

Week 3 Exercises

The questions below are due on Sunday September 24, 2017; 11:00:00 PM.

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- Videos
 - Week 3, Lecture 1 (https://introml.mit.edu/lecture_videos/lec_week3_part1.mp4)
 - Week 3, Lecture 2 (https://introml.mit.edu/lecture_videos/lec_week3_part2.mp4)
- Class Notes for Week 3 (https://introml.mit.edu/__STATIC__/fall17/exercises/ex03/Wk3_notes.pdf)
- Required Exercises

1) MARGIN DEFINITION

The signed distance from a point x with respect to a hyperplane θ, θ_0 is $sd(x, \theta, \theta_0) = \frac{\theta^T x + \theta_0}{\|\theta\|}$

1. You start with a hyperplane θ, θ_0 and a point x . Suppose a new separator is given, where $\hat{\theta} = -\theta$ and $\hat{\theta}_0 = -\theta_0$.

Which of the following is true:

both the sign and the magnitude may change

2. You start with a hyperplane θ, θ_0 and a point x . Suppose a new separator is given, where $\hat{\theta} = \theta$ and $\hat{\theta}_0 = -\theta_0$.

Which of the following is true:

both the sign and the magnitude may change

3. The margin of example x, y with respect to separator θ, θ_0 is:

$$\gamma(x, y, \theta, \theta_0) = \frac{y(\theta^T x + \theta_0)}{\|\theta\|}$$

Let sd stand for $sd(x, \theta, \theta_0)$, the signed distance from x to the separator. Define the margin in terms of sd and y , the label of x . Note that both of these are scalars. Provide an expression in Python syntax.

$$\gamma(x, y, \theta, \theta_0) = y * sd$$

4. What is the sign of the signed distance when the prediction is incorrect?

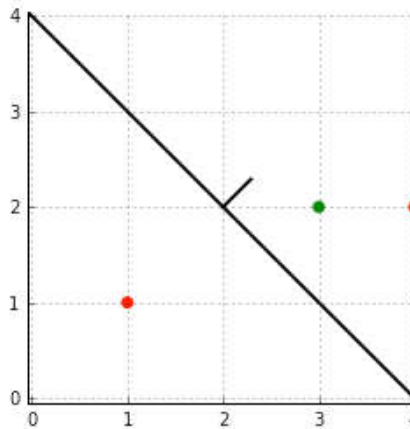
Which of the following is true: negative

5. What is the sign of the margin when the prediction is incorrect?

Which of the following is true: positive

2) MARGIN PRACTICE

What are the margins of the points $((3, 2), +1)$, $((1, 1), -1)$, and $((4, 2), -1)$ with respect to the separator defined by $\theta = (1, 1)$, $\theta_0 = -4$? The situation is illustrated in the figure below.



Enter the three margins in order as a Python list of 3 numbers.

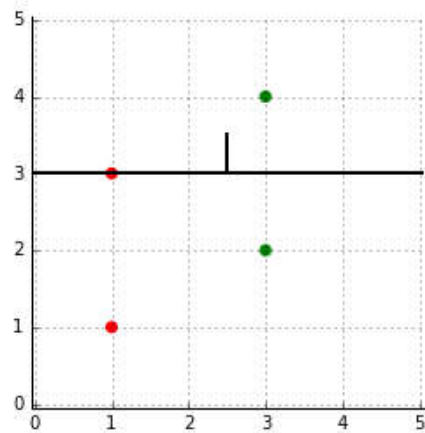
[0.70710678, 1.41421356, -1.41421356]

3) MAX MARGIN

Consider the four points and separator:

```
data = np.array([[1, 1, 3, 3], [3, 1, 4, 2]])
labels = np.array([[-1, -1, 1, 1]])
th = np.array([[0, 1]]).T
th0 = -3
```

The situation is shown below:



1.

Enter the four margins in order as a Python list of 4 numbers.

2.

Enter θ and θ_0 for a maximum margin separator as a Python list of three numbers.

3.

If you scaled this separator by a positive constant k , would it still be the a maximum margin separator?