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Gen AI & Agentic AI
DATA SCIENCE

Data Analytics | Machine Learning | Artificial Intelligence | NLP | Python | R

GENERATIVE AI (Gen AI)

- Gen AI Basics & Use-cases:
  - Generative vs. Discriminative
  - Text/code/image/audio generation
  - Common pitfalls (hallucination, bias)
- Large Language Models (LLMs):
  - LLM Assistants (ChatGPT, Gemini, Perplexity, Copilot)
  - Tokenization & embeddings
  - Attention and context window, System/user/tool messages
- Prompt Engineering:
  - Role/goal/context framing
  - Zero/few-shot, CoT, self-consistency
  - Prompt testing templates
- Retrieval-Augmented Generation (RAG):
  - Chunking & indexing
  - Vector stores and hybrid search
  - Grounding with citations
- Evaluation & Guardrails:
  - LLM-as-judge vs. metrics (BLEU/ROUGE)
  - Toxicity/PII filters, Factuality & hallucination checks
- Fine-tuning & Adaptation:
  - LoRA/QLoRA basics, Instruction-tuning vs. RAG
  - Data curation & alignment
- Multimodal GenAI:
  - Vision-language models
  - Doc Q&A and layout parsing
  - ASR/TTS pipelines
- GenAI MLOps:
  - Prompt/version tracking
  - Offline/online eval & observability
  - Caching and cost controls
- Deployment Patterns:
  - Batch vs. streaming tokens
  - Latency/SLO tuning, CPU/GPU selection

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AGENTIC AI (AGENTS)

- Agentic AI Foundations:
  - Planner–executor loop, Tools, memory, reflection
  - Multi-turn objectives
- Tool Use & Orchestration:
  - Function calling schemas
  - Retries/fallbacks/timeouts, Parallel tool execution
- Planning Strategies:
  - ReAct and Tree-of-Thought
  - Task decomposition, Checkpoints & sub-goals
- Memory for Agents:
  - Short-term scratchpad, Long-term vector memory
  - Episodic vs. semantic retrieval
- Multi-Agent Systems:
  - Role design (researcher/coder/critic)
  - Communication protocols, Handoff patterns
- Agent Workflows/Frameworks:
  - Graph/state-machine agents, DAG/event-driven flows
  - Overview of common OSS stacks
- Safety for Agents:
  - Tool allow/deny lists, Rate/budget limits
  - Human-in-the-loop (HITL)
- Agents + RAG:
  - Tool-augmented retrieval
  - Query rewriting, Citation enforcement
- Evaluation of Agents:
  - Task success & robustness
  - Cost/time to completion, Reproducibility & audits
- Productionizing Agents:
  - Secrets, key management
  - Telemetry & logs
  - Fail-safes, Rollback & Kill-switch

INTRODUCTION TO DATA SCIENCE

- What is a Data Science?
- Who is a Data Scientist?
- Who can become a Data Scientist?
- What is an Artificial Intelligence?
- What is a Machine Learning?
- What is a Deep Learning?
- Artificial Intelligence Vs Machine Learning Vs Deep Learning
- Real Time Process of Data Science
- Data Science Real Time Applications
- Technologies used in Data Science
- Prerequisites Knowledge to Learn Data Science

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INTRODUCTION TO MACHINE LEARINING

- What is a Machine Learning?
- Machine Learning Vs Statistics
- Traditional Programming Vs Machine Learning
- How Machine Will Learn like Human Learning
- Machine Learning Engineer Responsibilities
- Types of Machine Learning
  - Supervised learning
  - Un-Supervised learning
  - Reinforcement Learning

CORE PYTHON PROGRAMMING

- PYTHON Programming Introduction
- History of Python
- Python is Derived from?
- Python Features & Applications
- Why Python is Becoming Popular Now a Day?
- Existing Programming Vs Python Programming
- Writing Programs in Python
- Top Companies Using Python
- Python Programming Modes
  - Interactive Mode Programming
  - Scripting Mode Programming
- Flavors in Python, Python Versions
- Download & Install the Python in Windows & Linux
- How to set Python Environment in the System?
- Anaconda - Data Science Distributor
- Downloading and Installing Anaconda, Jupyter Notebook & Spyder
- Python IDE - Jupyter Notebook Environment
- Python IDE – Spyder Environment
- Python Identifiers(Literals), Reserved Keywords
- Variables, Comments, Lines and Indentations, Quotations
- Assigning Values to Variables
- Data Types in Python, Mutable Vs Immutable
- Fundamental Data Types: int, float, complex, bool, str
- Number Data Types: Decimal, Binary, Octal, Hexa Decimal & Number Conversions
- Inbuilt Functions in Python
- Data Type Conversions
- Priorities of Data Types in Python
- Python Operators
  - Arithmetic, Comparison (Relational), Assignment, Logical, Bitwise, Membership & Identity Operators
- Slicing & Indexing
  - Forward Direction Slicing with +ve Step
  - Backward Direction Slicing with -ve Step

