Perceptron implementation of the not operator

Machine Learning 2024-25 Course Activity

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November 24, 2024

NOT operator

The NOT operator can be implemented as a Perceptron with a single connection.

The input is a single binary variable, $x \in \{0, 1\}$. Which value should we assign to the weights?

The boolean function NOT returns the opposite value of the input:

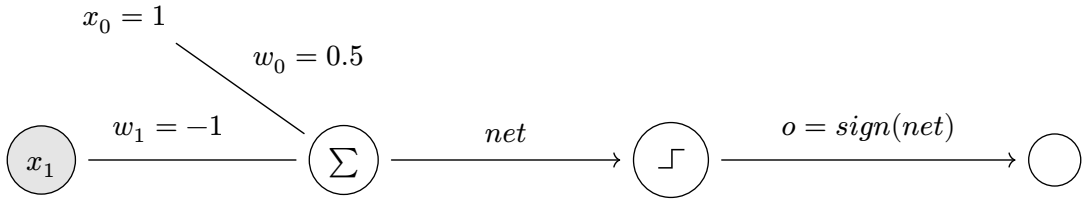
- input $= 1 \Rightarrow$ output $= -1$
- input $= 0 \Rightarrow$ output $= 1$

where $-1 = \textit{False}$ and $1 = \textit{True}$.

With $a = x_0 = 1$, the weights should be:

- $w_0 = 0.5$
- $w_1 = -1$, since we are interested in the opposite value of x_1

Thanks to this configuration, we can map $not(0) = 1$ and $not(1) = -1$:



where $net = \sum_{i=0}^{n} w_i x_i$ and $o = \sigma(net) = sign(net)$.

Example, $x = 1$

$$\begin{aligned} sign(net) &= sign(w_0 \cdot 1 + w_1 \cdot 1) \\ &= sign(0.5 \cdot 1 + (-1) \cdot 1) \\ &= sign(-0.5) = -1 \end{aligned}$$

Example, $x = 0$

$$\begin{aligned} sign(net) &= sign(w_0 \cdot 1 + w_1 \cdot 0) \\ &= sign(0.5 \cdot 1 + (-1) \cdot 0) \\ &= sign(0.5) = 1 \end{aligned}$$