Complexity Conference

Presented by the Northwestern Institute on Complex Systems and
the Science of Networks in Communities Laboratory at Northwestern University

March 5–7, 2011

Northwestern University

Evanston, Illinois

Northwestern Institute on Complex Systems

The Northwestern Institute on Complex Systems (NICO) is a research center comprised of a distinguished and diverse group of faculty from all areas of the University, including business, education, engineering, law, medicine, natural science, and social science. NICO faculty members are committed to the further understanding of the mechanisms by which a large collection of elements, building blocks, or agents can make up a cohesive whole through interactions with each other and with their environment. A NICO focus is on systems that exhibit complexity, i.e., organization or adaptability without the employment of external organizing principles.

Our mission: To serve as a hub and facilitator for pathbreaking and relevant research in the area of complexity science transcending the boundaries of established disciplines.

Schedule

Saturday, March 5

NICO, Chambers Hall, 600 Foster Street

1 p.m. **Tutorial registration**

1:30 p.m. **Complexity Tutorial**
P. J. Lamberson, visiting scholar, J .L. Kellogg School of Management, and senior lecturer, Massachusetts Institute of Technology Sloan School of Management

Sunday, March 6

Allen Center, 2169 Campus Drive

Noon **Registration**

1 p.m. **Welcome**
Sally E. Blount, dean, Kellogg School of Management
Kevin Lynch, codirector, NICO
Brian Uzzi, codirector, NICO
Noshir Contractor, director, Science of Networks in Communities Laboratory

1:20 p.m. **Finding Structure in Social and Biological Networks**
Mark Newman

2:10 p.m. **Social Interactions and Influence Mediated by ICT**
Felix Reed-Tsochas

3 p.m. **Break**

3:30 p.m. **Thinking in a Complex World: The Nexus of Art, Technology, and Science**
Julio Ottino

4:20 p.m. **Break and poster session**

5:30 p.m. **Human Dynamics: From Human Mobility to Predictability**
Albert-László Barabási

6:30 p.m. **Conference banquet**

Monday, March 7

Allen Center, 2169 Campus Drive

8 a.m. **Registration**

8:30 a.m. **An Open Elite? The Dynamics of Collaboration in the Life Sciences, 1988–2004**
Walter W. Powell

9:20 a.m. **Structural Holes in Virtual Worlds**
Ronald S. Burt

10:10 a.m. **Break**

10:40 a.m. **Network Synchronization in a Noisy Environment with Time Delays: Fundamental Limits and Trade-Offs**
Boleslaw K. Szymanski

11:30 a.m. **Network Science: Some History, Some Perspectives (and Some Comments on Data Mining)**
Stanley Wasserman

12:20 p.m. **Lunch**

1:30 p.m. **The Web as a Decentralized System**
Tim Berners-Lee

2:20 p.m. **Networked Governance**
Beth Simone Noveck

3:10 p.m. **Break**

3:40 p.m. **Network Cartography as a Tool for Hypothesis Generation**
Luís A. Nunes Amaral

4:30 p.m. **Using the Web to Do Social Science**
Duncan Watts

5:20 p.m. **Concluding remarks**

Abstracts

Luís A. Nunes Amaral

Network Cartography as a Tool for Hypothesis Generation

The cartographic approach enables researchers to extract the most significant information, at a given scale, within complex biological networks. The cartographic approach is based upon two crucial assumptions. The first assumption is that the nodes in a network can be grouped into modules. The modules are analogous, in the cartographic picture, to regions or neighborhoods and enable a coarse-grained, and thus simplified, description of the network. The second assumption is that one can classify the nodes within a network into a small number of system-independent "universal roles." This presentation's algorithm for classifying nodes into roles rests on the expectation that the nodes in a network are connected according to the role they fulfill. By developing network visualization methods grounded on the cartographic representation, complex networks can be investigated with a novel viewpoint that is enabling the development of novel biological hypotheses.

