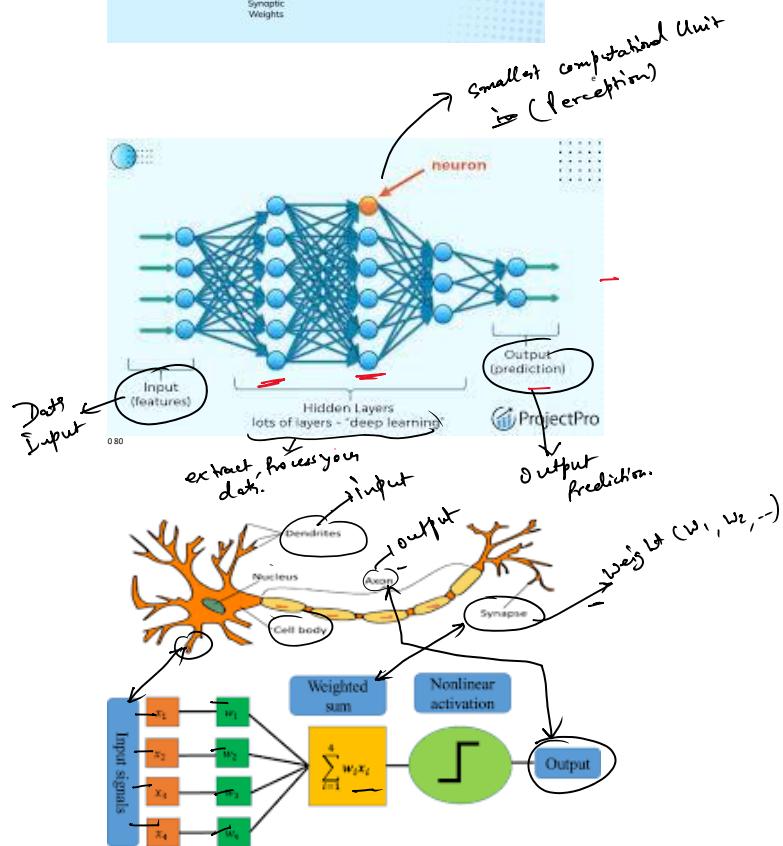
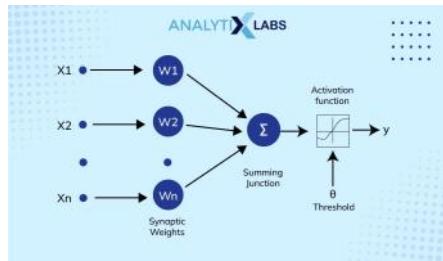
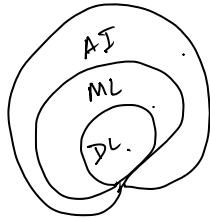


- ① Deep learning.
- ② Machine learning.
- ③ AI
  - ① Conventional AI
  - ② New AI

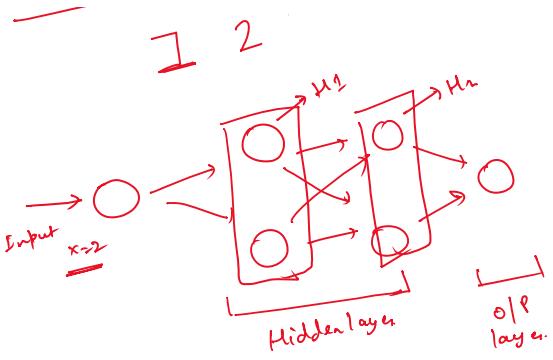


$$Z = w_1x_1 + w_2x_2 + w_3x_3 + \dots + w_nx_n + b$$

$$\text{Output} = f(Z)$$

$$\begin{array}{r} 2 \quad 2 \quad 2 \quad 2 \\ \hline 1 \quad 2 \end{array}$$

$\rightarrow u^1 \quad \rightarrow u^2$



Two Phases

- ① Forward propagation  $\rightarrow$  Prediction
- ② Back propagation  $\rightarrow$  learning  
(Weight update)

$$x=2$$

$$z = x_1 w_1 + b$$

How int. the input is?

