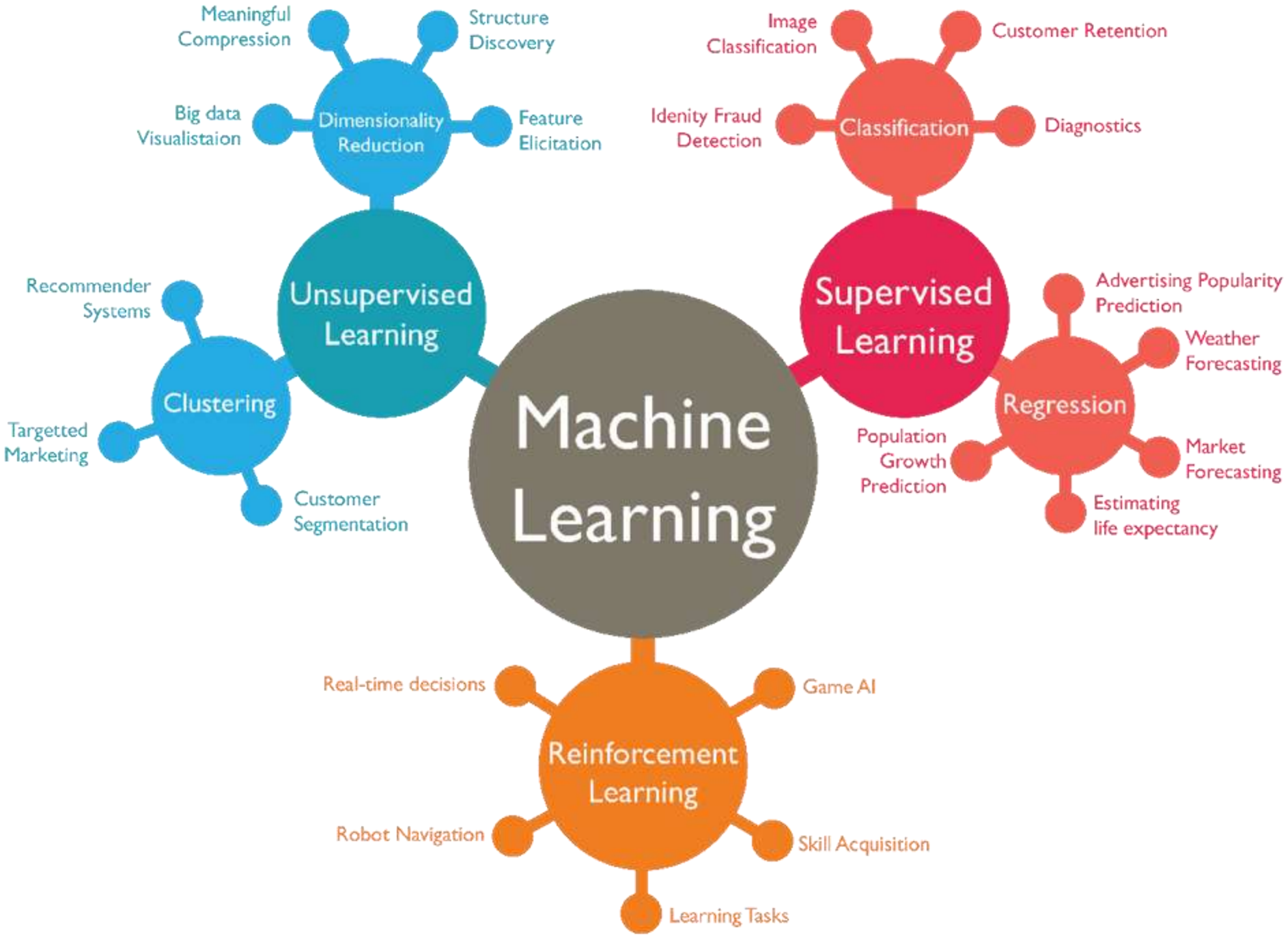
FUNDAMENTALS OF MACHINE LEARNING & IT'S TYPES

TOPICS

- **What is Machine Learning ?**
- **Definition.**
- **Machine Learning (ML) types.**


