

Q2

The following model achieves an impressive accuracy of 99.96%, demonstrating exceptional performance on the XOR classification task. Below, I describe the process that led to this model.

This is the model that achieves an impressive accuracy of 99.96%, demonstrating exceptional performance on the XOR classification task.

Model: 3 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: Adam, learning rate = 0.001.

Batch Size: 8 samples per batch.

Epochs: Model trained for 10 epochs

Test accuracy result : 99.96% after training.

```
Epoch [1/10], Loss: 0.6449
Epoch [2/10], Loss: 0.4647
Epoch [3/10], Loss: 0.0001
Epoch [4/10], Loss: 0.0000
Epoch [5/10], Loss: 0.0000
Epoch [6/10], Loss: 0.0000
Epoch [7/10], Loss: 0.0000
Epoch [8/10], Loss: 0.0000
Epoch [9/10], Loss: 0.0000
Epoch [10/10], Loss: 0.0000
Test Accuracy after training: 99.96%
```

(The overfitting here is surprisingly not detrimental to the test results.)

The process

Test 1:

Model: 1 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: SGD, learning rate = 0.1.

Batch Size: 64 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result: 71.66%

```
Epoch [1/20], Loss: 0.6867
Epoch [2/20], Loss: 0.6931
Epoch [3/20], Loss: 0.6811
Epoch [4/20], Loss: 0.7054
Epoch [5/20], Loss: 0.6765
Epoch [6/20], Loss: 0.6604
Epoch [7/20], Loss: 0.6947
Epoch [8/20], Loss: 0.7464
Epoch [9/20], Loss: 0.6365
Epoch [10/20], Loss: 0.7288
Epoch [11/20], Loss: 0.6653
Epoch [12/20], Loss: 0.7610
Epoch [13/20], Loss: 0.6986
Epoch [14/20], Loss: 0.6481
Epoch [15/20], Loss: 0.6085
Epoch [16/20], Loss: 0.5474
Epoch [17/20], Loss: 0.5309
Epoch [18/20], Loss: 0.8366
Epoch [19/20], Loss: 0.5346
Epoch [20/20], Loss: 0.5767
Test Accuracy after training: 71.66%
```

Test 2:

Model: 1 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: SGD, learning rate = 0.01.

Batch Size: 64 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result: 49.87%

```
Epoch [1/20], Loss: 0.7119
Epoch [2/20], Loss: 0.7129
Epoch [3/20], Loss: 0.6852
Epoch [4/20], Loss: 0.6998
Epoch [5/20], Loss: 0.6891
Epoch [6/20], Loss: 0.6931
Epoch [7/20], Loss: 0.6889
Epoch [8/20], Loss: 0.7078
Epoch [9/20], Loss: 0.7003
Epoch [10/20], Loss: 0.6946
Epoch [11/20], Loss: 0.7002
Epoch [12/20], Loss: 0.7045
Epoch [13/20], Loss: 0.6968
Epoch [14/20], Loss: 0.6896
Epoch [15/20], Loss: 0.6967
Epoch [16/20], Loss: 0.6951
Epoch [17/20], Loss: 0.6926
Epoch [18/20], Loss: 0.7003
Epoch [19/20], Loss: 0.6844
Epoch [20/20], Loss: 0.6918
Test Accuracy after training: 49.87%
```

Test 3:

Model: 1 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: SGD, learning rate = 0.001 , weight decay=0.1.

Batch Size: 64 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result: 50.27%

```
Epoch [1/20], Loss: 0.7324
Epoch [2/20], Loss: 0.7236
Epoch [3/20], Loss: 0.6794
Epoch [4/20], Loss: 0.6977
Epoch [5/20], Loss: 0.6974
Epoch [6/20], Loss: 0.6962
Epoch [7/20], Loss: 0.6933
Epoch [8/20], Loss: 0.7047
Epoch [9/20], Loss: 0.6925
Epoch [10/20], Loss: 0.6991
Epoch [11/20], Loss: 0.6962
Epoch [12/20], Loss: 0.6947
Epoch [13/20], Loss: 0.6941
Epoch [14/20], Loss: 0.6959
Epoch [15/20], Loss: 0.6949
Epoch [16/20], Loss: 0.6960
Epoch [17/20], Loss: 0.6927
Epoch [18/20], Loss: 0.6930
Epoch [19/20], Loss: 0.6923
Epoch [20/20], Loss: 0.6952
Test Accuracy after training: 50.27%
```

Test 4:

Model: 3 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: SGD, learning rate = 0.001 , weight decay=0.1.

