

CENTER FOR
COLLECTIVE
DYNAMICS
OF COMPLEX
SYSTEMS



IT'S ALL ABOUT NETWORKS

SEE THE WORLD AS INTERCONNECTED WEBS OF AGENTS

Complex systems are networks of a large number of dynamic components, or agents, that interact with each other and evolve through self-organization. Complex systems are everywhere, ranging from gene regulatory networks in a cell to food webs in an ecosystem, and from an individual human brain to the Internet and social media, among thousands of other examples. At the Center for Collective Dynamics of Complex Systems at Binghamton University (CoCo), we study how all the different pieces of life work together and against each other, all at the same time.

OVERVIEW

The Center for Collective Dynamics of Complex Systems (CoCo) is an interdisciplinary Organized Research Center (ORC) at Binghamton University that studies structural and dynamic properties of various complex systems to obtain general, cross-disciplinary implications and applications.

CoCo's goals are to:

1. advance our understanding about the collective dynamics of physical, biological, social and engineered complex systems through scientific research,
2. promote interdisciplinary collaboration among faculty and students in different schools and departments, and
3. translate the understanding to products and processes which will improve the well-being of people at regional, state, national and global scales.

With a diverse mix of active faculty members and graduate students, CoCo officially became a University ORC in July 2015, but had informally produced new interdisciplinary research projects since 2007. Since 2018, CoCo is also a host organization of the US Northeast Chapter of the International Complex Systems Society.

RESEARCH FOCI

SOCIAL DYNAMICS

Utilizing and extending computational agent-based modeling, evolutionary theory, game theory, cognitive science/psychology, and network theory to model, analyze and design policy for social systems. Research topics include: modeling of socio-economical dynamics of the Greater Binghamton area; leadership, team performance and organizational decision making; and evolution of cooperative/competitive strategies in social systems.

NETWORK DYNAMICS

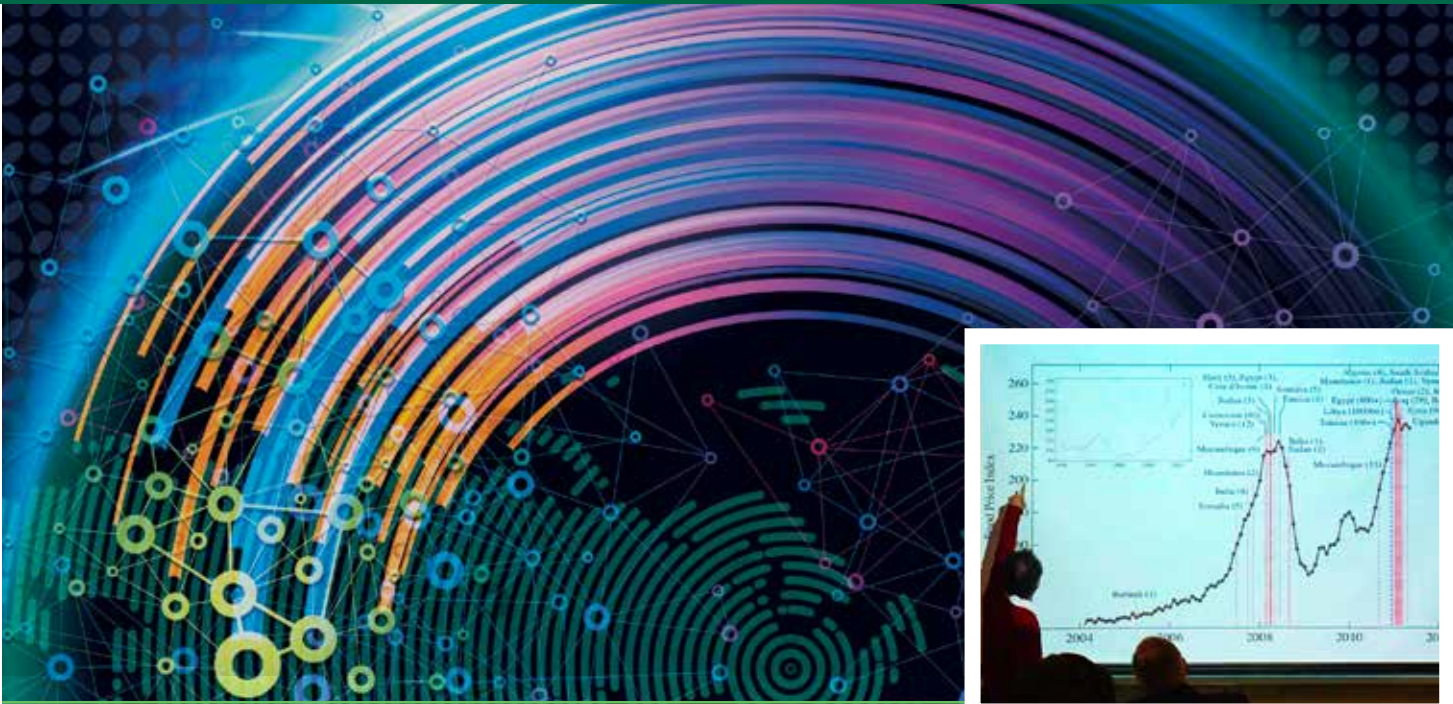
Utilizing and extending network theory to explore the connectivity between elements, growth and self-organization,

and dynamical evolution of complex networks. Research topics include: modeling power grids as multiplex networks; distributed control mechanisms for adaptive networks; and application of network analysis to psychological data.

