NETSCI 2015

SCIENTIFIC PROGRAM

World Trade Center Zaragoza-Spain

ORGANIZING COMMITTEE

- **GENERAL CHAIR: Yamir Moreno**, Head of Complex Systems and Networks Lab (COSNET), Institute for Bio-computation & Physics of Complex Systems (BIFI), and Department of Theoretical Physics, University of Zaragoza, Spain.

- **Co-CHAIR: Sandro Meloni**, Senior Research Scientist at Complex Systems and Networks Lab (COSNET), Institute for Bio-computation & Physics of Complex Systems (BIFI), University of Zaragoza, Spain.

- **SATELLITE Chair: Vittoria Colizza**, Senior Research Scientist at the Inserm, Pierre Louis Institute of Epidemiology and Public Health, and Université Pierre et Marie Curie, Faculté de Mèdicine, Paris, France.

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- **CONFERENCE SECRETARIAT: GRUPO PACÍFICO**

PROGRAM COMMITTEE

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Manuel Cebrián, Senior Research Scientist with NICTA at the University of Melbourne, Australia.
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Ernesto Estrada, Professor at the Department of Mathematics and Statistics & Member of the Institute of Complex Systems, University of Strathclyde Glasgow, U.K.
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Dmitri Krioukov, Associate Professor, Northeastern University, Departments of Physics, Mathematics, and Electrical & Computer Engineering.
Sune Lehman, Department of Applied Mathematics and Computer Science, Technical University of Denmark.
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Matjaž Perc, Professor of Physics, Faculty of Natural Sciences and Mathematics, University of Maribor, Slovenia.
Nicola Perra, Associate Research Scientist at the Northeastern University in Boston, MA, USA, (Mobs Lab).
Chiara Poletto, Postdoctoral researcher, EPIcx Lab, INSERM, UPMC UMR-S, Paris, France.
Mason Porter, Professor of Nonlinear and Complex Systems, Oxford Centre for Industrial and Applied Mathematics, Mathematical Institute, University of Oxford, UK.
José Javier Ramasco, Ramón y Cajal Researcher at IFISC (Institute for Cross-Disciplinary Physics and Complex Systems), Palma de Mallorca, Spain.
Taha Yasseri, Research Fellow in Computational Social Science at Oxford Internet Institute, University of Oxford, U.K.
Yong-Yeol "YY" Ahn, Assistant Professor at Center for Complex Networks and Systems Research, School of Informatics and Computing, Indiana University, Bloomington.

PROGRAM in a NUTSHELL

NETSCI 2015

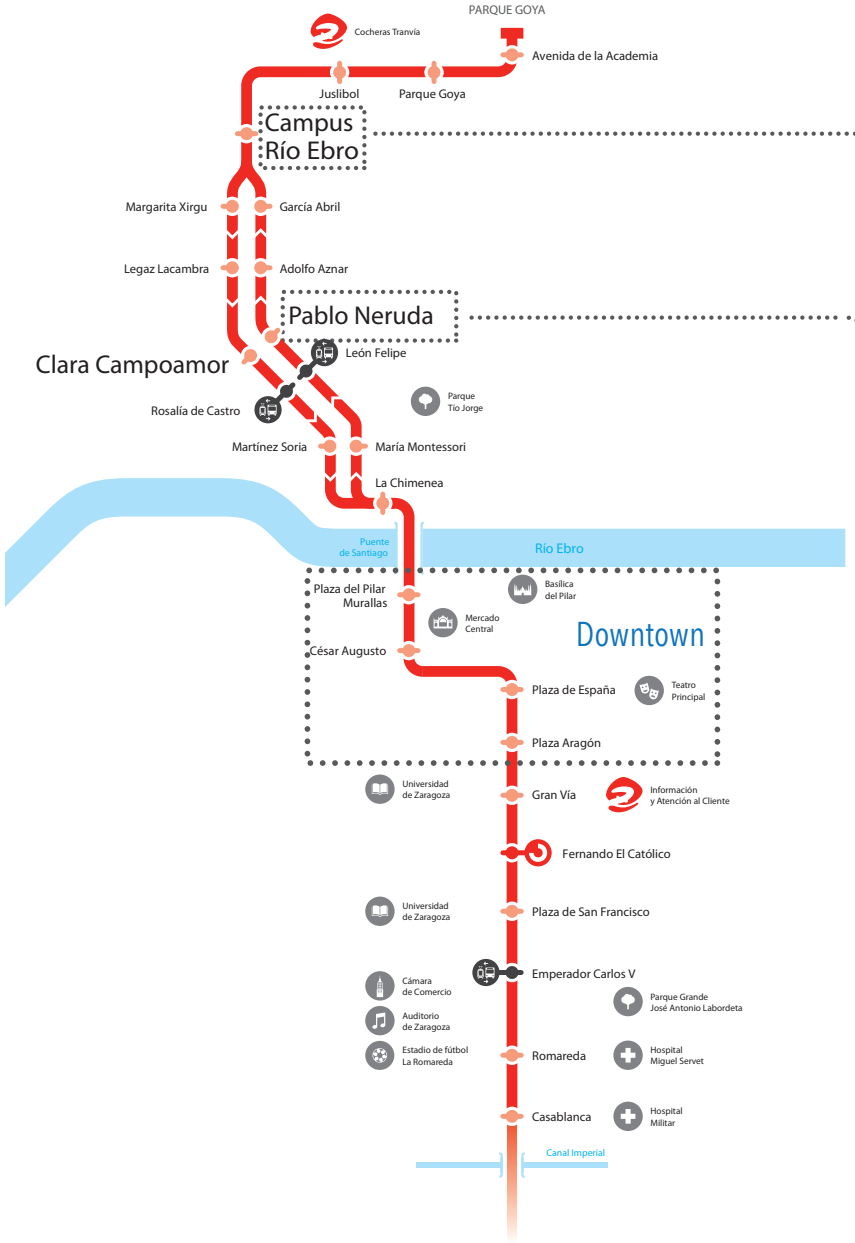
	Monday 1	Tuesday 2	Wednesday 3	Thursday 4	Friday 5
morning	Satellites & School	Satellites & School	Keynote & Invited Speakers	Keynote & Invited Speakers	Keynote & Invited Speakers / Parallel Sessions 3
	LUNCH BREAK				
afternoon	Satellites & School	Satellites & School	Parallel Sessions 1 / Poster Session 1	Parallel Sessions 2 / Poster Session 2	Lightning Talks / ER Prize

