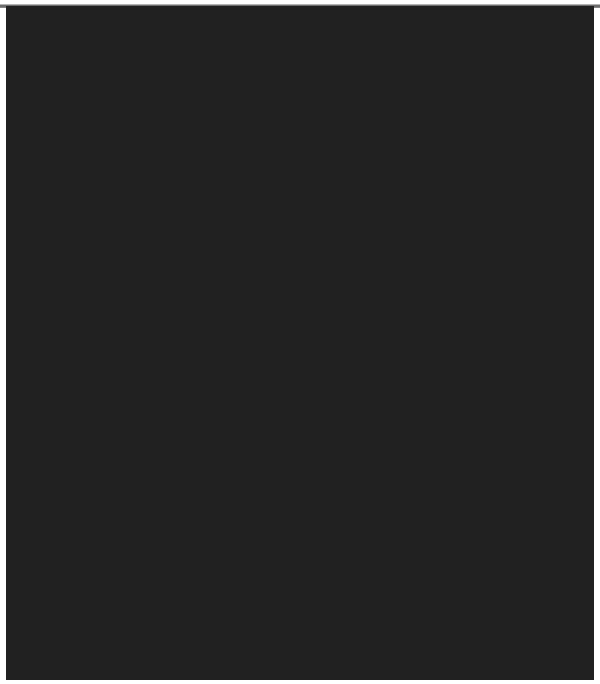

DL-Ops

Lab Assignment 5 - Report

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Problem Statement:

Question 1 [10 marks]

Implement a Neural Network using the IRIS dataset. Perform backpropagation using early stoppping. You can choose the activation function and loss function at your convenience, which gives the best performance.

The Neural Network should have 2 hidden layers, one with 4 neurons and one with 5 neurons. The input layer should have 4 neurons and the output layer should have 3 neurons.

Report the test loss, test accuracy, train loss and train accuracy. The loss should be reported in the form of curves.

Note - For today's lab you can use docker in your local system. If you don't have a GPU then also it's fine as the IRIS dataset is very small.

For running the code in docker you need to convert your .ipynb code in .py format.

Given Dataset:

IRIS

Training Set: 120

Testing Set: 30

Classes: 3 classes: 'setosa', 'versicolor', 'virginica'

Data Samples:

Dataset order	Sepal length	Sepal width	Petal length	Petal width	Species
1	5.1	3.5	1.4	0.2	*I. setosa*
2	4.9	3.0	1.4	0.2	*I. setosa*
3	4.7	3.2	1.3	0.2	*I. setosa*
4	4.6	3.1	1.5	0.2	*I. setosa*
5	5.0	3.6	1.4	0.3	*I. setosa*
6	5.4	3.9	1.7	0.4	*I. setosa*
7	4.6	3.4	1.4	0.3	*I. setosa*
8	5.0	3.4	1.5	0.2	*I. setosa*
9	4.4	2.9	1.4	0.2	*I. setosa*
10	4.9	3.1	1.5	0.1	*I. setosa*

Neural Network Model Architecture:

```
NeuralNet(
  (layers): Sequential(
    (0): Linear(in_features=4, out_features=4, bias=True)
    (1): ReLU()
    (2): Linear(in_features=4, out_features=5, bias=True)
    (3): ReLU()
    (4): Linear(in_features=5, out_features=3, bias=True)
    (5): LogSoftmax(dim=1)
  )
)
```

- Neural Network Input Layer size: **4**
- Neural Network no of hidden layers: **2 (of size 4 and 5)**
- Neural Network Output Layer size: **3**

- Loss Function: **Cross Entropy Loss**
- Optimizer **Adam**
- Max no of epochs used to train model: **500**
- Learning Rate: **0.05**
- **Early Stop Patience: 5**

Model Training:

Epoch: 1 (0m 0s) Training Loss: 1.084, Test Loss: 1.044, Training acc: 0.33, Test acc: 0.37, num_epochs_since_improvement = 0
Epoch: 2 (0m 0s) Training Loss: 1.046, Test Loss: 0.989, Training acc: 0.33, Test acc: 0.37, num_epochs_since_improvement = 0
Epoch: 3 (0m 0s) Training Loss: 0.997, Test Loss: 0.934, Training acc: 0.33, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 4 (0m 0s) Training Loss: 0.943, Test Loss: 0.867, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 5 (0m 0s) Training Loss: 0.872, Test Loss: 0.808, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 6 (0m 0s) Training Loss: 0.803, Test Loss: 0.723, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 7 (0m 0s) Training Loss: 0.721, Test Loss: 0.631, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 8 (0m 0s) Training Loss: 0.639, Test Loss: 0.557, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 9 (0m 0s) Training Loss: 0.576, Test Loss: 0.508, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 10 (0m 0s) Training Loss: 0.530, Test Loss: 0.472, Training acc: 0.66, Test acc: 0.70, num_epochs_since_improvement = 0
Epoch: 11 (0m 0s) Training Loss: 0.494, Test Loss: 0.445, Training acc: 0.66, Test acc: 0.73, num_epochs_since_improvement = 0
Epoch: 12 (0m 0s) Training Loss: 0.464, Test Loss: 0.428, Training acc: 0.69, Test acc: 0.80, num_epochs_since_improvement = 0
Epoch: 13 (0m 0s) Training Loss: 0.441, Test Loss: 0.417, Training acc: 0.77, Test acc: 0.90, num_epochs_since_improvement = 0
Epoch: 14 (0m 0s) Training Loss: 0.425, Test Loss: 0.400, Training acc: 0.91, Test acc: 0.80, num_epochs_since_improvement = 0
Epoch: 15 (0m 0s) Training Loss: 0.410, Test Loss: 0.383, Training acc: 0.90, Test acc: 0.80, num_epochs_since_improvement = 0
Epoch: 16 (0m 0s) Training Loss: 0.397, Test Loss: 0.370, Training acc: 0.78, Test acc: 0.80, num_epochs_since_improvement = 0
Epoch: 17 (0m 0s) Training Loss: 0.385, Test Loss: 0.360, Training acc: 0.78, Test acc: 0.83, num_epochs_since_improvement = 0
Epoch: 18 (0m 0s) Training Loss: 0.371, Test Loss: 0.351, Training acc: 0.90, Test acc: 0.93, num_epochs_since_improvement = 0
Epoch: 19 (0m 0s) Training Loss: 0.359, Test Loss: 0.335, Training acc: 0.96, Test acc: 0.93, num_epochs_since_improvement = 0
Epoch: 20 (0m 0s) Training Loss: 0.344, Test Loss: 0.317, Training acc: 0.94, Test acc: 0.90, num_epochs_since_improvement = 0
Epoch: 21 (0m 0s) Training Loss: 0.329, Test Loss: 0.302, Training acc: 0.92, Test acc: 0.90, num_epochs_since_improvement = 0
Epoch: 22 (0m 0s) Training Loss: 0.313, Test Loss: 0.288, Training acc: 0.93, Test acc: 0.93, num_epochs_since_improvement = 0
Epoch: 23 (0m 0s) Training Loss: 0.298, Test Loss: 0.274, Training acc: 0.97, Test acc: 0.97, num_epochs_since_improvement = 0
Epoch: 24 (0m 0s) Training Loss: 0.286, Test Loss: 0.260, Training acc: 0.97, Test acc: 0.93, num_epochs_since_improvement = 0

