benrbray.com
(more on my website!)

Benjamin R. Bray

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Education

Georgia Institute of Technology, M.S. Computer Science (Atlanta, GA) *2017 – 2019*
University of Michigan, B.S. Honors Applied Mathematics (Ann Arbor, MI) *2013 – 2017*

Work Experience

Research Engineer, Hasuo Lab @ National Institute of Informatics (Tokyo, Japan) *Feb 2023 – Now*

» Collaborated with researchers to translate their academic work into proof-of-concept software tools designed to improve **formal verification** workflows for engineers at Japanese automotive companies.
  → A **model checker** for a simple imperative probabilistic programming language.
  → A domain-specific language called `tempo-lang` which compiles to **signal temporal logic** expressions, along with a **language server** and a web app for creating, documenting, and exemplifying specifications.

» Technologies:
  → **Haskell** for implementing parsers, interpreters, type inference algorithms, and a language server.
  → **TypeScript** (React, Vite, CodeMirror) for a web app to edit and visualize `tempo-lang` specifications.
  → **Z3** (the SAT/SMT solver) for generating examples and counterexamples to signal temporal logic specs.

» Presented our work at the IAA Mobility 2023 automotive trade show in Munich, Germany.

Backend Engineer, Smartpay K.K. (Tokyo, Japan) *March 2022 – Feb 2023*

» Led the design, implementation, testing, and release of a programmatic disbursements backend service which integrates with bank APIs to automatically issue merchant payouts and consumer refunds.
» Code review, API design, and sprint planning for a backend powering mobile & web apps for a pay-later service.
» Technologies: **Scala** with `cats-effect`. GCP, Pub/Sub, Terraform, GraphQL.

Computer Vision Engineer, EmbodyMe (Tokyo, Japan) *May 2020 – Feb 2022*

» Trained deep learning models to transfer facial expressions from input video onto a target image in *real time*.
» Implemented graphics post-processing effects on rendered face meshes to enhance realism.
» Technologies: Python, PyTorch, ONNX, MediaPipe, GANs, NeRF, attention, transformers

Software Engineering Intern, Microsoft (Seattle, WA) *Summer 2016*

» Built a multiplatform mobile app (**C#** / Xamarin) to display Windows telemetry statistics to developers.

Projects

Noteworthy, a Markdown editor tailored for notes making heavy use of math, diagrams, and citations. *2020*

» My `prosemirror-math` NPM package adds interactive WYSIWYG math editing support to ProseMirror.
» My `remark-cite` NPM package adds `pandoc`-style citation syntax to the `remark` markdown parser.
» Technologies: TypeScript, SolidJS, ProseMirror, CodeMirror, Vite, PNPM, Electron.

Additional Projects (see my website for details!)

» (`rust`) An implementation of the *sequential impulse* algorithm for rigid body physics.
» (`C++/CUDA`) Simulation of incompressible fluid flow using parallel Jacobi solver, based on "Stable Fluids".
» (Haskell) `yagi-lang`, a toy language for learning about dependent type theory & language implementation.
» (Haskell) `borscht`, a command line tool to fill in missing music metadata by querying Discogs.

Academics & Research

Research Assistant, University of Michigan, advised by Dr. Peter McIsaac (Ann Arbor, MI) *2013 – 2015*

» Built a `flask` web app for humanities researchers to visualize topic models on 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 and HDP from scratch in Python.

Research Intern, Approximate Bayesian Inference Team, RIKEN AIP (Tokyo, Japan) *Summer 2019*

» Studied training dynamics of variational autoencoders (VAEs) and the amortization gap.

Teaching Assistant, CSE 7640, Computational Data Analysis (GaTech) *S20*
Teaching Assistant, CS 4540, Advanced Algorithms for Machine Learning (GaTech) *F18, F19*
Teaching Assistant, EECS 545/445, Machine Learning (UMich) *S16, F17, S17*

» Gave lectures on numerical methods, convex geometry, linear programming, statistical inference.

Publications

[1] Peter McIsaac, Sugih Jamin, Ines Ibanez, Oskar Singer, and **Benjamin Bray**. Die Geowissenschaftliche Analyse von großen Mengen historischer Texte: Die Visualisierung geographischer Verhältnisse in deutschen Familienzeitschriften. In Elisabeth Burr and Patrick Helling, editors, *3. Tagung des Verbands Digital Humanities im deutschsprachigen Raum, DHd 2016, Leipzig, Germany, March 7 - 12, 2016*, 2016.

[2] Jesse Reimann, Nico Mansion, James Haydon, **Benjamin Bray**, Agnishom Chattopadhyay, Sota Sato, Masaki Waga, Étienne André, Ichiro Hasuo, Naoki Ueda, and Yosuke Yokoyama. Temporal Logic Formalisation of ISO 34502 Critical Scenarios: Modular Construction with the RSS Safety Distance. *CoRR*, 2024.

Relevant Coursework (*audited)

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

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

CSE 6220, High-Performance Parallel Computing (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 (GT) *F18*
» Brownian motion; mean-square calculus; continuous-time martingales; stochastic integration

ISYE 7687, Discrete Optimization for Machine Learning (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 (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 (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 (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* (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 (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*