CHRISTIAN HOWARD

EDUCATION

University of Illinois @ Urbana-Champaign

PhD Computer Science
Interests: Theoretical Computer Science, Artificial Intelligence, Scientific Computing
GPA: 3.89/4.0
Date: 2019 - Current

MS Computer Science
Interests: Theoretical Computer Science, Artificial Intelligence, Scientific Computing
GPA: 3.7/4.0
Date: 2017 - 2019

BS Aerospace Engineering
Interests: Robotics, Scientific Computing, Controls, Fluid Dynamics
Date: 2010 - 2014

EXPERIENCE

University of Illinois @ U-C — Research Assistant — *Aug 2017 - Current*

- Working under **Prof Jeff Erickson** and **Prof Bob Haber** in Computational Geometry with both a theoretical and High Performance Computing (HPC) component
- Developed distributed spacetime meshing algorithms using template metaprogramming techniques in modern C++ and MPI, generalizing algorithms for stratified spaces
- Developed state machine model to arrive at modular MPI + pthread parallel architecture for meshing + physics code

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

- Worked with a Secret Clearance in the Guidance, Navigation, and Control (GNC) department building algorithms for precision weapon systems
- Developed an automated, black box, distributed Bayesian Filter building framework that was used to create missile Kalman Filters with performance superior to human tuned filters in 0.5% of the time a human engineer requires
- Developed adaptive algorithm for estimating Launch Acceptability Regions that reduced run-time by ≥70%

NASA JPL/Caltech — Robotics Group - Computer Vision Intern — *Jun 2013 - Sep 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 to estimate the Homography
- Developed a recursive 3-D triangulation algorithm to estimate relative distance to the desired landing location being tracked by the Homography tracker
- Slides at: https://github.com/choward1491/JPL_Project

PRESENTATIONS

University of Illinois @ U-C — CS 598 Project Presentation — *Dec 2019*

- Presented on the theoretical aspects of the CoveringLSH data structure and discussed applications for real world problems along with comparisons to the traditional LSH data structure.

University of Illinois @ U-C — CS 598 Project Presentation — *Dec 2019*

- Presented about Deep Learning Theory optimization paper showcasing global optimization result as number of weights becomes the square of the dataset size.

USNCCM15 — Conference Talk — *July 2019*

- Presented at the 15th U.S. National Congress on Computational Mechanics in Austin, TX about meshing algorithms used in computational mechanics
- Specifically discussed my work in spacetime meshing algorithms for hyperbolic PDEs and generalizations for multidimensional manifold situations

University of Illinois @ U-C — CS 598 PS Poster Presentation — *Dec 2017*

- Presented results of a set of classification algorithms applied to dimensionally reduced fMRI data associated with patients with and without depression
- Results showed high prediction performance of people with or without depression given fMRI data

University of Illinois @ U-C — CS 598 APK Project Presentation — *Dec 2017*

- Presented primary mathematical work done in a paper on the Decoupled Potential Integral Equations and using QBX to solve the system of integral equations discussed

github.com/choward1491 christianjhoward.me howard28@illinois.edu

PROJECTS

Reinforcement Learning with RKHS - Final Project
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

Adversarial Examples - Final Project
Spring 2019

- Formalized a new optimization technique for creating adversarial examples and implemented a study to compare with a simple baseline approach for attacks against generative models, such as variational autoencoders
- The new technique used a second order Taylor expansion to approximate behavior of generative model around some input and would solve a quadratic program on this simpler model to construct an adversarial example

Distributed Artificial Intelligence Software
Aug 2018 - Current

- A personal project to build a C++ library that implements a variety of Artificial Intelligence techniques, particularly in Machine Learning, that benefit from distributed computing
- This project is a fun way to test ideas that can benefit from heterogenous parallel programming techniques, such as mixing MPI with OpenMP and OpenCL

Decoupled Potential Integral Equations
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

Depression Identification from fMRI Data
Aug 2017 - Dec 2017

- As a part of Prof Paris Smaragdis' special topics course on Machine Learning for Signal Processing, worked with a team to build classifiers using dense fMRI datasets that could allow us to predict depression.
- A report and poster were made for the project.

Q-Learning C++ Framework
Aug 2017 - Dec 2017

- Developed a Q-Learning framework in C++ using metaprogramming techniques and compile-time optimizations
- Applied framework to solving various classical problems, such as building an intelligent agent for playing Pong

Constraint Satisfaction Problem C++ Framework
Aug 2017 - Dec 2017

- Developed a Constraint Satisfaction Problem (CSP) framework in C++ using metaprogramming techniques
- Applied framework to solve Flow Free game

α-β Agent C++ Framework
Aug 2017 - Dec 2017

- Developed a framework for building α-β pruning based agents to search minimax trees
- Applied framework to play Breakthrough game with a variety of custome heuristics to beat AI opponents

Distributed Euler Equation Solver
Jan 2013 - May 2013

- As part of an independent study with Prof Dan Bodony, built a distributed code in C and MPI to solve the Euler Equations using the Finite Volume method
- The software was used to model a shocktube problem and a corresponding report was written to discuss the results

Spacetime Discontinuous Galerkin Solver
Jan 2013 - May 2013

- As a part of Prof Bob Haber's course on advanced finite element methods, a C++ code was written that used the Spacetime Discontinuous Galerkin method
- The software was written to solve a system of 1D hyperbolic partial differential equations
- The software was used to perform an hp-convergence study using error estimates and then produced results to show a hyperbolic PDE converging to the parabolic limit
- Results made into report with necessary theoretical work

Computer Vision for Aerial Tracking
Jan 2013 - May 2013

- As a part of an independent study with Prof Soon-Jo Chung, worked on computer vision algorithms to allow for aerial tracking of multiple targets
- The code was written with OpenCV and C++ and used homographies and a projective image subtraction technique to identify moving targets in the scene

TEACHING

University of Illinois @ U-C Grader and Teaching Assistant *Aug 2013 - May 2014*

- Worked as a grader in AE 352 Aerospace Dynamical Systems. Graded homeworks revolving around topics of kinematics, dynamics, perturbation theory, and more.
- Worked as a grader and TA for AE 370 Aerospace Numerical Methods, grading and holding office hours to help students in areas of numerical analysis and coding.

PROFESSIONAL ORGANIZATIONS

SIAM ACM IEEE

AWARDS

- UIUC James Scholar
- Eagle Scout Award
- Sigma Gamma Tau Aerospace Honors Society
- Computational Science & Engineering Undergrad Award
- Computational Science & Engineering Graduate Certificate
- Raytheon GNC Individual Award
- Raytheon Griffin Team Award x 2

Programming Languages

- Intermediate to Expert in Modern C++
- Intermediate in C
- Intermediate in Python
- Intermediate in Swift
- Intermediate Objective-C

github.com/choward1491 christianjhoward.me howard28@illinois.edu