-Banquet Dinner
at Hotel Palafox

CONFERENCE VENUE

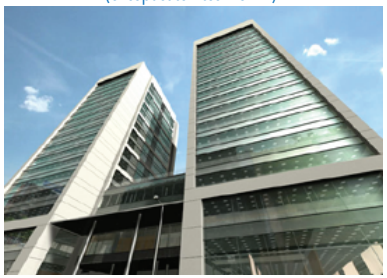
World Trade Center Zaragoza

Tram Line

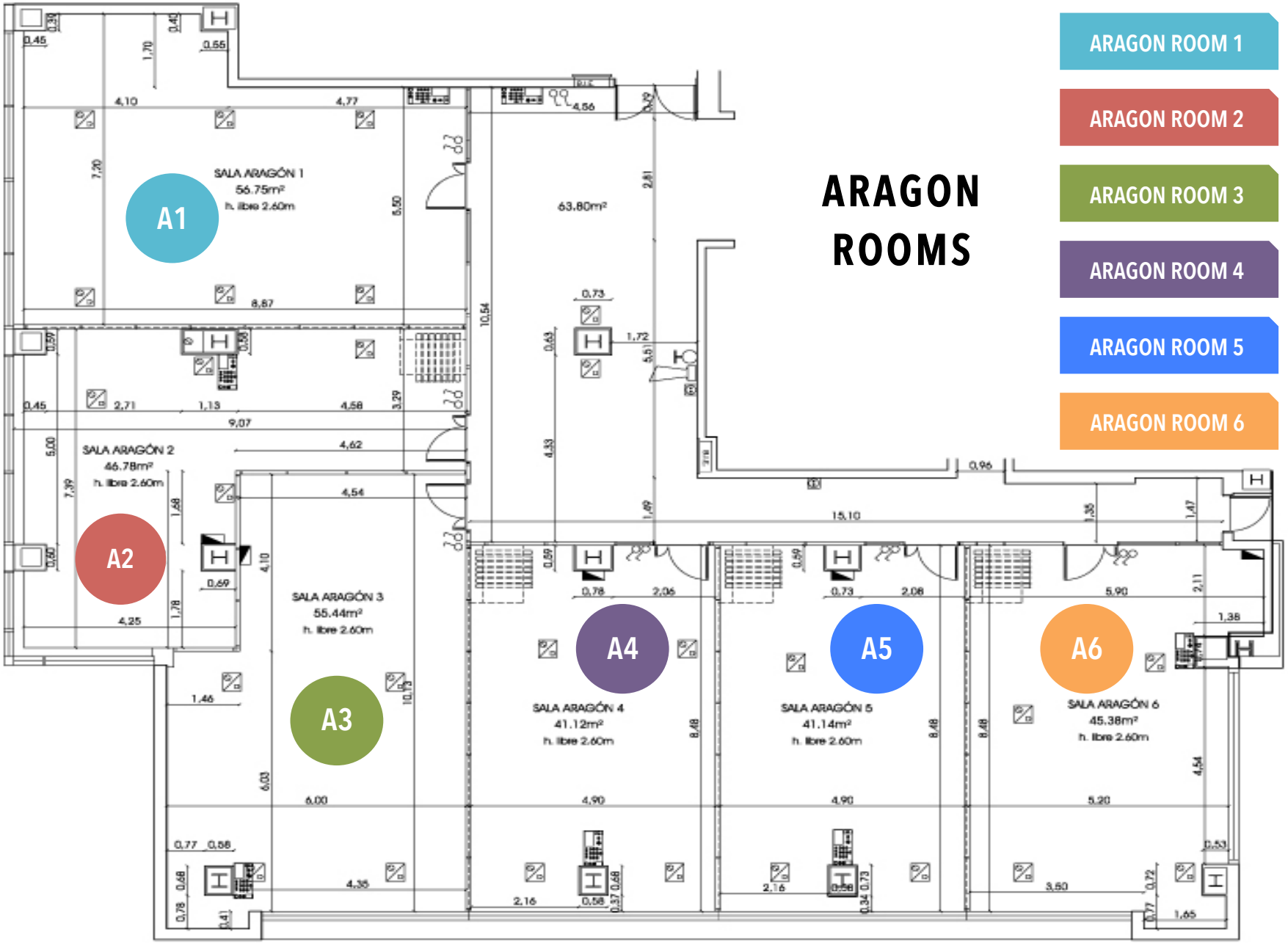


Institute BIFI
School and Satellites 4 & 14

World Trade Center Zaragoza (WTCZ)
Main Conference Venue & Satellites
(except satellites 4 & 14)



ARAGON ROOMS



ARAGON ROOM 1

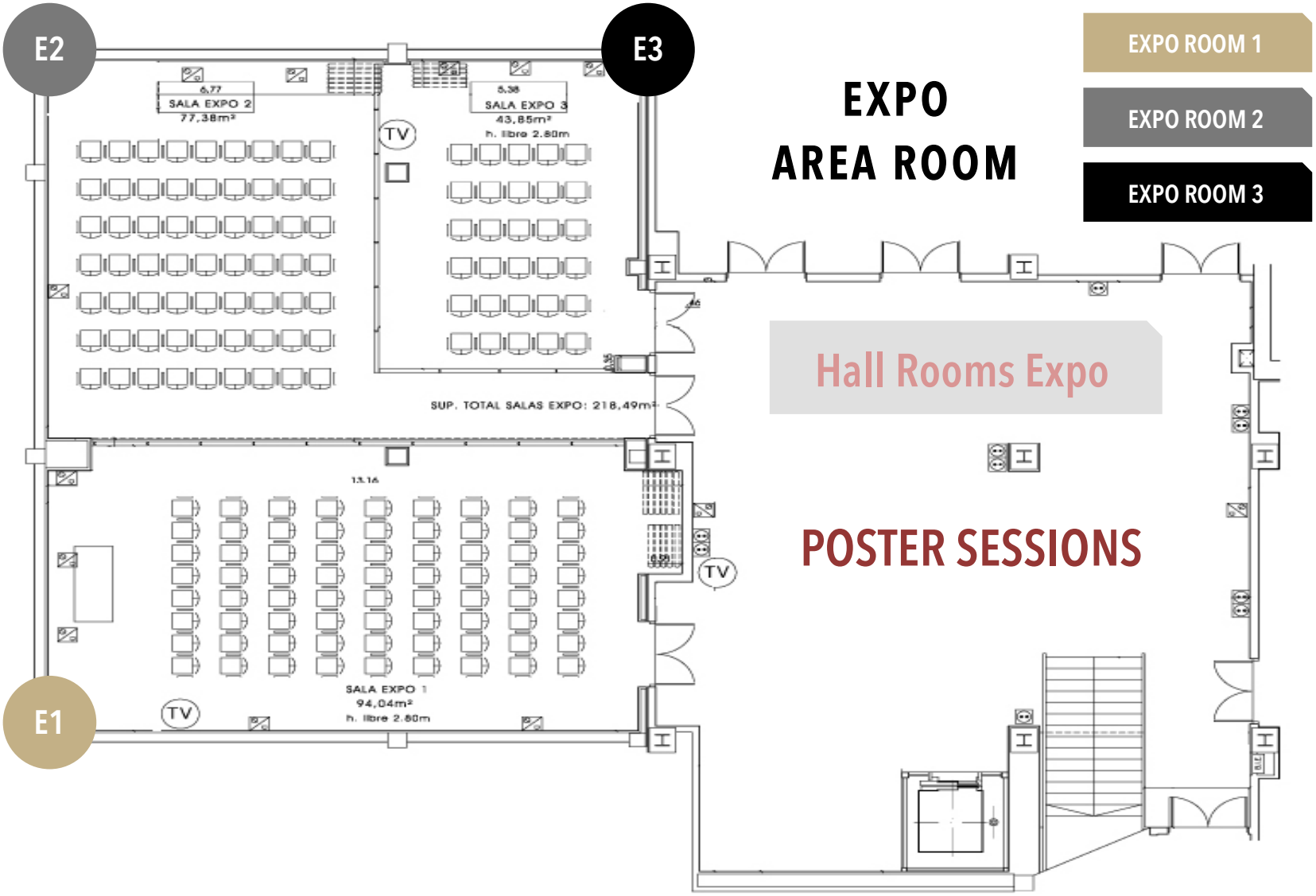
ARAGON ROOM 2

ARAGON ROOM 3

ARAGON ROOM 4

ARAGON ROOM 5

ARAGON ROOM 6


E2
E3
E1
EXPO ROOM 1
EXPO ROOM 2
EXPO ROOM 3
EXPO
AREA ROOM
SALA EXPO 2
77,38m²
SALA EXPO 3
43,85m²
h. libre 2.80m
TV
SUP. TOTAL SALAS EXPO: 218,49m²
SALA EXPO 1
94,04m²
h. libre 2.80m
Hall Rooms Expo
POSTER SESSIONS

SATELLITES SCHEDULE

NETSCI 2015

Venue	June 1-AM	June 1-PM	June 2-AM	June 2-PM
WTCZ	**1.** Brain Networks			**9.** Language and Network Science
WTCZ	**2.** Networks Models in Cellular Regulation		**11.** NetSci Backstage	
WTCZ	**20.** Network Science for National Defense	**3.** Complex Networks in Ecology	**19.** TOPONETS15	**16.** Dynamics on and of Complex Networks
WTCZ	**7.** Network Science in Education (NetSciEd4)		**8.** Arts, Humanities, and Complex Networks	
WTCZ	**17.** Statistical Inference for Network Models		**18.** Higher-Order Models in Network Science	
WTCZ	**21.** Structure and Mobility of Crime	**6.** Urbannet 2015	**10.** At the Crossroads: Lessons and Challenges in Computational Social Science	
WTCZ	**15.** Information, Self-Organizing Dynamics and Synchronization (ISODS) on Networks (**II**)		**5.** Policy Applications of Complex Networks in Economics and Finance	
WTCZ	**13.** Physics of Multilayered Interconnected Networks (**II**)		**12.** Networks of Networks	

BIFI	**4.** Network-enabled Wisdom for the Personalized Medicine of the Complex Diseases
BIFI	**14.** Controlling Complex Networks: When Control Theory Meets Network Science

