

## 1.1 Introduction of Machine Learning

**Machine Learning** is the field of study that gives computers the capability to learn without being explicitly programmed. As it is evident from the name, it gives the computer that makes it more similar to humans: *The ability to learn*.

Machine learning is a branch of artificial intelligence and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

A subset of machine learning is closely related to **computational statistics**, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions.

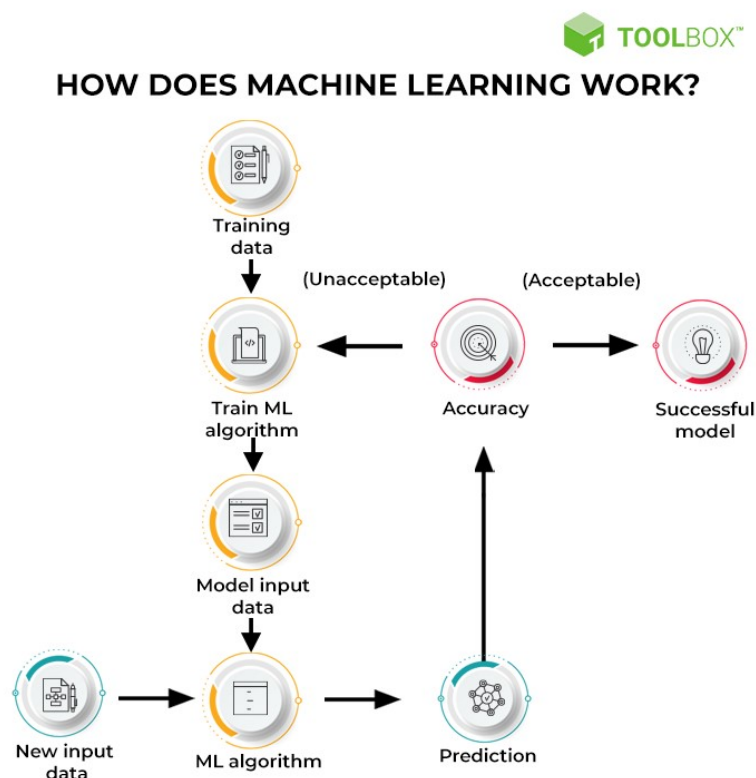


Fig1: Machine Learning

In 1997, Tom Mitchell gave a “well-posed” mathematical and relational definition for Machine Learning as, “A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.

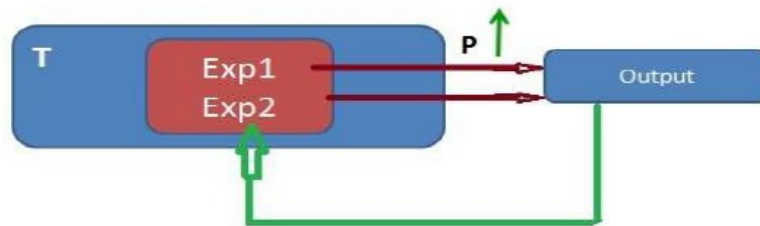


Fig2: Definition of Machine Learning

### Definitions in Machine Learning:

- **Algorithm:** A Machine Learning algorithm is a set of rules and statistical techniques used to learn patterns from data and draw significant information from it. It is the logic behind a Machine Learning model.  
An example of a Machine Learning algorithm is, the Linear Regression algorithm.
- **Model:** A model is the main component of Machine Learning. A model is trained by using a Machine Learning Algorithm. An algorithm maps all the decisions that a model is supposed to take based on the given input, in order to get the correct output.
- **Predictor Variable:** It is a feature(s) of the data that can be used to predict the output.
- **Response Variable:** It is the feature or the output variable that needs to be predicted by using the predictor variable(s).
- **Training Data:** The Machine Learning model is built using the training data. The training data helps the model to identify key trends and patterns essential to predict the output.

- **Testing Data:** After the model is trained, it must be tested to evaluate how accurately it can predict an outcome. This is done by the testing data set.

