# Machine Learning

# Introduction to Machine Learning

# Learning Objectives

By the end of this lesson, you will be able to:

- Analyze the distinctions and applications of machine learning, deep learning, and artificial intelligence through real-world examples for various technical applications
- Differentiate among various machine learning models and explore how each model learns from data to predict outcomes
- Explore Python libraries for effective data manipulation, visualization, and implementation of machine learning algorithms

# Business Scenario

ABC Inc., an e-commerce company, is struggling with a surge in fraudulent transactions on its website. The manual review process for transactions has caused delays in order processing and led to a negative customer experience.

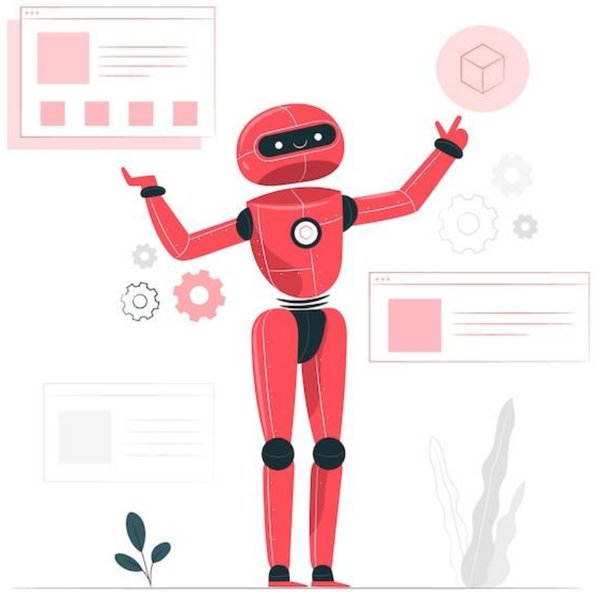
To address this, ABC Inc. will use machine learning algorithms to detect real-time fraudulent transactions. These algorithms will be integrated into ABC Inc.'s existing transaction processing system to flag suspicious transactions and prevent fraud.

Additionally, the company will use machine learning algorithms to predict customer behavior based on past purchase history, thereby improving the recommendation engine’s performance. With machine learning, ABC Inc. can provide a more personalized customer experience, streamline order processing, and increase sales.

# What Is Machine Learning?

# Machine Learning

It is a subset of artificial intelligence (AI) that assists systems to learn and improve automatically from experience without being explicitly programmed.



Arthur Samuel coined the term machine learning (ML) in 1959.

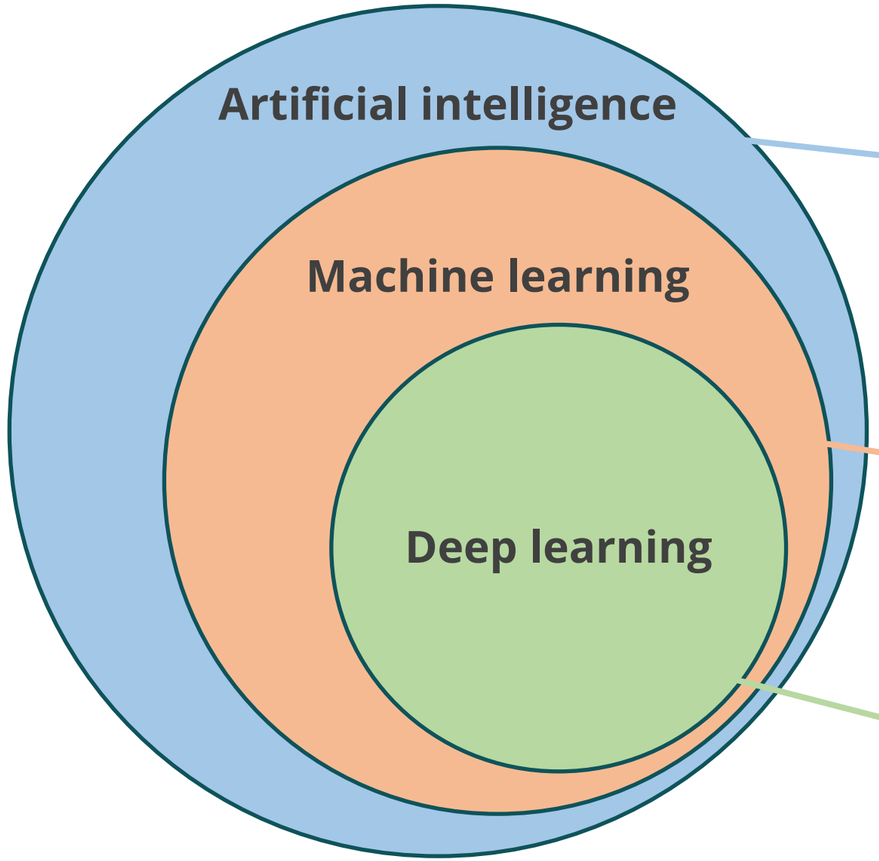
It enables programs to learn automatically, making computers more intelligent without human intervention.