Albert-László Barabási

Human Dynamics: From Human Mobility to Predictability

A range of applications, from predicting the spread of human and electronic viruses to city planning and resource management in mobile communications, depend on our ability to understand human activity patterns. This presentation will discuss recent efforts to explore human activity patterns, using the mobility of individuals as a proxy. As an application, it will be shown that by measuring the entropy of each individual's trajectory, the underlying predictability of human mobility can be explored, raising fundamental questions on how predictable we really are.

Tim Berners-Lee

The Web as a Decentralized System

The web works because it is a decentralized system. It is threatened when someone tries to centralize it. This presentation takes a look at the history of the web and the hopes for its future in the context of new developments in technology and social networking.

Ronald S. Burt

Structural Holes in Virtual Worlds

This presentation is about the validity of virtual worlds as a place to study network effects relevant to the real world. Virtual worlds offer good-quality, time-stamped, microlevel data on social networks in large, heterogeneous populations. Models can be formulated and tested with a precision impossible to match with standard sociometric survey methods. However, a preliminary question has to be answered before the research potential of virtual worlds can be harvested: Are virtual worlds a new context for familiar social processes or merely an odd context in which social processes play out in ways that do not generalize to the real world? It will be shown that two foundational network effects play out in a familiar way in at least one of the largest virtual worlds. The virtual world is Second Life. The two network effects are achievement increasing with network brokerage and trust increasing with network closure. As expected from previous theory and research in the real world, relations embedded in closed networks within Second Life are more likely to be close, trusting relationships, and network brokers in Second Life are more likely to be the leaders who provide social infrastructure that makes the virtual world valuable and attractive. Brokers were more likely to found groups, both invitation-only groups and groups open to the public. The groups they founded were more likely to survive and attract more people as members. The results are construct-validity evidence that it would be reasonable to use the rich network data available in virtual worlds to better understand networks in the real world.

Mark Newman

Finding Structure in Social and Biological Networks

Many systems of scientific interest take the form of networks, including social networks, the Internet, the World Wide Web, citation networks, metabolic networks, food webs, and others. Good data describing the patterns of connections in many networks are now becoming available, and a fundamental challenge facing us is how to understand the structure of these connections. Typical questions we would like answered are: What is the large-scale structure of a network? What parts does it have? Do the parts break into smaller parts? How do these things relate to the functions of the network? This presentation will describe some new methods, combining ideas from physics, machine learning, and statistics, that allow us to extract new knowledge from networks and a range of examples of their application to networks from different fields of study.

Beth Simone Noveck

Networked Governance

Networks offer the potential to transform citizens into citizen governors, producing greater accountability and more effective institutions. Key features of networks make it possible to design government that is both smaller and smarter without the need for new legislation or new budgets and enable us to move beyond antiquated modes of democratic thought and practice. This presentation will explore the effects and the effectiveness of networked governance.

Julio Ottino

Thinking in a Complex World: The Nexus of Art, Technology, and Science

Connectivity is changing all the rules. Complexity is the rule and creativity is the safeguard. Things that were disjointed combine, leading to spectacular new results. Science merges with technology and new disciplines appear, technologies combine with other technologies, services merge with technologies, and services combine with other services. Thinking is augmented in new ways; technology serving art and contemporary art showing the world under new, sometimes unrecognizable, light. How do we develop people who are comfortable bridging and blurring these domains? This presentation will focus on the evolution and lessons that may be transferred across art, science, and technology.

Walter W. Powell

An Open Elite? The Dynamics of Collaboration in the Life Sciences, 1988–2004

Most explanations for industrial and technological change paint organizations as pliant in response to exogenous shocks, which radiate outward like a tsunami. Whether in the form of a technological discontinuity or political events that disrupt the balance of power, external crises are purported to produce unsettled times, rendering extant routines brittle and opening up a window for change. Unfortunately, such punctuated accounts say little about which organizations are poised for change or best able to exploit new opportunities. Why do some organizations survive or even prosper through periods of ferment, whereas others are rendered obsolete or trapped in the dilemma of trying to adapt to a new era with outdated tools? This presentation's answer to these questions rests on the idea that the organizing principles of complex adaptive systems are encoded in their network topologies. Mapping the dynamics of affiliation among members of the life science community over 17 years shows how logics of attachment switch and diverse influences are felt by participants at different points in time. This approach allows us to see social change not as an invariant process that affects all parties equally but as reverberations felt differently, dependent on an organization's position and status in an evolving network. The approach illuminates how patterns of interaction emerge, take root, and evolve with divergent ramifications for the participants.