$w_1 = 0.5$   
 $b = 1$

constant value

$$H_1 = z = x_1 w_1 + b$$

$$= 2 \times 0.5 + 1$$

$$= 1 + 1 = 2$$

$$\underline{\text{ReLU}(2) \rightarrow \max(0, 2)} = 2$$

$$x_2 = b = 0.5$$

$$w = 1$$

$$z = 2x_2 + 0.5$$

$$\approx -1.5$$

$$\text{ReLU}(-1.5) = 0$$

$$\text{ReLU}(x) = \max(0, x)$$

$$z = -1.5$$

$$\text{ReLU}(-1.5) = \max(0, -1.5)$$

$$\downarrow$$

$$\underline{H_2 = 0}$$

[2, 0]  
Rectified linear unit

3 Phase to decide weight & Bias:-

- ① Initialize random value  $\rightarrow W=0$   $\rightarrow$  Learning will not happen

$$W = 0.12$$

$$b = -0.03$$

- ② Predict (Forward Pass)

$x \rightarrow$  Input  
 $y \rightarrow$  expected output  
Assumption:  $x_{(N)} \rightarrow$  Not s.t.

Assumption:

$$w = 0.5$$

$$b = 1$$

$$z = \underline{w} \cdot \underline{x} + b$$

$$= 2 \cdot 0.5 + 1$$

$$= 2$$

Not matching

(3) Learn (Back Propagation + Gradient Descent)  
Who is responsible for the error?

$$\text{Loss function} \rightarrow (10 - 2)^2 = 8^2 = 64$$

Gradient Descent  $\rightarrow$

$$w_{\text{new}} = w_{\text{old}} - \eta \times \text{error contribution}$$

$$b_{\text{new}} = b_{\text{old}} - \eta \times \text{error contribution}$$

$\eta$  = learning rate  
(how fast to correct)

$$x = 2$$

$$\hat{y} = 10$$

$$\text{Calculate } \delta = (10 - 2)^2 = 64$$

$$w_{\text{old}} = 0.5$$

$$b_{\text{old}} = 1$$

$$\eta = 0.01$$

$$\eta = 0.01 \rightarrow \text{Practical}$$

$$= 0.001 \rightarrow \text{Balanced}$$

$$= 0.1 \rightarrow \text{Very slow}$$

$$= 1.0 \rightarrow \text{Fast, risky}$$

$$= 1.0 \rightarrow \text{Too large} \rightarrow \text{Jumps}$$

(Correct)

gradient weight ( $\frac{\partial L}{\partial w}$ )

$$\begin{aligned} \frac{\partial L}{\partial w} &= -2(\hat{y} - y) x \\ &= -2(10 - 2)^2 \\ &= -2 \times 8 + 2 \\ &= \boxed{-32} \end{aligned}$$

gradient Bias ( $\frac{\partial L}{\partial b}$ )

$$\frac{\partial L}{\partial b} = -2(\hat{y} - y)$$

$$= -2(10 - 2) = -16$$

$$w_{\text{new}} = w_{\text{old}} - \eta \cdot \frac{\partial L}{\partial w}$$

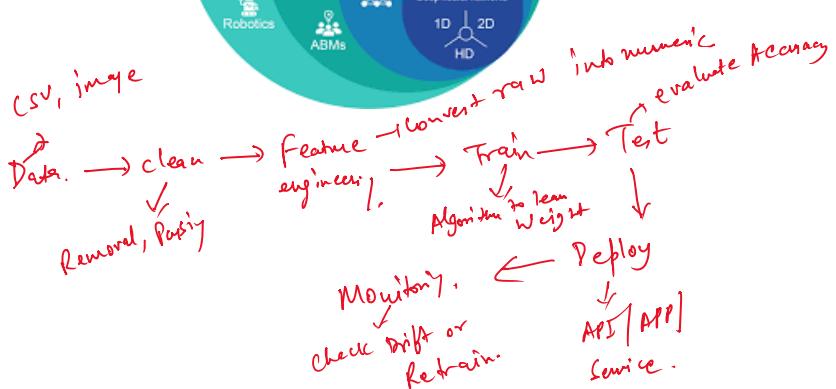
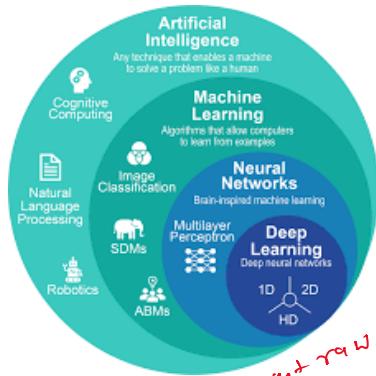
$$\therefore 0.01(-32)$$

