* Machine Learning *

⊙ Artificial Intelligence (AI) :-

Artificial + Intelligence

(Human / non-natural made thing.)

(Ability to understand / think)

> study of how to train computers, so that comp can do things which humans can do.

↳ Adding human abilities to machines.

⊙ Machine Learning (ML) :-

↳ Learning in which m/c can learn on its own, w/o explicitly programmed.

↳ Appln of AI - provide system ability to automatically learn & improve from experience.

> Learn from experience (E) w.r.t. some class of Task (T) & ~~perspo~~ performance (P), if learner's performance at the task as measured by P improves by experiences.

⊙ Difference betⁿ AI & ML :-

Artificial Intelligence	Machine Learning
① AI first used in 1956, by John McCarthy, hosted AI first conference.	① First used in 1952 by IBM comp scientist Arthur Samuel.
② Ability to acquire & apply knowledge.	② Acquisition of knowledge / skills.
③ Contains ML & DL as subsets.	③ ML is subset of AI.
④ Aim - ↑ chance of success, not accuracy.	④ ↑ accuracy, not care about success.
⑤ Develop system able to perform complex tasks like decision-making.	⑤ Construct m/c able to perform tasks trained to them.
⑥ Goal - Simulate natural intelligence to solve the complex problem.	⑥ Goal - Learn from data on certain task to maximize performance.
⑦ Develop systems that mimics humans to solve problems.	⑦ Involves creating self-learning algorithms.
⑧ Find optimal solution.	⑧ Find a solution, whether optimal or not.

Artificial Intelligence	Machine Learning
(9) Broad categories of AI: ↳ Narrow Intelligence ↳ General Intelligence ↳ Super Intelligence.	(9) Broad categories of ML: ↳ Supervised Learning ↳ Unsupervised Learning ↳ Reinforcement Learing.
(10) AI work with structured, semi-structured & unstructure data.	(10) ML works with the structured & semi-struc data only.
(11) Uses of AI - ↳ Siri, chatbots. ↳ Expert systems. ↳ Google Translate. ↳ Humanoid robots like Sophia.	(11) Uses of ML - ↳ Google search algo. ↳ Bank fraud analysis ↳ Stock price forecast. ↳ Online recommendan system - e-commerce.
(12) Perform tasks like - ↳ Natural lang Processing ↳ Recognize images. ↳ Making decisions ↳ Solve complex problems.	(12) Train algos on data to- ↳ make decisions ↳ Predictions ↳ Recommendations.

⊙ Machine Learning :-

↳ Enable computers to learn automatically from past data.

↳ ML uses algos for building math models & make predictions using historical data / info.

↳ Used for performing tasks like- image, speech recognition, speech recognition, email filtering, Facebook auto-tagging, recommendan systems.

> Machine has ability to learn, if it can improve its performance by gaining more data.

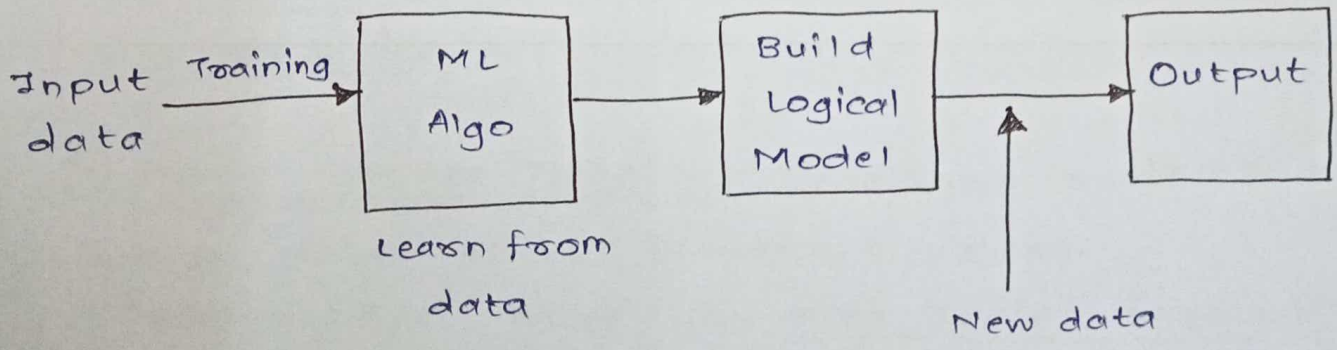
- **How ML works** —

① Learn from historical data.

② Build prediction models

③ Then receive a new data.

④ Predict o/p for new data.



Applications of Machine Learning:-

1. **Image Recognition** – classify images between cat & Dog & evolve to **Face Recognition** and real-world use cases like- **employee attendance**.

2. **Speech Recognition** – smart systems like **Alexa** & **Siri**, used for communication. convert voice instruc^n to text. **Google Speech searches** by speaking.

