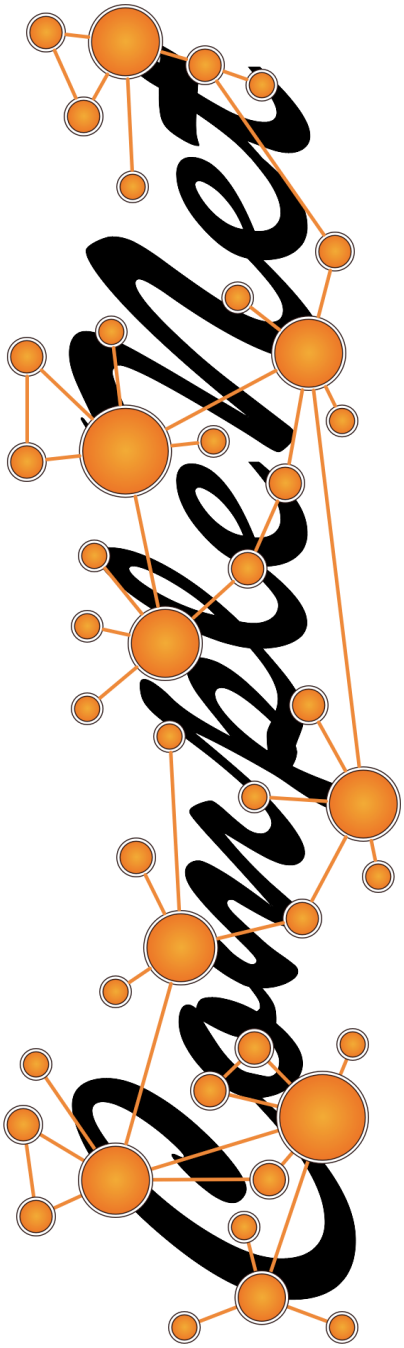

THE 2014 INTERNATIONAL WORKSHOP ON COMPLEX NETWORKS

Bologna, Italy

March 12-14, 2014

(with a Public Lecture on March 11)

FINAL PROGRAM

BOOK OF ABSTRACTS

GENERAL CHAIR

Andrea Omicini

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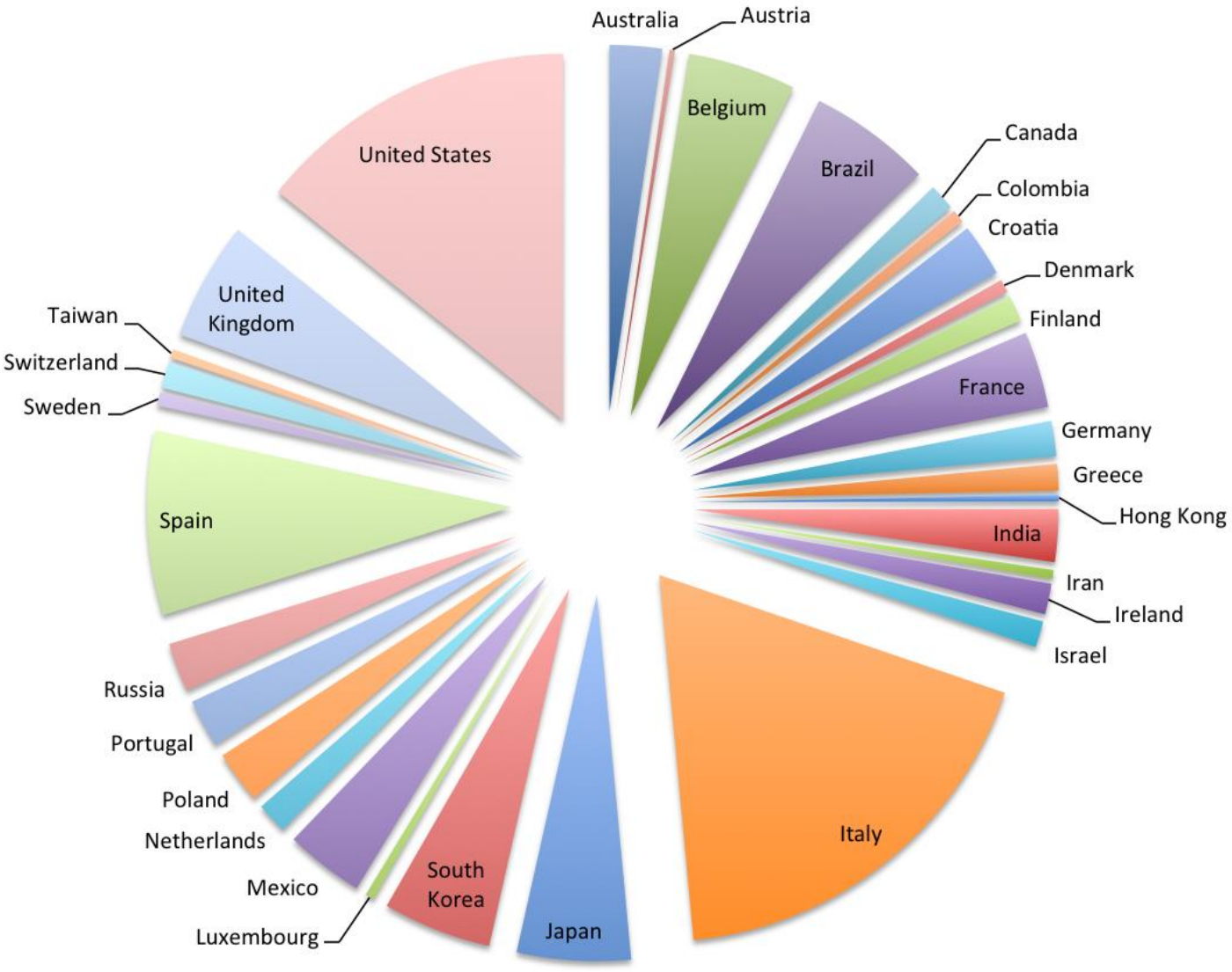


KEYNOTE SPEAKERS' BIOS

ALESSANDRO VESPIGNANI

Northeastern University, Boston, USA

ISI Foundation, Italy

Alessandro Vespignani is Sternberg Distinguished Professor at Northeastern University in Boston, where he leads the Laboratory for the Modeling of Biological and Socio-technical Systems. He is fellow of the American Physical Society, member of the Academy of Europe, and fellow of the Institute for Quantitative Social Sciences at Harvard University. He is also serving in the board/leadership of a variety of journals and the Institute for Scientific Interchange Foundation. He is president elected of the Complex Systems Society. Vespignani is focusing his research activity in modeling diffusion phenomena in complex systems, including data-driven computational approaches to infectious diseases spread.

TAMÁS VICSEK

Department of Biological Physics, Institute of Physics
Eötvös University Budapest

Tamás Vicsek is a Professor of Physics at the Biological Physics Department of Eötvös University and a head of the Statistical and Biological Physics research group of the Hungarian Academy of Sciences. Over the past 35 years he has been involved in doing computational and experimental research on fractals, pattern formation, granular materials, collective motion (bacterial colonies, flocks, crowds) and the and structure and evolution of complex networks. He has had visiting positions at various research institutes and universities, including Emory University, Yale University and the University of Notre Dame. Tamás Vicsek is a fellow of the APS and member of the Hungarian Academy of Sciences.

RAFFAELA BURIONI

Statistical Physics and Complex Systems Group and INFN
Università degli Studi di Parma

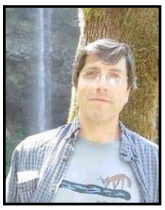
Raffaella Burioni is Associate Professor of Theoretical Physics of Matter in the Department of Physics at the University of Parma, Italy. Her main research areas are equilibrium and non-equilibrium statistical mechanics, complex networks and graphs, and their interdisciplinary applications to biology and social sciences.

INVITED SPEAKERS' BIOS

BRUNO GONÇALVES

Centre Physique Théorique, Aix-Marseille Université

Bruno Goncalves is currently a "Maître de Conférences" in Physics at the Centre de Physique Théorique of Aix-Marseille Université in Marseille, France where his research activity focuses on using computational visualization and data analysis methods for the study of Complex Systems in a multidisciplinary context. Current projects include the study of human behavior knowledge diffusion on large technological networks and detailed epidemic modeling in structured populations.