# Traditional Approach Vs Machine Learning Approach

| Traditional approach | Machine learning approach |
| --- | --- |
| Uses predefined rules and algorithms explicitly programmed by human developers | Learns from data to make predictions or take actions without being explicitly programmed |
| Relies on explicitly defined logic and rules to perform tasks | Uses statistical techniques and optimization algorithms to learn patterns and make decisions |
| Requires manual feature engineering, where relevant features must be identified and extracted by human experts | Automatically learns features from raw data, reducing the need for manual feature engineering |
| Faces challenges in handling complex and unstructured data without significant preprocessing | Handles complex and unstructured data, such as images, text, and audio, without requiring extensive preprocessing |
| Performance depends on the accuracy and completeness of the predefined rules and algorithms | Performance improves with more data and learning iterations, enhancing accuracy and generalization |

# Difference Between ML, DL, and AI

Machine learning (ML), deep learning (DL), and artificial intelligence (AI) are often used interchangeably.



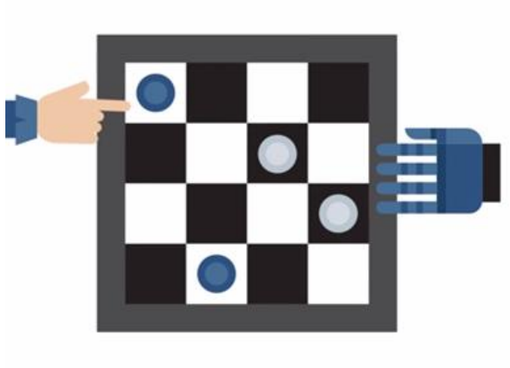

- It encompasses the simulation of human intelligence in machines.
- **Example:** Self-driving cars

- It is a subset of AI, which focuses on algorithms that enable computers to learn from data.
- **Example:** Amazon Alexa

- It is a subset of ML that uses neural networks with multiple layers for complex pattern recognition, such as recognizing patterns in images, speech, and text**.**
- **Example:** Handwriting recognition

# Machine Learning: Example

In a chess game between a computer and a person, the computer uses AI to analyze the game, predict moves, and decide its actions.

