

Assignment 2 Machine Learning COS4852

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1 Question 1

1.1 Question 1(a)

Firstly we calculate the line

$$x_2 = mx_1 + c \quad (1)$$

for the intersect points (2,0) and (0,6).

Calculating slope m,

$$\begin{aligned} m &= \frac{6 - 0}{0 - 2} \\ &= -3 \end{aligned} \quad (2)$$

x_2 intercept c is 6.

This makes equation 1

$$x_2 = -3x_1 + 6 \quad (3)$$

Nils J Nilsson (1998) gives the equation for the hyperplane as

$$\sum_{i=1}^n x_i \omega_i \geq \theta \quad (4)$$

which in this case gives the equation for the hyperplane to be

$$\omega_1 x_1 + \omega_2 x_2 + \omega_3 = 0 \quad (5)$$

We need to get equation 5 in the form of equation 1

$$\begin{aligned} \omega_1 x_1 + \omega_2 x_2 + \omega_3 &= 0 \\ \omega_2 x_2 &= -\omega_1 x_1 - \omega_3 \\ x_2 &= \frac{\omega_1 x_1}{\omega_2} - \frac{\omega_3}{\omega_2} \end{aligned} \quad (6)$$

Comparing coefficients m and c from equation 3 to 6 we get

$$\begin{aligned} -\frac{\omega_1}{\omega_2} &= -3 \\ \omega_1 &= 3\omega_2 \end{aligned} \quad (7)$$

and

$$\begin{aligned} -\frac{\omega_3}{\omega_2} &= 6 \\ \omega_3 &= -6\omega_2 \end{aligned} \quad (8)$$

If we choose $\omega_3 = -2$ then $\omega_1 = 1$ and $\omega_2 = \frac{1}{3}$. This makes the hyperplane equation from equation 5

$$x_1 + \frac{x_2}{3} - 2 = 0 \quad (9)$$

Now we need to test this hyperplane. For positive instance (2,6)

$$\begin{aligned} x_1 + \frac{x_2}{3} - 2 &= \\ 2 + \frac{6}{3} - 2 &= \\ 2 \end{aligned} \quad (10)$$

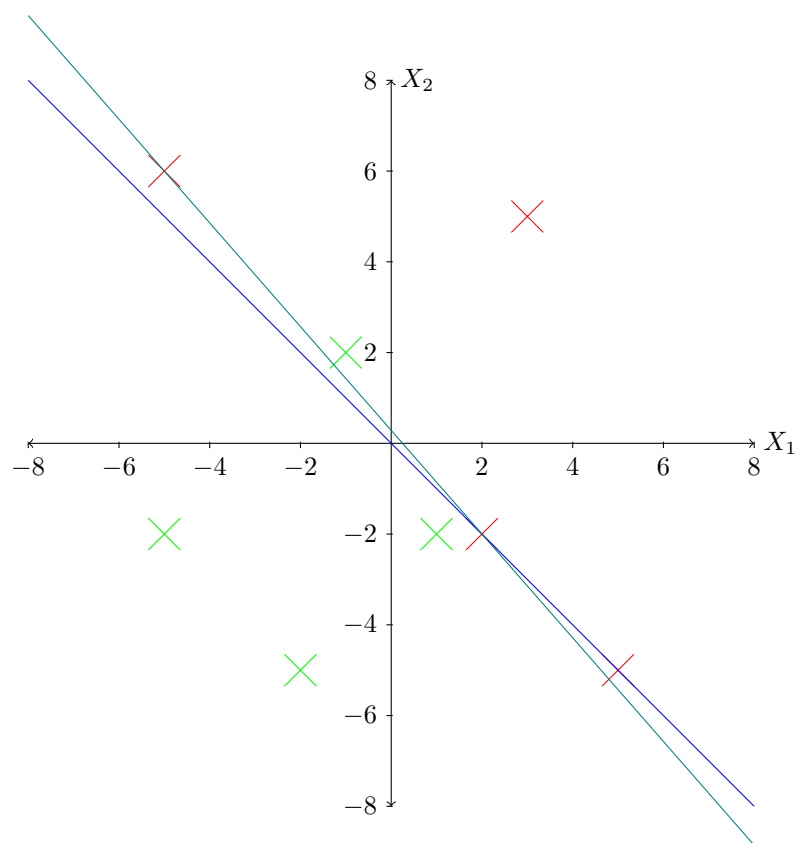
Which is as expected.

And the negative instance (-1,2)

$$\begin{aligned} x_1 + \frac{x_2}{3} - 2 &= \\ -1 + \frac{2}{3} - 2 &= \\ -\frac{7}{3} \end{aligned} \quad (11)$$

This is also as expected. The perceptron now classifies the the data correctly

1.2 Question 1(b)



From the above image we can see that any

1.3 Question 1(c)

1.4 Question 1(d)

2 Question 2

2.1 Question 2(a)

2.2 Question 2(b)

2.3 Question 2(c)

3 Question 3

3.1 Question 3(a)

3.2 Question 3(b)

3.3 Question 3(c)

3.4 Question 3(d)

3.5 Question 3(e)

References

Nils J Nilsson. (1998). *Introduction to Machine Learning*. Retrieved from
<http://robotics.stanford.edu/people/nilsson/MLBOOK.pdf>