



**Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology,
Baramati
(An Autonomous Institute)**

Board of Studies: Artificial Intelligence and Data Science

**Syllabus: Third Year (B. Tech) Artificial Intelligence and Data Science 2024
Pattern w.e.f 2026-2027
(As per NEP 2020)**

**Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology,
Baramati**


Board of Studies: Artificial Intelligence and Data Science

**Syllabus: Third Year (B. Tech) Artificial Intelligence and Data Science 2024
Pattern w.e.f 2026-2027**


SEMESTER-V																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	AI24301TH	Artificial Neural Networks	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PCC	AI24301PR	Artificial Neural Networks	-	2	-	-	-	-	-	30	-	30	-	1	-	
PCC	AI24302TH	Machine Learning	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PCC	AI24302PR	Machine Learning	-	2	-	-	-	-	-	30	-	30	-	1	-	
PCC	AI24303TH	Artificial Intelligence	2	-	-	10	-	60	-	-	-	70	2	-	-	3
PCC	AI24303PR	Artificial Intelligence	-	2	-	-	-	-	-	30	-	30	-	1	-	
PEC-I	AI24304XTH	Programme Elective Course I	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PEC-I	AI24304XPR	Programme Elective Course I	-	2	-	-	-	-	-	30	-	30	-	1	-	
VSEC	AI24305TH	DevOps and Git	1	-	-	40	-	-	-	-	-	40	1	-	-	2
VSEC	AI24305PR	DevOps and Git	-	2	-	-	-	-	-	30	-	30	-	1	-	
MDM	XXXXXXTH	Multi-Disciplinary Minor	3	-	-	10	30	60	-	-	-	100	3	-	-	4
MDM	XXXXXXPR	Multi-Disciplinary Minor	-	2	-	-	-	-	30	-	-	30	-	1	-	
AC	HS24301	Constitution of India	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total			15	12	-	90	120	300	30	120	30	690	14	6	1	21


List of Electives, Multi-Disciplinary Minor and Open Elective


Code	Elective Programme Course-I	Code	Multi-Disciplinary Minor	Code	Open Elective
AI24304A	Big Data Fundamentals & Applications	ET24052	Drone technology	NA	NA
AI24304B	Introduction to Web Development with AI				
AI24304C	Cybersecurity for Artificial Intelligence				


Mr. P.N. Shendage
Academic Coordinator


Dr. C.S. Kulkarni
Head of Department


Dr. S.M. Bhosale
Dean Academics


Dr. A.H. Kolekar
Controller of Examination


Dr. S.B. Lande
Principal



SEMESTER-VI																
Course Type	Course Code	Course Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
PCC	AI24311TH	Natural Language Processing	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PCC	AI24311PR	Natural Language Processing	-	2	-	-	-	-	-	30	-	30	-	1	-	
PCC	AI24312TH	Agentic AI	2	-	-	10	-	60	-	-	-	70	2	-	-	3
PCC	AI24312PR	Agentic AI	-	2	-	-	-	-	-	30	-	30	-	1	-	
PEC-II	AI24313TH	Programme Elective Course II	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PEC-II	AI24313PR	Programme Elective Course II	-	2	-	-	-	-	-	30	-	30	-	1	-	
PEC-III	AI24314TH	Programme Elective Course III	3	-	-	10	30	60	-	-	-	100	3	-	-	4
PEC-III	AI24314PR	Programme Elective Course III	-	2	-	-	-	-	-	30	-	30	-	1	-	
MDM	XXXXXXTH	Multi-Disciplinary Minor	2	-	-	10	-	60	-	-	-	70	2	-	-	3
MDM	XXXXXXPR	Multi-Disciplinary Minor	-	2	-	-	-	-	30	-	-	30	-	1	-	
OE	OE24XXXTH	Open Elective	3	-	-	10	30	60	-	-	-	100	3	-	-	3
AC	HS24311	Democracy, Election, and Governance	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total			16	10	-	60	120	360	30	120	-	690	16	5	-	21

List of Electives, Multi-Disciplinary Minor and Open Elective

Code	Program Elective-II	Code	Multi-Disciplinary Minor	Code	Open Elective
AI24313A	Advanced Big Data Analytics and Applications	CE24052	Green Building & Smart Cities	OE24003	Design Thinking
AI24313B	AI Powered Web Development				
AI24313C	AI-Driven Business Intelligence				
Code	Program Elective-III				
AI24314A	Federated Learning				
AI24314B	AI-based Innovation and Product Development				
AI24314C	Industrial AI-powered Intelligence(IndusAI)				

P. N. Shendage
Mr. P. N. Shendage
Academic Coordinator

C. S. Kulkarni
Dr. C. S. Kulkarni
Head of Department

S. M. Bhosale
28/03/2026
Dr. S. M. Bhosale
Dean Academics

A. H. Kolekar
Dr. A. H. Kolekar
Controller of Examination



S. B. Lande
Dr. S. B. Lande
Principal

SEMESTER V



**Vidya Pratishthan's
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AI24301- Artificial Neural Networks

Teaching Scheme: Theory: 3 Hours/Week Practical: 2 Hours/Week	Credits 04	Examination Scheme: CAA:10 Marks ISE: 30 Marks ESE: 60 Marks PR: 30 Marks
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Prerequisites: Basic knowledge of computer architecture, Artificial Intelligence and Statistics

- Course Objectives:**
- To provide students with a basic understanding of the fundamentals and applications of artificial neural networks.
 - To identify the learning algorithms and to know the issues of various feed forward and feedback neural networks.
 - To Understand the basic concepts of Associative Learning and pattern classification.
 - To solve real world problems using the concept of Artificial Neural Networks..

Course Outcomes (COs): The students will be able to:
CO1: Understand the basic features of neural systems and be able to build the neural model.
CO2: Perform the training of neural networks using various learning rules.
CO3: Apply the use of an Associative Learning Neural Network.
CO4: Describe the concept of Competitive Neural Networks.
CO5: Implement the concept of Convolutional Neural Networks and its models.
CO6: Use a new tool /tools to solve a wide variety of real-world problems.

Course Contents

Unit I: Introduction to ANN (07 Hours)
Introduction to ANN, History of Neural Network, Structure and working of Biological Neural Network, Neural net architecture, Topology of neural network architecture, Features, Characteristics, Types, Activation functions, Models of neuron-Mc Culloch & Pitts model, Perceptron, Adaline model, Basic learning laws, Applications of neural networks, Comparison of BNN and ANN.

Unit II: Learning Algorithms (07Hours)
Learning and Memory, Learning Algorithms, Numbers of hidden nodes, Error Correction and Gradient Decent Rules, Perceptron Learning Algorithms, Supervised Learning Backpropagation, Multilayered Network Architectures, Back propagation Learning Algorithm, Feed forward and feedback neural networks, example and applications.

Unit III: Associative Learning (07 Hours)
Introduction, Associative Learning, Hopfield network, Error Performance in Hopfield networks, simulated annealing, Boltzmann machine and Boltzmann learning, State transition diagram and false minima problem, stochastic update, simulated annealing. Basic functional units of ANN for pattern recognition tasks: Pattern association, pattern classification and pattern mapping tasks.

Unit IV: Competitive learning Neural Network (07 Hours)
Components of CL network, Pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network. Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Pattern Classification

Unit V: Convolution Neural Network
Building blocks of CNNs, Architectures, convolution / pooling layers, Padding, Strided convolutions, Convolutions over volumes, Soft Max regression, Deep Learning frameworks, Training and testing on different distributions, Bias and Variance with mismatched data distributions, Transfer learning, multitask learning, end-to-end deep learning, Introduction to CNN models: LeNet – 5, AlexNet, VGG – 16, Residual Network

Unit VI: Applications of ANN

Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron – Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation

Text Books:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell, Peter Norvig, 4th Edition, 2020, Pearson Education, Upper Saddle River, NJ, ISBN: 978-0134610993.
2. Introduction to Deep Learning and Neural Networks with Python: A Practical Guide, Ahmed Fawzy Gad, Fatima Ezzahra Jarmouni, 1st Edition, 2020, Elsevier, ISBN: 978-0323909334.
3. Neural Networks and Deep Learning is a technical textbook by computer scientist Charu C. Aggarwal, published in 2018 .

Reference Books:

1. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, 2nd Edition, 2023, Springer Nature, Cham, ISBN: 978-3031296413.
2. Neural Networks and Statistical Learning, Ke-Lin Du and M. N. S. Swamy, 2nd Edition, 2019 (Reprint 2020), Springer, London, ISBN: 978-1447174516.

E-Resources:

- <https://nptel.ac.in/courses/117105084>
- <https://www.coursera.org/projects/predicting-weather-artificial-neural-networks>

List of Assignments

1. Write a Python program to plot a few activation functions that are being used in neural networks.
2. Generate AND/OR function using McCulloch-Pitts neural net by a python program.
3. Write a Python Program using Perceptron Neural Network to recognize even and odd numbers. Given numbers are in ASCII form 0 to 9.
4. With a suitable example demonstrate the perceptron learning law with its decision regions using python. Give the output in graphical form.
5. Write a python Program for Bidirectional Associative Memory with two pairs of vectors.
6. Write a python program to recognize the number 0, 1, 2, 3, 9. A 5 * 3 matrix forms the numbers. For any valid point it is taken as 1 and invalid point it is taken as 0. The net has to be trained to recognize all the numbers and when the test data is given, the network has to recognize the particular numbers.
7. Implement Artificial Neural Network training process in Python by using Forward Propagation, Back Propagation.
8. Create a Neural network architecture from scratch in Python and use it to do multi-class classification on any data.
Parameters to be considered while creating the neural network from scratch are specified as:
 - (1) No of hidden layers : 1 or more
 - (2) No. of neurons in hidden layer: 100
 - (3) Non-linearity in the layer : Relu
 - (4) Use more than 1 neuron in the output layer. Use a suitable threshold valueUse appropriate Optimization algorithm
9. Write a python program to show Back Propagation Network for XOR function with Binary Input and Output.
10. Write a python program to illustrate ART neural network.



AI24302- Machine Learning

Teaching Scheme: Theory: 3 Hours/Week Practical: 2 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks ISE: 30 Marks ESE: 60 Marks PR: 30 Marks
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Prerequisites: Data Science , Python Programming Language.

Course Objectives:

- Describe various learning paradigms and machine learning models.
- Utilize regression techniques to make predictions across different applications.
- Implement classification algorithms to categorize data with suitable labels.
- Employ clustering algorithms to group unlabeled data based on similarities.
- Explore and incorporate advanced ensemble models.
- Explain reinforcement learning concepts and associated algorithms.

Course Outcomes (Cos): The students will be able to learn:

CO1: Describe the various types and applications of machine learning in real-world scenarios.

CO2: Develop ML models for predictive tasks using linear, non-linear, and logistic regression techniques.

CO3: Apply classification techniques to solve binary and multi-class problems.

CO4: Utilize clustering methods to organize and analyze unlabeled data.

CO5: Combine multiple machine learning algorithms through ensemble learning.

CO6: Implement reinforcement learning techniques for diverse applications.

Course Contents

Unit No. I: Introduction to Machine Learning (07 Hours)

Introduction: Machine Learning, Definition of Learning, Life Cycle, ML Vs AI, Classification, Regression, Clustering, Types, Applications. Feature Transformation: Dimensionality Reduction Techniques- PCA and LDA.

