

WEEK 1 ASSESSMENT

1. What is machine learning?

Machine Learning (ML) is a branch of Artificial Intelligence (AI) where computers learn from data to make predictions or decisions without being explicitly programmed for every rule. Instead of following fixed instructions, ML systems improve automatically through experience (training on data).

Real-World Explanation (Simple Analogy)

Imagine teaching a child to recognise cats:

- You show them many pictures of cats and say, "This is a cat."
- Over time, the child learns patterns (whiskers, pointy ears, fur) and can identify new cats they've never seen before.

Machine learning works similarly:

- A computer is "trained" on lots of data (e.g., cat/dog photos).
- It detects patterns (e.g., cats with pointy ears and dogs with longer snouts).
- Later, it can classify new images correctly.

Scientific Definition:

Machine learning is the study of algorithms that:

1. Learn from data (input → examples, output → predictions).
2. Improve performance** over time (optimisation).
3. Generalise to unseen data (avoid "memorising" training examples).

Key Types of ML:

1. Supervised Learning (Labelled data)
 - Example: Spam detection (input: email, output: "spam" or "not spam").
2. Unsupervised Learning (No labels)
 - Example: customer segmentation (grouping users by behaviour).
3. Reinforcement Learning (Trial & error)
 - Example: AI playing chess (reward for winning, penalty for losing).

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Real-World Applications

- Netflix Recommendations (Predicts what you'll watch next).
- Self-Driving Cars (Recognises pedestrians, traffic signs).
- Medical Diagnosis (Detects tumours in X-rays).
- Chatbots (like ChatGPT, which learns from conversations).

2. What is a supervised machine learning algorithm?

Supervised machine learning is a method where a computer algorithm learns from example data that has both inputs and the correct outputs (called "labels"). The goal is to train the algorithm so it can predict the correct output for new, unseen data.

How It Works: Step-by-Step

1. Labelled Data Collection

- You collect a dataset that includes both the features (inputs) and the labels (correct answers).
- Example: For predicting if an email is spam, each is labelled as "spam" or "not spam" and includes features like sender, subject, and content.

2. Training

- The algorithm looks at the input features and the correct outputs.
- It learns the relationship between the inputs and outputs by adjusting its internal settings to minimise mistakes.

3. Testing

- After training, you test the model on new data it hasn't seen before to check how well it predicts the correct output.

4. Prediction

- Once trained, the algorithm can predict the output (label) for new input data.

Types of Supervised Learning Problems

- **Classification:** The output is a category or class (e.g., spam vs. not spam, disease vs. no disease)
- **Regression:** The output is a continuous value (e.g., predicting house prices, temperature)

Common Supervised Machine Learning Algorithms

Algorithm	Type	What It Does	Example Use Case
Linear Regression	Regression	Predicts continuous values	Predicting house prices
Logistic Regression	Classification	Predicts categories (binary or multiple)	Email spam detection
Decision Tree	Both	Splits data into branches to make decisions	Medical diagnosis
Random Forest	Both	Combining many decision trees for better accuracy	Credit risk assessment
Support Vector Machine (SVM)	Both	Finds the best boundary between classes	Image classification
K-Nearest Neighbours (KNN)	Both	Looks at the closest data points to make predictions	Handwriting recognition
Neural Networks	Both	Mimics the human brain to find complex patterns	Speech recognition
Naive Bayes	Classification	Uses probability to predict categories	Text classification

Simple Example

Suppose you want to teach a computer to recognise apples and oranges:

- **Inputs (features):** Colour, weight, texture

- **Labels (outputs):** "Apple" or "Orange"
- **Process:** You show the computer many examples of apples and oranges with their features and labels. The algorithm learns patterns (e.g., apples are usually red or green and lighter; oranges are orange and heavier).
- **After Training:** You give the computer a new fruit's features, and it predicts if it's an apple or an orange.

3. What is regression and classification?

What is regression?

Regression is a statistical method used to understand and model the relationship between a *dependent variable* (the outcome you want to predict) and one or more *independent variables* (the factors you think influence the outcome). In simple terms, regression helps you answer questions like, "How does changing one thing affect another?" or "Can I predict a result based on certain inputs?"

