

Models and its Types

• What are Models?

Models are simplified mathematical or computational representations of real-world processes, used for analysis, prediction and understanding data patterns.

• Types of Models

1. **Statistical Models** - Uses mathematical equations and probability to describe data or relationships.
2. **Machine Learning Models** - Algorithms that learn from data to predict and classify outcomes.
3. **Deep Learning Models** - A subtype of ML using neural networks with multiple layers for complex data and tasks.
4. **Generative Models** - Create new data similar to training data by learning data distributions.

• Statistical Models

They describe real-world phenomena using assumptions about how data is generated, helping quantify relationships and predict future outcomes.

Examples:

- Linear Regression: Predicts continuous value.

There are two common types of linear regression -

- simple linear regression (one independent variable)

Formula of simple linear regression: $y = \beta_0 + \beta x$.

In the formula, y is the dependent variable, x is the independent variable, β_0 is the intercept and β is the slope.

Example: Predicting house prices based on size.

- multiple linear regression (two or more – multiple independent variables).

In the formula, y is the dependent variable, x is the independent vector of independent variables, β_0 is the intercept, and $\beta_1, \beta_1, \dots, \beta_n$ are coefficients for respective features such as x_1, x_2, \dots, x_n .

Example: Predicting house prices based on multiple independent variables such as size, location, number of bedrooms.

Formula of multiple linear regression: $y = \beta_0 + \beta_1 \times 1 + \beta_2 \times 2 + \dots + \beta_n \times n$.

- **Logistic Regression:** Predicts probability for binary outcomes.

Example: Whether a customer will buy a product or not.

• Machine Learning Models

ML models automatically learn from data examples to predict or classify unseen data.

The key advantage of ML is that it improves automatically through experience, making it suitable for solving complex problems where traditional programming fails.

Machine Learning can broadly be categorized into three main types:

1. Supervised Learning - It is a type of machine learning where the model is trained using a labeled dataset.

Examples -

- **Decision Trees** (Classify or predict outcomes in treelike structure),
- **Random Forest** (Combining multiple Decision Trees for better accuracy)

2. Unsupervised Learning - It is a type of ML where the data used for training is unlabelled. Examples - K means Clustering (Find clusters or groups in data classes)

3. Reinforcement Learning - It is a type of ML where an agent learns by interacting with its environment. The agent takes actions, receives feedback in the form of rewards or penalties, and adjusts its strategy to maximize long-term rewards.

• Deep Learning Models

Neural networks with multiple layers that can process complex data like images, text and sequences with human-like accuracy.

Examples -

- **Convolutional Neural Networks (CNN)** - Processes images for tasks like face detections.
- **Recurrent Neural Networks (RNN)** - Analyse sequential data like time series forecasting.
- **Transformers** - Handles language tasks like text summarization etc. and power models like GPT.

• Generative Models

Advances models that can create new content, from realistic images to human-like text, by learning data distributions.

Examples -

- **Generative Adversarial Networks (GAN)** - Neural Network that creates realistic images, audios and text.
- **Large Language Models (LLM)** - These are designed to understand and generate human-like natural language text. Eg - ChatGPT
- **Diffusion Models** - Specialized in generating continuous data types such as images, audio and video. Eg - DALL-E