

# **6CS012-Artificial Intelligence and Machine Learning. Week-01, Lecture-01.**

# **A. Module Introduction and Logistics.**

# A.1 Module Introductions.

- In this course, we will study various **Machine Learning and Deep learning algorithms** in conjunction with various supporting **ideas and knowledge** required to implement those algorithms successfully.
- Pre-requisites:
  - Introduction to Programming (Level-4)
    - Programming-Python – Recommended.
    - IDE-Jupyter Notebook/Google Colab- Recommended.
  - Concepts and Technologies of AI(Level-5)

# A.2 Module Delivery.

- **Lecture:**

- Lecture will provide proper theoretical and mathematical explanation of any content planned for that week.

- **Tutorial:**

- (If not defined otherwise)
  - Tutorial will focus on the recital of the lecture,
  - Doubt Clearing
  - Content for the Tutorial.

- **Workshops:**

- practical implementation of that particular week with codes.

# A.4 Module Team

- Akash Adhikari
- Sunita Parajuli
- Shiva Kumar Yadav – Incharge-Logistics.
- Communication Tools-My Second Teacher.
- Assignment Submission-Canvas.

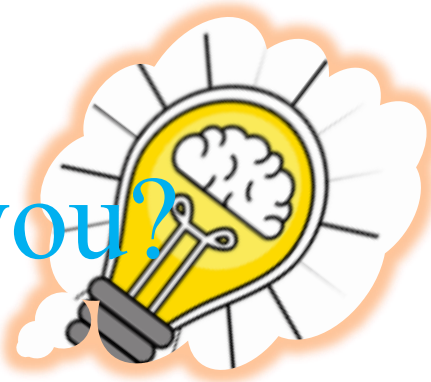
# A.5 How to pass the Module?

| S.N | Assignments                               | Weightages(100 | Submission Deadlin | Viva | Report | Plagarism Chec |
|-----|---|----------------|--------------------|------|--------|----------------|
| 1   | HW-1 Decision Tree and Cross Validations. | 10             | Week-4.            | Yes  | No     | No.            |
| 2   | Workshop Assessments and Surprise Tests.  | 10             | Weekly.            | No   | No     | No.            |
| 3   | Mid-Term Exam                             | 20             | Week-6             | No   | No     | No.            |
| 4   | Portfolio-I: Machine Learning.            | 30             | Week-7             | Yes  | Yes    | Yes(20%)       |
| 5   | Portfolio-II: Deep Learning.              | 30             | Week-12            | Yes  | Yes    | Yes(20%)       |

# **Introduction to Artificial Intelligence and Machine Learning.**

**Siman Giri**

# What's in it for you?



- Emergence and History of Artificial Intelligence(AI).
- Define Artificial Intelligence, Machine Learning and Deep learning.
- Describe the relationship between AI, ML, DL and Data Science.
- Describe different learning approaches.
- Application and used cases of AI.



# 1. History and Emergence of AI.

# 1.1 Some Major Moments in History of AI -1.

- **Pre-2000s**
  - **1950-Alan Turing**
    - Published a paper on “Computing Machinery and Intelligence”.
    - Argued Why can not Machine Thinks?
    - Coined a Term “**Turing Test**”.
  - **1955/56-Dartmouth College and First AI Conference**
    - John McCarthy and his team hosted the first **AI conference** and coined a term “**Artificial Intelligence**”.
    - Allen Newell, Cliff Shaw, and Herbert Simon’s published a paper titled “**Logic Theorist**”.
  - **1957-Frank Rosenblatt**
    - He built and proposed a first working **Artificial Neural Network-Perceptron**.
  - **1966-72-Shakey the Robot**
    - Artificial Intelligence Center of Stanford Research Institute, developed a general purpose mobile robot named Shakey
    - It was able to do the following:
      - Shakey could perform tasks that required **planning, route-finding, and the rearranging of simple objects**.
  - **1974-1980s: AI winter**
  - **1997-Deep Blue.**
    - Supercomputer “Deep Blue” developed by IBM defeated the world champion chess player- **Garry Kasparov**.

# 1.2 Some Major Moments in History of AI -2.

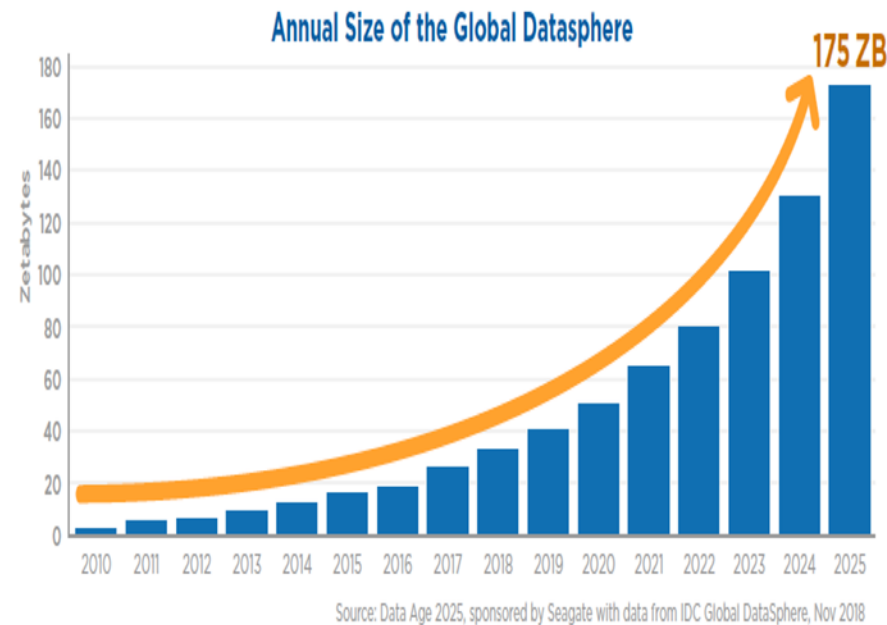
- **Post-2000s**
  - **2002-Roomba Vacuum.**
    - The first commercially successful robotic vacuum cleaner was created: “Roomba Vacuum” by **iRobot.**
  - **2011-Neural Net and Cats**
    - Google Engineer **Jeff Dean** and Professor **Andrew Ng** created a **Neural Nets** that trained itself to recognize “cats” from **YouTube** videos.
  - **2012-Geoffrey Hinton and Deep Neural Net**
    - He built a Deep Neural Network called **ALEXNET**, which won the **ImageNet** Competition.
  - **2016-AlphaGO beats GO Champion**
    - **Deepmind** built a machine learning system that beat **GO** Champion.
  - **2018-Google Assistant/BERT**
    - In Google I/O events of 2018 Google Assistant made a booking on saloon.
  - **2022-chatGPT(GPT4)**
    - You know it.

# 1.3 Emergence of AI-I

- Advancement of Computer storage devices
- Data Everywhere

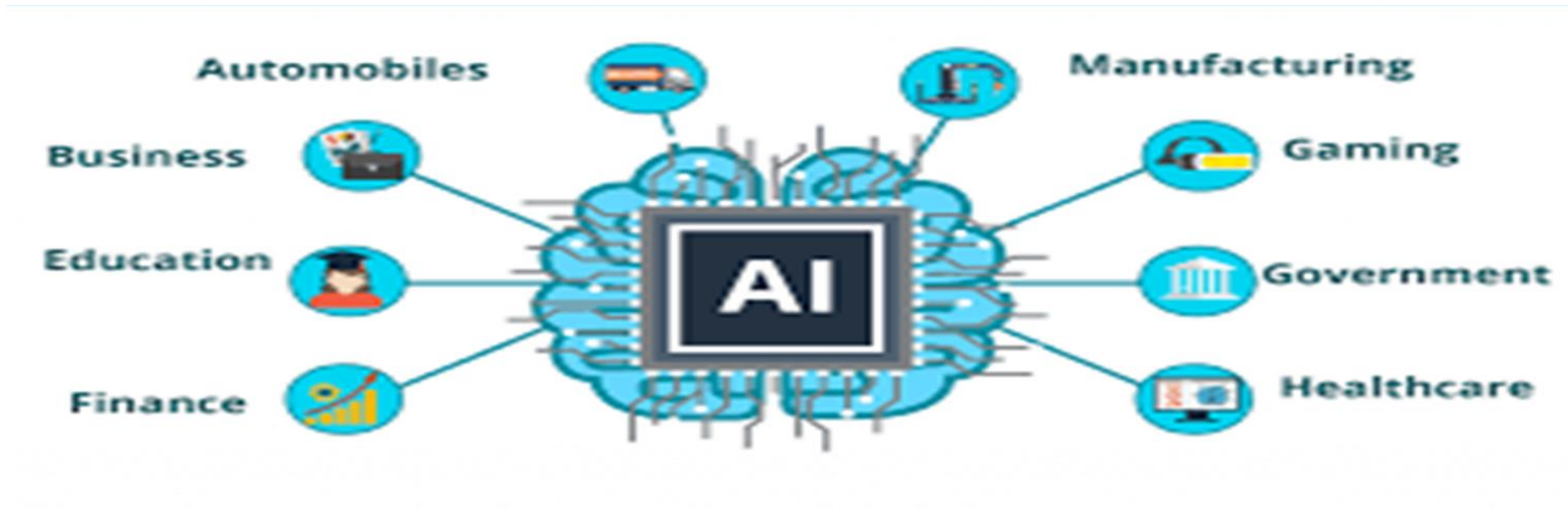


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# 1.4 Emergence of AI-II

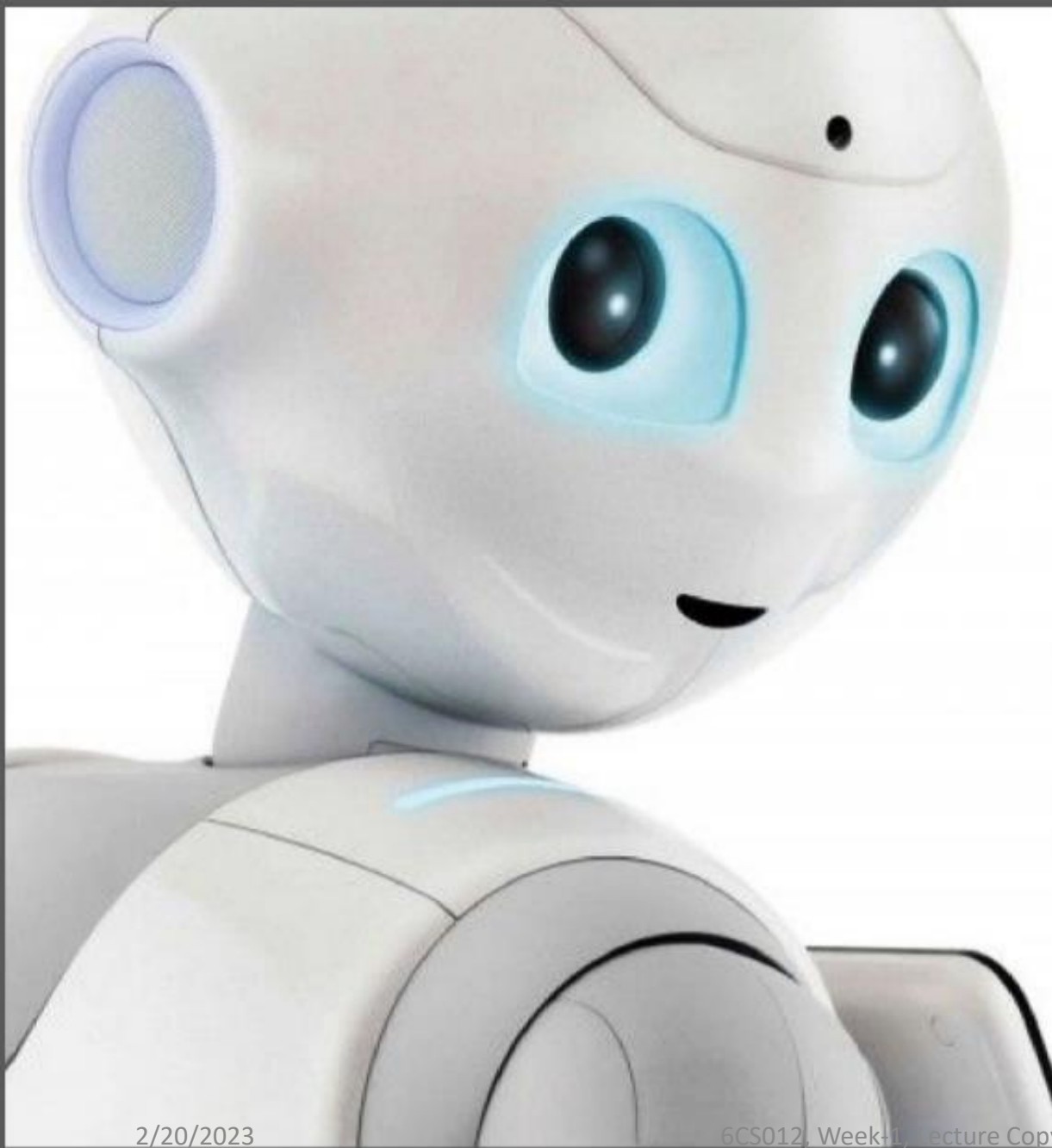
- Powered by “AI”



## 2. What is Intelligence?

## 2.1 Being Intelligent vs. Demonstrating Intelligent Behavior?

- Can there be a single definition of Intelligence?
- What is the difference between being intelligent and demonstrating intelligent behavior?
- maybe we can enumerate a list of elements that an intelligence must be able to perform:
  - **perceive, reason and infer, solve problems, learn and adapt, apply common sense, apply analogy, recall, apply intuition, reach emotional states, achieve self-awareness**
- What about AI ?
  - Criteria for machine to be intelligent?
  - Should we define AI in terms of human Intelligence?