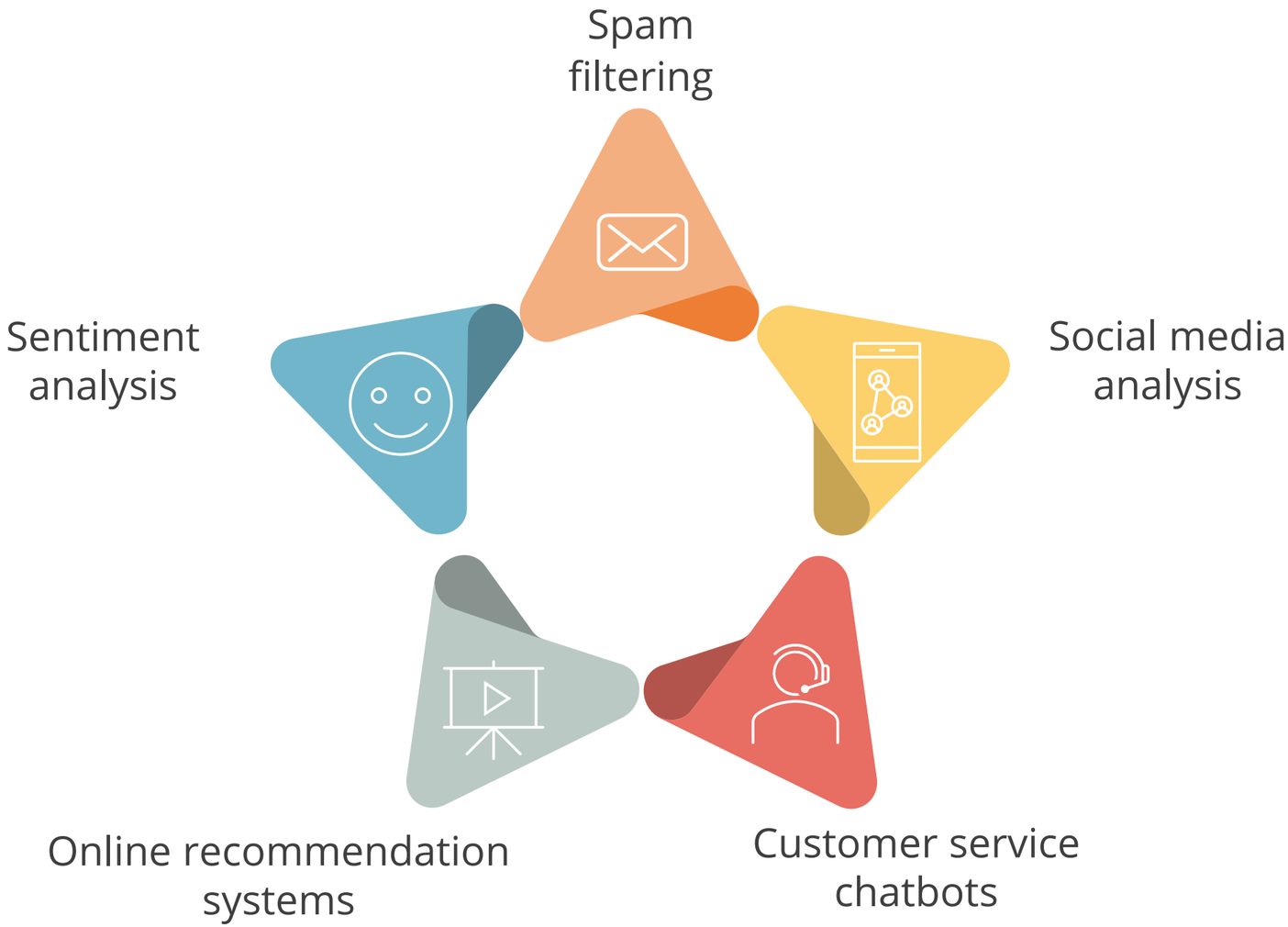


The AI uses machine learning to figure out if the opponent is a beginner, intermediate, or advanced player.

The AI decides its next move against the opponent using a complex neural network that learns various features and patterns from the data.

# Applications of Machine Learning

There are many applications for machine learning, including the following:

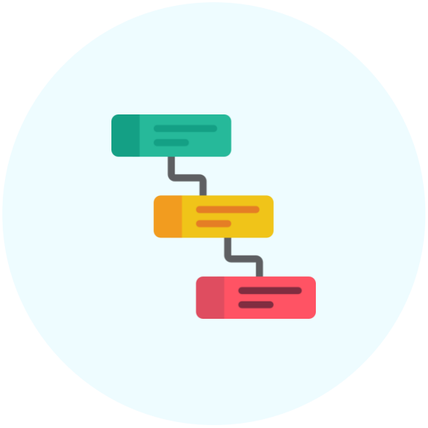


# Machine Learning Algorithms

These processes allow computers to learn patterns from data and make predictions on their own.

Machine learning algorithms help applications to:

Predict outcomes

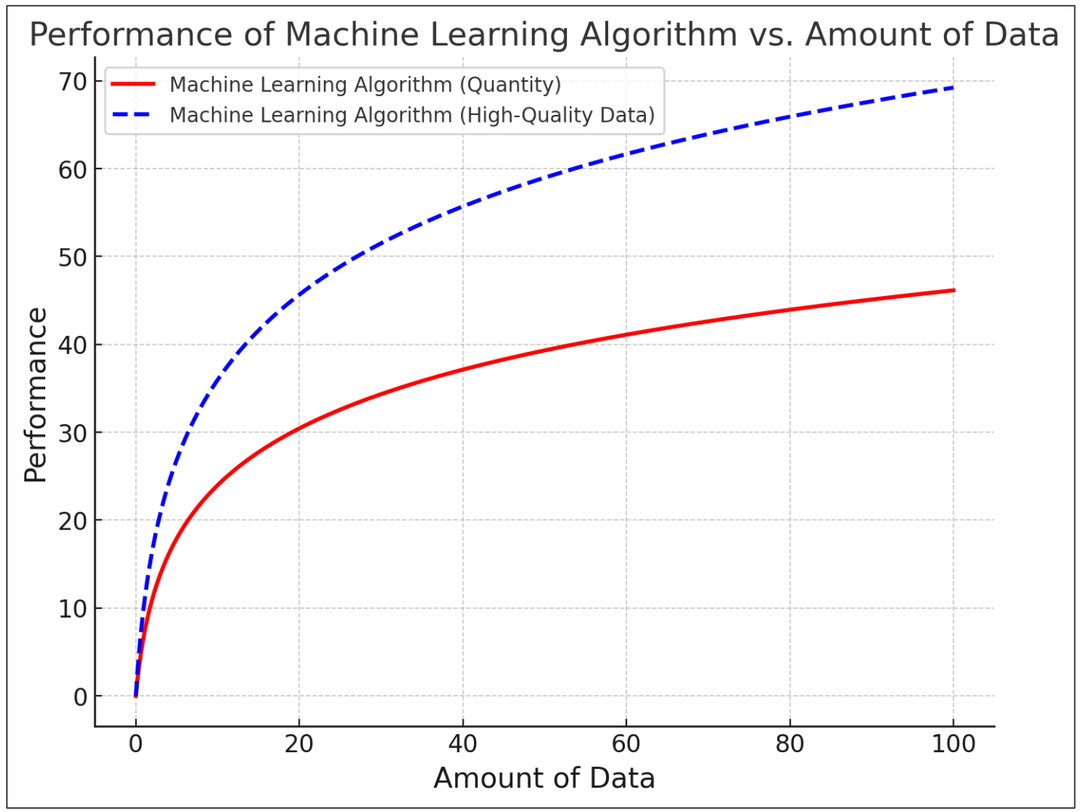


Classify the target feature

Improve the performance

# Data and Machine Learning Algorithms

The quality and quantity of the provided data evaluate the algorithm's performance.