Unit No. II: Regression (07 Hours)

Introduction: Regression, Types of Regression: Univariate vs. Multivariate, Linear vs. Nonlinear, Bias-Variance tradeoff, Overfitting, Underfitting. Regression Techniques: Polynomial, Stepwise, Decision Tree, Random Forest , Support Vector, Ridge, Lasso, Evaluation Metrics: Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE),R-squared, Adjusted R squared ,Mean Absolute Percentage Error (MAPE).

Unit No. III: Classification (07 Hours)

Introduction: Importance of classification, Types (Binary and Multiclass), Challenges in balanced vs. imbalanced classification problems. Binary Classification: Linear classification models, Performance metrics – Confusion matrix, Accuracy, Precision, Recall, F-measure, ROC and AUC-ROC and MCC. Multiclass Classification: Classification strategies – one-vs-one, one-vs-all approaches, Classification algorithms: K-Nearest Neighbor (KNN), linear support vector machines (SVM), and Multinomial Naïve Bayes.

Unit No. IV: Clustering (07 Hours)

Introduction: Clustering, Types of Clustering, Hierarchical clustering algorithms and its types, Centroid-based clustering algorithms: K-Means clustering algorithm, Elbow method, The Silhouette method, K-Medoids. Density-based clustering algorithms: DBSCAN algorithm and it's working.

Unit No. V: Ensemble Learning (07 Hours)

Introduction to Ensemble Learning and Its Applications, Types of Ensemble Methods: Bagging, Boosting, Stacking, Voting Ensemble: Max Voting, Averaging, Weighted Average, Advanced Techniques: AdaBoost, Gradient Boosting, XGBoost, Random Forest, Advantages of Ensemble Methods.

Unit No. VI: Reinforcement Learning (07 Hours)

Introduction: Reinforcement Learning, Supervised vs Unsupervised Vs Reinforcement Learning, Types of Reinforcement, Elements of Reinforcement Learning, Real time applications of Reinforcement learning, Markov's Decision Process: Markov property, Markov chain/process, Markov reward process (MRP), Markov decision process (MDP), Return, Policy, Value functions, Introduction of Q-Learning.

Text Books:

1. Ethem Alpaydin., "Introduction to Machine Learning" by The MIT Press ISBN: 978-0262043793, Fourth Edition (April 2020),
2. Peter Flach., "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012.
3. Bishop M., C., "Pattern Recognition and Machine Learning", Springer-Verlag (2011) 2nd Edition.
4. Alpaydin E. "Introduction to Machine Learning", MIT Press (2014) 3rd Edition.

Reference Books:

1. McKinney., "Python for Data Analysis" Second Edition (2017) O'Reilly Media ISBN: 978-1-491- 95766-0.
2. H. Witten, Eibe Frank, Mark A. Hall, and Christopher J. Pal. "Data Mining: Practical Machine Learning Tools and Techniques" The fourth edition was published in 2016.
3. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014.
4. Jiawei Han, Micheline Kamber, and Jian Pei. "Data Mining: Concepts and Techniques" The third edition was published in 2011.

E-Resources:

- Introduction to Machine Learning (IIT kharagpur): <https://nptel.ac.in/courses/106105152>.
- Introduction to Machine Learning: https://onlinecourses.nptel.ac.in/noc23_cs18/preview.

List of Assignments

1. Apply PCA on the Wine dataset to reduce dimensionality and visualize principal components for distinguishing between red and white wine. Dataset Link: <https://media.geeksforgeeks.org/wp-content/uploads/Wine.csv>
2. Develop a Ridge and Lasso regression model to predict the number of bike rentals based on weather conditions and time. Dataset: Bike Sharing Dataset (UCI)
3. Create a multiclass classification model to predict wine quality based on chemical properties. Dataset: Wine Quality Dataset (UCI)
4. Develop a Support Vector Machine (SVM) classification model to predict whether a tumor is malignant or benign based on various features derived from digitized images of fine needle aspirate (FNA) of breast mass. Dataset: Breast Cancer Wisconsin (Diagnostic) Dataset (UCI Machine Learning Repository).
5. Develop a Random Forest classification model to predict the forest cover type based on cartographic variables. Handle missing data and perform feature scaling. Evaluate the model using accuracy, precision, recall, and F1 score. Dataset: Forest Cover Type Dataset (UCI).
6. Use the K-Means clustering algorithm to segment customers based on their purchasing behavior. Apply the Elbow Method to determine the optimal number of clusters that best represent distinct customer segments for targeted marketing strategies. Dataset: UCI Machine Learning Repository - Wholesale Customers Data Set
7. Use K-Medoids clustering to segment wholesale customers based on their annual spending on different product categories. Identify the optimal number of clusters to effectively group customers with similar purchasing behaviours. Dataset: Wholesale Customers Dataset (UCI).
8. Develop a Gradient Boosting regression model to predict wine quality based on physicochemical properties. Handle missing values, perform feature scaling, and evaluate the model using MSE, MAE, RMSE, and R-squared. Dataset: Wine Quality Dataset (UCI).

9. Build an XGBoost classification model to predict loan defaults based on borrower information and loan characteristics. Preprocess the data by handling missing values, encoding categorical variables, and addressing class imbalance. Evaluate the model using AUC-ROC and F1 score. Dataset: Lending Club Loan Data (Kaggle).
10. Solve the Taxi problem using reinforcement learning, where an agent acts as a taxi driver to pick up and drop off passengers efficiently.



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AI24303- Artificial Intelligence

Teaching Scheme:

Theory: 2 Hours/Week

Practical: 2 Hours/Week

Credits

03

Examination Scheme:

CAA:10 Marks

ESE: 60 Marks

OR: 30 Marks

Prerequisites: Programming and Problem Solving, Data Structures and Algorithms

Course Objectives:

- To understand the fundamental concepts of Artificial Intelligence (AI)
- To explore problem-solving techniques, search strategies, knowledge representation, and logical reasoning for intelligent decision-making.
- To achieve goal-oriented AI systems analyze multi-agent environments, adversarial search, and automated planning.
- To study learning algorithms such as supervised, associative, and competitive learning, along with deep learning models.
- To apply AI techniques in solving complex real-world problems.

Course Outcomes (COs): The students will be able to:

CO1: Understand the basics of the theory and practice of Artificial Intelligence as a discipline and about intelligent agents capable of problem formulation.

CO2: Analyze and apply first-order logic for model assessment and inference understanding in AI systems.

CO3: Evaluate and integrate AI ethics and automated planning principles in the design of AI-based applications for responsible and efficient decision-making.

CO4: To understand the applications of AI and machine learning.

Course Contents

Unit I: Introduction to Artificial Intelligence & Intelligent Agents (07 Hours)

Introduction–Definition - Future of Artificial Intelligence, Types of AI, Characteristics of Intelligent Agents–Typical Intelligent Agents – Environment, Environment Types.

Unit II: Problem-Solving and Search Strategies (07Hours)

Problem-Solving by Searching: Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Local Search and Optimization Problems.

Adversarial Search and Games: Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, and Limitations of Game Search Algorithms. Constraint Satisfaction Problems (CSP).

Unit III: Knowledge Representation (07 Hours)

Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Approaches for knowledge Representation, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based Propositional Logic Knowledge representation, Approach & Issues in knowledge representation, Structured representation of knowledge, Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus & First order logic, Inference - Backward chaining, Forward chaining.

Unit IV: Planning, AI Ethics (07 Hours)

Automated Planning: Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning.

AI Ethics & Future of AI: Limits of AI, Ethics of AI, Future of AI, AI Components, AI Architectures

Text Books:

1. Stuart Russell, Peter Norvig, Artificial intelligence: A Modern Approach, Prentice Hall, Fourth edition, 2020
2. Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan-Kaufmann, 1998.
3. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0- 07008770- 5, TMH
4. Artificial Intelligence by Patrick Henry Winston, Addison-Wesley Publishing Company, ISBN 0-201-53377-4

Reference Books:

1. Nilsson Nils J, "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4.
2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4.
3. Dr. Lavika Goel, "Artificial Intelligence: Concepts and Applications", Wiley publication, ISBN: 9788126519934.
4. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1

E-Resources:

1. <https://nptel.ac.in/courses/106/102/106102220>
2. <https://nptel.ac.in/courses/106/105/106105077/>
3. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge63

List of Assignments (Perform any 5)

1. To develop a DFS algorithm for Finding a Path in a Map.
2. To implement the A (A-star) search algorithm to solve the 8-puzzle problem by finding the optimal sequence of moves from the initial state to the goal state.
3. Implement a problem-solving agent using Breadth First Search (BFS).
4. Develop a Python program to solve a CSP-based Sudoku Solver and a Map Coloring Problem using Backtracking Search with heuristics.
5. To apply a local search algorithm to solve a simple optimization problem by iteratively improving the current solution until an optimal or satisfactory solution is reached.
6. To simulate the Wumpus World environment.
7. To implement the Forward Chaining inference method to derive conclusions from a given set of facts and rules in a knowledge base.
8. To demonstrate resolution inference rule. a simple AI system that diagnoses diseases based on symptoms.



Vidya Pratishthan's
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Elective – I AI24304 (A) - Big Data Fundamentals & Applications

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA: 10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Database Management System, Data Science.

Course Objectives:

- Introduce students to fundamental concepts, terminology, and applications of big data.
- Develop an understanding of advanced analytical methods in data science.
- Familiarize students with essential tools such as Hadoop, NoSQL, and map reduce for big data management and analysis.
- Implement industry-standard solutions using big data analytics.
- To analyze the applications of big data across industries and understand its impact on real-world problem-solving.

Course Outcomes (COs): Upon completing the course, students will be able to:

CO1: Implement techniques for handling missing data in real-world applications.

CO2: Utilize modern architectures and platforms for big data, particularly hadoop and map reduce.

CO3: Demonstrate analytical methods such as clustering and association rules in big data analytics.

CO4: Apply various operations on distributed storage.

CO5: Distinguish advanced predictive analytics algorithms across domains like retail, finance, and healthcare.

CO6: Able to analyze and evaluate the role of big data in real-world problem-solving.

Course Contents

Unit I: Introduction to Big Data and Analytics: (07 Hours)

Big Data: Key Characteristics, Evolution, Definition, Challenges, Traditional Business Intelligence Vs. Big Data, Current Practices In Analytics, Roles In Big Data Ecosystems, Big Data Analytics: Introduction, Classification of Analytics, Challenges, Importance Of Analytics.

Unit II: Big Data Platforms (07 Hours)

Overview of Apache Spark, HDFS, YARN, MapReduce, MapReduce Programming Model with Spark, MapReduce Example: Word Count, Page Rank etc., CAP Theorem, Eventual Consistency, Consistency Trade-Off, ACID and BASE, Zookeeper and Paxos, Cassandra, Cassandra Internals, HBase, HBase Internals.

Unit III: Pattern Discovery and Clustering (07 Hours)

Frequent Itemset Mining: Market Basket Model, Apriori Algorithm, Managing Large Datasets in Main Memory, Limited Pass Algorithm for Efficient Processing, Counting Frequent Itemset in Data Streams Clustering Techniques Overview: Hierarchical Clustering, K-Means Clustering, Frequent Pattern-Based Clustering.

