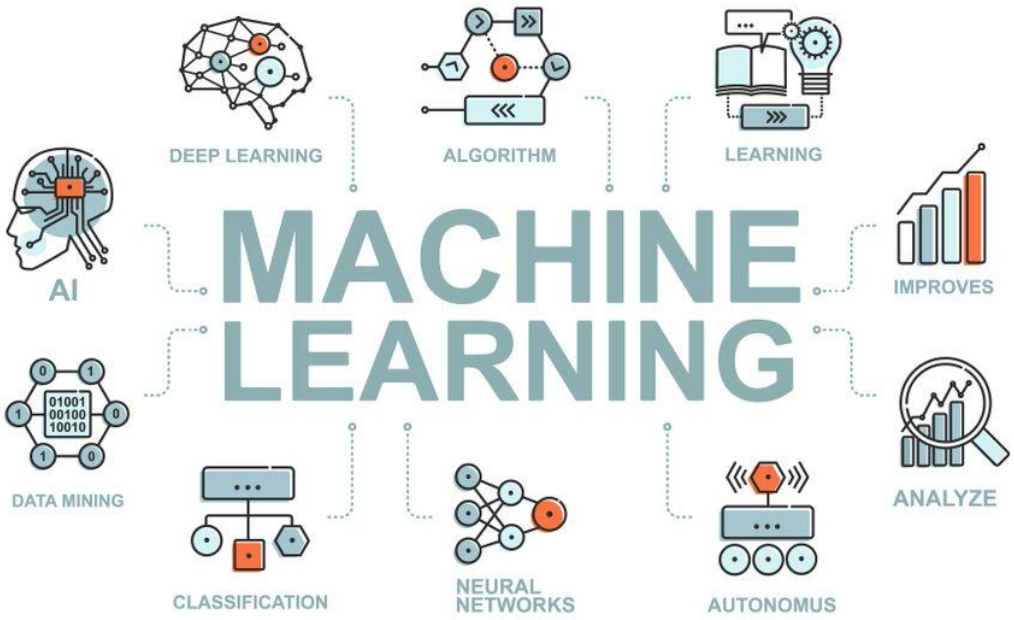
COURSE HANDOUT (COURSE CURRICULUM)

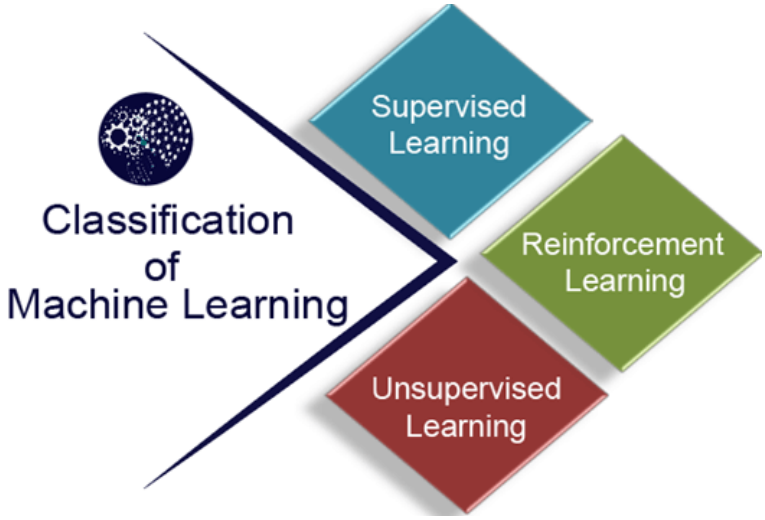
Course Title : **MACHINE LEARNING**

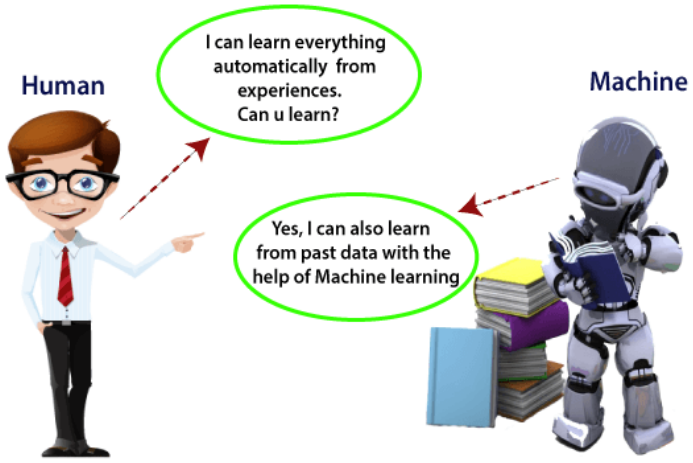
WHAT IS MACHINE LEARNING?



In the real world, we are surrounded by humans who can learn everything from their experiences with their learning capability, and we have computers or machines which work on our instructions. But can a machine also learn from experiences or past data like a human does? So here comes the role of Machine Learning.

