

Q1. Perceptron update rule

We have the following data points and labels:

x1	x2	Label
5	3	1
-1	-4	1

Our initial guess for the classifier is $2x_1 - x_2 - 6 = 0$. We will use the perceptron update rule for updating the coefficients of classifier, which says that:

1. If a label 1 datapoint is misclassified, we will update w using $w = w + x$, and
2. If a label -1 datapoint is misclassified, we will update w using $w = w - x$, where w is the coefficient vector and x is the variables vector.

What is the new equation after one update using the perceptron update rule?

Note: A classifier predicts label 1 if $w^T x > 0$ and -1 if $w^T x < 0$, where w ($[w_1, w_2, w_0]$) is the weight vector and w_0 is the intercept and $x = [x_1, x_2, 1]$

- A. $3x_1 + 3x_2 - 6 = 0$
- B. $3x_1 + 3x_2 + 6 = 0$
- C. $x_1 - 5x_2 + 5 = 0$
- D. $x_1 - 5x_2 - 5 = 0$

Q2. Classifier

Let the equation: $4x_1 + 3x_2 - 2x_3 + 8 = 0$ define a classifier

The classifier assigns a label of +1 if the datapoint lies in the +ve halfspace, and a label of -1 if it lies in the -ve halfspace. Which of the following points are wrongly classified by the classifier?

P1: (1, 2, 1), label: -1

P2: (-3, -7, 1), label: 1

P3: (2, -8, 1), label: -1

- A. P3 only
- B. P1 and P2
- C. P2 and P3
- D. P1, P2 and P3

Q3. Coordinates

We want to represent the point $\mathbf{x} = (4, 3, 5)$ in terms of the two vectors: $\mathbf{a} = (1, 2, -1)$ and $\mathbf{b} = (3, 1, 5)$. What is the new representation of \mathbf{x} considering that the vectors \mathbf{a} and \mathbf{b} are the axes of this new coordinate system?

Note: $\hat{\mathbf{A}}$ and $\hat{\mathbf{B}}$ are unit vectors in the directions of \mathbf{a} and \mathbf{b} respectively.

- A. $5 \hat{\mathbf{A}} + 40 \hat{\mathbf{B}}$
- B. $\frac{5}{\sqrt{6}} \hat{\mathbf{A}} + \frac{40}{\sqrt{35}} \hat{\mathbf{B}}$
- C. $-5 \hat{\mathbf{A}} + 40 \hat{\mathbf{B}}$
- D. $\frac{5}{\sqrt{6}} \hat{\mathbf{A}} - \frac{40}{\sqrt{35}} \hat{\mathbf{B}}$

Q4. Hyperplanes

Calculate the distance between the two hyperplanes:

P1: $x_1 + 2x_2 - x_3 = 0$

P2: $2x_1 + 4x_2 - 2x_3 - 8 = 0$

- A. $2 / \sqrt{6}$
- B. $4 / \sqrt{6}$
- C. $3 / \sqrt{6}$
- D. $1 / \sqrt{6}$

Q5. Ascending order

We are given the equation of a hyperplane: $4x_1 - x_2 - 2x_3 + 1 = 0$

We are also given the following points, all classified as +ve by the above hyperplane:

P1: (2, -1, -2), P2: (5, -1, -7), P3: (-1, -4, -3), P4: (5, 1, 2)

What is the ascending order of confidence for the given points?

The confidence of each point is directly proportional to the distance of a point from the hyperplane.

- A. P3, P1, P4, P2
- B. P1, P3, P2, P4
- C. P3, P1, P2, P4
- D. P1, P2, P3, P4

Q6. Positive half space

Given a plane: $4x_1 + 3x_2 - 5 = 0$, find the equation of a parallel plane that is at a distance of 3 away from this plane and lies in the positive half-space of this plane.

- A. $4x_1 + 3x_2 + 20 = 0$
- B. $4x_1 + 3x_2 - 20 = 0$
- C. $4x_1 + 3x_2 - 15 = 0$
- D. $4x_1 + 3x_2 + 15 = 0$