Introduction to Scientific Computation
Lecture 4
Fall 2019

Data related problems, Supervised learning
Perceptron

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Basic definitions
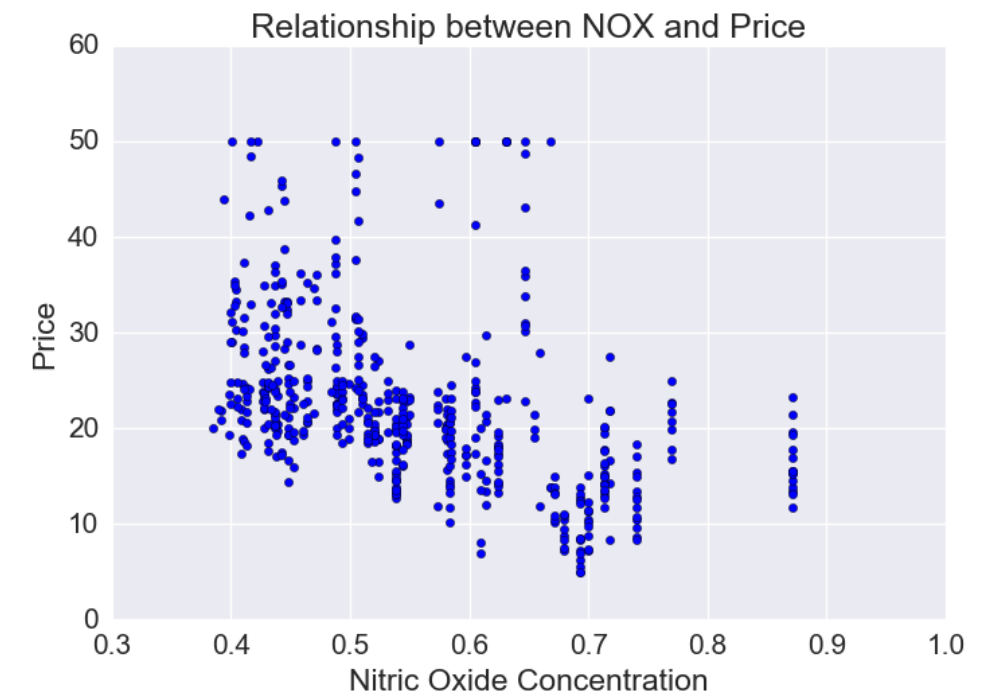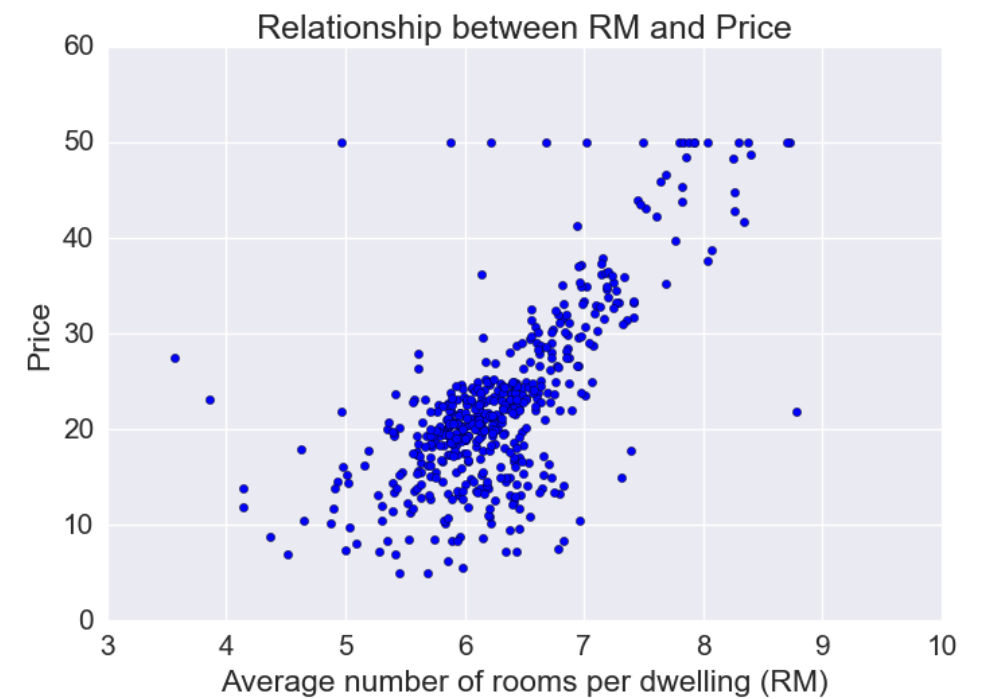
We have a set of objects: X

