

TIM BAER

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Education

University of Illinois at Urbana-Champaign

Bachelor of Science in Mathematics & Computer Science

May 2022

CS GPA: 3.80

Selected coursework: parallel numerical algorithms, tensor computations, randomized algorithms, approximation algorithms, numerical analysis, parallel programming, communication networks*

Research Projects

Parallel Minimum Spanning Forest

Advisor: Edgar Solomonik

August 2019 — October 2021

UIUC

Generalized matrix algebra has emerged as an expressive and powerful framework for designing parallel graph algorithms. We develop the first formulation of the Awerbuch-Shiloach parallel minimum spanning forest (MSF) algorithm using matrix algebra primitives. To achieve this, we introduce a novel multilinear primitive that updates graph vertices by simultaneously using information from both adjacent edges and vertices. We demonstrate scalability of our MSF algorithm on up to 256 nodes (16K cores) on some of the largest publicly available graphs. I was responsible for the design of the algorithm and implementation with the Cyclops Tensor Framework, a distributed-memory library for generalized sparse tensor algebra. In addition, I developed two optimizations to accelerate the shortcutting step.

Parallel Single Source Shortest Path

Advisor: Edgar Solomonik

September 2020 — current

UIUC

We explore connections between a recent theory paper on parallel SSSP in nearly optimal work and depth (Andoni, Stein, Zhong, STOC 20) and fast iterative solvers like algebraic multigrid. I developed a highly scalable algorithm for the main subroutine: given a vertex and a number k , find the k closest neighbors to that vertex. I expressed this calculation as a sequence of sparse matrix-vector multiplications (SpMV) with the adjacency matrix and a vector \mathbf{b} containing a sorted list for each vertex's tentative k closest neighbors. I found experimentally that it is faster to express this subroutine with the multilinear primitive described above. With this efficient subroutine, I then implemented the algorithm's main data structure called a low hop emulator.

Publications

Parallel Minimum Spanning Forest Computation using Sparse Matrix Kernels

Tim Baer, Raghavendra Kanakagiri, and Edgar Solomonik

October 2021

Accepted to SIAM PP 2022.

Talks

Parallel Minimum Spanning Forest Computation using Sparse Matrix Kernels

SIAM PP 2022

February 2022

Graph Algorithms with Sparse Linear Algebra

C3.ai Platform Engineering

July 2021

Low Hop Emulators and Uncapacitated Min-Cost Flow

UIUC Parallel Algorithms Reading Group

October 2020

Awards

CRA Outstanding Undergraduate Researcher Award

Honorable Mention

December 2021

This award program recognizes undergraduate students in North American colleges and universities who show outstanding research potential in an area of computing research.

Franz Hohn and J.P. Nash Scholarship

May 2021

Awarded to one undergraduate in recognition of outstanding scholarship and promise in applied mathematics, computational science, or scientific computing.

James Scholar

Selection is based upon academic achievement as well as diversity of identity, geography, and major/area of study.

Teaching

Software Design Studio

August 2019 — May 2020

Moderated and graded weekly code review sessions focusing on best practices.

Introduction to Computer Science

January 2019 — August 2019

Facilitated a lab section and held office hours.

Internships

C3.ai — Software Engineering Intern

June 2021 — August 2021

Machine Learning

- Researched open-source distributed deep learning frameworks & designed end-to-end integrations with the platform.
- Developed a transpiler for Python code generation to avoid serialization of large arrays across languages, improving performance up to 4000x.
- Presented hour-long talks on internship work & undergraduate research.
- Selected for a filmed 1:1 intern testimonial interview published to C3.ai's website.

IBM — Software Engineering Intern

June 2020 — December 2020

Db2z Tools

- Integrated static/dynamic code analysis into CI pipeline to detect security issues.
- Automated API & unit tests to improve code coverage by 85%.
- Developed a new internal documentation tool.

All Information Services — Technology Intern

May 2019 — August 2019

- Automated client workflow for file syncing with Microsoft Graph API.
- Developed Flask app to integrate Slack with our service desk platform.
- Leveraged NLP to automate classification of support ticket issue types.

Non-Research Projects

Shopical: Shop Ethical

IBM Intern Hackathon 2020

- Developed mobile app that leverages ML to highlight harmful ingredients in consumer products in real-time.
- Won 2nd place in the climate change division (126 teams across 3 divisions).

Evolution in the Stock Market

CS @ Illinois Sail 2019

- Taught a class to 50+ high school students interested in computer science.
- Developed a Jupyter notebook to apply genetic algorithms to real-time stock data.