CENTRAL UNIVERSITY OF ANDHRA PRADESH
ANANTHAPURAMU

Vidya Dadati Vinayam
(Education Gives Humility)

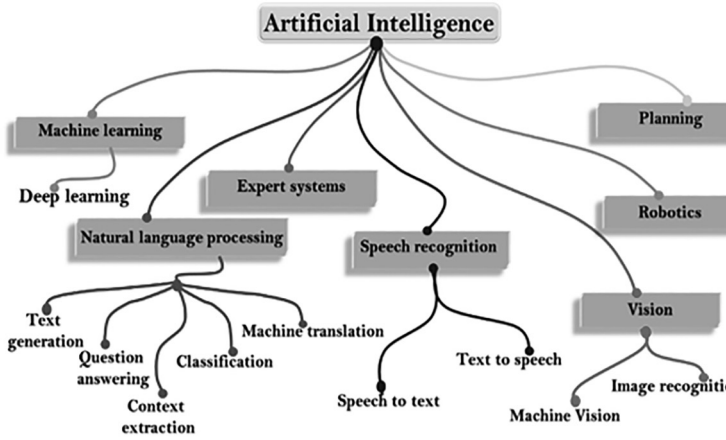
M.Tech.
Artificial Intelligence and Data Science

"Today's AI is about new ways of connecting people to computers, people to knowledge, people to the physical world, and people to people."

- Patrick Winston

Structure and Syllabus
(2021-2022 Batch)

CONTENTS



Source: https://www.javatpoint.com/subsets-of-ai

CENTRAL UNIVERSITY OF ANDHRA PRADESH

M.Tech. Artificial Intelligence and Data Science

Important Information to Students

I. Programme: M. Tech in Artificial Intelligence and Data Science.

II. Eligibility: Bachelor's Degree with at least 50% marks or Equivalent Grade in B.E. / B.TECH. in Computer Engineering or Computer Science Engineering or Information Technology or Information & Communication Technology or Electronics Engineering or Electronics & Communication Engineering or Electrical Engineering or Instrumentation or equivalent Qualification or Master of Computer Application (MCA) or M.Sc. in Computer Science or Information Technology or equivalent in the relevant field as recognized by the University.

III. The minimum duration for completion of any PG Programme is four semesters (two academic years) and the maximum duration is eight semesters (four academic years) or as per amendments made by the regulatory bodies from time to time.

IV. A student should attend at least 75% of the classes, seminars, practicals/ lab in each course of study.

V. All theory courses in the programme carry a Continuous Internal Assessment (CIA) component to a maximum of 40 marks and End Semester Examination (ESE) for a maximum of 60 marks. The minimum pass marks for a course is 40%.

All lab components carry a Continuous Internal Assessment (CIA) component to a maximum of 60 marks and End Semester Practical Examination (ESE) for maximum of 40 marks. The minimum pass marks for a course in 40%

VI. A student should pass separately in both CIA and the ESE, i.e., a student should secure 16 (40% of 40) out of 40 marks for theory and 24 (40% of 60) out of 60 marks for lab components in the CIA. Therefore, a student should secure 24 (40% of 60) out of 60 marks for theory and 16 (40% of 40) out of 40 marks for lab components in the end semester examination (ESE).

VII. A student failing to secure the minimum pass marks in the CIA is not allowed to take the end semester examination of that course. S/he has to redo the course by attending special classes for that course and get the pass percentage in the internal tests to become eligible to take the end semester examination.

VIII. Students failing a course due to lack of attendance should redo the course.

IX. Re-evaluation is applicable only for theory papers and shall not be entertained for other components such as practical/ thesis/ dissertation/ internship etc.

X. An on- campus elective course is offered only if a minimum of ten or 40% of the students registered, whichever is higher, exercise their option for that course.

Introduction to the Programme

Introduction:

M.Tech. Artificial Intelligence and Data Science is one of the new postgraduate programmes being offered by CUAP from 2021-22 academic year. Artificial Intelligence (AI) and Data Science are very close and fastest growing fields in contemporary scenario. AI is a branch of computer science that aims to create intelligence showcased by machines (computers and automation systems) in distinction to the natural intelligence of humans. The major goals of AI and Data Science are to attain success in knowledge reasoning, planning, machine learning, natural language processing, computer vision, data analytics and data engineering.

With a vision to impart knowledge of Artificial Intelligence and Data Science, the program focuses on training students to become analytical experts and critical thinkers in research and industry. The course is designed to encourage students to reason with data and build models which can predict future outcomes.

In this program, we aim to prepare students to work in various fields ranging from Artificial Intelligence, Data Science, Data Engineering and Data Analytics.

Programme Objectives:

- To impart knowledge of both fundamental and technical skills on various aspects of Artificial Intelligence and Data Science.
- To expose students to the developments in the area of Data Visualization, Data Cleaning, Machine Learning Models, Artificial Intelligence and their utilization in industry and research.
- To expose to techniques and developments in various domains where AI can be applied.

A Student completing this programme will be capable of taking a career path in the domain of Artificial Intelligence and Data Science.

Programme Outcomes:

On successful completion of the programme student should be able to:

- Understand the fundamentals of Artificial Intelligence, Machine Learning, Inference Engines, Speech, Vision, Natural Language Understanding, Robotics, and Human Computer Interaction.
- Unify the knowledge of Human Cognition, AI, Machine Learning and Data Engineering for designing systems.
- Apply ideas and intuition behind modern machine learning methods as well as a more formal understanding of how, why, and when they work.
- Develop real-time and robust AI-based systems with specific software, hardware and data requirements.
- Upgrade knowledge and undertake further study and research in Artificial Intelligence according to the need of society.

CENTRAL UNIVERSITY OF ANDHRA PRADESH

M.Tech. Artificial Intelligence and Data Science
Semester and Course wise Credits

Semester	Discipline Specific Core (DSC) (L+T+P)	Discipline Elective (DSE) / Elective (EL)	Project Work / Dissertation	Lab	Total Credits
I	DSC 1 (3) DSC 2 (3) DSC 3 (3) DSC 4 (3)	EL1 by MOOC (3) EL-2 (3)	-	System Building Lab- I (3) (DSC 2+ DSC 3+ DSC 4)	21
II	DSC 5 (3) DSC 6 (3) DSC 7 (3) DSC 8 (3)	EL-3 by MOOC (3) EL-4 (3)	-	System Building Lab- II (3) (DSC 5 + DSC 6+ DSC 8)	21
III	DSC 9 (3) DSC 10 (3) DSC 11 (3)	EL-5 by MOOC (4) EL-6 (3)	-	System Building Lab- III (2) (DSC 9 + DSC 10)	18
IV	-	-	Project Work/ Dissertation (12)	-	12
Total	33	19	12	8	72
Percentage	45.83	26.38	16.66	11.11	-

CENTRAL UNIVERSITY OF ANDHRA PRADESH

M. Tech. Artificial Intelligence and Data Science

Programme Structure

S. No	Course Code	Title of the Course	Credits	Contact Hours		
				L	T/L	P/S
Semester – I						
1.	MAI101	Mathematics for Data Science	3	35	5	5
2.	MAI102	Introduction to Artificial Intelligence	3	35	5	5
3.	MAI103	Advanced Data Structures and Algorithms	3	35	5	5
4.	MAI104	Foundations of Data Science	3	35	5	5
5.	MAI105	MOOC / Online/ Elective - **I**	3	-	-	-
	Any one of the following electives (Elective-II):		3	35	5	5
6.	MAI115	Cyber Security				
	MAI116	Recommender Systems				
	MAI117	Intelligent Systems				
	MAI118	Web Analytics				
	MAI119	Health Care Data Analytics				
7.	MAI125	System Building Labs -I: (Based on MAI 102,103,104 carrying 1 credit for each)	3	-	90	-
Total			**21**	**175**	**115**	**25**

