

Network Analysis, SMM638 — README

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Module Overview

Networks are ubiquitous: job offerings reach us via inter-personal connections; what we see on the screen of our digital device is a function of the relationships we develop in the digital world; market valuations are — largely — the byproduct of social influence, which accumulates and spreads over relations. This module provides students with cutting-edge network theories and practical tools to appreciate the organization and functioning of disparate networks. Ultimately, the goal is to develop a distinctive angle on how networks bring value to individuals, organizations, and communities.

Materials & Readings

For this module, students are not required to purchase any (expensive) book, whereas it is essential they carefully go through the following:

- lecture notes (to be uploaded onto Moodle/Github weekly);
- selected chapters from Networks, Crowds, Markets (access via our Library websiste)
- selected chapters from Network Science (access via the Book website)

Discretionary readings students may want to reference to:

- How networks matter: Linked
- Mathematical foundations of network analytics: Introduction to Graph Theory
- Social network analysis metrics: Social Network Analysis: Methods and Applications
- Journal articles (to be uploaded onto Moodle/Github weekly)

Learning Objectives

At the end of the module, students should be able:

- to appreciate the properties of networks;
- to appreciate the properties of communities of nodes belonging to a network;
- to appreciate the properties of individual nodes belonging to a network;
- to visually represent the key features of networks;
- to leverage the most advanced Python modules for network analytics;
- to mobilize key network analytics notions and tools in order to produce elegant, effective, and efficient solutions to practical problems in the field of business strategy, product innovation, and operations.

Assessment

As per the module specification, students will be assessed on the basis of coursework submissions, which all are the outcome of group-level efforts (yes, you understand correctly, for this module there is no final examination and you are not supposed to deliver any assignment on your own). Specifically, there are three pieces of coursework, namely:

- a ‘mid-term project’ (MTP)
- a ‘final course project’ (FCP)
- two case studies (CS)

These three pieces of coursework contribute to the final mark (FM) as follows:

$$FM = 0.20 \times MTP + 0.75 \times FCP + 0.05 \times [(CS1 + CS2)/2]$$

All types of assessment will be evaluated along four criteria: i) appropriate use of notions and frameworks discussed in class; ii) effectiveness of the proposed answer or solution; iii) originality/creativity of the proposed answer or solution; iv) organization and clarity of submitted materials. All criteria carry-out equal weight in terms of mark.

Mid-term project

For the **MTP**, groups are required to solve a network analytic problem. The details of the MTP will be available by week 3, when the project will be released. Submissions will be assessed on a 0 - 100% scale. The Groups who fail MTP can resubmit a revised version of the project; if the revision is sufficient, students receive a 50% mark. The deadline for the project is November 9 (week 6). Selected groups will be invited to present the outcome of their work to fellow students in week 6. Invited groups could also receive a maximum of 3 bonus points on the basis of the quality of their presentations.

Final-cours project

With the **FCP**, groups make their hands ‘dirty’ as they help a real-world client to face some network analytic challenges. The details about the client and the challenge will be available in week 8. Final course projects will be evaluated on a rolling-based window and should be submitted by mid December (the course office will liaise with the students soon about the exact deadline).

Case studies

Case studies provide students with the opportunity to learn how to integrate the ‘business’ and the ‘network analytic’ perspectives in order to deal effectively with real-world problems. In terms of process, groups of students will receive i) a detailed description of a business issue, and ii) relevant data; then, they will be working for one week to produce their own solution. Solutions will be discussed in class. Each presenting group will be associated with a discussant group whose role is to challenge the ideas, tools, and recommendations that will be brought to the table. I expect six pairs of presenting and discussant groups; this means group that will present their solution in week 8 will serve as discussant in week 10 (and viceversa). Both presenting and discussant groups will be assessed.

Discretionary problem sets

Problem sets will be launched weekly. Students may want to deal these problem sets and present their solution to the class. Up to three students per session will be selected on the basis of the novelty and effectiveness of the proposed solution. One bonus point (+1 FM) will be assigned.

Schedule of the Module

Week	Topic
1	Introduction to SMM638 Introduction to networks - how networks matter - networks are made-up of nodes and ties - graph and algebraic representations of networks - forms of networks Case discussion - markets & networks: the Soundcloud case
2	Network theory - strong ties and closure - weak ties and brokerage Network models and metrics - centrality - paths and distances

Week	Topic
	- connectedness Laboratory (NetworkX)
3	Network theory - small worlds and networks - core-periphery structures in networks - community structures in networks Network models and metrics - search and collective intelligence in networks Laboratory (NetworkX)
4	Network theory - homophily, selection, and social influence Network models and metrics - closure and link formation in online communities - spatial models of segregation Laboratory (NetworkX and Mesa)
5	Network theory - scale-free networks - preferential attachment - Barabasi-Albert model Network models and metrics - crowds and popularity - networks, recommenders, and popularity Laboratory (NetworkX)
6	Mid-term project - students' presentations Laboratory (Graph-Tool) - efficient network analysis with Graph-Tool
7	Final course project release Network theory - cascading behavior - diffusion in and through networks Network models and metrics - spreading phenomena Laboratory (NetworkX, Graph-Tool)
8	Case study #1 (associated with section 7 topics)
9	Network theory - percolation theory - network robustness Network models and metrics - attack tolerance - cascading failures Laboratory (NetworkX, Graph-Tool)
10	Case study # 2 (associated with section 9 topics)

Prerequisites

The SMM692 — Python Pre-Course module defines the knowledge students should possess in order to proficiently attend to SMM638 — Network Analytics.

Software Requirements

For this module you are supposed to run Python 3.6 on your machine. Now, how to get Python work on your machine? There are several ways to do that. A fast, smooth alternative is to install Anaconda, an open source distribution of Python that includes: i) 250+ popular data science packages; ii) the conda package, which makes quick and easy to install, run, and upgrade complex data science and machine learning environments.

Here is the workflow:

1. Use your preferred browser to open the link pointing to the Anaconda repository;
2. Select the installer the which suits your machine (32- or 64-bit) and operating system (Win, Mac OS, Linux). Mac users may want to download the graphical installer rather than the command-line installer (students may feel less comfortable with);
3. Retrieve the installer (perhaps in your download folder);
4. Run the installer;
5. Log-out from your current session (it does not matter if you use Win, Mac OS or Linux);
6. Log-in into a new session;
7. Run ‘Anaconda Navigator’—namely, a convenient place to launch the IPython shell or other user-interfaces to interact with IPython.

On top of Anaconda — Python, students should install the modules:

- NetworkX
- Mesa
- Graph-Tool. Note Graph-Tool is a ‘complex’ library (i.e., it depends on several Python and C++ libraries); you may want to follow the installation instructions reported under the **resources** section of this repo.

Versioning

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- Last change: no revisions so far