UNIT NO - 4

Machin Learning System

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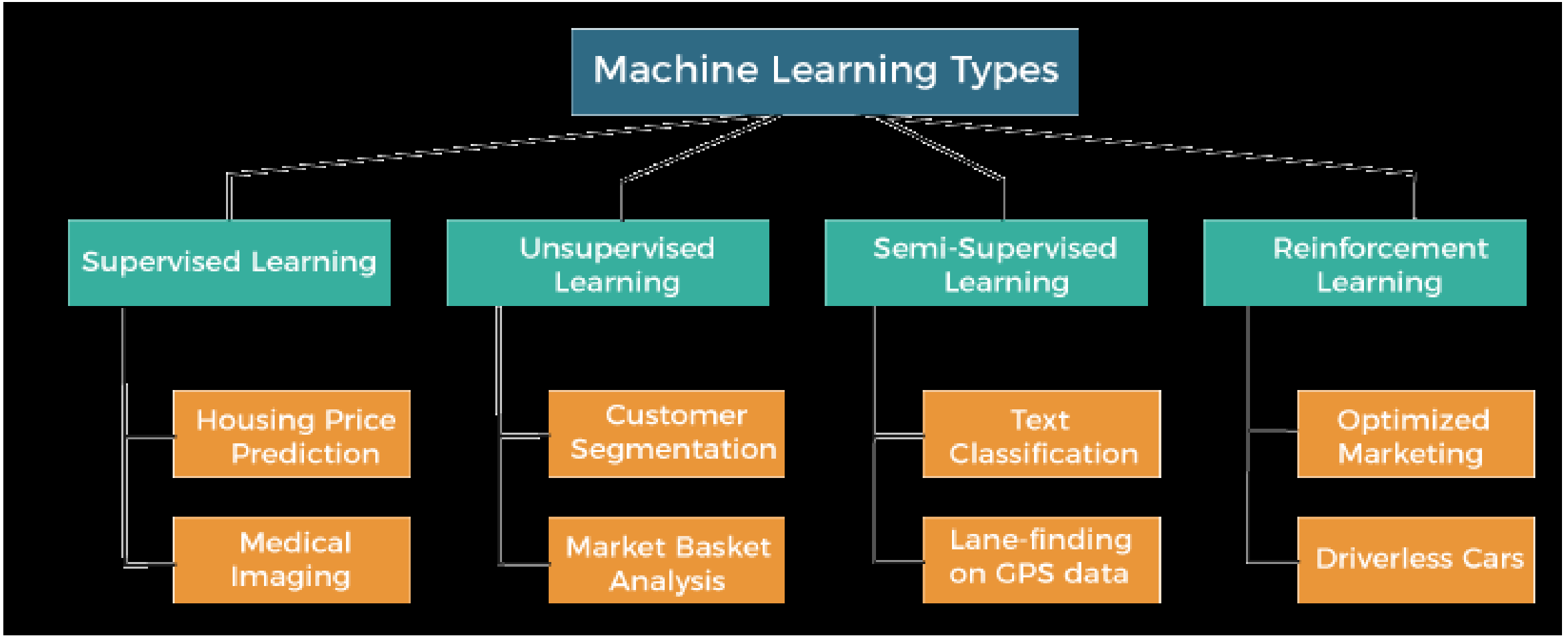
Types of Machine Learning

- Machine learning is a subset of AI, which enables the machine to automatically learn from data, improve performance from past experiences, and make predictions.
- Machine learning contains a set of algorithms that work on a huge amount of data.
- Data is fed to these algorithms to train them, and
- On the basis of training, they build the model &
- Perform a specific task.

Based on the methods and way of learning, machine learning is divided into mainly four types, which are:

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


Machine Learning Types
Supervised Learning
Unsupervised Learning
Semi-Supervised Learning
Reinforcement Learning
Housing Price Prediction
Medical Imaging
Customer Segmentation
Market Basket Analysis
Text Classification
Lane-finding on GPS data
Optimized Marketing
Driverless Cars

Supervised Machine Learning

- Based on supervision.
- We train the machines using the "labelled" dataset, and
- Based on the training, the machine predicts the output using the test dataset.
- Here, the labelled data specifies that some of the inputs are already mapped to the output.

- **Example -** Input dataset of cats and dog images.

- Training to the machine to understand the images, such as the shape & size of the tail of cat and dog, Shape of eyes, color, height (dogs 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.
- 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.

- The main goal of the supervised learning technique is to map the input variable(x) with the output variable(y).
- Some real-world applications of supervised learning are Risk Assessment, Fraud Detection, Spam filtering, etc.

Categories of Supervised Machine Learning

- Classification
- Regression

- A) **Classification**

- Solve the classification problems in which the output (DEPENDENT) 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 algorithms :

- Random Forest Algorithm
- Decision Tree Algorithm
- Logistic Regression Algorithm
- Support Vector Machine Algorithm

```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report, confusion_matrix

# Create a sample dataset
data = {
    'Area': [1200, 1500, 1800, 2500, 3000, 3200, 3600, 4000, 4100, 4500],
    'Location': [1, 2, 1, 3, 2, 1, 3, 2, 3, 1],  # Assume 1=Central, 2=Suburban, 3=Rural
    'Amenities': [3, 4, 2, 5, 3, 4, 5, 3, 4, 2],  # Number of amenities
    'Price_Category': ['Low', 'Low', 'Medium', 'High', 'High', 'High', 'High', 'Medium', 'I
}

# Convert data to a pandas DataFrame
df = pd.DataFrame(data)
```

```
X = df[['Area', 'Location', 'Amenities']]  # Features
y = df['Price_Category']  # Target variable

# Split the dataset into training and testing sets (80% training, 20% testin
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, ran

# Create a Decision Tree Classifier
classifier = DecisionTreeClassifier()

# Train the model
classifier.fit(X_train, y_train)

# Make predictions on the test set
y_pred = classifier.predict(X_test)
```

```python
# Predict the price category for a new house
new_house = np.array([[2000, 2, 3]])  # Area=2000, Location=2, Amenities=3
predicted_category = classifier.predict(new_house)
print("Predicted Price Category for new house:", predicted_category[0])
```

- **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.

- Simple Linear Regression Algorithm

Advantages of Supervised Learning

- Since supervised learning work with the labelled dataset so we can have an exact idea about the classes of objects.

- These algorithms are helpful in predicting the output on the basis of prior experience.

Disadvantages of Supervised Learning

- These algorithms are not able to solve complex tasks.
- It may predict the wrong output if the test data is different from the training data.
- It requires lots of computational time to train the algorithm.

Applications of Supervised Learning

- **Image Segmentation: I**mage classification is performed on different image data with pre-defined labels.

- **Medical Diagnosis: F**or diagnosis purposes. It is done by using medical images and past labelled data with labels for disease conditions. With such a process, the machine can identify a disease for the new patients.

