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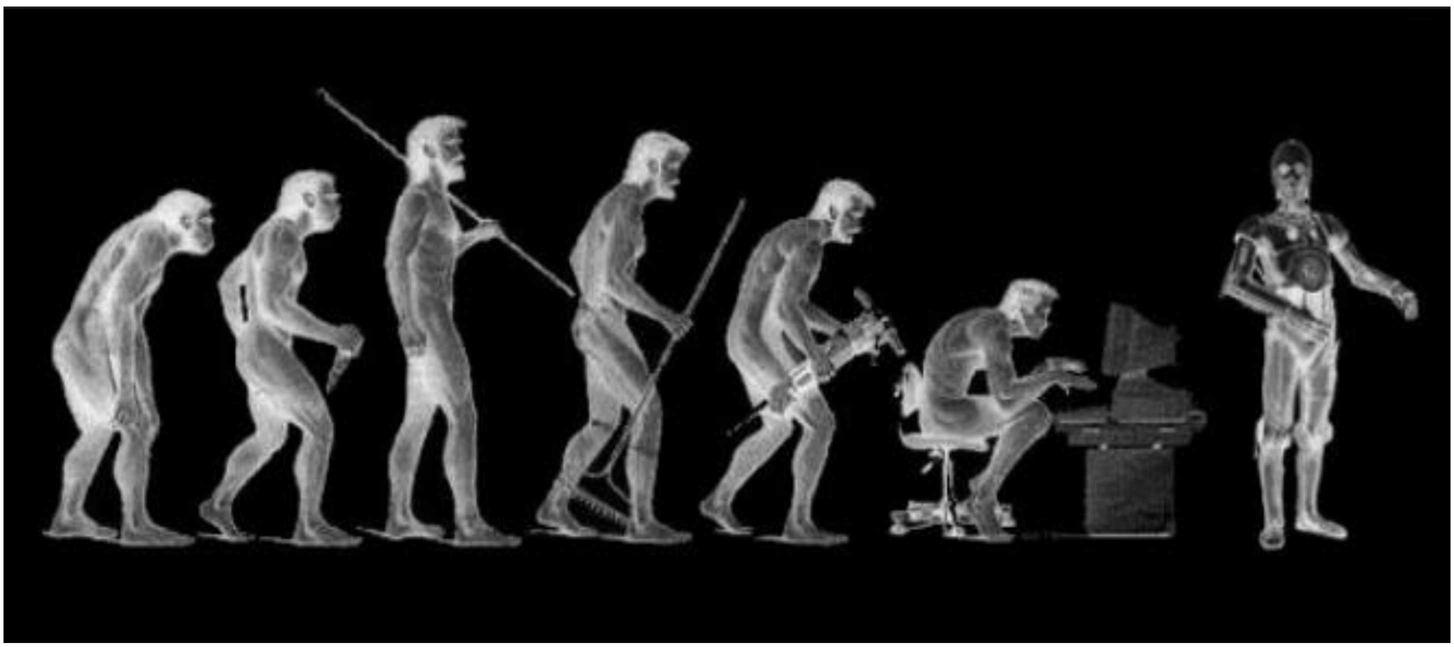
# Artificial Intelligence and Machine Learning



*White Paper*

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# Introduction:

Although Artificial Intelligence is a buzzing word now a days but almost 63 years back the first definition of AI was given by John McCarthy in 1956 in Dartmouth Conference, USA.

As per this definition AI or Artificial Intelligence is **“The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.”**

Beside this there are 7 aspects of AI were also described in the conference, which briefly describes the primary aim/objective of the research of AI :

- Simulating higher functions of brain
- Programing a computer to use general language
- Arranging hypothetical neurons in a manner so that they can form concepts
- A way to determine and measure problem complexity
- Self-Improvement
- Abstraction i.e. quality of dealing with ideas rather than events
- Randomness and creativity

Needless to say the conference was hugely successful and in the following years the AI became one of the most discussed subjects around the world especially in USA and Japan and within next 11 years there were some interesting works had been done in the field of AI :

**Reasoning as search:** Many early AI programs used the same basic algorithm. To achieve some goal (like winning a game or proving a theorem), they proceeded step by step towards it (by making a move or a deduction) as if searching through a maze, backtracking whenever they reached a dead end.