- Decision Making Statements
  - If, if-else & elif Statements
- Looping Statements
  - Why we use Loops in python?
  - Advantages of Loops
  - for Loop & Nested for Loop
  - Using else Statement with for Loop
  - while Loop & Infinite while Loop
  - Using else with Python while Loop
- Conditional Statements
  - Break, Continue, Pass Statements

ADVANCED PYTHON PROGRAMMING

- Advanced Data Types: List, Tuple, Set, Frozenset, Dictionary, Range, Bytes & Bytearray, None
- List Data Structure
  - List indexing and splitting
  - Updating List values
  - List Operations
  - Iterating a List
  - Adding Elements to the List
  - Removing Elements from the List
  - List Built-in Functions & Methods
- Tuple Data Structure
  - Tuple Indexing and Splitting
  - Tuple Operations
  - Tuple Inbuilt Functions
  - Where use Tuple
  - List Vs Tuple
  - Nesting List and Tuple
- Set Data Structure
  - Creating a Set
  - Set Operations
  - Adding Items to the Set
  - Removing Items from the Set
  - Difference Between discard() and remove()
  - Union of Two Sets
  - Intersection of Two Sets
  - Difference of Two Sets
  - Set Comparisons
- Frozenset Data Structure
- Dictionary Data Structure
  - Creating & Accessing the Dictionary Values
  - Updating Dictionary Values
  - Deleting Elements Using del Keyword
  - Iterating Dictionary

- Properties of Dictionary Keys
- Built-in Dictionary Functions
- Built-in Dictionary Methods

- List Vs Tuple Vs Set Vs Frozenset Vs Dict
- Range, Bytes, Bytearray & None
- Python Functions
  - Advantage of Functions in Python
  - Creating a Function
  - Function Calling
  - Parameters in Function
  - Call by Reference in Python
  - Types of Arguments
    - Required, Keyword, Default, Variable-Length Arguments
- Scope of Variables
- Python Built-in & Lambda Functions
- String with Functions
  - Strings Indexing and Splitting
  - String Operators
  - Python Formatting Operator
  - Built-in String Functions
- Python File Handling
  - Opening a File, Reading the File & Read Lines of the File
  - Looping through the File
  - Writing the File & Creating a New File
  - Using with Statement with Files
  - File Pointer Positions
  - Modifying File Pointer Position
  - Renaming the File & Removing the File
  - Writing Python Output to the Files
  - File Related Methods
- Python Exceptions
  - Common Exceptions
  - Problem without Handling Exceptions
  - except Statement with no Exception
  - Declaring Multiple Exceptions
  - Finally Block
  - Raising & Custom Exceptions
- Python Packages
  - Python Libraries
  - Python Modules
    - Collection, Math, OS, Random, Statistics, Sys Modules
    - Date & Time Module
  - Loading the Module in our Python Code
    - import Statement
    - from-import Statement
  - Renaming a Module

- Regular Expressions
- Command Line Arguments
- Object Oriented Programming (OOPs)
  - Object-oriented vs Procedure-oriented Programming languages
  - Object, Class, Method, Inheritance, Polymorphism, Data Abstraction & Encapsulation
- Python Class and Objects
  - Creating Classes in Python
  - Creating an Instance of the Class
- Python Constructor
  - Creating the Constructor in Python
  - Parameterized & Non-Parameterized Constructors
  - In-built Class Functions & Attributes
- Python Inheritance
  - Python Multi-Level & Multiple Inheritance
  - Method Overriding
  - Data Abstraction in Python
- Graphical User Interface (GUI) Programming
- Python TKinter
  - Tkinter Geometry
    - pack(), grid(), place() Methods
  - Tkinter Widgets

DATA ANALYSIS WITH PYTHON NUMPY

- NumPy Introduction
  - What is NumPy
  - The Need of NumPy
- NumPy Environment Setup
- N-Dimensional Array (Ndarray)
  - Creating a Ndarray Object
  - Finding the Dimensions of the Array
  - Finding the Size of Each Array Element
  - Finding the Data Type of Each Array Item
  - Finding the Shape and Size of the Array
  - Reshaping the Array Objects
  - Slicing in the Array
  - Finding the Maximum, Minimum, and Sum of the Array Elements
  - NumPy Array Axis
  - Finding Square Root and Standard Deviation
  - Arithmetic Operations on the Array
  - Array Concatenation
- NumPy Datatypes
  - NumPy dtype
  - Creating a Structured Data Type
- Numpy Array Creation
  - Numpy.empty

- Numpy.Zeros
- NumPy.ones

- Numpy Array from Existing Data
  - Numpy.asarray
- Numpy Arrays within the Numerical Range
  - Numpy.arrange
  - NumPy.linspace
  - Numpy.logspace
- NumPy Broadcasting
  - Broadcasting Rules
- NumPy Array Iteration
  - Order of Iteration
    - F-Style Order
    - C-Style Order
  - Array Values Modification
- NumPy String Functions
- NumPy Mathematical Functions
  - Trigonometric Functions
  - Rounding Functions
- NumPy Statistical functions
  - Finding the Min and Max Elements from the Array
  - Calculating Median, Mean, and Average of Array Items
- NumPy Sorting and Searching
- NumPy Copies and Views
- NumPy Matrix Library
- NumPy Linear Algebra
- NumPy Matrix Multiplication in Python

DATA ANALYSIS WITH PYTHON PANDAS

- Pandas Introduction & Pandas Environment Setup
  - Key Features of Pandas
  - Benefits of Pandas
  - Python Pandas Data Structure
    - Series
    - DataFrame
    - Panel
- Pandas Series
  - Creating a Series
    - Create an Empty Series
    - Create a Series using Inputs
  - Accessing Data from Series with Position
  - Series Object Attributes
  - Retrieving Index Array and Data Array of a Series Object
  - Retrieving Types (dtype) and Size of Type (itemsize)
  - Retrieving Shape
  - Retrieving Dimension, Size and Number of Bytes

- Checking Emptiness and Presence of NaNs
- Series Functions

- Pandas DataFrame
  - Create a DataFrame
    - Create an Empty DataFrame
    - Create a DataFrame using Inputs
- Column Selection, Addition & Deletion
- Row Selection, Addition & Deletion
- DataFrame Functions
- Merging, Joining & Combining DataFrames
- Pandas Concatenation
- Pandas Time Series
  - Datetime
  - Time Offset
  - Time Periods
  - Convert String to Date
- Viewing/Inspecting Data (loc & iloc)
- Data Cleaning
- Filter, Sort, and Groupby
- Statistics on DataFrame
- Pandas Vs NumPy
- DataFrame Plotting
  - Line: Line Plot (Default)
  - Bar: Vertical Bar Plot
  - Barh: Horizontal Bar Plot
  - Hist: Histogram Plot
  - Box: Box Plot
  - Pie: Pie Chart
  - Scatter: Scatter Plot

DBMS - Structured Query Language

- Introduction & Models of DBMS
- SQL & Sub Language of SQL
- Data Definition Language (DDL)
- Data Manipulation Language (DML)
- Data Query/Retrieval Language (DQL/DRL)
- Transaction Control Language (TCL)
- Data Control Language (DCL)
- Installation of MySQL & Database Normalization
- Sub Queries & Key Constraints
- Aggregative Functions, Clauses & Views

Importing & Exporting Data

- Data Extraction from CSV (pd.read_csv)
- Data Extraction from TEXT File (pd.read_table)
- Data Extraction from CLIPBOARD (pd.read_clipboard)

- Data Extraction from EXCEL (pd.read_excel)
- Data Extraction from URL (pd.read_html)
- Writing into CSV (df.to_csv)
- Writing into EXCEL (df.to_excel)
- Data Extraction from DATABASES
    - Python MySQL Database Connection
        - Import mysql.connector Module
        - Create the Connection Object
        - Create the Cursor Object
        - Execute the Query

DATA VISUALIZATION WITH PYTHON MATPLOTLIB

- Data Visualization Introduction
- Tasks of Data Visualization
- Benefit of Data Visualization
- Plots for Data Visualization
- Matplotlib Architecture
- General Concept of Matplotlib
- MatPlotLib Environment Setup
- Verify the MatPlotLib Installation
- Working with PyPlot
- Formatting the Style of the Plot
- Plotting with Categorical Variables
- Multi-Plots with Subplot Function
- Line Graph
- Bar Graph
- Histogram
- Scatter Plot
- Pie Plot
- 3Dimensional - 3D Graph Plot
- mpl_toolkits
- Functions of MatPlotLib
- Contour Plot, Quiver Plot, Violin Plot
- 3D Contour Plot
- 3D Wireframe Plot
- 3D Surface Plot
- Box Plot
    - What is a Boxplot?
    - Mean, Median, Quartiles, Outliers
    - Inter Quartile Range (IQR), Whiskers
    - Data Distribution Analysis
    - Boxplot on a Normal Distribution
    - Probability Density Function
    - 68–95–99.7 Rule (Empirical rule)