Felix Reed-Tsochas

Social Interactions and Influence Mediated by ICT

This overview presents some of the initial findings of the ICTeCollective project, which focuses on complex social systems where interactions between individuals are mediated by information and communication technology (ICT). The first example considers social-influence processes and the adoption of innovations in

an online environment, based on tracking the spread of Facebook applications. Unlike work on innovation diffusion in the offline world, this work allows observation of how successful and unsuccessful applications spread among the entire population of potential adopters. Temporal fluctuation scaling is used to identify two distinct regimes of behavior, where the actions of different users are either strongly correlated or entirely uncorrelated. A further example considers whether cognitive constraints that are believed to limit the size of different types of social ties (e.g., Dunbar's number) are reflected in empirically observed communication patterns for a group where social relationships are in flux.

Boleslaw K. Szymanski

Network Synchronization in a Noisy Environment with Time Delays: Fundamental Limits and Trade-Offs

This presentation examines the effects of nonzero time delays in stochastic synchronization with linear couplings in an arbitrary network. Using the known exact threshold value from the theory of differential equations with delays, the synchronizability threshold for an arbitrary network is established. Scaling the underlying fluctuations is used to derive the absolute limit of synchronization efficiency in a noisy environment with uniform time delays, i.e., the minimum attainable width of the synchronization landscape. In case of synchronization between two nodes, two types of delays are considered: transmission delays between interacting elements and processing, cognitive, or execution delays at each element. In this case, the scaling theory is established for the phase boundary of synchronization and for the steady-state fluctuations in the synchronizable regime. Finally, the asymptotic behavior near the boundary of the synchronizable regime is provided. The results imply the potential for optimization and trade-offs in synchronization problems with time delays.

Stanley Wasserman

Network Science: Some History, Some Perspectives (and Some Comments on Data Mining)

Data mining of network data often focuses on classification methods from machine learning, statistics, and pattern recognition perspectives. These techniques have been described by many, but many of these researchers are unaware of the rich history of classification and clustering techniques originating in social network analysis. The growth of rich social media, online communities, and collectively produced knowledge resources has greatly increased the need for good analytic techniques for social networks. We now have the opportunity to analyze social network data at unprecedented levels of scale and temporal resolution; this has led to a growing body of research at the intersection of the computing sciences, statistics, and the social and behavioral sciences. This presentation will note some of the current challenges in the analysis of large-scale social network data, focusing on the inference of social processes from data. The invasion of network science by computer scientists has produced much interesting research — both good and bad. A discussion of the history of network science will be followed by a review of a new, attractive, statistical framework for network analysis.

Duncan Watts

Using the Web to Do Social Science

Social science is often concerned with the emergence of collective behavior out of the interactions of large numbers of individuals, but in this regard it has long suffered from a severe measurement problem — namely, that interactions between people are hard to observe, especially at scale, over time, and at the same time as observing behavior. This presentation will argue that the technological revolution of the Internet is beginning to lift this constraint. Illustrations will include several examples of Internet-based research that would have been impractical to perform until recently and that shed light on some long-standing sociological questions. Although Internet-based research still faces serious methodological and procedural obstacles, the ability to study truly "social" dynamics at individual-level resolution can have dramatic consequences for social science.

Presenters

Luís A. Nunes Amaral is professor of chemical and biological engineering in the McCormick School of Engineering and Applied Science at Northwestern University. Amaral conducts and directs research that provides insight into the emergence, evolution, and stability of complex systems. This research — featured in numerous media sources both in the United States and abroad — aims to address some of the most pressing challenges facing human societies and the world's ecosystems, including the mitigation of errors in health care settings, the characterization of conditions fostering innovation and creativity, and the growth limits imposed by sustainability. Recipient of a CAREER award from the National Institutes of Health, Amaral was named to the 2006 class of Distinguished Young Scholars in Medical Research by the Keck Foundation and has been selected as an Earlier Career Scientist by the Howard Hughes Medical Institute.

