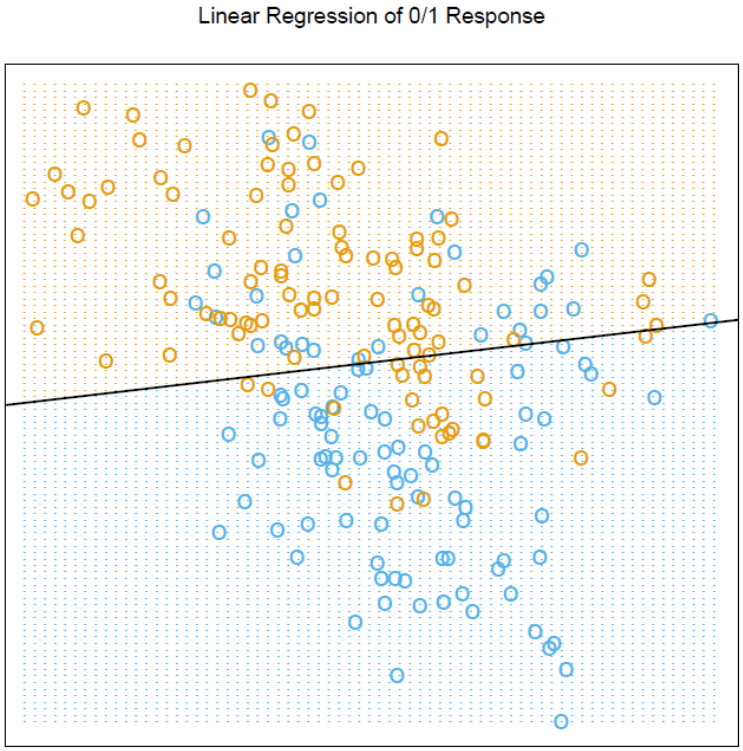
Linear Classifiers



Some slides from:

Andrew Ng

CSC321: Intro to Machine Learning and Neural Networks, Winter 2016

Michael Guerzhoy

Classification vs. Regression

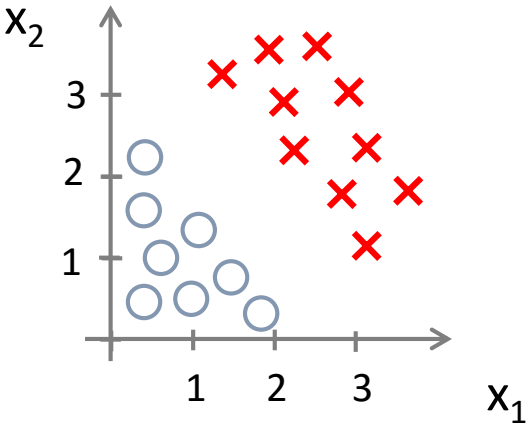
- Classification: for the example $(x_1, x_2, \ldots, x_n)$ predict the label y (e.g., face recognition)
- Regression: for the example $(x_1, x_2, \ldots, x_n)$ predict a real number y (e.g., house price prediction

Classification with two classes

- If there are only two classes, transform, e.g.,
  orange => 1
  blue => 0
  to turn the classification problem into a regression problem
- Find the best
$$h_\theta(x) = \theta^T x$$
- Predict:
$$\begin{cases} 1, h_\theta(x) > .5 \\ 0, otherwise \end{cases}$$

What is the equation of the decision boundary?

