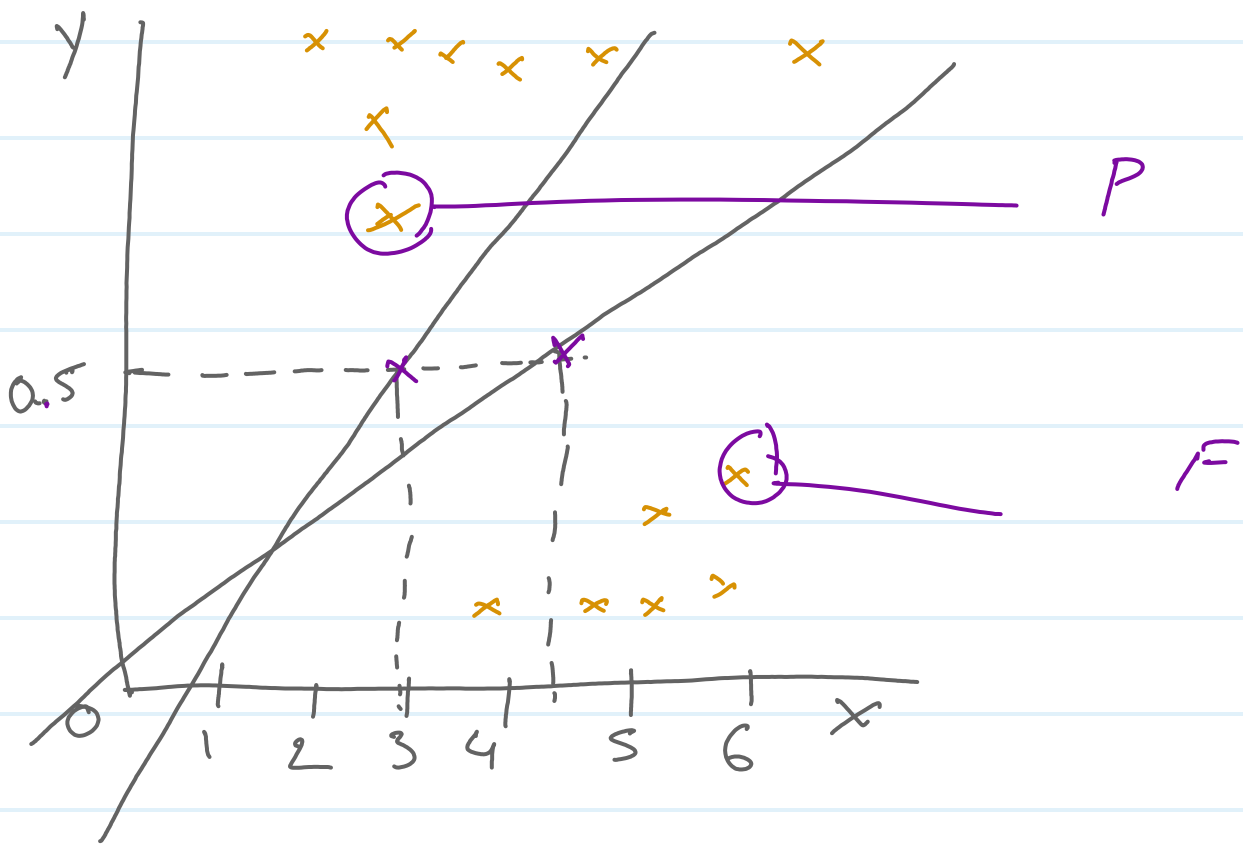
Logistic Regression



Line eqn $h_\theta(x) = \theta_0 + \theta_1 x_1$

but here we apply sigmoid function on line eqn.

Step-I $z = h_\theta(x) = \theta_0 + \theta_1 x$

step- II

$$\text{Sigmoid function} = \frac{1}{1+e^{-z}}$$

$$z = \theta_0 + \theta_1 x$$

We get always 0 and 1 value after applying this formula.

cost function -

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

· This is convex function of Linear Regress.