Albert-László Barabási is a Distinguished University Professor at Northeastern University, where he directs the Center for Complex Network Research and holds appointments in the Departments of Physics, Computer Science, and Biology. Also a member of the Center for Cancer Systems Biology at the Dana Farber Cancer Institute, he holds additional appointments in the Department of Medicine of Harvard Medical School and Brigham and Women's Hospital. Previously he was Emil T. Hofman Professor at the University of Notre Dame. His books include *Bursts: The Hidden Pattern Behind Everything We Do* (Dutton, 2010), available in five languages; *Linked: The New Science of Networks* (Perseus, 2002), available in eleven languages; as coauthor, *Fractal Concepts in Surface Growth* (Cambridge, 1995); and as coeditor, *The Structure and Dynamics of Networks* (Princeton, 2005). His work led to the discovery of scale-free networks in 1999 and to the Barabási-Albert model for explaining their widespread emergence in natural, technological, and social systems. Barabási's research on complex networks has been widely featured in the media, including coverage in *Nature, Science, Science News,* the *New York Times, USA Today,* the *Washington Post, American Scientist, Discover, Business Week, Die Zeit, El Pais, Le Monde,* London's *Daily Telegraph, National Geographic,* the *Chronicle of Higher Education, New Scientist,* and *La Republica,* as well as on BBC Radio, National Public Radio, CBS, ABC, CNN, and NBC. A fellow of the American Physical Society and an elected member of the Hungarian Academy of Sciences and the Academia Europaea, Barabási was awarded the Federation of European Biochemical Societies' Anniversary Prize for Systems Biology, the John von Neumann Computer Society's John von Neumann Medal, the NEC C&C Foundation's C&C Prize, and the National Academy of Sciences' Cozzarelli Prize. He holds a PhD from Boston University.

Tim Berners-Lee is the 3Com Founders Professor of Engineering in the School of Engineering with a joint appointment in the Department of Electrical Engineering and Computer Science at the Laboratory for Computer Science and Artificial Intelligence at the Massachusetts Institute of Technology, where he also heads the Decentralized Information Group. He is also a professor in the School of Electronics and Computer Science at the United Kingdom's University of Southampton. A graduate of the University of Oxford, Berners-Lee invented the World Wide Web, an Internet-based hypermedia initiative for global information sharing, in 1989 while at CERN, the European Particle Physics Laboratory; his specifications of URLs, HTTP, and HTML were refined as web technology spread. Berners-Lee is the director of the World Wide Web Consortium (W3C), a founding director of the Web Science Trust, and a director of the

World Wide Web Foundation. Named a fellow of the Royal Society in 2001, he is the recipient of the Japan Prize, the Prince of Asturias Foundation Prize, the Millennium Technology Prize, and Germany's Die Quadriga award. Berners-Lee was knighted by Queen Elizabeth II in 2004 and awarded the Order of Merit in 2007. In 2009 he was elected a foreign associate of the National Academy of Sciences. He is the author of *Weaving the Web* (Harper, 2000).

Ronald S. Burt is the Hobart W. Williams Professor of Sociology and Strategy in the Booth School of Business at the University of Chicago, where he earned his PhD. Previously he served on the faculties of Columbia University and the University of California, Berkeley. Burt's research focuses on how networks create advantage for organizations and individuals. He took a leave in 1999 to study European business as the Shell Professor of Human Resources at INSEAD, then a second leave in 2000 to explore practical implementation as the vice president of strategic learning for Raytheon Company. Burt's three most recent books are *Structural Holes: The Social Structure of Competition* (Harvard, 1992), introducing the concept of structural holes; *Brokerage and Closure: An Introduction to Social Capital* (Oxford, 2005), a broad review linking network structure with performance; and *Neighbor Networks: Competitive Advantage Local and Personal* (Oxford, 2010), which presents argument and evidence on the social psychology of network advantage.

Mark Newman is Paul Dirac Collegiate Professor of Physics and professor in the Center for the Study of Complex Systems at the University of Michigan. Previously he served on the staff of the Santa Fe Institute. His research centers on social and information networks and on methods for making sense of the vast amounts of data about these networks that are now becoming available. Newman received a PhD in physics from the University of Oxford and conducted postdoctoral research at Cornell University.

Beth Simone Noveck is a professor of law at New York Law School. She served in the White House as the nation's first deputy chief technology officer and leader of the White House Open Government Initiative, and with New York Law School students she designed and built the US government's first expert network. Founder of the Democracy Design Workshop, Noveck also developed Democracy Island and the Cairns Project and is spearheading the development of ORGPedia, a platform for public corporate accountability data and for organizational evolution tracking. The John D. and Catherine T. MacArthur Foundation has awarded Noveck a grant to develop a multiyear interdisciplinary research agenda on the impact of digital networks on institutions and on use of that technology to strengthen democratic culture. Named one of the "Hundred Most Creative People in Business" by *Fast Company* magazine and one of the "Top Five Game Changers" by *Politico,* she is coeditor of *The State of Play: Law, Games, and Virtual Worlds* (NYU, 2006) and author of *Wiki Government: How Technology Can Make Government Better, Democracy Stronger, and Citizens More Powerful* (Brookings Institution, 2009), which will appear this year in an audio edition and in Arabic and Chinese. Noveck earned a PhD as a Fulbright Scholar at the University of Innsbruck and a JD from Yale Law School.

Julio Ottino is the dean of McCormick School of Engineering and Applied Science at Northwestern University, where he is also Robert McCormick Institute Professor, Walter P. Murphy Professor, and professor of chemical

and biological engineering and of mechanical engineering. His research focuses on complex systems and nonlinear dynamics. A member of the National Academy of Engineering and the American Academy of Arts and Sciences, he was named one of the "One Hundred Engineers of the Modern Era" by the American Institute of Chemical Engineers and was selected to give its 62nd Institute Lecture. Ottino is also a painter and is working on a book about the creative processes connecting art, technology, and science. He holds a PhD from the University of Minnesota.

Walter W. Powell is professor of education, sociology, organizational behavior, management science and engineering, public policy, and communication at Stanford University and an external faculty member at the Santa Fe Institute. Previously he taught at Yale University, the Massachusetts Institute of Technology, and the University of Arizona. Powell works in the areas of organization theory, economic sociology, and the sociology of science. His interests focus on the processes through which knowledge is transferred across organizations and the role of networks in facilitating or hindering innovation and of institutions in codifying ideas. Winner of the Max Weber Prize and cowinner of the Viviana Zelizer Prize for best papers, he was also recognized as coauthor of *Administrative Science Quarterly*'s most influential 2002 publication, and he coauthored a 1983 paper that is the most cited article in the history of the *American Sociological Review.* Powell is the sole or joint author or editor of *The Culture and Commerce of Publishing* (Basic Books, 1982), *Getting into Print: The Decision-Making Process in Scholarly Publishing* (University of Chicago, 1985), *The New Institutionalism in Organizational Analysis* (University of Chicago, 1991), *Private Action and the Public Good* (Yale, 1997), *The Nonprofit Sector* (Yale, 2006), and the recently completed *The Emergence of Organizations and Markets.*

A foreign member of the Swedish Royal Academy of Science, Powell received his PhD from Stony Brook University, State University of New York, and holds honorary degrees from Uppsala University, Copenhagen Business School, and the Helsinki School of Economics.

Felix Reed-Tsochas is the James Martin Lecturer in Complex Systems at the Institute for Science, Innovation, and Society at the University of Oxford, where he is a codirector of the CABDyN Complexity Centre. His original research background is in theoretical condensed matter physics, and he currently works on the dynamic and functional properties of complex networks in a variety of contexts. Recent examples include the evolution of supplier networks in manufacturing industries, secondary extinctions in food webs, mutualistic and host-parasitoid networks, online social networks, social group structure and mobile communications, and the impact of social structure on group loans in microfinance. Reed-Tsochas holds a PhD from the University of Cambridge.

