Machine LEARNING

Introduction

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Meet the teacher

- **Dr. Imran Khalil**
  - **Assistant Professor**
  - **Post Graduate Advisor**
  - **Associate Head of Department**
- BS (Information Technology) – 2002
- MBA (HR) – 2006
- MS (Computer Networks) – 2008
- Ph.D. (Theoretical Computer Sciences) – 2020
  Energy Efficient Algorithms
- Research Areas
  - Energy Efficient Algorithms
  - Machine Learning, Deep Learning
  - Optimization
  - Geographical Load Balancing
  - Geographically distributed Data Centers
  - Cloud Computing

Contents

- What is machine learning?
- Types of Machine learning
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  - Unsupervised learning
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- Class policy
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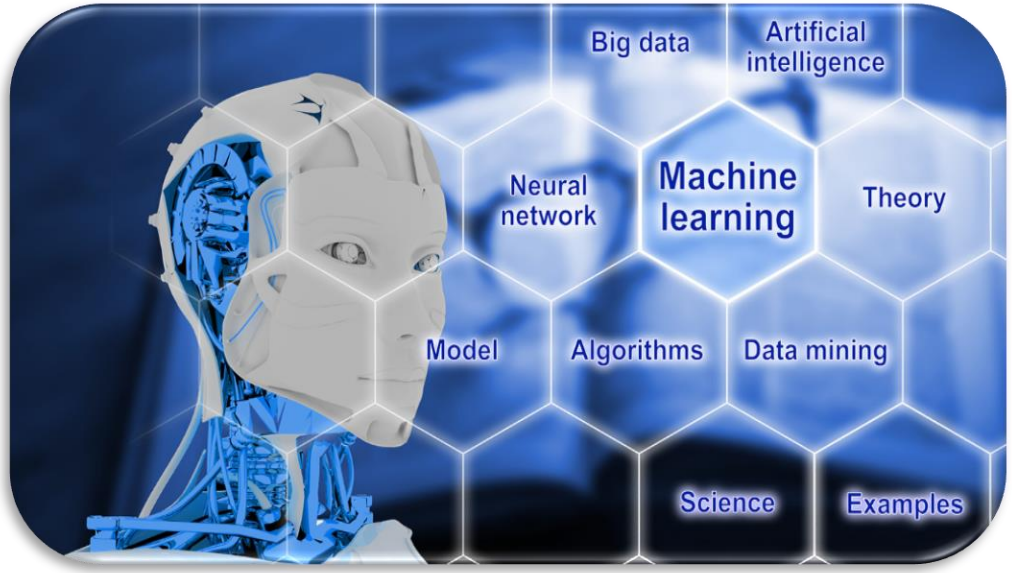
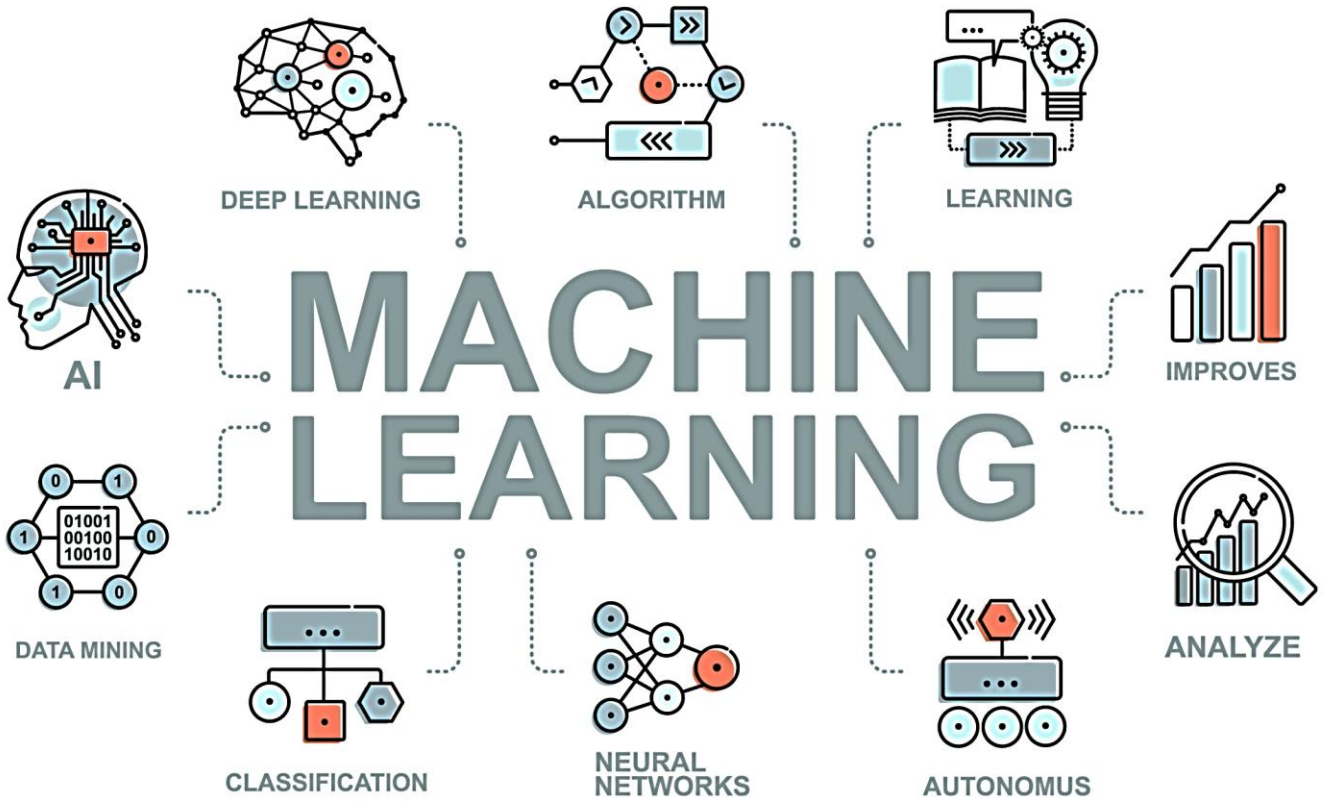
- Recommended Books



What is Machine Learning?



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Veg Dum **Biryani** Recipe |

The only Chicken **Biryani**

Vegetable **Biryani** | वेज

Biryani is a mixed rice dish originating among the Muslims of South Asia. It is made with Indian spices, vegetables, rice, and usually some type of meat, or in some cases without any meat, and sometime... +

Wikipedia

Alternative names Biriyani, biriani, beriani, briyani, bre... +

Course Main dish

Region or state South Asia, Western Asia, Central Asi... +

Serving temperature Hot

See more


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Local results for show me some pakistani restaurants in belgium

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Punjab Tandoori Cuisine

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Indian · €€

Closed · Opens at noon

Sawad

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Opens in 1

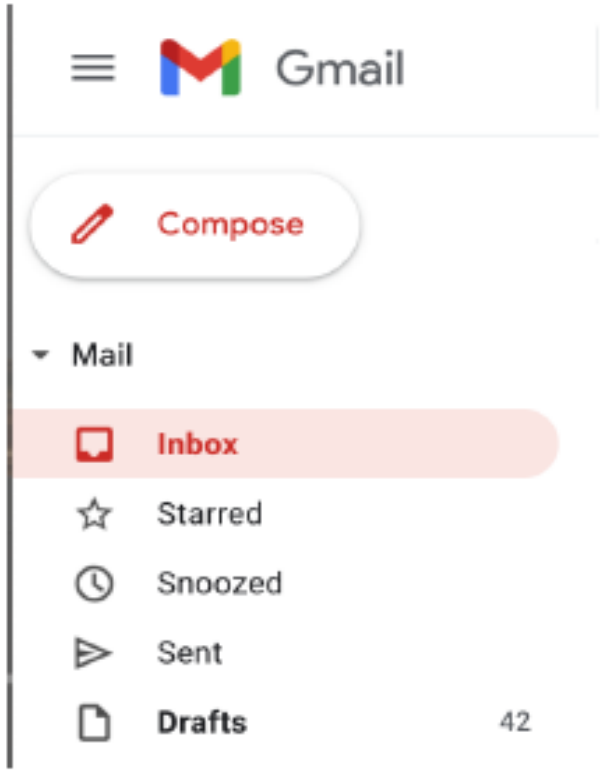
Including results for show me some pakistani **restaurants** in belgium.

Do you want results only for show me some pakistani rastaurants in belgium?