STEPHEN UZZO

VP Science and Technology
New York Hall of Science

Stephen Uzzo is Vice President for Science and Technology for the New York Hall of Science where he develops public programs and exhibitions on complex networks and systems thinking, and advocates for computational and data literacy. He also teaches science education theory and practice at the New York Institute of Technology Graduate School of Education. His background includes scientific visualization and computer graphics in STEM learning. Current research interests include the neurological basis for learning and creativity. Dr. Uzzo holds a terminal degree in network theory and environmental studies from the Union Institute.

ADRIANO BARRA

Department of Physics
Sapienza University of Rome

Laurea in theoretical physics (Sapienza Università di Roma), PhD in applied mathematics (King's College London), Post-doc (one year) at Mathematics Department (Bologna University), Post-doc (three years) at the Physics Department (Sapienza Università di Roma), Researcher in theoretical physics at the Physics Department of Sapienza Università di Roma. Three times winner of the GNFM-INdAM "young project" selection. Winner as PI of a FIRB grant on theoretical immunology and statistical mechanics. Author of more than fifty scientific publications.

MIRKO DEGLI ESPOSTI

Dipartimento di Matematica
University of Bologna

Full Professor in Mathematical Physics. He used to explore mathematical properties of classical and quantum complex systems. Recently he focused his attentions to mathematical models of textual data with emphasis to the nature of long-range correlations, to algorithms for authorship attribution and more broadly to the statistical properties of written language.

GIORGIO FAGIOLO

Laboratory of Economics and Management
Sant'Anna School of Advanced Studies

Giorgio Fagiolo is associate professor of economics at the S.Anna School of Advanced Studies (Pisa, Italy), where he holds a tenured position in the Institute of Economics. He holds a bachelor's degree in mathematical statistics from the University of Rome "La Sapienza" and a Ph.D. in economics from the European University Institute (Florence, Italy). His main areas of scientific interest include agent-based computational economics, complex networks, evolutionary games, industrial dynamics, and economic methodology (with particular emphasis on the scientific status of agent-based computational economics; empirical validation of economic models; and their policy-related implications). His papers were published, among others, in Science, Journal of Economic Geography, Journal of Applied Econometrics, Journal of Economics Dynamics and Control, Computational Economics, Physical Review E, Journal of Economic Behavior and Organization, Industrial and Corporate Change, Advances in Complex Systems, Journal of Evolutionary Economics, European Physical Journal B, Journal of Economic Interaction and Coordination; as well as in several peer-reviewed book chapters.

JUYONG PARK

Network Analytics and Informatics Group
KAIST, South Korea

Juyong Park has earned Ph.D in physics from the University of Michigan. Since then he has worked on biological, technical, and social networks. He specializes in analytical methods for network analysis and networks of sports, culture, and online games. He is currently assistant professor of Culture Technology and Korea Advanced Institute of Science and Technology.

CompleNet 2014 Program at a Glance

Tuesday, March 11, 2014	
17:00	*Public Lecture: Alessandro Vespignani (in Italian)*
Wednesday, March 12, 2014	
09:00	Opening Remarks by *Andrea Omicini* (Conference Chair), *Pierluigi Contucci*, *Julia Poncela-Casasnovas* (Program Co-Chairs)
09:10	Message from the Steering Committee by *Ronaldo Menezes*, *Giuseppe Mangioni* and *José Mendes*
09:20	*Keynote: Alessandro Vespignani*
10:20	Coffee Break
10:40	Technical Session 1: Social Networks, Social Media and the Arts
12:40	Lunch Break
13:40	*Invited Speaker: Bruno Gonçalves*
14:20	Technical Session 2: Community Detection and Co-Evolving Networks #1
15:40	Coffee Break (with Poster Session)
16:40	*Invited Speaker: Adriano Barra*
17:20	Technical Session 3: Multiplex, Synchronization and Cascades
Thursday, March 13, 2014	
09:20	*Keynote Speaker: Tamás Vicsek*
10:20	Coffee Break (with Poster Session)
11:20	Technical Session 4: Diffusion, Spreading and Searching on Networks
13:20	Lunch Break
14:20	*Invited Speaker: Giorgio Fagiolo*
15:00	Technical Session 5: Networks in Finance and Economics
16:00	*Invited Speaker: Stephen Uzzo*
16:40	FREE AFTERNOON
20:00	Social Event
Friday, March 14, 2014	
09:20	*Keynote Speaker: Raffaella Burioni*
10:20	Coffee Break
10:40	Technical Session 6: Biological and Health-Related Networks
11:20	Technical Session 7: Community Detection and Co-Evolving Networks #2
12:20	*Invited Speaker: Mirko Degli Esposti*
13:00	Lunch Break
14:00	Technical Session 8: Language Networks and Science of Science
15:40	Coffee Break
16:00	*Invited Speaker: Juyong Park*
16:40	Technical Session 9: Network Theory, Modeling and Metrics
18:00	Closing Remarks and Announcement of CompleNet 2015 Venue

CompleNet 2014 Detailed Program

Tuesday, March 11, 2014

17:00	Public Lecture (in Italian) Modeling and Forecast of Socio-technical Systems in the Data-science Age by *Alessandro Vespignani* Venue: Aula Magna, Accademia delle Belle Arti

Wednesday, March 12, 2014

09:00	Opening Remarks *Andrea Omicini* (Conference Chair) *Pierluigi Contucci and Julia Poncela-Casasnovas* (Program Co-Chairs)
09:10	Message from the Steering Committee *Ronaldo Menezes* (Member of the Steering Committee)
09:20	Modeling and Forecast of Network-driven Contagion Processes by *Alessandro Vespignani*
10:20	Coffee Break
10:40	Technical Session 1 (Chair Vespignani): Social Networks, Social Media and the Arts • The Network of Western Classical Music Composers. *Doheum Park, Arram Bae and Juyong Park* • The Network of Western Classical Musicians. *Arram Bae, Doheum Park and Juyong Park* • Systematic Dynamic and Heterogeneous Analysis of Rich Social Network Data. *Lei Meng, Tijana Milenkovic and Aaron Striegel* • Application of Text Mining to Analysis of Social Groups in Blogosphere. *Bogdan Gliwa, Anna Zygmunt, Jaroslaw Kozlak and Krzysztof Cetnarowicz* • Moneymakers and Bartering in Online Games: The Social Network Factors. *Jane Lee, Ah Reum Kang, Huy Kang Kim and Juyong Park* • Homophily, Stable Community Structure and Language Patterns in Social Networks. *John Bryden*
12:40	Lunch Break
13:40	Geolocation and Human Behavior

	by *Bruno Gonçalves*
14:20	Technical Session 2 (Chair Goncalves): Community Detection and Co-Evolving Networks #1 • Co-Evolution of Network and Attacker. *Holly Arnold, David Masad, Giuliano Andrea Pagani, Johannes Schmidt and Elena Stepanova* • Community Detection in Bipartite Networks Using Random Walks. *Taher Alzahrani, Kathy Horadam and Serdar Boztas* • A Coevolutionary Model of Strategic Network Formation. *Ibrahim Al-Shyoukh and Jeff Shamma* • Distributed Generation of Billion-node Social Graphs with Overlapping Community Structure. *Kyrylo Chykhradze, Anton Korshunov, Nazar Buzun, Roman Pastukhov, Nikolay Kuzyurin, Denis Turdakov and Hangkyu Kim*
15:40	Coffee Break (with Poster Session)
16:40	Stochastic Methods in Quantitative Sociology by *Adriano Barra*
17:20	Technical Session 3 (Chair Barra): Multiplex, Synchronization and Cascades • K-core Percolation on Multiplex Networks. *Nahid Azimi-Tafreshi, Jesus Gomez-Gardenes and Sergey Dorogovtsev* • Remote Synchronization in Complex Networks. *Lucia Valentina Gambuzza, Alessio Cardillo, Alessandro Fiasconaro, Luigi Fortuna, Jesus Gomez-Gardenes and Mattia Frasca* • Robustness of Chimera States in a System of Non-locally Coupled Oscillators. *Philipp Hoevel and Iryna Omelchenko* • Inferring Perturbation Cascades on Complex Networks. *Francesco Alessandro Massucci, Roger Guimera and Marta Sales-Pardo*
18:40	DAY 1 ENDS

Thursday, March 13, 2014

09:20	Why do we live in hierarchies? by *Tamás Vicsek*
10:20	Coffee Break (with Poster Session)
11:20	Technical Session 4 (Chair Vicsek): Diffusion, Spreading and Searching on Networks • Searching in Unstructured Overlays Using Local Knowledge and Gossip. *Stefano Ferretti*

