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THE NATIONAL COLLEGE
BASAVANGUDI, BANGALORE-560004
[AUTONOMOUS]
DEPARTMENT OF COMPUTER SCIENCE
ADVANCED ANALYTICS FOR DECISION MAKING

Duration: 30 Hours **Course code: CS-AAD**

Course Description:
This course provides an in-depth exploration of advanced analytical techniques and their applications in decision-making across various domains. Students will gain hands-on experience with cutting-edge tools and methods used to extract insights from data to support strategic decision-making processes. Topics covered include predictive modelling, prescriptive analytics, machine learning algorithms, optimization techniques, and data visualization. Emphasis will be placed on real-world case studies and practical applications to enhance students' analytical skills and decision-making capabilities.

Course Objectives:
1. Understand the principles of advanced analytics and their relevance to decision-making.
2. Gain proficiency in predictive modelling techniques for forecasting future trends and outcomes.
3. Learn prescriptive analytics methods to optimize decision-making processes.
4. Explore various machine learning algorithms and their applications in business and other domains.
5. Develop skills in data visualization for effective communication of analytical insights.

Module 1: **7 Hours**

Introduction to Advanced Analytics: Overview of advanced analytical techniques, Importance of analytics in decision making.
Predictive Modelling: Regression analysis, Time series forecasting, Classification algorithms (e.g., logistic regression, decision trees, etc.).

Module 2: **7 Hours**

Prescriptive Analytics: Optimization models (linear programming, integer programming, etc.), Decision trees and decision analysis, and Simulation modelling.
Machine Learning for Decision Making: Supervised learning techniques (e.g., support vector machines, random forests, etc.), Unsupervised learning techniques (e.g., clustering algorithms), Neural networks and deep learning.

Module 3: **8 Hours**

Data Visualization for Decision Support: Principles of effective data visualization, Tools and techniques for data visualization, Dashboard design and interactive visualization.
Optimization Techniques: Linear programming, Integer programming, Network optimization.

Module 4: **8 Hours**

Case Studies and Applications: Analysing real-world scenarios using advanced analytics techniques and application of advanced analytics in various domains (e.g., finance, healthcare, marketing, etc.).

Recommended Textbooks:
- "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel
- "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett
- "Python for Data Analysis" by Wes McKinney

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DEPARTMENT OF COMPUTER SCIENCE

Predictive Modelling and Pattern Recognition

Duration: 30 Hours | **Course code: CS-PMP**

Course Description:

This course provides an in-depth examination of predictive modelling techniques and pattern recognition algorithms used in various applications such as finance, marketing, healthcare, and more. Students will learn theoretical foundations as well as practical implementation of algorithms to extract meaningful patterns and insights from data. Emphasis will be placed on hands-on exercises and real-world case studies to reinforce learning and application of predictive modelling and pattern recognition methods.

Course Objectives:

1. Understand the principles and techniques of predictive modelling.
2. Gain proficiency in implementing pattern recognition algorithms.
3. Learn to pre-process and explore data for predictive modelling tasks.
4. Apply various machine learning algorithms for prediction and pattern recognition.
5. Evaluate and interpret the performance of predictive models.
6. Apply predictive modelling and pattern recognition techniques to real-world datasets and problems.
7. Develop critical thinking skills for selecting appropriate modelling techniques for different scenarios.

Module 1: **7 Hours**

Introduction to Predictive Modelling and Pattern Recognition

- Overview of predictive modelling and pattern recognition
- Importance and applications in various domains
- Types of predictive modelling tasks (classification, regression, clustering, etc.)