And the set of possible answers: Y

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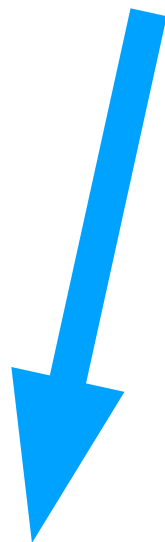We define the target function: $y^* : X \rightarrow Y$

Relationship between RM and Price

Relationship between NOX and Price

Basic definitions
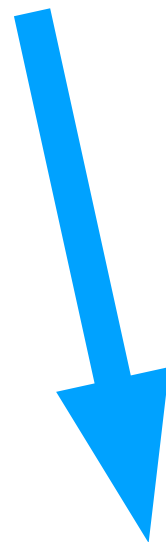
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Supervised

Unsupervised $Y \in \varnothing$

Supervised

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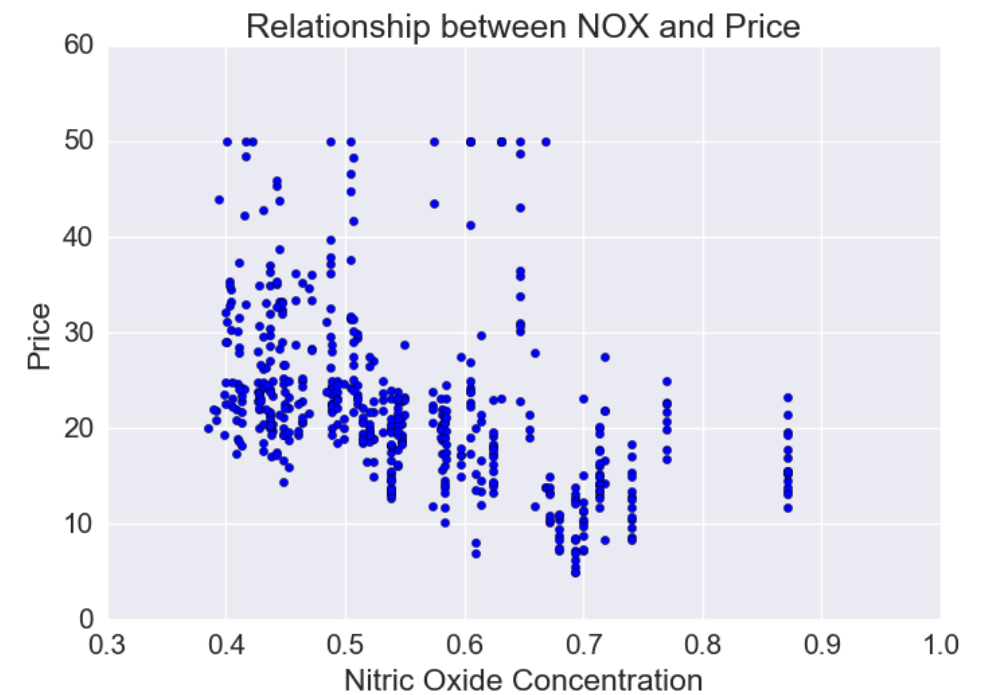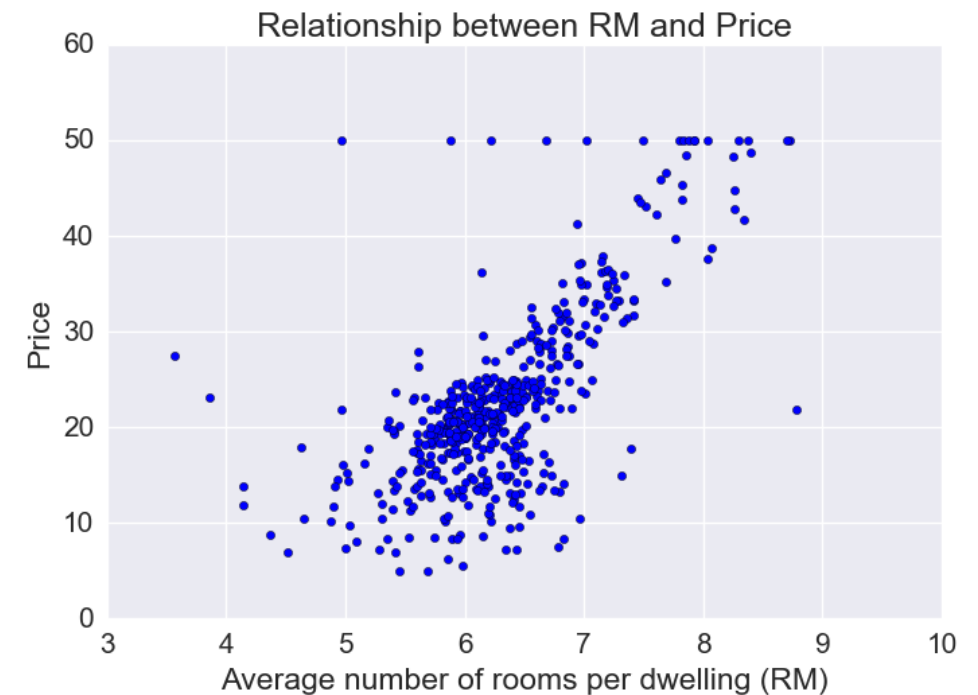
And the set of possible answers: Y