Unit IV: Hadoop Distributed File System (07 Hours)

Distributed System Overview, Distributed File System with NFS, Basic HDFS Architecture: NameNode, Secondary NameNode, DataNode, checkpoint Node. Features of HDFS, HDFS Assumption and Goals: Hardware failure, Streaming data access, Large datasets, coherency model. HDFS Read and Write Operations.

Unit V: Advanced Predictive Analytics Algorithms and Python (07 Hour)

Introduction to Exploratory Data Analysis (EDA): Definition, significance, key steps in data exploration, and various data types. Enhancing Classification Accuracy: Overview of ensemble methods, including Machine Learning, AdaBoost, and Random Forest techniques. Model Evaluation and Selection: Understanding the Confusion Matrix, dataset partitioning strategies such as the Holdout Method and Random Subsampling, and

the application of Cross-Validation.

Unit VI: Applications of Big Data (07 Hour)

Introduction To Real-World Use Cases, Key Benefits, And Challenges Case Studies: Healthcare, Finance & Banking, E-Commerce & Marketing, Smart Cities & Iot, Ethical & Future Trends In Big Data Applications.

Text Books:

1. Raj Kamal and Preeti Saxena, “Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning”, McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966.
2. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN13: 978-9332570351.
3. Data Analytics: The Ultimate Beginner's Guide to Data Analytics Paperback – 12 November 2017by Edward Mize.
4. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers, ISBN:9780123814791, 9780123814807.

Reference Books:

1. Professional Hadoop, Benoy Antony et al, July 2016, Wiley.
2. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Michael Minelli et al Wiley, 2013.
3. Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global, 2014.
4. Wajid Khattak, Paul Buhler, Thomas Erl, “Big Data Fundamentals: Concepts, Drivers & Techniques”, John Wiley & Sons, ISBN: 13: 9780134291079.

E-Resources:

- <https://archive.nptel.ac.in/courses/106/104/106104189/>

List of Assignments

1. Setup and Configuration of a Single-Node Hadoop System.
2. Develop a MapReduce Program for Word Frequency Analysis.
3. Implement Matrix Multiplication Using MapReduce.
4. Create a MapReduce Program to Determine Student Grades.
5. Develop and Implement Applications Using Apache Spark.
6. To implement and analyze frequent itemset mining and clustering techniques on a real-world dataset using Python.
7. To perform Exploratory Data Analysis (EDA), enhance classification accuracy using ensemble methods, and evaluate model performance using appropriate validation techniques in Python.
8. Analyze Titanic Disaster Data Using MapReduce.
 - a. Calculate the average age of deceased males.
 - b. Determine the number of deceased females in each class.
9. Hive: Introduction Creation of Database and Table, Hive Partition, Hive Built in Function and
10. Operators, Hive View and Index.
11. Visualization: Connect to data, Build Charts and Analyze Data, Create Dashboard, Create Stories using Tableau/PowerBI.



Vidya Pratishthan's
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Elective – I AI24304 (B) - Introduction to Web Development with AI

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA:10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Basics of JavaScript, Fundamentals of Machine Learning.

Course Objectives:

- To introduce the fundamentals of web development using HTML, CSS, and JavaScript.
- To provide an understanding of integrating AI into web applications for tasks like image classification and NLP.
- To equip students with the skills to build simple AI-based models in the browser using TensorFlow.js.
- To explore the creation and deployment of AI models on the web, including back-end integration.
- To provide hands-on experience with creating basic web applications that use AI for personalization and security.
- To teach the basics of web security, with a focus on integrating AI for fraud and anomaly detection.

Course Outcomes (COs): The students will be able to:

CO1: Recall basic web development concepts and tools used in AI integration.

CO2: Explain the role of AI in front-end and back-end web development.

CO3: Implement AI models in web applications to perform tasks like image classification and text analysis.

CO4: Analyze user behavior to personalize web application features.

CO5: Evaluate security and privacy risks associated with implementing AI in web applications.

CO6: Design and develop a fully functional web application that integrates AI features like personalization and security.

Course Contents

Unit I: Introduction to Web Development and AI Concepts (07 Hours)

Overview of Web Development: HTML, CSS, and JavaScript basics, Introduction to Web APIs and their use in web development. **Basics of machine learning:** Supervised vs. unsupervised learning, Introduction to TensorFlow.js and AI for the browser, Setting up a simple web development environment.

Unit II: Basic Front-end Development with AI Features (07 Hours)

Structure of a web page: HTML tags, attributes, and CSS styles, Introduction to JavaScript and its role in web development, Understanding DOM manipulation using JavaScript, Introduction to AI integration in web development with TensorFlow.js, Building interactive web pages with basic AI features (e.g., text classification, simple image processing), Using TensorFlow.js for image classification in the browser, Basic example of a facial detection model in the browser.

Unit III: Back-end Development for AI-based Web Applications (07 Hours)

Introduction to back-end development: Node.js, Express.js, Working with RESTful APIs and integrating AI models (e.g., using Flask/Django for Python), Introduction to databases: MongoDB basics, building simple AI-based APIs for text analysis or image classification, Hosting AI models on a server.

Introduction to cloud deployment (Heroku, AWS), Integrating AI with backend to serve real-time predictions.

Unit IV: Basic Natural Language Processing (NLP) in Web Apps (07 Hours)

Introduction to Natural Language Processing (NLP) and its applications in web development, building a basic chatbot using Rasa or Dialog Flow, Simple text classification and sentiment analysis. Introduction to Named Entity Recognition (NER) for extracting structured information, Integrating NLP features into web applications (chatbots, sentiment analysis), Using external NLP APIs (e.g., Google NLP API, IBM Watson).

Unit V: AI for User Personalization in Web Applications (07 Hours)

Introduction to recommendation systems (collaborative filtering, content-based filtering), Basics of building a recommendation system using AI, personalizing web pages based on user behavior and interactions, Simple machine learning model for product recommendations in a web application, Integration of user interaction data to improve personalization (user preferences, past behavior), AI-driven search and product recommendation in e-commerce websites.

Unit VI: Web Security and Privacy (07 Hours)

Introduction to web security concerns: Cross-site scripting (XSS), SQL injection, etc., Using AI for security features: anomaly detection, fraud detection in web applications, Building AI models for detecting malicious activity on a website, AI-powered testing frameworks for web applications (automated testing using TensorFlow and Jest), Implementing AI-based CAPTCHA systems for user verification, Ethical and privacy concerns in AI implementation.

Text Books:

1. Subramanian, V. (2019). Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node (2nd ed.). Apress. ISBN: 978-1-4842-4390-9.
2. Kanber, B. (2018). Hands-on Machine Learning with JavaScript: Solve Complex Computational Web Problems Using Machine Learning (1st ed.). Packt Publishing. ISBN: 978-1-78899-824-6.
3. Kaehler, A., & Bradski, G. (2018). Learning OpenCV 4: Computer Vision with Python (1st ed.). O'Reilly Media. ISBN: 978-1-4920-5568-1.

Reference Book:

1. Brown, E. (2019). Web Development with Node and Express: Leveraging the JavaScript Stack (2nd ed.). O'Reilly Media. ISBN: 978-1-4920-5351-9.
2. Bird, S., Klein, E., & Loper, E. (2009). Natural Language Processing with Python. O'Reilly Media. ISBN: 978-0-596-51649-9.
3. Bileschi, S., & Pignataro, R. P. (2020). Learning TensorFlow.js: Machine Learning in JavaScript. O'Reilly Media. ISBN: 978-1-4920-7076-9.
4. Fabbri, M. (2020). Artificial Intelligence for Web Development: Machine Learning and AI Concepts for Web Developers. Independently published. ISBN: 979-8-6500-1234-5.

List of Assignments

1. Develop a static webpage using HTML and CSS to display student details.
2. Develop a basic facial detection system using TensorFlow.js to detect faces in an image.
3. Develop a REST API using Node.js and Express.js to handle user authentication.
4. Develop a login authentication system using Node.js and Express.js.
5. Build a sentiment analysis tool to classify user feedback as positive, negative, or neutral.
6. Build a spam detection system that classifies messages using NLP techniques.
7. Create a web-based text-to-speech converter using NLP libraries.
8. Develop a recommendation system that suggests movies based on user preferences.
9. Implement input validation techniques to prevent SQL injection in a web form.
10. Implement a personalized e-commerce webpage that suggests products based on browsing history.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(An Autonomous Institute)

Elective – I AI24304 (C) - Cybersecurity for Artificial Intelligence

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA: 10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Basic understanding of Artificial Intelligence and Machine Learning.

Course Objectives:

- To introduce the fundamental principles of cybersecurity and their relevance in AI-based systems.
- To explore security vulnerabilities, threats, and attack types specific to AI applications.
- To implement ethical hacking techniques to test AI model security.
- To apply cryptographic methods for protecting AI-based data and models.
- To study privacy-preserving AI techniques and legal compliance frameworks.
- To analyse real-world AI security case studies and develop best practices.

Course Outcomes (COs):

CO 1: Understand the cybersecurity landscape and AI-specific threats.

CO 2: Identify and prevent adversarial attacks on AI models.

CO 3: Apply cryptographic and encryption techniques in AI security.

CO 4: Develop privacy-preserving AI applications.

CO 5: Conduct AI model security testing and ethical hacking.

CO 6: Analyse ethical, legal, and governance challenges in AI security.

Course Contents

Unit I: Introduction to AI Security & Cyber Threats (07 Hours)

Fundamentals of Cybersecurity: CIA Triad (Confidentiality, Integrity, Availability), Cyber Threats in AI: Data Poisoning, Model Evasion, Model Inversion, Backdoor Attacks, Attack Vectors in AI: Adversarial Examples, Model Extraction, Prompt Injection Attacks, Basics of Secure AI Development: Defensive Programming and Risk Mitigation.

Unit II: Adversarial Attacks and Defense in AI (07 Hours)

Adversarial AI and Its Impact, Types of Adversarial Attacks: White-Box, Black-Box, and Grey-Box Attacks
Real-World Case Studies: AI Misuse in Cybersecurity and Social Media, Defense Strategies: Adversarial Training, Noise Injection, Robust AI Models.

Unit III: Cryptography and AI Security (07 Hours)

Basics of Cryptographic Techniques in AI Security ,Symmetric vs Asymmetric Encryption in AI Data Protection ,Secure Model Sharing: Homomorphic Encryption and Federated Learning ,Blockchain for AI Security: Secure Model Training and Verification

Unit IV: Privacy-Preserving AI Techniques (07 Hours)

Differential Privacy and Secure AI Training, Secure Data Sharing and Federated Learning in AI Models, Data Protection Laws: GDPR, CCPA, AI Act, and their Impact, Ethical Considerations: Bias, Fairness, and Transparency in AI System.

Unit V: AI Security Testing and Ethical Hacking (07 Hour)

Ethical Hacking and Penetration Testing for AI Models, Red Team vs Blue Team AI Security Testing, Secure AI Deployment: Access Control, API Security, and Model Integrity, AI in Cyber Threat Detection: AI-Powered IDS and IPS.

Unit VI: Future Trends in AI Security (07 Hours)

AI for Cybersecurity: Threat Intelligence and Attack Detection, Quantum Cryptography and AI Security AI-Generated Deepfakes: Detection and Mitigation Strategies, The Future of AI Cybersecurity: AI-Driven Cyber Defense and Zero-Trust AI.

