

Joseph Shenouda

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Research Interests

Deep Learning, Machine Learning, Signal Processing, Optimization

Education

University of Wisconsin-Madison (In Progress)
Ph.D. Electrical and Computer Engineering
Advisors: Kangwook Lee & Robert D. Nowak

University of Wisconsin-Madison 2023
M.S. Electrical and Computer Engineering
Advisors: Kangwook Lee & Robert D. Nowak

Rutgers University 2021
B.S. Electrical and Computer Engineering
Summa Cum Laude

Preprints

- **Vector-Valued Variation Spaces and Width Bounds for DNNs: Insights on Weight Decay Regularization**
Joseph Shenouda, Rahul Parhi, Kangwook Lee, Robert D. Nowak
arXiv
- **PathProx: A Proximal Gradient Algorithm for Weight Decay Regularized Deep Neural Networks**
Liu Yang, Jifan Zhang, Joseph Shenouda, Dimitris Papailiopoulos, Kangwook Lee, Robert D. Nowak
arXiv

Publications

- **A Representer Theorem for Vector-Valued Neural Networks: Insights on Weight Decay Regularization and Widths of DNNs**
Joseph Shenouda, Rahul Parhi, Kangwook Lee, Robert D. Nowak
ICML Duality Principles for Modern ML Workshop (2023)
- **A Continuous Transform for Localized Ridgelets**
Joseph Shenouda, Rahul Parhi, Robert D. Nowak
Sampling Theory and Applications Conference (SampTA) (2023) paper
- **A Guide to Reproducible Research in Signal Processing and Machine Learning**
Joseph Shenouda and Waheed U. Bajwa.
IEEE Signal Processing Magazine (2023) paper.
- **A Better Way to Decay: Proximal Gradient Training Algorithms for Weight Decay**
Liu Yang, Jifan Zhang, Joseph Shenouda, Dimitris Papailiopoulos, Kangwook Lee, Robert Nowak.
Neural Information Processing Systems (NeurIPS) OPT-ML Workshop (2022) paper

Research Projects

Vector-Valued Variation Spaces and Bounds on Neural Network Widths

- Characterized the kinds of functions learned by training vector-valued neural networks with weight decay.
- Via a novel reduction of the weight decay optimal solution to the multi-task lasso, we presented a principled approach to compressing deep neural networks.

A Proximal Gradient Descent Algorithm for Training Neural Networks with Weight Decay

- Developed computational experiments implementing a novel proximal gradient algorithm to accelerate weight decay regularization in neural network training.
- Provided empirical and theoretical evidence that our approach can learn neural networks that are more robust than those trained with standard weight decay.

Selected Talks

- **Vector-Valued Variation Spaces and Width Bounds for DNNs** October 2023
University of Wisconsin-Madison (MLOPT Idea Seminar)
- **A Representer Theorem for Vector-Valued Neural Networks** July 2023
ICML Duality Principles for Modern Machine Learning Workshop (Video)
- **A Continuous Transform for Localized Ridgelets** July 2023
Sampling Theory and Applications Conference (SampTA)

Experience

MIT Lincoln Laboratory: Summer Research Intern Summer 2021

- Compared graphical and deep learning methods for segmenting RF spectrograms.
- Developed and implemented modified spectral clustering algorithms on both synthetic and real RF spectrograms.
- Presented our algorithm to the technical staff, highlighting its advantages over deep learning methods.

Undergraduate Research Assistant (INSPIRE Lab) Fall 2020-Spring 2021

- Senior thesis investigating hypergraph signal processing advised by Prof. Waheed Bajwa.

Los Alamos National Laboratory: Electrical Engineer Intern Summer 2020

- Research and development of digital signal processing algorithms for X-Ray radiation detection in space, to replace current analog approaches.
- Optimized simulation scripts to decrease simulation time by 75%
- Conducted analysis to determine the best parameters for our filter to accurately measure the energy levels of the signals coming into the detector.

Undergraduate Research Assistant (INSPIRE Lab) Fall 2019-Spring 2020

- Researched reproducibility of computational experiments in signal processing and machine learning under Prof. Waheed Bajwa.
- Read through recent publications of the lab to reproduce results of computational experiments; codebases can be found at <https://github.com/INSPIRE-Lab-US>.
- Created a set of standards and best practices for the lab to ensure that all computational experiments are readily reproducible by other researchers at the time of publication.

Lockheed Martin: Software Engineering Intern Summer 2019

- Successfully implemented a new messaging interface in C++ for radar simulation software.
- Independently worked to incorporate this new protocol into an existing system while learning about new technologies such as C++, gdb and network programming.

Relevant Coursework

- High Dimensional Statistics
- Randomized Linear Algebra
- Stochastic Signals and Systems
- Convex Optimization
- Error Control Coding
- Linear Algebra
- Analysis
- Mathematical Methods of Machine Learning
- Theoretical Foundations of Large Scale Machine Learning
- Non-linear Optimization

Service

- Reviewer: JMLR, NeurIPS Optimization in Machine Learning Workshop, Asilomar Conference 2021
- Organizer for Systems Information Learning Optimization (SILO) Seminar at University of Wisconsin-Madison
- Organizer for Signal and Information Processing (SIP) Seminar at Rutgers University.

Awards and Memberships

ECE 2021 Wisconsin Distinguished Graduate Fellowship-Richardson
 JJ Slade Scholar
 Tau Beta Pi
 Recipient of the Kuhl Memorial Engineering Scholarship