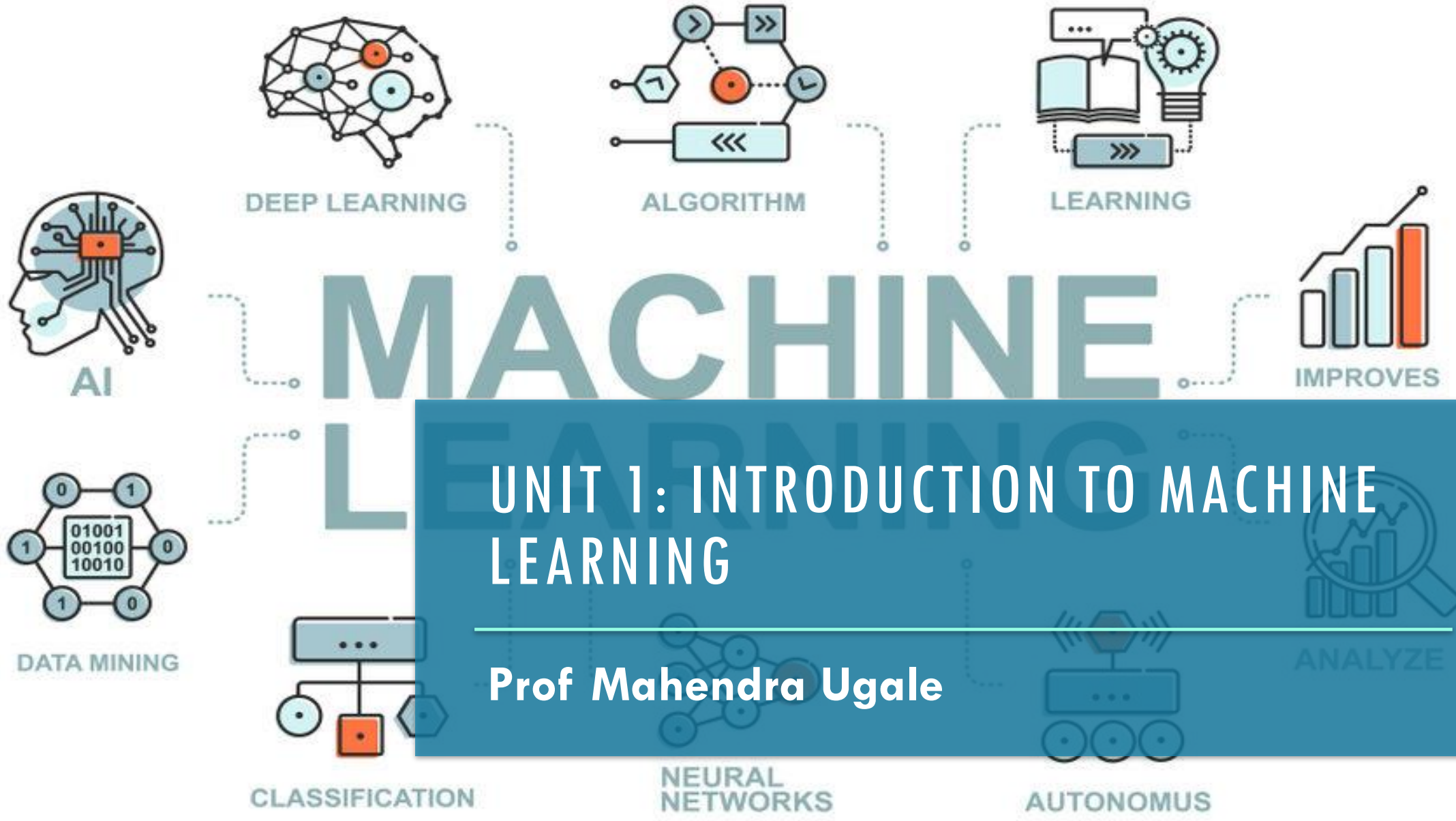

UNIT 1: INTRODUCTION TO MACHINE LEARNING

Prof Mahendra Ugale

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- **Introduction to Machine Learning**:
  - Definition of Machine Learning,
  - Definition of learning.
- **Classification of Machine Learning:**
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  - Unsupervised learning,
  - Reinforcement learning,
  - Semi-supervised learning.
- **Categorizing based on required Output:**
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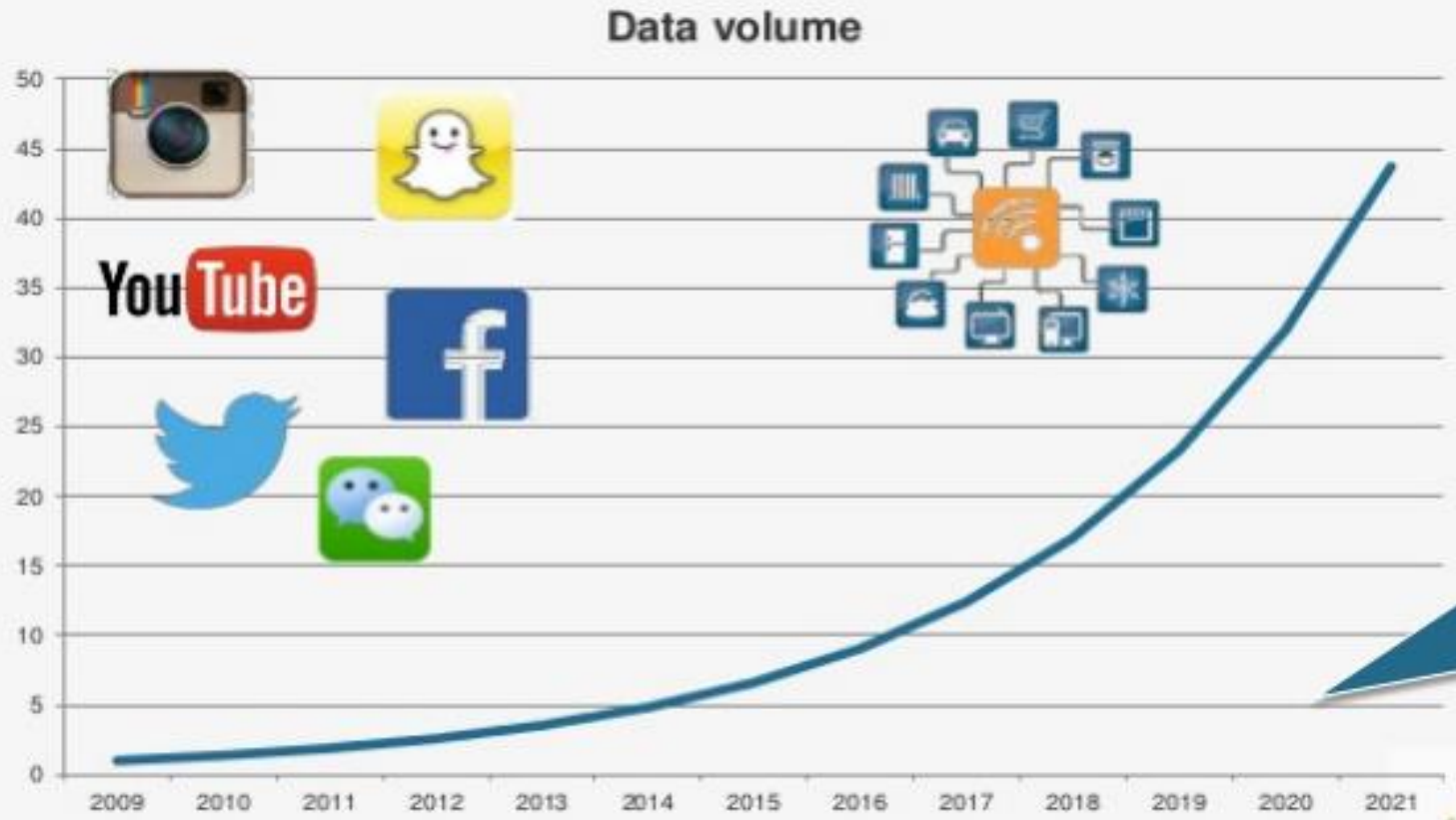
- **Split data in Machine Learning**:
  - Training Data,
  - Validation Data and
  - Testing Data.
- **Machine Learning:** Applications

