Joseph D. Daws Jr.

Contact Information

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Research Interests

Numerical Analysis, Approximation Theory, Optimization,
Neural Networks, Machine Learning and Image Processing.

My research interests are informed by my passion for finding connections between challenging real-world problems and rigorous theory. I believe finding solutions rooted in theory leads to precise answers to difficult questions and understanding techniques used in practice leads to theoretical insight.

Education

University of Tennessee at Knoxville

Ph.D. in Mathematics, Expected Summer 2020
M.S. in Mathematics, Fall 2016
B.A. in Mathematics, Spring 2013

- Chancellor's honor student with high honors in general scholarship
- Minor in Chinese

Work Experience

Spring 2017 - Present	Graduate Research Assistant, Department of Mathematics with frequent collaborations at Oak Ridge National Lab
Spring 2014 - Fall 2016	Graduate Teaching Associate, Department of Mathematics
Fall 2009 - Summer 2013	Mathematics Tutor, Thornton Center

Papers Written

J. Daws, C. Webster. A Polynomial-Based Approach for Architectural Design and Learning with Deep Neural Networks. *Preprint.* arXiv:1905.10457.

J. Daws, A. Petrosyan, H. Tran and C. Webster. A Weighted ℓ_1-Minimization Approach For Sparse Wavelet Reconstruction of Signals and Images on Closed Trees. *In Preparation.*

Conference Talks

A Deep Neural Network Architecture Inspired by Polynomial Approximation, Approximation Theory 16. Minisymposium on Reduced and Parametric Methods for Function Approximations. (May 2019)

A Weighted L1-Minimization Approach For Sparse Wavelet Reconstruction of Signals and Images, SIAM CSE 2019. Minisymposium on Nonlinear Reduced Order Modeling of Realistic Engineering Fluid Flows. (February 2019)

Compressed sensing for image reconstruction using hierarchical wavelets, IMI: 9^{th} Miniconference in Computational Mathematics. (February 2018)

Relevant Skills

Coding:	C, C++, Python, Matlab, OpenMP, MPI, BLAS
Software:	LaTeX, Microsoft Office Suite, Adobe Illustrator

Honors and Awards

Winter	2018	Travel Award IMI: 9^{th} Annual Graduate Student Mini-conference in Computational Mathematics
Summer	2018	Grand Prize: Ugly Data Days Competition at Oak Ridge National Lab
Summer	2016	Advanced Short-Term Research Opportunity (ASTRO) at Oak Ridge National Lab
Since	2013	Member of Phi Beta Kappa Honor Society

Research Projects

Deep Learning Algorithms for High-dimensional, Non-linear Approximation

University of Tennessee

As part of my dissertation work I have investigated and established a relationship between neural networks and traditional approximation techniques used in mathematics. My collaborators and I are developing methods to identify how deep network architectures can be made robust to many of their well-documented shortcomings by leveraging connections to traditional approximation techniques such as polynomial approximation. Our recent work delivers an initialization for deep networks so that it behaves like a polynomial. Numerical experiments indicate that this approach produces a network which is less susceptible to overfitting of the training data.

Compressed Sensing Approaches for Image Processing

University of Tennessee and Oak Ridge National Lab

I am developing algorithms and adapting existed algorithms for applying Compressed Sensing to image processing problems such as the inpainting problem, where an image is restored from only a small percentage randomly chosen measurements, and the denoising problem where a corrected image is recovered from a noisy one.

Spectral Clustering for Analyzing Complex Data

Oak Ridge National Lab

I worked with a diverse group of researchers, including Mathematicians, Physicists, and Engineers, at the Spallation Neutron Source (SNS), a division of Oak Ridge National Lab (ORNL), to propose improvements to its design using spectral clustering. The SNS is powered by a consumable component called the target module, which wears out due to radiation damage and cavitation erosion. We applied a spectral clustering algorithm to the data collected on one of the targets to correlate beam power, measured frequencies, and the time after proton beam impact for the highest strain to occur. The goal was to discern possible changes in the target mechanical structure. The clusters did not reveal such patterns for this particular target, but we identified several ideas for moving forward, which included data processing for improving signal-to-noise ratio and machine learning with supercomputing and model optimization.

Teaching Experience

2015 -	2016	Lecturer, Statistical Reasoning
Spring	2015	Grader, Ordinary Differential Equations
2014 -	2015	Lecturer, Mathematical Reasoning
Spring	2014	Recitation Leader, Basic Calculus

Graduate Coursework

- ❑ Real Analysis
- ❑ Complex Analysis
- ❑ Optimization
- ❑ Linear Algebra
- ❑ Partial Differential Equations
- ❑ Scientific Computing
- ❑ Parallel Programming
- ❑ Probability/Limit Theorems
- ❑ Fourier Analysis
- ❑ Combinatorics