**Natural language:** An important goal of AI research was to allow computers to communicate in natural languages like English. An early success was Daniel Bobrow's program STUDENT, which could solve high school algebra word problems.

**Micro-worlds:** In the late 60s, Marvin Minsky and Seymour Papert of the MIT AI Laboratory proposed that AI research should focus on artificially simple situations known as micro-worlds. They pointed out that in successful sciences like physics, basic principles were often best understood using simplified models like frictionless planes or perfectly rigid bodies. Much of the research focused on a "blocks world," which consists of colored blocks of various shapes and sizes arrayed on a flat surface.

**Robotics:** In Japan, Waseda University initiated the WABOT project in 1967, and in 1972 completed the WABOT-1, the world's first full-scale intelligent humanoid robot.

### AI Winter and Evolution of AI:

After the initial tide got settled, from early part of 70’s the funding behind AI research started decreasing gradually. The major reason of it was: the tremendous optimism of the researchers raised the expectations of impossibly high and eventually the financers became frustrated with the progress of the scientists. On the other hand the researchers had failed to appreciate the difficulty of the problems they faced. As a result of it, the entire funding was stopped behind AI research from 1974-1980. This era was called first AI Winter. In early 80’s again a boom of AI came in Japan when Japanese Government aggressively funded AI with its fifth generation computer project which inspired the other nations also to invest again in the field of AI research. But by the late 80s the investors became disillusioned by the absence of the needed computer power (hardware) and withdrew funding again. Finally the investment and interest in AI boomed in the first decades of the 21st century, when machine learning was successfully applied to many problems in academia and industry due to the presence of powerful computer hardware.

# What is AI:

From the name itself it is clear that there are two parts of the word Artificial Intelligence:

**1.Artificial:** Since it is something which is created by human being and not by Nature.

**2. Intelligence:** The word Intelligence was defined in various ways through out the history of philosophy and science but according to **Jack Copeland** , an author of several books of AI, intelligence can be defined through the following components:

***1. Learning:***

Learning is distinguished into a number of different forms. The simplest is learning by trial-and-error. For example, a simple program for solving mate-in-one chess problems might try out moves at random until one is found that achieves mate. The program remembers the successful move and next time the computer is given the same problem it is able to produce the answer immediately. Now there is another way of learning which Copeland termed as **generalisation learning.**

***Generalisation Learning* enables the learner to perform better in a situation not previously encountered.**

**Example:** A program that learns past tenses of regular English verbs by rote will not be able to produce the past tense of e.g. "jump" until presented at least once with "jumped", whereas a program that is able to generalise from examples can learn the "add-ed" rule, and so form the past tense of "jump" in the absence of any previous encounter with this verb.

***2. Reasoning:***

To reason is to draw inferences appropriate to the situation in hand. Inferences are classified as either deductive or inductive.

**Example:**

**Deductive:** Fred is either in the museum or the cafe; he isn't in the cafe; so he's in the museum.

**Inductive:** Previous accidents just like this one have been caused by instrument failure; so probably this one was caused by instrument failure.

***3. Problem-solving:***

Problems have the general form: given such-and-such data, find x. A huge variety of types of problem is addressed in AI. Some examples are: finding winning moves in board games; identifying people from their photographs; and planning series of movements that enable a robot to carry out a given task.

*4. **Perception:***

In perception the environment is scanned by means of various sense-organs, real or artificial, and analyse the scene into objects and their features and relationships.

**Example:** At present, artificial perception is sufficiently well advanced to enable a self-controlled car-like device to drive at moderate speeds on the open road, and a mobile robot to roam through a suite of busy offices searching for and clearing away empty soda cans.

***5. Language-understanding:***

A language is a system of signs having meaning by convention. Traffic signs, for example, form a mini-language, it being a matter of convention that, for example, the hazard-ahead sign means hazard ahead. In the same way, AI also tries to simulate the process of understanding the language by following the syntax or other role.

# Category of AI:

Research in AI divides into two categories**: Strong AI and Weak AI**.