Data Economy

44Zb of data by 2020 – 44x in 11 years

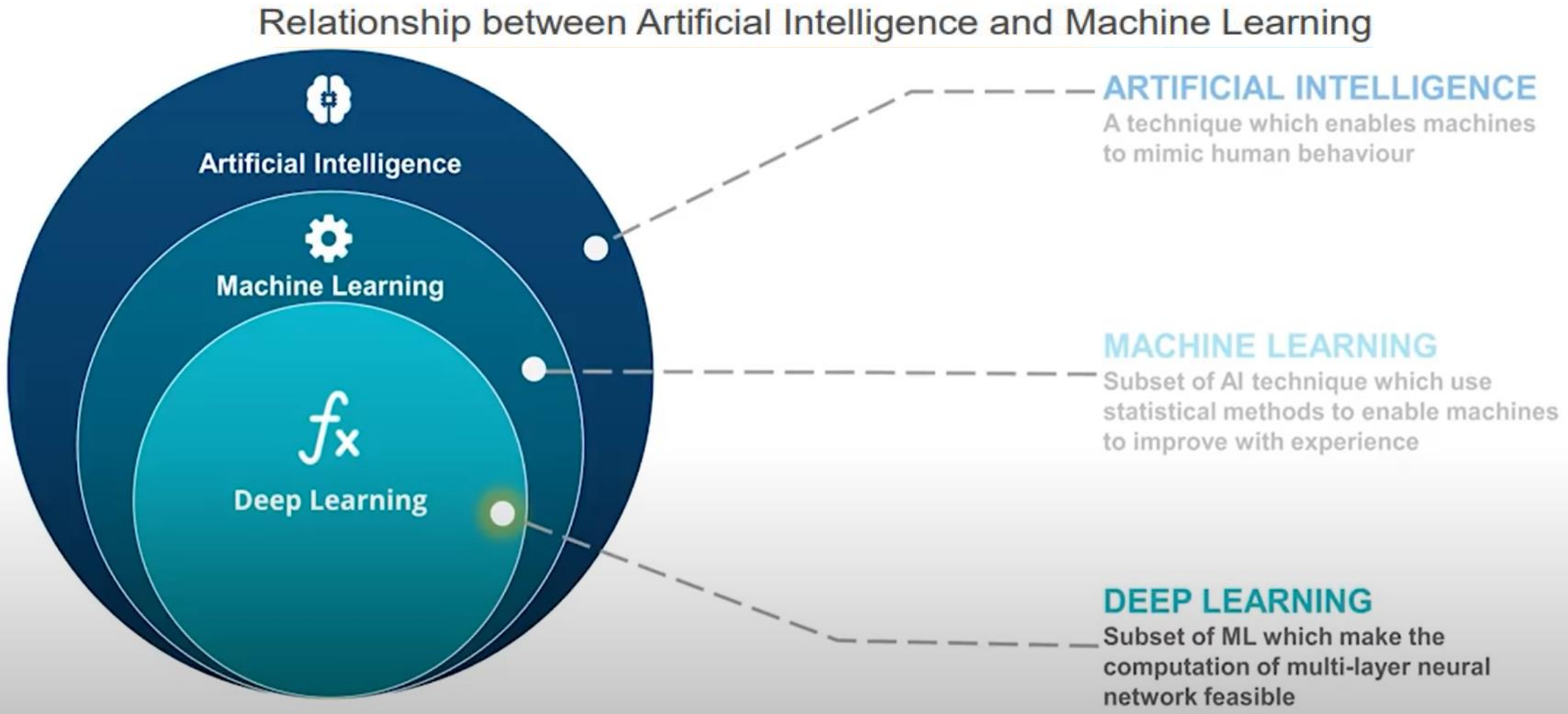


Sources: IDC, Azeem Azhar analysis

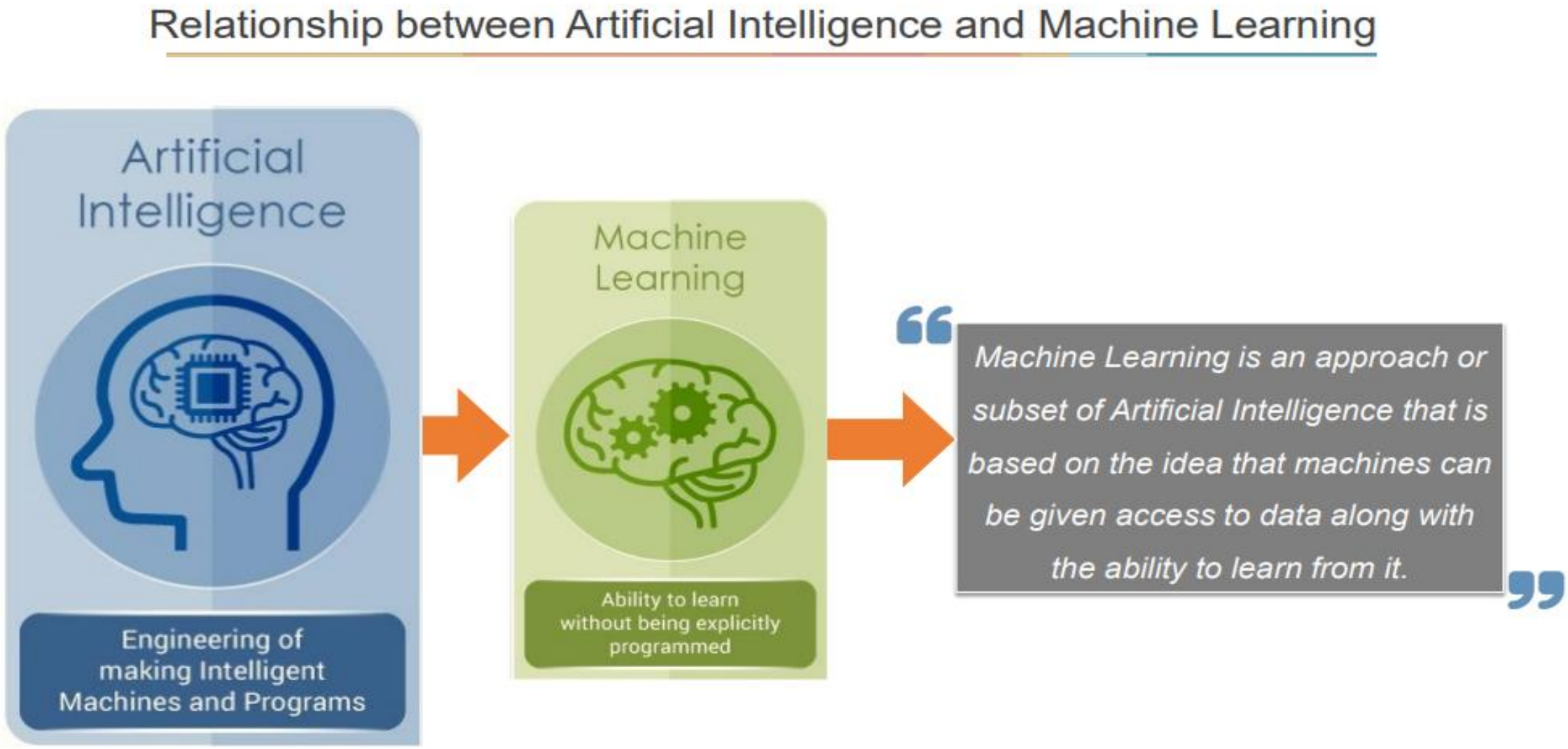
Brandwatch

Explosion of data has given rise to a new economy and there is a constant battle for ownership of data between enterprises to derive benefits from it.

1.INTRODUCTION TO MACHINE LEARNING:



1.INTRODUCTION TO MACHINE LEARNING:



1.INTRODUCTION TO MACHINE LEARNING:

Definition of Machine Learning

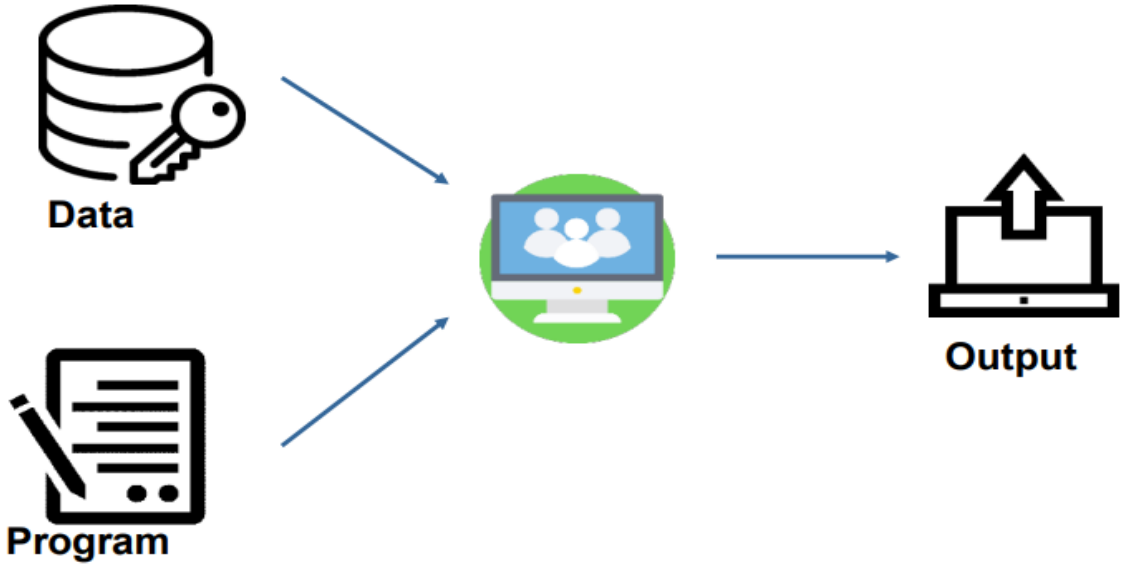
"Machine learning (ML) is defined as a discipline of artificial intelligence (AI) that provides machines the ability to automatically learn from data and past experiences to identify patterns and make predictions with minimal human intervention. "

> The capability of Artificial Intelligence systems to learn by extracting patterns from data is known as Machine Learning.

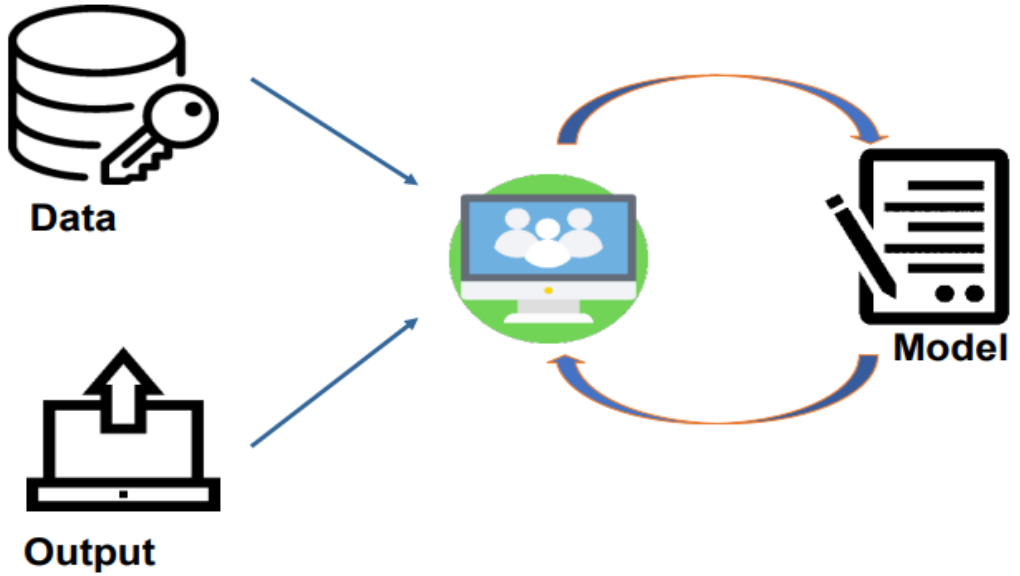
1.INTRODUCTION TO MACHINE LEARNING:

Traditional Approach vs. Machine Learning Approach

Traditional Programming: Data and program is run on the computer to produce the output