Data Analysis Project using Python Programming

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MACHINE LEARNING

- What is Machine Learning
- Importance of Machine Learning
- Need for Machine Learning
- Statistics Vs Machine Learning
- Traditional Programming Vs Machine Learning
- How Machine Learning like Human Learning
- How does Machine Learning Work?
- Machine Learning Engineer Responsibilities
- Life Cycle of Machine Learning
    - Gathering Data
    - Data preparation
    - Data Wrangling
    - Analyze Data
    - Train the model
    - Test the model
    - Deployment
- Features of Machine Learning
- History of Machine Learning
- Applications of Machine Learning
- Types of Machine Learning
    - Supervised Machine Learning
    - Unsupervised Machine Learning
    - Reinforcement Learning

Supervised Machine Learning

- How Supervised Learning Works?
- Steps Involved in Supervised Learning
- Types of supervised Machine Learning Algorithms
    - Classification
    - Regression
- Advantages of Supervised Learning
- Disadvantages of Supervised Learning

Unsupervised Machine Learning

- How Unsupervised Learning Works?
- Why use Unsupervised Learning?
- Types of Unsupervised Learning Algorithm
    - Clustering
    - Association
- Advantages of Unsupervised Learning
- Disadvantages of Unsupervised Learning
- Supervised Vs Unsupervised Learning
- Reinforcement Machine Learning
- How to get Datasets for Machine Learning?

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- What is a Dataset?
- Types of Data in Datasets
- Popular Sources for Machine Learning Datasets

Data Preprocessing in Machine Learning

- Why do we need Data Preprocessing?
  - Getting the Dataset
  - Importing Libraries
  - Importing Datasets
  - Finding Missing Data
    - By Deleting the Particular Row
    - By Calculating the Mean
  - Encoding Categorical Data
    - LableEncoder
    - OneHotEncoder
  - Splitting Dataset into Training and Test Set
  - Feature Scaling
    - Standardization
    - Normalization

Classification Algorithms in Machine Learning

- What is the Classification Algorithm?
- Types of Classifications
  - Binary Classifier
  - Multi-class Classifier
- Learners in Classification Problems
  - Lazy Learners
  - Eager Learners
- Types of ML Classification Algorithms
  - Linear Models
    - Logistic Regression
    - Support Vector Machines
  - Non-linear Models
    - K-Nearest Neighbors
    - Naïve Bayes
    - Decision Tree Classification
    - Random Forest Classification
    - Kernel SVM
- Evaluating a Classification Model
  - Confusion Matrix
    - What is a Confusion Matrix?
      - True Positive
      - True Negative
      - False Positive – Type 1 Error
      - False Negative – Type 2 Error
    - Why need a Confusion matrix?

        - Precision
        - Recall
        - Precision vs Recall
        - F1-score
        - Confusion Matrix in Scikit-Learn
        - Confusion Matrix for Multi-Class Classification
    - Log Loss or Cross-Entropy Loss
    - AUC-ROC curve
- Use cases of Classification Algorithms

K-Nearest Neighbor(KNN) Algorithm in Machine Learning

- Why do we Need a K-NN Algorithm?
- How does K-NN work?
    - What is Euclidean Distance
    - How it Calculates the Distance
- How to Select the Value of K in the K-NN Algorithm?
- Advantages of KNN Algorithm
- Disadvantages of KNN Algorithm
- Python Implementation of the KNN Algorithm
- Analysis on Social Network Ads Dataset
- Steps to Implement the K-NN Algorithm
    - Data Pre-processing Step
    - Fitting the K-NN algorithm to the Training Set
    - Predicting the Test Result
    - Test Accuracy of the Result (Creation of Confusion Matrix)
    - Visualizing the Test Set Result.
    - Improve the Performance of the K-NN Model

Naïve Bayes Classifier Algorithm in Machine Learning

- Why is it Called Naïve Bayes?
    - Naïve Means?
    - Bayes Means?
- Bayes' Theorem
    - Posterior Probability
    - Likelihood Probability
    - Prior Probability
    - Marginal Probability
- Working of Naïve Bayes' Classifier
- Advantages of Naïve Bayes Classifier
- Disadvantages of Naïve Bayes Classifier
- Applications of Naïve Bayes Classifier
- Types of Naïve Bayes Model
    - Gaussian Naïve Bayes Classifier
    - Multinomial Naïve Bayes Classifier
    - Bernoulli Naïve Bayes Classifier
- Python Implementation of the Naïve Bayes Algorithm