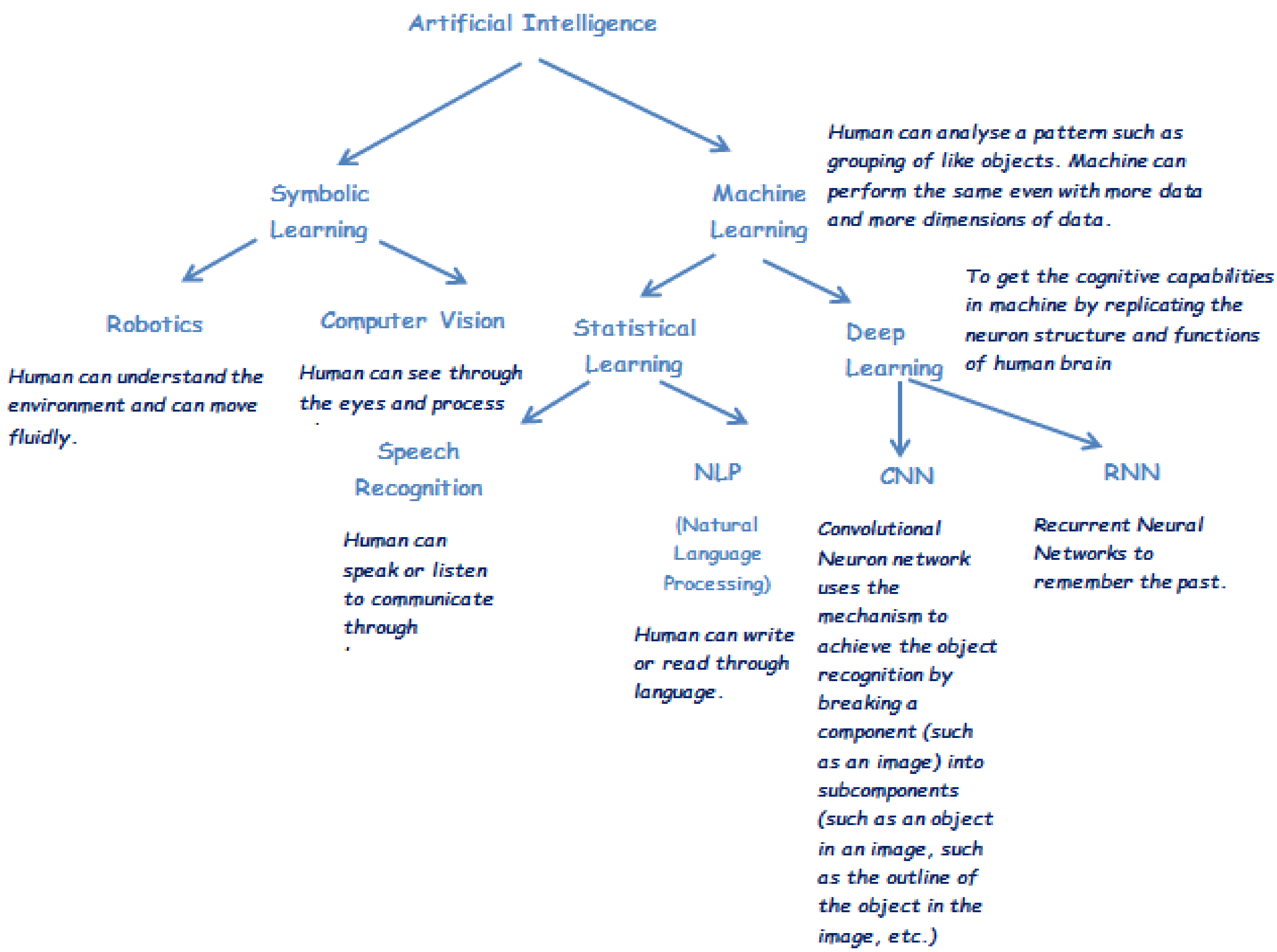
**Strong AI** aims to build machines which has a mind of its own and whose overall intellectual ability is indistinguishable from that of a human being. The Ultimate goal of strong AI as being "nothing less than to build a machine on the model of man, a robot that is to have its childhood, to learn language as a child does, to gain its knowledge of the world by sensing the world through its own organs, and ultimately to contemplate the whole domain of human thought". However there is no proper example of Strong AI since it is still in the initial stage.