	• Self-Organizing Techniques for Knowledge Diffusion in Dynamic Social Networks. *Luca Allodi, Luca Chiodi and Marco Cremonini* • Random walk Centrality for Temporal Networks. *Luis Rocha* • Efficient Routing in Data Center with Underlying Cayley Graph. *Miguel Camelo, Dimitri Papadimitriou, Lluis Fabrega and Pere Vila* • The Evolutionary Vaccination Dilemma in Complex Networks. *Alessio Cardillo, Catalina Reyes-Suárez, Fernando Naranjo and Jesus Gomez-Gardenes* • Localized Control of Vicsek's Agents. *Mattia Frasca, Arturo Buscarino, Luigi Fortuna and Alessandro*
13:20	Lunch Break
14:20	Macroeconomic Networks by *Giorgio Fagiolo*
15:00	Technical Session 5 (Chair Fagiolo): Networks in Finance and Economics • Financial Networks: How to Build, Analyze and Make the Best Use of Them. *Tomaso Aste, Nicolo Musmeci, Tiziana Di Matteo and Guido Previde Massara* • Growing Imbalance and Integration of European trade: a Network-Centric View. *Gautier Krings, Jean-François Carpantier and Jean-Charles Delvenne* • Choreography in Inter-Organizational Innovation Networks. *Giovanna Ferraro and Antonio Iovanella*
16:00	Toward a Network Model of Learning by *Stephen Uzzo*
16:40	DAY 2 ENDS
20:00	Social Event

Friday, March 14, 2014

09:20	Interacting Models in Social Sciences and Health Screening Campaigns by *Raffaella Burioni*
10:20	Coffee Break
10:40	Technical Session 6 (Chair Uzzo): Biological and Health-Related Networks • EGIA - Evolutionary optimization of Gene regulatory networks, an Integrative Approach. *Alina Sirbu, Martin Crane and Heather J Ruskin* • Dynamic Contact Network Analysis in Hospital Wards. *Lucie Martinet, Christophe Crespelle and Eric Fleury*
11:20	Technical Session 7 (Chair Uzzo): Community Detection and Co-Evolving Networks #2

	• Community Detection in Temporal Networks. *Vsevolod Salnikov and Renaud Lambiotte* • Detecting Community Structure in Quantum Complex Networks. *Mauro Faccin* • Co-Evolution of Multiple Social Networks: A Data-based, Parametric Study Framework. *Matteo Magnani and Luca Rossi*
12:20	Networks and Textual Data by *Mirko Degli Esposti*
13:00	Lunch Break
14:00	Technical Session 8 (Chair Degli Esposti): Language Networks and Science of Science • Inducing Language Networks from Continuous Space Word Representations. *Bryan Perozzi, Rami Al-Rfou', Vivek Kulkarni and Steven Skiena* • Network Differences Between Normal and Shuffled Texts: A Case of Croatian. *Domagoj Margan, Sanda Martinčić-Ipšić and Ana Meštrović* • Negative Implications of a Power-Law Distribution: A Study on Network of Scientific Reviewers. *Song Qin, Marius Silaghi, William Cheung and Ronaldo Menezes* • A Network-Autopoietic Perspective on Social Dynamics: Analyzing Knowledge and Communication Structures. *Nikita Basov* • The Story of your Big Hit. *Roberta Sinatra, Dashun Wang, Chaoming Song, Pierre Deville and Albert-László Barabási*
15:40	Coffee Break
16:00	At The Intersection: Data-Driven Discovery and Mathematical Modeling of Network Dynamics by *Juyong Park*
16:40	Technical Session 9 (Chair Park): Network Theory, Modeling and Metrics • Discovering Colored Network Motifs. *Pedro Ribeiro and Fernando Silva* • Core Decomposition in Directed Networks: Kernelization and Strong Connectivity. *Vincent Levorato* • Correlation Dimension of Spatial Complex Networks. *Jesus Gomez-Gardenes and Lucas Lacasa*
17:40	Closing Remarks and Announcement of CompleNet 2015 Venue
17:50	DAY 3 ENDS

KEYNOTE ADDRESSES

MODELING AND FORECAST OF NETWORK-DRIVEN CONTAGION PROCESSES

Alessandro Vespignani

Wednesday, March 12, 9:20

At the core of all epidemic modeling approaches is the structure of human interactions, mobility and contacts patterns that finds its best representation in the form of networks. While for a long time detailed data on those networks were simply unavailable, the recent big data revolution is finally enabling the data-driven study of the interplay between epidemic processes and networks. Mathematical and computational methods have expanded into schemes that explicitly include spatial structures, individuals' heterogeneity and the multiple networks at play during the dynamic of an epidemic. These models have gained importance in the public-health domain, especially in infectious disease epidemiology, by providing quantitative analysis in support of the policy-making processes. In this lecture I will focus on discussing the recent successes as well as the methodological challenges in the modeling and forecast of network-driven contagion processes. Namely I will discuss the phenomenology emerging from the integration of multi-scale networks, the accuracy provided by different levels of data-integration, the problem of real-time estimation of parameters, and the validation through high quality data sets of the computational models. Finally I will discuss a novel class of models, capable of encoding the concurrent evolution of spreading processes and the network dynamics.

WHY DO WE LIVE IN HIERARCHIES?

Tamás Vicsek

Thursday, March 13, 9:20

Social structure has the potential to impact the way that information flows through groups and the group decisions that emerge during collective action. The structure of social ties can depend on many factors, in particular, on the context in which they manifest themselves. In order to get deeper insights into the mechanisms favouring the emergence of context-dependent hierarchies we have carried out both experiments as well as constructed/investigated a family of computational models.

The problems we have addressed are rather general but still lack a satisfactory theoretical interpretation involving answers on a quantitative level. In spite of the abundant presence of hierarchy most of the related questions are still open. Why is hierarchy so common? Where is its advantage come from? Better adaptability? A more robust, stable structure?

First, we designed a model – based on first principles only -- to determine the optimal distribution of (costly) competences in a group with limited resources. We showed that this distribution is a highly skewed function with a structured fat tail. Potential applications include choosing the best composition for a group intended to solve a given task. Next we investigated the question of controllability of structures that can be described in terms of hierarchical networks. According to our results it is easier to steer these systems if the states of the edges (as opposed to the nodes) are controlled through a switchboard mechanism.

We have also addressed the question of how and why a hierarchical network of pairwise interactions emerges in a group of non-cooperating individuals. We showed that leader-follower relationships emerge spontaneously when the members of a group make use of copying decisions from others (having better abilities) while trying to optimize their own performance.

*In close collaboration with Zs. Ákos, D. Biro, M. Nagy, T. Nepusz, G. Vásárhelyi, A. Zafeiris

INTERACTING MODELS IN SOCIAL SCIENCES AND HEALTH SCREENING CAMPAIGNS

Raffaella Burioni

Friday, March 14, 9:20

Imitation and social pressure are usually observed in the aggregate behavior of populations, and they are responsible for the appearance of trends, herd effects, discontinuities and crashes. To account for these phenomena, interactions networks must be included in the modeling of social systems, and measured from data. We will review recent approaches in the field that lies between statistical mechanics and choice theory, with different languages but analogous results. We will then present a recent analysis on an extensive dataset from adhesion to cancer screening campaigns, where a quantitative estimate of average interaction effects can be performed and used to forecast effective social policies to enhance participation.

INVITED TALKS

GEOLOCATION AND HUMAN BEHAVIOR

Bruno Gonçalves

Wednesday, March 12, 13:40

The growing diffusion of GPS enabled cell phones coupled with the widespread adoption of social networking tools is opening up new avenues for the study of human behavior. Using a large dataset of geolocated Tweets we present an analysis of both at the temporal and spatial aspects of human communication and interaction.

1. We focus on Twitter activity surrounding American Idol voting as minimal and simplified version of complex societal phenomena such as political elections, and show that the volume of information available in online systems permits the real time gathering of quantitative indicators anticipating the future unfolding of opinion formation events.
2. By coupling the analysis of geocoded tweets over a period of two years with tools for automatic language detection we are able to present a large scale study of the geography of language use around the world at scales ranging from country to neighborhood level and how it varies over the course of a year due to seasonal variations of tourism.
3. Tracking several hundreds of thousands of individuals over the course of their entire usage of Twitter we analyse the impact of mobility on the development of social ties. With a simple benchmark, we are able to demonstrate that the model is able to reproduce various network and physical statistical properties of the system.

