MSDM 5056 Network Modeling (Fall, 2023)

Meeting Time and Venue

Wednesday 19:00 – 20:50 (lecture); 21:00 – 21:50 (tutorial), Room 2404

Course Description

Empirical study of networks in social science, economics, finance, biology and technology, network models: random networks, small world networks, scale free networks, spatial and hierarchical networks, evolving networks, methods to generate them with a computer, dynamical processes on complex networks: network search, epidemic spreading, rumor and information spreading, community detection algorithms, applications of network theory.

Course Objective

This course introduces analytical tools to describe, characterize and model network structures underlying complex interacting systems in social science, economics, finance, biology and technology, and how such structures facilitate dynamical processes involving the network flow of information, risks, and materials.

Course Outline

-- Introduction to complex systems and complex networks
-- Empirical study of networks in social science, economics, finance, biology and technology
-- Fundamentals of Network Theory: network mathematics, measures and metrics
-- Large Scale Structures of Networks: Components, shortest paths, degree distribution, clustering coefficients …
-- Network Models: random networks, small-world networks, scale-free networks, network formation, evolving networks
-- Dynamical Processes on Complex Networks: network search, epidemic spreading, rumors and information spreading
-- Computer Algorithms: basic concepts, fundamental network algorithms, community detection algorithms, other algorithms used in the study of networks ….
-- Application of network theory in finance, technology, biology and social science
-- Advanced topics: multilayer networks, higher order networks, causality in networks

Grading Policy

65% Lab and project (total of 3, 20% for each of the first two, 25% for the last one)
Objective: Allow students to have independent research ability through projects

30% Homework assignments (total of 4)

Objective: Allow students to learn through independent exercises

A total of 4 homework assignments. Each homework assignment will be put on canvas at least two weeks before due date. Attendance to tutorial is not compulsory and no attendance check for tutorial. However, the tutorial is very helpful in answering the homework assignments and the projects.

5% Attendance

According to the Continuing Education Fund (持續進修基金), all our courses must include class attendance in an assessment scheme. In this regard, the MSc-DDM task group resolved to let all MSDM courses include 5% class attendance to the assessment and such information has to be marked on the course outline/syllabus.

Teaching and Learning Activities –

a) Lectures: focus on clear exposition of concepts and basic techniques in problem solving
b) Tutorials/Laboratory: focus on detailed problem solutions, methodology and homework assignment help

Course Schedule

Meeting	Date	Remarks
Week 1: Introduction	Sept 6	
Week 2: Basics of Networks	Sept 13	
Week 3: Centrality Measures and Metrics	Sept 20	
Week 4: Large scale structures of networks	Sept 27	1st homework assignment due
Week 5: Graph Partitioning and Community Detection	Oct 4	
Week 6: Review and Examples of Application	Oct 11	2nd homework assignment due
Week 7: Network Models I	Oct 18	
Week 8: Network Models II	Oct 25	3rd homework assignment due
Week 9: Network Models III	Nov 1	
Week 10: Processes on Networks I	Nov 8	4th homework assignment due
Week 11: Processes on Networks II	Nov 15	
Week 12: Application of Complex Networks	Nov 22	Labs 1 & 2 due
Week 13: Advanced Topics in Complex Networks	Nov 29	
Project due – Dec 6		

Some Overview Articles

S.H. Strogatz, “Exploring Complex Networks”, Nature, 8 March 2001, 268-276.

R. Albert and A-L. Barabasi, “Statistical Mechanics of Complex Networks”, Reviews of Modern Physics (2002) 47-97.

M.E.J. Newman, “Models of the Small World: A review”, J. Statistical Physics (2000) 819-841.

M.E.J. Newman, “The Structure and Function of Complex Networks”, SIAM Review 45 (2003) 167-256.

Books

1. M.E.J. Newman, *Networks: An Introduction*, Oxford University Press (2010).
2. A. Barrat, M. Barthelemy, and A. Vespignanu, *Dynamical Processes on Complex Networks*, Cambridge University Press (2012).
3. A. Barabasi, *Network Science*, Cambridge University Press (2016).

Useful website

http://www.network-science.org/