# What is Artificial Intelligence?

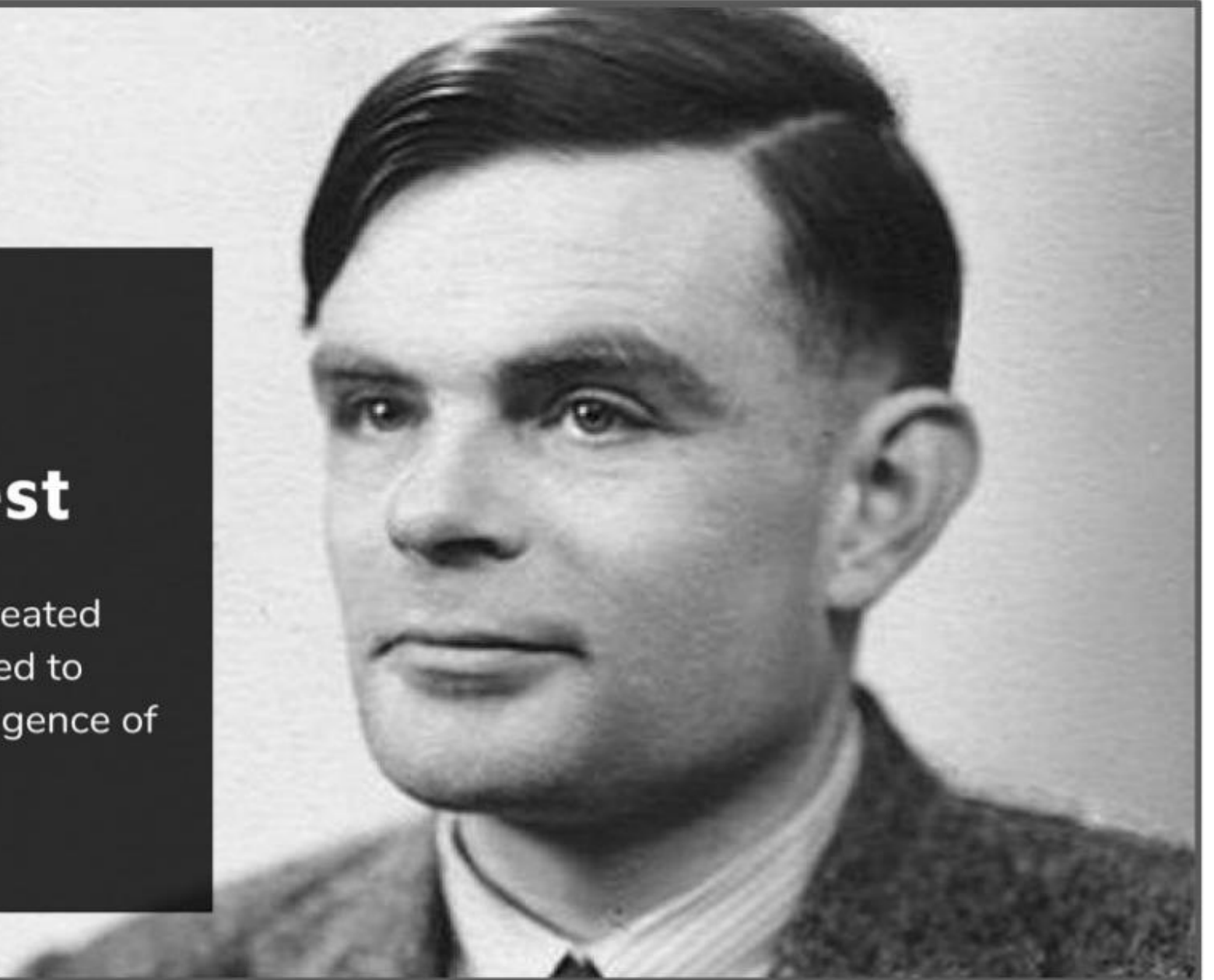
Artificial Intelligence is the development of computer systems that are able to perform tasks that would require human intelligence.

Examples of these tasks are visual perception, speech recognition, decision-making, and translation between languages.



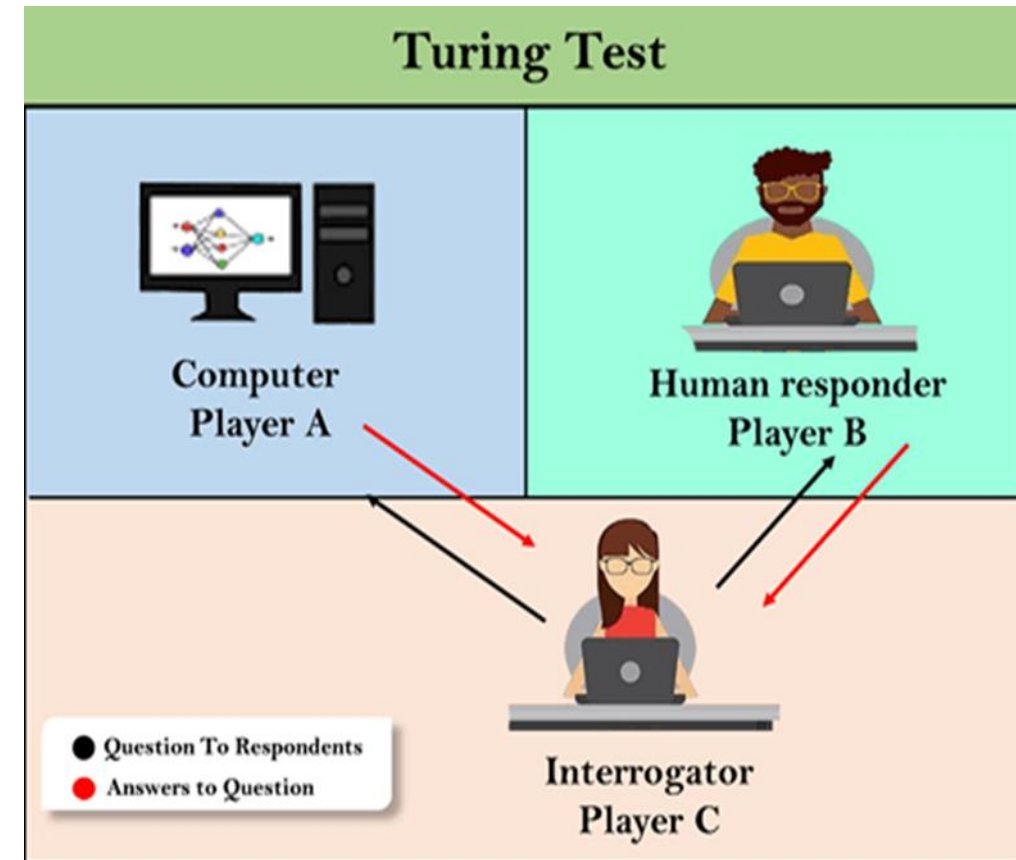
# The Turing Test

In the 1950s Alan Turing created the Turing Test which is used to determine the level of intelligence of a computer.