3. **Recommendation System** – Analyze user preferences & search history ⇒ recommend content/ service to them.
   Ex. **YouTube** recommend videos. **Netflix** recommend movies & series.

4. **Fraud Detection** – detect fraud transac^n & fraad activities.

5. **Self Driving cars** – car drive without driver.
   Ex. **Tesla** cars.

6. **Medical Diagnosis** – Perform health-related tasks. Detect disease & cure for that diseases.
   Ex. **Breast cacer classification**, **Parkinson's Disease Classification** & **Pneumonia Detection**.

7. **Stock Market Trading** – Intelligent systems predict future price trends & market values.
   ↳ Application based on- **time series forecasting**.

⊙ Limitations of Machine Learning :-

① **Data Quality** – Ensure data accurate, complete & representative of problem-domain.
↳ Inaccurate data ⇒ incurate / biased models.

② **Data Quantity** – Large data unavailability, esp complex problems, require large data.

③ **Bias & fairness** – Somtimes bias & discrimin^{n} in training ⇒ unfair outcomes (minorities).

④ **Overfitting & Underfitting** –

Overfitting: Model too complex & fits training data verry well, poor result for new data.

Underfitting: Model too simple & cannot capture all relevant patterns in data.

⑤ **Privacy & Security** – Interact sensitive info of people / organiza^{n} ⇒ Raise privacy & security concern.

⑥ **Interpretability** – some models like deep neural n/w, difficult interpret & understand, challange for predictions & decisions.

⊙ Types of Machine Learning :-

Points	Supervised	Unsupervised	Reinforcement
Aim	Calculate outcom.	Discover patterns.	Learn series of action.
Input data	Labelled	Unlabelled.	Not pre-defined.
Problem	Learn pattern in i/p & their labels.	Divide data into classes.	Find best reward betⁿ start & end state.
Solution	Find mapping eqⁿ on i/p data & its labels.	Find patterns in i/p & classify.	Maximize result by results of actions.
Model Building	First, build & train, then test.	Build & train, then test.	Train & test simultaneously.
Applications	classification & Regression problems.	clustering & association problems.	Deals with exploration & exploitation problems.
Algorithms used	• Linear Regrⁿ. • Decision tree. • K-nearest neighbors.	• k-means clustering. • k-medoids clustering • agglomerative clustering.	• Q-Learning. • SARSA • Deep Q n/w.
Examples	• Img Detecⁿ. • Population Growth Detecⁿ.	• Cust segmentaⁿ, • Feature elicitaⁿ. • Targeted market.	• Driver less car. • self-navigating cleaners.

1) Supervised Learning :-

↳ Teach / train m/c using well-labelled data.

↳ Then, new set of data provided to analyze training data & produce correct outcome.

↳ M/c learn from training data & then applies knowledge to test data.

- 2 categories of algo :

① Classification - Outcome variable is categorical.
Ex. Red / Blue, Yes/No.

② Regression - Output variable is a real value.
Ex. Price, weight, population.

- Advantages -

① Optimize performance with experience.
② Classification & Regression tasks.
③ Estimate / map result to new sample.

Limitations -

① Big data classificn challenge.
② Labelled data training large time required.
③ Require labelled data.
④ Cannot handle complex task.

- Algorithms -

① Regression
② Logistic Regression
③ classification
④ Naive Bayes classifiers
⑤ K-NN (K nearest neighbors)
⑥ Decision Tree
⑦ Support vector Machine (SVM)

2) Unsupervised Learning:-

↳ Training m/c using info not labelled / classified & allow act on them w/o guidance.

↳ Find underlying patterns in data without any prior training.

↳ Mainly deal with unlabelled data.

- 2 categories -

① clustering - Discover inherent groups in data, like grouping customer by purchasing.

② Association - Describe rules that describe large data, ex if customer buy X => also tend to buy Y.

- Clustering -

① Exclusive (partitioning)
② Agglomerative
③ Overlapping
④ Probabilistic.

- Clustering Algos -

① Hierarchical clustering
② K-means clustering
③ Principal Component Analysis
④ Singular Value Decomposition
⑤ Independent Component Analysis

- Advantages -

① No training data lebelled.
② Dimensionality reduction.
③ Find unknown patterns.
④ Flexible - Apply on wide range of problems - cluster, anomaly detec^n & association.
⑤ Exploration - Explore data & find patterns.
⑥ Low cost - Less expensive, because unlabelled data. Label - time & costly.

- Limitations -

① Lack measure accuracy.
② No predefined answers.
③ Time to interpret & label classes in classifica^n.
④ Lack guidance - No guidance & feedback, difficult know patterns relevant & useful.
⑤ Scalability - complex problems, computationally expensive.
⑥ Sensitivity to data quality - Data include missing values, outliers & noise.