Epoch: 25 (0m 0s) Training Loss: 0.271, Test Loss: 0.250, Training acc: 0.94, Test acc: 0.93,
num_epochs_since_improvement = 0
Epoch: 26 (0m 0s) Training Loss: 0.260, Test Loss: 0.234, Training acc: 0.93, Test acc: 0.93,
num_epochs_since_improvement = 0
Epoch: 27 (0m 0s) Training Loss: 0.246, Test Loss: 0.221, Training acc: 0.96, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 28 (0m 0s) Training Loss: 0.232, Test Loss: 0.212, Training acc: 0.97, Test acc: 0.93,
num_epochs_since_improvement = 0
Epoch: 29 (0m 0s) Training Loss: 0.217, Test Loss: 0.200, Training acc: 0.96, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 30 (0m 0s) Training Loss: 0.203, Test Loss: 0.187, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 31 (0m 0s) Training Loss: 0.191, Test Loss: 0.178, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 32 (0m 0s) Training Loss: 0.179, Test Loss: 0.170, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 33 (0m 0s) Training Loss: 0.169, Test Loss: 0.159, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 34 (0m 0s) Training Loss: 0.158, Test Loss: 0.149, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 35 (0m 0s) Training Loss: 0.149, Test Loss: 0.141, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 36 (0m 0s) Training Loss: 0.139, Test Loss: 0.132, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 37 (0m 0s) Training Loss: 0.130, Test Loss: 0.122, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 38 (0m 0s) Training Loss: 0.123, Test Loss: 0.116, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 39 (0m 0s) Training Loss: 0.116, Test Loss: 0.110, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 40 (0m 0s) Training Loss: 0.110, Test Loss: 0.102, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 41 (0m 0s) Training Loss: 0.105, Test Loss: 0.096, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 42 (0m 0s) Training Loss: 0.099, Test Loss: 0.093, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 43 (0m 0s) Training Loss: 0.095, Test Loss: 0.087, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 44 (0m 0s) Training Loss: 0.090, Test Loss: 0.082, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 45 (0m 0s) Training Loss: 0.087, Test Loss: 0.079, Training acc: 0.97, Test acc: 0.97,
num_epochs_since_improvement = 0
Epoch: 46 (0m 0s) Training Loss: 0.083, Test Loss: 0.075, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 47 (0m 0s) Training Loss: 0.080, Test Loss: 0.072, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 48 (0m 0s) Training Loss: 0.078, Test Loss: 0.069, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 49 (0m 0s) Training Loss: 0.075, Test Loss: 0.066, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0

Epoch: 50 (0m 0s) Training Loss: 0.073, Test Loss: 0.064, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 51 (0m 0s) Training Loss: 0.072, Test Loss: 0.061, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 52 (0m 0s) Training Loss: 0.070, Test Loss: 0.059, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 53 (0m 0s) Training Loss: 0.068, Test Loss: 0.057, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 54 (0m 0s) Training Loss: 0.067, Test Loss: 0.054, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 55 (0m 0s) Training Loss: 0.065, Test Loss: 0.052, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 56 (0m 0s) Training Loss: 0.064, Test Loss: 0.051, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 57 (0m 0s) Training Loss: 0.063, Test Loss: 0.049, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 58 (0m 0s) Training Loss: 0.062, Test Loss: 0.047, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 59 (0m 0s) Training Loss: 0.061, Test Loss: 0.046, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 60 (0m 0s) Training Loss: 0.060, Test Loss: 0.045, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 61 (0m 0s) Training Loss: 0.060, Test Loss: 0.043, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 62 (0m 0s) Training Loss: 0.059, Test Loss: 0.043, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 63 (0m 0s) Training Loss: 0.058, Test Loss: 0.041, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 64 (0m 0s) Training Loss: 0.058, Test Loss: 0.040, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 65 (0m 0s) Training Loss: 0.057, Test Loss: 0.040, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 66 (0m 0s) Training Loss: 0.056, Test Loss: 0.038, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 67 (0m 0s) Training Loss: 0.056, Test Loss: 0.038, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 68 (0m 0s) Training Loss: 0.055, Test Loss: 0.037, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 69 (0m 0s) Training Loss: 0.055, Test Loss: 0.035, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 70 (0m 0s) Training Loss: 0.055, Test Loss: 0.035, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 71 (0m 0s) Training Loss: 0.054, Test Loss: 0.034, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 72 (0m 0s) Training Loss: 0.054, Test Loss: 0.033, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 73 (0m 0s) Training Loss: 0.054, Test Loss: 0.033, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 74 (0m 0s) Training Loss: 0.053, Test Loss: 0.032, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0

