Data Sciene and Machine Learnig

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Lectures

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1. What is Data Science?
2. What is a dataset?
3. Types of Data?
4. Machine Learning
5. Supervised Learning (Regression)

What is Data Science?

نبذة عن تخصص علم البيانات

عرّفت مجلة Harvard Business علم البيانات أنّه من أكثر العلوم إثارة وشيوعًا في القرن الحادي والعشرين، وأشار العديد من الخبراء في علم البيانات أنّ التشويق الذي يتمتّع به علم البيانات قد أضاف لمسة مثيرة إلى بعض العلوم الأخرى كالإحصاء مثلًا!

هل تعلم أن اللقب "نفط القرن الحادي والعشرين" يُطلق على تخصص "علم البيانات" وذلك لإبراز أهميته وقيمته العلمية في حياتنا؟

يُعتبَر علم البيانات أنّه علم متعدّد المجالات، كما أنّه العلم الذي يستخدم الأساليب العلمية، والعمليات، والخوارزميات، والأنظمة بغرض استخراج المعرفة، والأفكار من البيانات سواءً كانت هذه البيانات منظّمة ام لا، تمامًا مثل التنقيب عن البيانات وما يُطلق عليه "Data Mining".

WHAT IS DATA SCIENCE?

- "**Data science**, also known as **data-driven science**, is an interdisciplinary field of scientific methods, processes, algorithms and systems to extract knowledge or insights from data in various forms, either structured or unstructured, similar to data mining."
- "Data science intends to analyze and understand actual phenomena with 'data'. In other words, the aim of data science is to reveal the features or the hidden structure of complicated natural, human, and social phenomena with data from a different point of view from the established or traditional theory and method."

WIKIPEDIA
The Free Encyclopedia

What is a Dataset?

A dataset is a collection of data, typically organized in a structured format. Datasets can include a wide range of information, such as numerical values, text, images, or audio recordings. They are mostly used in fields like machine learning, business, and government to gain insights, make informed decisions, or train algorithms.

مجموعة من البيانات المنظمة في صيغ معينة و هي إما تكون هيكلية أو غير هيكلية.
تعتبر البيانات حجر الأساس في علم البيانات و تعلم الآلة.

Task:

1. With your team, use AI tools to figure out the difference between a dataset and a database.
2. What defines a good prompt?

Types of Datasets?

Numerical or quantitative Dataset

Ex:
Marks
Temperature

Categorical or qualitative Dataset

Ex:
True/False
Eye colour

Multivariate Dataset

Ordered Dataset

Ex:
customer reviews

Time series Dataset

Ex:
GDP growth

Image Dataset

Ex:
types of diseases

Types of Data ?

✓ Structured and Unstructured data

(بيانات هيكلية و بيانات غير هيكلية)

✓ Labeled and **Unlabeled data**

بيانات تحتوي على مدخلات و مخرجات و **بيانات تحتوي على مدخلات فقط**

✓ Training data and Testing data

بيانات التدريب و تتستعمل لبناء الخوارزمية، أما بيانات التقييم فتكون بغية اختبار مدى نجاح الخوارزمية

