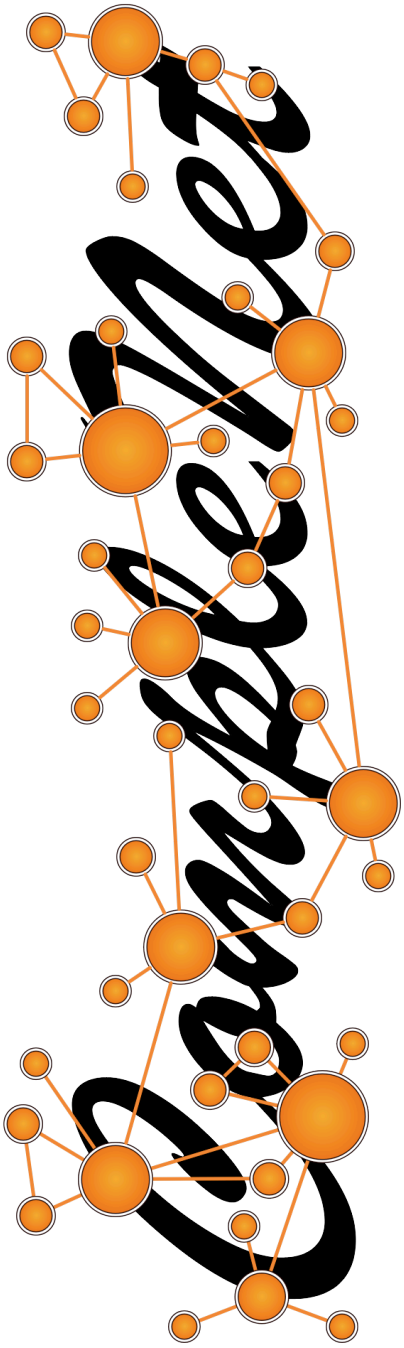

THE 2012 INTERNATIONAL WORKSHOP ON COMPLEX NETWORKS

Melbourne, Florida, USA
March 7-9, 2012

FINAL PROGRAM

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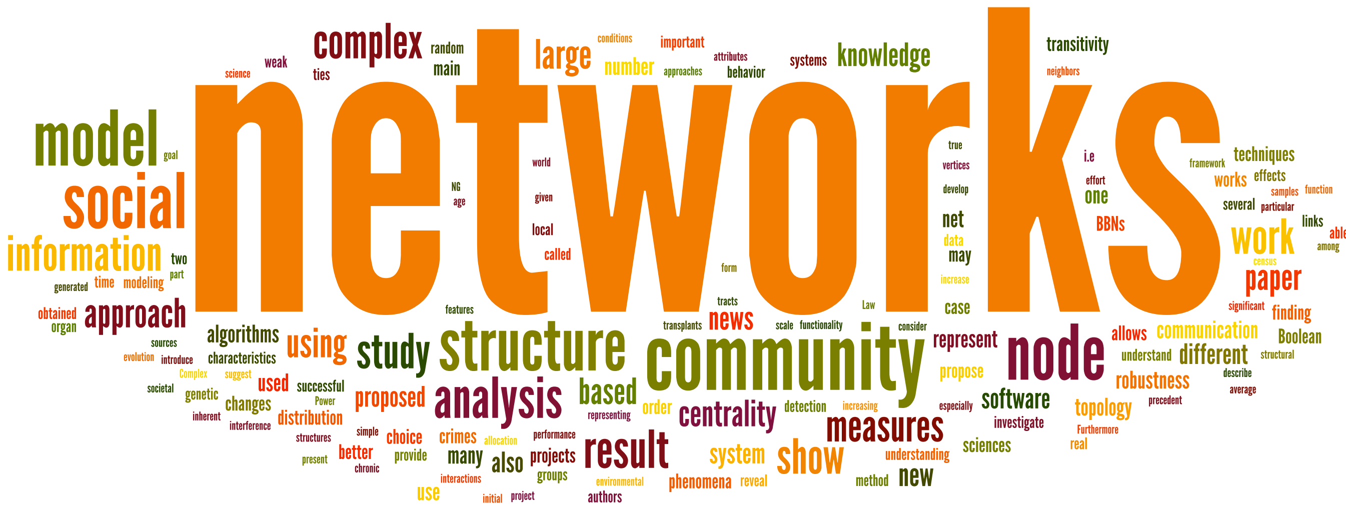
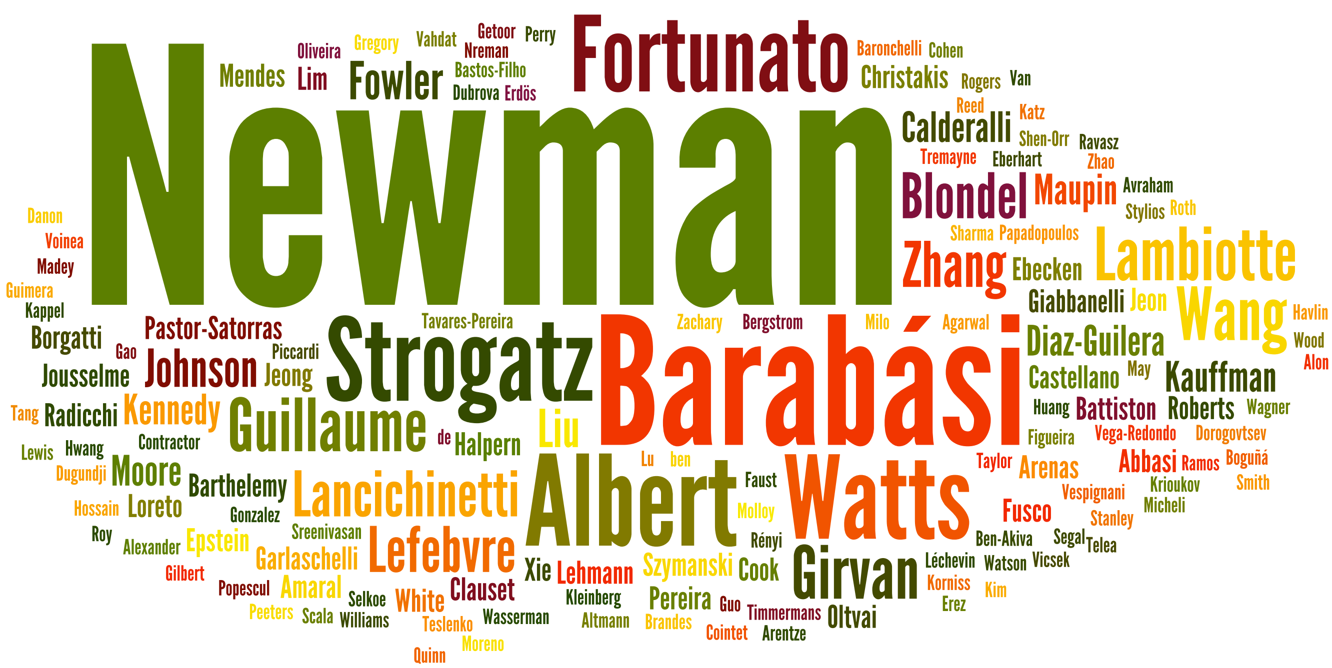
Abstracts of All Contributions

