Learning From Data

Lab Task 2 – Banknote Classification

Supervised by:

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The Architecture of MLNN

- **Inputs:** Variance of wavelet transformed image, skewness of wavelet transformed image, kurtosis of wavelet transformed image, and entropy of image.
- **Nodes:** 4 nodes in first layer, 4 nodes in second layer, one node in output layer.
- **Output:** Class.
- **Layers:** 3 layers.
- **Activation Function for all layers:** Sigmoid.

Training and Testing

- **Initial set of weights:**
- First layer weights:

	in1,1	in1,2	in1,3	in1,4	b1
0	0.048148	0.040534	0.019413	-0.011945	0.0
1	-0.010047	-0.031211	0.035783	-0.006983	0.0
2	-0.037384	0.043716	-0.035333	0.009298	0.0
3	0.016009	-0.042613	0.003699	0.022726	0.0

- Second layer weights:

	in2,1	in2,2	in2,3	in2,4	b2
0	-0.032005	-0.010698	-0.014787	0.017528	0.0
1	-0.040881	-0.013087	-0.004974	0.003960	0.0
2	0.001292	-0.000510	-0.029249	0.042502	0.0
3	0.012706	0.047622	0.006461	0.019053	0.0

- Third layer weights:

	in3	b3
0	0.005189	0.0

- **Training to testing ratio:** 0.70:0.30.
- **Number of epochs:** 50.
- **Patch size:** 10.
- **Epoch results:**

```
95/95 [==============================] - 1s 1ms/step - loss: 0.6945 - accuracy: 0.4788
95/95 [==============================] - 0s 1ms/step - loss: 0.6907 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6885 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6869 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6845 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6810 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6752 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6678 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6579 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6451 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6292 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.6100 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.5875 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.5625 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.5356 - accuracy: 0.5552
95/95 [==============================] - 0s 2ms/step - loss: 0.5075 - accuracy: 0.5552
95/95 [==============================] - 0s 1ms/step - loss: 0.4790 - accuracy: 0.5616
95/95 [==============================] - 0s 1ms/step - loss: 0.4506 - accuracy: 0.7261
95/95 [==============================] - 0s 1ms/step - loss: 0.4234 - accuracy: 0.8949
95/95 [==============================] - 0s 1ms/step - loss: 0.3973 - accuracy: 0.9310
95/95 [==============================] - 0s 1ms/step - loss: 0.3727 - accuracy: 0.9544
95/95 [==============================] - 0s 1ms/step - loss: 0.3496 - accuracy: 0.9756
95/95 [==============================] - 0s 1ms/step - loss: 0.3279 - accuracy: 0.9777
95/95 [==============================] - 0s 1ms/step - loss: 0.3077 - accuracy: 0.9841
95/95 [==============================] - 0s 1ms/step - loss: 0.2890 - accuracy: 0.9862
95/95 [==============================] - 0s 1ms/step - loss: 0.2717 - accuracy: 0.9862
95/95 [==============================] - 0s 1ms/step - loss: 0.2558 - accuracy: 0.9873
95/95 [==============================] - 0s 1ms/step - loss: 0.2411 - accuracy: 0.9883
95/95 [==============================] - 0s 1ms/step - loss: 0.2275 - accuracy: 0.9883
95/95 [==============================] - 0s 1ms/step - loss: 0.2149 - accuracy: 0.9883
95/95 [==============================] - 0s 1ms/step - loss: 0.2032 - accuracy: 0.9883
95/95 [==============================] - 0s 1ms/step - loss: 0.1924 - accuracy: 0.9883
95/95 [==============================] - 0s 1ms/step - loss: 0.1823 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1730 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1643 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1562 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1487 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1417 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1351 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1288 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1231 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1177 - accuracy: 0.9894
95/95 [==============================] - 0s 1ms/step - loss: 0.1126 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.1078 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.1034 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.0992 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.0951 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.0915 - accuracy: 0.9904
95/95 [==============================] - 0s 1ms/step - loss: 0.0878 - accuracy: 0.9915
95/95 [==============================] - 0s 1ms/step - loss: 0.0845 - accuracy: 0.9915
```

- **Final set of weights:**
- First layer weights:

	in1,1	in1,2	in1,3	in1,4	b1
0	2.661699	2.683354	2.524635	-0.217231	-0.363576
1	2.604937	2.605646	2.454270	-0.205165	-0.430506
2	2.591043	2.677500	2.485538	-0.198215	-0.393261
3	2.605340	2.570090	2.432949	-0.200051	-0.446737

