

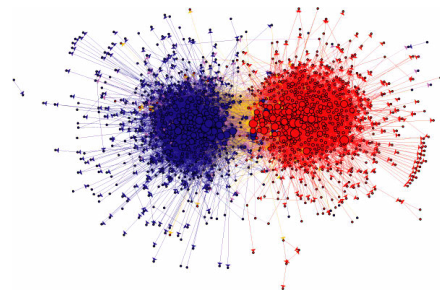
# PhD course in Network dynamics (6+3hp)

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[www.control.lth.se/Staff/GiacomoComo.html](http://www.control.lth.se/Staff/GiacomoComo.html)

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## 1 Brief introduction to the course topic

Networks permeate our modern societies. Everyday, we exchange information through the World Wide Web and other communication networks, modify our opinions and take decisions under the influence of our social interactions, commute across road networks, buy goods made available to us by production and distribution networks, use electrical power, gas and water that infrastructure networks bring directly to our homes, invest our savings in highly interconnected networks of financial funds, etc.



This course will focus on common principles at the heart of the functioning of these networks and on how the same notions related to resilience, fragility, centrality, and connectivity arise in several different domains. It will both introduce mathematical tools from graph theory, random graphs, probability, dynamical systems, optimization and game theory, and cover a wide variety of applications including: opinion dynamics and learning in social networks; economic and financial networks; communication networks and the Internet; averaging and consensus; spread and control of epidemics; dynamics and control of transportation and power networks.

### 1.1 Course aim

The aim of the course is to introduce the student to basic yet rigorous methods for the analysis and design of different emerging phenomena in networks. The emphasis will be on tools that allow to relate such behaviors to the network structure and the dynamical behavior of its single composing units.

### 1.2 Course material

The course will preliminary be based on lecture notes prepared by the lecturer. There is no single textbook covering the whole material. One which comes close to that is

- Newman, M. E. J. **Networks: an Introduction**, Oxford University Press, 2010.

Supplementary readings, with more focus on some specific parts of the course, include:

- R. Durrett. **Random graph dynamics**. Cambridge University Press, 2007.
- F. Vega-Redondo. **Complex Social Networks**. Cambridge University Press, 2007.
- M.O. Jackson, **Social and Economic Networks**, Princeton University Press, 2010.
- D. Easley, and J. Kleinberg, **Networks, Crowds, and Markets: Reasoning About a Highly Connected World**, Cambridge Univ. Press, 2010.
- D.A. Levin, Y. Peres, and E.L. Wilmer, **Markov Chains and Mixing Times**, American Mathematical Society, 2009.
- M. Chiang, **Networked Life: 20 Questions and Answers**, Cambridge University Press, 2012.

## 2 About the lecturer and the course history

The lecturer is Giacomo Como, who is Associate Professor in Automatic Control at Lund University.

[www.control.lth.se/Staff/GiacomoComo.html](http://www.control.lth.se/Staff/GiacomoComo.html)

This PhD course has been given on several occasions during the time 2011–2014, both in Lund and at the Dutch Institute of Systems and Control (<http://www.disc.tudelft.nl>). There is also a Master's level version available in Lund. (<http://www.control.lth.se/Education/EngineeringProgram/FRTN30.html>)

## 3 Lecture plan

- L1** Networks as graphs. Centrality and connectivity.
- L2** Linear network Dynamics. Markov chains and random walks 1.
- L3** Markov chains and random walks 2.
- L4** Voter model and distributed averaging.
- L5** Network flow optimization.
- L6** Elements of game theory. Network games.
- L7** Mean-field techniques for network dynamics.
- L8** Dynamics in locally tree-like networks.

## 4 Practicalities, time frame and registering

All practical details, links, slides, etc. will be available from the course web site:

<http://www.control.lth.se/Staff/GiacomoComo/uppsala-2016.html>

The course is offered in April 2016. It will be given as an intensive course split in the following two blocks:

- Part 1: April 13-15, (Lecture 1-4),
- Part 2: April 20-22, (Lecture 5-8).

This gives you a chance to digest and work with the material in-between the two blocks. The course will be examined by successfully completing hand-in assignments (6hp). There will also be a possibility of carrying out a project within the course (3hp).

You **register** for the course by sending an e-mail to Andreas Svensson ([andreas.svensson@it.uu.se](mailto:andreas.svensson@it.uu.se)).