Artificial Intelligence

Unit-IV

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- **UNIT - IV**

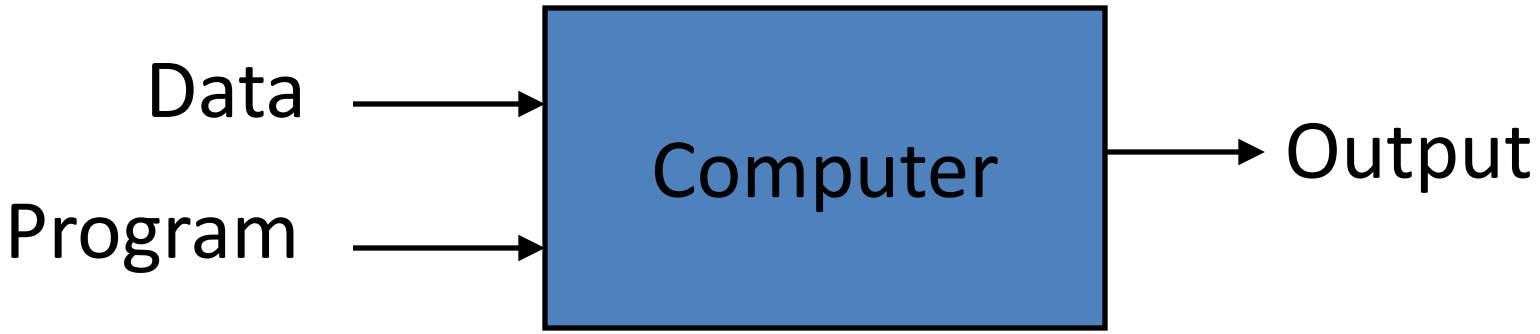
- **Learning:** What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

What Is Learning?

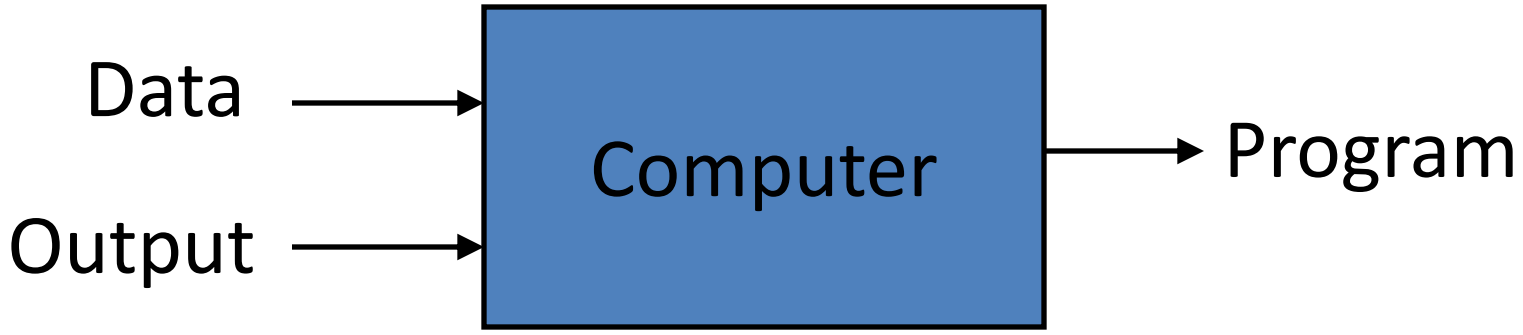
- According to **Herbert** , learning denotes **changes in a system that enable a system to do the same task more efficiently the next time**.

- **Arthur Samuel** stated that, "Machine learning is the subfield of computer science, that gives computers the ability **to learn without being explicitly programmed ".**

Traditional Programming



Machine Learning



What Is Learning?

- In 1997, **Mitchell** proposed that, " A computer program is said to learn from experience 'E' with respect to some class of tasks 'T' and performance measure 'P', if its performance at tasks in 'T', **as measured by 'P', improves with experience E** ".

- The main purpose of machine learning is to study and design the algorithms that can be **used to produce the predicates from the given dataset.**

- Besides these, the machine learning includes the **agents percepts for acting** as well as **to improve their future performance.**

The following tasks must be learned by an agent.

- To predict or decide the result state for an action.
- To know the values for each state(understand which state has high or low value).
- To keep record of relevant percepts.

Why do we require machine learning?

- Machine learning plays an important role in improving and understanding the efficiency of human learning.
- Machine learning is used to discover a new things not known to many human beings.

- There are four categories of machine learning algorithms as shown below –

- Supervised learning algorithm
- Unsupervised learning algorithm
- Semi-supervised learning algorithm
- Reinforcement learning algorithm

- **Supervised Learning:**
- Supervised learning, as the name indicates, has the presence of a supervisor as a teacher.

- Basically supervised learning is when we teach or train the machine using data that is well labeled. Which means some data is **already tagged with the correct answer.** After that, the machine is provided with a new set of examples(data) so that the supervised learning algorithm analyses the training data(set of training examples) and produces a correct outcome from labeled data.

- Supervised learning is commonly used in real world applications, such as **face and speech recognition,** products or movie recommendations, and sales forecasting.