## 2.2 How Turing Test Work?

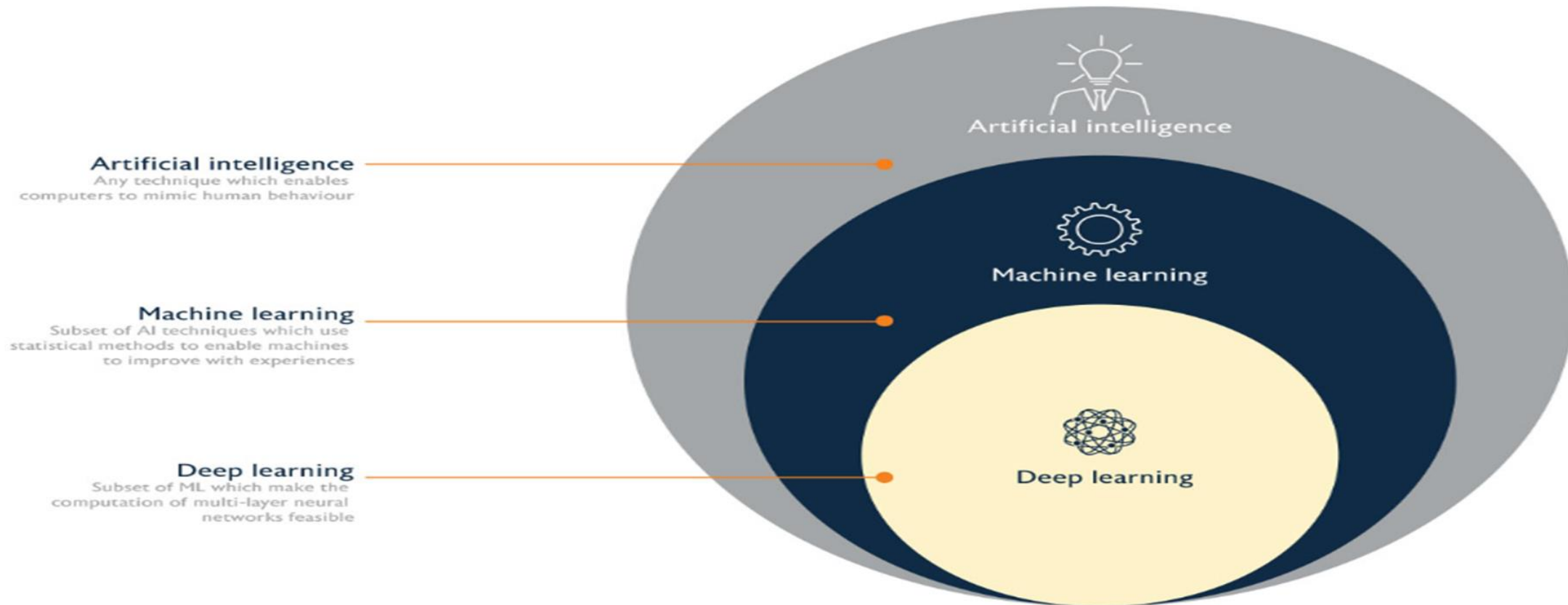
- **Interrogator:** Are you a computer?
- **Player A (Computer):** No
- **Interrogator:** Multiply two large numbers such as  $(256896489 * 456725896)$
- **Player A:** Long pause and give the wrong answer.
- In this game, if an interrogator would not be able to identify which is a machine and which is human, then the computer passes the test successfully, and the machine is said to be intelligent and can think like a human.



## 2.3 Then What really is an AI?

- Can machine achieve human like Intelligence?
  - Not till date
- **For me, AI can be any system that posses the ability of at least one characteristics of Intelligence described in slide 10.**

## 2.4 AI Universe



# 3. AI Vs. ML Vs. Data Science.

# 3. AI Vs. ML Vs. Data Science

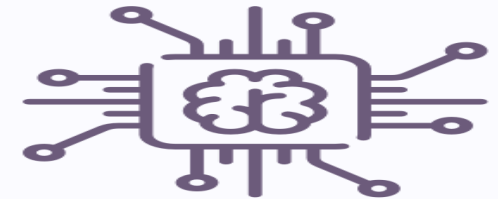
## Data Science

- based on strict analytical evidence
- deals with structured & unstructured data
- includes various data operations



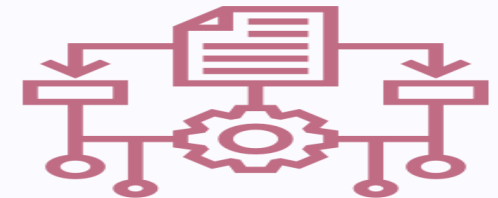
## Artificial Intelligence

- imparts human intellect to machines
- uses logic and decision trees
- includes machine learning



## Machine Learning

- subset of AI
- uses statistical models
- machines improve with experience



## 3.2 Example: Self Driving Car

- Artificial Intelligence:
  - Car should apply the brake as soon as it sees stop signs.
  - Car should be able to judge the surrounding conditions while doing so.
- Machine Learning/Deep Learning:
  - Car must be able to recognize stop signs,
  - We create a dataset of millions of image with street signs
  - Build and Train a model to recognize the signs
- Data Science:
  - Analyze the dataset and results to understand the false positives.
  - Under what conditions the brake are not correctly applied.



**When to apply for Brake?**

# 4. Machine and Deep Learning.



# 4.1 What is Machine Learning?

- How can we solve a specific problem?
  - As computer scientists we write a program that encodes a set of rules that are useful to solve the problem.
  - In many cases is very difficult to specify those rules, e.g., given a picture determine whether there is a cat in the image.



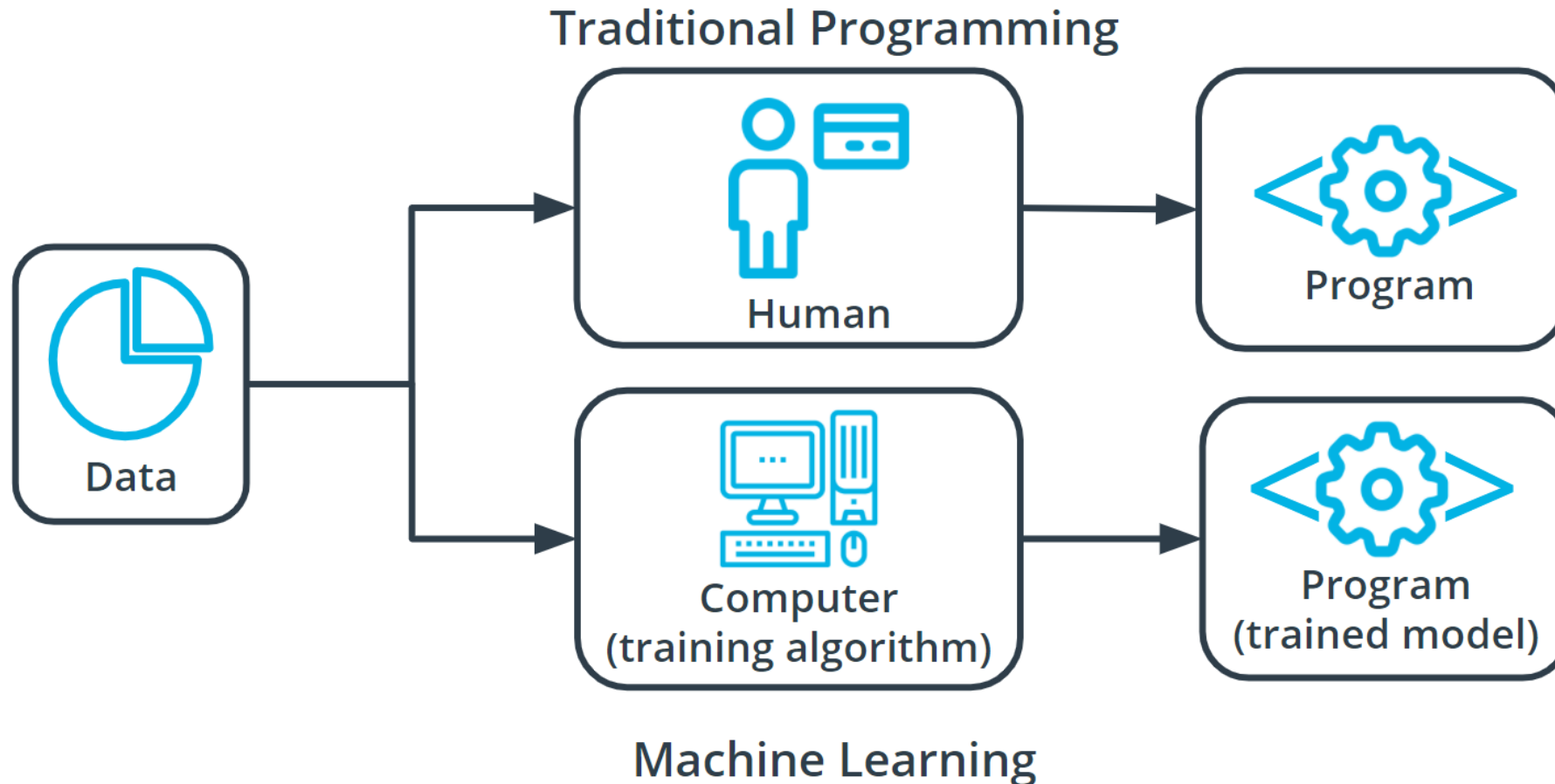
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  - In many cases is very difficult to specify those rules, e.g., given a picture determine whether there is a cat in the image.
- **Learning systems** are not directly programmed to solve a problem, instead develop own program based on
  - **Examples** of how they should behave
  - From **trial-and-error** experience trying to solve the problem
- Learning simply means incorporating information from the **examples(training)into the system.**

## 4.2 Why use Learning?

- It is very hard to write programs that solve problems like recognizing a handwritten digit
- Instead of writing a program by hand, we collect examples that specify the correct output for a given input
- A machine learning algorithm then takes these examples and produces a program that does the job
  - The program produced by the learning algorithm may look very different from a typical hand-written program. It may contain millions of numbers.
  - If we do it right, the program works for new cases as well as the ones we trained it on.

## 4.3 Machine Learning Vs. Traditional Programming.

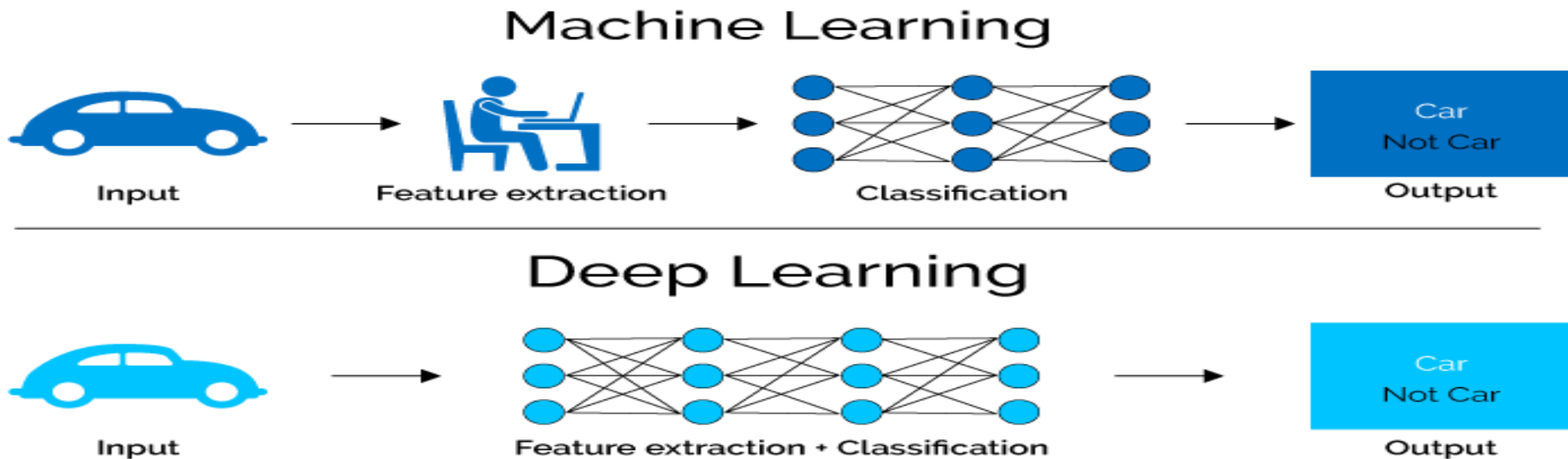


## 4.4 Machine Learning: Definition.

- “ *Field of study that gives computers the ability to learn without being explicitly programmed.* ” -- Arthur Samuel ,1959 (an AI pioneer at IBM)
- “ *A machine 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  $E$ .* ” --Mitchell, Tom. (1997)
- Machine learning is a sub-domain of artificial intelligence (AI) that utilizes **Statistics, Pattern recognition, knowledge discovery and data mining** to **automatically learn and improve with experiences without being explicitly programmed.**

## 4.5 What is Deep Learning ?

- “*Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks*”.



# **5. Machine Learning Vs. Deep Learning.**

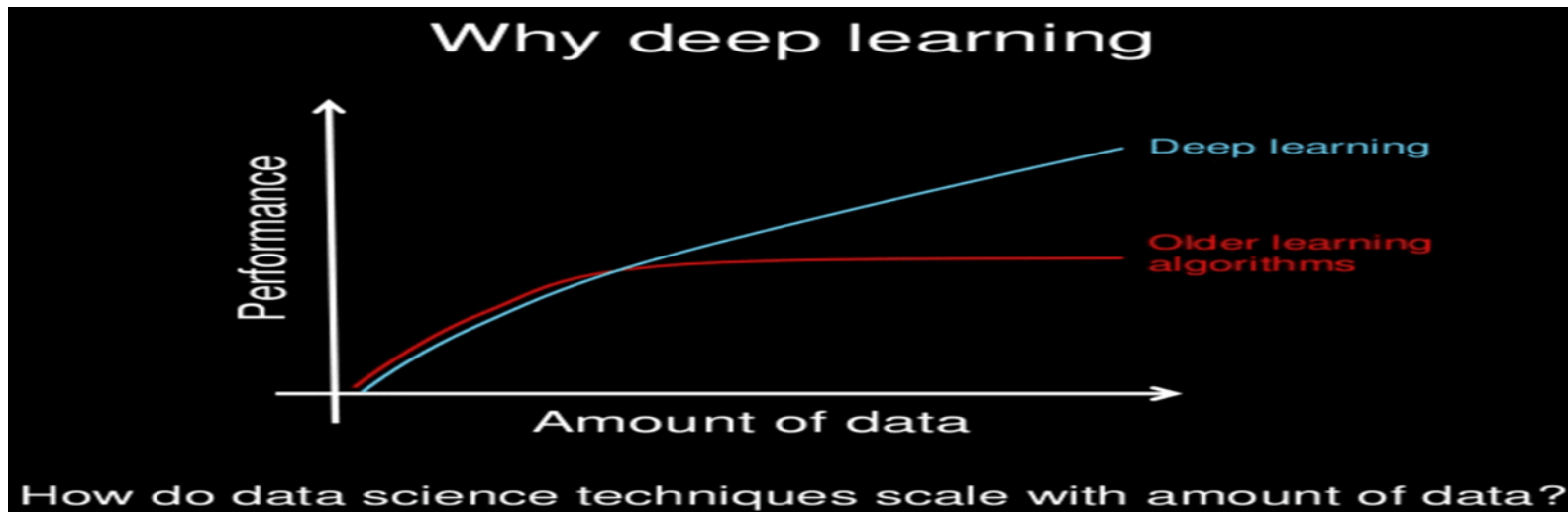
# 5.1 Data Dependency.

## Machine Learning

- machine learning works perfectly on smaller datasets.

## Deep Learning

- deep learning algorithm requires a large amount of data.





## 5.2 Hardware Dependency.

### Machine Learning

- machine learning algorithms can work on low-end machines.
- No GPU necessary...

### Deep Learning

- Deep learning algorithms are highly dependent on high-end machines
- requirement of deep learning algorithms includes GPU's which is an integral part of its working.

