

NIRAV ATRE

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EDUCATION

- Carnegie Mellon University** • Pittsburgh, PA, USA Aug, 2018 – Present
Ph.D. in Computer Science (Computer Networking)
Advisor: Prof. Justine Sherry
- University of Toronto** • Toronto, Canada Sep, 2013 – May, 2018
B.A.Sc. in Computer Engineering
Advisors: Prof. Jonathan Rose, Prof. Ravi Adve
• CGPA: 3.9/4.0 • Graduated with highest honors in engineering

RESEARCH INTERESTS

Computer systems, computer networking, performance modeling. Building high-performance networked systems (on x86, FPGAs) and proving theoretical properties about their performance and stability.

HONORS AND AWARDS

- French-American Doctoral Exchange ([FADEX](#)) Laureate, Cybersecurity. *CMU, French Embassy in the US.* 2023
- Jay Lepreau Best Paper Award at OSDI '23. *USENIX.* 2023
- [CyLab Presidential Fellowship](#). *CyLab, Carnegie Mellon University.* 2021
- CNIB Hochhausen Prize for Excellence in Accessible Design in Engineering. *CNIB, University of Toronto.* 2018
- NSERC [University of Toronto Excellence Award](#) (UTEA-NSE). *NSERC, University of Toronto.* 2015
- Applied Science and Engineering (APSC) Undergraduate Research Fellowship. *University of Toronto.* 2014

PUBLICATIONS

- Nirav Atre**, Hugo Sadok, and Justine Sherry. 2024. [BBQ: A Fast and Scalable Integer Priority Queue for Hardware Packet Scheduling](#). In Proceedings of the 21st USENIX Symposium on Networked Systems Design and Implementation (**NSDI '24**).
- Hugo Sadok, **Nirav Atre**, Zhipeng Zhao, Daniel S. Berger, James C. Hoe, Aurojit Panda, Justine Sherry, and Ren Wang. 2023. [Ensō: A Streaming Interface for NIC-Application Communication](#). In Proceedings of the 17th USENIX Symposium on Operating Systems Design and Implementation (**OSDI '23**).
🏆 *Jay Lepreau Best Paper Award.* 🏆 *Distinguished Artifact Award.*
- Nirav Atre**, Hugo Sadok, Erica Chiang, Weina Wang, and Justine Sherry. 2022. [SurgeProtector: Mitigating Temporal Algorithmic Complexity Attacks using Adversarial Scheduling](#). In Proceedings of the Annual Conference of the ACM Special Interest Group on Data Communication (**SIGCOMM '22**).
- Hugo Sadok, Zhipeng Zhao, Valerie Choung, **Nirav Atre**, Daniel S. Berger, James C. Hoe, Aurojit Panda, and Justine Sherry. 2021. [We Need Kernel Interposition over the Network Dataplane](#). In Proceedings of the Workshop on Hot Topics in Operating Systems (**HotOS '21**).
- Zhipeng Zhao, Hugo Sadok, **Nirav Atre**, James C. Hoe, Vyas Sekar, and Justine Sherry. 2020. [Achieving 100Gbps Intrusion Prevention on a Single Server](#). In Proceedings of the 14th USENIX Symposium on Operating Systems Design and Implementation (**OSDI '20**).
- Nirav Atre**, Justine Sherry, Weina Wang, and Daniel S. Berger. 2020. [Caching with Delayed Hits](#). In Proceedings of the Annual Conference of the ACM Special Interest Group on Data Communication (**SIGCOMM '20**).

SELECTED POSTERS

- Erica Chiang, **Nirav Atre**, Hugo Sadok, Weina Wang, and Justine Sherry. 2022. [Robust Heuristics: Attacks and Defenses on Job Size Estimation for WSJF Systems](#). ACM SIGCOMM '22 Poster Session.
🏆 *Runner-up at the ACM SIGCOMM '22 Undergraduate Student Research Competition (SRC).*
- Zhipeng Zhao, **Nirav Atre**, Hugo Sadok, Siddharth Sahay, Shashank Obla, James C Hoe, and Justine Sherry. 2022. [Pigasus 2.0: Making the Pigasus IDS Robust to Attacks and Different Workloads](#). ACM SIGCOMM '22 Poster Session.

- Benjamin Carleton, **Nirav Atre**, Justine Sherry, and Weina Wang. 2021. [Delayed Hits in Multi-Level Caches](#). ACM SOSP 2021 Poster Session. 🏆 *Winner of the ACM SIGOPS '21 Undergraduate SRC.*

INDUSTRY EXPERIENCE

Software Engineering Intern, Microsoft May, 2020 – Aug, 2020
Azure Physical Networking (PhyNet) team *Virtual*

- Designed and implemented a simulator to help uncover NIC performance bottlenecks

Software Engineering Intern, Google May, 2018 – Aug, 2018
Android Project Treble team *Mountain View, CA, USA*

- Contributed to a source-to-source compiler (*hidl-gen*) for Android HIDL (HAL Interface Definition Language)
- Helped implement several framework-level improvements for Android Q, including Safe Unions and Java Native Handles (the corresponding AOSP changelists are public, and can be found [here](#))

Software Engineering Intern, Intel Sep, 2016 – Aug, 2017
Deep Learning Inference Accelerator (DLIA) team for Intel FPGAs *Toronto, Canada*

- Helped develop a C++ software stack for the DLIA from the ground-up (pre-Alpha contributor)
- Implemented key features, including a cache-aware memory management framework for the accelerator overlay
- Contributed to Intel’s LLVM-based OpenCL compiler (*i++*), a high-level synthesis (HLS) tool for Intel FPGAs

Software Engineering Intern, Google May, 2016 – Aug, 2016
Android Nearby team *Mountain View, CA, USA*