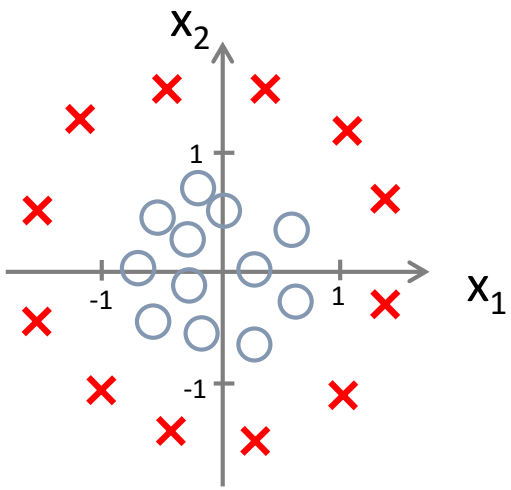
Decision boundary shapes



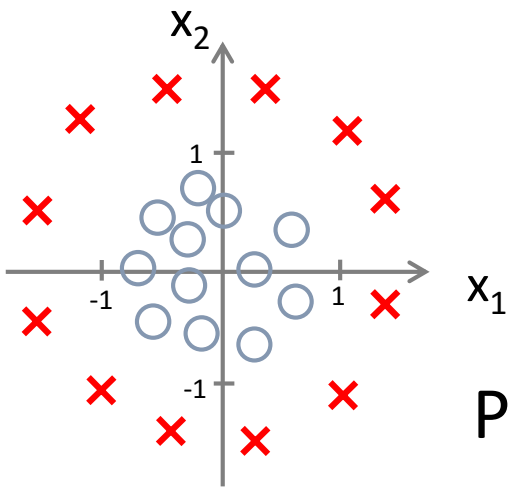
$$h_\theta(x) = g(\theta_0 + \theta_1 x_1 + \theta_2 x_2)$$

Predict $y = 1$ if $-3 + x_1 + x_2 \geq 0$

Decision boundary shapes



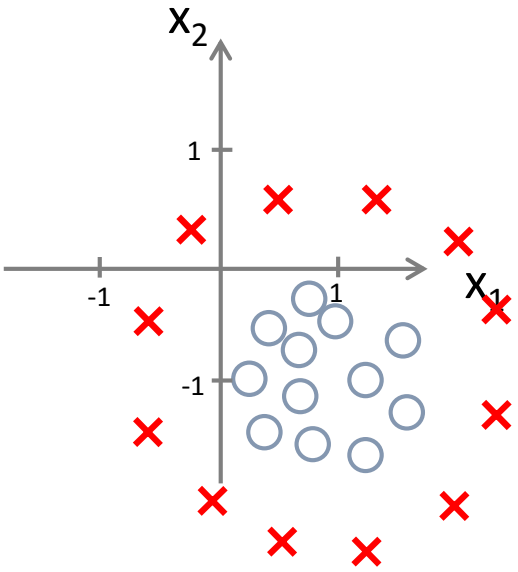
Decision boundary shapes



$$h_\theta(x) = g(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1^2 + \theta_4 x_2^2)$$

Predict $y = 1$ if $-1 + x_1^2 + x_2^2 \geq 0$

What is the equation for a good decision boundary?