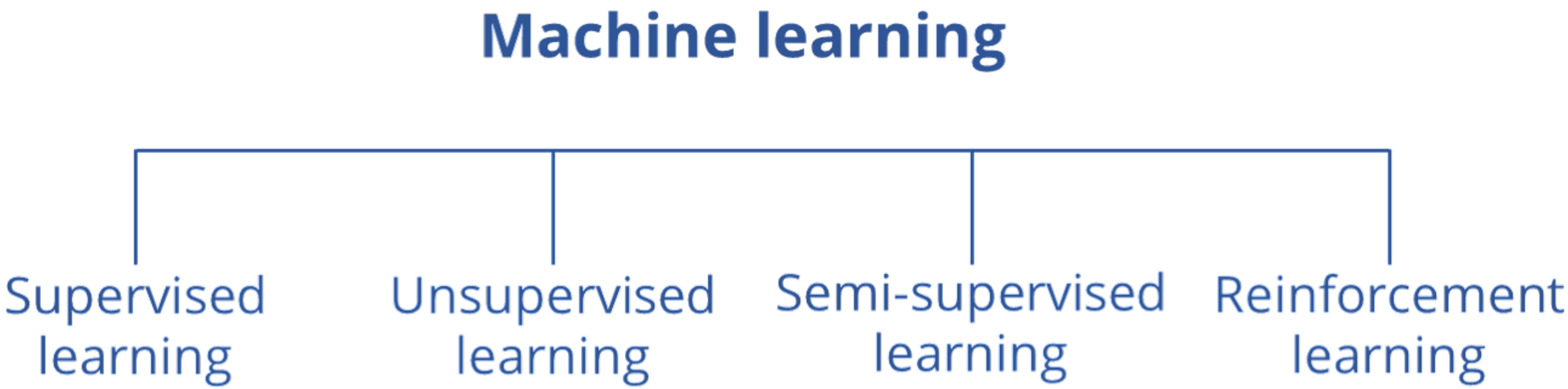

High-quality and quantity of data is crucial for machine learning as it ensure better predictions and insights.

