1. Perceptron Mistakes

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Homework due Sep 30, 2020 05:29 IST *Completed*

In this problem, we will investigate the perceptron algorithm with different iteration ordering.

Consider applying the perceptron algorithm **through the origin** based on a small training set containing three points:

$x^{(1)}$ =[-1,-1],	$y^{(1)}$=1
$x^{(2)}$ =[1,0],	$y^{(2)}$=-1
$x^{(3)}$ =[-1, 1.5],	$y^{(3)}$=1

Given that the algorithm starts with $\theta^{(0)} = 0$, the first point that the algorithm sees is always considered a mistake. The algorithm starts with some data point and then cycles through the data (in order) until it makes no further mistakes.

1. (a)

4.0/4 points (graded)

How many mistakes does the algorithm make until convergence if the algorithm starts with data point $x^{(1)}$? How many mistakes does the algorithm make if it starts with data point $x^{(2)}$?

Also provide the progression of the separating plane as the algorithm cycles in the following **list format**: $[[\theta_1^{(1)}, \theta_2^{(1)}], \ldots, [\theta_1^{(N)}, \theta_2^{(N)}]]$, where the superscript denotes different θ as the separating plane progresses. For example, if θ progress from $[0, 0]$ (initialization) to $[1, 2]$ to $[3, -2]$, you should enter $[[1, 2], [3, -2]]$

Please enter the **number of mistakes** of Perceptron algorithm if the algorithm starts with $x^{(1)}$.

2

Please enter the **progression of the separating hyperplane (θ, in the list format described above)** of Perceptron algorithm if the algorithm starts with $x^{(1)}$.

()

[[-1,-1],[-2,0.5]]

Please enter the **number of mistakes** of Perceptron algorithm if the algorithm starts with $x^{(2)}$.

1

Please enter the **progression of the separating hyperplane (θ, in the list format described above)** of Perceptron algorithm if the algorithm starts with $x^{(2)}$.

[[-1,0]]

Submit You have used 1 of 3 attempts

1. (b)

1/1 point (graded)

In part (a), what are the factors that affect the number of mistakes made by the algorithm?

Note: Only choose factors that were changed in part (a), **not** all factors that can affect the number of mistakes

(Choose all that apply.)

- [x] Iteration order
- [ ] Maximum margin between positive and negative data points
- [ ] Maximum norm of data points

✔

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1. (c)

4.0/4 points (graded)

Now assume that $x^{(3)} = [-1, 10]$. How many mistakes does the algorithm make until convergence if cycling starts with data point $x^{(1)}$?

Also provide the progression of the separating plane as the algorithm cycles in the following **list format**: $[[\theta_1^{(1)}, \theta_2^{(1)}], \ldots, [\theta_1^{(N)}, \theta_2^{(N)}]]$, where the superscript denotes different θ as the separating plane progresses. For example, if θ progress from $[0, 0]$ (initialization) to $[1, 2]$ to $[3, -2]$, you should enter $[[1, 2], [3, -2]]$

Please enter the **number of mistakes** of Perceptron algorithm if the algorithm starts with $x^{(1)}$.

6 ✔

Please enter the **progression of the separating hyperplane (θ, in a list format described above)** of Perceptron algorithm if the algorithm starts with $x^{(1)}$.

[[-1,-1],[-2,9],[-3,8],[-4,7],[✔

Please enter the **number of mistakes** of Perceptron algorithm if the algorithm starts with $x^{(2)}$.

1 ✔

Please enter the **progression of the separating hyperplane (θ, in the list format described above)** of Perceptron algorithm if the algorithm starts with $x^{(2)}$.

[[-1,0]] ✔

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1. (d)

1/1 point (graded)

For a fixed iteration order, what are the factors that affect the number of mistakes made by the algorithm between part (a) and part (c)?

Note: Only choose factors that were changed between part (a) and part (c), **not** all factors that can affect the number of mistakes

(Choose all that apply.)

(Choose all that apply.)

- [ ] Iteration order
- [ ] Maximum margin between positive and negative data points
- [x] Maximum norm of data points

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1. (e) (Optional)

0 points possible (ungraded)

In 1962, Novikoff has proven the following theorem.

Assume:

- There exists θ^* such that $\frac{y^{(i)}(\theta^* x^{(i)})}{\|\theta^*\|} \geq \gamma$ for all $i = 1, \cdots, n$ and some $\gamma > 0$
- All the examples are bounded $\|x^{(i)}\| \leq R, i = 1, \cdots, n$

Then the number k of updates made by the perceptron algorithm is bounded by $\frac{R^2}{\gamma^2}$.

(Note that the first condition implies that the data is linearly separable)

For proof, refer to theorem 1 of this paper. Based on this theorem, what are the factors that constitute the bound on the number of mistakes made by the algorithm?

(Choose all that apply.)

- [ ] Iteration order
- [x] Maximum margin between positive and negative data points
- [x] Maximum norm of data points
- [ ] Average norm of data points

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1. (f) (Optional)

0 points possible (ungraded)

Now we want to establish an adversarial procedure to maximize the number of mistakes the perceptron algorithm makes. What are possible solutions? You should consider a general dataset instead of part (a) and part (c). (Choose all that apply.)

- [ ] Exhaustive search the worst ordering
- [ ] Dynamic Programming the worst ordering

☑ Greedily select the data point with the maximum norm

✖

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