S. No	Course Code	Title of the Course	Credits	Contact Hours		
				L	T/L	P/S
Semester – II						
1.	MAI201	Artificial Neural Networks	3	35	5	5
2.	MAI202	Big Data Analytics	3	35	5	5
3.	MAI203	Natural Language Processing	3	35	5	5
4.	MAI204	Machine Learning	3	35	5	5
5.	MAI205	MOOC / Online/ Elective **III**	3	-	-	-
	Any one of the following electives: **(Elective-IV)**		3	35	5	5
6.	MAI215	Blockchain & Cryptocurrency Fundamentals				

	MAI216	Fuzzy Logic and Fuzzy Sets				
	MAI217	Social Networking and Mining				
	MAI218	Data Preparation and Analysis				
	MAI219	Digital Forensics				
7.	MAI225	System Building Labs -II (Based on MAI 201,202,204 carrying 1 credit for each)	3	-	90	-
Total			**21**	**175**	**115**	**25**

S. No	Course Code	Title of the Course	Credits	Contact Hours		
				L	T/L	P/S
Semester – III						
1.	MAI301	Introduction to Deep Learning	3	35	5	5
2.	MAI302	Scalable Systems for Data Science	3	35	5	5
3.	MAI303	Research Methodology & IPR	3	35	5	5
4.	MAI304	MOOC / Online/ Elective -**V**	4	-	-	-
	Elective- VI		3	35	5	5
5.	MAI315	Genetic Algorithms and Applications				
	MAI316	Digital Image Processing				
	MAI317	Theory of Computation				
	MAI318	Free Open-Source Software (Foss)				
6.	MAI325	System Building Labs-III (Based on MAI 301,302 carrying 1 credit for each)	2	-	60	-
Total			**18**	**140**	**80**	**20**
Semester – IV						
1.	MAI401	Dissertation	12	0	0	0
Total			**12**	**0**	**0**	**0**

L – Lectures **T/L – Tutorials/Lab** **S/P– Seminar/Presentation**

Note 1: Project Dissertation Phase-I shall be identified and students have to compulsorily make a presentation at the end of III Semester.

Note 2: One more MOOC course can be done by student to score additional credits. Any course that taken by student can be approved by the competent authority of the University.

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M.A. Political Science

Credit Distribution

Semester	Total Credits	Cumulative Credit at the end of the Semester
Semester-I	21	21
Semester-II	21	42
Semester-III	18	60
Semester-IV	12	72

Assessment Pattern: 40% of internal [formative evaluation – two best out of three tests (for a maximum of 15 marks each = 30 marks) and seminar/ assignments/attendance (10 marks)] and 60% (summative evaluation – end of the semester examination)

End Semester Examination

Maximum Marks: 60 Time: 3 Hours

Dissertation / Project Report:

Dissertation Evaluation - 60 Marks

Seminar and Viva-Voce- 40 Marks

SEMESTER-WISE DETAILED SYLLABUS

SEMESTER-I

Course Code : **MAI101** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Mathematics for Data Science**

Course Objectives:

- To enable the understanding of the mathematical and logical basis to many modern techniques in the technology like Data Science, Artificial Intelligence, Machine Learning and Programming Language Design etc.
- To understand important characteristics of Matrices, Eigen values, Eigen vectors and vector spaces etc.
- To learn how to analyze and solve a linear system of equations.

Learning Outcomes:

After completion of the course student will be able to:

- Understand the basic concepts of sets, vector space, subspace, basis and dimension
- Check linear dependency of vectors and identify Eigen values and Eigen vectors derivative of matrix, which will form the basis for Principal Component Analysis.

Course Outline:

Unit-I

Set Theory: Binary Operations, Functions and Relations, Recurrence relations and Generating Functions, Permutations and Combinations: Pigeon Hole Principle, Probability Theory, Prepositional calculus, Tautology & Contradiction, Boolean Algebra, Idea of Continuity.

Unit-II

Differentiation: Logarithmic differentiation, Partial differentiation, Euler's Theorem for Homogenous Functions, Maxima and Minima. Integration: Double Integration, Range of Order of Integration, Find Ideas; Vectors: dot product, cross product, Divergence and convergence of a vector.

Unit-III

Matrices & Determinants: Matrix, Def., types, Addition, Subtraction, Multiplication of Matrices, Singular and Non-Singular Matrices, Rank of a Matrix, Solution of Simultaneous Equations, Cayle Hamilton Theorem, Eigen Values & Eigen Vectors, Diagonalization of a Matrix, Concept of Positive Definite, Semi Definite.

Unit-IV

Matrix Algebra and Linear Algebra**:** Introduction of groups, rings and Vector Spaces. Linear Independence and Dependence of Vectors, Linear Combination. Basis and Dimension of Vector space, Sub-Space, Intersection, Union of sub Spaces.

Unit-V

Linear Transformation: Matrices as Linear Mapping, Kernel and Image. Statement of Rank Nullity Theorem, Singular and Non- Regular Linear Mappings.

References:

Seymour Lipschutz, Marc Lipson, "*Linear Algebra*", 6th Edition, Schaum Series, 2018.

Seymour Lipschutz, Marc Lipson, H. Patil, "*Discrete Mathematics*", 3rd Edition, Schaum Series, 2017.

Elliott Mendelson, Frank Ayres, "*Calculus*", 6th Edition, Schaum Series, 2012.

Philip N. Klein, "*Coding the Matrix: Linear Algebra Through Applications to Computer Science*", Newtonian Press, 2013.

Sheldon Axler, "*Linear Algebra Done Right*", 3rd Edition, Springer, 2015.

Course Code : **MAI102** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Introduction to Artificial Intelligence**

Course Objectives:

- To learn the differences between optimal reasoning vs human like reasoning.
- To understand basic principles of AI towards problem solving, inference perception, knowledge representation and learning.
- To understand the notions of state space representation, heuristic search, time and space complexities.
- To understand the applications of AI namely Intelligent Agents, Game Play, Expert Systems, Machine Learning and NLP.

Learning Outcomes:

After completion of the course student will be able to:

- Able to demonstrate knowledge of building blocks of AI as presented in terms of Intelligent Agents.
- Attain the capability to represent various real-life problem domains using logic-based techniques and use this to perform inference and planning.

Course Outline:

Unit-I

Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, the nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies

Unit -II

Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First-order logic, forward and Backward Chaining

Unit -III

Learning: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Why Learning Works, Learning in Neural and Belief networks

Unit -IV

Practical Natural Language Processing: Practical applications, Efficient parsing, scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis

Unit -V

Robotics: Introduction, Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools

References:

Stuart Russell, Peter Norvig, "*Artificial Intelligence: A Modern Approach*", 2nd Edition, Pearson Education, 2007.

B. Yagna Narayana, "*Artificial Neural Networks*", PHI, 2005.

E. Rich and K. Knight, "*Artificial Intelligence*", 3rd Edition, TMH, 2017.

Dan W. Patterson, "*Artificial Intelligence and Expert Systems*", PHI, 2015.

Giarrantana, Riley, "*Expert Systems: Principles and Programming*", 4th Edition, Course Technology Inc, 2004.

Ivan Bratka, "*PROLOG Programming for Artificial Intelligence*", Pearson Education, 3rd Edition, 2012.

Course Code : **MAI103** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Advanced Data Structures and Algorithms**

Course Objectives:

- To provide an overview of Data Structures and Algorithms commonly used in Computer Science.
- To solve complex problems by applying appropriate Data Structures and Algorithms.
- To critically analyse the complexity of various algorithms and to select appropriate design strategy to solve real world problems.

Learning Outcomes:

After completion of the course student will be able to:

- Identify and apply appropriate data structures to solve problems and improve their efficiency.
- Analyze and understand the complexity of data structures and associated methods.

Course Outline:

Unit - I

Dictionaries: Definition, Dictionary, Abstract Data Type, Implementation of Dictionaries.

Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

Unit - II

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists.

Unit - III

Trees and Graphs: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees, Graphs terminology, Graph ADT, representations, graph traversals/search methods DFS and BFS, Applications of Graphs-Minimum cost spanning tree using Kruskal's algorithm, Dijkstra's algorithm for Single Source Shortest Path Problem.

Unit - IV

Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer- Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Trees, Compressed Trees, Suffix Trees, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem

Unit - V

Computational Geometry: One Dimensional Range Searching, Two-Dimensional Range Searching, constructing a Priority, Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees. Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem

References:

Mark Allen Weiss, "*Data Structures and Algorithm Analysis in C++",* 2nd Edition, Pearson, 2004.

M T Goodrich, Roberto Tamassia, "*Data Structures and Algorithms in Java*", 6th Edition, Wiley, 2014.

Sartaj Sahni, "*Data Structures, Algorithms and Applications in Java*", 2nd Edition, Universities Press, 2005.

M T Goodrich, Roberto Tamassia, "*Algorithm Design*", John Wiley, 2002.

Course Code : **MAI104** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Foundations of Data Science**

Course Objectives:

- To obtain a comprehensive knowledge of various tools and techniques for data transformation and visualization.
- To learn the probability, probabilistic models and prediction models of data science.
- To learn the basic statistics and testing hypothesis for specific problems.

Learning Outcomes:

After completion of the course student will be able to:

- Apply preprocessing techniques to convert raw data to enable further analysis.
- Apply exploratory data analysis and create visualizations to identify patterns.

Course Outline:

Unit-I

Introduction, Causality and Experiments - Data Pre-processing: Knowing data, Data cleaning, Data reduction, Data transformation, Data discretization.

Unit -II

Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of Exploratory Data Analysis (EDA). Exploring Univariate Data - Histograms -Stem-and-Leaf Quantile Based Plots - Continuous Distributions - Quantile Plots - QQ Plot - Box Plots.

Unit-III

Probability Concepts - Axioms of Probability - Conditional Probability and Independence - Bayes Theorem - Expectation - Mean and Variance Skewness Kurtosis; Common Distributions Binomial Poisson Uniform-Normal Exponential Gamma - Chi-Square Weibull Beta.

Unit-IV

Introduction to Statistics- Sampling, Sample Means and Sample variance sample moments, covariance, correlation, Sampling Distributions - Parameter Estimation Bias - Mean Squared Error - Relative Efficiency - Standard Error - Maximum Likelihood Estimation. Empirical Distributions - Sampling from a Population - Empirical Distribution of a Statistic - Testing Hypotheses Error probabilities - Assessing Models-Multiple Categories - Decisions and Uncertainty - Comparing Two Samples -A/B Testing - ANOVA.

Unit-V

Estimation- Percentiles- The Bootstrap - Confidence Intervals- Using Confidence Intervals - The SD and the Normal Curve - The Central Limit Theorem - point and interval estimation, Prediction - Correlation - The Regression Line - The Method of Least Squares - Least Squares Regression - Visual Diagnostics - Numerical Diagnostics - Inference for Regression - A Regression Model - Inference for the True Slope - Prediction Intervals - simple and multiple regression.

References:

Adi Adhikari and John De Nero, "*Computational and Inferential Thinking: The Foundations of Data Science*", 1st edition, 2019.

Jiawei Han, Micheline Kamber, Jian Pei, "*Data Mining Concepts and Techniques*", 3rd Edition, Elsevier, 2006.

Wendy L. Martinez, Angel R. Martinez, "*Computational Statistics Handbook with MATLAB*", 2nd Edition, Chapman Hall/CRC, 2008.

Douglas C. Montgomery, George C. Runger, "*Applied Statistics and Probability for Engineers*", 6th Edition, Wiley,2013.

Dr. J. Ravichandran, "*Probability and Statistics for Engineers*", 1st Edition, Wiley, 2010.

Course Code : **MAI115** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Cyber Security**

Course Objectives:

- To understand the concept of security, types of attack experienced, encryption and authentication for deal with attacks
- To understand the concepts of Intrusion prevention, detection and firewall and attack detection and prevention.

Learning Outcomes:

After completion of the course student will be able to:

- Have the knowledge of plaintext, cipher text, RSA and other cryptographic algorithm, Key Distribution, Intrusion detection, Attacks and their prevention.

Course Outline:

Unit-I

Critical characteristics of Information - NSTISSC Security Model - Components of information System - SDLC - Information assurance - Security Threats and vulnerabilities - Overview of Security threats - Security Standards.

Unit-II

Classical Cryptography - Symmetric Cryptography- Asymmetric Cryptography - Modern Cryptography - Access Control - DRM - Steganography - Biometrics.

Unit-III

Network Security - Intrusion Prevention, detection and Management - Firewall - Ecommerce Security - Computer Forensics - Security for VPN and Next Generation Networks.

Unit-IV

Host and Application security -Control hijacking, Software architecture and a simple buffer overflow - Common exploitable application bugs, shellcode - Buffer Overflow - Side-channel attacks - Timing attacks, power analysis, cold-boot attacks, defenses - Malware - Viruses and worms, spyware, key loggers, and botnets; defenses auditing, policy - Defending weak applications - Isolation, sandboxing, virtual machines.

Unit-V

Mobile, GSM and Wireless LAN security - Protection measures - Business risk analysis - Information Warfare and Surveillance - Case study on Attack prevention, detection and response.

References:

William Stallings, "*Cryptography and Network Security: Principles and Practice*", 6th Edition, PHI,2014.

Michael E. Whitman and Herbert J Mattord, "*Principles of Information Security*", 6th Edition, Vikas Publishing House, 2017.

Bill Nelson, Amelia Phillips, F. Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 4th Edition, Thomson Course Technology, 2010.

Matt Bishop, "*Computer Security: Art and Science*", 1st Edition, Addison-Wesley Professional, 2015.

Course Code : **MAI116** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Recommender Systems**

Course Objectives:

- To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering.
- To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations.

Learning Outcomes:

After completion of the course student will be able to:

- Design recommendation system for a particular application domain.
- Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity

Course Outline:

Unit-I

Introduction: Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Unit-II

Content-based Filtering: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Unit-III

Collaborative Filtering: User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

Unit-IV

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

Unit-V

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations, Types of Recommender System.

References:

Jannach D., Zanker M., Fel Fering A., "*Recommender Systems: An Introduction*", 1st Edition, Cambridge University Press, 2011.

Charu C. Aggarwal, "*Recommender Systems: The Textbook*", 1st Edition, Springer, (2016).

Ricci F., Rokach L., Shapira D., Kantor B.P., "*Recommender Systems Handbook*", Springer, 2011.

Manouselis N., Drachsler H., Verbert K., Duval E., "*Recommender Systems for Learning*", Springer, 2013.

Course Code : **MAI117** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Intelligent Systems**

Course Objectives:

- To introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach.
- To explore about the essential theory behind methodologies for developing systems that demonstrate intelligent behaviour including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

Learning Outcomes:

After completion of the course student will be able to:

- Demonstrate knowledge of the fundamental principles of intelligent systems and would be able to analyse and compare the relative merits of a variety of AI problem solving techniques.

Course Outline:

Unit-I

Knowledge Representation: Data and knowledge: Data representation and data items in traditional databases, Data representation and data items in relational databases. Rules: Logical operations, Syntax and semantics of rules, Data log rule sets, The dependence graph of data log rule sets, Objects**,** Frames, Semantic nets, Solving problems by reasoning: The structure of the knowledge base, The reasoning algorithm, Conflict resolution, Explanation of the reasoning.

Unit-II

Rule Based Systems**:** Forward reasoning: The method of forward reasoning, A simple case study of forward reasoning. Backward reasoning: Solving problems by reduction, The method of backward reasoning, A simple case study of backward reasoning, Bidirectional reasoning. Search Methods:

Depth-first search, Breadth-first search, Hill climbing search, A* search. Contradiction freeness: The notion of contradiction freeness, Testing contradiction freeness, The search problem of contradiction freeness. Completeness: The notion of completeness, Testing completeness, The search problem of completeness. Decomposition of knowledge bases: Strict decomposition, Heuristic decomposition.

Unit-III

Tools for Representation and Reasoning: The Lisp programming language: The fundamental data types in Lisp, Expressions and their evaluation, Some useful Lisp primitives, Some simple examples in Lisp, The Prolog programming language: The elements of Prolog programs, The execution of Prolog programs, Built-in predicates, and Some simple examples in Prolog. Expert system shells: Components of an expert system shell, Basic functions and services in an expert system shell.

Unit-IV

Real-Time Expert Systems: The architecture of real-time expert systems: The real-time subsystem, The intelligent subsystem Synchronization and communication between real-time and intelligent subsystems: Synchronization and communication primitives, Priority handling and time-out. Data exchange between the real-time and the intelligent subsystems: Loose data exchange, The blackboard architecture. Software engineering of real-time expert systems: The software lifecycle of real time expert systems, Special steps and tool, An Example of A Real-Time expert System.

Unit-V

Qualitative Reasoning and Petri Nets: Sign and interval calculus, Qualitative simulation: Constraint type qualitative differential equations, The solution of QDEs: the qualitative simulation algorithm: Initial data for the simulation, Steps of the simulation algorithm, Simulation results. Qualitative physics, signed directed graph (SDG) models, The Notion of Petri nets, The firing of transitions, Special cases and extensions, The state-space of Petri nets The use of Petri nets for intelligent control, The analysis of Petri nets: Analysis Problems for Petri Nets, Analysis techniques.

References:

Katalin M. Hangos, Rozalia Lakner, Miklos Gerzson, "*Intelligent Control Systems- An Introduction with Examples*", 1st Edition, Kluwer Academic Publishers, 2004.

Laxmidhar Behera, Indrani Kar, "*Intelligent Systems and Control: Principles and Applications*", Oxford University Press,2009.

Teodorescu, Horia-Nicolai, Watada, Junzo, Jain, Lakhmi C., "*Intelligent Systems and Technologies Methods and Applications*", 1st Edition, Springer publications, 2009.

Yung C. Shin and Chengying Xu, "*Intelligent Systems - Modeling, Optimization and Control*", 1st Edition, CRC Press, Taylor & Francis Group, 2009.

Course Code : **MAI118** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Web Analytics**

Course Objectives:

- To know the importance of qualitative data, get insights and techniques.
- To develop customer-centric approach in dealing with data.
- To know the principles, tools and methods of web intelligence.
- To apply analytics for business situations

Learning Outcomes:

After completion of the course student will be able to:

- Know the concepts and terminologies related to web analytics.
- Explore various parameters used for web analytics and their impact.
- Explore the use of tools and techniques of web analytics.
- Get experience on websites, web data insights and conversions.

Course Outline:

Unit-I

Web Analytics - Basics - Traditional Ways - Expectations - Data Collection - Clickstream Data - Weblogs - Beacons - JavaScript Tags - Packet Sniffing - Outcomes data - Competitive data - Search Engine Data.

Unit-II

Qualitative Analysis - Customer Centricity - Site Visits - Surveys - Questionnaires - Website Surveys - Post visits - Creating and Running- Benefits of surveys - Critical components of successful strategy.

Unit-III

Web Analytic concepts - URLS - Cookies - Time on site - Page views - Understand standard reports - Website content quality - Navigation reports

(top pages, top destinations, site overlay). - Search Analytics - Internal search, SEO and PPC - Measuring Email and Multichannel Marketing - Competitive intelligence and Web 2.0 Analytics - Segmentation - Connectable reports.

Unit-IV

Search Engine Analytics: Analytics - Cookies - Accounts vs Property - Tracking Code - Tracking Unique Visitors - Demographics - Page Views & Bounce Rate Acquisitions - Custom Reporting.

Unit-V

Goals & Funnels - Filters - Ecommerce Tracking - Real Time Reports - Customer Data Alert - AdWords Linking - AdSense Linking -Attribution Modelling - Segmentation - Campaign Tracking - Multi-Channel Attribution.

References:

Avinash Kaushik, "*Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity*", 1st Edition, Sybex, 2009.

Michael Beasley, "*Practical Web Analytics for User Experience: How Analytics can help you Understand your Users*", 1st Edition, Morgan Kaufmann, 2013.

Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, "*Game Analytics: Maximizing the Value of Player Data*", 1st Edition, Springer, 2013.

Bing Liu, "*Web Data Mining: Exploring Hyperlinks, Content, and Usage Data*", 2nd Edition, Springer, 2011.

Justin Cutroni, "*Google Analytics*", 1st Edition, O'Reilly, 2010.

Eric Fettman, Shiraz Asif, Feras Alhlou, "*Google Analytics Breakthrough*", John Wiley & sons, 2016.

Course Code : **MAI119** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Health Care Data Analysis**

Course Objectives:

- To explore the various forms of electronic health care information.
- To learn the techniques adopted to analyse health care data.
- To understand the predictive models for clinical data.

Learning Outcomes:

After completion of the course student will be able to:

- Analyse health care data using appropriate analytical techniques.
- Apply analytics for decision making in healthcare services.
- Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.

Course Outline

Unit-I

Introduction: Introduction to Healthcare Data Analytics - Electronic Health Records- Components of EHR - Coding Systems- Benefits of EHR - Barrier to Adopting HER Challenges - Phenotyping Algorithms.

Unit-II

Analysis: Biomedical Image Analysis - Mining of Sensor Data in Healthcare - Biomedical Signal Analysis - Genomic Data Analysis for Personalized Medicine.

Unit-III

Analytics: Natural Language Processing and Data Mining for Clinical Text - Mining the Biomedical - Social Media Analytics for Healthcare.

Unit-IV

Advanced Data Analytics: Advanced Data Analytics for Healthcare - Review of Clinical Prediction Models - Temporal Data Mining for Healthcare Data - Visual Analytics for Healthcare - Predictive Models for Integrating Clinical and Genomic Data - Information Retrieval for Healthcare - Privacy-Preserving Data Publishing Methods in Healthcare.

Unit-V

Applications: Applications and Practical Systems for Healthcare - Data Analytics for Pervasive Health - Fraud Detection in Healthcare - Data Analytics for Pharmaceutical Discoveries - Clinical Decision Support Systems - Computer - Assisted Medical Image Analysis Systems - Mobile Imaging and Analytics for Biomedical Data.

References:

Chandan K. Reddy and Charu C Aggarwal, "*Healthcare data analytics*", 1st Edition, Taylor & Francis, 2015

Hui Yang and Eva K. Lee, "*Healthcare Analytics: From Data to Knowledge to Healthcare Improvement*", 1st Edition, Wiley, 2016.

SEMESTER-II

Course Code : **MAI201** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Artificial Neural Networks (ANN)**

Course Objectives:

- To understand fundamentals of neural networks.
- To understand algorithms and models.
- To design the required and related systems.

Learning Outcomes:

After completion of the course student will be able to:

- Demonstrate ANN structure and activation Functions.
- Define foundations, learning mechanisms and state-space concepts.
- Identify structure and learning of perceptions, Explain Feed forward, multi-layer feed forward networks and Back propagation algorithms

Course Outline:

Unit-I

Introduction: History of Neural Networks, Structure and Functions of Biological And Artificial Neuron, Neural Network Architectures, Characteristics of ANN, Basic Learning Laws and Methods.

Unit-II

SUPERVISED LEARNING: Single Layer Neural Network and architecture, McCulloch-Pitts Neuron Model, Learning Rules, Perceptron Model, Perceptron Convergence Theorem, Delta learning rule, ADALINE, Multi-Layer Neural Network and architecture, MADALINE, Back Propagation learning, Back Propagation Algorithm.

Unit-III

UNSUPERVISED LEARNING-1: Outstar Learning, Kohenen Self Organization Networks, Hamming Network And MAXNET, Learning Vector Quantization, Mexican hat.

