



# Introduction to Scientific Computation

## Lecture 4

### Fall 2021

Data related problems, Supervised learning  
Perceptron

## Basic definitions

We have a set of objects:  $X$

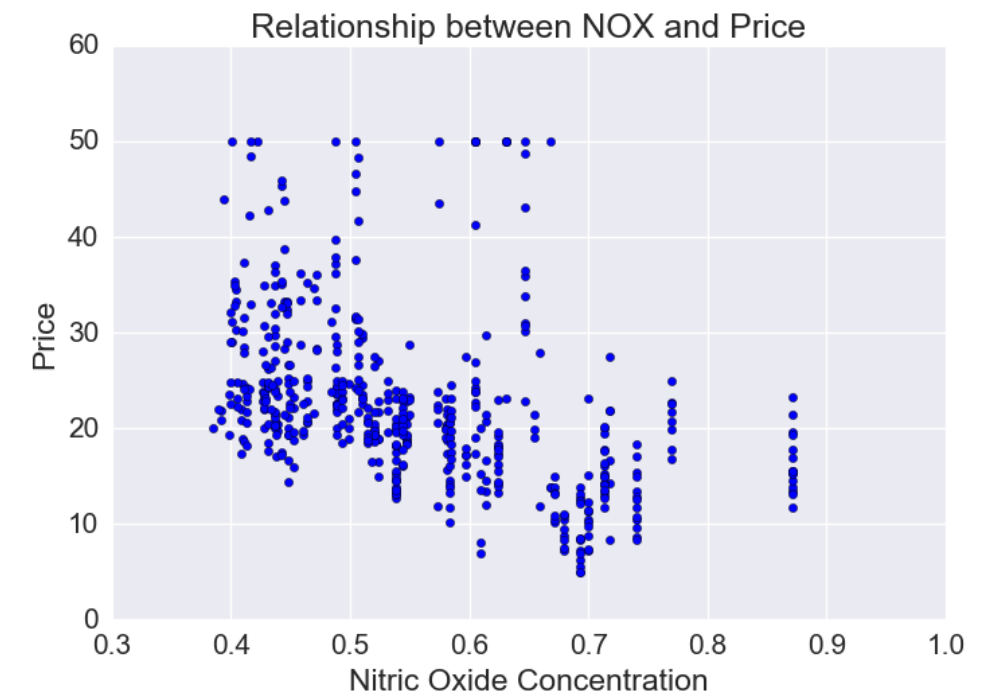
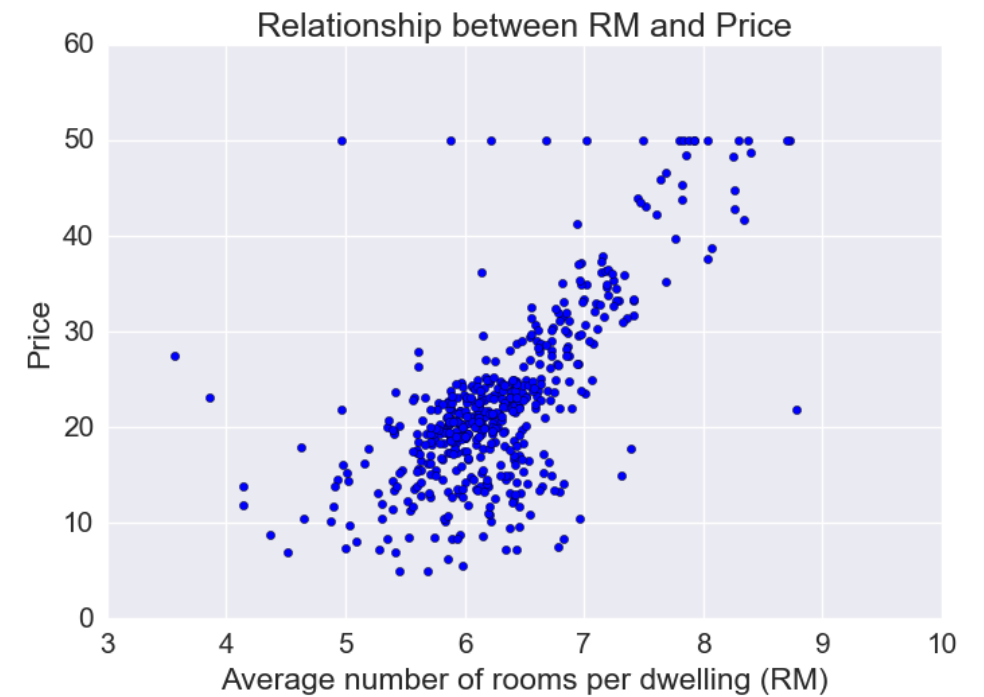
And the set of possible answers:  $Y$