Applications of Supervised Learning

- **Fraud Detection:** To identifying fraud transactions, fraud customers, etc. It is done by using **historic data** to identify the patterns that can lead to possible fraud.
- **Speech Recognition:** Algorithm is trained with voice data, and various identifications can be done using the same, such as voice-activated passwords, voice commands, etc.

Unsupervised Machine Learning

- **There is no need for supervision.**

- Machine is trained using the unlabeled dataset, and the machine predicts the output without any supervision.

- Models are trained with the data that is neither classified nor labelled, and the model acts on that data without any supervision.

- The main aim of the unsupervised learning algorithm is to **group or categories the unsorted dataset according to the similarities, patterns, and differences.**

- Machines are instructed to find the **hidden patterns from the input dataset.**

Example

- **Basket of fruit images**

- The images are totally unknown to the model, and the task of the machine is to find the patterns and categories of the objects.
- So, the machine will discover its patterns and differences, such as color difference, shape difference,

- **Spam detection:** Classify an email as spam or not spam. The spam emails are sent to the spam folder.

Categories of Unsupervised Machine Learning

- Clustering
- Association

1) Clustering

- 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.

- **Grouping the customers by their purchasing behavior.**

Clustering algorithms :

- K-Means Clustering algorithm
- Mean-shift algorithm
- DBSCAN Algorithm
- Principal Component Analysis

2) **Association**

- Association rule learning is an unsupervised learning technique, which finds interesting relations among variables within a large dataset.
- 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 Basket analysis, Web usage mining, continuous production, etc.
- Apriori Algorithm, FP-growth algorithm.

Advantages of Unsupervised Learning Algorithm

- These algorithms can be used for complicated tasks compared to the supervised ones because these algorithms work on the **unlabeled dataset.**

- Unsupervised algorithms are preferable for various tasks as getting the unlabeled dataset is easier as compared to the labelled dataset.

Disadvantages of Unsupervised Learning Algorithm

- The output of an unsupervised algorithm can be less accurate as the dataset is not labelled, and algorithms are not trained with the exact output in prior.

- Working with Unsupervised learning is more difficult as it works with the unlabeled dataset that does not map with the output.

Applications of Unsupervised Learning

- **Network Analysis: I**dentifying plagiarism and copyright in document network analysis of text data for scholarly articles.

- **Recommendation Systems: F**or building recommendation applications for different web applications and e-commerce websites.

- **Anomaly Detection: I**dentify unusual data points within the dataset. It is used to discover fraudulent transactions.

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
- Uses the combination of labelled and unlabeled datasets during the training period.

Semi-Supervised Learning

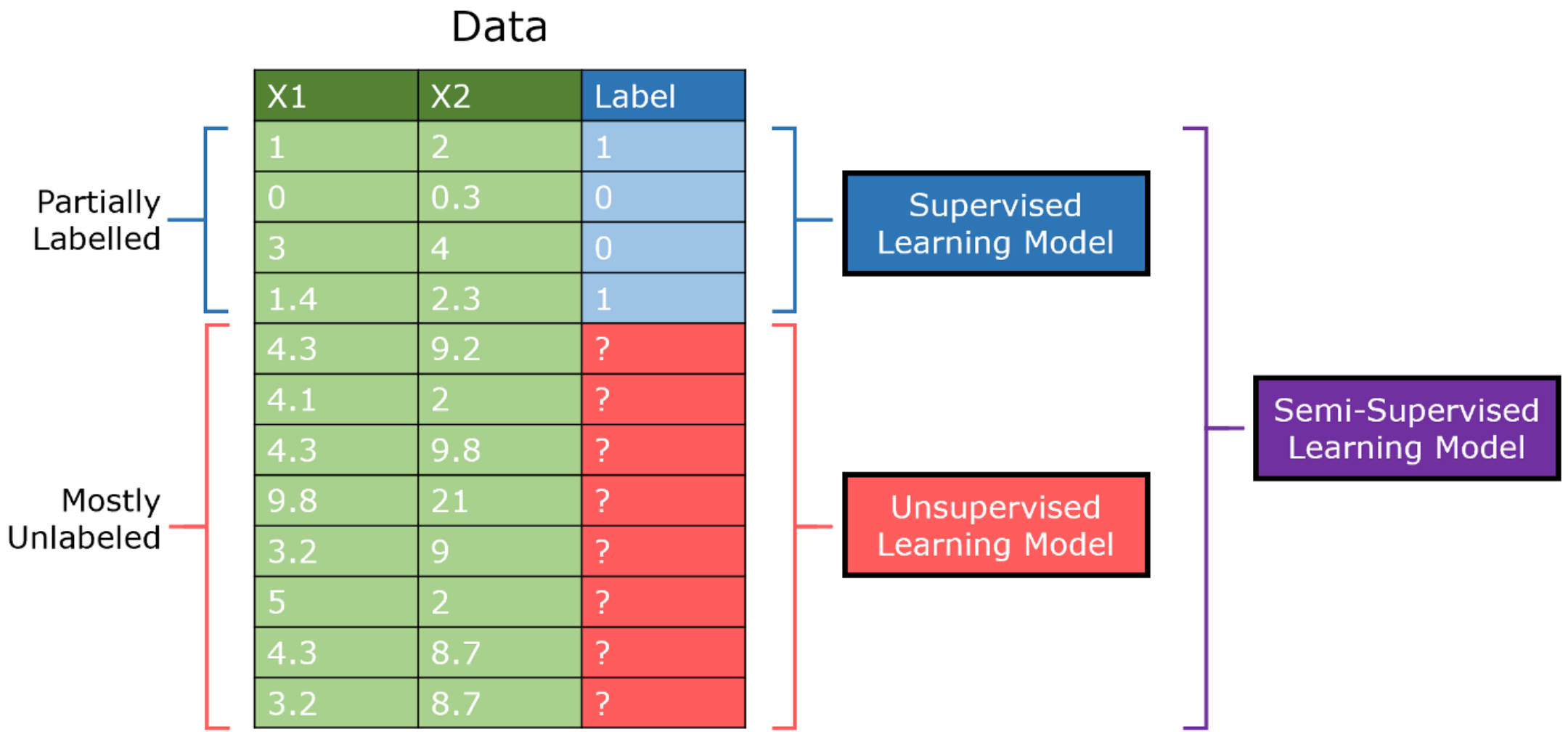
- Although Semi-supervised learning is the middle ground between supervised and unsupervised learning and operates on the data that consists of a few labels, **it mostly consists of unlabeled data.**
- As labels are costly, but for corporate purposes, they may have few labels.
- It is completely different from supervised and unsupervised learning as they are **based on the presence & absence of labels.**

Semi-Supervised Learning

- To overcome the drawbacks of supervised learning and unsupervised learning algorithms, the concept of Semi-supervised learning is introduced.
- The main aim of semi-supervised learning is to **effectively use all the available data**, rather than only labelled data like in supervised learning.
- Initially, **similar data is clustered along with an unsupervised learning algorithm, and further, it helps to label the unlabeled data into labelled data.**

Semi-Supervised Learning

- It is because **labelled data is a comparatively more expensive** acquisition (PURCHASE) than unlabeled data.
- **Supervised learning** is where a student is under the supervision of an instructor at home and college.
- Further, if that student is self-analysing the same concept without any help from the instructor, it comes under **unsupervised learning**.
- Under semi-supervised learning, the student has to revise himself after analyzing the same concept under the guidance of an instructor at college.


