Seyed Armin Vakil Ghahani

EDUCATION

University of Michigan, Ann Arbor, MI — Aug 2021 – Now

- PhD Student in Computer Science & Engineering Department
  - Advisor: Prof. Manos Kapritsos
  - **Relevant Graduate Courses**: Distributed Systems, Advanced Operating System

Pennsylvania State University, University Park, PA — Aug 2018 – Aug 2021

- PhD Student in Computer Science & Engineering Department (Transfer to UMich)
  - Advisor: Prof. Mahmut Taylan Kandemir
  - GPA: 4/4
  - **Relevant Graduate Courses**: Fundamentals of Computer Architecture, Algorithm Design and Analysis, Binary-level Analysis, Language-based Security, Operating System Design, Emerging Technologies, Compiler Construction

Sharif University Of Technology, Tehran, Iran — Sep 2013 – Jul 2018

- Bachelor of Science (B.S.) in Computer Engineering - Hardware
  - Thesis: Cache Replacement Policy Based on Expected Hit Count
    Advisor: Prof. Pejman Lotfi-Kamran, Prof. Hamid Sarbazi-Azad
  - GPA: 16.48/20 **(CE Major Coursework: 18.1/20)**

RESEARCH INTERESTS

- Formal Verification
- Distributed Systems

RESEARCH EXPERIENCE

- **University of Michigan**

  ◇ **Formal Verification at Scale** - Formal verification introduces a unique way of programming applications that are always correct, and work as expected. However, applying this technique to real-world applications is a challenging task. In my current research, I am working on providing a framework that facilitates applying formal verification to distributed and multi-threaded applications. Currently, writing proofs for distributed and multithreaded applications requires significant programming effort. My research addresses these challenges and facilitates writing proofs by automating different aspects of this process and aids the real-world adoption of formal verification at scale.

- **Pennsylvania State University**

  ◇ **Virtual Memory** - Applications with large memory footprint experience high number of page walks during their execution, leading to high performance degradation, especially in virtualized systems. In this project, we characterize the page walk memory accesses to identify the main overhead of page walk and propose different optimizations throughout the memory hierarchy to reduce this overhead.

  ◇ **DRAM** - DRAM needs refresh operations because DRAM cells lose their content/charge over time. The overhead of these refreshes increases with larger DRAM devices. My research in this area reduces the memory refresh overhead in virtualized systems by leveraging the same-content values in DRAM.

  ◇ **Persistent Memory** - Memory persistency models constrain the order of reaching persistent writes to persistent memory (PM). To enforce this order in x86 processors, programmers should use expensive sfence instructions. In this project, we propose an extension to the x86 memory persistency model based on two existing paths to PM, enabling implicit persist ordering without using sfence instructions.

- **Sharif University of Technology**

  ◇ **Cache Replacement Policies** - My B.Sc. thesis project is on predicting the correlation of reuse-distance of each cache block and its remaining hit count. In my thesis, I proposed a cache replacement policy that leverages this correlation and reduces the miss rate of last-level caches.

WORK EXPERIENCE

- Software Engineer Intern, **Google** May 2021 – Aug 2021
  - Database team - Napa
- Software Developer, **I-Cliqq** Jan 2018 – Aug 2018
  - Designing Embroidery Software
- Software Developer, **Viratech Sharif**, Tehran, Iran Sep 2015 – Sep 2016
  - Traffic Simulator (C++) - Network Simulator

PUBLICATIONS

- **Seyed Armin Vakil Ghahani**, Soheil Khadirsharbiyani, Jagadish Kotra, Mahmut Taylan Kandemir "Athena: An Early-Fetch Architecture To Reduce On-Chip Page Walk Latencies", *In Proceedings of Parallel Architectures and Compilation Techniques*, **(PACT 2022)**
- Sara Mahdizadeh Shahri, **Seyed Armin Vakil Ghahani**, Aasheesh Kolli "(Almost) Fence-less Persist Ordering", *In Proceedings of the 53rd Annual IEEE/ACM International Symposium on Microarchitecture*, **(MICRO 2020)**
- **Seyed Armin Vakil Ghahani**, Mahmut Taylan Kandemir, Jagadish Kotra "DSM: A Case for Hardware-Assisted Merging of DRAM Rows with Same Content", *In Proceedings of the ACM on Measurement and Analysis of Computing Systems*, **(SIGMETRICS 2020)**
- Mohammad Bakhshalipour, Aydin Faraji, **Seyed Armin Vakil Ghahani**, Farid Samandi, Pejman Lotfi-Kamran, Hamid Sarbazi-Azad "Reducing Writebacks Through In-Cache Displacement", *ACM Transactions on Design Automation of Electronic Systems*, **(TODAES 2019)**
- **Seyed Armin Vakil Ghahani**, Sara Mahdizadeh Shahri, Mohammad Bakhshalipour, Pejman Lotfi-Kamran, Hamid Sarbazi-Azad "Making Belady-Inspired Replacement Policies More Effective Using Expected Hit Count." *arXiv preprint*, **(arXiv 2018)**
- **Seyed Armin Vakil Ghahani**, Sara Mahdizadeh Shahri, Mohammad-Reza Lotfi-Namin, Mohammad Bakhshalipour, Pejman Lotfi-Kamran, Hamid Sarbazi-Azad, "Cache Replacement Policy Based on Expected Hit Count", *IEEE Computer Architecture Letters*, **(CAL 2017)**

