# 🌟 Machine Learning

Think of ML like teaching a kid.

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# 1️⃣ Supervised Learning → "Teacher helps"

You give:

- **Question**

- **Correct Answer**

Kid learns by seeing examples again and again.

## ✅ Two Types inside Supervised Learning

## (i) Classification → Choose a category

Model predicts *labels*.

Examples:

- Cat vs Dog

- Spam vs Not spam

- Disease vs No disease

**Methods used:**

- Logistic Regression

- SVM

- Decision Trees

- Random Forest

- KNN

- Naive Bayes

- Neural Networks

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**(ii) Regression → Predict a number**

Model predicts *continuous value*.

Examples:

- House price

- Temperature

- Salary

**Methods used:**

- Linear Regression

- Polynomial Regression

- SVR

- Decision Tree Regressor

- Random Forest Regressor

🧠 **Model learns: Input → Output**

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# 2️⃣ Unsupervised Learning → "Kid explores alone"

No answers given.
 Kid finds hidden patterns by himself.

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# ✅ Types of Unsupervised Learning

## (i) Clustering → Group similar things

Examples:

- Group customers (rich, medium, low spenders)

- Google Photos grouping faces

**Methods used:**

- K-Means

- Hierarchical Clustering

- DBSCAN

- Gaussian Mixture Models

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## (ii) Dimensionality Reduction → Compress information

Examples:

- Reduce 100 features → 2 features

- Remove noise

- Visualize data

**Methods used:**

- PCA

- t-SNE

- UMAP

- Autoencoders

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**(iii) Association Rule Learning → Find items that go together**

Examples:

- Amazon "People also bought"

- Market basket

**Methods used:**

- Apriori

- FP-Growth

🧠 **Model learns: Patterns, groups, similarities**

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# ③ Semi-Supervised Learning → "Teacher gives few answers"

A little labeled data + lots of unlabeled data.

Useful when **labeling is expensive**.

Examples:

- Medical images

- Speech recognition

- Google Photos face grouping

**Methods used:**

- Pseudo-labeling

- Self-training

- Consistency regularization

- Graph-based methods

🧠 Model uses both:
**Few examples + a lot of raw data**

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# 4️⃣ Reinforcement Learning → "Kid learns by trial & error"

Kid tries → reward or penalty → learns best behavior.

Examples:

- Self-driving car

- Robotics

- Chess AI

- Stock trading bots

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# ✅ Types inside Reinforcement Learning

**(i) Value-Based Methods**

Learn value of states/actions.

- Q-Learning

- Deep Q-Networks (DQN)

## (ii) Policy-Based Methods

Learn the best policy directly.

- REINFORCE

- PPO (Proximal Policy Optimization)

## (iii) Actor–Critic Methods

Combination of value + policy learning.

- A2C

- A3C

- DDPG

🧠 **Model learns: Do → Get Reward → Improve**

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# 5️⃣ Self-Supervised Learning → "Kid creates his own questions"

The model creates labels from data itself.
It hides some part of input → predicts missing part.

Examples:

- GPT predicting next word

- BERT masking words

- Vision transformers predicting image patches

## Methods used:

- Masked Language Modeling (MLM)

- Next Token Prediction (GPT)

- Contrastive Learning (SimCLR, MoCo)

- Autoencoders

- BYOL / DINO

🧠 **Model learns internal structure of data**
(This is the core of modern Deep Learning)

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# ⭐ THE BEST MEMORY TRICK (Now with Types + Methods)

| Student Type | ML Type | How They Learn | Sub-types | Main Algorithms |
|---|---|---|---|---|
| Teacher + Answers | **Supervised** | Labeled data | Classification, Regression | SVM, LR, RF, NN |
| No teacher | **Unsupervised** | Finds patterns | Clustering, Dimensionality Reduction, Association | K-Means, PCA, Apriori |
| Few answers | **Semi-supervised** | Mix of both | Pseudo-label, Graph methods | Self-training, Consistency loss |
| Learns by reward | **Reinforcement** | Trial & error | Value, Policy, Actor-Critic | Q-learning, PPO, DQN |
| Creates own questions | **Self-supervised** | Predict missing parts | Masking, contrastive | BERT, GPT, SimCLR |