Epoch: 75 (0m 0s) Training Loss: 0.053, Test Loss: 0.032, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 76 (0m 0s) Training Loss: 0.053, Test Loss: 0.031, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 77 (0m 0s) Training Loss: 0.052, Test Loss: 0.030, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 78 (0m 0s) Training Loss: 0.052, Test Loss: 0.030, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 79 (0m 0s) Training Loss: 0.052, Test Loss: 0.029, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 80 (0m 0s) Training Loss: 0.052, Test Loss: 0.029, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 81 (0m 0s) Training Loss: 0.051, Test Loss: 0.028, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 82 (0m 0s) Training Loss: 0.051, Test Loss: 0.028, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 83 (0m 0s) Training Loss: 0.051, Test Loss: 0.028, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 84 (0m 0s) Training Loss: 0.051, Test Loss: 0.027, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 85 (0m 0s) Training Loss: 0.051, Test Loss: 0.027, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 86 (0m 0s) Training Loss: 0.051, Test Loss: 0.026, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 87 (0m 0s) Training Loss: 0.051, Test Loss: 0.026, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 88 (0m 0s) Training Loss: 0.050, Test Loss: 0.025, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 89 (0m 0s) Training Loss: 0.050, Test Loss: 0.026, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 90 (0m 0s) Training Loss: 0.050, Test Loss: 0.024, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 91 (0m 0s) Training Loss: 0.050, Test Loss: 0.026, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 92 (0m 0s) Training Loss: 0.050, Test Loss: 0.023, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 93 (0m 0s) Training Loss: 0.051, Test Loss: 0.028, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 94 (0m 0s) Training Loss: 0.051, Test Loss: 0.023, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 95 (0m 0s) Training Loss: 0.053, Test Loss: 0.032, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 96 (0m 0s) Training Loss: 0.053, Test Loss: 0.022, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 97 (0m 0s) Training Loss: 0.053, Test Loss: 0.025, Training acc: 0.97, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 98 (0m 0s) Training Loss: 0.050, Test Loss: 0.025, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 2
Epoch: 99 (0m 0s) Training Loss: 0.050, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0

