

MACHINE LEARNING

Date.....

Logistic Regression

Q Introduction

Q How we can study the Logistic Regression?

Aw

[Logistic Regression]

Geometric Way

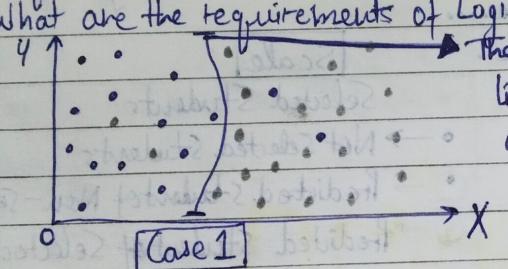
Probabilistic Way

We will do this approach!!!

Q Requirements

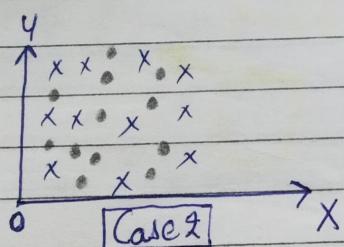
Q What are the requirements of Logistic Regression?

Aw



The data should be mostly

linearly Separable. Here, applying the
Logistic Regression provides better prediction
(Results).



In Case 2, the data is not at all

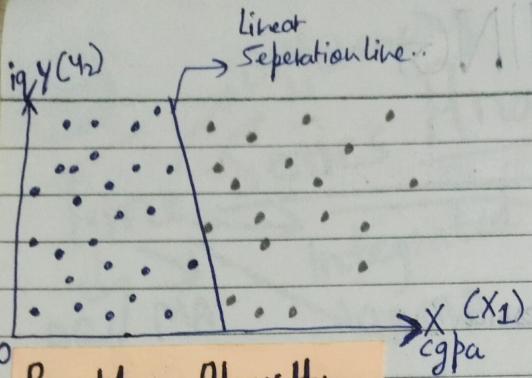
Linearly Separable. So, applying Logistic
Regression in this Case will not provide us
the better results.

Perceptron Trick

Firstly, in the Linear Regression we have $\Rightarrow y = mx + b$

But, in the Logistic Regression we have $\Rightarrow y \Rightarrow Ax + By + C = 0$
 $\Rightarrow Ax_1 + By_1 + C = 0 \Rightarrow Ax_1 + Bx_2 + C = 0$

Basically, our task is to get the Values of A, B, C Spiral



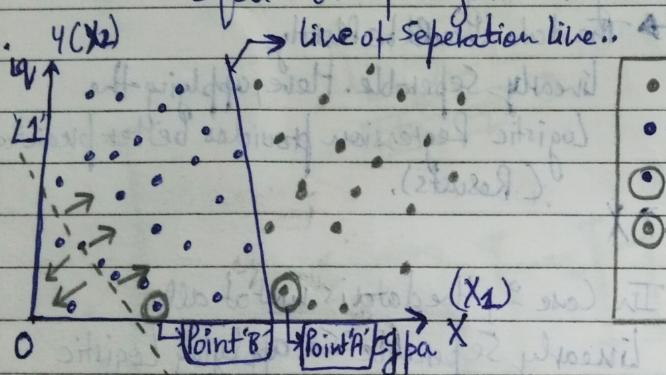
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Our task is to get the equation so that we can find the Equation of this Linear Separation Line..

$$AX_1 + BX_2 + C = 0$$

$$A, B, C, = ?$$

Perception Trick \Rightarrow Perception Trick says that assume all the values, [A, B, C].

(Matlab) \Rightarrow EK Loop chal atleast '1000' times or more which provides the assume or any values of A, B and C till we get the Equation of Logistic line....



[Scale]

- \rightarrow Selected Students
- \rightarrow Not Selected Students
- \rightarrow Predicted Student of Non-Selected
- \rightarrow Predicted Student of Selected

[Graph 'A']

Q How this Perception Trick Works?

Ans ① Firstly, I provide the Random values of A, B, C, let's say $\Rightarrow 1, 1, 0$.

② Selected Values of 'A', 'B' and 'C' draws an Predicted line 'L1'.