- Steps to Implement the Naïve Bayes Algorithm
  - Data Pre-processing Step
  - Fitting Naive Bayes to the Training set
  - Predicting the Test Result
  - Test Accuracy of the Result (Creation of Confusion matrix)
  - Visualizing the Test Set Result
  - Improve the Performance of the Naïve Bayes Model

Decision Tree Classification Algorithm in Machine Learning

- Why use Decision Trees?
- Types of Decision Trees
  - Categorical Variable Decision Tree
  - Continuous Variable Decision Tree
- Decision Tree Terminologies
- How does the Decision Tree Algorithm Work?
- Attribute Selection Measures
  - Entropy
  - Information Gain
  - Gini index
  - Gain Ratio
- Algorithms used in Decision Trees
  - ID3 Algorithm → (Extension of D3)
  - C4.5 Algorithm→ (Successor of ID3)
  - CART Algorithm → (Classification & Regression Tree)
- How to Avoid/Counter Overfitting in Decision Trees?
  - Pruning Decision Trees
  - Random Forest
- Pruning: Getting an Optimal Decision tree
- Advantages of the Decision Tree
- Disadvantages of the Decision Tree
- Python Implementation of Decision Tree
- Steps to Implement the Decision Tree Algorithm
  - Data Pre-processing Step
  - Fitting a Decision-Tree Algorithm to the Training Set
  - Predicting the Test Result
  - Test Accuracy of the Result (Creation of Confusion matrix)
  - Visualizing the Test Set Result
  - Improve the Performance of the Decision Tree Model

Random Forest Classifier Algorithm in Machine Learning

- Working of the Random Forest Algorithm
- Assumptions for Random Forest
- Why use Random Forest?
- How does Random Forest Algorithm Work?
  - Ensemble Techniques
  - Bagging (Bootstrap Aggregation)

- Applications of Random Forest
- Disadvantages of Random Forest
- Python Implementation of Random Forest Algorithm
- Steps to Implement the Random Forest Algorithm:
    - Data Pre-processing Step
    - Fitting the Random Forest Algorithm to the Training Set
    - Predicting the Test Result
    - Test Accuracy of the Result (Creation of Confusion Matrix)
    - Visualizing the Test Set Result
    - Improving the Performance of the Random Forest Model

Logistic Regression Algorithm in Machine Learning

- Logistic Function (Sigmoid Function)
- Assumptions for Logistic Regression
- Logistic Regression Equation
- Type of Logistic Regression
    - Binomial Logistic Regression
    - Multinomial Logistic Regression
    - Ordinal Logistic Regression
- Python Implementation of Logistic Regression (Binomial)
- Steps to Implement the Logistic Regression:
    - Data Pre-processing Step
    - Fitting Logistic Regression to the Training Set
    - Predicting the Test Result
    - Test Accuracy of the Result (Creation of Confusion Matrix)
    - Visualizing the Test Set Result
    - Improve the Performance of the Logistic Regression Model

Support Vector Machine Algorithm

- Types of Support Vector Machines
    - Linear Support Vector Machine
    - Non-Linear Support Vector Machine
- Hyperplane in the SVM Algorithm
- Support Vectors in the SVM Algorithm
- How does SVM Works?
    - How does Linear SVM Works?
    - How does Non-Linear SVM Works?
- Python Implementation of Support Vector Machine
- Steps to Implement the Support Vector Machine:
    - Data Pre-processing Step
    - Fitting Support Vector Machine to the Training Set
    - Predicting the Test Result
    - Test Accuracy of the Result (Creation of Confusion Matrix)
    - Visualizing the Test Set Result
    - Improve the Performance of the Support Vector Machine Model

Regression Algorithms in Machine Learning

- Terminologies Related to the Regression Analysis
  - Dependent Variable
  - Independent Variable
  - Outliers
  - Multi-collinearity
  - Under fitting and Overfitting
- Why do we use Regression Analysis?
- Types of Regression
  - Linear Regression
  - Logistic Regression
  - Polynomial Regression
  - Support Vector Regression
  - Decision Tree Regression
  - Random Forest Regression
  - Ridge Regression
  - Lasso Regression

Linear Regression in Machine Learning

- Types of Linear Regression
  - Simple Linear Regression
  - Multiple Linear Regression
- Linear Regression Line
  - Positive Linear Relationship
  - Negative Linear Relationship
- Finding the Best Fit Line
  - Cost Function
  - Gradient Descent
  - Model Performance
  - R-Squared Method
- Assumptions of Linear Regression

Simple Linear Regression in Machine Learning

- SLR Model
- Implementation of Simple Linear Regression Algorithm using Python
  - Data Pre-processing Step
  - Fitting Simple Linear Regression to the Training Set
  - Predicting the Test Result
  - Test Accuracy of the
  - Visualizing the Test Set Result.
  - Try to Improve the Performance of the Model