Data Pre-processing for Predictive Modelling

- Data cleaning and handling missing values
- Feature selection and transformation
- Data scaling and normalization

Module 2: **7 Hours**

Supervised Learning Techniques

- Linear regression
- Logistic regression
- Decision trees and ensemble methods (e.g., Random Forest, Gradient Boosting)

Unsupervised Learning Techniques

- Clustering algorithms (e.g., K-means, hierarchical clustering)
- Dimensionality reduction techniques (e.g., PCA, t-SNE)

Module 3:	**8 Hours**
Neural Networks for Predictive Modelling • Introduction to neural networks • Feedforward neural networks • Deep learning architectures (e.g., CNNs, RNNs) Evaluation of Predictive Models • Performance metrics for classification and regression tasks • Cross-validation techniques • Model selection and hyperparameter tuning	
Module 4:	**8 Hours**
Time Series Analysis and Forecasting • Introduction to time series data • Time series decomposition • Forecasting techniques (e.g., ARIMA, Exponential Smoothing) Pattern Recognition • Introduction to pattern recognition • Feature extraction and selection • Support Vector Machines (SVM) for pattern recognition	
Recommended Textbooks: • "Pattern Recognition and Machine Learning" by Christopher M. Bishop • "Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani • "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron	

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THE NATIONAL COLLEGE
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DEPARTMENT OF COMPUTER SCIENCE

Computational Data Analysis Specialization

Duration: 30 Hours | **Course code: CS-CDA**

Course Description:

The Computational Data Analysis Specialization is designed to provide students with a comprehensive understanding of computational methods and tools for analysing and interpreting large datasets. Through a combination of theoretical instruction and hands-on practical experience, students will develop the skills necessary to extract valuable insights from complex data sources. The specialization covers topics such as data pre-processing, statistical analysis, machine learning, data visualization, and high-performance computing. Students will also have the opportunity to work on real-world projects to apply their knowledge in solving practical data analysis problems.

Course Objectives:

1. Develop proficiency in data pre-processing techniques for cleaning, transforming, and preparing data for analysis.
2. Understand and apply statistical methods for descriptive and inferential analysis of data.
3. Gain practical experience with machine learning algorithms for classification, regression, clustering, and dimensionality reduction.
4. Learn to visualize data effectively to communicate insights and findings.
5. Explore techniques for handling and analysing large-scale datasets using high-performance computing resources.
6. Apply computational data analysis methods to real-world problems in various domains.

Module 1:	**7 Hours**

Introduction to Computational Data Analysis

- Overview of computational methods and tools for data analysis
- Importance and applications of data analysis in various domains
- Introduction to programming languages and libraries for data analysis (e.g., Python, R, NumPy, Pandas)

Data Pre-processing

- Data cleaning and pre-processing techniques
- Handling missing values and outliers
- Feature engineering and selection

Module 2:	**7 Hours**

Statistical Analysis

- Descriptive statistics
- Probability distributions and hypothesis testing
- Correlation and regression analysis

Machine Learning Fundamentals

- Supervised learning algorithms (e.g., linear regression, logistic regression, decision trees, support vector machines)
- Unsupervised learning algorithms (e.g., K-means clustering, hierarchical clustering, principal component analysis)
- Evaluation metrics for machine learning models

Module 3:	**8 Hours**

Advanced Machine Learning Techniques

- Ensemble methods (e.g., random forests, gradient boosting)
- Neural networks and deep learning
- Model selection and hyper parameter tuning

Data Visualization

- Principles of data visualization
- Visualization techniques and tools (e.g., Matplotlib, Seaborn, ggplot2)
- Interactive visualization using libraries like Plotly and D3.js

Module 4:	**8 Hours**

High-Performance Computing for Data Analysis

- Parallel computing and distributed systems
- Introduction to cloud computing platforms (e.g., AWS, Google Cloud, Microsoft Azure)
- Optimization techniques for large-scale data analysis

Real-World Applications and Case Studies

- Analysis of real-world datasets from various domains (e.g., finance, healthcare, social media)
- Case studies highlighting the application of computational data analysis techniques
- Ethical considerations and challenges in data analysis

Recommended Textbooks:

- "Python for Data Analysis" by Wes McKinney
- "Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

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DEPARTMENT OF COMPUTER SCIENCE

ROBOTICS

Duration: 30 Hours | **Course code: CS-RO**

Course Description:

The Robotics course is designed to provide students with a comprehensive understanding of robotics principles, technologies, and applications. Through a combination of theoretical lectures, hands-on projects, and practical exercises, students will learn about robot kinematics, dynamics, control systems, sensors, actuators, and programming techniques. Emphasis will be placed on both theoretical concepts and practical implementation, with the goal of enabling students to design, build, and program robots for various applications.

