Behrooz Zarebavani

Ph.D. Candidate - Department of Computer Science - University of Toronto

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Work Experience

Research Assistant at University of Toronto

- **Current Project:** Aiming to develop an efficient procedure for generating preconditioners using machine learning networks such as Graph Neural Networks (GNNs) to accelerate the Preconditioned Conjugate Gradient (PCG) iterative method utilized in physics-based animation. For now, I am mainly focus on understanding the limitations and advantages of this integration.
- **Mesh-aware Framework for Sparse Symbolic Analysis Reuse [1]:*Parth***, an innovative framework, enhances the computation process of direct solvers, notably Apple Accelerate, Intel MKL, and CHOLMOD. It especially shows its performance benefits in computing complex physics-based simulations such as those involving contacts. For practitioners, it manages to add an impressive speedup of 3x to Apple Accelerate, the fastest direct solver, during the computation needed for each frame of the simulation.
- **Sparse Kernels Scheduler [2]: *HDagg*** is an open-source scheduler that accelerates sparse kernel computations with loop-carried dependencies. It optimizes computation sequences based on sparsity patterns, kernel specifics, and hardware type. HDagg's precise adjustments of load-balance, locality and synchronization provide significant efficiency, outperforming current advanced kernels implemented in MKL by up to 13x speedup.
  - https://github.com/BehroozZare/HDagg-benchmark

Research Assistant at Sharif University of Technology

- **GPU-based Causal Structure Learning Algorithm [3]: *cuPC***, our innovative method, offers an efficient implementation of the Peter-Clark (PC) algorithm. This solution provide a fast and efficient method towards uncovering causal relationships in observational data and significantly surpasses the performance of previous methods. cuPC represents the first GPU deployment of this algorithm, which has effectively reduced the runtime from 11 hours to a mere 4 seconds on challenging dataset.
  - https://github.com/LIS-Laboratory/cupc

Publications

1. Zarebavani, B., Kaufman, D. M., Levin, D. I., and Dehnavi, M. M. Parth: Enabling symbolic analysis reuse for linear direct-solvers in the present of dynamic sparsity pattern via mesh-aware design. *Submitted to ACM SIGGRAPH - Journal Track* (2024)
2. Zarebavani, B., Cheshmi, K., Liu, B., Strout, M. M., and Dehnavi, M. M. Hdagg: hybrid aggregation of loop-carried dependence iterations in sparse matrix computations. In *2022 IEEE International Parallel and Distributed Processing Symposium (IPDPS)* (2022), IEEE, pp. 1217–1227
3. Zarebavani, B., Jafarinejad, F., Hashemi, M., and Salehkaleybar, S. cupc: Cuda-based parallel pc algorithm for causal structure learning on gpu. *IEEE Transactions on Parallel and Distributed Systems 31*, 3 (2019), 530–542

Areas of Interest

- Graphics and Scientific Simulation
- High-Performance Computing (HPC)
- Machine Learning

Skills and Courses

- **Skills**: C/C++, CUDA, Python, Java, LaTeX, OpenMP, git, scikit-learn
- **Parallel Computing Courses**: Parallel Processing (A+), Distributed Systems (A+), Advanced Computer Architecture(A+), Advanced Systems Programming(A+), Compilation Techniques for Parallel Processors (A-)
- **Machine Learning Courses**: Statistical Learning (A+), Theory of Learning (A+), Causal Inference (A+), Probability & Statistics (A+)
- **Graphic Courses**: Physics-based Animation (A+)

Honors and Awards

- **Talent Bursary** from Alberta Machine Intelligence Institute(AMII) (2023 and 2022)
- **Top 0.1**% among more than 60000 and 350000 participants in nation-wide University Entrance Exam for M.Sc. and B.Sc. programs (2017 and 2013)
- **Qualified** for double-major program (EE and CE) at Amirkabir University of Technology 2015

Education

Ph.D. Computer Science | *University of Toronto*

September 2020 – Ongoing

- Focus: High-Performance Computing (HPC) in Graphic
- Supervisors: Maryam Mehri Dehnavi

M.Sc. Electrical Engineering | *Sharif University of Technology*

September 2017 – August 2019

- Focus: High-Performance Computing (HPC) in Machine Learning
- Supervisors: Matin Hashemi and Saber Salehkaleybar