SBIT TECHMENTORS CURRICULUM ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

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ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

This program provides a comprehensive introduction to AI and deep learning, beginning with foundational mathematical concepts and Python programming. It progresses through key topics in AI and machine learning, building up to the construction and implementation of neural networks and advanced deep learning architectures. The course emphasizes practical applications across various domains, culminating in a capstone project where students apply their knowledge to solve real-world problems.

PROGRAM OUTCOMES

- Understand and apply foundational mathematical concepts relevant to AI and deep learning, including linear algebra, calculus, and probability.
- Gain proficiency in Python programming and utilize libraries essential for AI and data science, such as NumPy, pandas, and Matplotlib.
- Comprehend the principles of artificial intelligence and machine learning, including supervised and unsupervised learning techniques.
- Design, build, and train neural networks from scratch using deep learning frameworks like TensorFlow or PyTorch.
- Explore and implement advanced deep learning architectures, such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative models.
- Apply deep learning techniques to real-world applications, including image recognition, natural language processing, and more.
- Complete a capstone project that demonstrates the ability to solve complex problems using AI and deep learning, showcasing practical skills and knowledge.

LEARNING PATH VISUALIZATION

1) Foundations - Mathematics & Python Programming
2) Mathematical Constructs and Data Visualization
3) Artificial Intelligence and Machine Learning
4) Building Neural Networks
5) Advanced Deep Learning Architectures
6) Deep Learning and its Applications
7) Capstone Project

MODULE 1: FOUNDATIONS - MATHEMATICS & PYTHON PROGRAMMING

LEARNING OUTCOMES:

- Overview of Google Colab environment for using Jupiter notebooks
- Understanding of basic mathematical concepts like Matrix, Calculus, and Probability
- Basic Python concepts like data types, operators, conditional statements, loops
- Apply Python concepts like strings, Lambda functions, and lists
- Understand Python concepts such as strings, lambda expressions, lists, functions, and error handling.
- Gain proficiency in Python libraries such as NumPy, pandas for handling data.
- Practical working of Pandas primary data structures: Series and DataFrame

- Data normalization and standardization using techniques like data binning
- Construct informative graphs using Matplotlib, Seaborn, and Plotly

TOPICS COVERED:

- Google Colab
- Basic mathematics: Matrix, Calculus, Probability
- Introduction to Python Programming
    - Python Data Types and Operators
    - Conditional Statements and Loops in Python
    - Python Functions
- Object-Oriented Programming Concepts with Python
- Threading
- Matplotlib, NumPy, Pandas, Sci Kit Learn
- Data preprocessing Data Cleaning/Munging

MODULE 2: MATHEMATICAL CONSTRUCTS AND DATA VISUALIZATION

LEARNING OUTCOMES:

- Gain familiarity with linear algebra concepts
- Fundamentals of eigenvalues, eigenvectors, and eigen decomposition
- Comprehensive coverage in calculus, covering limits, derivatives, and integrals
- Differentiate between structured and unstructured data
- Overview of statistical measures such as means, medians, deciles, percentiles, modes, and quartiles
- Understand mean absolute deviation (MAD), standard deviation, and variance
- Fundamentals of probability concepts like independent and dependent events, Bayes' Theorem, sampling methods
- Introduction to hypothesis testing
- Data Stories and Data Visualization

TOPICS COVERED:

- Calculus Fundamentals
    - Derivatives and Partial Derivatives, Composite Functions and the Chain Rule, Automatic Differentiation
    - Gradient Descent and Backpropagation
- Deep Dive into Linear Algebra
    - Vectors, Bases, Dimensions, Norms, Matrices, Matrix Operations
    - Eigenvalues, Eigenvectors, and Eigen decomposition
- Descriptive Statistics
    - Probability and Probability Distributions
    - Sampling and Sampling Techniques
    - Inferential Statistics
- Data Visualization

MODULE 3: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

LEARNING OUTCOMES:

- Overview of Artificial Intelligence landscape including workflows and applications
- Comprehensive coverage of different machine learning algorithms and their working
- Understand the difference between supervised and unsupervised learning and their respective real-world applications
- Coverage of different types of regression models and their applications
- Understanding of the concepts of overfitting and underfitting and how to prevent them
- Coverage of different types of classification algorithms and their applications
- Create correlation maps between variables
- Examine various ensemble modeling techniques such as bagging, boosting, and stacking
- Introduction to different machine learning frameworks like Keras and TensorFlow

TOPICS COVERED:

- Introduction to Artificial Intelligence and Machine Learning
    - AI/ML Workflow, AI/ML Applications and Problems it can solve
- Regression Models
    - Model Building using Least squares, Model Accuracy & Selection
    - Regularization and Overfitting, Interpretability of regression models
- Classification Models
    - Classification algorithms, Logistic Regression
    - Nearest-neighbour Methods, Naive Bayes Classifier
    - Decision Tree and Random Forests
- Evaluation Metrics - MSE, Accuracy, Precision, Recall, F1 Score
- Boosting Models - XGBoost, Light GBM
- Unsupervised Learning
    - Clustering: K-Means, Hierarchical, Density based clustering
    - Association Rule Mining, Apriori Algorithm
    - Anomaly Detection

MODULE 4: BUILDING NEURAL NETWORKS

LEARNING OUTCOMES:

- Understand the differences between deep learning and machine learning
- When to use deep learning and practical applications
- Comprehensive coverage of fundamental neural networks - Multi-Layer Perceptrons (MLP)
- Gain expertise in the concepts of forward propagation and backward propagation in neural networks
- Introduction of modeling and performance improvement techniques in deep learning
- Understand hyperparameter tuning and model interpretability
- Overview of dropout and early stopping techniques and their implementation
- Understand the basics of PyTorch and learn how to create a neural network using PyTorch

TOPICS COVERED:

- Introduction to Neural Networks
    - Multi-Layer Perceptrons (MLP) and Backpropagation
    - Regression / Classification with MLP
    - Pytorch, Tensorflow, and Keras
- Fine Tuning of MLP
    - Gradient Issues
    - Activation functions batch normalization
    - Overfitting and Dropouts
    - Optimizers and Learning Rate

MODULE 5: ADVANCED DEEP LEARNING ARCHITECTURES

LEARNING OUTCOMES:

- Extensive coverage of advance neural networks like Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN)
- Overview of advanced concepts like filtering, convolution, pooling
- Introduction to advanced architectures like U-net, Resnet
- Architectures like GRU, LSM and corresponding gradient issues
- Building recommendation systems
- Overview of dimensionality reduction using different techniques like PCA, t-SNE, LLE
- Coverage of Auto-encoder architectures

TOPICS COVERED:

- Convolutional Neural Networks (CNN)
    - Filtering, Convolution, Pooling
    - Different Architectures: U-net, Resnet, etc.
    - Classification, localization, segmentation
- Recurrent Neural Networks
    - Sequence Modeling, Memory cell
    - GRU, LSTM, Gradient issues
    - Recommendation Systems
- Dimensionality Reduction and Self-Supervised Networks
    - PCA, Matrix Completion, LDA, CCA Manifold Learning, t-SNE, LLE
    - Auto-encoder architectures

MODULE 6: DEEP LEARNING AND ITS APPLICATIONS

LEARNING OUTCOMES:

- Extensive coverage of Natural Language Processing including data preprocessing and key text preprocessing techniques
- Application text vectorization and embedding methods, Use TF-IDF for word importance in documents.

- Understand tokenization methods and Byte Pair Encoding (BPE)
- Explore attention mechanisms and BERT
- Learn about GPT and Large Language Models (LLMs)
- Use OpenAI API, ChatGPT, and Llama for NLP tasks
- Understand RAG and utilize LangChain for custom NLP pipelines
- Extensive coverage of Audio Representations and Speech Recognition
- Extract features for speech recognition tasks
- Develop deep learning models for speech and audio
- Understanding of Computer Vision concepts like Transfer Learning and Object Detection
- Understand image segmentation and RNNs in captioning

TOPICS COVERED:

- Natural Language Processing
    - Data Preprocessing for NLP - Text Vectorization Layer, Standardization, Vocabulary Indexing, Embedding Word Vectors, TF-IDF
    - Tokenization, Byte Pair Encoding, Bag of Words Model and Sequential Models, Attention Mechanism, BERT Models
    - Generative AI – GPT, LLMs (OpenAI API, ChatGPT, Llama), RAG, LangChain
- Speech and Audio Processing
    - Audio Representations, Speech Recognition
    - End-to-end Deep Networks, Detection Models
- Computer Vision
    - Transfer Learning, Object Detection
    - Image Segmentation RNN, Image / Video Captioning

MODULE 7: CAPSTONE PROJECT

LEARNING OUTCOMES:

- Showcase your Deep Learning skills starting from decision making process and covering other areas like data processing, model development, and results presentation.

TOPICS COVERED:

- Image based plant disease identification
- Smart Traffic Management System
- Personalized Financial Advisor using Large Language Model (LLM)
- Personalized Health Monitoring System
- Movie recommendation system based on user preferences
- Fraud Detection in Financial Transactions
- House price trends and prediction for metropolitan cities of India
- Real-Time Speech Translation System
- Anomaly detection in Industrial IOT