CS353 ML Lab 8

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Batch: Section 2

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Q: Implementation of **AND Gate using Artificial Neural Network**. To understand the working of neural networks using AND Gates implemented through neural network.

Import Libraries

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

Sigmoid Function

```
def sigmoid(z):
    return 1 / (1 + np.exp(-z))
```

Initalizing Weights

```
# Weights are random values between 0 and 1 with bias value 1
def initializeParameters(input, HiddenLayers, output):

    W1 = np.random.randn(HiddenLayers, input)
    W2 = np.random.randn(output, HiddenLayers)
    b1 = np.zeros((HiddenLayers, 1))
    b2 = np.zeros((output, 1))

    parameters = {"W1":W1, "b1":b1, "W2":W2, "b2":b2}
    return parameters
```

Forward Propagation

```
def forwardPropagation(X, Y, parameters):
    m = X.shape[1]
    W1 = parameters["W1"]
    W2 = parameters["W2"]
    b1 = parameters["b1"]
    b2 = parameters["b2"]

    Z1 = np.dot(W1, X) + b1
    A1 = sigmoid(Z1)
    Z2 = np.dot(W2, A1) + b2
    A2 = sigmoid(Z2)

    cache = (Z1, A1, W1, b1, Z2, A2, W2, b2)
    logprobs = np.multiply(np.log(A2), Y) + np.multiply(np.log(1 - A
    cost = -np.sum(logprobs) / m
    return cost, cache, A2
```

Backward Propagation

```
def backwardPropagation(X, Y, cache):
    m = X.shape[1]
    (Z1, A1, W1, b1, Z2, A2, W2, b2) = cache

    dZ2 = A2 - Y
    dW2 = np.dot(dZ2, A1.T) / m
    db2 = np.sum(dZ2, axis = 1, keepdims = True)

    dA1 = np.dot(W2.T, dZ2)
    dZ1 = np.multiply(dA1, A1 * (1- A1))
    dW1 = np.dot(dZ1, X.T) / m
    db1 = np.sum(dZ1, axis = 1, keepdims = True) / m

    gradients = {"dZ2":dZ2, "dW2":dW2, "db2":db2, "dZ1":dZ1, "dW1":d
    return gradients
```

```
# Updating the weights based on the negative gradients
def updateParameters(parameters, gradients, learningRate):
    parameters["W1"] = parameters["W1"] - learningRate * gradients["
    parameters["W2"] = parameters["W2"] - learningRate * gradients["
    parameters["b1"] = parameters["b1"] - learningRate * gradients["
    parameters["b2"] = parameters["b2"] - learningRate * gradients["
    return parameters

# Model inputs for AND truth table
```

```
# model inputs for AND truth table
X = np.array([[0, 0, 1, 1], [0, 1, 0, 1]]) # AND input
Y = np.array([[0, 0, 0, 1]]) # AND output
```

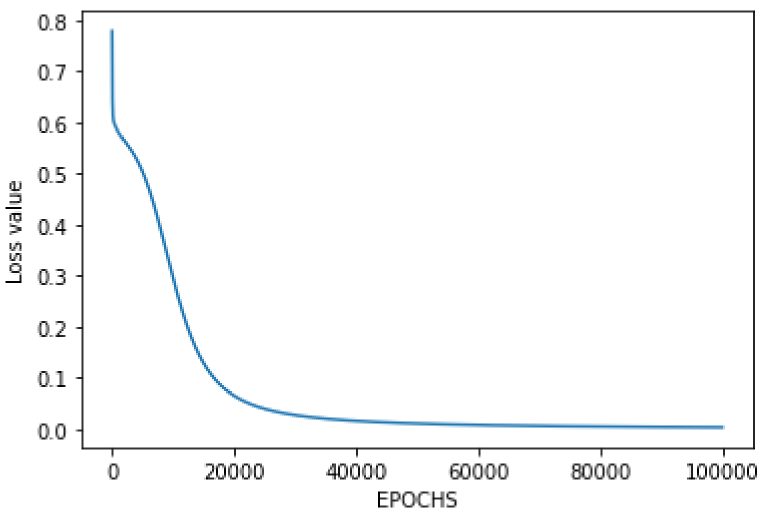
Model Parameters

```
HiddenLayers = 2          # number of hidden layer neurons (2)
input = X.shape[0]        # number of input features (2)
output = Y.shape[0]       # number of output features (1)
parameters = initializeParameters(input, HiddenLayers, output)
epoch = 100000
learningRate = 0.01
losses = np.zeros((epoch, 1))

for i in range(epoch):
    losses[i, 0], cache, A2 = forwardPropagation(X, Y, parameters)
    gradients = backwardPropagation(X, Y, cache)
    parameters = updateParameters(parameters, gradients, learningRat
```

Results

```
# Evaluating the performance
plt.figure()
plt.plot(losses)
plt.xlabel("EPOCHS")
plt.ylabel("Loss value")
plt.show()
```



Predicting Values

```
X = np.array([[1, 1, 0, 0], [0, 1, 0, 1]]) # AND input
```

```
cost, _, A2 = forwardPropagation(X, Y, parameters)
prediction = (A2 > 0.5) * 1.0
print(prediction)
```

```
[[0. 1. 0. 0.]]
```

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