Text Books:

1. Clarence Chio and David Freeman, “*Machine Learning Security*”, O’Reilly, 2018. ISBN: 9781491979853
2. Mark Stamp, “*Artificial Intelligence for cyber-Security*”, Springer, 2022. ISBN: 9783030970871.
3. Anthony Joseph, “*Adversarial Machine Learning*”, Cambridge University Press, 2019. ISBN: 9781107043466.

Reference Books:

1. Alessandro Parisi, “*Hands-On Artificial Intelligence for Cybersecurity*”, Packt Publishing, 2019. ISBN: 9781789804027.
2. Max Bramer, “*Artificial Intelligence in Cyber Security*”, Springer, 2018. ISBN: 9783319988429.
3. J. Morris, R. Gupta, “*Privacy-Preserving Machine Learning*”, Manning Publications, 2023. ISBN: 9781617298042
4. Hans Delfs, Helmut Knebl, “*Introduction to Cryptography*”, Chapman & Hall/CRC, 2014. ISBN: 9781466570269.
5. Zahid Akhtar, Ajita Rattani, “*Cybersecurity for Intelligent Systems*”, Springer, 2019. ISBN: 9783030075397.

E-Resources:

NPTEL/IBM:

1. NPTEL Course Cyber Security and Privacy: https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2. IBM Cybersecurity Analyst Professional Certificate: <https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst#courses>

List of Assignments

1. Create an image classifier using a traditional machine learning approach Random Forest and analyze how minor modifications (like noise) affect its predictions. (dataset: MNIST (handwritten digits))
2. Train a Decision Tree or Logistic Regression model on basic URL features (e.g., presence of "https", number of subdomains) to classify phishing websites.
3. Use Naïve Bayes or TF-IDF + SVM to classify emails as phishing or legitimate based on word patterns.
4. Build a simple Rule-based Classifier or Random Forest Model to evaluate password strength based on length, special characters, and dictionary words.
5. Develop a machine learning model using Support Vector Machine (SVM) to classify real vs. fake images using a small dataset of real and AI-generated faces.
6. Develop a chatbot using Dialogflow or Rasa with basic encryption techniques (e.g., hashing user inputs).
7. Test a simple AI-based API (like an image classifier) for basic security flaws, such as model prediction leaks.
8. Train a basic Federated Learning model using TensorFlow Federated on small datasets stored on different devices.
9. Building a Basic K-Means Clustering Model to Detect Unusual Network Traffic Patterns patterns using an open-access dataset.
10. Create a simple text-based CAPTCHA and try breaking it using OCR tools (like Tesseract) to understand AI-based attacks.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

AI24305:VSEC - DevOps and Git

Teaching Scheme: Theory: 1 Hour/Week Practical: 2 Hours/Week	Credits 02	Examination Scheme: CAA:40 Marks PR: 30 Marks
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Prerequisites: Basic python programming, Data Science.

Course Objectives:

- To Understand DevOps principles and their relevance to AI & Data Science projects.
- To Learn Git operations for version control, collaboration, and project management.
- To Apply DevOps practices to automate CI/CD pipelines using Jenkins, Docker, and Kubernetes.
- To Utilize collaborative Git workflows, including pull requests, branching, and merging.
- To deploy AI/DS applications and maintain environment consistency.
- To Utilize Kubernetes for orchestration to scale and deploy AI/DS solutions efficiently in production.

Course Outcomes (COs): The students will be able to

CO1: Apply the key concepts of Git and DevOps to demonstrate their importance in development.

CO2: Use Git for version control, branching, merging, and team collaboration in a development environment.

CO3: Set up and implement CI/CD pipelines with Jenkins and GitHub for automated deployment.

CO4: Deploy applications using Docker containers and automate processes with Docker files.

CO5: Implement Kubernetes orchestration to scale and manage models in production.

CO6: Collaborate in teams using Git and CI/CD tools to deploy projects effectively

List of Assignments

1. Set up a Git repository for a data science project and push it to GitHub to manage version control, track changes, and ensure code stability.
2. Create feature branches for the project, merge them, and resolve conflicts to maintain separate workspaces for team collaboration.
3. Fork an open-source AI project, create a feature branch, submit a pull request, and address conflicts during the review process.
4. Research and explain how DevOps principles, like CI/CD, can improve deployment and updates for machine learning projects.
5. Set up Jenkins to trigger automated builds whenever new code is pushed to GitHub for your AI/DS project.
6. Create a Docker container for your AI model and test it on your local machine to ensure consistent performance across environments.
7. Use Docker Compose to manage multiple containers for a web-based AI app, including containers for the AI model, database, and frontend.
8. Set up a local Kubernetes cluster with Minikube to deploy and scale your Dockerized AI application.
9. Implement auto-scaling for your AI app on Kubernetes and monitor its health and performance metrics.
10. Set up a CI/CD pipeline with Jenkins, Docker, and Kubernetes to automate the development-to-deployment process for your AI model.

Text Books:

1. Chacon, Scott, and Ben Straub, "Pro Git", Apress, 2014, ISBN: 978-1484200773.
2. Poulton, Nigel, "Docker Deep Dive", Leanpub, 2023, ISBN: 978-1916585256.

3. Hightower, Kelsey, Brendan Burns, and Joe Beda, "Kubernetes Up & Running", 3rd Edition O'Reilly Media, 2022, ISBN: 9781098110208.

Reference Books:

1. Richard E. Silverman, "A Working Introduction Git Pocket Guide", O'Reilly Media, Inc
2. Ferdinando Santacroce, "Git Essentials" Packt Publishing Ltd.
3. Gene Kim, Patrick Debois, John Willis, and Jez Humble, "The DevOps Handbook" IT Revolution Press, ISBN- 978-1942788003.
4. Jez Humble and David Farley, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", Pearson Education, Inc, ISBN-13: 978-0-321-60191-9
5. John Ferguson Smart, "Jenkins: The Definitive Guide", O'Reilly Media, Inc, ISBN-978-1-449-30535-2
6. Russell Glass and Sean Callahan, "The Big Data-Driven Business", WILEY, ISBN- 978-1118889800

E-Resources:

- Git and GitHub for Beginners (FreeCodeCamp) – <https://www.freecodecamp.org/news/git-and-github-for-beginners/>
- Docker Essentials - Free Course by IBM : <https://cognitiveclass.ai/courses/docker-essentials/>
- Kubernetes for Beginners - FreeCodeCamp – <https://www.freecodecamp.org/news/the-docker-handbook/>
- DevOps Essentials by edX (Free) – <https://www.edx.org/learn/devops>
- Shubham Soni, "CI/CD with Docker, Jenkins, and Kubernetes"- <https://surajsoni3332.medium.com/deployment-of-django-app-using-jenkins-ci-cd-pipeline-2ddf54971f03>

Open Access Datasets for AIDS Projects:

- Kaggle Datasets: <https://www.kaggle.com/datasets>
- UCI Machine Learning Repository: <https://archive.ics.uci.edu/ml/index.php>
- Google Dataset Search: <https://datasetsearch.research.google.com/>
- AWS Public Datasets: [https://registry .opendata.aws](https://registry.opendata.aws)



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(An Autonomous Institute)

Audit Course : HS24301- Constitution of India

Course Objectives:

- Familiarize students with the salient features, structure, and significance of the Constitution, including the principles enshrined in the Preamble.
- Provide an understanding of fundamental rights and duties, their scope, significance, and role in ensuring justice, equality, and freedom in a democratic society
- Explain the concept of Directive Principles of State Policy (DPSP) and their role in governance, emphasizing their interrelationship with Fundamental Rights.
- Analyze emergency provisions and constitutional amendments, discussing their implications on Indian democracy and governance.
- Encourage a comparative understanding of the Indian Constitution with other constitutions worldwide, fostering awareness of global governance models.

Course Outcomes:

CO1: Describe the salient features and basic structure doctrine of the Constitution and Interpret the values enshrined in the Preamble

CO2: Comprehend Fundamental Rights and Duties of Indian Citizens

CO3: Analyze the Role of Directive Principles of State Policy (DPSP) in Governance

Course Contents

Unit I: Introduction to the Constitution of India (05 Hours)

Historical Perspective and Making of the Indian Constitution, Salient Features of the Constitution, Preamble and its Significance, Basic Structure of the Constitution ,Emergency Provisions in the Indian Constitution, Important Amendments to the Constitution.

Unit II: Fundamental Rights and Duties (04 Hours)

Fundamental Rights: Meaning, Scope, and Significance, Right to Equality, Freedom, Protection from Exploitation, Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Fundamental Duties of Indian Citizens.

Unit III: Directive Principles and Governance (04 Hours)

Directive Principles of State Policy: Meaning and Purpose, Relationship between Fundamental Rights and Directive Principles, Role of Directive Principles in Policy Formulation, Comparison with Other Constitutions

Reference Books:

1. M. Laxmikanth, Indian Polity, McGraw Hill Education, 6th Edition, 2020.
2. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 25th Edition, 2021.
3. Subhash Kashyap, Our Constitution: An Introduction to India's Constitution and Constitutional Law, National Book Trust, 2019.
4. J.N. Pandey, The Constitutional Law of India, Central Law Agency, 2020.
5. Bare Act, Constitution of India, Government of India Publications.

Evaluation and Assessment

Since this is an audit course, there is a mandatory internal evaluation which can be based on the following:

- **Assignments & Reports**– Writing about a constitutional provision or case study.
- **Quiz/MCQs** – To test basic understanding of the Constitution.
- **Group Discussion/Presentation** – On relevant topics like Fundamental Rights or Constitutional Amendments.

SEMESTER VI



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

AI24311- Natural Language Processing

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA:10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Discrete Mathematics, Data Structures and Algorithms, Artificial Intelligence

Course Objectives:

- To understand the basic concepts of Natural Language Processing.
- To understand use of morphological aspect in NLP.
- To learn and understand word level analysis in NLP.
- To learn and implement syntax parsing techniques.
- To learn and implement semantics parsing techniques.
- To learn and implement Machine Learning text analytics.

Course Outcomes (COs): The students will be able to:

CO1: Understand the fundamental concepts in field of NLP.

CO2: Understand morphological aspect and processing in NLP.

CO3: Demonstrate part-of-speech taggers and perform word level analysis.

CO4: Demonstrate the syntax structure and grammar through different techniques.

CO5: Build and Analyze different word embedding techniques.

CO6: Apply and Evaluate Machine translation techniques like classification/clustering.

Course Contents

Unit I: Introduction to NLP (07 Hours)

Introduction: NLP-Definition, Phases of NLP, Challenges of NLP, Applications of NLP, Empirical Laws of language, Zipf's law, Heap's law, Approaches of NLP: Rule based, Data Based, Knowledge Based approaches.

Unit II: Basic Text Processing and Morphology (07 Hours)

Tokenization, Sentence segmentation, Spelling correction, Morphology-morphemes, Types, Inflectional and Derivational morphology, Stemming, lemmatization, Porters algorithm, Minimum edit distance, N-gram Language Modeling- probabilistic language model, Auto completion prediction, Evaluation and perplexity, Smoothing techniques.