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Population Growth Prediction
Market Forecasting
Estimating life expectancy
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

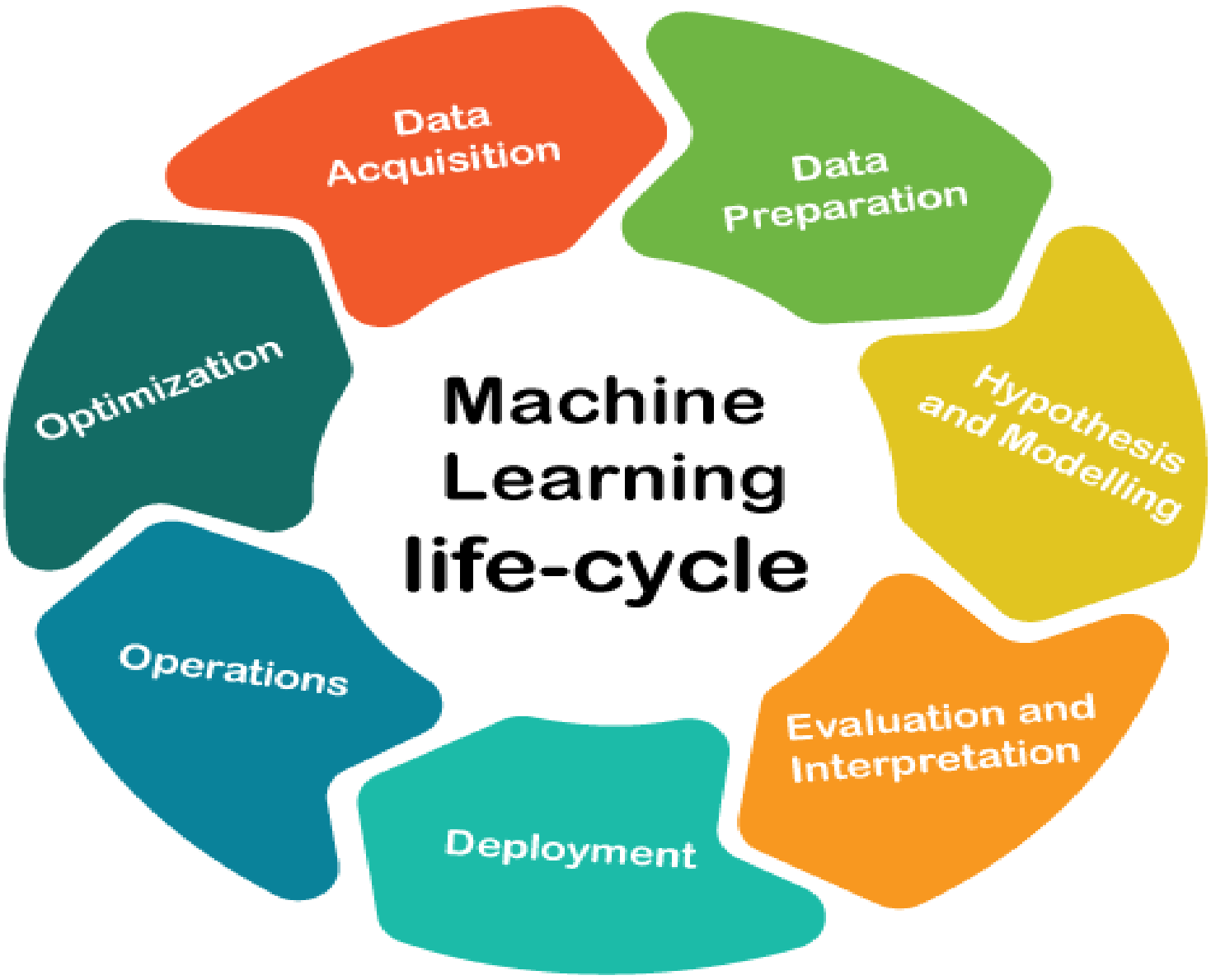
WHAT IS MACHINE LEARNING ?

