MGT-416

Network analytics

Penner Orion B

Cursus	Sem.	Type
Financial engineering	MA2, MA4	Opt.
Management, Technology and Entrepreneurship minor	E	Opt.
Managmt, tech et entr.	MA2, MA4	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	During the semester
Workload	90h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Students will learn the core concepts and techniques of network analysis. Theory and application will be balanced, with students working directly with network data throughout the course.

Content

This course will cover a broad range of approaches - drawn from social network analysis, graph theory, and network science - for analyzing real world network data. Throughout the course theoretical material will be presented in parallel with data and code. The assignments, mid-term and final project will require students to handle, analyze and interpret real network data using Python in the Jupyter Notebook environment.
Specific topics include, but are not limited to, the following:

- The basic conceptual and mathematical formulation of networks
- Basic metrics of networks (*e.g.* paths, components, degree distributions, *etc.*)
- Centrality measures
- General properties of real world networks
- Models of networks
- Community detection
- Dynamics of, and on, networks (*e.g.* percolation and resilience, growth, spreading, random walks, *etc.*)

Care will be taken to reinforce these techniques and concepts with examples using real world data, and to faciliate the development of intuition for when and how networks are a useful avenue of analysis.

Keywords

Data Analysis; Business Analytics; Statistics; Complex Systems; python

Learning Prerequisites

Required courses

This course attempts to be as self contained as possible, but it does approach the topic from a quantitative point of view and, as such, students should be comfortable with the basics of (*i.e.* have taken at least one course in) the following topics before enrolling:

- Statistics
- Probability Theory
- Linear Algebra

- Calculus (integral and differential)

As course work will be largely computational, experience with at least one programming language is also required.

Recommended courses

It is strongly recommended that each student complete an introductory course in python before the start of the course. Many MOOCs and/or tutorials are available online.
Statistics and probability experience beyond the introductory level are also recommended.

Learning Outcomes

By the end of the course, the student must be able to:

- Identify situations in which a problem/data can be thought of as a network.
- Differentiate between instances in which analyzing data using network analytics can be clarifying, as opposed to obfuscating.
- Analyze data appropriately using a variety of network analytic techniques.
- Interpret the results of applying network analytics.
- Propose action based on sound interpretation of network analytics.

Transversal skills

- Demonstrate the capacity for critical thinking
- Use both general and domain specific IT resources and tools
- Access and evaluate appropriate sources of information.
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

The weekly lectures integrate both theory and application. Exercise sessions give students "hands on" experience writing and running analysis code, and interpreting results. In both, care is taken in both to help develop computational thinking skills.

Expected student activities

- Attendance of lecture and exercise sessions.
- Completion of regularly scheduled assignments in Python (or R if you have a strong affinity for it)*.
- Completion of an individual mid-term project in which the student identifies and carries out preliminary analysis on a network data set.
- Completion of a group end-of-year project in which the students analyze and extract knowledge from a network data set.

*Notes, exercises and assignments containing Python code will be made available to students in the form of Jupyter Notebooks. From past experience, this works best if students run Jupyter on their own computer, for example, through Conda. However, Docker containers with all packages necessary to follow and complete the course will also be made available.

Assessment methods

Regular individual assignments: 52%
Individual mid-term project: 13%
Final group project: 35%

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Lecture notes and Jupyter Notebooks will represent the bulk of course material, but the following references may prove useful for various topics*:

- M.E.J. Newman. Networks - An introduction, Oxford Univ Press, 2010.
- A-L. Barabási. Network Science, 2015.
- D. Easley and J. Kleinberg. Networks, Crowds and Markets, Cambridge Univ Press, 2010.
- M.O. Jackson. Social and Economic Networks, Princeton Univ Press, 2008.
- G. Caldarelli and A. Chessa. Data Science and Complex Networks: Real Case Studies with Python, OUP, 2016.

*Sections of interest will be specifically noted in course notes. Small portions may be distributed as necessary, and as may be consistent with intellectual property constraints.

Ressources en bibliothèque

- Data science and complex networks : real cases studies with Python / Caldarelli
- Social and Economic Networks / Jackson
- Network Science / Barabási
- Networks : an introduction / Newman
- Networks, crowds, and markets : reasoning about a highly connected world / Easley

Websites

- https://networkx.github.io/
- https://developers.google.com/edu/python/
- https://cran.r-project.org/doc/manuals/r-release/R-intro.html
- http://jupyter.org/
- https://gephi.org/
- http://vlado.fmf.uni-lj.si/pub/networks/pajek/