THE BEST Restaurants in Belgium (Updated July 2023) - Tripadvisor

https://www.tripadvisor.com/Restaurants-g188634

Web Best Dining in **Belgium**: See 1,747,392 **Tripadvisor** traveler reviews of 26,503 **Belgium**



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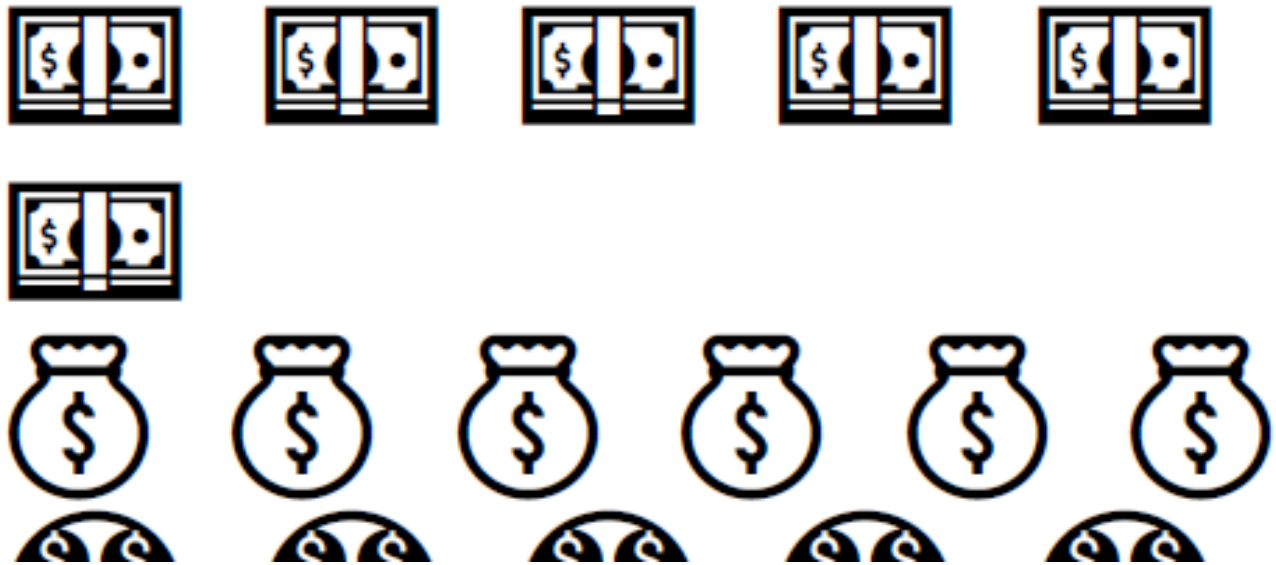


1

A wind turbine converts wind into power

2

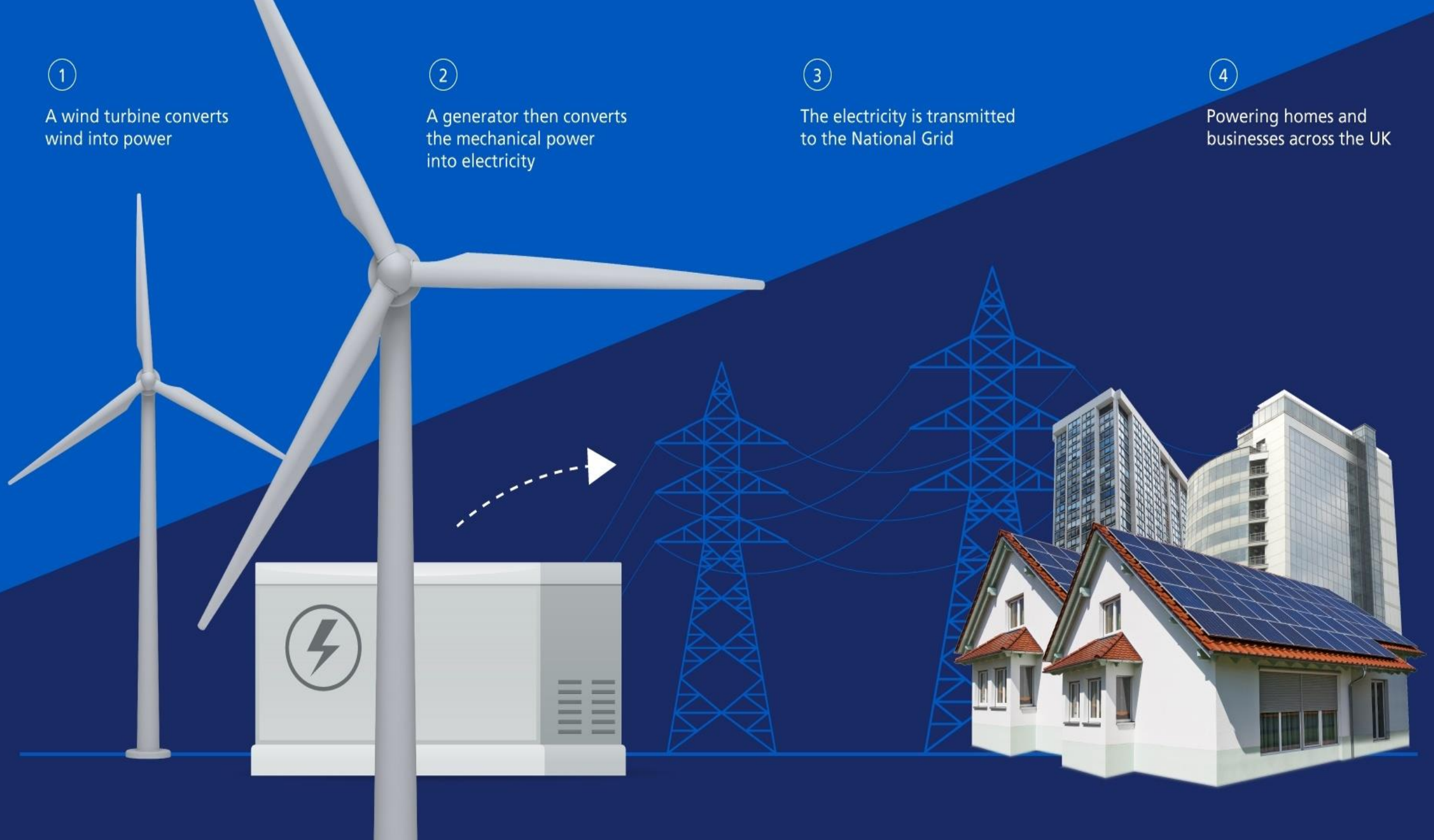
A generator then converts the mechanical power into electricity

3

The electricity is transmitted to the National Grid

4

Powering homes and businesses across the UK

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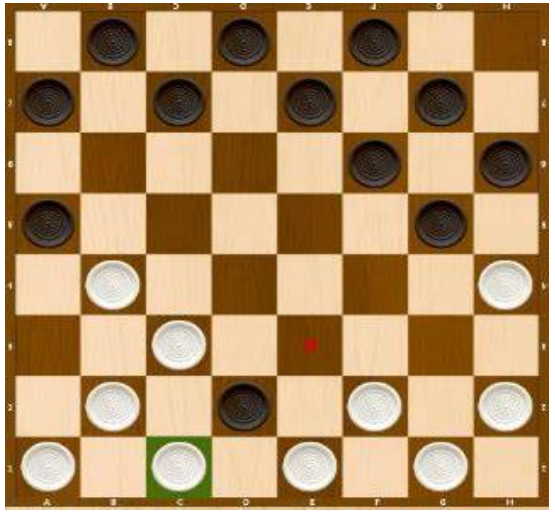
SEARCH

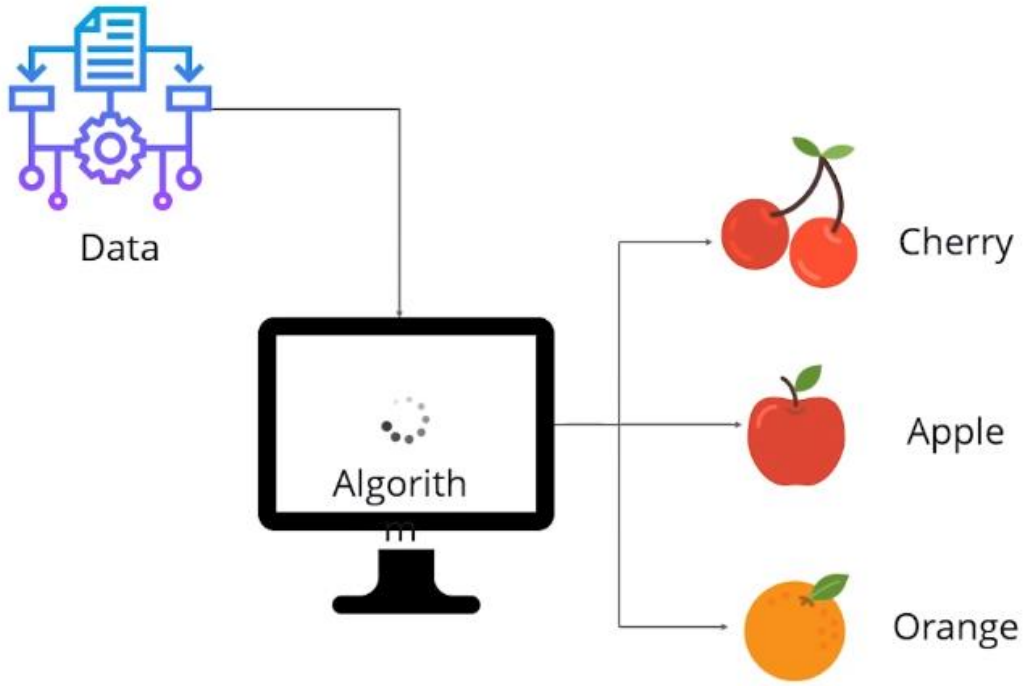
What is Machine Learning?

Field of study that gives computers the ability to learn without being explicitly programmed.

Arthur Samuel (1959)



What is Machine Learning?



ML is a subset of AI which provides machines the ability to learn automatically & improve from experience without being explicitly programmed.

Questions

If the checkers program had been allowed to play only ten games (instead of tens of thousands) against itself, a much smaller number of games, how would this have affected its performance?

