How to Train Your Perceptron

16-385 Computer Vision (Kris Kitani)

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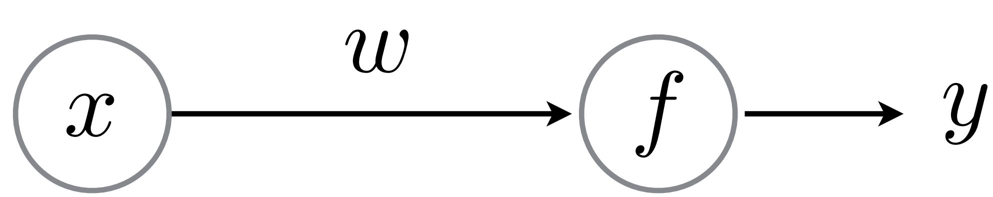
Let’s start easy

world's smallest perceptron!



$$y = wx$$

(a.k.a. line equation, linear regression)

Learning a Perceptron

Given a set of samples and a Perceptron

$$\{x_i, y_i\}$$

$$y = f_{\text{PER}}(x; w)$$

Estimate the parameters of the Perceptron

$$w$$

Given training data:

x	y
10	10.1
2	1.9
3.5	3.4
1	1.1

What do you think the weight parameter is?

$$y = wx$$

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What do you think the weight parameter is?

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not so obvious as the network gets more complicated so we use …

An Incremental Learning Strategy

(gradient descent)

Given several examples

$$\{(x_1, y_1), (x_2, y_2), \ldots, (x_N, y_N)\}$$

and a perceptron

$$\hat{y} = wx$$

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Modify weight w such that $\hat{y}$ gets **'closer'** to y

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perceptron parameter

perceptron output

true label

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what does this mean?

true label

Before diving into gradient descent, we need to understand …

Loss Function

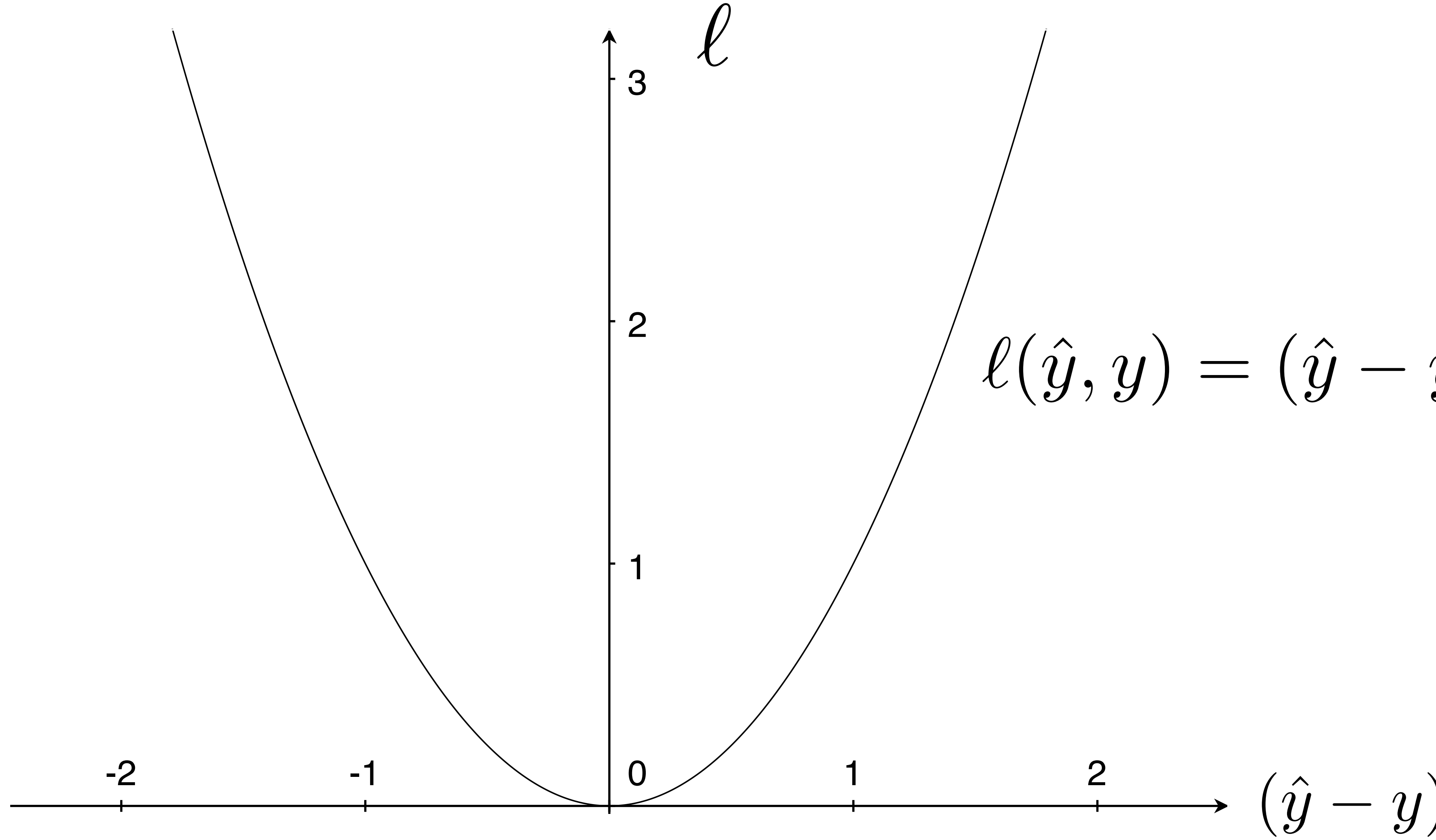
defines what is means to be
close to the true solution

