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Benjamin R. Bray

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Education

Georgia Institute of Technology, M.S. Computer Science   (Atlanta, GA) *2017 – 2019*
  » Specialization in High Performance Computing.
  » Research in optimization & machine learning theory, advised by Dr. Jacob Abernethy.

University of Michigan, B.S. Honors Applied Mathematics   (Ann Arbor, MI) *2013 – 2017*

Research

Research Intern, RIKEN AIP, advised by Dr. Emtiyaz Khan   (Tokyo, Japan)   *Summer 2019*
  » Studied training dynamics of variational autoencoders (VAEs) and the amortization gap.
  » Ran experiments in PyTorch; became interested in automatic differentiation and compiler tools for ML.

Graduate Researcher, advised by Dr. Jacob Abernethy (GT)   *2017 – Current*
  » Continuous-time analysis of gradient descent and its relatives; study of discretization error.
  » Optimization and online learning on manifolds; natural gradient and projection-free methods.

Digital Humanities & German Periodicals, advised by Dr. Peter McIsaac (UM)   *2013 – 2015*
  » Built a `flask` webapp enabling humanities researchers to run and visualize statistical topic models on a large corpus of 19th-century German periodicals.
  » Corrected noisy digital scans using a Hidden Markov Model over word fragments. Trained on a synthetic dataset of eroded digital scans with known text. Segmented words based on letter-successor-variety.
  » Implemented online variational inference for LDA/HDP from scratch in Python.
  » Trained a logistic regression classifier to detect toponyms using `word2vec` features, achieving near state-of-the-art performance (0.85 F_1-score) on a Dutch dataset.

Internships

Software Engineering Intern, Microsoft   (Seattle, WA)   *Summer 2016*
  » Built a multiplatform mobile app with Xamarin to display Windows telemetry insights to developers.

Data Science Intern, Are You a Human   (Detroit, MI)   *Summer 2015*
  » Designed new features to improve bot classification accuracy by 4%
  » Implemented random forest models for user fingerprinting based on device capabilities.

Teaching

Teaching Assistant, CS 4540, Advanced Algorithms for Machine Learning (GT)   *F18, F19*
  » Authored lecture notes, homework, and demonstrations for a flipped-classroom course.
  » Designed a new curriculum with the goal of exposing undergrads to the math behind modern ML.
  » Topics included convex geometry, numerical methods, linear programming, and statistical inference.

Teaching Assistant, EECS 545/445, Machine Learning (UM)   *S16, F17, S17*
  » Redesigned the curriculum with Prof. Jacob Abernethy, with emphasis on statistical methods.
  » Taught a weekly discussion section of around twenty students.

Selected Projects

Incompressible Fluid Simulation   *2019*
  » Interactive CUDA simulation of incompressible flow using parallel Jacobi solver with vorticity confinement.
  » Compared against CPU implementation of incomplete Cholesky precondtioned conjugate gradient.

Matey, a numerical linear algebra library for Python, written in C++.   *2017*
  » Fast matrix operations, factorization, linear system solving, and eigenvalue computations from scratch.
  » Built as a Python C-extension, using CUDA to parallelize existing algorithms.

Technical Experience	*Advanced*	*Proficient*	*Familiar*
Programming Languages	Python	JavaScript/TypeScript, C#, CUDA	C++, Haskell, Go
Machine Learning	`numpy`, `gensim`	`matplotlib`, `scikit-learn`	`pytorch`
Miscellaneous		LaTeX, Git, LLVM, `flask`	AWS, Node, Docker

Relevant Coursework (*audited)

Cs 6290, Advanced Computer Architecture (Prof. Tom Conte, GT) *S19*
  » Pipelining; instruction-level parallelism; superscalar processors; VLIW; Tomasulo/ROB/RAT
  » Memory hierarchies; multiprocessors; shared memory vs. message passing; cache coherency/consistency

Cs 6241, Advanced Compiler Optimizations (Prof. Santosh Pande, GT) *S19*
  » For projects, wrote LLVM transform passes to perform optimizations discussed in class.
  » Reaching definitions; available expressions; partial redundancy elimination; SCCP; infeasible paths
  » Data/loop/control dependencies; loop parallelism, reordering, unrolling, and vectorization

Cse 6220, High-Performance Parallel Computing (Profs. Aluru & Catalyurek, GT) *S19*
  » Parallel runtime analysis; efficiency; interconnection networks & embeddings; MPI programming
  » Prefix sum; bitonic sort; sample sort; Cannon's algorithm; parallel FFT

Math 7244, Stochastic Calculus (Prof. Michael Damron, GT) *F18*
  » Brownian motion; mean-square calculus; continuous-time martingales; stochastic integration

Isye 7687, Discrete Optimization for Machine Learning (Prof. Sebastian Pokutta, GT) *S18*
  » Boosting and online learning; bandits and reinforcement learning; away-step conditional gradient
  » Completed a final report surveying algorithms for online submodular maximization.

Stats 700, Bayesian Nonparametrics Seminar (Prof. Long Nguyen, UM) *F14, S16*
  » Existence and construction of Dirichlet processes; stick-breaking and Chinese restaurant processes
  » Indian Buffet Processes; Hierarchical Dirichlet Processes; online variational inference and natural gradients
  » Likelihood and sufficiency principles; Bayesian vs. frequentist statistics
  » Exponential families and conjugacy; Gibbs sampling; variational inference

Cs 7545, Statistical Learning Theory (Prof. Jacob Abernethy, GT) *F17*
  » PAC-learning and VC-dimension; margin learning and kernel methods; boosting
  » Online convex optimization; convex-concave games; exponential weights; mirror descent

Cs 6550, Design & Analysis of Algorithms (Prof. Jamie Morgenstern, GT) *S18*
  » Matroids and greedy algorithms; graph connectivity and shortest paths; matchings; linear programming
  » Gradient and mirror descent; ellipsoid method; Johnson-Lindenstrauss and random projections
  » Completed a final report on random matrix theory and algorithms for sampling random matrices.

Math 6455, Differential Geometry* (Prof. Mohammad Ghomi, GT) *S18*
  » Smooth manifolds; vector fields; geodesics; Riemannian metrics; Levi-Civita connection
  » Submanifolds; differential forms; Lie groups; integral curves and flows

Math 571, Numerical Linear Algebra (UM) *F15*
Math 671, Fast Numerical Methods (UM) *S17*
Cse 8803, Advanced Scientific Computing (Prof. Edmond Chow, GT) *S18*
  » Stationary iterative methods; conjugate gradient and Krylov subspaces; Chebychev polynomials
  » Nonuniform FFT and butterfly algorithms; Ewald summation; multigrid; fast multipole methods
  » Finite element analysis; molecular simulation with hydrodynamic interactions

Math 597, Measure Theory & Real Analysis (UM) *S16*
Math 525, Probability Theory (UM) *F16*
Math 420, Advanced Linear Algebra (UM) *F15*

Other Involvement

President, Michigan Student Artificial Intelligence Lab *2015-2017*
  » Organized a weekly machine learning reading group for undergraduate & graduate students