↑

linear Reg - one global minima

logistic - local minima

logistic cost funct -

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

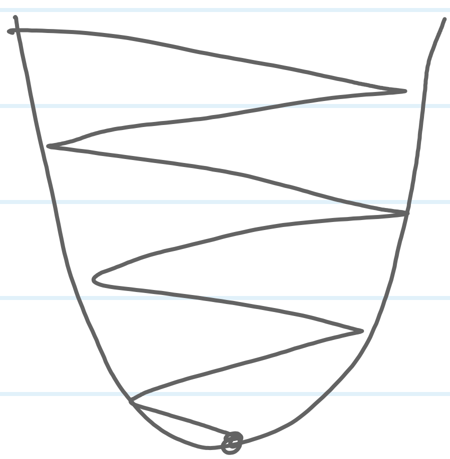
$$h_\theta(x) = \sigma(\theta_0 + \theta_1 x)$$

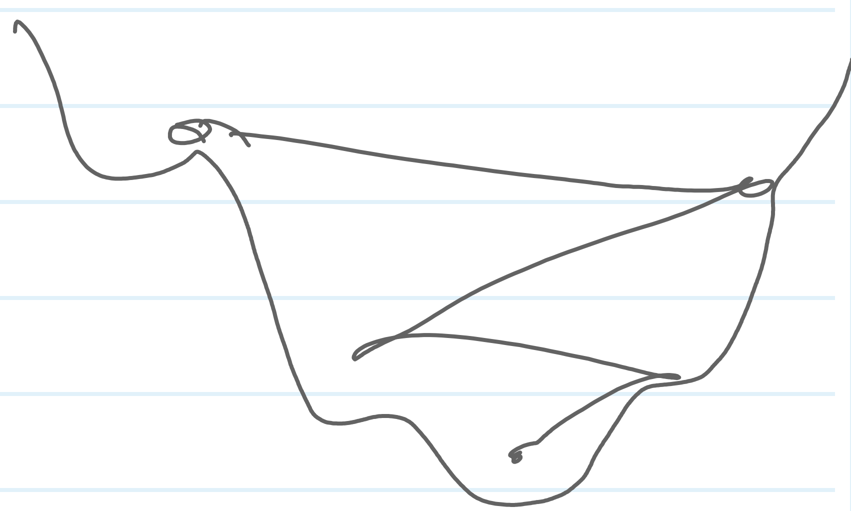
$$\sigma(z) = \frac{1}{1+e}$$

$$\sigma = \frac{1}{1+e^{-z}}$$

$$\frac{1}{1+e^{-z}} = \frac{1}{1+e^{-(\theta_0+\theta_1 x)}}$$

This is non-convax function.





Repeat Conversion theorem

[J = 0 and 1 }

$$\theta_j = \theta_j - \alpha \frac{\partial}{\partial \theta_j} j(\theta_0, \theta_1)$$

α is learning rate

Note- ① Logistic Regression can use for Binary or multiclass classification.

② Only solve class. problem

③ sigmoid function is key of logistic regre

④ usually it gives best model for Binary class classification.

model evaluation

Performance metrics

1. confusion matrix
2. Accuracy score
3. Precision
4. Recall
5. F-Beta score

1. Confusion matrix

F_1	F_2	Y	$\hat{Y}$
–	–	0	1
–	–	1	1
–	–	0	0
–	–	1	1
–	–	1	1
–	–	0	1
–	–	1	0

Y Actual

$\hat{Y}$ Predict	1	0
1	3	2
0	1	1

$\hat{Y}$ \ Y	1	0
1	T.P	F.P.
0	F.N.	T.N

② Accuracy score:-

$$= \frac{TP + TN}{TP + FP + FN + TN}$$

$$= \frac{3 + 1}{3 + 2 + 1 + 1}$$

$$\Rightarrow \frac{4}{7} = 5.7$$

③ <u>Precision</u>

$$= \frac{TP}{TP + FP}$$

$$= \frac{3}{3+2} = \frac{3}{5} \Rightarrow 0.6$$

④ <u>Recall</u>

$$= \frac{TP}{TP + FN}$$

$$= \frac{3}{3+1} = \frac{3}{4} \Rightarrow 0.75$$

⑤ <u>F-Beta score</u>

$$= \frac{(1 - \beta^2) \times \text{Precision} \times \text{Recall}}{\beta^2 \times (\text{Precision} + \text{Recall})}$$