## Basic definitions

We have a set of objects:  $X$

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We define the target function:  $y^* : X \rightarrow Y$

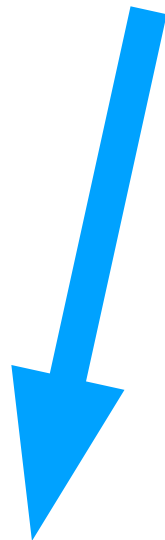


## Basic definitions

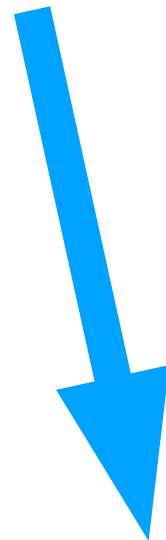
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Supervised



Unsupervised  $Y \in \emptyset$



## Supervised

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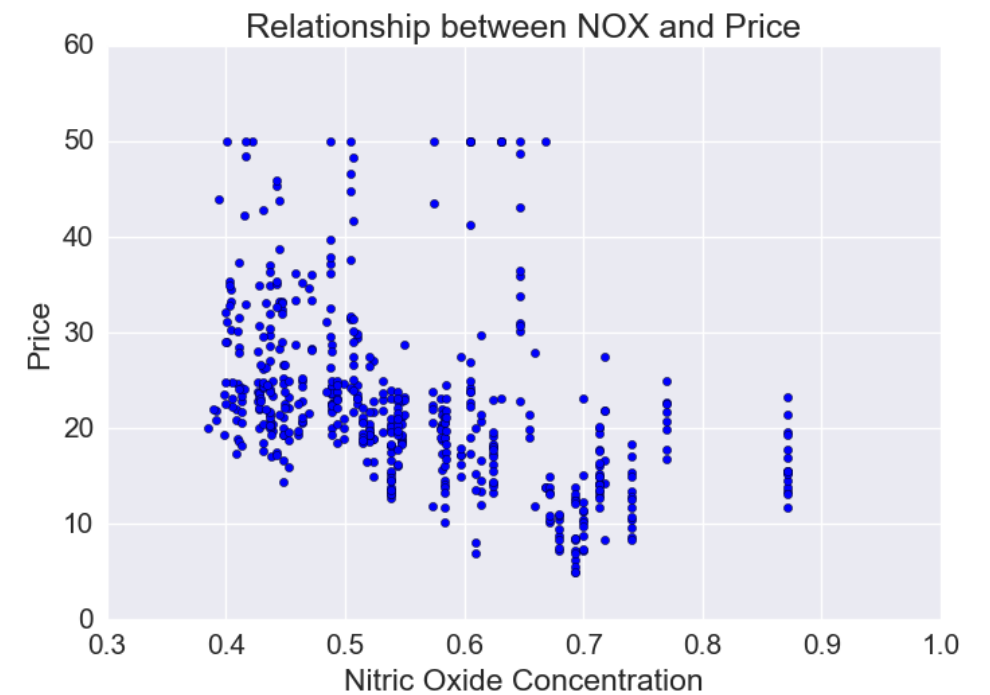
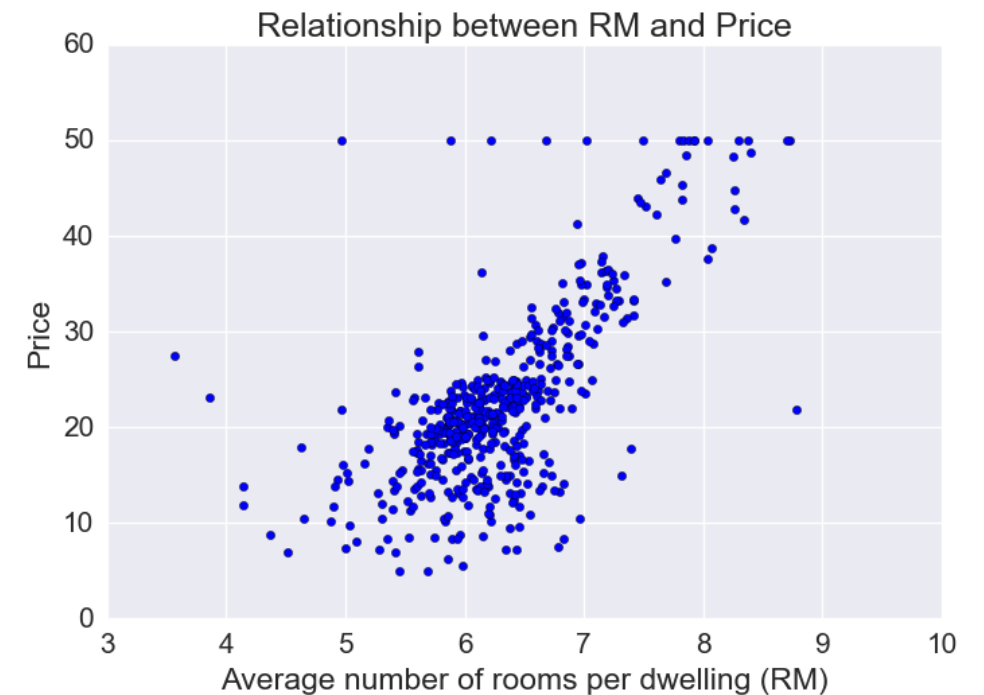
We define the target function:  $y^* : X \rightarrow Y$

