ZHAO SONG

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EDUCATION

Ph.D. in Mathematics, University at Buffalo, the State University of New York   2022
Relative courses: Intro Machine Learning, Advanced Machine Learning

M.A. in Applied Mathematics, University at Buffalo, the State University of New York   2018
Relative courses: Data-Oriented Computing, Mathematical Finance

B.S. in Information and Computing Science, Henan University of Technology, China   2015
Relative courses: Possibility Theory, Mathematical Statistics, Data Structure

EMPLOYMENT

Dartmouth College, Hanover, NH   2021- present
Research Associate B, Department of Mathematics

PUBLICATIONS

- **Song, Z.**, & Jung, J. H. (2020). The exact formula of the optimal penalty parameter value of the spectral penalty method for differential equations. *Applied Mathematics and Computation*, 381, 125313.
- **Song, Z.**, & Taylor, D. (2023). Coupling Asymmetry Optimizes Collective Dynamics over Multiplex Networks. *IEEE Transactions on Network Science and Engineering* 11 (2), 1524-1541.
- **Song, Z.**, & Taylor, D. (2024). Laplacian Spectra of Multiplex Networks with Asymmetric Coupling. To be submitted in 2024.
- Boyd, Z., Lee, E., **Song, Z.**, & Mucha, P. (2024). You Need to Explain How You Thresholded. To be submitted in 2024.

TECHNICAL SKILLS

Languages: Python, R, SQL, MATLAB, JAVA, LaTeX
Tools: Jupyter Notebook, NumPy, Pandas, Matplotlib, Scikit-learn, SciPy, TensorFlow, PyTorch

RESEARCH EXPERIENCE

Postdoctoral Research Associate, *Dartmouth College*, Hanover, NH   2021-Present
- Thresholding of Weighted Network Ensembles
  - Conducted statistical analysis and Python programming to study the correlation of two thresholding methods on a fMRI neural data;
  - Built an ensemble of networks model and concluded with criteria of negative correlation on the model.

- ➢ Social Health Impact of Network Effects (SHINE)
  - • Explored the impact of students' ego networks on the drinking behaviors of students in college groups using Python programming and Principal Component Analysis (PCA).
- ➢ Integrating Data Exchange and Analysis of Networks
  - • Developed R implementation for multilayer networks functionality in community detection.

Graduate Student Researcher, *University at Buffalo, SUNY*, Buffalo, NY   2018-2021
- ➢ Collective Dynamics over Multiplex Networks with Asymmetric Coupling
  - • Explored the nonlinear effects of asymmetric coupling on convergence rate towards a collective state of interconnected networks;
  - • Illustrated different optima and predicted the conditions for their existence utilizing Python;
  - • Highlighted optimization of coupling asymmetry and timescale balancing for the design of collective behavior over interconnected systems.
- ➢ Laplacian Spectra for Multiplex Networks with Asymmetric Coupling
  - • Investigated Laplacian spectra for multiplex networks with asymmetric coupling, employing singular perturbation theory and Python programming;
  - • Predicted the asymptotic behaviors in limits of decoupling and aggregation of network layers;
  - • Concluded by studying a multiplex model for collective decision-making by human-AI teams, predicting how coupling asymmetry can bias collective decisions.
- ➢ The Exact Formula of the Optimal Penalty Parameter
  - • Optimized penalty parameters of the spectral penalty method for differential equations using Matlab programming.

Graduate Student Coursework, *University at Buffalo, SUNY*, Buffalo, NY   2017-2020
- ➢ Machine Learning Based Breast Cancer Detection
  - • Classified fine needle aspirate (FNA) cells of a breast mass to benign or malignant employing logistic regression.
- ➢ Detection of Cell Boundary Using Deep Learning Methods
  - • Applied data augmentation (image rotation) on the Drosophila cell dataset from ISBI challenge;
  - • Employed U-Net, SegNet and Pyramid Scene Parsing Network deep learning methods to detect cell boundaries, where U-Net achieved the best performance with the precision of 0.95.
- ➢ Classification of Fashion-MNIST Clothing Images
  - • Implemented two supervised deep learning models: deep neural network and convolutional neural network to classify clothes into various categories;
  - • Performed Auto-Encoder based unsupervised cluster analysis on the task of clothes classification.
- ➢ Reinforcement Learning Based Path Planning
  - • Built a Q-Learning agent to navigate the classic 4×4 grid-world environment.
- ➢ Product Ratings and Reviews System
  - • Created a system where people can share and analyze products preferences using JAVA language code.
- ➢ Geography
  - • Wrote JAVA language code to build a graphical user interface that will allow users to interact graphically with the data by reading data from a file, and structuring and filtering them.
- ➢ The Game of TextTwist2
  - • Wrote JAVA language code of TextTwist2, the game in which you create words from the letters in a given seven-letter word, successfully running in the Eclipse software.

