

## CS4780 Lec16 Empirical Risk Minimization

Squared loss

$$\frac{1}{2} (h_w(x_i) - y_i)^2$$

estimates mean

so not good for scenarios  
like income prediction  
one guy with million \$

Absolute loss

$$|h_w(x_i) - y_i|$$

estimates median  
good for income  
(outliers)

Not differentiable at zero, so difficult

Huber loss

combines above two

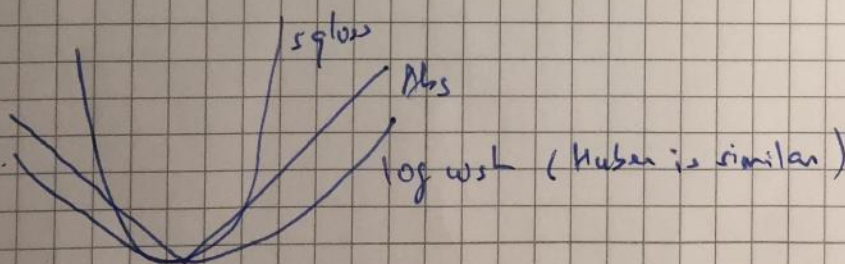
$$\begin{cases} \frac{1}{2} (h(x_i) - y_i)^2 & \text{if } |h(x_i) - y_i| \leq \delta \\ \delta \left( |h(x_i) - y_i| - \frac{\delta}{2} \right) & \text{otherwise} \end{cases} \Rightarrow \text{makes quadratic around zero}$$

log-cosh

$$\log(\cosh(h(x_i) - y_i))$$

- differentiable everywhere

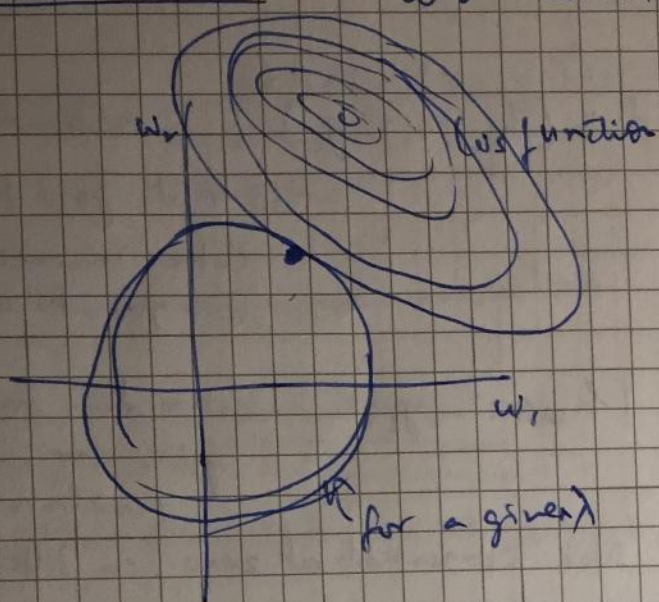
$$\cosh(x) = \frac{e^x + e^{-x}}{2}$$





# Regularization:

$w^T w$  with this constraint minimize loss.



minimize loss function  
but  $w_1, w_2$  must  
lie in this circle