Causal Inference for Complex Networks

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Timetable: 16 hrs. see on https://phd.dei.unipd.it/course-catalogues/

Enrollment: students must enroll in the course using the Enrollment Form on the PhD Program eLearning platform (requires SSO authentication).

Course requirements: familiarity with basic probability. Knowledge of network theory also helps, but it is not a requirement.

Examination and grading: a final project or a take-home exam.

SSD: INF/01 Information Engineering

Aim: One of the notable analytical challenges of our century is the intricate complexity of systems that shape our civilization ranging from electricity networks to computer networks to biological networks and social networks due to all interdependency and interconnectivity among them. It is near impossible to understand complex network systems behavior unless we go beyond the classic machine learning and network science and develop a casual insight into the machinery behind different networks. Nevertheless, the notable differences in forms, scopes, components, and nature of different networks, most networks follow common cause and effect principles. This course provides a selection of concepts from information theory and causality inference domains to analyze complex networks considering their inherent interdependencies. During the course, students will be familiar with use cases from electric grids, roadways, and social networks.

Course contents:

1. Motivating problems in complex networked systems. i) some analytical problems in smart grids. ii) some analytical problems in smart cities.
2. Elements of Graph Theory: i) overview of graphs. ii) path, connectivity, and weighted graphs. iii) metrics for graphs.
3. Causality Inference: i) causality language ii) theory of causation and intervention iii) state-of-the-art causality inference methods
4. Causality for Complex networks i) causality methods for large scale networks ii) example applications in smart grids

References:

3. F. Bullo, Lectures on Network Systems, CreateSpase, 2018. Class lectures and other material and research papers will be available online for download.