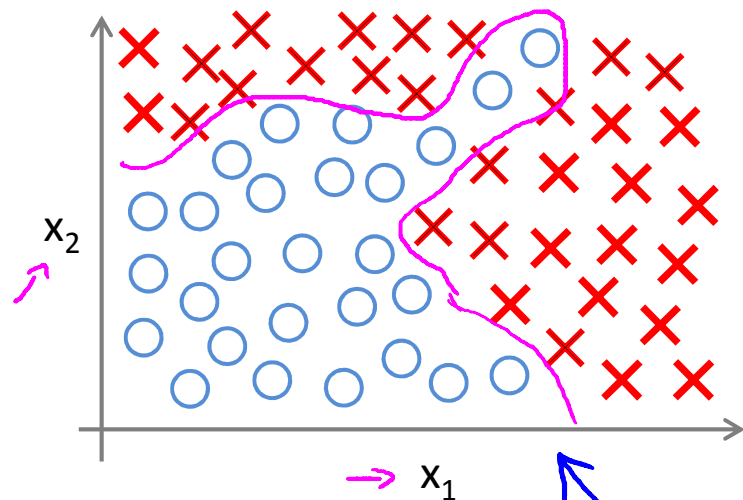


Machine Learning

Neural Networks: Representation

Non-linear hypotheses

Non-linear Classification



$$g(\theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_1 x_2 + \theta_4 x_1^2 x_2 + \theta_5 x_1^3 x_2 + \theta_6 x_1 x_2^2 + \dots)$$

meter tantas
variáveis não é
boa ideia e
podemos fazer
overfitting e
perdemos rapidez

$$\rightarrow x_1^2, x_1 x_2, x_1 x_3, x_1 x_4, \dots, x_1 x_{100}, x_2^2, x_2 x_3, \dots$$

podem n ser
suficientes

~ 5000 feature $O(n^2)$

$$\rightarrow x_1^2, x_2^2, x_3^2, \dots, x_{100}^2$$

$$\rightarrow x_1 x_2 x_3, x_1^2 x_2, x_{10} x_{11} x_{17}, \dots$$

$O(n^3)$

170,000

n=100

$$\sim \frac{n^2}{2}$$

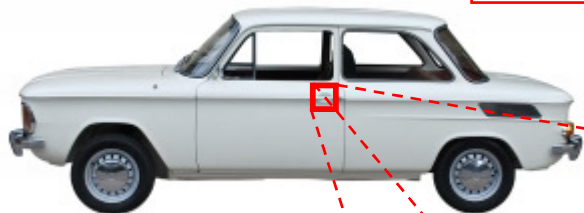
10

x_1 = size
 x_2 = # bedrooms
 x_3 = # floors
 x_4 = age
...
 x_{100}

What is this?

You see this:

queremos um
algoritmo que ao
observar imagem
nos diga se é um
carro



But the camera sees this: ppi

194	210	201	212	199	213	215	195	178	158	182	209
180	189	190	221	209	205	191	167	147	115	129	163
114	126	140	188	176	165	152	140	170	106	78	88
87	103	115	154	143	142	149	153	173	101	57	57
102	112	106	131	122	138	152	147	128	84	58	66
94	95	79	104	105	124	129	113	107	87	69	67
68	71	69	98	89	92	98	95	89	88	76	67
41	56	68	99	63	45	60	82	58	76	75	65
20	43	69	75	56	41	51	73	55	70	63	44
50	50	57	69	75	75	73	74	53	68	59	37
72	59	53	66	84	92	84	74	57	72	63	42
67	61	58	65	75	78	76	73	59	75	69	50

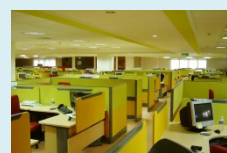


Computer Vision: Car detection

training set de
carros e nao
carros



Cars



Not a car

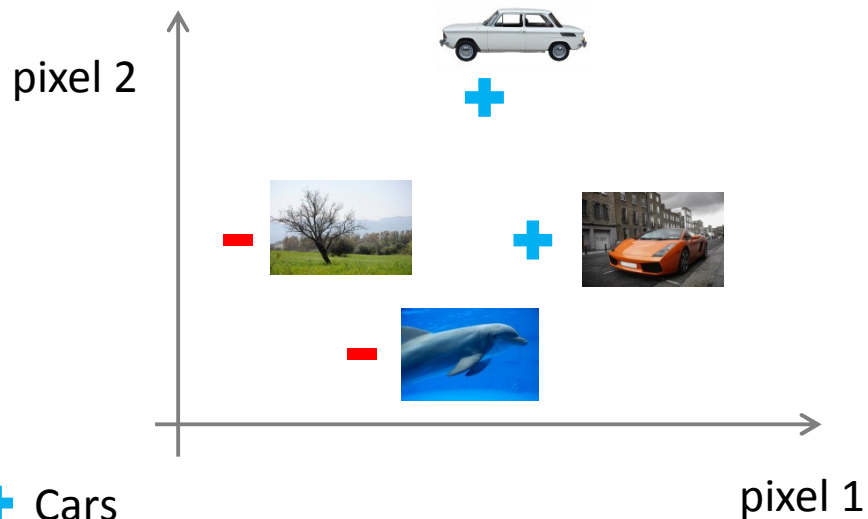
Testing:



What is this?