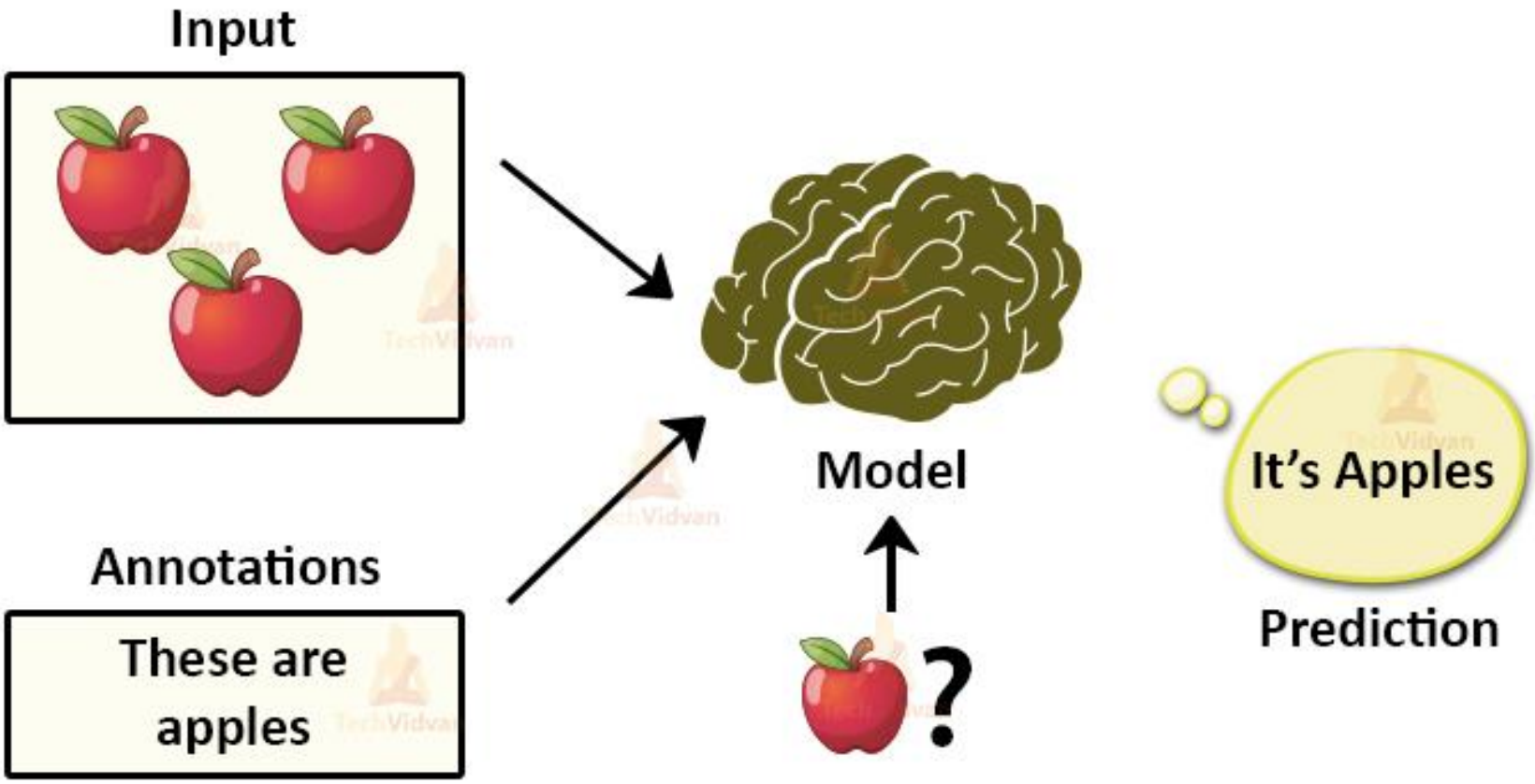
- Supervised learning can be further classified into two types - **Regression** and **Classification**.

- **Classification** attempts to find the **appropriate class label**, such as analyzing positive/negative sentiment, male and female persons, secure and unsecure loans etc.

- **Regression** trains on and predicts a **continuous-valued** response, for example predicting real estate prices.

- Common **examples** of supervised learning include classifying e-mails into spam and not-spam categories, labeling webpages based on their content, and voice recognition.

Supervised Learning in ML



Supervised learning Example: Classification

label

apple

apple

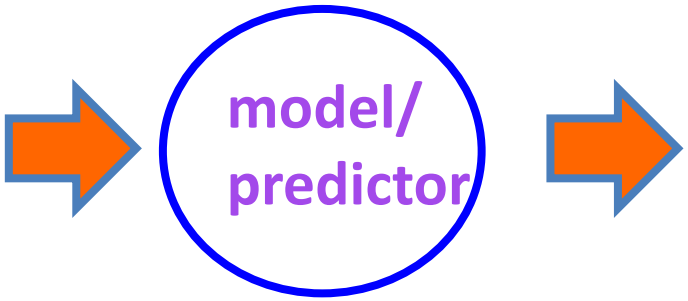
banana

banana

Classification: a finite set of labels

Supervised learning: given labeled examples

Supervised learning Example



predicted label

Supervised learning: learn to predict new example

Supervised learning: regression

4.5

10.1

3.2

4.3

label

Regression: label is real-valued

Supervised learning: given labeled examples

- **Unsupervised Learning**
- Unsupervised learning is the training of a machine using information that is **neither classified nor labeled** and allowing the algorithm to act on that information without guidance. Here the task of the machine is to group unsorted information according to similarities, patterns, and differences without any prior training of data.

- Unsupervised learning is used to detect anomalies, outliers, such as fraud or defective equipment, or to group customers with similar behaviors for a sales campaign.

- It is the opposite of supervised learning. There is no labeled data here.