Multiple Linear Regression in Machine Learning

- MLR Equation
- Assumptions for Multiple Linear Regression
- Implementation of Multiple Linear Regression model using Python

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- Data Pre-processing Step
- Fitting Multiple Linear Regression to the Training Set
- Predicting the Test Result
- Test Accuracy of the
- Visualizing the Test Set Result.
- Try to Improve the Performance of the Model

Backward Elimination

- What is Backward Elimination?
- Steps of Backward Elimination
- Need for Backward Elimination: An optimal Multiple Linear Regression model
- Implement the Steps for Backward Elimination method

Polynomial Regression in Machine Learning

- Need for Polynomial Regression
- Equation of the Polynomial Regression Model
- Implementation of Polynomial Regression using Python
- Steps for Polynomial Regression:
  - Data Pre-processing
  - Build a Linear Regression Model
  - Build a Polynomial Regression Model
  - Visualize the Result for Linear Regression Model
  - Visualize the Result for Polynomial Regression Model
  - Predicting the Final Result with the Linear Regression Model
  - Predicting the Final Result with the Polynomial Regression Model
- Support Vector Regression (SVR)
- Decision Tree Regression
- Random Forest Regression
- Ridge Regression
- Lasso Regression
- Linear Regression Vs Logistic Regression
- Classification vs Regression

Clustering Algorithms in Machine Learning

- Types of Clustering Methods
  - Partitioning Clustering
  - Density-Based Clustering
  - Distribution Model-Based Clustering
  - Hierarchical Clustering
  - Fuzzy Clustering
- Clustering Algorithms
  - K-Means Algorithm
  - Mean-shift Algorithm
  - DBSCAN Algorithm
  - Expectation-Maximization Clustering using GMM

  - Agglomerative Hierarchical Algorithm
  - Affinity Propagation
- Applications of Clustering

Hierarchical Clustering Algorithm in Machine Learning

- Hierarchical Clustering Technique Approaches
- Why Hierarchical Clustering?
- Agglomerative Hierarchical Clustering
- How the Agglomerative Hierarchical Clustering Work?
- Measure for the Distance between two Clusters
  - Single Linkage
  - Complete Linkage
  - Average Linkage
  - Centroid Linkage
- Working of Dendrogram in Hierarchical Clustering
- Hierarchical Clustering Example with Scratch Data
- Python Implementation of Agglomerative Hierarchical Clustering
- Steps for Implementation of Agglomerative Hierarchical Clustering using Python
  - Data Pre-processing
  - Finding the Optimal Number of Clusters using the Dendrogram
  - Training the Hierarchical Clustering Model
  - Visualizing the Clusters

K-Means Clustering Algorithm in Machine Learning

- What is K-Means Algorithm?
- How does the K-Means Algorithm Work?
- How to Choose the Value of "K Number of Clusters" in K-Means Clustering?
  - Elbow Method
  - Within Cluster Sum of Squares (WCSS)
- K-Means Clustering Example with Scratch Data
- Python Implementation of K-means Clustering Algorithm
- Steps to Implement of K-means Clustering Algorithm
  - Data Pre-processing
  - Finding the Optimal Number of Clusters using the Elbow Method
  - Training the K-means Algorithm on the Training Dataset
  - Visualizing the Clusters

Association Rules in Machine Learning

- Association Rules
- Pattern Detection
- Market Basket Analysis
- Support, Confidence, Expected Confidence, Lift
- Finding Item Sets with High Support
- Finding Item Rules with High Confidence or Lift

Apriori Algorithm in Machine Learning

- Apriori Algorithm
- How does Apriori Algorithm Works?
- Apriori Algorithm Example
- Implementation of Apriori Algorithm using Python
- Limitations of Apriori Algorithm

Dimensionality Reduction & Model Selection Boosting

- Dimensionality Reduction
  - Principal Component Analysis (PCA)
  - Linear Discriminant Analysis (LDA)
  - Kernel PCA
- Model Selection Boosting
  - Model Selection
    - Grid Search & K-Fold Cross Validation
  - XGBoost

STATISTICS

- Mean, Median and Mode
- Data Variability, Range, Quartiles
- IQR, Calculating Percentiles
- Variance, Standard Deviation, Statistical Summaries
- Types of Distributions – Normal, Binomial, Poisson
- Probability Distributions & Skewness
- Data Distribution, 68–95–99.7 rule (Empirical rule)
- Descriptive Statistics and Inferential Statistics
- Statistics Terms and Definitions, Types of Data
- Data Measurement Scales, Normalization, Standardization
- Measure of Distance, Euclidean Distance
- Probability Calculation – Independent & Dependent
- Entropy, Information Gain
- Regression

NATURAL LANGUAGE PROCESSING

- Natural Language Processing Introduction
  - What is NLP?
  - History of NLP
  - Advantages of NLP
  - Disadvantages of NLP
- Components of NLP
  - Natural Language Understanding (NLU)
  - Natural Language Generation (NLG)
  - Difference between NLU and NLG
- Applications of NLP
- How to build an NLP Pipeline?