And we know values of  $y^*$  only on a finite subset  $\{x_1, \dots, x_l\} \subset X$

Training sample:

$$X^l = (x_i, y_i)_{i=1}^l$$

Precedent



Let's look into this guy



↓

$$X^l = (x_i, y_i)_{i=1}^l$$

Let's look into this guy



↓

$$X^l = (x_i, y_i)_{i=1}^l$$

	N_Rooms	Floor	Smokers?
Hous1	1	1	Yes
...	...	...	...
Hous N	3	-	No

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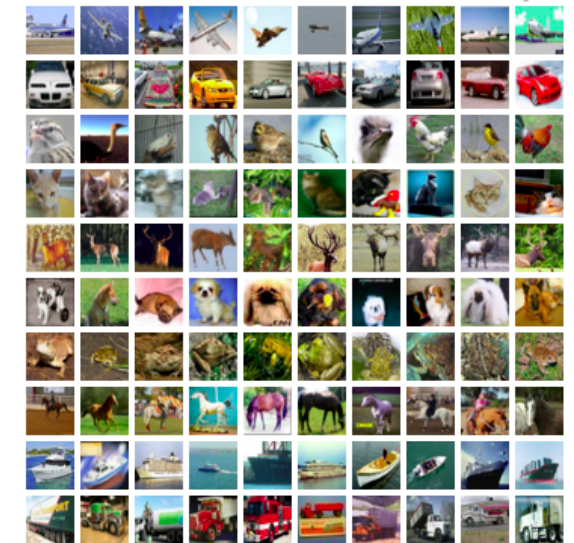
If  $Y$  is discrete  $\{1, \dots, N\}$