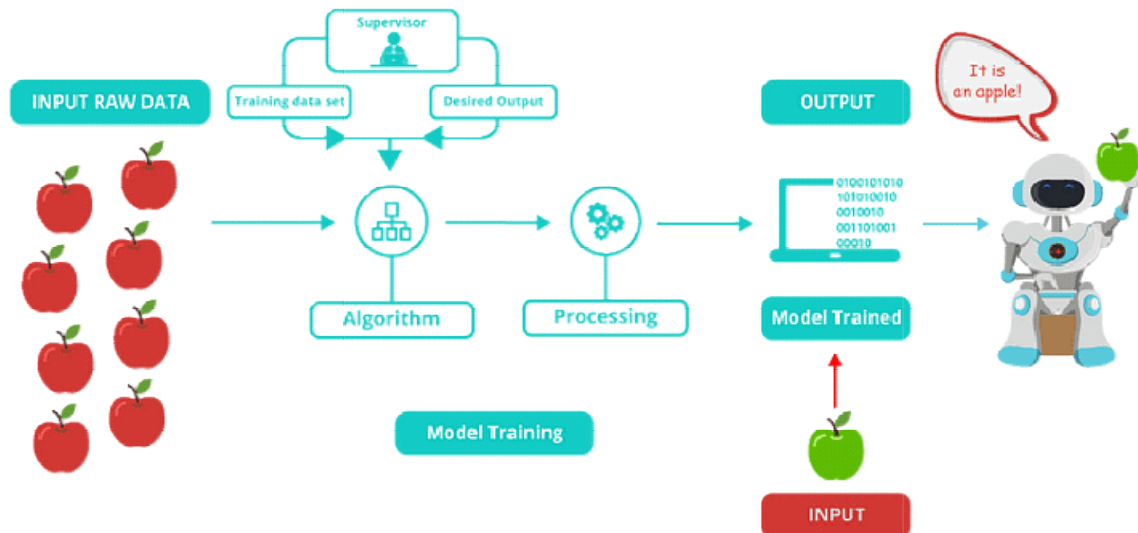


Fig3: Flow of Machine Learning

## Machine Learning Process:

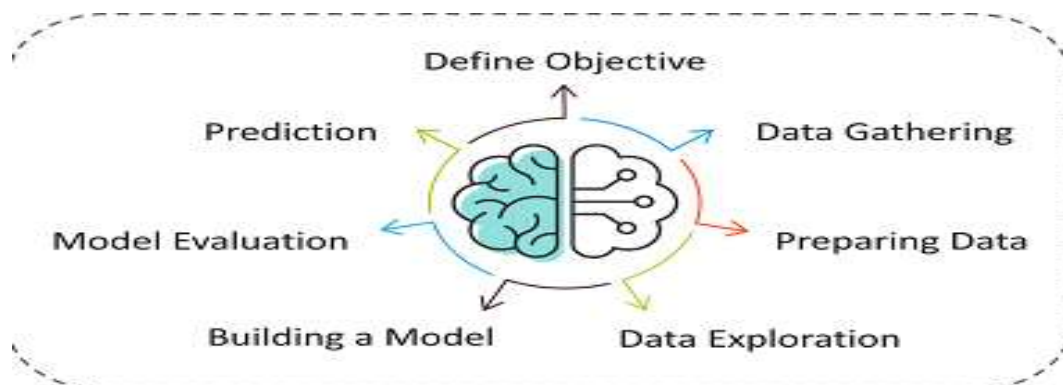


Fig4: Process of Machine Learning

### Step 1: Define the objective of the Problem Statement

At this step, we must understand **what exactly needs to be predicted**. In our case, the objective is to predict the possibility of rain by studying weather conditions. At this stage, it is also essential to take mental notes on **what kind of data can be used** to solve this problem or the type of approach you must follow to get to the solution.

## Step 2: Data Gathering

At this stage, you must be asking questions such as,

- What kind of data is needed to solve this problem?
- Is the data available?
- How can I get the data?

Once you know the types of data that is required, you must understand how you can derive this data. Data collection can be done **manually or by web scraping**. However, if you're a beginner and you're just looking to learn Machine Learning you don't have to worry about getting the data. There are 1000s of data resources on the web, you can just download the data set and get going.

Coming back to the problem at hand, the data needed for weather forecasting includes measures such as humidity level, temperature, pressure, locality, whether or not you live in a hill station, etc. Such data must be collected and stored for analysis.

## Step 3: Data Preparation

The data you collected is almost never in the right format. You will encounter a lot of **inconsistencies in the data set such as missing values, redundant variables, duplicate values, etc.** Removing such inconsistencies is very essential because they might lead to wrongful computations and predictions. Therefore, at this stage, you scan the data set for any inconsistencies and you fix them then and there.

## Step 4: Exploratory Data Analysis

Grab your detective glasses because this stage is all about diving deep into data and finding all the hidden data mysteries. EDA or Exploratory Data Analysis is the brainstorming stage of Machine Learning. **Data Exploration involves understanding the patterns and trends in the data.** At this stage, all the useful insights are **drawn and correlations** between the variables are understood.

For example, in the case of predicting rainfall, we know that there is a strong possibility of rain if the temperature has fallen low. Such correlations must be understood and mapped at this stage.

### **Step 5: Building a Machine Learning Model**

All the insights and patterns derived during Data Exploration are used to build the Machine Learning Model. This stage always begins by splitting the data set into two parts, **training data**, **and testing data**. The training data will be used to build and analyze the model. The logic of the model is based on the Machine Learning Algorithm that is being implemented.

In the case of predicting rainfall, since the output will be in the form of True (if it will rain tomorrow) or False (no rain tomorrow), we can use a [Classification Algorithm](#) such as [Logistic Regression](#).

