COOPER SIMPSON

Computational and Mathematical Scientist

RS-Coop | rs-coop.github.io | Google Scholar | rscooper@uw.edu | Seattle, WA

April 29, 2025

EDUCATION

Applied Mathematics Ph.D

University of Washington Seattle | 2024 – Present | GPA: 3.83

Dissertation: N.A.
Advisor: Aleksandr (Sasha) Aravkin

Applied Mathematics M.S.

University of Colorado Boulder | 2020 – 2022 | GPA: 3.863

Thesis: Second-Order Non-Convex Optimization
Advisor: Stephen Becker

Applied Mathematics B.S.

University of Colorado Boulder | 2017 – 2020 | GPA: 3.933

Minor: Computer Science

Deep Learning | Optimization | Functional Analysis | Real Analysis | Complex Analysis | Differential Eqs. | Machine Learning | Linear Algebra | Probability | Statistics | Algorithms | Numerics | Algorithmic Economics

WORK & RESEARCH EXPERIENCE

Professional Research Assistant

Aerospace Mechanics Research Center | May 2022–Sep 2024 | CU, Boulder

- Supervised by Prof. Alireza Doostan and in collaboration with Profs. Stephen Becker, John Evans, and Ken Jansen
- Investigated non-linear compression techniques, such as autoencoding and implicit representation neural networks, for large-scale scientific simulations
- Developed QuadConv, a quadrature-based convolution operator for use in deep learning on non-uniform meshes
- Developed a limited memory sketching-based paradigm for online (in-situ) training of neural compressors
- Working with supercomputer systems through Argonne Leadership Computing Facility (Polaris & Theta) and CU Boulder (Alpine & Blanca)

Development Intern

Electro Magnetic Applications (EMA3D) | June–Aug 2021 | Denver, CO

- Developed production software for Charge and Cable – electromagnetic simulation tools
- Implemented generalized barycentric interpolation for arbitrary convex polyhedra
- Built post-processing functionality for complex unstructured 3D meshes

Research Assistant

Correll Robotics Lab | Dec 2018–May 2021 | CU, Boulder

- Aided in the development of nn4mc, a software package which facilitates embedding complex neural networks on microcontrollers
- Investigated methods and tools for embedding complex distributed robotic behaviour through compiled high level primitives

Visiting Research Assistant

University of Southern California: ANRG | May–Aug 2020 | Remote

- Participated in the Robotics and Autonomous Systems Research Experience for Undergraduates
- Conducted research with professor Bhaskar Krishnamachari on a drift-plus-penalty inspired method for constrained robotic resource collection in a stochastic environment.

TEACHING EXPERIENCE

Various duties which included teaching recitations, running office hours, developing course materials, grading, and more.

Lecturer

Department of Applied Mathematics | CU, Boulder

- APPM 4720/5720 Applied Deep Learning 1 | Fall 2023

Graduate Teaching Assistant

Department of Applied Mathematics | CU, Boulder

- APPM 2360 Differential Equations with Linear Algebra | Fall 2021

- APPM 1350 Calculus 1 for Engineers — Fall 2020

Undergradute Course Assistant — College of Engineering — CU, Boulder

- APPM 3570 Applied Probability — Fall 2019
- CSCI 2360 Computer Science 2: Data Structures — Spring 2019
- CSCI 1300 Computer Science 1: Starting Computing — Fall 2018

PROJECTS & PUBLICATIONS

Regularized Saddle-Free Newton — Independent, Master's Thesis

R-SFN is a novel second-order Newton-type method for non-convex optimization. A non-linear transformation to the Hessian ensures global convergence to second-order stationary points and an efficient matrix-free implementation.

- Cooper Simpson and Stephen Becker. *Regularized Saddle-Free Newton: Saddle Avoidance and Efficient Implementation*. 2023. URL: `https://rs-coop.github.io/projects/research/rsfn`
- Cooper Simpson. "Regularized Saddle-Free Newton: Saddle Avoidance and Efficient Implementation". M.S. Thesis. Dept. of Applied Mathematics, CU Boulder, 2022. URL: `https://rs-coop.github.io/projects/research/rsfn`

Quadrature-Based Convolutions — CU AMReC

QuadConv is a quadrature-based discrete convolution operator for use in training deep neural networks on non-uniform data. For neural compression, we have shown it matches or exceeds the performance of traditional convolution on a grid, and maintains strong results on meshes with non-uniform distributions.

- Kevin Doherty, Cooper Simpson, et al. "QuadConv: Quadrature-Based Convolutions with Applications to Non-Uniform PDE Data Compression". In: *Journal of Computational Physics* (2023). DOI: `10.1016/j.jcp.2023.112636`

Exchange Economy Dynamics — Independent

Work towards generalizing the proportional response dynamic to graphical exchange economies with arbitrary network structure and endowments.

- Cooper Simpson. *Generalizing the Proportional Response Dynamic for Exchange Economies*. 2023. URL: `https://rs-coop.github.io/projects/research/prd`

Neural Networks for Microcontrollers — Correll Robotics Lab

Software packages for translating trained neural networks into C code for use in embedded systems.

- S. Aguasvivas, D. Hughes, C. Simpson, et al. "Embedded Neural Networks for Robot Autonomy". In: *Robotics Research*. Cham: Springer International Publishing, 2022, pp. 242–257. DOI: `10.1007/978-3-030-95459-8_15`

SOFTWARE

QuasiNewton Lead
A Julia package for non-convex Newton-type optimization algorithms.

PyTorch-QuadConv Co-Lead
Quadrature-based convolutions for deep learning in PyTorch.

RandNLA Lead
A Julia package for randomized numerical linear algebra.

nn4mc Co-Lead
Python and C++ packages for translating trained neural networks into C code for use in embedded systems.

PyTorch-ARC Co-Lead
A PyTorch implementation of the Adaptive Regularization with Cubics optimization algorithm.

AWARDS & CERTIFICATES

Department of Energy Computational Science Graduate Fellowship
Highly prestigious national fellowship providing four years of doctoral funding and professional development to pursue research in computational science and engineering with a focus on enabling advances for high-performance computing.

Wan Fellowship
Two-year UW Applied Math departmental fellowship. Dropped with a year remaining after receiving the DOE CSGF.

CRA Honorable Mention
2020 Computing Research Association Outstanding Undergraduate Researcher.

Solidworks Associate
Certified with a perfect score on the CSWA exam in May 2019.

Gateway to Space
Received best in option award at spring 2018 ITLL Design Expo for balloon satellite kinetic energy generation experiment.

SKILLS

Python | PyTorch | Julia | C++ | C# | C | LaTex | Linux | Git | HPC | CAD

LANGUAGES

English: Native
German: Conversational
French: Beginner

REFERENCES

Sasha Aravkin	Assistant Professor of Applied Math, UW Seattle	saravkin@uw.edu
Stephen Becker	Associate Professor of Applied Math, CU Boulder	stephen.becker@colorado.edu
Alireza Doostan	Associate Professor of Aerospace Engineering, CU Boulder	doostan@colorado.edu
Rafael Frongillo	Associate Professor of Computer Science, CU Boulder	raf@colorado.edu