*Source: https://academic.oup.com/nsr/article/10/7/nwad125/7147579*

# Types of Machine Learning

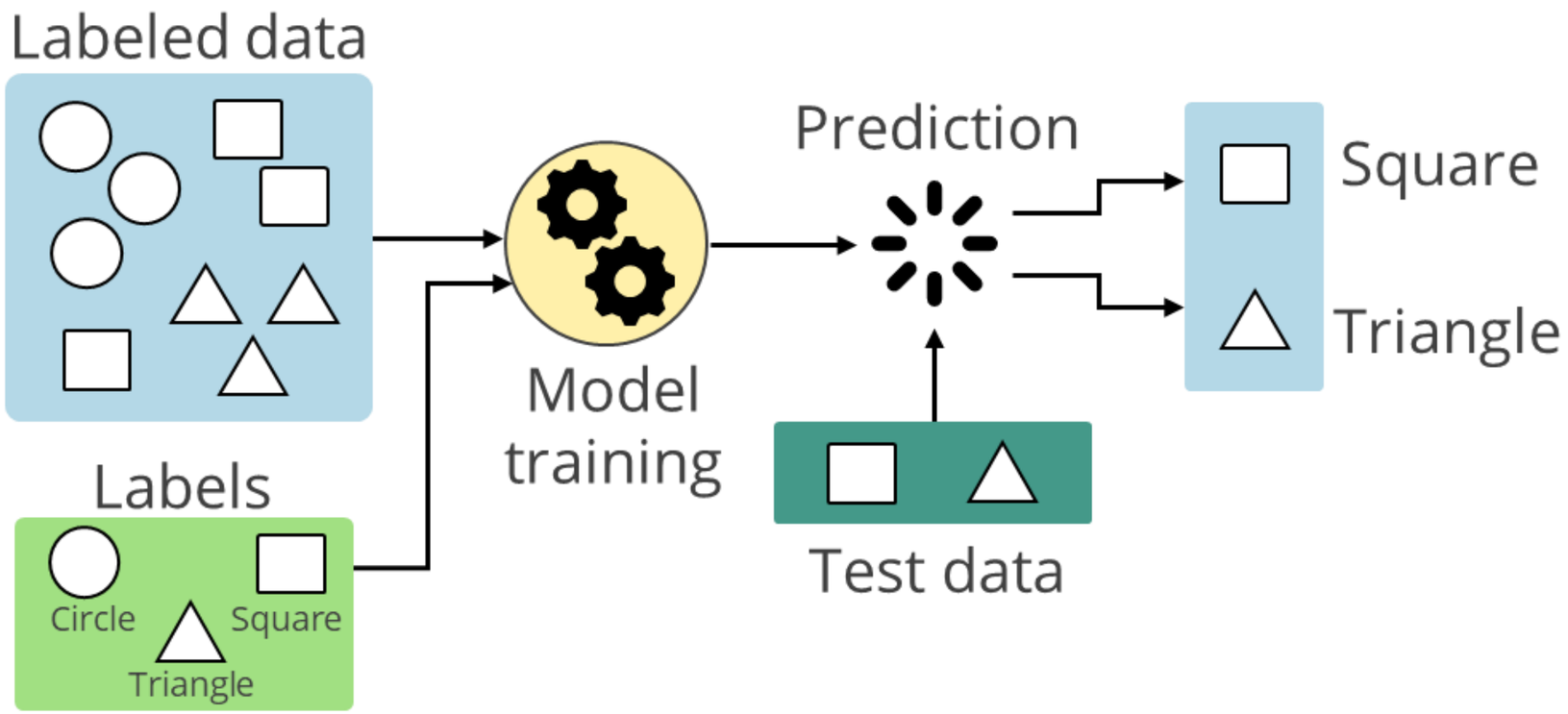
# Types of Machine Learning

ML can be divided into four main categories; each characterized by its capacity to predict conditions or identify patterns to produce outcomes.



# Supervised Learning

A supervised learning method uses labeled data to predict outcomes guided by specific input-output pairs.




Here, both inputs and outputs are known.

# Supervised Learning Algorithms

Some commonly known supervised learning algorithms are:

- Linear regression
- Decision trees
- Logistic regression
- Support vector machines

# Supervised Learning: Examples

Some examples of supervised learning are:

Predicting temperature rise based on yearly temperature trends

Predicting crop yield based on seasonal crop quality changes

Sorting waste based on known waste items and their corresponding waste types

In spam filtering, computers learn from labeled emails to decide if new emails are spam or not.

# Unsupervised Learning

It allows models to identify patterns and structures in unlabeled data without explicit guidance.

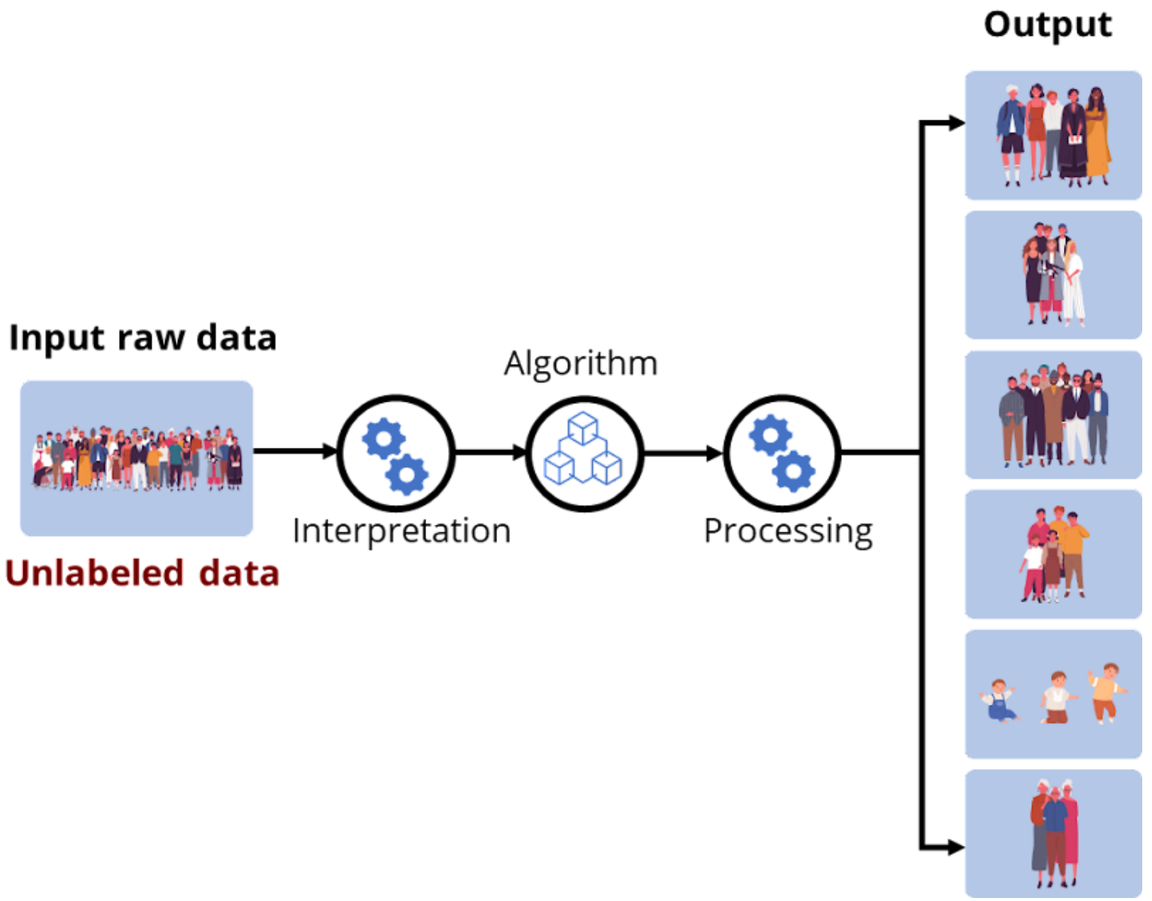
Some examples are:

- Image segmentation for object detection
- Identification of user groups based on commonalities
- Identification of anomalies over geographical landscapes based on the data patterns

The unlabeled dataset is provided to an unsupervised learning algorithm to discover hidden patterns and recognize their relationship.

# Unsupervised Learning: Example

It automatically groups images into distinct categories based on similarities, such as age group or gender, without any prior labels.



# Semi-Supervised Learning

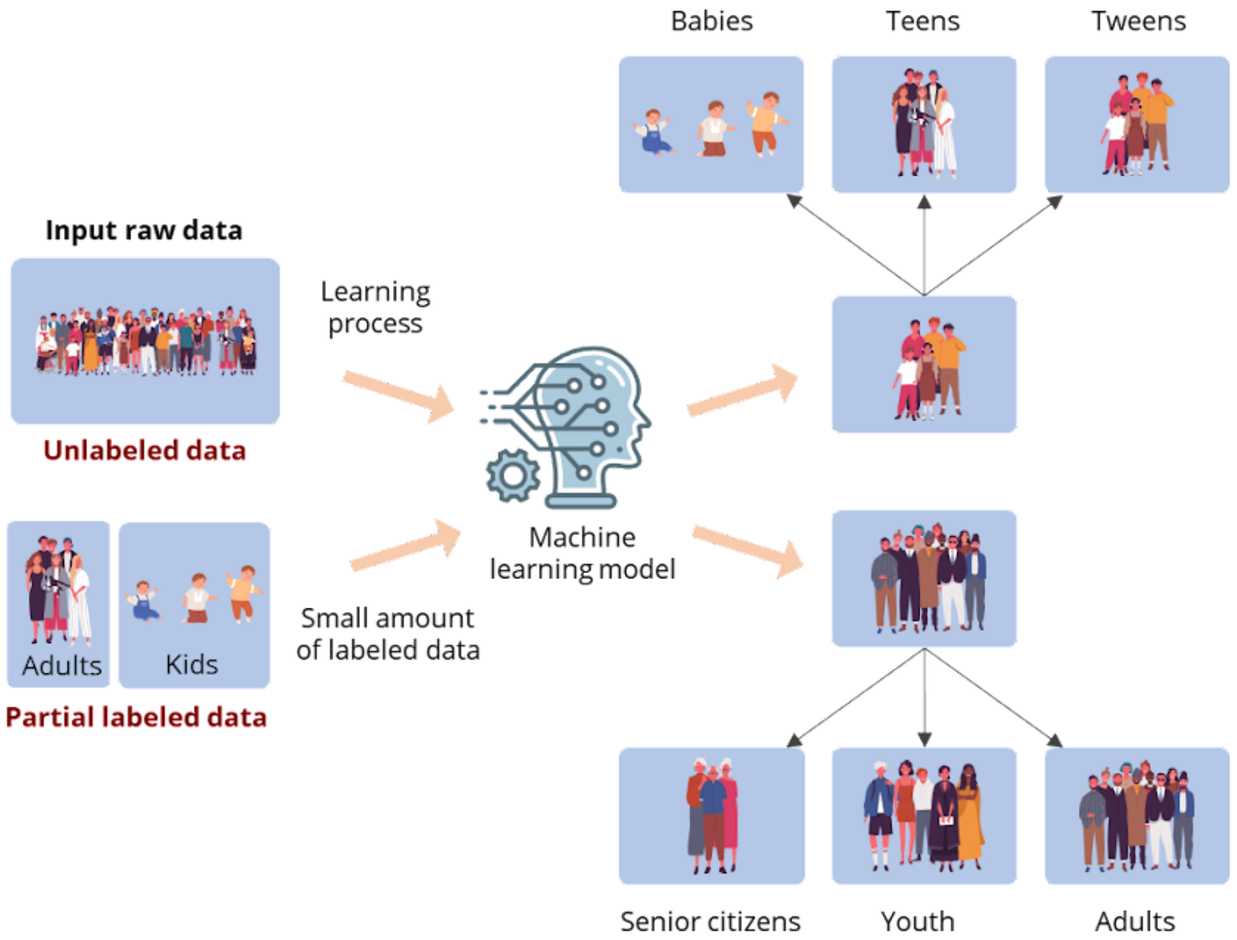
It uses a combination of a small amount of labeled data and a large amount of unlabeled data for training.

