# COOPER SIMPSON

**Computational and Mathematical Scientist**

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## EDUCATION

### Applied Mathematics M.S.
**University of Colorado Boulder**

2020 – 2022    GPA: 3.863

Thesis: Second-Order Optimization

### Applied Mathematics B.S.
**University of Colorado Boulder**

2017 – 2020    GPA: 3.933

Minor: Computer Science

## SKILLS

Python · PyTorch · Julia · C++
C# · C · LaTex · Linux · Git · HPC
CAD · German

## COURSES

Deep Learning · Numerical Analysis
Real Analysis · Complex Analysis
Differential Eqs. · Machine Learning
Linear Algebra · Optimization
Probability · Statistics · Algorithms
Algorithmic Economics

## SOFTWARE*

**.jl RSFN**
A Julia implementation of the second-order R-SFN optimization algorithm

**PyTorch-QuadConv**
Quadrature-based convolutions for deep learning in PyTorch

**PyTorch-ARC**
PyTorch implementation of the second-order Adaptive Regularization with Cubics optimization algorithm

## CERTIFICATIONS

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

## WORK EXPERIENCE*

### Temporary Researcher
**Aerospace Mechanics Research Center**    May 2022–Present    CU, Boulder

- Investigating large-scale compression of PDE simulation data via autoencoder neural network architectures
- Developed QuadConv, a quadrature-based convolution operator for use in deep learning on unstructured and non-uniform meshes
- Working with multiple 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

### Teaching & Course Assistantships
**College of Engineering**    Variable 2018–2021    CU, Boulder

- Ran recitations and office hours helping to teach students fundamental skills in mathematics
- Developed course material, and worked with faculty members to maintain an organized and effective teaching environment

Differential Eqs. & Linear Algebra (TA) · Calculus 1 (TA) · Applied Probability (CA)
Data Structures (CA) · Starting Computing (CA)

## PROJECTS & PUBLICATIONS*

### Regularized Saddle-Free Newton    **Master's Thesis**

Presents R-SFN: a novel second-order method for non-convex optimization. A non-linear transformation to the Hessian in Newton's method provides provable saddle-avoidance and an efficient matrix-free implementation.

- Cooper Simpson. "Regularized Saddle-Free Newton: Saddle Avoidance and Efficient Implementation". M.S. Thesis. Dept. of Applied Mathematics, CU Boulder, 2022

### Quadrature-Based Convolutions    **CU Research**

Introduces QuadConv, a quadrature-based discrete convolution operator suitable for non-uniform data. We show it can match the effectiveness of traditional discrete convolutions for autoencoder based data compression, and it can achieve similar performance when the data exists on a non-uniform mesh.

- Kevin Doherty et al. "QuadConv: Quadrature-Based Convolutions with Applications to Non-Uniform PDE Data Compression". In: *arXiv* (2022). DOI: `10.48550/ARXIV.2211.05151`

### Neural Networks for Microcontrollers    **Correll Robotics Lab**

A Python package for translating trained neural networks into C code for use in embedded systems.

- S. Aguasvivas 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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*Visit the links in the header for complete lists.