

CONTACT INFORMATION	Email: mabdalla@amd.com Personal Email: khairy2011@gmail.com Phone: (+1) 425-440-1840 Personal Website: https://mkhairy.github.io/ Other Websites: Linkedin - Google Scholar - GitHub - Medium
INTERESTS	GPU/SIMT Architecture, Multi-GPU Scaling, Deep Learning Acceleration, Performance Modeling and Simulation, Hardware-Software Co-design, Compilers, Data Center Microservices
EDUCATION	<p>Purdue University, West Lafayette, IN, US</p> <p>Ph.D., Computer Engineering, January 2017 - July 2022</p> <ul style="list-style-type: none"> Thesis Title: “Scalable and Energy-Efficient SIMT Systems for Deep Learning and Data Center Microservices” Advisor: Prof. Timothy Rogers <p>Cairo University, Cairo, Egypt</p> <p>M.Sc., Computer Engineering, Sep 2012 - May 2015</p> <ul style="list-style-type: none"> Thesis Title: “Efficient Utilization of GPGPU Cache Hierarchy” <p>Cairo University, Cairo, Egypt</p> <p>B.Sc., Computer Engineering, Sep 2006 - May 2011</p> <ul style="list-style-type: none"> Distinction with degree of honor (90.19%) – GPA: 3.88/4.0 Ranked 3rd in group of 45 students.
PEER-REVIEWED CONFERENCE & JOURNAL PUBLICATIONS	<ol style="list-style-type: none"> Mahmoud Khairy, Ahmad Alawneh, Aaron Barnes, and Timothy G. Rogers, “SIMR: Single Instruction Multiple Request Processing for Energy-Efficient Data Center Microservices”, 2022 International Symposium on Microarchitecture (MICRO 2022), acceptance rate=22%. Cesar Avalos, Mahmoud Khairy, Roland N. Green, Mathias Payer, Timothy G. Rogers, “Principal Kernel Analysis: A Tractable Methodology to Simulate Scaled GPU Workloads” 2021 International Symposium on Microarchitecture (MICRO 2021), acceptance rate=22%. Vijay Kandiah, Scott Peverelle, Mahmoud Khairy, Amogh Manjunath, Junrui Pan, Timothy G. Rogers, Tor Aamodt, Nikos Hardavellas, “AccelWattch: A Power Modeling Framework for Modern GPUs” 2021 International Symposium on Microarchitecture (MICRO 2021), acceptance rate=22%. Mahmoud Khairy, Vadim Nikiforov, David Nellans, and Timothy G. Rogers, “Locality-Centric Data and Threadblock Management for Massive GPUs” 2020 International Symposium on Microarchitecture (MICRO 2020), acceptance rate=18%. Mahmoud Khairy, Jason Shen, Tor M. Aamodt, and Timothy G. Rogers, “Accel-Sim: An Extensible Simulation Framework for Validated GPU Modeling” 2020 International Symposium on Computer Architecture (ISCA 2020), acceptance rate=18%. Mahmoud Khairy, Amr G. Wassal, and Mohamed Zahran. “A Survey of Architectural Approaches for Improving GPGPU Performance, Programmability and Heterogeneity.” Journal of Parallel and Distributed Computing 127 (2019): 65-88 (JPDC 2019). Jain Akshay*, Mahmoud Khairy*, Timothy G. Rogers, “A Quantitative Evaluation of Contemporary GPU Simulation Methodology”, ACM SIGMETRICS, 2018, (SIGMETRICS 2018), *First Co-authors. Mahmoud Khairy, Mohamed Zahran, and Amr G. Wassal, “SACAT: Streaming-Aware Conflict-Avoiding Thrashing-Resistant GPGPU Cache Management Scheme”, IEEE Transcation on Parallel and Distributed Systems (TPDS 2016)

WORKSHOPS AND
POSTERS

1. Ahmad Alawneh, **Mahmoud Khairy**, Timothy G. Rogers, “A SIMT Analyzer for Multi-Threaded CPU Applications.” 2022 IEEE International Symposium on Performance Analysis of Systems and Software (**ISPASS 2022**).
2. **Mahmoud Khairy**, Jain Akshay, Tor M. Aamodt, and Timothy G. Rogers, “A Detailed Model for Contemporary GPU Memory Systems.” 2019 IEEE International Symposium on Performance Analysis of Systems and Software (**ISPASS 2019**).
3. **Mahmoud Khairy**, Mohamed Zahran, and Amr G. Wassal, “Efficient Utilization of GPGPU Cache Hierarchy”, 8th Workshop on General Purpose Computing using GPUs (GPGPU8), 2015, (**GPGPU 2015**)