Like supervised learning, it aims to learn a function that can accurately predict the output variable from the input variables.

It uses unlabeled input to assist the learning process by collecting more information or improving model generalization.

Hence, it falls between supervised and unsupervised learning.

# Semi-Supervised Learning: Example




This dataset contains both labeled and unlabeled data. Hence, semi-supervised learning is applied.

# Semi-Supervised Learning: Example

Google Photos is a popular example of semi-supervised learning.

Whenever a picture is taken, it gets stored in the Google Cloud platform or a database.

In various instances, uploaders label images. Despite Google's lack of knowledge regarding image names, its algorithm can identify them by analyzing visual features like shapes and colors.

# Reinforcement Learning

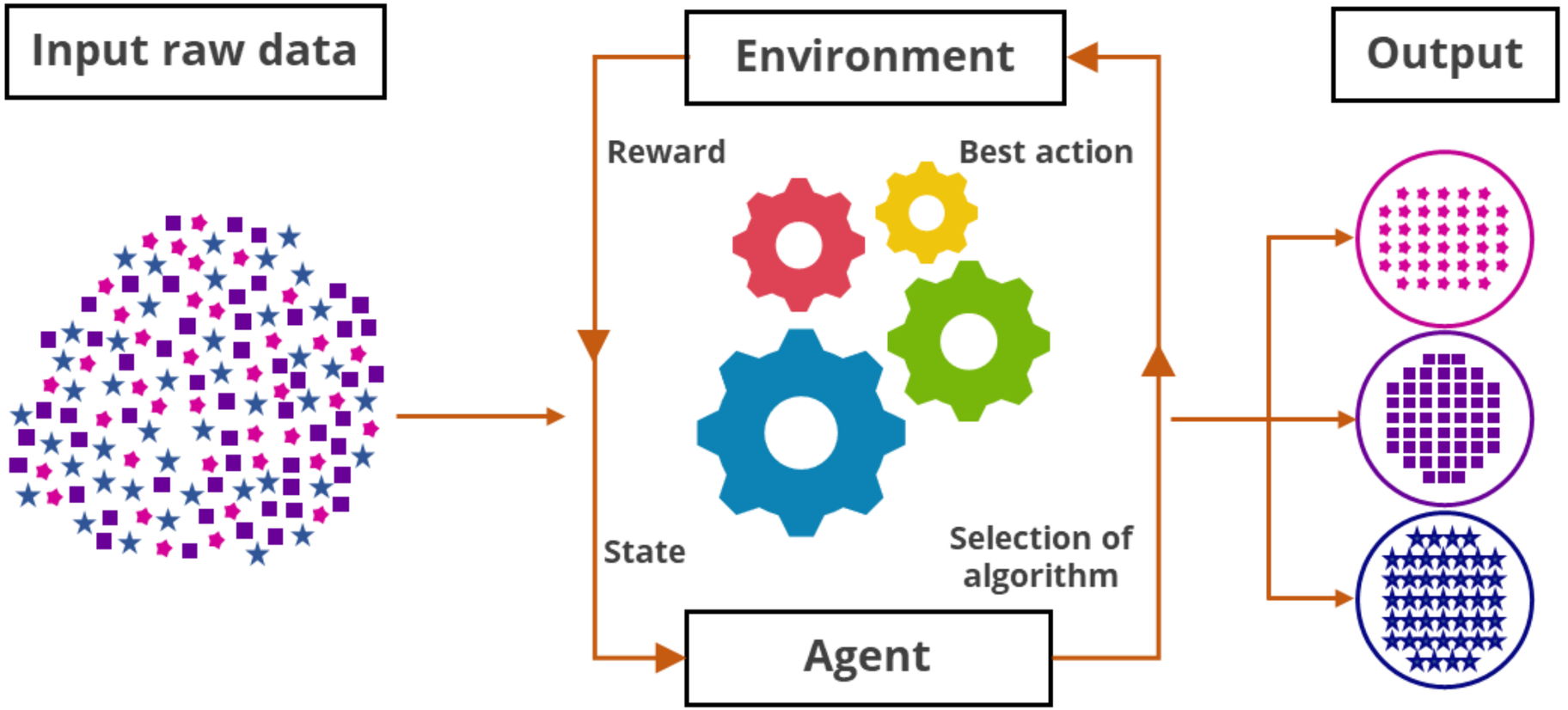
Reinforcement learning is a type of machine learning where algorithms learn from the environment by performing actions and receiving either rewards or penalties as feedback.