Unit-IV

UNSUPERVISED LEARNING-2: Counter Propagation Network -Full Counter Propagation network, Forward Only Counter Propagation Network, Adaptive Resonance Theory (ART) - Architecture, Algorithms.

Unit-V

ASSOCIATIVE MEMORY NETWORKS: Introduction, Auto Associative Memory, Hetero Associative Memory, Bidirectional Associative Memory (BAM) -Theory and Architecture, BAM Training Algorithm, Hopfield Network: Introduction, Architecture of Hopfield Network.

References:

B.Yegnanarayana, "*Artificial Neural Networks*" PHI, 2006.

S.N.Sivanandam, S.N.Deepa, "*Introduction to Neural Networks using MATLAB 6.0*", 2nd Reprint, TATA MCGraw- Hill, 2006.

J .M. Zurada , "*Introduction to Artificial Neural Systems*" -Jaico publishing,1994.

S.Rajasekaran and G.A.Vijayalakshmi Pai, "*Neural Networks, Fuzzy Logic and Genetic Algorithms*", PHI, 2013.

James A Freeman and Davis Skapura, "*Neural Networks Algorithm, Applications and Programming Techniques*", Pearson Education, 2002.

Simon Hakins, "*Neural Networks*", 3rd Edition, Pearson Education, 2009.

Course Code : **MAI202** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Big Data Analytics**

Course Objectives:

- Understand big data for business intelligence and learn business case studies for big data analytics.
- Understand nosql big data management.
- Perform map-reduce analytics using Hadoop and related tools.

Learning Outcomes:

After completion of the course student will be able to:

- Describe big data and use cases from selected business domains.
- Explain NoSQL big data management.
- Perform map-reduce analytics using Hadoop and use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

Course Outline:

Unit-I

Introduction-What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open-source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

Unit-II

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency,

version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.

Unit-III

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures.

Unit-IV

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

Unit-V

Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration. Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

References:

Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "*Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses*", 1st Edition, Wiley, 2013.

P. J. Sadalage, M. Fowler, "*NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*", Addison-Wesley Professional, 2012.

Tom White, "*Hadoop: The Definitive Guide*", 3rd Edition, O'Reilly, 2012.

Course Code : **MAI203** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Natural Language Processing (NLP)**

Course Objectives:

- To acquire basic understanding of linguistic concepts and natural language complexity, variability.
- To acquire basic understanding of machine learning techniques as applied to language.
- To implement N-grams Models.

Learning Outcomes:

After completion of the course student will be able to:

- Able to understand Natural Language Processing.
- Applying Hidden Markov model and Speech Recognition.
- Able to implement probabilistic and language parsing.

Course Outline:

Unit-I

Introduction: Natural Language Processing, hands-on demonstrations. Ambiguity and uncertainty in language. The Turing test. Regular Expressions, Chomsky hierarchy, regular languages, and their limitations. Finite-state automata, Practical regular expressions for finding and counting language phenomena, Exploring a large corpus with regex tools. An introduction to programming in Python- Variables, numbers, strings, arrays, dictionaries, conditionals, iteration. The NLTK (Natural Language Toolkit) String Edit Distance and Alignment Key algorithmic tool: dynamic programming, a simple example, use in optimal alignment of sequences. String edit operations, edit distance, and examples of use in spelling correction, and machine translation.

Unit-II

Context Free Grammars Constituency, CFG definition, use and limitations. Chomsky Normal Form, Top-down parsing, bottom-up parsing, Non-

probabilistic Parsing Efficient CFG parsing with CYK, another dynamic programming algorithms. Early parser. Designing a little grammar, and parsing with it on some test data.

Probability Introduction to probability theory Joint and conditional probability, marginals, independence, Bayes rule, combining evidence. Examples of applications in natural language. Information Theory The "Shannon game"--motivated by language! Entropy, cross entropy, information gain. Its application to some language phenomena.

Unit-III

Language modelling and Naive Bayes Probabilistic language modeling and its applications. Markov models. N-grams. Estimating the probability of a word, and smoothing. Generative models of language. Part of Speech Tagging and Hidden Markov Models, Viterbi Algorithm for Finding Most Likely HMM Path Dynamic programming with Hidden Markov Models, and its use for part-of-speech tagging, Chinese word segmentation, prosody, information extraction, etc.

Unit-IV

Probabilistic Context Free Grammars, Weighted context free grammars, Weighted CYK. Pruning and beam search, Parsing with PCFGs, A tree bank, the probabilistic version of CYK, how do humans parse, Experiments with eye-tracking, Modern parsers, Maximum Entropy Classifiers, The maximum entropy principle and its relation to maximum likelihood, Maximum entropy classifiers and their application to document classification, sentence segmentation, and other language tasks

Unit-V

Maximum Entropy Markov Models & Conditional Random Fields Part-of-speech tagging, noun-phrase segmentation and information extraction models that combine maximum entropy and finite-state machines, State-of-the-art models for NLP, Lexical Semantics Mathematics of Multinomial and Dirichlet distributions, Dirichlet as a smoothing All for multinomial's Information Extraction & Reference Resolution- Various methods, including HMMs.

Models of anaphora resolution. Machine learning methods for co reference.

References:

Jurafsky and Martin, "*Speech and Language Processing*", 2nd Edition, Prentice Hall, 2008.

Manning and Schutze, "*Statistical Natural Language Processing*", MIT Press, 2001.

James Allen, "*Natural Language Understanding*", The Benajmins/Cummings Publishing Company,1998.

Cover, T. M. and J. A. Thomas, "*Elements of Information Theory*", 2nd Edition, Wiley, 2006.

Charniak, E., "*Statistical Language Learning*", The MIT Press,1994.

Jelinek, F, "*Statistical Methods for Speech Recognition*", 4th Edition, The MIT Press,1998.

Course Code : **MAI204** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Machine Learning**

Course Objectives:

- To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IoT nodes.
- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction strategies.

Learning Outcomes:

After completion of the course student will be able to:

- Extract features that can be used for a particular machine learning approach in various IoT applications.
- Compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
- Mathematically analyse various machine learning approaches and paradigms.

Course Outline:

Unit-I

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi- class/Structured Outputs, Ranking

Unit-II

Unsupervised Learning: Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

Unit-III

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit-IV

Sparse Modelling and Estimation, Modelling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Unit-V

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

References:

Kevin Murphy, "*Machine Learning: A Probabilistic Perspective*", MIT Press, 2012.

Trevor Hastie, Robert Tibshirani, Jerome Friedman, "*The Elements of Statistical Learning*", Springer, 2009.

Christopher Bishop, "*Pattern Recognition and Machine Learning*", Springer, 2007.

Course Code : **MAI215** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Blockchain and Cryptocurrency Fundamentals**

Course Objectives:

- To understand Blockchain and its main application cryptocurrency.
- To explore various aspects of Blockchain technology like application in various domains.
- To provide the skills and knowledge necessary to implement private, public block chain and smart contract.

Learning Outcomes:

After completion of this course, student will be able to.

- Understand and explore the working of Blockchain technology.
- Analyze the working of smart contracts.
- Understand how to store and use Bitcoins.

Course Outline:

Unit-I

Blockchain definition: Bitcoin & Blockchain, Blockchain Structure, Basic Operations. Ethereum Blockchain: Smart Contracts, Ethereum Structure, Ethereum Operations.

Unit-II

Integrity of transactions and blocks in blockchain: Algorithms & Techniques: Public-Key Cryptography, Hashing, Transaction Integrity.

Unit-III

Introduction to Crypto and Cryptocurrencies: Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities.

Unit-IV

Mechanics of Bitcoin: components of the Bitcoin protocol, Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network.

Unit-V

How Bitcoin Achieves Decentralization: Centralization vs. Decentralization, Distributed Consensus, Consensus without Identity: The Block Chain, Incentives and Proof of Work.