Course Objectives:

1. Understand the fundamentals of robotics, including robot kinematics and dynamics.
2. Gain proficiency in designing and building robotic systems.
3. Learn about different types of sensors and actuators used in robotics.
4. Develop skills in robot programming and control algorithms.
5. Explore advanced topics in robotics, such as robot perception and localization.
6. Apply robotics principles to solve real-world problems and challenges.

Module 1: **7 Hours**

Introduction to Robotics

- History and evolution of robotics
- Applications of robotics in various industries
- Overview of robotic systems and components

Robot Kinematics

- Forward and inverse kinematics
- Denavit- Hartenberg parameters
- Robot manipulator architectures

Module 2: **7 Hours**

Robot Dynamics

- Newton-Euler equations of motion
- Lagrange-Euler equations
- Dynamic modelling of robotic systems

Robot Control Systems

- Feedback control principles
- PID control
- Model-based and model-free control techniques

Module 3: **8 Hours**

Sensors and Actuators in Robotics

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- Types of sensors used in robotics (e.g., proximity sensors, vision sensors, IMUs)
- Actuators (e.g., motors, servos, pneumatic actuators)
- Sensor fusion and data integration

Robot Programming

- Programming languages and environments for robotics (e.g., ROS, MATLAB, Python)
- Motion planning algorithms (e.g., A*, RRT, PRM)
- Trajectory generation and control

Module 4:	**8 Hours**

Robot Perception and Localization

- Introduction to robot perception
- Localization techniques (e.g., SLAM, Kalman filtering)
- Object recognition and tracking

Robotic Applications and Case Studies

- Industrial robotics
- Autonomous vehicles and drones
- Medical robotics
- Humanoid robots
- Robotic manipulators for space exploration

Recommended Textbooks:

- "Introduction to Robotics: Mechanics and Control" by John J. Craig
- "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo
- "Robotics: Everything You Need to Know About Robotics from Beginner to Expert" by Peter Mckinnon

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DEPARTMENT OF COMPUTER SCIENCE

MACHINE LEARNING

Duration: 30 Hours | **Course code: CS-ML**

Course Description:

The Machine Learning course offers a comprehensive introduction to the principles, algorithms, and applications of machine learning. Through a combination of theoretical lectures, practical exercises, and hands-on projects, students will gain a solid understanding of various machine learning techniques and their real-world applications. Topics covered include supervised learning, unsupervised learning, reinforcement learning, neural networks, deep learning, and ethical considerations in machine learning.

Course Objectives:

1. Understand the fundamental concepts and principles of machine learning.
2. Gain proficiency in implementing and evaluating supervised and unsupervised learning algorithms.
3. Learn about advanced machine learning techniques such as reinforcement learning and deep learning.
4. Develop skills in using machine learning libraries and frameworks.
5. Apply machine learning algorithms to real-world datasets and problems.
6. Explore ethical considerations and challenges in machine learning.