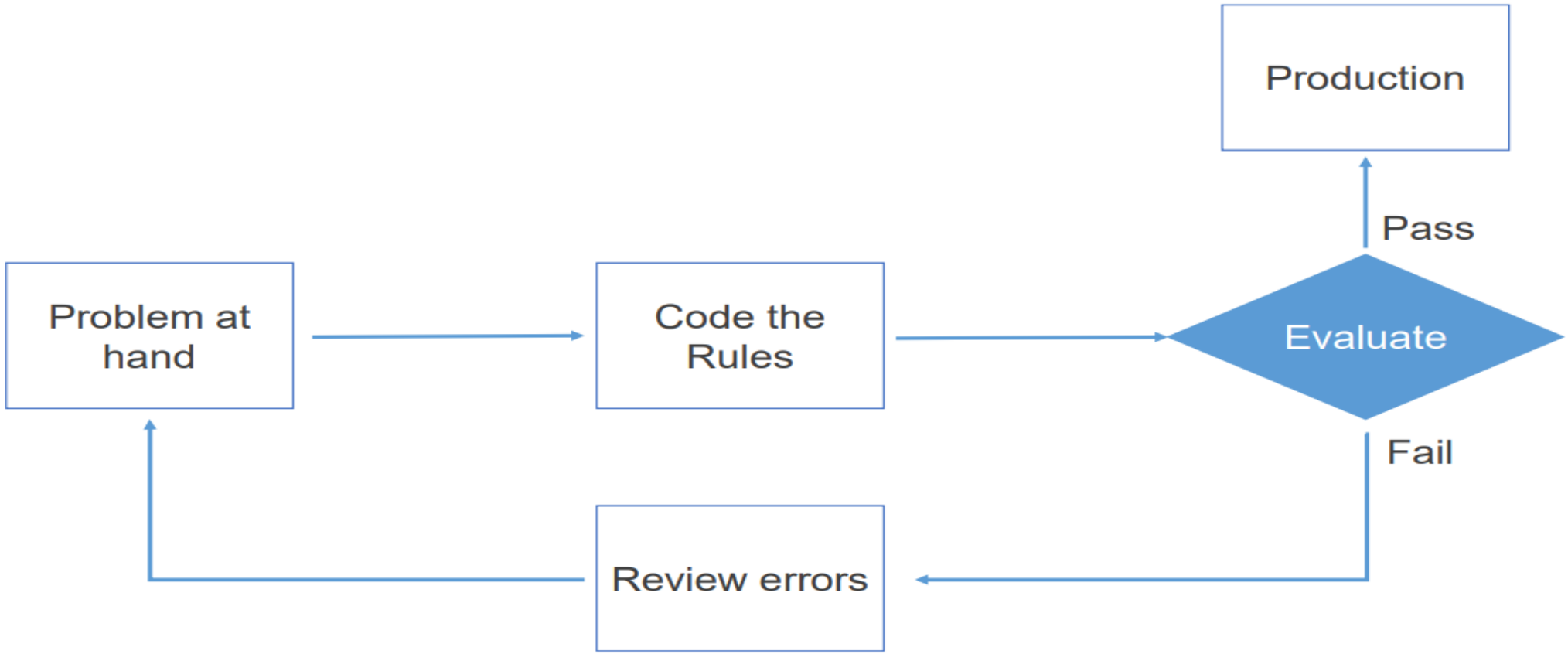
Machine Learning: Data and output is run on the computer to create a program



1.INTRODUCTION TO MACHINE LEARNING:

Traditional Approach

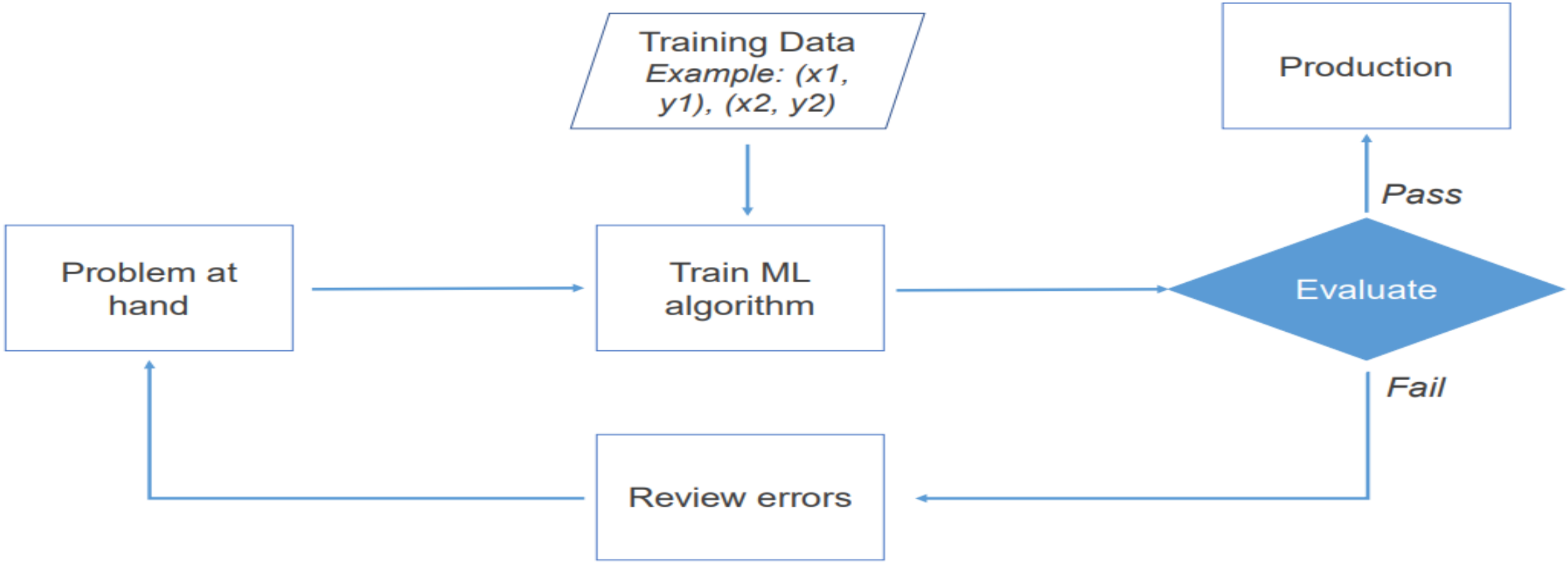
Traditional programming relies on hard-coded rules.



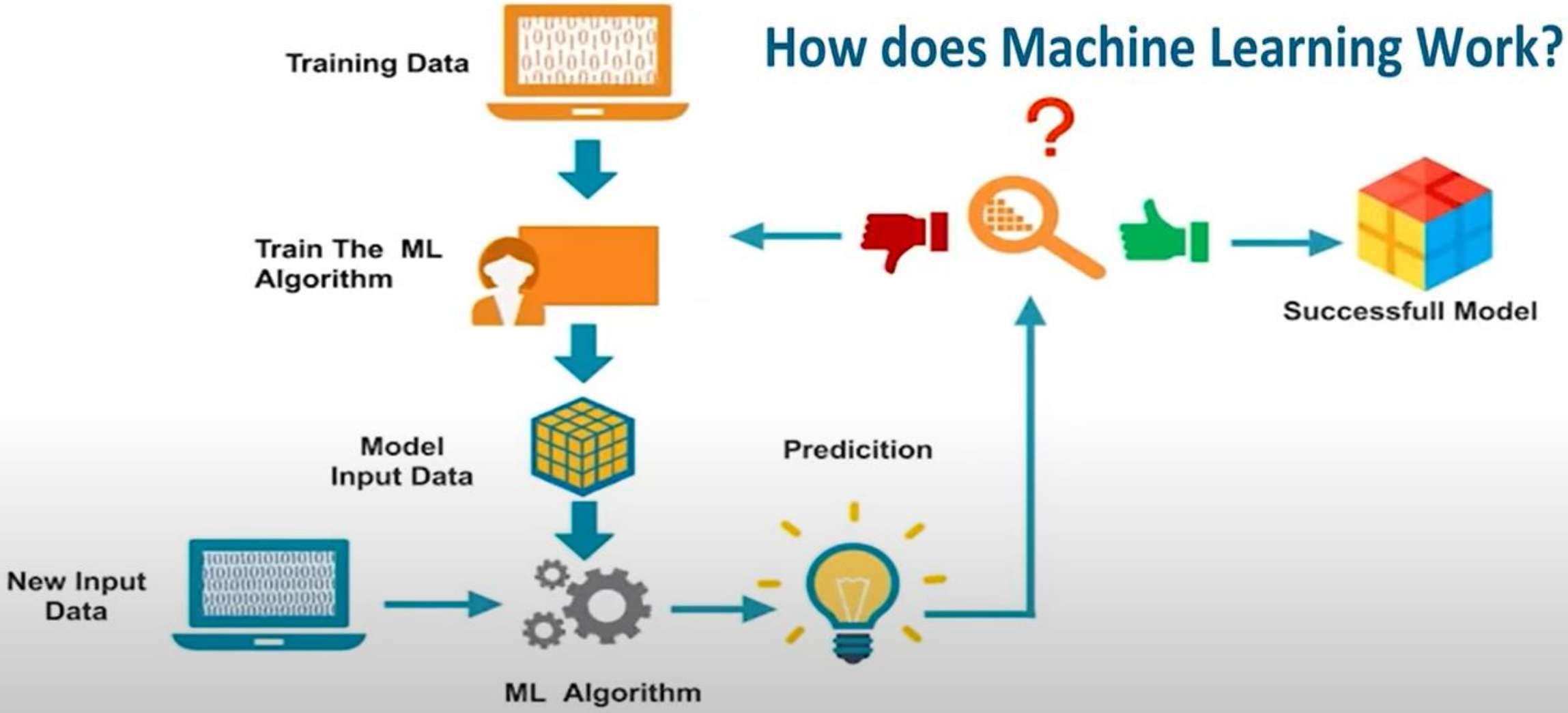
1.INTRODUCTION TO MACHINE LEARNING:

Machine Learning Approach

Machine Learning relies on learning patterns based on sample data.