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- Phases of NLP
  - Lexical Analysis and Morphological
  - Syntactic Analysis (Parsing)
  - Semantic Analysis
  - Discourse Integration
  - Pragmatic Analysis
- Why NLP is Difficult?
- NLP APIs
- NLP Libraries
- Natural Language Vs Computer Language

Exploring Features of NLTK

  - Open the Text File for Processing
  - Import Required Libraries
  - Sentence Tokenizing
  - Word Tokenizing
  - Find the Frequency Distribution
  - Plot the Frequency Graph
  - Remove Punctuation Marks
  - Plotting Graph without Punctuation Marks
  - List of Stopwords
  - Removing Stopwords
  - Final Frequency Distribution
- Word Cloud
  - Word Cloud Properties
  - Python Code Implementation of the Word Cloud
  - Word Cloud with the Circle Shape
  - Word Cloud Advantages
  - Word Cloud Disadvantages
- Stemming
  - Stemmer Examples
  - Stemming Algorithms
    - Porter's Stemmer
    - Lovin's Stemmer
    - Dawson's Stemmer
    - Krovetz Stemmer
    - Xerox Stemmer
    - Snowball Stemmer
- Lemmatization
  - Difference between Stemmer and Lemmatizer
  - Demonstrating how a lemmatizer works
  - Lemmatizer with default PoS value
  - Demonstrating the power of lemmatizer
  - Lemmatizer with different POS values
- Part-of-Speech (PoS) Tagging
  - Why do we need Part of Speech (POS)?

    - Part of Speech (PoS) Tags
- Chunking
    - Categories of Phrases
    - Phrase Structure Rules
- Chinking
- Named Entity Recognition (NER)
    - Use-Cases
    - Commonly used Types of Named Entity
- WordNet
- Bag of Words
    - What is the Bag-of-Words method?
    - Creating a basic Structure on Sentences
    - Words with Frequencies
    - Combining all the Words
    - Final Model of our Bag of Words
    - Applications & Limitations
- TF-IDF
    - Term Frequency
    - Inverse Document Frequency
    - Term Frequency - Inverse Document Frequency

Deploying a Machine Learning Model on a Web using Flask

- What is Model Deployment?
- What is Flask?
- Installing Flask on your Machine
- Understanding the Problem Statement
- Build our Machine Learning Model
- Create the Webpage
- Connect the Webpage with the Model
- Working of the Deployed Model

DEEP LEARNING INTRODUCTION

- What is Deep Learning?
- Deep learning Process
- Types of Deep Learning Networks
    - Deep Neural Networks
    - Artificial Neural Networks
    - Convolutional Neural Networks
    - Recurrent Neural Networks
- TensorFlow
    - History of TensorFlow
    - Components of TensorFlow
    - Use Cases/Applications of TensorFlow
    - Features of TensorFlow
- Installation of TensorFlow through pip & conda

- Advantage and Disadvantage of TensorFlow
- TensorFlow Playground
- Introduction to Keras, OpenCV & Theano
- Implementation of Deep Learning

ARTIFICIAL INTELLIGENCE INTRODUCTION

- What is Artificial Intelligence?
  - Why Artificial Intelligence?
  - Goals of Artificial Intelligence
  - What Comprises to Artificial Intelligence?
  - Advantages of Artificial Intelligence
  - Disadvantages of Artificial Intelligence
- Applications of Artificial Intelligence
- History of Artificial Intelligence
- Types of Artificial Intelligence
- Types of AI Agents
  - Simple Reflex Agent
  - Model-Based Reflex Agent
  - Goal-Based Agents
  - Utility-Based Agent
  - Learning Agent
- Search Algorithms in Artificial Intelligence
  - Search Algorithm Terminologies
  - Properties of Search Algorithms
  - Types of Search Algorithms
- Subsets of Artificial Intelligence
- Implementation of Artificial Intelligence

R PROGRAMMING

- Why R Programming is Important?
- Why Learn R?
- History of Python
- Features of R
- Applications of R
- Comparison between R and Python
- Which is Better to Choose
- Pros and Cons of R
- Companies using R
- R Packages
- Downloading and Installing R
- What is CRAN?
- Setting R Environment:
  - Search Packages in R Environment
  - Search Packages in Machine with inbuilt function and manual searching