- Would have made it better
- Would have made it worse

Types of Machine Learning

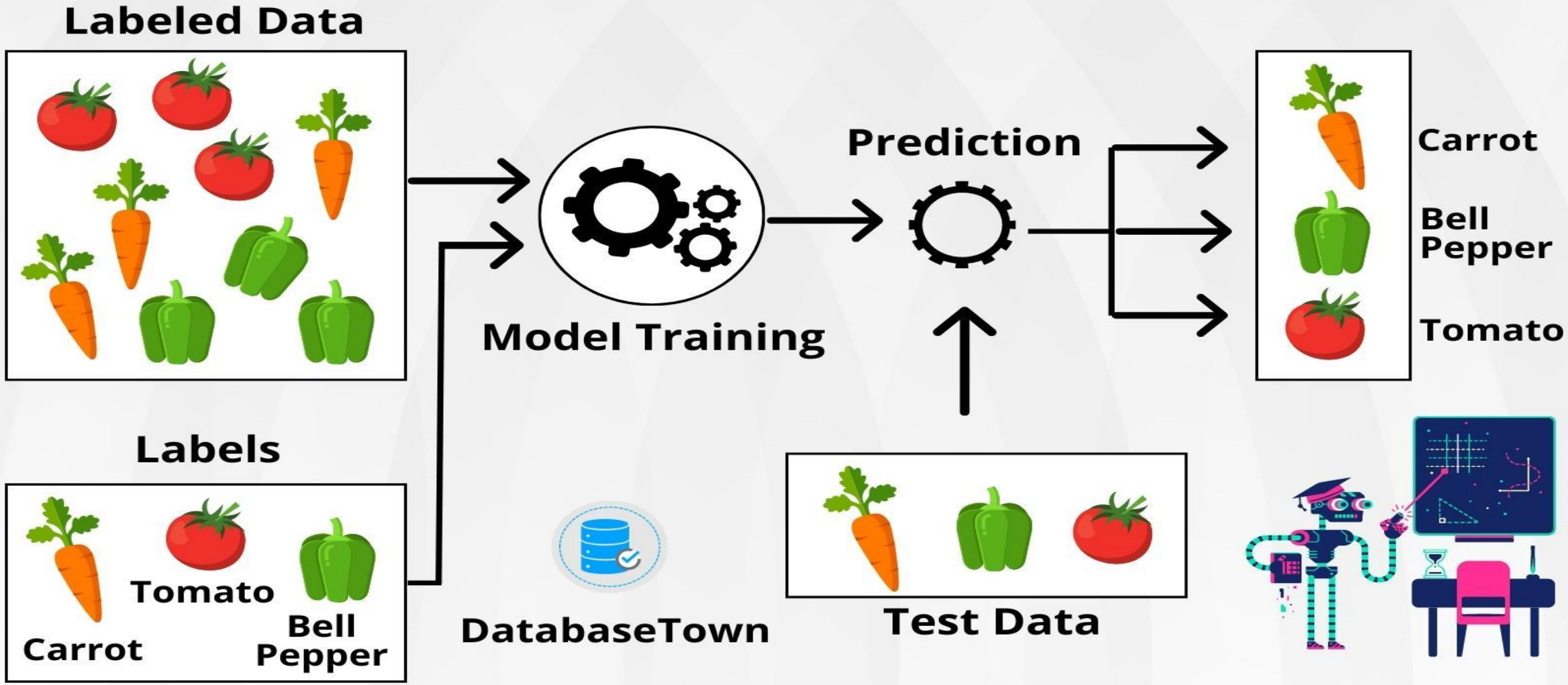
Supervised Learning

Unsupervised Learning

Reinforcement Learning

SUPERVISED LEARNING

Supervised machine learning is a branch of artificial intelligence that focuses on training models to make predictions or decisions based on labeled training data.



Supervised Learning

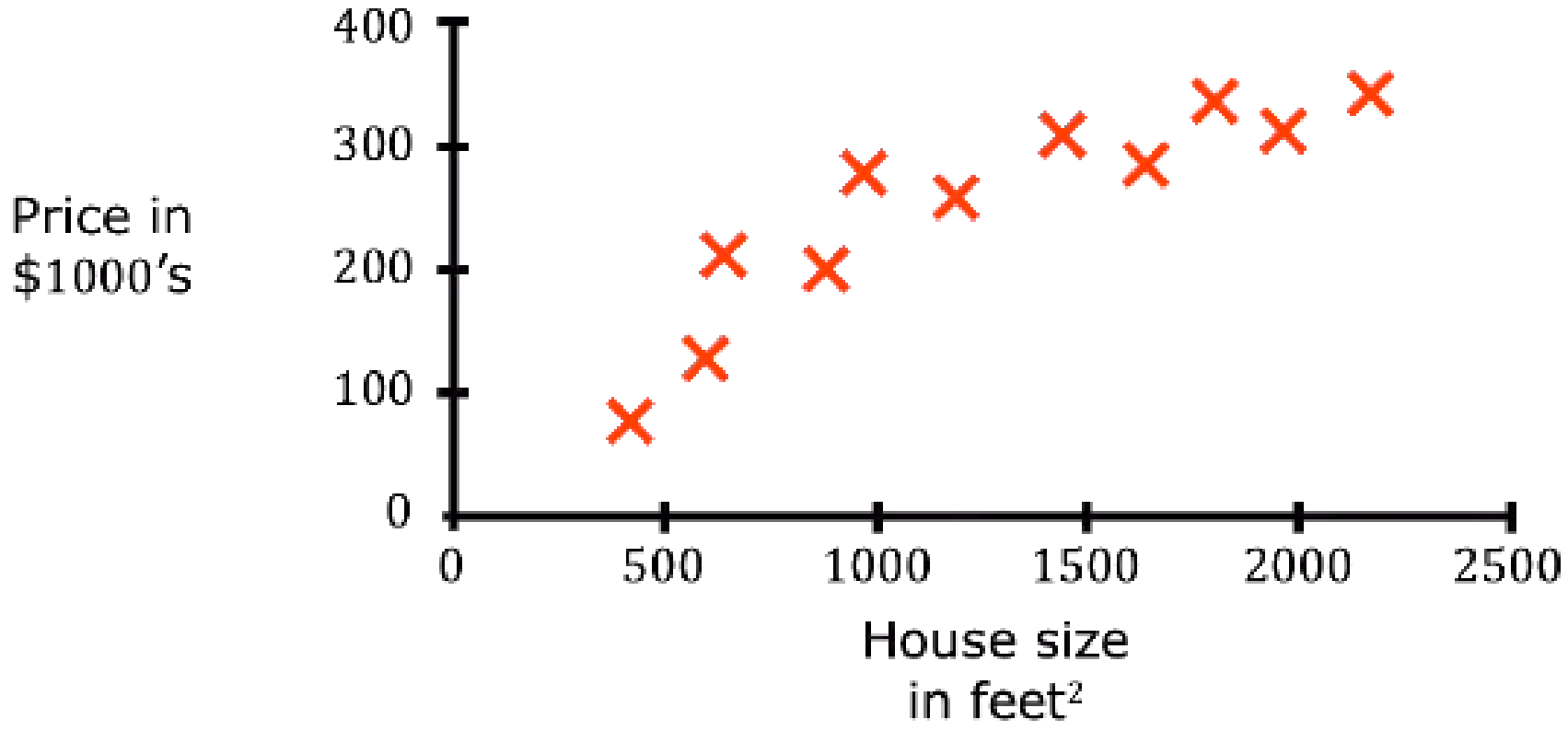
x y

Input Output Label

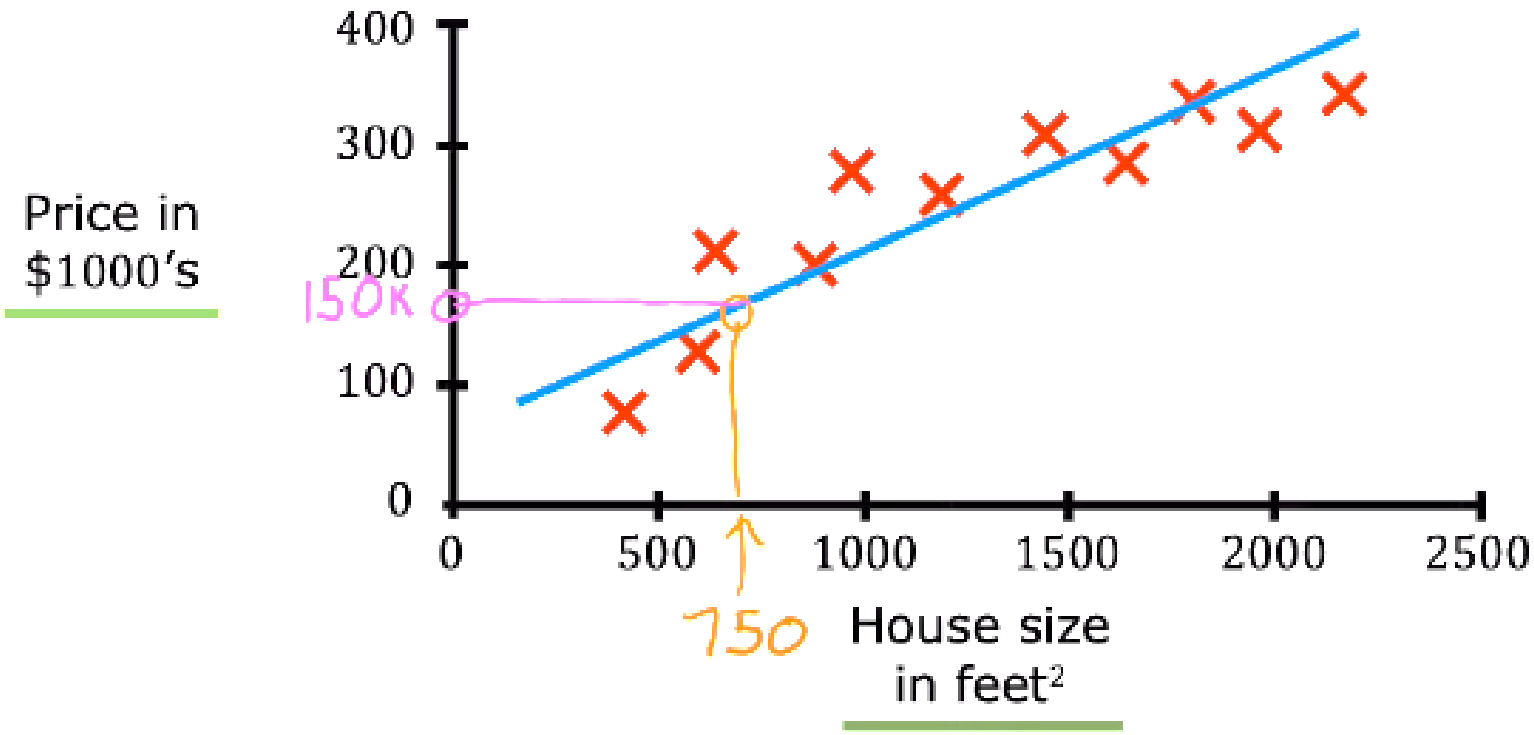
Learns from being given "right answer"

