# Introduction to AI/ML

Goal

- The goal of this module is to provide a high-level introduction of the foundations of Artificial Intelligence and Machine Learning (ML)
- By the end of this module, you will be able to:
  - Understand the principles of AI and ML
  - Provide key distinctions between both concepts
  - Hands on experience on the ML workflow

What is Artificial Intelligence?

- AI is a branch of computer science aimed at building machines capable of performing tasks that typically require human intelligence.

- These tasks include learning, reasoning, problem-solving, understanding natural language, and perception.

Artificial Intelligence
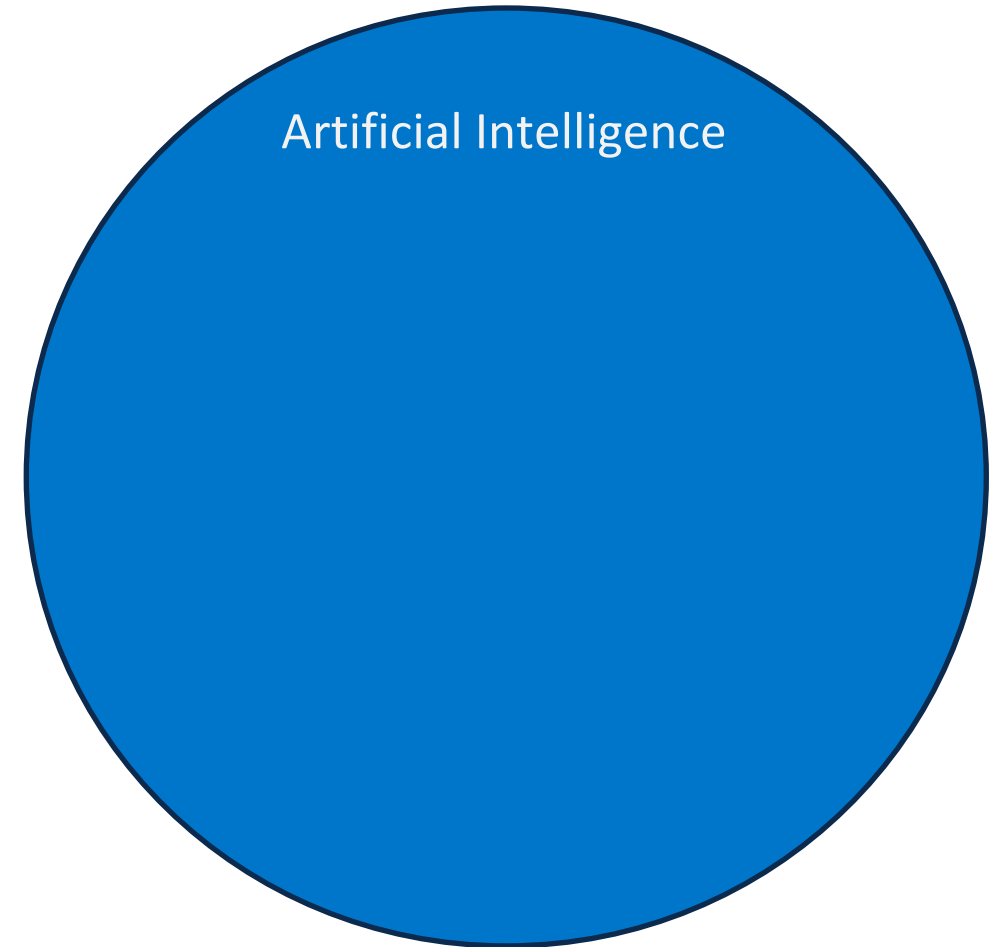
- Narrow AI
  – Performs specific tasks (e.g. Siri, Alexa, Netflix recommendations).
  – Task-specific systems without general understanding.

- General AI
  – Theoretical concept of AI with human-like intelligence
  – Capable of understanding, learning, and applying knowledge across various tasks.
  – No real-world examples yet; remains speculative

- Super intelligent AI
  – AI that exceeds human intelligence and capability
  – Encompasses scientific creativity, wisdom, and social skills
 – Highly theoretical and speculative with no current real-world instances.