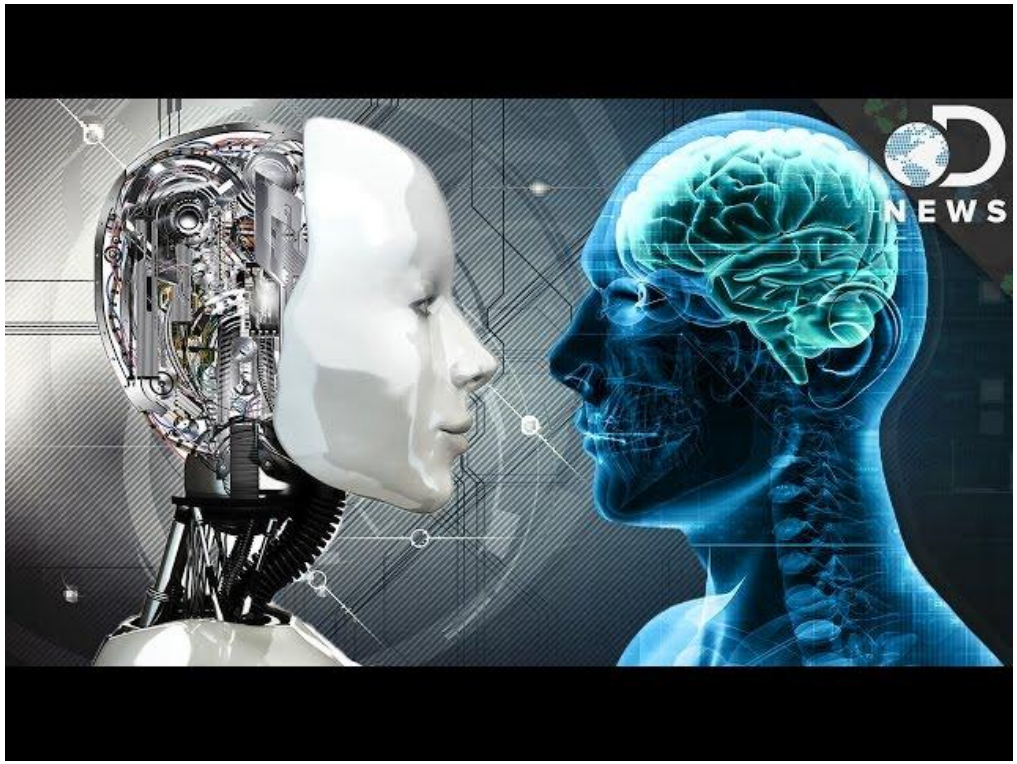
Machine Learning

Artificial Intelligence

قدرة الآلة على اتخاذ القرار المناسب

The ability of taking the right decision

How Human Thinks?

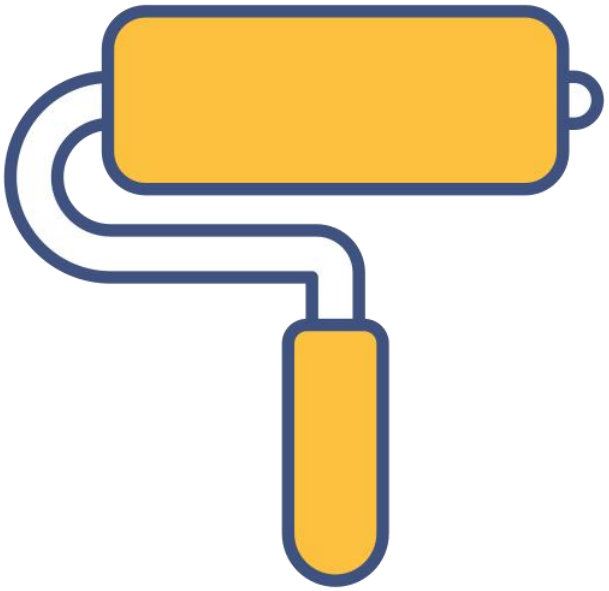


How Human Thinks?

