Bonus Question for Lab 9: Building an AND Gate Using a Perceptron

Mohammad Parsa Dini
Student ID: 400101204

Introduction

A perceptron is a simple neural network model that can be used to implement logical gates such as the AND gate. In this document, we will build an AND gate using a perceptron and visualize it with some test cases using Python.

Perceptron Model

The perceptron model for an AND gate is defined with the following parameters:
- Inputs: x_1 and x_2 - Weights: $w_1 = 1$, $w_2 = 1$ - Bias: $b = -1.5$

The output of the perceptron is given by:

$$\text{output} = \begin{cases} 1 & \text{if } (w_1 \cdot x_1 + w_2 \cdot x_2 + b) \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Python Code for Visualization

The following Python code implements the perceptron model for the AND gate and visualizes the results for all possible input combinations.

Listing 1: Perceptron Implementation for AND Gate

```
import numpy as np
import matplotlib.pyplot as plt

def perceptron(x1, x2, w1=1, w2=1, b=-1.5):
    weighted_sum = w1 * x1 + w2 * x2 + b
    return 1 if weighted_sum >= 0 else 0

# Test the perceptron with all input combinations for an AND gate
inputs = [(0, 0), (0, 1), (1, 0), (1, 1)]
outputs = [perceptron(x1, x2) for x1, x2 in inputs]
```

```
# Print the results
for inp, out in zip(inputs, outputs):
    print(f"Input: {inp} -> Output: {out}")

# Visualize the perceptron decision boundary
plt.figure()
for x1, x2 in inputs:
    plt.scatter(x1, x2, color='blue' if perceptron(x1, x2) else 'red')
plt.xlabel('x1')
plt.ylabel('x2')
plt.title('AND Gate with Perceptron')
plt.grid(True)
plt.show()
```

Results

The perceptron correctly implements the AND gate, as shown by the following output:

```
Input: (0, 0) -> Output: 0
Input: (0, 1) -> Output: 0
Input: (1, 0) -> Output: 0
Input: (1, 1) -> Output: 1
```

The decision boundary and visualization are displayed in the plot, where blue points represent output 1 and red points represent output 0.

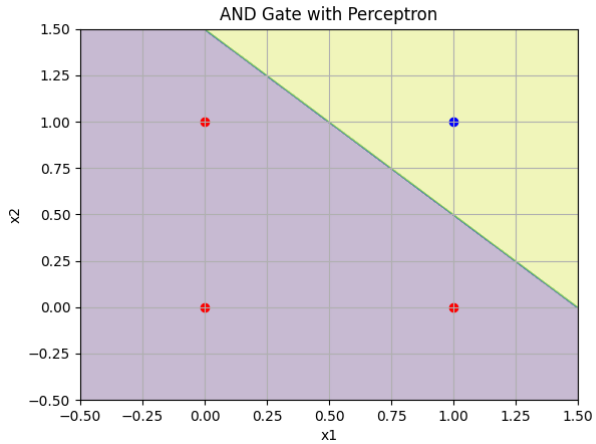

Figure 1: The output of the model for AND gate and the decision boundary.