- ➢ Three-Box Model of Thermohaline Circulation
  - • Constructed a three-box model of thermohaline circulation and showed how the circulation pattern can vary with temperature and salinity;
  - • Used MATLAB programming to find the equilibrium states of the given dynamical system and discuss their stability.

Undergraduate Research, *Henan University of Technology*, Zhengzhou, Henan, China   2013-2015
- ➢ American Undergraduate Mathematical Modeling Competition
  Topic: We can and must stop Ebola-now
  - • Responsibility: Constructed mathematical models and wrote reports。
  - • Achievement: successful participant.
- ➢ National Undergraduate Mathematical Modeling Competition
  Topic: Innovative Folding Table Design
  - • Responsibility: Constructed mathematical models and wrote reports
  - • Achievement: Henan Provincial First Prize
- ➢ "Shenzhen Cup" Mathematics Modeling Summer Camp
  Topic: Rubbish Incineration Factory
  - • Responsibility: Constructed mathematical models
  - • Achievement: as model in campus exhibition and was highly thought of
- ➢ National Undergraduate Mathematical Modeling Competition
  Topic: Matching and Recovery of Paper Scrap
  - • Responsibility: Constructed mathematical models and wrote reports
  - • Achievement: Henan Provincial First Prize
- ➢ Campus Mathematical Modeling Competition
  - • Responsibility: Constructed mathematical models
  - • Achievement: The Third Prize in Henan University of Technology

RESEACH TALKS

➢ Networks 2021. Online		Jul 2021
Asymmetric Coupling of Networks Optimally Accelerates Collective Dynamics		
➢ Fourth Northeast Regional Conference on Complex Systems (NERCCS). Online		Apr 2021
Asymmetric Coupling of Networks Optimally Accelerates Collective Dynamics		
➢ International School and Conference on Network Science (NetSci). Rome, Italy		Sep 2020
Diffusion on Multiplex Networks with Asymmetric Coupling		
➢ Tenth International Conference on Complex Systems (ICCS). Cambridge, MA		Jul 2020
Diffusion on Multiplex Networks with Asymmetric Coupling		
➢ Third Northeast Regional Conference on Complex Systems (NERCCS). Buffalo, NY		Apr 2020
Diffusion on Multiplex Networks with Asymmetric Coupling		
➢ Second Northeast Regional Conference on Complex Systems (NERCCS). Binghamton, NY		Apr 2019
Spectrum Behavior of Laplacian for Multiplex Networks		

POSTER PRESENTATIONS

➢ SIAM Workshop on Network Science 2020 (NS20). Online   Jul 2020
Asymmetric Coupling of Layers Accelerates Diffusion on Multiplex Networks
➢ 5th Annual CDSE Days 2019. Buffalo, NY   Apr 2019
Spectrum Behavior of Laplacian for Multiplex Networks

TEACHING EXPERIENCE

Department of Mathematics, Dartmouth College

➢ MATH 3: Calculus (Instructor)   Fall 2022

Department of Mathematics, University at Buffalo

➢ MTH 142: College Calculus 2 (Teaching Assistant)   Spring 2021
➢ MTH 141: College Calculus 1 (Teaching Assistant)   Fall 2020
➢ MTH 122: Survey of Calculus and Its Applications 2 (Teaching Assistant)   Summer 2020
➢ MTH 437: Introduction to Numerical Analysis (Teaching Assistant)   Spring 2020

CERTIFICATES & HONORS

➢ Successful participant in 2015 American Undergraduate Mathematical Modeling Competition   Jun 2015
➢ National Undergraduate Mathematical Modeling Competition, Henan Provincial First Prize   Jun 2015
➢ Henan Provincial Excellent College Graduate   Apr 2015
➢ Excellent College Graduate in Henan University of Technology   Mar 2015
➢ National Encouragement scholarship during 2013 and 2014 academic year   Dec 2014
➢ Henan Provincial First Prize in 2013 Mathematical Modeling Competition   Jun 2014
➢ Excellent Class Leader in Henan University of Technology   May 2014
➢ Technological Innovation Star of Henan University of Technology   Dec 2013
➢ The Third Prize in Mathematical Modeling Competition of Henan University of Technology   Jun 2013
➢ The Third Prize in "Qinxue Cup" Mathematical Competition of Henan University of Technology   Jun 2013