1.INTRODUCTION TO MACHINE LEARNING:



2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

Supervised learning uses **labeled data** (data with known answers) to train algorithms to:

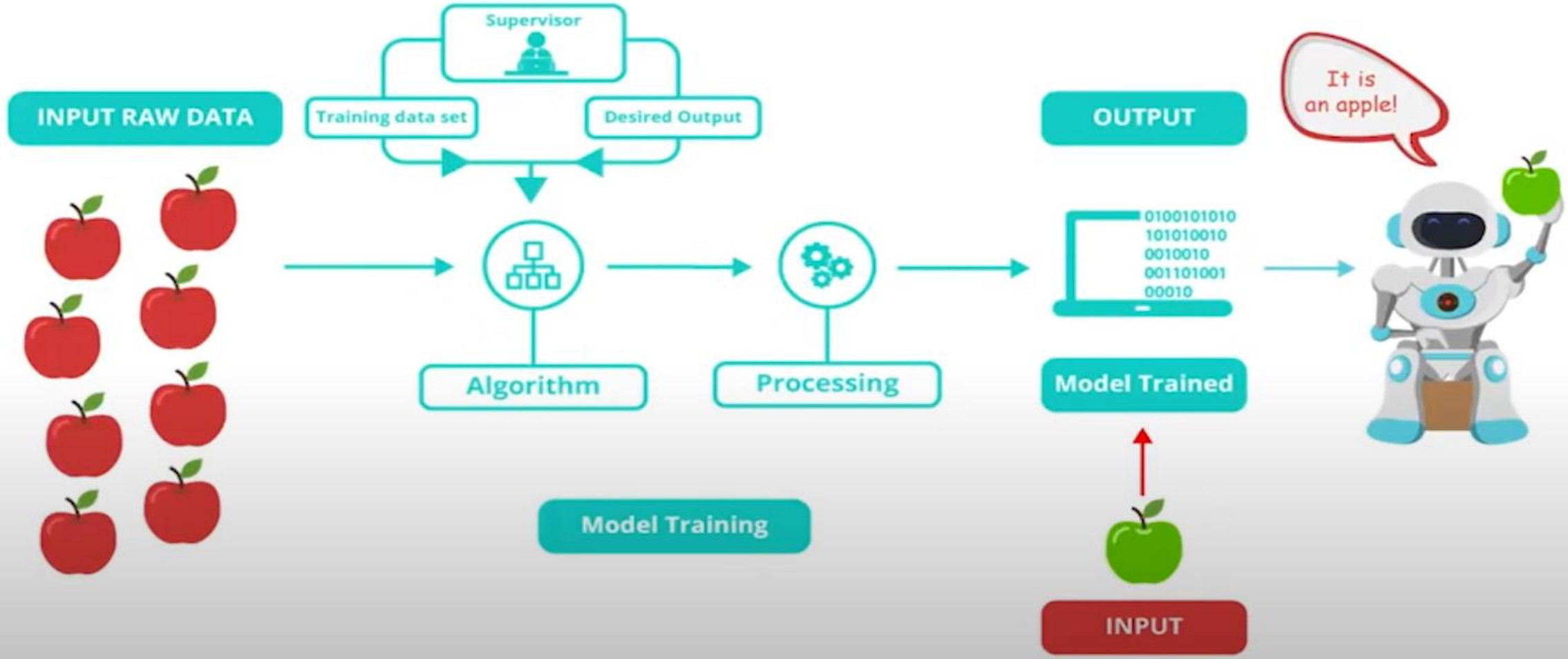
- **Classify Data**
- **Predict Outcomes**

- Supervised learning can **classify** data like "What is spam in an e-mail", based on known spam examples.

- Supervised learning can **predict** outcomes like predicting what kind of video you like, based on the videos you have played.

2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning



2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

Examples of Supervised Learning

Example 1: Weather Apps

The predictions made by weather apps at a given time are based on prior knowledge and analysis of weather over a period of time for a particular place.

2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

Supervised Learning: Case Study

Netflix uses **supervised learning** algorithms to recommend users the shows they may watch based on the viewing history and ratings by similar classes of users

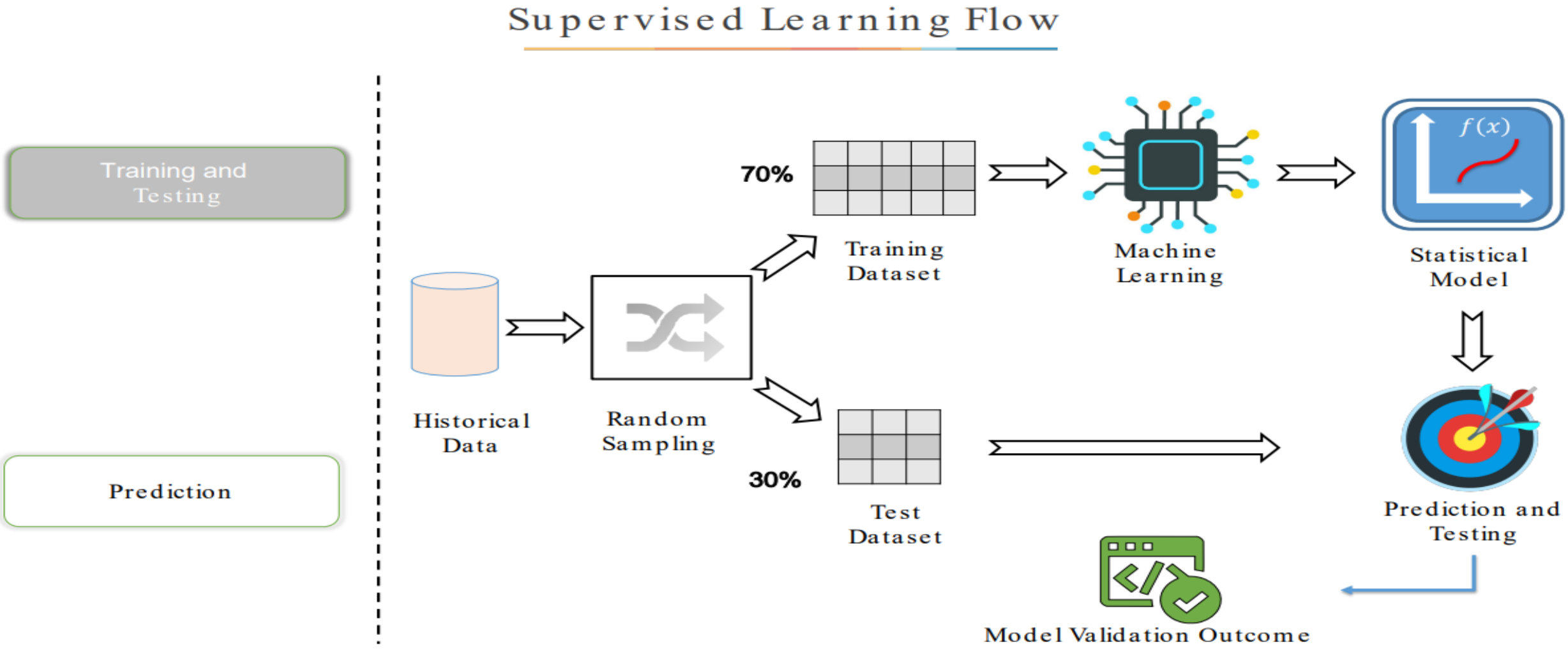
New Input

Predicted Outcome

Algorithm Trained on Historical Data

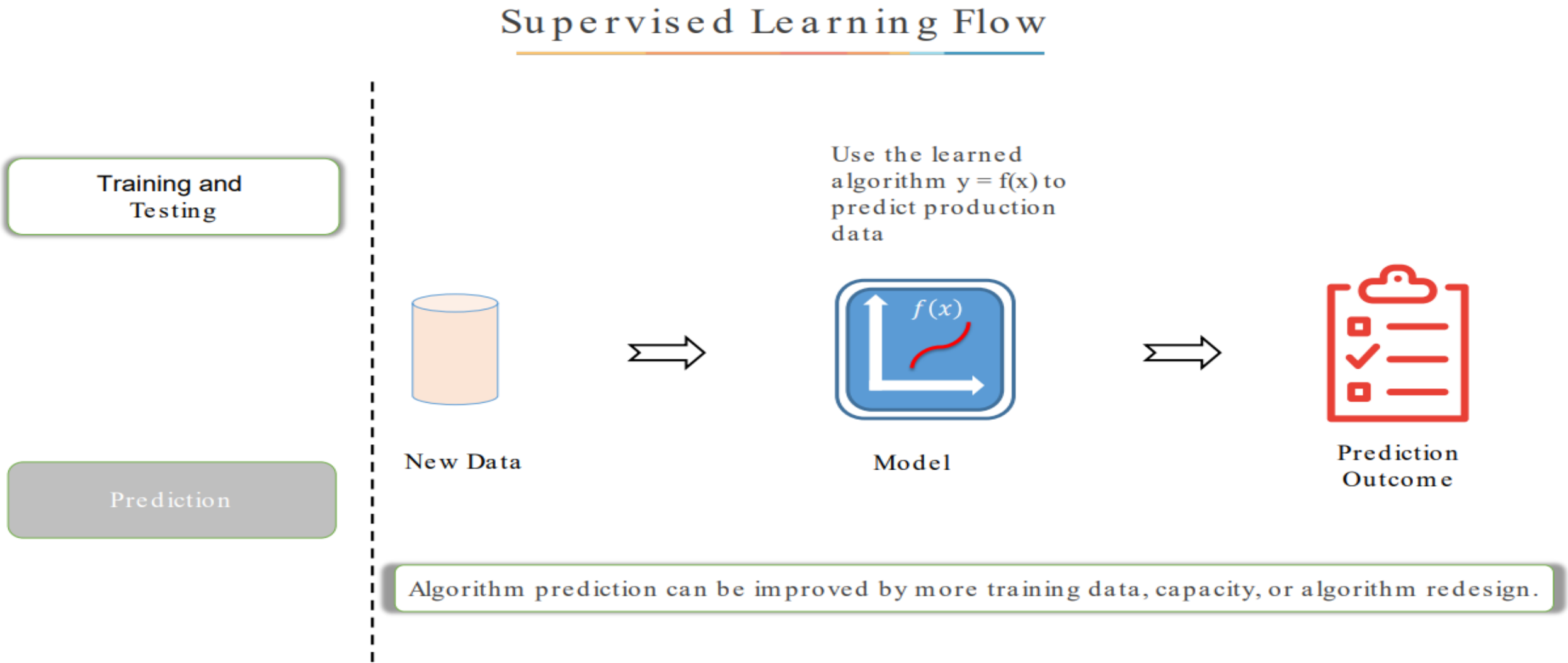
2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning



2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning



2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

- Supervised machine learning is based on supervision. It means in the supervised learning technique, we train the machines using the "labelled" dataset, and based on the training, the machine predicts the output.

