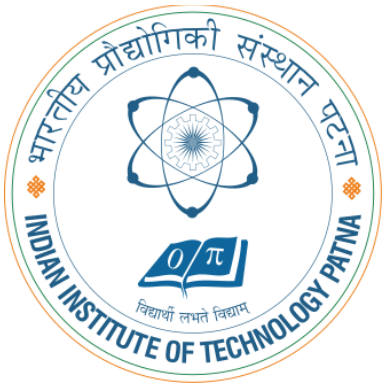
CS571: Artificial Intelligence Lab

Indian Institute of Technology Patna



ASSIGNMENT 10

Neural Networks

Group Members

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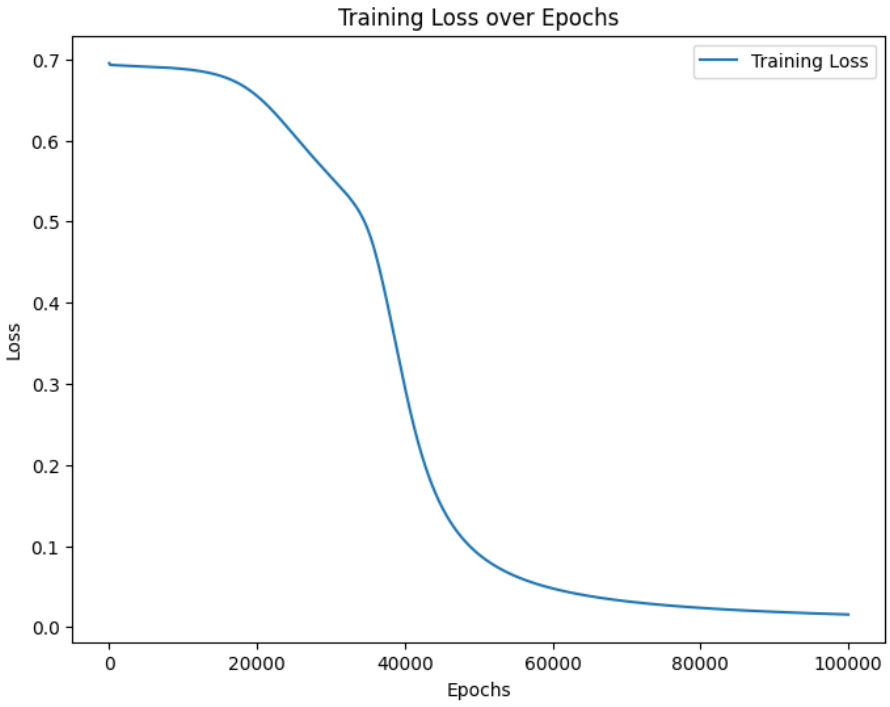
Q1: Artificial Neural Network to simulate a 2-input XOR gate.

Result

Learning Rate: 0.01
Epochs: 100,000

```
Training Model...
Epoch 0, Loss: 0.6951005361526587, Accuracy: 0.75
Epoch 10000, Loss: 0.6880136890727035, Accuracy: 0.5
Epoch 20000, Loss: 0.6546970145907982, Accuracy: 0.5
Epoch 30000, Loss: 0.555092306010166, Accuracy: 0.75
Epoch 40000, Loss: 0.29559097962656045, Accuracy: 1.0
Epoch 50000, Loss: 0.08975193538759861, Accuracy: 1.0
Epoch 60000, Loss: 0.047691949111367704, Accuracy: 1.0
Epoch 70000, Loss: 0.031859419426584754, Accuracy: 1.0
Epoch 80000, Loss: 0.023745464093313667, Accuracy: 1.0
Epoch 90000, Loss: 0.018857352986887087, Accuracy: 1.0
Training Completed !
```

Loss Graph



Accuracy Graph

Test Prediction:

```
Input:  [ [0 0 1 1] [0 1 0 1] ]
Prediction:  [[0. 1. 1. 0.]]
```

Conclusion:

The XORNN successfully learns the XOR function, as evidenced by the decreasing loss and increasing accuracy. The chosen hyperparameters contribute to the convergence of the network. Further analysis and experimentation may involve varying hyperparameters or exploring additional network architectures for similar problems.