Boleslaw K. Szymanski is the Claire and Roland Schmitt Distinguished Professor and the director of the Army Research Laboratory Social and Cognitive Networks Academic Research Center at the Rensselaer Polytechnic Institute. His research focuses on computer networks and technology-based social networks. Winner of the British Computer Society's Wilkes Medal, he was a national lecturer for the Association for Computing Machinery and has published more than 300 scientific articles. Szymanski is a foreign member of the National Academy of Science in Poland and a fellow of IEEE. He received his PhD from Poland's National Academy of Sciences.

Stanley Wasserman is the Rudy Professor of Psychological and Brain Sciences and of Statistics in the Departments of Sociology and Psychology at Indiana University Bloomington, where he helped create the new Department of Statistics and became its first chair. Previously he held faculty positions at Carnegie Mellon University, the University of Minnesota, and the University of Illinois, where he was also a part-time faculty member in the Beckman Institute of Advanced Science and Technology. Wasserman has held visiting appointments at Columbia University and the University of Melbourne. Best known for his work on statistical models for social networks, he has published widely in sociology, psychology, and statistics journals and has been elected to a variety of leadership positions in the Classification Society of North America and the American Statistical Association. His books have been published by Sage Publications and Cambridge University Press. A fellow of the Royal Statistical Society and an honorary fellow of the American Statistical Association and the American Association for the Advancement of Science, Wasserman has served as book review editor of *Chance* and as an associate editor of *Psychometrika,* the *Journal of the American Statistical Association, Sociological Methodology,* and other statistics and methodological journals. His research has been supported over the years by the National Science Foundation, the Office of Naval Research, the Army Research Laboratory, and the National Institute of Mental Health. Wasserman was also chief scientist of Visible Path Corporation, a California software firm developing social network analysis for corporate settings. He holds a PhD from Harvard University.

Duncan Watts is a principal research scientist at Yahoo! Research, where he directs the human social dynamics group. Previously he was a professor of sociology at Columbia University, where he taught from 2000 to 2007. He has also served on the external faculties of the Santa Fe Institute and of Nuffield College at the University of Oxford. His research on social networks and collective dynamics has appeared in a wide range of journals, from *Nature, Science,* and *Physical Review Letters* to the *American Journal of Sociology.* Watts is the author of *Six Degrees: The Science of a Connected Age* (Norton, 2003) and the forthcoming *Everything is Obvious (Once You Know the Answer)* (Crown Business, 2011). He holds a PhD from Cornell University.

Poster Presentations

Fundamentals

Eyjafjallajökull and 9/11: The Impact of Large-Scale Disasters
Olivia Woolley Meza, Christian Thiemann, Daniel Grady, and Dirk Brockmann
Northwestern University and Max Planck Institute for Dynamics and Self-Organization

Interactive Network Exploration using Shortest-Path-Tree Tomography
Christian Thiemann and Dirk Brockmann
Northwestern University and Max Planck Institute for Dynamics and Self-Organization

Backbones and Borders from Shortest Path Trees
Daniel Grady, Christian Thiemann, and Dirk Brockmann
Northwestern University and Max Planck Institute for Dynamics and Self-Organization

Handle with Care: Robustness of Interorganizational Networks to Bridge Decay
Adam Tatarynowicz and **Maxim Sytch**
Tilburg University and University of Michigan

Long Division Unites – Long Union Divides: A Model for Cultural Evolution
J. Jiang, R. Wang, Michel Pezeril, and Q. A. Wang
Institute Superior des Materiaux et Mecaniques Avances, Hua-Zhong Normal University, Université du Maine, and Huajiao University

A Characterization of the Equilibrium of Threshold Models of Collective Behavior
J. Tipan Verella and Stephen D. Patek
University of Virginia

Naïve Network Polarization Model
Jules Ottino-Loffler and Forrest Stonedahl
Northwestern University

Social Networks

Social Networks and Organizational Citizenship: School Chums and Donations to an Alma Mater
Mark T. Rivera, Helena Buhr, and Brian Uzzi
Northwestern University and Google Inc.