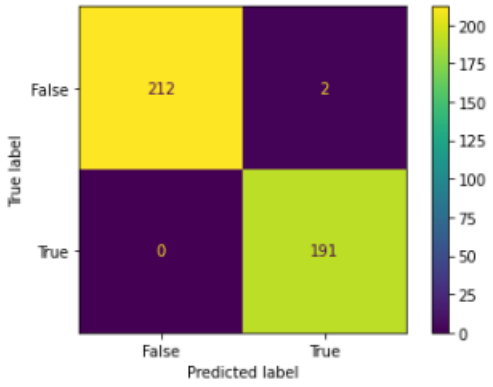
- Second layer weights:

	in2,1	in2,2	in2,3	in2,4	b2
0	2.476756	2.271924	2.409771	2.320524	-3.206244
1	2.551883	2.423661	2.518995	2.444657	-3.338208
2	2.595026	2.477781	2.504146	2.509394	-3.380202
3	2.590844	2.516434	2.525136	2.473797	-3.385567

- Third layer weights:

	in3	b3
0	0.005189	0.0

- **Confusion matrix:**



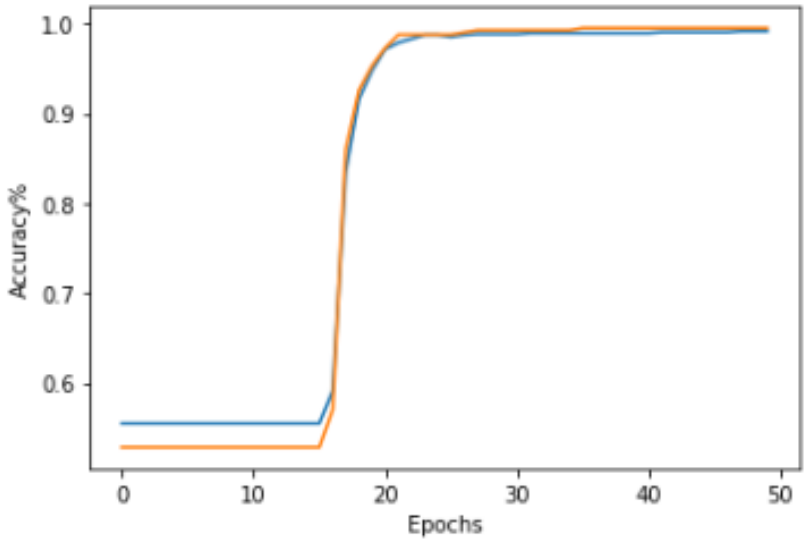
- **Classification report:**

	precision	recall	f1-score	support
0	1.00	0.99	1.00	214
1	0.99	1.00	0.99	191
accuracy			1.00	405
macro avg	0.99	1.00	1.00	405
weighted avg	1.00	1.00	1.00	405

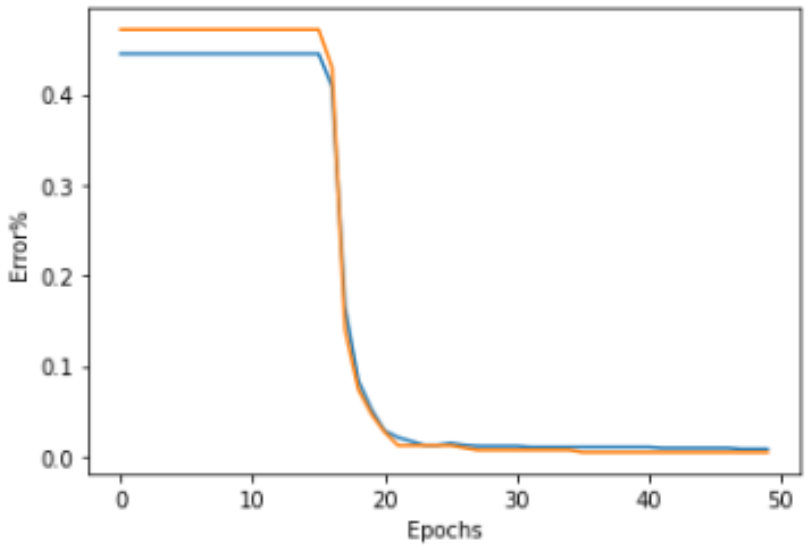
- **Accuracy:** 99.50617283950616.

Plots

- Training and testing accuracy:



- Training and testing error:



- ROC: