**Reflection**

Honestly, I do not remember about the classification matrix and what any of precision, recall, f1, accuracy are. But, I tried my best to revise and do the assignment in a short time. During hyperparameters tuning, I noticed I faced with the testing scores not changing, but I was able to resolve it.

**Report**

Layer 1 – 1 input x 32 + 1 bias x 32 = 64

Layer 2 – 32 x 16 + 16 = 528

Layer 3 – 16 x 18 + 18 = 306

Total number of parameters in initial model = 898

Number of layers used in initial architecture = 4 including input layer

The initial model was clearly overfitted with the training set having significantly better f1 scores than the testing set.

Added another layer with 24, I noticed that the testing results stayed the same while the training scores decreased a little.

Then, I tested that model with 16 neuron layer removed. It turned out better.

I also tested with 256, 128, 18 layers. It took 5x more time but the model seems to underfit no matter how the hyperparameters are tuned.

I also noticed that the results with the same hyperparameters do not seem to be consistent.

**Appendix**

|  |  |  |
| --- | --- | --- |
|  | Test | Train |
| 32, 16, 18  4m 11.6s | precision,recall,f1-score,support  0.21,0.37,0.27,617.0  0.4,0.14,0.21,273.0  0.46,0.16,0.23,243.0  0.95,0.18,0.3,214.0  0.6,0.17,0.27,258.0  0.89,0.15,0.25,54.0  0.74,0.17,0.28,171.0  0.52,0.23,0.32,664.0  0.42,0.2,0.27,569.0  0.65,0.24,0.35,199.0  0.28,0.11,0.15,85.0  0.61,0.22,0.33,399.0  0.21,0.69,0.32,968.0  0.41,0.11,0.17,82.0  0.78,0.24,0.36,472.0  0.63,0.16,0.26,188.0  0.62,0.3,0.4,152.0  0.48,0.19,0.27,246.0  0.3,0.3,0.3,0.3  0.55,0.22,0.28,5854.0  0.48,0.3,0.29,5854.0 | precision,recall,f1-score,support  0.8,0.91,0.85,1561.0  0.81,0.81,0.81,648.0  0.87,0.72,0.79,571.0  0.99,0.98,0.99,434.0  0.96,0.9,0.93,620.0  0.98,0.95,0.97,174.0  0.91,0.91,0.91,381.0  0.83,0.83,0.83,1580.0  0.8,0.84,0.82,1334.0  0.94,0.8,0.86,401.0  0.82,0.66,0.74,149.0  0.95,0.88,0.91,932.0  0.86,0.85,0.86,2310.0  0.99,0.93,0.96,175.0  0.92,0.98,0.95,1004.0  0.92,0.87,0.89,428.0  0.86,0.94,0.9,372.0  0.89,0.81,0.85,585.0  0.87,0.87,0.87,0.87  0.89,0.87,0.88,13659.0  0.87,0.87,0.87,13659.0 |
| 32, 24, 16, 18  4m 22.6s | precision,recall,f1-score,support  0.13,0.81,0.23,617.0  0.38,0.13,0.19,273.0  0.32,0.21,0.25,243.0  0.93,0.18,0.3,214.0  0.64,0.16,0.26,258.0  0.89,0.15,0.25,54.0  0.7,0.18,0.29,171.0  0.48,0.27,0.34,664.0  0.52,0.18,0.27,569.0  0.6,0.25,0.35,199.0  0.39,0.08,0.14,85.0  0.71,0.21,0.32,399.0  0.57,0.28,0.38,968.0  0.45,0.11,0.18,82.0  0.7,0.24,0.35,472.0  0.54,0.17,0.26,188.0  0.64,0.32,0.42,152.0  