Course Syllabus

SMM638 - Network Analytics | Term I 2025/26

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Course Overview

Module Description

Network Analytics (SMM638) provides a comprehensive introduction to the theory and practice of analyzing networked systems in business and organizational contexts. This module equips students with cutting-edge tools and techniques to understand, visualize, and leverage network structures for strategic decision-making.

Learning Objectives

By the end of this module, you will be able to:

Core Competencies

1. **Theoretical Foundation**
   - Master fundamental network concepts, terminology, and mathematical foundations
   - Understand different types of networks (social, organizational, technological)
   - Apply network theory to real-world business problems
2. **Technical Skills**
   - Collect, clean, and structure network data from multiple sources
   - Implement network analysis algorithms in R and Python
   - Create compelling visualizations of complex network structures
   - Perform statistical analysis on network data
3. **Analytical Capabilities**
   - Calculate and interpret centrality measures to identify key actors
   - Detect communities and clusters within networks
   - Model network formation and behavior
   - Analyze network evolution and dynamics over time
4. **Business Applications**
   - Transform network insights into actionable business strategies
   - Apply network analysis to marketing, operations, and organizational design
   - Evaluate the impact of network position on performance
   - Design network interventions for business outcomes

Module Relevance

In today's interconnected world, understanding networks is crucial for:

- **Marketing**: Influencer identification, viral marketing, customer segmentation
- **Operations**: Supply chain optimization, knowledge management, innovation diffusion
- **Strategy**: Partnership formation, competitive analysis, ecosystem mapping
- **HR**: Organizational design, team composition, talent management

Topic 1: Introduction to Network Analytics

Week 1

Learning Outcomes:

- Understand fundamental network concepts and terminology
- Differentiate between network types (one-mode, two-mode, signed, weighted)

- Set up R/Python environment for network analysis
- Perform basic network data management and visualization

Topics Covered:

- Network elements: nodes, edges, dyads, triads
- Real-world network examples (economic, organizational, social)
- Taxonomy of network measures (node, meso, macro levels)
- Introduction to network analysis software

Case Study: RCB: Social network analysis

Topic 2: Network Centrality

Weeks 2-3

Learning Outcomes:

- Calculate and interpret various centrality measures
- Understand when to apply different centrality metrics
- Analyze the relationship between centrality and outcomes
- Implement centrality algorithms in R/Python

Topics Covered:

- Degree centrality and its variants
- Closeness centrality and information flow
- Betweenness centrality and brokerage
- Eigenvector centrality and influence
- PageRank and its applications
- Local clustering coefficient

Case Study: Who is the right influencer? A social network analysis

Topic 3: Dyads, Triads, and Network Dynamics

Weeks 4-5

Learning Outcomes:

- Analyze dyadic patterns and relationships
- Model homophily and its effects
- Understand triadic closure and its implications
- Network evolution patterns
- Test network hypotheses

Topics Covered:

- Reciprocity and mutuality
- Homophily and selection effects

- Triadic census and transitivity
- Conditional Uniform Graph (CUG) tests

Case Study: Feeding SoundCloud's recommendation system with social network data

Topic 4: Network Cohesion and Communities

Weeks 7-8

Learning Outcomes:

- Measure network cohesion at multiple levels
- Apply community detection algorithms
- Interpret community structure for business insights
- Implement blockmodeling techniques

Topics Covered:

- Network density and cohesion metrics
- Core-periphery structures
- Community detection algorithms (Louvain, modularity optimization)
- Blockmodeling

Case Study: Profiling beer enthusiasts at BeerAdvocate

Topic 5: Network Position and Performance

Weeks 9-10

Learning Outcomes:

- Analyze the strategic value of network positions
- Understand closure vs. brokerage trade-offs
- Apply network insights to career development
- Design network interventions

Topics Covered:

- Structural holes and brokerage opportunities
- Network closure and social capital
- The strength of weak ties
- Network position and innovation
- Career implications of network structure

Case Study: Network position and employee performance in Silico's R&D lab

Assessment Strategy

Assessment Components

Class Participation (10%)

- Active engagement in discussions
- Quality of questions and insights
- In-class case discussion contribution

Ongoing throughout term

Mid-Term Project (50%)

- Team-based analysis (3-4 students)
- Real-world dataset
- Technical implementation
- Business recommendations
- 15-minute presentation

Due: November 10, 2025

Final Project (40%)

- Individual research project
- Business case requesting network analysis
- Executive summary of case discussion (1,000 words)
- 10-minute case discussion, job interview style

Due: November 28, 2025

Assessment Criteria

All assessments will be evaluated on:

1. **Technical Proficiency** (30%)
    - Correct implementation of methods
    - Code quality and documentation
    - Appropriate use of techniques
2. **Analytical Rigor** (30%)
    - Sound methodology
    - Proper interpretation of results
    - Statistical validity
3. **Business Relevance** (30%)
    - Clear problem definition
    - Actionable insights
    - Strategic recommendations