① If FP and FN both are imp

$\beta = 1$

$$F_1 \text{ Score} = \frac{(1+\beta^2) \times P \times R}{\beta^2 \times (P+R)}$$

$$= \frac{(1+1^2) \times 0.6 \times 0.75}{1^2 \times (0.6+0.75)}$$

$$= \frac{2 \times 0.45}{1.35}$$

$$= 0.33$$

② If FP is more imp. than FN

$\beta = 0.5$

$$= \frac{[1+(0.5)^2] \times 0.6 \times 0.75}{(0.5)^2 \times (0.6+0.75)}$$

$$= \frac{(1+0.25) \times 0.45}{0.25 \times 1.35}$$

$$\Rightarrow \quad \frac{0.5625}{0.3375}$$

$$\Rightarrow \quad 1.66$$

(iii) If FN is more imp. FP

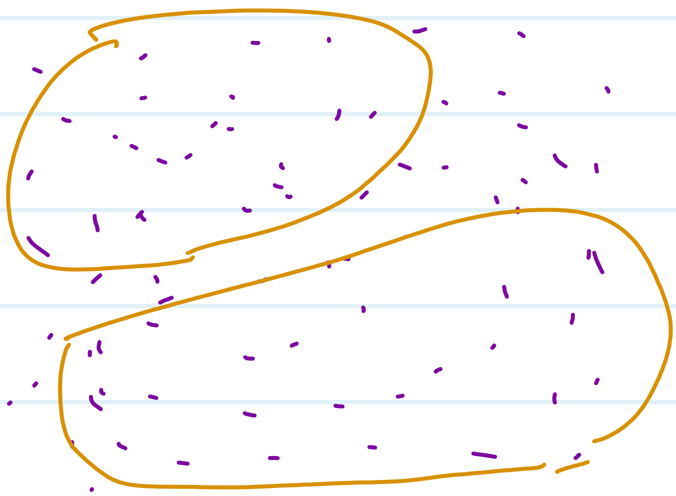
$\beta = 2$

$$= \frac{1+4\,(P \times R)}{4 \times (P + R}$$

$=$

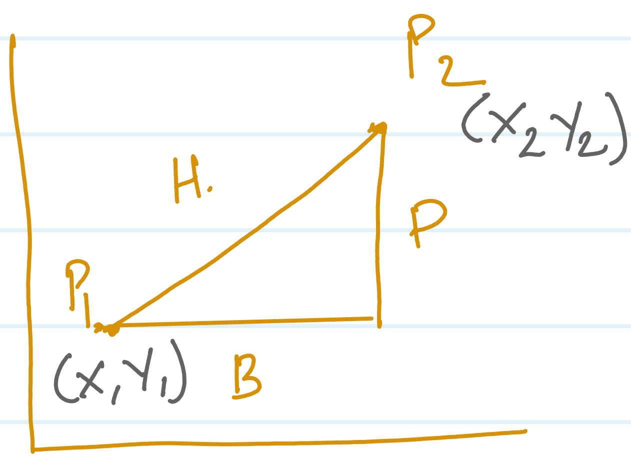
* Unsupervised ML

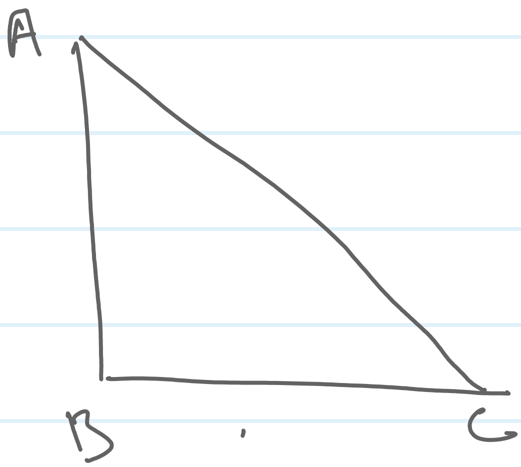
* K-mean clustering



It is centroid based clustering

Heigh	weight
185	72
170	56
168	60
179	68
182	72
188	77
180	71
160	70
183	84
180	88
167	76





