Universitat Pompeu Fabra Barcelona

Academic Year: 2025/26

22997 - Networks, Crowds and Markets

Teaching Guide Information

Academic Course: 2025/26

Academic Center: 304 - Faculty of Law and Economics
332 - Faculty of Economic and Business Sciences

Study: 3327 - Bachelor's degree in International Business Economics

Subject: 22997 - Networks, Crowds and Markets

Credits: 5.0

Course: 3 and 4

Teaching languages:

Theory:	Group 1: English
Seminar:	Group 101: Pending
	Group 102: Pending

Teachers: Piotr Wiktor Zwiernik

Teaching Period: First term

Presentation

Networks and social groups play a pivotal role in shaping our decisions and influencing outcomes, both on an individual and collective level. In the realm of academia, an extensive body of literature has emerged, delving into the profound impact of networks and group dynamics within diverse economic contexts. These investigations draw upon established theories from fields such as network science, crowd behaviour, and information diffusion.

The course is designed to provide students with a comprehensive introduction to this dynamic and burgeoning field. Throughout this journey, you will explore a wealth of ideas, models, and analytical methods. These tools not only enhance your understanding of network phenomena, but also have wide-ranging applications across various domains. For instance, if you aspire to pursue careers in information industries or data science, the knowledge and skills acquired in this course will prove invaluable.

Be prepared for a rigorous and mathematical exploration. We will delve into the depths of mathematical models, algorithms, and their rigorous analysis. To thrive in this course, students are expected to have a solid foundation in mathematics, encompassing topics covered in Mathematics 1, 2, and 3, as well as Probability and Statistics. Familiarity with certain elements of Game Theory, as introduced in courses like "Introduction to Game Theory," will also be beneficial. It is highly recommended to revisit concepts in linear algebra, distribution theory (including the binomial and Poisson distributions), and basic differential equations, as these underpin the core content of our classes.

This course falls under the category of Advanced Quantitative Methods (MQA). For more detailed information about MQA

and its implications, please refer to the provided link.

Associated skills | General learning outcomes

Instrumental Skills

- **Analytical and Synthesis Skills:** The ability to analyse complex information and synthesise it into clear and concise insights.
- **Organisational and Planning Skills:** Proficiency in organising tasks, setting priorities, and creating effective plans.
- **Basic Mathematical Knowledge:** A foundational understanding of mathematics, including key concepts and principles.
- **Problem-Solving:** The capacity to identify, analyse, and solve problems, both independently and collaboratively.
- **Written and Verbal Communication Skills:** Strong written and spoken communication abilities for effective expression of ideas.

Interpersonal Skills

- **Critical Thinking:** The ability to think critically, evaluate information, and make informed decisions.
- **Learning Capabilities:** A commitment to continuous learning and adapting to new information and ideas.
- **Research Skills:** Competency in conducting research, collecting data, and analysing findings.
- **Autonomous Work:** The capacity to work independently, take initiative, and manage tasks effectively.
- **Creativity:** The skill to generate innovative ideas and approaches to problem-solving.

Systemic Skills

- **Specialised Language Proficiency:** Proficiency in written and oral communication using specialised mathematical language, particularly in the context of this course.

Specific Skills

- **Mathematical Model Formalisation:** The ability to formalise various real-world scenarios and problems into mathematical models.
- **Mathematical Model Solutions:** Competency in solving mathematical models, applying mathematical techniques to find solutions.
- **Mathematical Analysis and Linear Algebra Knowledge:** Proficiency in essential mathematical tools, including mathematical analysis and linear algebra, and their applications in economics and business contexts.

Learning outcomes | Specific learning outcomes

Upon successful completion of this course, students should be able to:

1. **Understand Fundamental Graph Theory Concepts:** Explain and apply fundamental concepts of graph theory, including nodes, edges, paths, cycles, and connectivity.

2. **Model Real-World Networks:** Develop and construct models to represent and analyse real-world networks, demonstrating the ability to abstract complex systems into graph structures.

3. **Analyse Network Properties:** Analyse and interpret key network properties, such as degree distribution, clustering coefficient, and network diameter, to gain insights into network structure and behaviour.

4. **Apply Centrality Measures:** Utilize centrality measures, such as degree centrality, betweenness centrality, and eigenvector centrality, to identify and evaluate the importance of nodes in networks.

5. **Detect and Characterize Communities:** Apply community detection algorithms to identify and characterize clusters within networks, and explain their significance in various applications.

6. **Evaluate Network Models:** Critically assess different network models, including random networks and scale-free

networks, to understand their relevance in different domains.

7. **Explore Social Groups from a Network Perspective:** Gain introductory insights into social network analysis, recognizing patterns of social interaction and information flow within social systems. Understand the potential of studying complex social phenomena from a network-centric perspective, highlighting the interconnected nature of social relationships and the value of network analysis in social science research.

8. **Explore Economic and Financial Networks:** Investigate economic and financial networks to analyse systemic risk, interconnections, and the dynamics of financial markets.

9. **Communicate Findings:** Effectively communicate network analysis results through clear and concise presentations and reports, making complex concepts accessible to diverse audiences.

10. **Continuously Learn and Adapt:** Demonstrate a commitment to continuous learning in the field of network analysis and an ability to adapt these skills to evolving challenges and contexts.

Contents

Throughout this course, you will delve into the fascinating realm of Graph Theory, exploring various facets of network analysis. The following topics will be covered:

1. **Introduction to Graph Theory:** A comprehensive introduction to the fundamental principles and concepts of graph theory, laying the foundation for understanding network structures and their applications.

2. **Network Models:** Examining different models used to represent and study networks, providing insights into real-world applications and theoretical frameworks.
    i. **Random Networks:** Investigating the properties and characteristics of random networks, including their relevance in understanding complex systems.
    ii. **Scale-Free Networks:** Exploring the intriguing world of scale-free networks and their prevalence in various natural and man-made systems.

3. **Centrality Measures:** Analysing methods for identifying the most influential nodes within networks, essential for understanding information flow and network dynamics.

4. **Community Detection:** Uncovering techniques for identifying and characterizing communities or clusters within networks, revealing hidden structures and patterns.

5. **Social Networks:** A deep dive into the study of social networks, examining their role in contemporary society, and applying network analysis to social phenomena.

6. **Economic and Financial Networks:** Understanding how network theory is applied to analyse economic and financial systems, with a focus on systemic risk and interconnections.

Please note that while this course will introduce mathematical concepts integral to the topics covered, prior exposure to these concepts is not required. Mathematical concepts will be introduced progressively throughout the course, ensuring that all students can grasp and apply them effectively.

Sustainable Development Goals

1 - No poverty
2 - Zero Hunger
3 - Good Health and Well-being
4 - Quality Education

Evaluation and grading system

1. **Final Exam (40%)**
   Two-hour exam at the end of term covering all course material. A minimum score of 4 is required on the final exam.
2. **Midterm (30%)**
   Held in week 5 during a lecture session.
3. **Group Presentation and Report (30%)**

Groups of 3–4 students prepare a short presentation and report on a chosen topic related to the course (suggestions provided in week 2). Groups must be formed by October 31. Individual grades may differ within a group.

Final Grade

Calculated as a weighted average of the three components. Passing requires a final grade of 5 or higher.

Recovery Exam

Available to students with a final grade below 5 who have:

- attended the last three seminars, and
- earned at least a 4 in the presentation/report.

The recovery exam is in the second term. A minimum score of 4 is required, and the final grade is still based on the same weightings.