Data
X1
X2
Label
1
2
1
0
0.3
0
3
4
0
1.4
2.3
1
4.3
9.2
?
4.1
2
?
4.3
9.8
?
9.8
21
?
3.2
9
?
5
2
?
4.3
8.7
?
3.2
8.7
?
Partially Labelled
Mostly Unlabeled
Supervised Learning Model
Unsupervised Learning Model
Semi-Supervised Learning Model

Semi-supervised Learning

- **Advantages:**
- It is simple and easy to understand the algorithm.
- It is highly efficient.
- It is used to solve drawbacks of Supervised and Unsupervised Learning algorithms.

- **Disadvantages:**
- Iterations results may not be stable.
- We cannot apply these algorithms to network-level data.
- Accuracy is low.

Reinforcement Learning

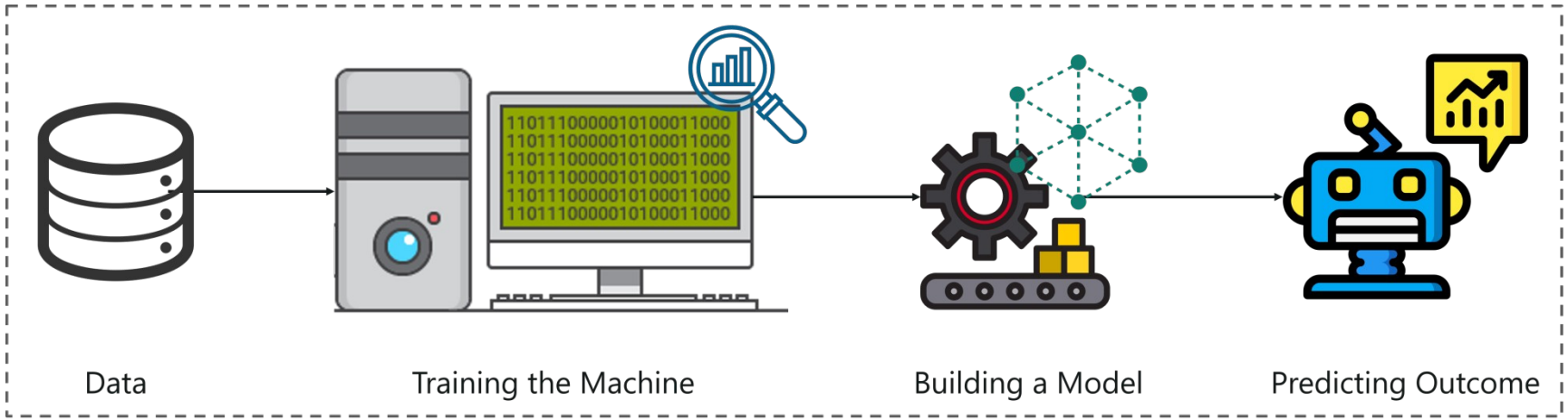
- **Example:** Suppose there is an AI agent present within a maze environment, and his goal is to find the diamond.

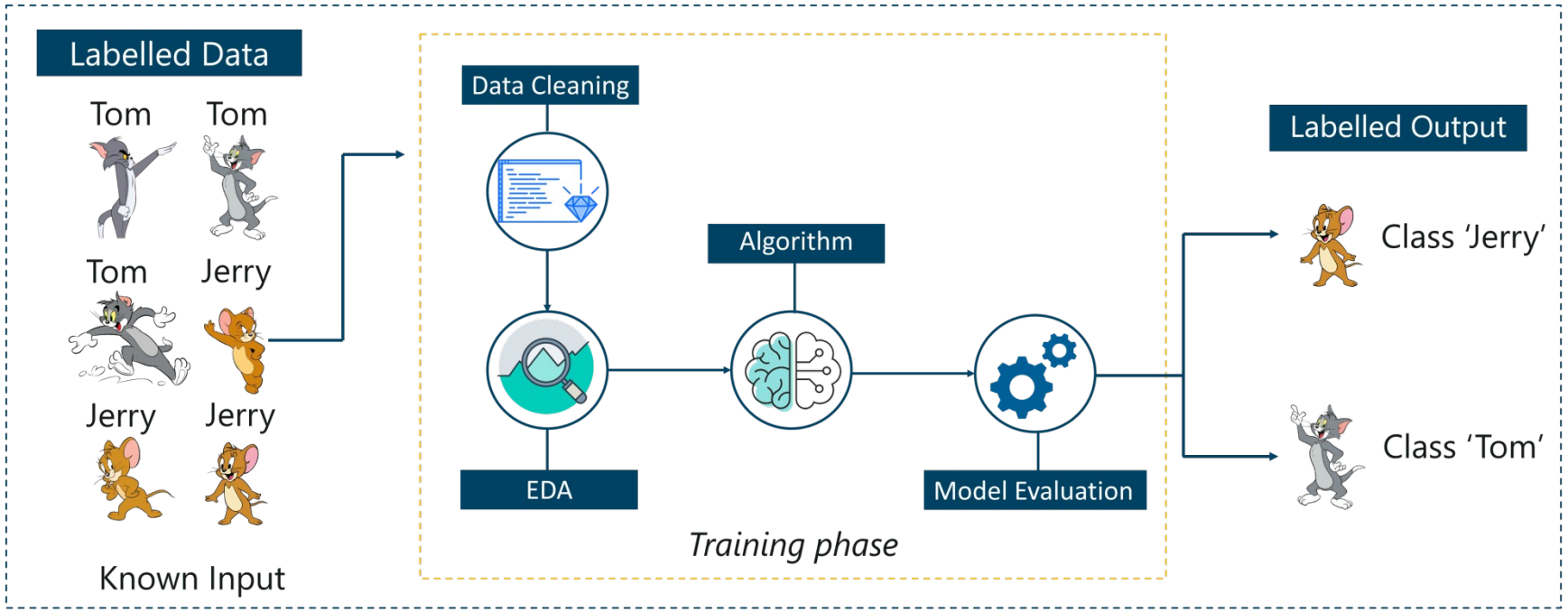
- The agent interacts with the environment by performing some actions, and based on those actions, the state of the agent gets changed, and it also receives a reward or penalty as feedback.