$$\begin{aligned}
 w_{\text{new}} &= w_{\text{old}} + \eta \Delta w \\
 &\approx 0.5 - 0.01(-32) \\
 &\approx 0.5 + 0.32 \\
 &\approx 0.82
 \end{aligned}$$

$$\begin{aligned}
 b_{\text{new}} &= b_{\text{old}} + \eta \frac{\Delta L}{\Delta b} \\
 &\approx 1 - 0.01(-16) \\
 b_{\text{new}} &= 1.16
 \end{aligned}$$

$$\begin{aligned}
 y_{\text{new}} &= Z = X_1 w_1 + b_1 \\
 &\approx 2 \times 0.82 + 1.16 \\
 &= 1.64 + 1.16 \\
 &\approx 2.8
 \end{aligned}$$

Machine learning :- Subset of AI

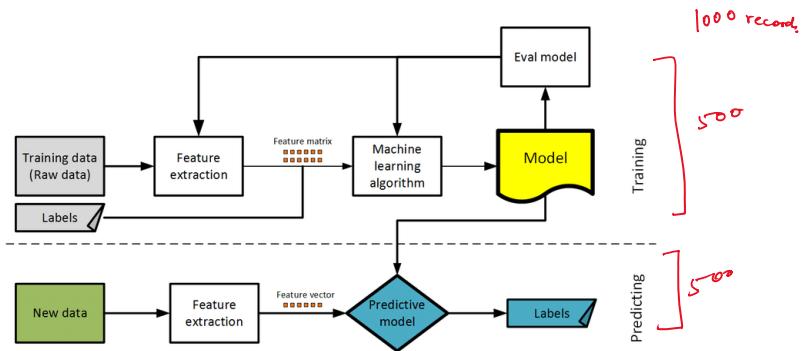


ML :-

① Supervised learning. →  $f(x) \rightarrow y$

② Unsupervised learning.

- ① Supervised  
 ② Unsupervised learning  
 ③ Reinforcement learning



$$y = f(x)$$

↓ input  
↓ output

Supervised learning

classification. (predict → category)

regression-

(predict → number)

linear  
reg.

Multi  
reg.

Multiple  
Variable

Price × Size

$w \rightarrow$  price per sq.  
 $x \rightarrow$  housesize  
 $b \rightarrow$  base price

$$\hat{y} = w \cdot x + b$$

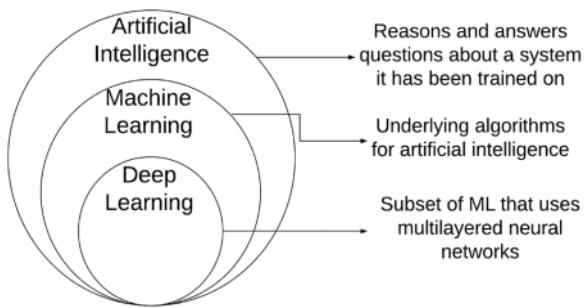
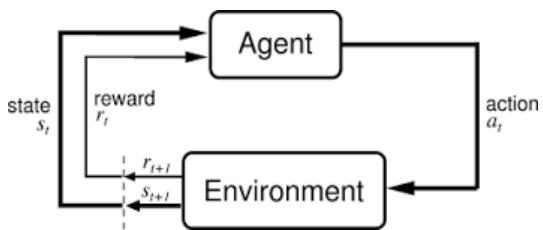
$$f(x) \rightarrow y$$

$$y = f(x)$$

Unsupervised learning:-

- ④ Clustering.
- ① Anomaly Detection.
- ③ Association Rule Mining.
- ⑤ Dimensionality Reduction.

Reinforcement learning:-

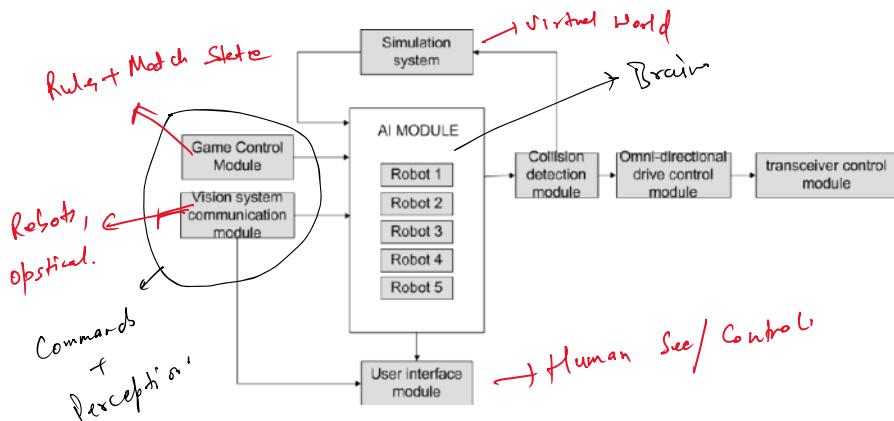


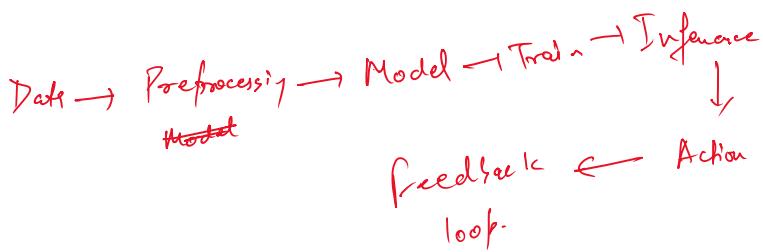
### Core Capabilities of AI:-

- ① Perception → Face Recognition
- ② Reasoning → Chess, Game AI
- ③ Learning → Improve / Recommendation
- ④ Language → Chatbot
- ⑤ Action → Robot / AutoPilot

### Types of AI:-

- ① Narrow AI (Weak AI) - only one task
- ② General AI (Strong AI) -
- ③ Super AI (Theoretical)





### Azure AI Vision:-

- ① Image classification.
- ② Object Detection.
- ③ Segmentation.
- ④ Face API
- ⑤ Spatial analysis.

③ Segmentation →

Pixel  
↓  
Smallest unit of image.

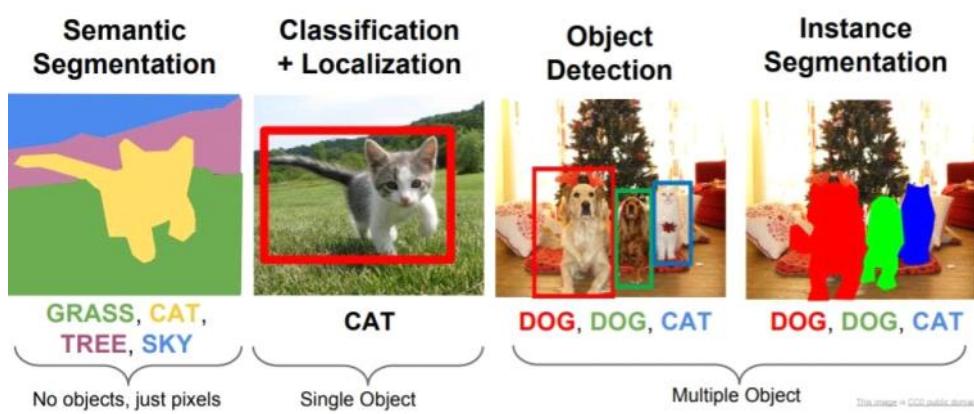
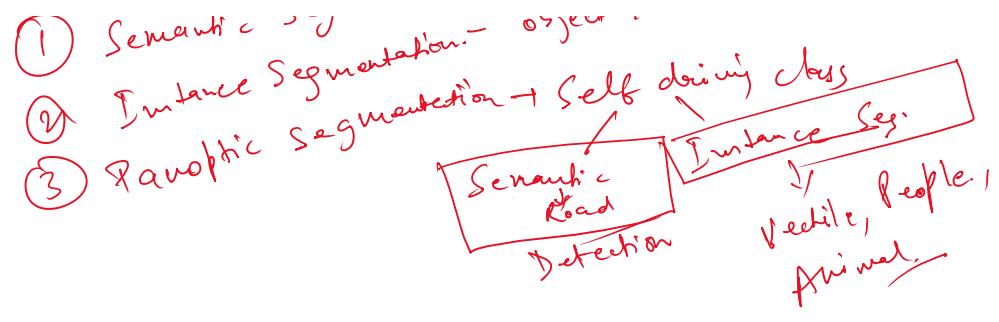


