Complex networks: theory, methods, and applications

Lake Como School of Advanced Studies - May 15-19, 2017

Complex networks: theory, methods, and applications (3rd edition)

Villa del Grumello, Como, Italy, 15-19 May 2017

Many real systems can be modeled as networks, where the elements of the system are nodes and interactions between elements are edges. An even larger set of systems can be modeled using **dynamical processes on networks**, which are in turn affected by the dynamics. Networks thus represent the backbone of many **complex systems**, and their theoretical and computational analysis makes it possible to gain insights into numerous applications. **Networks permeate almost every conceivable discipline** —including sociology, transportation, economics and finance, biology, and myriad others — and the study of "network science" has thus become a crucial component of modern scientific education.

The school "**Complex Networks: Theory, Methods, and Applications**" offers a succinct education in network science. It is open to all aspiring scholars in any area of science or engineering who wish to study networks of any kind (whether theoretical or applied), and it is especially addressed to **doctoral students** and **young postdoctoral scholars**. The aim of the school is to deepen into both theoretical developments and applications in targeted fields.

This is the **3rd edition** of the school: click here to visit the website of the **2nd edition** (2016).

Download the mini-poster (pdf) of the school.

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COMPLEX SYSTEMS SOCIETY

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Application

The School will be open to 50 qualified and selected students.

Registration fee: **500 euro,** VAT 22% included.
The fee covers all lectures; course material; wi-fi connections; lunches and coffee breaks; social dinner.

HOW TO APPLY: Prospective participants have to fill out and **submit the form** below, and **upload a 1-page letter** succinctly describing their educational background, current position, research interests, and motivations for participating in the School.

PREREQUISITES: Basic notions and metrics on complex networks are required to be able to follow the entire course.

SELECTION CRITERIA: In addition to applicant quality, the Organizing Committee will consider a number of features including: the coherence of the motivation with the aim and scope of the school, the potential benefit for the student's research, the timeliness for the development of the student's career. Preference will be given to applicants not participating in the previous two editions of the school.

SHORT TALKS: Participants who intend to give a short talk (4 minutes) on **Wednesday 17, afternoon**, should declare it in the **application form** (see below) and provide a **title** and a list of **keywords** (from 3 to 5). As there will be room for no more than 25-30 talks, in case of a larger number of proposals the Organizing Committee will select on the basis of the potential interest to the audience, the coherence with the aim and scope of the school, and the diversification of topics.

Deadlines
• Student application: **March 5, 2017**
• Notification of acceptance: **March 27, 2017**
• Registration (only accepted students): **April 10, 2017**

CSS-TSS fee waivers

The Complex Systems Society (CSS), in the framework of the Thematic School Support (TSS) Program 2017, grants 2 fee waivers to support the attendance of PhD students and Junior Post Doctoral researchers who are members of the CSS.

Prospective participants who are eligible for the TSS grant should accompany their application (see the form below) with an email to the Organizing Committee (Carlo Piccardi, email carlo.piccardi@polimi.it) requiring the fee waiver, providing evidence of their eligibility (academic status and CSS membership, holding at the application deadline, March 5, 2017). The acceptance will be notified together with the admission to the school (before April 10, 2017).

APPLICATION FORM

The application form for Complex networks: theory, methods, and applications (3rd edition) is currently closed.

For information, please contact the Organizing Secretariat (Ms. Alessandra Cazzaniga – email: alessandra.cazzaniga@fondazionealessandrovolta.it) .

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Contacts

For enquiries about the **scientific aspects of the school**, please contact Carlo Piccardi (carlo.piccardi@polimi.it) or any other member of the Organizing Committee.

For enquiries about the **venue** of the school, **travel**, **accommodation**, and **application** procedure, please contact Alessandra Cazzaniga (alessandra.cazzaniga@fondazionealessandrovolta.it) at Fondazione Alessandro Volta, Como.

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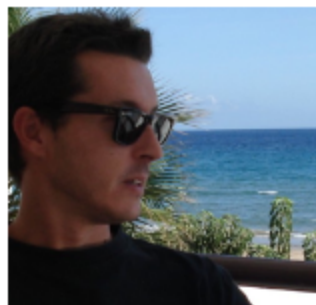*Lake Como School of Advanced Studies - May 15-19, 2017*

Lecturers

Ginestra Bianconi
Queen Mary University of London
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Javier Borge-Holthoefer
CoSIN3 – Complex Systems Group, Internet Interdisciplinary Institute (IN3), Universitat Oberta de Catalunya (UOC), Barcelona
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Ciro Cattuto
Scientific Director & Data Science Laboratory head, ISI Foundation, Turin
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James Gleeson
MACSI, Department of Mathematics and Statistics, University of Limerick
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Thilo Gross
Department of Engineering Mathematics, Merchant Venturers School of Engineering, University of Bristol
www.biond.org, www.reallygross.de