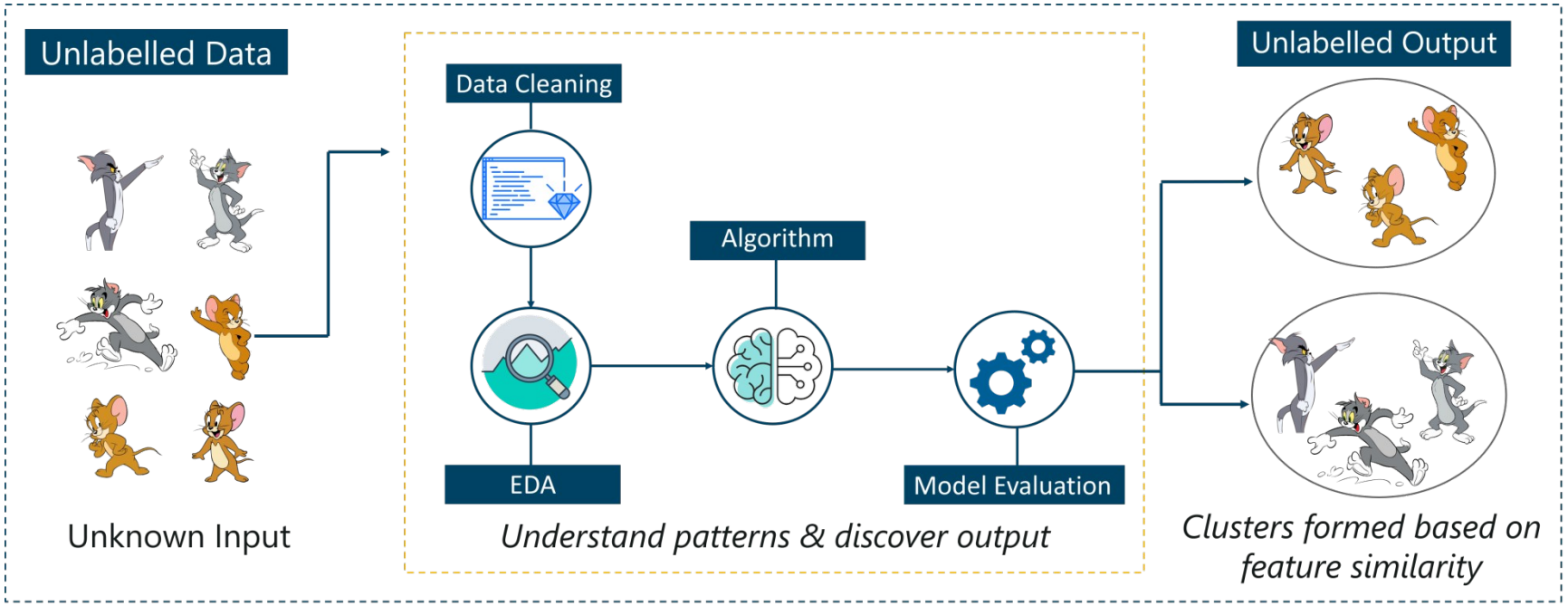
- The agent continues doing these three things (**take action, change state/remain in the same state, and get feedback**), and by doing these actions, he learns and explores the environment.

Reinforcement Learning

- The **agent learns that what actions lead to positive feedback** or rewards and what actions lead to negative feedback penalty.
- As a positive reward, the agent gets a **positive point, and as a penalty, it gets a negative point**.


Data
Training the Machine
Building a Model
Predicting Outcome


Labelled Data
Tom
Tom
Tom
Jerry
Jerry
Jerry
Known Input
Data Cleaning
EDA
Algorithm
Model Evaluation
Training phase
Labelled Output
Class 'Jerry'
Class 'Tom'


Unlabelled Data
Unknown Input
Data Cleaning
EDA
Algorithm
Model Evaluation
Understand patterns & discover output
Unlabelled Output
Clusters formed based on feature similarity

Regression

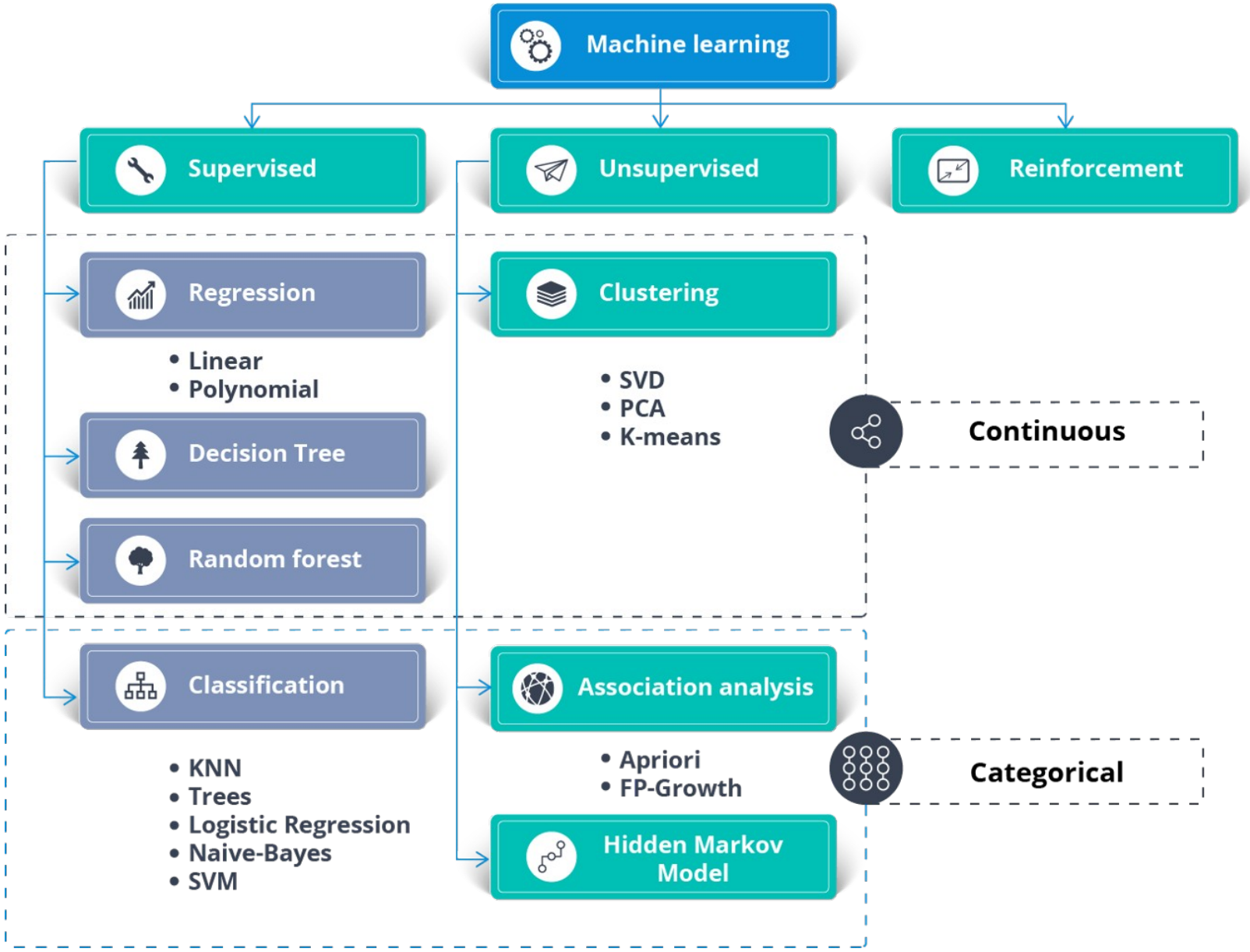
- Supervised Learning
- Output is a continuous quantity
- Main aim is to forecast or predict
- E.g. : Predict stock market price
- Algorithm: Linear Regression