Multiclass Classification

Email foldering/tagging : Work, Friends, Family, Hobby

$y = 1$ $y = 2$ $y = 3$ $y = 4$

Features: x_1: 1 if “extension” is in the email, 0 otherwise

x_2: 1 if “dog” is in the email, 0 otherwise

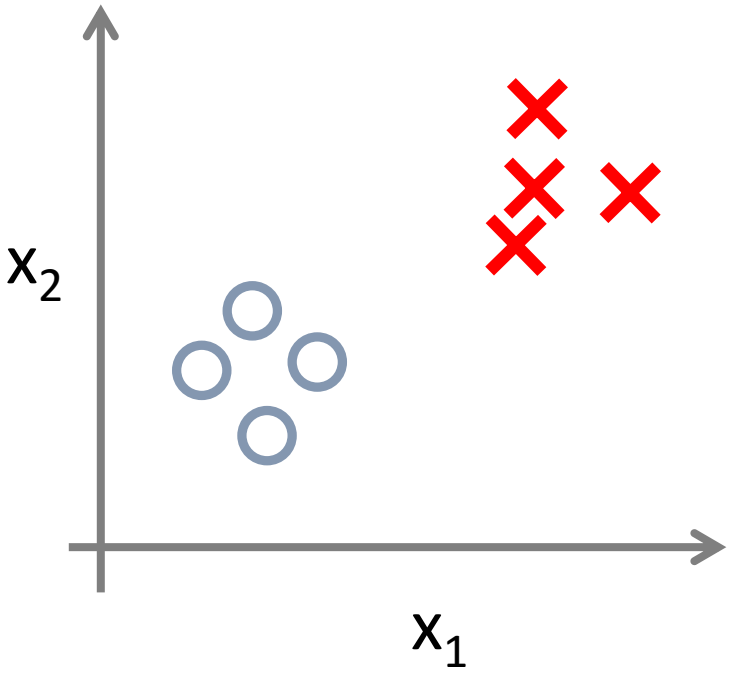
…

Medical diagrams: Not ill, Cold, Flu

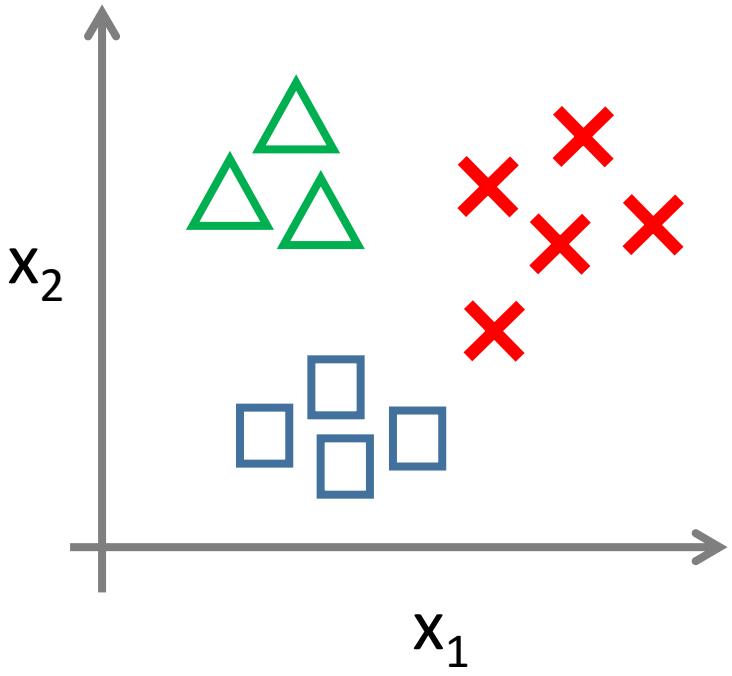
$y = 1$ $y = 2$ $y = 3$

Features: temperature, cough presence, …

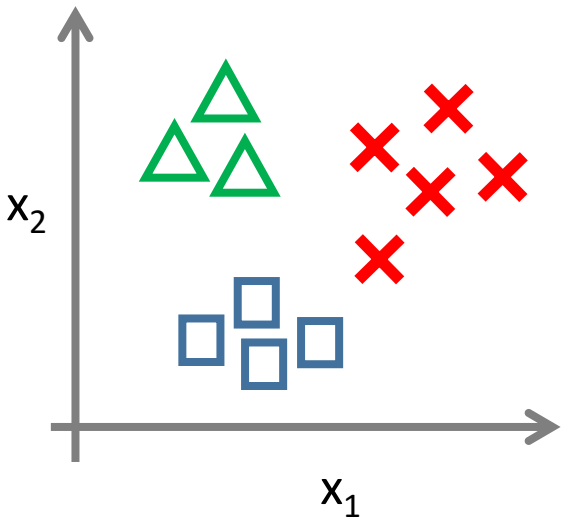
Binary classification:



Multi-class classification:



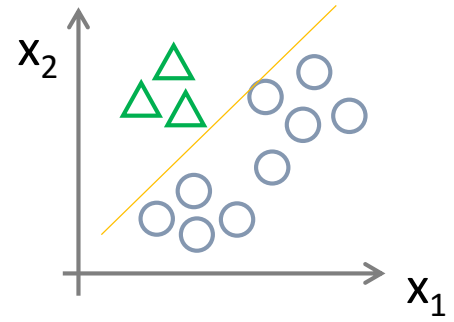
One-vs-all (one-vs-rest):



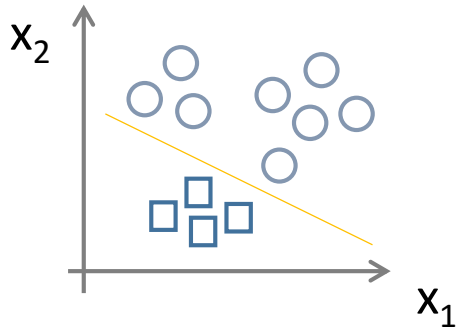
Class 1: △

Class 2: □

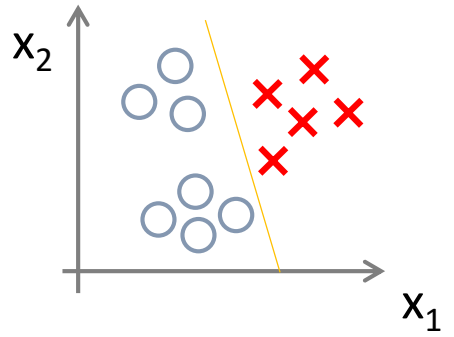
Class 3: ×



$h_\theta^1(x)$



$h_\theta^2(x)$



$h_\theta^3(x)$

Output the i such that $h_\theta^i(x)$ is the largest

(Idea: a large $h_\theta^i(x)$ means that the classifier is "sure")