TECHNICAL
BLOGS

1. Tim Rogers and **Mahmoud Khairy** “An Academic’s Attempt to Clear the Fog of the Machine Learning Accelerator War.” **SigArch blog**, August 2021
Blog Link: <https://www.sigarch.org/an-academics-attempt-to-clear-the-fog-of-the-machine-learning-accelerator-war/>
2. **Mahmoud Khairy** “TPU vs GPU vs Cerebras vs Graphcore: A Fair Comparison between ML Hardware,” **Medium article**, July 2020
Article Link: <https://khairy2011.medium.com/tpu-vs-gpu-vs-cerebras-vs-graphcore-a-fair-comparison-between-ml-hardware-3f5a19d89e38>

TECHNICAL
REPORTS

1. **Mahmoud Khairy**, Jain Akshay, Tor Aamodt, and Timothy G. Rogers. “Exploring Modern GPU Memory System Design Challenges through Accurate Modeling.” arXiv preprint arXiv:1810.07269 (2018).
2. Hughes, Clayton, Simon David Hammond, **Mahmoud Khairy**, Mengchi Zhang, Roland Green, Timothy Rogers, and Robert J. Hoekstra. “Balar: A SST GPU Component for Performance Modeling and Profiling”. No. SAND2019-10389. Sandia National Lab., 2019.
3. **Mahmoud Khairy**, Mengchi Zhang, Roland Green, Simon David Hammond, Robert J. Hoekstra, Timothy Rogers, and Clayton Hughes. “SST_GPU: An Execution-Driven CUDA Kernel Scheduler and Streaming-Multiprocessor Compute Model.” No. SAND2019-1967. Sandia National Lab.(SNL-NM), Albuquerque, NM (United States), 2019

PENDING PATENTS

1. Timothy Rogers, **Mahmoud Khairy** “System and Methods for Single Instruction Multiple Request Processing”, US Pending Patent, app# 63307853, filled by Purdue University

DISSERTATIONS

1. **Mahmoud Khairy** “Scalable and Energy-Efficient SIMT Systems for Deep Learning and Data Center Microservices”, August 2022, Ph.D. dissertation, Purdue University. (**In Progress**)
2. **Mahmoud Khairy** “Efficient Utilization of GPGPU Cache Hierarchy,” May 2015, M.Sc. dissertation, Cairo University, Egypt

GRANTS

I assisted and contributed with my PhD adviser to write an accepted NSF grant #1910924 “Addressing Challenges for the Next Decade of Massively Parallel NUMA Accelerators”.

OPEN-SOURCE
TOOLS

- **Accel-Sim**: Principle contributor
Project website: <https://accel-sim.github.io/>
- **Accel-Wattch**: Co-author
Project website: <https://accel-sim.github.io/accelwattch.html>

- **Principle Kernel Analysis:** Co-author
Project website: To be released soon
- **SIMTec**, SIMT analysis tool for CPU workloads: Co-author
Project website: To be released soon
- **SST-GPU:** Co-author
Project website: <http://sst-simulator.org/SSTPages/SSTElementBalar/>

AWARDS & HONORS

- Purdue Graduate Fellowship, Purdue University, 2017-2018
- Fully-funded internship from SAFARI group, Carnegie Mellon University, 2015
- M.Sc. Scholarship from Cairo University, September 2012 - May 2015
- B.Sc. with Honors from Cairo University, May 2011
- Fully-funded undergraduate internship from Technical University of Munich, Germany, 2010
- Undergraduate Academic Outstanding Award from the Egyptian Government, 2006-2010

PRESS & MEDIA REPORT

- *HPCWire*
Purdue Researchers Peer into the ‘Fog of the Machine Learning Accelerator War’
<https://www.hpcwire.com/2021/09/27/purdue-researchers-peer-into-the-fog-of-the-machine-learning-accelerator-war/>
- *ZDnet*
AI computer maker Cerebras nabs TotalEnergies SE as first energy sector customer
<https://www.zdnet.com/article/ai-computer-maker-cerebras-nabs-totalenergies-se-as-first-energy-sector-customer/>
- *Analytics India Magazine*
Thinking Beyond Generative AI, One Token At A Time
<https://analyticsindiamag.com/thinking-beyond-generative-ai-one-token-at-a-time/>

