Subject : Social Networks **Subject Code : BTCME801.1T**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03Hrs (Theory)	03	100	30	70	100

Aim : To understand social networks and use of tools for social network analysis.
Prerequisite(s): Discrete Mathematics

Course Objectives:

1	To understand highly interconnected and highly complex social network
2	To represent connected social networks in form of graph
3	To apply graph theory, sociology, game theory
4	To use tools and extract statistics from social networks

Course Outcomes:
At the end of this course Student are able to:

CO1	Learn social networks , its types and representation
CO2	Understand weak ties, strong and weak relationships , homophily and calculate
CO3	Analyse links
CO4	Understand Power Laws and Rich-Get-Richer Phenomena
CO5	Understand Small World Phenomenon

Week 1: Introduction
Week 2: Handling Real-world Network Datasets
Week 3: Strength of Weak Ties
Week 4: Strong and Weak Relationships (Continued) & Homophily
Week 5: Homophily Continued and +Ve / -Ve Relationships
Week 6: Link Analysis
Week 7: Cascading Behavior in Networks
Week 8: Link Analysis (Continued)
Week 9: Power Laws and Rich-Get-Richer Phenomena
Week 10: Power law (contd..) and Epidemics
Week 11: Small World Phenomenon
Week 12: Pseudocode (How to go viral on web)

References:
1. https://onlinecourses.nptel.ac.in/noc23_cs19/preview
2. Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
3. Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.

(Dr. V. P. Mahatme) (Ashesh Shahare) (P. S. Prasad)

Subject: Reinforcement Learning **Subject Code: BTCME801.2T**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03Hrs (Theory)	03	100	30	70	100

Aim : The goal of the course is to introduce the basic mathematical foundations of reinforcement learning, as well as highlight some of the recent directions of research.

Prerequisite(s): Neural Networks

Course Objectives:

1	It aims to model the trial-and-error learning process that is needed in many problem situations where explicit instructive signals are not available.
2	It has roots in operations research, behavioral psychology and AI.
3	The goal of the course is to introduce the basic mathematical foundations of reinforcement learning.
4	It highlight some of the recent directions of research

Course Outcomes:

At the end of this course Student are able to:

CO1	Understand Bandit algorithm and its mathematical formulation.
CO2	Use dynamic programming for reinforcement learning
CO3	Perform function approximation and apply LSM
CO4	Fit Q, DQN & Policy Gradient for Full RL
CO5	Use combinatorial models for complex problems

Week 1 Introduction
Week 2 Bandit algorithms – UCB, PAC
Week 3 Bandit algorithms –Median Elimination, Policy Gradient
Week 4 Full RL & MDPs
Week 5 Bellman Optimality
Week 6 Dynamic Programming & TD Methods
Week 7 Eligibility Traces
Week 8 Function Approximation
Week 9 Least Squares Methods
Week 10 Fitted Q, DQN & Policy Gradient for Full RL
Week 11 Hierarchical RL
Week 12 POMDPs

References

1. https://archive.nptel.ac.in/courses/106/106/106106143/
2. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

Subject: GPU Architecture and Programming **Subject Code : BTCME801.3T**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03Hrs (Theory)	03	100	30	70	100

Aim : To understand GPU architecture basics in terms of functional units and then dive into the popular CUDA programming model commonly used for GPU programming.
Prerequisite(s): Programming and Data Structure, Digital Logic, Computer architecture

Course Objectives:

1	To introduce basics of conventional CPU architectures, their extensions for single instruction multiple data processing (SIMD)
2	To understand concept in the form of single instruction multiple thread processing (SIMT) as is done in modern GPUs.
3	To teach architecture specific details
4	To introduce different architecture-aware optimization techniques relevant to both CUDA and OpenCL

Course Outcome:
At the end of this course Student are able to:

CO1	Understand conventional CPU architectures, their extensions for single instruction multiple data processing (SIMD)
CO2	Program in CUDA about data space & synchronization
CO3	Apply optimization on kernals, treads etc
CO4	Learn basics of OpenCL
CO5	Design an application using neural networks

Week 1: Review of Traditional Computer Architecture – Basic five stage RISC Pipeline, Cache Memory, Register File, SIMD instructions
Week 2: GPU architectures - Streaming Multi Processors, Cache Hierarchy, The Graphics Pipeline
Week 3: Introduction to CUDA programming
Week 4: Multi-dimensional mapping of dataspace, Synchronization
Week 5: Warp Scheduling, Divergence
Week 6: Memory Access Coalescing
Week 7: Optimization examples: optimizing Reduction Kernels
Week 8: Optimization examples: Kernel Fusion, Thread and Block Coarsening
Week 9: OpenCL basics
Week 10: CPU GPU Program Partitioning
Week 11: Application Design: Efficient Neural Network Training/Inferencing
Week 12: Application Design: Efficient Neural Network Training/Inferencing,cont'd

References:

1. https://onlinecourses.nptel.ac.in/noc23_cs61/preview
2. "Computer Architecture -- A Quantitative Approach" - John L. Hennessy and David A. Patterson
"Programming Massively Parallel Processors" - David Kirk and Wen-mei Hwu

3. Heterogeneous Computing with OpenCL" -- Benedict Gaster, Lee Howes, David R. Kaeli

Subject : Predictive Analytics - Regression and Classification Subject Code : BTCME802.1T

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03Hrs (Theory)	03	100	30	70	100

Aim : The course will provide an overview of fundamental ideas in statistical **predictive** models.
Prerequisite(s): Probability and Statistics

Course Objectives:

1	The course will provide an overview of fundamental ideas in statistical predictive models
2	. The objective is to understand how statistical models handle prediction problems.
3	The stress will be on understanding the construction of the models and implementation.
4	It is a core course if students aspire to be Data Scientists.

Course Outcomes:
At the end of this course Student are able to:

CO1	To understand predictive models, LSM, Normal equations and GMT
CO2	Understand regression models and infer its statistical inference
CO3	Check model assumptions and bias variance tradeoff.
CO4	Perform regression analysis in various programming languages
CO5	Apply regression models and classification for predictive analysis

Week 1:
- Landscape of the predictive models.
- Least Squares method

Week 2:
- Normal Equations:
- Gauss Markov theorem

Week 3:
- The geometry of Regression Model and Feature Engineering
- Statistical Inference of Regression Coefficient

Week 4:
- Checking Model Assumptions
- Model Comparison with R-squared, RMSE, AIC or BIC

Week 5:
- Model Complexity and Bias-Variance tradeoff
- Feature selection and Dimension Reduction

Week 6:
- Multicollinearity and Variance Inflation Factor
- Regularization with LASSO, Ridge and Elastic Net
- Ridge Regression with Python

Week 7:
- Regression Analysis with Python
- Regression Analysis with R
- Regression Analysis with Julia

Week 8: Major Applications of Regression Models
- Capital Asset Pricing Model
- Bootstrap Regression
- Time Series Forecasting with Regression Model
- Granger Causal model.

Week 9:
- Logistic Regression
- MLE of coefficient of Logistic Regression

Week 10:
- Fit Logistic Regression with optim function in R
- Fit Logistic Regression with glm function in R
- Fit Logistic Regression with sklearn in Python
- Fit Logistic Regression in Julia

Week 11:
- Logistic Regression and Inference
- Discriminant Analysis

Week 12:
- Multinomial Logit Regression
- Generalised Linear Regression
- Poisson Regression
- Negative Binomial Regression

References:

1. https://onlinecourses.nptel.ac.in/noc23_ma46/preview
2. An Introduction to Statistical Learning by James, Witten, Hastie, and Tibshirani, Springer (https://www.statlearning.com/)
3. The Elements of Statistical Learning by Hastie, Tibshirani, and Friedman, Springer (https://hastie.su.domains/Papers/ESLII.pd)
4. Regression and Other Stories by Gelman, Hill, and Vehtari, by Cambridge University Press (https://avehtari.github.io/ROS-Examples/)

