Artificial Intelligence: *Modeling Human Intelligence with Networks*

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The Perceptron Algorithm!!

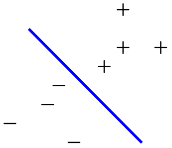
The perceptron

Algorithms

- Set of instructions, typically to solve a class of problems or perform a computation.

From last class

- We had a rule: separate the data using a line,



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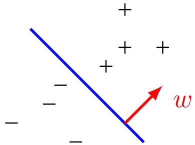

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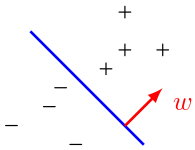

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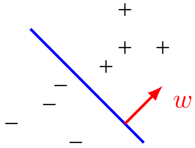

- How do we find w automatically?
- The Perceptron Algorithm!

The perceptron

Set up

- In our exercises, we begin with a matrix *data* that contains the data: the points and the classes (negatives or positives).
- The matrix *data* will look like this:

$$data = \begin{bmatrix} 2.1 & 5.2 & 1 \\ 1.1 & -2.7 & -1 \\ 1.4 & 2.2 & -1 \\ \vdots & \vdots & \vdots \\ 3.5 & 1.7 & 1 \end{bmatrix}$$

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- We then break it up in two variables: a matrix X of points and a vector $classes$ of classes:

$$X = \begin{bmatrix} 2.1 & 5.2 \\ 1.1 & -2.7 \\ \vdots & \vdots \\ 3.5 & 1.7 \end{bmatrix}, \quad classes = [1, -1, \ldots, 1]$$

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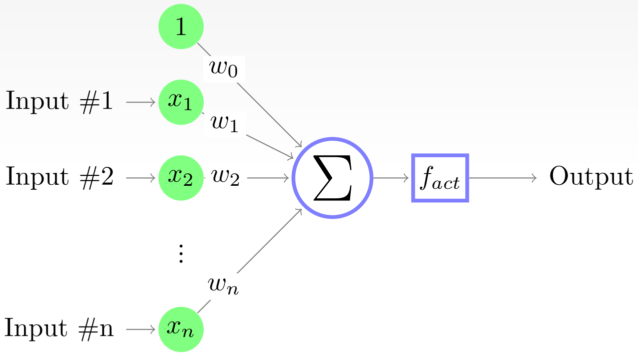
Remember the neuron model?



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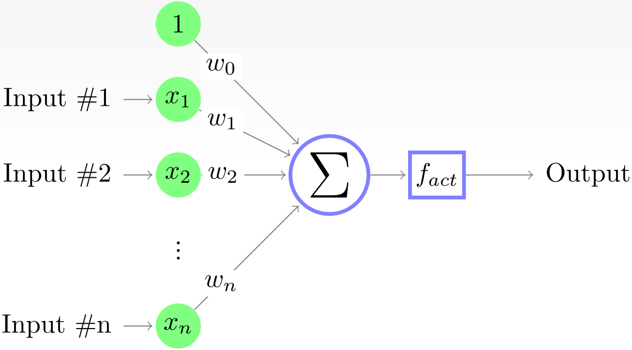

- We need to add a bias...

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Adding the bias

- Each row of X is an input point $x = [x_1, x_2]$ and there are m data points.

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Adding the bias

- Each row of X is an input point $x = [x_1, x_2]$ and there are m data points. We need to add a 1 before them:

$$X = \begin{bmatrix} 2.1 & 5.2 \\ 1.1 & -2.7 \\ \vdots & \vdots \\ 3.5 & 1.7 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 2.1 & 5.2 \\ 1 & 1.1 & -2.7 \\ \vdots & \vdots & \vdots \\ 1 & 3.5 & 1.7 \end{bmatrix}$$

- This can be done in python by a function `np.concatenate()`.

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The Algorithm

Algorithm 1 Perceptron - v2

Input: $X \in \mathbb{R}^{m \times 3}$ and $classes \in \mathbb{R}^m$
Output $w \in \mathbb{R}^3$

Initialize w
for $i = 1$ to m **do**
    $x = X[i,:]$
    if $x \cdot w > 0$ **and** $classes[i] == -1$ **then**
        $w = w - x$
    end if
    if $x \cdot w \leq 0$ **and** $classes[i] == 1$ **then**
        $w = w + x$
    end if
end for

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Algorithm 2 Perceptron - v2

Input: $X \in \mathbb{R}^{m \times 3}$, $classes \in \mathbb{R}^m$, $num\_epochs \in \mathbb{Z}$
Output $w \in \mathbb{R}^3$

Initialize w
for $epoch = 1$ to num_epochs **do**
    for $i = 1$ to m **do**
        $x = X[i,:]$
        if $x \cdot w > 0$ **and** $classes[i] == -1$ **then**
            $w = w - x$
        end if
        if $x \cdot w \leq 0$ **and** $classes[i] == 1$ **then**
            $w = w + x$
        end if
    end for
end for

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Algorithm 3 Perceptron - Final

Input: $X \in \mathbb{R}^{m \times 3}$, $classes \in \mathbb{R}^m$, $num\_epochs \in \mathbb{Z}$
Output $w \in \mathbb{R}^3$

```
Initialize w
for epoch = 1 to num_epochs do
    for i = 1 to m do
        x = X[i,:],
        if classes[i] × (x · w) < 0 then
            w = w + classes[i] × x
        end if
    end for
end for
```