LIST OF SATELLITES

NETSCI 2015

Venue	Satellite Symposium	Date	Room
WTCZ	**1.** Brain Networks	June 1/June 2	A5+A6
WTCZ	**2.** Networks Models in Cellular Regulation	June 1	E1
WTCZ	**3.** Complex Networks in Ecology	June 1	A1
BIFI	**4.** Network-enabled Wisdom for the Personalized Medicine of the Complex Diseases	June 2	ROOM AB (BIFI)
WTCZ	**5.** Policy Applications of Complex Networks in Economics and Finance	June 2	E1
WTCZ	**6.** Urbannet 2015	June 1	E2+E3
WTCZ	**7.** Network Science in Education (NetSciEd4)	June 1	Panoramic ROOM
WTCZ	**8.** Arts, Humanities, and Complex Networks	June 2	Panoramic ROOM
WTCZ	**9.** Language and Network Science	June 2	A1
WTCZ	**10.** At the Crossroads: Lessons and Challenges in Computational Social Science	June 2	E2+E3
WTCZ	**11.** NetSci Backstage	June 2	Auditorium
WTCZ	**12.** Networks of Networks	June 2	Expo Area ROOM
WTCZ	**13.** Physics of Multilayered Interconnected Networks (**II**)	June 1	Auditorium
BIFI	**14.** Controlling Complex Networks: When Control Theory Meets Network Science	June 2	ROOM 2 (BIFI)
WTCZ	**15.** Information, Self-Organizing Dynamics and Synchronization (ISODS) on Networks (**II**)	June 1	Expo Area ROOM
WTCZ	**16.** Dynamics on and of Complex Networks	June 2	A5+A6
WTCZ	**17.** Statistical Inference for Network Models	June 1	A3+A4
WTCZ	**18.** Higher-Order Models in Network Science	June 2	A3+A4
WTCZ	**19.** TOPONETS15	June 2	A1
WTCZ	**20.** Network Science for National Defense	June 1	A1
WTCZ	**21.** Structure and Mobility of Crime	June 1	E2+E3

SCHOOL SCHEDULE

NETSCI 2015

Institute BIFI, Campus Rio Ebro,
University of Zaragoza, Spain.

Shedule	Monday June 1st.	Tuesday June 2nd.
Morning Session		
09:30 – 11:00	Structural Network Theory. Traditional vs. Non-traditional Methods I, Prof. Ernesto Estrada, University of Strathclyde, Glasgow, U.K.	Statistical Inference in Network Analysis. The Statistics of Network Modeling, Prof. Eric D. Kolaczyk, Boston University, USA.
11:00 – 11:30	**BREAK**	
11:30 – 13:00	Structural Network Theory. Traditional vs. Non-traditional Methods II, Prof. Ernesto Estrada, University of Strathclyde, Glasgow, U.K.	Statistical Inference in Network Analysis. Network Topology Inference, Prof. Eric D. Kolaczyk, Boston University, USA.
13:00 – 14:30	**LUNCH BREAK**	
Afternoon Session		
14:30 – 16:00	Making Sense of Big Data & Small I, Prof. Bruno Gonçalves, Université d'Aix-Marseille, France.	Spectral Properties & Synchronization in Complex Networks, Prof. Albert Díaz-Guilera, University of Barcelona, Spain.
16:00 – 16:30	**BREAK**	
16:30 – 18:00	Making Sense of Big Data & Small II, Prof. Bruno Gonçalves, Université d'Aix-Marseille, France.	Spectral Properties of Time-dependent Networks, Prof. Albert Díaz-Guilera, University of Barcelona, Spain.

"Structural Network Theory. Traditional vs. Non-traditional Methods"

ERNESTO ESTRADA

I will introduce or refresh some of the most basic concepts of structural network theory, such as degree distributions, assortativity, communication by shortest paths, etc. Then, I will illustrate some of the difficulties that you may find in the practical application of these concepts to real-world situations. In contrast, I will show how novel algebraic and spectral techniques can sort out these difficulties. The main questions that these approaches will respond include: How to compare degree heterogeneities of diverse networks in the presence of scarce data? What is the structural meaning of assortativity? How can you navigate a network without knowing the shortest paths routes? etc.

"Making Sense of Data Big and Small"

BRUNO GONÇALVES

The increasing availability of huge amounts of data on every aspect of societal and individual behavior has created unprecedented opportunities but it also created new challenges. On one hand, it is now much easier to acquire detailed datasets no practically anything while on the other it is much harder to make sure that our observations and conclusions are well justified and robust. In this short 3h tutorial we will briefly introduce some of the fundamental principles and algorithms of Machine Learning in an intuitive and practical way. Mathematical requirements will be kept to a minimum and short snippets of Python code will be presented to illustrate the application of each algorithm.

"Statistical Inference in Network Analysis"

ERIC D. KOLACZYK

In the analysis of network data, as with any other data type, there are many contexts in which problems of statistical inference arise. However, the inherently relational nature of network-indexed data poses a number of additional challenges in performing statistical analysis, which are further compounded in many cases by the sheer magnitude of the data at hand. In these talks, we will examine two major paradigms in which statistical inference arises: (1) the statistics of network modeling, and (2) network topology inference. The focus will be on drawing parallels with more familiar (e.g., `Statistics 101') formulations of these types of inference problems, allowing us to compare and contrast, and hence highlight the unique aspects of these problems when networks enter the picture.

I) "Spectral Properties and Synchronization in Complex Networks"

ALBERT DÍAZ-GUILERA

I will introduce the Kuramoto model of synchronization of phase oscillators. Starting from very simple settings I will show which are the conditions for the system to synchronize. If oscillators are identical, after a transient, the system approaches the synchronized state in such a way that the equations of motion can be linearized. This can be solved in terms of

normal modes and establish the relation between topology (by means of eigenvalues of the static Laplacian matrix of the network) and dynamics (in terms of the time needed to synchronize). Furthermore, I will show that intermediate time scales are related to subsets of eigenvalues and communities.

A. Díaz-Guilera

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II) "Spectral Properties of Time-dependent Networks"

I will show how to generalize spectral properties and dynamical approach to a synchronized state in the case of moving oscillators. When oscillators move and they can interact with nearby oscillators they form a time dependent contact network. In terms of the time scales for motion and synchronization we describe the different regimes of the system.

MAIN CONFERENCE SCHEDULE

NETSCI 2015

Schedule	Wednesday June 3rd	Thursday June 4th	Friday June 5th
	Morning Session: all will be at the Auditorium WTCZ, (except the parallel sessions of Friday 5th morning)		
08:45 – 09:00	**OPENING SESSION**	**UPDATES**	**UPDATES**
Chair	**Yamir Moreno**	**Alessandro Vespignani**	**Vittoria Colizza**
09:00 – 09:45	Alessandro Vespignani	Raissa D´Souza	Jürgen Kurths
09:45 – 10:15	Sandra González-Bailón	Byungnam Kahng	Guido Caldarelli
10:15 – 10:45	Hans Herrmann	Alan Mislove	Dmitri Krioukov
10:45 – 11:15	**COFFEE BREAK**		
Chair	**Raissa D'Souza**	**Natasa Przulj**	
11:15 – 12.00	Jordi García-Ojalvo	Ed Bullmore	11:15 - 12:55 PARALLEL SESSIONS
12:00 – 12:30	Natasa Przulj	Alex Arenas	
12:30 – 13:00	Iyad Rahwan	Michelle Girvan	
13:00 – 14:30	**LUNCH BREAK**		
	Afternoon Session (check booklet for rooms assignment)		
14:30 – 16:10	PARALLEL SESSIONS		LIGHTNING TALKS (7 minutes per Talk)
16:10 – 16:40	**COFFEE BREAK**		
16:40 – 18:20	PARALLEL SESSIONS		16:40 –17:40 **Erdös Renyi Prize/ Lecture**
18:20 – 19:00	Poster Session 1 (Posters 1-85)	Poster Session 2 (Posters 86-170)	17:40 –18:00 Closing Remarks **NetSci 2015**
21:00	BANQUET DINNER at Hotel Palafox	Dinner on your own	