- ## Machine Learning (ML):
  - Algorithms that allow machines to learn from data.

- ## Deep Learning:
  - A subset of ML using multi-layered neural networks.
  - Recognizes complex patterns in large datasets.

- ## Natural Language Processing (NLP):
  - Technology enabling machines to understand human language.

- ## Robotics:
  - Design and creation of robots for autonomous or semi-autonomous tasks

- ## Computer Vision:
 - Allows machines to interpret visual data and make decisions.

Machine Learning

- Machine Learning is a subset of AI that focuses on the development of algorithms that can learn to make predictions or decisions based on data.

- This learning can improve over time with more data and experiences.

Artificial Intelligence

Machine Learning

ML vs. Traditional Programming
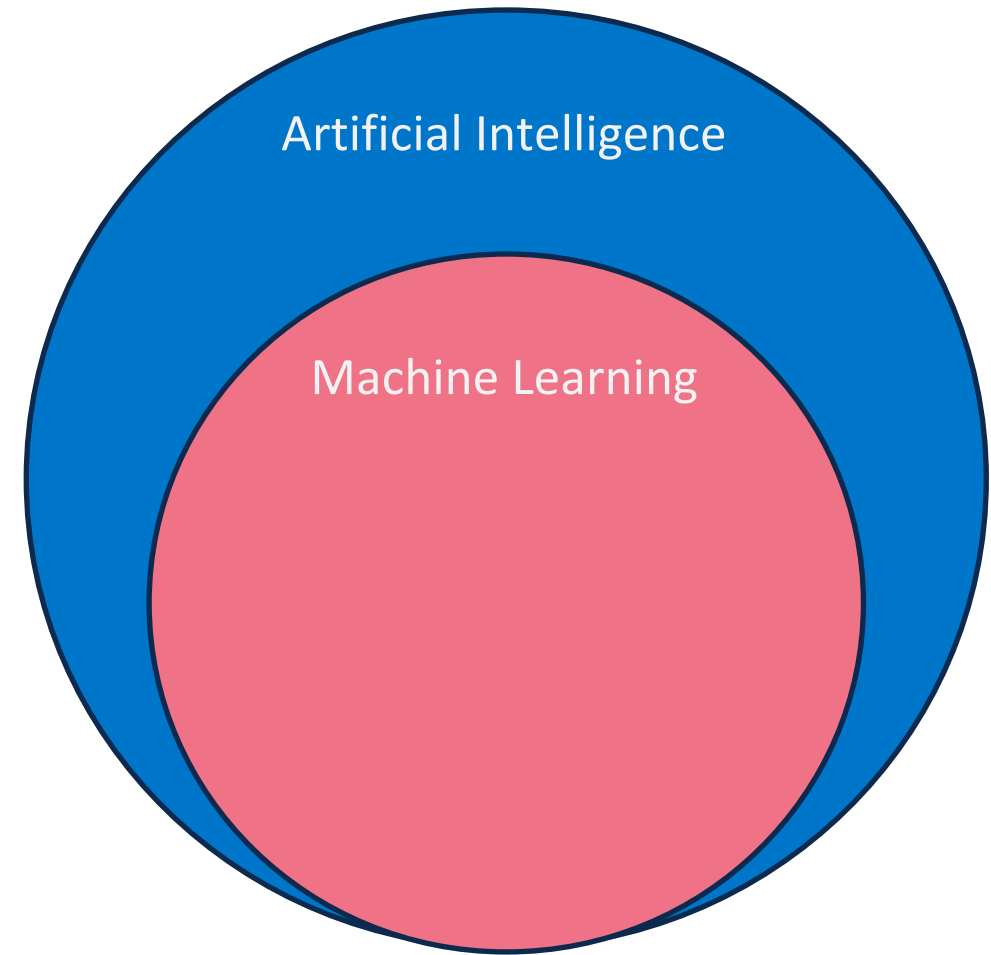
- ## Traditional Programming
  - Relies on explicit rules and instructions defined by developers
  - Works well for tasks with clear, deterministic algorithms.

- ## Machine Learning
  - Learns patterns from data and makes decisions or predictions
  - Ideal for complex tasks where rules are not easily definable.

