

Quiz 7

⚠ This is a preview of the published version of the quiz

Started: Dec 11 at 4:46pm

Quiz Instructions

Question 1

1 pts

Select all of the statements that are true below.

- Consider two learning scenarios using the same learning algorithm L , and the same hypothesis space H . In the first scenario we can tolerate error rate of ϵ_1 , and in the second, error rate of ϵ_2 . If $\epsilon_1 < \epsilon_2$, then in the first scenario we will probably need to train L on more examples than in the second scenario.
- When learning using a finite hypothesis space H , if the sample complexity of the learning algorithm is super-polynomial in the log of the size of H , then the concept class, C , is not PAC learnable.
- Let S be a set training examples of size m that is labeled according to a function $f \in C$. If the learning algorithm L is completely consistent with all m examples in S then C is PAC learnable.
- If the algorithm's time complexity is not polynomial, then the concept class, C , is not PAC learnable.

Question 2

1 pts

Is the class H_{disj} (all disjunctions over n variables) PAC learnable ?

- Yes, since $|H_{disj}| = 3^n$ and learnability depends on the log of this size, and there exists an algorithm that is consistent with an hypothesis in H_{disj} .

- Yes, since $|H_{disj}| = poly(n)$
-
- No, since it is NP hard to find the smallest disjunction that is consistent with the dataset.
-
- No, since $|H_{disj}| = 3^n$

Question 3**1 pts**

We want to learn a weight vector by optimizing the Soft SVM formulation. We want to use the L2 loss for optimization:

$$\min_w \left(\frac{1}{2} w^T w + C \max(0, 1 - y_i w^T x_i)^2 \right)$$

Assume that we have $1 > y_i w^T x_i$. If we want to use SGD to update our weight vector, which one of the following is the correct update equation?

- $w_{t+1} = w_t - \eta w_t + 2C\eta(1 - y_i w_t^T x_i) y_i x_i$
-
- $w_{t+1} = w_t + \eta w_t - 2C\eta(1 - y_i w_t^T x_i) y_i x_i$
-
- $w_{t+1} = w_t - \eta w_t + 2\eta C y_i x_i$
-
- $w_{t+1} = w_t + \eta w_t - 2\eta C y_i x_i$
-
- $w_{t+1} = w_t - \eta \|w_t\| + 2\eta C y_i x_i$
-
- $w_{t+1} = w_t + \eta \|w_t\| - 2\eta C y_i x_i$

Question 4**1 pts**

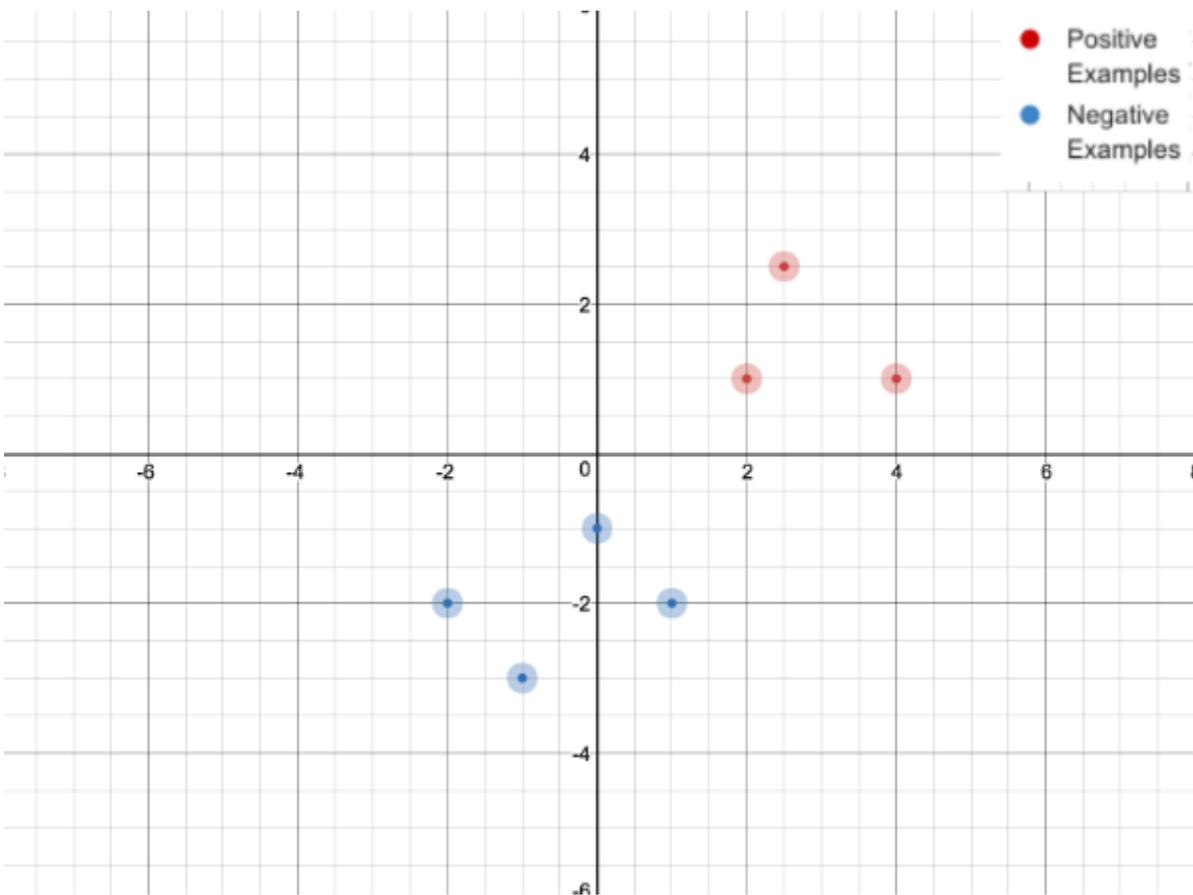
Which weight vector will you obtain when you optimize according to the Hard SVM formulation

