Syllabus for the proposed course Economic Theory of Networks

Econ 3522

Dimitrios Diamantaras

March 15, 2012

General

This course presents an overview of networks with emphasis on social networks, online and offline. The student will learn the basic mathematical techniques for representing networks as well as techniques from game theory and economics for the analysis of network structure and evolution.

Disability Statement

This course is open to all students who meet the academic requirements for participation. Any student who has a need for accommodation based on the impact of a disability should contact the instructor privately to discuss the specific situation as soon as possible. Contact Disability Resources and Services at 215-204-1280 in 100 Ritter Annex to coordinate reasonable accommodations for students with documented disabilities.

Statement on Academic Freedom

Freedom to teach and freedom to learn are inseparable facets of academic freedom. The University has adopted a policy on *Student and Faculty Academic Rights and Responsibilities* (Policy # 03.70.02) which can be accessed through the following link: http://policies.temple.edu/getdoc.asp?policy_no=03.70.02.

Prerequisites

Econ 1102, Principles of Microeconomics, or Econ 1902 (honors version). There is no formal mathematical prerequisite; the necessary mathematical tools will be explained in the course.

Text

The textbook for this course is *Networks, Crowds, and Markets*, by David Easley and Jon Kleinberg, Cambridge University Press 2010. The book is available online as chapter-by-chapter PDF files at http://goo.gl/omWV and the printed book can be purchased from the Temple bookstore on the Main campus.

Grading

Student progress will be evaluated on the basis of contributions to a class blog (20%), biweekly homework assignments (20%, the two worst assignment grades are dropped from the calculation), a midterm examination (30%), and a final examination (30%).

There will be 7 homework sets, each consisting of problems designed to help the student practice network analysis along the lines of the material covered in the most recent class meetings.

The class blog will be open to every student, who will be expected to *make at minimum one blog post per week*, every week of the semester except for Week 7 (during which the midterm exam will be held) and Week 15 (during which the final exam will be held) *and* one comment to another student's post per week except Weeks 7 and 15. Each post should discuss how a news item is relevant to the material covered in the course or some new development in the theory of networks that the student making the post has discovered.

Blog posts and comments will be graded on relevance to the course material, coherence, clarity, and incisiveness. Homework assignments and exams will be graded for correctness and clarity. Letter grades will be given according to the following scale.

A: 93-100

A-: 90-92

B+: 87-89

B: 83-86

B-: 80-82

C+: 77-79

C: 73-76

C-: 70-72

D+: 67-69

D: 63-66

D-: 60-62

F: 0-59

The midterm exam will be held in week 8 of the semester and the final exam as scheduled by the University during exam week. All exams are closed-book. There is no opportunity for extra credit.

Course Policies

Class *attendance* is not required and is not part of assessment, but students who miss classes will find that their ability to master the material and obtain good grades will be severely compromised as a result of absences beyond very few occasional absence necessitated by illness or other reasons. Students who know they will miss class, come late, or leave early, are requested to let me know in advance.

Missing an exam is not acceptable except if (1) you have a very serious reason (such as being treated at the hospital) ***and*** (2) you notify me ahead of time. If both conditions (1) and (2) are met, I will offer you a make-up exam, upon seeing credible proof of the condition that necessitated missing the exam.

Academic dishonesty is reprehensible and I will punish it severely by referring the student for University disciplinary action ***and*** giving a zero grade for the exam or assignment involved. Please refer to the *Student Code of Contact*, which can be found here <link>.