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

Relationship between RM and Price

(Price vs. Average number of rooms per dwelling (RM))

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

Training sample: $\qquad X^l = \left(x_i, y_i\right)_{i=1}^{l}$

Precedent

Relationship between NOX and Price

(Price vs. Nitric Oxide Concentration)

Let's look into this guy

$$X^l = \left(x_i, y_i\right)^l_{i=1}$$

Let's look into this guy

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

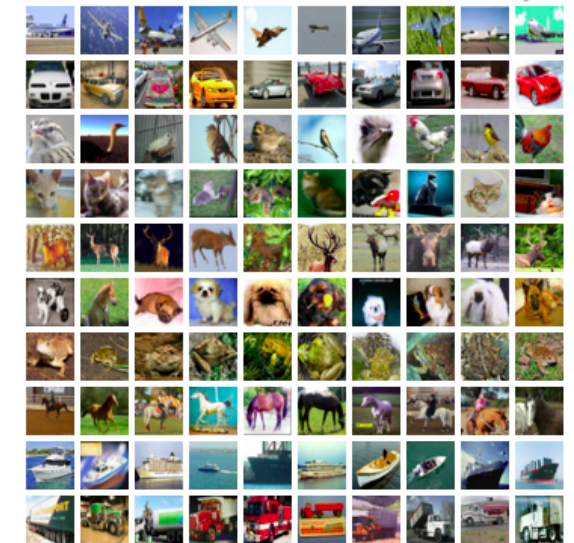|	N_Rooms	Floor	Smokers?
Hous1	1	1	Yes
...	…	…	…
Hous N	3	-	No

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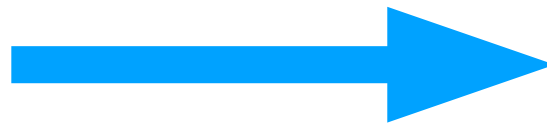
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If Y is discrete $\{1,\ldots,N\}$

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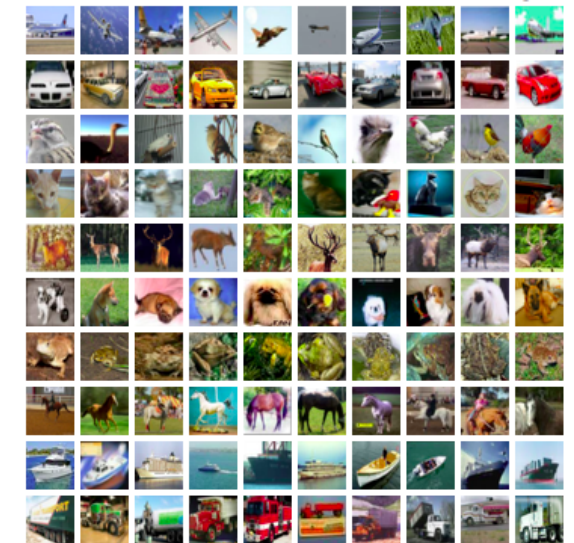We define the target function: $y^* : X \to Y$

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Classification

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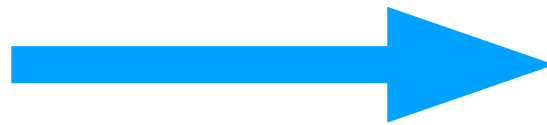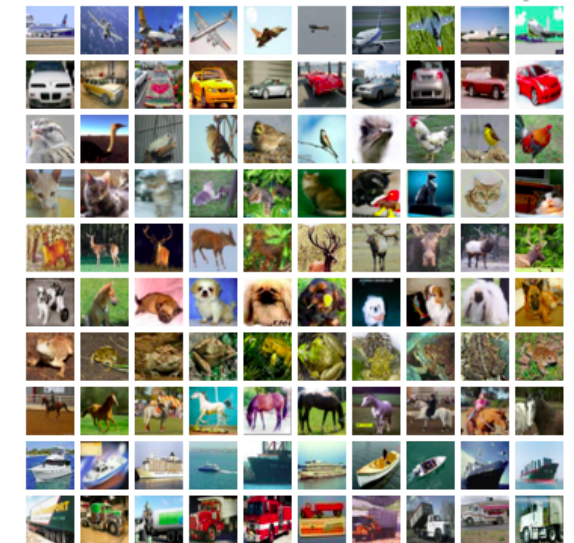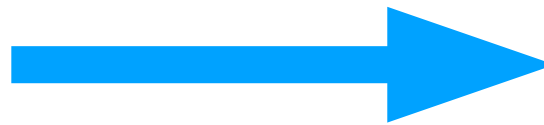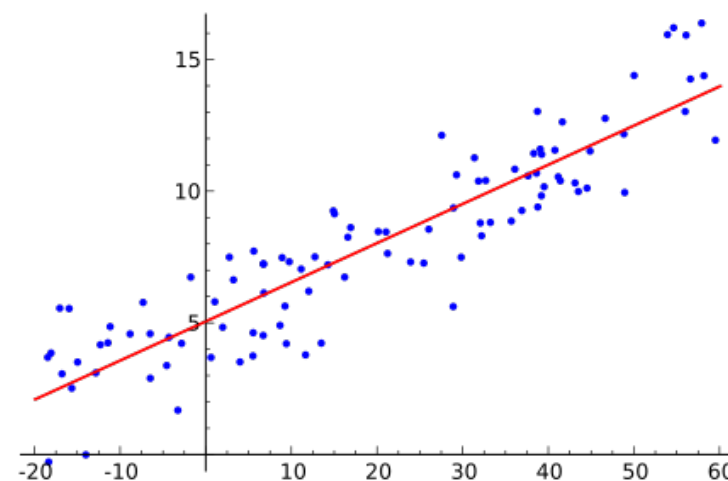
If Y is discrete $\{1, \ldots, N\}$

Classification

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

We have a set of objects: $\quad X$

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

If $\quad Y \quad$ is discrete $\{1,\ldots,N\}$ $\quad\longrightarrow\quad$ **Classification**

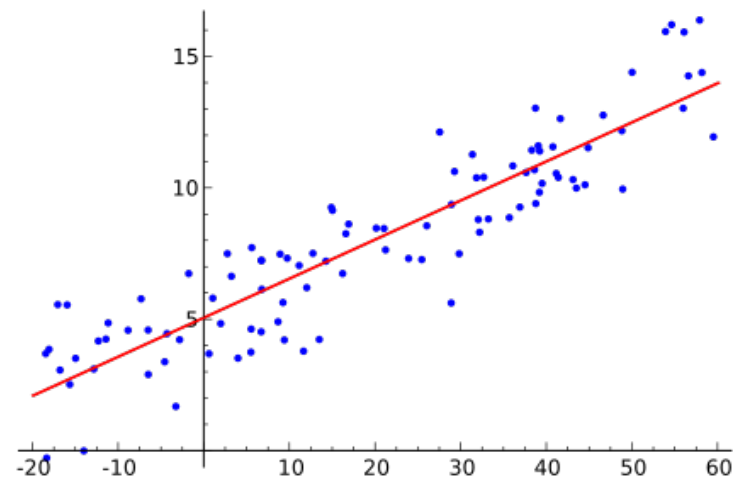If $\quad Y \quad$ is continuous $[-25,100]$ $\quad\longrightarrow\quad$ **Regression**

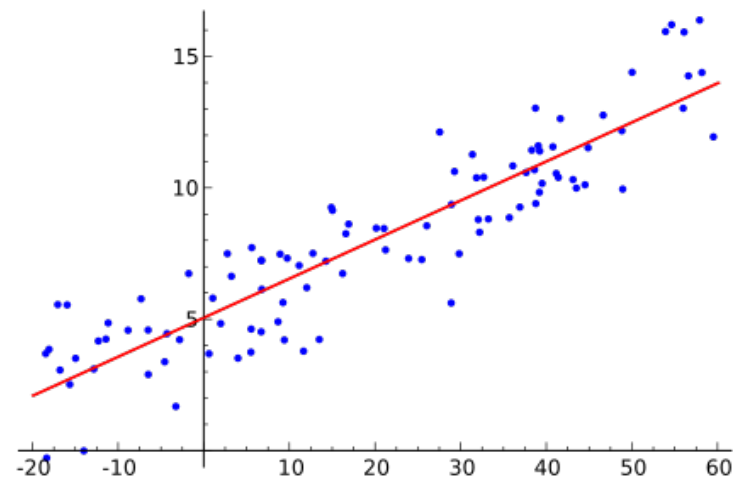# How to say if one target function is better?

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

How to say if one target function is better?

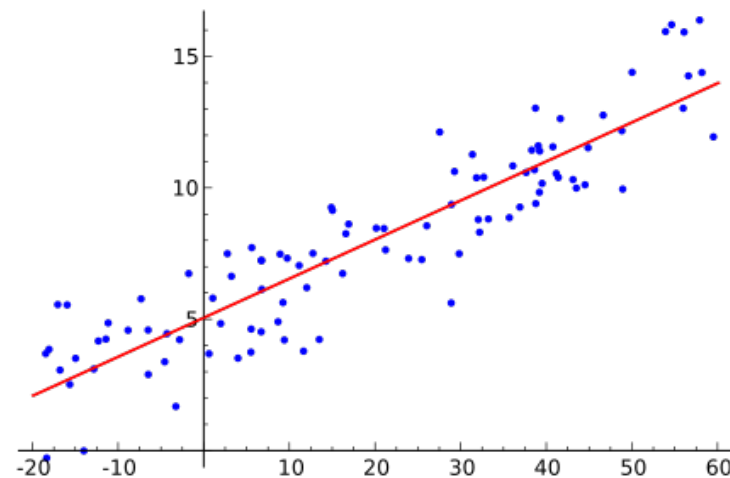$$y_1^* = 5x + 6 \quad \text{or} \quad y_2^* = 4x^3 - 2x + 1$$

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

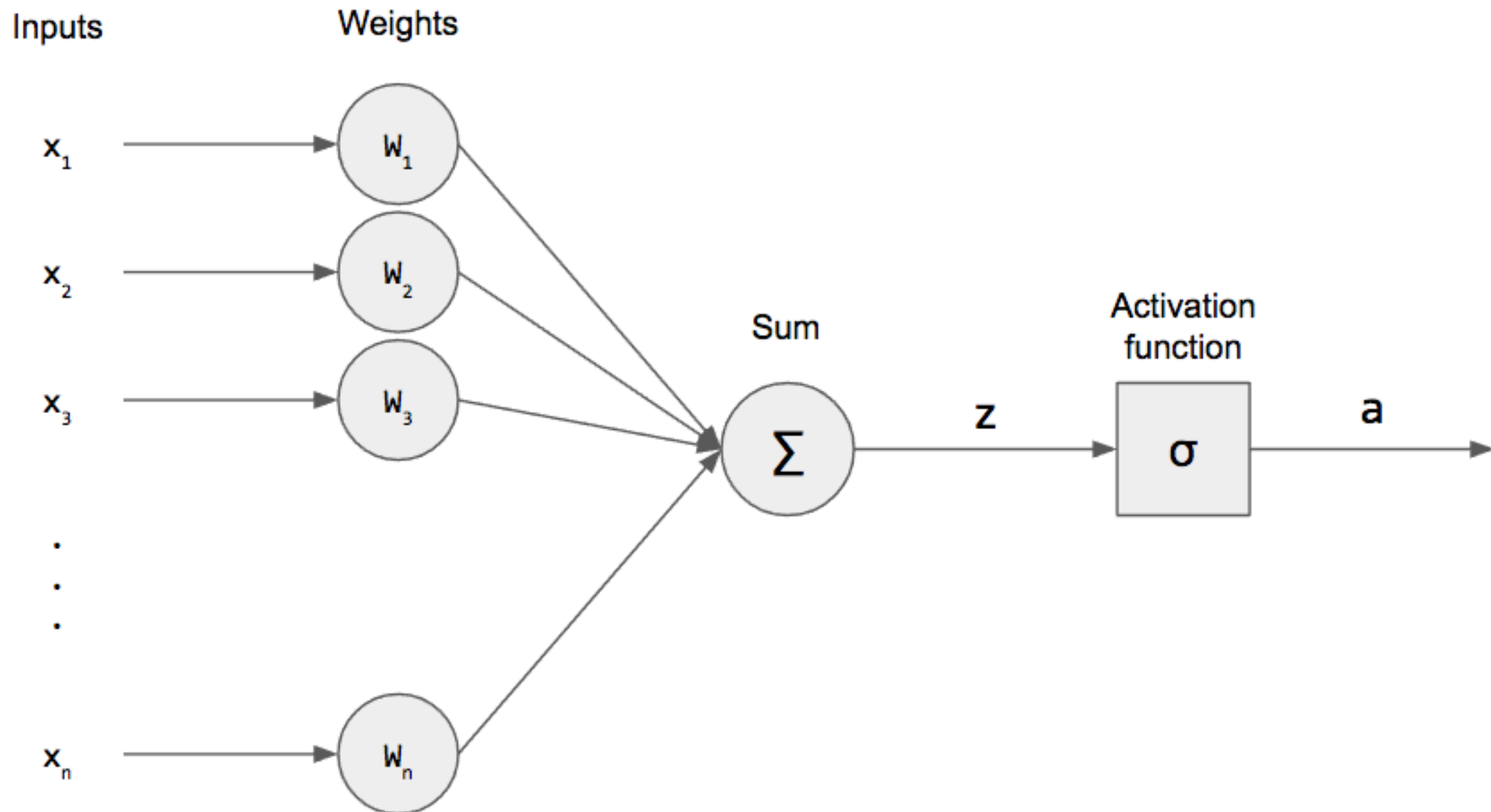**Popular loss functions:**

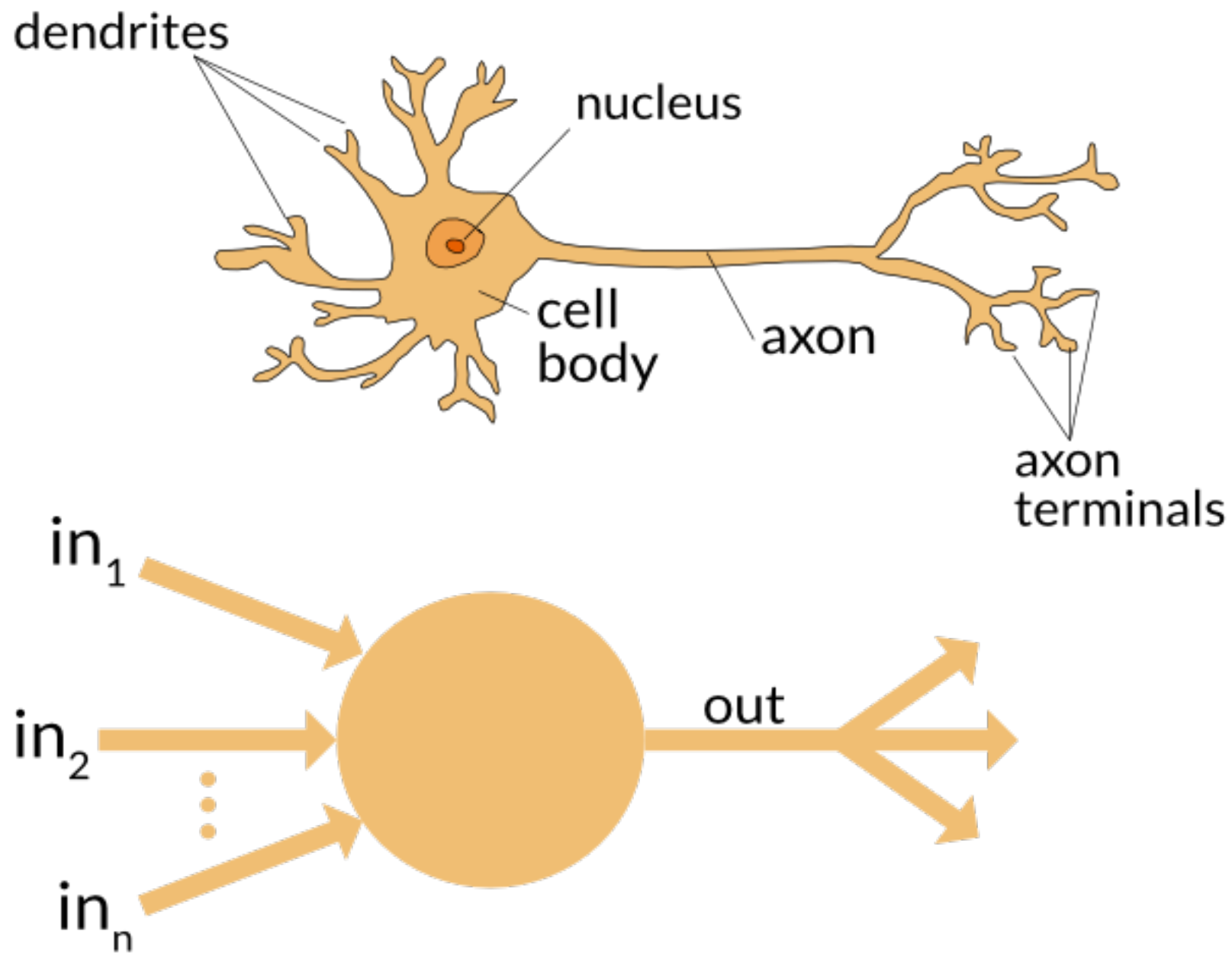Classification $\longrightarrow$ $-(y_i \log(p_i) + (1 - y_i)\log(1 - p_i))$
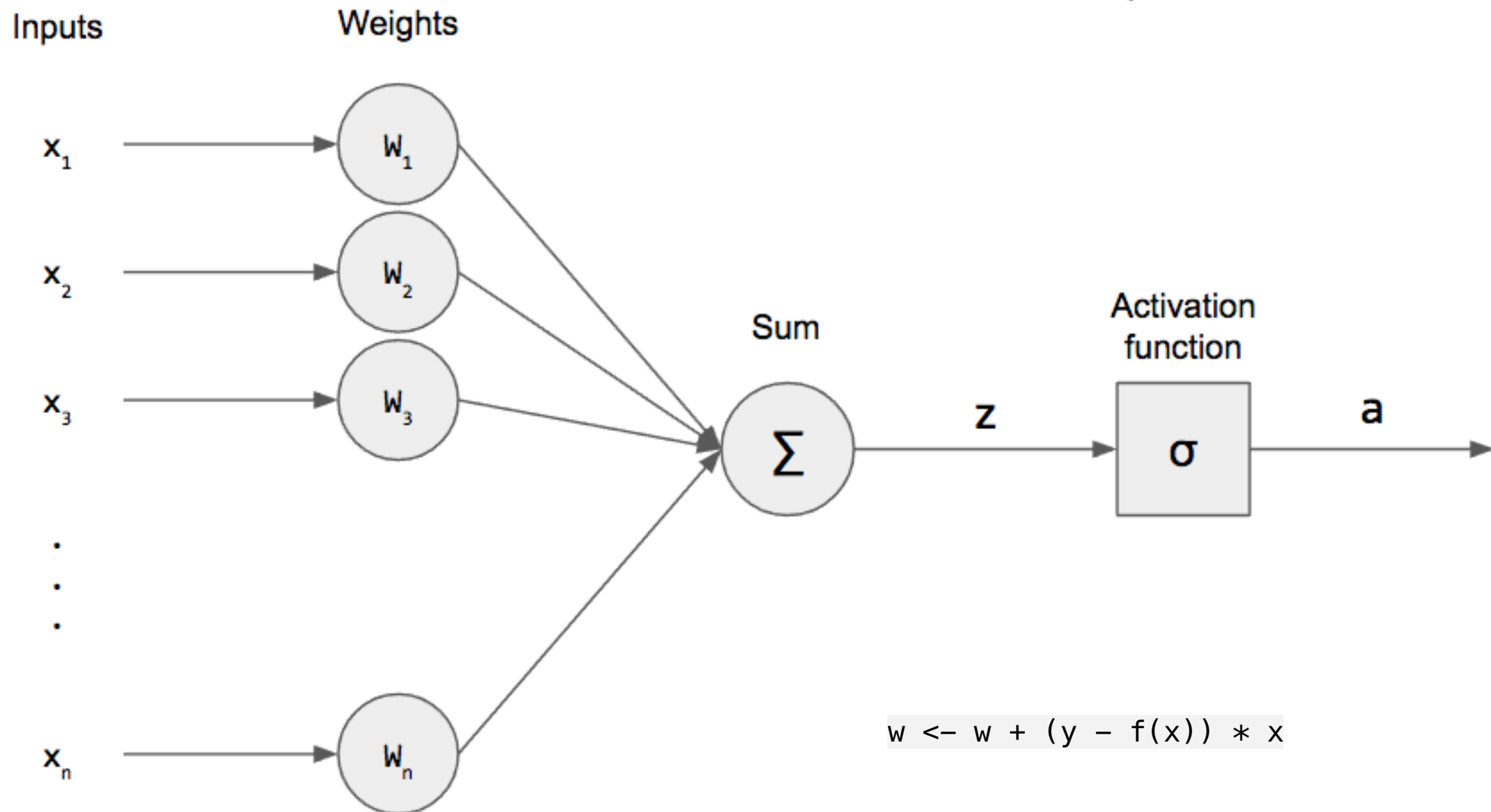
Regression $\longrightarrow$ $(y_i - p_i)^2$

Perceptron:

dendrites

nucleus

cell body

axon

axon terminals

in_1

in_2

in_n

out

(c) https://appliedgo.net/perceptron/

Perceptron:

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

Inputs   Weights

x_1 W_1

x_2 W_2 Sum

x_3 W_3 Σ z   Activation function σ a

x_n W_n

```
w <- w + (y - f(x)) * x
```

(c) https://towardsdatascience.com/what-the-hell-is-perceptron-626217814f53

Perceptron:

linear — non-linear — inseparable