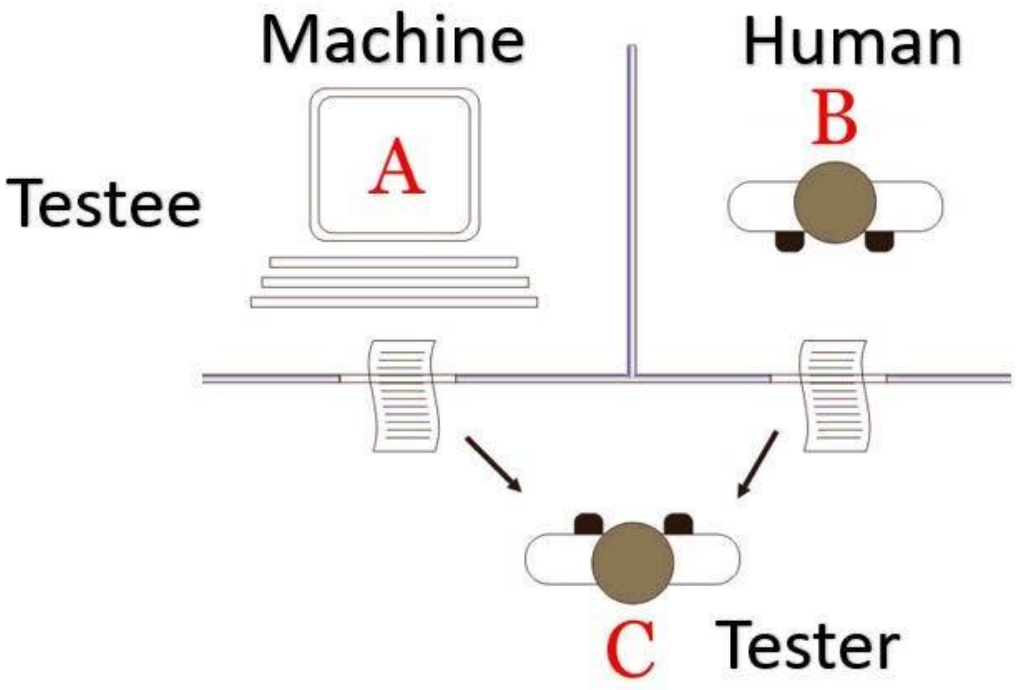
Model 1: Punishement and Reward

How Human Thinks?

Model 1: Supervision



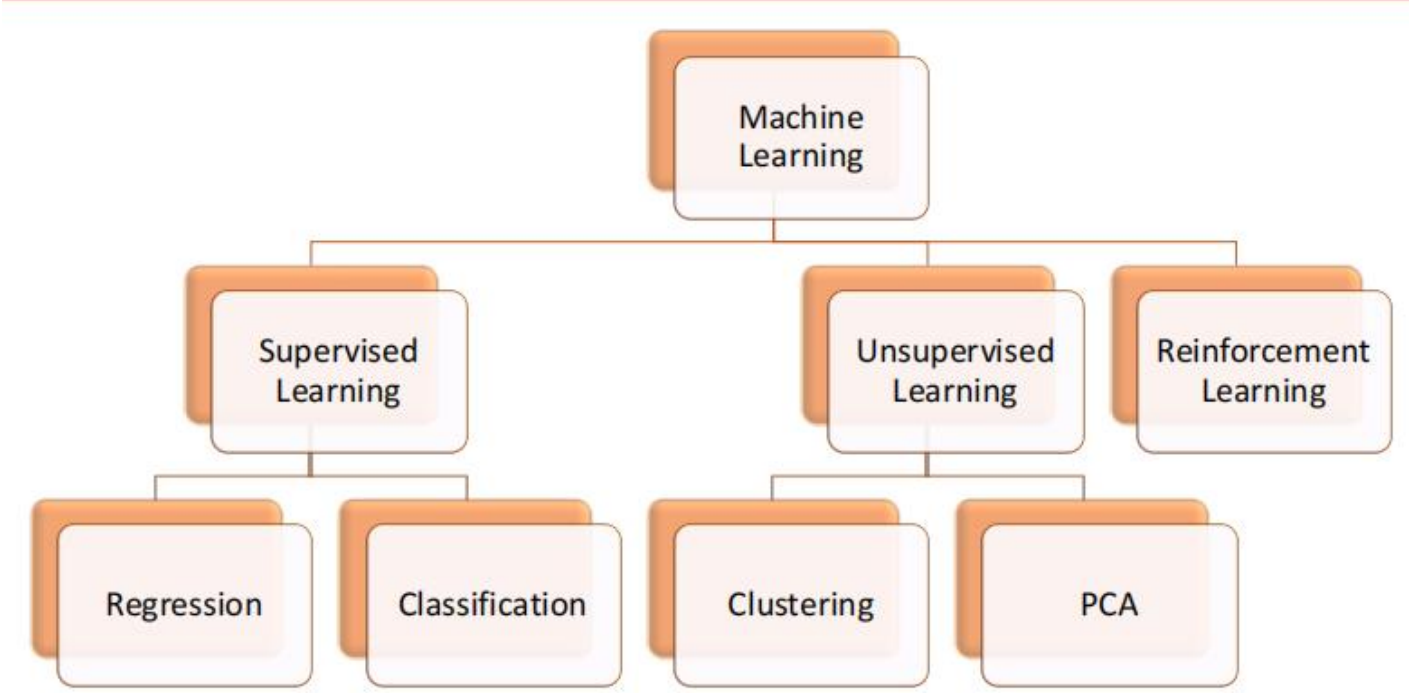
Turing Test



Machine learning is a subfield of computer science that deals with the design and development of algorithms that allow computers to learn from data without being explicitly programmed