Classification

- Supervised Learning
- Output is a categorical quantity
- Main aim is to compute the category of the data
- E.g. : Classify emails as spam or non-spam
- Algorithm: Logistic Regression

Clustering

- Unsupervised Learning
- Assigns data points into clusters
- Main aim is to group similar items clusters
- E.g. : Find all transactions which are fraudulent
- Algorithm: K-means


Machine learning
Supervised
Unsupervised
Reinforcement
Regression
Linear
Polynomial
Decision Tree
Random forest
Clustering
SVD
PCA
K-means
Continuous
Classification
KNN
Trees
Logistic Regression
Naive-Bayes
SVM
Association analysis
Apriori
FP-Growth
Hidden Markov Model
Categorical

Categories of Reinforcement Learning

- **Positive Reinforcement Learning:** Positive reinforcement learning specifies increasing the tendency that the required behavior would occur again by adding something.
- **Scenario: Teaching a dog to sit on command.**

- The positive reinforcement of providing a reward (treat, toy, or praise) immediately after the desired behavior (sitting) increases the likelihood that the dog will sit on command in the future.
- Over time, the dog associates the "sit" command with a positive outcome and is more likely to respond to it consistently.

Categories of Reinforcement Learning

- **Negative Reinforcement Learning:** Negative reinforcement learning works exactly opposite to the positive RL.
- It increases the tendency that the specific behavior would occur again by avoiding the negative condition.

- **Scenario**: Encouraging a child to wear their seatbelt in the car.
- **negative reinforcement is used to encourage the desired behavior (wearing a seatbelt) by stimulus (the car alarm)** when the behavior is performed, leading to the likelihood of the child continuing to wear their seatbelt in the future.

Real-world Use cases of Reinforcement Learning

- **Video Games:**
- RL algorithms are much popular in gaming applications.
- It is used to gain super-human performance.

- **Resource Management:**
- **T**he "Resource Management with Deep Reinforcement Learning" paper showed that how to use RL in computer to automatically learn and schedule resources to wait for different jobs in order to minimize average job slowdown.

Real-world Use cases of Reinforcement Learning

- **Robotics:** Robots are used in the industrial and manufacturing area, and these robots are made more powerful with reinforcement learning.
- There are different industries that have their vision of building intelligent robots using AI and Machine learning technology.

- **Text Mining:** Text-mining, one of the great applications of NLP, is now being implemented with the help of Reinforcement Learning by Salesforce company.

Advantages of Reinforcement Learning

- It helps in solving complex real-world problems which are difficult to be solved by general techniques.
- The learning model of RL is similar to the learning of human beings; hence most accurate results can be found.
- Helps in achieving long term results.

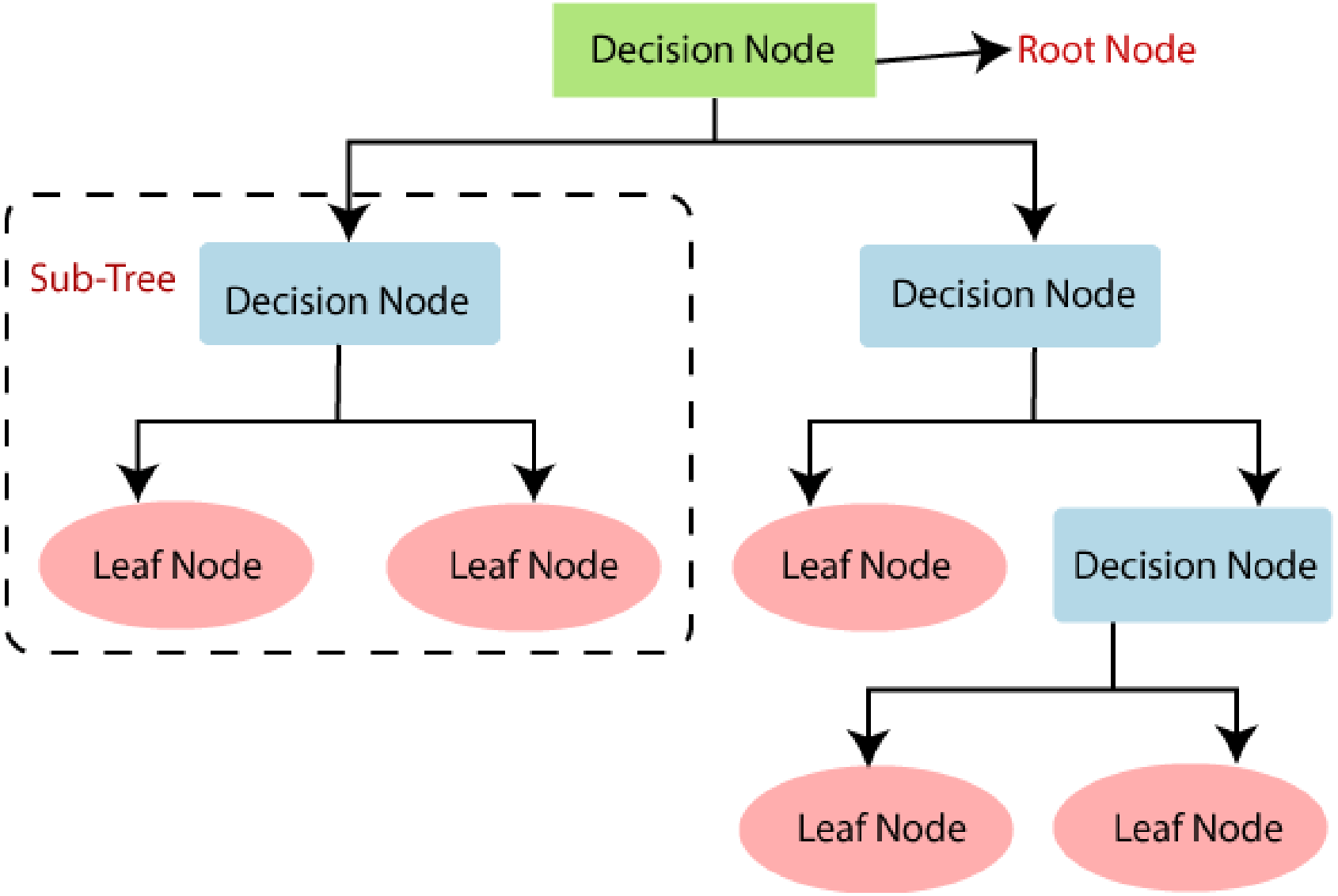
Disadvantages of Reinforcement Learning

- RL algorithms are not preferred for simple problems.
- RL algorithms require huge data and computations.
- Too much reinforcement learning can lead to an overload of states which can weaken the results.