On the other hand **Weak AI** also known as narrow AI is artificial intelligence that is focused on one narrow task. One of the good examples of Weak AI is Deep Blue. It is basically a chess playing computer developed by IBM back in 1996 and it challenged Garry Kasparov - world champion of that point of time. Although it defeated Kasparov in the first game but finally Kasparov won the series by 4-2. After that 1n 1997, it was heavily upgraded with the unofficial name as Deeper Blue and won the series finally against Kasparov. The main feature of Deep Blue is it can look at 200 million positions per second and looks ahead 12 moves deep.
Siri is another good example of Weak AI.

Also there is a middle ground between strong and weak AI. IBM Watson is an example of it. Like Human it reads a lot of information, recognises its span and builds up the evidences to say that “I am x % confident that this the right solution of the question you asked based on the information I've read”.

## Branches of AI :

Researchers in computer science and statistics have developed advanced techniques to obtain insights from large disparate data sets. Data may be of different types, from different sources, and of different quality (structured and unstructured data). These techniques can leverage the ability of computers to perform tasks, such as recognising images and processing natural languages, by learning from experience. Recent increases in computing power coupled with increases in the availability and quantity of data have resulted in a resurgence of interest in potential applications of artificial intelligence. These applications are already being used to diagnose diseases, translate languages, and drive cars; and they are increasingly being used in the financial sector as well.



# Machine Learning :

The basic difference between human and computer is:  human can learn from experience but machine need to be told what to do by means of programing.  The question is “Can a computer learn things through experience too?” And the answer is “Yes”. Precisely this is **machine learning** in an easy way. Though for the computers the word ‘**experience**’ can be replaced with the word ‘**data**’ .

From the above diagram it is clear that AI is a broad field, of which ‘machine learning’ is a sub-category. Machine learning may be defined as a method of designing a sequence of actions to solve a problem, known as **algorithms**, which optimise automatically through experience and with limited or no human intervention. These techniques can be used to find patterns in large amounts of data from increasingly diverse and innovative sources.


# Types Machine Learning  Algorithms:

There some variations of how to define the types of Machine Learning Algorithms but commonly they can be divided into categories according to their purpose and the main categories are the following:

- **Supervised learning**
- **Unsupervised Learning**
- **Semi-supervised Learning**
- **Reinforcement Learning**

Before moving on let’s quickly go through the below terms frequently used to describe the machine learning algorithms:

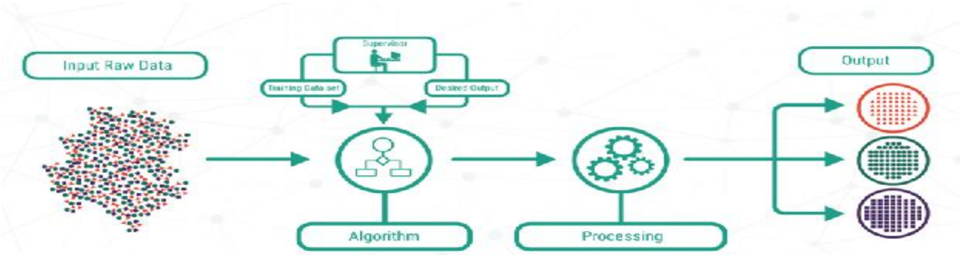
***Labeled data:*** Data consisting of a set of training examples, where each example is a pair consisting of an input and a desired output value (also called the supervisory signal, labels, etc.)

***Classification:*** The goal is to predict discrete values, e.g. {1,0}, {True, False}, {spam, not spam}.

***Regression:*** The goal is to predict continuous values, e.g. home prices.

# Supervised Learning:

**Supervised learning** algorithms try to model relationships and dependencies between the target prediction output and the input features such that we can predict the output values for new data based on those relationships which it learned from the previous data sets.



