Subject: U24CST362 – Machine Learning Fundamentals

Course: B. Sc Computer Science with specialization in Artificial Intelligence and Machine Language

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UNIT I : Introduction

Learning Objectives

- Understand the foundation of machine learning
- Explore how ML evolved from traditional computing
- Identify types of machine learning
- Learn real-world applications
- Know basic tools for ML development

What is Machine Learning ?

Definition:

Machine Learning (ML) is a subset of Artificial Intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

Arthur Samuel (1959) defined ML as:

"The field of study that gives computers the ability to learn without being explicitly programmed."

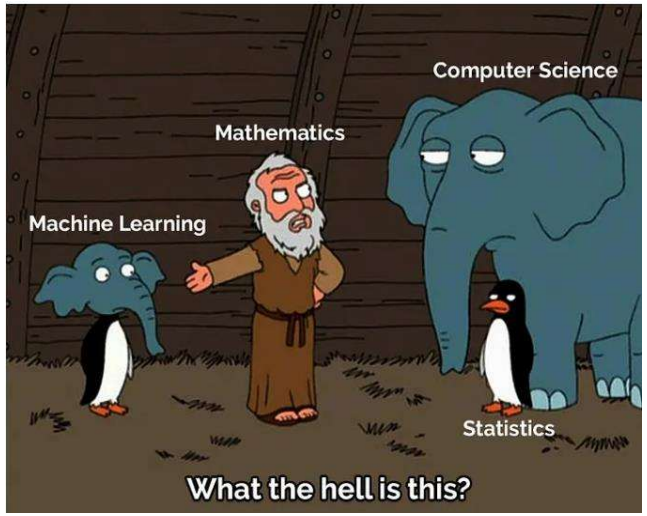
Example:

Email spam filters

Movie recommendations on Netflix

Fraud detection in banking

A Brief History/ Evolution of Machine Learning

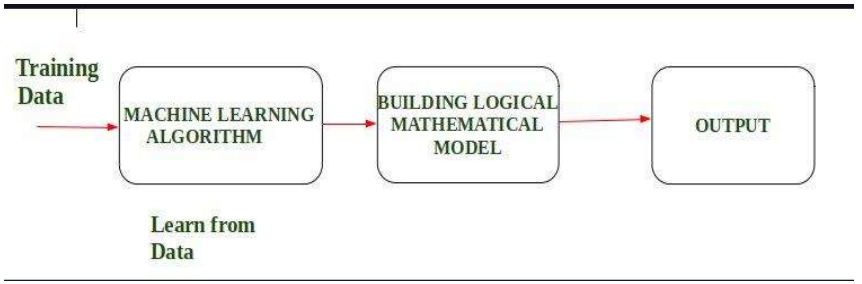


ERA	MILESTONE
1950s	Turing Test, Alan Turing proposes "learning machines"
1957	Perceptron introduced by Frank Rosenblatt
1967	Nearest Neighbor algorithm developed
1980s	Emergence of neural networks (backpropagation)
1997	IBM's Deep Blue defeats chess champion Garry Kasparov
2006	"Deep Learning" term popularized by Geoffrey Hinton
2012–Present	ImageNet, AlphaGo, GPT, Self-driving cars

Traditional Programming vs ML

Aspect	Traditional Programming	Machine Learning
Approach	Rules and logic are hardcoded	Learns from data
Input	Data + Program	Data + Output
Output	Output	Program (Model)
Flexibility	Fixed for all inputs	Adapts to new data
Example	If age > 18 then eligible	Learns eligibility from examples

Key Components of ML System



Core Components:

Data (examples or observations)

Model (the pattern-finding logic)

Learning Algorithm (optimizes the model to fit the data)

Design of Learning System

Step 1: Choosing the Training Experience

Select meaningful and high-impact training data.

Example: In chess, data helps evaluate better moves.

Step 2: Choosing the Target Function

Define the goal or function the model should learn.

Example: In chess, `NextMove()` function predicts the best legal move.

Step 3: Representing the Target Function

How the target function is structured internally

Example: Out of 4 legal chess moves, choose the one with highest win probability.