NOTABLE PROJECTS

Graduate Projects:

- **Loop Analysis** (Compiler Construction) May 2020
  - Loop properties analysis based on LLVM
- **Parallel Distributed File System** (Operating System Design) Dec 2019
  - Based on gRPC and Google Protobuf
- **Binary Instrumentation** (Binary-Level Program Analysis) May 2019
  - Instrumentation for DLLs during runtime of applications for providing persistency guarantees
- **Efficient Undo Logging Implementation** (Fundamentals of Computer Architecture) Dec 2018
  - Rethinking undo logging state-of-the-art design for efficiently updating undo-logging metadata

Undergraduate Projects:

- **Domain-Specific Language for Financial Calculations** (Compiler Design) Jan 2018
  - Implementing a DSL for Financial Contracts based on ANTLR and C++
- **Hospital Management System** (Real-time Systems) Jan 2017
  - Patient's condition monitoring scheduler
- **Chat** (Computer Networks) May 2016
  - Server-Client Chat system over TCP network based on C++ and Qt
- **Linux Development** (Operating System) Mar 2016 – Jul 2016
  - Implementing a system call to provide the MAC address of network interfaces to the user space
  - Adding proc files to provide details, number of occured interrupts, enable/disable, and show number of sk_buff data structures for each network interface
- **Trax Game** (FPGA National Contest) Apr 2016
  - Two player game based on Verilog
- **NoC** (Digital System Design) Jan 2016
  - 3D Mesh Network on Chip based on Verilog
- **Judge** Mar 2015
  - Designing and implementing a judge system for testing codes
- **Plants vs Zombies** (Advanced Programming - C++) Jul 2014
  - Based on Qt Creator
- **Suduko** (Introduction to Programming) Jan 2014
  - Graphical Suduko game based on GTK
- **Billiard** (Introduction to Programming) Jan 2014
  - Graphical Billiard game based on GTK

COMMUNITY SERVICE

- **Sharif AI Challenge** (Contest Organizer) — Jan 2015 – Jan 2017
  - Undergraduate Programming Contest
- **1st Gateuino Contest** (Contest Organizer) — May 2016
  - Founded a hardware contest for undergraduate freshman and sophomore

PRESENTATIONS

- DSM: A Case for Hardware-Assisted Merging of DRAM Rows with Same Content
  - ACM SIGMETRICS — Jun 2020

HONORS AND AWARDS

- Qualified for 2nd Cache Replacement Championship (CRC-2)
  - Cache Replacement Policy Based on Expected Hit Count — Jun 2017
- **Silver Medal** in 22nd Iran National Olympiad in Informatics(INOI) — Sep 2012

TEACHING EXPERIENCE

- Teaching Assistant at Pennsylvania State University
  - Introduction to Computer Architecture (CMPEN 431) — Spring 2020, Fall 2020
  - Computer Organization and Design (CMPEN 331) — Fall 2018, 2019, Spring 2019
- Teaching Assistant at Sharif University of Technology
  - Computer Architecture — Fall 2016, 2017
  - Digital System Design — Spring & Fall 2017
  - Digital Design — Spring 2017
  - Advanced Logic Design — Fall 2016
  - Discrete Structures — Spring 2016
  - Advanced Programming — Fall 2014, 2015
  - Fundamental Of Programming — Spring & Fall 2014
- High School Teacher — 2013 – 2018
  - Teaching Combinatorics, Graph Theory, Algorithm, and C++ Programming

SKILLS

- Programming Languages: C/C++, C#, Python, Dafny, Boogie, SQL, CUDA/OpenMP, Verilog, R, Shell, Assembly
- Simulators: gem5, BadgerTrap, DRAMsim2, BigHouse, Ramulator, CACTI, ChampSim
- Tools & Frameworks: Google Protobuf, gRPC, Armada, Qemu, Pin, DynamoRIO, LLVM, ANTLR
- Operating Systems: Ubuntu(Native), Windows
- Type Setting: LaTeX, Microsoft Office