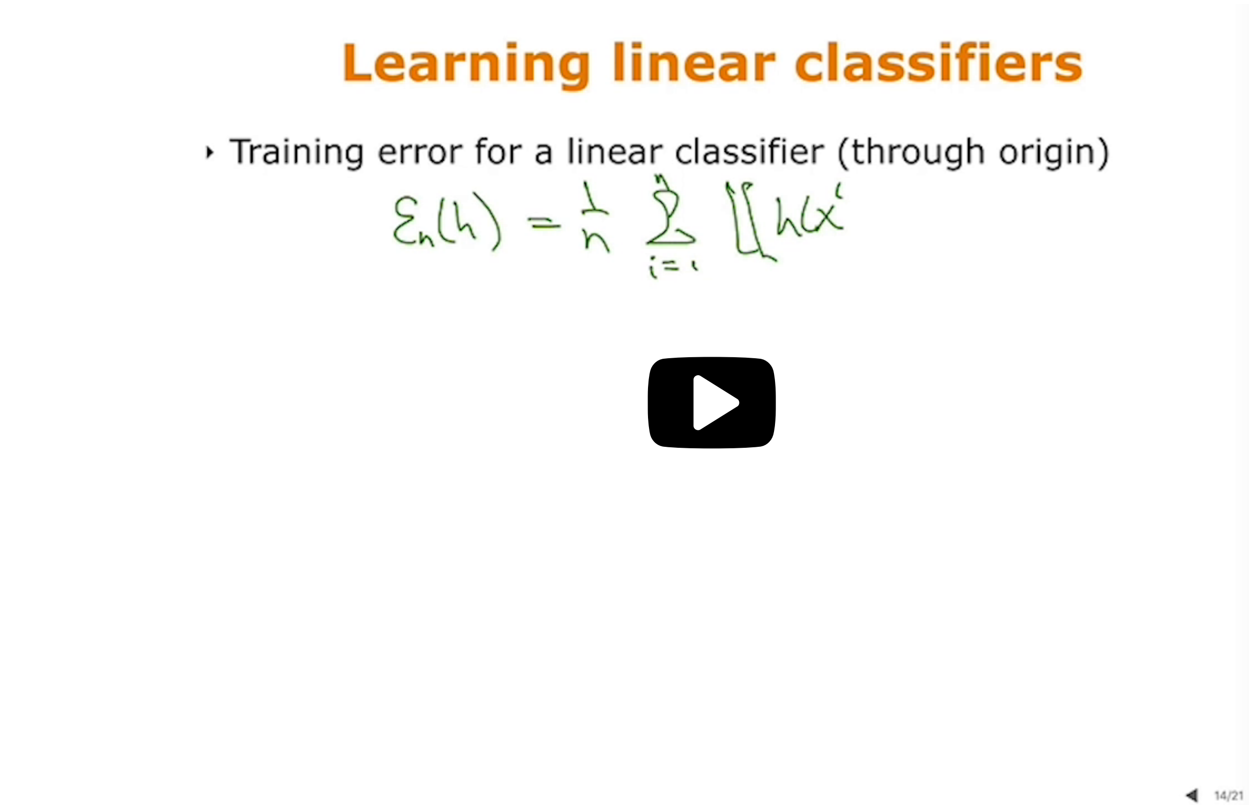
5. The Perceptron Algorithm

The Perceptron Algorithm



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Start of transcript. Skip to the end.

All right.

We defined earlier, training error

for any classifier as a fraction of training samples

that are misclassified--

so in terms of whether or not the classifier

applied to their training example,

whether it disagrees with a given label for that example.

All right.

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Perceptron Concept Questions 1

1/1 point (graded)

Remember that the Perceptron Algorithm (without offset) is stated as the following:

Perceptron $\left(\left\{\left(x^{(i)}, y^{(i)}\right), i=1, \ldots, n\right\}, T\right)$:

initialize $\theta = 0$(vector);

for $t = 1, \ldots, T$ do

for $i = 1, \ldots, n$ do

if $y^{(i)}\left(\theta \cdot x^{(i)}\right) \leq 0$ then

update $\theta = \theta + y^{(i)} x^{(i)}$

What does the Perceptron algorithm take as inputs among the following? Choose all those apply.

- [x] Training set ✔
- [x] T - the number of times the algorithm iterates through the whole training set ✔
- [ ] Test set
- [ ] θ
- [ ] θ_0

✔

Solution:

The perceptron algorithm takes T and the training set as input, and aims to learn the optimal "θ","θ_0"

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Answers are displayed within the problem

Perceptron Update 1

1/1 point (graded)

Now consider the Perceptron algorithm with Offset. Whenever there is a "mistake" (or equivalently, whenever $y^{(i)}\left(\theta \cdot x^{(i)}+\theta_0\right) \leq 0$ i.e. when the label y^{i} and $h\left(x\right)$ do not match), perceptron updates

$$\theta \text{ with } \theta+y^{(i)}x^{(i)}$$

and

$$\theta_0 \text{ with } \theta_0+y^{(i)}.$$

More formally, the Perceptron Algorithm with Offset is defined as follows:

Perceptron $\left(\left\{\left(x^{(i)}, y^{(i)}\right), i=1,\ldots,n\right\}, T\right)$:

initialize $\theta=0$(vector); $\theta_0=0$(scalar)

for $t=1,\ldots,T$ do

for $i=1,\ldots,n$ do

if $y^{(i)}\left(\theta \cdot x^{(i)}+\theta_0\right) \leq 0$ then

update $\theta=\theta+y^{(i)}x^{(i)}$

update $\theta_0=\theta_0+y^{(i)}$

In the next set of problems, we will try to understand why such an update is a reasonable one.

