DISCIPLINE SPECIFIC Elective - (DSE-4a) : Applied Network Analytics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Semester 6

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE 04a Applied Network Analytics	**4**	**3**	**0**	**1**	Pass in Class XII	Knowledge of Python Programming

Learning Objectives

The course introduces basic concepts and methods analysis of networks whose foundation is graph theory. Distinction between a graph as an abstract structure and a real-life situation modeled as a network is detailed in this paper. The objective of this course is to expose the students to the strengths and capabilities of network analysis and their applications in real life. The students will be encouraged to apply the concepts taught in the course to real life problems using open-source software.

Learning outcomes

On successful completion of the course, students will be able to :

- Mapping of real world situation into networks
- Identify and apply quantitative network measures to characterize social networks at the local and global level
- Generate synthetic networks that satisfy properties of real world networks and its traversal
- Discover, analyze and evaluate the disjoint community structure of networks
- Model an information diffusion process for predictive analysis of social networks

SYLLABUS OF DSE 04a

Unit 1 (8 Hours)

Introduction to Network Science: Elementary Graph theory, Degree and degree distribution, Applications of network science in social network analysis, Network types.

Unit 2 (6 Hours)

Restructuring Data for use in Graph: Mapping of real world situation into networks, Representation of graphs, Transforming tabular and semi-structured data into graphs

Unit 3 (10 Hours)

Graph Traversal: Traversing the graph, Path, Distance, Path length, Shortest Path algorithms, Diameter, Density

Generative Network Models: Random, Small-world and Scale-free networks, Properties of real-world networks.

Unit 4 (10 Hours)

Vertex Importance and Centrality: Centrality measures, Hubs and authority, Page rank algorithm, Assortativity, Transitivity and Reciprocity, Calculating and illustrating vertex centrality

Unit 5 (11 Hours)

Community Structure: Different types of communities, Modularity, Algorithm for disjoint community detection

Information Diffusion in Social Networks: Cascading of information and innovations, Standard epidemic models for information diffusion

Essential/recommended readings

1. Chakraborty T. *Social Network Analysis*, 1st edition, Wiley India Pvt. Ltd., 2021.
2. McNulty, Keith. *Handbook of Graphs and Networks in People Analytics With Examples in R and Python.* 1st edition, CRC Press, 2022.

3. Yang S., Keller F. B., Zheng L.. *Social Network Analysis: Methods and Examples.* 1st edition, Sage Publications, 2017.

Additional References

1. Barabási A. L. , Pósfai M. *Network Science*, 1st edition, Cambridge University Press, 2016.
2. Easley, Kleinberg J. *Networks, Crowds, and Markets: Reasoning About a Highly Connected World*, 1st edition, Cambridge University Press, 2012.

Suggested Practical List (If any): (30 Hours)

Python Packages like igraph, NetworkX, NDlib etc. may be used for programming

1. Create a graph from an edge-list and another graph from an adjacency matrix. Explore the graph to determine its number of vertices and edges.
2. Plot a weighted network such that node size and edge width is proportional to their degree and edge weight respectively. Experiment with different layouts for visualization.
3. Compute and plot degree distribution of a small real-world network. Use appropriate functions to determine shortest paths between all pairs of vertices.
4. Generate three networks of 1000 nodes each using Random Network Model, Small World Network Model, Scale Free Model and compare their characteristics.
5. Compute different centrality measures to identify top-N nodes and compare their ranks with those obtained by PageRank method.
6. Apply community detection algorithms on a small real-world network (e.g. Karate club) and compare modularity using bar plot. Also plot the communities revealed with different colors.
7. Simulate diffusion trends for different epidemic models and present results using appropriate visuals.