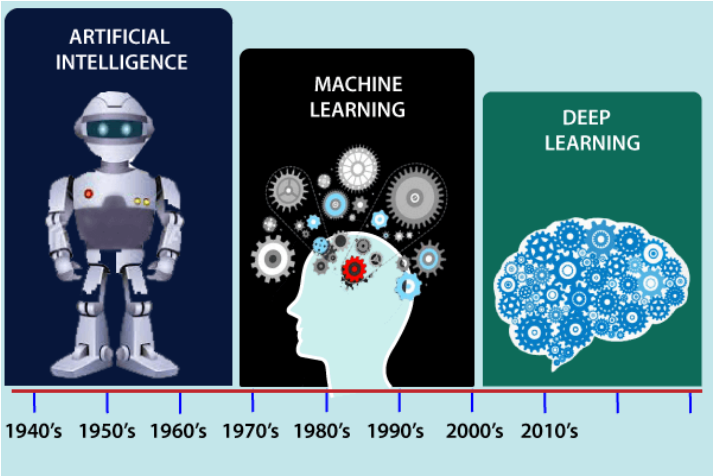
Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed.





HISTORY OF MACHINE LEARNING:

Before some years (about 40-50 years), machine learning was science fiction, but today it is the part of our daily life. Machine learning is making our day-to-day life easy from self-driving cars to Amazon virtual assistant "Alexa". However, the idea behind machine learning is so old and has a long history. Below some milestones are given which have occurred in the history of machine learning:



Machine Learning Engineer:

As we said earlier, a Machine Learning Engineer career path is one of the most coveted and promising ones in the field of Data Science. Machine Learning Engineers are primarily involved with the design and development of ML systems and applications by using ML algorithms and tools.

Machine learning engineers are also required for creating programs or models that can run without human supervision. Depending upon the requirement these engineers make models that follow different types of learning such as unsupervised, supervised or reinforcement.

The professionals are also required to write programs and extract information pertaining to the requirement. They are also required to perform, analyze or monitor the data structures. The demand for skilled professionals is very high as reflected in the numerous machine learning job roles available in the market.

MODULES THAT YOU WILL LEARN:

Module 1: Introduction to Machine Learning

- **Overview of Machine Learning (ML)**
  - Definition, importance, and real-world applications
  - Types of ML: Supervised, unsupervised, and reinforcement learning
- **ML Workflow**
  - Data collection, preprocessing, model building, evaluation, and deployment
- **Tools and Frameworks**
  - Python libraries: NumPy, Pandas, Matplotlib, Scikit-learn
  - Introduction to TensorFlow and PyTorch

Module 2: Mathematics for Machine Learning

- **Linear Algebra**
  - Vectors, matrices, and operations
  - Eigenvalues, eigenvectors, and matrix decomposition
- **Probability and Statistics**
  - Probability distributions and Bayes' theorem
  - Statistical measures: Mean, variance, standard deviation
- **Calculus and Optimization**
  - Derivatives, gradients, and chain rule
  - Gradient descent and cost functions

Module 3: Data Preprocessing and Feature Engineering

- **Data Cleaning**
  - Handling missing values, outliers, and duplicates
- **Feature Scaling and Transformation**
  - Standardization and normalization
  - Encoding categorical data
- **Feature Selection and Extraction**
  - Principal Component Analysis (PCA)
  - Feature importance and correlation analysis

Module 4: Supervised Learning

- **Regression Models**
  - Linear regression and multiple regression
  - Ridge, Lasso, and polynomial regression
- **Classification Models**
  - Logistic regression
  - Decision trees, random forests, and gradient boosting (XGBoost, LightGBM)
  - Support vector machines (SVM)
- **Model Evaluation Metrics**
  - Accuracy, precision, recall, F1 score, and ROC-AUC

Module 5: Unsupervised Learning

- **Clustering Techniques**
  - K-means, hierarchical clustering, DBSCAN
- **Dimensionality Reduction**
  - PCA, t-SNE, and UMAP
- **Anomaly Detection**
  - Applications in fraud detection and network security

Module 6: Neural Networks and Deep Learning

- **Introduction to Neural Networks**
  - Perceptrons, activation functions, and feedforward networks
  - Backpropagation and weight updates
- **Deep Learning Architectures**
  - Convolutional Neural Networks (CNNs) for image processing
  - Recurrent Neural Networks (RNNs) and LSTMs for time-series data
  - Transformers and attention mechanisms
- **Deep Learning Frameworks**
  - Building models with TensorFlow and PyTorch

Module 7: Specialized Topics

- **Natural Language Processing (NLP)**
  - Text preprocessing, tokenization, and embeddings
  - Sentiment analysis and text classification
  - Transformer models (BERT, GPT)
- **Time-Series Analysis**
  - ARIMA, Prophet, and LSTM for forecasting
  - Applications in finance and IoT
- **Reinforcement Learning**
  - Q-learning and policy gradient methods
  - Applications in robotics and game AI

Module 8: Model Deployment and MLOps

- **Model Deployment**
  - Exporting and deploying models using Flask/Django
  - Introduction to cloud platforms (AWS, Azure, GCP)
- **MLOps and Automation**
  - Version control with DVC
  - CI/CD pipelines for ML models
  - Monitoring and maintaining deployed models

Module 9: Industry Applications

- **Real-World Case Studies**
  - Predictive analytics in healthcare
  - Fraud detection in banking

- Recommender systems in e-commerce
- Image recognition in autonomous vehicles

Module 10: Capstone Projects

- **Hands-On Industry Projects**
  - Building an end-to-end recommender system
  - Predictive maintenance using IoT sensor data
  - Customer segmentation using clustering
  - Time-series forecasting for stock prices

Module 11: Soft Skills and Career Preparation

- **Data Storytelling**
  - Creating effective visualizations and reports
- **Interview Preparation**
  - Solving ML problems in coding interviews
  - Common industry scenarios and challenges

FOR FURTHER INFORMATION:

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