## 5.3 Feature Engineering.

### Machine Learning

- In the case of machine learning, most of the features are to need to be identified by an expert and then hand-coded as per the domain and data type.
- This process it's difficult and expensive in terms of time and expertise
- The performance of machine learning depends upon how accurately features are identified and extracted.

### Deep Learning

- it tries to learn high-level features from the data and because of this, it makes ahead of machine learning.

## 5.4 Problem Solving Approach.

### Machine Learning

- When we solve the problem using machine learning, its recommended that break down the problem into subparts first, solve them individually and then combine them to get the final result.

### Deep Learning

- deep learning, it solves the problem end to end.

# 5.5 Execution Time.

## Machine Learning

- machine learning the training time is relatively less as compared to deep learning.

## Deep Learning

- Deep learning algorithms take a lot of time to train.
- During testing/Execution deep learning algorithms takes very less time to run.

# Break.



00:09:59

## 6. Tasks that requires Machine Learning.

- What makes a 2?
- What distinguishes a 2 from 7?



# 6.1 Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is

# Examples of Classification

- Am I going to pass the exam?
- Do I have diabetes?





# Some Tasks that uses Learning Algorithms

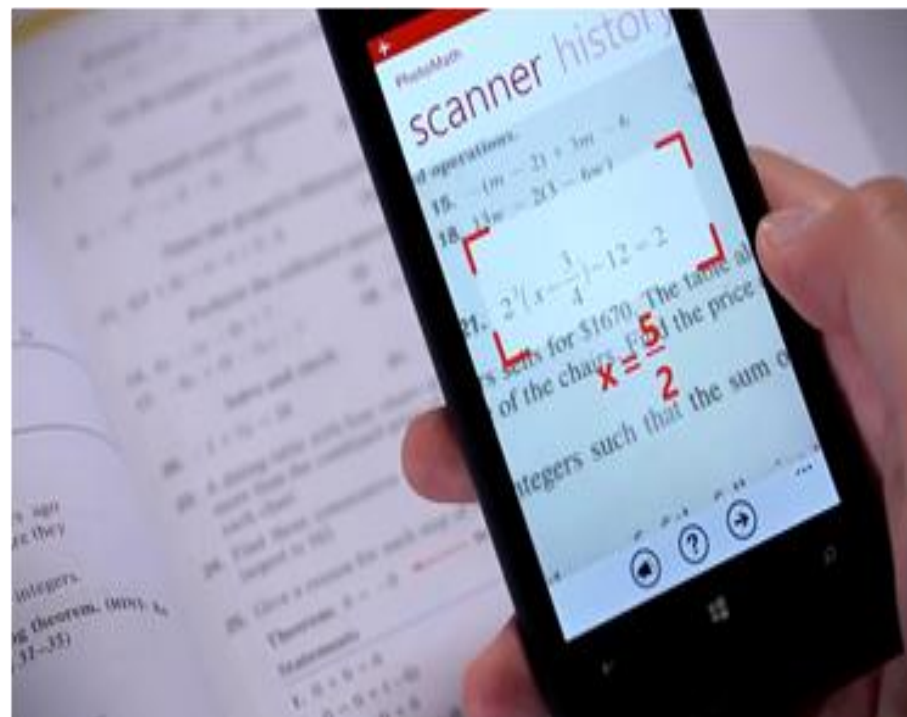
1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.

# Examples of Recognizing Patterns

- Siri



- Photomath

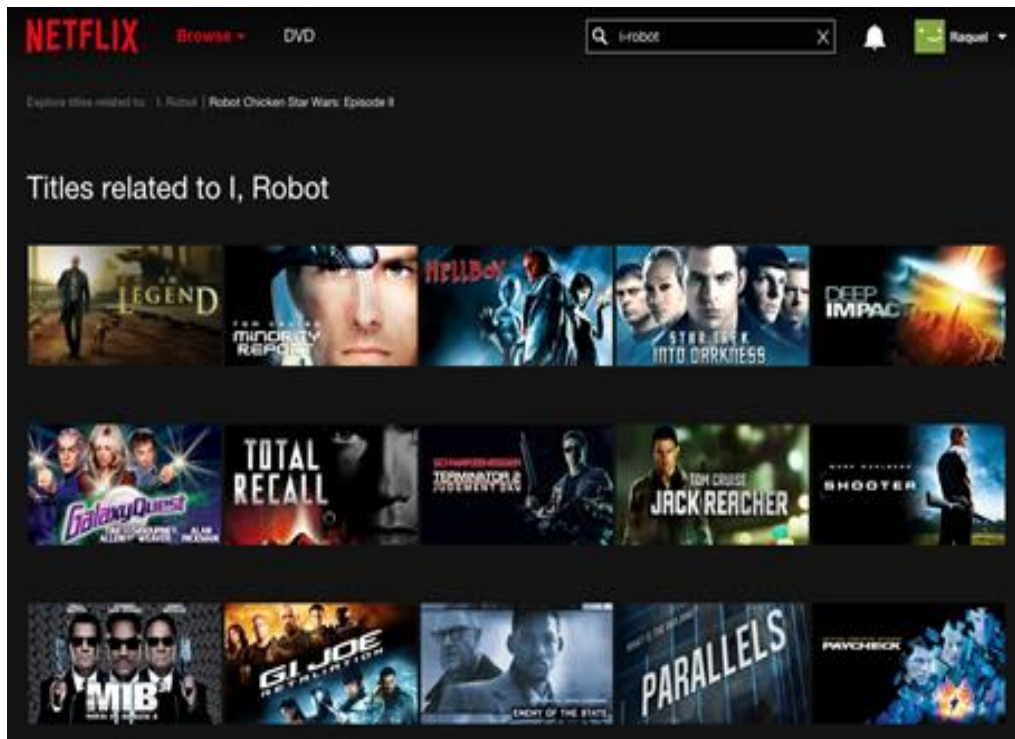


# Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.
3. Recommender Systems: Amazon, Netflix