Input (x)	Output (y)	Applications
email	Spam?(0/1)	Spam filtering
Audio clip	Text transcripts	Speech recognitions
English	Urdu	Machine translation
Ad, user info	Click? (0/1)	Online advertising
Image, radar info.	Position of other cars	Self driving car
Image of phone	Defect (0/1)	Visual inspection

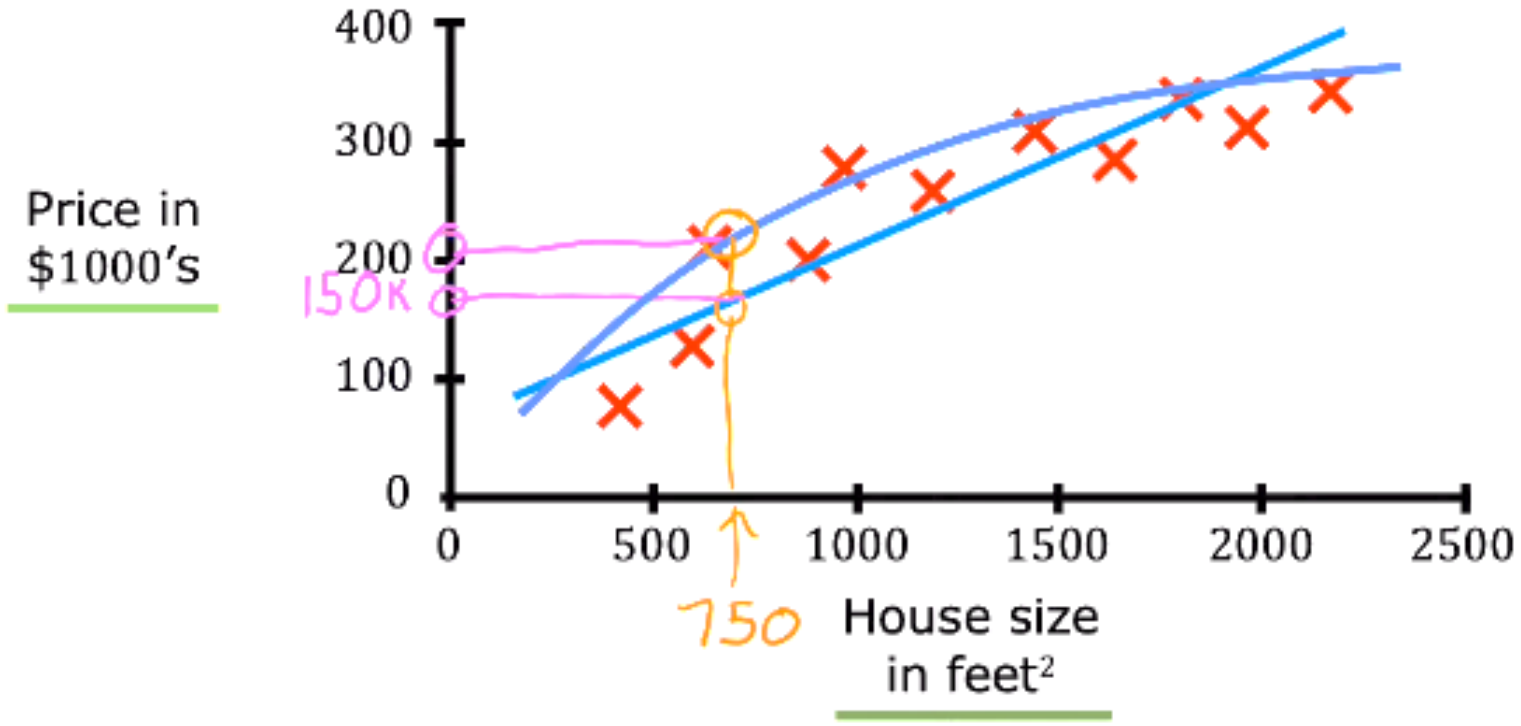
Regression: Housing Price Prediction



Regression: Housing Price Prediction



Regression: Housing Price Prediction

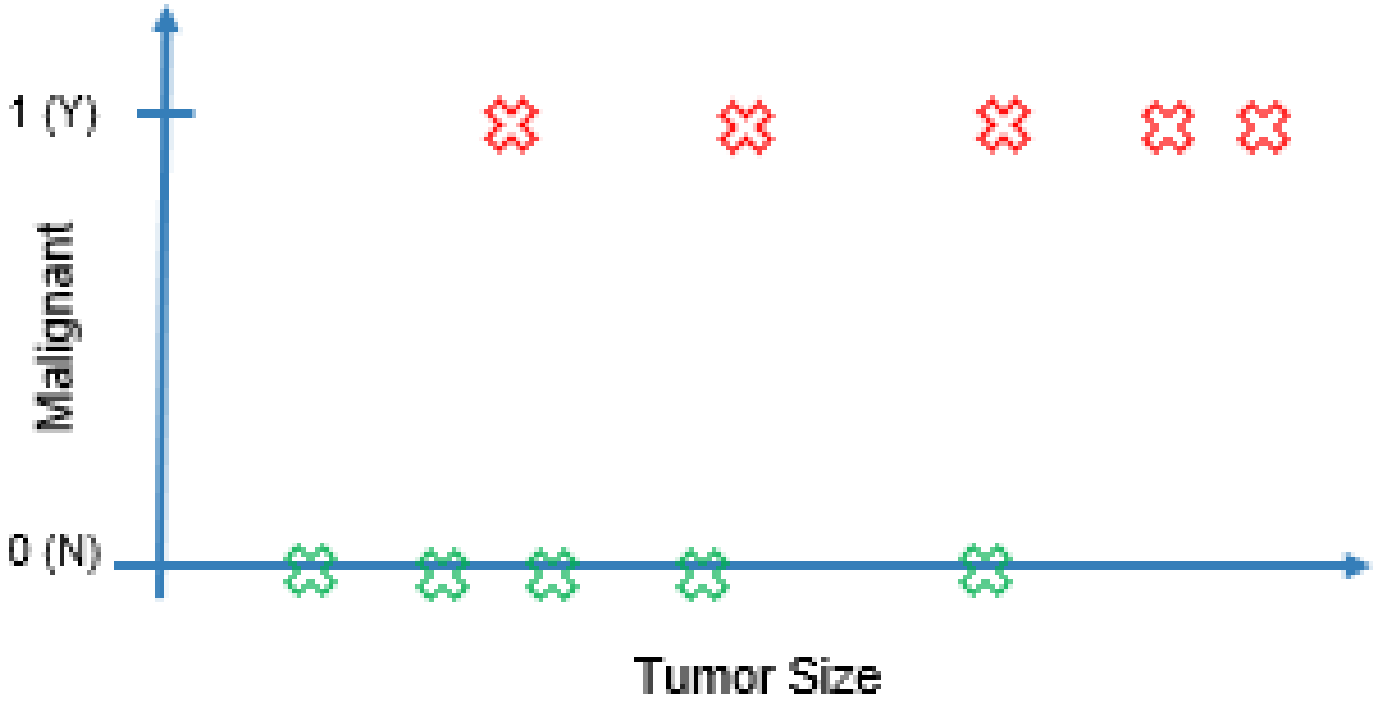


Supervised Learning

- **Given**
  - Data set of houses
  - For each house, given correct size and price
- **Objective**
  - For an unseen size of the house, what is the price?
- **Also called a "Regression Problem"**
  - Predict continuous valued output (Price)

Regression predict a number infinitely many possible outputs

Classification: Cancer Detection



Machine Learning Question

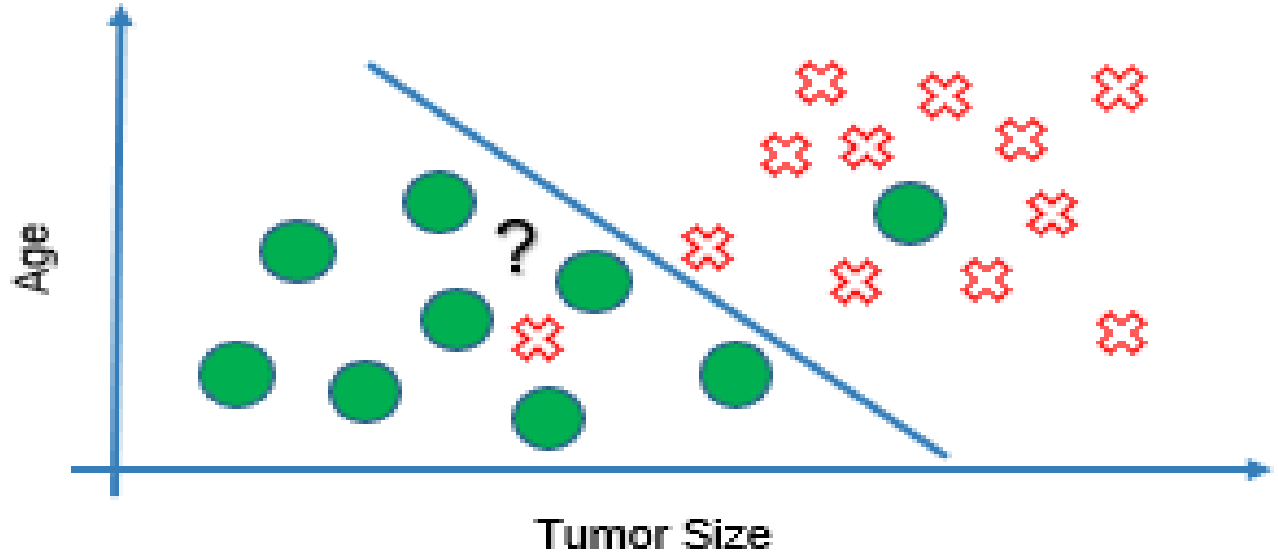
Given the tumor size, what is the probability that the tumor is malignant?