AI vs ML – What's the difference?
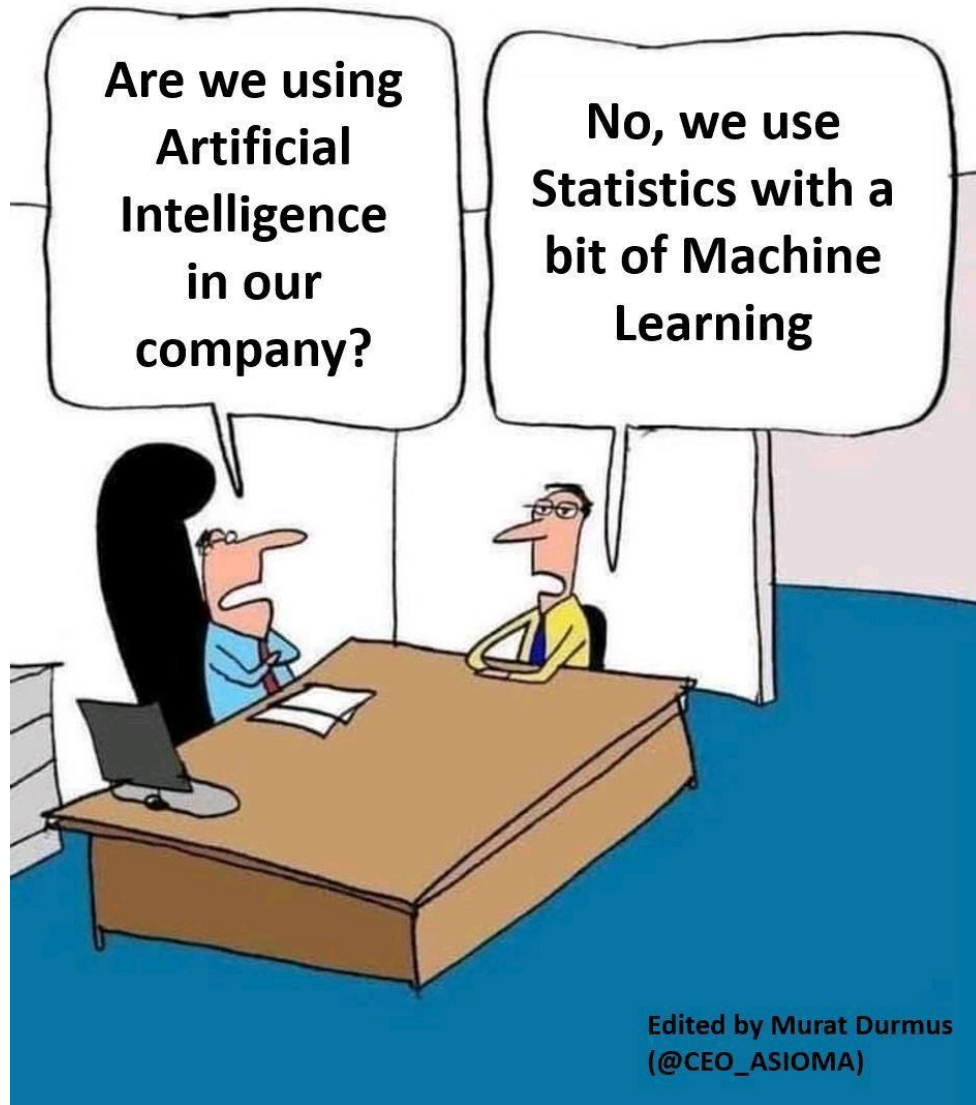
- ## AI (Artificial Intelligence)
  - Broad field aiming to create machines capable of intelligent behavior
  - Encompasses reasoning, learning, perception, and language understanding
  - The goal is to achieve both narrow (task-specific) and general (human-like) intelligence.

- ## ML (Machine Learning)
  - A subset of AI focused on algorithms that learn from data
  - Employs statistical methods to enable machines to improve tasks with experience
  - Primarily concerned with prediction and pattern recognition

What part of AI is not ML?