YOU get to chose the loss function!

(some are better than others depending on what you want to do)

Squared Error (L2)

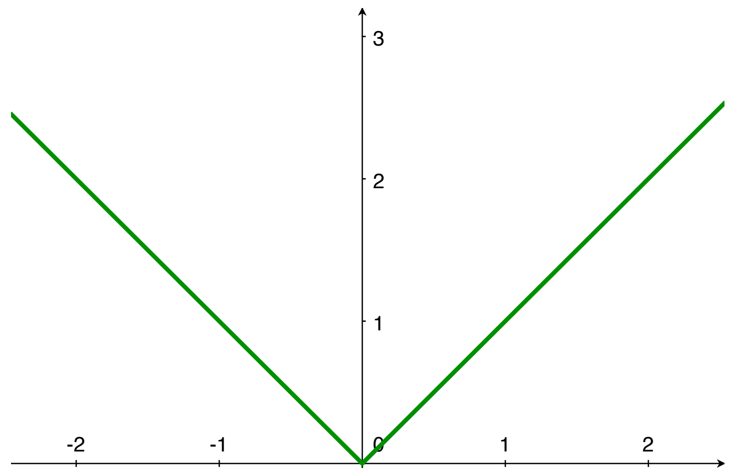
(a popular loss function)



$$\ell(\hat{y}, y) = (\hat{y} - y)^2$$

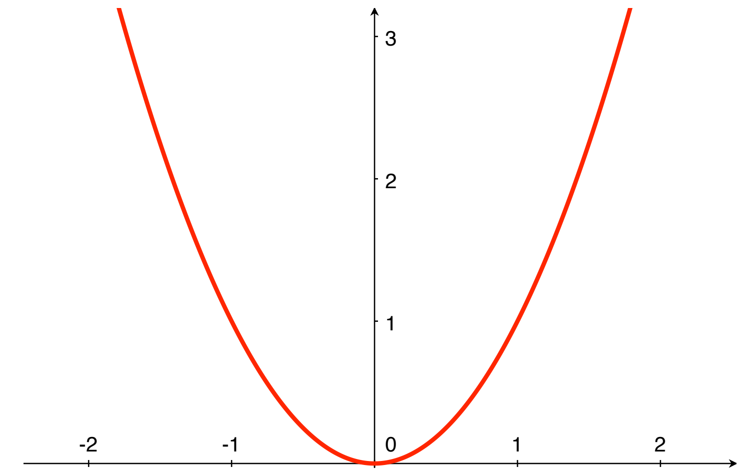
L1 Loss

$$\ell(\hat{y}, y) = |\hat{y} - y|$$



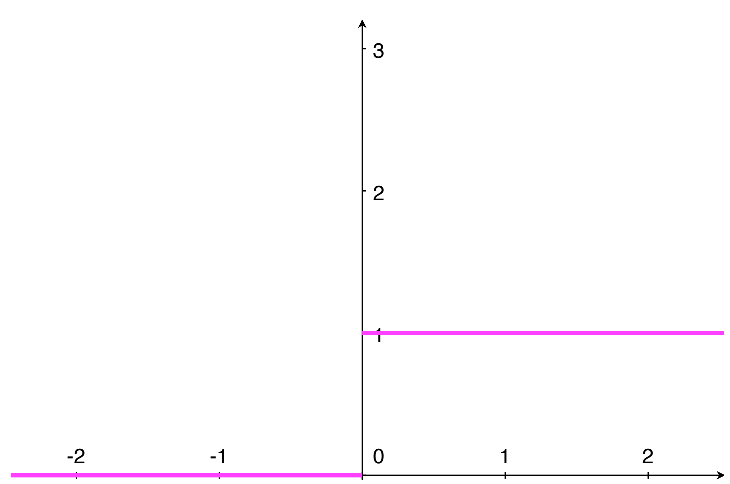
L2 Loss

$$\ell(\hat{y}, y) = (\hat{y} - y)^2$$



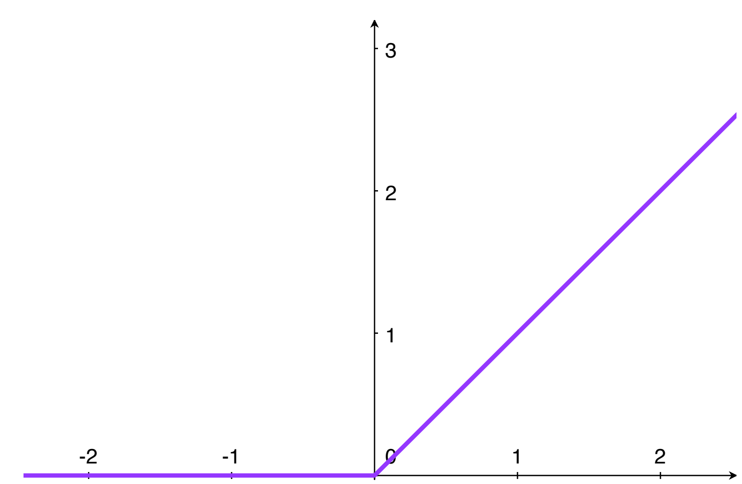
Zero-One Loss

$$\ell(\hat{y}, y) = \mathbf{1}[\hat{y} = y]$$



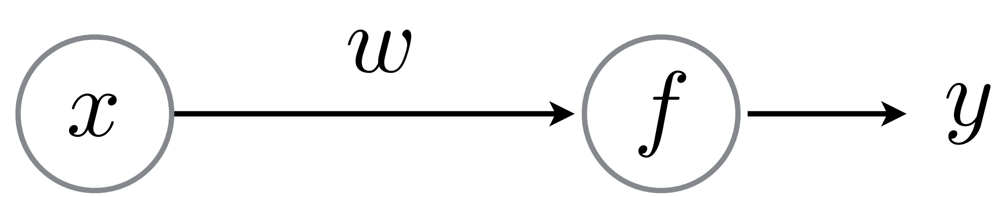
Hinge Loss

$$\ell(\hat{y}, y) = \max(0, 1 - y \cdot \hat{y})$$



back to the…

World's Smallest Perceptron!



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function of **ONE** parameter!

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linear function! $f(x) = wx$

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(gradient descent)

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$$\textbf{for} \;\; n = 1 \ldots N$$

$$w = w + (y_n - \hat{y})x_i;$$

just one line of code!

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Now where does this come from?