

COOPER SIMPSON

Computational and Mathematical Scientist



RS-Coop



rs-coop.github.io



Google Scholar



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Boulder, CO

December 1, 2023

EDUCATION

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–Present

CU, Boulder

- Supervised by Prof. Alireza Doostan and in collaboration with Profs. Stephen Becker, John Evans, and Ken Jansen
- Investigating compression techniques, e.g. autoencoding neural networks, for large-scale scientific simulations
- Developing QuadConv, a quadrature-based convolution operator for use in deep learning on non-uniform meshes
- 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
- APPM 1350 Calculus 1 for Engineers

Fall 2021

Fall 2020

Undergraduate Course Assistant

College of Engineering

CU, Boulder

- APPM 3570 Applied Probability
- CSCI 2360 Computer Science 2: Data Structures
- CSCI 1300 Computer Science 1: Starting Computing

Fall 2019

Spring 2019

Fall 2018

PROJECTS & PUBLICATIONS

Regularized Saddle-Free Newton Master's Thesis, Independent

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>
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Quadrature-Based Convolutions CU Research

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
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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>
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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
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SOFTWARE

 **SFN** 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 methods in 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.

ACHIEVEMENTS

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

 **CRA Honorable Mention**
2020 Computing Research Association Outstanding Undergraduate Researcher.

SKILLS

Python PyTorch Julia C++ C# C LaTeX Linux Git HPC CAD

LANGUAGES

English: Native

German: Conversational

REFERENCES

Stephen Becker

Associate Professor of Applied Math, CU Boulder

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Alireza Doostan

Associate Professor of Aerospace Engineering, CU Boulder

✉ doostan@colorado.edu

Rafael Frongillo

Associate Professor of Computer Science, CU Boulder

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