STOCHASTIC METHODS IN QUANTITATIVE SOCIOLOGY

Adriano Barra

Wednesday, March 12, 16:40

In this talk I will try to summarize some recent investigation I did in trying to understand complex behaviors in social sciences, focusing on a concrete test-case, namely migrant's integration in Spain in the first decade of the new millennium. I will infer information trough different routes: Graph theory, statistical mechanics, and stochastic processes.

This is a shared work with E. Agliari, P. Contucci, F. Guerra, R. Sandell, and C. Vernia.

MACROECONOMIC NETWORKS

Giorgio Fagiolo

Thursday, March 13, 14:20

In the last years, a lot effort has been devoted in understanding the topological properties of macroeconomic networks (MN)s, and how they evolve across time. MNs are graphs where nodes are world countries and links represent different between-country interaction channels, such as trade, finance, investment, migration and people mobility, etc. This talk surveys recent work on this subject. We discuss how MNs are shaped, how they can be modeled, and why studying MNs may be important to understand the diffusion of economic shocks and economic-crisis spreading.

TOWARD A NETWORK MODEL OF LEARNING

Stephen Uzzo

Thursday, March 13, 16:00

There is tremendous interest in functionally and structurally modeling the brain, its evolution and dynamics. Three significant major initiatives are underway to accomplish this, including the Human Connectome Project, The Blue Brain, and the BRAIN initiative. What all of these projects have in common is that they look for functional and structural connections within the brain and try to map them. But when we look at the process of learning from a network perspective, we realize that the physical brain is just a part of the equation. Recent research into brain function and theories about embodied cognition point to the need to map whole dynamic neurological systems, their environmental contexts and interscale behaviors in order to understand the process of learning in any meaningful way. This will be needed to revise cognitive and learning sciences, and ultimately, teaching and learning practice. This paper will describe what is missing in the study of learning and the network basis for a new human learning model.

NETWORKS AND TEXTUAL DATA

Mirko Degli Esposti

Friday, March 14, 12:20

Networks can be associated to textual data in several different ways. We will discuss some of these choices and some recent mathematical and numerical results, with emphasis to the nature of long correlations in texts and other statistical properties of written languages. Possible applications to authorship attribution and semantic extraction will be discussed.

AT THE INTERSECTION: DATA-DRIVEN DISCOVERY AND MATHEMATICAL MODELING OF NETWORK DYNAMICS

Juyong Park

Friday, March 4, 16:00

Competitions between a complex system’s constituents and a corresponding reward mechanism based on it have profound influence on the functioning, stability, and evolution of the system. But determining the dominance hierarchy or ranking among the constituent parts from the strongest to the weakest -- essential in determining reward or penalty -- is almost always ambiguous due to the incomplete nature of competition networks. Here we introduce the ``Natural Ranking,'' a desirably unambiguous ranking method applicable to a complete (full) competition network, and formulate an analytical model based on the Bayesian formula for inferring the expected mean and error of the natural ranking of nodes from an incomplete network. We investigate its potential and uses in resolving important issues of ranking by applying it to a real-world competition network.

TECHNICAL SESSION 1: SOCIAL NETWORKS, SOCIAL MEDIA AND THE ARTS

Wednesday, March 12, 10:40

Chair: Alessandro Vespignani (Northeastern University, USA and ISI Foundation, Italy)

THE NETWORK OF WESTERN CLASSICAL MUSIC COMPOSERS

Doheum Park, Arram Bae and Juyong Park

Network science focuses on the connections between the elements of a complex system in order to uncover the nature and the underlying patterns of interaction relationships inside the system. In this paper we apply network theory to understand associations between the composers of western classical music constructed from a comprehensive data of CD recordings. We study the properties of the network of composer-composer ties including the degree distribution, the component structure, clustering, and several types of centralities of the composers. We also investigate the nature of prominent modules found in the network, and show how the tastes of consumers of western classical music manifest themselves in the network. We believe that our work shows us how network science can be a useful tool studies in arts and humanities.

THE NETWORK OF WESTERN CLASSICAL MUSICIANS

Arram Bae, Doheum Park and Juyong Park

The expanding availability of large-scale data is leading to increased opportunities for applying advanced data analysis and modeling methodology to a wide range of problems and systems, allowing us to deepen our understandings and make novel discoveries. In this paper we use the tools of network science to the network of composers and performers from the western classical musical tradition constructed from an extensive data archive of CD recordings. We measure the fundamental characteristics of the network such as the small-world property and the power-law degree distribution. We also investigate the community structures of the musicians, revealing how individual attributes such as musical style, positions, and nationalities factor into the large-scale association patterns of the network. We believe that our work showcases the potential benefits of network science in the study of arts and humanities.

SYSTEMATIC DYNAMIC AND HETEROGENEOUS ANALYSIS OF RICH SOCIAL NETWORK DATA

Lei Meng, Tijana Milenkovic and Aaron Striegel

Recent technological advances have lead to increasing amounts of social network data that is longitudinal or encompasses multiple link types. We aim to provide a framework for systematic analysis of such data. We test and validate the framework on a unique and rich social network, by studying the evolution of network structure over an 18-month period as well as the relationships between different communication types (including both digital (e.g., Facebook) and face-to-face interactions).

APPLICATION OF TEXT MINING TO ANALYSIS OF SOCIAL GROUPS IN BLOGOSPHERE

Bogdan Gliwa, Anna Zygmunt, Jaroslaw Kozlak and Krzysztof Cetnarowicz

The paper concerns analysis of social groups in blogosphere with utilizing text-mining methods to discover additional knowledge about groups and users. Two methods to distinct messages (the first one - in main and secondary thread, the second one - between facts and opinions) in blogosphere were proposed and their quality was assessed on manually annotated dataset. Both tasks are very important and proposed methods deal with them in a fully automatic way. The results were obtained on real-world data from Polish blogosphere.

MONEYMAKERS AND BARTERING IN ONLINE GAMES: THE SOCIAL NETWORK FACTORS

Jane Lee, Ah Reum Kang, Huy Kang Kim and Juyong Park

Here we study the interpersonal trade network found in a Massively Multiplayer Online Role-Playing Game (MMORPG), where players actively engage in the exchange and sales of goods and items in a hyperrealistic virtual environment. The most common form of interpersonal trade is bartering, which makes determining the total value of items a nontrivial manner. In this paper we introduce the concept of Standard Price (SP) of items measured in a common in-game currency computed from the trade network itself. Based on the standard prices of items thus determined we investigate the relation between the profitability of a trade and the structure of the social networks of trading partners. We find that the social network plays a role in the outcome of interpersonal trades. For instance, we observe that the margin of profit in a trade correlates with the social distance between trading partners, suggesting that social affinity implies shared information on the value of an item.

HOMOPHILY, STABLE COMMUNITY STRUCTURE AND LANGUAGE PATTERNS IN SOCIAL NETWORKS

John Bryden

I look at the role homophily plays in social networks by studying a model of dynamic networks and then applying the model's results to data gathered from the online social network Twitter.

The model looks at dynamic networks with stochastic processes. Although often portrayed as fixed in time, many real world networks are inherently dynamic, as the edges that join nodes are cut and rewired, and nodes themselves update their states. I will present a model that builds upon existing models of coevolving networks. This model characterizes how dynamic and stochastic behaviour at the level of individual nodes can generate stable aggregate behaviours. An important process in the model is homophily, where nodes tend to rewire to other similar nodes. The results show the network modularity reaches a stable equilibrium in our dynamic network that is quantified analytically. Furthermore, if node state is not fixed, but can be adopted from neighbouring nodes, the distribution of group sizes reaches a dynamic equilibrium, which remains stable even as the composition and identity of the groups change. These results show that dynamic networks can maintain the stable community structure that has been observed in many social and biological systems.

Following on from this is a study looking at how language and social network structure interlink on Twitter, an online social network. Language has functions that transcend the transmission of information and varies with social context. The study found that the network emerging from user communication on Twitter can be structured into communities, and that the frequencies of words used within those communities closely replicate this pattern. Looking at the word usage of the community members, we found that community members share language features that indicate common interests. The approach can be used for enriching community detection with word analysis, which provides the ability to automate the classification of communities in social networks and identify emerging social groups. Put together with the model, this indicates that the Twitter network was formed by a process of homophily, with users of similar interests linking to one another, as described by the dynamic network model.