$$AC^2 = \sqrt{AB^2 + BC^2}$$

formula

$$D(P_1P_2) = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$$

* Important point

① centroid ✓

② Distance ✓

③ mean ✓

step-① Random centroid choose

2-centroid

① 185 – 72

② 170 – 56

Step ②

3rd	C_1	C_2	3rd
	$(185-72)$	$(170,56)$	$(168, 60)$

$$D(C_1, 3^{rd}) = \sqrt{(168-185)^2 + (60-72)^2}$$

$$= 20.80$$

$$D(C_2, 3^{rd}) = \sqrt{(168-170)^2 + (60-56)^2}$$

$$= 4.4$$

3rd point distance is less for C-2, so It will belong to C-2

C-2 update

$$C_2 = \frac{170+168}{2}, \frac{60+56}{2}$$

$$C_2 = (169, 58)$$

$\underline{\underline{4^{rd}}}$ $= (179, 68)$

$$D(C_1, 4^{th}) = \sqrt{(179-185)^2 + (68-72)^2}$$

$$\sqrt{36+16}$$

$$= 7.21$$

$$D(C_2, 4^{th}) = \sqrt{(179-169)^2 + (68-58)^2}$$

$$= \sqrt{(10)^2 + (10)^2}$$

$$\Rightarrow \sqrt{200}$$

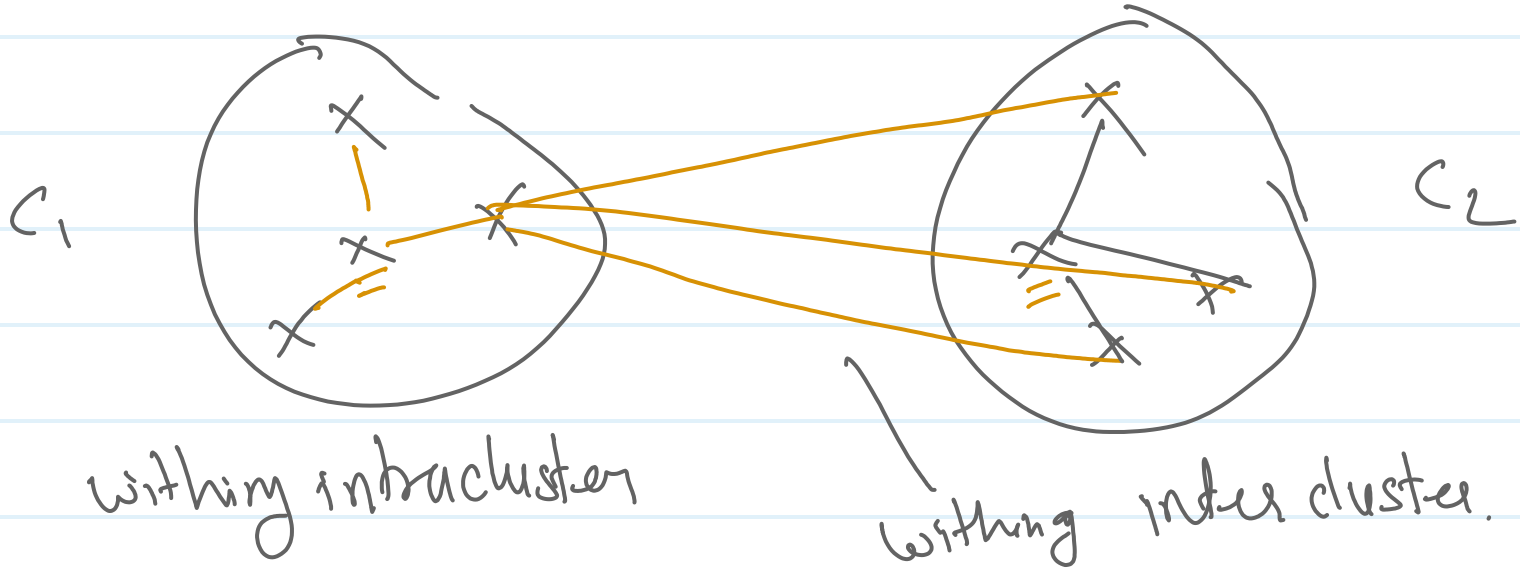
$$\Rightarrow 14.14$$

$\underline{4^{th}}$ point since distance is less for C-1 so it belong to C-1

C_1 - update

$$C_1 = \frac{185+169}{2}, \frac{72+58}{2}$$

$$C_1 \Rightarrow (177, 70)$$



model evaluation

1. Dunn Indexing
2. Silhout score.

1. Dunn Indexing -

$$= \frac{\max \text{ dist. } (x_i \; x_j)}{\max \text{ dist } (Y_i, Y_j)}$$

2. Silhout score

$$= \frac{b_i - a_i}{\max(b_i - a_i)}$$

a_i = withing same clustes (Intra)

b_i = withing other cluster (Inter)

Rang of silhout score

-1 to $+1$

worst

best