Khaled Abdelaal

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Education

The University of Oklahoma — Norman, OK
PhD in Computer Science (High-Performance Computing) — *2020 – May 2024 (Expected)*

Lehigh University — Bethlehem, PA
Master of Science in Computer Engineering, GPA 3.73 /4.00 — *2018 – 2020*

Mansoura University — Mansoura, Egypt
Master of Science in Automatic Control Systems Engineering — *2014 – 2017*

- **Thesis:** A Clustering Scheme for Power Management in Asymmetric Multicore Processors

Mansoura University — Mansoura, Egypt
Bachelor of Science in Computers and Systems Engineering, GPA 90.24%, Ranked 2 / 109 — *2008 – 2013*

Related Coursework

- Principles and Practice of Parallel Computing, Design and Analysis of Algorithms, Advanced Operating Systems, Advanced Computer Architecture, Memory Systems, Data Mining, Intro. to Machine Learning, Data Networks

Experience

Graduate Research and Teaching Assistant — Aug. 2022 – Present
The University of Oklahoma — *Norman, OK*

- Led research in High-Performance Computing, Graph Processing, and Applied Machine Learning.
- Designed extensible Graph Neural Network-based classifier (98% accuracy) for sparse matrix structure detection, agnostic to node order and reliable against random sub-sampling.
- Innovated robustness evaluation framework, analyzing graph structure variations based on model generation parameters and noise tolerance.
- Optimized storage formats for Kroncker Graph operands in SpMV through performance evaluation of tools like Intel MKL, TACO, SciPy, and cuSparse.
- Utilized CUDA, cuSparse, PyTorch, MKL, TACO, SciPy; proficient in Python, C/C++.

GPU Compiler Engineering Intern — May 2023 – Aug. 2023
Intel Corporation — *Santa Clara, CA (Remote)*

- Spearheaded runtime optimization strategies for diverse GPU workloads using Intel Graphics Compiler (IGC).
- Collaborated with cross-functional teams to integrate GPU performance-enhancing techniques.
- Successfully optimized GPU workloads (at least 3x speedup), contributing to enhanced performance and efficiency.
- Utilized OpenCL Runtime, Level Zero Runtime, and SYCL DPC++ to streamline development and boost application performance.

GPU Compiler Engineering Intern — May 2022 – Aug. 2022
Intel Corporation — *Santa Clara, CA (Remote)*

- Developed and ported multiple workloads to leverage the new DPC++ extension "invoke simd," assessing its impact on programmability and performance.
- Evaluated the benefits of "invoke simd" compared to existing programming models like SPMD and Intel's ESIMD.
- Conducted rigorous testing of Intel Graphics Compiler's existing support for "invoke simd," identifying and reporting bugs and issues to the backend, debug, and code generation teams.
- Collaborated closely with development teams to identify and communicate issues in Intel Graphics Compiler, ensuring seamless integration and robust support for the new extension.

Graduate Teaching Assistant — Aug. 2021 – May 2022
The University of Oklahoma — *Norman, OK*

- Led interactive lab sessions for a significant number of students, ensuring comprehension of complex programming principles.

- Demonstrated strong organizational skills in grading lab reports and projects, providing timely feedback to aid student learning.
- Created a supportive learning environment through well-structured office hours, addressing individual queries and concerns.

HPC Research Intern June 2021 – Aug. 2021

Argonne National Laboratory *Lemont, IL (Remote)*

- Conducted pioneering research in high-performance computing, focusing on optimizing memory traffic in matrix-based applications.
- Achieved up to a 12x reduction in memory traffic using a novel compression and caching technique, surpassing baseline performance.
- Developed a unified parallel framework that seamlessly envelops parallel code written in CUDA, Sycl, and HIP within OpenMP, enhancing code portability and optimization capabilities.

Graduate Research Assistant Aug. 2020 – June 2021

The University of Oklahoma *Norman, OK*

- Conducted in-depth research on optimizing affine programs on GPGPUs, focusing on automatic selection of near-optimal tile sizes.
- Utilized Integer Linear Programming and the Polyhedral model to guarantee a remarkable performance around 75% of the best empirically found tile configuration performance.
- Developed an innovative Pattern-Aware Vectorization technique for Sparse Matrix Computations, leveraging pattern exploration and vector code generation to accelerate computations.
- Achieved a noteworthy 4.95x speedup over clang auto-vectorization for specific applications using the Facebook graph from SNAP.
- Expertly employed C/C++, SIMD, Python, and Bash Scripting to implement and validate research methodologies, showcasing a comprehensive skillset in diverse technologies.

Graduate Research and Teaching Assistant Jan. 2018 – Jan. 2020

Lehigh University *Bethlehem, PA*

- Conducted in-depth research in computer architecture, with a specific focus on emerging memory systems (NVM) and In-Memory Processing.
- Designed and simulated a novel hybrid technique for stuck-at fault detection in Phase-Change Memories, yielding an average 9.4% performance enhancement over baseline methods.
- Successfully implemented this technique within the gem5 memory controller module, a widely used architectural open-source simulator.
- Actively participated in Intel's Computer-Assisted Programming for Heterogeneous Architectures (CAPA) program, contributing to advancements in heterogeneous computing.
- Conducted comprehensive benchmarking and performance evaluations using diverse benchmark suites such as PARSEC, SPEC2006/2017, and more.
- Utilized programming languages including C, C++, and Python to realize research objectives.
- Played a pivotal role as a full teaching assistant for ECE033: Introduction to Computer Engineering.