- **Expert Systems**
  - Mimic the decision-making ability of human experts
- **Robotics**
  - Designing and building robots to perform tasks which may not always incorporate learning algorithms
- **Search Algorithms**
  - Algorithms like A* or Dijkstra's for pathfinding and optimization, which don't learn from data but are designed to solve specific problems
  - Evolutionary Algorithms

- **Application:** PayPal uses ML algorithms to combat fraud by analyzing millions of transactions. These algorithms learn to distinguish between legitimate and fraudulent transactions based on patterns and anomalies.

- **Impact:** Reduces false positives, enhances customer experience, and minimizes financial losses due to fraud.

- **Application:** Google Health developed a machine learning model to screen for diabetic retinopathy (DR), a condition that can lead to blindness if untreated. The model analyzes retinal images to detect signs of the disease.

- **Impact:** The automated screening tool can assist doctors in diagnosing and treating diabetic retinopathy more efficiently, especially in underserved communities with limited access to ophthalmologists.

Source: https://blog.google/technology/ai/detecting-diabetic-eye-disease-machine-learning/

- **Application:** John Deere integrates ML into its agricultural equipment to enable precision farming, using data from sensors and satellites to make informed decisions about planting, fertilizing, and harvesting.

- **Impact:** Increases crop yields and sustainability by optimizing resource use.

- Group discussion on AI products you use in your daily lives

- ## Supervised Learning
  - Models learn from labeled data.
  - Predictions based on input-output pairs.
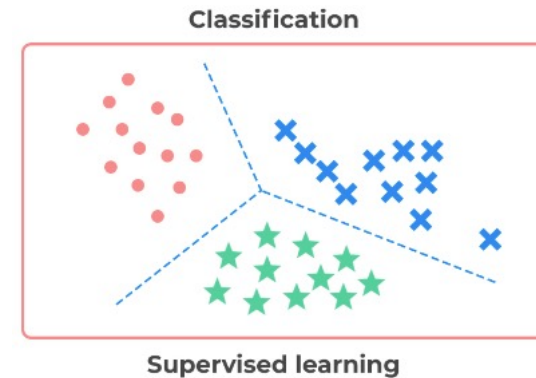
- ## Unsupervised Learning
  - Identifies patterns in unlabeled data.
  - Clusters similar data points together.
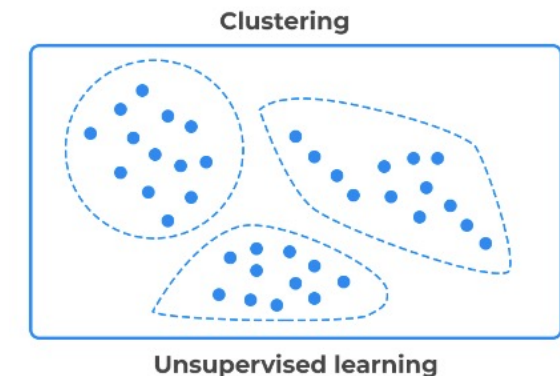
- ## Reinforcement Learning
  - Learns by trial and error from actions in an environment.
  - Aims to achieve defined goals.

Classification

Supervised learning

environment

agent

actions

rewards

observations

Clustering

Unsupervised learning

Supervised Learning – Fruit Labeling Analogy

- ## Training Phase:
  - – Demonstrate sorting fruits (apples, Oranges)
  - – Each fruit type and its corresponding basket acts as labelled examples

- ## Prediction Phase
  - – Machine learning model sorts a new basket of fruits independently
  - – Uses knowledge from training to recognize and categorize new fruits

Image source: https://www.kdnuggets.com/understanding-supervised-learning-theory-and-overview

- Definition:
  - Trains model on labeled dataset
  - Each example has an input vector and a corresponding output label.

- Goal:
  - Learn a function mapping inputs to outputs
  - Use this function for predictions on new data

- Types of Problems:
  - Classification:
    - Output is categorical (e.g. Spam detection, disease diagnosis)
  - Regression:
    - Output is a continuous value (e.g. house price prediction, weight estimation based on height).

- ## Classification
  - Logistic Regression
  - Support Vector Machines
  - Random Forest

- ## Regression
  - Linear Regression

- No categories provided; task is to organize books logically.
- Process: Identify patterns (size, color, topic) to create groups.
- Similar to clustering algorithms finding inherent data groupings.