4. **Communication** (10%)
    - Clear presentation
    - Effective visualizations
    - Professional writing

Course Resources

Technical Requirements

! Essential Software Setup

Programming Environments:

- **R** (version 4.3+) with RStudio
- **Python** (version 3.9+) with Spyder or Jupyter Lab/Notebooks
- Git for version control

Sample R Packages:

```r
# Core packages
install.packages(c("igraph", "tidygraph", "ggraph"))

# Statistical modeling
install.packages(c("statnet", "ergm", "btergm"))

# Visualization
install.packages(c("networkD3", "visNetwork", "graphlayouts"))

# Data manipulation
install.packages(c("tidyverse"))
```

Sample Python Modules:

```
# Data manipulation and computation
conda install -c conda-forge numpy scipy matplotlib pandas

# Network libraries
conda install -c conda-forge networkx graph-tool

# Interactive visualization
conda install -c conda-forge plotly bokeh pyvis
```

Alternatively, you can create the environment directly using the provided `smm638.yaml` file:

```
conda env create -f smm638.yaml
conda activate smm638
```

Reading List

Core Textbooks:

1. **Menczer, F., Fortunato, S., & Davis, C. A. (2020).** *A first course in network science.* Cambridge University Press.
    - Comprehensive yet accessible survey of network science notions and tools
    - Excellent first course in network analysis book
2. **Newman, M. (2018).** *Networks* (2nd ed.). Oxford University Press.
    - Comprehensive mathematical treatment of network problems
    - Excellent for understanding algorithms
    - For the braves...
3. **Easley, D., & Kleinberg, J. (2010).** *Networks, crowds, and markets: Reasoning about a highly connected world*. Cambridge: Cambridge University Press.
    - Focus on economic applications of network concepts and methods
    - Plenty of examples
    - Variety of organizational and market issues, from auctions to social influence in digital platforms
4. **Rawlings, C. M., Smith, J. A., Moody, J., & McFarland, D. A. (2023).** *Network analysis: integrating social network theory, method, and application with R.* Cambridge University Press.
    - Focus on social networks
    - Excellent survey of network notions and methods
    - Online companion with R applications
5. **Carpenter, M. (2009).** *An executive's primer on the strategy of social networks.* Business Expert Press.
    - An executive's perspective on networks
    - A very actionable framework to maximize the value of your network

Supplementary Readings:

- **Barabási, A. L. (2014).** Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life. Basic Books.
- **Jackson, M. O. (2019).** *The Human Network*. Pantheon Books.
- **Watts, D. J. (2003).** *Six Degrees: The Science of a Connected Age.* Norton.

Online Resources

Course Materials: - GitHub repository: github.com/simoneSantoni/net-analysis-smm638 - Moodle page with lectures and assignments - Slack workspace for discussions

External Resources: - Awesome Network Analysis

Course Policies

Attendance and Participation

- **Attendance**: Mandatory for all sessions
- **Punctuality**: Sessions start promptly; late arrivals disrupt learning
- **Preparation**: Complete readings and exercises before class
- **Engagement**: Active participation expected in all activities

Collaboration Policy

- **Teamwork**: Encouraged for designated group projects
- **Individual Work**: Must be completed independently
- **Code Sharing**: Allowed for learning, not for assignments
- **Citation**: Always attribute sources and collaborators
- **AI**: Disclose how you use LLMs to get your work done

Communication

Getting Help

1. **Moodle Forum**: First point of contact for content questions
   - Response time: 24-48 hours on weekdays
2. **Office Hours**: Wednesdays 14:00-16:00 (by appointment)
   - Book via: simone.santoni.1@city.ac.uk
3. **Email**: For personal/administrative matters only
   - Use clear subject lines: "SMM638 - [Topic]"
4. **Peer Support**: Join study groups on Slack

Accessibility and Accommodations

Students requiring accommodations should:

1. Contact Student Services for documentation
2. Notify instructor within first two weeks
3. Discuss specific needs and arrangements

All accommodations will be made in accordance with university policies.

Academic Integrity

- **Plagiarism**: Zero tolerance; all work must be original
- **Collaboration**: Clearly acknowledge all contributions
- **Data Sources**: Properly cite all datasets used
- **Code Attribution**: Credit all borrowed/adapted code (included LLM generated code)

Violations will be reported to the Academic Misconduct Committee.

Syllabus Modifications

This syllabus may be adjusted to:

- Accommodate class progress
- Incorporate current events/examples
- Respond to student feedback

All changes will be announced via Moodle with one week's notice.

Ready to Start?

Network Analytics is a powerful lens for understanding our interconnected world. This module will challenge you to think structurally about business problems and equip you with tools to uncover hidden patterns in complex systems.
Let's build networks together!