Module 1: **7 Hours**

Introduction to Machine Learning

- Definition and scope of machine learning
- Types of machine learning (supervised, unsupervised, reinforcement learning)
- Applications of machine learning in various domains

Supervised Learning

- Linear regression
- Logistic regression
- Decision trees and ensemble methods (e.g., Random Forest, Gradient Boosting)
-

Module 2: **7 Hours**

Unsupervised Learning

- Clustering algorithms (e.g., K-means, hierarchical clustering)
- Dimensionality reduction techniques (e.g., PCA, t-SNE)
- Association rule learning

Model Evaluation and Validation

- Cross-validation techniques
- Evaluation metrics for classification and regression tasks
- Hyper parameter tuning

Module 3:	**8 Hours**
Introduction to Neural Networks • Perceptron and feedforward neural networks • Activation functions • Backpropagation algorithm Deep Learning • Convolutional Neural Networks (CNNs) • Recurrent Neural Networks (RNNs) • Transfer learning and fine-tuning	
Module 4:	**8 Hours**
Reinforcement Learning • Markov Decision Processes (MDPs) • Q-Learning and policy gradient methods • Deep Reinforcement Learning Machine Learning Libraries and Frameworks • Introduction to popular machine learning libraries (e.g., scikit-learn, TensorFlow, PyTorch) • Hands-on exercises using machine learning frameworks Applications of Machine Learning • Natural Language Processing (NLP) • Computer Vision • Recommender Systems • Healthcare • Finance	
Recommended Textbooks: • "Introduction to Robotics: Mechanics and Control" by John J. Craig • "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo • "Robotics: Everything You Need to Know About Robotics from Beginner to Expert" by Peter Mckinnon	

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INTELLIGENT DATA MODELING AND ANALYSIS

Duration: 30 Hours | **Course code: CS-IDM**

Course Description:

Intelligent Data Modelling and Analysis explores advanced techniques and methodologies for modelling and analysing complex datasets to extract meaningful insights and make informed decisions. Through a combination of theoretical lectures, hands-on exercises, and practical projects, students will learn state-of-the-art approaches in data modelling, machine learning, and data analysis. Topics covered include predictive modelling, clustering, anomaly detection, feature engineering, and deep learning. Emphasis will be placed on understanding the underlying principles of intelligent data modelling and applying them to solve real-world problems.

Course Objectives:

1. Understand advanced concepts and techniques in data modelling and analysis.
2. Gain proficiency in using machine learning algorithms for predictive modelling and clustering.
3. Learn methods for feature engineering and dimensionality reduction.
4. Explore deep learning architectures and their applications in data analysis.
5. Develop skills in evaluating model performance and interpreting analysis results.
6. Apply intelligent data modelling techniques to real-world datasets and problems.

Module 1: **7 Hours**

Introduction to Intelligent Data Modelling and Analysis

- Overview of intelligent data modelling techniques
- Importance and applications of data analysis in various domains
- Introduction to machine learning frameworks (e.g., scikit-learn, TensorFlow)

Predictive Modelling

- Linear regression
- Logistic regression
- Decision trees and ensemble methods (e.g., Random Forest, Gradient Boosting)
-

Module 2. **7 Hours**

Clustering and Unsupervised Learning

- K-means clustering
- Hierarchical clustering
- Density-based clustering algorithms (e.g., DBSCAN)

Feature Engineering

- Handling missing data

- Feature scaling and normalization
- Feature selection techniques

Module 3.	**8 Hours**

Dimensionality Reduction

- Principal Component Analysis (PCA)
- t-Distributed Stochastic Neighbour Embedding (t-SNE)
- Singular Value Decomposition (SVD)

Anomaly Detection

- Introduction to anomaly detection techniques
- Statistical methods (e.g., z-score, isolation forest)
- Machine learning-based anomaly detection algorithms

Module 4:	**8 Hours**

Introduction to Deep Learning

- Neural network architectures
- Feedforward neural networks
- Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs)

Real-World Applications and Case Studies

- Analysing real-world datasets using intelligent data modelling techniques
- Case studies from finance, healthcare, marketing, etc.

Ethical considerations and challenges in intelligent data modelling and analysis

Recommended Textbooks:

- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
- "Pattern Recognition and Machine Learning" by Christopher M. Bishop
- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville