3. Linear Classifiers Mathematically Revisited

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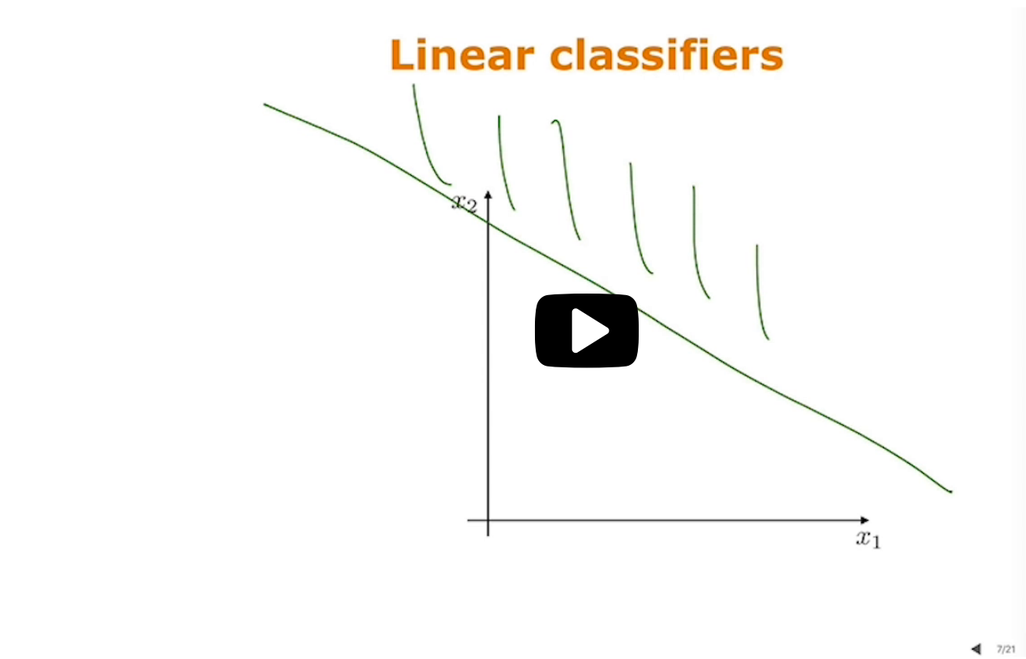

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Start of transcript. Skip to the end.

All right, let's try to understand

the set of linear classifiers.

In particular, let's take a specific linear classifier.

It divides the space into two halves linearly.

So on one side, the classifier says that all the examples

are positive.

And on the other side, they are labeled negative.

The dividing line here is also called decision boundary.

In 2D, that decision boundary is a line

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Inner product and Orthogonal vectors

1/1 point (graded)
What is the inner product of $[0, 1, 1]$ and $[1, 1, 1]$?

2 ✔ **Answer:** 2

Solution:

$0 \cdot 1 + 1 \cdot 1 + 1 \cdot 1 = 2$

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Answers are displayed within the problem

Linear Classifier Practice

1/1 point (graded)
We saw in the lecture above that for a linear classifier h, $h(x; \theta) = sign(\theta \cdot x)$, i.e. the sign of the dot product of θ and x. Now consider θ which is given by

$$\theta = (1, -1) \tag{3.1}$$

Which of the following points would be classified as positive by θ? Please choose all correct answers.

- [x] $(1, -1)$ ✔
- [x] $(1, 0)$ ✔
- [ ] $(0, 1)$
- [ ] $(0, 0)$

✔

Solution:

$X$is positively classified by the classifier if and only if $x \cdot \theta > 0$. The dot product of $(1, -1)$ with θ is positive. Also, $(1, 0) \cdot \theta$ is positive. On the other hand, $(0, 1) \cdot \theta$ and $(0, 0) \cdot \theta$ are nonpositive. Thus the first and second points are positively classified by θ.

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Offset Added

1/1 point (graded)

Again, we have a linear classifier with θ given by

$$\theta = (1, -1) \tag{3.2}$$

and the offset, θ_0 given by $\theta_0 = -1$ Now which of the following points would be classified as positive by θ? Please choose all correct answers.

- [x] $(1, -1)$ ✔
- [ ] $(1, 0)$
- [ ] $(0, 1)$
- [ ] $(0, 0)$

✔

Solution:

$X$is positively classified by the classifier if and only if $x \cdot \theta + \theta_0 > 0$. The dot product of $(1, -1)$ with θ is 2, and adding -1 makes it still positive. However,$x \cdot \theta + \theta_0 \leq 0$ for other data points.

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Answers are displayed within the problem

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theta . x + theta_0 = 0 if theta is already orthogonal to x wouldn't their dot product be zero? Then how is it that adding a scalar theta_0 would return the value 0?	2
Distance from point to plane, origin to plane, theta_0, etc. Could someone provide a visual ilustration (or recommend a source) for the distance concepts and geometry we are using here (and in unit 0), please? It would be greatly ...	2
Calculating offset	3
"You change theta, you get a different classifier" "So however we multiply the value theta here, we will get the same classifier as a result" I'm hoping that I understand this clearly, is this because the vector theta has to be...	3
[Staff] Typo at 6:27 There is a typo in transcript. It should be theta lives in **d-dimensional** space instead of **three-dimensional**.	2
What happens if the dot product between theta and x is zero? In the case we have a dot product equal to zero, it would mean that the sample lies on the decision boundary. In that case, which would be the output for the classificatio...	7
Why theta not sigma??? I think the letter poffessor wrote on the screen is sigma not theta? why calling so? Sorry I'm really conpulsive	3
Theta 0 Is theta 0 the orthogonal distance of the origin from the decision boundary?	7
dot product of 2 orthogonal vectors is not zero? dot(theta,x)+theta_0 = 0 implies dot(theta,x) = -theta, but theta and x are orthogonal and the dot product should be zero not -theta, which seems contradictory. explanatio...	6
"strongly positively" I don't quite understand two points being equal distance to the decision boundary has anything to do with being classified as "strongly positively", what does "strongly po...	4
What is the degree of freedom of a decision boundary? At 7:24 in the video lecture, the definition of "degree of freedom" for a decision boundary is mentioned. Can anyone elaborate on this concept?	5
offset parameter Any hints on how to calculate the offset parameter?	4
Multi-label classifier	

- [x] What if we have more than 2 labels?

4

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