

Benjamin M. Cobb

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EDUCATION

Georgia Institute of Technology, Atlanta, GA, August 2019 – present

PhD student in Computational Science and Engineering (CSE)

GPA: 4.0

Wake Forest University, Winston-Salem, NC, August 2015 – May 2019

Bachelor of Science with Honors in Computer Science

Bachelor of Science in Mathematical Business

Minor in Chinese

Graduated Magnum Cum Laude

WORK EXPERIENCE

Graduate Research Assistant

Georgia Institute of Technology, Atlanta, GA, August 2019 – present, 20 hrs/week

- Researching tensor kernels and tensor decompositions (a form of unsupervised machine learning)
- Currently engaged in improving state-of-the-art tensor decomposition techniques
- Implementing distributed Non-negative Matrix Factorization (NMF) algorithms for PLANC project through Oak Ridge National Labs
- Implementing tensor algorithms for use in the GenTen project through Sandia National Labs
- Collaborating with researchers at Sandia National Labs and Oak Ridge National Lab
- Using the Kokkos programming model to write performance portable applications

Graduate Teaching Assistant

Georgia Institute of Technology, Atlanta, GA, August – December 2020, 20 hrs/week

- TA'ed graduate level algorithms course with 200+ students
- Graded exams and homework
- Developed and proofread homework problems
- Explained concepts such as dynamic programming, NP-completeness, divide-and-conquer, local search algorithms and multiple types of proofs to students during office hours

Sandia National Laboratories Computer Science Research Institute Summer Intern

Sandia National Laboratories, Albuquerque, NM, May – August 2020, 40 hrs/week

- Researched portable tensor kernels for use in compressing large combustion simulation datasets
- Researched tensor surrogate models
- Worked closely with employees in the Scalable Algorithms department
- Received hands-on experience developing, unit testing and benchmarking code on Sandia's advanced testbeds
- Implemented performance portable dense Tensor Times Matrix (TTM) kernels as part of the GenTen project
- Became proficient with the Kokkos programming model

SuperComputing (SC) 2020 and 2021 Student Volunteer

Virtual, November 2020 and 2021

- Moderated presentation and panel on advanced OpenMP
- Handled questions and comments from attendees
- Presented poster on tensor research

Undergraduate Research and Creative Activities Center (URECA) Researcher

Wake Forest University, Winston-Salem, NC, May – August 2018, 40 hrs/wk

- Researched hypergraph partitioning methods applied to Sparse Matrix Vector products (SpMxV)
- Worked to speed up the coarsening phase of the Karlsruhe Hypergraph Partitioner (KaHyPar) using Wedge-Sampling heuristics
- Learned the many nuances of hypergraph partitioning, the useful applications of hypergraph models and how to proficiently use Linux command line

Resident Advisor

Wake Forest University, Winston-Salem, NC, August 2016 – May 2019, 20 hrs/wk

- Presented housing reforms for transfer students to the directors of the Residence Life and Housing Board, which were subsequently implemented into official Wake Forest housing policy
- Met and engaged with transfer student residents on a weekly basis to cultivate a close-knit community
- Mediated resident conflicts through arbitratative conversations

PROJECTS

PLANC: Parallel Low-rank Approximations with Non-negativity Constraints

Oak Ridge National Laboratory, Oak Ridge, TN, December 2021 – present

url: <https://github.com/ramkikannan/planc>

- Worked to implement first distributed MPI based implementation of Joint-NMF
- Utilized distributed implementation to process previously computationally infeasible large text dataset
- Text classification results presented at SIAM Conference on Parallel Processing as part of plenary talk

GenTen Portable Tensor Decompositions

Sandia National Laboratories, Albuquerque, NM, October 2019 – present

url: <https://gitlab.com/tensors/genten>

- Developed novel, Fused In-place Sequentially Truncated Higher Order Singular Value Decomposition (FIST-HOSVD), algorithm to compute Tucker Decomposition in-place
- Demonstrated $\sim 135\times$ reduction in memory consumption when computing Tucker Decomposition for compressing large combustion simulation datasets
- Implemented Tensor Times Matrix (TTM) and Gram kernels utilizing the Kokkos programming model portable to Intel, ARM, and IBM CPU architectures, as well as NVIDIA GPU architectures
- Demonstrated that TTM kernel implementations outperform other state-of-the-art-tensor contraction implementations such as Eigen (Used by Google's TensorFlow) and the Matlab Tensor Toolbox
- Used Roofline model to show Gram kernel implementation achieved maximum bandwidth performance on V100 GPU

MATLAB Tensor Toolbox

Wake Forest University, Winston-Salem, NC, March – May 2018

- Worked to implement polynomial time perfect minimum cost Bipartite Matching algorithm for use in the Matlab Tensor Toolbox score function to calculate ktensor least-squares cosine differences
- Created multiple unit tests to verify correctness
- Gained experience rigorously testing and refining contributable code