In other words in ‘supervised learning’ , the algorithm is fed a set of ‘training’ data that contains labels on some portion of the observations. For instance, a data set of transactions may contain labels on some data points identifying those that are fraudulent and those that are not fraudulent. The algorithm will ‘learn’ a general rule of classification that it will use to predict the labels for the remaining observations in the data set.
Below are the aspects of the supervised learning:

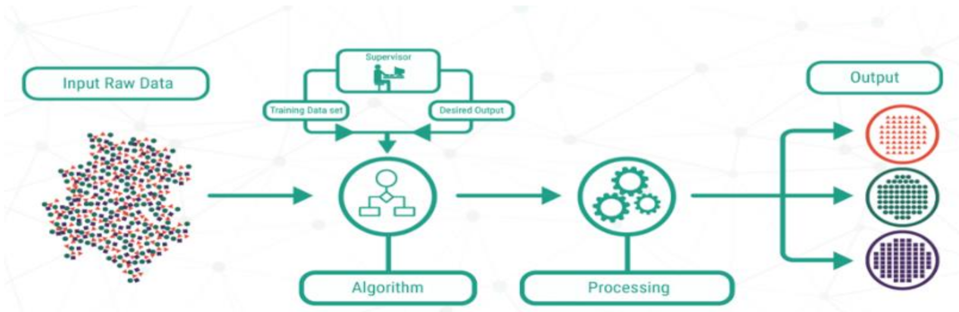
- Predictive Model
- Labeled Data
- Problems includes *regression* and *classification*

**List of Common Algorithms:**

- Nearest Neighbour
- Naive Bayes
- Decision Trees
- Linear Regression
- Support Vector Machines (SVM)
- Neural Networks

# Unsupervised Learning:

**Unsupervised learning** is the family of machine learning algorithms which are mainly used in pattern detection and descriptive modeling. However, there are no output categories or labels here based on which the algorithm can try to model relationships. These algorithms try to use techniques on the input data to mine for rules, detect patterns, and summarize and group the data points which help in deriving meaningful insights and describe the data better to the users.




In other words in ‘unsupervised learning’ refers to situations where the data provided to the algorithm does not contain labels. The algorithm is asked to detect patterns in the data by identifying clusters of observations that depend on similar underlying characteristics. For example, an unsupervised machine learning algorithm could be set up to look for securities that have characteristics similar to an illiquid security that is hard to price. If it finds an appropriate cluster for the illiquid security, pricing of other securities in the cluster can be used to help price the illiquid security.

Below are the aspects of the unsupervised learning:

- Descriptive Model
- Includes *Clustering algorithms and Association rule learning algorithms.*

**List of Common Algorithms:**
k-means clustering, Association Rules

# Semi-supervised Learning:

**Semi-supervised learning** falls in between the above mentioned two categories. In many practical situations, the cost to label is quite high, since it requires skilled human experts to do that. So, in the absence of labels in the majority of the observations but present in few, semi-supervised algorithms are the best candidates for the model building.

# Reinforcement Learning:

**Reinforcement Learning** aims at using observations gathered from the interaction with the environment to take actions that would maximize the reward or minimize the risk. Reinforcement learning algorithm (called the agent) continuously learns from the environment in an iterative fashion. In the process, the agent learns from its experiences of the environment until it explores the full range of possible states. Reinforcement Learning is defined by a specific type of problem, and all its solutions are classed as Reinforcement Learning algorithms.


In order to produce intelligent programs (also called agents), reinforcement learning goes through the following steps:

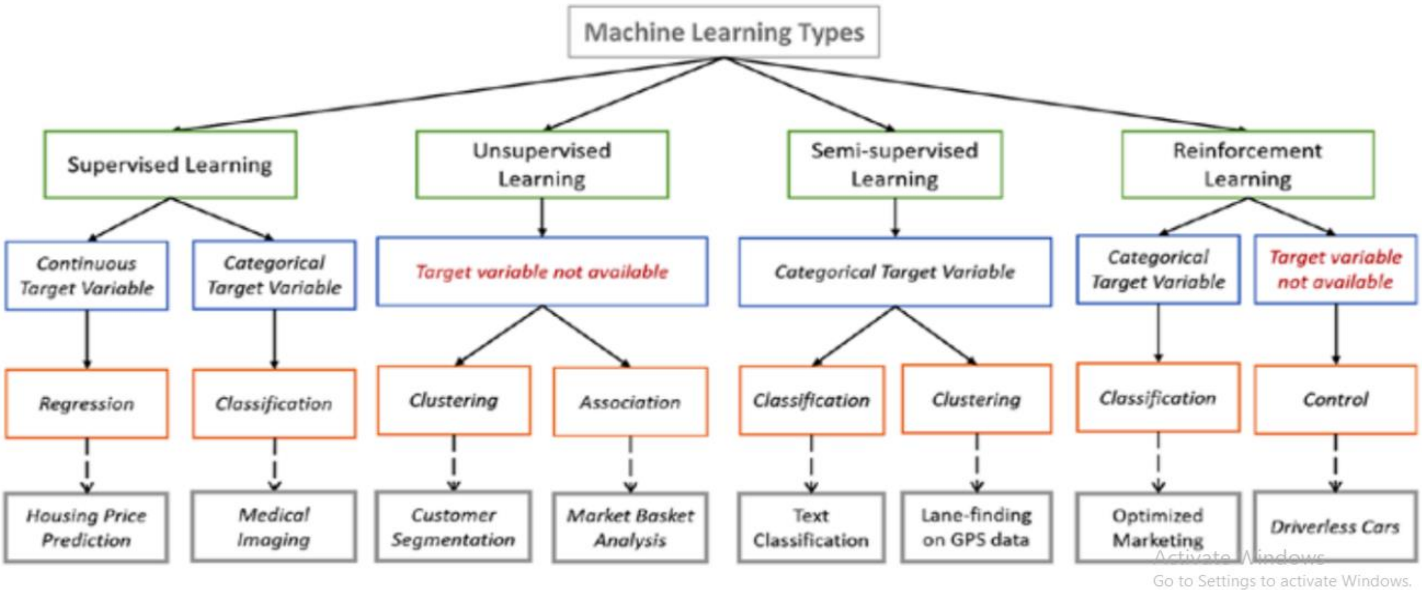
- Input state is observed by the agent.
- Decision making function is used to make the agent perform an action.
- After the action is performed, the agent receives reward or reinforcement from the environment.
- The state-action pair information about the reward is stored.

**List of Common Algorithms:**

- Q-Learning
- Temporal Difference (TD)
- Deep Adversarial Networks

**Below are the differences between the above mentioned Learning Algorithm in a nut shell:**

| Supervised | Unsupervised | Semi-Supervised | Reinforcement |
|---|---|---|---|
| • Data has **known labels** or output | • Labels or output unknown<br>• Focus on **finding patterns and gaining insight** from the data | • Labels or output known for **a subset of data**<br>• A blend of supervised and unsupervised learning | • Focus on **making decisions** based on previous experience<br>• Policy-making with feedback |
| • Insurance underwriting<br>• Fraud detection | • Customer clustering<br>• Association rule mining | • Medical predictions (where tests and expert diagnoses are expensive, and only part of the population receives them) | • Game AI<br>• Complex decision problems<br>• Reward systems |




## Practical Example of Implementing Machine Learning Algorithm:

**Detecting Spam emails through Naïve Bayes Algorithm:**

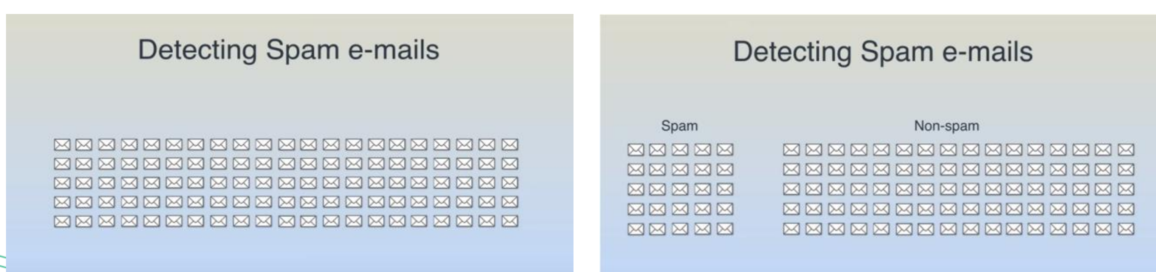
**Naïve Bayes Algorithm** learns the probability of an object with certain features belonging to a particular group or class.
In simple words, this theorem is used to group the objects.
**P(A/B)=P(B/A)P(A)/P(B) where**

P(A/B): probability of occurrence of event A given the event B is true.
P(A) and P(B) probability of occurrence of event A and B respectively
P(B/ A): probability of occurrence of event B given the event A is true.
A is called proposition and B is called evidence.
P(A) means prior probability of proposition and P(B) is called prior probability of evidence.
P(A/B) has been termed as posterior
P(B/A) has been termed as likelihood.