Unit III: Word Level Analysis (07 Hours)

Sequence labeling tasks of NLP, POS tagging, POS tag sets, Hidden Markov Model-Introduction, Markov processes, HMM characterization -Likelihood of a sequence (Forward Procedure, Backward Procedure), Best state sequence-Viterbi algorithm, Re-estimation (Baum-Welch: Forward-Backward Algorithm) , Models for sequential tagging – Maximum Entropy (ME), Conditional Random Field(CRF), Long Short Term Memory (LSTM).

Unit IV: Syntax Analysis (07 Hours)

Parsing Natural Language, Tree banks: A data-driven approach to syntax, Representation of syntactic structure: Syntax analysis using Dependency Graph and Phrase Structure Trees(CFG), Models for ambiguity resolution: Probabilistic Context Free Grammar(PCFG), Generative models, Discriminative models..

Unit V: Semantics and Text Representation (07 Hours)

Basic ideas in Lexical semantics, Vector semantics, Words and Vector, Semantics with dense vectors, Singular Value Decomposition (SVD) and Latent Semantic Analysis(LSA), TF-IDF, Embedding's

from prediction:- One hot encoding, Word2vec, Skip-gram and CBOW, Glove model, Soft-max, evaluation measures-rough scores, Applications.

Unit VI: Text Analytics (07 Hours)

Chunking: Chunking strategies, Topic models, Text summarization, Text classification, Text categorization Opinion mining. Use Case(any 1): Customer segmentation/Health care/Social media/sales and marketing.

Text Books:

1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing”, Third Edition, Prentice Hall, ISBN: 978-0131873216, 2025
2. Christopher D.Manning and Hinrich Schutze,, “Foundations of Statistical Natural Language Processing”, MIT Press, ISBN-10. 0262133601, 1999
3. Allen James, “Natural Language Understanding”, Second Edition, Benjamin/Cumming, ISBN: 978-0805303346, 1994

Reference Books:

1. Steven Bird,Ewan Klein and Edword Loper,” NLP with Python:Analyzing text with the Natural Language Toolkit”, O’Reilly Media,Inc, ISBN- 0596516495, 2009
2. Nitin Indurkha and Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd ed. CRC press, ISBN 9781498798105, 2010
3. Journals: Computational Linguistics, Natural Language Engineering, Machine Learning, Machine Translation, Artificial Intelligence.
4. Conferences: Annual Meeting of the Association of Computational Linguistics (ACL), Computational Linguistics (COLING), European ACL (EACL), Empirical Methods in NLP (EMNLP), Annual Meeting of the Special Interest Group in Information Retrieval (SIGIR), Human Language Technology (HLT)

E-Resources:

- https://onlinecourses.nptel.ac.in/noc23_cs45/preview
- https://onlinecourses.nptel.ac.in/noc20_cs87/preview

List of Assignments

Guidelines:

- Open source NLP libraries like NLTK, spaCy, TensorFlow/PyTorch etc. Develop strong coding skills, particularly in Python, which is a common language for NLP.
- Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality and sincerity.

1. Text Preprocessing - Implement text preprocessing techniques, including tokenization and normalization, and apply it to any text data.
2. Spell checking and correction: Apply minimum edit distance between two strings for spelling correction.
3. Viterbi Decoding Algorithm for POS: Given a sequence of words, implement the Viterbi algorithm to find the most likely sequence of POS tags by estimating emission and transition probabilities from a tagged corpus.
4. LSTM for Part of Speech tagging: Implement LSTM-based model for Parts of Speech (POS) tagging. Given a sequence of words, train the LSTM network to predict the corresponding POS tags by learning word dependencies and context from a labeled dataset.
5. Co-reference resolution model: Implement a co-reference resolution model to identify and link pronouns or noun phrases to the entities they refer to within a given text.
6. Word sense disambiguation: Implement a Word Sense Disambiguation (WSD) model using WordNet to determine the correct meaning of a word based on its context in a sentence.

7. Word embedding: Implement word embeddings for the English language to analyze word representations and their semantic relationships (Word2Vec/GloVe/fastText).
8. By using multinomial Naive Bayes, RandomForest, Logistic Regression classifiers, perform news classification and analysis to categorize news articles into predefined categories and extract actionable insights. Use AG_news dataset.
9. Implement Agglomerative hierarchical clustering algorithm to predict the quality of wine. Use Wine Quality dataset from UCI Machine Learning repository.
10. Text mining: Implement a text mining model to analyze customer reviews and identify sentiments (positive, negative, neutral) and preferences using techniques like sentiment analysis and keyword extraction.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

AI24312:Agentic AI

Teaching Scheme:

Theory: 2 Hours/Week

Practical: 2 Hours/Week

Credits

03

Examination Scheme:

CAA:10 Marks

ESE: 60 Marks

PR: 30 Marks

Prerequisites: Artificial Intelligence

Course Objectives:

- To introduce the fundamental concepts of Artificial Intelligence, intelligent agents, and their architectures.
- To understand decision-making, search, and planning techniques used in intelligent agent systems.
- To explore Generative Artificial Intelligence, Large Language Models, and modern agent development frameworks.
- To develop simple AI agents using modern tools and APIs and understand the ethical and societal implications of Agentic AI systems.

Course Outcomes (COs): The students will be able to learn:

CO1: Explain the fundamental concepts of Artificial Intelligence, Generative AI, and intelligent agents.

CO2: Analyze different types of agent architectures and apply search and decision-making techniques in intelligent systems.

CO3: Use modern frameworks to develop simple AI agents.

CO4: Evaluate the ethical, societal, and responsible use of Agentic AI systems in real-world applications

Course Contents

Unit I: Foundations of Artificial Intelligence and Intelligent Agents (07 Hours)

Introduction to Agentic Artificial Intelligence and comparison with traditional AI systems. Overview of Generative AI and Large Language Models. Architecture of LLM-based systems. Components of intelligent agents including goal, memory, reasoning, planning, action, and tool usage. Agent loop and autonomous decision cycle. Prompt engineering techniques including zero-shot, few-shot, role prompting, and chain-of-thought reasoning. Re Act pattern and tool calling. System prompts, user prompts, and structured prompts. Prompt safety, prompt injection, and secure prompt design. Development of simple LLM-based agents using APIs.

Unit II: Agent Architectures, Design Patterns and Frameworks (06 Hours)

Principles of autonomous agents including reactivity, proactiveness, planning, and collaboration. Agent architectures and design patterns such as Reflection, Re Act, Planning, Tool-use, and Multi-agent collaboration. Memory systems and context management in agentic applications. Vector embedding and semantic search basics. Introduction to modern agent frameworks including Lang Chain, Lang Graph, and Llama Index. Tool integration, memory integration, and reasoning pipelines. Design of modular and reusable agent workflows.

Unit III: Agentic RAG and Multi-Agent Systems (07 Hours)

Retrieval Augmented Generation and Agentic RAG architecture. Document loaders, embedding, vector databases, and retrievers. Knowledge-enabled agents using external data sources. Planning agents and task decomposition. Multi-agent collaboration and communication. Supervisor-worker and planner-executor models. Introduction to Auto Gen, Crew AI, and collaborative agent frameworks. Designing multi-agent workflows for solving complex tasks.

Unit IV: Agent Orchestration, Deployment and Responsible AI (06 Hours)

End-to-end agent pipelines and orchestration. Integration of agents with APIs, databases, and external tools. Workflow automation using agent pipelines. Event-driven execution, triggers, and web hooks. Error handling, retry mechanisms, and fallback agents. Monitoring, logging, and evaluation of agents. Guardrails, hallucination control, and prompt versioning. Responsible AI principles including transparency, explain ability, privacy, and security. Ethical issues and real-world deployment of autonomous agents.

Text Books:

1. Stuart Russell, Peter Norvig – "*Artificial Intelligence: A Modern Approach*" – Pearson – 4th Edition – ISBN: 978-0134610993
2. David L. Poole, Alan K. Mackworth – "*Artificial Intelligence: Foundations of Computational Agents*" – Cambridge University Press – 2nd Edition – ISBN: 978-1107180657
3. Sebastian Raschka, Vahid Mirjalili – "*Python Machine Learning*" – Packt – 3rd Edition – ISBN: 978-1800567708
4. Aurélien Géron – "*Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*" – O'Reilly – 2nd Edition – ISBN: 978-1492032649

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville – "*Deep Learning*" – MIT Press – 1st Edition – ISBN: 978-0262035613
2. Valentino Zocca, Ram Sriharsha – "*Building LLM Powered Applications*" – O'Reilly – 1st Edition – ISBN: 978-1098106625
3. Joseph Babcock, Raghav Bali – "*Generative AI with Python and PyTorch*" – Packt – 1st Edition – ISBN: 978-1803245174

E-Resources:

1. <https://nptel.ac.in/courses/106106226>
2. <https://nptel.ac.in/courses/106105158>

List of Assignments(Any 08)

1. Develop a simple LLM-based AI agent using Python API to generate responses for user queries.
2. Design prompt engineering examples demonstrating zero-shot, few-shot, and chain-of-thought prompting techniques using an LLM.
3. Develop a Re Act-based AI agent using Lang Chain to solve multi-step reasoning queries.
4. Design and develop an AI agent with conversation memory using Lang Chain memory modules.
5. Develop a Retrieval Augmented Generation (RAG) system using text documents and vector embedding.
6. Design and develop an Agentic RAG system with tool usage and reasoning capability using Lang Chain.
7. Develop an agent workflow using Lang Graph with planner and worker agent.
8. Design and develop a multi-agent collaboration system using Crew AI framework.
9. Develop an API-enabled AI agent that uses external tools such as search, calculator, or weather API
10. Design and implement guardrails and safety checks to control hallucination and unsafe responses in an AI agent.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

Elective – II AI24313 (A) - Advanced Big Data Analytics and Applications

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA: 10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR:30 Marks

Prerequisites: Big Data Fundamentals & Applications

Course Objectives:

- To delve into the advanced methodologies and tools in Big Data Analytics and their applications.
- To provide a deeper understanding of distributed computing, machine learning, and data processing for large-scale datasets.
- To explore advanced algorithms for data mining, clustering, regression, and predictive analytics in the context of Big Data.
- To understand the integration of artificial intelligence techniques with Big Data systems for predictive modeling and real-time data analytics.
- To design and implement scalable data solutions for Big Data storage and processing using distributed frameworks like Apache Spark and Hadoop.
- To analyze industry-specific use cases of Big Data in domains like healthcare, finance, and social media, and explore their impact on decision-making and business strategies.

Course Outcomes (COs): Upon completing the course, students will be able to:

CO1: Design and implement advanced data processing frameworks to handle large datasets effectively.

CO2: Utilize and integrate machine learning algorithms within Big Data platforms for enhanced decision-making.

CO3: Develop custom solutions for data storage, retrieval, and analytics using NoSQL databases and distributed computing tools.

CO4: Evaluate and optimize Big Data applications for specific industry needs.

CO5: Investigate the ethical implications of Big Data applications and propose frameworks for responsible data usage.

CO6: Analyze the impact of Big Data in practical applications and its contribution to driving innovation in data science.

Course Contents

Unit I: Advanced Data Processing Architectures (07 Hours)

Advanced Hadoop Ecosystem: Map Reduce, YARN, and Hadoop 3.x, Apache Flink and Apache Kafka: Real-Time Data Processing, Advanced Spark: RDD, DataFrames, and Spark Streaming, Big Data Management: Distributed File Systems & Storage Mechanisms, Introduction to NoSQL Databases: Cassandra, HBase, MongoDB.