KEYNOTE & INVITED SPEAKERS

Schedule	Wednesday 3rd	Thursday 4th	Friday 5th
			Morning Session
08:45	**OPENING SESSION**	**UPDATES**	**UPDATES**
09:00	**Alessandro Vespignani,** (KS) "Data-driven Modeling of Contagion Processes in Networks"	**Raissa D'Souza,** (KS) "Steering and Controlling Systems of Interdependent Networks"	**Jürgen Kurths,** (KS) "Quantifying Stability in Complex Networks: From Linear to Basin Stability"
09:45	**Sandra González-Bailón,** (IS) "Core-Periphery Dynamics in Protest Networks"	**Byungnam Kahng,** (IS) "Hybrid Percolation Transitions in Complex Networks"	**Guido Caldarelli,** (IS) "Financial Networks"
10:15	**Hans Herrmann,** (IS) "Rolling and Synchronization in the Contact Network of Bearings"	**Alan Mislove,** (IS) "Measuring Personalization of Online Services"	**Dmitri Krioukov,** (IS) "First Principles behind Network Structure, Function, and Dynamics"
10:45 - 11:15		**COFFEE BREAK**	
11:15	**Jordi García-Ojalvo,** (KS) "Noise and Information Processing in Recurrent Biological Networks"	**Ed Bullmore,** (KS) "Brain Networks"	PARALLEL SESSIONS 11:15 12:55
12:00	**Natasa Przulj,** (IS) "Mining Real-World Networks: from Biology to Economics"	**Alex Arenas,** (IS) "Multilayer Interconnected Complex Networks"	
12:30	**Iyad Rahwan,** (IS) "Making Social Networks Work"	**Michelle Girvan,** (IS) "Elucidating the Role of Network Structure in Gene Regulation: Connecting Models and Data"	
13:00 – 14:30		**LUNCH BREAK**	

ABSTRACTS: KEYNOTE Speakers

in order of appearance

ALESSANDRO VESPIGNANI

"Data-driven Modeling of Contagion Processes in Networks"

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. Network models have gained importance in the public-health domain, especially in infectious disease epidemiology, by providing quantitative approaches in support of the policy-making processes. In this talk I will focus on discussing the recent successes as well as the methodological challenges in the modeling and forecast of 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. The example of the Ebola epidemic in West Africa will be used to ground some of these questions in the case of a current emerging disease threat.

JORDI GARCÍA-OJALVO

"Noise and Information Processing in Recurrent Biological Networks"

Biological networks frequently possess complex coupling architectures with large numbers of cyclic paths embedded within them. These recurrent structures routinely lead to emergent dynamics, as in the case of the collective oscillations exhibited by neuronal networks. In normal physiological conditions, cortical neuronal populations display relatively regular oscillatory behavior, which contrasts with the highly irregular firing dynamics of the individual neurons forming the population. In the first part of this talk we discuss how noise and coherence coexist in this collective dynamical regime. In the second part we examine the potential use of recurrent dynamics by gene regulatory networks for information-processing purposes.

RAISSA D'SOUZA

"Steering and Controlling Systems of Interdependent networks"

Networks are at the core of modern society, spanning physical, biological and social systems. Each distinct network is typically a complex system, shaped by the collective action of individual agents and displaying emergent behaviors. Moreover, collections of these complex networks often interact and depend upon one another, which can lead to unanticipated consequences such as cascading failures and novel phase transitions. This talk begins with a focus on control of phase transitions in an individual network then moves on to cascading failures in coupled networks establishing the notion of optimal interdependence. We then consider the cost of cascades and show that there can exist optimal levels of control interventions. Finally, we discuss very recent work on dynamical spillovers in multiplex networks (where potential interventions in one layer may yield desired outcomes on other layers) and the phenomena of catastrophe-hopping in coupled systems where an intermediate

system can facilitate the propagation of a sudden change or collapse, suggestive of the events observed during the Arab Spring protests of 2011.

"Brain Networks"

ED BULLMORE

There has been growing interest in understanding the network organization of the human brain, also known as the connectome. By graph theoretical analysis of connectivity matrices derived from magnetic resonance imaging (MRI) it has been shown that human brain networks have a complex topology, characterised by small-worldness, modularity, and the existence of hub nodes and rich clubs. Human brains are also parsimoniously "wired", with a strong bias towards short physical distances between connected regions, but wiring cost is not strictly minimized. It is suggested that brain networks have been selected by a trade-off between competitive pressures to minimize biological cost and to maximise cognitively valuable topological integration. High cost / high value network components, like connector hubs, are preferentially implicated by diverse clinical brain disorders. We show that analogous principles apply to brain networks of the nematode worm *C elegans* and the mouse, and that new technologies will enable a more detailed analysis of the biological mechanisms driving network topology and development. It seems that network science is in a strong position to understand more completely both the nearly-universal principles and the specific biological details of the connectome.

"Quantifying Stability in Complex Networks: From Linear to Basin Stability"

JÜRGEN KURTHS

The human brain, power grids, arrays of coupled lasers and the Amazon rainforest are all characterized by multistability. The likelihood that these systems will remain in the most desirable of their many stable states depends on their stability against significant perturbations, particularly in a state space populated by undesirable states. Here we claim that the traditional linearization-based approach to stability is in several cases too local to adequately assess how stable a state is. Instead, we quantify it in terms of basin stability, a new measure related to the volume of the basin of attraction. Basin stability is non-local, nonlinear and easily applicable, even to high-dimensional systems. It provides a long-sought-after explanation for the surprisingly regular topologies of neural networks and power grids, which have eluded theoretical description based solely on linear stability. Specifically, we employ a component-wise version of basin stability, a nonlinear inspection scheme, to investigate how a grid's degree of stability is influenced by certain patterns in the wiring topology. Various statistics from our ensemble simulations all support one main finding: The widespread and cheapest of all connection schemes, namely dead ends and dead trees, strongly diminish stability. For the Northern European power system we demonstrate that the inverse is also true: `Healing' dead ends by addition of transmission lines substantially enhances stability. This indicates a crucial smart-design principle for tomorrow's sustainable power grids: add just a few more lines to avoid dead ends. Further, we analyse the particular function of certain

network motifs to promote the stability of the system. Here we uncover the impact of so-called detour motifs on the appearance of nodes with a poor stability score and discuss the implications for power grid design. Moreover, it will be shown that basin stability enables uncovering the mechanism for explosive synchronization and understanding of evolving networks.

ABSTRACTS: INVITED Speakers

in order of appearance

SANDRA GONZÁLEZ-BAILÓN

"Core-Periphery Dynamics in Protest Networks"

The role of social media in facilitating political protest has received much attention in recent years, within and beyond academic circles. For some, social media encourages spurious, 'feel-good' activism; for others, they are key to understanding the rippling effects of contentious politics. This talk will discuss novel evidence that aims to solve the dispute. Using a network reduction technique, we map and measure the complex synergies that emerge between core and peripheral participants when organizing and ramping up protest visibility. We analyze three datasets tracking protest communication in three different languages and political contexts, and two additional control datasets unrelated to protests. We show that when networks channel protest communication, peripheral participants consistently have an impact on activity and reach that is comparable to that of the committed minority at the core, offering important resources for growth.

HANS HERRMANN

"Rolling and Synchronization in the Contact Network of Bearings"

A large family of packing topologies allows for slip-less rotations between touching disks or spheres forming bipartite networks of bearings. Bearings are mechanical dissipative systems that, when perturbed, relax toward a synchronized "bearing state". In fact bearings can be perceived as physical realizations of complex networks of oscillators with asymmetrically weighted couplings. These networks can exhibit optimal synchronization properties through tuning of the local interaction strength as a function of node degree. In analogy, the synchronizability of bearings can be maximized by counterbalancing the number of contacts and the inertia of their constituting rotor disks through a power-law mass-radius relation with an optimal exponent, which converges to unity for a large number of rotors. Under this condition, and regardless of the presence of a long-tailed distribution of disk radii composing the mechanical system, the average participation per disk is maximized and the energy dissipation rate is homogeneously distributed among elementary rotors. The synchronization of rotations occurs in avalanches following a broad size distribution. The bearing configurations also fulfill Kolmogoroff scaling and display Richardson's diffusion law in the limit of small Stokes numbers and constitute also an interesting toy model for turbulence. The contact network of two-dimensional space-filling bearings is small-world and scale-free with an exponent that can be calculated analytically as function of the bearing parameters. In particular can the two species of the bipartite network have different exponents in different regions.

"Mining Real-World Networks: from Biology to Economics"

NATASA PRZULJ

We are faced with a flood of molecular data. Various biomolecules interact in a cell to perform biological function, forming very large networks. The challenge is how to collectively mine these data to answer fundamental questions, including gaining new insight into aging, diseases, and improving therapeutics. Just as computational approaches for analyzing genetic sequence data have revolutionized biological understanding, the expectation is that analyses of biological networks will have similar ground-breaking impacts. However, dealing with network data is nontrivial, since many methods for analyzing large networks fall into the category of computationally intractable problems. We develop methods for extracting new biological knowledge from the wiring patterns of a multitude of molecular network data, linking network wiring with biological function and disease, as well as translating the information hidden in the wiring patterns into everyday language. We apply our methods to other domains, including tracking the dynamics of the world trade network and finding new insights into the origins of wealth and economic crises.