Yamir Moreno
Institute for Biocomputation and Physics of Complex Systems (BIFI) & Department of Theoretical Physics, University of Zaragoza
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Organizing Committee

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Vittoria Colizza
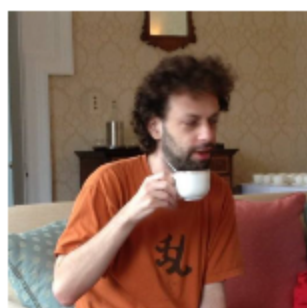*Inserm & Université Pierre et Marie Curie, Paris, and ISI Foundation, Turin*
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Program

(updated October 14, 2016)

Monday, 15 May, morning (9.30-12.30)
Introduction to Networks **(Bianconi)**: Networks and complex systems, a general introduction. Structural properties of networks: from the local quantities (degree, clustering coefficient, motifs) to mesoscale (communities) and global quantities (diameter, degree distributions). Models of networks: growing network models, configuration model, exponential random graphs. Interplay between structure and dynamics on complex networks: percolation, epidemic spreading and synchronization.

Monday, 15 May, afternoon (14.30-17.30)
Continuous-state Dynamics on Networks **(Gross)**: Modelling networks of continuous variables. Adjacency, Laplacian, Jacobian, and other matrix approaches. Tools from matrix theory. Generalized models. Multilayer dynamics. Bifurcations and phase transitions in continuous network dynamics.

Tuesday, 16 May, morning (9.30-12.30)
Discrete-state Dynamics on Networks **(Gleeson)**: Binary-state models, discrete-time and continuous time models. Biological contagions (disease-spread models). Social contagions (threshold models). Mean-field, pair approximations, and beyond. Branching processes.

Tuesday, 16 May, afternoon
no lectures

Wednesday, 17 May, morning (9.30-12.30)
Multilayer Networks **(Bianconi)**: Why do we need multilayer networks? Network of networks, multiplex networks and multislice networks. Multilayer networks encode more information than single layer taken in isolation: multilinks, overlap, multilayer communities, and centrality measures. Models of multilayer networks: from growing models to multilayer network ensembles, and tensor models. Interplay between multiplexity and dynamics: percolation, random walk and epidemic spreading.

Wednesday, 17 May, afternoon (14.30-17.30)
short talks by students (see page Application)

Wednesday, 17 May, evening (19.30)
social dinner

Thursday, 18 May, morning (9.30-12.30)
Evolutionary Game Theory and Human Behavior **(Moreno)**: Introduction to game theory. Evolutionary rules, replicator equation. Evolution of cooperation. Evolutionary Graph Theory. Social Dilemmas. N-person games. Behavioral response in humans (experimental results). Open problems and future challenges.

Thursday, 18 May, afternoon
no lectures

Friday, 19 May, morning (9.30-12.30)
Computational Social Science/1 – Unconventional Approaches to Collective Behavior: Information and Urban ecosystems **(Borge-Holthoefer)**: Bidirectional links between Sociology and Complex Systems. Empirical social networks. Unipartite view: information spreading and influence. Bipartite view: natural and social "ecosystems". Bipartite networks methods: mesoscale pattern detection (modularity, nestedness). Information ecosystems: growth and structural evolution. Spatial ecosystems. Future directions: nested multilayers.

Friday, 19 May, afternoon (14.30-17.30)
Computational Social Science/2 **(Cattuto)**: Measuring social networks in physical space: mobility and proximity, informal social networks, physical proxies for social links and contacts, wearable sensors and smartphones. Structural and temporal properties of close-range proximity networks in various empirical contexts. Sampling and reconstruction of time-varying social networks. Homophily in social networks, social influence and social selection. Meso-scale structure of time-varying social networks and its impact on spreading processes.

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Venue and Accommodation

7The School is housed in **Villa del Grumello,** Como, which is set in a park over Como lake.

How to get there

Click here for information on how to reach Como

Villa del Grumello is 20 min on foot from Como city center – you can also take a bus, lines 6 and 11 (bus stop: "Como Via Regina Piscine Villa Olmo", just after "Villa Olmo").

From the main Train Station (Como S. Giovanni), the nearest bus stop to catch line 6 and 11 is "Piazzale Rocchetto".

Click here for a map

Accommodation

Villa del Grumello has a **guest house** ("foresteria") with 19 beds in 2- or 4-bed rooms. The rate is **33 euros** per night (breakfast not included; a kitchen for self preparing breakfast is available). Please notice that **only shared accommodation with other students is allowed** (no accompanying persons).

A few rooms have been blocked in 3-star **hotels in Como**, with rates ranging from 75 to 120 euros per night (breakfast included).

The **School Secretariat** will take care of the accommodation of the accepted students who have accomplished the payment of the fee, and who have filled out and sent a suitable accommodationNTMC before April 10, 2017.