TECHNICAL REPORT

GenTen Performance Portable Dense TTM Kernels*Sandia National Laboratories, Albuquerque, NM, August 2020*url: <https://cfwebprod.sandia.gov/cfdocs/CompResearch/docs/proceedings/csri20.pdf>

- Published report with technical details of Tensor Times Matrix (TTM) kernel and benchmark results as part of Sandia National Lab's Computer Science Research Institute (CSRI) Summer Program
- Detailed motivating combustion simulation anomaly detection application
- Demonstrated that TTM kernel achieved GEMM like performance for problem sizes of interest

PRESENTATIONS

SIAM Conference on Parallel Processing for Scientific Computing*Virtual, Seattle, WA, February 2022*

- Presented Fused In-place Sequentially Truncated Higher Order Singular Value Decomposition (FIST-HOSVD) algorithm to leading experts in the field of tensor decompositions
- Explained intricate cache-blocking techniques used to drastically reduce memory consumption of computing the Tucker Decomposition by $\sim 135\times$ for compressing large combustion simulation datasets

Center for Research into Novel Computing Hierarchies (CRNCH) Summit*Georgia Institute of Technology, Atlanta, GA, January 2021*

- Presented poster on Tensor Times Matrix (TTM) and Gram kernel benchmark results
- Explained application to Sequentially Truncated Higher Order Singular Value Decomposition (ST-HOSVD)
- Explained research to those unfamiliar with tensor decompositions

GT@SC20*Georgia Institute of Technology, Atlanta, GA, November 2020*

- Presented poster on Tensor Times Matrix (TTM) kernel benchmark results
- Explained importance of code portability
- Highlighted performance results competitive with other state-of-the-art, less portable libraries

Computer Science Research Institute (CSRI) Poster Blitz*Sandia National Laboratories, Albuquerque, NM, August 2020*

- Presented progress on summer research project to researchers at Sandia National Labs
- Answered technical questions pertaining to project

Wake Forest Computer Science Honors Thesis Defense*Wake Forest, Winston-Salem, NC, May 2019*

- Presented honors thesis on hypergraph partitioning methods and wedge-sampling heuristics for Sparse Matrix Vector products (SpMxV) to panel of computer science professors
- Successfully defended thesis

Undergraduate Research Day*Wake Forest, Winston-Salem, NC, May 2019*

- Presented poster on hypergraph partitioning methods and wedge-sampling heuristics for Sparse Matrix Vector products (SpMxV)
- Explained research to those unfamiliar with hypergraph partitioning methods, wedge-sampling heuristics and SpMxV

SCHOLARSHIP

H. Howell Taylor, Jr. Risk Management Scholarship*Wake Forest University, Winston-Salem, NC, June 2018 – May 2019*

- Awarded based upon risk management essay competition
- Assists business students interested in risk management

FELLOWSHIPS

Presidential Fellowship (PF)*Georgia Institute of Technology, Atlanta, GA, August 2019 – present*

- \$5,500 in financial support to Georgia Tech doctoral applicants in the top 10% of the applicant pool
- Renewable for up to three additional years

Wake Forest Research Fellowship (WFRF)*Wake Forest University, Winston-Salem, NC, May – August 2018*

- \$4,000 stipend and housing over the course of a summer
- Supports students participating in research under the mentorship of a Wake Forest faculty member

COMPETITIONS

*Putnam Math Competition: tied for best 2016 Wake Forest University score**Virginia Tech Math Competition: tied for best 2015 Wake Forest University score**ACM International Collegiate Programming Contest (ICPC): best 2018 Wake Forest University team score***NOTABLE GRADUATE LEVEL COURSES**

Computational Science and Engineering Algorithms*Georgia Institute of Technology, Atlanta, GA, Fall 2019*

Grade: A

Computational Data Analysis*Georgia Institute of Technology, Atlanta, GA, Fall 2019*

A

Numerical Linear Algebra*Georgia Institute of Technology, Atlanta, GA, Spring 2020*

A

High Performance Computing*Georgia Institute of Technology, Atlanta, GA, Spring 2020*

A

High Performance Parallel Computing*Georgia Institute of Technology, Atlanta, GA, Fall 2020*

A

High Performance Computer Architecture*Georgia Institute of Technology, Atlanta, GA, Spring 2021*

A

Deep Learning*Georgia Institute of Technology, Atlanta, GA, Fall 2022*

A

SKILLS

Languages: C/C++, Python, Matlab, Latex, Bash**High Performance Computing:** Kokkos, OpenMP, MPI, CUDA, cache aware programming**Software Development:** Git, CMake, Unit Tests, Vim, Slurm, Tmux, Linux Command Line, Scripting**Performance Analysis and Debugging:** Roofline Bandwidth Analysis, VTune, GNU Debugger (GDB)**Machine Learning:** Deep Learning, Neural Nets, PyTorch, Linear Algebra, Calculus, HOSVD, NMF**Expertise:** Tensor Kernels, Tensor Decompositions, Tensor Analysis, Unsupervised Machine Learning