"Making Social Networks Work"

IYAD RAHWAN

How is social media changing the way social networks solve complex tasks? And what are the physical and cognitive limits of these networks? I will describe a number of real-world experiments on mobilizing very large numbers of people via social media to achieve complex tasks, from finding balloons tethered at random locations all over a continent in under 9 hours, to locating individuals in remote cities in under 12 hours using only their mug shots, to reconstructing shredded documents with the help of hundreds of volunteers. I will also discuss how things can go wrong, from deliberate misinformation and sabotage, to cognitive biases that can impede the collective intelligence of networks.

"Hybrid percolation transitions in complex networks"

BYUNGNAM KAHNG

Recently hybrid phase transitions including natures of both continuous and discontinuous phase transitions have been obtained in diverse evolving complex systems, for example, cascading failures in interdependent networks. For such dynamics that proceeds in edge removal processes, the critical behavior is determined by randomness only, independent of the forthcoming discontinuous transition. However, it is not clear if a critical behavior that occurs in the hybrid phase transition following edge addition processes is independent of the preceded dynamics of the discontinuous transition. Here, we investigate a hybrid percolation transition induced in cluster merging processes using the so-called restricted Erdos-Renyi model. We obtain the critical exponents for $t > t_c$ analytically, which vary continuously depending on a model parameter that determines dynamical properties of the first-order transition for $t < t_c$.

"Measuring Personalization of Online Services"

ALAN MISLOVE

Today, many web services personalize their content, including Netflix (movie recommendations), Amazon (product suggestions), and Yelp (business reviews). In many cases, personalization provides advantages for users: for example, when a user searches for an ambiguous query such as "router," Amazon may be able to suggest the woodworking tool instead of the networking device. However, personalization is rarely transparent (or even labeled), and has the potential to be used to the user's disadvantage. For example, on e-commerce sites, personalization could be used to manipulate the set of products shown (price steering) or by customizing the prices of products (price discrimination). Unfortunately, today, we lack the tools and techniques necessary to be able to detect when personalization is occurring, as well as what inputs are used to perform personalization. In this talk, I discuss my group's recent work that aims to address this problem. First, we develop a methodology for accurately measuring when web services are personalizing their content. While conceptually simple, there are numerous details that our methodology must handle in order to accurately attribute differences in results to personalization (as opposed to other sources of noise). Second, we apply this methodology to two domains: Web search services (e.g., Google, Bing) and e-commerce sites (e.g., BestBuy.com, Expedia). We find evidence of personalization for real users on both Google search and nine of the popular e-commerce sites. Third, using fake accounts, we investigate the effect of user attributes and behaviors on personalization; we find that the choice of browser, logging in, and a user's previously content can significantly affect the results presented.

"Multilayer Interconnected Complex Networks"

ALEX ARENAS

The constituents of a wide variety of real-world complex systems interact with each other in complicated patterns that can encompass multiple types of relationships, change in time, and include other types of complications. Recently, the interest of the research community increased towards such systems because accounting for the "multilayer" features of those systems is a challenge. In this talk, we will discuss several real-world examples, put in evidence their multilayer information and review the most recent advance in this relatively new field.

"Elucidating the Role of Network Structure in Gene Regulation: Connecting Models and Data"

MICHELLE GIRVAN

The complex process of genetic control relies upon an elaborate network of interactions between genes. Our goal is to combine simple mathematical models with empirical data to understand the role of network structure in gene regulation. Our modeling efforts focus primarily on Boolean systems, which have received extensive attention as useful models for genetic control. An important aspect of Boolean network models is the stability of their dynamics in response to small perturbations. Previous approaches to studying stability have generally assumed uncorrelated random network structure, even though real gene networks

typically have nontrivial topology significantly different from the random network paradigm. To address such situations, we present a general method for determining the stability of large gene networks, given some specified network topology. Additionally, we generalize our framework to handle a variety of more biologically realistic update rules, including non-synchronous update and non-Boolean models, in which there are more than two possible gene states. We discuss the application of our modeling approach to experimentally inferred gene networks, and explore the role of dynamical instability in both the evolution of gene networks and the occurrence of some cancers.

"Financial Networks"

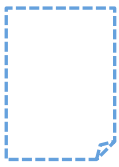
GUIDO CALDARELLI

In this talk I will present some of our recent activity in the field of Financial Networks, namely network reconstruction, stability and evolution. I will give also an overview of the open problems in the field.

"First Principles behind Network Structure, Function, and Dynamics"

DMITRI KRIOUKOV

A variety of phenomena in many areas of physics can be explained by the same set of first principles. The central element of these principles is system invariance with respect to a group of symmetries of the system. These symmetries are usually geometric; they can be either the isometries of the physical space, or gauge transformations in a latent space. The symmetry group then defines, via renormalization, the system behavior near critical points in statistical mechanics, or, via action extremization, Lagrange's or Hamilton's dynamic equations describing all the fundamental interactions in nature, from electromagnetic to gravitational. It turns out that to a great extent the same first principles apply to networks. Imposing the Lorentz invariance requirement to a certain class of maximum-entropy network ensembles, one arrives to a geometric model of random networks that share with real networks a wide range of structural properties, from scale-free degree distributions and strong clustering, to community structure. The efficiency of transport phenomena on these networks is nearly optimal, or conversely, the maximization of transport efficiency at minimal costs leads to network structure observed in reality. The large-scale growth dynamics of these geometric networks is also remarkably close to evolution of real networks, while preferential attachment appears as a solution of Hamilton's equations with degenerate symmetries. Open problems, such as the description of network dynamics at small scales, the emergence of continuous geometry from discrete network structure, and generalizations to higher-dimensional simplicial complexes describing n-point versus dyadic interactions in real systems, are also discussed.



PARALLEL SESSIONS

WEDNESDAY June 3rd, 2015 *Afternoon* (check booklet for rooms assignment)

Time	Biological Networks I	Computational Social Sciences I	Networks I	Theory I
Chair	**Roger Guimerá**	**Nicola Perra**	**Dmitri Krioukov**	**Alain Barrat**
14:30	J. Sung. Global metabolic interaction network of the human gut microbiota.	A. Sela. Temporal Network Seeding for Improved Social Contagion.	F. Schweitzer. The rise and fall of collaborations - Insights from a large-scale analysis of R&D networks.	D. Garlaschelli. Breaking of ensemble equivalence in networks.
14:50	A. Sharma. Multi-network signature genes of Preeclampsia disease.	E. Moro. Social media fingerprints of unemployment.	S. Way. Gender inequality and return on investment in faculty hiring networks.	S. Melnik. Analytical calculation of shortest path lengths on networks.
15:10	D. Larremore. Revealing evolutionary constraints on genetic recombination in malaria parasites by mapping genes to networks.	M. Tambuscio. Fact-checking effect on viral hoaxes: a model of misinformation spread in social networks.	R. Sinatra. The Chaperone phenomenon in Science.	E. Estrada. On Growth and Form of Networks.
15:30	C. A. Lugo. Structural features of RNA phenotype networks and its effects on biological evolution.	D. J.P. O'Sullivan. Mathematical Modelling of Complex Contagion on Clustered Networks.	L. Bohlin. Second-order Markov dynamics reveal overlapping fields and multidisciplinary journals in citation data.	P. Colomer. Local percolation thresholds.
15:50	O. Nebilj. Topology-Function Conservation in Protein-Protein Interaction Networks.	P. Fennell. Non-Markovian contagion on social networks.	T. Carletti. Driving forces of researchers' mobility.	M. Williams. Metrics for the Analysis of Robustness in Spatio-temporal Networks.
16:10 – 16:40	*COFFEE BREAK*			

WEDNESDAY June 3rd, 2015 *Afternoon* (check booklet for rooms assignment)

