MGT-416

Network analytics

Penner Orion B

Cursus	Sem.	Type
Management, Technology and Entrepreneurship minor	H	Opt.
Managmt, tech et entr.	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	During the semester
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	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. Assignments and the final project will require students to handle, analyze and interpret real network data using R or 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.*)
- Games on Networks
- Social Network Analysis

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; R

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 either python or R 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

Weekly lectures integrating both theory and application. Computational examples will be explored using Jupyter Notebooks. Accompanying exercise sessions will give students "hands on" experience writing and running analysis code, and interpreting results.

Expected student activities

- Attendance of, and participation in, lecture and exercise sessions.
- Completion of regularly scheduled assignments in R or Python*.
- Completion of an individual end-of-year project in which the student identifies, analyzes and extracts knowledge from a network data set of her of his choosing.

*Notes and assignments containing R and Python code will be made available to students through Jupyter Notebooks by way of Docker containers. Hence, it is not necessary that students install R and/or Python themselves, although students will find benefits to having their own installation of one or the other for the final project.

Assessment methods

Regular individual assignments: 50%
Individual mid-term project: 25%
Final group project: 25%

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

Yes

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

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

Websites

- http://igraph.org/
- 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/