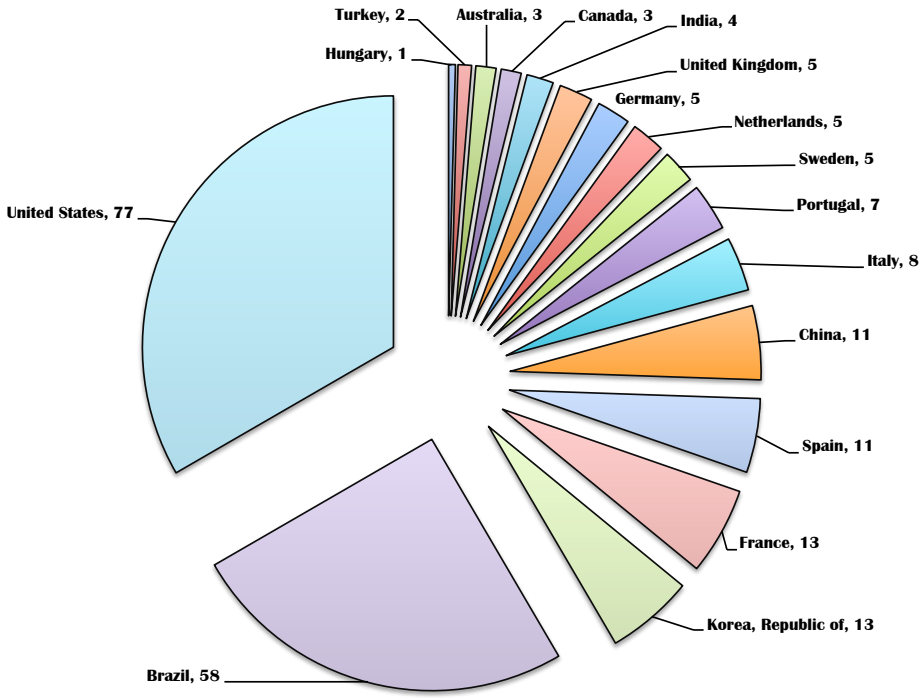


Citations of All Works

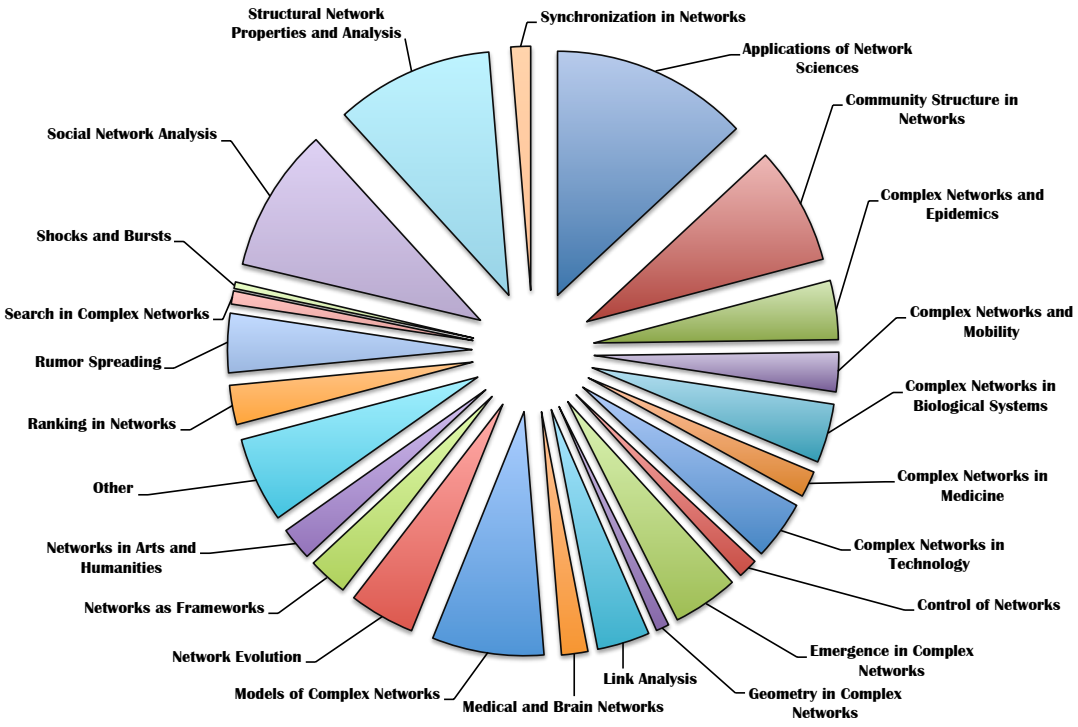


NUMBERS

Authors per Country



Contributions per Topic



KEYNOTE SPEAKERS' BIOS

ALBERT-LÁSZLÓ BARABÁSI

Center for Complex Network Research, Northeastern University

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, as well as in the Department of Medicine, Harvard Medical School and Brigham and Women Hospital, and is a member of the Center for Cancer Systems Biology at Dana Farber Cancer Institute. A Hungarian born native of Transylvania, Romania, he received his Masters in Theoretical Physics at the Eötvös University in Budapest, Hungary and was awarded a Ph.D. three years later at Boston University. After a year at the IBM T.J. Watson Research Center, he joined Notre Dame as an Assistant Professor, and in 2001 was promoted to the Professor and the Emil T. Hofman Chair. Barabási recently released on April 29th his newest book "Bursts: The Hidden Pattern Behind Everything We Do" (Dutton, 2010) available in five languages. He has also authored "Linked: The New Science of Networks" (Perseus, 2002), currently available in eleven languages, is co-author of "Fractal Concepts in Surface Growth" (Cambridge, 1995), and the co-editor of "The Structure and Dynamics of Networks" (Princeton, 2005). His work lead to the discovery of scale-free networks in 1999, and proposed the Barabási-Albert model to explain their widespread emergence in natural, technological and social systems, from the cellular telephone to the WWW or online communities. His work on complex networks have been widely featured in the media, including the cover of Nature, Science News and many other journals, and written about in Science, Science News, New York Times, USA Today, 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, among others. He has been interviewed by BBC Radio, National Public Radio, CBS and ABC News, CNN, NBC, and many other media outlets.

SINAN ARAL

Leonard N. Stern School of Business
Kaufman Management Center

Sinan Aral is an Assistant Professor and Microsoft Faculty Fellow at the NYU Stern School of Business. His research focuses on social contagion and measuring and managing how information diffusion in massive social networks affects information worker productivity, consumer demand and viral marketing. This research has won numerous awards including the Microsoft Faculty Fellowship (2010), the PopTech Science and Public Leaders Fellowship (2010), an NSF Early Career Development (CAREER) Award (2009), the Best Overall Paper Award at the International Conference on Information Systems (ICIS) (in both 2006 and 2008), the ICIS Best Paper in IT Economics Award (2006), the ICIS Best Paper in IT Business Value Research Award (2006), the ACM SIGMIS Best Dissertation Award (2007), and the IBM Faculty Award (2009). Sinan has been a Fulbright Scholar, serves as Chief Scientist of SocialAmp, a social commerce company that enables targeting and peer referral in social media networks, and is currently an organizer of the Workshop on Information in Networks (WIN): http://www.winworkshop.net. His work has been published in leading journals such as the American Journal of Sociology, IEEE Intelligent Systems, Information Systems Research, Management Science, Marketing Science, the Proceedings of the National Academy of Sciences (PNAS), Science, Organization Science, the Harvard Business Review and the Sloan Management Review, and been mentioned in popular press outlets such as the Economist, the New York Times, Businessweek, Wired and CIO Magazine. Sinan is a Phi Beta Kappa graduate of Northwestern University and holds masters degrees from the London School of Economics and Harvard University. He received his PhD from MIT.

ROBERT BONNEAU

Air Force Office of Scientific Research

Robert Bonneau is a Program Manager at the Air Force Office of Scientific Research, and has established programs in Networking, Statistics, and Computing in the Mathematics, Information, and Biological Sciences Division. Previously, Dr. Bonneau was a Senior Research Scientist at the Air Force Research Laboratory, Information Directorate in networking, communications, sensing, and computing, a Program Manager at the Defense Advanced Research Projects Agency (DARPA) in communications. He has held academic positions in communications and sensing at Rensselaer Polytechnic Institute and Columbia University. Dr. Bonneau has a Ph.D. in electrical engineering from Columbia University, and a Masters and Bachelors in electrical engineering from Cornell University. Dr. Bonneau is a senior member of IEEE and has over 75 journal and conference papers, 1 book co-authorship, contributed to 2 book chapters, and holds 3 patents.

INVITED SPEAKERS' BIOS

GOURAB GHOSHAL

BarabasiLab, Northeastern University

Gourab Ghoshal completed his PhD under the supervision of Prof. Mark Newman at the University of Michigan in statistical Physics. He is currently a postdoctoral research scientist at the Center for Complex Networks Research headed by Prof. A.-L. Barabási and a visiting research scholar at the Media Lab at MIT in the group of Alex "Sandy" Pentland. Gourab's research interests are in complex systems (primarily in the theory and applications of networks) as well as game theory, econophysics and non-equilibrium statistical physics.

MY T. THAI

Optima Network Science Lab
University of Florida

My T. Thai is an Associate Professor in the Computer and Information Science and Engineering Department at the University of Florida. She received her Ph.D. degree in Computer Science at the University of Minnesota in 2005. Her research interests are centered on the Combinatorial Optimization and its connection to Networks, including communication networks, social networks, wireless sensor networks, and biological networks. More specifically, the focus of her research is to design and analyze several new models and approximation algorithms for various fundamental problems.

NEIL JOHNSON

Complex Systems Research Group
University of Miami

Neil Johnson heads up a new inter-disciplinary research group in Complexity within the University of Miami's Physics Department, where he is a professor. He earned his B.A. at Cambridge University and his Ph.D. at Harvard University. He was professor of physics at Oxford University from 1992-2007, when he moved to Miami. He established and co-directed Oxford University's inter-disciplinary research center in Complexity Science (CABDyN: Complex Agent-Based Dynamical Systems. He also co-directed Oxford University's interdisciplinary research center in financial complexity (OCCF).

JULIA PONCELA CASASNOVAS

Amaral Lab, Northwestern University

Julia Poncela Casasnovas studied Physics at University of Zaragoza (Spain), where she also got her Ph.D in 2010, under the supervision of Dr. Yamir Moreno, Dr. Jesus Gomez-Gardenes and Dr. Mario Floria. She joined the Amaral Lab on November 2010, where she has been working on several projects, mainly on social networks. Her interests are in Statistical Physics, Non-Linear Physics and Complex Systems in general, and more specifically, in different processes on top of complex topologies, such as social networks.

SUNE LEHMANN

DTU Informatics
Technical University of Denmark

Sune Lehmann is an Assistant Professor at DTU Informatics, Technical University of Denmark. Prior work includes postdoc positions at Institute for Quantitative Social Science at Harvard University, College of Computer and Information Science at Northeasthern University, and Center for Complex Network Research at Northeastern University. Sune's research focuses on understanding the structural and dynamical aspects of complex network topology, as seen from a statistical standpoint. Previous research has focused on link

NATHALIE (HENRY) RICHE

Microsoft Research

Nathalie is a researcher at Microsoft Research since December 2008. Her interests lie in the visual exploration of graphs and networks, visualization of groups, interactive graph navigation techniques and evaluation methods for information visualization. She completed her Ph.D on the visual exploration of social networks in 2008, supervised by Pr. Jean-Daniel Fekete in France and Pr. Peter Eades in Australia. Exciting projects she is involved in at MSR include the visualization of heterogeneous networks (multiple types of nodes and edges), the visualization of networks evolving over time, and taking advantage of natural user interactions (sketch, natural language) to create and interact with visualizations.

CompleNet 2012 Program at a Glance

Wednesday, March 7, 2012

08:40	Opening Remarks Ronaldo Menezes (Conference Chair) & Alexandre Evsukoff (Program Chair)
08:50	Welcome from T. Dwayne McCay (Executive Vice-President of Florida Tech)
09:00	Keynote: Albert-László Barabási
10:00	Coffee Break
10:20	Technical Session 1: Network Measures and Models
12:00	Lunch Break
13:30	Invited Speaker: Nathalie (Henry) Riche
14:10	Technical Session 2: Agents and Communication
15:10	Coffee Break
15:30	Technical Session 3: Epidemics, Fads and Influence
17:30	Poster Session

Thursday, March 8, 2012

08:40	Invited Speaker: Sune Lehmann
09:20	Invited Speaker: Julia Poncela Casasnovas
10:00	Coffee Break
10:20	Technical Session 4: Communities, Clusters and Partitions
12:20	Lunch Break
13:30	Invited Speaker: Neil Johnson
14:10	Technical Session 5: Emergence in Networks
15:30	Coffee Break
15:50	Technical Session 6: Social Structures and Networks
19:00	The “Art of Networks” Exhibition at Foosaner Art Museum (with Cocktail)

Friday, March 9, 2012

09:00	Keynote: Sinan Aral
10:00	Invited Speaker: Gourab Ghoshal
10:40	Coffee Break
11:00	Technical Session 7: Networks in Biology and Medicine
12:20	Lunch Break
13:30	Keynote: Robert Bonneau
14:30	Invited Speaker: My T. Thai
15:10	Coffee Break
15:30	Technical Session 8: Applications of Networks
17:50	Closing Remarks: Announcement of Location for CompleNet 2013
19:00	Trip to Downtown Melbourne

CompleNet 2012 Detailed Program

Wednesday, March 7th, 2012

08:40 Opening Remarks
Ronaldo Menezes (Conference Chair)
Alexandre Evsukoff (Program Chair)

08:50 Welcome Message
T. Dwayne McCay (Executive Vice-President of Florida Tech)

09:00 Taming Complexity: Controlling Networks
by Albert-László Barabási

10:00 Coffee Break

10:20 Technical Session 1: Network Measures and Models

- Hybrid Centrality Measures for Binary and Weighted Networks
- A Growing Model for Scale-Free Networks Embedded in Hyperbolic Metric Spaces
- The Robustness of Balanced Boolean Networks
- Emergence of Hourglass-Shaped Structures in the Evolution of Layered Networks
- Hirsch Index as a Network Centrality Measure

12:00 Lunch Break

13:30 Novel Visualizations and Interactions for Social Networks Exploration
by Nathalie (Henry) Riche

14:10 Technical Session 2: Agents and Communication

- Structural Evolution in Knowledge Transfer Network: An Agent-based Model
- Using Network Science to Define a Dynamic Communication Topology for Particle Swarm Optimizers
- Weak Ties in Complex Wireless Communication Networks

15:10 Coffee Break

15:30 Technical Session 3: Epidemics, Fads and Influence

- Analysis of Tipping Points for Threshold Models on Arbitrary Networks
- A Model for Knowledge Transfer in a Production Chain.
- Modeling annual Supreme Court influence: The role of citation practices and judicial tenure in determining precedent network growth
- IRIE: A Scalable Influence Maximization Algorithm in Social Networks
- Tipping Point of Information Spreading in Random Clustered Networks with Heterogeneous Contact Rates
- Multiscale Algorithms for Analysis and Optimization Problems on Large Networks