- Designed a fast, audio-based indoor localization protocol, realizing a 3× speedup over the existing design
- Implemented a prototype audio codec in C++ (native code), including several optimized DSP components

SELECTED RESEARCH PROJECTS

Fast and Scalable Hardware Packet Scheduling, SNAP Lab, CMU 🏆 2022 – 2023

Packet scheduling refers to the problem of deciding what order network packets ought to be served or transmitted, and is a fundamental problem in networking. At the heart of packet schedulers is a *priority queue* (PQ) data-structure that allows dequeuing the highest-priority element. Unfortunately, the comparison-based sorting scheme underlying existing hardware-based PQs imposes a fundamental limitation on their scalability or performance. In this work, we design the Bitmapped Bucket Queue (BBQ), a fully-pipelined implementation of an Integer Priority Queue (IPQ) that is both fast and scalable, supporting priority queueing for 100K+ flows with 32K+ priorities at 148.8 Mpps (100 Gbps line-rate) on a commodity FPGA.

Adversarial Job Scheduling in Network Functions, SNAP Lab, CMU 🏆 2020 – 2022

Denial-of-Service (DoS) attacks are the bane of public-facing NFs. Algorithmic complexity attacks (ACAs) are a class of DoS attacks where an attacker uses a *small* amount of adversarial traffic to induce a *large* amount of work in the target system, pushing the system into overload and causing it to drop packets from innocent users. In this work, we use novel insights from adversarial scheduling theory to *provably* mitigate ACAs on NFs. Our scheduling framework, SURGEPROTECTOR, imposes a theoretical upper-bound on the amount of ‘harm’ an attacker can induce relative to the amount of resources they invest into the attack, reducing ACA-induced goodput drop by 90 – 99%.

Caching with Delayed Hits, SNAP Lab, CMU 🏆 2018 – 2020

Traditional caching models assume that cache requests result in one of two outcomes: hits and misses. In reality, high-throughput caches experience a phenomenon known as ‘delayed hits’, which subvert expectations of caching models and simulators. In this work, we quantify the effect of delayed hits on practical caching systems. We then develop BELATEDLY, a latency-optimal, offline caching strategy for the delayed hits problem. Using insights from BELATEDLY, we present a practical caching strategy that outperforms existing algorithms by 10-40%.

Continuous, Real-Time Face Recognition on Mobile Devices, University of Toronto 2017 – 2018
Senior Design (Capstone) Project, Advisor: Prof. Ravi Adve

To bridge the gap between (a) poor accuracy and generality of existing mobile-based face recognition algorithms, and (b) low throughput of state-of-the-art Deep Neural Networks on embedded devices, we used recent advancements in statistical learning theory to develop an accurate, yet real-time, *offline* facial recognition system.

🏆 *CNIB Hochhausen Prize for Excellence in Accessible Design.* 🏆 *Outstanding Senior Design Project.*

- Implementing Real-Time Eye-Tracking in a Mobile Context**, University of Toronto Summer, 2015
Summer Research Intern, Advisor: Prof. Jonathan Rose
 Helped improve the accuracy of an infrared-based gaze-point estimator by 15%
- Smartphone-Based Automation of Ankle Physiotherapy**, University of Toronto Summer, 2014
Summer Research Fellow, Advisor: Prof. Jonathan Rose
- Contributed to myAnkle, an Android application to quantitatively measure balance
 - Presented the research at an undergraduate research conference (UnERD, 2014) at the University of Toronto

RESEARCH TALKS

BBQ

- at the [Pigasus IDS Developers Meeting](#) Apr, 2023

SurgeProtector ■◀

- at ACM SIGCOMM '22 Aug, 2022
- at MIT, Networks and Mobile Systems (NMS) Group Seminar Aug, 2022
- at UT Austin, Networking Research Group Seminar Jul, 2022
- at UC Berkeley, Systems Research Group Seminar Mar, 2022
- at the Pigasus IDS Developers Meeting Mar, 2022
- at the [Crossroads 3D-FPGA Research Center](#) Nov, 2021

Caching with Delayed Hits ■◀

- at [Principles of Memory Hierarchy Optimization \(PMHO\)](#) '22 Apr, 2022
- at ACM SIGCOMM '20 Aug, 2020
- at the University of Cambridge (Systems Research Group Seminar) Jul, 2020
- at Microsoft Research (MSR Systems Research Group) Jul, 2020

TEACHING EXPERIENCE

- Co-Instructor**, Doctoral-Level Graduate Networking (15-744) CMU, Spring 2024
- Graduate Teaching Assistant**, Undergraduate/Masters Networking (15-441/641) CMU, Fall 2023
- Graduate Teaching Assistant**, Undergraduate/Masters Networking (15-441/641) CMU, Fall 2022
- Graduate Teaching Assistant**, Undergraduate/Masters Distributed Systems (15-440/640) CMU, Fall 2021
- Undergraduate Teaching Assistant**, Undergraduate (FY) Calculus and Programming (C++) UofT, 2016

MENTORSHIP EXPERIENCE

- **Erica Chiang**, Undergraduate at CMU → CS Ph.D. at Cornell 2021 – 2022
 ↳ NSF Graduate Research Fellowship
 ↳ Runner-up at the ACM SIGCOMM '22 SRC
- **Benjamin Carleton**, CMU REU → CS Ph.D. at Cornell Summer, 2021
 ↳ Winner of the ACM SIGOPS '21 SRC

COMMUNITY SERVICE

- Student Evaluator**, CSD Speakers Club, CMU Sep, 2022 - Present
- External Reviewer**, ACM PODC '23 2023
- External Reviewer**, ACM CoNEXT '22 2022
- Treasurer**, CSD Ph.D. Student Council, CMU Sep, 2021 – Present