القدرة على اتخاذ القرار المناسب بعد التدرب على بيانات

Machine Learning Models



Supervised Learning

Regression

Labeled data

Quantitative
OUTPUT

Classification

Labeled data

Categorical
OUTPUT

ML Vocabulary

Input	X
Output	Y
Rows	m
Features	n
h(x)	Prediction function
Cost J	Cost function
Theta	Weights

Regression with one feature (variable)

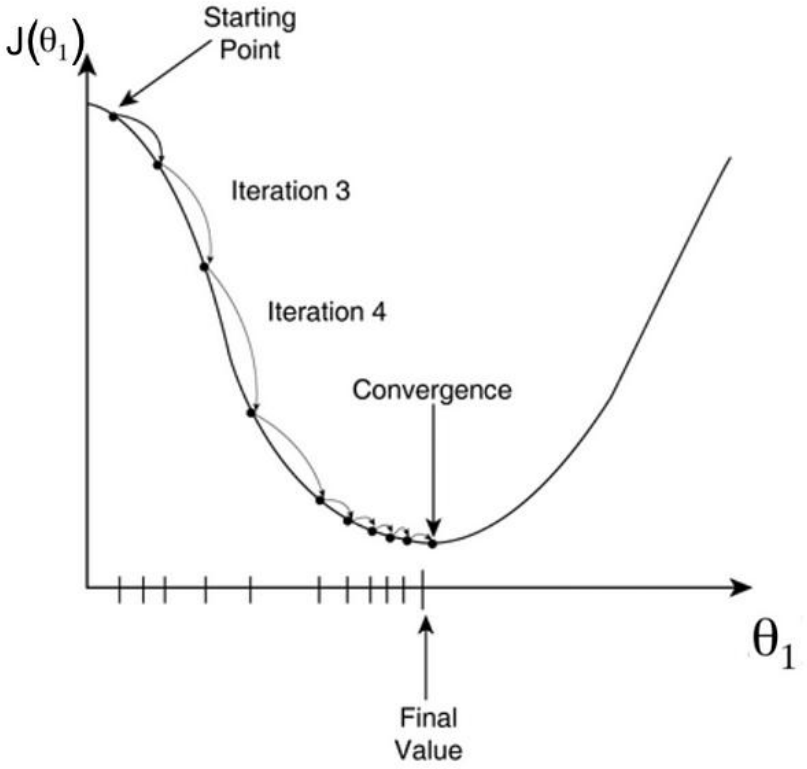
Hypothesis: $h_\theta(x) = \theta_0 + \theta_1 x$

Parameters: θ_0, θ_1

Cost Function: $J(\theta_0, \theta_1) = \frac{1}{2m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)} \right)^2$

Goal: $\underset{\theta_0, \theta_1}{\text{minimize}}\ J(\theta_0, \theta_1)$

Gradient Descent



Cost Function – "One Half Mean Squared Error":

$$J(\theta_0, \theta_1) = \frac{1}{2m}\sum_{i=1}^{m}\left(h_\theta\left(x^{(i)}\right) - y^{(i)}\right)^2$$

Objective:

$$\min_{\theta_0, \theta_1} J(\theta_0, \theta_1)$$

Derivatives:

$$\frac{\partial}{\partial\theta_0}J(\theta_0, \theta_1) = \frac{1}{m}\sum_{i=1}^{m}\left(h_\theta\left(x^{(i)}\right) - y^{(i)}\right)$$

$$\frac{\partial}{\partial\theta_1}J(\theta_0, \theta_1) = \frac{1}{m}\sum_{i=1}^{m}\left(h_\theta\left(x^{(i)}\right) - y^{(i)}\right)\cdot x^{(i)}$$

Example :

Theta 0= 5, Theta 1= 2, Alpha=0.01

X	Y	h(x)	h(x)-y	$(h(x)-y)^2$
1	7	7	0	0
2	8	9	1	1
2	7	9	2	4
3	9	11	2	4
4	11	13	2	4
5	10	15	5	25
5	12	15	3	9

Cost J= 3.3, **Convergence**!!