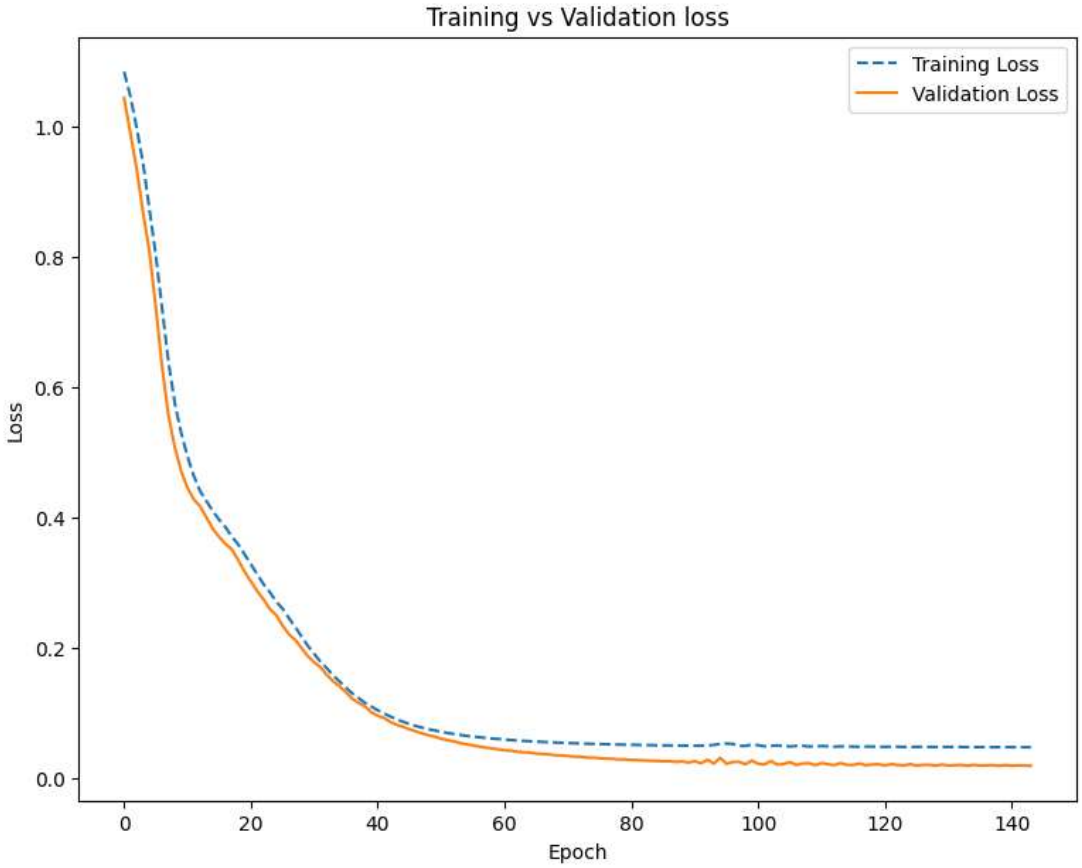
Epoch: 100 (0m 0s) Training Loss: 0.052, Test Loss: 0.027, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 101 (0m 0s) Training Loss: 0.051, Test Loss: 0.022, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 102 (0m 0s) Training Loss: 0.049, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 103 (0m 0s) Training Loss: 0.050, Test Loss: 0.027, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 104 (0m 0s) Training Loss: 0.051, Test Loss: 0.021, Training acc: 0.97, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 105 (0m 0s) Training Loss: 0.050, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 106 (0m 0s) Training Loss: 0.049, Test Loss: 0.025, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 107 (0m 0s) Training Loss: 0.050, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 108 (0m 0s) Training Loss: 0.050, Test Loss: 0.023, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 109 (0m 0s) Training Loss: 0.049, Test Loss: 0.023, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 110 (0m 0s) Training Loss: 0.049, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 111 (0m 0s) Training Loss: 0.050, Test Loss: 0.024, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 112 (0m 0s) Training Loss: 0.049, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 113 (0m 0s) Training Loss: 0.049, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 114 (0m 0s) Training Loss: 0.049, Test Loss: 0.024, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 115 (0m 0s) Training Loss: 0.049, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 116 (0m 0s) Training Loss: 0.049, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 3
Epoch: 117 (0m 0s) Training Loss: 0.049, Test Loss: 0.023, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 4
Epoch: 118 (0m 0s) Training Loss: 0.049, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 119 (0m 0s) Training Loss: 0.049, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 120 (0m 0s) Training Loss: 0.048, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 121 (0m 0s) Training Loss: 0.049, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 0
Epoch: 122 (0m 0s) Training Loss: 0.049, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 1
Epoch: 123 (0m 0s) Training Loss: 0.049, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 2
Epoch: 124 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00,
num_epochs_since_improvement = 3