17:30 Poster Session

19:30 DAY 1 ENDS

Thursday, March 8th, 2012

08:40 Validation of Network Communities
by Sune Lehmann

09:20 Social Networking & Self-monitoring Adherence Offer Additive Benefits in an Online Weight Management Program
by Julia Poncela Casasnovas

10:00 Coffee Break

10:20 Technical Session 4: Communities, Clusters and Partitions

- A Comparison of Methods for Community Detection in Large Scale Networks
- Stable community cores in complex networks
- An Empirical Study of the Relation Between Community Structure and Transitivity
- Detecting Overlapping Communities in Complex Networks Using Swarm Intelligence for Multi-Threaded Label Propagation
- Using Network Sciences in Music Recommendation A case study with Brazilian Music
- A Genetic Algorithm to Partition Weighted Planar Graphs in Which the Weight of Nodes Follows a Power Law

12:20 Lunch Break

13:30 Conflicts, Terrorism and Global Financial Instability: Different Problems, Similar Underlying Network Dynamics
by Neil Johnson

14:10 Technical Session 5: Emergence in Networks

- Socio-Dynamic Discrete Choice on Networks in Space: Impact of Initial Conditions, Network Size and Connectivity on Emergent Outcomes in a Simple Nested Logit Model
- Tipping Points of Diehards in Social Consensus on Large Random Networks
- Signaling Conventions in Small-World Networks
- The Birth of Retweeting Conventions in Twitter

15:30 Coffee Break

15:50 Technical Session 6: Social Structures and Networks

- The Effect of Committed Groups on Consensus Formation in Social Networks
- Social Features of Online Networks: The Strength of Intermediary Ties in Online Social Media
- Twitter follow links reveal bicameral landscape of newspapers
- Gathering Metrics from Software Repositories using Network Analysis
- The Social Structure of Organ Transplantation in the United States
- The Effect of Citations to Collaboration Networks

17:50 DAY 2 ENDS

19:00 The “Art of Networks” Exhibition at Foosaner Art Museum (with Cocktail)

Friday, March 9th, 2012

09:00	Content and Causality in Influence Networks by Sinan Aral
10:00	Ranking Stability in Complex Networks by Gourab Ghoshal
10:40	Coffee Break
11:00	Technical Session 7: Networks in Biology and Medicine • Identification of Racial Disparities in Organ Transplantation using Network Sciences • A Drug-Target Network Mapped onto the Metabolic Network as a Tool for Drug Design • A Novel Framework for Complex Networks and Chronic Diseases • Centrality and Network Analysis in a Natural Perturbed Ecosystem
12:20	Lunch Break
13:30	Complex Information Systems by Robert Bonneau
14:30	How the Power-law Distribution Impacts on the Complex Network Vulnerability by My T. Thai
15:10	Coffee Break
15:30	Technical Session 8: Applications of Networks • The Explanatory Power of Relations and an Application to an Economic Network • The Network of Driving Forces of Global Environmental Change • Evaluation of Coupled Climate Models Using Network Analysis • Mapping Emerging News Networks: A Case Study of the San Francisco Bay Area • Complex Network for Modeling Crime Reports in Collaborative Maps • Identifying Critical Traffic Jam Areas with Node Centralities Interference and Robustness • Influence Maximization for Advertising in Multi-agent Markets
17:50	Closing Remarks: Announcement of Location for CompleNet 2013
18:00	DAY 3 ENDS
18:30	Trip to Downtown Melbourne (not part of the workshop)

KEYNOTE ADDRESSES

TAMING COMPLEXITY: CONTROLLING NETWORKS

Albert-László Barabási

Wednesday, March 7, 9:00

The ultimate proof of our understanding of natural or technological systems is reflected in our ability to control them. While control theory offers mathematical tools to steer engineered and natural systems towards a desired state, we lack a framework to control complex self-organized systems. Here we develop analytical tools to study the controllability of an arbitrary complex directed network, identifying the set of driver nodes whose time-dependent control can guide the system's entire dynamics. We apply these tools to several real networks, finding that the number of driver nodes is determined mainly by the network's degree distribution. We show that sparse inhomogeneous networks, which emerge in many real complex systems, are the most difficult to control, but dense and homogeneous networks can be controlled via a few driver nodes. Counter intuitively, we find that in both model and real systems the driver nodes tend to avoid the hubs.

CONTENT AND CAUSALITY IN INFLUENCE NETWORKS

Sinan Aral

Friday, March 9, 9:00

Many of us are interested in whether "networks matter." Whether in the spread of disease, the diffusion of information, the propagation of social contagions, the effectiveness of viral marketing, or the magnitude of peer effects in a variety of settings, two key questions must be answered before we can understand whether networks matter: 1) how the content that flows through networks affects the patterns of outcomes we see across nodes and 2) whether the statistical relationships we observe can be interpreted causally. Sinan will review what we know and where research might go with respect to content and causality in networks. He will provide two examples from each area to structure the discussion: One from an analysis of email networks and the information content that flows through them at a mid-sized executive recruiting firm (published in the American Journal of Sociology) and the other from a randomized field experiment on a popular social networking website that tests the effectiveness of "viral product design" strategies in creating peer influence and social contagion among the 1.4 million friends of 9,687 experimental users (published in Management Science).

COMPLEX INFORMATION SYSTEMS

Robert Bonneau

Friday, March 9, 13:30

The talk will provide an overview of complex information systems including quantifying, managing, and designing heterogeneous networked systems. Methods of measuring and assessing the performance of network, software, and hardware infrastructures such as cloud architectures will be discussed including techniques of sparse approximation in systems measurement, and algebraic and topological statistical metrics for performance. Strategies of quantifying risk over different geometric and statistical classes of distributed systems will be examined as well as methods of tracking and coding dynamic information flows.

INVITED TALKS

NOVEL VISUALIZATIONS AND INTERACTIONS FOR SOCIAL NETWORKS EXPLORATION

Nathalie (Henry) Riche

Wednesday, March 7, 13:30

Collecting data to understand how people communicate, collaborate, what information they exchange, what role they play in social groups has been tremendously simplified with the popularity of online networking systems such as Friendster, LinkedIn, or Facebook. Compared to data collected through polls and interviews, collected networks require less processing as they are directly stored digitally and open new opportunities for social scientists as they are far larger and often contain much richer information. However, this avalanche of data raises new challenges for their analysis: tools need to support a very large amount of data often evolving through time.

As human brain is particularly effective at processing visual information, researchers in computer science developed a number of visual exploration system to analyze graphs and networks. In the last five years, an increasing part of the research in information visualization focused on graph visualization, tackling the problem from novel angles. Our research focused on novel representations based on adjacency matrices, supporting the analysis of denser networks as well as novel interaction techniques to scale to larger datasets. In this talk, I will present an overview of these novel visual exploration systems.

VALIDATION OF NETWORK COMMUNITIES

Sune Lehmann

Thursday, March 8, 8:40

One of the most active areas in the study of complex networks is community detection. Over the past few years, dozens – if not hundreds – of methods have been suggested for detecting the "best" set of communities. And in spite of much progress in our understanding of strengths and weaknesses of the most popular methods, consensus on a unified way forward seems as unlikely today as it did years ago. An aspect of this lack of consensus is that the field has yet to agree on a way to validate the results obtained via this varied set of methods. Here we review and discuss popular methods for validation of community structure, distinguishing between the case when only the network connections are known, and the case when additional metadata is available. Finally, we suggest a few ideas for a way forward for both networks with and without metadata.

SOCIAL NETWORKING & SELF-MONITORING ADHERENCE OFFER ADDITIVE BENEFITS IN AN ONLINE WEIGHT MANAGEMENT PROGRAM

Julia Poncela Casasnovas

Thursday, March 8, 9:20

Obesity is a growing public health problem throughout the developed world. While many approaches to weight loss have been proposed, including those making use of information technologies, research shows that success depends strongly on repeated contacts with human interventionists. However, the cost of interventionists prevents obesity treatment from scaling to the population level.

We test the hypothesis that peer interaction within an online social organization of individuals motivated to manage their weight may lead to clinically significant weight loss for its members over and above the effect of behavioral adherence. We studied the online activity and weight change of 16,918 members of a virtual weight management community during a two-year period and found that the 13,398 self-monitoring adherent members lost significantly more weight than the non-adherent members. The 1,210 adherent members strongly engaged in online social networking lost the most weight, with a remarkable 50% losing at least 5% of their body weight.

Our analysis revealed that weight loss was increased by peer interactions whether peers were losing weight or not, and that adherence and online peer interaction have equally important and additive contributions to the magnitude of the weight loss. The broad reach and easy scalability of online programs offers a highly efficient use of social networking to promote weight loss and address other health risk behaviors at the population level.

CONFLICTS, TERRORISM AND GLOBAL FINANCIAL INSTABILITY: DIFFERENT PROBLEMS, SIMILAR UNDERLYING NETWORK DYNAMICS

Neil Johnson

Thursday, March 8, 13:30

There are plenty of urgent national and international threats that might potentially benefit from the emerging sciences of complex networks, in order to assess and quantify their future risk and likely evolution. But what are the game-changing 'take-aways' for practitioners and policy-makers? The number of candidate complex systems/network models of financial markets, for example, has exploded in the past decade -- so has the number of descriptions of human conflict and terrorism. Indeed, it is now a significant challenge for any researcher (let alone graduate student) to translate between the various candidate models, compare their respective assumptions, and know which is better and for what reason. The natural tendency is therefore simply to create yet another new model, leading to further model proliferation. So are we in danger of losing the plot? In this talk, I try to reverse this model proliferation by addressing a number of quite different societal threats using a common 'bare-bones' complex dynamical network model which mimics features of human grouping dynamics and decision-making. I will then compare its predictions to state-of-the-art high frequency data from the real-world domains of human insurgency, global terrorism, massively multiplayer online role-playing games (e.g. World of Warcraft), urban street gangs and cyber-attacks – also in the financial domain, I will use it to examine the murky subsecond world of algorithmic trading which occupies 70% percent of all financial trades, is openly blamed in the media for flash-crash phenomena, but where the future risk has not yet been mitigated or regulated because of a lack of reliable models.

RANKING STABILITY IN COMPLEX NETWORKS

Gourab Ghoshal

Friday, March 9, 10:00

PageRank, a network-based diffusion algorithm, has emerged as the leading method to rank web content, ecological species and even scientists. Despite its wide use, it remains unknown how the structure of the network on which it operates affects its performance. Here we show that for random networks the ranking provided by PageRank is sensitive to perturbations in the network topology, making it unreliable for incomplete or noisy systems. In contrast, in scale-free networks we predict analytically the emergence of super-stable nodes whose ranking is exceptionally stable to perturbations. We calculate the dependence of the number of super-stable nodes on network characteristics and demonstrate their presence in real networks, in agreement with the analytical predictions. These results not only deepen our understanding of the interplay between network topology and dynamical processes but also have implications in all areas where ranking has a role, from science to marketing.

