Michael Wilkins

HPC/AI Researcher

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EDUCATION

Ph.D. Computer Engineering 2023
Northwestern University

M.S. Computer Engineering 2021
Northwestern University

B.S. Computer Engineering 2019
Rose-Hulman Institute of Technology

SKILLS

- **Software/Scripting Languages:** C, C++, Python, Standard/Parallel ML, C#, LabVIEW, Java, SQL, Bash
- **Parallel Programming/Communication:** MPI, Libfabric, NCCL, CUDA, PyTorch, Parallel ML
- **Simulators/Tools:** Sniper, gem5, ZSim, Xilinx Vivado, Xilinx ISE, Quartus II
- **Hardware Description Languages:** Chisel, VHDL, Verilog, SPICE

LEADERSHIP

- **Research Supervisor** (2021-Present)
  Guided 13 students through novel research projects at Nortwestern and ANL
- **Pi Kappa Alpha Fraternity Iota Delta Chapter** (2017-2019)
  Managed a budget of over $400,000 across two school years
- **Rose-Hulman Bowling Club** (2016-2019)
  Restructured the club's leadership and daily operation; increased membership by 300%
- **Mooseheart Tutoring Program** (2014-2016)
  Began program to tutor orphaned students at Mooseheart Child City; after 3 years of growth, had 45 students and 24 tutors meeting twice a week

HONORS & AWARDS

- **Argonne Laboratory Directed Research and Development (LDRD) Project** (2024-2027)
  $1m funding over 3 years to pursue independent research
- **Argonne National Laboratory Research Subcontract** (2020-2023)
  Full funding for my Ph.D. from ANL
- **Cabell Fellowship** (2019-2020)
  Awarded to the top 10 1st year Ph.D. students across all engineering majors
- **Department Choice Award** (2019)
  Awarded to the best senior research project
- **Embedded Systems Design Competition Champion** (2018)
- **Freshman ECE Design Competition Champion** (2016)
- **Dean's List** (All Semesters (2016-2019))
- **Class of 1940 Endowed Scholarship** (2016-2019)
- **National AP Scholar** (2016)
- **Illinois State Scholar** (2016)
- **36 ACT Certificate** (2015)

Experiences

Maria Goeppert Mayer Fellow Oct 2024 - Present
Argonne National Laboratory
- Directed an independent research program on autotuning and collective communication, supported by a 3-year, $1M award from Argonne
- Translated my MPI autotuning research into production, achieving speedups up to 35x for collective operations on Argonne's exascale system, Aurora
- Contributed major enhancements to MPICH, the leading open-source MPI implementation, with a focus on optimizing collective communication for high-performance computing environments

Software Engineer Jan-Sep 2024
Cornelis Networks
- Spearheaded major performance optimizations for the OPX libfabric provider, achieving 5× bandwidth improvements for GPU communications and other critical improvements
- Led the architecture and development of the reference libfabric provider for the Ultra Ethernet Consortium, achieving a key milestone in the standard's development
- Created OPX developer tools, including a profiler and autotuner, boosting team velocity

AI Research Intern Summer 2023
Meta
- Designed and implemented an application-aware communication (NCCL) autotuner for large-scale AI workloads
- Developed an AI application emulation tool that mimics production models by overlapping communication and genericized compute kernels

Research Aide/Visiting Student 2020 - 2023
Argonne National Laboratory
- Founded the MPI collective algorithm/machine learning project, initially under the supervision of Dr. Min Si and Dr. Pavan Balaji, later Dr. Yanfei Guo and Dr. Rajeev Thakur
- Earned perpetual external funding from ANL for the remainder of my Ph.D

Undergraduate Internships
Power Solutions International (2016), Flexware Innovation (2017), National Instruments (2018)

Sample Research Projects

ML Autotuning for MPI (Ongoing)
- Invented many optimizations to make ML-based MPI autotuning feasible on large-scale systems
- Developed the world's first exascale-capable MPI collective algorithm autotuner and achieved up to 20% speedups for production applications
- Exploring new "holistic" tuning methodologies to encompass performance-critical parameters across the software stack, targeting large scale AI workloads

Algorithms for Collective Communication (Ongoing)
- Created new generalized MPI collective algorithms that expose a tunable radix and outperform the previous best algorithms by up to 4.5x
- Exploring new generalized algorithms for GPU-specific collective communication (e.g., NCCL) and new abstractions (e.g., circulant graphs)

Publications

On Transparent Optimizations for Communication in Highly Parallel Systems
Michael Wilkins • Ph.D. Thesis

Generalized Collective Algorithms for the Exascale Era
Michael Wilkins, Hanming Wang, Peizhi Liu, Bangyen Pham, Yanfei Guo, Rajeev Thakur, Nikos Hardavellas, and Peter Dinda • CLUSTER'23

Evaluating Functional Memory-Managed Parallel Languages for HPC using the NAS Parallel Benchmarks
Michael Wilkins, Garrett Weil, Luke Arnold, Nikos Hardavellas, Peter Dinda • HIPS'23 Workshop

WARDen: Specializing Cache Coherence for High-Level Parallel Languages
Michael Wilkins, Sam Westrick, Vijay Kandiah, Alex Bernat, Brian Suchy, Enrico Armenio Deiana, Simone Campanoni, Umut Acar, Peter Dinda, Nikos Hardavellas • CGO'23

Program State Element Characterization
Enrico Deiana, Brian Suchy, Michael Wilkins, Brian Homerding, Tommy McMichen, Katarzyna Dunajewski, Nikos Hardavellas, Peter Dinda, Simone Campanoni • CGO'23

ACCLAiM: Advancing the Practicality of MPI Collective Communication Autotuning Using Machine Learning
Michael Wilkins, Yanfei Guo, Rajeev Thakur, Peter Dinda, Nikos Hardavellas • CLUSTER'22

A FACT-Based Approach: Making Machine Learning Collective Autotuning Feasible on Exascale Systems
Michael Wilkins, Yanfei Guo, Rajeev Thakur, Nikos Hardavellas, Peter Dinda, Min Si • ExaMPI'21 Workshop