Step 4: Choosing the Function Approximation Algorithm

Use learning algorithms to approximate the target function.

Example: ML model fails initially but improves with repeated play.

Step 5: Final Design of the Learning System

Model is finalized after:

Experiencing many examples

earning from past mistakes

Example: **IBM's Deep Blue** defeated Garry Kasparov by learning from past

Types of Machine Learning

1. Supervised Learning

Trains on labeled data (input + output).

Goal: Predict outputs from known inputs.

Common Tasks: Classification (spam detection), Regression (house price prediction).

Examples: Decision Trees, SVM, Linear Regression.

2. Unsupervised Learning

Trains on unlabeled data (only inputs).

Goal: Discover hidden patterns or groupings.

Common Tasks: Clustering (customer segmentation), Association (market basket analysis).

Examples: K-Means, DBSCAN, Apriori.

3. Reinforcement Learning

Goal: Learn through **trial-and-error** with rewards/penalties.

Agent interacts with environment, improves performance over time.

Examples: Q-Learning, Deep Q-Networks.

Use Cases: Robotics, Game AI, Self-driving cars.

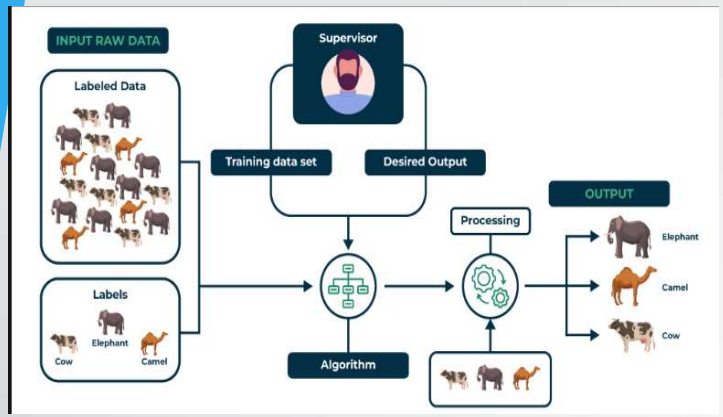
4. Semi-Supervised Learning

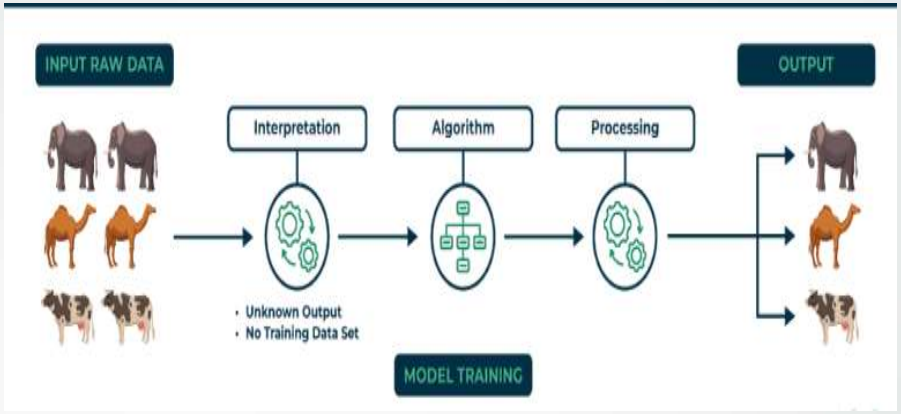
Combines **small labeled** + **large unlabeled** data.

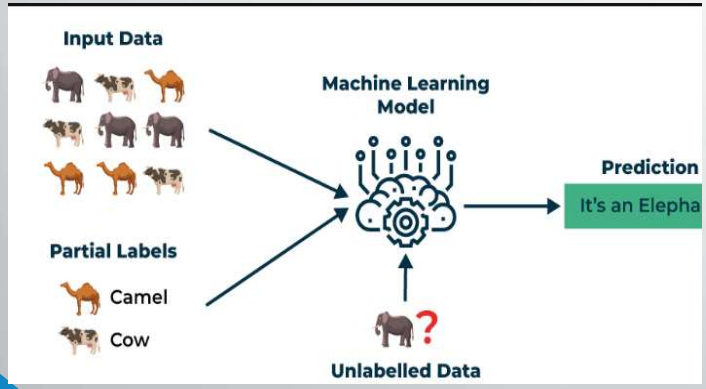
Useful when labeling data is expensive.

