Artificial Intelligence

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Course Introduction

Couse No.: CSE 3209

Course Title: Artificial Intelligence

Contact Hours/Week: 3

Credits: 3.00

Couse No.: CSE 3210

Course Title: Sessional based on CSE 3209

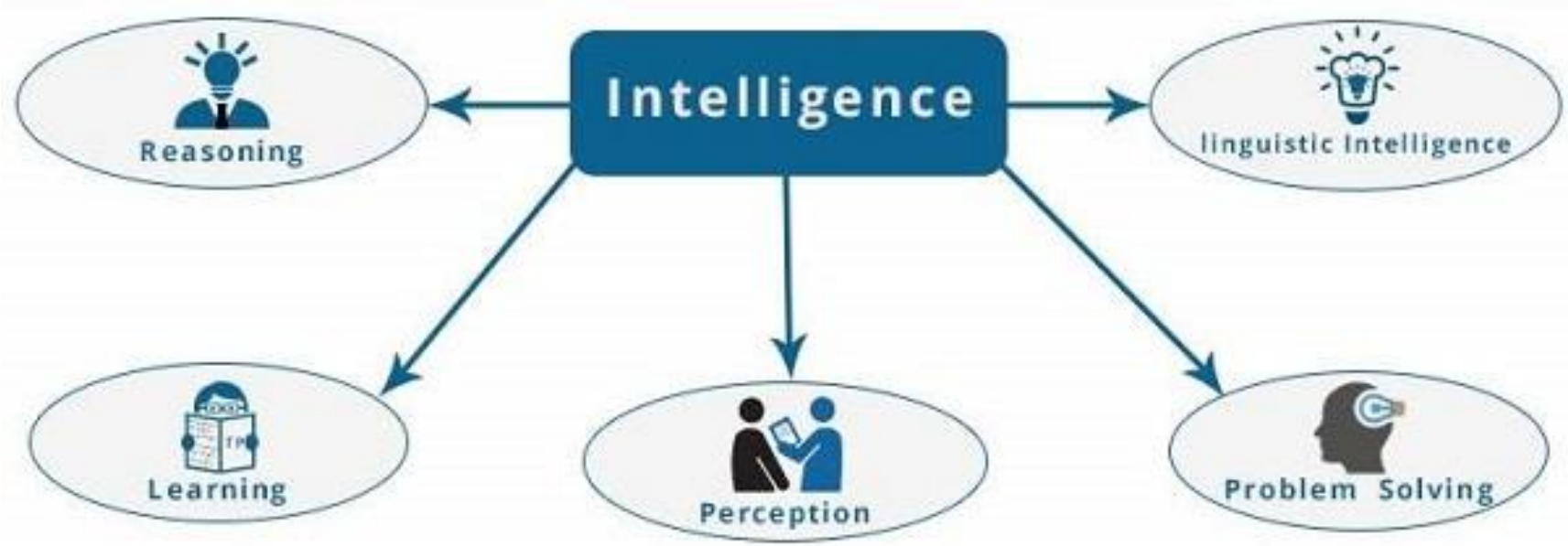
Contact Hours/Week: 3/2

Credits: 0.75

What is Intelligence?

- Learning, manipulating with facts, but also creativity, consciousness, emotion and intuition.

Intelligence Composed of What?



https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligent_systems.htm

What is Artificial Intelligence (AI)?

- **Artificial Intelligence (AI)** is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans.

What is Artificial Intelligence (AI)?…

- Artificial intelligence is complex in nature. It uses very complicated mixture of computer science, mathematics and other complex sciences.

- Complex programming helps these machines to replicate the cognitive abilities of human beings.

Can Machines be Intelligent?

- Up to the present day it is not sure whether it is possible to build a machine that has all aspects of intelligence.

- This kind of research is central in the field of

AI

Goals of AI

- As a science, AI attempts to **establish** a theory of intelligence to explain human intellectual activities and abilities.

- As a technology, AI attempts to **implement** a theory of intelligence in computer systems to reproduce these activities and abilities and use them to solve practical problems.

Birth of AI

John McCarthy used the term "Artificial Intelligence" for the first time as the topic of the Dartmouth conference in 1956.

- Venue:

  -Dartmouth College, Hanover, state New Hamphshire, USA

- Organizers:

  -John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon

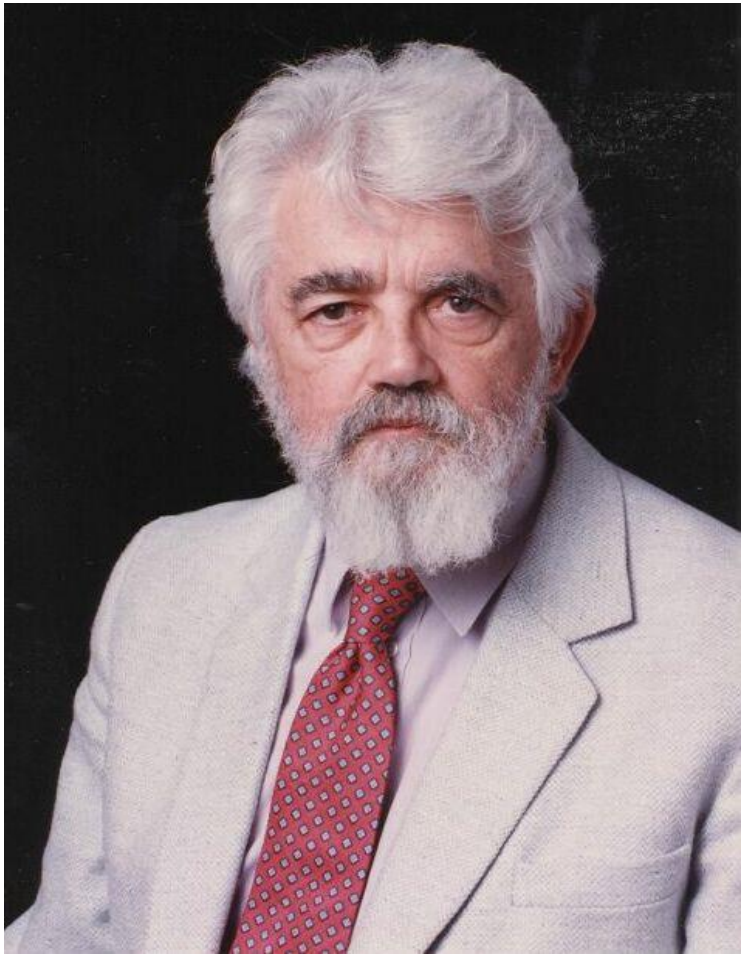
- Participants:

  -Ray Solomonoff, Oliver Selfridge, Trenchard More, Arthur Samuel, Herbert Simon, and Allen Newell

- Proposal:

  To prove that every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it.

Birth of AI…

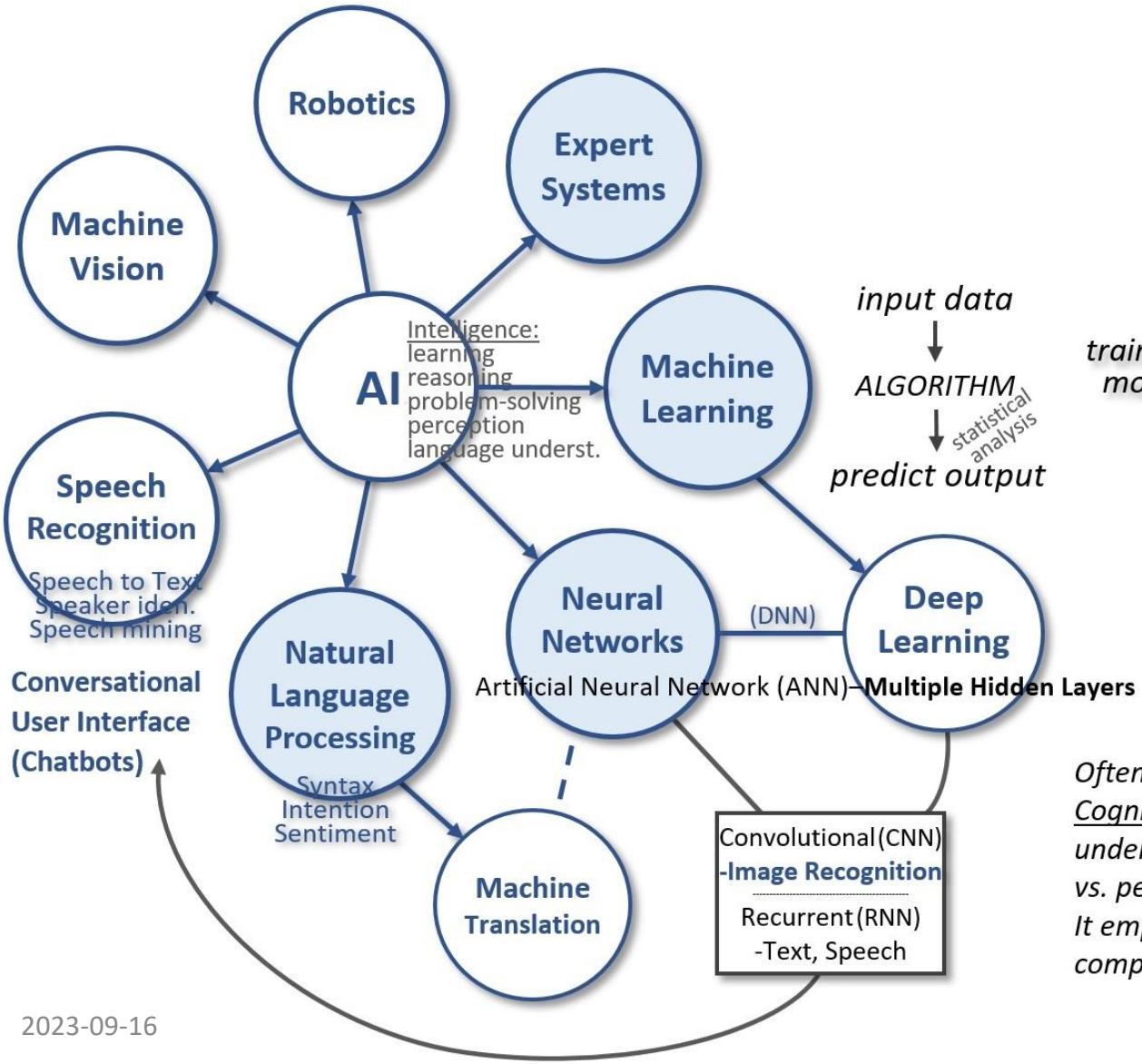


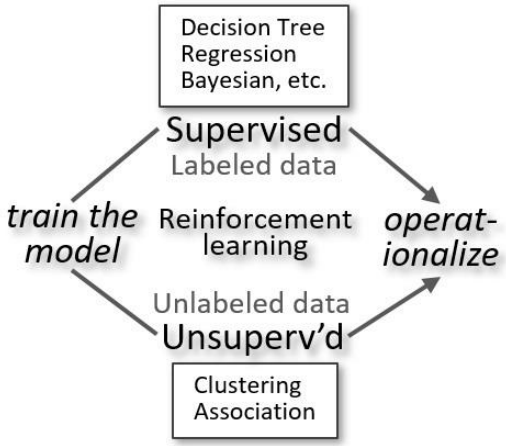
John McCarthy

Quick Review of AI

Web-link: https://content.wisestep.com/advantages-disadvantages-artificial-intelligence/

Areas of AI





Often used as marketing jargon, Cognitive Computing is focused on understanding and reasoning ("thinking" vs. perception and motor control.)
It employs multiple AI subsystems for complex decision-making.