Subject : Data Analytics using Python **Subject Code: BTCME802.2T**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03 Hrs (Theory)	03	100	30	70	100

Aim : To give hands-on experience using python for creating analytics models

Prerequisite(s): Nil

Course Objectives:

1	To learn analytics using python programming language
2	Learn hypothesis testing and ANOVA model
3	Regression models and its implementation
4	*Learn clustering and classification*

Course Outcomes:

At the end of this course student are able to:

CO1	Understand data analytics and Python fundamentals
CO2	Perform sampling using various methods and perform hypothesis test or ANOVA test
CO3	Fit linear regression model and calculate various errors
CO4	Apply ROC
CO5	Apply clustering and classification using python programming

Week 1: Introduction to data analytics and Python fundamentals

Week 2: Introduction to probability

Week 3: Sampling and sampling distributions

Week 4: Hypothesis testing

Week 5: Two sample testing and introduction to ANOVA

Week 6: Two way ANOVA and linear regression

Week 7: Linear regression and multiple regressions

Week 8: Concepts of MLE and Logistic regression

Week 9: ROC and Regression Analysis Model Building

Week 10: c^2 Test and introduction to cluster analysis

Week 11: Clustering analysis

Week 12: Classification and Regression Trees (CART)

References:

- **https://archive.nptel.ac.in/courses/106/107/106107220/**
- McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".
- Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
- Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. "John Wiley & Sons, Inc".
- Anderson Sweeney Williams (2011). Statistics for Business and Economics. "Cengage Learning".
- Douglas C. Montgomery, George C. Runger (2002). Applied Statistics & Probability for Engineering. "John Wiley & Sons, Inc"
- Jay L. Devore (2011). Probability and Statistics for Engineering and the Sciences. "Cengage Learning".
- David W. Hosmer, Stanley Lemeshow (2000). Applied logistic regression (Wiley Series in probability and statistics). "Wiley-Interscience Publication".
- Jiawei Han and Micheline Kamber (2006). Data Mining: Concepts and Techniques. "
- Leonard Kaufman, Peter J. Rousseeuw (1990). Finding Groups in Data: An Introduction to Cluster Analysis. "John Wiley & Sons, Inc".

Subject: Cloud Computing **Subject Code : BTCME802.3T**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
03 Hrs (Theory)	03	100	30	70	100

Aim : This will help students to use and explore the cloud computing platforms.

Prerequisite(s): Basics of Computer Architecture and Organization, Networking

Course Objectives:

1	This course will introduce various aspects of cloud computing.
2	Learn cloud fundamentals, management issues, security challenges and future research trends.
3	VM resource management and cloud fog edge enabled analytics
4	Teach case studies and advanced research areas

Course Outcomes:
At the end of this course Student are able to:

CO1	Understand on-demand computing service for shared pool of resources, namely servers, storage, networking, software, database, applications etc.,
CO2	Understand cloud model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources, which can be rapidly provisioned and released with minimal management effort.
CO3	Create a cloud and use cloud simulator softwares
CO4	PerformVM resource management and cloud fog edge enabled analytics.
CO5	Practice case studies and understand advanced research areas

Week 1: Introduction to Cloud Computing

Week 2: Cloud Computing Architecture

Week 3: Service Management in Cloud Computing

Week 4: Data Management in Cloud Computing

Week 5: Resource Management in Cloud

Week 6: Cloud Security

Week 7: Open Source and Commercial Clouds, Cloud Simulator

Week 8: Research trend in Cloud Computing, Fog Computing

Week 9: VM Resource Allocation, Management and Monitoring

Week 10: Cloud-Fog-Edge enabled Analytics

Week 11: Serverless Computing and FaaS Model

Week 12: Case Studies and Recent Advancements

References

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011

2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010

3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010

4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010

5. https://archive.nptel.ac.in/courses/106/105/106105167/

Subject : Project Work/Industry Project (Phase II) **Subject Code: BTCME803P**

Load	Credit	Total Marks	Internal Marks	University Marks	Total
12 Hrs (Practical)	08	200	100	100	200