How to Store and Use Bitcoins: Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

References:

Andreas Antonopoulos (2014), "*Mastering Bitcoin: Unlocking Digital Cryptocurrencies*", O'Reilly, 1st Edition, 2014.

Melanie Swa, "*Blockchain*", 1st Edition, O'Reilly, 2015.

Bob Dill, David Smits, "*Zero to Blockchain - An IBM Redbooks course*".

Course Code : **MAI216** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Fuzzy Logic and Fuzzy Sets**

Course Objectives:

- To understand fuzzy logic basics and operations.
- To understand fuzzy arithmetic and representations and classical logic.

Learning Outcomes:

After completion of the course student will be able to:

- Understand automated methods for fuzzy systems.
- Apply fuzzy logic for engineering problems.

Course Outline:

Unit-I

Fuzzy Set: Introduction, uncertainty, Newtonian mechanics, Probability Theory, organized simplicity, disorganized complexity, trans computational problems.

Unit-II

Crisp Sets: An overview, fuzzy sets: Basic types, basic concepts. Fuzzy sets versus crisp sets, additional properties of alpha-cuts, representations of fuzzy sets.

Unit-III

Operations on Fuzzy sets: Types of operations, fuzzy complements, Fuzzy instructions: t-Norms. Fuzzy Unicons: t-co norms, combination of operations, aggregation operations.

Unit-IV

Fuzzy Logic: Classical logic, logic, reasoning, propositional logic, logic operation's logic formulas, tautology, inference rules, Boolean algebra, properties of Boolean algebra, quantification, predicate logic, multi-valued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges.

Unit-V

Inference from conditional Fuzzy propositions, Inference from conditional and quantified propositions. Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Model, Input space partitioning, Fuzzy modelling.

References:

Li Min Fu," *Neural Networks in Computer Intelligence*", 1st Edition, McGraw-Hill, Inc,1994.

George J Klir/Bo Yuan, "*Fuzzy sets & Fuzzy Logic, Theory & Applications*", 1st Edition, PHI, 2015.

S.R. Jang, C.T. Sun, E. Mizutani. "*Neuro Fuzzy & Soft Computing: A Computational approach to learning & Machine Intelligence*" J Pearson Education, 1996.

Course Code : **MAI217** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Social Networking and Mining**

Course Objectives:

- To understand the components of the social network.
- To model and visualize the social network.
- To mine the users in the social network.
- To understand the evolution of the social network.
- To mine the interest of the user.

Learning Outcomes:

After completion of the course student will be able to:

- Work on the internal components of the social network.
- Model and visualize the social network.
- Mine the behavior of the users in the social network.
- Predict the possible next outcome of the social network.
- Mine the opinion of the user.

Course Outline:

Unit-I

Introduction- Introduction to Web - Limitations of current Web, Development of Semantic Web, Emergence of the Social Web, Statistical Properties of Social Networks, Network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis, Discussion networks, Blogs and online communities, Web-based networks.

Unit-II

Modelling and Visualization- Visualizing Online Social Networks, A Taxonomy of 26 Visualizations, Graph Representation, Centrality, Clustering, Node-Edge

Diagrams, Visualizing Social Networks with Matrix-Based Representations, Node-Link Diagrams, Hybrid Representations, Modelling and aggregating social network data, Random Walks and their Applications, Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

Unit-III

Mining Communities- Aggregating and reasoning with social network data, Advanced Representations, Extracting evolution of Web Community from a Series of Web Archive, Detecting Communities in Social Networks, Evaluating Communities, Core Methods for Community Detection & Mining, Applications of Community Mining Algorithms, Node Classification in Social Networks.

Unit-IV

Text and Opinion Mining- Text Mining in Social Networks, Opinion extraction, Sentiment classification and clustering, Temporal sentiment analysis, Irony detection in opinion mining, Wish analysis, Product review mining, Review Classification, Tracking sentiments towards topics over time.

Unit-V

Tools for Social Network Analysis- UCINET, PAJEK, ETDRAW, StOCNET, Splus, R, NodeXL, SIENA and RSIENA - Real world Social Networks (Facebook- Twitter etc.).

References:

Charu C. Aggarwal, "*Social Network Data Analytics*", Springer, 2011.

Peter Mika, "*Social Networks and the Semantic Web*", 1st Edition, Springer, 2007.

BorkoFurht, "*Handbook of Social Network Technologies and Applications*", 1st Edition, Springer,2010.

GuandongXu, Yanchun Zhang and Lin Li, "*Web Mining and Social Networking - Techniques and Applications*", 1st Edition, Springer, 2011.

Giles, Mark Smith, John Yen, "*Advances in Social Network Mining and Analysis*", Springer, 2010.

Ajith Abraham, Aboul Ella Hassanien, VáclavSnáel, "*Computational Social Network Analysis: Trends, Tools and Research Advances*", Springer, 2009.

Sule Gündüz-Ogüdücü, A. Şima Etaner-Uyar, "*Social Networks: Analysis and Case Studies*", Springer, 2014.

Course Code : **MAI218** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Data Preparation and Analysis**

Course Objective:

- To prepare the data for analysis and develop meaningful data visualization using latest technologies.

Learning Outcomes:

After completion of the course student will be able to:

- Extract the data for performing the Analysis.

Course Outline

Unit-I

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.

Unit-II

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

Unit-III

Exploratory Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation.

Unit-IV

Visualization: Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity.

Unit-V

Visualizations using R or Python.

Reference:

Glenn J. Myatt, "*Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining*", 2nd Edition, John Wiley Publishers, 2014.

Course Code : **MAI219** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Digital Forensics**

Course Objectives:

- To provide an in-depth study of the rapidly changing and fascinating field of computer forensics.
- To combine both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
- To provide Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools.
- To understand E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics.

Learning Outcomes:

After completion of the course student will be able to:

- Understand relevant legislation and codes of ethics., Computer forensics and digital detective and various processes, policies and procedures.
- Understand E-discovery, guidelines and standards, E-evidence, tools and environment, Email and web forensics and network forensics.

Course Outline:

Unit-I

Computer forensics fundamentals**,** Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

Unit-II

Understanding Computing Investigations - Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

Unit-III

Data acquisition - Understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisition tools. Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

Unit-IV

Current computer forensics tools - software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions.

Unit-V

E-Mail investigations - investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

References:

Warren G. Kruse II and Jay G. Heiser, "*Computer Forensics: Incident Response Essentials*", Addison Wesley, 2002.

Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 2nd Edition. Thomson Course Technology, 2006.

John R. Vacca, "*Computer Forensics: Computer Crime Scene Investigation*", 2nd Edition, Charles River Media, 2005.

Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, "*Guide to Computer Forensics and Investigations*", 4th Edition., Thomson Course Technology, 2010.

Anthony T. S. Ho and Shujun Li, "*Handbook of Digital Forensics of Multimedia Data and Devices*", IEEE Press, John Wiley & Sons, 2015.

SEMESTER-III

Course Code : **MAI301** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Introduction to Deep Learning**

Course Objectives:

- To understand the theoretical foundations, algorithms and methodologies of Neural Network.
- To design and develop an application using specific deep learning models.
- To provide the practical knowledge in handling and analysing real world applications.

Learning Outcomes:

After completion of the course student will be able to:

- Recognize the characteristics of deep learning models that are useful to solve real-world problems.
- Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
- Implement different deep learning algorithms.

Course Outline:

Unit-I

Introduction to Deep Learning: Definition, Applications, Neural Networks, Machine Learning vs Deep Learning, Deep Learning Libraries (Tensorflow, Keras, PyTorch), Types (Supervised Learning, Unsupervised Learning, Reinforcement Learning) and their Comparison. Datasets: Numerical Data, Categorical Data, Data Quality, Data Remediation, Data Preprocessing (Dimensionality Reduction, Feature Transformation, Feature Subset Selection).