Supervised Learning

- **Machine Learning Question**
  - Given the tumor size, what is the probability that the tumor is malignant or benign?
- **Classification Problem**
  - Discrete Valued Output (0 or 1)
- **In classification problem, can have**
  - A discrete number of possible values for the output
  - 0: Benign
  - 1: Type 1
  - 2: Type 2
  - 3: Type 3

Classification predict categories of small number (finite) of possible outputs

Classification: Cancer Detection - Two or more features



- **Other attributes can also be added**
  - **Thickness of the tumor**
  - **Uniformity of cell size**
  - **Uniformity of cell shape, etc.**
- **More features can be added**

Supervised Learning

Learns from being given "right answers"

Regression

Predict a number

infinitely many possible outputs

Classification

predict categories

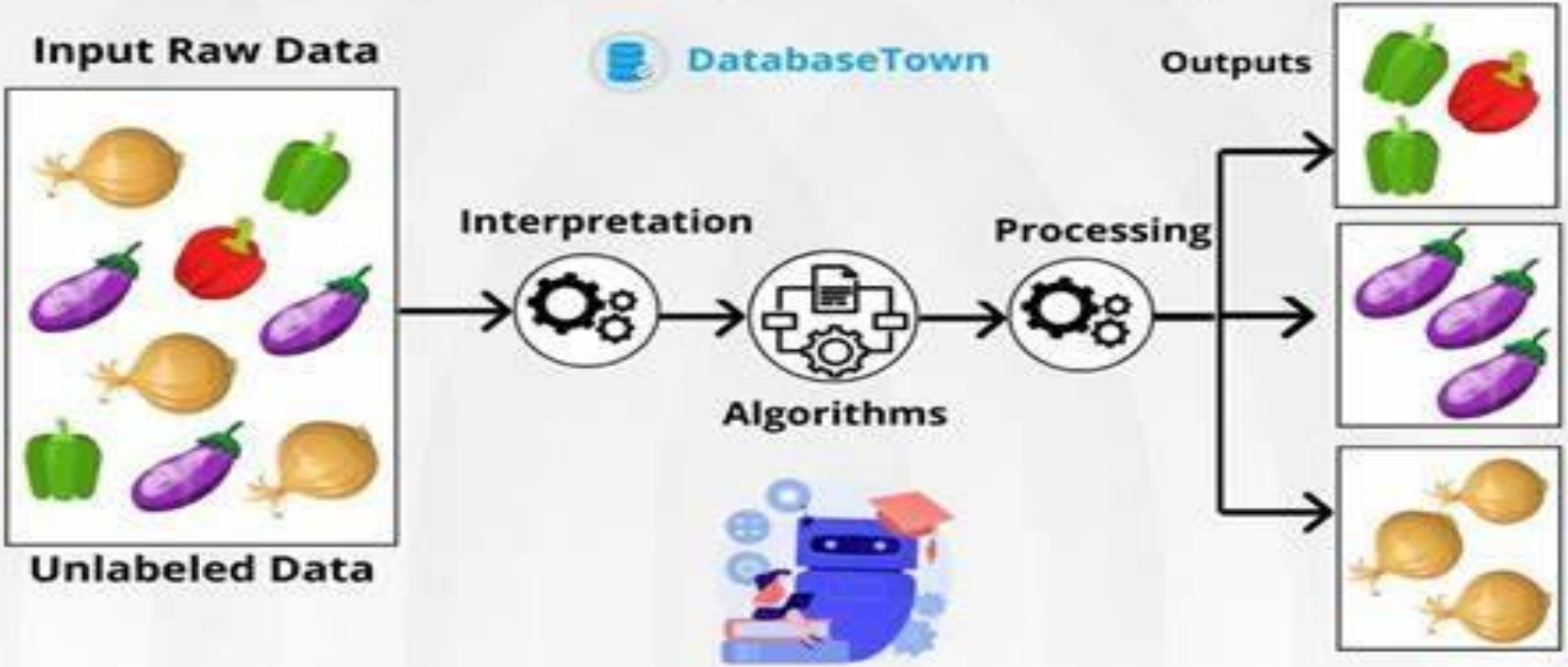
small number of possible outputs

Question

- You are running a company, and you want to develop learning algorithm to address each of two problems
  1. You have a large inventory of identical items. You want to predict how many of these items will sell over the next 3 months.
  2. You'd like software to examine individual customer accounts, and for each account decide if it has been hacked/compromised.
- Should you treat these as classification or as regression problems?

UNSUPERVISED LEARNING

Unsupervised learning is a type of machine learning where the algorithm learns from unlabeled data without any predefined outputs or target variables.



Unsupervised Learning

iris setosa

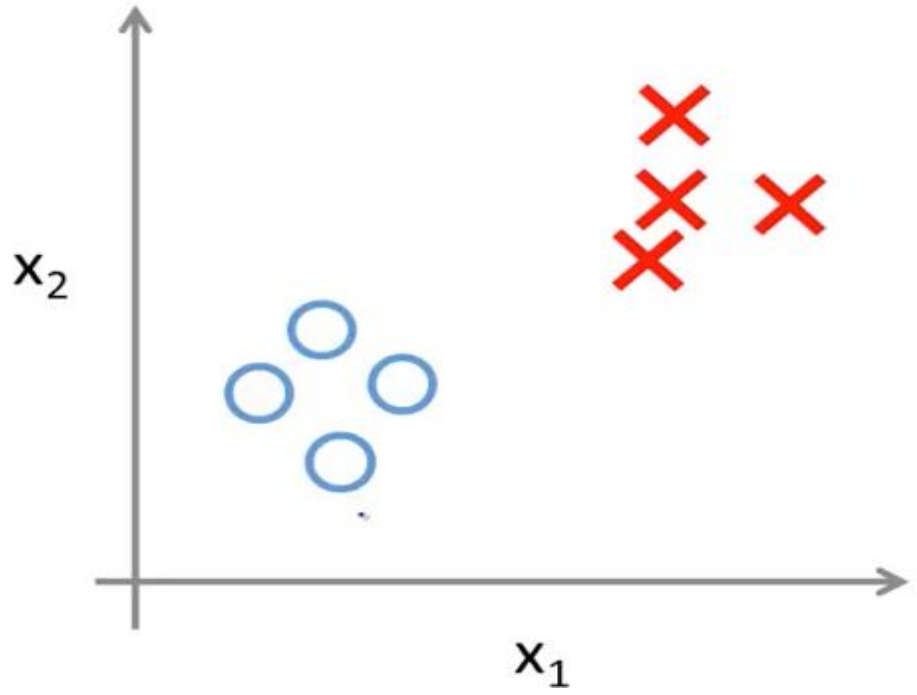
iris versicolor

iris virginica

Iris unlabelled dataset

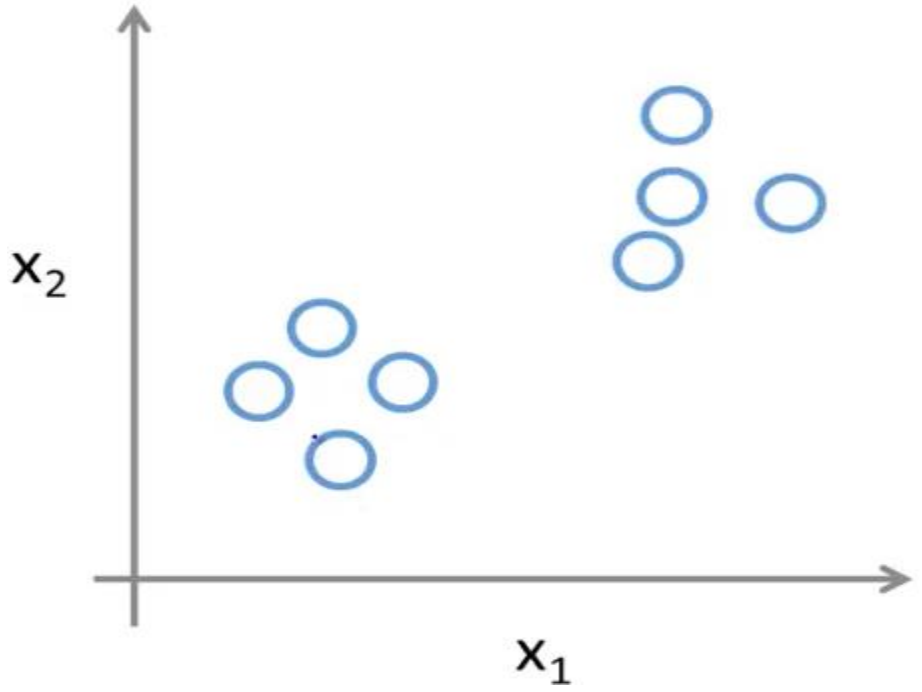
	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2
...	...	...	...	...
145	6.7	3.0	5.2	2.3
146	6.3	2.5	5.0	1.9
147	6.5	3.0	5.2	2.0
148	6.2	3.4	5.4	2.3
149	5.9	3.0	5.1	1.8