# Examples of Recommendation system

- Netflix



- Amazon



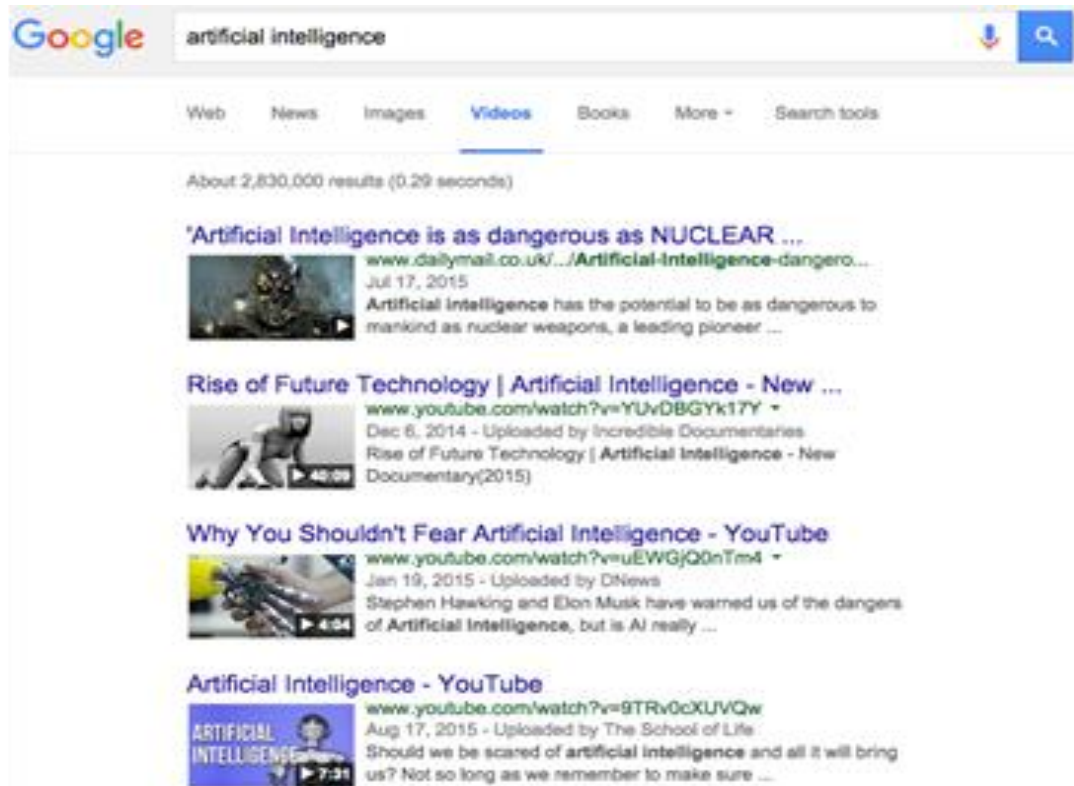
# Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.
3. Recommender Systems: Amazon, Netflix etc
4. Information Retrieval system: Find Documents or images with similar content

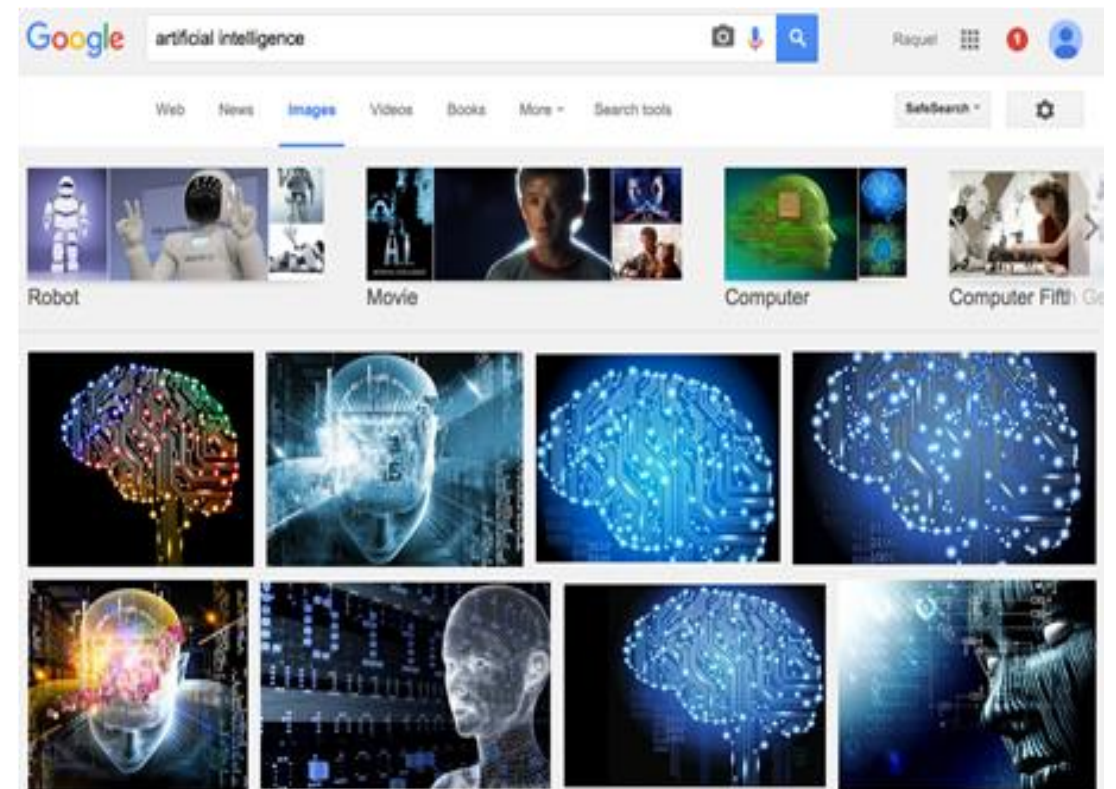


# Examples of Information Retrieval

- Google text Search



- Google Image Search



# Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.
3. Recommender Systems: Amazon, Netflix etc.
4. Information Retrieval system: Find Documents or images with similar content
5. Computer Vision: detection, segmentation, depth estimation, optical flow, etc.

# Examples of Computer Vision

- Segmentation



- Image Inpainting





# Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.
3. Recommender Systems: Amazon, Netflix etc.
4. Information Retrieval system: Find Documents or images with similar content
5. Computer Vision: detection, segmentation, depth estimation, optical flow, etc.
6. Robotics: Autonomous Driving etc.

# Examples of Robotics

- Self driving Car



- Drone/UAV



# Some Tasks that uses Learning Algorithms

1. Classification: Determine which discrete category the example is
2. Recognizing Patterns: Speech Recognition, facial identification etc.
3. Recommender Systems: Amazon, Netflix etc.
4. Information Retrieval system: Find Documents or images with similar content
5. Computer Vision: detection, segmentation, depth estimation, optical flow, etc.
6. Robotics: Autonomous Driving etc.
7. Learning to play games
8. Recognizing anomalies
9. Spam filtering, fraud detection
10. Many More!!!!

# 7. Types of Learning Task.

**Supervised Learning**

**Unsupervised Learning**

**Reinforcement Learning**

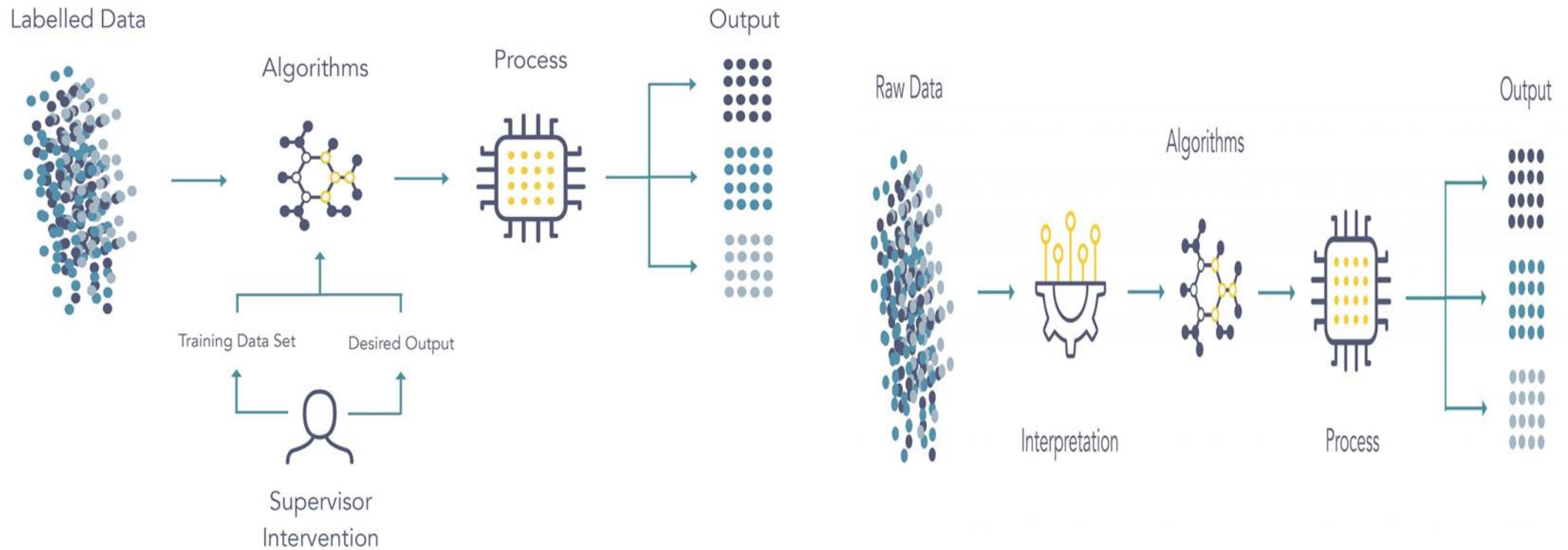
# 7.1 Supervised Machine Learning.