- Here, the labelled data specifies that some of the inputs are already mapped to the output. More preciously, we can say; first, we train the machine with the input and corresponding output, and then we ask the machine to predict the output using the test dataset.

2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

- Let's understand supervised learning with an example. Suppose we have an input dataset of cats and dog images.
- So, first, we will provide the training to the machine to understand the images, such as the **shape & size of the tail of cat and dog, Shape of eyes, colour, 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. Now, 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. This is the process of how the machine identifies the objects in Supervised Learning.
- **The main goal of the supervised learning technique is to map the input variable(x) with the output variable(y).**

2.CLASSIFICATION OF MACHINE LEARNING

i. Supervised Learning

Advantages and Disadvantages of Supervised Learning

Advantages:

- 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:

- 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.

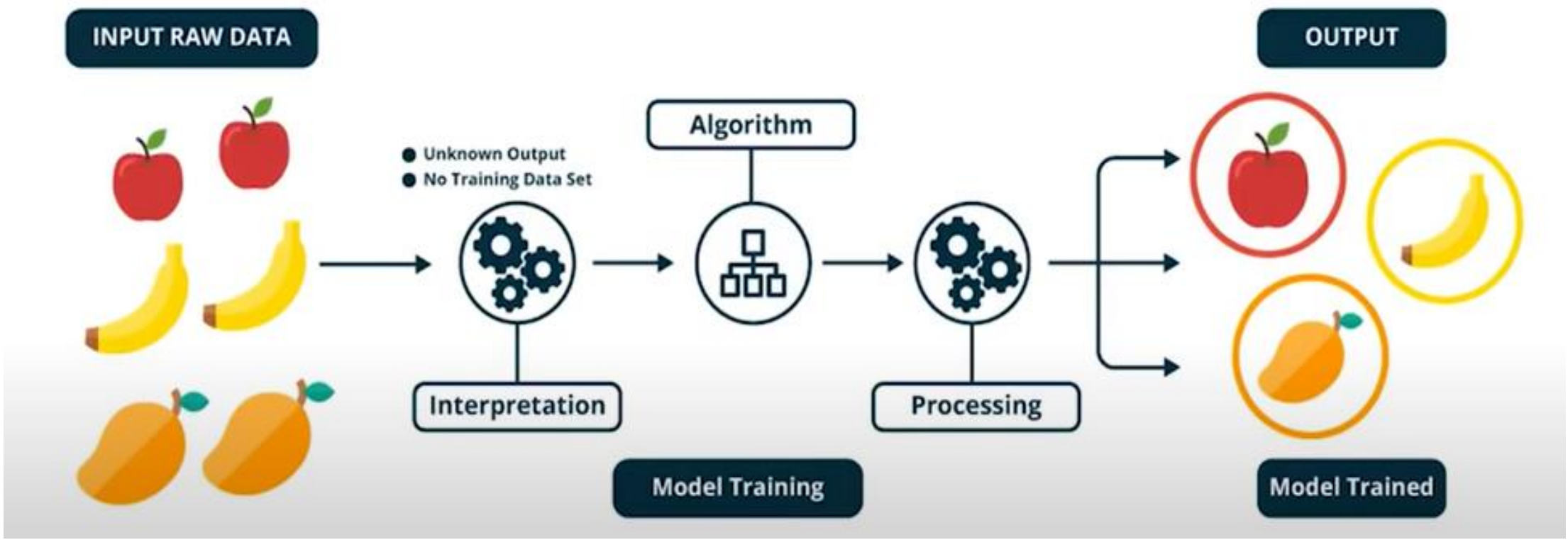
2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning

- Unsupervised learning is used to predict undefined relationships like meaningful patterns in data.
- It is about creating computer algorithms than can improve themselves.
- It is expected that machine learning will shift to unsupervised learning to allow programmers to solve problems without creating models.

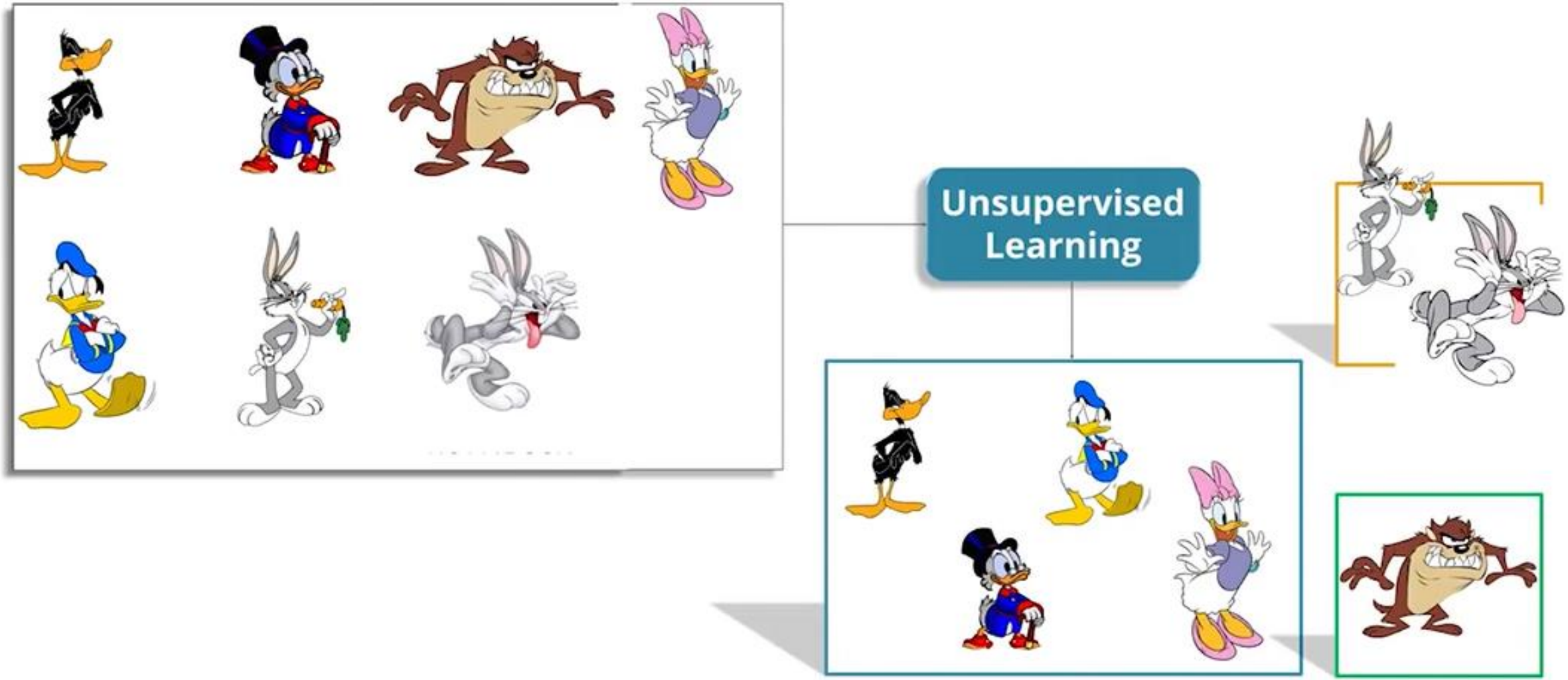
2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning



2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning



2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning

- Unsupervised learning is different from the Supervised learning technique; as its name suggests, there is no need for supervision. It means, in unsupervised machine learning, the machine is trained using the unlabeled dataset, and the machine predicts the output without any supervision.

- In unsupervised learning, the 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.

2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning

Let's take an example to understand it more preciously; suppose there is a basket of fruit images, and we input it into the machine learning model. 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, now the machine will discover its patterns and differences, such as colour difference, shape difference, and predict the output when it is tested with the test dataset.

2.CLASSIFICATION OF MACHINE LEARNING

ii. Unsupervised Learning

Advantages and Disadvantages of Unsupervised Learning Algorithm

Advantages:

- 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:

- 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 unlabelled dataset that does not map with the output.

2.CLASSIFICATION OF MACHINE LEARNING

iii. 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 and uses the combination of labelled and unlabeled datasets during the training period.
- **A**lthough 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.

2.CLASSIFICATION OF MACHINE LEARNING

iii. 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 unlabelled data into labelled data. It is because labelled data is a comparatively more expensive acquisition than unlabelled data.
- We can imagine these algorithms with an example. 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 analysing the same concept under the guidance of an instructor at college.

2.CLASSIFICATION OF MACHINE LEARNING

iii. Semi-supervised Learning

Advantages and disadvantages of 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.