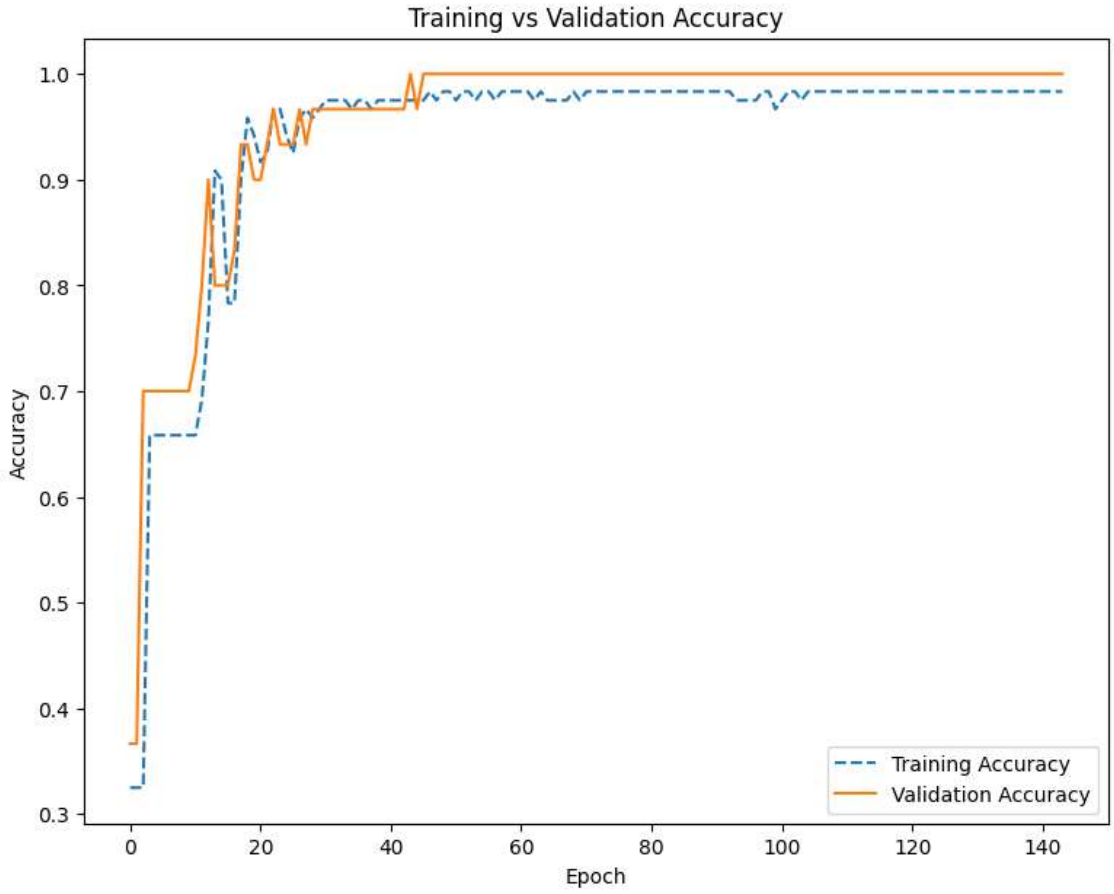
Epoch: 125 (0m 0s) Training Loss: 0.048, Test Loss: 0.022, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 4
Epoch: 126 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 127 (0m 0s) Training Loss: 0.048, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 128 (0m 0s) Training Loss: 0.048, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 2
Epoch: 129 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 130 (0m 0s) Training Loss: 0.048, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 131 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 2
Epoch: 132 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 3
Epoch: 133 (0m 0s) Training Loss: 0.048, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 4
Epoch: 134 (0m 0s) Training Loss: 0.048, Test Loss: 0.019, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 135 (0m 0s) Training Loss: 0.048, Test Loss: 0.021, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 136 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 2
Epoch: 137 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 3
Epoch: 138 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 4
Epoch: 139 (0m 0s) Training Loss: 0.048, Test Loss: 0.019, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 0
Epoch: 140 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 1
Epoch: 141 (0m 0s) Training Loss: 0.048, Test Loss: 0.019, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 2
Epoch: 142 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 3
Epoch: 143 (0m 0s) Training Loss: 0.048, Test Loss: 0.020, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 4
Epoch: 144 (0m 0s) Training Loss: 0.048, Test Loss: 0.019, Training acc: 0.98, Test acc: 1.00, num_epochs_since_improvement = 5

