CHRISTIAN HOWARD

SUMMARY

Theoretical computer scientist (Ph.D.) and aerospace engineer passionate about building the simplest solutions with the strongest guarantees, with skills applying advanced theory to solve hard real-world problems. Expertise spans designing resource-efficient algorithms for many domains, high-performance scientific computing, embedded robotic systems, and machine learning.

EDUCATION

University of Illinois @ Urbana-Champaign

PhD Computer Science — **Interests**: Theoretical Computer Science, **GPA**: 3.86/4.0, **Date**: August 2019 - June 2026

MS Computer Science [thesis] — **Interests**: Theoretical Computer Science, Artificial Intelligence, Scientific Computing

BS Aerospace Engineering — **Interests**: Robotics, Scientific Computing, Control Theory, Fluid Dynamics

SKILLS

Main Languages: C++, C, Python

Misc Programming Skills: C++ threads, pthreads, OpenMP, MPI, Boost.interprocess, protobufs, GoogleTest

Other Notable Skills: Algorithms, Machine Learning, High Performance Computing, Mathematics, Simulation, Optimization

EXPERIENCE

University of Illinois — PhD Research Assistant — *Fall 2021 - Current*

- **[Current work]** Working with advisor **Jeff Erickson** towards the first polynomial time algorithm that computes a morph between two given isomorphic spherical embeddings with shortest-path geodesic edges.
» Published ***Shelling and Sinking Graphs on the Sphere*** with Erickson [SoCG '25], progress morphing spherical triangulations.
» In the pipeline: efficiently morphing 3-connected spherical graphs with bends; reducing arbitrary planar graphs to triangulations; fast algorithms for triangulating spherical polygons; reducing morphing triangulations to convexifying spherical quadrilaterals.

Google (Remote & Sunnyvale, CA) — PhD Software Engineering Intern — *Summers 2023 & 2024*

- Worked on the **Unified Traffic Engineering** (UTE) team to improve the robustness of Google's B4 network to failures.
- **Identified & Fixed flaw in Google's B4 network**:
» **High impact**; impacted all of Google's services.
» Mathematically proved the production Free Range Routing (FRR) backup path policy could be made to fail due to a flaw.
» Proposed a simple fix shown via simulation to reduce transient risk in the network by **63+%**.
» ***Fun fact***: The fix was expedited to production after a major network failure matching my characterization occurred.
- **Designed Improved FRR Backup Path Policies**:
» Designed and built **14+** new FRR backup path policies in C++ robust to Shared Risk Link Groups (SRLGs), **6+** of which were capacity-aware; **all showed major improvements** over prod.
- **Improved compression by 10+% for path representation**:
- **Built fast tools for simulating and assessing policies**
- **Given verbal job offer mid-internship for great performance.**

Google (Irvine, CA) — PhD Software Engineering Intern — *Fall 2022*

- Worked on the **Data Infrastructure for Smart Analytics** (DISA) team and built key components of a high impact distributed supervised learning service, usable via SQL, to easily enable distributed machine learning on large datasets.

Raytheon Missile Systems — GNC Systems Engineer II — *Jun 2014 - Aug 2017*

- Worked on missiles with a **Secret Clearance** in the **Guidance, Navigation, and Control** (GNC) department.
- **Led building software tools to improve team efficiency**:
» Designed fast algorithms to adaptively collect data from 6DOF simulations to build statistical models; reduced overall data collection time by **≥70%.**
» Designed distributed machine learning tools to efficiently build statistical models; runtime was reduced by **≥ 99%**.
- **Built missile guidance policies and target state estimators**:
» Developed guidance policies with **reinforcement learning** and **optimal control**, mixing analytical and numerical methods.
» Designed a distributed optimization package that was used to optimally tune hyperparameters of a Bayesian estimator; produced an estimator with **performance superior** to human tuned filters, while being constructed in 0.5% of the time.
- **Led iPad mission planning software for SOCOM**

NASA JPL/Caltech — Robotics Group - Computer Vision Intern — *Summer 2013*

- Developed Real-Time Homography-based algorithm in C++ to track a landing location in a limited texture environment
- Built filtering algorithms to reduce noisy features fed into a RANS-based algorithm estimating a homography.