2.CLASSIFICATION OF MACHINE LEARNING

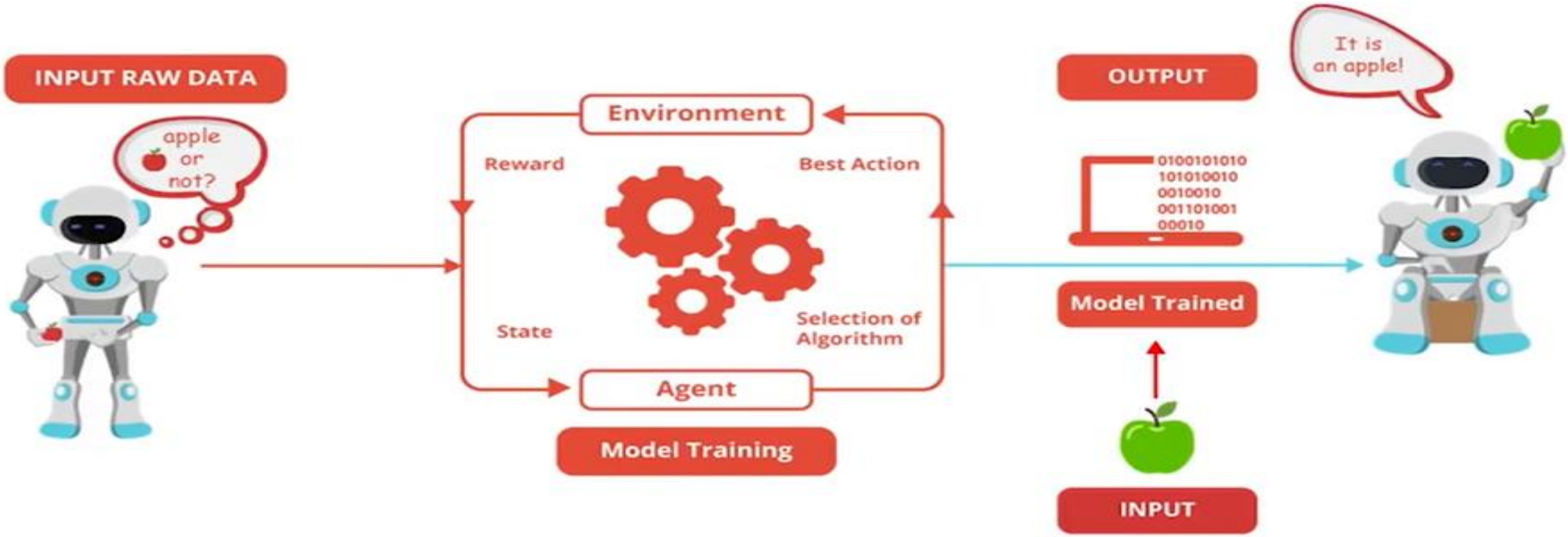
iv. Reinforcement Learning

- Reinforcement learning works on a feedback-based process, in which an AI agent (A software component) automatically explore its surrounding by hitting & trail, taking action, learning from experiences, and improving its performance. Agent gets rewarded for each good action and get punished for each bad action; hence the goal of reinforcement learning agent is to maximize the rewards.
- In reinforcement learning, there is no labelled data like supervised learning, and agents learn from their experiences only.
- The Reinforcement learning process is similar to a human being;
  - for example, a child learns various things by experiences in his day-to-day life. An example of reinforcement learning is to play a game, where the Game is the environment, moves of an agent at each step define states, and the goal of the agent is to get a high score. Agent receives feedback in terms of punishment and rewards.

2.CLASSIFICATION OF MACHINE LEARNING

iv. Reinforcement Learning

- Due to its way of working, reinforcement learning is employed in different fields such as **Game theory, Operation Research, Information theory, multi-agent systems.**



2.CLASSIFICATION OF MACHINE LEARNING

iv. Reinforcement Learning

Advantages and Disadvantages of Reinforcement Learning

Advantages

- 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.

Disadvantage

- 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.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

- Classification
- Regression
- Clustering

3. CATEGORIZING BASED ON REQUIRED OUTPUT

i. Regression Analysis in Machine learning-

- As we know, the Supervised Machine Learning algorithm can be broadly classified into
  - Regression and
  - Classification Algorithms.
- Regression analysis is a statistical method to model the relationship between a dependent (target) and independent (predictor) variables with one or more independent variables.
- More specifically, Regression analysis helps us to understand how the value of the dependent variable is changing corresponding to an independent variable when other independent variables are held fixed. It predicts continuous/real values such as **temperature, age, salary, price,** etc.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

i.Regression Analysis in Machine learning-

We can understand the concept of regression analysis using the below example:

- **Example:** Suppose there is a marketing company A, who does various advertisement every year and get sales on that. The below list shows the advertisement made by the company in the last 5 years and the corresponding sales:

Advertisement	Sales
$90	$1000
$120	$1300
$150	$1800
$100	$1200
$130	$1380
$200	??

- Now, the company wants to do the advertisement of $200 in the year 2019 and wants to know the prediction about the sales for this year. So to solve such type of prediction problems in machine learning, we need regression analysis.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

i.Regression Analysis in Machine learning-

- Regression is a supervised learning technique which helps in finding the correlation between variables and enables us to predict the continuous output variable based on the one or more predictor variables.
- It is mainly used for prediction, forecasting, time series modeling, and determining the causal-effect relationship between variables.

Some examples of regression can be as:

- Prediction of rain using temperature and other factors
- Determining Market trends
- Prediction of road accidents due to rash driving.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

ii. Classification

- As we know, the Supervised Machine Learning algorithm can be broadly classified into Regression and Classification Algorithms. In Regression algorithms, we have predicted the output for continuous values, but to predict the categorical values, we need Classification algorithms.

- The Classification algorithm is a Supervised Learning technique that is used to identify the category of new observations on the basis of training data.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

ii. Classification

- In Classification, a program learns from the given dataset or observations and then classifies new observation into a number of classes or groups. Such as, **Yes or No, 0 or 1, Spam or Not Spam, cat or dog,** etc. Classes can be called as targets/labels or categories.

- Unlike regression, the output variable of Classification is a category, not a value, such as "Green or Blue", "fruit or animal", etc. Since the Classification algorithm is a Supervised learning technique, hence it takes labeled input data, which means it contains input with the corresponding output.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

ii. Classification

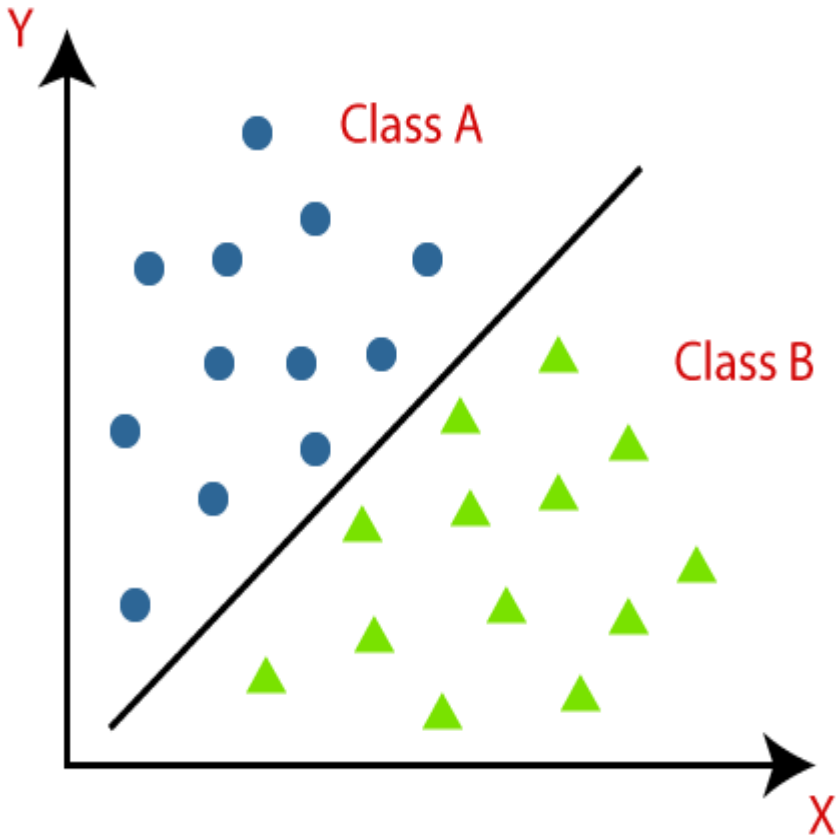
In classification algorithm, a discrete output function(y) is mapped to input variable(x).

y=f(x), where y = categorical output

- The best example of an ML classification algorithm is **Email Spam Detector**.
- The main goal of the Classification algorithm is to identify the category of a given dataset, and these algorithms are mainly used to predict the output for the categorical data.
- Classification algorithms can be better understood using the below diagram. In the below diagram, there are two classes, class A and Class B. These classes have features that are similar to each other and dissimilar to other classes.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

ii. Classification



The algorithm which implements the classification on a dataset is known as a classifier. There are two types of Classifications:

Binary Classifier: If the classification problem has only two possible outcomes, then it is called as Binary Classifier.

Examples: YES or NO, MALE or FEMALE, SPAM or NOT SPAM, CAT or DOG, etc.

•**Multi-class Classifier:** If a classification problem has more than two outcomes, then it is called as Multi-class Classifier.

Example: Classifications of types of crops, Classification of types of music.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

iii. Clustering

- Clustering or cluster analysis is a machine learning technique, which groups the unlabelled dataset. It can be defined as *"A way of grouping the data points into different clusters, consisting of similar data points. The objects with the possible similarities remain in a group that has less or no similarities with another group."*
- It does it by finding some similar patterns in the unlabelled dataset such as shape, size, color, behavior, etc., and divides them as per the presence and absence of those similar patterns.
- It is an unsupervised learning method, hence no supervision is provided to the algorithm, and it deals with the unlabeled dataset.
- After applying this clustering technique, each cluster or group is provided with a cluster-ID. ML system can use this id to simplify the processing of large and complex datasets.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