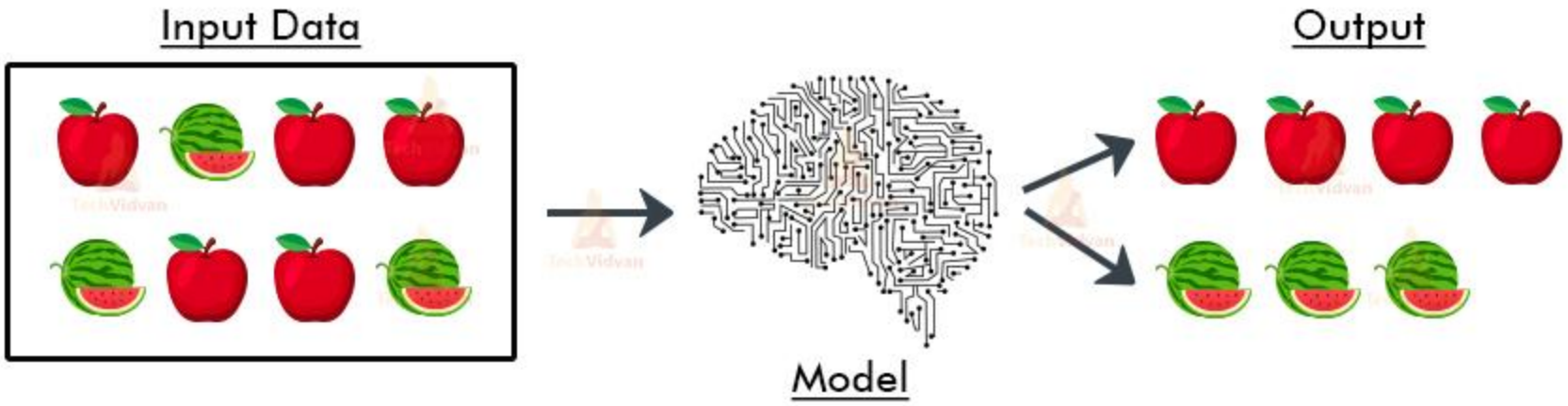
Unsupervised learning

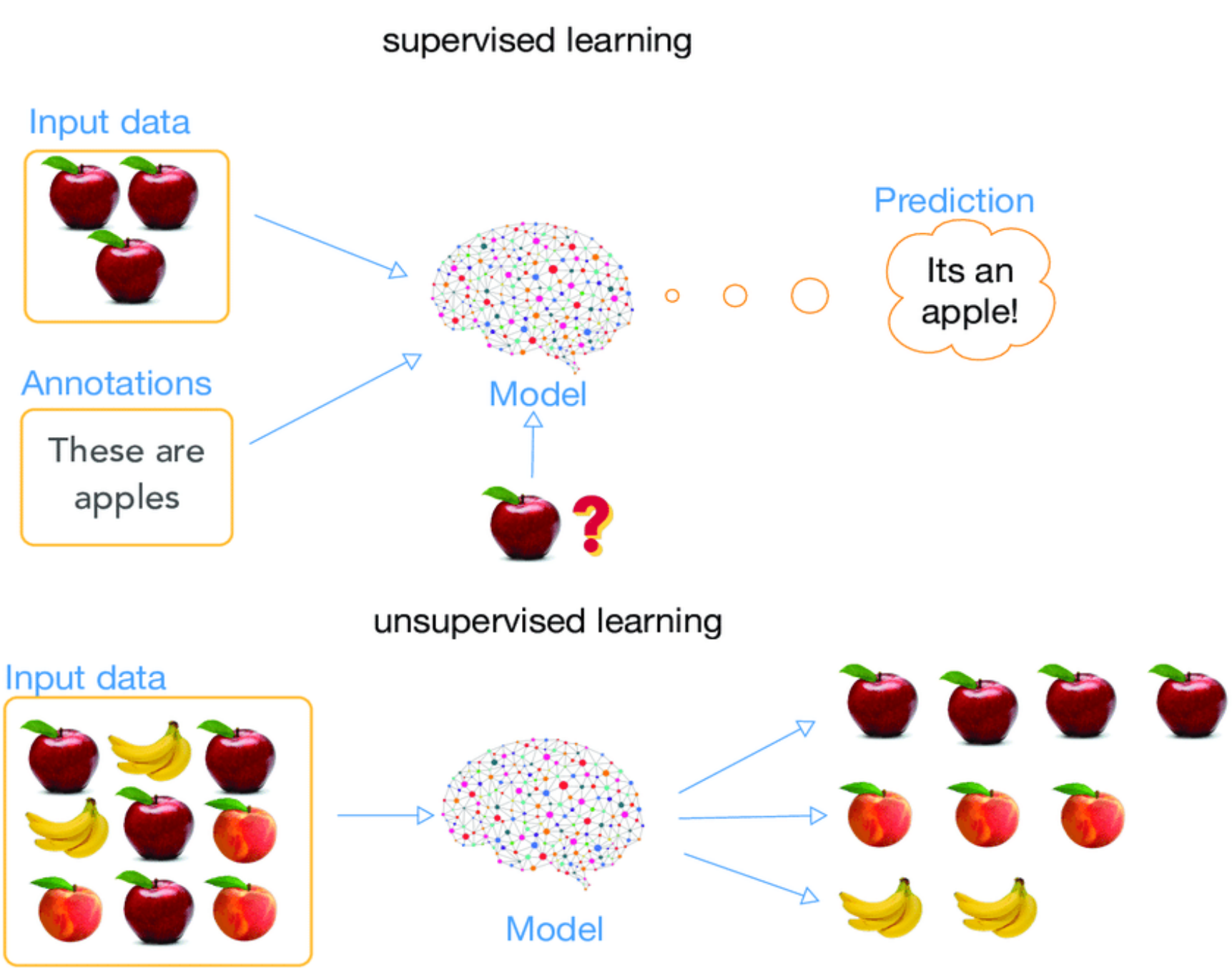




Unupervised learning: given data, i.e. examples, but no labels

Unsupervised Learning in ML

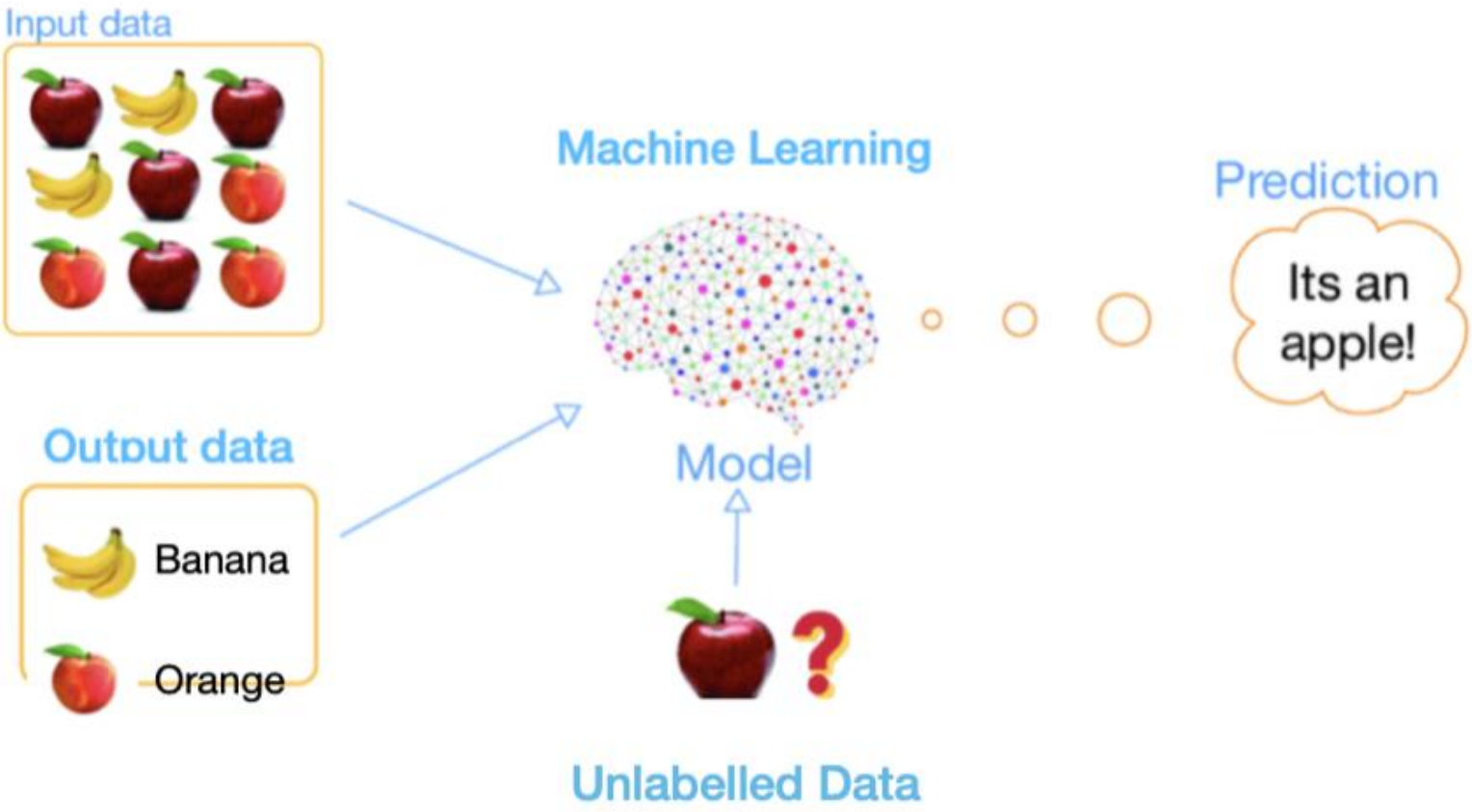



supervised learning
Input data
Prediction
Its an apple!
Annotations
These are apples
Model
unsupervised learning
Input data
Model

- **Semi-supervised Learning:**

- If some learning samples are labeled, but some other are not labeled, then it is semi-supervised learning.

- It makes use of a large amount of **unlabeled data for training** and a small amount of **labeled data for testing**.