Time	Dynamics on Networks	Epidemics I	Social & Economics Networks I	Urban Networks
Chair	**Roberta Sinatra**	**Sandro Meloni**	**Javier Borge-Holthoefer**	**Camile Roth**
16:40	G. C. Rodi. Optimal learning paths in information networks.	R. Mastrandrea. Assessing the risk of epidemic spread in a hospital by merging data about hand-hygiene compliance and daily contacts.	J. Park. Ranking Competitors Using Degree-Neutralized Random Walks.	A. Cardillo. Several multiplexes in the same city: The role of socioeconomic differences in urban mobility.
17:00	S. Thurner. Zipf's law in node visiting frequencies in diffusion processes on directed networks.	J. Fournet. Comparing contact data from different sources: impact on simulations of epidemic spread.	A. Jacobs. Vintage and heterogeneity in online social network assembly.	A. Llorente. Temporal dynamics of intra and inter-city social networks.
17:20	G. Morrison. Control in ownership networks using a majority rule model.	C. Poletto. Competing spreading processes on temporal networks.	K.-K. Kleineberg. Ecology 2.0: Coexistence and Domination among Interacting Networks.	R. Gallotti. Lost in transportation.
17:40	M. Diakonova. Networks with Coevolution and Noise.	J. Manitz. Bayesian Inference for the Estimation of Networks given Epidemic Metapopulation Data.	M. Everett. A simplified bridging measure for social networks	J. J. Ramasco. Human diffusion and city influence.
18:00	P. S. Skardal. Chaos in assortative coupled oscillator networks.	J. Miller. Are you new here? Infection spread in networks with demographic turnover.	F. Battiston. Layered social influence promotes multiculturality.	M. Lenormand. Functional Network of the City.
18:20 – 19:00	**POSTER SESSION 1** (1-85 and L1-L9)			

PARALLEL SESSIONS

THURSDAY June 4th, 2015 *Afternoon* (check booklet for rooms assignment)

Time	Epidemics II	Computational Social Sciences II	Networks II	Theory II
Chair	**Chiara Poletto**	**Esteban Moro**	**James Gleeson**	**Ernesto Estrada**
14:30	E. Valdano. Impact of empirically constrained contact sampling on spreading potential.	J. Bagrow. Information flux and its role in social prediction.	Y.-Y. Liu. Stability of Heterogeneous Ecological Systems.	T. Peixoto. Model selection and hypothesis testing for large-scale network models with overlapping groups.
14:50	J. Gómez-Gardeñes. Explosive Epidemics: when social context influences contagions.	J. Borge-Holthoefer. From modular to nested architectures: the push towards mutualism in information ecosystems.	K. Takemoto. Heterogeneity is the main factor in determining the stability of ecological mutualistic networks.	F. Vaccarino. A computational topology paradigm for network science.
15:10	H. H. K. Lentz. Paths for infections and the role of memory in temporal networks.	N. Perra. Attention on Weak Ties in Social and Communication Networks.	H. Makse. Collective influence optimization makes visible the invisible.	B. Maier. Modular Hierarchical Random Networks: Characteristics and Dynamics.
15:30	L. Hébert-Dufresne. Optimal coupling of network clustering and dynamics: when interacting diseases can benefit from modular contact structure.	S. Oh. Complex Contagions with Lazy Adoption.	N. Boers. Prediction of the most extreme rainfall events in the South American Andes: A statistical forecast based on complex networks.	B. D. Sullivan. Characterizing, Exploiting and Predicting Algorithmic Structure in Complex Networks.
15:50	O. Baranov. Allocation of resources during emergent infectious diseases.	A. Horvát. Market vs network relations: The role of friends in the early stages of bidding in crowdfunding.	H. Sayama. What Are Essential Concepts about Networks?	C. Roth. Automatic discovery of plausible network generators.
16:10 – 16:40	*COFFEE BREAK*			

THURSDAY June 4th, 2015 *Afternoon* (check booklet for rooms assignment)

Time	Biological Networks II	Multilayer Networks I	Social & Economics Networks II	Temporal Networks
Chair	**Javier M. Buldú**	**Jesús Gómez-Gardeñes**	**Guido Caldarelli**	**Ciro Catutto**
16:40	J. Menche. Diseases in the Human Interactome.	S. Gómez. Competing awareness and epidemic processes on networks.	S. Battiston. Leveraging the network: a stress-test framework based on DebtRank.	M. Starnini. Burstiness and aging in social temporal networks.
17:00	A. Rinaldi. Reverse Engineering the Multiplexity of Inflammatory Diseases.	E. Cozzo. Structural organization of multiplex networks.	I. Vodenska. Coupled network approach to predictability of financial market returns and news sentiments.	I. Scholtes. Spectral Methods in the Analysis of Non-Markovian Temporal Networks.
17:20	J. H. Martínez. Hemisphere Competition in Functional Brain Networks.	P. Bródka. Group Extraction in Multi-layered Social Network.	E. A. Horvát. Leveraging collective intelligence in organizations.	G. García-Pérez. Regulation of burstiness by network-driven activation.
17:40	I. Leyva. Emergence of small-world networks in self-organizing clustered neuronal cultures.	T. Vallès Català. Multilayer stochastic block models reveal the multilayer structure of complex networks.	K. Schaar. The Role of Contact Networks in Outbreaks of Healthcare-Associated Infections.	L. Gauvin. Revealing mesocale structures to control dynamical processes in socio-technical systems.
18:00	M. Faccin. Structural controllability of EEG temporal causal networks.	R. A. Da Costa. Critical phase and infinite-order transition in explosive percolation.	J. Fernandez-Gracia. Spreading of antibiotic-resistant infections in the hospital transfer network.	J.-Ch. Delvenne. Effects of burstiness on diffusion in temporal networks.
18:20 – 19:00	**POSTER SESSION 2** (86-170 and L10-L17)			

PARALLEL SESSIONS & LIGHTNING TALKS

FRIDAY June 5th, 2015 *Contributed talks* (check booklet for rooms assignment)

Morning Session

Time	Computational Social Sciences III	Multilayer Networks II	Theory III	Phase Transitions
Chair	**Bruno Gonçalves**	**Albert Díaz-Guilera**	**Tiago Peixoto**	**Alex Arenas**
11:15	G. L. Giampaglia. Computational fact checking from knowledge networks.	M. A. Serrano. Escaping the avalanche collapse in self-similar multiplexes.	J. Clough. Centrality in Spatio-Temporal Networks.	G. Baxter. Critical dynamics of the k-core pruning process.
11:35	M. Karsai. Structure and dynamics of online service adoption spreading.	V. Gemmetto. Multiplexity and multireciprocity in real-world multiplexes.	E. R. Hancock. A Measure of Graph Similarity based on the Quantum Jensen-Shannon Divergence.	S. M. Krause. Color avoiding Percolation on Networks.
11:55	N. Rodriguez. A network model of social transition and upheaval.	M. Maragakis. Multiplex networks with varying interlayer link strength.	G. Zamora-López. Individual node's contribution to the mesoscale of complex networks.	A. Faqeeh. Accurate percolation theory for modular networks with finite number of interlinks.
12:15	M. Beguerisse Diaz. Beyond metadata: Using content to reveal the evolution of narratives in social media.	M. de Domenico. Structural reducibility of multi-layer networks.	L. Subelj. Exploratory and predictive tasks of network community detection.	A. Goltsev. Critical phenomena and phase transitions in neuronal networks with complex network architecture.
12:35	R. M. Benito. Measuring Political Polarization on Twitter Conversations.	N. Kouvaris. Topology-induced instabilities in multiplex activator-inhibitor networks.	E. Guney. Network-based relative proximity: A novel measure for quantifying the closeness between two sets of nodes and its application to network.	L. F. Seoane. Phase transitions in Pareto optimal complex networks.
13:00 – 14:30	*LUNCH BREAK*			

FRIDAY June 5th, 2015 Lightning talks — Afternoon Sessions-Auditorium

Time	**LIGHTNING TALKS** (Title & speaker)
14:30	"Forecasting Seasonal Influenza with Dynamic Models Assimilating Digital Social Data", Q. Zhang.
14:37	"Context-Specific Networks of Protein-Protein Interactions in *Mycobacterium tuberculosis*", S. Arregui.
14:44	"Generalized Models of Ecological Metacommunities", T. Gross.
14:51	"Quantifying Team Effort and Success", M. Szell.
14:58	"Reclaiming the Value of Interdisciplinary Research: a New Index of Scientific Impact", E. Omodei.
15:05	"Collective Behavior in the Evolution of Scientific Research Interests", T. Jia.
15:12	"Automatic Identification of Relevant Concepts in Scientific Publications", A. Martini.
15:19	"Assessing Inter-Cultural Patterns through Ranking Biographies", P. Aragón.
15:26	"The Scientific Competitiveness of Nations", G. Cimini.
15:33	"From Land-Use to Human Mobility: Predicting intra-city human mobility using individual daily movement pattern and land-use", M. Lee.
15:40	"Opening Bottlenecks on Weighted Networks by Local Adaptation to Cascade Failures", J. Alstott.
15:47	"On Social System Identification using Stubborn Agents", H.-T. Wai.
15:54	"Abrupt Percolation Transitions on Multiplex", M. Maragakis.
16:01	"Dynamically Emergent Explosive Synchronization", J. A. Almendral-Sánchez.
16:10 – 16:40	*COFFEE BREAK*
16:40 – 17:40	ERDÖS RENYY PRIZE & LECTURE
17:40 – 18:00	CLOSING REMARKS **NETSCI 2015**