SWARM DYNAMICS

Investigating collective behavior and pattern formation in massive populations of biological or biomimetic autonomous agents. Research topics include: theoretical investigation of morphogenetic collective systems; design and evaluation of hierarchical heterogeneous particle swarm optimization; and automated model construction of biological collectives.





NEWS HIGHLIGHTS

THE FIRST NORTHEAST REGIONAL CONFERENCE ON COMPLEX SYSTEMS—NERCCS 2018

What caused the Arab Spring? How can we slow the spread of the Ebola virus? What makes the American political system so volatile in 2018?

These questions and more were discussed at the First Northeast Regional Conference on Complex Systems (NERCCS 2018) sponsored by the Center for Collective Dynamics and Complex Systems (CoCo).

In fact, those questions were all discussed in just one keynote talk by Yaneer Bar-Yam from the New England Complex Systems Institute. Other keynote speakers asked questions about whether endothelial cells dream of eclectic shape (Katie Bentley from Boston University), if robots can be designed to work collectively (Kirstin Petersen from Cornell University), how to best combine the philosophy and science of change (Patrick Grim from Stony Brook University) and many more.

Read more: bit.ly/2VLIG2U

HIGH SCHOOLERS MENTORED BY COCO FACULTY PRESENT AT NETSCI 2017

Six students from Vestal High School (Vestal, New York) who worked with Binghamton University Associate Professor Hiroki Sayama throughout the 2016-17 academic year had the opportunity to present their work at NetSci 2017, a professional network science conference held in June in Indianapolis. They were the only high school students whose poster was accepted for presentation.

“How Behavioral Attributes Affect the Cohesiveness of Society: An Agent-Based Social Network Simulation,” was an investigation of community interaction conducted by Vestal High School seniors Evan George, Kashaf Nadeem and Sheng-Liang Slogar; and juniors Ewa Sulicz, Alexis Van Donsel and Joyce Zhu.

“This was my first venture into the world of academics and research,” says George. “It has convinced me to pursue research of some kind at college.”

Read more: bit.ly/2vPNYxU

OTHER SELECT PROJECTS

RESEARCH

- Diversity, network structure and the effectiveness of collective design and innovation
- Collective planning and leadership
- Network modeling and analysis of psychological/psychiatric data and processes
- Robustness and adaptation in morphogenetic collective systems
- Complexity measures and concept learning
- Evolutionary perspective on collective decision making
- Modeling and predicting state-topology coevolution of complex adaptive networks
- Self-organization of large-scale heterogeneous self-propelled particle swarms

EDUCATION

- Advanced Certificate Program in Complex Systems Science and Engineering (binghamton.edu/cx)
- NetSci High educational outreach program (bit.ly/2wGa1tS)



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For a full list of participating faculty members, see the CoCo website.

GET INVOLVED

Website: coco.binghamton.edu

Email list: COCO-ML@listserv.binghamton.edu

Facebook: facebook.com/BinghamtonCoCo

Twitter: [@BinghamtonCoCo](https://twitter.com/BinghamtonCoCo)

CoCo Seminar Series (vimeo.com/user4630872)

is a long-running interdisciplinary seminar series that hosts research talks on a wide variety of topics related to complex systems. Seminars are open to anyone. Contact CoCo directors if you are interested in participating and/or presenting.

BINGHAMTON UNIVERSITY AT A GLANCE

- Founded: 1946
- Highly selective, mid-size public university
- One of four research university centers within the State University of New York (SUNY) system
- Total enrollment: 17,700+
- Graduate students: 3,700+
- Academic colleges: 6
- Federally designated research centers: 4
- Master's programs: 60+
- Doctoral programs: 30+
- Accelerated degree programs: 50+
- Certificate programs: 20+
- Students of color: 29%
- International students: 16%
- Students come from all 50 U.S. states and 100+ countries

GREAT LOCATION

Located in the high-tech heart of New York state, the University sits on 930 acres in a beautiful hillside setting. Greater Binghamton is a friendly, affordable and safe community only hours from major metropolitan areas such as New York City, Boston, Philadelphia and Washington, D.C. A number of bus companies serve the area, including the Broome County Transit and Binghamton University's OCC Transport buses that offer transportation between home and campus, as well as to area businesses and downtown Binghamton free of charge.

ACADEMIC EXCELLENCE

- *U.S. News & World Report* consistently ranks Binghamton University among the top 50 public universities.
- Rated one of only 10 Best Buy public universities in the nation and a premier public university in the Northeast by *The Fiske Guide to Colleges* (2019)
- A top 25 public university in the nation for net 20-year return on investment (\$590,000 versus a \$99,444 four-year cost of attendance, based on 2016-2017 costs), according to *Money* and based on the PayScale 2018 College ROI Report
- #26 in the nation (out of 2,400 colleges and universities) for best value according to *Money* magazine's Best Colleges for your Money ranking (2018)

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