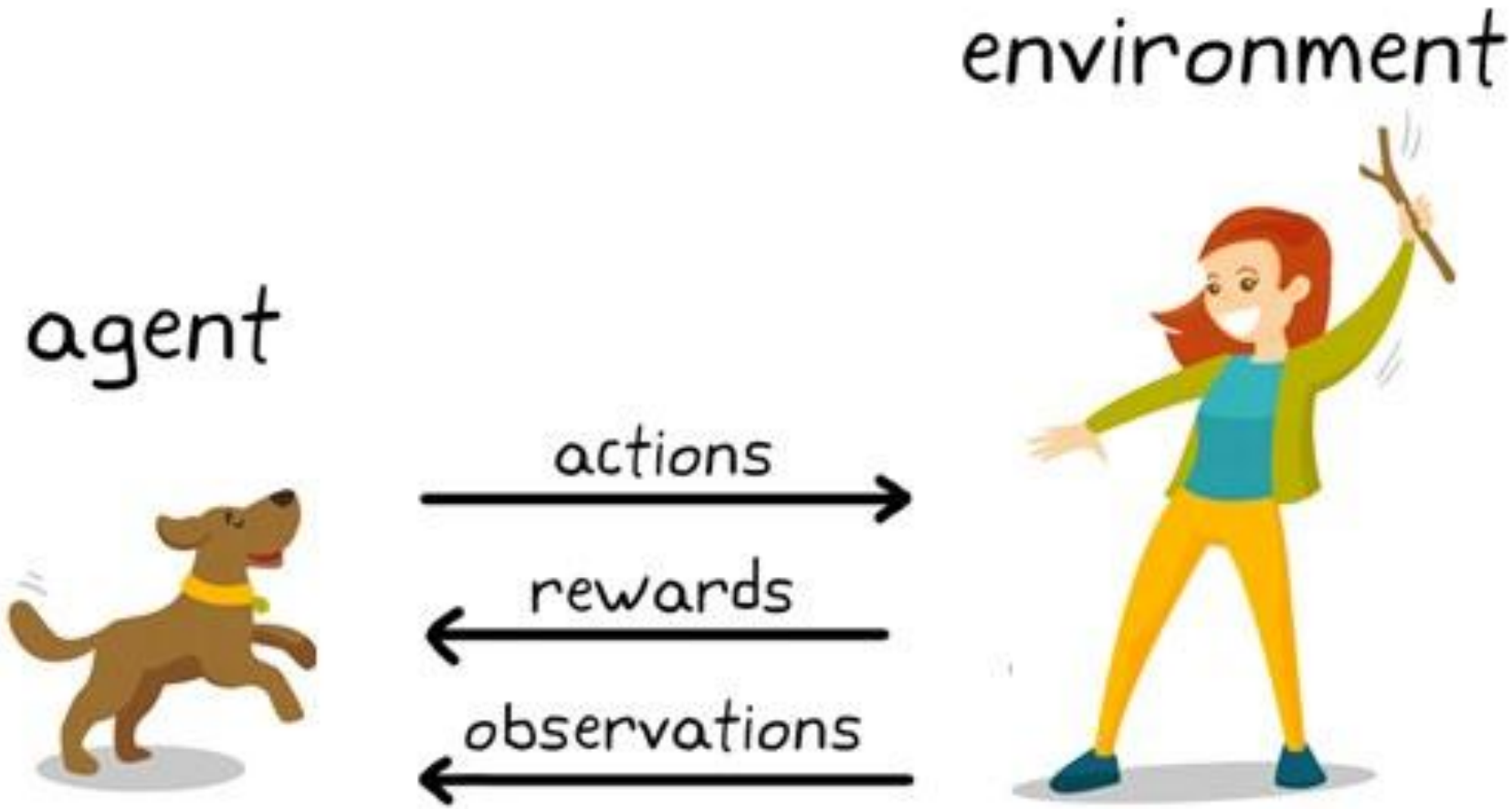

Input data
Machine Learning
Prediction
Its an apple!
Output data
Banana
Orange
Model
Unlabelled Data

- **Reinforcement Learning:**

- Here learning data **gives feedback** so that the system adjusts to dynamic conditions in order to achieve a certain objective.

- The system evaluates its performance based on the feedback responses and reacts accordingly.

- The best known instances include self-driving cars and chess master algorithm AlphaGo.


environment
agent
actions
rewards
observations

Various forms of learning

- **1. Rote learning**
- **2. Inductive learning (Learning by example)**
- **3. Learning by taking advice**

- **1. Rote learning:**

- Rote Learning is a conventional learning procedure that is **solely based on the memorization** of information based on repetitions.

- Best examples of rote learning are multiplication tables and spelling words.

- The ’80s or 90’s born people now can remember how they used to recall tables and word spellings.

- For example, an AI system might be designed to recognize faces by extracting a variety of features (such as distance between the eyes) from an image and searching for a match within a database of 1000 stored feature sets.

- If it finds a match, it has recognized the person; if not, it reports “unknown person.”

- In this latter case, the person or some human operator can provide the necessary details of this unknown person, and the system can enter the details in its database so that next time this person is presented to the system he or she will be correctly recognized.

2. Inductive learning (Learning by example):

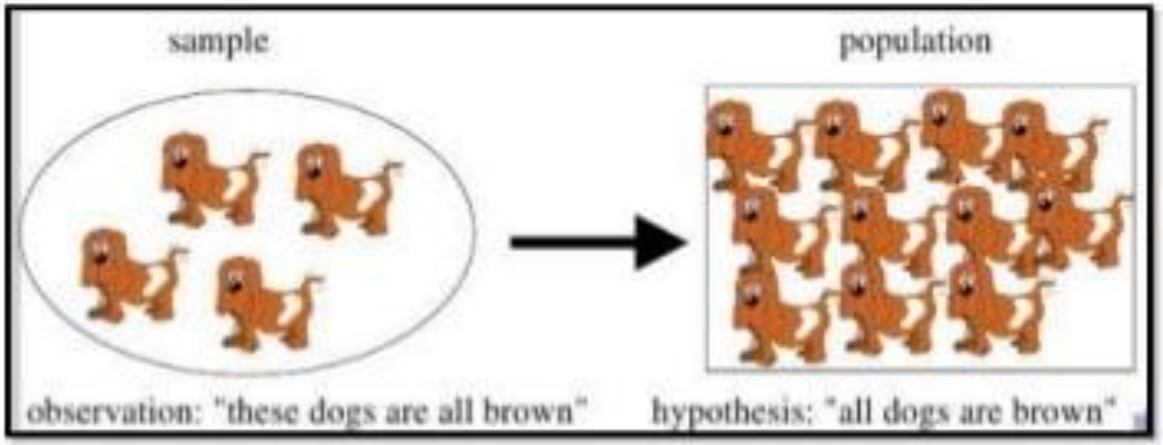
- Induction learning is carried out on the basis of supervised learning.

- In this learning process, a general rule is induced by the system from a set of observed instance.

Inductive learning

- ***Inductive:***

This cat is black. That cat is black A third cat is black. Therefore all cats are black



- ***Deductive:***

Bachelor's are unmarried men. Bill is unmarried. Therefore, Bill is a bachelor

LEARNING BY TAKING ADVICE

- In the computer when the programmer writes a series of instruction into a computer a rudimentary kind of learning is taking place. Hence the programmer is sort of teacher and computer is sort of student. Hence being programmed the computer is now able to do something it previously could not do.
- People process advice in an analogous way. The different type of advice takes a particular
- on different situation . Computer program might make use of the advice by adjusting its static evaluation function to include a factor depending on the other control. If we have design a data structure for playing any game then first we rule out all the advise before playing the game. Hence human user first translates the advice then plays the game.

What is EBL ?

- Learning *general* problem-solving techniques by observing and analyzing human solutions to *specific* problems.
- EBL attempts to formulate a *generalization* after observing only a single example.
- Introduced by Gerald De Jong in 1981.

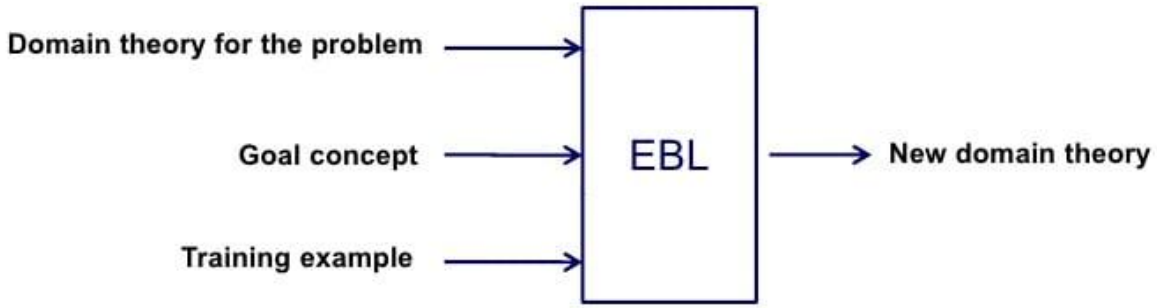
"Hey! Look what Zog do!"