Image → CNN Encodes → Decodes → Pixel Wise classifier

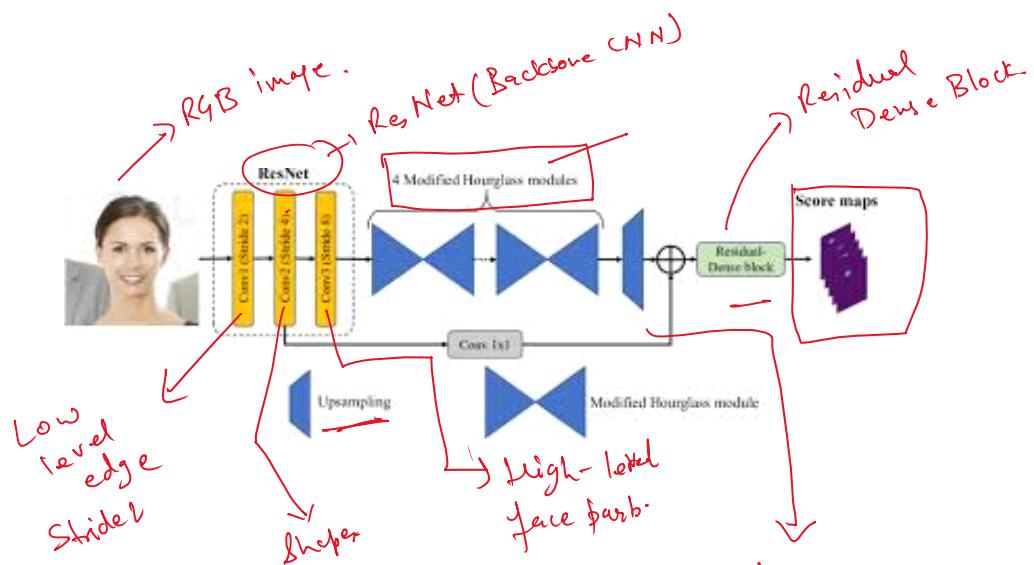
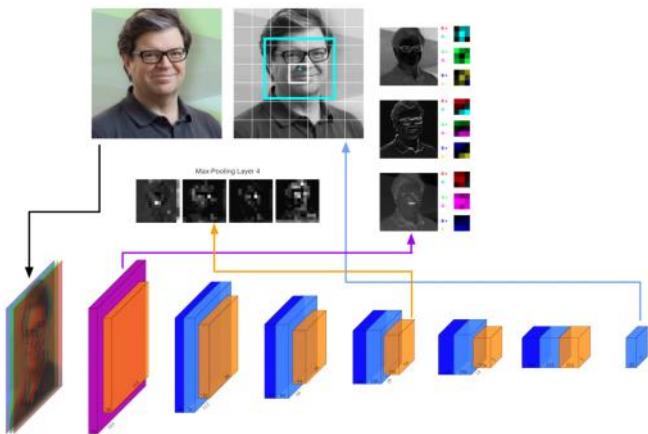
### Semantic:-

- ① Semantic Segmentation - Every pixel defines the Segmentation category mark.
- ② Instance Segmentation - object detection + annotation → Self driving class.