- use of labeled datasets to train algorithms that to classify data or predict outcomes accurately.
- input data is fed into the model, it adjusts its weights until the model has been fitted appropriately.
- Some methods used in supervised learning include neural networks, naïve Bayes, linear regression, logistic regression, random forest, support vector machine (SVM), and more.
- solve for a variety of real-world problems at scale, such as classifying spam in a separate folder from your inbox.

## 7.2 Unsupervised Machine Learning.

- uses machine learning algorithms to analyze and cluster unlabeled datasets
- discover hidden patterns or data groupings without the need for human intervention.
- ideal solution for exploratory data analysis, cross-selling strategies, customer segmentation, image and pattern recognition
- Some methods used in Unsupervised learning include principal component analysis (PCA), singular value decomposition (SVD), k-means clustering and more

# Supervised vs. Unsupervised Learning

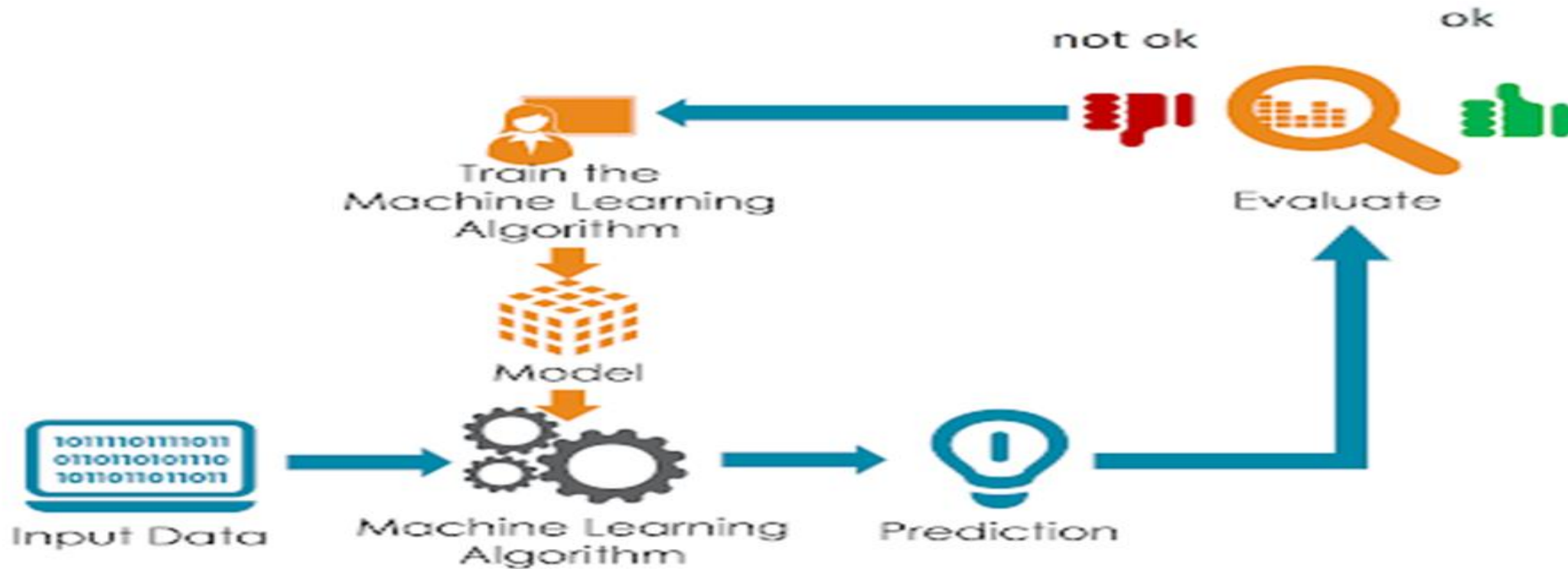


# 7.3 How ML/DL Algorithm Works?

- **A Decision Process/Function Representation:**
  - machine learning algorithms are used to make a prediction or classification.
  - Based on some input data, which can be labelled or unlabeled,
  - algorithm will produce an estimate about a pattern in the data.
- **An Error Function/Evaluation:**
  - serves to evaluate the prediction/classification of the model.
  - For labelled data, an error function can make a comparison to assess the accuracy of the model.
- **An Model Optimization Process:**
  - to reduce the discrepancy between the known example and the model estimate.
  - The algorithm will repeat this evaluate and optimize process, updating weights autonomously until a threshold of accuracy has been met.



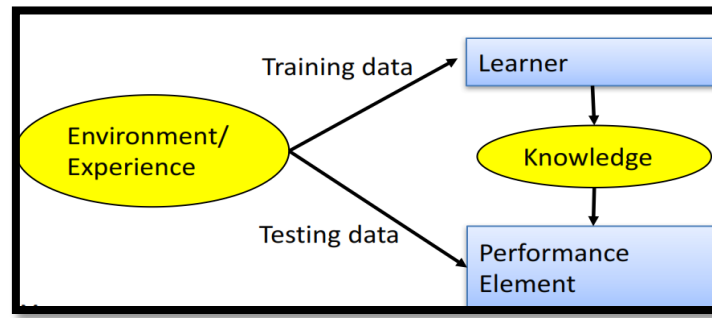
## 6.3.1 How ML/DL Algorithm Works?



# 7. Framing a Learning Problem.

# 7.1 Designing a Learning System.

- Chose the training experience.
- Choose exactly what is to be learned.
  - target function
- Choose how to represent the target function.
- Choose a learning algorithm to infer the target function from the experience.



## 7.2 Various Function Representations.

- Numerical Functions:
  - Linear Regression
  - Neural Network
- Symbolic Functions:
  - Decision Trees
- Instance-based functions(distance):
  - NN methods
  - Case based

# 7.3 Optimization Process and Evaluation.


## Optimization

- Gradient Descent:
  - Perceptron
  - Back-propagation
- Divide and Conquer:
  - Decision tree induction
  - Rule learning
- And Many more....

## Evaluation

- Accuracy
- Precision and recall
- Likelihood
- Squared Error
- And many more..

## 7.4 ML in Practice.

- 
- Understand domain-(prior knowledge).
  - Data Understanding.
  - Learn Models.
  - Interpret results.
  - Consolidate and deploy discovered knowledge.

# Tutorial and Workshops

- In Tutorial:
  - Data and Data Pre-processing.
- Workshop:
  - Coding.

# At the end.....

- Now you are qualified to distinguish between AI and Non AI!!!!
- Questions?