(drawn by Gary Larson)

Explanation/Example based learning:

Explanation-Based Learning

- **Deduce information from a set of observations**
  - Humans learn a lot from few examples
  - Machine: use results from one example to solve the next problem



Explanation/Example based learning:

- Explanation-based learning (EBL) deals with an idea of single-example learning.

- This type of learning usually requires a sufficient number of training instances but there are two difficulties in this:

  •

  I. it is difficult to have such a number of training instances

  ii. Sometimes, it may help us to learn certain things effectively, specially when we have enough knowledge.

- Hence, it is clear that instance-based learning is more data-intensive, data-driven while EBL is more knowledge-intensive, knowledge-driven.

Explanation/Example based learning:

- Initially, an EBL system accepts a training example.
- On the basis of the given goal concept, an operationality criteria and domain theory, it "generalizes" the training example to describe the goal concept and to satisfy the operationality criteria (which are usually a set of rules that describe relationships between objects and actions in a domain).
- Thus, several applications are possible for the knowledge acquisition and engineering aspects.

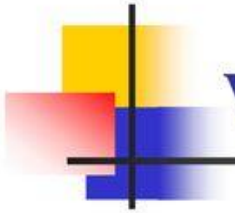
Learning in Problem Solving

- Humans have a tendency to learn by solving various real world problems.

- The forms of problem solving principle is **based on reinforcement learning.**

- Therefore, **repeating certain action results in desirable outcome** while the action is avoided if it results into undesirable outcomes.

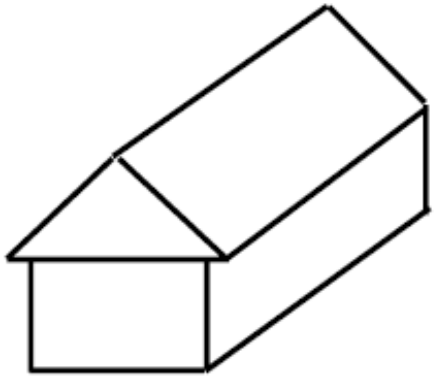
- As the outcomes have to be evaluated, this type of learning also involves the definition of a utility function. This function shows how much is a particular outcome worth?



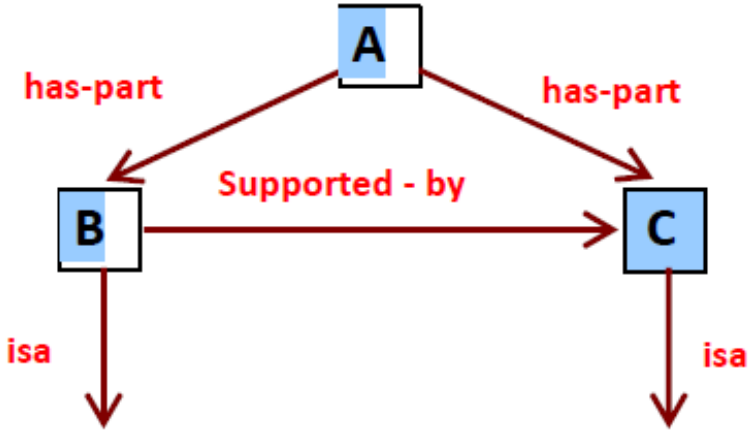
WINSTON' S LEARNING PROGRAM

- The basic approach that Winston' s program took the problem of concept formation can be described as:
- Begin with structural description of one known instance of the concept call that description the concept definition.
- Examine descriptions of other known instances of the concept. Generalize the definition to include them.
- Examine descriptions of near misses of the concept. Restrict the definition to exclude these

