

Perceptron Homework

Parameters:

- **Number of Inputs:** 3 (plus bias)
- **Learning Rate (c):** 1
- **Initial Weights:** $w_1 = 1$, $w_2 = 1$, $w_3 = 1$, and bias $w_b = 1$
- **Activation Function:** Outputs 1 if $\text{Net} > 0$, otherwise 0.

Training Set:

1. **Pattern 1:** $[1, 0, 1] \rightarrow 0$
2. **Pattern 2:** $[1, 0.5, 0] \rightarrow 0$
3. **Pattern 3:** $[1, -0.4, 1] \rightarrow 1$
4. **Pattern 4:** $[0, 1, 0.5] \rightarrow 1$

Weight Update Rule:

$$\Delta w_i = c \times (t - z) \times x_i$$

where:

- t = target output
- z = actual output
- x_i = input value
- c = learning rate (1 here)

Process Each Pattern:

Initial Weights

- $w_1 = 1$
- $w_2 = 1$
- $w_3 = 1$

- $w_b = 1$

Pattern 1: $[1, 0, 1] \rightarrow 0$

- **Net Input Calculation:**
 - $\text{Net} = w_1 \times 1 + w_2 \times 0 + w_3 \times 1 + w_b \times 1$
 - $\text{Net} = 1 \times 1 + 1 \times 0 + 1 \times 1 + 1 \times 1 = 3$
- **Output (z):** 1 (because $\text{net} > 0$)
- **Error Calculation:** $t - z = 0 - 1 = -1$
- **Weight Updates:**
 - For w_1 : $\Delta w_1 = 1 \times (-1) \times 1 = -1$
 - For w_2 : $\Delta w_2 = 1 \times (-1) \times 0 = 0$
 - For w_3 : $\Delta w_3 = 1 \times (-1) \times 1 = -1$
 - For w_b : $\Delta w_b = 1 \times (-1) \times 1 = -1$
- **Updated Weights:**
 - $w_1 = 1 - 1 = 0$
 - $w_2 = 1 + 0 = 1$
 - $w_3 = 1 - 1 = 0$
 - $w_b = 1 - 1 = 0$

Pattern 2: $[1, 0.5, 0] \rightarrow 0$

- **Net Input Calculation:**
 - $\text{Net} = w_1 \times 1 + w_2 \times 0.5 + w_3 \times 0 + w_b \times 1$
 - $\text{Net} = 0 \times 1 + 1 \times 0.5 + 0 \times 0 + 0 \times 1 = 0.5$
- **Output (z):** 1 (because $\text{net} > 0$)
- **Error Calculation:** $t - z = 0 - 1 = -1$
- **Weight Updates:**
 - For w_1 : $\Delta w_1 = 1 \times (-1) \times 1 = -1$
 - For w_2 : $\Delta w_2 = 1 \times (-1) \times 0.5 = -0.5$
 - For w_3 : $\Delta w_3 = 1 \times (-1) \times 0 = 0$
 - For w_b : $\Delta w_b = 1 \times (-1) \times 1 = -1$
- **Updated Weights:**
 - $w_1 = 0 - 1 = -1$

- $w_2 = 1 - 0.5 = 0.5$
- $w_3 = 0 + 0 = 0$
- $w_b = 0 - 1 = -1$

Pattern 3: $[1, -0.4, 1] \rightarrow 1$

- **Net Input Calculation:**
 - $\text{Net} = w_1 \times 1 + w_2 \times (-0.4) + w_3 \times 1 + w_b \times 1$
 - $\text{Net} = (-1) \times 1 + 0.5 \times (-0.4) + 0 \times 1 + (-1) \times 1$
 - $\text{Net} = -1 - 0.2 - 1 = -2.2$
- **Output (z):** 0 (because $\text{net} \leq 0$)
- **Error Calculation:** $t - z = 1 - 0 = 1$
- **Weight Updates:**
 - For w_1 : $\Delta w_1 = 1 \times 1 \times 1 = 1$
 - For w_2 : $\Delta w_2 = 1 \times 1 \times (-0.4) = -0.4$
 - For w_3 : $\Delta w_3 = 1 \times 1 \times 1 = 1$
 - For w_b : $\Delta w_b = 1 \times 1 \times 1 = 1$
- **Updated Weights:**
 - $w_1 = -1 + 1 = 0$
 - $w_2 = 0.5 - 0.4 = 0.1$
 - $w_3 = 0 + 1 = 1$
 - $w_b = -1 + 1 = 0$

Pattern 4: $[0, 1, 0.5] \rightarrow 1$

- **Net Input Calculation:**
 - $\text{Net} = w_1 \times 0 + w_2 \times 1 + w_3 \times 0.5 + w_b \times 1$
 - $\text{Net} = 0 \times 0 + 0.1 \times 1 + 1 \times 0.5 + 0 \times 1$
 - $\text{Net} = 0 + 0.1 + 0.5 = 0.6$
- **Output (z):** 1 (because $\text{net} > 0$)
- **Error Calculation:** $t - z = 1 - 1 = 0$
- **Weight Updates:** No change as error is 0.
- **Updated Weights:**
 - $w_1 = 0$

- $w_2 = 0.1$
- $w_3 = 1$
- $w_b = 0$

Summary of Weights After Each Pattern

1. **After Pattern 1:** $w_1 = 0$, $w_2 = 1$, $w_3 = 0$, $w_b = 0$
2. **After Pattern 2:** $w_1 = -1$, $w_2 = 0.5$, $w_3 = 0$, $w_b = -1$
3. **After Pattern 3:** $w_1 = 0$, $w_2 = 0.1$, $w_3 = 1$, $w_b = 0$
4. **After Pattern 4:** $w_1 = 0$, $w_2 = 0.1$, $w_3 = 1$, $w_b = 0$