

Graph Analysis

Course title – Intitulé du cours	Graph Analysis
Level / Semester – Niveau / semestre	M2 / second semester
School – Composante	Ecole d'Economie de Toulouse
Teacher – Enseignant responsable	Madalina Olteanu
Other teacher(s) – Autre(s) enseignant(s)	Yasser Abbas (practicals)
Other teacher(s) – Autre(s) enseignant(s)	
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Lecture Hours – Volume Horaire CM	18
TA Hours – Volume horaire TD	
TP Hours – Volume horaire TP	
Course Language – Langue du cours	English / Anglais
TA and/or TP Language – Langue des TD et/ou TP	English / Anglais

Teaching staff contacts – Coordonnées de l'équipe pédagogique :

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Course Objectives – Objectifs du cours :

Social networks, internet routes, transport systems, biological networks, scientific co-authorship. These are just a few examples of the numerous real-life situations involving relational information, and illustrating how networks are everywhere! Understanding interactions within networks is a challenging and important topic, and so are the practical applications: recommendation systems, viral marketing, epidemics-spreading control, traffic control and optimization.

This lecture aims at giving an introduction to network and graph analysis, where by graph one will understand a mathematical object used to model relations, possibly complex, between entities. After having introduced the formal definition and notations, we will focus on five main topics: how to visualize a graph or a network? which are the characteristics of a graph (important nodes, connectivity)? are there any specific patterns of connectivity or any communities? what is a random graph and how can one test for a random graph? how are epidemics spreading on a network?

The lecture is organized into six three-hour sessions. Each session contains a practical where the different notions and methods will be illustrated using simulated and real-life data, and the existing R libraries.

1. Introduction to networks and graphs, graph visualization, global characteristics of a graph
2. Centrality measures

3. Community detection and graph clustering
4. Random graphs models and permutation tests
5. The stochastic block model
6. Epidemics spreading on networks

Prerequisites – Pré requis :

Basic knowledge of R.

Practical information about the sessions – Modalités pratiques de gestion du cours :

Students are expected to attend and actively participate in all lectures.

Grading system – Modalités d'évaluation :

The grading will be based on the participation during the practicals, and on a class project and final report.

Bibliography/references – Bibliographie/références :

1. Albert Barabasi's book on networks, <http://networksciencebook.com/>
2. Aaron Clauset's lecture notes, <https://aaronclauset.github.io/courses/5352>
3. M. Newman, Networks, Oxford University Press, 2018.