Decision Tree Classification Algorithm

- **Decision Tree** is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems.
- It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.
- In a Decision tree, there are two nodes, which are the **Decision Node** and **Leaf Node.**
- Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches.
- The decisions or the test are performed on the basis of features of the given dataset.

- It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions.
- It is called a decision tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure.
- In order to build a tree, we use the CART algorithm, which stands for Classification and Regression Tree algorithm.
- A decision tree simply asks a question, and based on the answer (Yes/No), it further split the tree into subtrees.


Decision Node
Root Node
Sub-Tree
Decision Node
Decision Node
Leaf Node
Leaf Node
Leaf Node
Decision Node
Leaf Node
Leaf Node

Why use Decision Trees?

- There are various algorithms in Machine learning, so choosing the best algorithm for the given dataset and problem is the main point to remember while creating a machine learning model. Below are the two reasons for using the Decision tree:

- Decision Trees usually mimic human thinking ability while making a decision, so it is easy to understand.
- The logic behind the decision tree can be easily understood because it shows a tree-like structure.

Decision Tree Terminologies

- **Root Node:** Root node is from where the decision tree starts. It represents the entire dataset, which further gets divided into two or more homogeneous sets.
- **Leaf Node:** Leaf nodes are the final output node, and the tree cannot be segregated further after getting a leaf node.
- **Splitting:** Splitting is the process of dividing the decision node/root node into sub-nodes according to the given conditions.
- **Branch/Sub Tree:** A tree formed by splitting the tree.
- **Pruning:** Pruning is the process of removing the unwanted branches from the tree.
- **Parent/Child node:** The root node of the tree is called the parent node, and other nodes are called the child nodes.

How does the Decision Tree algorithm Work?

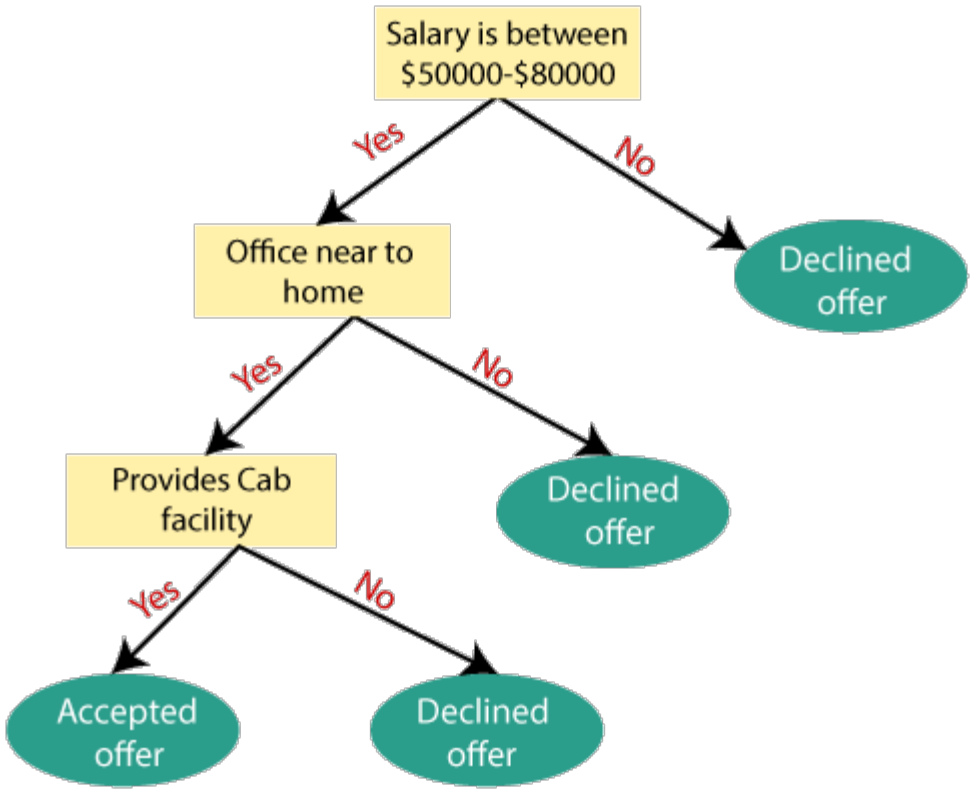
- In a decision tree, for predicting the class of the given dataset, the algorithm starts from the root node of the tree. This algorithm compares the values of root attribute with the record (real dataset) attribute and, based on the comparison, follows the branch and jumps to the next node.

- For the next node, the algorithm again compares the attribute value with the other sub-nodes and move further. It continues the process until it reaches the leaf node of the tree. The complete process can be better understood using the below algorithm:

- **Step-1:** Begin the tree with the root node, says S, which contains the complete dataset.
- **Step-2:** Find the best attribute in the dataset using Attribute Selection Measure (ASM).
- **Step-3:** Divide the S into subsets that contains possible values for the best attributes.
- **Step-4:** Generate the decision tree node, which contains the best attribute.
- **Step-5:** Recursively make new decision trees using the subsets of the dataset created in step -3. Continue this process until a stage is reached where you cannot further classify the nodes and called the final node as a leaf node.

Example:

- Suppose there is a candidate who has a job offer and wants to decide whether he should accept the offer or Not.
- So, to solve this problem, the decision tree starts with the root node (Salary attribute by ASM).
- The root node splits further into the next decision node (distance from the office) and one leaf node based on the corresponding labels.
- The next decision node further gets split into one decision node (Cab facility) and one leaf node.
- Finally, the decision node splits into two leaf nodes (Accepted offers and Declined offer). Consider the below diagram:


Salary is between $50000-$80000
Yes
No
Office near to home
Declined offer
Yes
No
Provides Cab facility
Declined offer
Yes
No
Accepted offer
Declined offer

Attribute Selection Measures

- While implementing a Decision tree, the main issue arises that how to select the best attribute for the root node and for sub-nodes.
- So, to solve such problems there is a technique which is called as Attribute selection measure or ASM.
- By this measurement, we can easily select the best attribute for the nodes of the tree.
- There are two popular techniques for ASM, which are:

- Information Gain
- Gini Index

Information Gain:

- Information gain is the measurement of changes in entropy after the segmentation of a dataset based on an attribute.
- It calculates how much information a feature provides us about a class.
- According to the value of information gain, we split the node and build the decision tree.
- A decision tree algorithm always tries to maximize the value of information gain, and a node/attribute having the highest information gain is split first. It can be calculated using the below formula:
- Information Gain= Entropy(S)- [(Weighted Avg) *Entropy(each feature)
- Entropy: Entropy is a metric to measure the impurity in a given attribute. It specifies randomness in data. Entropy can be calculated as:

- Entropy(s)= -P(yes)log2 P(yes)- P(no) log2 P(no)
- Where,

- S= Total number of samples
- P(yes)= probability of yes
- P(no)= probability of no

Gini Index:

- Gini index is a measure of impurity or purity used while creating a decision tree in the CART(Classification and Regression Tree) algorithm.
- An attribute with the low Gini index should be preferred as compared to the high Gini index.
- It only creates binary splits, and the CART algorithm uses the Gini index to create binary splits.
- Gini index can be calculated using the below formula:

Advantages of the Decision Tree

- It is simple to understand as it follows the same process which a human follow while making any decision in real-life.
- It can be very useful for solving decision-related problems.
- It helps to think about all the possible outcomes for a problem.
- There is less requirement of data cleaning compared to other algorithms.

