23MA810 Complex Networks 4 0 0 4

Course outcomes:

CO1: To acquaint participants with some of the fundamental concepts and state-of-the-art research in the areas of complex networks and network science.
CO2: To study of the models and behaviors of networked systems. Empirical studies of social, technological, information and financial networks.
CO3: Exploring the concepts of small world effect, degree distribution, clustering, network correlations, random graphs, models of network growth.
CO4: To understand the dynamical processes taking place on networks.
CO5: To implement these concepts with some large network data sets.

Syllabus

Introduction: Overview of Network science, Motivation, Large scale dynamic networks, Challenges of graph theory Basic Concepts related to Networks: Small world effect, transitivity and clustering, degree distribution, scale free networks, maximum degree; network resilience; mixing patterns; degree correlations; community structures; network navigation.

Measures and metrics: Degree centrality, eigenvector centrality, katz centrality, PageRank, Hubs and authorities, closeness centrality, betweenness centrality, Transitivity, reciprocity, similarity, assortative mixing.

Community Structure Analysis: Basic concepts of network communities, Modularity, various community finding approaches like Girvan-Newman Algorithm, Spectral Bisection Algorithm, Radicchi Edge Clustering Algorithm (for binary as well as weighted graphs), Wu-Hubermann Algorithm, and Random Walk based Algorithm, Louvain, InfoMap.

Random Graphs: Poisson random graphs, generalized random graphs, the configuration model, generating functions, power-law degree distribution, directed graph, bipartite graph, degree correlations.

Models of Network Growth: Price model, Barabasi & Albert model, other growth models, vertex copying models, Bipartite Network.

Applications: Search on networks, exhaustive network search, guided network search, network navigation; network visualization and semantic zooming.

Text / Reference Books:

1. M.E.J Newman, Networks: An Introduction, Oxford University Press, Oxford, 2010.
2. Dorogovtsev S.N, Evolution of Networks, Oxford University Press, Oxford, 2003.
3. The Structure and Dynamics of Networks, Newman, Barabasi and Watts, Princeton, 2006.
4. Albert, R., and A-L Barabási. "Statistical Mechanics of Complex Networks." *Reviews of Modern Physics* 74 (2002): 47-97.
5. Papers from the ACM and IEEE digital libraries.