- Analogy Insight:
  - Unsupervised learning discovers data patterns and structures without labels.

Unsupervised Learning Overview

- **Definition:**
  - Machine learning without explicit labels or targets.
  - Identifies patterns and structures in input data.

- **Applications:**
  - Discovers hidden patters and correlations.
  - Useful for data exploration and enhancing model efficiency.

- **Challenges:**
  - Results can be difficult to interpret without "ground truth"

- **Main Types:**
  - Clustering Algorithms:
    - Groups data based on similarities
  - Dimensionality reduction:
    - Reduces variables, preserving essential features.

- Clustering
  - K-means
  - Hierarchal Clustering
  - Density-based Spatial Clustering of Applications with Noise (DB-SCAN)
- Dimensionality Reduction Algorithms
  - Principal Component Analysis (PCA)
  - t-SNE

- **Data Collection:**
  - Gather diverse and representative datasets relevant to the problem
- **Data Preparation:**
  - Clean and preprocess data for compatibility with ML models.
- **Model Training:**
  - Feed prepared data into algorithms to learn and identify patterns
- **Evaluation:**
  - Assess model performance with metrics like accuracy, precision, recall, F1 Score
- **Deployment**
  - Implement the trained model for real-world predictions and decisions

Data is the new oil…
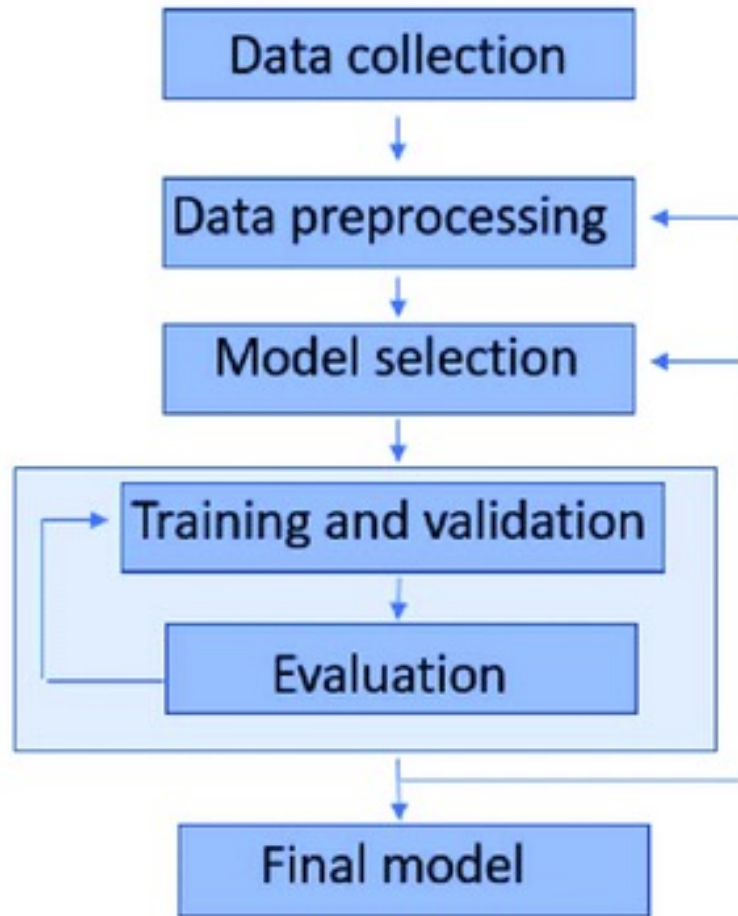
- Data is the cornerstone for every machine learning approach.

- High-quality, large dataset lead to more accurate and reliable models.

- Quality includes relevance, cleanliness, and diversity of data

- But how do we ensure that we have properly sanitized our input data before machine learning is applied?

Data Preparation Techniques

- **Definition:**
  - The process of cleaning and transforming raw data before analysis.
- **Key steps:**
  - Data cleaning:
    - Handle missing values
    - Correct errors and remove outliers
  - Data Transformation:
    - Normalize or scale features
    - Encode categorical data
  - Feature Selection:
    - Identify and select the most relevant features for analysis
  - Data Splitting:
    - Divide data into training, validation, and test sets.