TECHNICAL SESSION 2: COMMUNITY DETECTION AND CO-EVOLVING NETWORKS #1

Wednesday, March 12, 14:20

Chair: Bruno Gonçalves (Aix-Marseille Université, France)

CO-EVOLUTION OF NETWORK AND ATTACKER

Holly Arnold, David Masad, Giuliano Andrea Pagani, Johannes Schmidt and Elena Stepanova

The evolution of interactions between individuals or organizations is a central theme of complexity research. We aim at modeling a dynamic game on a network where an attacker and a defender compete in disrupting and reconnecting a network. The choices of how to attack and defend the network are governed by a Genetic Algorithm (GA), which is used to dynamically choose among a set of available strategies. Our analysis shows that the choice of strategy is particularly important if the resources available to the attacker and defender are similar. In such a situation, the defender and attacker genomes co-evolve and find equilibrium. The best strategies found through GAs by the attackers and defenders are based on betweenness centrality. Our results agree with previous literature assessing strategies for network attack and defense in a static context. However, our paper is the first to show how a GA approach can be applied in a dynamic game on a network. This research provides a starting-point to further explore strategies as we currently apply a limited set of strategies only.

COMMUNITY DETECTION IN BIPARTITE NETWORKS USING RANDOM WALKS

Taher Alzahrani, Kathy Horadam and Serdar Boztas

Community detection plays a crucial role in many complex networks, including the increasingly important class of bipartite networks. Modularity-based community detection algorithms for bipartite networks are hampered by their well-known resolution limit. Unfortunately, the high-performing random walk based algorithm Infomap, which does not have the same constraint, cannot be applied to bipartite networks. To overcome this we integrate the projection method for bipartite networks into Infomap, to acquire a weighted one mode network that can be clustered by the random walks technique. We also compare results obtained from this process with results in the literature. We illustrate the proposed method on four real bipartite networks, showing that the random walks technique is more effective than the modularity technique in finding communities from bipartite networks as well.

A COEVOLUTIONARY MODEL OF STRATEGIC NETWORK FORMATION

Ibrahim Al-Shyoukh and Jeff Shamma

In foundational models of network formation, the mechanisms for link formation are based solely on network topology. For example, preferential attachment uses degree distributions, whereas a strategic connections model uses internode distances. These dynamics implicitly presume that such benefits and costs are instantaneous functions of the network topology. A more detailed model would include that benefits and costs are themselves derived through a dynamic process, which, in the absence of time-scale separation, necessitates a coevolutionary analysis. This paper introduces a new coevolutionary model of strategic network formation. In this model, network formation evolves along with the flow of benefits from one node to another. We examine the emergent equilibria of this combined dynamics of network formation and benefit flow. We show that the class of strict equilibria is stable (or robust to small perturbations in the benefits flows).

DISTRIBUTED GENERATION OF BILLION-NODE SOCIAL GRAPHS WITH OVERLAPPING COMMUNITY STRUCTURE

Kyrylo Chykhradze, Anton Korshunov, Nazar Buzun, Roman Pastukhov, Nikolay Kuzyurin, Denis Turdakov and

Hangkyu Kim

In the field of social community detection, it is commonly accepted to utilize graphs with reference community structure for accuracy evaluation. The resulting accuracy value is obtained by directly comparing the ground-truth set of communities with the one produced by the algorithm. Therefore, a generic tool capable of generating random social graphs with realistic community structure and diverse properties is required. As soon as populations of modern social networks reach billion users in size, the tool must be scalable enough to produce synthetic networks of similar scale.

The method for generating large random social graphs with realistic community structure is introduced in the paper. The resulting graphs have several of recently discovered properties of social community structure which run counter to conventional wisdom: dense community overlaps, superlinear growth of number of edges inside a community with its size, and power law distribution of user-community memberships. Further, the method is by-design distributable and showed near-linear scalability in Amazon EC2 cloud using Apache Spark implementation.

TECHNICAL SESSION 3: MULTIPLEX, SYNCHRONIZATION AND CASCADES

Wednesday, March 12, 17:20

Chair: Adriano Barra (Sapienza University of Rome, Italy)

K-CORE PERCOLATION ON MULTIPLEX NETWORKS

Nahid Azimi-Tafreshi, Jesus Gomez-Gardenes and Sergey Dorogovtsev

We generalize the k-core percolation theory to multiplex networks, where k = (k_a, k_b,...). Multiplex networks are networks with vertices of one kind but different types of edges a, b,... . For these networks, the k-core is defined as the largest subgraph in which each vertex has at least k_i edges of type i, for each type i = a, b,.... Using locally tree-like structure of networks, we derive analytically self-consist equations that allow us to obtain the emergence points of k-cores and their sizes for uncorrelated multiplex networks with arbitrary degree distributions. To clarify our general results, we consider multiplex networks with two types of edges and solve the resulting equations for particular case of Erdös–Rényi and scale-free multiplex networks. We find so-called hybrid phase transitions at the emergence points of k-cores for $k_a \geq 2$ and $k_b \geq 2$. Our results are confirmed by analyzing the data obtained from real world networks.

REMOTE SYNCHRONIZATION IN COMPLEX NETWORKS

Lucia Valentina Gambuzza, Alessio Cardillo, Alessandro Fiasconaro, Luigi Fortuna, Jesus Gomez-Gardenes and Mattia Frasca

In this work we show a novel synchronization state in networks of coupled oscillators. This state, called Remote Synchronization, is characterized by the synchronization of pairs of nodes that are not directly connected via a physical link or any sequence of synchronized nodes. Moreover, remote synchronization is manifested when considering oscillators having amplitude and phase as dynamical variables, in contrast to the usual setting in which phase oscillators are considered, as its underlying mechanism is the modulation of the amplitude of those intermediary nodes allowing the exchange of information between remotely synchronized units. Although some previous observations of such phenomenon were made in simple star-like graphs, here we show its ubiquity in the general framework of complex networks. To this end we analyze its existence as a robust dynamical state that appears before global synchronization shows up. Our findings thus show the ubiquity and robustness of these states and bridge the gap from their recent observation in simple toy graphs to complex networks. In addition, our results highlight the important difference between the real (i.e. associated to physical links) and the functional (i.e. emerging from synchronization) connectivity of a network.

ROBUSTNESS OF CHIMERA STATES IN A SYSTEM OF NONLOCALLY COUPLED OSCILLATORS

Philipp Hoevel and Iryna Omelchenko

Chimera states, a peculiar type of dynamics that exhibits a hybrid nature combining both coherent and incoherent parts, were first reported for the well-known model of phase oscillators. The most surprising aspect of this discovery was that these states exist in a system of identical oscillators coupled in a symmetric ring topology with a symmetric interaction function. Recent works have shown that chimeras are not limited to phase oscillators, but can in fact be found in a large variety of different systems and are not restricted to one spatial dimension. The nonlocality of the coupling is a crucial ingredient for appearance of chimera states. We present evidence that the habitat of chimeras extends to neural models and demonstrate the robustness of these interesting states for inhomogeneous parameter distributions.

INFERRING PERTURBATION CASCADES ON COMPLEX NETWORKS

Francesco Alessandro Massucci, Roger Guimera and Marta Sales-Pardo

In many different problems, ranging from disease spreading, to power network failure, to genetic/metabolic malfunctioning, one faces with a perturbation that propagates across a network. While much attention has been devoted to the study of the dynamics of such processes, the problem of reconstructing the path followed by the perturbation cascade has not frequently been addressed. This is a challenging task, as in many cases only a partial observation is available of the perturbed system. Reconstructing the perturbation path from partial observation has a crucial value, as identifying malfunctioning nodes in a network (by only monitoring a few) may prevent the whole system to collapse. In this work, we thus aim at identifying the path followed by a perturbation cascade by relying on a sparse observation of the whole system, after the perturbation has halted. We estimate the probability of nodes in the network to be perturbed, by using a combination of Bayesian inference and techniques drawn from statistical mechanics.

TECHNICAL SESSION 4: DIFFUSION, SPREADING AND SEARCHING ON NETWORKS

Thursday, March 13, 11:20

Chair: Tamás Vicsek (Eötvös University Budapest)

SEARCHING IN UNSTRUCTURED OVERLAYS USING LOCAL KNOWLEDGE AND GOSSIP

Stefano Ferretti

This paper analyzes a class of dissemination algorithms for the discovery of distributed contents in Peer-to-Peer unstructured overlay networks. The algorithms are a mix of protocols employing local knowledge of peers' neighborhood and gossip. By tuning the gossip probability and the depth k of the k-neighborhood of which nodes have information, we obtain different dissemination protocols employed in literature over unstructured P2P overlays. The provided analysis and simulation results confirm that, when properly configured, these schemes represent a viable approach to build effective P2P resource discovery in large-scale, dynamic distributed systems.