Unit II: Machine Learning & Predictive Analytics (07 Hours)

Supervised and Unsupervised Learning: A Comprehensive Exploration, Advanced Clustering Algorithms for Big Data, Neural Networks and Deep Learning, Predictive Analytics Using Time Series Analysis, Cross-Validation and Hyper Parameter Tuning.

Unit III: Big Data Security and Privacy (07 Hours)

Privacy and Security Challenges in Big Data Systems, Cryptography and Secure Data Transmission in Big Data, Data Anonymization and Masking Techniques, Compliance with Data Protection Regulations (GDPR, CCPA), Ethical Issues in Big Data Analytics.

Unit IV: Scalable Data Storage and Distributed Computing (07 Hours)

Advanced Concepts in Distributed File Systems (DFS), Scalability Techniques in Cloud-Based Storage Systems, Consistency Models in Distributed Databases (CAP Theorem), Data Replication and Fault Tolerance in Big Data Platforms, Big Data Infrastructure Optimization.

Unit V: Big Data Applications in Industry (07 Hour)

Big Data in Healthcare: Predictive Diagnostics and Personalized Medicine, Financial Services: Fraud Detection and Risk Management, Marketing and E-commerce: Customer Segmentation and Personalization, Real-time Analytics for Smart Cities and IoT Applications, Case Studies on the Impact of Big Data in Industry

Unit VI: Future Trends and Innovations in Big Data Analytics (07 Hours)

AI Integration with Big Data, Quantum Computing and Big Data, Advanced Visualization for Big Data Insights, Blockchain and Big Data, Privacy and Ethics in Big Data.

Text Books:

1. Raj Kamal and Preeti Saxena, "Big Data Analytics: Introduction to Hadoop, Spark, and Machine Learning", McGraw-Hill Education, 2018. ISBN: 9789353164966.
2. Benoy Antony, "Professional Hadoop", Wiley, 2016.
3. Michael Minelli et al., "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
4. Jiawei Han, Micheline Kamber, and Jian Pei, "Data Mining: Concepts and Techniques", Elsevier Publishers, 3rd Edition, ISBN: 9780123814791.

Reference Books:

1. Wajid Khattak, Paul Buhler, and Thomas Erl, "Big Data Fundamentals: Concepts, Drivers & Techniques", Wiley, 2015.
2. "Data Science for Business", Foster Provost, Tom Fawcett, O'Reilly Media, 2013.
3. Tom White, "Hadoop: The Definitive Guide", O'Reilly Media, 2015.
4. Tarek S. S. and Mohamed E. S, "Data Science and Big Data Analytics", Wiley, 2016.

E-Resources:

- NPTEL Online Courses on Big Data and Hadoop (<https://archive.nptel.ac.in>)
- Coursera: "Big Data Specialization" by UC San Diego: (<https://www.coursera.org/specializations/big-data>)
- edX: "Big Data Analysis with Scala and Spark" by UC Berkeley :(<https://www.edx.org/course/big-data-analysis-with-scala-and-spark>)
- YouTube: "Data Science and Big Data Analytics" playlist (<https://www.youtube.com>)
- MIT Open Courseware: "Advanced Data Analytics" (<https://ocw.mit.edu>)

List of Assignments

1. Implement a distributed data processing pipeline using Apache Hadoop and Spark.
2. Develop a machine learning model to predict customer churn based on historical data.
3. Create a data security model for encrypting and anonymizing sensitive information in a Big Data system.
4. Implement and test a distributed storage system using HDFS and Apache HBase for large-scale data storage.
5. Create a real-time fraud detection system using streaming data from financial transactions.
6. Develop a predictive analytics solution for personalized healthcare recommendations using patient data.
7. Configure a multi-node Hadoop cluster and process large datasets for a business intelligence solution.
8. Build a recommendation engine for an e-commerce platform using collaborative filtering and clustering algorithms
9. Design a privacy-preserving Big Data system using data masking techniques.
10. Deploy a cloud-based Big Data storage and processing solution using Docker containers.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

Elective – II AI24313 (B) - AI Powered Web Development

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA:10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Foundational knowledge in AI:

Course Objectives:

- To enhance understanding of AI integration in advanced web development techniques.
- To introduce back-end frameworks for deploying AI models in production.
- To provide practical experience in computer vision and NLP for web applications.
- To explore recommendation systems and personalized user experiences using AI.
- To deepen knowledge of web security using AI for fraud and anomaly detection.
- To empower students to create robust AI-driven web applications for real-world use.

Course Outcomes (COs): The students will be able to:

CO1: Recall advanced concepts in JavaScript, AI tools, and frameworks.

CO2: Describe the workings of AI in real-time web applications, including personalization and computer vision.

CO3: Develop AI-powered web applications using TensorFlow.js and other AI frameworks.

CO4: Assess the performance and ethical considerations of AI models integrated into web apps.

CO5: Evaluate the effectiveness of recommendation systems, chat-bots, and AI security features.

CO6: Design and deploy fully functional AI-driven web applications with advanced features.

Course Contents

Unit I: Advanced Web Development with JavaScript and AI (07 Hours)

Introduction to advanced JavaScript concepts (ES6+, async programming, modules). Working with front-end frameworks: React.js basics, Integrating AI in React.js apps with TensorFlow.js, Using TensorFlow.js for real-time predictions in the browser, building dynamic UIs based on AI-driven data, Overview of Single Page Applications (SPAs) and AI integration.

Unit II: Deep Dive into Backend Development for AI (07 Hours)

Setting up Node.js, Express.js for back-end development, Advanced handling of data: Fetch API, Web Sockets for real-time communication, Deploying AI models on a server using Flask or Django, Serving AI models through RESTful APIs, Introduction to cloud services: AWS, Google Cloud for hosting AI models, Authentication and security concerns when integrating AI models.

Unit III: Computer Vision for Web Applications (07 Hours)

Introduction to OpenCV and its use in web development: Implementing object detection and classification in web apps, Real-time image processing in web browsers using TensorFlow.js, Building AI-powered web applications with image and video analysis (e.g., real-time facial recognition), Integrating computer vision features in web applications (image search, object tracking), Hands-on project: Building a simple image classification web app.

Unit IV: Advanced Natural Language Processing in Web Apps (07 Hours)

Understanding deep learning models for NLP (RNN, LSTM, Transformers), Implementing text classification, translation, and summarization in web applications, Advanced chatbot development with machine learning (dialog management, NLP libraries), Integrating real-time speech-to-text and text-to-speech features into web applications, Using pre-trained models for named entity recognition (NER), sentiment analysis, Hands-on project: Building an advanced NLP web app with text processing and chatbot features.

Unit V: Real-time AI based Personalization and Recommendations (7 Hours)

Understanding collaborative filtering and content-based filtering for recommendation systems, Building AI-driven recommendation engines (product, content, movie), Implementing real-time AI features in web applications for personalized user experience, AI-powered predictive models to optimize web search results, Building and testing recommendation engines in real-time applications, Hands-on project: Building an AI-powered recommendation system for e-commerce or social media.

Unit VI: Web Security and Privacy (7 Hours)

Introduction to AI-based security measures for web applications, Detecting and preventing web attacks (XSS, SQL injection) using machine learning, Using AI for fraud detection in online platforms, ensuring privacy in AI-driven applications (data anonymization, GDPR compliance), AI-powered monitoring and anomaly detection in web traffic, Implementing AI-based CAPTCHA and two-factor authentication (2FA) systems.

Text Books:

1. Casciaro, M., & Mammino, L. (2020). Node.js Design Patterns: Design and Implement Production-Grade Node.js Applications Using Proven Patterns and Techniques (3rd ed.). Packt Publishing. ISBN: 978-1839214110.
2. Grinberg, M. (2018). Flask Web Development: Developing Web Applications with Python (2nd ed.). O'Reilly Media. ISBN: 978-1491991732.

Reference Books:

1. Subramanian, V. (2019). Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node (2nd ed.). Apress. ISBN: 978-1484243909.
2. Kanber, B. (2018). Hands-On Machine Learning with JavaScript: Solve Complex Computational Web Problems Using Machine Learning. Packt Publishing. ISBN: 978-1788998246.
3. Kaehler, A., & Bradski, G. (2018). Learning OpenCV 4: Computer Vision with Python. O'Reilly Media. ISBN: 978-1491937990.
4. Bird, S., Klein, E., & Loper, E. (2009). *Natural Language Processing with Python*. O'Reilly Media. ISBN: 978-0596516499.

List of Assignments(Any 10)

1. Develop a React.js app that integrates TensorFlow.js for real-time predictions.
2. Build a Node.js backend to deploy and serve AI models for text classification.
3. Implement a computer vision feature in a web app for object recognition.
4. Create a chatbot with NLP using TensorFlow.js or DialogFlow.
5. Develop a recommendation system with AI for personalized user content.
6. Implement a real-time sentiment analysis feature for user comments.
7. Build a dynamic e-commerce web app with product recommendations powered by AI.
8. Integrate an AI-powered search engine into a web application.
9. Create a web application with speech-to-text and text-to-speech capabilities
10. Implement AI-based web security features (e.g., fraud detection, anomaly detection).
11. Develop an image processing app with real-time AI predictions.
12. Implement a multi-factor authentication system using AI-based security features.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

Elective-II AI24313(C) AI-Driven Business Intelligence

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA: 10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Database Management Systems, Data Visualization Basics, Business and Decision-Making Concepts.

Course Objectives:

- To understand the fundamentals of Business Intelligence (BI) and its significance in decision-making.
- To explore data warehousing, data mining, and OLAP techniques for business applications.
- To apply various BI tools and visualization techniques to analyze business data.
- To study predictive analytics and machine learning models in BI applications.
- To develop BI dashboards and reports using industry-standard tools.
- To study real-world case studies on AI implementation in e-commerce BI.

Course Outcomes: The students will be able to learn:

- CO1:** Explain the fundamentals of Business Intelligence and its applications.
CO2: Design and implement Data Warehousing solutions for business applications.
CO3: Apply Data Mining techniques for pattern extraction and decision-making.
CO4: Use BI tools for reporting and dashboard creation.
CO5: Implement predictive analytics and machine learning techniques in BI.
CO6: Investigate and present a case study on AI-driven BI implementation in e-commerce.

Course Contents

Unit No. I: Introduction to AI-Driven Business Intelligence (07 Hours)

Overview of Business Intelligence, Evolution and Need for BI, BI Applications in Various Industries, Data Sources and Data Integration, Data Sources and AI-Powered Data Integration.

Unit No. II: Data Warehousing, OLAP, and AI Integration (07 Hours)

Introduction to Data Warehousing, OLAP and its Operations with AI Enhancements, Data Marts vs. Data Warehouses, Star Schema and Snowflake Schema, AI in Data Modeling, AI-Driven Data Warehouse for a Retail Business.

Unit No. III: AI-Powered Data Mining for Business Intelligence (07 Hours)

AI-Based Association Rule Mining, Classification, and Clustering, Decision Trees, k-Means, Apriori Algorithm with AI Enhancements, Sentiment Analysis and AI-Driven Text Mining, AI-Powered Customer Relationship Management

Unit No. IV: AI-Driven BI Tools and Visualization (07 Hours)

Introduction to AI-Powered BI Tools, AI in Data Visualization, Smart Dashboards and Automated Reports, AI-Based KPI and Performance Metrics, Case Study: AI-Enhanced BI Visualization for Sales and Marketing.

