ZHAO SONG

Department of Mathematics
Dartmouth College
27 N. Main Street
Hanover, NH 03755

Email: zhao.song.math@gmail.com
https://zhao-song-math.github.io/
https://www.linkedin.com/in/zhaosongmath/
https://github.com/zhao-song-math

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

RESEARCH 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