Assistant Lecturer Dec. 2013 – Present (on leave)

Mansoura University *Mansoura, Egypt*

- Instructed a total of 5 undergraduate courses in Computer Science and Engineering, encompassing an average of 95 students, distributed across 3 to 4 sections.
- Led teaching efforts for a diverse set of courses, including CSE3214 Programming Languages 2, CSE3223 Programming Languages 3, CSE3412 Network Design & Programming, CSE3422 Distributed Computer Systems, and Web Development (Summer training).
- Directed comprehensive teaching activities, spanning lab design, recitations, office hours, and assessment tasks like grading assignments, projects, and exams.
- Demonstrated a commitment to fostering a productive and interactive learning experience, both in and outside the classroom.

Advising and Mentorship

High-Performance Stencil Code Generation for CPUs and GPUs Fall 2023
The University of Oklahoma *Norman, OK*

- Guiding and supervising a group of three undergraduate students explore efficient implementations of stencil kernel using different optimizations relying on : instruction level parallelism, loop optimizations, SIMD, shared and distributed memory, and GPUs.
- Organizing regular research group meetings to facilitate knowledge sharing and project updates.
- Designing project plan and experiments setups.

A Web Tool to Analyze the Robustness of Graph Models Fall 2023
The University of Oklahoma *Norman, OK*

- Advising an undergraduate student through a project to port our graph analysis tool to a web application.
- Providing one-on-one mentoring sessions to assist the student in understanding complex research concepts.

Publications

- ***Khaled Abdelaal*** and Richard Veras, **"A Framework for Analyzing the Robustness of Graph Models"** 2023 IEEE High Performance Extreme Computing Conference (HPEC), Virtual Event, USA, 2023. (to appear).
- ***Khaled Abdelaal*** and Richard Veras, **"Observe Locally, Classify Globally: Using GNNs to Identify Sparse Matrix Structure"** in Proceedings of the 18th International Work-Conference on Artificial Neural Networks (IWANN 2023), Ponta Delgada, Portugal, June 2023. (to appear).
- Johannes Doerfert, Marc Jasper, Joseph Huber, ***Khaled Abdelaal***, Giorgis Georgakoudis, Thomas Scogland, and Konstantinos Parasyris, **"Breaking the Vendor Lock — Performance Portable Programming Through OpenMP as Target Independent Runtime Layer"** in Proceedings of the 31st International Conference on Parallel Architectures and Compilation Techniques (PACT 2022)
- ***Khaled Abdelaal*** and Martin Kong. 2021. **"Tile Size Selection of Affine Programs for GPGPUs using Polyhedral Cross-Compilation"** Proceedings of the ACM International Conference on Supercomputing. Association for Computing Machinery, New York, NY, USA, 13-26. DOI: https://doi.org/10.1145/3447818.346036
- ***Khaled Abdelaal***, Richard Veras, and Martin Kong. **"Pattern-Aware Vectorization for Sparse Matrix Computation"**. Poster presented at: 2021 IEEE International Parallel and Distributed Processing Symposium (IPDPS) PhD Forum; April 2021; Portland, OR, USA.
- Chao Zhang, ***Khaled Abdelaal***, Angel Chen, Xinhui Zhao, Wujie Wen, and Xiaochen Guo, **"ECC Cache: A Lightweight Error Detection for Phase-Change Memory Stuck-At Faults,"** in Proceedings of the 39th IEEE/ACM International Conference on Computer-Aided Design (ICCAD), Virtual Conference, November 2020.
- ***Khaled M. Attia***, Mostafa A. El-Hosseini, Hesham A. Ali, **Dynamic power management techniques in multi-core architectures: A survey study**, Ain Shams Engineering Journal, Volume 8, Issue 3, 2017, Pages 445-456, ISSN 2090-4479, https://doi.org/10.1016/j.asej.2015.08.010.

Technical Skills

Programming Languages: C/C++, Python, Bash Scripting
Graph Analysis: networkx, cuGraph
Dense and Sparse Linear Algebra Libraries : cuBLAS, cuSparse, MKL, SciPy, SuiteSparse, Eigen
Parallel Programming Frameworks: CUDA, OpenMP, HIP, SYCL/DPC++
Compilers: clang, LLVM, IGC
Profiling and Performance Analysis: perf, nvprof, nsight systems, nsight compute, heaptrack, clang sanitizers
Data Analysis: pandas, cuDF
Benchmark suites: Polybench, Rodinia, PARSEC, SPEC
Documentation: Doxygen, Sphinx

Awards

- **NSF Travel Grant for CLUSTER 2023 Conference in Santa Fe, NM**
- **Travel Support provided by Internet2 through funds from NSF Award #2100003, "CI: CoE: Demo Pilot: Advancing Research Computing and Data: Strategic Tools, Prcatices, and Professional Development" to attend PEARC23 Conference in Portland, OR** : 7/22/2023 to 7/27/2023
- **Intel Graphics Academic GPU Donation: Intel ARC 770 to support Doctoral Research** : July, 2023

- **The University of Oklahoma Gallogly College of Engineering Scholarship** : 2022/2023
- **The University of Oklahoma School of Computer Science Alumni Graduate Fellowship Award** Awarded to CS graduate students in good academic standing actively involved in a teaching assistantship (Awarded for 2 years: 2021/2022 - 2022/2023)
- **The University of Oklahoma Provost's Certificate of Distinction in Teaching** Awarded to the top 10% of all graduate assistants across campus by student evaluations for courses taught during the Fall 2021 semester.
- **The University of Oklahoma Gallogly College of Engineering PhD Recruitment Excellence Fellowship** (Academic Year 2020-2021)
- **Mansoura University Best Engineering Graduation Project Award** (Academic Year 2012-2013)
- **Second Place in Mansoura University First Scientific Conference** 2013
- Graduated with Honors in 2013 from Computers and Systems Engineering Department, Mansoura, Egypt