Unit No. V: Predictive Analytics and AI in Business Intelligence: (07 Hours)

Introduction to AI-Based Predictive Analytics, Regression Analysis and AI-Based Forecasting, Supervised and Unsupervised Learning in BI, AI-Powered Time Series Analysis in BI, Case Study: AI-Driven Customer Churn Prediction.

Unit No. VI: AI Applications in Business Intelligence and Case Studies (07 Hours)

AI in Supply Chain Management, AI-Driven Financial BI and Fraud Detection, Social Media Analytics with AI, Role of AI in Cloud-Based BI Solutions, Ethical Issues in AI-Driven Business Intelligence. Role of AI in Cloud-Based BI Solutions, Ethical Issues in AI-Driven Business Intelligence, Case Study: Implementing AI-Driven BI in E-commerce.

Text Books:

1. R. N. Prasad, Seema Acharya, "Fundamentals of Business Analytics, 2nd Edition, Wiley India, 2016.
2. David Loshin, "Business Intelligence: The Savvy Manager's Guide", 2nd Edition, Morgan Kaufmann, 2012.
3. Data Mining for Business Analytics: Concepts, Techniques, and Applications in Python" (3rd Edition, 2019) by Galit Shmueli, Peter C. Bruce, Peter Gedeck, and Nitin R. Patel.
4. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit", 3rd Edition, Wiley, 2013.

Reference Books:

1. The Business Case for AI: A Leader's Guide to AI Strategies, Best Practices & Real-World Applications" by Kavita Ganesan, 1st Edition, 2022.
2. Augmented Intelligence: Making Better Decisions with Data & AI" by Thomas Rame, 1st Edition, 2023.
3. Access Rules: Freeing Data from Big Tech for a Better Future" by Viktor Mayer-Schönberger and Thomas Rame, 1st Edition, 2022.

List of Assignments:

1. Perform Extract, Transform, and Load (ETL) using Python and SQL on a sample sales dataset. Create a star schema and performing AI-enhanced OLAP operations.
2. Design a star schema for an e-commerce company and implement OLAP queries.
3. Perform sentiment analysis on product reviews using NLP techniques.
4. Develop an AI-powered sales performance dashboard with interactive filters and KPIs.
5. Build a predictive model to forecast future sales trends using regression techniques.
6. Implement a real-time data streaming pipeline using Apache Kafka and AI models.
7. Implement anomaly detection using Auto encoders or Isolation Forest to identify unusual sales patterns.
8. Implement the Apriori algorithm to identify frequent itemsets and generate association rules in retail transactions.
9. Use LSTM/ARIMA models to predict future sales trends based on historical data.
10. Implement collaborative filtering and content-based filtering to recommend products based on user behavior.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

Elective – III AI24314 (A) - Federated Learning

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

Credits
04

Examination Scheme:
CAA:10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Machine Learning, Deep Learning, Probability and Statistics

Course Objectives:

- Understand the fundamentals of Federated Learning (FL) and its necessity in AI & DS.
- Explore FL architectures, algorithms, and privacy-preserving techniques.
- Learn about optimization techniques to improve model training efficiency in Federated Learning.
- Address challenges related to heterogeneous data, personalization, and security in Federated Learning.
- Examine real-world applications and research trends in Federated Learning.
- Identify and discuss future research challenges and advancements in Federated Learning.

Course Outcomes (COs): The students will be able to:

CO1: Describe the principles and applications of Federated Learning.

CO2: Implement FL algorithms and frameworks for distributed AI models.

CO3: Analyze and apply privacy-preserving techniques in Federated Learning.

CO4: Optimize federated learning models for communication efficiency and scalability.

CO5: Solve challenges related to non-IID data and personalization in Federated Learning.

CO6: Identify future research directions and emerging challenges in Federated Learning.

Course Contents

Unit I: Introduction to Federated Learning (07 Hours)

Overview of Distributed Machine Learning, need for FL in AI & DS, Centralized vs. Decentralized Learning Applications of FL (Healthcare, Finance, IoT, Edge AI).

Unit II: Federated Learning Frameworks & Architectures (07 Hours)

FL System Design & Components, Federated Averaging (FedAvg) Algorithm, Client-Server vs. Peer-to-Peer FL, Cross-Silo vs. Cross-Device FL, Open-Source FL Frameworks (TensorFlow Federated, PySyft, Flower).

Unit III: Privacy-Preserving Techniques in FL (07 Hour)

Privacy Concerns in FL, Secure Aggregation Methods, Differential Privacy & Homomorphic Encryption, Secure Multi-Party Computation (MPC), Adversarial Attacks & Defenses in FL.

Unit IV: Optimization & Communication Efficiency in FL (07 Hour)

Optimization Challenges in FL, Model Compression (Quantization, Pruning, Knowledge Distillation), Communication-Efficient FL, Asynchronous vs. Synchronous FL, FL for Low-Power & Edge Devices.

Unit V: Personalization & Heterogeneous Data Handling (07 Hours)

Non-IID Data Challenges, Personalization Strategies in FL, Adaptive FL & Transfer Learning, Case Study: Google's FL in Gboard, Apple's FL for Siri.

Unit VI: FL in Healthcare, IoT, Edge Computing, and Smart Cities (07 Hours)

Federated Reinforcement Learning, Blockchain for Secure FL, Explain ability & Fairness in FL, Ethical & Regulatory Considerations, Future Research Challenges in FL.

Text Books:

1. Federated learning comprehensive overview of methods and applications Springer Nature Switzerland AG; 1st ed. 2022 edition by Heiko Ludwig (Editor), Nathalie Baracaldo.
2. Federated Learning, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and Han Yu - Synthesis Lectures on Artificial Intelligence and Machine Learning 2019.
3. Federated Learning Systems: Towards Next-Generation AI, Marcello Trovati, 2022.

Reference Books:

1. Federated Learning for Healthcare: Principles and Applications, Megha Annavaram, Morgan & Claypool Publishers, 2021.
2. Secure and Trustworthy Federated Learning, Joey Tianyi Zhou, 2022.
3. Federated Learning with Python by Kiyoshi Nakayama PhD, George Jenó, O'Reilly Media, Inc. Pub.

E-Resources:

- <https://research.aimultiple.com/federated-learning>
- <https://towardsdatascience.com>
- <https://www.persistent.com/blogs/privacy-preserving-ai-private-ai-the-rise-of-federated-learning>

List of Assignments

1. Train a classification model using both centralized and federated learning on the same dataset and compare accuracy.
2. Develop a peer-to-peer Federated Learning system where clients communicate without a central server.
3. Train a personalized FL model for predicting disease risk across hospitals with diverse patient data.
4. Simulate an adversarial attack on an FL model and implement defense techniques.
5. Implement an FL model to train a medical image classifier without sharing patient data across hospitals.
6. Implement local fine-tuning techniques to personalize federated models for different clients.
7. Implement an FL-based text classification or sentiment analysis model trained on decentralized data sources (e.g., mobile devices with different users' text data).
8. Develop a federated reinforcement learning (FRL) system for traffic signal optimization in smart cities.
9. Implement FL on IoT devices to predict user energy consumption while ensuring data privacy.
10. Develop an explainable FL model that provides transparent decision-making.



**Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)**

Elective – III AI24314 (B) - AI-based Innovation and Product Development

Teaching Scheme:
Theory: 3 Hours/Week
Practical: 2 Hours/Week

**Credits
04**

Examination Scheme:
CAA:10 Marks
ISE: 30 Marks
ESE: 60 Marks
PR: 30 Marks

Prerequisites: Basics of Artificial Intelligence, Machine Learning, and Software Engineering

Course Objectives:

- To introduce students to the principles of AI-based innovation and its application in product development.
- To develop problem-solving skills using AI methodologies.
- To understand the AI lifecycle and integrate AI into real-world product development.
- To foster creativity in AI-based startups and entrepreneurship.
- To understand ethical considerations, intellectual property rights, and deployment strategies for AI-based innovations.
- To explore AI applications in various industries for problem-solving and business transformation.

Course Outcomes (COs): The students will be able to:

CO1: Develop AI-based solutions for real-world problems.

CO2: Apply AI technologies to create scalable and efficient products.

CO3: Analyze case studies of successful AI-based products.

CO4: Implement AI models in a product development cycle with appropriate tools.

CO5: Evaluate the business impact and feasibility of AI-based products.

CO6: Develop an AI-based prototype that addresses a real-world problem.

Course Contents

Unit I: Introduction to AI-Based Innovation and Product Development (07 Hours)

Fundamentals of Innovation and AI in Product Development, Role of AI in Emerging Technologies (IoT, Blockchain, AR/VR, etc.), AI Innovation Lifecycle: From Idea to Market.

Unit II: AI Product Ideation and Problem Solving (07 Hours)

Ideation Techniques: Brainstorming, Design Thinking, Identifying AI-Driven Opportunities and Market Gaps, Problem-Solution Fit for AI-Based Products, User-Centric AI Design.

Unit III: AI Model Development for Product Integration (07 Hour)

Selection of AI/ML Algorithms for Product Development, Data Collection, Processing, and Annotation, Model Development and Deployment Strategies, Transfer Learning and Model Optimization, Tools: TensorFlow, PyTorch, AutoML, and MLOps.

Unit IV: AI Product Engineering and Prototyping (07 Hour)

System Architecture for AI-Based Products, Integration of AI with Cloud and Edge Computing, APIs and AI Services, Testing and Validation of AI Systems.

Unit V: AI Business Strategies and Entrepreneurship (07 Hours)

System Architecture for AI-Based Products, Integration of AI with Cloud and Edge Computing, APIs and AI Services: OpenAI, Google AI, AWS AI, Azure AI, Testing and Validation of AI Systems.

Unit VI: AI Product Deployment, Scaling, and Regulations (07 Hours)

Deployment Strategies: Cloud, On-Premise, and Edge AI, Performance Monitoring and Continuous Improvement, AI Governance, Compliance, and Regulatory Frameworks, Security, Privacy, and Ethical Challenges in AI Product Development.

Text Books:

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, 4th Edition, 2020.
2. Machine Learning Yearning by Andrew Ng, 1st Edition, 2018.
3. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 1st Edition, 2016.

Reference Books:

1. Artificial Intelligence: A Guide for Thinking Humans by Melanie Mitchell, 1st Edition, 2019.
2. AI Superpowers by Kai-Fu Lee, 1st Edition, 2018.
3. The Hundred-Page Machine Learning Book by Andriy Burkov, 1st Edition, 2019.
4. Data Science for Business by Foster Provost and Tom Fawcett, 1st Edition, 2013.

E-Resources:

1. Coursera – AI for Everyone by Andrew Ng (DeepLearning.AI).
2. Coursera – AI Product Management by Duke University.
3. edX – Artificial Intelligence for Innovation by HarvardX.

