Exercise: Neural Network Backpropagation Calculation

Dataset

Consider a binary classification problem with the following two sentences, each converted into a feature vector based on the vocabulary:

1. "I love data"

2. "Data is fun"

Vocabulary: [I, love, data, fun]

Feature vectors:

- Sentence 1: [1, 1, 1, 0] (I, love, data)

- Sentence 2: [0, 0, 1, 1] (data, fun)

Labels:

- Sentence 1: 1 (positive)

- Sentence 2: 0 (negative)

Neural Network Architecture

- **Input Layer**: 4 features (words of the vocabulary)

- **Hidden Layer**: 2 neurons with the tanh activation function

- **Output Layer**: 1 neuron with the sigmoid activation function

- **Loss Function**: Binary cross-entropy

Initial Weights

All initial weights and biases are set to zero.

Initial Weights and Biases

- Input to Hidden Layer Weights: $W1=[00000000]W1=\lfloor\lfloor 00000000 \rfloor\rfloor$

- Hidden Layer Bias: $b1=[00]b1=[00]$

- Hidden to Output Layer Weights: $W2=[00]W2=[00]$

- Output Layer Bias: $b2=0b2=0$

Steps

1. **Forward Propagation**: Calculate the output for each input sentence.

2. **Backward Propagation**: Update weights and biases using gradient descent.