

Research Interests

Optimization, resource allocation, foundations of large-scale systems, machine learning, dynamical systems, game theory, computational social science, pandemic science

Publications

Learning Discrete Dynamical Systems under *Classification Noise* [pdf]

Under submission

- Authors: **Zirou Qiu**^{*}, Zakaria Mehrab^{*}, Abhijin Adiga, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We propose efficient noise-tolerant learning algorithms for learning discrete dynamical systems under classification noise.

Theoretical Foundations for Parent Divorcing Transformations in Bayesian Networks [pdf]

Under submission

- With Daniel Rosenkrantz, Madhav Marathe, and S.S. Ravi
- Summary: We establish the theoretical foundations for parent divorcing transformations and propose divorcing algorithms with provable guarantees.

Efficient PAC Learnability of Dynamical Systems Over *Multilayer Networks* [pdf]

International Conference on Machine Learning (ICML) – 2024

- Authors: **Zirou Qiu**, Abhijin Adiga, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We propose efficient PAC algorithms with provable guarantees for learning the *behavior* of dynamical systems over *multilayer* networks.

Learning the *Topology* and *Behavior* of Discrete Dynamical Systems [pdf]

AAAI Conference on Artificial Intelligence (AAAI) – 2024

(Acc rate: 23.8%)

- Authors: **Zirou Qiu**, Abhijin Adiga, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We propose rigorous methods for learning both the *topology* and *behavior* of a black-box dynamical system.

Assigning Agents to Increase Network-Based Neighborhood Diversity [pdf]

Intl. Conf. on Autonomous Agents and Multiagent Systems (AAMAS) – 2023

(Acc rate: 23.3%, Oral)

- Authors: **Zirou Qiu**, Andrew Yuan, Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We present rigorous methods to allocate public resources over networks while maintaining a social *diversity* guarantee.

Networked Anti-Coordination Games Meet Graphical Dynamical Systems: *Equilibria and Convergence* [pdf]

AAAI Conference on Artificial Intelligence (AAAI) – 2023

(Acc rate: 19.6%, Oral)

- Authors: **Zirou Qiu**, Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We provide tight analyses on the *equilibria* and *convergence* of the *anti-coordinations* games, which model strategic situations such as social competition.

Airborne disease transmission during indoor gatherings over multiple time scales: Modeling framework and policy implications [pdf]

Proceedings of the National Academy of Sciences (PNAS) – 2023

- Authors: Avinash Dixit, Baltazar Espinoza, **Zirou Qiu**, Anil Vullikanti, and Madhav Marathe.
- Summary: We propose a modeling framework that couples the *fast* dynamics of the viral load in *enclosed spaces* and the *slow* dynamics of disease progression at the population level. We derive *policy guidelines* to lessen the negative impact of epidemics.

Understanding the Co-evolution of Mask-wearing and Epidemics: A Network Perspective [pdf]

Proceedings of the National Academy of Sciences (PNAS) – 2022

- Authors: **Zirou Qiu**, Baltazar Espinoza, Vitor V. Vasconcelos, Chen Chen, Sara M. Constantino, Stefani A. Crabtree, LuoJun Yang, Anil Vullikanti, Jiangzhuo Chen, Jörgen Weibull, Kaushik Basu, Avinash Dixit, Simon Levin, Madhav Marathe.
- Summary: We present a framework that models the *dueling dynamics* of non-pharmaceutical interventions and disease on *multilayer* graphs. We then derive *policy guidelines* to suppress the ongoing epidemic and prevent its future revival.

Finding Nontrivial Minimum Fixed Points in Networked Dynamical Systems [pdf]

AAAI Conference on Artificial Intelligence (AAAI) – 2022

(Acc rate: 15%, Oral: 4.8%)

- Authors: **Zirou Qiu**, Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: We propose theoretically sound methods to find a nontrivial equilibrium in a dynamical system with the *minimum number of infected vertices*.

Efficiently Learning the Topology and Behavior of a Networked Dynamical System Via Active Queries [pdf]

International Conference on Machine Learning (ICML) – 2022

(Acc rate: 22%, Spotlight)

- Authors: Daniel Rosenkrantz,^(α - β) Abhijin Adiga, Madhav Marathe, **Zirou Qiu**, S.S. Ravi, Richard Stearns, and Anil Vullikanti.
- Summary: We introduce *active* query methods with provable guarantees to infer the network *topology* and the *behavior* of a dynamical system.

ELRUNA: Elimination Rule-based Network Alignment [pdf]

ACM Journal of Experimental Algorithmics (ACM-JEA) – 2021.

- Authors: **Zirou Qiu**, Ruslan Shaydulín, Xiaoyuan Liu, Yuri Alexeev, Christopher S. Henry, Ilya Saфро.
- Summary: We propose algorithms for the topology-based *network alignment* problem that outperforms the state-of-the-art methods.

Research Experience

University of Virginia

Graduate Research Assistant

Advisor: Prof. Madhav Marathe

Fall 2020 – Present

- Topic: Graph problems in computational social science, dynamical systems, machine learning, and pandemic science.

Clemson University

Graduate Research Assistant

Advisor: Prof. Ilya Saфро

Jan 2019 - May 2020

- Topic: Combinatorial optimization and computational biology.

Argonne National Laboratory

Graduate Research Aide

Host: Chris Henry

Summer 2019

- Topic: Combinatorial optimization and computational biology.

Education

University of Virginia

Ph.D. in Computer Science

Overall GPA: 4.0/4.0

Charlottesville, VA

Aug 2020 – Present

Clemson University

M.S. in Computer Science

Overall GPA: 3.75/4.0

Clemson, SC

Aug 2018 - May 2020

Southeast Missouri State University

B.S. in Computer Science – Dean's List, Cum Laude

Major GPA: 3.878/4.0; Overall GPA: 3.708/4.0

Cape Girardeau, MO

Aug 2013 - May 2018

Skills

Research skills: Design and analysis of algorithms; foundations of machine learning; network science; combinatorics; game theory; mathematical modeling of large socio-technical systems

Programming skills: Data science; C++; PyTorch; foundation models; Matlab; R