List of Assignments(Any 10)

1. Identify a real-world problem in a specific industry (e.g., Agriculture, Healthcare, Finance, Education, or Retail) and propose an AI-driven solution. Outline the problem statement, AI methodology, expected impact, and feasibility of implementation.
2. Implement a basic AI prototype using TensorFlow/PyTorch for an application and Train the model with relevant datasets and evaluate its performance.
3. Develop a sentiment analysis model to analyze customer reviews of products or services.
4. Compare and contrast AI deployment strategies (Cloud AI vs. Edge AI) based on cost, performance, latency, scalability, and security. Conduct a small-scale experiment or case study to support your comparison.
5. Business Model Development for AI Products
6. Create a Business Model Canvas for an AI-based product. Define the value proposition, customer segments, revenue streams, and cost structures. Ethical Challenges in AI
7. Analyze a real-world AI application (e.g., facial recognition, deep fake technology, AI bias in hiring) and discuss the ethical challenges involved. Propose solutions to mitigate risks and ensure responsible AI usage.
8. Develop and test an AI model for a simple yet practical application (e.g., movie recommendation system, AI-based spam detector, sentiment analysis tool). Use appropriate datasets and evaluate accuracy, precision, and recall.
9. Design the architecture of an AI-based product, including cloud and edge integration.
10. Implement AI security measures to protect against adversarial attacks and data breaches.
11. Develop an AI model to analyze social media sentiment trends for financial markets.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(Autonomous Institute)

Elective – III AI24314 (C) - Industrial AI-Powered Intelligence(IndusAI)

Teaching Scheme: Theory: 3 Hours/Week Practical: 2 Hours/Week	Credits 04	Examination Scheme: CAA: 10 Marks ISE: 30 Marks ESE: 60 Marks PR: 30 Marks
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Prerequisites: : Internet of Things , Cloud Computing , Cyber Security.

Course Objectives:

- Gain an in-depth understanding of Industrial IoT (IIoT) systems and their significance in industrial applications.
- Explore the implementation of IIoT systems and their practical deployment.
- Identify the key components essential for building IIoT architecture.
- Examine the role of cloud computing in the context of IIoT.
- Investigate security challenges in IIoT systems and explore potential solutions.
- Analyze diverse IIoT applications and understand real-world use cases that benefit society.

Course Outcomes: The students will be able to learn:

CO1: Comprehend the fundamentals of Industrial IoT (IIoT), including its challenges, benefits, and significance in industrial applications.

CO2: Demonstrate the application of sensors, actuators, and communication protocols in IIoT implementation.

CO3: Explain the essential components required for IIoT architecture.

CO4: Assess the role of cloud computing in IIoT, focusing on data storage, processing, analytics, and Digital Twin technology.

CO5: Understand the critical importance of IIoT security and explore strategies to mitigate security risks.

CO6: Classify various IIoT applications and analyze real-world use cases across different industries.

Course Contents

Unit No. I: Fundamentals of the Industrial Internet of Things (IIoT) (07 Hours)

Introduction, Comparison: IoT and IIoT, Evolution of Industrial Revolutions, Optimizing Manufacturing with IIoT: Efficiency and Automation, Fundamental Requirements and Design Principles for IIoT Deployment, Harnessing IIoT for Plant Maintenance and Predictive Management, Key Opportunities, Challenges, and Advantages of IIoT Integration, Real Applications of IIoT Across Various Industries

Unit No. II: Communication Protocols for IIoT Systems (07 Hours)

Industrial Sensors and Actuators for Process Control, Functions of Sensors and Actuators in IIoT, IIoT Sensor Networks and Connectivity, Process Automation and Data Acquisition in IIoT Systems, Wireless Communication Technologies for IIoT: ZigBee, ZigBee IP, Z-Wave, Wi-Fi Backscatter, NFC, 6LoWPAN, and RPL, IoT Low-Power WAN Technologies: SigFox, nWave, Dash7, Low-Power Wi-Fi, LTE Category-M, and Ingenu RPMA.

Unit No. III: Industrial IoT (IIoT) Framework and Architecture (07 Hours)

Core Components of IIoT: An overview of sensors, gateways, routers, modems, cloud brokers, servers, and wireless sensor networks (WSN), along with their seamless integration. IIoT Architecture: Examination of business models, reference architectures, and the Industrial Internet Architecture Framework (IIAF). Layered Structure of IIoT: Understanding the sensing, processing, communication, and networking layers in IIoT systems.

Unit No. IV: Cloud Computing and Data Analytics for IIoT (07 Hours)

IoT Cloud Ecosystem: Introduction to Cloud of Things (CoT) platforms such as Predix, PTC ThingWorx, and Microsoft Azure, along with cloud-based services and business models like SaaS, PaaS, and IaaS. Data Analytics in IIoT: Exploring the role of data analytics in IIoT and key techniques for data visualization. Digital Twin Technology in IIoT: Understanding the concept, significance, core components, process design, and data requirements of Digital Twins in industrial applications.

Unit No. V: Security Challenges and Solutions in Industrial IoT (IIoT) (07 Hours)

Overview of IIoT Security: Exploring the importance of security in Industrial IoT, its relationship with traditional web technologies, key vulnerabilities, privacy challenges, and essential security requirements, Key Elements of IIoT Security: Covering threat analysis, identity management, access control, message integrity, non-repudiation, and ensuring system availability. IIoT Network Security & Cybersecurity Management: Implementing network protection strategies and best practices for securing industrial environments against cyber threats.

Unit No. VI: Industrial Applications, Use Cases, and Impact on Industry Evolution (07 Hours)

Applications and Use Cases – Smart robotics, smart metering, smart irrigation, smart factories, healthcare services, smart offices, smart logistics, and cyber manufacturing systems. Industrial Evolution – Introduction to Industry 4.0, its definition, significance, key characteristics, design principles, benefits, applications, and an introduction to Industry 5.0 (Society 5.0).

Text Books:

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2017
2. S. Misra, C. Roy, and A. Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press, 2020
3. Veneri, Giacomo, and Antonio Capasso, “Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0”, 1st edition, Packt Publishing Ltd., 2018.

Reference Book:

1. Ulrich Sandler München, Germany, "The Internet of Things Ulrich Sandler Editor Industrie 4.0 Unleashed", Springer Viewg
2. R. Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, “Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance”, Wiley publication.

E-Resources:

- How Protocol Conversion Addresses IIoT Challenges: White Paper ByRed Lion .
https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SECA4005.pdf
- <https://www.ge.com/digital/applications/digital-twin>
- <https://www2.deloitte.com/us/en/insights/focus/industry-4-0/digital-twin-technology-smartfactory.html>
- Introduction to Industry 4.0 and Industrial Internet of Things : https://onlinecourses.nptel.ac.in/noc20_cs69/preview

List of Assignments

1. Utilize wireless communication protocols for device connectivity and data exchange.
2. Write a program to send real-time notifications for monitoring and interacting with industrial environments using Gas sensor (MQ-135).
3. Develop a program for motion detection and automation experiments using PIR sensor,
4. Design a User Interface for Monitoring and Controlling a CPS System – Create a UI for real-time visualization and control of a Cyber-Physical System (CPS). Using temperature sensor, Humidity sensor, Pressure sensor.
5. Write a program to transmit IIoT sensor data to the cloud and store it in a database (Soil Moisture).
6. Develop an IIoT-Based Energy Monitoring and Optimization Application – Implement a program for tracking and improving energy efficiency.
7. Enabled Robotics and Automation Solutions – Write a program to integrate IIoT with robotic systems for industrial automation.
8. Develop a program to implement security protocols and data protection techniques in an IIoT system.
9. Perform Industrial Data Analysis Using IIoT Tools – Write a program to analyze industrial data using machine learning, big data techniques, and visualization tools.
10. Implement IIoT-based fleet tracking using GPS and AI-based route optimization for smart logistics management.



Vidya Pratishthan's
Kamalnayan Bajaj Institute of Engineering and Technology, Baramati
(An Autonomous Institute)

Audit Course : HS24311- Democracy, Election, and Governance

Course Objectives:

- Analyze the structure and role of democratic institutions
- Understand the electoral process and the role of the Election Commission of India,
- Study the framework of governance in India, covering the executive, legislative, and judicial branches at both central and state levels.

Course Outcomes:

CO1: Explain the evolution and significance of democracy in India, its core principles, and its role in nation-building.

CO2: Describe the composition, powers, and functions of the Election Commission of India, and understand the electoral process.

CO3: Interpret the governance structures at the Union and State levels, covering executive, legislative, and judicial functions

Course Contents

Unit I: Democracy in India

Evolution of Democracy, Dimensions of Democracy: Social, Economic and Political, Decentralization: Grassroots Level Democracy, Challenges before Democracy: women and marginalized sections of the society

Unit II: Election

Election Commission of India-composition, powers and functions, and electoral process. Types of emergency grounds, procedure, duration, and effects. Amendment of the constitution- meaning, procedure, and limitations.

Unit III: Governance

Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature-Parliament and Parliamentary proceedings. Union Judiciary-Supreme Court of India – composition and powers and functions. State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchayat raj system Challenges of caste, gender, class, democracy and ethnicity.

Reference Books:

1. Banerjee-Dube, I. (2014). A history of modern India. Cambridge University Press.
2. Bhargava, R. (2008). Political theory: An introduction. Pearson Education India.
3. Bhargava, R., Vanaik, A. (2010) Understanding Contemporary India: Critical Perspective. New Delhi: Orient Blackswan.
4. Chandhoke. N., Proyadardhi.P, (ed) (2009), 'Contemporary India: Economy, Society, Politics', Pearson India Education Services Pvt. Ltd, ISBN 978-81- 317-1929-9.
5. Chandra, B. (1999). Essays on contemporary India. Har-Anand Publications.
6. Chaterjee, P. (1997). State and Politics in India.
7. Dasgupta. S., (ed) (2011), 'Political Sociology', Dorling Kindersley (India) Pvt. Ltd., Licensees of Pearson Education in south Asia. ISBN: 978-317-6027- 7.
8. Deshpande, S. (2003). Contemporary India: A Sociological View, New Delhi:Viking Publication.
9. Guha, R. (2007). India After Gandhi: The History of the World's Largest. Democracy, HarperCollins Publishers, New York.
10. Guha, R. (2013). Gandhi before India. Penguin UK.
11. Jayal. N.G. (2001). Democracy in India.New Delhi: Oxford University Press.
12. Kohli, A. (1990). Democracy and discontent: India's growing crisis of governability. Cambridge

University Press.

13. Kohli, A., Breman, J., & Hawthorn, G. P. (Eds.). (2001). The success of India's democracy (Vol. 6). Cambridge University Press.
14. Kothari, R. (1989). State against democracy: In search of humane governance. Apex Pr.
15. Kothari, R. (1970). Politics in India. New Delhi: Orient Blackswan.
16. Kothari, R. (1995). Caste in Indian politics. Orient Blackswan.
17. Sarkar, S. (2001). Indian democracy: the historical inheritance. the Success of India's Democracy, 23-46.

Evaluation and Assessment

Since this is an audit course, evaluation will be based on active participation, understanding of concepts, and analytical skills:

1. Assignments & Reports – Writing assignments on topics like electoral reforms, democratic challenges, or constitutional amendments.
2. Quizzes/MCQs – Multiple-choice or short-answer questions covering key topics like the Election Commission, parliamentary proceedings, and governance.
3. Group Discussions/Presentations– Debates on issues like democracy and social justice, governance challenges, and the effectiveness of grassroots-level democracy.