Learning

"A **computer program** is said to learn if it's performance measured by P, on some task denoted by T, improves with experience denoted by E."- **Mitchell,1997.**

Learning can be represented as a set {P, T, E}

If E and P increasing then Learning occurs.

Otherwise memorizing

https://www.tutorialride.com/artificial-intelligence/learning-and-expert-system-in-ai.htm

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.

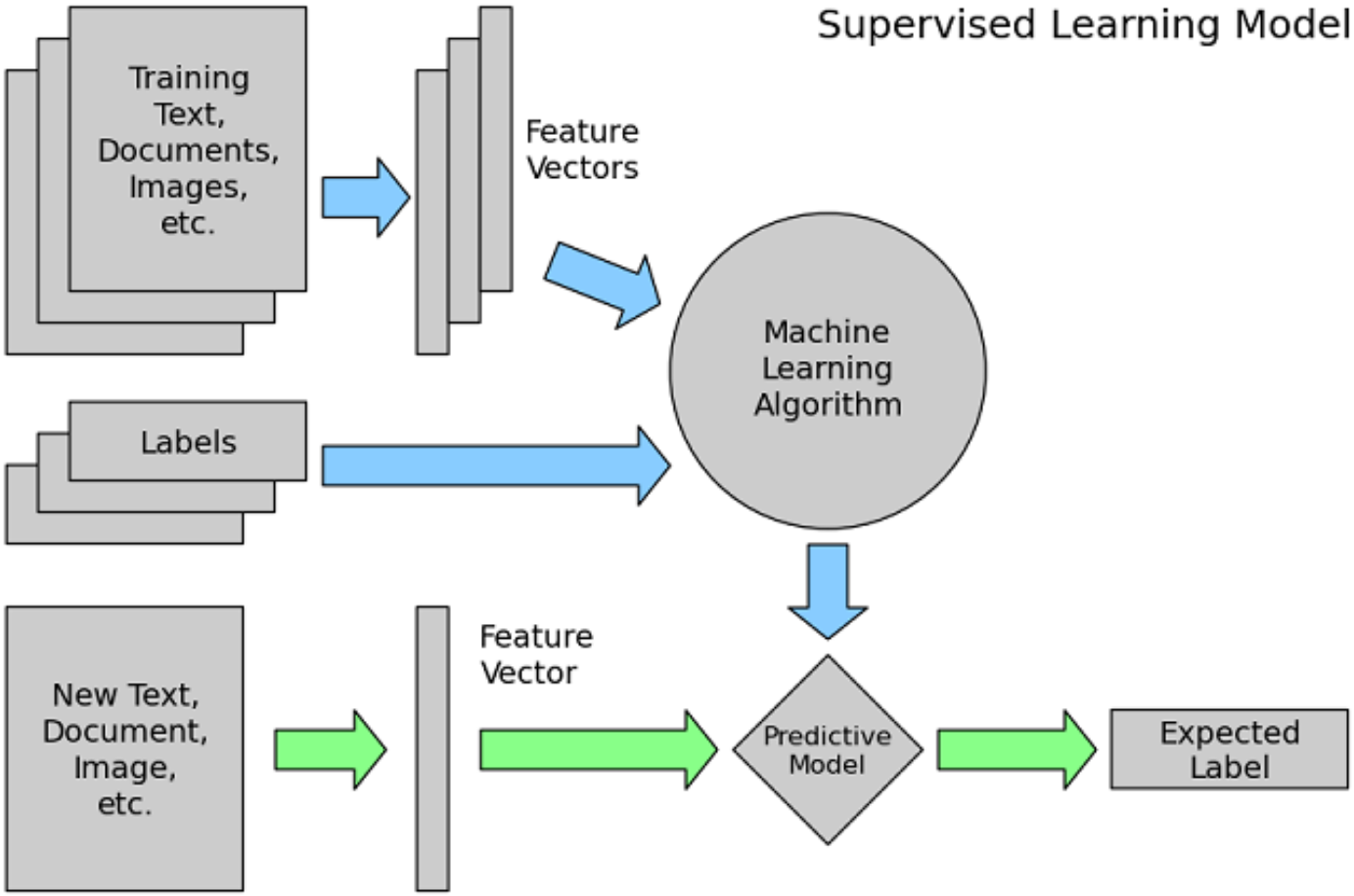
https://www.tutorialride.com/artificial-intelligence/learning-and-expert-system-in-ai.htm

Supervised, Unsupervised & Semi-Supervised Learning

Reference to Supervised, Unsupervised & Semi-Supervised Learning

Web-link: https://machinelearningmastery.com/supervised-and-unsupervised-machine-learning-algorithms/

Supervised Learning Model



Web-link:

https://www.google.com/search?q=example+of+supervised+learning&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi1iKiA18bZAhUElpQKHRIFCO4Q_AUICigB&biw=1280&bih=590#imgrc=8J9-H2UbuhFQiM:

Supervised Learning: Decision Tree (DT)

DT Algorithms:

- The *core* algorithm for building decision trees is **ID3** (Iterative Dichotomiser 3) by J. R. Quinlan.

- ID3 uses ***Entropy*** and ***Information Gain*** to construct a decision tree.

Decision Tree (DT)…

- **Information Entropy** is a concept from information theory. It tells how much information there is in an **event**.
- ***Information Entropy*** is the average rate at which information is produced by a **random source of data**.
- Entropy in Decision Tree stands for **homogeneity**. If the data is completely homogenous, the **entropy is 0**.

