SSM
Scuola Superiore Meridionale

Course title:

Networks beyond pairwise interactions

Duration [number of hours]: 10 hours
Timetable (CEST):

- **12 April, Wednesday – 16:00 to 18:00, Classroom 4, at SSM**
- **13 April, Thursday – 09:00 to 11:00, Classroom I9, at SSM**
- **14 April, Friday – 14:00 to 18:00, Classroom 4, at SSM**
- **17 April, Monday – 11:00 to 13:00, Classroom 4, at SSM**

Also broadcast on Zoom
https://us02web.zoom.us/j/89186735198?pwd=Ymx3NUpEamVpNmhEQXlqekcwN0ZYQT09
Meeting ID: 891 8673 5198
Passcode: happy

PhD Program [MERC/MPS/SPACE]: MERC

Name and Contact Details of Lecturer(s):

Prof. Stefano Boccaletti, CNR - Institute of Complex Systems, stefano.boccaletti@isc.cnr.it
Prof. Regino Criado, Universidad Rey Juan Carlos of Madrid; regino.criado@urjc.es

Course Description [max 150 words]:

The last twenty-five years have seen the development of the field of Network Science, wherein a variety of distributed systems have been modelled as networks of coupled units. There is, however, a fundamental limit in such a representation: networks capture only pairwise interactions, whereas the dynamics of many real-world systems is the outcome of collective actions at the level of groups of nodes, that can only be grasped through either hypergraphs or simplicial complexes.
This course will explain the fundamental mathematical tools to describe hypergraphs and simplicial complexes and will describe the consequences that such kind of interactions have in the network's dynamical organization and functioning.

Syllabus [itemized list of course topics]:

1. Complex networks
2. Higher-order interactions
3. Synchronization of dynamical systems
4. Centrality and ranking of nodes
5. Derivative of a hypergraph

Assessment [form of assessment, e.g. final written/oral exam, solutions of problems during the course, final project to be handed-in etc]:

Solutions of problems during the course

Suggested reading and online resources:

1. Complex networks: Structure and dynamics, S Boccaletti, V Latora, Y Moreno, M Chavez, DU Hwang, Physics reports 424 (4-5), 175-308 (2006)
2. The structure and dynamics of multilayer networks, S Boccaletti, G Bianconi, R Criado, CI Del Genio, J Gómez-Gardenes, ..., Physics reports 544 (1), 1-122 (2014)
3. Stability of synchronization in simplicial complexes, LV Gambuzza, F Di Patti, L Gallo, S Lepri, M Romance, R Criado, ..., Nature communications 12 (1), 1255 (2021)