Object - house



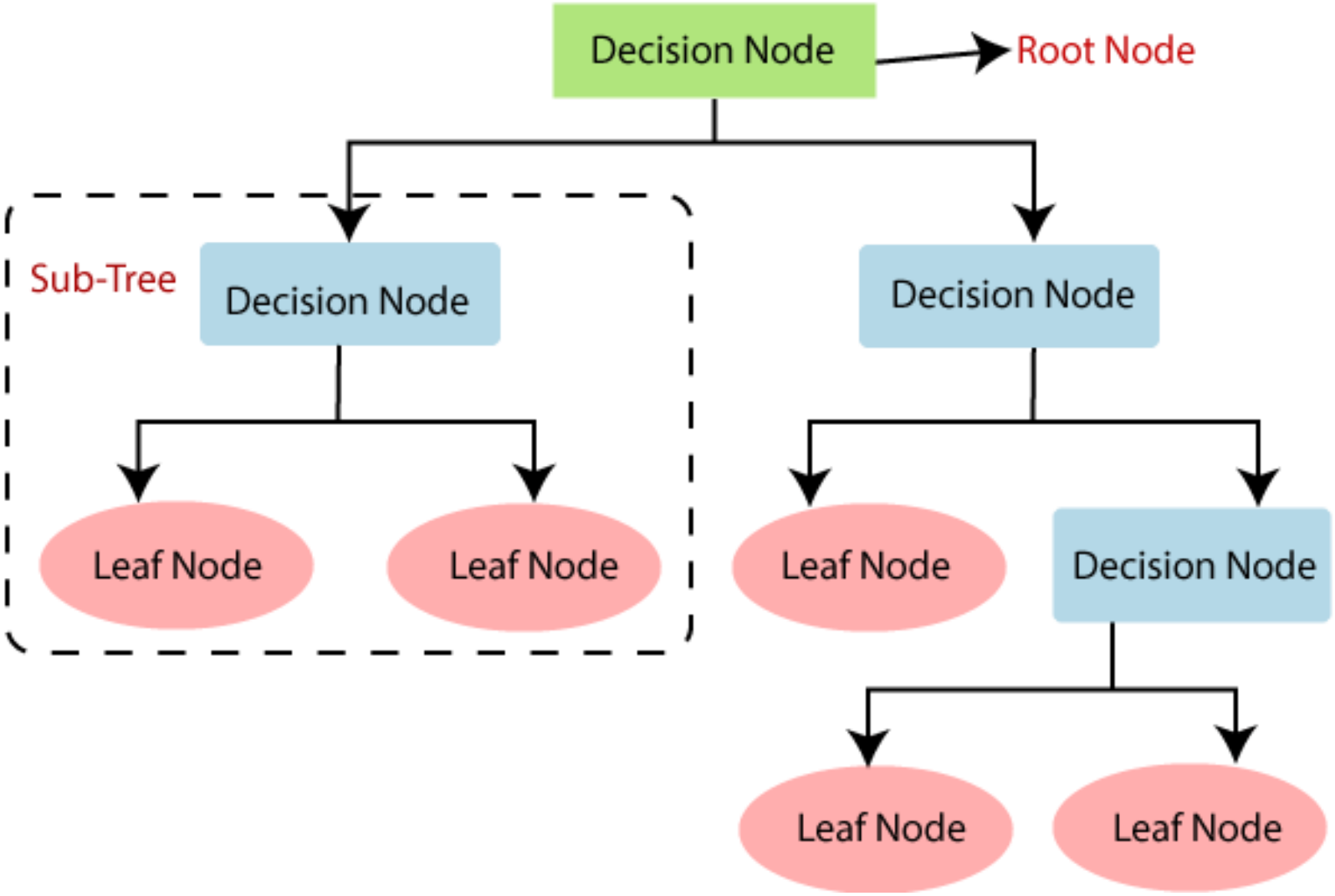
Semantic net

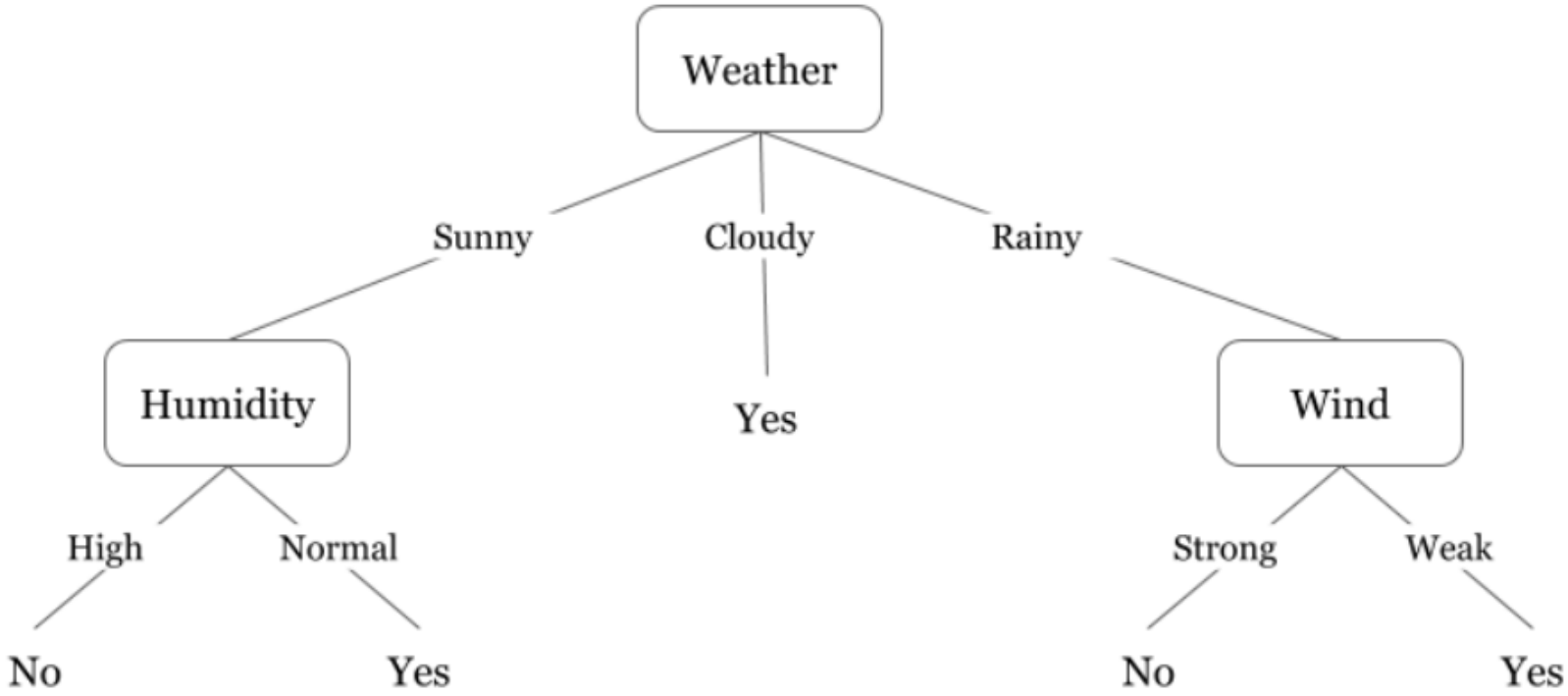


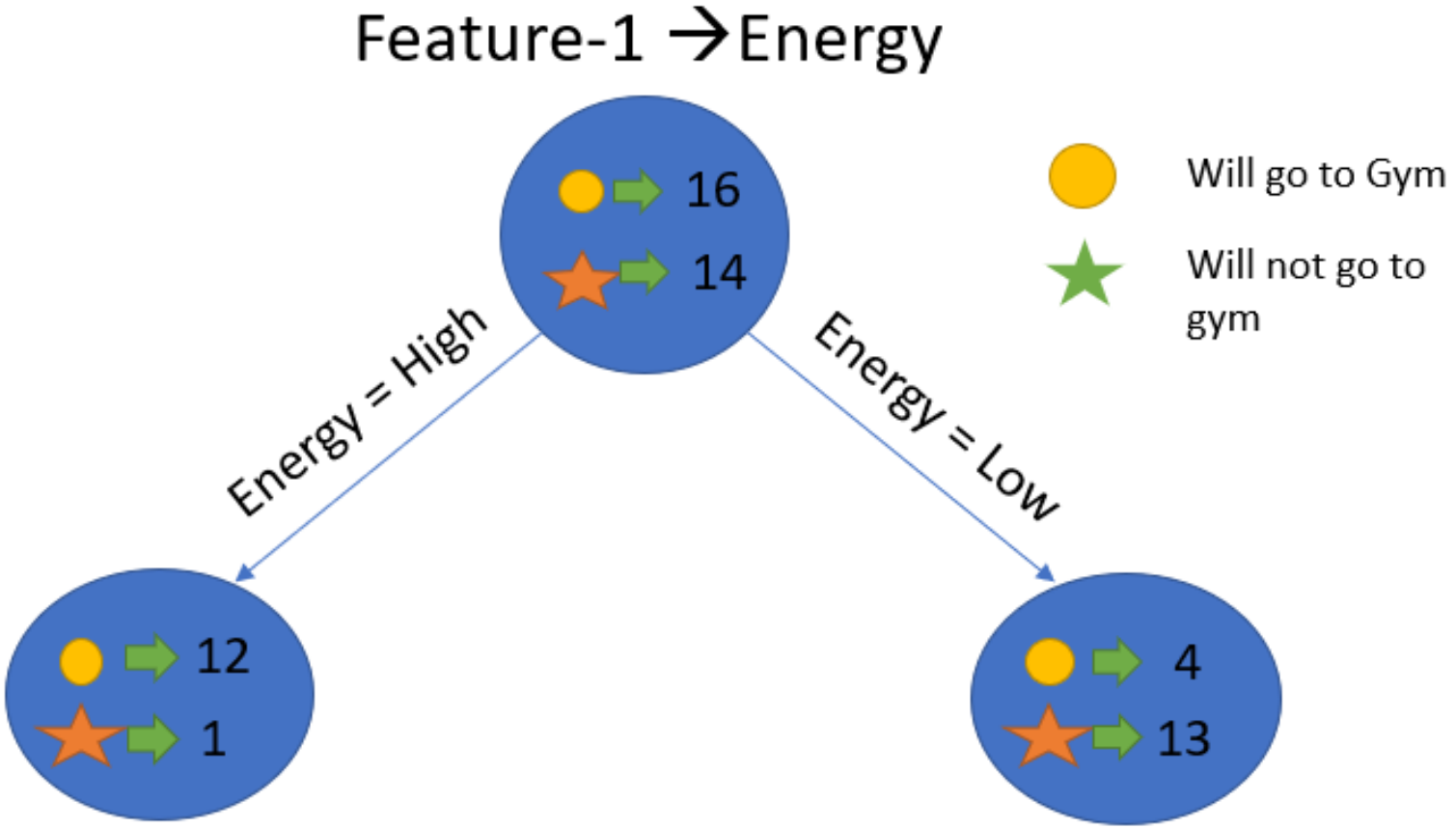
Decision Trees

- **Decision Tree :** Decision tree is the most powerful and popular tool for classification and prediction.

- A Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.


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


Weather
Sunny
Cloudy
Rainy
Humidity
Yes
Wind
High
Normal
Strong
Weak
No
Yes
No
Yes


Feature-1 → Energy
16
14
Will go to Gym
Will not go to gym
Energy = High
Energy = Low
12
1
4
13

- *A decision tree for the concept PlayTennis.*

- **Construction of Decision Tree :**

- A tree can be *"learned"* by splitting the source set into subsets based on an attribute value test. This process is repeated on each derived subset in a recursive manner called *recursive partitioning*.

- The recursion is completed when the subset at a node all has the same value of the target variable, or when splitting no longer adds value to the predictions.

- The construction of decision tree classifier does not require any domain knowledge or parameter setting, and therefore is appropriate for exploratory knowledge discovery.

- Decision trees can handle high dimensional data. In general decision tree classifier has good accuracy. Decision tree induction is a typical inductive approach to learn knowledge on classification.

- **Decision Tree Representation :**

- Decision trees classify instances by sorting them down the tree from the root to some leaf node, which provides the classification of the instance.

- An instance is classified by starting at the root node of the tree,testing the attribute specified by this node,then moving down the tree branch corresponding to the value of the attribute as shown in the above figure.

- This process is then repeated for the subtree rooted at the new node.

- The decision tree in above figure classifies a particular morning according to whether it is suitable for playing tennis and returning the classification associated with the particular leaf.(in this case Yes or No).

- For example,the instance
- (Outlook = Rain, Temperature = Hot, Humidity = High, Wind = Strong)

- </blockquote> would be sorted down the leftmost branch of this decision tree and would therefore be classified as a negative instance.

- In other words we can say that decision tree represent a disjunction of conjunctions of constraints on the attribute values of instances.

- (Outlook = Sunny ^ Humidity = Normal) v (Outllok = Overcast) v (Outlook = Rain ^ Wind = Weak)

- **Strengths of Decision Tree approach are:**

- Decision trees are able to generate understandable rules.

- Decision trees perform classification without requiring much computation.

- Decision trees are able to handle both continuous and categorical variables.

- Decision trees provide a clear indication of which fields are most important for prediction or classification.

- **Weakness of Decision Tree approach:**

- Decision trees are less appropriate for estimation tasks where the goal is to predict the value of a continuous attribute.

- Decision trees are prone to errors in classification problems with many class and relatively small number of training examples.

- Decision tree can be computationally expensive to train. The process of growing a decision tree is computationally expensive. At each node, each candidate splitting field must be sorted before its best split can be found.

- In some algorithms, combinations of fields are used and a search must be made for optimal combining weights.