Decision Tree (DT)…

- Entropy ***H*** of a discrete random variable $X = \{x_{1,\ldots\ldots,}x_n\}$ can be defined as following where *P(X)* is probability mass function:

$$\mathrm{H}(X) = -\sum_{i=1}^{n} \mathrm{P}(x_i) \log_b \mathrm{P}(x_i)$$

where b is the base of the logarithm. Unit of entropy is the bits for $b = 2$.

**We will use b = 2

Decision Tree (DT)…

Information Gain

Information Gain is the difference between the original information gain requirement (i.e. based on just the proportion of classes) and the new requirement (i.e. obtained after the partitioning of Attributes).

Information Gain, IG = (Entropy of class) – (Entropy of Attributes)

https://pdfs.semanticscholar.org/fd39/e1fa85e5b3fd2b0d000230f6f8bc9dc694ae.pdf

Decision Tree (DT)…

Information Gain

- Information Gain is the decrease/increase in Entropy value when the node is split.

- An attribute should have the highest information gain to be selected for splitting. Based on the computed values of Entropy and Information Gain, we choose the best attribute at any particular step.

https://www.edureka.co/blog/decision-trees/

Decision Tree (DT)…

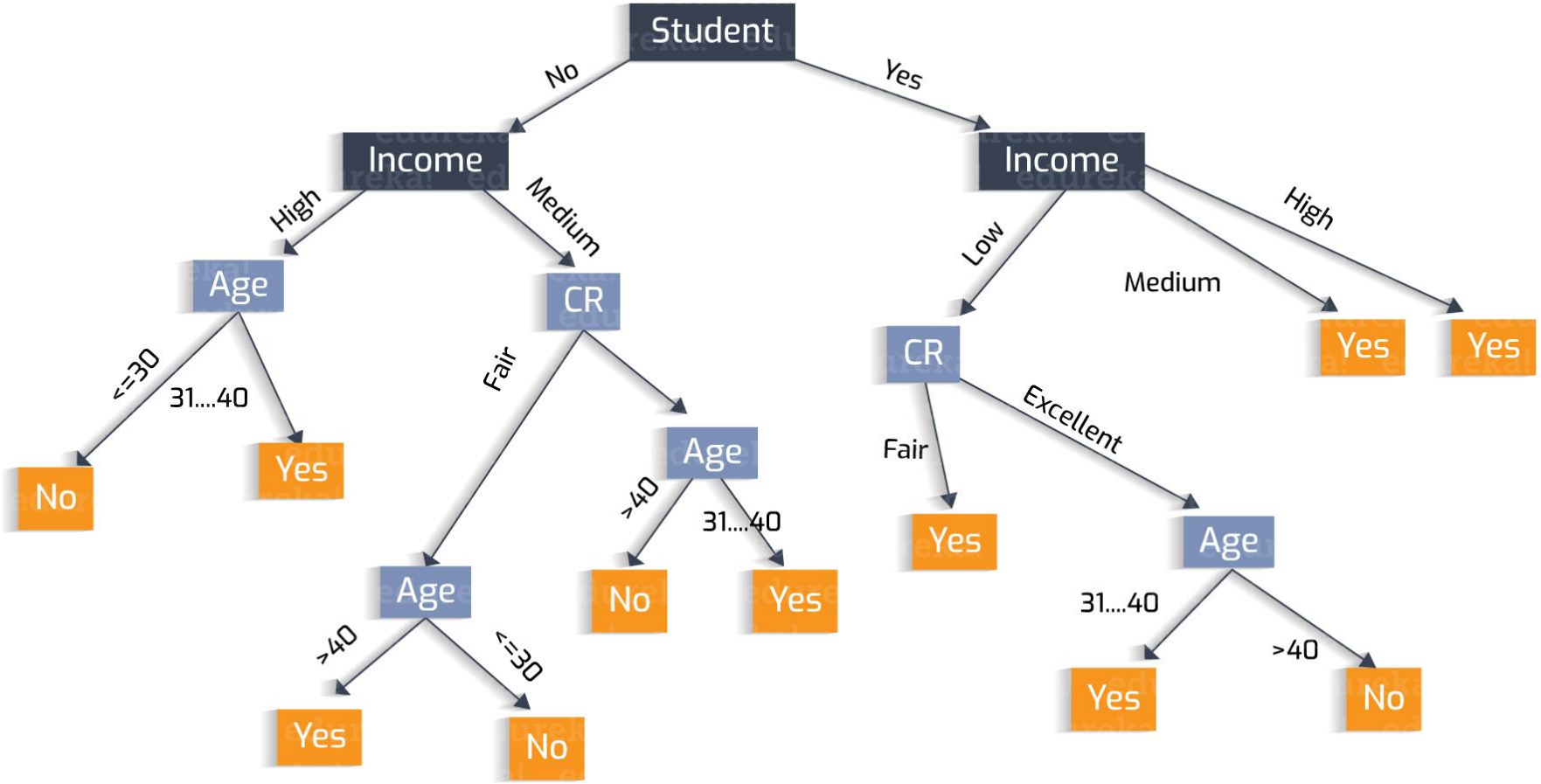
- Decision tree builds classification or regression models in the form of a tree structure.
- It breaks down a dataset into smaller and smaller subsets while at the same time an associated decision tree is incrementally developed.
- The final result is a tree with decision nodes and leaf nodes. A decision node has *two or more branches*.
- *Leaf node represents a classification or decision*.
- The topmost decision node in a tree which corresponds to the best predictor called *root node*.
- Decision trees can handle both categorical and numerical data.