### **Step 6: Model Evaluation & Optimization**

After building a model by using the training data set, it is finally time to put the model to a test. **The testing data set is used to check the efficiency of the model and how accurately it can predict the outcome**. Once the accuracy is calculated, any further **improvements** in the model can be implemented at this stage. Methods like **parameter tuning and cross-validation** can be used to improve the performance of the model.

### **Step 7: Predictions**

Once the model is evaluated and improved, it is finally used to make predictions. The final output can be a **Categorical variable** (eg. True or False) or it can be a Continuous Quantity (eg. the predicted value of a stock).

In our case, for predicting the occurrence of rainfall, the output will be a categorical variable.

So that was the entire Machine Learning process. Now it's time to learn about the different ways in which Machines can learn.

## 1.2 Uses (Applications) of Machine Learning

The need for machine learning is increasing day by day. The reason behind the need for machine learning is that it is capable of doing tasks that are too complex for a person to implement directly. As a human, we have some limitations as we cannot access the huge amount of data manually, so for this, we need some computer systems and here comes the machine learning to make things easy for us.

We can train machine learning algorithms by providing them the huge amount of data and let them explore the data, construct the models, and predict the required output automatically.

### 1. Image Recognition:

Image recognition is one of the most common applications of machine learning. It is used to identify objects, persons, places, digital images, etc. The popular use case of image recognition and face detection is, **Automatic friend tagging suggestion:**

Facebook provides us a feature of auto friend tagging suggestion. Whenever we upload a photo with our Facebook friends, then we automatically get a tagging suggestion with name, and the technology behind this is machine learning's **face detection and recognition algorithm.**

It is based on the Facebook project named "**Deep Face,**" which is responsible for face recognition and person identification in the picture.

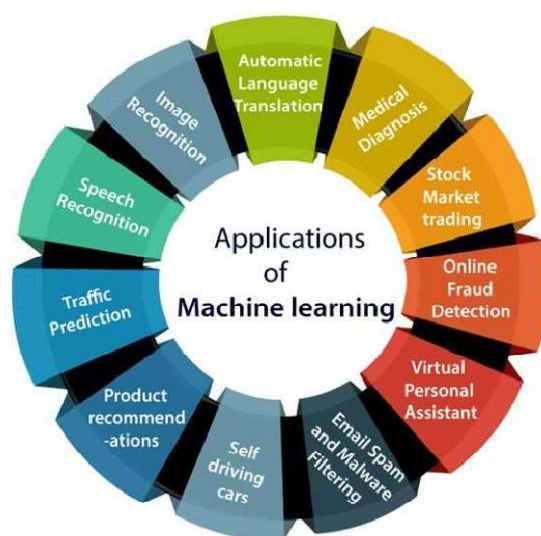


Fig5: Machine Learning Applications

## 2. Speech Recognition

While using Google, we get an option of "**Search by voice**," it comes under speech recognition, and it's a popular application of machine learning.

Speech recognition is a process of **converting voice instructions into text**, and it is also known as "**Speech to text**", or "**Computer speech recognition**." At present, machine learning algorithms are widely used by various applications of speech recognition. **Google assistant, Siri, Cortana, and Alexa** are using speech recognition technology to follow the voice instructions.

## 3. Traffic prediction:

If we want to visit a new place, we take help of Google Maps, which shows us the correct path with the shortest route and predicts the traffic conditions.

## 4. Product recommendations:

Machine learning is widely used by various e-commerce and entertainment companies such as **Amazon, Netflix**, etc., for product recommendation to the user. Whenever we search for some product on Amazon, then we started getting an advertisement for the same product **while internet surfing on the same browser** and this is because of machine learning. **Google understands the user interest using various machine learning algorithms** and suggests the product as per customer interest.

## 5. Self-driving cars:

One of the most exciting applications of machine learning is self-driving cars. Machine learning plays a significant role in self-driving cars. Tesla, the most popular car manufacturing company is working on self-driving car. It is using **unsupervised learning method to train the car models to detect people and objects while driving.**

## 6. Email Spam and Malware Filtering:

Whenever we receive a new email, it is filtered automatically as important, normal, and spam. We always receive an important mail in our inbox with the important symbol and spam emails in our spam box, and the technology behind this is Machine learning.

### **7. Virtual Personal Assistant:**

We have various virtual personal assistants such as **Google assistant, Alexa, Cortana, Siri**. As the name suggests, they help us in finding the information using our voice instruction. These assistants can help us in various ways just by our voice instructions such as Play music, call someone, Open an email, Scheduling an appointment, etc.

### **8. Online Fraud Detection:**

Machine learning is making our online transaction safe and secure by detecting fraud transaction. Whenever we perform some online transaction, there may be various ways that a fraudulent transaction can take place such as **fake accounts, fake ids**, and **steal money** in the middle of a transaction. So to detect this, **Feed Forward Neural network** helps us by checking whether it is a genuine transaction or a fraud transaction.