When a mistake is spotted, do the updated values of θ and θ_0 provide a better prediction? In other words, is

$$y^{(i)}\left(\left(\theta+y^{(i)}x^{(i)}\right)\cdot x^{(i)}+\theta_0+y^{(i)}\right)$$

always greater than or equal to

$$y^{(i)}\left(\theta \cdot x^{(i)}+\theta_0\right)$$

- Yes, because $\theta+y^{(i)}x^{(i)}$ is always larger than θ

- [x] Yes, because $\left(y^{(i)}\right)^2 \|x^{(i)}\|^2 + \left(y^{(i)}\right)^2 \geq 0$ ✔
- [ ] No, because $\left(y^{(i)}\right)^2 \|x^{(i)}\|^2 - \left(y^{i}\right)^2 \leq 0$
- [ ] No, because $\theta + y^{(i)} x^{(i)}$ is always larger than θ

Solution:

Comparing the two terms,

$$y^{(i)}\left(\left(\theta + y^{(i)} x^{(i)}\right) \cdot x^{(i)} + \theta_0 + y^{(i)}\right) - y^{(i)}\left(\theta \cdot x^{(i)} + \theta_0\right) = \left(y^{(i)}\right)^2 \|x^{(i)}\|^2 + \left(y^{(i)}\right)^2 = \left(y^{(i)}\right)^2 \left(\|x^{(i)}\|^2 + 1\right)\right) > 0$$

the first is always greater than the latter. Considering that our goal is to minimize the training error, the update always makes the training error decrease, which is desirable.

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Answers are displayed within the problem

Perceptron Update 2

0 points possible (ungraded)

For a given example i, we defined the training error as 1 if $y^{(i)}\left(\theta \cdot x^{(i)} + \theta_0\right) \leq 0$, and 0 otherwise:

$$\varepsilon_i\left(\theta, \theta_0\right) = \left[\left[y^{(i)}\left(\theta \cdot x^{(i)} + \theta_0\right) \leq 0 \right]\right]$$

Say we have a linear classifier given by θ, θ_0. After the perceptron update using example i, the training error $\varepsilon_i\left(\theta, \theta_0\right)$ for that example can (select all those apply):

- [ ] Increase

- [x] Stay the same ✔
- [x] Decrease ✔

✔

Solution:

From the previous problem, we saw that $y^i\left(\theta \cdot x + \theta_0\right)$ increases after the perceptron update. Thus $\left[\left[y^i\left(\theta \cdot x + \theta_0\right) \leq 0\right]\right]$ becomes zero or stays 1.

Submit You have used 2 of 2 attempts

Answers are displayed within the problem

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- Mistake on the algorithm? (restart from first observation after theta update) 2
  In the described algorithm, if there is an update of theta on the observation n, it then continues to the observation n+1. Based on the questions I believe that after each u...
- Perceptron Update 1 2
- [Staff] [Typo] Perceptron Update 2 5
  Community TA
- R & Coffee - The Perceptron Algorithm 7
- Analysis of training set 5
  How to find the optimal T to use in the perceptron algorithm for a given training set? Is there a (theoretical) way to check the separability of a training set?
- Solution to perceptron update 1 and 2 possibly not well worded 3
- Perceptron Algo 2
  Why the double square brackets?

Geometric Interpretation -- Projection or Something Else?
I remember my calc a lot better than linear algebra. When he adds the second point, a second vector is discovered between the first line of orthogonality and the second ... 2

2nd step on the perceptron
why do you consider the 1st observation y(i) = 1 and not -1? thanks! 5

[Staff] Perception Update 2 grading is wrong
Hi, My answer was correct but graded wrong by the system. --- deleted; BB --- [1]: https://edxuploads.s3.amazonaws.com/1561151064347887.png 3

Proof of the convergence of the perceptron
This set of notes has a proof of the convergence of the perceptron algorithm after a bounded number of steps): https://www.cse.iitb.ac.in/~shivaram/teaching/old/cs344+... 3

Transforming yi((θ+yix)·x+θ0+yi) for later iterations
So I understand that in the beginning θ and θ0 are null and therefore yi((θ+yix)·x+θ0+yi) = (yi)^2*x^2+(yi)^2 But how does it hold up for the further iterations? Isn't it possi... 5

[Staff]Q2
Is the question about error on ith point immediately after ith point has been processed by the algo or is it after all T passes ? 4

Is this the same as the perceptron in NN? 2

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