Unit-II

Neural Networks: Basics, Types, Intuitions, Neurons, Kernels, Biases, Weights, Initialization, Gradient Descent, Heuristics, Training (Holdout Method, K-Fold Cross-Validation Method, Bootstrap Sampling, Lazy vs Eager Learner), Evaluation (Regression, Classification and Clustering), Perceptrons, Derivatives, Computation graph, Vectorization, Broadcasting, Propagation (Forward and Back), Parameters vs Hyperparameters.

Unit-III

Deep Feedforward Network: Feed-forward Networks, Gradient-based Learning, Hidden Units, Architecture Design, Computational Graphs, Back-Propagation, Regularization, Parameter Penalties, Data Augmentation, Multi-task Learning, Bagging, Dropout and Adversarial Training and Optimization.

Unit-IV

Convolution Networks: Convolution Operation, Pooling, Basic Convolution Function, Convolution Algorithm, Unsupervised Features and Neuroscientific for convolution Network.

Sequence Modelling: Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder Decoder Sequence-to-Sequence Architectures, Deep Recurrent Network, Recursive Neural Networks and Echo State networks.

Unit-V

Adversarial Learning: Unifying Variational Autoencoders and Generative Adversarial Networks - Adversarial Autoencoders - Evaluation of Generative Models.

Deep Generative Models: Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Sigmoid Belief Networks, Directed Generative Net, Drawing Samples from Auto -encoders.

References:

Goodfellow L., Bengio Y. and Courville A., "*Deep Learning*", MIT Press, 2016.

Patterson J. and Gibson A., "*Deep Learning: A Practitioner's Approach*", O'Reilly 1st Edition, 2017.

Haykin S., "*Neural Network and Machine Learning*", Prentice Hall Pearson 3rd Edition, 2009.

Geron A., "*Hands-on Machine Learning with Sci-kit and TensorFlow*", O'Reilly Media, 2017.

Course Code : **MAI302** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Scalable Systems for Data Science**

Course Objectives:

- To introduce systems and approaches for large scale data science problems.
- To understand handling large data sets.
- To learn how large-scale machine learning and distributed machine learning approaches work

Learning Outcomes:

After completion of the course student will be able to:

- Understand handling large data sets
- Learn approaches for solving large scale data science problems link analysis and finding similar items
- Understand real-world problems which need scalable systems for large scale data science such as web advertising and recommendation systems
- Learn the basic principles of large-scale machine learning and distributed machine learning
- Implement models using programming languages to solve large scale data science projects

Course Outline:

Unit-I

Overview of Data Mining and map-reduce, Hash Functions - Indexes, Shingling LSH, Mining Data Streams - Finding similar items near-neighbor search, shingling of documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, Link-analysis Page Rank, Link spam, Hubs and authorities.

Unit-II

Frequent Item sets Market based model, A-Priori Algorithm, Handling larger data sets in memory, Limited-pass algorithms.

Unit-III

Clustering Hierarchical clustering, k-means, CURE, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.

Unit-IV

Advertising on the web Matching problem, ad-words problem, Recommendation systems - Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction.

Unit-V

Large-scale machine learning Parallel Implementation of Perceptrons, Parallel implementation of SVM, Dealing with High-Dimensional Euclidean Data in nearest neighbors, Distributed machine learning.

References:

Jure Leskovec, Anand Rajaraman, Jerey David Ullman, "*Mining of Massive Datasets*", Cambridge University Press, 2014.

Jimmy Lin and Chris Dyer, "*Data-Intensive Text Processing with MapReduce*", 1st Edition, Morgan and Claypool Publishers, 2010.

Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "*Advanced Analytics with Spark: Patterns for Learning from Data at Scale*", Oreilly, 2015.

Ankit Jain, "*Mastering Apache Storm: Processing big data streaming in real time*", Packt Publishing, 2017.

Course Code : **MAI303** Core/ Elective : **Core** No. of Credits : **3**	Course Title **Research Methodology and IPR**

Course Objectives:

- To understand the research problem and to know the literature studies, plagiarism and ethics.
- To get the knowledge about technical writing.
- To analyze the nature of intellectual property rights and new developments.

Learning Outcomes:

After completion of the course student will be able to:

- Understand research problem formulation, Analyze research related information and follow research ethics.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Course Outline:

Unit-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit-II

Effective literature studies approach, analysis Plagiarism and Research ethics.

Unit-III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit-IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit-V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

Stuart Melville and Wayne Goddard, "*Research methodology: An Introduction for Science and Engineering Students*", Tata Mc Graw Hill India, 2013.

Ranjit Kumar, "*Research Methodology: A Step by Step Guide for beginners*", 2/e, Prentice Hall of India, 2013.

Halbert, "*Resisting Intellectual Property*", Taylor and Francis Limited, 2007.

Robert P. Merges, Peter S. Menell (2016), Mark A. Lemley, "*Intellectual Property in New Technological Age*", 2016.

T. Ramappa, "*Intellectual Property Rights Under WTO*", S. Chand Publishers, 2008.

Course Code : **MAI315** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Genetic Algorithms and Applications**

Course Objectives:

- To understand the search methods in the genetic algorithms.
- To implement the reproduction concepts.
- To design the techniques of dominance in genetic algorithms.

Learning Outcomes:

After completion of the course student will be able to:

- Understand the fundamental concepts of Genetic algorithms.
- Understand the consequence of applying various genetic operators.
- Analyze GA operators and implement them to solve different types of GA problems.
- Create and understand about the way the GA is used and the domain of application.

Course Outline:

Unit - I

Introduction to Genetic Algorithm - Robustness of Traditional Optimization and Search methods - Goals of optimization-GA versus Traditional methods - Simple GA - GA at work - Similarity templates (Schemata) - Learning the lingo - Mathematical foundations: The fundamental theorem - Schema processing at work. - The 2-armed & k-armed Bandit problem. - The building Block Hypothesis. - Minimal deceptive problem.

Unit - II

GA Operators-Data structures - Reproduction - Roulette-wheel Selection - Boltzman Selection - Tournament Selection - Rank Selection - Steady - State selection - Crossover mutation - A time to reproduce, a time to cross. - Get with

the Main program. - How well does it work. - Mapping objective functions to fitness forum. - Fitness scaling. Coding - A Multi parameter, Mapped, Fixed - point coding - Discretization - constraints.

Unit - III

Applications of GA The rise of GA - GA application of Historical Interaction. - Dejung & Function optimization - Current applications of GA -Advanced operators & techniques in genetic search: Dominance, Diploidy & abeyance - Inversion & other reordering operators. - other mine-operators - Niche & Speciation - Multi objective optimization - Knowledge-Based Techniques. - GA & parallel processes - Real life problem.

Unit - IV

Introduction to Genetics-Based Machine Learning-Genetics - Based Machine learning - Classifier system - Rule & Message system - Apportionment of credit: The bucket brigade - Genetic Algorithm - A simple classifier system in Pascal. - Results using the simple classifier system.

Unit - V

Applications of Genetics - Based Machine Learning - The Rise of GBMC - Development of CS-1, the first classifier system. - Smitch's Poker player. - Other Early GBMC efforts. - Current Applications.

References:

David E. Gold Berg, "*Genetic Algorithms in Search, Optimization & Machine Learning*", Pearson Education, 2001.

S. Rajasekaran, G. A. Vijayalakshmi Pai, "*Neural Networks, Fuzzy Logic and Genetic Algorithms*", PHI (Chapters 8 and 9), 2003.

Kalyanmoy Deb, "*Optimization for Engineering Design, Algorithms and Examples*", PHI, 1995.

Melanie Mitchell, "*An Introduction to Genetic Algorithm*", PHI, 1999.

Michael P. Vosk, "*The Simple Genetic Algorithm Foundation & Theories*"

Course Code : **MAI316** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Digital Image Processing**

Course Objectives:

- To describe and explain basic principles of digital image processing.
- To design and implement algorithms that perform basic image processing (e.g. noise removal and image enhancement).
- To design and implement algorithms for advanced image analysis (e.g. image compression, image segmentation).