SELF-ORGANIZING TECHNIQUES FOR KNOWLEDGE DIFFUSION IN DYNAMIC SOCIAL NETWORKS

Luca Allodi, Luca Chiodi and Marco Cremonini

In this paper, we model a knowledge diffusion process in a dynamic social network and study two different techniques for self-organization aimed at improving the average knowledge owned by agents and the overall knowledge diffusion within the network. One is a weak self-organization technique requiring a system-level central control, while the other is a strong self-organization technique that each agent exploits based on local information only. The two techniques are aimed at increasing the knowledge diffusion by mitigating the hype effect that the system shows systematically. Results of simulations are analyzed for different reference configurations, discussing how the improvements in knowledge diffusion are influenced by the emergent network topology and the dynamics produced by interacting agents. Our theoretical results may have practical implications for real cases where the polarization of interests in a community, thus the hype effect, is critical. Examples are the adoption of new technologies, subscriptions to online services, sales diversity in a market, or news published by media.

RANDOM WALK CENTRALITY FOR TEMPORAL NETWORKS

Luis Rocha

Nodes can be ranked according to their relative importance within the network. Ranking algorithms based on random walks are particularly useful because they connect topological and diffusive properties of the network. Previous methods based on random walks, as for example the PageRank, have focused on static structures. However, several realistic networks are indeed dynamic, meaning that their structure changes in time. In this paper, we propose a centrality measure for temporal networks based on random walks that we call TempoRank. While in a static network, the stationary density of the random walk is proportional to the degree or the strength of a node; we find that in temporal networks, the stationary density is proportional to the in-strength of the so-called effective network. The stationary density also depends on the sojourn probability q that regulates the tendency of the walker to stay in the node. We apply our method to human interaction networks and show that although it is important for a node to be connected to another node with many random walkers at the right moment (one of the principles of the PageRank), this effect is negligible in practice when the time order of link activation is included.

EFFICIENT ROUTING IN DATA CENTER WITH UNDERLYING CAYLEY GRAPH

Miguel Camelo, Dimitri Papadimitriou, Lluis Fabrega and Pere Vila

Nowadays data centers are becoming huge facilities with hundreds of thousands of nodes. A fundamental component of them is the interconnection network that provides communication efficiently among the different components of the physical infrastructure. The design of such networks involves finding graph models that have good topological properties and that allow the use of efficient routing schemes. Cayley Graphs, a kind of graphs that represents an algebraic group and the relationship between the group elements, have been proposed as a good solution for data-center interconnection networks. In this paper we present a routing scheme based on Shortlex Automatic Structures (SAS) for route computation, which can be used on any interconnection network with an underlying Cayley Graph (of some finite group). The input of the algorithm is either a group presentation (in terms of generators and relators) or a matrix (or permutation) representation. We show that our proposal computes the shortest path between any two vertices with low complexity in space and time.

THE EVOLUTIONARY VACCINATION DILEMMA IN COMPLEX NETWORKS

Alessio Cardillo, Catalina Reyes-Suárez, Fernando Naranjo and Jesus Gomez-Gardenes

In this work we analyze the evolution of voluntary vaccination in networked populations by entangling the spreading dynamics of an influenza-like disease with an evolutionary framework taking place at the end of each influenza season so that individuals take or not the vaccine upon their previous experience. Our framework thus put in competition two well-known dynamical properties of scale-free networks: the fast propagation of diseases and the promotion of cooperative behaviors. Our results show that when vaccine is perfect scale-free networks enhance the vaccination behavior with respect to random graphs with homogeneous connectivity patterns. However, when imperfection appears we find a crossover effect so that the number of infected (vaccinated) individuals increases (decreases) with respect to homogeneous networks, thus showing up the competition between the aforementioned properties of scale-free graphs.

LOCALIZED CONTROL OF VICSEK'S AGENTS

Mattia Frasca, Arturo Buscarino, Luigi Fortuna and Alessandro Rizzo

In this work we study a system of mobile agents that interact according to the Vicsek model and, in addition to this, are subjected to a control law acting on a limited portion of the space in which they are distributed. The control law forces the pinned agents to follow a criterion mediating between the tendency to adopt the average direction of neighboring agents and that to follow an externally fixed preferential direction. We show that, for low and medium levels of noise in the system, the control law is effective to drive the system towards a global ordered state, while, for high levels of noise, a strong control action leads to the, for some aspects paradoxical, situation in which all agents tend to avoid the control region and to occupy for most of the time the remaining part of the space.

TECHNICAL SESSION 5: NETWORKS IN FINANCE AND ECONOMICS

Thursday, March 13, 15:00

Chair: Giorgio Fagiolo (Sant'Anna School of Advanced Studies, Italy)

FINANCIAL NETWORKS: HOW TO BUILD, ANALYZE AND MAKE THE BEST USE OF THEM

Tomaso Aste, Nicolo Musmeci, Tiziana Di Matteo and Guido Previde Massara

Filtering information out of big complex data has become one of the major tasks and a crucial bottleneck in present scientific and industrial endeavors. In financial datasets, information content and flow is often associated with large degrees of dependency and redundancy creating a tangled network of interrelations. Financial networks can be used to reduce this complex interweaved dependency structure unwinding the backbone network of relevant relations. Network-theoretic tools can be then used to analyze the overall data-structure extracting content and reducing complexity.

In this presentation, several possible ways to build financial networks with different topological properties are reviewed and the corresponding different kinds and levels of information content filtered out by the networks are discussed and compared. A new computationally-efficient method [5] that improves the planar maximum filtered graph method is also introduced. Clustering techniques that make use of planarity properties are discussed and applications to quantification of risk and strategies for portfolio selection are presented.

GROWING IMBALANCE AND INTEGRATION OF EUROPEAN TRADE: A NETWORK-CENTRIC VIEW

Gautier Krings, Jean-François Carpantier and Jean-Charles Delvenne

We argue in this work that uncovering the paths followed by trade in the international network of exchange of goods and services matter at least as much as the study of direct trade partnerships for a systemic understanding of international trade. We illustrate this principle on the European trade network from 1993 to 2007 and assess the progress of integration and growth of imbalances inside the European Union and inside the Euro zone. While many economic studies focus on direct bilateral quantities, such as the trade-to-GDP ratio of a country (where trade sums imports and exports) or the net trade between two countries, we propose tools that extract easily readable information from the many trade paths that relate countries. This allows highlighting the special role played by Germany or France before and after the introduction of the Euro.

CHOREOGRAPHY IN INTER-ORGANIZATIONAL INNOVATION NETWORKS

Giovanna Ferraro and Antonio Iovanella

This paper introduces the concept of choreography with respect to inter-organizational innovation network, as it constitutes an attractive environment to create innovation in different sectors. We argue that choreography governs behaviours by shaping the level of connectivity and cohesion among network members. It represents a valid organizational system able to sustain some activities and to reach effects generating innovation outcomes. This issue is tackled introducing a new framework in which we propose a network model as prerequisite for our hypothesis. We focus on inter-organizational innovation networks characterized by the presence of hubs, semi-peripheral and peripheral members lacking hierarchical authority. We prove the effectiveness of our model by providing an in-depth real case study that gives preliminary empirical hints on the network aptitude to perform choreography.

TECHNICAL SESSION 6: BIOLOGICAL AND HEALTH-RELATED NETWORKS

Friday, March 14, 10:40

Chair: Raffaella Burioni (University of Parma, Italy)

EGIA – EVOLUTIONARY OPTIMIZATION OF GENE REGULATORY NETWORKS, AN INTEGRATIVE APPROACH

Alina Sirbu, Martin Crane and Heather J Ruskin

Quantitative modelling of gene regulatory networks (GRNs) is still limited by data issues such as noise and the restricted length of available time series, creating an under-determination problem. However, large amounts of other types of biological data and knowledge are available, such as knockout experiments, annotations and so on, and it has been postulated that integration of these can improve model quality. However, integration has not been fully explored, to date.

Here, we present a novel integrative framework for different types of data that aims to enhance model inference. This is based on evolutionary computation and uses different types of knowledge to introduce a novel customised initialisation and mutation operator and complex evaluation criteria, used to distinguish between candidate models. Specifically, the algorithm uses information from (i) knockout experiments, (ii) annotations of transcription factors, (iii) binding site motifs (expressed as position weight matrices) and (iv) DNA sequence of gene promoters, to drive the algorithm towards more plausible network structures. Further, the evaluation basis is also extended to include structure information included in these additional data. This framework is applied to both synthetic and real gene expression data. Models obtained by data integration display both quantitative and qualitative improvement.