How Regression Works:

- You collect data that includes both the outcome (dependent variable) and the influencing factors (independent variables).
- The regression algorithm analyses this data to find a mathematical relationship between the inputs and the output.
- The result is usually an equation or a line (in the case of linear regression) that best fits the data and can be used to make predictions.

Key Concepts:

- **Dependent Variable (Y):** The main variable you want to predict or explain (e.g., house price).
- **Independent Variable(s) (X):** The factors that might affect the dependent variable (e.g., size of the house, number of bedrooms).
- **Regression Line:** In linear regression, this is a straight line that best represents the relationship between X and Y.

Types of Regression:

- **Linear Regression:** Models a straight-line relationship between the dependent and independent variables.
- **Multiple Regression:** Uses two or more independent variables to predict the dependent variable.
- **Other Types:** There are many other forms, such as logistic regression (for classification), polynomial regression (for curved relationships), ridge and lasso regression (for complex data), and more.

Simple Example:

Suppose you want to predict a person's salary based on their years of experience:

- *Dependent variable:* Salary
- *Independent variable:* Years of experience

Regression analysis would help you find out how much salary increases for each additional year of experience, and you could use the resulting equation to predict salaries for new employees.

What Is Regression Used For?

- Making predictions (e.g., forecasting sales, prices, or trends)
- Understanding relationships between variables (e.g., how advertising spend affects sales)
- Identifying which factors have the most impact on an outcome.

What is classification?

Classification is a supervised machine learning method where the goal is to predict the correct category or label for a given input data based on patterns learned from labeled training data. Essentially, classification algorithms learn from examples where the input data is already tagged with the correct class, and then use this learning to assign labels to new, unseen data points.

- **Purpose:** To categorise input data into discrete classes or groups.
- **Input:** Features or variables describing the data.

- **Output:** A class label (e.g., spam or not spam, cat or dog).
- **Training:** The model is trained on labelled data (inputs with known outputs).
- **Prediction:** After training, the model predicts the class of new data.

Types of Classification Problems:

- **Binary Classification:** Involves two classes, such as spam vs. not spam or disease vs. no disease.
- **Multi-Class Classification:** Involves more than two classes, such as classifying an image as a cat, dog, or bird.
- **Multi-Label Classification:** Each instance can belong to multiple classes simultaneously (e.g., tagging a photo with multiple labels).
- **Imbalanced Classification:** When the classes are not equally represented in the dataset (e.g., 90% one class, 10% another).

How Classification Works:

1. The algorithm learns from a training dataset with known labels.
2. It builds a model that captures the relationship between input features and class labels.
3. The model is tested on new data without labels.
4. It assigns the most probable class label to each new data point.

Examples of Classification Applications:

- Email spam detection (spam or not spam)
- Medical diagnosis (disease or no disease)
- Image recognition (identifying objects in photos)
- Customer churn prediction (will a customer leave or stay)

- Sentiment analysis (positive, negative, or neutral sentiment)

Popular Classification Algorithms:

- Logistic Regression
- Decision Trees
- Support Vector Machines (SVM)
- K-Nearest Neighbors (KNN)
- Artificial Neural Networks⁸

Feature	Regression	Classification
Prediction Output	Continuous value (e.g., price, temperature, age)	Discrete class/label (e.g., spam/not spam, cat/dog)
Goal	Estimate or predict a numeric quantity	Assign input to one of several predefined categories
Examples	Predicting house prices, stock values, rainfall	Email spam detection, disease diagnosis, image labels
Algorithm Types	Linear regression, polynomial regression, decision tree regression, random forest regression	Logistic regression, decision tree classification, random forest classification, SVM, KNN, Naive Bayes
Nature of Output	Ordered, infinite possible values	Unordered, finite possible values

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Evaluation Metrics	Mean Squared Error (MSE), Root Mean Squared Error (RMSE), R^2 score	Accuracy, Precision, Recall, F1-score, ROC-AUC
Typical Use Case	Forecasting, trend analysis, risk assessment	Categorization, diagnosis, fraud detection
Mapping Function	Maps input to a continuous output	Maps input to a class label