Course Outline

Week 1	*Introduction (ch. 1)* Chapter 1 Brief overview of networks and the theories that have been developed by mathematicians, game theorists, and economists to analyze networks. Introduction of the main topics of the course: markets and games on networks, information networks, and network dynamics.
Week 2	*Basics: Graph Theory and Social Networks (chs. 2, 3, 5)* Chapter 2 Basics of graph theory as needed for the analysis of networks: edges and nodes on graphs; paths; connectivity; graph components; network distance; the small worlds phenomenon; six degrees of Kevin Bacon and Erdős numbers; network data set sources. Chapter 3 Strong and weak ties; the strength of weak ties; strength and network structure in large data sets; strength, social media, and passive engagement; closure, structural holes, and social capital. ***Homework assignment 1 due***
Week 3	Chapter 5 Structural balance; structure of balanced networks; applications of structural balance to international relations, trust and online ratings; weak form of structural balance. *Some Game Theory (chs. 6, 7, 8, 9)* Chapter 6 Introduction to games; how to reason about behavior in a game; best responses and dominant strategies; Nash equilibrium; multiple equilibria and coordination games; multiple equilibria and the hawk-dove game; mixed strategies; Pareto optimality and social optimality.
Week 4	Chapter 7 Evolutionary game theory: fitness as a result of interaction, evolutionarily stable strategies; relationship of Evolutionary and Nash equilibria; evolutionarily stable mixed strategies. Chapter 8 Modeling network traffic with game theory: traffic at equilibrium; Braess's paradox (adding more roads may increase congestion); social cost of traffic at equilibrium. ***Homework assignment 2 due***

Week 5	Chapter 9 Auctions: types of auctions; relationships between auction formats; second-price auctions and truthful bidding; first-price auctions and other auction formats; common values and the winner's curse. *Markets and Games on Networks (chs. 10, 11, 12)* Chapter 10 Matching markets: bipartite graphs and perfect matchings; valuations and optimal assignments; prices and market clearing; constructing a set of market-clearing prices; relation to single-item auctions.
Week 6	Chapter 11 Network models of markets with intermediaries: price setting in markets; modeling trade on networks; equilibria in trading networks; auctions and ripple effects; trader profits. Chapter 12 Bargaining and power in networks: power in social networks; experiments on power and exchange; connection to buyer-seller networks; Nash bargaining solution; ultimatum game; stable outcomes; balanced outcomes. ***Homework assignment 3 due***
Week 7	Review and MIDTERM EXAM ***No blog posts or comments due***
Week 8	*Information Networks and the Web (chs. 13, 14, 15)* Chapter 13 The structure of the Web: World Wide Web; information networks, hypertext, associative memory; the Web as a directed graph; the bow-tie structure of the Web; Web 2.0 emerging.
Week 9	Chapter 14 Link analysis and Web search: the problem of ranking; hubs and authorities; PageRank; applying link analysis in modern Web search; applications beyond the Web (scientific citation analysis, U.S. Supreme Court Citation analysis). Chapter 15 Sponsored search markets: advertising based on search behavior; advertising as a matching market; encouraging truthful bidding in matching markets with the Vickrey-Clarke-Groves principle; truth-telling as a dominant strategy in the VCG mechanism; the generalized second-price auction and its equilibria; ad quality; complex queries and interactions among keywords. ***Homework assignment 4 due***
Week 10	*Network Dynamics: Population Models (chs. 16, 17, 18)* Chapter 16

	Information cascades: following the crowd; a herding experiment; Bayes's rule; Bayes's rule in the herding experiment; a simple, general cascade model; sequential decision making and cascades; lessons from cascades.
Week 11	Chapter 17 Network effects: network effects as externalities; the economy without network effects; the economy with network effects; stability, instability, and tipping points, dynamic view of the market; industries with network goods; mixing individual effects with population-level effects. Chapter 18 Power laws and rich-getting-richer: popularity as a network phenomenon; power laws; rich-get-richer models; the unpredictability of rich-get-richer effects; the long tail; the effect of search tools and recommendation systems. ***Homework assignment 5 due***
Week 12	*Network Dynamics: Structural Models, Markets and Information (chs. 19, 20, 21)* Chapter 19 Cascading behavior in networks: diffusion in networks; modeling diffusion through a network; cascades and clusters; diffusion, thresholds, and weak ties; extensions of the basic cascade model; knowledge, thresholds, and collective action. ***Homework assignment 6 due***
Week 13	Chapter 20 The small-world phenomenon: six degrees of separation; structure and randomness; decentralized search; modeling the process of decentralized search; empirical analysis and generalizations; core-periphery structures and difficulties in decentralized search. Chapter 21 Epidemics: diseases and their transmission networks; branching processes; the SIR epidemic model; the SIS epidemic model; synchronization; transient contacts and the dangers of concurrency; genealogy, genetic inheritance, and mitochondrial Eve.
Week 14	Review and synthesis ***Homework assignment 7 due***
Week 15	FINAL EXAM ***No blog posts or comments due***