If the program finds the correct solution, the interpreter rewards the algorithm.

If the outcome is incorrect, the algorithm is penalized for incorrect predictions. It must reiterate until it finds a better result.

# Reinforcement Learning

It involves an agent interacting with an environment, learning from rewards and states, to choose the best actions and improve performance over time.



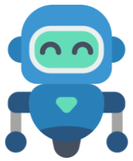
# Reinforcement Learning: Example

This type of learning is best seen in YouTube recommendations, where a user searches for a particular song, and the program shows the list of available songs.

When the user selects a specific song, the system trains itself to remember and deliver a similar result for future searches based on user interactions, such as likes, views and shares.

# Reinforcement Learning: Examples

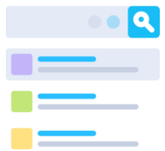
Examples of reinforcement learning include:



Games where players can play with bots

Self-driving cars

Autocorrect tools



Search recommendation engines

# Introduction to Python Packages for Machine Learning

# Python Libraries Used in Machine Learning

Some Python libraries used in machine learning include:


NumPy is a powerful library for numerical computing in Python.


Matplotlib performs data visualization and graphical plotting.


Pandas is a versatile data manipulation library in Python, offering data structures like DataFrames.

# Python Libraries Used in Machine Learning

Some Python libraries used in machine learning are:


SciPy solves mathematical equations and processes algorithms.


Scikit-learn offers efficient versions of common algorithms, facilitating the development of machine learning models.

# Key Takeaways

- Machine learning refers to a machine's ability to learn from data and replicate human behavior.
- AI includes machine learning and deep learning, each with unique capabilities for simulating intelligence.
- There are four main types of machine learning: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning.
- Python packages are folders with modules that organize code for easy reuse and maintenance, improving development efficiency.


# Knowledge Check

**Knowledge Check**

**1**

**Which of the following best describes machine learning?**

A. A subset of artificial intelligence (AI) that assists systems to learn and improve automatically from experience without being explicitly programmed.

B. A method of programming where developers manually define a set of rules and instructions.

C. The process of creating a set of fixed logic that a program will follow.

D. A technique used only for image and speech recognition tasks.

**Knowledge Check 1**

## Which of the following best describes machine learning?

A. A subset of artificial intelligence (AI) that assists systems to learn and improve automatically from experience without being explicitly programmed.

B. A method of programming where developers manually define a set of rules and instructions.

C. The process of creating a set of fixed logic that a program will follow.

D. A technique used only for image and speech recognition tasks.

The correct answer is **A**

**Machine learning is a subset of AI that enables systems to learn and improve automatically from experience without explicit programming.**

**Knowledge Check 2**

**Which example illustrates the use of machine learning to enhance customer experience in an e-commerce company?**

A. ABC Inc. using predefined rules for transaction processing.

B. ABC Inc. using manual review to detect fraudulent transactions.

C. ABC Inc. using machine learning algorithms to detect real-time fraudulent transactions and predict customer behavior.

D. ABC Inc. using machine learning solely for inventory management.

**Knowledge Check 2**

**Which example illustrates the use of machine learning to enhance customer experience in an e-commerce company?**

A. ABC Inc. using predefined rules for transaction processing.

B. ABC Inc. using manual review to detect fraudulent transactions.

C. ABC Inc. using machine learning algorithms to detect real-time fraudulent transactions and predict customer behavior.

D. ABC Inc. using machine learning solely for inventory management.

The correct answer is **C**

**ABC Inc. uses machine learning to detect fraudulent transactions in real-time and predict customer behavior to enhance the recommendation engine and customer experience.**

**Knowledge Check 3**

**What distinguishes deep learning (DL) from machine learning (ML) and artificial intelligence (AI)?**

A. Deep Learning is a subset of AI focused on learning from data.

B. Deep Learning uses neural networks with multiple layers for complex pattern recognition.

C. Deep Learning encompasses the simulation of human intelligence in machines.

D. Deep Learning involves manually defined rules and instructions

**Knowledge Check 3**

**What distinguishes deep learning (DL) from machine learning (ML) and artificial intelligence (AI)?**

A. Deep Learning is a subset of AI focused on learning from data.

B. Deep Learning uses neural networks with multiple layers for complex pattern recognition.

C. Deep Learning encompasses the simulation of human intelligence in machines.

D. Deep Learning involves manually defined rules and instructions

The correct answer is **B**

**Deep learning is a subset of ML that uses neural networks with multiple layers for complex pattern recognition, such as recognizing patterns in images, speech, and text.**

# Thank You