③ Now this It selects any random points.

\rightarrow It means all the points available
 \rightarrow here are Black

\rightarrow It means all the points available here are

"Blue"

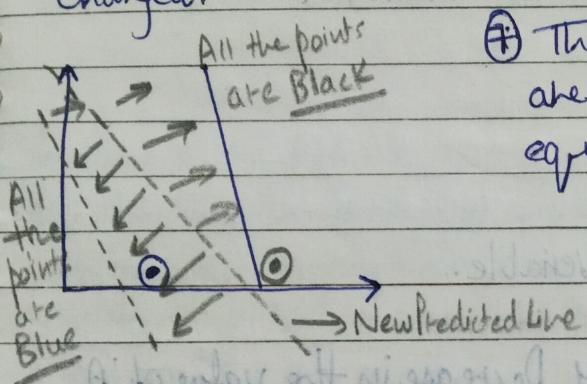
④ Selected Point 'A' by Perception Trick and asks that, I have drawn the "Right line". Point 'A' replies "yes". i.e; no values of A, B and C will be changed.

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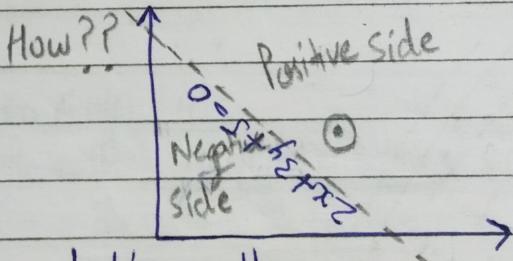
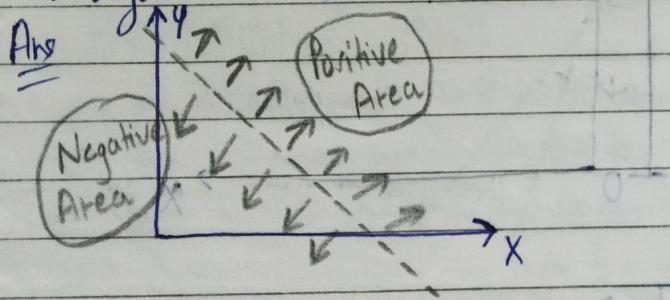
(5) Selected point is now point 'B' in Graph 'A' and asks the same question that I have created the right line no. But at this time, point 'B' replies 'No, I ~~am~~ am a Blue point, but you said that all the points which lies at the right side are Black.'

(6) Now the values of 'A', '~~B~~' and 'C' of the equation will be randomly changed.



(7) This process continues and when all the points are satisfied then we get the Linear partition equation.

Q How to identify whether the particular point belongs to 'Positive' axis or part or negative axis or not?



Let's say the
Equation of this line is:-

$$[2x + 3y + 5 = 0]$$

Case 1:- if $2x + 3y + 5 > 0$
Positive Side

Case 2:- if $2x + 3y + 5 < 0$

Negative Side

Case 3:- if $2x + 3y + 5 = 0$

On the line

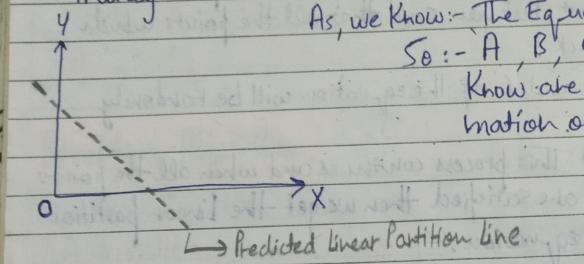
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Transformations in the Line

As, we know:- The Equation of line $\Rightarrow Ax+By+C=0$

So:- 'A', 'B', 'C' as we

Know are responsible for line transformation or movement.

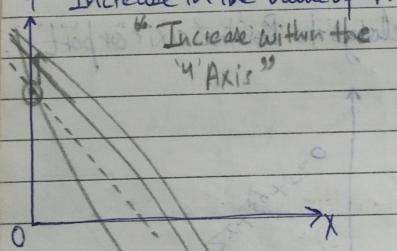


Movement [Transformation] at every Variable..