DYNAMIC CONTACT NETWORK ANALYSIS IN HOSPITAL WARDS

Lucie Martinet, Christophe Crespelle and Eric Fleury

We analyse a huge and very precise trace of contact data collected during 6 months on the entire population of a rehabilitation hospital. We investigate both the graph structure of the average daily contact network and the temporal structure of the evolution of contacts in the hospital. Our main results are to unveil striking properties of these two structures in the considered hospital, and to present a methodology that can be used for analysing any dynamic complex network where nodes are classified into groups.

TECHNICAL SESSION 7: COMMUNITY DETECTION AND CO-EVOLVING NETWORKS #2

Friday, March 14, 11:20

Chair: Raffaella Burioni (University of Parma, Italy)

COMMUNITY DETECTION IN TEMPORAL NETWORKS

Vsevolod Salnikov and Renaud Lambiotte

The field of community detection has attracted much attention in recent years. If efficient methods exit for overlapping or non-overlapping communities in static networks, the problem of finding communities in temporal networks is still a challenge. Basic approaches consider the temporal system as a sequence of static networks where standard methods can be used. Alternative approaches represent the system by a tensor to be clustered. The main purpose of this work is to develop a statistical approach taking advantage of the temporal correlations between edges in order to uncover overlapping, synchronized communities in networks.

DETECTING COMMUNITY STRUCTURE IN QUANTUM COMPLEX NETWORKS

Mauro Faccin

Determining community structure in interacting systems, ranging from technological to social, from biological to chemical, is a topic of central importance in the study of networks. Extending this concept to apply to quantum systems represents an open challenge and a crucial missing component towards a theory of complex networks based on quantum mechanics. This talk will cover the work primarily in which accomplishes this goal by introducing methods for identifying the community structure of a network governed by quantum dynamics. We found that community structure is relevant for a host of problems commonly faced in quantum physics, and moreover that the state-of-the art methods used to detect communities in complex networks fail to give meaningful results in these cases. We overcome these limitation and present methods to detect communities in quantum systems. To illustrate our approach we turn to a host of examples, including a naturally occurring light-harvesting network, where from first principles we determine a consistent community structure. In certain regimes the communities we determine agree with a partitioning currently done by hand in the quantum chemistry literature. In other regimes, we uncover an improved community structure. Our approach rely on the definition of distances between clusters using two quantum properties: coherent transport and fidelity of the evolved state with the initial one. We define the optimal community structure using a modified modularity function.

Merging concepts from quantum physics and complex network theory is providing a bidirectional bridge of relevant analysis tools to address networks in both disciplines. Although this work focuses on extending the concept of community detection to apply to quantum systems, it also opens the door for the application of quantum techniques to determine community structure and other key properties of traditional complex networks. However, our objective here was only to create methods that enable one to determine communities in quantum systems, wherein and as already mentioned, the existing techniques to detect communities in complex networks fail to give meaningful results.

CO-EVOLUTION OF MULTIPLE SOCIAL NETWORKS: A DATA-BASED, PARAMETRIC STUDY FRAMEWORK

Matteo Magnani and Luca Rossi

We present a framework to study the co-evolution of multiple interdependent social networks. The study is based on real data and focuses on the identification of assumptions resulting in realistic networks, including time synchronization, the probability of participating in more than one network and different configurations for the inter-network dependencies.

TECHNICAL SESSION 8: LANGUAGE NETWORKS AND SCIENCE OF SCIENCE

Friday, March 14, 14:00

Chair: Stephen Uzzo (New York Hall of Science, USA)

INDUCING LANGUAGE NETWORKS FROM CONTINUOUS SPACE WORD REPRESENTATIONS

Bryan Perozzi, Rami Al-Rfou', Vivek Kulkarni and Steven Skiena

Recent advancements in unsupervised feature learning have developed powerful latent representations of words. However, it is still not clear what makes one representation better than another and how we can learn the ideal the representation. Understanding the structure of latent spaces attained is key to any future advancement in unsupervised learning.

In this work, we introduce a new view of continuous space word representations as language networks. We explore two techniques to create language networks from learned features by inducing them for two popular word representation methods and examining the properties of their resulting networks. We find that the induced networks differ from other methods of creating language networks, and that they contain meaningful community structure.

NETWORK DIFFERENCES BETWEEN NORMAL AND SHUFFLED TEXTS: A CASE OF CROATIAN

Domagoj Margan, Sanda Martinčić-Ipšić and Ana Meštrović

This paper is an initial attempt to study properties of the Croatian word order via complex networks. We present network properties of original and shuffled Croatian texts for different co-occurrence window sizes and different linkage boundaries. The results of network analysis are showing that the text shuffling causes the decrease of the network diameter, due to the establishment of previously non-existing links. This indicates that the syntax does play the significant role in the Croatian language, although it is a mostly free word-order language.

NEGATIVE IMPLICATIONS OF A POWER-LAW DISTRIBUTION: A STUDY ON NETWORK OF SCIENTIFIC REVIEWERS

Song Qin, Marius Silaghi, William Cheung and Ronaldo Menezes

Traditional peer reviewing is a process whereby submissions by various scientists are selected based on certain criteria passed on to reviewers by organizers of conference or editors of journals. This process has been used to maintain the quality of the works being presented and also to help grouping reports relevant to a given community (or topic). However, certain scientific opinions and theories compete and have partisans. Common examples of such competitions appear when deciding the most important metric in classification algorithms, what to use as a basis for recommendation algorithms, the best predicting models for a known phenomena, to name a few. The common assumption is that the community will be equally informed about the arguments of all involved studies, in order to come out with objective conclusions. This assumption is reasonable when partisans of each competing opinion can eventually review and recommend for publication the studies that agree with their perspective. In its turn, this can be expected to eventually happen whenever expert reviewers are randomly assigned to corresponding papers. However in recent years we have seen that power-law distributions instead of randomness are present in many social relationships. In this study we investigate what happens in the world of peer reviewing, more specifically in a network build from reviewers for an open review journal. We found that a power-law distribution is indeed present and that very few reviewers evaluate a significant fraction of all submissions. The problem however is that this is undesirable since these ``hubs'' have an unmatched influence on what gets published. This experiment presents a first case where arguably the power-law structure of the social network can be considered as an overall negative factor. It also supports an argument for employing the social graph of reviewers as an additional metric of the quality of a journal/conference.

A NETWORK-AUTOPOIETIC PERSPECTIVE ON SOCIAL DYNAMICS: ANALYZING KNOWLEDGE AND COMMUNICATION STRUCTURES

Nikita Basov

The paper proposes a perspective for the study of social dynamics based on a combination of autopoiesis theory and network approach. Social dynamics, at its elementary level, are seen as structural processes of emergence and disappearing of relations between individuals. The mechanism of this process is structural coupling – a continuous inter-personal co-relating process taking place in a common environment, involving interaction and resulting in the structural congruence of individual psychic structures; – and de-coupling (the reverse process). Such continuous co-relating process between multiple individuals results in the co-evolution of two social dimensions: knowledge – sets of sustaining mutually (op)posed psychic structures of different individuals as thinkers, – and communication – sets of direct information exchange structures between individuals as signal producers. In these sets, individual psychic structures are delineated by the network of (meaningful) relations they have with the psychic structures surrounding them, while the communicative positions of individuals are defined by the network of meaningful relations with other individuals.

The proposed perspective based on a combination of autopoiesis theory and network approach opens a broad field of research opportunities to model and analyze social dynamics allowing multi-scale observation of the constantly changing heterogeneous, comprised of operationally closed social entities, self-organizing structural scopes of contemporary societies, which are characterized by growing intellectualization, as well as intensification of large-scale knowledge and communication co-evolution.

THE STORY OF YOUR BIG HIT

Roberta Sinatra, Dashun Wang, Chaoming Song, Pierre Deville and Albert-László Barabási

The path to major accomplishments inmost areas of human performance, from sport to music, poetry or engineering, usually requires a steep learning curve, long practice and many trials. Athletes go through demanding training and participate in many competitions before setting new records; musicians practice since early age and perform in secondary venues before earning the spotlight; programmers participate in numerous routine tasks before addressing more innovative projects. A gradual increase in performance through learning and practice characterize most innovative trades and common sense suggests this to be true in science as well: the outstanding discoveries a scientist is known for are typically preceded by results and papers of less memorable impact. This prompts us to ask: what are the precise patterns that lead to scientific excellence? Does performance indeed improve throughout a scientific career? Are there quantifiable signs of an impending scientific hit? Will a scientist, having made a major discovery, produce higher impact paper than before his/her breakthrough? We explore these questions by analyzing and modelling citation data of all the papers published by the American Physical Society in more than one hundred of years. Using normalized citation-based measures as a proxy of impact, we identify the highest impact paper in each scientist's career and quantify the changes in impact and productivity induced by this highest impact work. We show that, while there are reproducible productivity patterns leading to the highest impact work, surprisingly major discoveries are not preceded by works of increasing impact, nor are followed by work of higher impact. Yet, the emergence of the highest impact paper is not entirely random either: while the sequence of papers' impact in each individual career appears to be dramatically unpredictable, scientists with outstanding publications have higher productivity and a different paper impact distribution, indicating that there are statistical features peculiar to outliers.

TECHNICAL SESSION 9: NETWORK THEORY, MODELING AND METRICS

Friday, March 14, 16:40

Chair: Juyong Park (KAIST, South Korea)

DISCOVERING COLORED NETWORK MOTIFS

Pedro Ribeiro and Fernando Silva

Network motifs are small overrepresented patterns that have been used successfully to characterize complex networks. Current algorithmic approaches focus essentially on pure topology and disregard node and edge nature. However, it is often the case that nodes and edges can also be classified and separated into different classes. This kind of networks can be modeled by colored (or labeled) graphs and in this paper we present a definition of a colored motif and an algorithm that efficiently discovers this kind of motifs. We use g-tries, a specialized data-structure created for finding sets of subgraphs. G-Tries encapsulate common sub-structure, and with the aid of symmetry breaking conditions and a customized canonization methodology, we are able to efficiently search for several colored patterns at the same time. We apply our algorithm to a set of representative complex networks, showing that we can find colored motifs, outperforming previous methods.

CORE DECOMPOSITION IN DIRECTED NETWORKS: KERNELIZATION AND STRONG CONNECTIVITY

Vincent Levorato

In this paper, we propose a method allowing decomposition of directed networks into cores, which final objective is the detection of communities. We based our approach on the fact that a community should be composed of elements having communication in both directions. Therefore, we propose a method based on digraph kernelization and strongly p-connected components. By identifying cores, one can use based-centers clustering methods to generate full communities. Some experiments have been made on three real-world networks, and have been evaluated using the V-Measure, allowing a more precise analysis through its two sub-measures: homogeneity and completeness. Our work proposes different directions about the use of kernelization into structure analysis, and strong connectivity concept as an alternative to modularity optimization.

DUAL LAYER SCALE-FREE NETWORK TOPOLOGY SYNTHESIS

Mehmet Burak Akgun and Mehmet Gunes

Comprehensive analysis that aim to better understand the topology of real world networks and development of algorithms that replicate their characteristics have been an important research issue. Internet topology generators focus on generating synthetic graphs that attempt to imitate certain topological characteristics of the Internet at various levels. Although the accuracy of newly developed network protocols or algorithms do not depend on the underlying topology, the performance generally depends on the topology. As a result, network researchers have concentrated on generating representative synthetic topologies and widely utilize them to analyze the performance of their design in simulation or emulation environments. Topology generators typically represent the Internet topology as a graph composed of point-to-point links. In this presentation, we focus on the multi-access links, i.e., link-layer networks that form the same collision domain between attached devices, as they should be considered to reflect the single hop connectivity of the devices attached to a subnetwork. While consideration of the multi-access links helps to better capture the underlying networks, this also introduces challenges in the generation of hyper graphs that accurately represent the Internet. In addition, we discuss the implications of multi-access links on the synthetic network generation. We also analyze the large-scale characteristics of sampled Internet topology data sets and observe that in addition to the commonly analyzed node degree distribution, the subnet size and the router interface distributions exhibit power-law characteristics. Based on findings from the measurement studies, we introduce subnet based topology generation methodologies that incorporate the observed measures to

produce 2-mode Internet topologies. In particular, generated topologies capture the 2-mode subnet and interface distributions that are missing from the current network generators that produce 1-mode graphs.

CORRELATION DIMENSION OF SPATIAL COMPLEX NETWORKS

Jesus Gomez-Gardenes and Lucas Lacasa

Recently, geometrical concepts have been exploited to describe and classify the structure of complex networks beyond purely topological aspects. In particular, the box-counting technique, widely used for estimating the capacity dimension of an object, has been recently extended, as a box-covering algorithm, to characterize the dimensionality of complex networks. The box-covering approach, while being the most natural and elegant extension of the concept of fractal dimension to networks, suffers from some technical difficulties such as the need of the full knowledge about network structure and, more importantly, the computational costs of finding the optimum covering, whose computational complexity is known to be NP hard. In this talk we propose a new measure to characterize the dimension of spatial complex networks based on the ergodic theory of dynamical systems. This measure is derived from the correlation sum of a trajectory generated by a random walker navigating the network, and extends the classical Grassberger-Procaccia algorithm to the context of complex networks. The method is validated with reliable results for both synthetic networks and real-world networks such as the world air-transportation network or urban networks, and provides a computationally fast way for estimating the dimensionality of networks which only relies on the local information provided by the walkers.

POSTER SESSION

Wednesday, March 12, 15:40 – 16:40

Thursday, March 13, 10:20 – 11:20

STRUCTURE COMPARISON OF BINARY AND NICHE-OVERLAP GRAPHS

Nayla Sokhn, Richard Baltensperger, Louis-Felix Bersier, Ulrich Ultes-Nitsche and Jean Hennebert

Designing a Social Network Survey for Cancer Care Coordination

Andrew Levula and Kon Shing Kenneth Chung

GENRE CLASSIFICATION USING CENTRALITY MEASURES ON A WORD NETWORK

Arjun Nitin Bhagoji and Poorna Kumar

EXPLORING SOCIAL PROCESSES ON ONLINE COMMUNITIES: EMERGENCE AND EVOLUTION OF SOCIAL NETWORKS

Spyros Angelopoulos and Yasmin Merali

COMPLEX NETWORK ANALYSIS OF OZONE TRANSPORT

Guoxun Tian and Mehmet Gunes

POLITICS MATTERS. DYNAMICS OF INTER-ORGANIZATIONAL NETWORKS AMONG IMMIGRANT ASSOCIATIONS

Matteo Gagliolo, Tom Lenaerts and Dirk Jacobs

ONE-MAX CONSTANT-PROBABILITY MODELS FOR SCALE-FREE NETWORKS

Mark Korenblit, Vadim Talis and Ilya Levin

A STATISTICAL MECHANICS APPROACH TO IMMIGRANTS' INTEGRATION IN EMILIA ROMAGNA (ITALY)

Francesco De Pretis

SOCIAL NETWORK ANALYSIS METRICS AND THEIR APPLICATION IN MICROBIOLOGICAL NETWORK STUDIES

Juliana S Silva, Nancy C Stoppe, Tatiana T Torres, Laura M Ottoboni and Antonio M Saraiva

THE ROLE OF THE SHANNON ENTROPY IN THE IDENTIFICATION OF ACRONYMS

Marco Alberto Javarone

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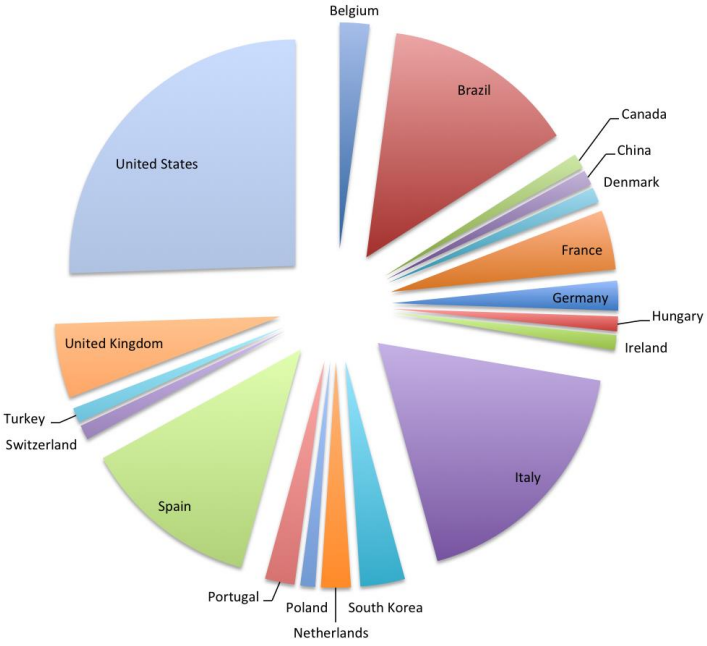
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