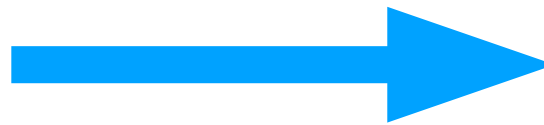
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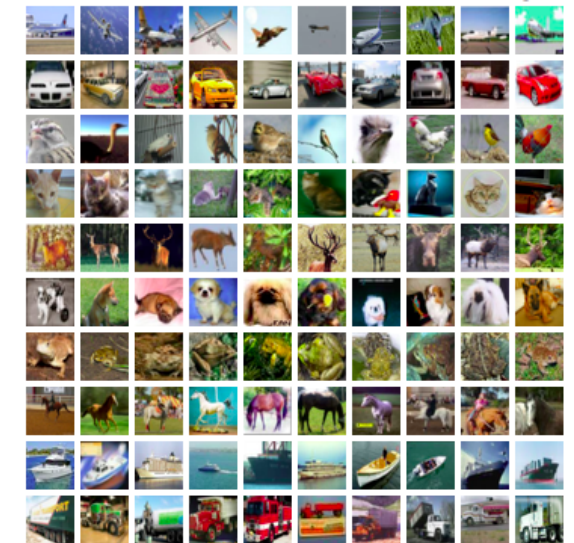


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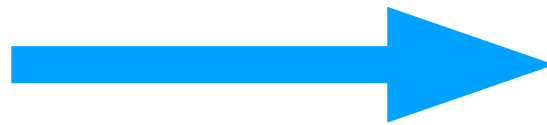


# Classification

We have a set of objects:  $X$   
And the set of possible answers:  $Y$   
We define the target function:  $y^* : X \rightarrow Y$

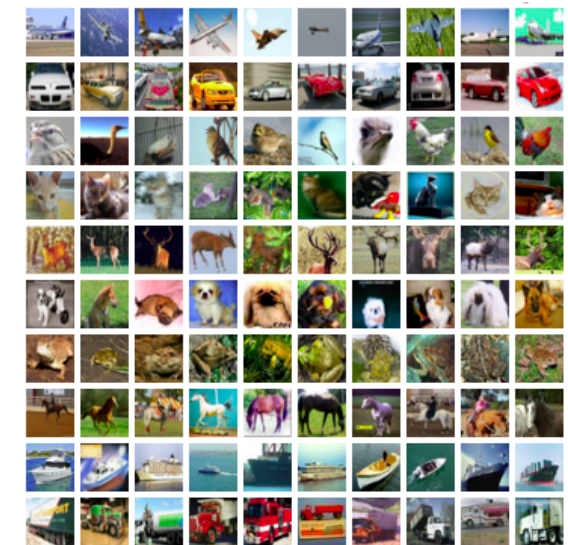


If  $Y$  is discrete  $\{1, \dots, N\}$



Classification

If  $Y$  is continuous  $[-25, 100]$



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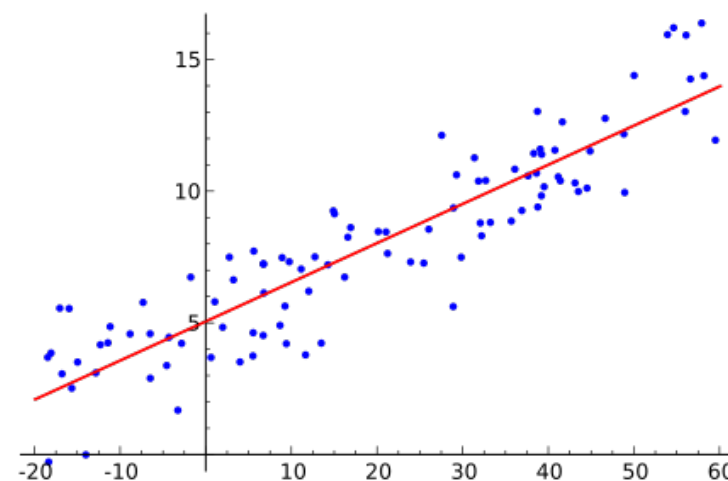