github.com/choward1491 linkedin.com/in/cjhoward1491 choward1491@gmail.com

RELEVANT GRADUATE LEVEL COURSEWORK

- Machine Learning
- Machine learning for Signal Processing
- Deep Learning Theory
- Statistical Reinforcement Learning
- Optimization in Computer Vision & ML
- Convex Optimization
- Fast Algorithms & Integral Equations
- Algorithms
- Randomized Algorithms
- Approximation Algorithms
- Geometric Data Structures
- Computational Topology
- Algos for Big Data (e.g. hashing, sketching, streaming)
- Computational Complexity

SELECT PROJECTS

Async Spacetime Discontinuous Galerkin Solver [link] *Fall 2017 - Fall 2021*

- Worked with **Prof Bob Haber** and **Prof Jeff Erickson** (advisor) as a research assistant on adaptive spacetime meshing algorithms for solving hyperbolic partial differential equations (PDEs) using the discontinuous Galerkin finite element method.
- Worked with Prof Erickson to develop the theoretical generalizations of these adaptive techniques to 3-D x Time.
- Applied a novel energy minimization idea in 3-D space and generalized it to 3-D x Time for adaptive operations like smoothing and bistellar flips, with algorithmic modifications for high performance computing (HPC) purposes.
- Major contributor to architecting and implementing a high performance parallel distributed software package to solve hyperbolic systems of PDEs.
- Singular contributor to implementation of the adaptive meshing algorithms for a high performance context.
- Presented results over time at numerous conferences.

Computational Topology - Final Project [link] *Fall 2020*

- Wrote up proofs reducing from the cyclic edit distance problem to an edge-disjoint path problem in planar maps and implemented this new algorithm and contrasted it to other algorithms for the cyclic edit distance problem.

Geometric Data Structures - Final Project [link] *Spring 2020*

- Implemented two threaded locality sensitive hashing (LSH) data structures in C++14 using OpenMP and applied them to a k-nearest neighbor problem. The variants include the vanilla LSH and the CoveringLSH data structures.

Deep Learning Theory - Final Project [link] *Fall 2019*

- Gave presentation on "**Towards moderate overparameterization: global convergence guarantees for training shallow neural networks**" by Oymak et al. '19; worked through key proofs for high probability guarantees of global convergence for training overparametrized networks using stochastic gradient descent.

Reinforcement Learning with RKHS - Final Project [link] *Spring 2019*

- Looked at a collection of papers and formalized a measure theoretic perspective on the work in those papers discussing the use of Reproducing Kernel Hilbert Spaces to construct efficient Approximate Dynamic Programming algorithms for Reinforcement Learning problems
- Worked out a variety of proofs using an integral operator approach and derived convergence properties, with high probability, in the infinite dimensional RKHS case

Decoupled Potential Integral Equations [link] *Aug 2017 - May 2018*

- Worked with **Prof Andreas Kloeckner** in CS 598 and an Independent Study to build a computational physics model based on the Decoupled Potential Integral Equations to allow for robust solutions to the Maxwell Equations
- Implemented the model as an extension to Andreas' pytential Python package to take advantage of his GPGPU and Quadrature by Expansion (QBX) infrastructure

TEACHING

University of Illinois @ U-C — Teaching Assistant for CS 473 *Jan 2022 - May 2024*

- Working as a Teaching Assistant for CS 473, an elective/graduate course in algorithms
- Covered material such as: advanced dynamic programming, advanced graph algorithms, randomized algorithms, approximation algorithms, NP-hardness.
- Manage course assistants to get grading done
- Run office hours and answer questions on Piazza/EdStem
- Solve homeworks and write up solutions for students
- Help design homeworks and exams

University of Illinois @ U-C — Teaching Assistant for CS 374 *Aug 2021 - Dec 2021*

- Worked as a Teaching Assistant for CS 374, a course introducing models of computation and algorithms
- Managed course assistants to help with grading
- Taught lab sections to help students learn the mechanics and techniques behind automata and algorithms
- Helped to manage other platforms such as a Discord server for the course and a Piazza page for the course, answering questions of students
- Held office hours to help students with course material and guide them on homeworks

github.com/choward1491 linkedin.com/in/cjhoward1491 choward1491@gmail.com