AI and Data Science

Course Syllabus (40 Weeks) (Tentative)

Instructor Name: Nasir Hussain Course Duration: 40 Weeks
Sessions: 2 Sessions per Week (2 hours
each) Course Level: Beginner to Advanced
Course Pre-requisites: Basic knowledge of programming is preferred but not mandatory.

Course Objectives:

- Master Python programming fundamentals.
- Learn object-oriented programming (OOP) concepts in Python.
- Utilize Python libraries for data analysis and visualization.
- Understand statistical and probability concepts in Python.
- Apply machine learning algorithms using Scikit-learn.
- Explore deep learning with Tensorflow, including CNNs, RNNs, and ANNs.
- Learn about generative AI models, including Transformers and Large Language Models (LLMs)

Module 1: Programming Fundamentals using Python (Weeks 1–5)

Week 1-2:

- Introduction to Python: Variables, Data Types, Operators, and Expressions
- Control Flow in Python: If-else, Loops (For and While)
- Functions in Python: Defining and Calling Functions, Scope of Variables
- Hands-on: Basic Python programs

Week 3-4:

- Data Structures: Lists, Tuples, Dictionaries, and Sets
- String Manipulation and Operations
- File Handling: Reading and Writing Files
- Hands-on: File I/O operations and data manipulation

Week 5:

Exception Handling and Debugging Techniques Working with Modules and Packages in Python Hands-on: Error handling in Python programs

Module 2: Object-Oriented Programming in Python (Weeks 6–8) Week 6-7:

- Introduction to OOP Concepts: Classes, Objects, and Methods
- Encapsulation, Abstraction, Inheritance, and Polymorphism
- Hands-on: Building Classes and using OOP principles in real-world scenarios

Week 8:

Advanced OOP: Magic Methods, Static Methods, Class Methods Hands-on: Create a small project using OOP in Python

Module 3: Statistics and Data Analytics (Weeks 9–18) Week 9-10:

- **NumPy Fundamentals:** Arrays, Vectorization, Indexing, and Slicing
- Broadcasting, Array Math Operations
- Hands-on: Basic Data Manipulation with NumPy

Week 11-12:

- **Pandas for Data Science:** Dataframes, Series, Indexing, and Filtering Data
- Merging, Grouping, and Aggregating Data in Pandas
- Hands-on: Data Manipulation and Analysis with Pandas

Week 13:

- **Matplotlib for Data Visualization:** Creating Line Plots, Bar Charts, Histograms, Scatter Plots
- Customizing Visualizations (Legends, Titles, Axes)
- Hands-on: Plotting real-world data using Matplotlib

Week 14:

- **Seaborn for Advanced Visualization:** Heat-maps, Pair Plots, Violin Plots
- Hands-on: Creating Advanced Visualizations with Seaborn

Module 4: Statistics and Probability in Python (Weeks 15–18)

Week 15-16:

- Descriptive Statistics: Mean, Median, Mode, Variance, Standard Deviation
- Probability Theory: Distributions, Random Variables, and Events
- Hands-on: Implementing Descriptive Statistics with Python

Week 17:

- Inferential Statistics: Hypothesis Testing, P-Value, Confidence Intervals
- Correlation and Covariance
- Hands-on: Hypothesis Testing in Python

Week 18:

- Statistical Models: Linear Regression, Correlation Coefficient
- Hands-on: Build and Evaluate a Regression Model

Module 5: Machine Learning using Scikit-learn (Weeks 19–26) Week 19-20:

- Introduction to Machine Learning: Supervised vs Unsupervised Learning
- Train-Test Split, Cross-Validation, and Model Evaluation Metrics
- Linear Regression in Depth: Gradient Descent, Regularization (L1, L2)
- Hands-on: Implement Linear Regression

Week 21-22:

- Classification Algorithms: Logistic Regression, Decision Trees, Random Forests
- Evaluation Metrics: Precision, Recall, F1-Score, ROC-AUC
- Hands-on: Build and Evaluate a Classification Model

Week 23-24:

- Clustering Algorithms: K-Means, Hierarchical Clustering, DBSCAN
- Dimensionality Reduction: PCA (Principal Component Analysis)
- Hands-on: Clustering and Dimensionality Reduction

Week 25-26:

- Support Vector Machines (SVM): Theory and Implementation
- K-Nearest Neighbors (KNN): Theory and Implementation
- Hands-on: Implement SVM and KNN on real datasets
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Module 6: Deep Learning with Tensorflow (Weeks 27–33) Week 27-28:

- Introduction to Neural Networks (NN): Perceptrons, Activation Functions, Forward and Backpropagation
- Hands-on: Build a basic Neural Network using TensorFlow

Week 29-30:

- Convolutional Neural Networks (CNN): Filters, Pooling, Layers, Image Classification
- Hands-on: Build and Train CNN for Image Classification

Week 31-32:

- Recurrent Neural Networks (RNN): Sequence Modeling, LSTMs, GRUs
- Time Series Forecasting with RNNs
- Hands-on: Implement RNN for Sequence Data

Week 33:

- Autoencoders and GANs: Unsupervised Representation Learning
- Hands-on: Build an Autoencoder for Dimensionality Reduction

Module 7: Generative AI and Transformers (Weeks 34–39)

Week 34-35:

- Introduction to Transformers and Attention Mechanism: Self-attention, Positional Encoding
- Large Language Models (LLMs): GPT, BERT
- Hands-on: Implement Text Generation with Pre-trained LLMs (Hugging Face, OpenAI API)

Week 36-37:

- LangChain for Building AI Applications: Combining Language Models with External Tools
- Building AI-powered Conversational Agents
- Hands-on: Create AI-powered chatbots using LangChain and Transformers

Week 38-39:

- Generative Adversarial Networks (GANs): Architecture and Applications in Image and Text Generation
- Hands-on: Build and Train a GAN for Image Generation

Module 8: Final Project and Presentations (Week 40)

Week 40:

- Project Presentations: Students present their final projects demonstrating AI or data science applications.
- Peer Review and Feedback
- Course Wrap-Up: Final discussions and feedback