LTCC Advanced Course

Title: Higher-order networks

Basic Details:
- Core Audience: 2nd/3rd yr app.
- Course Format: Extended: 5 x 2hr lectures

Course Description:
- Keywords: higher-order networks, applied topology, synchronization
- Syllabus:

  Higher-order networks encode interactions between two or more nodes and allow us to describe complex systems going beyond the assumption of having exclusively pairwise interactions. New results have shown that higher-order networks can sustain higher-order dynamical processes that take advantage of the topology and geometry of the higher-order networks. Most relevantly these processes cannot be accounted by considering only the pairwise interactions of higher-order networks.
  For these reasons higher-order networks constitute a very hot topic in Mathematics of Network with applications spanning from brain networks to social collaboration networks.

  In this course we will cover the main aspects of this exciting new research subject covering:

  1. the main structural combinatorial, topological and geometrical aspects of higher-order networks;
  2. important equilibrium (maximum entropy) and non-equilibrium (growing) models for higher-order networks;
  3. the interplay between higher-order network topology and dynamics.

  The module will be based on the recent book:

  Bianconi, Ginestra. *Higher order network: An Introduction to Simplicial Complexes*. Cambridge University Press, 2021.

  The module is designed to be a self-contained course for 2nd and 3rd year PhD students in applied mathematics with general interest in networks, applied topology and dynamical systems.

- Recommended reading:
  G. Bianconi Higher-order networks: An introduction to simplicial complexes Cambridge University Press 2021
- Additional Optional reading: will be given during the lectures

- Prerequisites: The module is designed to be self-contained, however some background on network theory, and a good understanding of the foundation of linear algebra will be beneficial.

Format:
- No of discussion/problem sheets: 4
- Electronic lecture notes: Yes: they will be provided after each lesson.

Lecturer Details:
- Lecturer: Professor Ginestra Bianconi
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