




# ZHAO SONG

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## EDUCATION

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**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

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

## PUBLICATIONS

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- **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

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Languages: Python, R, SQL, MATLAB, JAVA, L<sup>A</sup>T<sub>E</sub>X  
Tools: Jupyter Notebook, NumPy, Pandas, Matplotlib, Scikit-learn, SciPy, TensorFlow, PyTorch

## RESEARCH EXPERIENCE

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**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  $4 \times 4$  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

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- [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

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- [SIAM Workshop on Network Science 2020 \(NS20\)](#). Online Jul 2020  
Asymmetric Coupling of Layers Accelerates Diffusion on Multiplex Networks
- [5<sup>th</sup> Annual CDSE Days 2019](#). Buffalo, NY Apr 2019  
Spectrum Behavior of Laplacian for Multiplex Networks

## TEACHING EXPERIENCE

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### 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

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- 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