Age	Education	Income	Marital Status	Buy Computer
36-55	Master’s	High	Single	Yes
18-35	High School	Low	Single	No
36-55	Master’s	Low	Single	Yes
18-35	Bachelor’s	High	Single	No
<18	High School	Low	Single	Yes
18-35	Bachelor’s	High	Married	No
36-55	Bachelor’s	Low	Married	No
>55	Bachelor’s	High	Single	Yes
36-55	Master’s	Low	Married	No
>55	Master’s	Low	Married	Yes
36-55	Master’s	High	Single	Yes
>55	Master’s	High	Single	Yes
<18	High School	High	Single	No
36-55	Master’s	Low	Single	Yes
36-55	High School	Low	Single	Yes
<18	High School	Low	Married	Yes
18-35	Bachelor’s	High	Married	No
>55	High School	High	Married	Yes
>55	Bachelor’s	Low	Single	Yes
36-55	High School	High	Married	No

Decision Tree (DT)…<Demo>

rec	Age	Income	Student	Credit _rating	Buys_computer
r1	<=30	Hight	No	Fair	No
r2	<=30	Hight	No	Excellent	No
r3	31…40	Hight	No	Fair	Yes
r4	>40	Medium	No	Fair	Yes
r5	>40	Low	Yes	Fair	Yes
r6	>40	Low	Yes	Excellent	No
r7	31…40	Low	Yes	Excellent	Yes
r8	<=30	Medium	No	Fair	No
r9	,=30	Low	Yes	Fair	Yes
r10	>30	Medium	Yes	Fair	Yes
r11	<=30	Medium	Yes	Excellent	Yes
r12	31…40	Medium	No	Excellent	Yes
r13	31…40	High	Yes	Fair	Yes
r14	>40	Medium	No	Excellent	No

Decision Tree (DT)…<Demo>



Decision Tree (DT)…

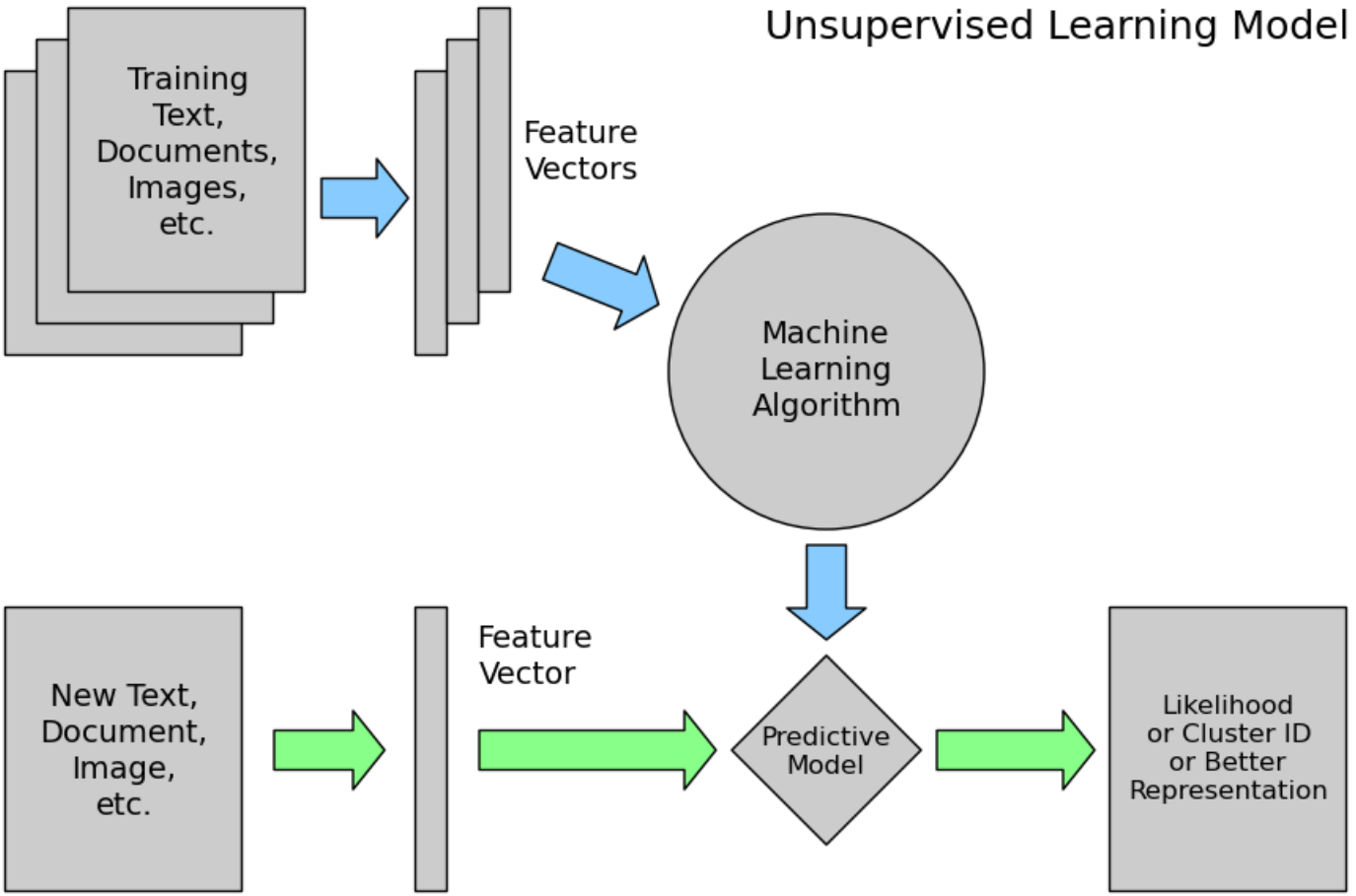
Various DT Algorithms:

- C4.5
- CART (Classification and Regression Tree)
- CHAID (CHi- squared Automatic Interaction Detector)
- MARS and so on.