Example :

Cost J= 3.3, **Convergence**!!

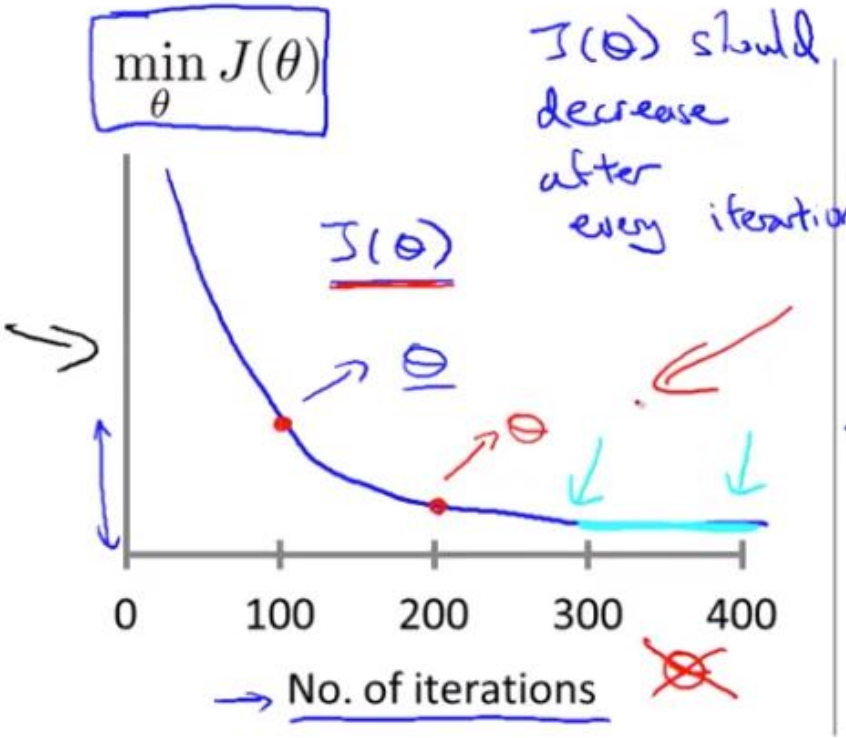
$$\text{repeat until convergence } \{$$
$$\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)} \right)$$
$$\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)} \right) \cdot x^{(i)}$$
$$\}$$

ϕ_0 = 4.993, ϕ_1 = 1.48....etc **How many times?**

Number of Iteration

عدد المحاولات

Making sure gradient descent is working correctly.



→ Example automatic convergence test:

→ Declare convergence if $J(\theta)$ decreases by less than 10^{-3} in one iteration.

ε

Example:

Theta0= 5, **Theta1**= 2, **Theta2**= 3, **Theta3**= 6, **Alpha**=0.01

X1	X2	X3	Y
5	20	6	114
5	35	6	120
6	38	8	123
7	40	8	121
7	46	10	135

أحسب قيمة الخطأ

بالاعتماد على خوارزمية الانحدار التدريجي أحسب قيمة ϕ_1 باستخدام محاولة واحدة

GD algorithm

Repeat until convergence

{

$$\theta_j := \theta_j - \alpha \frac{1}{m} \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

j= 0,...,n

}

Normal Equation

$$\theta = (X^T X)^{-1} . (X^T y)$$

Singular matrix

Normal equation vs Gradient Descent

1. do no require iterative approach;
2. do not require a learning rate;
3. do not require scaling.

Example with Python

1. Regression with one variabe;
2. Multivariable Regression;
3. Normal Function;