POSTERS

Please, consider that the Posters will be displayed in two sessions. ***Posters from 1-85 are scheduled for Wednesday 3rd****, whereas* ***the rest of Posters (86 onward) will be shown on Thursday 4th****.* ***Thank you all for the effort and the quality of contributions.***

1.	Miron Kaufman and Sanda Kaufman. "Krugman Model of Urban Spatial Economy on Networks".
2.	Ralucca Gera. "A structural evaluation of inferred networks".
3.	Alex Becheru and Sorin Ilie. "Automatic service composition using swarmintelligence for human collaboration in agileorganizations".
4.	Per Sebastian Skardal and Alex Arenas. "Control of coupled oscillator networks".
5.	Vladimir Marbukh. "On Managing Cost/Benefit Connectivity Tradeoff in a Networked Infrastructure Susceptible to Adverse Cascades".
6.	Bronislav Sidik, Yisrael Mirsky, Luiza Nacshon and Rami Puzis. "Efficient Temporal Anomaly Detection in Evolving Graphs".
7.	Christian Lyngby Vestergaard and Mathieu Génois. "Fast Gillespie-like algorithm for simulation of contagion processes on temporal networks".
8.	Luis Andrey Fajardo Fajardo. "Implementation in python of a method to transform one-dimensional signals in graphs".
9.	Mathieu Génois, Christian Lyngby Vestergaard, Ciro Cattuto and Alain Barrat. "Compensating for sampling effects in simulations of epidemic spreading on temporal contact networks".
10.	Ernesto Estrada and Matthew Sheerin. "Random Rectangular Graphs. Structure and Dynamics".
11.	Leo Speidel, Taro Takaguchi, Kazuyuki Aihara and Naoki Masuda. "Community detection in directed acyclic graphs".
12.	Alfonso Nino, Camelia Munoz-Caro and Sebastian Reyes. "Systematic mapping analysis of the time evolution of community detection studies in networks. Past, present, and future trends".
13.	Federico Botta and Charo I. Del Genio. "Quantifying the behaviour of human communication through community detection".
14.	Francesca Arrigo and Michele Benzi. "Updating and Downdating techniques for optimizing network communicability".
15.	Yasmin Bokobza, Abigail Paradise, Guy Rapaport, Rami Puzis and Bracha Shapira. "Information Leakage Detection in Social Networks Using an Artificial Profile".
16.	Ying Liu, Ming Tang, Jie Gong and Jing Yue. "Improving K-shell decomposition method by identifying redundant links in networks".
17.	Quantong Guo, Xin Jiang, Yanjun Lei, Meng Lei, Yifang Ma and Zhiming Zheng. "Two-stage effects of awareness cascade on epidemic spreading in multiplex networks".
18.	Hilla Brot, Jacob Goldenberg, Lev Muchnik and Yoram Louzoun. "Evolution through bursts: Network

	structure develops through localized bursts in time and space".
19.	Shan Lu, Bo Jiang, Jieqi Kang, Weibo Gong, Gennady Samorodnitsky and Don Towsley. "Multivariate Heavy Tailed Distribution Generator Using Poisson Processes for Complex Network Analysis".
20.	Deokjae Lee, Sungmin Hwang, Sangmin Choi and Byungnam Kahng. "Efficient dynamic algorithm for mutually connected components".
21.	Alessandro Di Stefano, Aurelio La Corte and Marialisa Scatà. "A Novel Multi-agent Social Multilayer Framework for Improving Health Information Exchange and Management".
22.	Juddy Heliana Arias Castro and Jesús Gómez Gardeñes. "Vector Borne Diseases in Metapopulations".
23.	Dirk Ahlers. "Geospatial Grounding of the Web Graph."
24.	Martijn Boussé, Paul Smyth, Johan Suykens and Lieven De Lathauwer. "New Applications of Tensors to Graphs".
25.	Adam Svenkeson and Ananthram Swami. "Reaching Consensus by Allowing Moments of Indecision".
26.	Shai Pilosof, Gili Greenbaum and Yuval Zelnik. "Disease dynamics in multi-host interconnected networks".
27.	Michele Tizzoni, Kaiyuan Sun, Diego Benusiglio, Marton Karsai and Nicola Perra. "The Scaling of Human Contacts in Reaction-Diffusion Processes on Heterogeneous Metapopulation Networks".
28.	Atsushi Miyauchi and Yasushi Kawase. "Z-score-based modularity for community detection in networks".
29.	Jeff Alstott, Bowen Yan, Giorgio Triulzi and Jianxi Luo. "Technology Relatedness Networks Predict The Future Activity of Inventors".
30.	Borut Sluban, Jasmina Smailovic, Igor Mozetic and Stefano Battiston. "Sentiment Leaning of Influential Communities in Social Networks".
31.	Carlos Gracia-Lázaro, Yamir Moreno, Anxo Sanchez and Jose Cuesta. "Reputation drives cooperative behaviour and network formation in human groups".
32.	Adam Jakubik. "The effects of complexity and information in spatial competition".
33.	Dongfeng Tan. "De Morgan's Laws for the Formation and Destruction of Networked Force".
34.	An Zeng and Stefano Battiston. "The multiplex network of EU lobby organizations".
35.	Bruno Ribeiro, Minh Hoang and Ambuj Singh. "Beyond Models: Forecasting Complex Network Processes Directly from Data".
36.	Sude Tavassoli and Katharina Anna Zweig. "Group chat analysis using network analytic approaches: interpreting a psychotherapeutic process".
37.	Massimiliano Zanin. "The multi-layer structure of functional networks".
38.	David Papo and Massimiliano Zanin. "Characterizing motif dynamics using symbolic analysis".
39.	Marco Bardoscia, Stefano Battiston, Fabio Caccioli and Guido Caldarelli. "Propagating shocks in the

	interbank network: a new foundation for DebtRank".
40.	Benjamin Althouse and Laurent Hebert-Dufresne. "Epidemic Cycles Driven by Host Behavior".
41.	Alberto Aleta, Sandro Meloni and Yamir Moreno. "Towards more realistic contact networks".
42.	Saray Shai, Dror Kenett, Yoed Kenett, Miriam Faust, Simon Dobson and Shlomo Havlin. "Attacks on modular networks".
43.	Zhen Zhu, Michelangelo Puliga, Federica Cerina, Alessandro Chessa and Massimo Riccaboni. "Global Value Trees".
44.	Benjamin Lind. "Contrasting Protest from Mundanity in Communication Networks: Leadership, Formal Organization, and Solidarity among the Russian Opposition Movement".
45.	Rene Markovič, Dean Korošak and Marko Marhl. "Modeling the topological evolution of social media".
46.	Federica Cerina, Zhen Zhu, Alessandro Chessa and Massimo Riccaboni. "World Input-Output Network".
47.	Manlio De Domenico, Joan Matamalas and Alex Arenas. "Interplay Between Human Mobility and Telecommunication".
48.	Nicholas Haynes, Otti D'Huys and Daniel Gauthier. "Extreme transients in experimental time-delay autonomous Boolean networks".
49.	Arturo Buscarino, Mattia Frasca, Lucia Valentina Gambuzza and Philipp Hoevel. "Chimera states in time-varying networks".
50.	Edward Laurence, Jean-Gabriel Young, Sergey Melnik and Louis J. Dubé. "Exact analytical solution of binary dynamics on networks".
51.	Timoteo Carletti. "Turing patterns in multiplex networks".
52.	Navid Dianati and Nima Dehmamy. "Arbitrary degree distribution and high clustering from a local geometric network growth model".
53.	Mina Kim, Su-Chan Park and Jae Dong Noh. "Anomalous Coarsening Dyanmics of Nonequilibrium Chiral Ising Model".
54.	Bryan Perozzi, Vivek Kulkarni, Rami Al-Rfou' and Steven Skiena. "Statistically Significant Detection of Linguistic Change".
55.	Miao Qingying, Wang Xiaofan and Juergen Kurths. "Synchronization of multiplex networks of different inter-connections".
56.	Niki Boumpali and Maximilian Schich. "The Animation Movie Release Network - 110 Years of Cultural Attention".
57.	Levente Varga, Ferenc Járai-Szabó, Dávid Deritei, Zsolt I. Lázár, István Papp, Razvan Florian and Mária Ercsey-Ravasz. "Local Cluster Detection Method for Normalizing Scientometric Indicators".
58.	Tim Weninger. "Large Scale Graph Analytics with Vertex Programming".
59.	Lovro Šubelj, Dalibor Fiala and Marko Bajec. "Consistency of citation topology of bibliographic databases."