Disadvantages of the Decision Tree

- The decision tree contains lots of layers, which makes it complex.
- It may have an overfitting issue, which can be resolved using the Random Forest algorithm.
- For more class labels, the computational complexity of the decision tree may increase.

What is an Expert System?

- An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert.

- It performs this by **extracting** knowledge from its **knowledge base** using the reasoning and inference rules according to the user queries.

Expert System

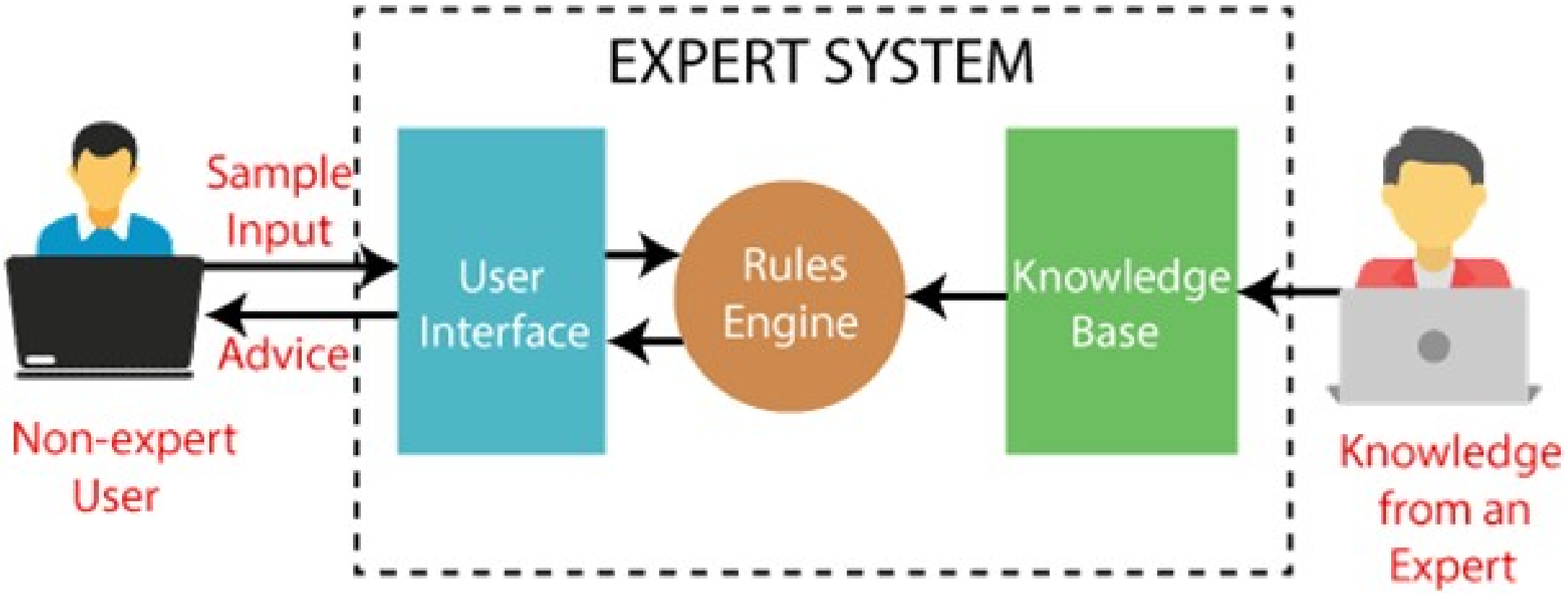
- The expert system is a part of AI, and the first ES was developed in the year 1970, which was the first successful approach of artificial intelligence.
- It solves the most complex issue as an expert by extracting the knowledge stored in its knowledge base.

Expert System

- The system helps in decision making for complex problems using **both facts and heuristics like a human expert**.
- It is called so because it contains the expert knowledge of a specific domain and can solve any complex problem of that particular domain.
- These systems are designed for a specific domain, such as **medicine, science,** etc.

Expert System

- The performance of an expert system is based on the expert's knowledge stored in its knowledge base.
- The more knowledge stored in the **KB**, the more that system improves its performance.
- One of the common examples of an ES is a **suggestion of spelling errors** while typing in the Google search box.