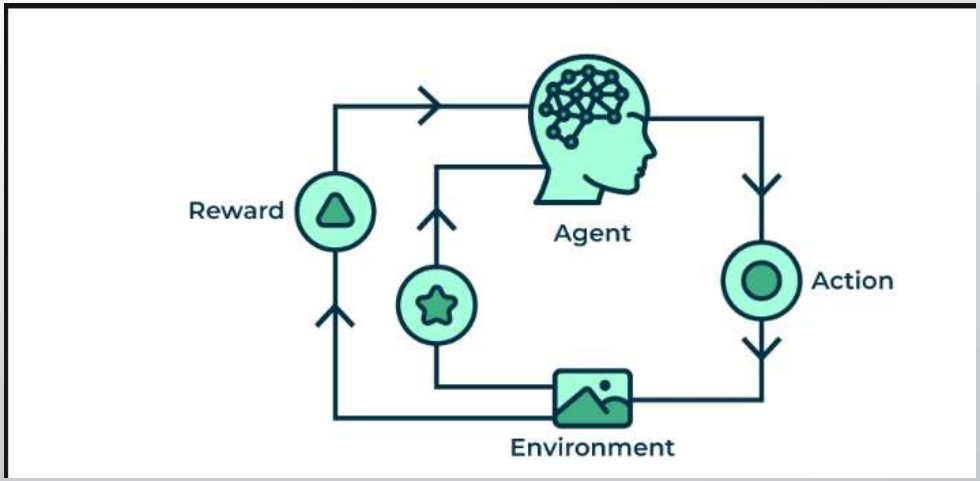
Methods: Label Propagation, Self-training, GANs.

Applications: NLP, Image Recognition, Healthcare.


INPUT RAW DATA
Supervisor
Labeled Data
Training data set
Desired Output
OUTPUT
Processing
Elephant
Camel
Cow
Labels
Elephant
Cow
Camel
Algorithm


INPUT RAW DATA
OUTPUT
Interpretation
Algorithm
Processing
Unknown Output
No Training Data Set
MODEL TRAINING


Input Data
Machine Learning Model
Prediction
It's an Elepha
Partial Labels
Camel
Cow
Unlabelled Data


Reward
Agent
Action
Environment

Applications of Machine Learning

Domain	Use Case
Healthcare	Disease prediction, medical imaging
Finance	Credit scoring, fraud detection
Retail	Recommendation systems
Manufacturing	Predictive maintenance
Agriculture	Crop yield prediction
Security	Intrusion detection, facial recognition
Education	Student performance prediction

Real-World Examples

Netflix / YouTube	Recommender systems based on user history
Google Translate	NLP models trained on multilingual data
Amazon Alexa / Siri	Voice recognition using deep learning
Self-Driving Cars	Computer vision and reinforcement learning
Facebook / Instagram	Face recognition and content filtering
Stock Market	Algorithmic trading and price prediction

Tools & Libraries for Machine Learning

Language	Why it's Used in ML
Python	Most popular ML language; simple syntax, huge library support (NumPy, scikit-learn, TensorFlow, PyTorch).
R	Best for statistical modeling and data visualization. Preferred by statisticians.
Java	Used in large-scale, high-performance systems (e.g., Apache Spark MLlib).
Julia	Fast mathematical computation, good for numerical ML tasks and large datasets.

Platform	Description
Jupyter Note book	Interactive coding environment; ideal for step-by-step ML model development.
Google Colab	Free cloud-based Jupyter Notebook with free GPU/TPU support. Ideal for students & researchers.
Azure ML	Microsoft's cloud-based ML platform with automation, deployment, and scalability support.
AWS SageMaker	Amazon's fully-managed ML service that allows building, training, and deploying ML models at scale.