Unsupervised Learning



Supervised learning learn from data labeled with the “right answers”

Unsupervised Learning

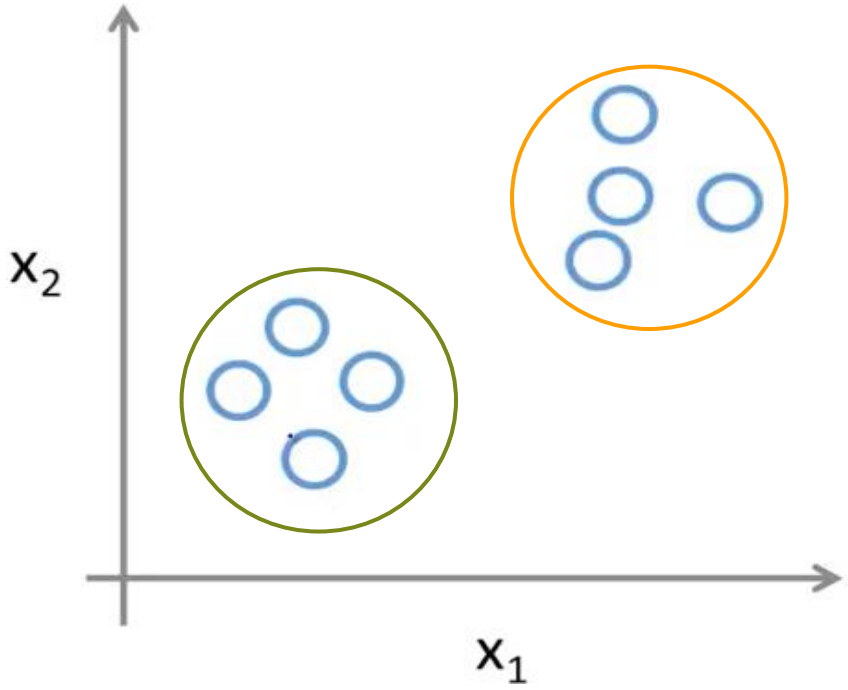


Unsupervised learning find something interesting in unlabeled data.

Unsupervised Learning

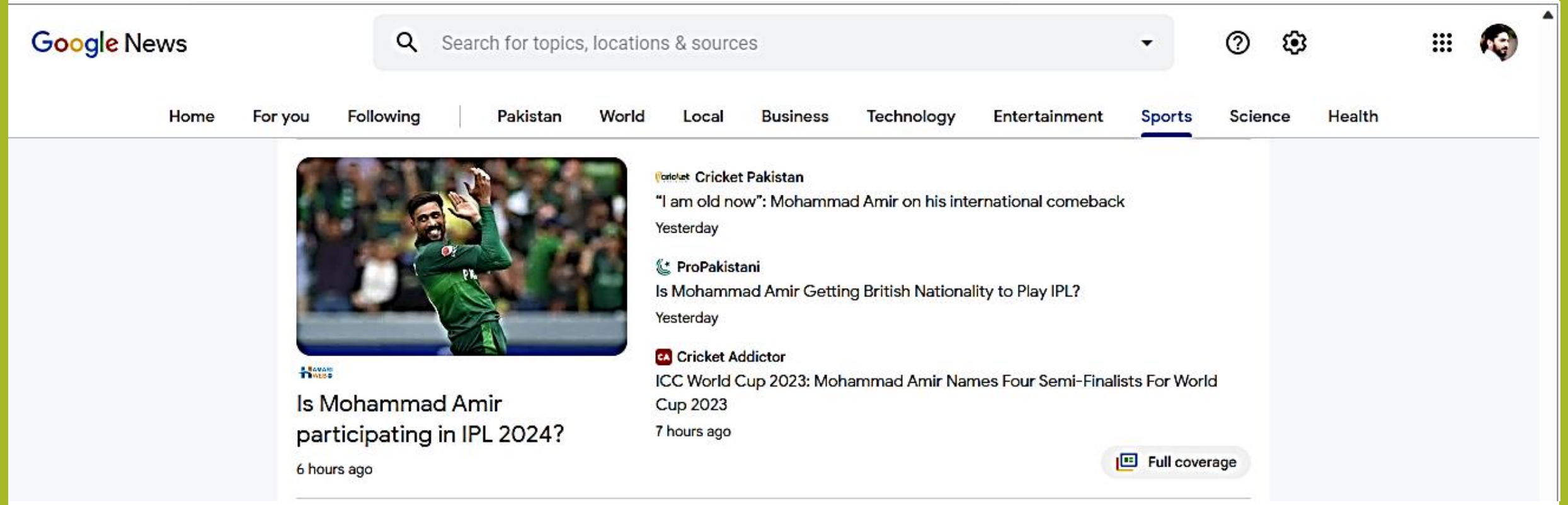
- **Given**
  - A data set
  - No information about the structure or output
- **Output**
  - Find structure in the data
- **Unsupervised learning algorithm**
  - Decide on the structure of the data

Unsupervised Learning



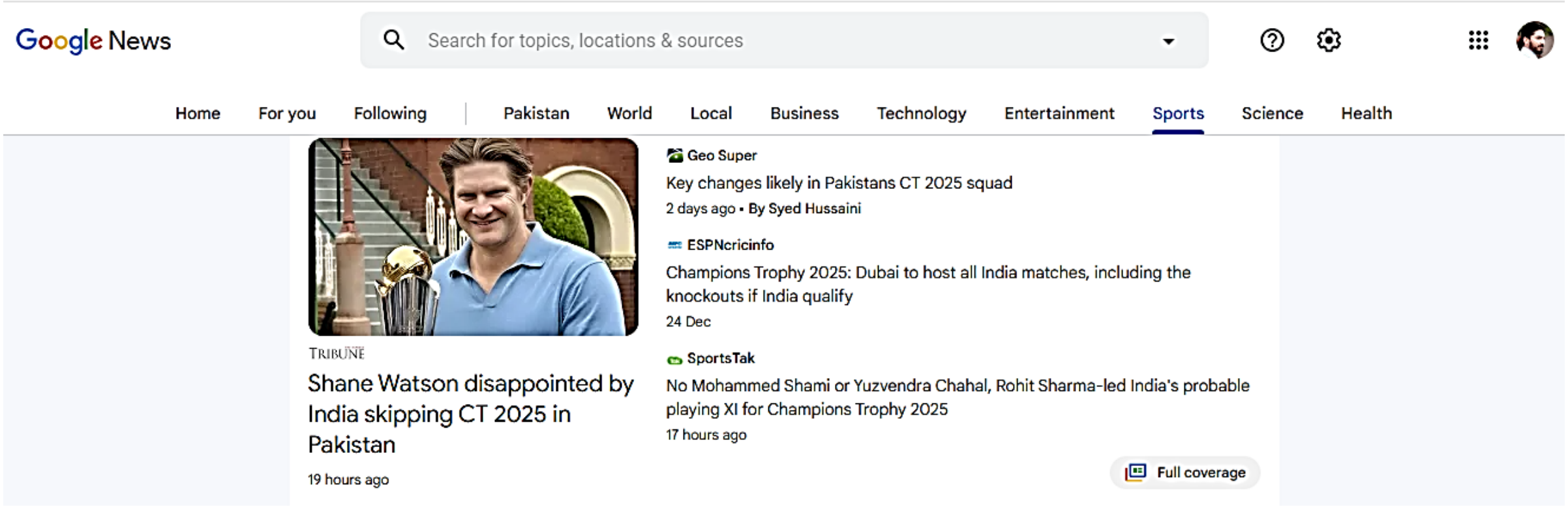
The unsupervised learning clusters the data in two groups

Unsupervised Learning - Clustering



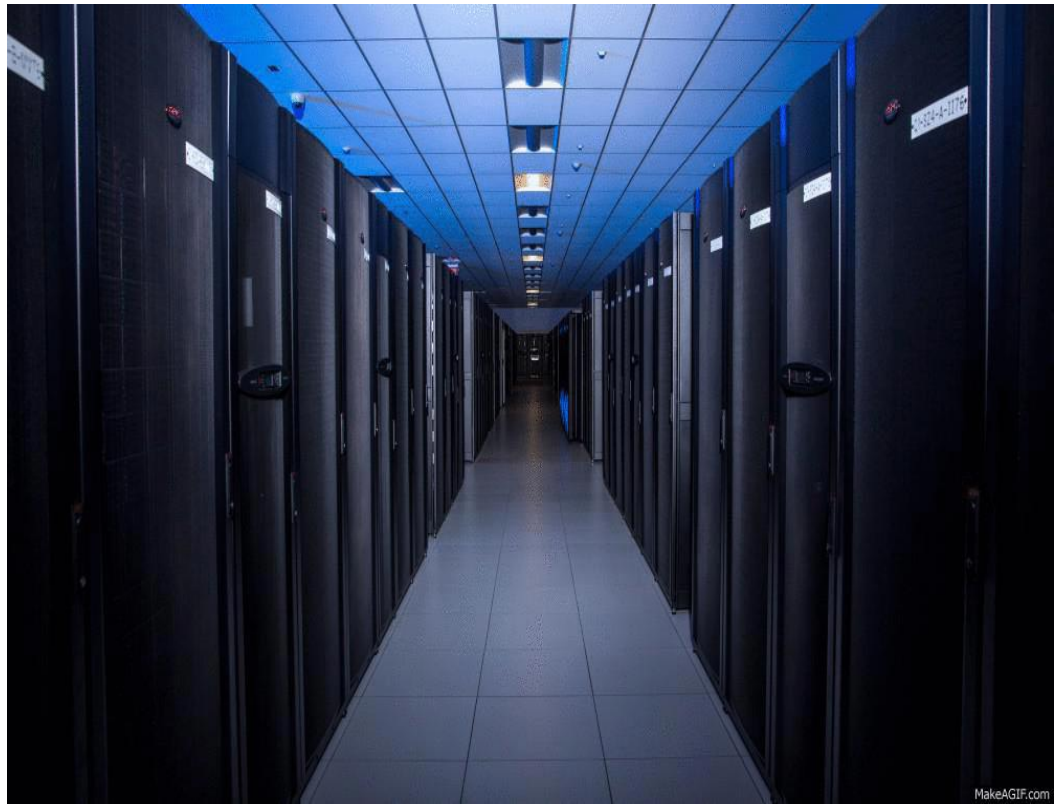
Screen grab from news.google.com (July 06, 2023)

