Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2021-2022

Course Handout Part II

Date: 20-08-2021

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : ***CS F426***
Course Title : **Graph Mining**
Instructor-in-Charge : **Dr. Apurba Das**

Scope and Objective of the Course:

This course studies managing and mining graphs which are massive and cannot held in main memory as the size of the applications are often very large. Classic examples of graphs are web, social networks, computational biology, communication networking etc. In some cases, the entire graph is not available in the form of continuous stream. Edges are received continuously with time. The course includes the basics of the graphs, static and dynamic graphs, PageRank & random walks, graph or graph node classification, graph clustering, community detection, anomaly detection, frequent sub-graph mining. The course is designed to provide students with an understanding parallel and streaming graph mining to deal with massive graphs and evolving graphs. The course also aims at providing a holistic view of dealing and mining with graphs.

Textbooks:

1. T1: Jure Leskovec, Anand Rajaraman, Jeff Ullman. Mining of Massive Datasets. Book 3rd edition. 2020, Cambridge University Press. [http://www.mmds.org/]

Reference books

1. **R1:** Agarwal Charu C. and Wang Haixun, Managing and Mining Graph Data, Springer
2. **R2:** Social Media Mining - An introduction, Reza Zafarani, Mohammad Ali Abbasi, Huan Liu , Cambridge University Press , 2014 [http://dmml.asu.edu/smm/SMM.pdf]
3. **R3:** Chakrabarti, D. and Faloutsos, C., 2012. Graph mining: laws, tools, and case studies. *Synthesis Lectures on Data Mining and Knowledge Discovery*, *7*(1), pp.1-207.
4. **R4:**Mohammad Hossein Bateni Soheil Behnezhad Mahsa Derakhshan MohammadTaghi Hajiaghayi Raimondas Kiveris Silvio Lattanzi Vahab Mirrokni, Affinity Clustering: Hierarchical Clustering at Scale, NIPS 2017, pp. 6867-6877 [https://research.google/pubs/pub46700/]
5. **R5:** Fenxiao Chen, Yun-Cheng Wang, Bin Wang and C.-C. Jay Kuo, Graph representation learning: a survey DOI: https://doi.org/10.1017/ATSIP.2020.13, Cambridge University Press: 28 May 2020 [https://arxiv.org/pdf/1909.00958.pdf]
6. **R6:** William L. Hamilton, Rex Ying, Jure Leskovec, Representation Learning on Graphs: Methods and Applications, [https://www-cs.stanford.edu/people/jure/pubs/graphrepresentation-ieee17.pdf]
7. **R7:** Easley, D. and Kleinberg, J., 2010. *Networks, crowds, and markets: Reasoning about a highly connected world*. Cambridge University Press.

8. **R8**: R Angles, et al. Foundations of Modern Query Languages for Graph Databases, 2017, ACM Computing Surveys
9. **R9**: D Koutra and Faloutsos, C., Individual and Collective Graph Mining: Principles, Algorithms, and Applications, 2017, https://www.morganclaypool.com/doi/10.2200/S00796ED1V01Y201708DMK014
10. **R10**: L. Lu and T Zhou, Link Prediction in Complex Networks: A Survey
11. **R11**: M Needham and A. E. Hodler, Graph Algorithms: Practical Examples in Apache Spark and Neo4j, [https://neo4j.com/graph-algorithms-book/]

Course Plan:

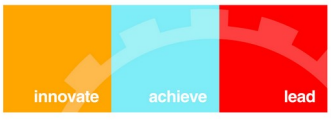
Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1	**M1: Graph Basics Static and dynamic graphs** To understand graphs and their applications To understand how to traverse graphs and perform random walks to rank nodes for different applications To learn how to do computations in parallel for massive graphs	Course Overview Graph Terminology and Applications	R1 Ch 1, R2 Ch 1
2-4		Static Graphs and basic algorithms	R2 Ch 2 R1 Ch 2
5-6		Dynamic Graphs	Class Notes
7-10		Link Analysis PageRank, Connectivity, triangle computation, Personalized Random walk, parallel computation	T1 Ch 5
11-12	**M2**: **Managing Graph Data** To study how to manage, index and query graph data	Representing and Using Graph Data	R1: Ch 2.1, 2.2
13-14		Indexing & Querying Graph data Feature Based Graph Index Indexing for Similarity Search	R1: Ch 5
14-15		Graph Querying Algorithms Patterns and querying for Patterns Navigational Querries	R8
16-19	**M3: Graph Mining** To study how to search graphs based on key words To understand how to	Node Classification Link Based methods Belief Propagation Semi-supervised learning Bipartite Graphs SimRank	R1 Ch 11 R9 R10

	classify graph nodes/graphs with labeled data or without labeled data To learn how to detect communities from a graph and how to compare two graphs/graph nodes To learn how to detect anomalies and mining frequent subgraphs To understand how graph mining is required and applied to real problems	Link Prediction Graph classification	
20-24		Graph Clustering Clustering in Bipartite graphs Hierarchical Clustering Community Detection Graph Partitioning Spectral methods Graph Similarity and Alignment Iterative similarity methods Edge similarity scores Network Similarity Methods	T2: 10.1-10.6 R4 R1 Ch 9
25-29		Sub-graph mining Sub-graph Enumeration Frequent Subgraph Mining Apriori-based Approach Pattern-growth Approach Mining Significant Graph Patterns Branch-and-Bound Approach	T1 10.7
30		Case Study	
31-36	**M4:** **Advanced Topics**	Deep learning for graphs Graph Convolution Networks (GCN) Link Prediction Graph Representation Learning	R5 R11
37-38		Distributed Graph Algorithms	Research Papers
39-42		Streaming Graphs Stream Model for massive graphs Graph streams	T2 Ch 4 T1 Ch13

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid-Semester Test	90 Mins.	30	19/10/2021 1.30 - 3.00PM	Open Book
Lab based evaluation (3 Nos.)		25	TBA	Open Book
Project		10	TBA	Open Book
Comprehensive Examination	120 Mins.	35	15/12 AN	Open Book

Note: ***40% of the evaluation to be completed by midsem grading.***


innovate
achieve
lead

Consultation Hour:

To be announced in the class

Notices:

Make-up Policy:

Prior Permission is must and Make-up shall be granted only in genuine cases based on individual's need and circumstances.

Academic Honesty and Integrity Policy:

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE
Apurba Das