



# Course Introduction



## 1. Python Programming

- Programming in Python and basic data structures
- OOPS in Python and examples
- File I/O
- Numpy and Implementing basic algorithms
- Pandas and EDA on datasets
- SQL and usage in Python
- Data visualization using Matplotlib and Seaborn

## 2. Calculus and optimization

- Limit, continuity and differentiability
- Taylor Series
- Maxima & Minima
- Optimization involving a single variable

### 3. Linear Algebra

- Vector Space, Subspaces, Linear dependence and independence of vectors
- Matrices, their types and properties
- System of linear equation and Solutions
- Eigen Values and eigen vectors
- determinant, rank and projections
- Singular Value decomposition , LU decomposition

### 4. Probability and statistics

- Permutation and combinations
- Probability basic concepts : Sample Space, events, marginal Conditional and joint Probability; Bayes Theorem
- Mean, Median, Mode, Variance and std. deviations
- Correlation and Covariance
- discrete Random Variable - PMF, Uniform, Bernoulli and Binomial distribution

- Continuous Random Variables - PDF, CDF, Uniform, Exponential, Poisson, normal, Standard normal, t-distribution, Chi-Squared distribution.
- Central limit theorem
- Confidence interval and hypothesis testing (z test, t-test, Chi-Squared test), A/B testing

## 5. Machine Learning

- Introduction and types - Supervised and Unsupervised Learning.
- Linear Regression, Ridge regression
- Evaluation metrics for classification and Regression
- Logistic Regression and gradient descent algorithm.
- K-nearest neighbour, naive bayes, support vector machines (SVM)
- Decision Trees and Ensemble learning (Bagging & Boosting)
- Clustering Algorithms (Hierarchical, DBSCAN, K-means, K-means++)
- Dimensionality Reduction, PCA
- Time Series Analysis
- NLP Basics

## 6. Deep Learning

- AI vs ML vs DL
- Multi layer perceptron and Gradient descent Algorithms
- Activation functions ( Sigmoid, tanh , softmax, Relu , LRelu )
- Optimization Algorithms and types
- Basics of Pytorch and tensors
- Advanced NLP and Embedding concepts (word2vec)
- CNN and Important architectures ( VGG16 , Resnet , Inception networks etc)
- RNN , GRU , LSTM and Attention basics

## 7. Generative AI

- Transformers and BERT
- Large Language models (LLMs) → GPT , Llama , mistral .
- Finetuning LLMs and Evaluations.
- GANs → StyleGAN
- Diffusion models → DALL-E , stable diffusion
- BLIP , CLIP , ViT etc

## 8. ML development tools

- Version Control Systems – GIT and GitHub
- Relational vs NoSQL databases (MongoDB)
- API development using FastAPI
- Testing model performance using API locally.

## 9. Model deployment and inference

- Hands on Extract, transform and load data pipeline on AWS
- Types of model deployments – on-device (low-end and high-end devices), on Server deployment (AWS, GCP)
- Model deployment and inference on AWS – Sagemaker, EC2.

## 10. Recommendation Engine

- Content based filtering, Collaborative filtering , Neural network based (2-tower approach)
- Retrieval and candidate set generation
- Learning to rank and Loss functions
- Pointwise (cross-entropy), Pair-wise (RankNET) and Listwise (lambda MART, lambdaRANK) loss functions

→ Evaluation metrics - Offline (MRR@K, MAP@K, NDCG@K) and Online (Click through rate (CTR), Successful session rate, CAVEAT, Time to Success, Avg Session duration)

## 11. ML design Interview Questions

- Interview patterns of top AI Companies
- Important Concepts go through.
- Multi-modal representations using Embeddings
- Search, Retrieval and Recommendations
- Spam / outlier detection or classification
- Multi-class classifications
- Multi-modal classifications

## 12. Data Structures and Algorithms (DSA)

- Python and their important data structures
- Problems practice - Array, Linked list, Greedy Algorithms, Recursion, Binary Search, Heaps, Stack and Queue, String, binary tree types, Graph, Dynamic programming.
- Advanced Topics - Trie, Fenwick Tree (BIT), Segment Tree

Happy Learning!