HOW THE POWER-LAW DISTRIBUTION IMPACTS ON THE COMPLEX NETWORK VULNERABILITY

My T. Thai

Friday, March 9, 14:30

The power-law distribution of degree sequence has been discovered in many complex networks, ranging from the Internet, WWW, to social networks. Unfortunately, these complex networks are very vulnerability under natural or man-made attacks. Therefore, it is crucial to understand the impact of the power-law distribution on complex network vulnerability. Intuitively, a fundamental question is raised: Does this important property make the assessment of the network vulnerability much easier?

In this talk, we show that most related network vulnerability problems still remain intractable on power-law networks. However, the near-optimal polynomial solutions can be easier to obtain, that is, these problems are proven to have better inapproximability factors on power-law networks. In addition, we deeply investigate the behavior of power-law networks under various failures and attacks. By using the probabilistic approaches, the results theoretically justify why power-law networks are very robust under random failures but not adversarial attacks. In addition, we find the best range of exponential factors in which the power-law networks are almost surely unaffected by any random failures and less likely to be destructed under adversarial attacks.

TECHNICAL SESSION 1: NETWORK MEASURES AND MODELS

Wednesday, March 7, 10:20

Chair: Sune Lehmann (Technical University of Denmark)

HYBRID CENTRALITY MEASURES FOR BINARY AND WEIGHTED NETWORKS

Alireza Abbasi, Liaquat Hossain and Kenneth Chung

There are several centrality measures in social network analysis (SNA) studies (i.e., degree, closeness, betweenness and eigenvector centralities), which primarily suggest the importance of an actor with a consideration of actor's given structural position in the network. Each of the existing measures suggest specific attribute of an actor (i.e., popularity, accessibility, brokerage or gate keeping behavior). In this study, we propose new hybrid centrality measures (i.e., Degree-Degree, Degree-Closeness and Degree-Betweenness), which combines existing measures (degree, closeness and betweenness) in developing a better understanding of importance of actors in a network. Generalized set of measures also proposed for weighted networks (the network which their tie are weighted). To demonstrate that the new measures are useful in practice to evaluate actors' importance in the network, we test it with a real co-authorship (collaboration) network dataset having performance measures (e.g., sum of citations, h-index and g-index) of actors (scholars). Our analysis suggests that the proposed new centrality measures (especially for weighted networks) have higher significant correlation than traditional centrality measures with performance of the actors. Thus, they are useful measures which can be used instead of traditional measures to show importance of the nodes in a network.

A GROWING MODEL FOR SCALE-FREE NETWORKS EMBEDDED IN HYPERBOLIC METRIC SPACES

Giuseppe Mangioni and Antonio Lima

Some particular kinds of complex networks exhibit interesting properties which make them suitable to many classes of applications, among those are power-law networks. Some results by Krioukov et al. show how real world networks are produced by hidden metric spaces. Specifically, scale-free networks can be obtained from hyperbolic metric spaces. While the model proposed by Krioukov can produce a static scale-free network, all nodes are created at one time and none can be later added. In this work we propose a growing model which leverages the same concepts and allows to gradually add nodes to a scale-free network, obtained from a discretized hyperbolic model. We also show how nodes are correctly positioned relying on local information and how greedy routing works can efficiently build paths in the network.

THE ROBUSTNESS OF BALANCED BOOLEAN NETWORKS

Ming Liu and Elena Dubrova

One of the characteristic features of genetic regulatory networks is their inherent robustness, that is, their ability to retain functionality in spite of the introduction of random errors. In this paper, we focus on the robustness of Balanced Boolean Networks (BBNs), which is a special kind of Boolean Network model of genetic regulatory networks. Our goal is to formalize and analyse the robustness of BBNs. Based on these results, applications using Boolean network model can be improved and optimized to be more robust. We formalize BBNs and introduce a method to construct BBNs for 2-singleton attractors Boolean networks. The experiment results show that BBNs have a good performance on tolerating the single stuck-at faults on every edge. Our method improves the robustness of Boolean networks by at least 13% in average, and in some special case, up to 61%.

EMERGENCE OF HOURGLASS-SHAPED STRUCTURES IN THE EVOLUTION OF LAYERED NETWORKS

Saamer Akhshabi and Constantine Dovrolis

Technological systems are often designed and implemented in a modular layered manner, in which modules of layer X are constructed using modules of layer X-1. At the lowest layer the modules are of the most basic function or form, while at the highest considered layer the modules are the ultimate products or services. Examples of such systems include software and hardware systems as well as supply chain networks and organization structures. Another example of a layered system is the well-known TCP/IP protocol stack. In that system, each node is a protocol and the (directed) edge from protocol X to protocol Y means that Y relies on the service provided by X. As new technologies, constraints, requirements and applications appear, layered systems need to evolve. New nodes are created at each layer, new connections are formed, and existing nodes are removed as a result of competition with other nodes at the same layer.

An interesting characteristic of some of these layered systems is that they take an hourglass-like structure (e.g. the Internet protocol stack). Further, this structure emerges in a self-organized manner, as a result of an evolutionary process that is currently not well understood. In this work, we propose EvoArch, a simple abstract model for the evolution of layered technological

networks (and in particular the Internet protocol stack). EvoArch, is based on a few principles about layered network architectures and their evolution in a competitive environment where modules acquire value based on their higher layer applications and compete with other modules at the same layer. EvoArch produces hourglass-like structures from general initial conditions in a robust way. It also predicts the emergence of evolutionary kernels at the waist of the architecture, i.e., those few nodes that survive much longer than other nodes. Similar kernel nodes have appeared in some technological systems such as the Internet protocol stack as well as some biological systems such as developmental GRNs. In this extended abstract we simply describe the model at a high level and include a few results.

HIRSCH INDEX AS A NETWORK CENTRALITY MEASURE

Mônica Campiteli, Adriano J. Holanda, Paulo Soles, Leonardo Soares and Osame Kinouchi

We study the h Hirsch index (h-index) as a local node centrality measure for complex networks. The h-index is compared with the Degree (a local measure), the Betweenness and Eigenvector centralities (two global measures) in the case of a biological network (Yeast interaction protein-protein network) and a linguistic network Moby Thesaurus II. In both networks, the Hirsch index has poor correlation with Betweenness but correlates with Degree and Eigenvector. As a local measure, one can take advantage in using h-index as it carries more information about the neighbors when compared with Degree centrality. It also requires less computational time when compared with Eigenvector centrality, suggesting a better outcome than both measures for ranking purposes.

TECHNICAL SESSION 2: AGENTS AND COMMUNICATION

Wednesday, March 7, 14:10

Chair: Giuseppe Mangioni (University of Catania, Italy)

STRUCTURAL EVOLUTION IN KNOWLEDGE TRANSFER NETWORK: AN AGENT-BASED MODEL

Haoxiang Xia, Yanyan Du and Zhaoguo Xuan

The transfer of knowledge on social networks has become a focal research topic in the last decade. Under this topic, the mainstream endeavors are on studying the impacts of network properties and social ties on the performance of knowledge transfer. We in this paper investigate a reverse problem, by proposing an agent-based model to examine whether and how the activity of knowledge transfer affects the structural evolution of the social network. In the proposed model, we consider a networked society of knowledge transfering agents. The agents on one hand make knowledge transfer with their neighbors; one the other hand, they also move around the society to improve their opportunity for knowledge transfer. Some interesting phenomena are observed by simulating this model.

USING NETWORK SCIENCE TO DEFINE A DYNAMIC COMMUNICATION TOPOLOGY FOR PARTICLE SWARM OPTIMIZERS

Marcos A. C. Oliveira Junior, Carmelo J. A. Bastos Filho and Ronaldo Menezes

We propose here to use network sciences, specifically an approach based on the Barabási-Albert model, to define a dynamic communication topology for Particle Swarm Optimizers. We compared our proposal to previous approaches, including a simpler Barabási-Albert-based approach and other most used approaches, and we obtained better results in average for well-known benchmark functions.

WEAK TIES IN COMPLEX WIRELESS COMMUNICATION NETWORKS

Amanda Leonel, Carlos H. C. Ribeiro and Matthias R. Brust

Hundreds of millions of devices - from book-sized notebooks to tiny hand-held mobile phones - are equipped with wireless communication adapters that are able to form a network among themselves. The spontaneous creation of this kind of network and the unpredictable joining and leaving of devices bring forward new challenges on network and topology organization. Network Science has proven to deliver a fruitful methodology to investigate systems such as complex communication networks, and new insights and solutions can be gained by understanding and imitating the function and structure of social networks. Following this line, this paper initially focuses on the development of a model that reveals characteristics found to be inherent to social networks. In particular, we consider the finding that social networks can contain a diversity of links: We create clusters of friends, connected by strong links and, additionally, there are links to acquaintances, the so-called weak ties which, despite the name, have been

hypothesized as essential for finding jobs or disseminating rumors when strong ties fail.

As such links seem to be highly important to deal with the requirements of a complex network such as our own social network, we argue that bringing these structures to the design principles of complex communication networks may result in an increase of efficiency and robustness, and we describe the implementation of an algorithm for wireless communication networks using only local neighborhood information and producing features of complex social networks (weak ties in particular). The results imply that local removing promotes the emergence of weak ties, which we found by using a recently proposed link-clustering algorithm for identifying link communities.

TECHNICAL SESSION 3: EPIDEMICS, FADS AND INFLUENCE

Wednesday, March 7, 15:30

Chair: Julia Poncela Casasnovas (Northwestern University, USA)

ANALYSIS OF TIPPING POINTS FOR THRESHOLD MODELS ON ARBITRARY NETWORKS

Hyuna Kim, Seulki Lee and Kyomin Jung

Tipping point phenomena (events that had rarely observed becomes suddenly common) for information diffusion have received huge attention from academia and industry. Understanding tipping point phenomena has numerous applications including viral marketing and minimizing the spread of contamination. Depending on the characteristics of the information and network structures, the information either cascades globally or terminates quickly. In this work, we identify conditions for the occurrence of tipping points for general classes of network structures and provide a novel proof for its correctness. Various models of information spreading have been studied. In particular, the SIR model and the linear threshold model are established based on the common assumption that the neighbors play significant roles for the spread of information. Under the SIR model, some sufficient conditions for a global cascade have been studied.

On the other hand, for the diffusion of new technologies or innovations which requires relatively high costs to adopters, the linear threshold model and its generalization are widely used. Despite its significance, tipping point analysis of the threshold models has focused on limited conditions such as the complete graph, homogeneous thresholds, and locally tree-like networks. In the linear threshold model, individuals make their decisions based on the decisions of their neighbors. Each node has its own threshold value and if the fraction of neighbors who have already adopted the innovation is greater than the threshold, it will adopt the innovation. In this work, we assume that each node takes its threshold value from any distribution f independently. Originally, the linear threshold model assumes that f is the uniform distribution on [0,1]. However, it is known that f usually follow diverse distributions such as the normal distribution. We consider that each individual becomes an initial adopter independently with a given probability x in [0,1]. This process can be regarded as diffusion of innovation initiated by public marketing that affects to each individual independently with probability x. Under the linear threshold model with an arbitrary f and on an arbitrary network, we prove that a final cascade size is highly concentrated around its mean with high probability only if all nodes are of degrees omega. Secondly we extend our result to the general threshold model, where the threshold function of each individual is an arbitrary function of its neighbors' decision (which is linear for the linear threshold model). We also generalize so that each individual v becomes an initial adopter independently with probability x_v. We provide an upper bound and a lower bound of the cascade size for the general threshold model under similar conditions.

Furthermore, we provide an efficient heuristic algorithm under the general threshold model that estimates the average cascade size and the probability of being influenced for each individual for any network. Our algorithm can be employed as a subroutine of many algorithms for information spreading including the influence maximization problem. Finally we confirm by extensive experiments on real-world social networks including opinions and political blogs, that final cascade sizes are actually concentrated around their means and a tipping point appears at the predicted point even though the degree of each individual are not so large.

A MODEL FOR KNOWLEDGE TRANSFER IN A PRODUCTION CHAIN

Luiz Bevilacqua, Augusto Galeão and Ana-Paula Rio-Doce

This paper deals with the study of a model intended to describe the knowledge evolution in a productive chain. With the discrete approach assuming the disturbance introduced by a partial and temporary retention of information it is derived a new diffusion equation. This new governing equation includes a fourth order differential term and the fractions of information diffusing and partially retained. The knowledge flow according to this new model evolves in two different tracks with twos different speeds. The chain contains two main variables knowledge density and human creativity density. The influence in the dynamics of the production process of parameters like creativity, knowledge permeability, knowledge impedance, disturbance in the knowledge permeability,

learning speed are examined. It is shown that the critical parameter in the evolution process is the ratio creativity/knowledge diffusion.

Also the boundary conditions specifying the knowledge flow through the extremities of the chain play a key role in the evolution process. For some critical values of the knowledge flow the chain could disappear, that is the production could stop completely. The process admits a positive feedback behavior in the sense that creativity generates more creativity. The size of the groups in the chain varies also in time according to the production capacity. Productive segments attract more individuals for the group. Some qualitative results are deduced from the predictions of the model. Finally the stability analysis of an infinite chain incorporating knowledge retention is presented. The relative influence of retention, knowledge permeability and creativity is examined and their role in the growth of a productive chain.

MODELING ANNUAL SUPREME COURT INFLUENCE: THE ROLE OF CITATION PRACTICES AND JUDICIAL TENURE IN DETERMINING PRECEDENT NETWORK GROWTH

Ryan Whalen

Using networks generated from the entire set of United States Supreme Court decision citations, this paper models yearly court influence as a function of system stability, complexity, precedent age and judicial tenure. The model demonstrates that decisions written in years when the mean judicial age is low and judges are more stable in their use of precedent, more conservative in terms of the age of precedent cited, and the yearly citation network is less complex are more likely to be cited in future years. By incorporating system endogenous variables in modeling efforts, this paper contributes to the development of complex legal systems studies, and proposes new ways to develop the field.

IRIE: A SCALABLE INFLUENCE MAXIMIZATION ALGORITHM IN SOCIAL NETWORKS

Kyomin Jung, Wooram Heo and Wei Chen

Finding influential users in a social network is essential for viral marketing and social media marketing. Influence maximization problem is defined as finding a node set S of given size K in a social network to maximize their influence spread - the expected total number of activated nodes under a certain diffusion process initiated from the set S. In this work, we propose a novel scalable and memory-efficient Influence Rank Influence Estimation (IRIE) algorithm for the influence maximization problem under the popular independent cascade (IC) model and its extension. In the IC model, each activated node has a single chance to activate each of its outgoing neighbor with a probability assigned to the edge. The IC model can be identified with the Susceptible/Infective/Recovered (SIR) model for the epidemic spreading. Kempe et al. showed that finding optimum solution for the influence maximization under the IC model is NP-hard, and proposed a Greedy algorithm that obtains (1 - 1/e)-approximation for the problem. A number of follow-up works tackle the problem by designing more efficient and scalable optimizations and heuristics. Among them PMIA has stood out as the most efficient heuristic so far. In the greedy algorithm as well as in PMIA, each round a new seed with the largest marginal influence spread is selected. To select this seed, the greedy algorithm uses Monte-Carlo simulations while PMIA uses more efficient local tree based heuristics to estimate marginal influence spread of every possible candidate.

These are especially slow for the first round where the influence spread of every node needs to be estimated. Instead of estimating influence spread for each node at each round, we devise a global influence ranking method, Influence Rank (IR), derived from a belief propagation approach. By integrating IR with tree-based influence estimation IE, we propose our scalable and memory-efficient IRIE algorithm. We conduct extensive experiments using synthetic networks as well as six real-world networks such as Amazon and DBLP whose size ranging from 29K to 69M edges, and different IC model parameter settings. In the experiments comparing IRIE with the state-of-the-art algorithms such as Greedy with Cost-effective Lazy forward (CELF), PMIA, and SA, our results show that IRIE has matching or sometimes even better influence spread as the CELF and PMIA, and generates much better influence spread than SA. For the scalability and memory usage, IRIE achieves up to two orders of magnitude speedup comparing with PMIA (much more with CELF) while using significant less memory than PMIA, especially for large and relatively dense networks. To show the wide applicability of our IRIE approach, we also suggest an invariant of IRIE to the IC-N model that incorporates negative opinion propagations. Our simulation results show that IRIE has better influence coverage with less running time than the known state-of-the-art MIA-N heuristic.

TIPPING POINT OF INFORMATION SPREADING IN RANDOM CLUSTERED NETWORKS WITH HETEROGENEOUS CONTACT RATES

Sungsu Lim and Kyomin Jung

Tipping point phenomena for information spreading in complex networks have been studied for decades in various disciplines. A tipping point is a moment at which information suddenly spreads rapidly and globally. Understanding how tipping points occur in

networks is an important problem, which is closely related to the eruption of an epidemic in epidemiology, the initiation of a trend in marketing, and so on. In this work, we identify condition for tipping points to occur and analyze spreading behaviors in random clustered networks with heterogeneous contact rates. The Susceptible-Infected-Recovered (SIR) model and its variants have been widely used to explain the tipping point phenomena. Much of the previous research on the SIR model have concentrated on locally tree-like networks such as the configuration model. However, triadic closure (friends of friends are more likely to become friends) occurs in social networks. To demonstrate this, Newman and Miller proposed simultaneously a model for random clustered networks by considering the degree distribution and the number of triangles each node participates. Miller introduced a method to calculate the probabilities and the sizes of the large-scale spreading in random clustered networks for constant contact rates. However, contact rates almost never be the constant in social networks. Using a similar argument, we also compute the probability that a large-scale spreading occurs when the spreading is initiated by a single node.

Our argument can be applied to any specific substructure of the network of finite size including cliques, motifs, and chains rather than triangles. Furthermore, we provide a formula to estimate the probability and the size of the large-scale spreading when the network topology is given and not random. We conducted Monte Carlo experiments of information spreading on real-world social network topologies such as Facebook (63K nodes) and MySpace (100K nodes) to compare the computed values of the sizes and the probabilities of the large-scale spreading based on our proposed method with the Monte Carlo estimates. The simulations show that the values obtained by our formula with random clustered networks are more accurate than with configuration models. Moreover, the accuracy of predictions using our formula for the actual network topology is better than the accuracy of predictions using random clustered networks.

MULTISCALE ALGORITHMS FOR ANALYSIS AND OPTIMIZATION PROBLEMS ON LARGE NETWORKS

Ilya Safro

We present the multiscale method as a generic tool to design optimization and analysis algorithms for large-scale networks. We demonstrate in details how to design multiscale algorithms for two applications: network compression, and optimal response to cyber attacks and epidemics on networks.

TECHNICAL SESSION 4: COMMUNITIES, CLUSTERS AND PARTITIONS

Thursday, March 8, 10:20

Chair: My T. Thai (University of Florida, USA)

A COMPARISON OF METHODS FOR COMMUNITY DETECTION IN LARGE SCALE NETWORKS

Vinícius Vieira and Alexandre Evsukoff

The modeling of complex systems by networks is an interesting approach for revealing the way that relationships occur and an increasing effort has been spent in the study of community structures. The main goal of this work is to show a comparative study of some of the state-of-art methods for community detection in large-scale networks using modularity maximization. In this sense, we take into account not just the quality of the provided partitioning, but the computational cost associated to the method. Hence, we consider many aspects related to the algorithms efficiency, in order to provide the suitability to real scale applications. The results presented in this work are obtained from the literature, in a preliminary sense, and form a solid basis for the implementation and application of efficient algorithms for community detection in large-scale networks.

STABLE COMMUNITY CORES IN COMPLEX NETWORKS

Massoud Seifi, Jean-Loup Guillaume, Ivan Junier, Jean-Baptiste Rouquier and Svilen Iskrov

Complex networks are generally composed of dense sub-networks called communities. Many algorithms have been proposed to automatically detect such communities. However, they are often unstable and behave non-deterministically. We propose here to use this non-determinism in order to compute groups of nodes on which community detection algorithms agree most of the time. We show that these groups of nodes, called community cores, are more similar to Ground Truth than communities in real and artificial networks. Furthermore, we show that in contrary to the classical approaches, we can reveal the absence of community structure in random graphs.

AN EMPIRICAL STUDY OF THE RELATION BETWEEN COMMUNITY STRUCTURE AND TRANSITIVITY

Keziban Orman, Vincent Labatut and Hocine Cherifi

One of the most prominent properties in real-world networks is the presence of a community structure, i.e. dense and loosely interconnected groups of nodes called communities. In an attempt to better understand this concept, we study the relationship between the strength of the community structure and the network transitivity (or clustering coefficient). Although intuitively appealing, this analysis was not performed before. We adopt an approach based on random models to empirically study how one property varies depending on the other. It turns out the transitivity increases with the community structure strength, and is also affected by the distribution of the community sizes. Furthermore, increasing the transitivity also results in a stronger community structure. More surprisingly, if a very weak community structure causes almost zero transitivity, the opposite is not true and a network with a close to zero transitivity can still have a clearly defined community structure. Further analytical work is necessary to characterize the exact nature of the identified relationship.

DETECTING OVERLAPPING COMMUNITIES IN COMPLEX NETWORKS USING SWARM INTELLIGENCE FOR MULTI-THREADED LABEL PROPAGATION

Bradley Rees and Keith Gallagher

We propose a unique approach to finding overlapping communities within complex networks that leverage swarm intelligence with label propagation. Swarm intelligence allows for every node to be processed independently and asynchronously, providing an environment that supports multi-threading and eliminating the need for a central control process. Label propagation allows for fast identification of communities. The combination of the two technologies offers a high performance approach to overlapped community detection that allow for the processing of very large networks in tractable time.