1. 'A' point

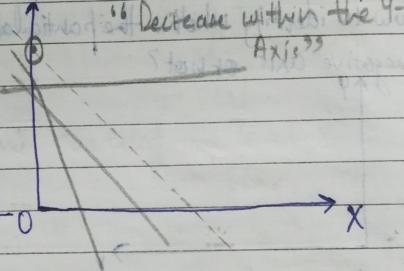
4 Increase in the value of 'A'

"Increase within the
"Y-Axis"



4 Decrease in the value of 'A'

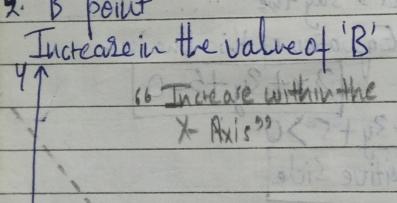
"Decrease within the
"Y-Axis"



2. 'B' point

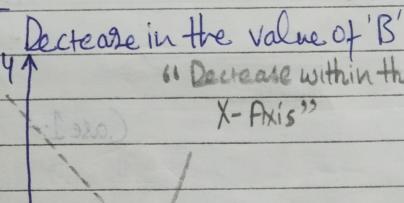
4 Increase in the value of 'B'

"Increase within the
"X-Axis"



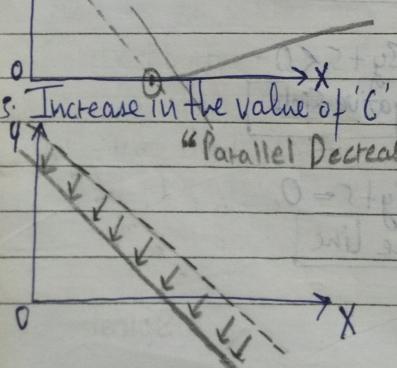
4 Decrease in the value of 'B'

"Decrease within the
"X-Axis"



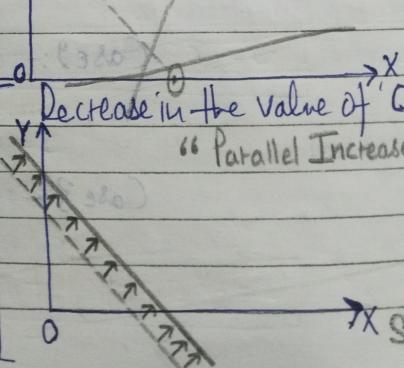
3. Increase in the value of 'C'

"Parallel Decrease"



4 Decrease in the value of 'C'

"Parallel Increase"



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Q How to Label Regions?

Ans

Positive Region

P (x, y)

Q. What is the positive and Negative Region
of the given line?

Negative Region \rightarrow Above and left to the line will be negative.

Positive Region \rightarrow Below and right to the line will be positive.

$2x + 3y + 5 > 0$

[Positive Region] $\rightarrow 2x + 3y + 5 > 0$

[Negative Region] $\rightarrow 2x + 3y + 5 < 0$

Q. How we can find whether the point 'P' lies in Positive Region or Negative Region?

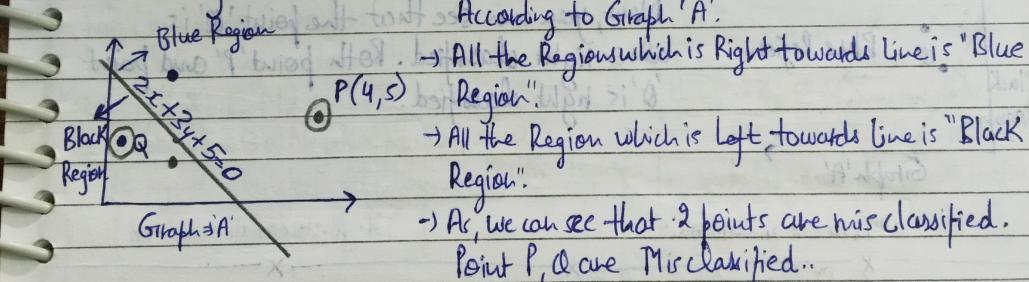
Ans. Let's say the coordinates of P (x, y).