Decision Tree (DT)…

- A decision tree can easily be transformed to a ***set of rules*** by mapping from the root node to the leaf nodes one by one.

Unsupervised Learning Model



Web-link:

https://www.google.com/search?q=example+of+supervised+learning&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi1iKiA18bZAhUElpQKHRIFCO4Q_AUICigB&biw=1280&bih=590#imgdii=u-kFJqLboCu9PM:&imgrc=8J9-H2UbuhFQiM:

Unsupervised Learning: K-Means

Algorithmic steps for k-means clustering

Let $X = \{x_1, x_2, x_3, \ldots\ldots, x_n\}$ be the set of data points and $V = \{v_1, v_2, \ldots\ldots, v_c\}$ be the set of centers.

1) Randomly select *'c'* cluster centers.

2) Calculate the distance between each data point and cluster centers.

3) Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers..

4) Recalculate the new cluster center using:

$$v_i = (1/c_i) \sum_{j=1}^{c_i} x_i$$

where, 'c_i' represents the number of data points in i^{th} cluster.

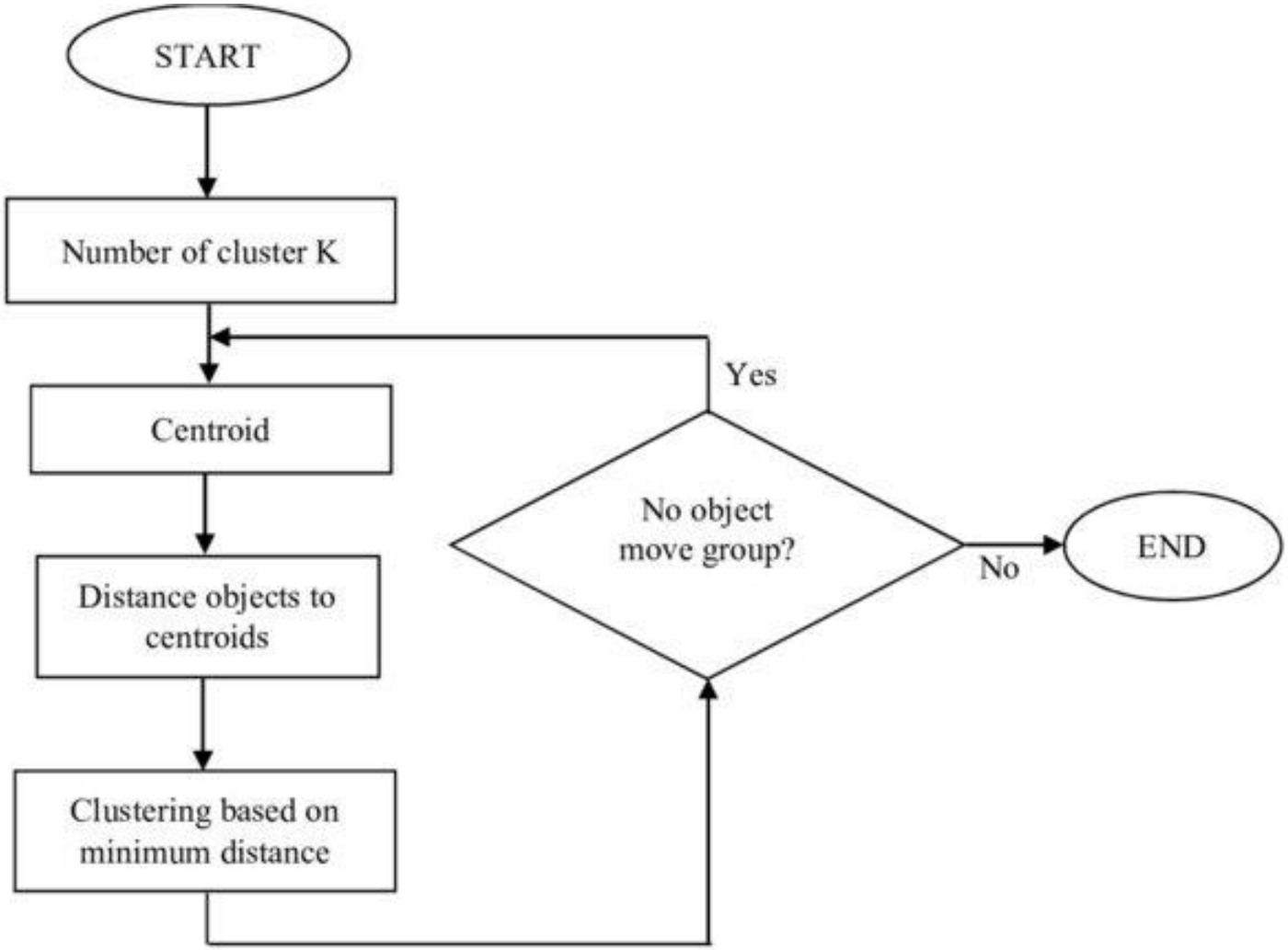
5) Recalculate the distance between each data point and new obtained cluster centers.

6) If no data point was reassigned then stop, otherwise repeat from step 3).

