track*, Virtual.
MAR. 2020	**Speculation-Free Out-of-Order Commit** *2nd Young Architect Workshop at the 25th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2020)*, Virtual.

Skills

PROGRAMMING LANGUAGES:	C, C++, Python, bash, and familiar with Java, Matlab, Scala
INSTRUCTION SET ARCHITECTURES:	x86, Arm, RISC-V
SCIENTIFIC TOOLS:	LLVM Compiler Infrastructure, gem5 Simulator, Sniper Simulator, Intel Pin, DynamoRIO
TYPESETTING:	LaTeX, Microsoft Word