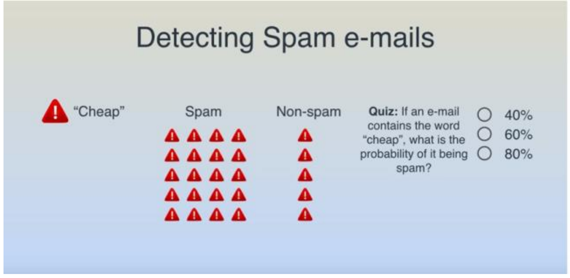
**Posterior= (Likelihood* prior probability of proposition)/ prior probability of evidence**

**Problem Statement:** Create Email spam detection classifier : something which will tell us whether an email is a spam or not.

**Step 1:** To do this we will look into the previous data. Let's take a sample of 100 emails. Out of these 100, 25 have already been classified as spam emails whereas 75 have been classified as non-spam.



**Step 2:** Now analysing the features of the spam emails it has been observed that one of the features is containing the word ‘Cheap’.
**Step 3:** We look for the word ‘Cheap’ in all the 100 emails and find that 20 out of spam and 5 out non-spam emails are containing the word ‘Cheap’.
**Step 4:** Question is based on our data if an email contains the word “cheap” ,what is the probability of it being spam?




**Step 5:** Now it is clear that out of 25 spam emails 20 are containing the word cheap and 5 out 75 non spams are containing the word cheap. Hence we can conclude that: if the email contains the word “cheap” the probability of it being spam is :

P (Spam/Cheap) = (P (Cheap/Spam)*P (Spam))/P (Cheap)

P (Cheap/Spam) =20/25=4/5.

P (Spam) = 25/100=1/4.

P (Cheap) = 25/100=1/4.

Therefore, P (Cheap/Spam)*P (Spam) = (4/5*1/4) =1/5.

P (Spam/Cheap) =(1/5/1/4)=4/5=80%.

# Implementation of AI and Machine Learning:

Below are some practical implementation of AI and Machine Learning in today’s world:

- **Smartphones:** More and more manufacturers are including AI in their smartphones with big chip manufacturers including Qualcomm and Huawei producing chips with built-in AI capabilities. The AI integration is helping in bringing features like scene detection, mixed and virtual reality elements, portrait mode effect while shooting a picture and many more. Features like app actions, splices, and adaptive battery in Android Pie and Siri shortcut and Siri suggestions in iOS12 are made possible with AI.

- **Smart Cars:** Tesla cars are the prime example of how the AI has been implemented in the area of automobile industry. Through AI all the Tesla cars are connected and the things learned by one Tesla car is shared across all the cars. For example if the driver had to take an unanticipated hard-left on a cross-road, all the Tesla cars will know how to manoeuvre that turn after they are updated.

- **Social Media Feeds:** In social media, from the feeds that user sees in the timeline to the notifications that she/he receives from these apps, everything is curated by AI. AI takes all past behaviour, web searches, interactions, and everything else that user does on these websites and tailors the experience to make the apps addictive to the user.

- **Music and Media Streaming Services:** With the implementation of AI Music and Media Streaming websites creates the recommended lists for the users.

- **Videos Games:** The video game industry is probably one of the earliest adopters of AI and offers the user to play the game against the virtual opponents.

- **Online Ads Network:** One of the biggest users of artificial intelligence is the online ad industry which uses AI to not only track user statistics but also serve ads based on those statistics. AI has become so successful in determining interests and serving ads that the global digital ad industry has crossed 250 billion US dollars with the industry projected to cross the 300 billion mark in 2019.

- **Navigation and Travel:** Both Google and Apple along with other navigation services use artificial intelligence to interpret hundreds of thousands of data point that they receive to give you real-time traffic data.