Unsupervised Learning - Clustering



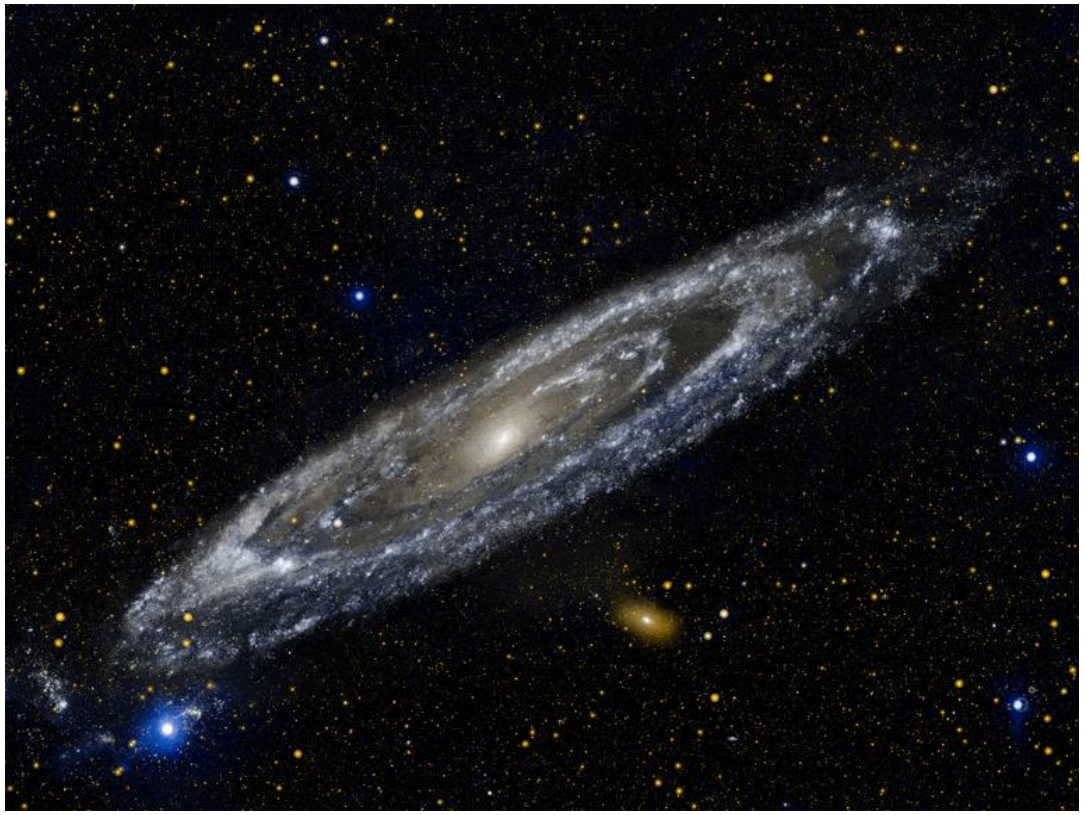
Screen grab from news.google.com (Jan. 02, 2025)

Data Centers - Clustering



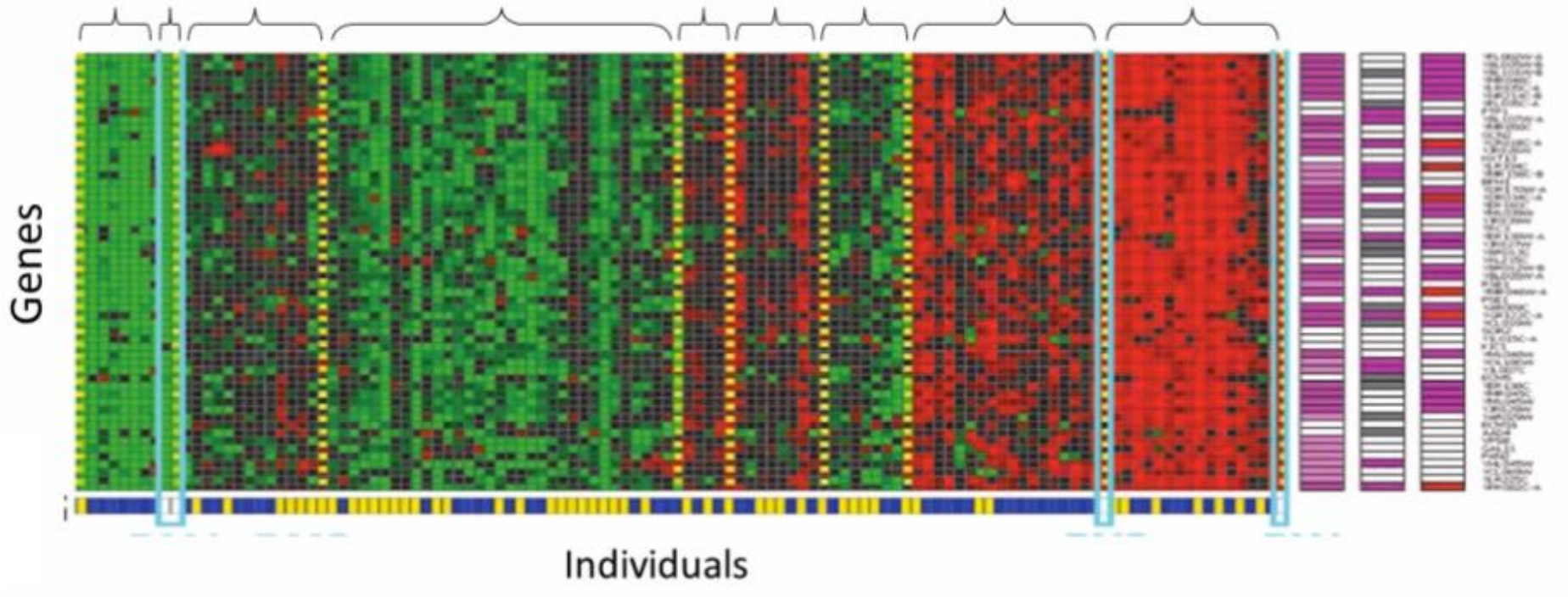
- **2016 Estimates:**
  - A Gartner report from July 2016 estimated that Google had approximately 2.5 million servers at that time.
- **How Many Google Searches Per Day (2025 Statistics)**
  - More than 99,000 queries processed each second
  - 8.5 billion Google searches are made every day.

Astronomical Data Analysis - Clustering



Social Network Analysis - Clustering

Unsupervised Learning - Clustering



- **Genomics - Microarray data**
  - **Have a group of individuals**
  - **On each measure expression of a gene**
  - **Run algorithm to cluster individuals into types of people.**

Question

Of the following examples, which would you address using an unsupervised learning algorithm?

1. Given email as spam/not-spam, learn a spam filter.
2. Given a set of new articles found on the web, group them into set of articles about the same story.
3. Given a database of customer data, automatically discover market segments and group customers into different market segments.
4. Given a data set of patients diagnosed as either having diabetes or not, learn to classify new patients as having diabetes or not.

REINFORCEMENT LEARNING

Reinforcement learning is a machine learning paradigm that focuses on how agents learn to interact with an environment to maximize cumulative rewards.

DatabaseTown

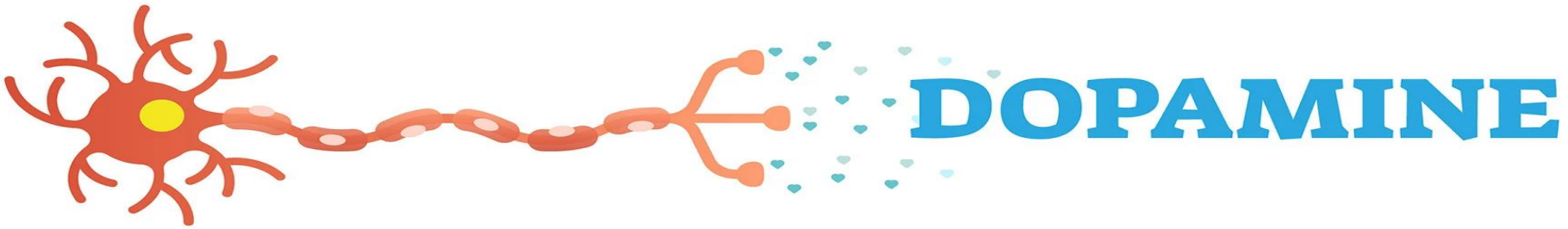
Baby (Agent)