60.	Deokjae Lee, Kyu S. Hahn, Soon-Hyung Yook and Juyong Park. "Quantifying discrepancies in opinion spectra from online and offline networks".
61.	Doheum Park, Arram Bae, Maximilian Schich and Juyong Park. "Topology and Evolution of the Network of Western Classical Composers."
62.	Travis Martin, Brian Ball and Mark Newman. "Structural inference on uncertain networks".
63.	Kaelkrittaya Trurktham and Tsuyoshi Murata. "Analyzing Communities in Directed Networks Based on Motif Frequencies".
64.	Hiroyasu Inoue. "Effect of economic policy through network of firms and reaction to disasters".
65.	Massimo Stella and Markus Brede. "Investigating the English Language via Phonological Networks and Percolation Techniques".
66.	Jeff Alstott, Giorgio Triulzi and Jianxi Luo. "Patent Networks Can Be Rewired to Normalize for Many Phenomena Simultaneously, Revealing Innate Technology Structures".
67.	Vincent Traag. "Faster unfolding of communities: speeding up the Louvain algorithm".
68.	Vincent Traag, Rodrigo Aldecoa and Jean-Charles Delvenne. "Detecting communities using asymptotical Surprise".
69.	Tomokatsu Onaga and Shigeru Shinomoto. "Criticality of epidemic bursts spreading through a network of individuals".
70.	Tatsuro Kawamoto and Yoshiyuki Kabashima. "Detectability threshold of the spectral method for graph partitioning in sparse graphs".
71.	Francesca Di Patti, Duccio Fanelli and Francesco Piazza. "Optimal search strategies on complex multi-linked networks".
72.	Gabriele Ranco, Darko Aleksovski, Guido Caldarelli, Miha Garafolj and Igor Mozetič. "Comparison of networks of stock price returns and Twitter sentiment".
73.	Lvlin Hou, Songyang Lao, Michael Small, Yandong Xiao and Liang Bai. "Enhancing Complex Network Controllability by Minimum Link Direction Reversal".
74.	Cheng Ye, Richard Wilson and Edwin Hancock. "Thermodynamics of Dynamic Complex Networks".
75.	Federico Battiston, Mario Chavez, Vincenzo Nicosia and Vito Latora. "Multilayer motifs in brain networks".
76.	Elvis Xu and Pak Ming Hui. "PCMA: Identifying Communities with Significant Overlap in Linear Time".
77.	Bedartha Goswami, Aljoscha Rheinwalt, Niklas Boers, Norbert Marwan, Jobst Heitzig, Sebastian Breitenbach and Jürgen Kurths. "Detecting paleoclimate transitions of the East Asian Summer Monsoon with recurrence networks".
78.	Pai-Ju Chang, Wei Lee Woon, Talal Rahwan, Brad Leveck and Iyad Rahwan. "Temporal Trends in International Relations from Event Data".
79.	Veronika Stolbova and Jürgen Kurths. "Network of extreme rainfall events over the Indian subcontinent: spatial structures, dynamics and prospects for predictability".

80.	Konstantin Kilimnik, Miriam Hoderker and Rami Puzis. "Category Extraction Through Community Detection in Wikipedia ".
81.	Ying Wang, Wen Yang and Xiaofan Wang. "Quantization of Complex Networks".
82.	Jianjia Wang, Edwin Hancock and Richard Wilson. "Partition Functions of Complex Networks".
83.	Nicolas Wider. "An ensemble perspective on multi-layer networks".
84.	Albert Sole, Sergio Gómez and Alex Arenas. "Optimal multiplex topologies for search and congestion".
85.	Jorge Cruz, Marco Correia, Pedro A. Sousa and Massimiliano Zanin. "Parameters optimisation of generative models through probability constraint programming".
86.	Juan Ignacio Perotti, Claudio Juan Tessone and Guido Caldarelli. "Finding and Validating Hierarchical-Modular Decompositions of Complex Networks".
87.	Massimiliano Zanin, Pedro A. Sousa and Ernestina Menasalvas. "Information Content and meso-scales in complex networks".
88.	Francesco Alderisio, Chao Zhai, Benoît Bardy and Mario di Bernardo. "Modeling Human Coordination in Multiplayer Games as a Synchronization Problem".
89.	David Papo, Ernesto Pereda, Ricardo Bajo, Ernestina Menasalvas, Pedro A. Sousa and Massimiliano Zanin. "Connectivity metrics reveal different aspects of functional brain organization".
90.	Takaaki Aoki, Luis E. C. Rocha and Thilo Gross. "Two kinds of heterogeneities emerging in adaptive temporal networks".
91.	Bernat Corominas-Murtra and Stefan Thurner. "The entangled nature of the core of social networks: A new view on elite detection".
92.	Jonathan Silva, Laura Bennett, Sophia Tsoka and Lazaros G. Papageorgiou. "Sequential Clustering of Dynamic Network Snapshots using Mathematical Programming".
93.	Marc Wiedermann, Jonathan Donges, Reik Donner and Jürgen Kurths. "Random network models for spatially embedded complex networks".
94.	Takayuki Mizuno, Takaaki Ohnishi and Tsutomu Watanabe. "Estimating firm-level risk in global inter-firm networks".
95.	Mario Mureddu, Alfonso Damiano, Guido Caldarelli, Antonio Scala and Hildegard Meyer-Ortmanns. "Percolation in power grids with high renewable-like generation: conditions for the emergence of operating islands".
96.	Jiyoung Woo, Sung Wook Kang, Huy Kang Kim and Juyong Park. "Social contagion of cheating behaviors in online games".
97.	Andrea Cuttone, Jakob Eg Larsen and Sune Lehmann. "Multi-Level Hierarchical Structure of Human Mobility".
98.	Matija Piškorec, Nino Antulov-Fantulin, Iva Miholić, Tomislav Šmuc and Mile Šikic. "Modeling peer and external influence in online social network".
99.	Agnieszka Czaplicka, Raul Toral and Maxi San Miguel. "Competition of different mechanisms of

	spreading on multi-layer networks".
100.	Nino Antulov-Fantulin, Alen Lancic, Mile Šikic, Tomislav Šmuc and Hrvoje Stefancic. "Multiple source epidemic recognition in complex networks".
101.	Gregorio D'Agostino and Antonio De Nicola. "Interests Diffusion in Social Networks".
102.	Thibaud Arnoux, Jordan Viard, Matthieu Latapy, Clémence Magnien and Christophe Prieur. "Maximal cliques in real-world interaction streams".
103.	Alice Patania, Francesco Vaccarino, Soroosh Nazem and Giovanni Petri. "Topology of Networks Time-delay Embeddings".
104.	Javier Borondo, Alfredo Morales, Rosa M. Benito and Juan Carlos Losada. "Influence of the embedded Social Network on the online communication patterns of political conversations".
105.	Kyung Yeon Moon, Semi Min and Juyong Park. "Computational Narratology: Structure of Drama and Social Networks in Victor Hugo's Les Mis".
106.	Alexander Radebach, Hauke Schult and Jan Steckel. "On the importance of manufacturing sectors for economic development and growth".
107.	Kosuke Shinoda and Satoshi Kurihara. "Generation of conference map and extraction of conference importance used by the relationship author and conference acceptance".
108.	Jwen Fai Low. "Of Points and Player Synergy: A Study of Basketball Team Performance".
109.	Aamena Alshamsi, Fabio Pianesi, Bruno Lepri, Alex Pentland and Iyad Rahwan. "Communication Diversity and Affect Dynamics".
110.	Aamena Alshamsi, Edmond Awad, Maryam Almehrezi, Vahan Babushkin, Pai-Ju Chang, Zakariyah Shoroye, Attila P. Toth and Iyad Rahwan. "Misery Loves Company: Happiness and Communication in the City".
111.	Dominik Traxl, Niklas Boers and Jürgen Kurths. "General Scaling of Maximum Degree of Synchronization in Noisy Complex Networks".
112.	Javier Borondo, Alfredo Morales, Rosa M. Benito and Juan Carlos Losada. "Multiple leaders on a multilayer social media".
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