Q2: Multi-Layer Perceptron (MLP) classifier

Result for IRIS Dataset:

```
IRIS - Neurons: 32, Activation: relu, Accuracy: 0.8333
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.86      0.60      0.71        10
           2       0.69      0.90      0.78        10

    accuracy                           0.83        30
   macro avg       0.85      0.83      0.83        30
weighted avg       0.85      0.83      0.83        30


IRIS - Neurons: 64, Activation: relu, Accuracy: 0.9000
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.89      0.80      0.84        10
           2       0.82      0.90      0.86        10

    accuracy                           0.90        30
   macro avg       0.90      0.90      0.90        30
weighted avg       0.90      0.90      0.90        30
```

```
IRIS - Neurons: 128, Activation: relu, Accuracy: 0.9333
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.90      0.90      0.90        10
           2       0.90      0.90      0.90        10

    accuracy                           0.93        30
   macro avg       0.93      0.93      0.93        30
weighted avg       0.93      0.93      0.93        30


IRIS - Neurons: 32, Activation: LeakyReLU, Accuracy: 0.8667
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.88      0.70      0.78        10
           2       0.75      0.90      0.82        10

    accuracy                           0.87        30
   macro avg       0.88      0.87      0.87        30
weighted avg       0.88      0.87      0.87        30
```

```
IRIS - Neurons: 64, Activation: LeakyReLU, Accuracy: 0.9000
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.89      0.80      0.84        10
           2       0.82      0.90      0.86        10

    accuracy                           0.90        30
   macro avg       0.90      0.90      0.90        30
weighted avg       0.90      0.90      0.90        30


IRIS - Neurons: 128, Activation: LeakyReLU, Accuracy: 0.9333
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       0.90      0.90      0.90        10
           2       0.90      0.90      0.90        10

    accuracy                           0.93        30
   macro avg       0.93      0.93      0.93        30
weighted avg       0.93      0.93      0.93        30
```

Result for CIFAR10 Dataset:

```
CIFAR-10 - Neurons: 32, Activation: relu, Accuracy: 0.4258
Classification Report:
              precision    recall  f1-score   support

           0       0.46      0.43      0.44       973
           1       0.50      0.53      0.51       979
           2       0.33      0.31      0.32      1030
           3       0.31      0.27      0.29      1023
           4       0.36      0.43      0.39       933
           5       0.37      0.33      0.35      1015
           6       0.44      0.44      0.44       996
           7       0.46      0.51      0.48       994
           8       0.54      0.59      0.56      1017
           9       0.48      0.43      0.45      1040

    accuracy                           0.43     10000
   macro avg       0.42      0.43      0.42     10000
weighted avg       0.42      0.43      0.42     10000
```

```
CIFAR-10 - Neurons: 64, Activation: relu, Accuracy: 0.4285
Classification Report:
              precision    recall  f1-score   support

           0       0.45      0.46      0.46       973
           1       0.54      0.53      0.54       979
           2       0.34      0.32      0.33      1030
           3       0.28      0.26      0.27      1023
           4       0.37      0.39      0.38       933
           5       0.34      0.37      0.35      1015
           6       0.47      0.46      0.46       996
           7       0.46      0.50      0.48       994
           8       0.56      0.56      0.56      1017
           9       0.48      0.44      0.46      1040

    accuracy                           0.43     10000
   macro avg       0.43      0.43      0.43     10000
weighted avg       0.43      0.43      0.43     10000
```

CIFAR-10 - Neurons: 128, Activation: relu, Accuracy: 0.4625
Classification Report:

	precision	recall	f1-score	support
0	0.49	0.57	0.53	973
1	0.56	0.54	0.55	979
2	0.35	0.37	0.36	1030
3	0.32	0.31	0.31	1023
4	0.39	0.40	0.40	933
5	0.36	0.40	0.38	1015
6	0.55	0.41	0.47	996
7	0.52	0.53	0.52	994
8	0.60	0.62	0.61	1017
9	0.52	0.48	0.50	1040
accuracy			0.46	10000
macro avg	0.47	0.46	0.46	10000
weighted avg	0.47	0.46	0.46	10000