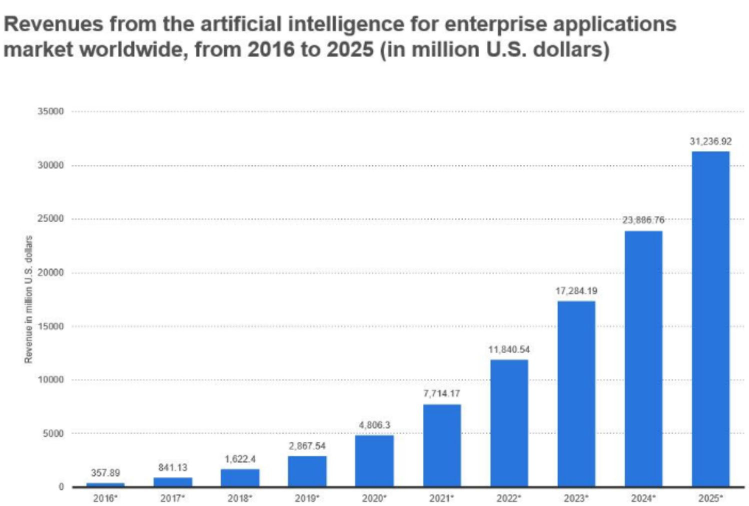
- **Banking and Finance:** Banking and finance industry heavily relies on artificial intelligence for things like customer service, fraud protection, investment . A simple example is the automated emails that user receives from banks whenever does an out of the ordinary transaction.

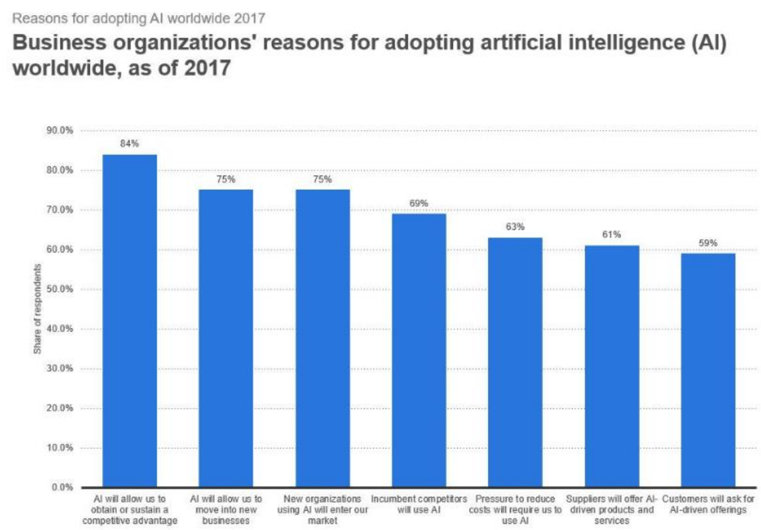
- **Smart Home Devices:** Many of the smart home devices that use artificial intelligence to learn the user's behaviour so that they can adjust the settings themselves to make the experience as frictionless as possible. Smart thermostats which adjust the temperature based on your preferences, smart lights that change the colour and intensity of lights based on time and much more.

- **Security and Surveillance:** With technologies like object recognition and facial recognition AI has already been implemented to keep monitoring multiple monitors with feeds from number of cameras at the same time.

## Growth and Future of AI and Machine Learning:

Below are some facts and figures related to overall and predictive future growth in the field of Artificial Intelligence and machine learning




Apart from the above statistics there are also few pointers which represent the current situation of AI market and it's potentials:

- In 2018, the global AI market is expected to be worth approximately 7,35 billion U.S. dollars
- Over the ten years between 2016 and 2025, AI software for vehicular object detection, identification, and avoidance is expected to generate 9 billion U.S. dollars.
- In 2018, the AI market in North America is estimated to be worth around 3.3 billion U.S. dollars. Artificial intelligence technologies are being used in a variety of situations across consumer, enterprise, and government markets.
- In 2017, AI startups attracted around 15.2 billion U.S. dollars in investment.
- In 2018, spending on robotics and drones is expected to total about 96 billion U.S. dollars
- It is estimated that the market for fully autonomous vehicles will grow to some six billion U.S. dollars by 2025.
- In 2018, the source projects the global big data market size to grow to 42 billion U.S. dollars in size.

## Summary

In a nut shell it can be concluded that AI / Machine learning together are becoming the integrated part of the modern existence through the incredible accuracy in automating repetitive learning ,discovery through data and adding Intelligence to the existing products. They adapt through progressive learning algorithms to let the data do the programming and also analyse more and deeper data that have many hidden layers.

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