$$\min_{\mathbf{w}} \frac{1}{2} \|\mathbf{w}\|^2$$

$$\text{s.t. } y^{(i)} (\mathbf{w} \cdot \mathbf{x}^{(i)} + \theta) \geq 1, \forall (\mathbf{x}^{(i)}, y^{(i)}) \in D$$

for the following data points below?

Example	x_1	x_2	$y = \text{Label}$
1	2	1	1
2	0	-1	-1
3	2.5	2.5	1
4	4	1	1
5	-2	-2	-1
6	-1	-3	-1
7	1	-2	-1



$\mathbf{w}^T = [0.5, -0.5], \theta = 0$

$w^T = [0.5, -0.5], \theta = -0.5$

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$w^T = [0.5, -0.5], \theta = 0.5$

$w^T = [0.5, 0.5], \theta = 0$

Question 5

1 pts

Consider the hypothesis space of “origin-centered spheres”, the set of all spheres that are centered at the origin of the three-dimensional space. The class can be formally represented as:

$$H_{\circ} = \{h_r : x^2 + y^2 + z^2 = r^2 : r \in \mathbb{R}, r > 0\}$$

For each r , h_r assigns a positive or negative label based on if the point is inside or outside of the sphere. (for example, it can assign positive a label to the point outside of the circle and vice versa.)

Is this hypothesis PAC learnable? What is the VC Dimension of the hypothesis space?

Yes, The hypothesis space is PAC learnable. $VC(H) = 3$, because we can shatter a subset of size 3 but no subset of size 4 can be shattered.

Yes, The hypothesis space is PAC learnable. $VC(H) = 2$, because we can shatter a subset of size 2 but no subset of size 3 can be shattered.

No, The hypothesis space is PAC learnable. $VC(H) = 4$, because we can shatter a subset of size 3 but no subset of size 4 can be shattered.

Yes, The hypothesis space is PAC learnable. $VC(H) = 3$, because we can shatter a subset of size 2 but no subset of size 3 can be shattered.

- No , The hypothesis space is not PAC learnable. $VC(H) = 2$, because we can shatter a subset of size 2 but no subset of size 3 can be shattered.
-
- No , The hypothesis space is not PAC learnable. $VC(H) = 3$, because we can shatter a subset of size 2 but no subset of size 3 can be shattered.

Question 6**1 pts**

We define a hypothesis space H that is the union of two intervals $[a, b]$, $[c, d]$, where $a < b < c < d$. An instance x is positive if and only if $a < x < b$ or $c < x < d$.

What is the VC dimension of H ?

Quiz saved at 4:52pm

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