

Research Interests

Dynamical systems, game theory, graphs, combinatorial optimization, computational social science.

Research Experience

University of Virginia

Graduate Research Assistant

Advisor: Prof. Madhav Marathe

Fall 2020 – Present

- Main responsibilities: Research graph theoretic problems that arise in domains such as dynamical systems, game theory, and computational social science.
- Main projects: (i) Equilibria and Convergence of Dynamical Systems. (ii) Diversity Maximization in Agent Assignment. (iii) Modeling dueling dynamics on multilayer networks.

Clemson University

Graduate Research Assistant

Advisor: Prof. Ilya Safro

Jan 2019 - May 2020

- Main responsibilities: Study network science problems with a focus on network alignment problems.
- Main projects: Topology-based network alignment.

Argonne National Laboratory

Graduate Research Aide

Host: Chris Henry

Summer 2019

- Main responsibilities: Investigate topology-based network alignment problems.
- Main projects: Topology-based network alignment.

Publications

Assigning Agents to Increase Network-Based Neighborhood Diversity

International Conference on Autonomous Agents and Multiagent Systems (AAMAS) – 2023

- Authors: Zirou Qiu, Andrew Yuan, Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, and Anil Vullikanti.
- Summary: Motivated by applications such as the allocation of public housing, we study the problem of assigning a group of entities to vertices (e.g., spatial locations) of a network so that *the diversity level* is maximized. We propose assignment methods with mathematically provable performance guarantees.

Networked Anti-Coordination Games Meet Graphical Dynamical Systems: Equilibria and Convergence

AAAI Conference on Artificial Intelligence (AAAI) – 2023

- Authors: Zirou Qiu, Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, Anil Vullikanti.
- Summary: We study the anti-coordination game (in the area of game theory), that captures strategic situations such as traffic routing. To this end, we conducted a theoretical analysis of the following properties of such games: (i) the existence of equilibria and (ii) the convergence time of the dynamics.

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

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 attained over meetings in enclosed spaces and the slow dynamics of disease progression at the population level. We then derive *policy guidelines* to (i) reduce the infection rate under a certain threshold; and (ii) lessen the negative impact of epidemics.

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

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 study the dueling dynamics of mask-wearing and disease on multilayer graphs, aiming to understand their correlations. Based on the findings, we derive policy guidelines to suppress the epidemic and prevent its revival.

Finding Nontrivial Minimum Fixed Points in Networked Dynamical Systems

AAAI Conference on Artificial Intelligence (AAAI) – 2022

- Authors: [Zirou Qiu](#), Chen Chen, Madhav Marathe, S.S. Ravi, Daniel Rosenkrantz, Richard Stearns, Anil Vullikanti.
- Summary: We study the problem of finding equilibria (also called fixed points) in a dynamical system that models a coordination game. We formulate a novel optimization problem of finding an equilibrium of the system with the minimum number of active vertices, and propose theoretically sound methods to tackle the problem.

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

International Conference on Machine Learning (ICML) – 2022

- Authors: Daniel Rosenkrantz, Abhijin Adiga, Madhav Marathe, [Zirou Qiu](#), S.S. Ravi, Richard Stearns, Anil Vullikanti.
- Summary: We study the problem of inferring the network topology and the behavior of a dynamical system through active queries. We propose query strategies with provable performance guarantees.

ELRUNA: Elimination Rule-based Network Alignment

ACM Journal of Experimental Algorithmics (JEA) – 2021.

- Authors: [Zirou Qiu](#), Ruslan Shaydulín, Xiaoyuan Liu, Yuri Alexeev, Christopher S. Henry, Ilya Saфро.
- Summary: We study the network alignment problem, a classic NP-hard graph-theoretic problem. We propose a novel heuristics that outperforms the state-of-the-art methods on different graph structures.

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

Relevant Coursework for my Research

Discrete math I & II, algorithms I & II, theory of computational, probability and statistics, graph theory, combinatorial optimization, calculus I & II, linear algebra, programming languages I & II

Skills

Discrete math and algorithms, approximation methods, theorem proving, C++ programming.