Classification

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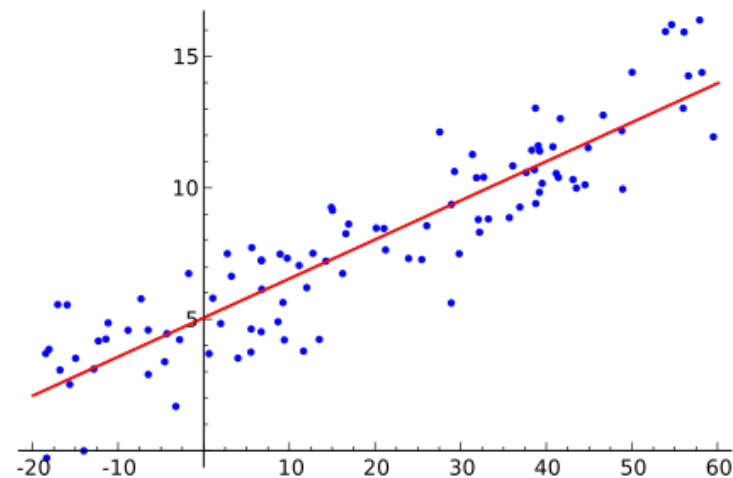


Regression



## How to say if one target function is better?

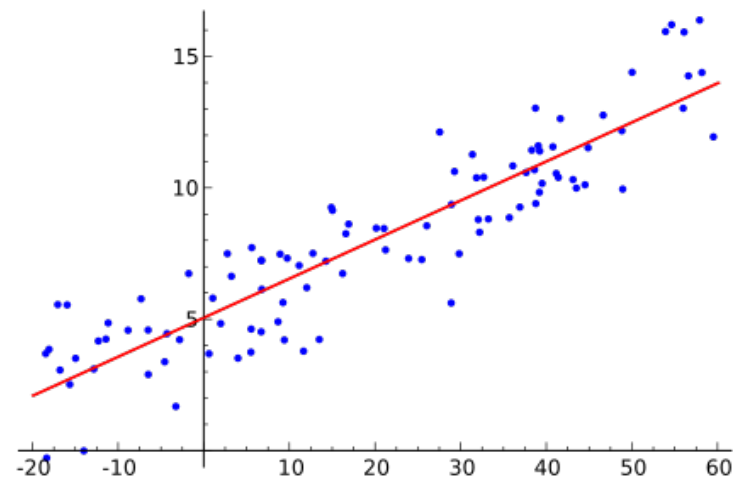
$$y_1^* = 5x + 6 \quad \text{or} \quad y_2^* = 4x^3 - 2x + 1$$



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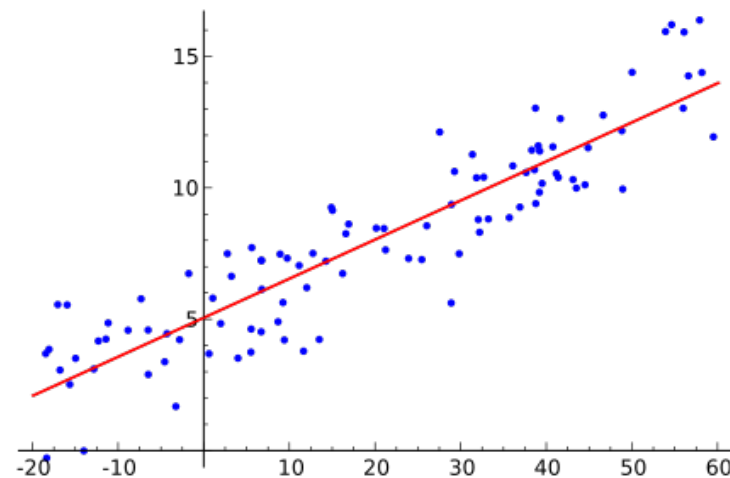
We need to compare them.



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$$y_1^* = 5x + 6 \quad \text{or} \quad y_2^* = 4x^3 - 2x + 1$$

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$$L(\theta, x_i, y_i)$$

Loss Function



## Popular loss functions:

Classification



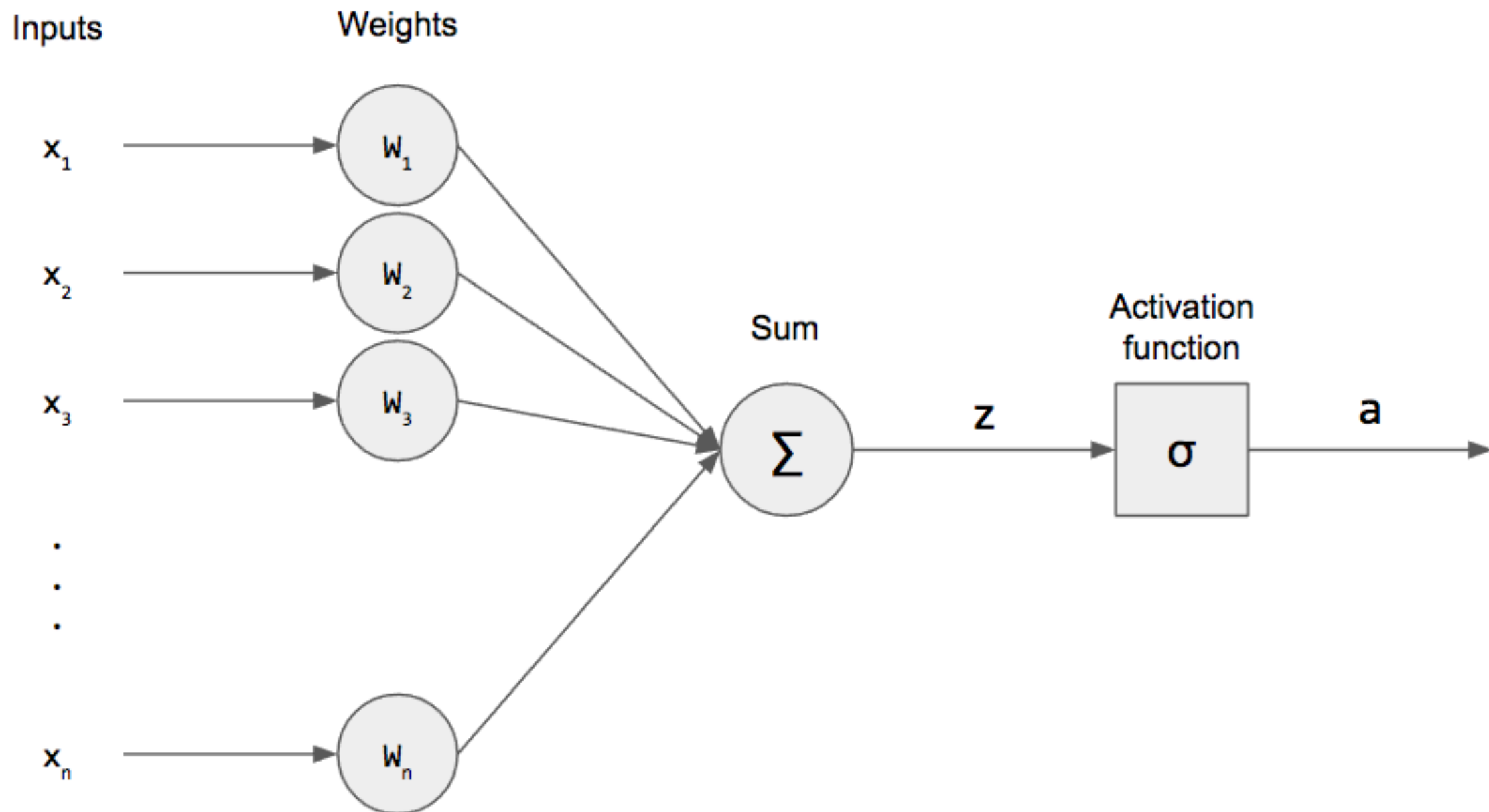
$$-(y_i \log(p_i) + (1 - y_i) \log(1 - p_i))$$