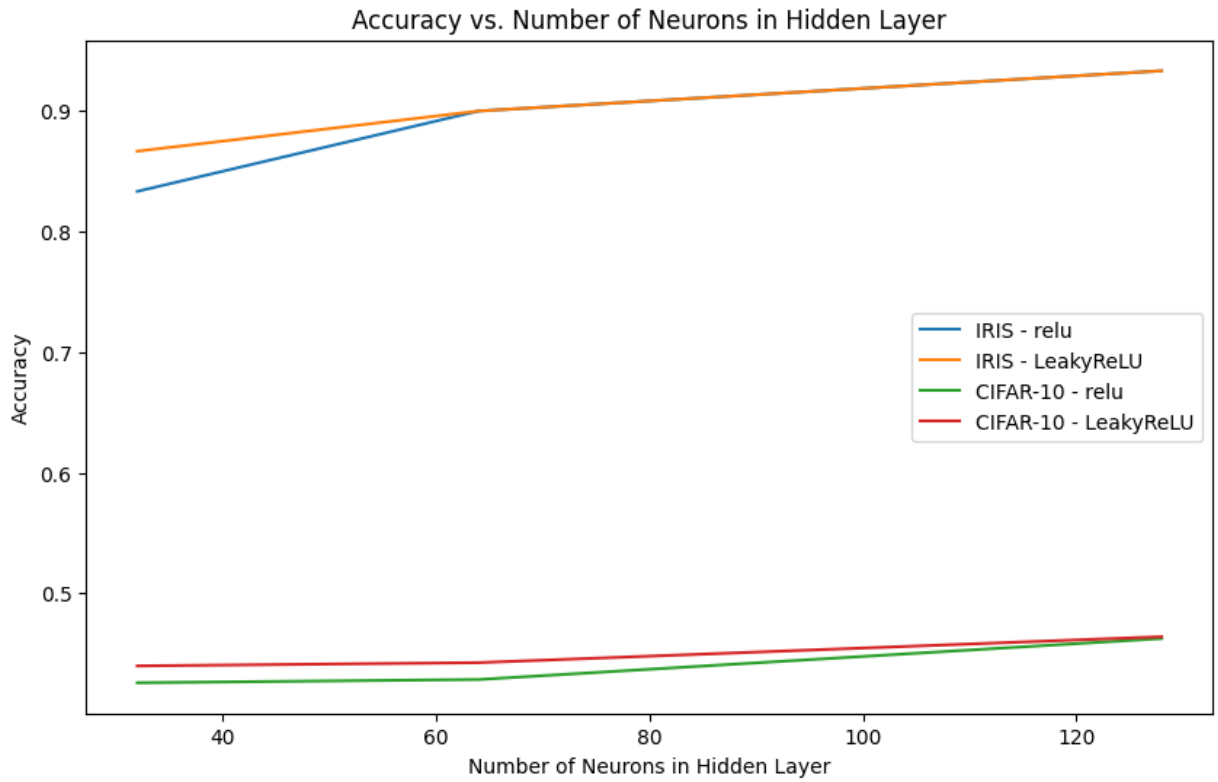
CIFAR-10 - Neurons: 32, Activation: LeakyReLU, Accuracy: 0.4398
Classification Report:

	precision	recall	f1-score	support
0	0.50	0.46	0.48	973
1	0.52	0.56	0.54	979
2	0.35	0.33	0.34	1030
3	0.31	0.23	0.26	1023
4	0.36	0.47	0.41	933
5	0.34	0.34	0.34	1015
6	0.45	0.46	0.45	996
7	0.49	0.52	0.51	994
8	0.57	0.60	0.58	1017
9	0.48	0.45	0.46	1040
accuracy			0.44	10000
macro avg	0.44	0.44	0.44	10000
weighted avg	0.44	0.44	0.44	10000

```
CIFAR-10 - Neurons: 64, Activation: LeakyReLU, Accuracy: 0.4425
Classification Report:
              precision    recall  f1-score   support

           0       0.47      0.54      0.51       973
           1       0.52      0.50      0.51       979
           2       0.33      0.38      0.35      1030
           3       0.30      0.27      0.28      1023
           4       0.37      0.43      0.40       933
           5       0.36      0.32      0.34      1015
           6       0.52      0.46      0.49       996
           7       0.50      0.53      0.51       994
           8       0.57      0.54      0.56      1017
           9       0.49      0.47      0.48      1040

    accuracy                           0.44     10000
   macro avg       0.44      0.44      0.44     10000
weighted avg       0.44      0.44      0.44     10000
```

```
CIFAR-10 - Neurons: 128, Activation: LeakyReLU, Accuracy: 0.4640
Classification Report:
              precision    recall  f1-score   support

           0       0.51      0.49      0.50       973
           1       0.59      0.53      0.56       979
           2       0.38      0.40      0.39      1030
           3       0.31      0.33      0.32      1023
           4       0.39      0.37      0.38       933
           5       0.37      0.34      0.35      1015
           6       0.50      0.48      0.49       996
           7       0.50      0.50      0.50       994
           8       0.59      0.66      0.62      1017
           9       0.51      0.54      0.53      1040

    accuracy                           0.46     10000
   macro avg       0.46      0.46      0.46     10000
weighted avg       0.46      0.46      0.46     10000
```

Accuracy vs No. of Neurons Graph



Conclusion

IRIS Dataset:

- ReLU and LeakyReLU activations perform well.
- Increasing the number of neurons generally improves performance.

CIFAR-10 Dataset:

- ReLU and LeakyReLU activations exhibit moderate performance.
- Increasing the number of neurons shows marginal improvements.