Batch Size: 64 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result:49.83%

```
Epoch [1/20], Loss: 0.6839
Epoch [2/20], Loss: 0.6887
Epoch [3/20], Loss: 0.6913
Epoch [4/20], Loss: 0.6938
Epoch [5/20], Loss: 0.6945
Epoch [6/20], Loss: 0.6930
Epoch [7/20], Loss: 0.6930
Epoch [8/20], Loss: 0.6926
Epoch [9/20], Loss: 0.6936
Epoch [10/20], Loss: 0.6930
Epoch [11/20], Loss: 0.6934
Epoch [12/20], Loss: 0.6933
Epoch [13/20], Loss: 0.6930
Epoch [14/20], Loss: 0.6930
Epoch [15/20], Loss: 0.6934
Epoch [16/20], Loss: 0.6930
Epoch [17/20], Loss: 0.6930
Epoch [18/20], Loss: 0.6937
Epoch [19/20], Loss: 0.6932
Epoch [20/20], Loss: 0.6935
Test Accuracy after training: 49.83%
```

Test 5:

Model: 3 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: ADAM, learning rate = 0.001 , weight decay=0.1.

Batch Size: 8 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result:50.17%

```
Epoch [1/20], Loss: 0.6899
Epoch [2/20], Loss: 0.6831
Epoch [3/20], Loss: 0.6931
Epoch [4/20], Loss: 0.6901
Epoch [5/20], Loss: 0.6837
Epoch [6/20], Loss: 0.6861
Epoch [7/20], Loss: 0.6990
Epoch [8/20], Loss: 0.7013
Epoch [9/20], Loss: 0.6894
Epoch [10/20], Loss: 0.6945
Epoch [11/20], Loss: 0.6902
Epoch [12/20], Loss: 0.7021
Epoch [13/20], Loss: 0.6946
Epoch [14/20], Loss: 0.7003
Epoch [15/20], Loss: 0.6854
Epoch [16/20], Loss: 0.6948
Epoch [17/20], Loss: 0.6952
Epoch [18/20], Loss: 0.6972
Epoch [19/20], Loss: 0.6885
Epoch [20/20], Loss: 0.6927
Test Accuracy after training: 50.17%
```

Test 6:

Model: 3 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: ADAM, learning rate = 0.001 , weight decay=0.

Batch Size: 8 samples per batch.

Epochs: Model trained for 20 epochs

Test accuracy result: 99.98%

```
Epoch [1/20], Loss: 0.6449
Epoch [2/20], Loss: 0.4647
Epoch [3/20], Loss: 0.0001
Epoch [4/20], Loss: 0.0000
Epoch [5/20], Loss: 0.0000
Epoch [6/20], Loss: 0.0000
Epoch [7/20], Loss: 0.0000
Epoch [8/20], Loss: 0.0000
Epoch [9/20], Loss: 0.0000
Epoch [10/20], Loss: 0.0000
Epoch [11/20], Loss: 0.0000
Epoch [12/20], Loss: 0.0000
Epoch [13/20], Loss: 0.0000
Epoch [14/20], Loss: 0.0000
Epoch [15/20], Loss: 0.0000
Epoch [16/20], Loss: 0.0000
Epoch [17/20], Loss: 0.0000
Epoch [18/20], Loss: 0.0000
Epoch [19/20], Loss: 0.0000
Epoch [20/20], Loss: 0.0000
Test Accuracy after training: 99.98%
```

Test 7:

Model: 3 hidden layers, 80 neurons each.

Loss: Binary Cross-Entropy.

Activation Functions: ReLU for hidden layers and Sigmoid for the output

Optimizer: ADAM, learning rate = 0.001 , weight decay=0.

Batch Size: 8 samples per batch.

Epochs: Model trained for 10 epochs

Test accuracy result:99.96%

```
Epoch [1/10], Loss: 0.6449
Epoch [2/10], Loss: 0.4647
Epoch [3/10], Loss: 0.0001
Epoch [4/10], Loss: 0.0000
Epoch [5/10], Loss: 0.0000
Epoch [6/10], Loss: 0.0000
Epoch [7/10], Loss: 0.0000
Epoch [8/10], Loss: 0.0000
Epoch [9/10], Loss: 0.0000
Epoch [10/10], Loss: 0.0000
Test Accuracy after training: 99.96%
```
