Graduate Program in Economics

IDEA

Course: Networks

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Term: Second semester, year 2

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Description: Network Analysis is a relatively new approach to microeconomics that explores the impact of structures of interactions on economic outcomes, both theoretically and empirically. This approach leverages the tools of graph theory to elaborate detailed descriptions of bilateral relationships in a host of models of strategic interaction.

Objective: This is a second year graduate course. The goals of the course are to introduce the basic methods used by the social networks literature, and to help students identify cutting-edge research opportunities. A unifying question throughout the course will be: What insights has the networks approach added to our understanding of development economics?

Outline:

1. *Introduction to Networks in Economics*
    a. What are networks?
        - Node and Edge Attributes
        - Walks and Paths

    b. Measures of Influence
        - Closeness and Betweeness
        - Clustering

    b. Detecting Communities in Networks
        - Modularity

2. *Random Graph Models I*

a. The Erdos-Renyi Model
- Exponential Degree Distribution
- Phase Transitions & Giant Components
- Contagion

b. The Configuration Model
- Empirical Degree Distributions
- Properties of Configuration

b. The Small Worlds Model
- Low path lengths & high clustering
- Simulations

3. *Random Graph Models II*

a. Community Detection
- Basic Principle
- Modularity
- Greedy Agglomeration & Hierarchical Clustering
- Stochastic Block Models

b. Power Law Distributions
- Empirical Regularity
- Scale-Free Property & Zipf's Law

c. The Preferential Attachment Model
- Growing Random Graphs
- Mean Field Approximations
- Barabasi-Albert Model

d. Applications
- Hybrid Models
- Jackson & Rogers Model

4. *Strategic Network Formation*

a. Pairwise Stability
- Stability vs Efficiency
- Pos. and Neg. Externalities
- Distance-based Utility

b. Dynamic Models of Formation
- Improving Paths
- Stochastic Stability

c. Network Formation with Transfers
- Balance Conditions
- Bloch & Jackson

d. Directed Network Formation
- One-way vs. Two-way Flows
- Moral Hazard: Galeotti & Goyal

5. *Imitation, Adoption, and Diffusion*
    a. Imitation
        - The Bass Model of Innovation
        - S-Curves

    b. Adoption
        - Kirman's Ants
        - Social Sensitivity

    c. Epidemiology and Contagion
        - The SIS Model

6. *Opinion Formation, Learning, and Social Influence*
    a. Observational Learning
        - Bala & Goyal
        - Gale & Kariv

    b. DeGroot Learning
        - Influence Matrix and Persuasion Bias
        - Convergence of Beliefs
        - Speed of Convergence & Homophily
        - Convergence without Consensus

    c. Global Games on Networks
        - Regime Change in Large Information Networks

7. *Two Important Applications of Information Transmission*
    a. The Diffusion of Microfinance
        - Eigenvector Centrality
        - Structural Estimation

    b. Labor Market
        - Transition Probabilities
        - Employment Probability

8. *Peer Effects I*
    a. Strategic Complements: The Key Player
        - Intercentrality

    b. Strategic Substitutes: Public Goods in Networks
        - Multiplicity
        - Specialized Equilibria

    c. Strategic Interaction in Networks

- Minimum Eigenvalue
- Potential Games

9. *Peer Effects II*
    a. Estimating Peer Effects
        - The Linear-in-Means Model
        - The Reflection Problem

    b. Network Approach
        - Intransitive Networks
        - Classroom of Different Sizes

10. Informal Insurance, *Trust, and Social Collateral*
    a. Informal Insurance
        - Risk Sharing between Two Households
        - The Townsend Test of Perfect Insurance
        - Potential Frictions to Risk Sharing

    b. Networks of Trust and Collateral
        - Credible Punishments
        - Consumption Risk Sharing in Social Networks

11. *Risk Sharing with Local Information*
    a. The Diffusion of Microfinance
        - Eigenvector Centrality
        - Structural Estimation

    b. Labor Market
        - Transition Probabilities
        - Employment Probability

12. *Production Networks and the Propagation of Shocks*
    a. Firm Networks
        - Input-output Matrices
        - Productivity Linkages

    b. Shocks to Supply Chains
        - Downstream vs Upstream Propagation
        - The Importance of Structure
        - Higher-order Results

References:

- Jackson, Matthew O. *Social and economic networks*. Princeton University Press, 2010.

Other Sources:

- Newman, Mark. *Networks: an introduction*. Oxford University Press, 2009.
- Extended reading list provided on my website.

Grading: Problem Sets (25%), Presentation (25%), Term Paper (50%)