0.39,0.2,0.26,246.0  0.28,0.28,0.28,0.28  0.55,0.23,0.28,5854.0  0.52,0.28,0.3,5854.0 | precision,recall,f1-score,support  0.79,0.89,0.84,1561.0  0.87,0.76,0.82,648.0  0.71,0.85,0.77,571.0  0.98,0.99,0.99,434.0  0.95,0.9,0.93,620.0  0.99,0.94,0.96,174.0  0.95,0.89,0.92,381.0  0.8,0.85,0.82,1580.0  0.91,0.74,0.82,1334.0  0.91,0.82,0.86,401.0  0.88,0.66,0.76,149.0  0.92,0.9,0.91,932.0  0.86,0.85,0.85,2310.0  0.98,0.94,0.96,175.0  0.92,0.97,0.95,1004.0  0.93,0.86,0.89,428.0  0.87,0.94,0.91,372.0  0.79,0.86,0.82,585.0  0.86,0.86,0.86,0.86  0.89,0.87,0.88,13659.0  0.87,0.86,0.86,13659.0 |
| 32, 24, 18  4m 15.3s | precision,recall,f1-score,support  0.48,0.22,0.3,617.0  0.35,0.14,0.19,273.0  0.47,0.15,0.23,243.0  0.93,0.18,0.3,214.0  0.72,0.16,0.27,258.0  0.89,0.15,0.25,54.0  0.52,0.18,0.27,171.0  0.2,0.45,0.28,664.0  0.38,0.22,0.28,569.0  0.57,0.24,0.34,199.0  0.28,0.11,0.15,85.0  0.77,0.2,0.31,399.0  0.21,0.61,0.31,968.0  0.43,0.11,0.17,82.0  0.79,0.24,0.36,472.0  0.58,0.18,0.28,188.0  0.74,0.28,0.41,152.0  0.39,0.2,0.26,246.0  0.29,0.29,0.29,0.29  0.54,0.22,0.28,5854.0  0.47,0.29,0.29,5854.0 | precision,recall,f1-score,support  0.8,0.91,0.85,1561.0  0.96,0.7,0.81,648.0  0.9,0.69,0.78,571.0  1.0,0.98,0.99,434.0  0.91,0.93,0.92,620.0  0.99,0.94,0.96,174.0  0.97,0.88,0.92,381.0  0.81,0.85,0.83,1580.0  0.8,0.84,0.82,1334.0  0.89,0.84,0.86,401.0  0.92,0.64,0.75,149.0  0.86,0.93,0.89,932.0  0.86,0.85,0.86,2310.0  0.99,0.93,0.96,175.0  0.93,0.97,0.95,1004.0  0.93,0.86,0.89,428.0  0.93,0.91,0.92,372.0  0.83,0.85,0.84,585.0  0.87,0.87,0.87,0.87  0.9,0.86,0.88,13659.0  0.87,0.87,0.87,13659.0 |
| 256, 128, 18  20m | precision,recall,f1-score,support  0.38,0.25,0.3,617.0  0.43,0.11,0.17,273.0  0.33,0.19,0.24,243.0  0.95,0.18,0.3,214.0  0.5,0.18,0.26,258.0  0.53,0.15,0.23,54.0  0.66,0.17,0.27,171.0  0.13,0.71,0.22,664.0  0.42,0.21,0.28,569.0  0.69,0.24,0.35,199.0  0.28,0.11,0.15,85.0  0.71,0.21,0.32,399.0  0.52,0.28,0.37,968.0  0.41,0.11,0.17,82.0  0.73,0.23,0.35,472.0  0.61,0.16,0.26,188.0  0.63,0.3,0.41,152.0  0.42,0.19,0.26,246.0  0.27,0.27,0.27,0.27  0.52,0.22,0.27,5854.0  0.49,0.27,0.29,5854.0 | precision,recall,f1-score,support  0.78,0.92,0.84,1561.0  0.91,0.74,0.82,648.0  0.76,0.8,0.78,571.0  0.99,0.98,0.99,434.0  0.89,0.95,0.92,620.0  0.94,0.97,0.95,174.0  0.92,0.91,0.92,381.0  0.85,0.8,0.83,1580.0  0.82,0.83,0.82,1334.0  0.95,0.79,0.86,401.0  0.74,0.74,0.74,149.0  0.92,0.9,0.91,932.0  0.87,0.85,0.86,2310.0  0.99,0.93,0.96,175.0  0.94,0.97,0.95,1004.0  0.95,0.85,0.89,428.0  0.93,0.92,0.92,372.0  0.84,0.86,0.85,585.0  0.87,0.87,0.87,0.87  0.89,0.87,0.88,13659.0  0.87,0.87,0.87,13659.0 |