USING NETWORK SCIENCES IN MUSIC RECOMMENDATION A CASE STUDY WITH BRAZILIAN MUSIC

Charith Gunaratna, Monali Patel and Ronaldo Menezes

Rapid growth of online music content in the past decade has resulted in an information overload. Online digital music libraries such as Amazon mp3 and iTunes contain millions of songs. Therefore, browsing and searching these music libraries require effective methods. Music recommendation systems automate searching and browsing for music by automatically retrieving music according to user preference. In this paper, we describe a novel approach to music recommendation based on Network sciences. Using a large database of popular Brazilian music, we constructed collaboration networks for musicians, composers and songs. The recommendation system, described in this paper, combines results of the community analysis of these networks and constructs a model for each song that can be used to define similarities between two songs. Our approach to music recommendation does not suffer from drawbacks from techniques such as content-based recommendation and user preference analysis. Our method can be used to recommend a wide variety of music that encourages music rediscovery. Furthermore, the process is very fast and simple.

A GENETIC ALGORITHM TO PARTITION WEIGHTED PLANAR GRAPHS IN WHICH THE WEIGHT OF NODES FOLLOWS A POWER LAW

Rodrigo Palheta and Vasco Furtado

This research makes use of evidence that the distribution of crime by census tract in large cities follows a power law. It means that there are few places that concentrate many crimes and many places that concentrate few crimes. In this article we investigate how modeling complex networks and genetic algorithms can help to understand the behavior of samples representing views of part of the map of crimes of a large metropolis. The representation of the network is a planar graph where the nodes are the centroids of census tracts, the edges represent the adjacency between the tracts and each node has a weight representing the number of crimes recorded in the census tract. The problem of this research lies in the context of the study of sampling distributions that have long tail (e.g. the weight of the nodes of the graph follows a power law).

The motivation of the study is the fact that the identification of patterns indicating malicious activities in the map requires viewing crimes at different levels of zooms. Said another, view a map with crime occurrences at different levels of zoom is equivalent to explore a network and different divisions of it. These subdivisions or subnets are actually samples of the larger network. In particular, we describe a genetic algorithm to explore the space of possible samples of the initial distribution (plotted crimes throughout the city) so that the maximum number of samples holds feature to follow a Power Law with exponent close to the original distribution.

TECHNICAL SESSION 5: EMERGENCE IN NETWORKS

Thursday, March 8, 14:10

Chair: Gourab Ghoshal (Northeastern University/MIT, USA)

SOCIO-DYNAMIC DISCRETE CHOICE ON NETWORKS IN SPACE: IMPACT OF INITIAL CONDITIONS, NETWORK SIZE AND CONNECTIVITY ON EMERGENT OUTCOMES IN A SIMPLE NESTED LOGIT MODEL

Elenna Dugundji and Laszlo Gulyas

The reported research treats interactions between agents and generated feedback dynamics in the adoption and diffusion of various transportation mode alternatives. We consider a simple nested logit model where an agent's choice is directly influenced by the percentages of the agent's neighbors and socioeconomic peers making each choice, and which accounts for common unobserved attributes of the choice alternatives in the error structure. We explicitly address non-global interactions within several hypothesized social and spatial network structures. Discrete choice estimation results controlling heterogeneous individual preferences are embedded in a multi-agent based simulation model in order to observe the evolution of choice behavior over time with socio-dynamic feedback due to the network effects. For the particular simple model under study, we find the impact of initial conditions on the emergent long-run behavioral outcomes is dependent on network size and network connectivity. We conclude highlighting limitations of our present study and recommendations for future work.

TIPPING POINTS OF DIEHARDS IN SOCIAL CONSENSUS ON LARGE RANDOM NETWORKS

Weituo Zhang, Chjan Lim, Gyorgy Korniss, Bolek Szymanski, Sameet Sreenivasan and Jerry Xie

In recent papers that appeared in Chaos and Phys. Rev. E 2011, the surprising tipping point effects of the proportion of committed agents or diehards in a binary agreement model were worked out theoretically for complete graphs and corroborated by simulations on large random networks – 10% marked the robust tipping proportion of committed minority agents that resulted in relatively fast domination of the whole network of otherwise susceptible agents. A remarkable effect observed in simulations of fixed average degree random networks is the monotonic decrease of the tipping proportion of committed agents as the average degree goes down. This talk is devoted to describing the inhomogeneous mean field analysis of this model on large random networks and reporting the main result – the tipping proportions in various simulated random networks are more closely predicted by this new analysis than by the mean field calculations on complete graphs. Moreover, this analysis also predicted the rate at which the tipping fractions of committed agents decreased with average degree of the networks. Comparisons of the analytical predictions for tipping proportions of diehards – as low as 5 percent for random networks with low degrees - and simulated tipping proportions as well as times to consensus will be discussed.

SIGNALING CONVENTIONS IN SMALL-WORLD NETWORKS

Roland Mühlenbernd and Michael Franke

Lewis (1969) invented signaling games to show that meaning conventions can arise simply from regularities in communicative behavior. Since then Lewisean signaling games have become a standard model for the evolution of semantic meaning. This paper contributes to the theory of signaling games by showing how language evolution depends on the social structure of a population, thus paving the way for a more thorough understanding of language variability and language contact phenomena in terms of evolutionary game theory. Previous studies have mainly looked at imitation-based dynamics, to show that (i) multiple language conventions can coevolve in suitably structured populations, (ii) which network properties are most conducive for the formation of uniform conventions, or (iii) which nodes in the network are responsible for the initiation of language change. Our simulations built not on imitation, but on usage-based learning dynamics from evolutionary game theory, so as to relate more directly to previous theoretical work on conventionalization in signaling games.

THE BIRTH OF RETWEETING CONVENTIONS IN TWITTER

Meeyoung Cha, Krishna Gummadi, Farshad Kooti, Winter A. Mason and Haeryun Yang

Observing the emergence of social conventions and the processes by which one comes to be adopted by an entire community has been very difficult until recent technological advances. In this study we examine the birth of a social convention on the microblogging platform Twitter: the token signifying one is forwarding someone else's message – an act popularly known as retweeting. Based on

longitudinal data that spans a two-year period, we describe properties of the adopter network for seven popular variations of the retweeting convention and discuss how and when these variations emerged.

TECHNICAL SESSION 6: SOCIAL STRUCTURES AND NETWORKS

Thursday, March 8, 15:30

Chair: Kevin Huggins (West Point US Military Academy, USA)

THE EFFECT OF COMMITTED GROUPS ON CONSENSUS FORMATION IN SOCIAL NETWORKS

Sameet Sreenivasan, Jierui Xie, Weituo Zhang, Chjan Lim, Jeff Emenheiser, Matt Kirby, Boleslaw Szymanski and Gyorgy Korniss

Interpersonal social networks are widely thought to be the substrates for the spread and adoption of opinions/behaviors in a population. The most common models of information or opinion spread on social networks utilize either the framework of classical models in sociology like the threshold model or epidemic-like models such as the susceptible-infected-susceptible (SIS) model. However both these types of models have drawbacks in modeling a situation in which multiple opinions compete for domination or consensus. The threshold model is more suited to modeling product adoption in which once a node has switched its state it will never revert back. The SIS model allows a node to switch back and forth between states; however the rules which govern this switching are not symmetric.

Here we present a model called the binary agreement model which overcomes these limitations and is particularly well suited to understanding the evolution of public opinion in situations where nodes do not incur any cost to switch back and forth between competing states. Using this model, we demonstrate how the prevailing majority opinion in a social network can be rapidly reversed by a small fraction p of randomly distributed committed nodes that consistently hold the opposing opinion and are immune to influence. Specifically, we show that when the committed fraction grows beyond a critical value $p_c \sim 10\%$, there is a dramatic decrease in the time, T_c, taken for the entire population to adopt the opinion of the committed group. Below pc, the system is characterized by two stable steady states – one of these is the committed opinion consensus state, the other a metastable state - and a single unstable, steady state (saddle point). As p is increased ($p < p_c$), the metastable state and the saddle point approach each other in phase space, until they meet and vanish at p_c.

Beyond p_c the only existing steady state is the consensus state where all nodes hold the opinion of the committed group. We also show through simulation results that the evolution of opinion on random graphs and scale-free networks have a qualitatively similar behavior in the presence of a committed group. Next, we study the case where there are two committed groups in the population, one associated with each of the two opinions. Due to the presence of these opposing committed groups it is clear that no consensus is possible. We analyze analytically and using simulations the parameter space (p1, p2) where p1, p2 are the fractions of committed nodes in each state, for complete graphs, Erdõs-Rényi graphs and scale- free networks. We show the existence of two distinct regions in parameter space, one of which is characterized by the presence of multiple steady states for the system, while the other is characterized by a single steady state. In summary, our simple model provides insights that could be useful to under- stand several real-world scenarios which are characterized by two committed groups competing with each other to influence the remainder of the population. Examples of such situations include political campaigns, the climate-change debate and the adoption of technological standards.

SOCIAL FEATURES OF ONLINE NETWORKS: THE STRENGTH OF INTERMEDIARY TIES IN ONLINE SOCIAL MEDIA

Premyslaw A. Grabowicz, Jose Javier Ramasco, Esteban Moro, Josep M. Pujol and Victor M. Eguiluz

An increasing fraction of today social interactions occurs using online social media as communication channels. Recent worldwide events, such as the revolts in Middle East or the recent social movements in Spain, reflect their capacity to boost people coordination. Online networks display, in general, a rich internal structure where users can choose among different types and intensity of interactions. Despite of this and their growing popularity, there are still open questions regarding the social value of online relations. For example, the existence of users with thousands or millions of online friends sheds doubts on the relevance of these connections. In this work, we focus on Twitter, one of the most popular online social networks, and find that the network formed by the basic type of relations is organized in groups. The activity of the users in the network is related to the landscape determined by such groups. Twitter's distinction between different types o interactions allows us to establish a parallelism between online and offline social networks: personal interactions are more likely to occur on internal links of groups (the weakness of strong

ties), events transmitting information pass preferentially through links connecting different groups (the strength of weak ties) or even more through links connecting to users belonging to several groups that act as brokers (the strength of intermediary ties).

TWITTER FOLLOW LINKS REVEAL BICAMERAL LANDSCAPE OF NEWSPAPERS

Jisun An, Meeyoung Cha, Krishna Gummadi and Jon Crowcroft

Media influence has been widely studied in cultivation theory, which holds that the popular media such as newspapers has power to influence our view of the world and set our day-to-day norms. Yet it is well known that mainstream newspapers today have bias in selecting what to report and in choosing a slant on a particular report. Exposure to biased news information may even increase intolerance of dissent and foster more ideological segregation of political and social issues. Therefore, tracking bias in everyday news and building a platform where people can receive balanced news information is important. Unfortunately, existing studies on identifying media bias have been restricted to examining a small set of news outlets, due to challenges in gathering and analyzing a huge amount of appropriate data. As a first step toward building a such platform, in this work we propose a novel model for inferring bias of news media outlets in real-time from the way social network users subscribe and disseminate news articles. With the advent of social media services, news media outlets have started publishing on social networking sites. Likewise Internet users have moved from scanning traditional mediums such as newspapers and television to using the Internet, in particular social networking sites, to find news.

In the popular microblogging site Twitter, users actively follow a wide set of news sources, form interpersonal networks, and propagate interesting news articles to their peers. These media subscription and interaction patterns, which had previously been hidden behind media corporations, poses as a new opportunity to understand media supply and consumption across society, for example, examining how different sources report different angles on the same event, and how the news consumers react to that. In this work, we investigated a methodological issue: can we draw a valid ideological map of news media based on users subscription and interaction patterns?