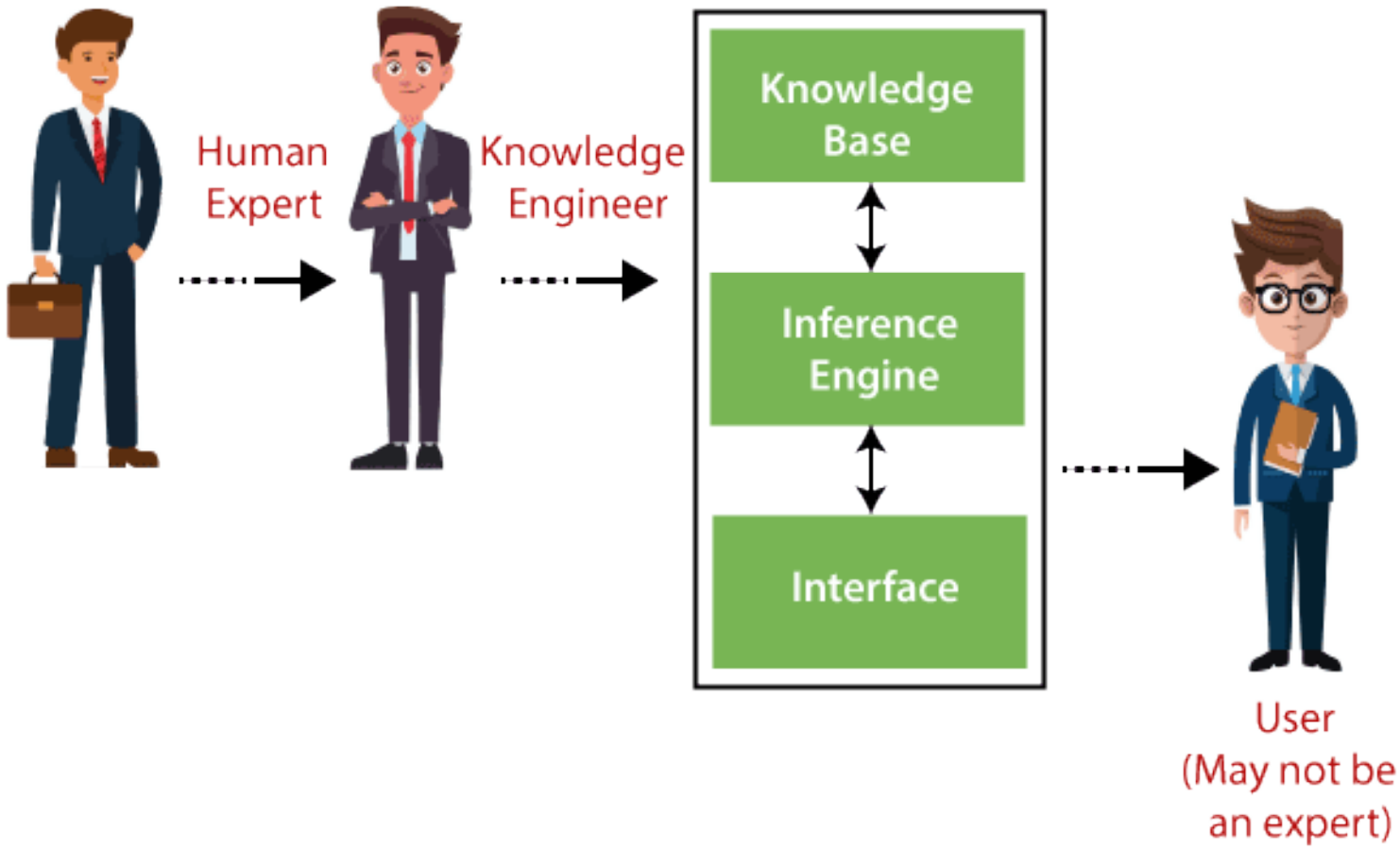

EXPERT SYSTEM
Sample Input
Advice
User Interface
Rules Engine
Knowledge Base
Non-expert User
Knowledge from an Expert

Characteristics of Expert System

- **High Performance:** The expert system provides high performance for solving any type of complex problem of a specific domain with high efficiency and accuracy.
- **Understandable:** It responds in a way that can be easily understandable by the user.
- It can take input in human language and provides the output in the same way.
- **Reliable:** It is much reliable for generating an efficient and accurate output.
- **Highly responsive:** ES provides the result for any complex query within a very short period of time.

Components of Expert System

- **User Interface**
- **Inference Engine**
- **Knowledge Base**


Human
Expert
Knowledge
Engineer
Knowledge
Base
Inference
Engine
Interface
User
(May not be
an expert)

1. User Interface

- With the help of a user interface, the expert system interacts with the user, takes queries as an input in a readable format, and passes it to the inference engine.
- After getting the response from the inference engine, it displays the output to the user.
- In other words, **it is an interface that helps a non-expert user to communicate with the expert system to find a solution**.

2. Inference Engine (Rules of Engine)

- The **inference engine** is known as the brain of the expert system as it is the main processing unit of the system.
- It applies **inference rules** to the knowledge base to derive a conclusion or deduce new information.
- It helps in deriving an error-free solution of queries asked by the user.
- With the help of an inference engine, the system extracts the knowledge from the knowledge base.

2. Inference Engine (Rules of Engine)

- There are two types of inference engine:
- **Deterministic Inference engine:** The conclusions drawn from this type of inference engine are assumed to be true. It is based on **facts** and **rules**.
- **Probabilistic Inference engine:** This type of inference engine contains **uncertainty in conclusions**, and based on the probability.

- Inference engine uses the below modes to derive the solutions:

- **Forward Chaining:** It starts from the known facts and rules, and applies the inference rules to add their conclusion to the known facts.

- **Backward Chaining:** It is a backward reasoning method that starts from the goal and works backward to prove the known facts.

3. Knowledge Base

- The knowledgebase is a type of storage that **stores knowledge acquired from the different experts of the particular domain**.
- It is considered as big storage of knowledge.
- The **more the knowledge base, the more precise will be the Expert System.**
- It is similar to a database that contains information and rules of a particular domain or subject.
- One can also view the knowledge base as collections of objects and their attributes.

Components of Knowledge Base

- **Factual Knowledge:** The knowledge which is based on facts and accepted by knowledge engineers comes under **factual knowledge.**
- **Heuristic Knowledge:** This knowledge is based on **practice, the ability to guess, evaluation, and experiences**.

- **Knowledge Representation:** It is used to formalize the knowledge stored in the knowledge base using **the If-else rules.**
- **Knowledge Acquisitions:** It is the process of extracting, organizing, and structuring the domain knowledge, specifying the rules to acquire the knowledge from various experts, and store that knowledge into the knowledge base.

Why Expert System

- No emotion
- High Efficiency
- Expertise in a domain
- No Memory limitation
- Regular updates improve the performance
- High Security
- Considers all facts

Capabilities of the Expert System

- **Advising:** It is capable of advising the human being for the query of any domain from the particular ES.
- **Provide decision-making capabilities:** It provides the capability of decision making in any domain, such as for making any financial decision, decisions in medical science, etc.
- **Demonstrate a device:** It is capable of demonstrating any new products such as its features, specifications, how to use that product, etc.
- **Problem-solving:** It has problem-solving capabilities.

Capabilities of the Expert System

- **Explaining a problem:** It is also capable of providing a detailed description of an input problem.
- **Interpreting the input:** It is capable of interpreting the input given by the user.
- **Predicting results:** It can be used for the prediction of a result.
- **Diagnosis:** An ES designed for the medical field is capable of diagnosing a disease without using multiple components as it already contains various inbuilt medical tools.

Advantages of Expert System

- These systems are **highly reproducible.**
- They can be used for **risky places where the human presence is not safe.**
- Error possibilities are less if the **KB contains correct knowledge**.
- The performance of these systems remains **steady as it is not affected by emotions, tension, or fatigue**.
- They provide a very high speed to respond to a particular query.

Limitations of Expert System

- The response of the expert system may get wrong **if the knowledge base contains the wrong information.**
- Like a human being, it **cannot produce a creative output for different scenarios.**
- Its maintenance and development costs are very high.
- Knowledge acquisition for designing is much difficult.
- **For each domain, we require a specific ES, which is one of the big limitations.**
- It cannot learn from itself and hence requires manual updates.

Applications of Expert System

- **In designing and manufacturing domain**
  It can be broadly used for designing and manufacturing physical devices such as camera lenses and automobiles.

- **In the knowledge domain**
  These systems are primarily used for publishing the relevant knowledge to the users.
- The two popular ES used for this domain is an advisor and a tax advisor.

- **In the finance domain**
  In the finance industries, it is used to detect any type of possible fraud, suspicious activity, and advise bankers that if they should provide loans for business or not.
- **In the diagnosis and troubleshooting of devices**
  In medical diagnosis, the ES system is used, and it was the first area where these systems were used.
- **Planning and Scheduling**
  The expert systems can also be used for planning and scheduling some particular tasks for achieving the goal of that task.

Tutorial 4 Questions

- Distinguish between Supervised, Unsupervised and Semi-supervised Learning
- Describe components of expert systems.
- Explain capabilities of expert systems.

Thank You