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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*

» Analysis of 19th century German periodicals with statistical topic models.
» Implemented online variational inference for LDA/HDP from scratch in Python.
» 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.
» 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
Machine Learning	`numpy`, `gensim`	`matplotlib`, `scikit-learn`	`pytorch`
Miscellaneous		LaTeX, Git, LLVM	AWS, Node, `flask`

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

(Modified: November 2019)