The term machine learning was first introduced by **Arthur Samuel** in **1959**. Machine Learning is said as a subset of **artificial intelligence** that is mainly concerned with the development of algorithms which allow the computer to learn from the data and past experiences on their own.

DEFINITION

Machine learning is a branch of artificial intelligence that enables algorithms to uncover hidden patterns within datasets, allowing them to make predictions on new, similar data without explicit programming for each task.

Machine learning's impact extends to autonomous vehicles, drones, and robots, enhancing their adaptability in dynamic environments. This approach marks a breakthrough where machines learn from data examples to generate accurate outcomes, closely intertwined with data mining and data science.


Machine Learning life-cycle
Data Acquisition
Data Preparation
Hypothesis and Modelling
Evaluation and Interpretation
Deployment
Operations
Optimization

Difference between Machine Learning and Traditional Programming

Machine Learning	Traditional Programming	Artificial Intelligence
Machine Learning is a subset of artificial intelligence(AI) that focus on learning from data to develop an algorithm that can be used to make a prediction.	In traditional programming, rule-based code is written by the developers depending on the problem statements.	Artificial Intelligence involves making the machine as much capable, So that it can perform the tasks that typically require human intelligence.
Machine Learning uses a data-driven approach, It is typically trained on historical data and then used to make predictions on new data.	Traditional programming is typically rule-based and deterministic. It hasn't self-learning features like Machine Learning and AI.	AI can involve many different techniques, including Machine Learning and Deep Learning, as well as traditional rule-based programming.
ML can find patterns and insights in large datasets that might be difficult for humans to discover.	Traditional programming is totally dependent on the intelligence of developers. So, it has very limited capability.	Sometimes AI uses a combination of both Data and Pre-defined rules, which gives it a great edge in solving complex tasks with good accuracy which seem impossible to humans.
Machine Learning is the subset of AI. And Now it is used in various AI-based tasks like Chatbot Question answering, self-driven car., etc.	Traditional programming is often used to build applications and software systems that have specific functionality.	AI is a broad field that includes many different applications, including natural language processing, computer vision, and robotics.

MACHINE LEARNING (ML) TYPES

- Supervised Machine Learning.
- Unsupervised Machine Learning.
- Semi-Supervised Machine Learning.
- Reinforcement Learning.

SUPERVISED MACHINE LEARNING

First, we train the machine with the input and corresponding output, and then we ask the machine to predict the output using the test dataset.

Applications of supervised learning are **Fraud Detection, Spam filtering, Risk Assessment** etc.

EXAMPLE OF SUPERVISED MACHINE LEARNING

Suppose we have an input dataset of cats and cow images. So, first, we will provide the training to the machine to understand the images, such as the **shape & size of the tail of cat and cow, Shape of eyes, colour, height (cows are taller, cats are smaller), etc.** After completion of training, we input the picture of a cat and ask the machine to identify the object and predict the output. Now, the machine is well trained, so it will check all the features of the object, such as height, shape, colour, eyes, ears, tail, etc., and find that it's a cat. So, it will put it in the Cat category. This is the process of how the machine identifies the objects in Supervised Learning.

CLASSIFICATION OF SUPERVISED ML.

- **Classification**
- **Regression**

- **CLASSIFICATION**

Classification algorithms are used to solve the classification problems in which the output variable is categorical, such as "**Yes" or No, Male or Female, Red or Blue, etc**. The classification algorithms predict the categories present in the dataset. Some real-world examples of classification algorithms are **Spam Detection, Email filtering, etc.**

CLASSIFICATION OF SUPERVISED ML.

- **Regression**

Regression algorithms are used to solve regression problems in which there is a linear relationship between input and output variables. These are used to predict continuous output variables, such as **market trends, weather prediction, etc.**

Regression	Classification
The task of predicting a continuous quantity is known as regression.	The classification process involves anticipating a discrete class label.
The task is to map the input value (x) to the continuous output variable (y).	The task is to map the input value(x) to the discrete output variable (y).
A regression model can predict a discrete value, but only in the form of an integer quantity.	A classification model can predict a continuous value, but it is in the form of a probability for a class label.
The output variable in regression must be of continuous value.	The output variable in Classification must be discrete.

APPLICATIONS OF SUPERVISED LEARNING

- Image Segmentation
- Medical Diagnosis
- Fraud Detection
- Spam detection
- Speech Recognition

UNSUPERVISED MACHINE LEARNING

In unsupervised machine learning, the machine is trained using the unlabeled dataset, and the machine predicts the output without any supervision.

EXAMPLE OF UNSUPERVISED ML

Suppose there is a **basket of fruit** images, and we input it into the machine learning model. The images are totally unknown to the model, and the task of the machine is to find the patterns and categories of the objects.

CATEGORIES OF UNSUPERVISED ML

1) Clustering

The clustering technique is used when we want to find the **inherent groups** from the data. It is a way to group the objects into a cluster such that the objects with the most similarities remain in one group and have fewer or no similarities with the objects of other groups.

An example of the clustering algorithm is grouping the customers by their purchasing behaviour.

CATEGORIES OF UNSUPERVISED ML

2) Association

Association rule learning is an unsupervised learning technique, which finds interesting **relations** among variables within a large dataset. The main aim of this learning algorithm is to find the **dependency** of one data item on another data item and map those variables accordingly so that it can generate maximum profit. This algorithm is mainly applied in **Market analysis, Web usage mining, continuous production**, etc.

APPLICATIONS OF UNSUPERVISED LEARNING

- Network Analysis
- Recommendation
- Anomaly Detection
- Image and Text Clustering