iii. Clustering

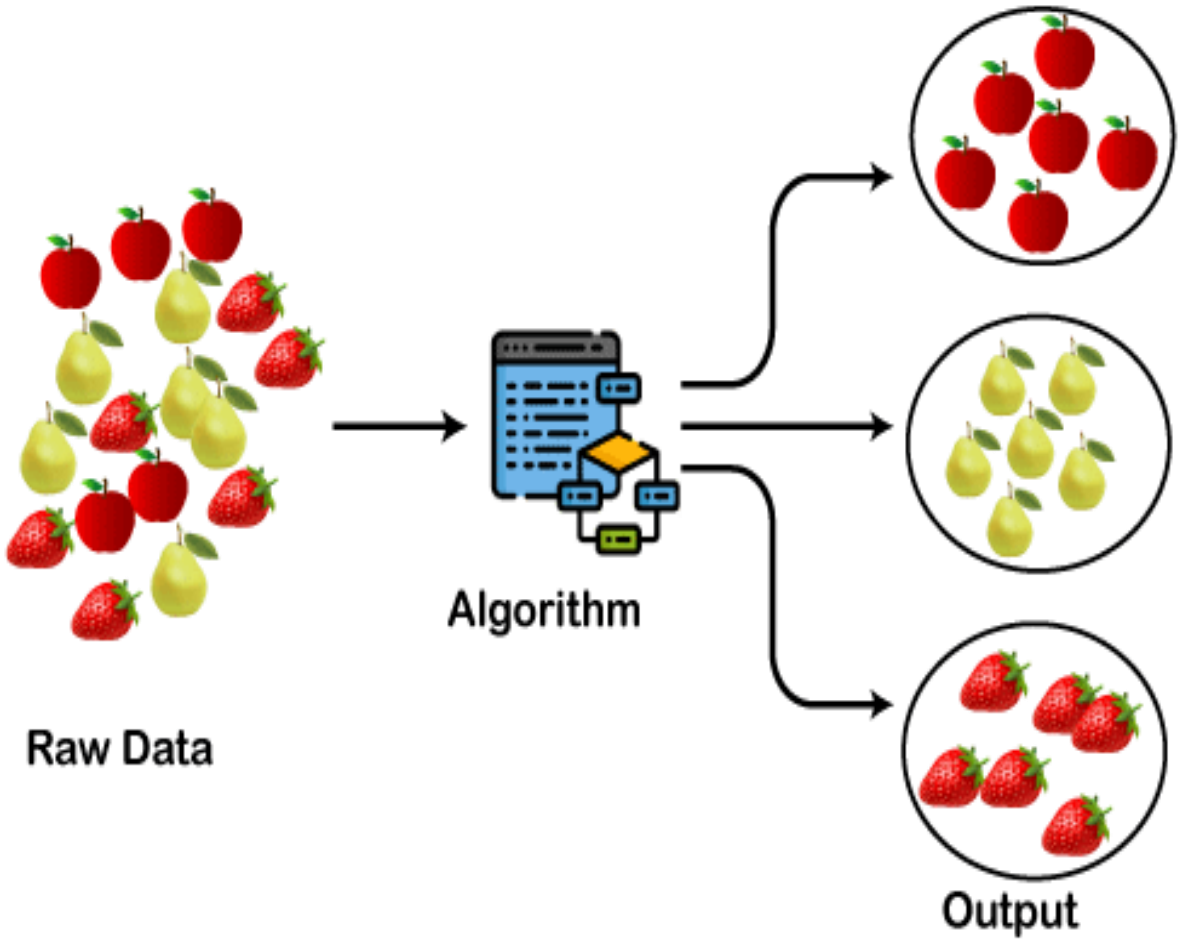
Example: Let's understand the clustering technique with the real-world example of Mall:

- When we visit any shopping mall, we can observe that the things with similar usage are grouped together. Such as the t-shirts are grouped in one section, and trousers are at other sections, similarly, at vegetable sections, apples, bananas, Mangoes, etc., are grouped in separate sections, so that we can easily find out the things.
- The clustering technique also works in the same way.
- Other examples of clustering are grouping documents according to the topic.

3. CATEGORIZING BASED ON REQUIRED OUTPUT

iii. Clustering

- Apart from these general usages, it is used by the **Amazon** in its recommendation system to provide the recommendations as per the past search of products.
- **Netflix** also uses this technique to recommend the movies and web-series to its users as per the watch history.
- The below diagram explains the working of the clustering algorithm. We can see the different fruits are divided into several groups with similar properties.



3. CATEGORIZING BASED ON REQUIRED OUTPUT

iii. Clustering

The clustering technique can be widely used in various tasks. Some most common uses of this technique are:

- Market Segmentation
- Statistical data analysis
- Social network analysis
- Image segmentation
- Anomaly detection, etc.

4. DEFINITION OF DATA, INFORMATION & KNOWLEDGE

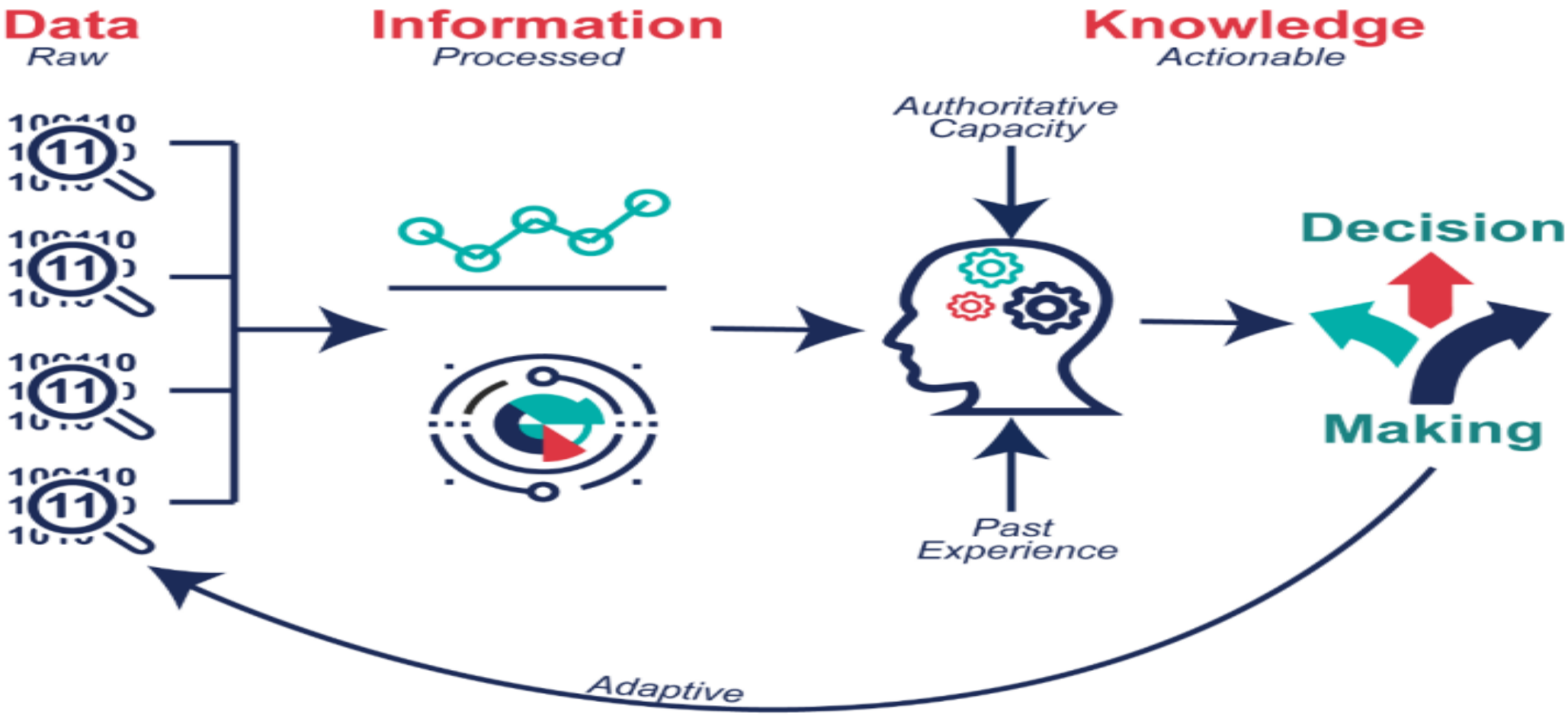


Figure 1: The flow from data to information to knowledge.

4. DEFINITION OF DATA, INFORMATION & KNOWLEDGE

- Data, information, and knowledge are often used interchangeably. However, these terms represent different stages of value creation from data to decision-making.

- Data are the raw alphanumeric values obtained through different acquisition methods. Data in their simplest form consist of raw alphanumeric values.

- Information is created when data are processed, organized, or structured to provide context and meaning. Information is essentially processed data. Knowledge is what we know.

- Knowledge is unique to each individual and is the accumulation of past experience and insight that shapes the lens by which we interpret, and assign meaning to, information. For knowledge to result in action, an individual must have the authority and capacity to make and implement a decision. Knowledge (and authority) are needed to produce actionable information that can lead to impact.

5. SPLIT DATA IN MACHINE LEARNING:

- In Machine Learning we create models to predict the outcome of certain events, like in the previous chapter where we predicted the CO2 emission of a car when we knew the weight and engine size.

- To measure if the model is good enough, we can use a method called Train/Test.

5. SPLIT DATA IN MACHINE LEARNING:

What is Train/Test

Train/Test is a method to measure the accuracy of your model.

It is called Train/Test because you split the the data set into two sets:

- a training set and
- a testing set.

80% for training, and 20% for testing.

You *train* the model using the training set.
You *test* the model using the testing set.

Train the model means *create* the model.
Test the model means test the accuracy of the model.

5. SPLIT DATA IN MACHINE LEARNING:

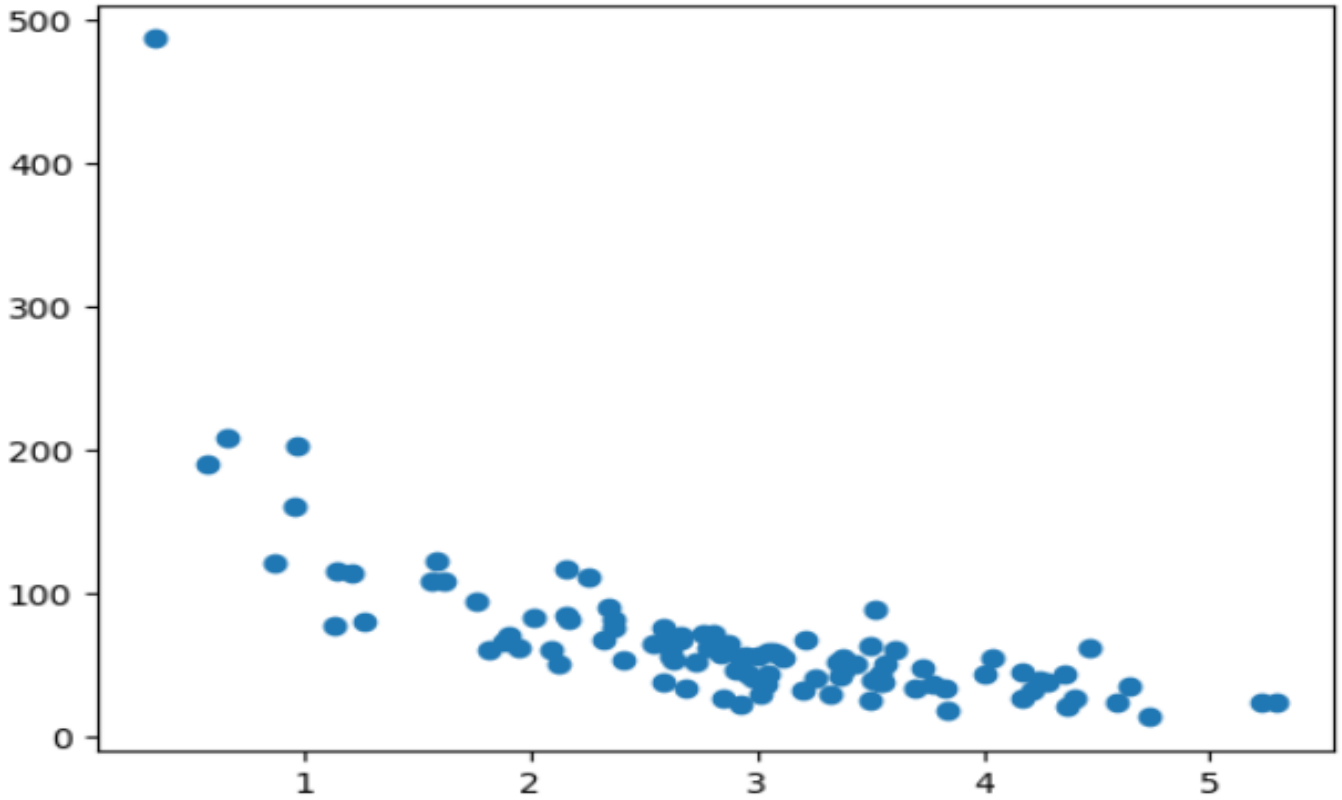
Start With a Data Set

- Start with a data set you want to test.
- Our data set illustrates 100 customers in a shop, and their shopping habits.

```
import numpy
import matplotlib.pyplot as plt
numpy.random.seed(2)

x = numpy.random.normal(3, 1, 100)
y = numpy.random.normal(150, 40, 100) / x

plt.scatter(x, y)
plt.show()
```



Result:

The x axis represents the number of minutes before making a purchase.