PROFESSIONAL EXPERIENCE

- Member of Technical Staff, AMD Research** Aug 2022 to Present
High Performance Computing Researcher, AMD Research, Santa Clara, CA
- Conducting research related to advanced computer architecture and systems.
- Graduate Research Assistant, Purdue University** Jan 2017 to July 2022
Computer Engineering Department, Purdue University, IN, US
- Principal contributor to a new open-source GPU simulation infrastructure, **Accel-Sim**, that models next-generation GPU architectures quickly and accurately with tensor cores, deep learning support and multi-GPU systems. This work appeared at the **ISCA 2020** venue. Accel-Sim website: <https://accel-sim.github.io/>
 - Investigating a transparent compiler-assisted solution to overcome the non-uniform-memory-access (NUMA) overhead for multi-GPU DGX server and next-generation multi-chiplet-modules GPUs. This work appeared at the **MICRO 2020** venue.
 - Performance profiling of data center microservices-based workloads and identifying performance bottlenecks and hardware acceleration opportunities. This work appeared at the **MICRO 2022** venue.
 - Collaborating with Sandia Lab to integrate GPGPU-Sim simulator into SST infrastructure to enable simulating large-scale GPU-based supercomputer.
Project website: <http://sst-simulator.org/SSTPages/SSTElementBalar/>
 - Deep learning system evaluation and compared between the leading ML training hardware solutions, focusing on efficiency metrics and identifying the ML training bottlenecks. See my [Medium](#) and [SigArch](#) articles for further details about this work.
 - Mentoring a group of undergraduate, master’s and fresh PhD students to put their first hands on academic research and assisting them through their own research ideas. This has resulted in several 2nd author publications.
- Software Engineer, Microsoft** Dec 2015 to Dec 2016
Data Mining and Tooling team, Bing Ads, Microsoft, Redmond, WA, US

- Developing and improving a microservices-based data analytics platform that collects data from distributed data sources in order to monitor Bing Ads performance metrics in real-time and analyze the marketplace trends. In particular, I was fully responsible for managing anomaly detection microservice that dynamically checks data on a regular basis and notifies our users if any anomaly exists.

Research Assistant Intern, CMU

June 2015 to September 2015

Carnegie Mellon University, Pittsburgh, Penn, US.

- Research: Studying the implications of High Bandwidth Memory (HBM) on next-generation GPGPU workloads and architectures.

Graduate Research and Teaching Assistant, Cairo University

Sept 2012 to May 2015

Computer Engineering Department, Cairo University, Egypt.

- Research: Investigating high-performance cache management techniques to mitigate GPGPU cache contention. This work results in [GPGPU 2015] and [TPDS 2016] publications.
- Teaching: Computer Architecture, GPGPU Programming, Modeling & Simulation courses.

Software Engineer, Mentor Graphics

Nov 2011 to July 2012

Mentor Graphics, Cairo, Egypt

I worked on R&D project which aims to build a new electronic design automation (EDA) tool for automated VLSI layout migration. My responsibilities included software performance profiling and improving the tool's execution time through algorithm optimization and parallel programming. My contributions resulted in 2.5x overall speedup.

TEACHING
EXPERIENCE

Teaching Assistant at Computer Engineering Department, Cairo University

- Computer Architecture: Spring 2012, Spring 2013, Spring 2014
- Modeling & Simulation: Fall 2012, Fall 2013, Fall 2014
- GPGPU Programming: Summer 2013

INVITED
TALKS

- “Scalable and Energy-Efficient SIMT Systems for Deep Learning and Data Center Microservices”
 - Intel AI, April 2022
 - University of Rochester, March 2022
 - AMD Research, February 2022
 - University of Central Florida, February 2022
- AMD Corporation, GPU Architecture team, “TPU vs GPU vs Cerebras vs Graphcore: A Fair Comparison between ML Hardware”, April 2021
- MICRO 2020 talk, “Locality-Centric Data and Threadblock Management for Massive GPUs”, September 2020
- ISCA 2020 talk, “Accel-Sim: An Extensible Simulation Framework for Validated GPU Modeling”, June 2020

RESEARCH
MENTORSHIPS

- Vadim Nikiforov, Undergraduate Research. Currently a PhD student at Berkeley
Research: Efficient CUDA kernel scheduling and data placement for multi-GPU systems
- Jason Shen, M.Sc. Research. Currently a hardware engineering at Intel
Research: Demystifying modern GPU architecture through microbenchmarking
- Weili An, Undergraduate Research
Research: Supporting and studying AMD ISA traces and architecture in Accel-Sim framework
- Cesar Avalos, 2nd year PhD student
Research: Efficient GPU simulation of large scale workloads, like MLPerf benchmarks
- Ahmad Alawneh, 3rd year PhD student
Research: Building a new simulation tool that identifies the SIMT GPU acceleration opportunities for MIMD CPU-based workloads

TECHNICAL
SKILLS

Programming languages: C/C++, C#, Python, Assembly
Web Programming: ASP.NET, SQL, NoSQL Azure Storage
Developments tools: Visual Studio, Linux development tools, Git Source Control
Libraries and SDKs: OpenMP, Pthread, CUDA, OpenCL, MPI, PyTorch, LLVM
Research tools & Simulators: GPGPU-Sim, Accel-Sim, SST

WORK
ELIGIBILITY

H1-B visa holder

REFERENCES

References available upon request.