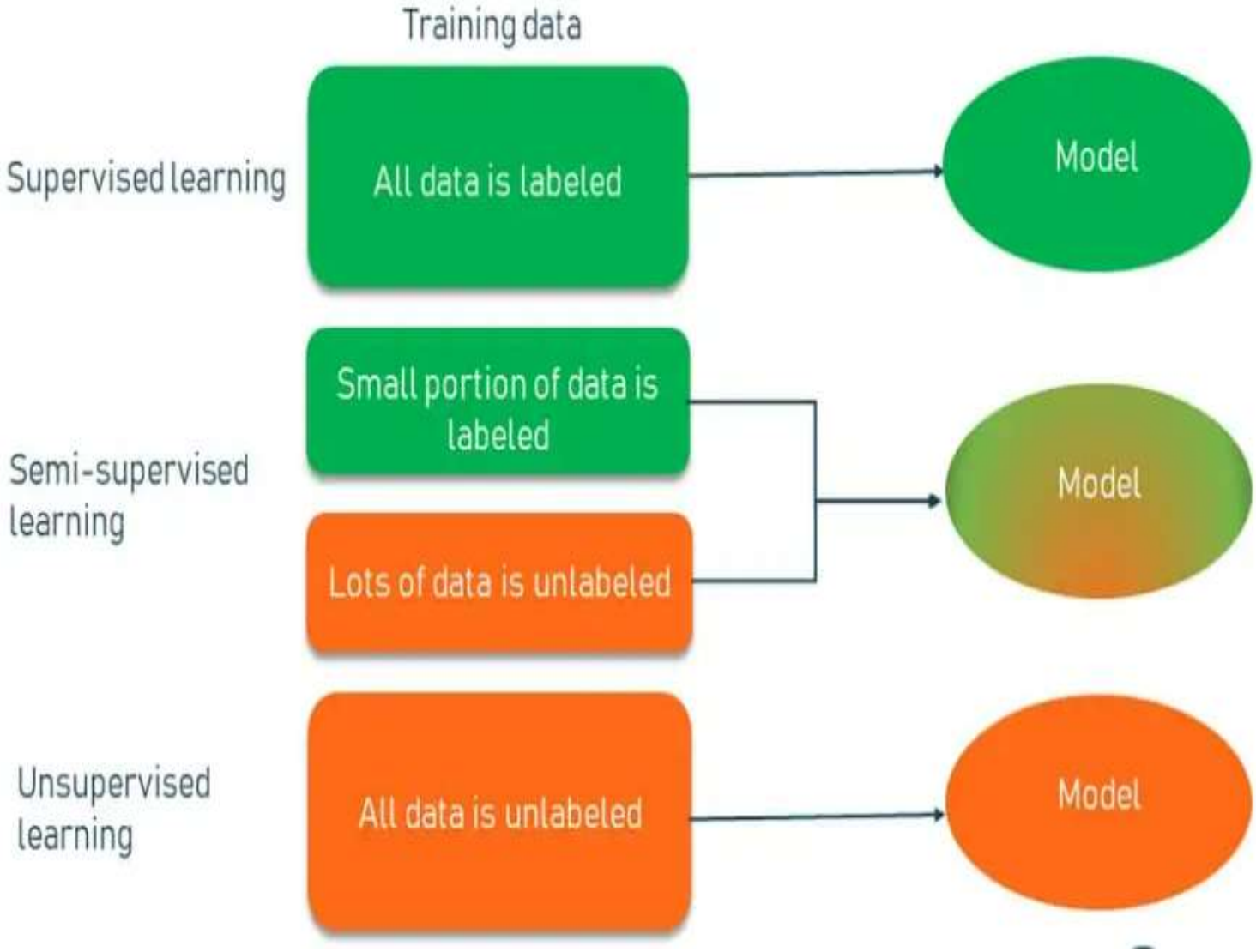
SEMI-SUPERVISED LEARNING

Semi-Supervised learning is a type of Machine Learning algorithm that lies between Supervised and Unsupervised machine learning. It represents the intermediate ground between Supervised (With Labelled training data) and Unsupervised learning (with no labelled training data) algorithms and uses the **combination of labelled and unlabeled datasets** during the training period.

EXAMPLE SEMI-SUPERVISED LEARNING

- Speech recognition
- Web content classification
- Text document classification

SUPERVISED LEARNING vs SEMI-SUPERVISED LEARNING vs UNSUPERVISED LEARNING



REINFORCEMENT LEARNING

Reinforcement learning works on a feedback-based process, in which an AI agent (A software component) automatically explore its surrounding by hit & trail method, taking action, learning from experiences, and improving its performance.

In RL, an agent learns to achieve a goal in an uncertain, potentially complex environment by performing actions and receiving feedback through rewards or penalties.

REINFORCEMENT LEARNING

Key Concepts of Reinforcement Learning

Agent: The learner or decision-maker**.**

Environment: Everything the agent interacts with.

State: A specific situation in which the agent finds itself.

Action: All possible moves the agent can make.

Reward: Feedback from the environment based on the action taken.

