edge list Network motifs and substructures. (10 hours)

Unit II: Graph Theory and Social Network Analysis: Graph Theory Fundamentals Key concepts: paths, cycles, connectivity, cliques, and components, Properties of networks: degree distribution, clustering coefficient, and shortest path, Centrality measures: degree, betweenness, closeness, and eigenvector centrality Identifying influential nodes and authorities (e.g., PageRank), Social Network Analysis (SNA): Structural analysis of social systems and applications

(10 hours)

Unit III: Communities, Spreading Phenomena, and Societal Impacts: Community Detection Modularity optimization and algorithms: Louvain, Girvan-Newman, and spectral clustering, Overlapping and hierarchical communities and applications, Spreading Phenomena in Networks Epidemic models, Measuring and mitigating polarization Case studies: social media platforms and political discourse. (15 hours)

Unit IV: Network Dynamics and Temporal Evolution: Network Dynamics Cascading behaviours: threshold and tipping-point models Influence maximization: greedy algorithms and heuristics Information diffusion models: independent cascade and linear threshold models, Applications: tracking disease spread, communication networks, and transportation systems. (15 hours)

References

1. Albert-László Barabási, Márton Pósfai, Network Science, Cambridge University Press, 2021
2. Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, and Giuseppe Labianca. "Network analysis in the social sciences." Science 323, no. 5916 (2009): 892-895.
3. Easley, D., & Kleinberg, J. (2010). *Networks, crowds, and markets: Reasoning about a highly connected world*. Cambridge University Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE):

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Deep Learning and Applications (DSE)	**4**	**3**	**1**	**0**	**Class XII pass**	**Programming languages and Artificial intelligence, Data structure and design**

Learning Objectives

It is an introductory course on deep learning methods with applications to computer vision and natural language processing in several fields. Students will gain foundational knowledge of deep learning algorithms and practical experience building deep neural networks.

Learning outcomes

- Will have understanding of deep neural networks
- Will have understanding of the design of single and multi-layer feed-forward deep networks and tune various hyper-parameters.
- Will have an understanding of the practical aspects of Deep Learning.

SYLLABUS

Unit I: Introduction to Machine Learning and Deep Learning: Overview of learning paradigms: supervised, unsupervised, and reinforcement learning, Fundamentals of machine learning (ML) and deep learning (DL), and the distinctions between the two, Introduction to deep neural networks and their role in modern AI applications. (9 hours)

Unit II: Deep Learning Architectures and Optimization: Deep feedforward networks and their implementation for real-world problems, Techniques for regularization and optimization to improve deep learning model performance, Key strategies for training deep models effectively, including backpropagation and gradient descent. (9 hours)

Unit III: Advanced Deep Learning Models: Convolutional neural networks (CNNs) for image processing and computer vision tasks, Sequence modeling with recurrent neural networks (RNNs) and recursive nets for time-series and language data. (15 hours)

Unit IV: Practical Applications and Advanced Models: Methodologies for applying deep learning to real-world problems in various domains, Exploration of autoencoders, representation learning, and deep generative models like GANs, Introduction to linear factor models and their use in data compression and anomaly detection.
(9 hours)

Essential/recommended readings

1. Ian Goodfellow, Deep Learning, MIT Press, 2016.
2. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.
3. Mindy L Hall, Deep Learning, VDM Verlag, 2011.
4. Li Deng (Author), Dong Yu, Deep Learning: Methods and Applications (Foundations and Trends in Signal Processing), Now Publishers Inc, 2009.

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