- Attach Packages to R Environment
- Install Add-on Packages from CRAN
- Detach Packages from R Environment
- Functions and Packages Help

- R Programming IDE
  - RStudio
  - Downloading and Installing RStudio
- Variable Assignment
  - Displaying Variables
  - Deleting Variables
- Comments
  - Single Line
  - Multi Line Comments
- Data Types
  - Logical
  - Integer
  - Double
  - Complex
  - Character
- Operators
  - Arithmetic, Relational, Logical, Assignment Operators
  - R as Calculator
  - Performing different Calculations
- Functions
  - Inbuilt Functions
  - User Defined Functions
- STRUCTURES
  - Vector
  - List
  - Matrix
  - Data frame
  - Array
  - Factors
- Inbuilt Constants & Functions
- Vectors
  - Vector Creation
  - Single Element Vector
  - Multiple Element Vector
  - Vector Manipulation
  - Sub setting & Accessing the Data in Vector
- Lists
  - Creating a List
  - Naming List Elements
  - Accessing List Elements
  - Manipulating List Elements

- Merging Lists
- Converting List to Vector

- Matrix
  - Creating a Matrix
  - Accessing Elements of a Matrix
  - Matrix Manipulations
  - Dimensions & Transpose of Matrix
- Data Frames
  - Create Data Frame
  - Vector to Data Frame
  - Character Data Converting into Factors: StringsAsFactors
  - Convert the columns of a data frame to characters
  - Extract Data from Data Frame
  - Expand Data Frame, Column Bind and Row Bind
- Merging / Joining Data Frames
  - Inner, Outer & Cross Join
- Arrays
  - Create Array with Multiple Dimensions
  - Naming Columns and Rows
  - Accessing Array Elements
  - Manipulating Array Elements
  - Calculations across Array Elements
- Factors
  - Factors in Data Frame
  - Changing the Order of Levels
  - Generating & Deleting Factor Levels

Loading and Reading Data in R

- Data Extraction from CSV
  - Getting and Setting the Working Directory
  - Input as CSV File, Reading a CSV File
  - Analyzing the CSV File, Writing into a CSV File
- Data Extraction from URL
- Data Extraction from CLIPBOARD
- Data Extraction from EXCEL
  - Install "xlsx" Package
  - Verify and Load the "xlsx" Package, Input as "xlsx" File
  - Reading the Excel File, Writing the Excel File
- Data Extraction from DATABASES
  - RMySQL Package, Connecting to MySql
  - Querying the Tables, Query with Filter Clause
  - Updating Rows in the Tables, Inserting Data into the Tables
  - Creating Tables in MySql, Dropping Tables in MySql
  - Using dplyr and tidyr package

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Machine Learning using R

- Data Pre-processing
- Classification Algorithms
  - K Nearest Neighbors & Naive Bayes Classification
  - Decision Tree & Random Forest Classification
  - Support Vector Machine Classification
  - Logistic Regression & Kernel SVM
- Regression Algorithms
  - Simple & Multiple Linear Regression
  - Polynomial & Support Vector Regression
  - Decision Tree & Random Forest Regression
- Clustering Algorithms
  - K-Means & Hierarchical Clustering
- Association Rule Algorithms
  - Apriori & Eclat
- Dimensionality-Reduction
  - Principal Component Analysis
  - Linear Discriminant Analysis & Kernal PCA
- Model Selection & Boosting
  - Grid Search, K Fold Cross Validation & XGBoost
- Natural Language Processing
- Deep Learning - Artificial Neural Networks

DATA MINING WEKA

- Explore Weka Machine Learning Toolkit
  - Installation of WEKA, Features of WEKA Toolkit
  - Explore & Load data sets in Weka
- Perform Data Preprocessing Tasks
  - Apply Filters on Data Sets
- Performing Classification on Data Sets
  - J48 Classification & Decision Trees Algorithm
  - K-NN & Naive-Bayes Classification Algorithm
  - Comparing Classification Results
- Performing Regression on Data Sets
  - Simple, Multi Linear & Logistic Regression Model
  - Cross-Validation and Percentage Split
- Performing Clustering on Data Sets
  - Clustering Techniques in Weka
  - Simple K-means Clustering Algorithm
  - Association Rule Mining on Data Sets
  - Apriori Association Rule Algorithm
  - Discretization in the Rule Generation Process
- Graphical Visualization in Weka
  - Visualization Features in Weka
  - Visualize the data in various dimensions
  - Plot Histogram, Derive Interesting Insights

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