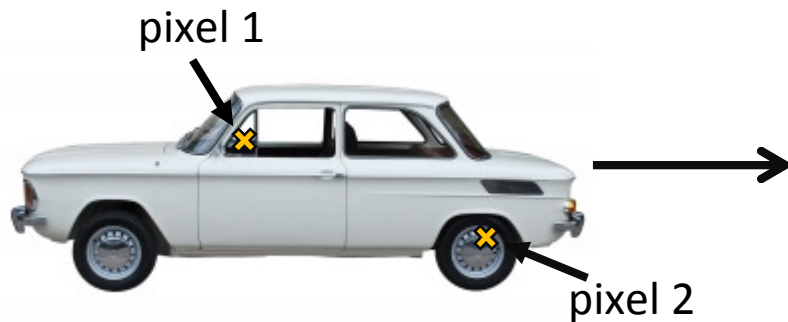
Learning
Algorithm



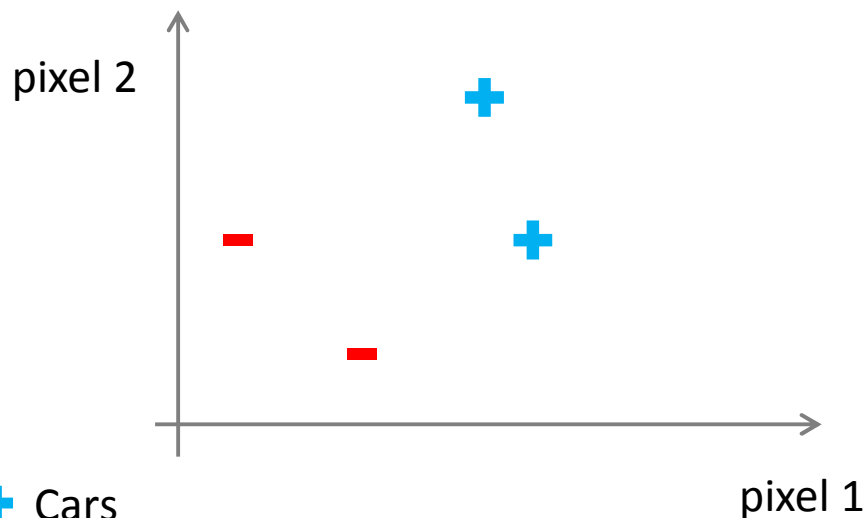
1- vamos tirar 2
localizações pixeis
do carro

2- vamos
desenhar carro
num determinado
ponto baseado n
intensidade dos 2
pixeis

3- repetimos para
outras imagens



Learning
Algorithm



+ Cars
- "Non"-Cars

1- vamos tirar 2
localizações pixels
do carro

2- vamos
desenhar carro
num determinado
ponto baseado n
intensidade dos 2
pixels

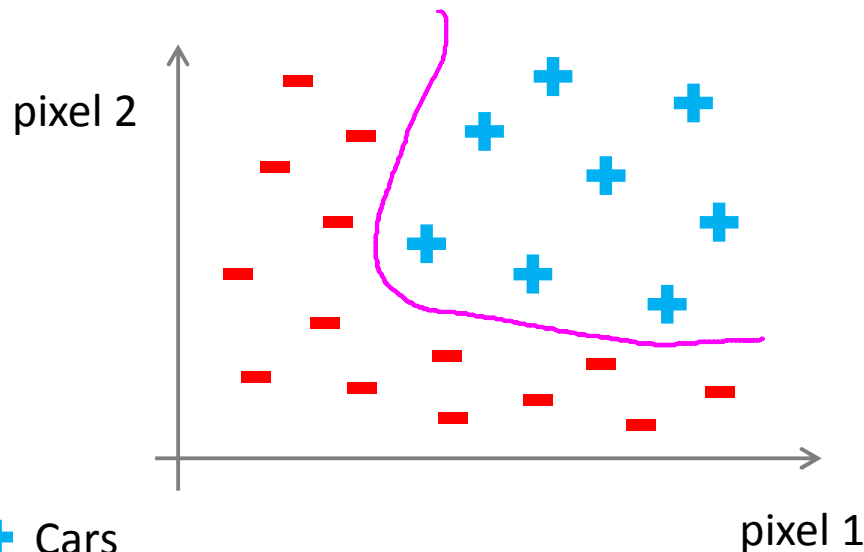
3- repetimos para
outras imagens



Learning
Algorithm

$$2500/50 = 50$$

50 x 50 pixel images \rightarrow 2500 pixels
 $n = 2500$ (7500 if RGB)



+ Cars
 - "Non"-Cars

$$\rightarrow x = \begin{bmatrix} \text{pixel 1 intensity} \\ \text{pixel 2 intensity} \\ \vdots \\ \text{pixel 2500 intensity} \end{bmatrix}$$

0-255

Quadratic features ($x_i \times x_j$): ≈ 3 million features