REINFORCEMENT LEARNING

How Reinforcement Learning Works

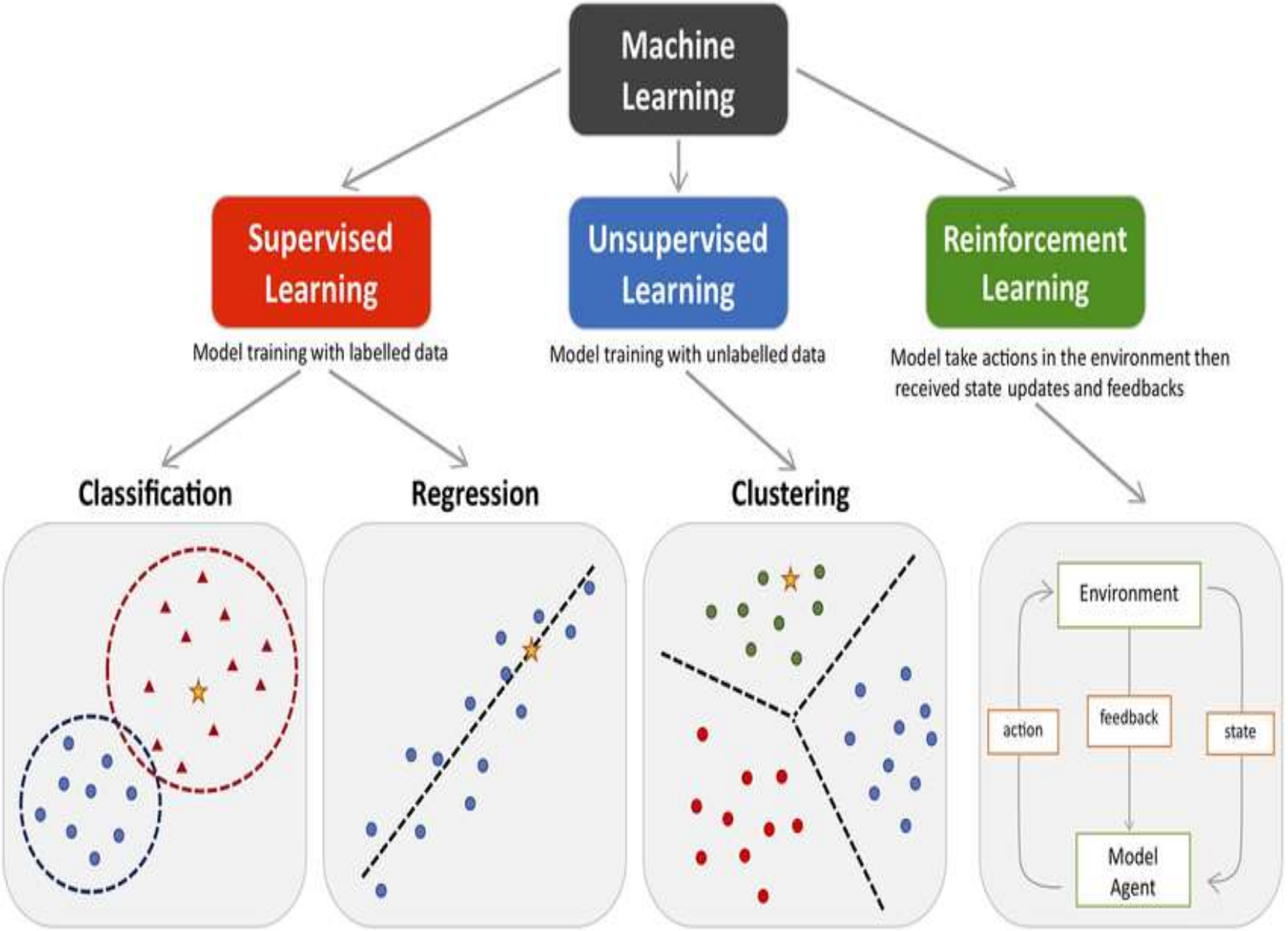
RL operates on the principle of learning optimal behavior through **trial and error**. The agent takes actions within the environment, receives rewards or penalties, and adjusts its behavior to maximize the cumulative reward.

This **learning process** is characterized by the following elements:

- **Policy:** A strategy used by the agent to determine the next action based on the current state.
- **Reward Function:** A function that provides a scalar feedback signal based on the state and action.
- **Value Function:** A function that estimates the expected cumulative reward from a given state.
- **Model of the Environment:** A representation of the environment that helps in planning by predicting future states and rewards.

EXAMPLE OF REINFORCEMENT LEARNING

- **Automated Robots**
- **Natural Language Processing**
- **Marketing and Advertising**
- **Image Processing**
- **Recommendation Systems**
- **Gaming**
- **Healthcare**
- **Traffic Control**


Machine Learning
Supervised Learning
Unsupervised Learning
Reinforcement Learning
Model training with labelled data
Model training with unlabelled data
Model take actions in the environment then received state updates and feedbacks
Classification
Regression
Clustering
Environment
action
feedback
state
Model Agent

Limitations of Machine Learning

1.The primary challenge of machine learning is the lack of data or the diversity in the dataset.

2. A machine cannot learn if there is no data available. Besides, a dataset with a lack of diversity gives the machine a hard time.

3.A machine needs to have heterogeneity to learn meaningful insight.

4.It is rare that an algorithm can extract information when there are no or few variations.

5. It is recommended to have at least 20 observations per group to help the machine learn. This constraint leads to poor evaluation and prediction.