Put the coordinates in the equation of line $2x + 3y + 5$.

If the value comes out > 0 then it is Positive Region, otherwise ' 0 '

Negative and if $= 0$ that means the point 'P' is on the line.

Transformations



To transform the line towards 'point P' will do :-

According to Perceptron Trick :-

① Firstly, take the coordinates of point which is misclassified and want to transform. and add extra '1' to those coordinates. $P(4, 5) \Rightarrow (4, 5, 1)$

② Now, as we transform line to right means ... Subtract all the Constant values of line with the coordinates [Updated Coordinates of $P(4, 5, 1)$].

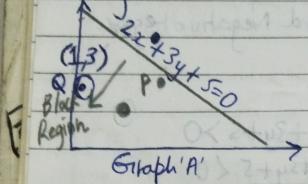
$$2x + 3y + 5 = 0 \Rightarrow \begin{array}{r} 2 \\ -4 \end{array} \quad \begin{array}{r} 3 \\ 5 \end{array} \quad \begin{array}{r} 5 \\ 1 \end{array}$$

The Updated Line will be $-2x - 2y + 4 = 0$] Spiral

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After applying the Perceptron Trick on point 'P', the Graph will be changed as:-

As you can see that the point 'P' is moved to its region [Black Region] i.e., the point is properly classified now..



For Updating the values of the line always Subtract the Co-ordinate values with the coef-values of the line. [For Positive Region].

Now, let's say selecting the point 'Q'.

① Transform the coordinates of Q \rightarrow Q(1,3) \rightarrow Q(1,3,1)

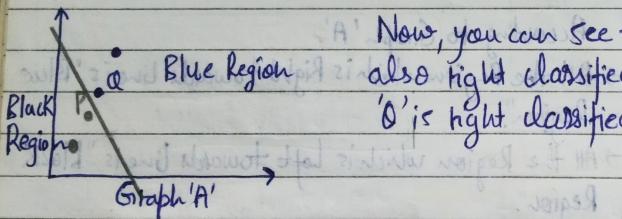
② Now, because we want to transform the line towards left. means "Addition"

For Updating the Line always Add the Co-ordinates

$$+ \begin{matrix} 2 & 3 & 5 \\ 1 & 3 & 1 \\ 3 & 6 & 6 \end{matrix}$$

 values with the coef-values of the line [For Negative Region].
 So, Updated equation of line will be: $3x + 3y + 6 = 0$

After applying the Perceptron Trick, the graph 'A' will be:-



Now, you can see that the point 'Q' is also right classified. Both point 'P' and point 'Q' is right classified.

① Writing the Algorithm for Perceptron Trick

$$\textcircled{1} \quad Ax + By + C = 0 \rightarrow w_0 + w_1 x_1 + w_2 x_2 = 0$$

(X₀) (X₁) (X₂) (C)

Added:	cgpa	iq	placed
1	7.5	81	1
1	8.9	109	1
1	7.0	81	0

Where:-

$$w_0 = C$$

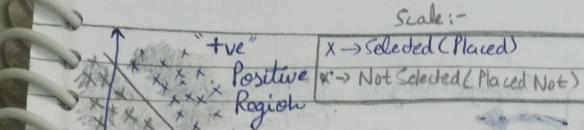
$$w_1 = A$$

$$w_2 = B$$

$$w_0 x_0 + w_1 x_1 + w_2 x_2 = 0$$

Given Data..

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-ve Negative Region

② Now this equation becomes the standard formula :-

Standard formula will be :- $\sum_{i=0}^2 w_i x_i = 0 \Rightarrow w_0 x_0 + w_1 x_1 + w_2 x_2 = 0$

③ How the Algorithm predict the value of 'Y' [Placed or not].

$w_0 x_0 + w_1 x_1 + w_2 x_2 > 0$

$\sum_{i=0}^2 w_i x_i > 0$ it means, we know the value of w_1, w_2 and w_3 ...

Simplify provide the values of x_0, x_1 and x_2 ..