Birth of Knowledge Broker: Brokering Design Practices throughout a Firm
Elizabeth Gerber
Northwestern University

The Organizational Limits of Space: Spatial Networks' Effects on Social Network Formation
Johan S.G. Chu, **Natalie C. Cotton,** and Felichism Kabo
University of Michigan

Audience Fragmentation and Polarization of Television Consumption from a Network Analytic Perspective
Su Jung Kim
Northwestern University

Overcoming Differences: Activities and Diversity in a Social Network
Mark T. Rivera, **Helena Buhr,** and Brian Uzzi
Northwestern University and Google, Inc.

Tracking Communities in Dynamic Social Networks
Kevin S. Xu, Mark Kliger, and Alfred O. Hero
University of Michigan

Diffusion and Contagion

What Is the Front Velocity in Wave Propagation without Fronts? – Epidemics on Complex Networks Provide an Answer
Rafael Brune, Christian Thiemann, and Dirk Brockmann
Northwestern University and Max Planck Institute for Dynamics and Self-Organization

Computational Aspects of Complex Contagions in Real Networks
Chris J. Kuhlman, V. S. Anil Kumar, Madhav V. Marathe, S. S. Ravi, and Daniel J. Rosenkrantz
Virginia Tech, and University at Albany – SUNY

Differences in the Mechanics of Information Diffusion across Topics: Idioms, Political Hashtags, and Complex Contagion on Twitter
Daniel M. Romero, Brendan Meeder and Jon Kleinberg
Cornell University and Carnegie Mellon University

Anomalous Transport along River Networks
Antoine F. Aubeneau, Jennifer D. Drummond, and Aaron I. Packman
Northwestern University

Complex Interactions of Topographic Scales Affecting Hyporheic Exchange in Fluvial Systems
Susa Stonedahl, Judson Harvey, and Aaron I. Packman
Northwestern University and US Geological Survey

Agent-Based Systems

An Agent-based Social Network Model of the Spread of Obesity
Jun Zhang, Liping Tong, P. J. Lamberson, David Steh, Amy Luke, and David A. Shoham
Loyola University, Old Dominion University, and Massachusetts Institute of Technology

Willing to Learn but Ready to Move – An Extension of Schelling's Model
Bruno Abrahao, Zhiyuan Song, and **Bogdan State**
Cornell University and Stanford University

Agent-based Description of the Homogeneous Assumption
Michael Busch and Jeff Moehlis
University of California

Experiments in Emergent Behavior in Multi-Agent Robotic Systems
Michael Hwang, **Matthew L. Elwin**, Peng Yang, Randy A. Freeman, and Kevin M. Lynch
Northwestern University

Evolutionary Robustness Checking in the Artificial Anasazi Model
Forrest Stonedahl and Uri Wilensky
Northwestern University

Biology

A Physically Grounded Approach for Estimating Gene Expression from Microarray Data
Patrick D. McMullen, Richard I. Morimoto, and Luis A. N. Amaral
Howard Hughes Medical Institute and Northwestern University

The Multi-scale Behavior of the C. Elegans Reproductive System during Chronic Heat Stress
Patrick D. McMullen, **Peter B. Winter**, Erin Z. Aprison, Luis A. Nunes Amaral, Richard Morimoto, and Ilya Ruvinsky
Northwestern University and University of Chicago

What Is Causing Corneal Epithelial Cells to Spiral?
Jerry Rhee, Talisa Mohammad Nejad, Dipika Gongal, Craig Foster, and Phillip Iannaccone
Children's Memorial Research Center and University of Illinois at Chicago

Building Models for the Evolution and Development of Brain Networks from Anatomical Data
Diarmuid J. Cahalane, Olaf Sporns, and Barbara L. Finlay
Cornell University and Indiana University

Debugging Biology Detecting Evolutionary Changes in Metabolic Networks
Adam R. Pah and Luis A. N. Amaral
Northwestern University and Howard Hughes Medical Institute

Identification and Classification of Functional Modules in the Brain
Jane X. Wang, Daniel W. McClary, Luis A. Nunes Amaral, and James R. Booth
Northwestern University and Howard Hughes Medical Institute

Physiological Network Structure Predication in Sleep Disordered Breathing
Jonathan Waxman, Mayank Lahiri, Tanya Berger-Wolf, Matas Morkevicius, Natasha Garg, and David Carley
University of Illinois at Chicago

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