Web-link: https://sites.google.com/site/dataclusteringalgorithms/k-means-clustering-algorithm

Unsupervised Learning: K-Means

Flowchart:



Unsupervised Learning: K-Means

Example:

Using K-means clustering, we have to cluster the following data into two clusters:

{2, 4, 10, 12, 3, 20, 30, 11, 25}

Unsupervised Learning: K-Means

Example:

$$\{2, 4, 10, 12, 3, 20, 30, 11, 25\}$$

Randomly assign the means: $m_1 = 3$, $m_2 = 4$

$k_1 = \{2, 3\}$, $k_2 = \{4, 10, 12, 20, 30, 11, 25\}$, $m_1 = 2.5$, $m_2 = 16$

$k_1 = \{2, 3, 4\}$, $k_2 = \{10, 12, 20, 30, 11, 25\}$, $m_1 = 3$ $m_2 = 18$

$k_1 = \{2, 3, 4, 10\}$, $k_2 = \{12, 20, 30, 11, 25\}$, $m_1 = 4.75$, $m_2 = 19.6$

$k_1 = \{2, 3, 4, 10, 11, 12\}$, $k_2 = \{20, 30, 25\}$, $m_1 = 7$, $m_2 = 25$

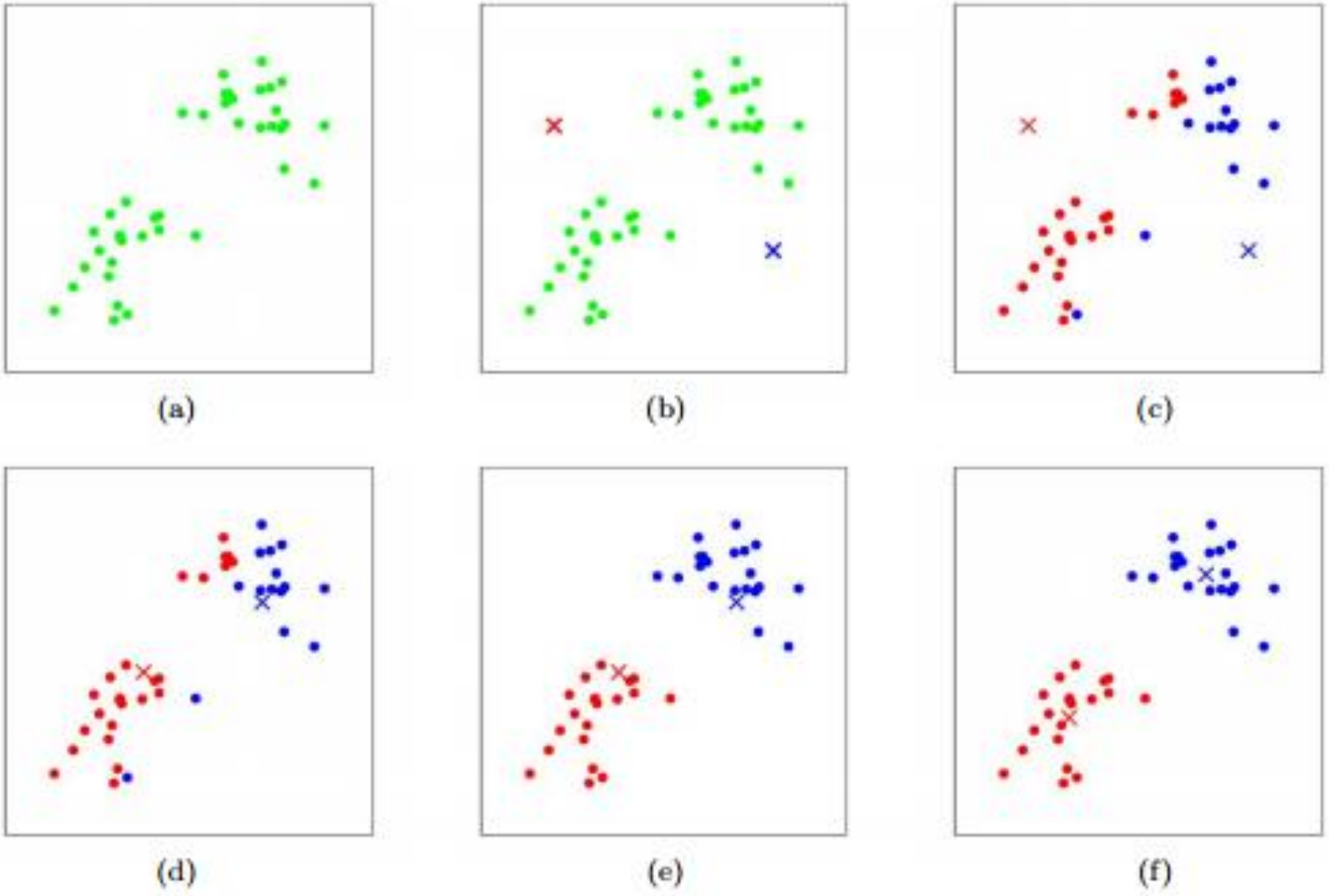
$k_1 = \{2, 3, 4, 10, 11, 12\}$, $k_2 = \{20, 30, 25\}$, $m_1 = 7$, $m_2 = 25$

Stop. The clusters in step 6 and 7 are same.