For eg. - $[w_0 \cdot 1 + w_1 \cdot 7 + w_2 \cdot 8] > 0$

if [Answer] $> 0 \Rightarrow$ Placed = 1

else [Answer] $< 0 \Rightarrow$ Not Placed = 0.

epoch $\rightarrow 1000, \eta = 0.01$ [Learning rate]

for i in range (epoch):

selecting any random student from training data

Case1:- if $((x_i \in N) \text{ and } (\sum_{i=0}^2 w_i x_i > 0))$:

It means, this is a Negative pt but stuck in

I just transform the line... i.e., Positive region...

$W_{new} = W_{old} - \eta \cdot x_i$

Here:- " $x_i \in N$ " means that

the actually the student belongs to Negative region.

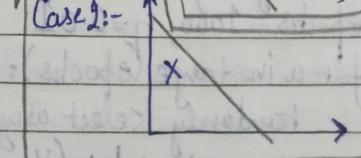
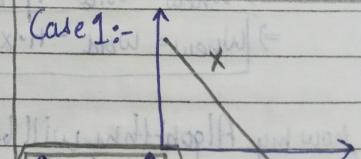
" $\sum_{i=0}^2 w_i x_i$ " is the Predicted value.

Case2:- if $((x_i \in P) \text{ and } (\sum_{i=0}^2 w_i x_i < 0))$:

I just update the values of w_0, w_1 and w_2

$W_{new} = W_{old} + \eta \cdot x_i$

It means this is a Positive pt but stuck in Negative region...



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Our Algorithm will be :-

$\boxed{\text{if } ((X_i \in N) \text{ and } (\sum_{i=0}^2 w_i x_i > 0)):$

 $w_{\text{new}} = w_{\text{old}} - \eta \cdot x_i$

 $\text{if } ((X_i \in P) \text{ and } (\sum_{i=0}^2 w_i x_i < 0)):$
 $w_{\text{new}} = w_{\text{old}} + \eta \cdot x_i$

$$\boxed{w_{\text{new}} = w_{\text{old}} + \eta \cdot (y - \hat{y}) \cdot x_i}$$

Simplified way..

$y \Rightarrow$ Actual value of y .
 $\hat{y} \Rightarrow$ Predicted Value of y .

y	\hat{y}	$y - \hat{y}$	
1	1	0	\Rightarrow Case 1
0	0	0	\Rightarrow Case 2
1	0	1	\Rightarrow Case 3
0	1	-1	\Rightarrow Case 4

Drug. Running of program with each case...

Case 1 :- $w_{\text{new}} = w_{\text{old}} + 0.01(0) \cdot x_i$

and Case 2 :- $w_{\text{new}} = w_{\text{old}} + 0$

$\therefore \boxed{w_{\text{new}} = w_{\text{old}}} \Rightarrow$ It means no change in the values of w_1, w_0 and w_2 ...

Case 3 :- $w_{\text{new}} = w_{\text{old}} + \eta(4 - \hat{y}) \cdot x_i$

$\Rightarrow \boxed{w_{\text{new}} = w_{\text{old}} + \eta(1) \cdot x_i}$

$\Rightarrow \boxed{w_{\text{new}} = w_{\text{old}} + \eta x_i}$ \Rightarrow This is what I received from the case 3 and it exactly equals to the second if case body...

Case 4 :- $w_{\text{new}} = w_{\text{old}} + \eta(4 - \hat{y}) \cdot x_i$

$\Rightarrow \boxed{w_{\text{new}} = w_{\text{old}} + \eta(-1) \cdot x_i}$

$\Rightarrow \boxed{w_{\text{new}} = w_{\text{old}} - \eta \cdot x_i}$

$\Rightarrow \boxed{w_{\text{new}} = w_{\text{old}} - \eta \cdot x_i}$ \Rightarrow This is same I received, what I have proved in first's if case...

So, how my Algorithm will be like :-

epochs = 1000, $\eta = 0.01$

for a in range (epochs):

 randomly select any Student(i)

$w_{\text{new}} = w_{\text{old}} + \eta(4 - \hat{y}) \cdot x_i$