In order to answer these questions, we focused on 28 major U.S. based news outlets in Twitter and their aggregate 7 million followers. We created a closeness model based on the co-subscription relationships and mapped the news media outlets along a one-dimensional dichotomous political spectrum by using the global network positioning algorithm. Our data analysis revealed extreme polarization among media sources. The political ideological map in user subscription networks was strikingly similar to that proposed in previous work, which assigned an ADA (Americans for Democratic Action) score for each media outlet by manually investigating the think-tank citations of its news articles. Out of 18 news sources reported, we found 10 of them in our dateset. The result is shown in Figure 1. Note that we would not necessarily expect a perfect match to the result, both because our result represents the relationship among media sources in Twitter and the relationship changes over time. Nevertheless, we found a strong tendency of known political dichotomy where NPR News and New York Times, which are known to be left-slanted, are positioned to one side and Washington Times, Fox News, and U.S News, which are known to be rightslanted, are positioned on the other side.

However we also found a few exceptions; Washington Post and Washington Times, known to have conflicting political preferences, lined up close to each other – possibly due to regional proximity. Extending this work, we are currently examining how news media sources of different political slants cover the same news story by conducting topic classification on news articles that are shared on Twitter. It is noteworthy that an ideological map of news media sources can be generated automatically from our proposed methodology on inferring media bias, which is based on gathering online data and aggregating it via a closeness measure, without any complex procedures unlike in the past. Hence our methodology is suitable for a large-scale, repeated study. Furthermore the ideological map of a particular issue can be created in real time in conjunction with a public stream of tweets from Twitter. It is said that individuals need to have access to a pool of multiple points of view against which they can contrast their own values and belief as it helps them shape their eventual opinion. We hope to build a real-time platform that helps people receive balanced news information based on the proposed model that tracks bias in news in the future.

GATHERING METRICS FROM SOFTWARE REPOSITORIES USING NETWORK ANALYSIS

Andrew Dittrich, Mehmet Gunes and Sergiu Dascalu

Working on any large software project can be overwhelming at first. There is usually a steep learning curve before a developer is able to make real contributions. One challenge is finding the subject matter experts who can answer questions about a specific area of the software or to review changes. This is especially true of large projects with many modules and a large number of authors. In this paper, we describe a method to model a software project as a network using information mined from the project's version control repository, and demonstrate how network analysis techniques can be used to identify the key authors and subject matter experts. We investigate metrics that can be gathered using network analysis, such as which groups of authors typically work together, and how closely knit the developers are on a project. We analyze several specific projects to demonstrate the applicability of these techniques and several hundred projects to show general trends.

THE SOCIAL STRUCTURE OF ORGAN TRANSPLANTATION IN THE UNITED STATES

Srividhya Venugopal, Evan Stoner, Martin Cadeiras and Ronaldo Menezes

As of today, 110,629 Americans are waiting for an organ transplant and yet only 28,664 people received organ transplants in 2010. This fact alone demonstrates we have an organ-shortage crisis. Numbers such as these make it absolutely clear that we need to constantly be looking for improvements in the organ allocation systems. Before one ventures into proposing new allocation systems, it is crucial to understand the structure of the current system. In spite of availability of data on transplants, to our knowledge no proper analysis has been done using the data. This paper look at this data and what it may reveal about the allocation process currently in place. In order to structure the data we used techniques from network sciences to create a network of locations (henceforth called a Geographical Social Network) representing all the transplants in the USA since 1987 where nodes represent states in the USA. This "social structure" is then analyzed using techniques from network sciences to bring clarity to the organ donation process.

THE EFFECT OF CITATIONS TO COLLABORATION NETWORKS

Pramod Divakarmurthy and Ronaldo Menezes

We focus on Computer Science collaboration and our study is based on the publication of available at Association for Computing and Machinery (ACM) Digital Library. Understanding these networks help us better understand, how scientific discoveries and innovations are communicated within the scientific community. There are works that are never cited. This makes us wonder what is the effect of these uncited works to the studies done in collaboration networks. We generate two types of networks of authors, one considering the citations of papers and another without considering the citations. We measure and discuss the characteristics of both the networks.

TECHNICAL SESSION 7: NETWORKS IN BIOLOGY AND MEDICINE

Friday, March 9, 11:00

Chair: Neil Johnson (University of Miami, USA)

IDENTIFICATION OF RACIAL DISPARITIES IN ORGAN TRANSPLANTATION USING NETWORK SCIENCES

Srividhya Venugopal, Martin Cadeiras and Ronaldo Menezes

Organ transplantation is one of the best available treatments for several life-threatening diseases, such as end-stage renal disease where kidney transplantation is the only appropriate technique used to save the life of millions of people. However, there is an organ shortage crisis faced by people waiting for an organ for transplant in the USA. We need to analyze the process of organ allocation and find a way to improve the current system of allocation. In our previous work, we introduced a geographical social network (GSN) where the node represents the actual geographic locations, and the edges represent the number of transplantation between the location. We analyzed the community formation of GSN and found disparities in the geographical division between the communities.

Our work makes use of network techniques to understand the flow of organs among the ethnical divisions of the country. We demonstrate that as suggested in the previous studies, there are racial disparities existing in the allocation of organs in certain critical regions of the country when a community analysis was performed on the GSN network at state and zipcode levels. Through the use of statistical methods and network metrics, we evaluate the inter-community links that contribute to the unfair distribution. We then show that the distribution of organs across the state and zipcode levels between the donors and recipients display the unequal allocation among the ethnic groups. We also analyze the possible factors that contribute to the allocation process and the role played by factors such as education level and income level towards the unequal distribution.

A DRUG-TARGET NETWORK MAPPED ONTO THE METABOLIC NETWORK AS A TOOL FOR DRUG DESIGN

Mônica Campiteli, Matheus Viana, Francisco Aparecido Rodrigues and Luciano da Fontoura Costa

Drug design is a major subject that demands efforts from several disciplines. The search for new drugs with increased efficiency and fewer side effects is increasingly more dependent on computational aids to guide experiments. Among the means to design more efficient drugs are graph approaches with drug-target networks which are bipartite structures where nodes representing drugs are

connected to the nodes representing respective targets. The latter can represent target proteins, diseases or even symptoms. From the bipartite network,

One can derive two networks: drug-drug network, where drugs are connected whenever they are related to the same target; and target-target network, where targets are connected if they are related to the same drug. Such networks have revealed several characteristics of the drugs actions and diseases. Here we present a drug-target network where targets represent enzymes. The databases were donwloaded from the BioCyc and the Drugbank. We compare networks of Homo sapiens and E. coli. Besides the analysis of the two derived networks that reveals interesting characteristics of nodes that are drug targets in humans and the pathogenic organism, the enzymes can be mapped onto a metabolic network leading to a promising tool for analysis and discovery of drug targets that, when knocked-down, can shift the system's equilibrium to the healthy state.

A NOVEL FRAMEWORK FOR COMPLEX NETWORKS AND CHRONIC DISEASES

Philippe Giabbanelli

Complex networks have provided a wealth of information regarding infectious diseases, for example by understanding how the network structure impacts the basic reproduction number or immunization strategies. However, researchers have struggled to translate this knowledge to chronic diseases, where social networks are at play but broad societal factors also have an important role. This translation is becoming urgent given the increasing prevalence, and the escalating healthcare costs, of conditions such as obesity. In this paper, we provide a mathematical framework that enables us to represent both the network and societal aspects of chronic disease, thereby facilitating this translation effort. Our framework uses Complex Networks to represent the population, where influences between neighboring nodes are modeled through Fuzzy Cognitive Maps that also account for societal effects. Ease of use being an important concern for practitioners, we have also informally defined the framework and illustrated it for obesity and diabetes in Canadian Aboriginals. Further application of our framework to real-world cases, possibly through processes such as Group Model Building, may facilitate the better direction of policy towards the management of chronic diseases.

CENTRALITY AND NETWORK ANALYSIS IN A NATURAL PERTURBED ECOSYSTEM

Gilberto Pereira, Fátima Santos and Nelson Ebecken

The aim of this work is to gain knowledge on the interactions between the chlorophyll-a and nine meroplankton larvae of epibenthonic fauna. The studied case is the Arraial do Cabo upwelling system, Southeastern of Brazil, which provides different environmental conditions. To access this information a network approach based in probability estimative was used. Comparisons among the generated graphs are made in the light of different water masses, application of Shannon biodiversity index, and the closeness and betweenness centralities measurements. Our results show the main pattern among different water masses and how the core organisms belonging to the network skeleton are correlated to the main environmental variable. We conclude that the approach of complex networks is a promising tool for environmental diagnostic.

TECHNICAL SESSION 8: APPLICATIONS OF NETWORKS

Friday, March 9, 15:30

Chair: Fernando Buarque (State University of Pernambuco, Brazil)

THE EXPLANATORY POWER OF RELATIONS AND AN APPLICATION TO AN ECONOMIC NETWORK

Mauricio Monsalve

Understanding the topology of complex networks is a central concern of network science. Within this endeavor, we study the problems of building theories from the non-topological attributes of linked vertices and assessing their explanatory power. We design a simple framework for building theories from the attributes of vertices and apply it to explain the topology of the Chilean shareholding network, an economic network which vertices represent firms and edges represent an ownership relation, finding that a relational theory based on financial information explained the topology of the network only in part.

THE NETWORK OF DRIVING FORCES OF GLOBAL ENVIRONMENTAL CHANGE

Juan Carlos Rocha Gordo, Reinette Biggs and Garry Peterson

Over the past 50 years humans have changed ecosystems faster and more extensively than in any other comparable period in the

past. These changes have contributed to various global syndromes or regime shifts: abrupt, non-linear changes in social-ecological systems that can severely impact the flux of ecosystem services human societies rely upon. Inspired by recent work on the application of relational networks to human diseases, this paper explores the patterns of relationships among driving causes of regime shifts. Bipartite networks are analysed based on information collected in the Regime Shifts Database (www.regimeshifts.org). Relations among drivers of change are studied for 25 regime shifts in marine, terrestrial and polar ecosystems. Despite regime shifts are a multi-causal phenomena; preliminary results shows that global drivers or regime shifts tend to interact in a non-random pattern. Agriculture-related activities, global warming, biodiversity loss and economic drivers are the main causes of regime shifts independently of scale or ecosystem type. The ecosystem services most affected by regime shifts include provisioning services such as food (freshwater, crops and fish); regulating services such as water purification; as well as important impacts on cultural services like aesthetics and recreation. Networks analysis seems to open a window of opportunity to analyse regime shifts interactions in context where (i) time series data needed for early warnings and (ii) detailed information on causal mechanisms needed for models is limited or unavailable. Further research will explore the possibilities to expand the analysis to causal mechanisms, feedback loop strength and cascading effects among regime shifts. A research framework is proposed to approach regime shifts management in high uncertainty settings based on recent progress on network controllability.

EVALUATION OF COUPLED CLIMATE MODELS USING NETWORK ANALYSIS

Ilias Foudalis, Constantine Dovrolis and Annalisa Bracco

Network analysis provides a powerful, but only marginally explored, framework to validate climate models, quantify uncertainties and investigate teleconnections, assessing their strength, range, and impacts on the climate system. The application of network analysis in climate science is still at an early phase, with only a handful of related work. The goal of this approach is first to uncover relations in the climate system that are not (or not fully) captured by more traditional methodologies used in climate science and often adopted from nonlinear dynamical systems analysis. Secondly we aim to explain known climate phenomena in terms of the network structure or its metrics. In this work we compare the network structure of observations to the one of various state-of-the-art climate models. We conduct an extensive model comparison in terms of the climate network characteristics that each model leads to and of their robustness in past, present and future climate scenarios. We present algorithms that quantify how each model reproduces global teleconnections, identify common or specific errors found when comparing model outputs and observations for the XX century, and characterize how/whether networks changed over the recent past and how they may change under global warming scenarios. In this extended abstract we briefly describe our approach on inferring a network from climate data and present a few results.

MAPPING EMERGING NEWS NETWORKS: A CASE STUDY OF THE SAN FRANCISCO BAY AREA

Daniel Ramos, Mehmet Gunes, Donica Mensing and David M. Ryfe

The news and information system in the United States is undergoing a significant transformation. From a limited number of professional, major metropolitan newspapers, television and radio stations to a networked system of hundreds of small and medium size information sources, structural changes in news production and distribution are significantly altering the supply and flow of news to citizens. Using network analysis, we seek to map changes in the news ecology of the San Francisco Bay area. In this study, we graph the relationships between 143 locally based news Web sites to examine connections between news organizations, between journalists and their sources and between users of the news sites.

COMPLEX NETWORK FOR MODELING CRIME REPORTS IN COLLABORATIVE MAPS

Carlos Caminha, Vasco Furtado and Bruno Muniz

This research is based around a system for collaborative crime mapping, called WikiCrimes (www.wikicrimes.org). WikiCrimes subverts the traditional logic of the handling of information about crimes occurrences, because it allows citizens to build their own map of crime. Wikis, in general, and WikiCrimes in particular, are based on the concept of radical trust, i.e.; it is believed that individual participation mostly includes correct information. Nevertheless, the identification of fraud is necessary. The challenge imposed on WikiCrimes and collaborative maps in general is to ensure the credibility of the information recorded on the map and requires the study of different approaches. This challenge is the main motivation that brings us here to consider the use of information that can be modeled as a complex network. The distribution of crime by census tract is one of such information. Previous studies show that this distribution follows a power law. In this context there are few places that concentrate many crimes and many places that concentrate few crimes. This finding is very useful because it can support the identification of a malicious activity by the identification of abnormalities in the original power law distribution. However, the problem to do this is that the most prejudicial and difficult malicious activity to identify in this kind of maps is specific to a local area (in short, a local geographical

trend). These localized activities typically do not affect the original distribution (e.g. the crime distribution for an entire city). The perception of the trends in a digital map is typically made via kernel density algorithms, which identify areas that have a high concentration of crimes or hot spots. Note that a hot spot computed via kernel density methods depends on the number of crimes being analyzed, which in turn depends on the geographical area and the period to be considered. Whenever a user is visualizing a digital map, the screen is the limitation for perceiving the events on it. The manner the user has to vary the visualization of a geographical area is by regulating the zoom level. Therefore, the identification of hot spots must be done for different levels of zoom, and for each one of these levels, the hot spots configuration can be different. The representation of the network is a planar graph where the nodes (V) are the centroids of census tracts, the edges (E) represent the adjacency between the sectors and each node has a weight (w) representing the number of crimes recorded in the sector. The initial dataset has 1,570 crime reports made in WikiCrimes in a city of approximately 2 Million inhabitants and 2300 census tracts. We have first computed the distribution of reports per census tract. It is a Power Law distribution in which the exponent is 0,9. To simulate the process of zooming in the map of the city, we apply a model of extraction of samples that divides the original graph (the entire city) making use of a bisection method that guarantees to keep the samples connected and balanced. The process is recursive and, as two partitions are generated in each iteration, a binary tree is created. The bisection alternates the cut-off level of the tree between the x and y-axis, in order to keep the graphs generated closer to square. The stop condition is the minimum number of nodes (QMV < number of nodes) of the sample defined a priori. At the end of the process of sample extraction, we obtain a tree of height h = ($\log_2$ (V) - $\log_2$ (QMV)), i.e. we obtain 2h graphs. We calculate then the exponent of the distribution of crime by census tract for each one of these graphs. As deeper the level that the sample is, the smaller its size, the average slope decreases as the level deepens. In all datasets the standard deviation of the exponents of the distribution in each level was greater as long as we go down in the tree.

In a second step we model networks that are formed with the participation of people and their reports of crimes. Thus we have a bipartite undirected graph G = (V, E) where the census tracts, s, and users, u are the vertices and edges indicate a report of the crime by u in v. Each edge has a weight, w, which is the number of reports made by a user in a certain census tract. From the bipartite graph, we have generated a unipartite version in which the nodes represent census tracts and the edges indicate the sectors that are connected via a user. More specifically, the edges indicate if a user reported a crime in one sector and another. The weight of the edge is thus to identify how strong is the correlation between two census tracts. We found also that the distribution of edges follow a PL with exponent of 0.75. That is, few census tracts have a strong correlation and many sectors have little correlation. The next steps are to investigate whether this pattern is seen in samples in order to support the identification of malicious activities that subvert this standard.

IDENTIFYING CRITICAL TRAFFIC JAM AREAS WITH NODE CENTRALITIES INTERFERENCE AND ROBUSTNESS

Giovanni Scardoni and Carlo Laudanna

We introduce the notions of centrality interference and centrality robustness, as measures of variation of centrality values when the structure of a network is modified by removing or adding individual nodes from/to a network. Centrality analysis allows categorizing nodes according to their topological relevance in a network. Thus, centrality interference analysis allows understanding which parts of a network are mostly influenced by a node and, conversely, centrality robustness allows quantifying the functional dependency of a node from other nodes in the network. We examine the theoretical significance of these measures and apply them to classify nodes in a road network to predict the effects on the traffic jam due to variations in the structure of the network. In this case the interference analysis allows to predict which are the distinct regions of the network affected by the function of different nodes. Such notions, when applied to a variety of different contexts, opens new perspectives in network analysis since they allow predicting the effects of local network modifications on single node as well as global network functionality.

INFLUENCE MAXIMIZATION FOR ADVERTISING IN MULTI-AGENT MARKETS

Mahsa Maghami and Gita Sukthankar

The question of how to influence people in a large social system is a perennial problem in marketing, politics, and publishing. It differs from more personal inter-agent interactions that occur in negotiation and argumentation since network structure and group membership often pay a more significant role than the content of what is being said, making the messenger more important than the message. In this abstract, we propose a new method for propagating information through a social system and demonstrate how it can be used to develop a product advertisement strategy in a simulated market. We consider the desire of agents toward purchasing an item as a random variable and solve the influence maximization problem in steady state using an optimization method to assign the advertisement of available products to appropriate messenger agents. Our market simulation accounts for the 1) effects of group membership on agent attitudes 2) has a network structure that is similar to realistic human 3) models inter-product preference correlations that can be learned from market data. The results show that our method is significantly better than network analysis methods based on centrality measures.

POSTER SESSION

Wednesday, March 7, 17:30

MEASURING A CATEGORY-BASED BLOGOSPHERE

Priya Saha and Ronaldo Menezes

VULNERABILITY-AWARE ARCHITECTURE FOR A TACTICAL, MOBILE CLOUD

Anne-Laure Jousselme, Kevin Huggins, Nicolas Léchevin, Dominic Larkin and Patrick Maupin

MIGRATION, COMMUNICATION AND SOCIAL NETWORKS – AN AGENT-BASED SOCIAL SIMULATION

Hugo Barbosa Filho, Fernando B. de Lima Neto and Wilson Fusco

SOFTWARE COLLABORATION NETWORKS

Christopher Zachor and Mehmet Gunes

RIPPLE EFFECTS: SMALL-SCALE INVESTIGATIONS INTO THE SUSTAIN-ABILITY OF OCEAN SCIENCE EDUCATION NETWORKS

Robert Chen, Catherine Cramer, Pam Dibona, Russell Faux and Stephen Uzzo

REVEALING THE STRUCTURE OF PROGRAMMING ONLINE COMPETITIONS

Hilary Miller, Kesann Walrond-Mcclean and Ronaldo Menezes

EMERGING SOCIAL STRUCTURE AND DYNAMICS FROM TWITTER'S CONVERSATION

Alfredo Morales, F. Javier Borondo, Juan Carlos Losada and Rosa M. Benito

DISTRIBUTED FLOW OPTIMIZATION AND CASCADING EFFECTS IN WEIGHTED COMPLEX NETWORKS

Andrea Asztalos, Sameet Sreenivasan, Boleslaw Szymanski and Gyorgy Korniss

FACEBOOK RELATIONSHIPS IN THE WORKPLACE

Cristina Robles and Jennifer Golbeck

SUBCALLOSAL CINGULATE GYRUS IS THE MOST CENTRAL REGION IN THE NETWORK OF MAJOR DEPRESSIVE DISORDER (MDD)

Saeideh Bakhshi, David Gutman and Constantine Dovrolis

MICRO-LEVEL DYNAMICS OF CONTAGION IN MACRO-LEVEL NETWORKS: GLOBAL TRADE 1995-2008

Otto Koppius and Wouter Vermeer

WORK & PLAY: SIMULATING LANGUAGE CONTACT WITH DYNAMIC NETWORKS

Roland Muehlenbernd and Jason Quinley

A NETWORK APPROACH TO THE ORIENTATION PROBLEM IN GENOME ASSEMBLY

Karl Schmitt, Michelle Girvan, James Yorke and Alexsey Zimmin

SPREAD OF INFLUENCE WITH MULTIPLE INITIATORS

P. Singh, S. Sreenivasan, B. Szymanski and G. Korniss

CONSTRUCTION OF INFORMATION CAMPAIGN NETWORKS

Tommy Nguyen and Boleslaw Szymanski

STATISTICAL COMPLEX ANALYSIS OF TAXI MOBILITY IN SAN FRANCISCO
Oleguer Sagarra and Albert Diaz-Guilera

RIGID NETWORK STRUCTURE UNDERLIES COGNITIVE INFLEXIBILITY IN MATURE ADULTS
Malaak Nasser Moussa, Linda Porrino, Satoru Hayasaka, Jonathan Burdette and Paul Laurienti

INTER EVENT STUDIES ON THE OFC MODEL FOR EARTHQUAKES
Douglas S. R. Ferreira, Marco A. E. Santo and Andrés R. R. Papa

THE SMART GRID'S LAST MILE AS A COMPLEX NETWORK
Giuliano Andrea Pagani and Marco Aiello

MULTIPLEXITY-FACILITATED CASCADES IN NETWORKS
Charlie Brummitt, Kyu-Min Lee and Kwang-Il Goh

DISCOVERING THE GEOGRAPHY OF HUMAN MOVEMENTS
Michele Coscia, Fosca Giannotti, Dino Pedreschi, Salvatore Rinzivillo

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