Final answer: $k_1 = \{2, 3, 4, 10, 11, 12\}$ and $k_2 = \{20, 30, 25\}$

Unsupervised Learning: K-Means

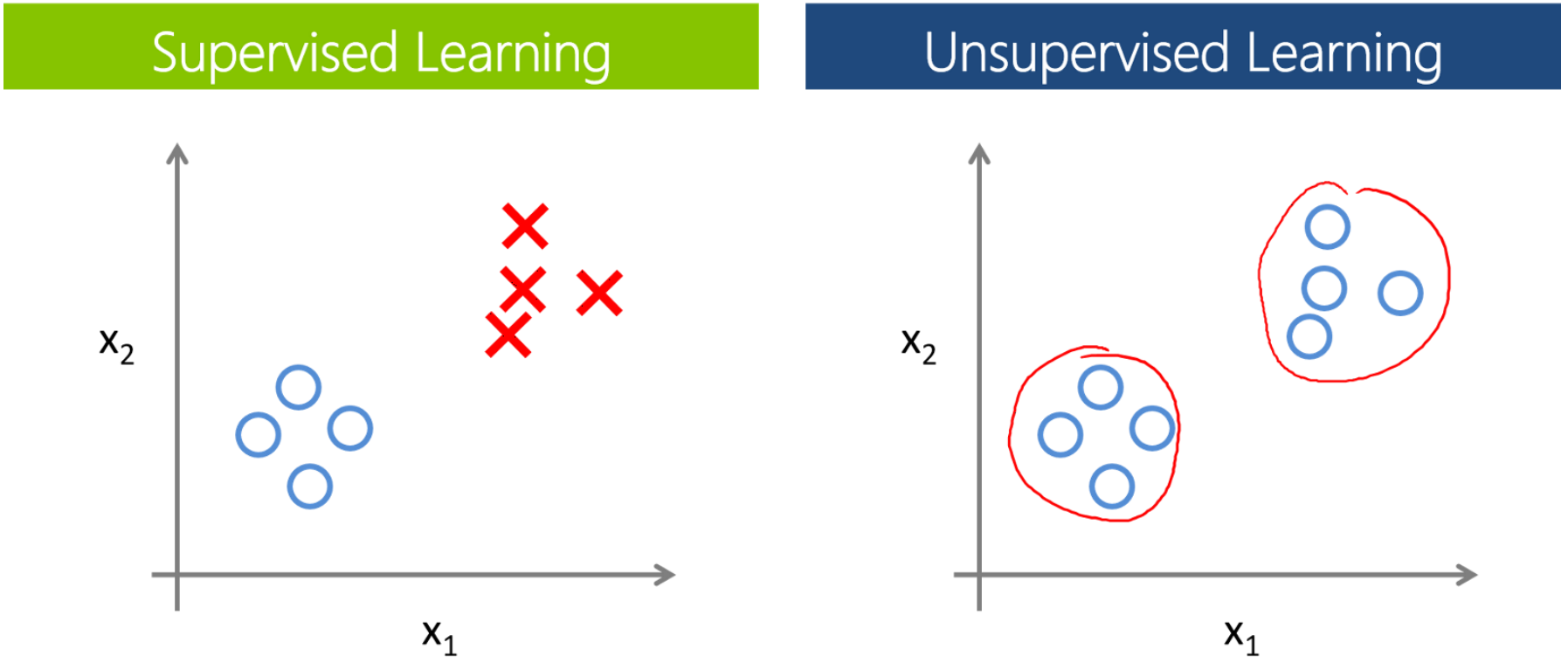
Sample Output Depiction:



Supervised & Unsupervised Learning Example…

Web-link: http://dataaspirant.com/2014/09/19/supervised-and-unsupervised-learning/

Supervised & Unsupervised Learning Example…

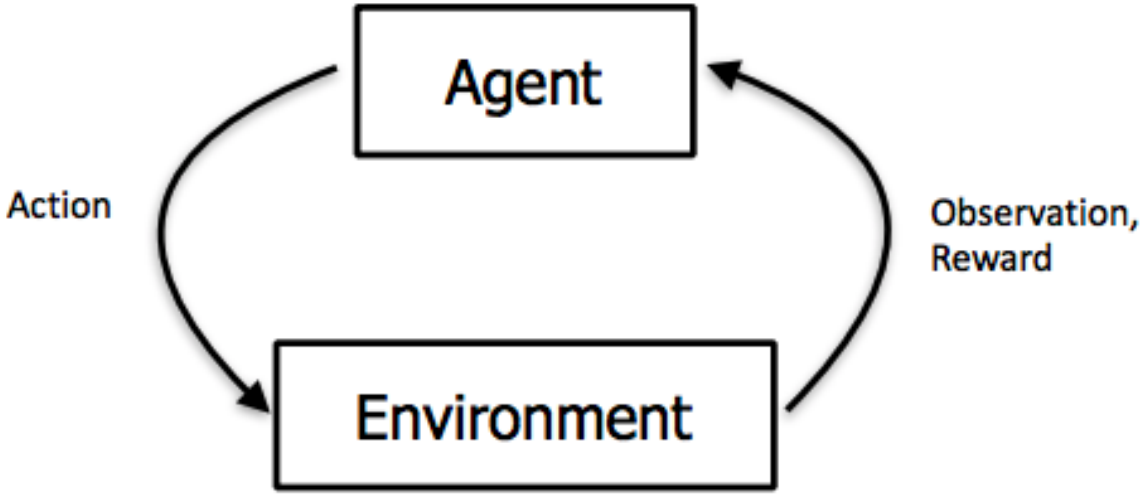


Web-link:

https://www.google.com/search?q=example+of+supervised+learning&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi1iKiA18bZAhUElpQKHRIFCO4Q_AUICigB&biw=1280&bih=590#imgdii=NnP4rZpzR0US6M:&imgrc=wKV9mHPQDwPA7M:

Reinforcement Learning

- Receives feedback in the form of rewards
- Agents' utility is defined by the reward function
- Must learn to act so as to maximize expected rewards



The agent **observes** the environment, takes an **action** to interact with the environment, and receives positive or negative **reward.** Diagram from Berkeley's CS 294: Deep Reinforcement Learning by John Schulman & Pieter Abbeel

Reinforcement Learning-Example

Web-link: https://medium.com/machine-learning-for-humans/reinforcement-learning-6eacf258b265

Reinforcement Learning

More details about Reinforcement Learning

Source-link:
http://incompleteideas.net/book/bookdraft2017nov5.pdf

33 Types of AI

Interested one can see the below website to have insight on further areas of AI

Web-link: https://simplicable.com/new/types-of-artificial-intelligence

THANKS