Deep Learning

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Perceptron Learning Algorithm

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McCulloch-Pitts (MCP) Neuron (1943)

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- **Drawbacks of MCP Neuron?**
  - **No Non-Boolean Inputs**
  - **Hard-coded Threshold (No Learning)**
  - **No Weightage for Inputs**
  - **Non-linearly Separable not Possible – Eg: XOR**

The Perceptron: Learning Begins (1957)

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- **Designer**: Frank Rosenblat
- Focused on drawbacks of MCP Neuron
  - **No Non-Boolean Inputs**
  - **Hard-coded Threshold (No Learning)**
  - **No Weightage for Inputs**
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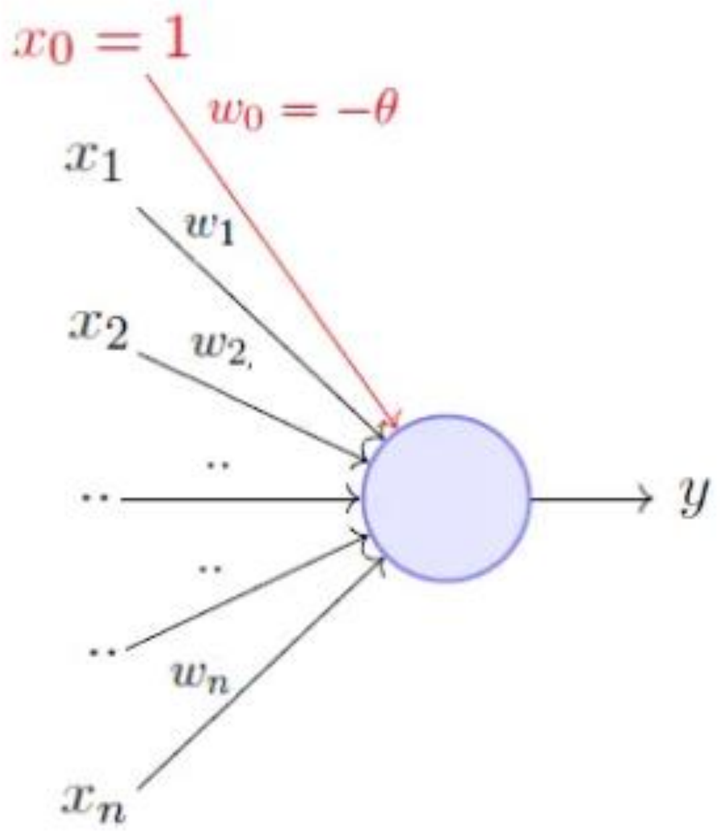
The Perceptron: Learning Begins (1957)

- **Designer**: Frank Rosenblat
- Perceptron (Left) and MCP (Right)



$$y = 1 \quad if \sum_{i=1}^{n} w_i * x_i - \theta \geq 0$$

$$= 0 \quad if \sum_{i=1}^{n} w_i * x_i - \theta < 0$$

$$y = 1 \quad if \sum_{i=0}^{n} w_i * x_i \geq 0$$

$$= 0 \quad if \sum_{i=0}^{n} w_i * x_i < 0$$

$$where, \quad x_0 = 1 \quad and \quad w_0 = -\theta$$

K1

The Perceptron Learning Algorithm

- Let
  - $Z = \sum_{i=0}^{n} w_i * x_i$

K1

The Perceptron Learning Algorithm

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- Then vector form $Z = w \cdot x$

The Perceptron Learning Algorithm

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- Then vector form $Z = w \cdot x$
- Vector $\mathbf{x} = [x_0, x_1, x_2, \ldots, x_n]$
- Vector $\mathbf{w} = [w_0, w_1, w_2, \ldots, w_n]$

The Perceptron Learning Algorithm

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  - $Z = \sum_{i=0}^{n} w_i * x_i$

- Then vector form Z = w · x
- Vector $\mathbf{x} = [x_0, x_1, x_2, \ldots, x_n]$
- Vector $\mathbf{w} = [w_0, w_1, w_2, \ldots, w_n]$
- Mathematically,

$$y = f(Z) = \begin{cases} 1 & \text{if } Z \geq 0 \\ 0 & \text{if } Z < 0 \end{cases}$$

K1

The Perceptron Learning Algorithm

- Mathematically,

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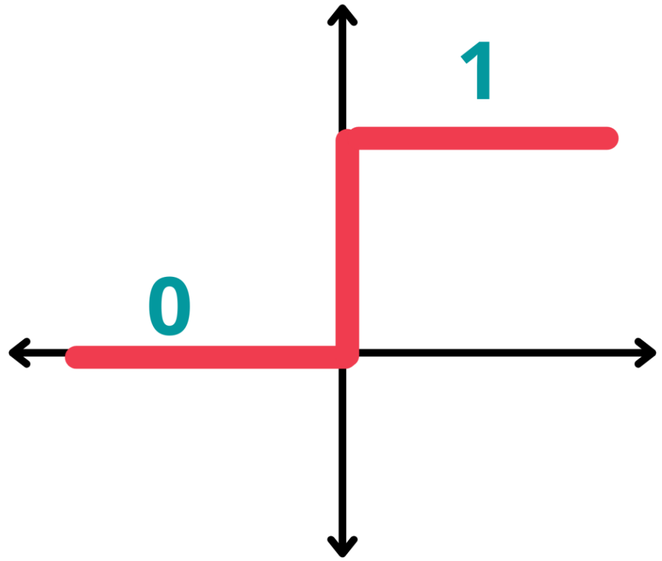
- Sharp change at 0 => Step function



K1

The Perceptron Learning Algorithm

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Algorithm: Perceptron Learning

Input: Learning rate α, Training dataset D

Output: Learned weights w

1. Initialize weights w to zero
2. Repeat until convergence
   - for each data point i in D
     - if y_i misclassified
       1. $w \leftarrow w + \alpha*(t_i - y_i)*x$
3. return w

K1

The Perceptron Learning Algorithm

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Boolean AND gate

K3

References

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1. **Goodfellow I, Bengio Y, Courville A, Bengio Y. Deep learning. Cambridge: MIT press; 2016 Nov 18.**

THANK YOU

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