Learning Outcomes:

After completion of the course student will be able to:

- Demonstrate the components of image processing, Explain various filtration techniques.
- Apply image compression techniques.
- Discuss the concepts of wavelet transforms and analyze the concept of morphological image processing.

Course Outline:

Unit-I

Digital Image Processing: Definition, Examples of Fields that use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.

Digital Image Fundamentals: Image Sensing, and Acquisition, Image Sampling and Quantization, Basic Relationship between Pixels, Distance Measures, Linear and Non-linear Operations.

Unit-II

Intensity Transformations and Spatial Filtering: Basic Gray Level Transformations, Histogram Processing, Enhancements using Arithmetic/ Logic Operations, Basics of Spatial Filtering, Smoothing, Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Unit-III

Filtering in the Frequency Domain: Fourier Series, Fourier transform of Functions of One Continuous Variable, Discrete Fourier Transform (DFT) of one variable and Its Inverse, 2-D Discrete Fourier Transform and Its inverse, Properties of 2-D DFT, Image Smoothing using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters, Laplacian in Frequency Domain, Homomorphic Filtering, Band reject and Bandpass Filters, Notch Filters, The Fast Fourier Transform in 1-D .

Unit-IV

Image Restoration: Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations. Colour Image Processing: Colour Models, Pseudo colour Image Processing, Basics of Full Colour Image Processing. Colour Transformations, Smoothing and Sharpening. Colour Segmentation.

Unit-V

Wavelets and Multi Resolution Processing**:** The Haar Transform, series expansion, scaling functions, wavelet functions, wavelet transform in 1-D, Inverse Discrete wavelet Transform in 1-D, Fast wavelet Transform in 1-D, Discrete wavelet Transform in 2-D, wavelet Packets.

Image Segmentation: Point Detection, Line Detection and Edge Detection, Edge Linking and Boundary Detection, Basic Global Thresholding, Otsu's Method, Multiple Thresholds, Variable Thresholding, Multivariable Thresholding, Region Growing, Region Splitting and Merging, Use of Motion in Segmentation, Spatial Techniques, Frequency Domain Techniques.

References:

R. C. Gonzalez, R. E. Woods, "*Digital Image Processing*", 4th Edition, PHI, 2018.

A. K. Jain, "*Fundamentals of Digital Image Processing*", PHI, 1988.

Course Code : **MAI317** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Theory of Computation**

Course Objectives:

- To give an overview of the theoretical foundations of computer science from the perspective of formal languages.
- To illustrate finite state machines to solve problems in computing.
- To familiarize Regular grammars, context frees grammar.

Learning Outcomes:

After completion of the course student will be able to:

- Use basic concepts of formal languages of finite automata techniques.
- Design Finite Automata's for different Regular Expressions and Languages.
- Construct context free grammar for various languages.
- Solve various problems of applying normal form techniques, push down automata and Turing Machines.

Course Outline:

Unit-I

Finite Automata: Deterministic finite Automata, Non deterministic finite Automata, Equivalence of NFA and DFA, Finite Automata with Epsilon-moves. 2-Way Finite Automata, Crossing sequences, Moore and Mealy Machine, Application of finite automata i.e. Lexical Analyzers, text editors.

Unit-II

Regular Expression and Languages: Regular expression, Equivalence of finite Automata and Regular expressions, Conversion between regular expressions and finite automata: Application of Regular Expressions: Regular Expression in UNIX, Lexical analysis, Finding pattern in text.

Unit-III

Regular Languages and Regular sets: Pumping lemma for regular sets, Applications of pumping lemma. Minimization of finite Automata.

Context free Grammar and Languages: Context Free Grammars: Derivation Trees, Leftmost and rightmost derivations, Ambiguity. Normal forms for context free grammars.

Unit-IV

Pushdown Automata: Deterministic Push Down Automata; Equivalence of Push Down Automata and Context free grammar.

Unit-V

Turning Machine (TM): One Tape, multitape, The notions of time and space complexity in terms of T.M. Construction of simple problems.

Chomsky Hierarchy of Languages: Recursive and recursively-enumerable languages.

References:

J.E. Hopcroft, R. Motwani and J.D. Ullamn, "*Introduction to Automata Theory, Languages and Computation*", 3rd Edition, Pearson Education Asia, 2007.

Daniel I.A. Cohen, "*Introduction to Computer Theory*", 2nd Edition, Wiley, 1996.

B. M. Moret, "*The Theory of Computation*", 2nd Edition, Pearson Education Asia.

H.R. Lewis and C.H. Papa dimitriou, "*Elements of the theory of Computation*", 2nd Edition, Pearson Education Asia,1998.

Course Code : **MAI318** Core/ Elective : **Elective** No. of Credits : **3**	Course Title **Free Open-Source Software (FOSS)**

Course Objectives:

- To introduce different free and open source software.
- Exposure to the context and operation of free and open source software (FOSS) communities and associated software projects.
- To understand intellectual property rights and licensing for FOSS, GPL etc.

Learning Outcomes:

After completion of the course student will be able to:

- Install and run open source operating systems.
- Gather information about Free and Open Source Software projects from software releases and from sites on the internet.
- Build and modify one or more FOSS packages and contribute software to and interact with FOSS development projects.

Course Outline:

Unit-I

Introduction: FOSS Definition, FOSS philosophy, FOSS development method, FOSS history, FOSS movement, FOSS within businesses, FOSS Hardware Platforms.

Why Foss: Is FOSS free? Direct Cost Savings, benefits of using FOSS Implementation: Getting started in a FOSS project, Source code management for FOSS projects, git Benefits: Security, Reliability/Stability, Open standards and vendor independence, reduced reliance on imports, developing local software capacity, Piracy, IPR, and the WTO, Localization etc.

Unit-II

Shortcomings: Lack of business applications, Interoperability with proprietary systems, Documentation and "polish" etc.

Foss Success Stories: some successful FOSS projects, BIND (DNS Server), Apache (Web Server), Sendmail (Email Server), OpenSSH (Secure Network Administration Tool), Open Office (Office Productivity Suite), Libreoffice (Office Productivity Suite).

Unit-III

Linux: Introduction, Various Architectures, Various Linux Distributions, Linux vs. Windows, Installation, Usage, Basic Administration, File System, Bash, Shell Scripting, ssh, vim, Virtualization, QEMU, Virtual box.

Unit-IV

Intellectual Property Rights and Licensing: Licensing Arrangements for FOSS, GNU General Public License (GPL), BSD-style Licenses, Can FOSS be combined with proprietary software?

Unit-V

Localization and Internationalization: What is localization? What is internationalization? Examples, Methods of localizing GNU/Linux, Unicode standard corrections/enhancements, Font development, Input methods, modify applications to handle local language characteristics, translating application messages, ensuring that changes are accepted by the global FOSS community.

Case Studies: FOSS in Government, FOSS in Education, Linux Kernels.

Reference:

Kenneth Wong, "*FOSS A General Introduction*", UNDP-APDIP.

SEMESTER-IV

Course Code : **MAI401** Core/ Elective : **Elective (Compulsory)** No. of Credits : **3**	Course Title **Dissertation**

Objective:

Implement some of the existing techniques and develop some new algorithm/ tool and produce meaningful research outputs.

Each student will work on a dissertation to apply the knowledge of Artificial Intelligence and Data science for solving a wide variety of real-world problems. Problems may be decided based on literature survey by standard research articles. Significance of proposed problem and the state-of the art to be explored. Relevant tools may be used for demonstrating the results with physical meaning and create necessary research components

Student is required to submit a detailed project report on the selected topic for their project as per the guidelines decided by the department. The project work is to be evaluated through presentations and viva-voce during the semester and final evaluation will be done at the end of the semester as per the guidelines decided by the department from time to time. The candidate shall present/ publish one paper in national/international conference/seminar/journal of repute.

However, candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.