The y axis represents the amount of money spent on the purchase.

5. SPLIT DATA IN MACHINE LEARNING:

Split Into Train/Test

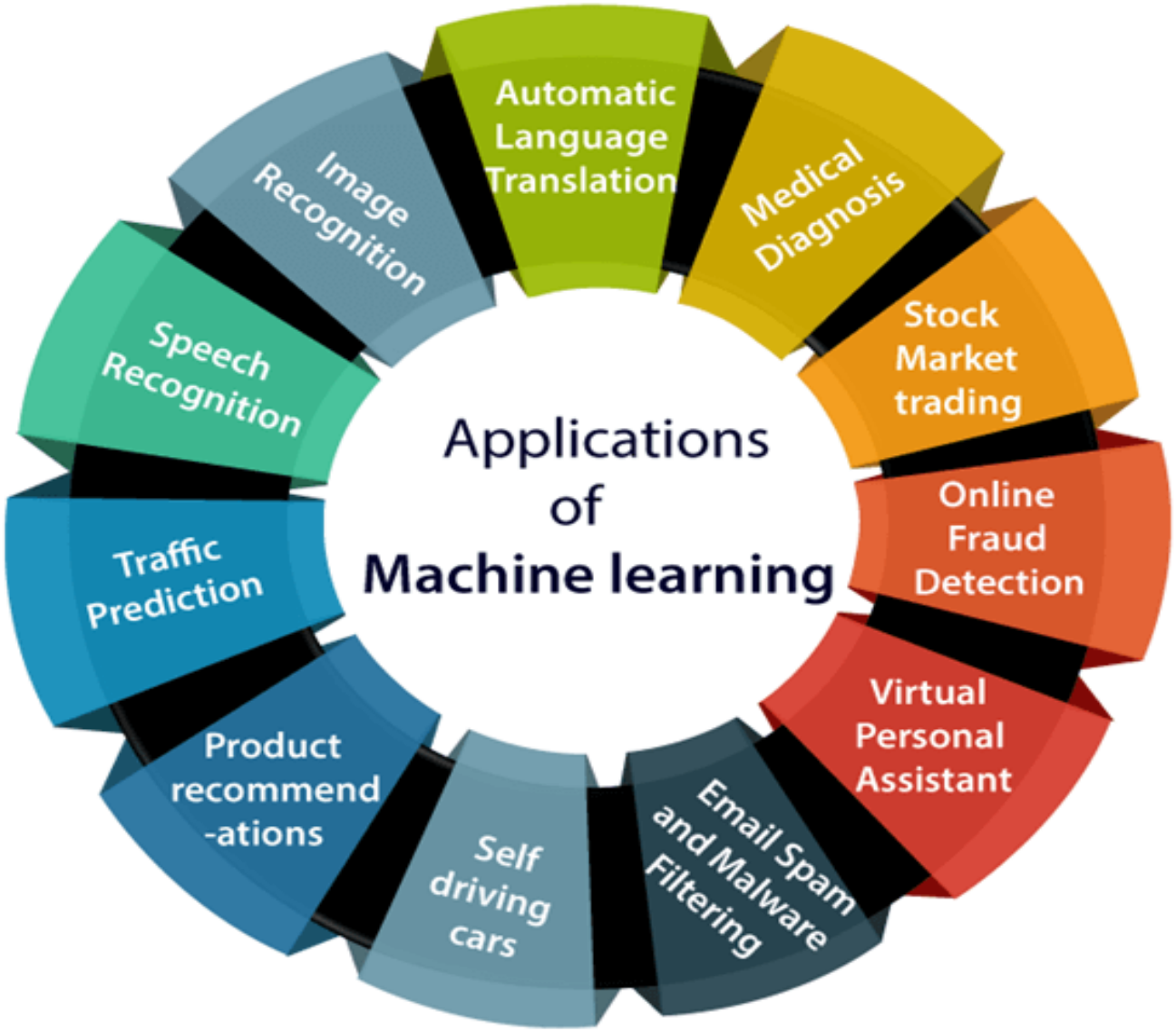
The *training* set should be a random selection of 80% of the original data.
The *testing* set should be the remaining 20%.

```
train_x = x[:80]
train_y = y[:80]


test_x = x[80:]
test_y = y[80:]
```

6. MACHINE LEARNING-APPLICATIONS

- Machine learning is a buzzword for today's technology, and it is growing very rapidly day by day. We are using machine learning in our daily life even without knowing it such as Google Maps, Google assistant, Alexa, etc.
- Below are some most trending real-world applications of Machine Learning:



6. MACHINE LEARNING-APPLICATIONS

a. 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.

6. MACHINE LEARNING-APPLICATIONS

b. 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.

6. MACHINE LEARNING-APPLICATIONS

c. 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.
- It predicts the traffic conditions such as whether traffic is cleared, slow-moving, or heavily congested with the help of two ways:

    - **Real Time location** of the vehicle form Google Map app and sensors
    - **Average time has taken** on past days at the same time.

- Everyone who is using Google Map is helping this app to make it better. It takes information from the user and sends back to its database to improve the performance.

6. MACHINE LEARNING-APPLICATIONS

d. 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.
- As similar, when we use Netflix, we find some recommendations for entertainment series, movies, etc., and this is also done with the help of machine learning.

6. MACHINE LEARNING-APPLICATIONS

e. 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.

f. 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. Below are some spam filters used by Gmail:
  - Content Filter
  - Header filter
  - General blacklists filter
  - Rules-based filters
  - Permission filters

6. MACHINE LEARNING-APPLICATIONS

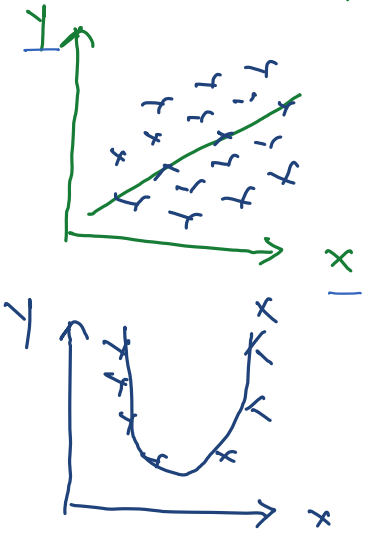
g. Virtual Personal Assistant:

- 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.
- These virtual assistants use machine learning algorithms as an important part.
- These assistant record our voice instructions, send it over the server on a cloud, and decode it using ML algorithms and act accordingly.

Assumptions of Linear Regression

22 November 2022 04:13 PM

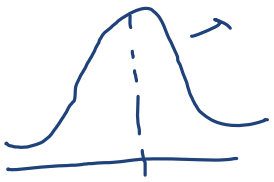
① Linear Relationship betn Dependent and Independent Variables



⇒ Linear Relation betn X & Y
(Linearly seperable)

2] Normally Distributed error component :

↳ Data Need to be Normally Distribution



Bell Shape curve

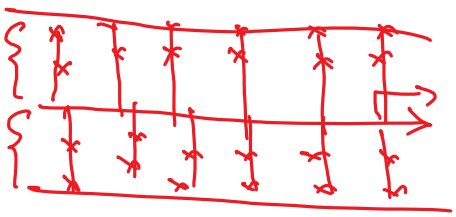
1] K-S Test
2] Shapiro Wilk Test } Analytical Test

i.e. Normality Test

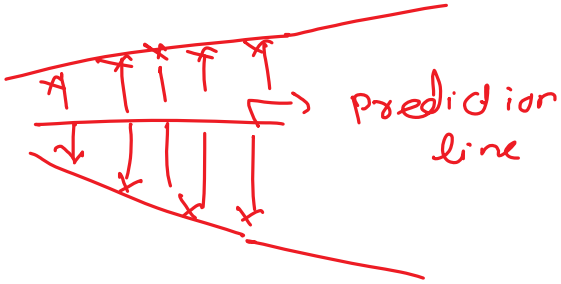
3] There should not be "Heteroscedacity" i.e.

→ Variance of residuals/error must be constant across predicted values.

Homocedacity ✓



Heteroscedacity X



4] No multicollinearity : →

4] No Multicollinearity : →

→ instability of Regression coefficient

→ two or more predictor variables are strongly correlated with other

$$\hat{y} = b_1 x_1 + b_2 x_2 + \dots + b_n x_n + a$$

(b_1: 50, b_2: 50, a: intercept)

coefficient.

→ Let's Assume x_1 & x_2 feature having some coefficient.

* Multicollinearity Diagnosis: →

$$\hat{y} = b_1 x_1 + b_2 x_2 + \dots + b_k x_k + a$$

↳ Tolerance

$$T = 1 - R^2$$

↳ coefficient of determination

↳ VIF : variation inflation factor

$$VIF = \frac{1}{1 - R^2}$$

↳ coefficient of determination

$T < 0.1$

$VIF > 10$

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