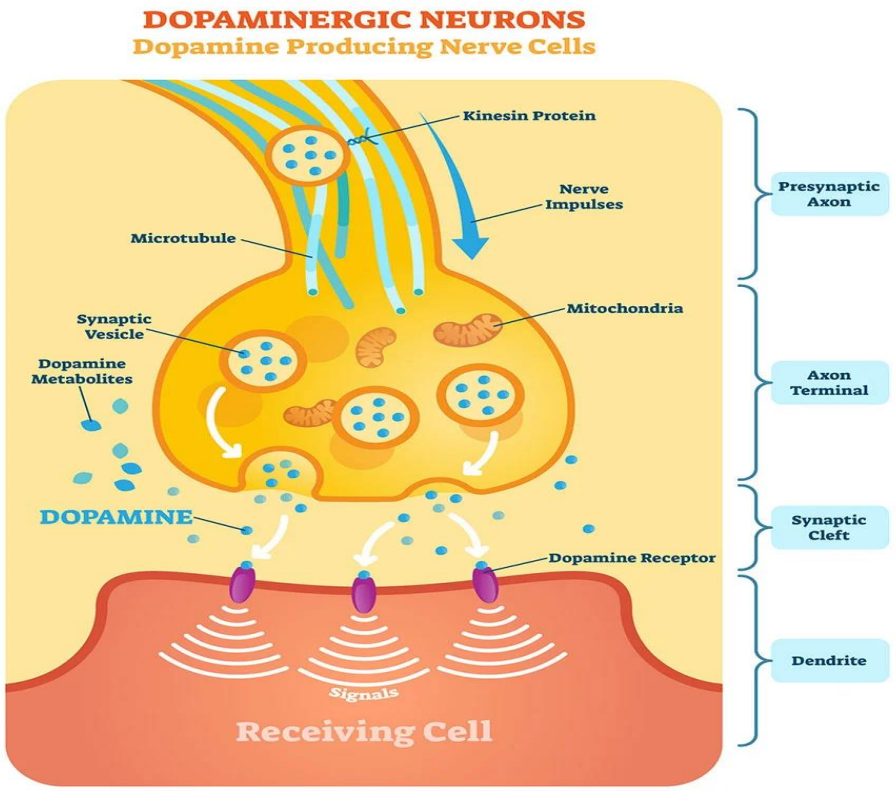
Algorithms and Approaches in Reinforcement Learning

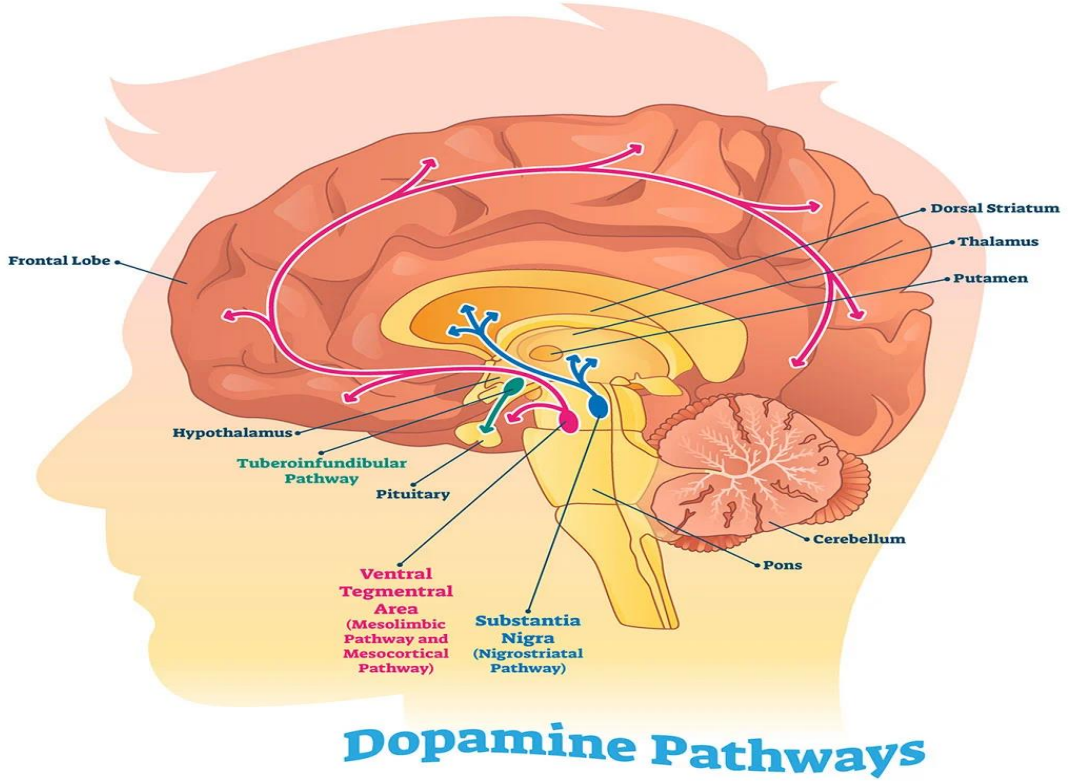
- Q-learning
- Deep Q-networks (DQN)
- Policy Gradients Methods
- Proximal Policy Optimization (PPO)

Reinforcement Learning :: Introduction

Reinforcement Learning :: Introduction







Reinforcement Learning :: Introduction

Reinforcement Learning :: Introduction

- A reinforcement learning model will learn from its experience and over time will be able to identify which actions lead to the best rewards.
- In Reinforcement Learning (RL), agents are trained on a reward and punishment mechanism. The agent is rewarded for correct moves and punished for the wrong ones. In doing so, the agent tries to minimize wrong moves and maximize the right ones.

Application of Reinforcement Learning

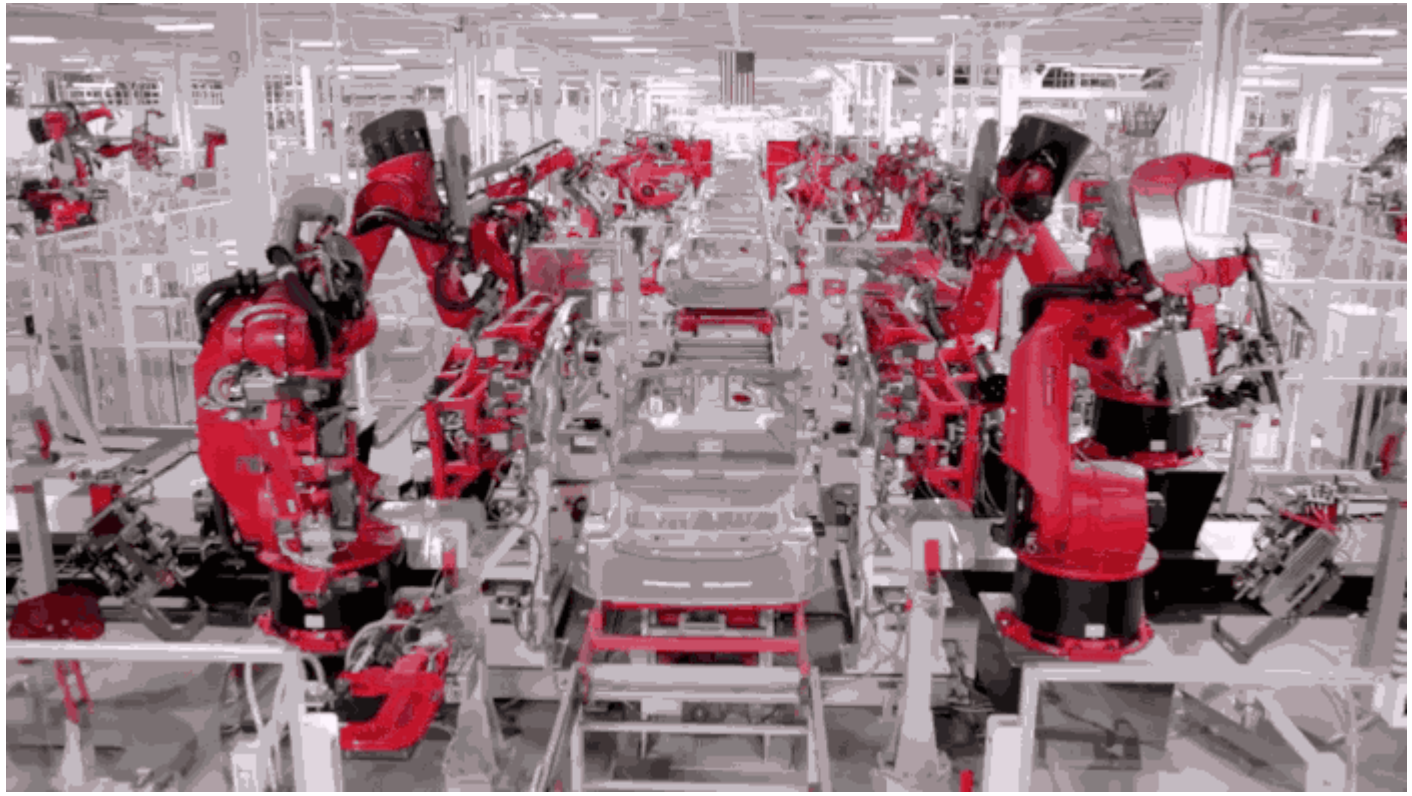
- Self Driving Car (Autonomous Driving)
- Factory Optimization
- Financial (Stock) Trading
- Playing Games

Application of Reinforcement Learning

- Self Driving Car (Autonomous Driving)

Application of Reinforcement Learning

- Industry Automation (Industry Optimization)



Application of Reinforcement Learning

- Stock (Financial) Trading

Application of Reinforcement Learning

- Playing Games

Prerequisite

- Core Computer Science Knowledge
- Statistics & Probability
- Linear Algebra & Calculus

Tools

- Python
- Install Jupyter Notebook

Class Policy

- Attendance, as per the university policy.
- IF Attendance < 75% THEN SET Allow In Exam = FALSE.
- No relaxation.
- No mobile phones!!!

Grading Policy

- **Sessional = 25%**
  - Assignments
  - Quizzes
  - Class Attendance
  - Presentations/Semester Project etc.
- **Mid Term = 25%**
- **Final Term = 50%**

Acknowledgment

- Material presented in these lecture slides is obtained from Prof. Dr. Andrew Ng course on Machine Learning
- Dr. Iftikhar Ahmad's lecture slides were consulted for assistance.
- .