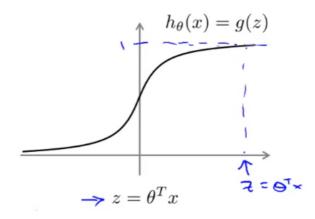
## **Support Vector Machine**

## Alternate view of Logistic Regression

$$h_{ heta}(x) = rac{1}{1 + e^{- heta^T x}}$$

If y=1, we want  $h_{ heta}(x) pprox 1$ , which is  $heta^T x >> 0$ 

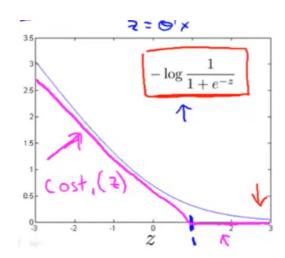
If y=0, we want  $h_{ heta}(x)pprox 0$ , which is  $heta^Tx<<1$ 



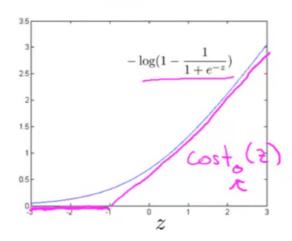
The term which a single training example contributes to the overall logistic regression:

$$\begin{aligned} \text{Cost of Example} &= -(y \log h_{\theta}(x) + (1-y) \log(1-h_{\theta}(x))) \\ &= -y \log \frac{1}{1+e^{-\theta^T x}} - (1-y) \log(1-\frac{1}{1+e^{-\theta^T x}}) \end{aligned}$$

If y=1 (want  $heta^Tx>>0$ ):



If y=0 (want  $\theta^T x << 1$ ):



We had the cost function for Logistic Regression as:

$$\min_{ heta} rac{1}{m} \Big[ \sum_{i=1}^m y^{(i)} ig( -\log_{ heta}(x^{(i)}) ig) + (1-y^{(i)}) ig( -\log(1-h_{ heta}(x^{(i)})) ig) \Big] + rac{\lambda}{2m} \sum_{j=1}^n heta_j^2$$

## **Support Vector Machine**

**Cost Function:** 

$$\min_{\theta} \frac{1}{m} \left[ \sum_{i=1}^{m} y^{(i)} \operatorname{cost}_{1}(\theta^{T} x^{(i)}) + (1 - y^{(i)}) \operatorname{cost}_{0}(\theta^{T} x^{(i)}) \right] + \frac{\lambda}{2m} \sum_{j=1}^{n} \theta_{j}^{2}$$
Getting rid of  $\frac{1}{m}$  terms

$$\min_{ heta} igg[ \sum_{i=1}^m y^{(i)} \mathrm{cost}_1( heta^T x^{(i)}) + (1-y^{(i)}) \mathrm{cost}_0( heta^T x^{(i)}) igg] + rac{\lambda}{2} \sum_{j=1}^n heta_j^2$$

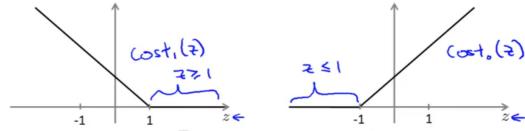
Getting rid of  $\lambda$  and adding new constant C

$$\min_{ heta} C igg[ \sum_{i=1}^m y^{(i)} \mathrm{cost}_1( heta^T x^{(i)}) + (1-y^{(i)}) \mathrm{cost}_0( heta^T x^{(i)}) igg] + rac{\lambda}{2} \sum_{j=1}^n heta_j^2$$

Where  $C pprox rac{1}{\lambda}$ 

Hypothesis:

$$h_{ heta}(x) = \left\{ egin{array}{ll} 1 & ext{if } heta^x >> 0 \ 0 & ext{otherwise} \end{array} 
ight.$$



 $\rightarrow$  If y=1, we want  $\theta^T x \ge 1$  (not just  $\ge 0$ )  $\rightarrow$  If y=0, we want  $\theta^T x \le -1$  (not just < 0)

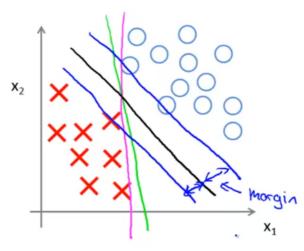
## **SVM Decision Boundary**

• Whenever  $y^{(i)}=1$ 

$$heta^T x^{(i)} \geq 1$$

 $\bullet \quad \text{Whenever} \ y^{(i)} = 0 \\$ 

$$heta^T x^{(i)} \leq -1$$



Large margin classifier