Early stopping at epoch 143

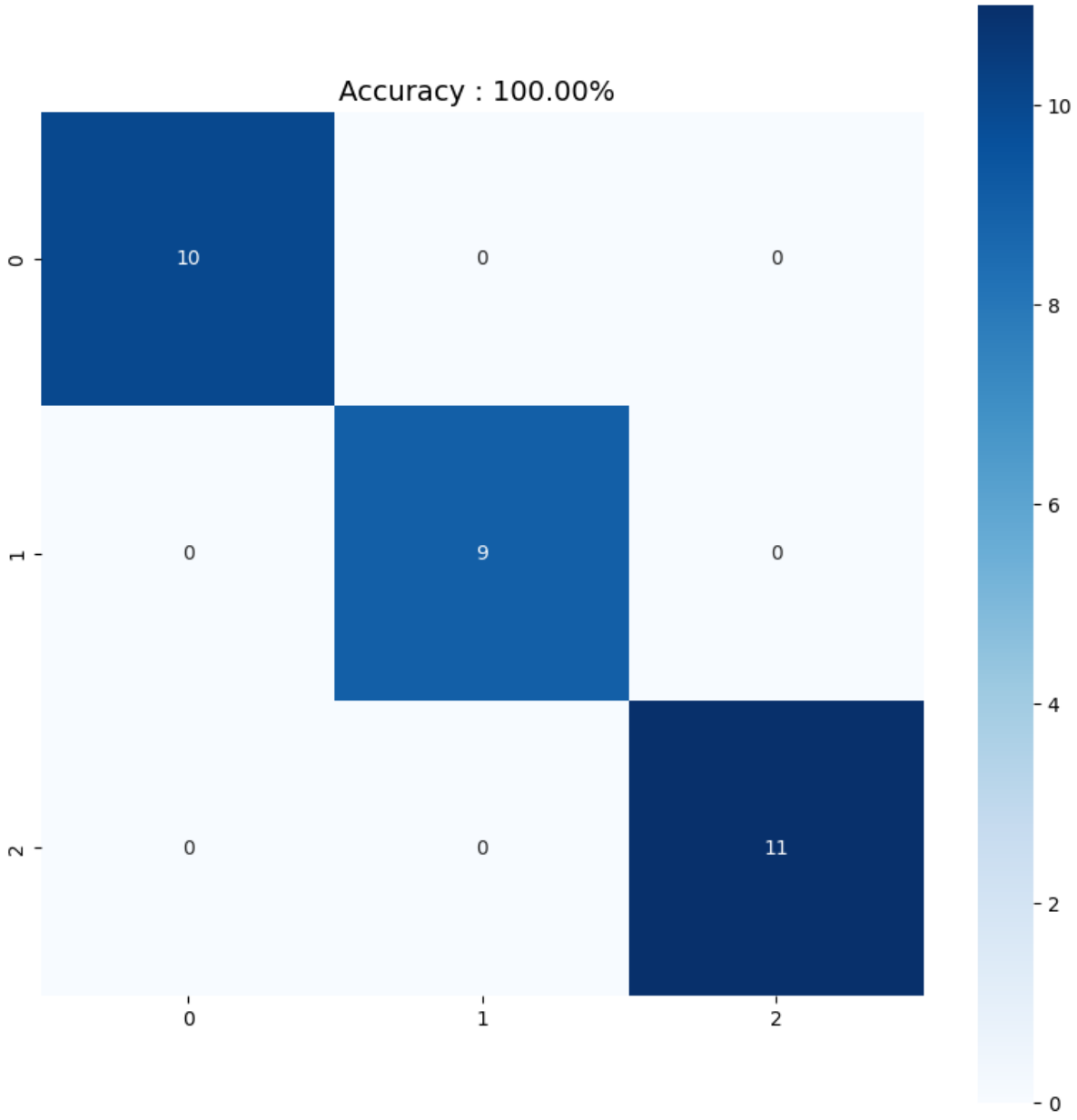
Training completed in 0m 0s Training Loss: 0.048, Test Loss: 0.019, Training acc: 0.98, Test acc: 1.00,

Training Loss and accuracy curve:





Confusion Matrix:



Accuracy:

100.000%

Class-wise Accuracy Score:

[1. 1. 1.]

Docker Commands used:

docker build -t dlopslab5:v1 -f Dockerfile .

docker run -it dlopslab5:v1

Dockerfile

```
FROM python:3.10
COPY ./*.py /exp/
COPY ./requirements.txt /exp/requirements.txt
RUN pip3 install --no-cache-dir -r /exp/requirements.txt
WORKDIR /exp
CMD python M21AIE225_Lab_Assignment_5.py
```

Docker Image list:

```
docker image ls
REPOSITORY                    TAG                  IMAGE ID
CREATED         SIZE
<none>                        <none>               09f2b686083b   13
minutes ago   4.69GB
dlopslab5                     v1                   f267b00167c3   13
minutes ago   4.69GB
<none>                        <none>               6932613119e9   13
minutes ago   4.69GB
<none>                        <none>               f20fd3ade775   13
minutes ago   4.69GB
final_exam_q5                 v1                   7e74a43774c1   3
months ago    1.43GB
final_exam_image              v1                   1c605180d6bf   3
months ago    1.43GB
```