## Face API & Spatial Analysis:-

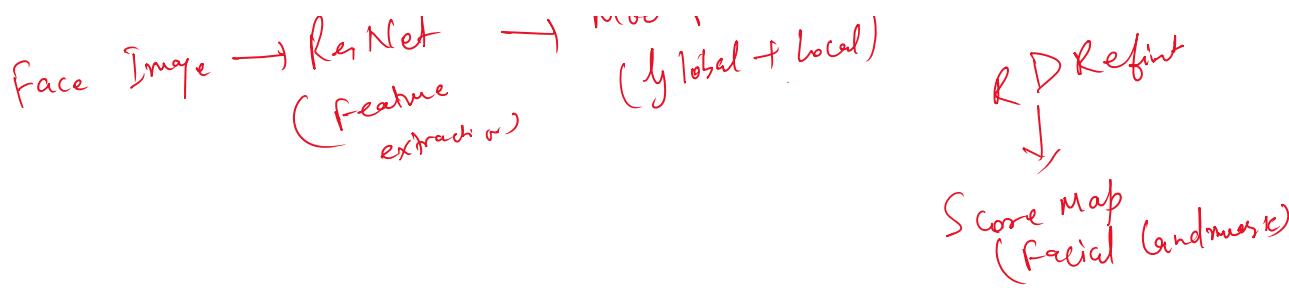
### ① Face API:-



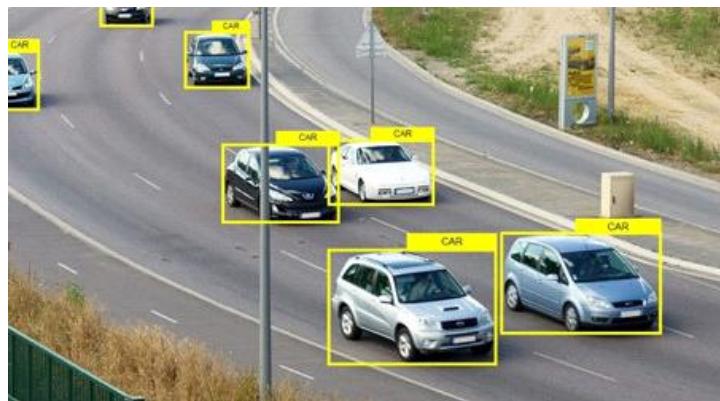
Face Image → ResNet  
↓ receptive field

→ Modified Hourglass → upsample →  
(global + local)  
R/D Refine

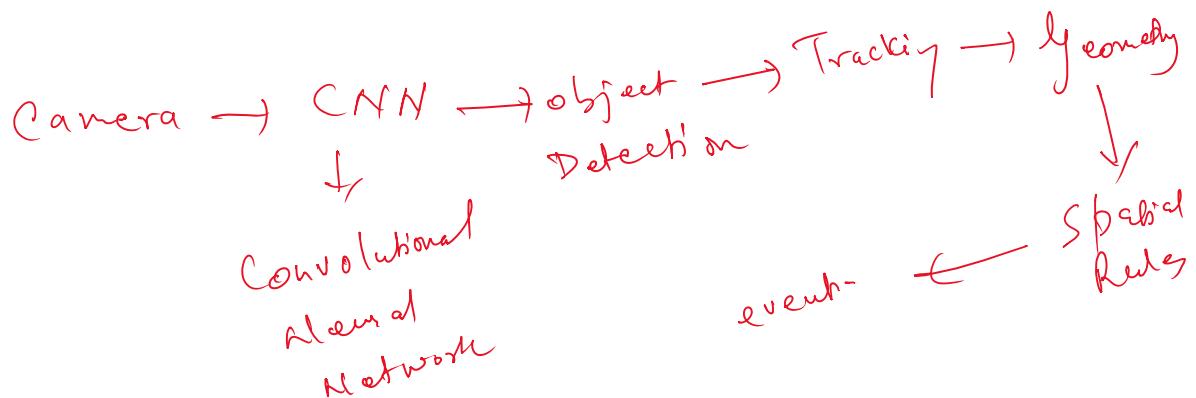
Hourglass  
Downsampling → Bottleneck  
upsampling



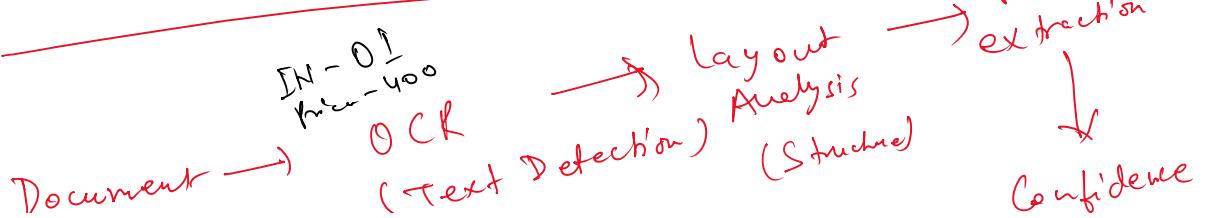
## Spatial Analysis:

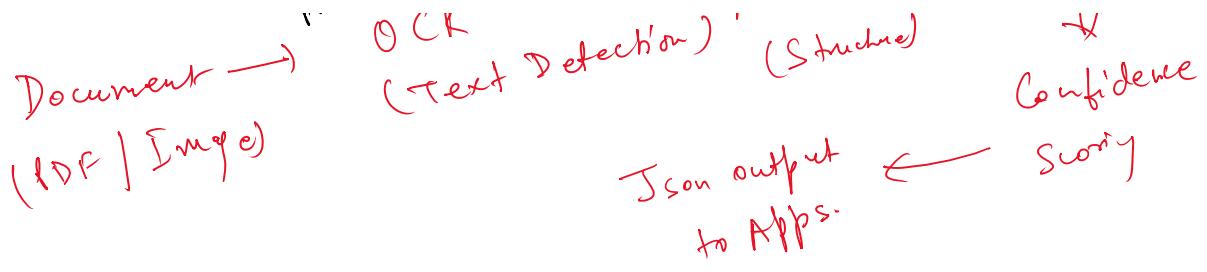


A) position :-  $(x, y)$  pixel coordinate

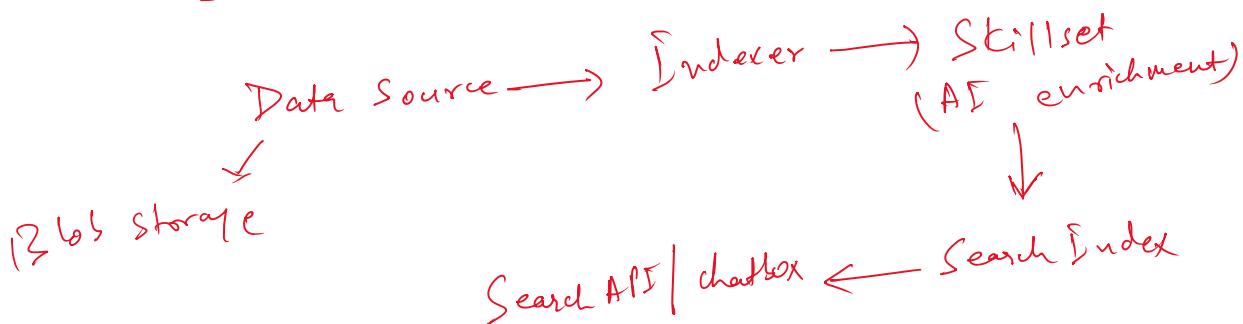


## Azure Document Intelligence

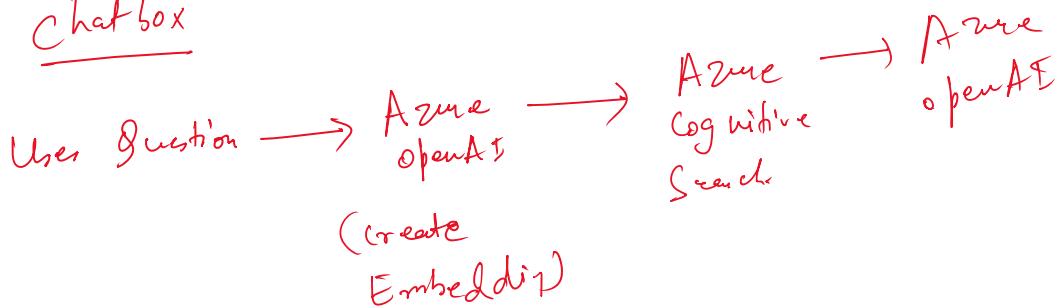




## Azure Cognitive Search



## Chatbox



What is leave policy?

[0.01, -0.35, 0.457, -]

↑  
Embedded.

Search → leave policy  
Doc → Employee vacation rules.

What is the leave policy?

, 1...n-th vector

What is the leave policy?

Sentence → To Lex. → Transformer → fixed length vector  
(embedding)

↓  
Used in search.

what is leave policy? (Text Normalization)



[ "what", "is", "leave", "policy", "?" ]

what - 5012

is - 318

leave - 5632

policy - 29

? - 5632, 29 ]

[ 5012, 318, 5632, 29 ]

embedding Matrix



Shape = V + D → Dimension



Vocab



size

[ 0.12, 0.11, -0.54, ... ]

↓

[ z1, z2, z3, z4, ... ]



Intent  
(what?)

Intent

Entities

(extract important  
values)

Conversational AI :-

→ Speech To Text → NLU → Business logic