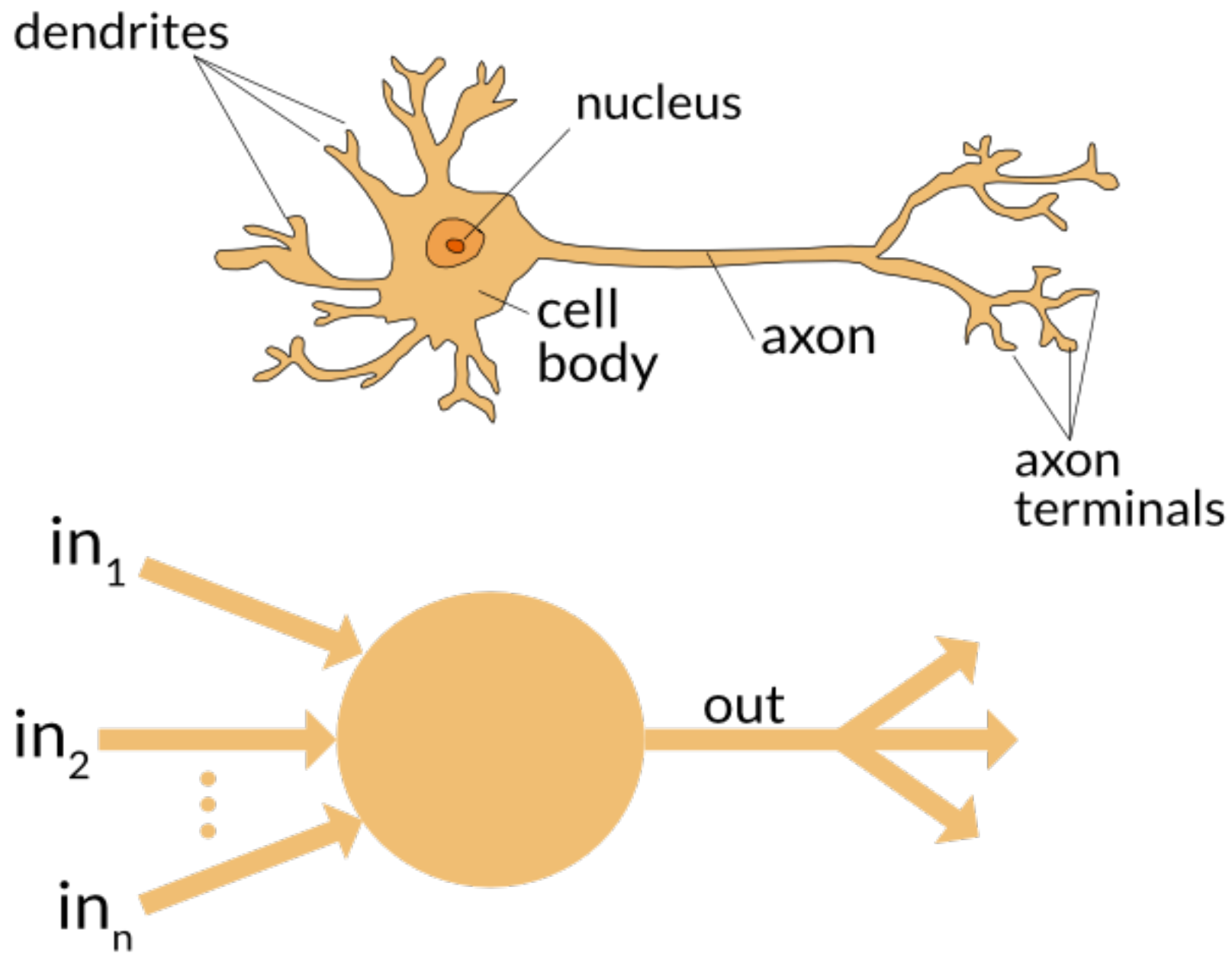
Regression



$$(y_i - p_i)^2$$

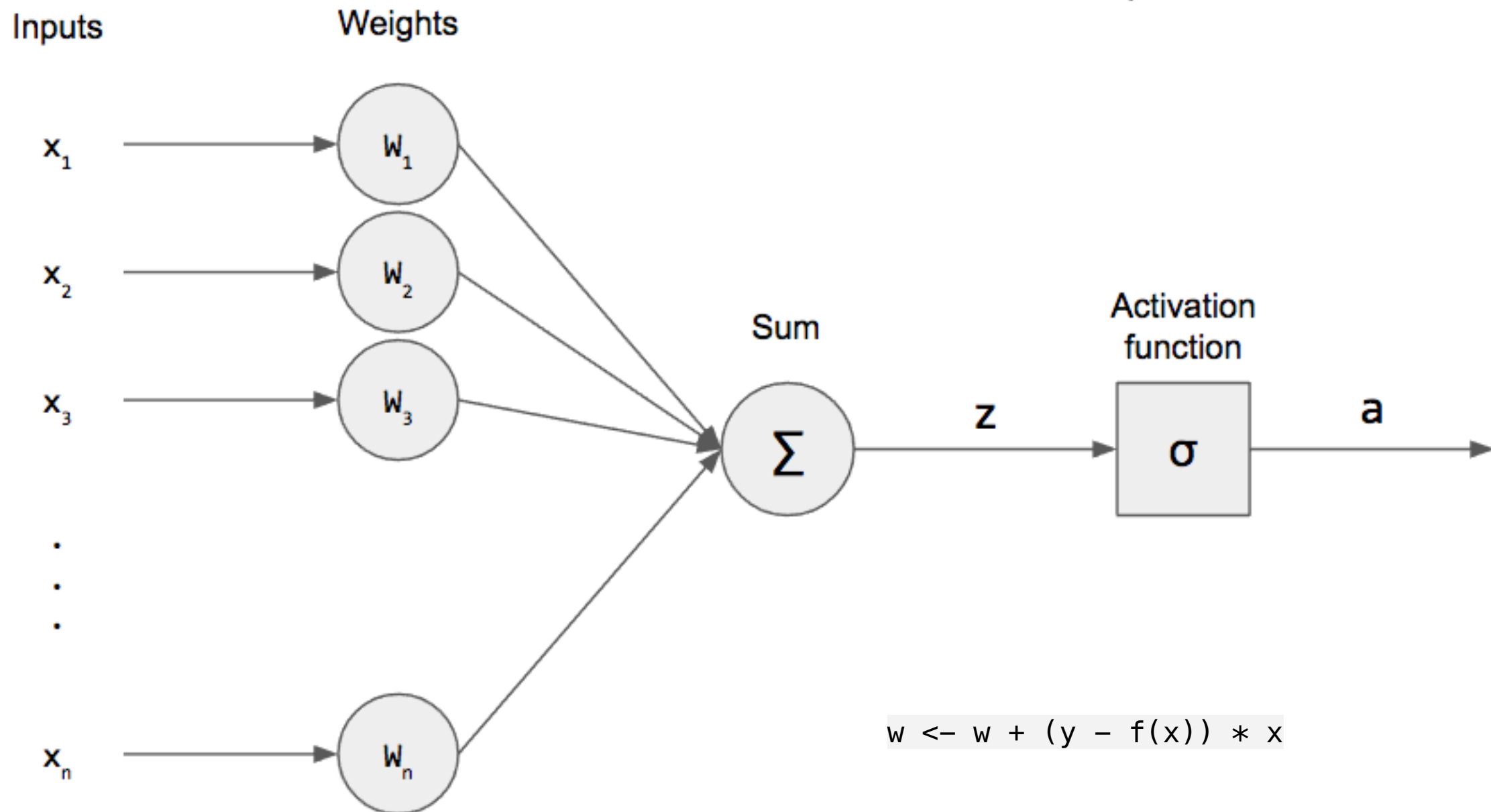
## Perceptron:





## Perceptron:

$$f(x) = \begin{cases} 1 & \text{if } w \cdot x + b > 0 \\ 0 & \text{otherwise} \end{cases}$$



$$w \leftarrow w + (y - f(x)) * x$$

## Perceptron:

