

BITS F464: Machine Learning

Assignment-2

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Part A - Naive Bayes Classifier to predict income:

Results Metrics for Naive Bayes Classifier:

The naive bayes' model was run on 10 different random samplings of the dataset, and the results are cumulated below:

	Split No./Metric	Accuracy	Precision	Recall	F-1 Score	Smoothed Acc.	Smoothed Pre.	Logistic Reg. Acc.	KNN Acc.
0	Random Split 1	82.0485	86.4	28.18	42.4988	80.7893	97.6351	79.4994	79.6222
1	Random Split 2	81.1886	88.5835	26.3522	40.6205	79.5608	98.5019	80.4975	78.6087
2	Random Split 3	81.4496	84.4444	26.9852	40.9002	80.1597	97.417	79.9754	79.1001
3	Random Split 4	81.941	86.7424	29.2839	43.7859	80.4208	98.0066	79.5608	79.3458
4	Random Split 5	81.3729	89.7436	29.7511	44.6876	79.4994	98.1481	78.9466	78.7316
5	Random Split 6	81.8335	84.7866	29.3325	43.5861	80.7586	96.6361	78.8851	79.1308
6	Random Split 7	81.8643	90.2335	27.2436	41.8513	80.1904	99.6324	79.6222	79.3151
7	Random Split 8	80.9275	85.2295	26.7712	40.7443	79.5915	97.5	78.8698	78.3016
8	Random Split 9	81.25	87.0763	26.1617	40.2349	79.8065	97.4074	79.7604	79.2537
9	Random Split 10	81.5725	87.1369	26.9576	41.1765	80.2058	96.8641	79.1462	79.0848
10	Average	81.54	87.03	27.7	42	80.09	97.77	79.47	79.04
11	Variance	0.123	3.549	1.592	2.168	0.203	0.665	0.25	0.139

Results:

After testing with multiple training-testing splits, and different random seeds, we see that the performance of the logistic regression and KNN Classifier do not vary too much from the naive Bayes classifier.

This can probably be attributed to the large size of the dataset.

Part B: Building a Basic Neural Network for Image Classification:

Neural Network -1:

Epoch [1/10], Loss: 48.6419%, Accuracy: 86.0202%
Epoch [2/10], Loss: 19.2424%, Accuracy: 94.1970%
Epoch [3/10], Loss: 14.5822%, Accuracy: 95.5076%
Epoch [4/10], Loss: 11.7992%, Accuracy: 96.3561%
Epoch [5/10], Loss: 9.9330%, Accuracy: 96.9217%
Epoch [6/10], Loss: 8.6278%, Accuracy: 97.3485%
Epoch [7/10], Loss: 7.5454%, Accuracy: 97.6162%
Epoch [8/10], Loss: 7.0139%, Accuracy: 97.7500%
Epoch [9/10], Loss: 6.4400%, Accuracy: 98.0152%
Epoch [10/10], Loss: 5.8040%, Accuracy: 98.0581%

Confusion Matrix:

```
[[1954  0 14  3  7  5 15  1  0  0]
 [ 0 2286  8  1  4  2  8  7  2  0]
 [ 7  2 1999 11  9  1  3  7  3  3]
 [ 1  2  26 2032  1 13  0  5 11  8]
 [ 1  1  9  0 1906  2  6  3  2 15]
 [11  2  6  30  3 1751 23  3  5  7]
 [10  3 10  0  9  3 2014  0  5  0]
 [ 0  9 38  9 12  0  1 2038  3 17]
 [ 6 15 25 43  5 19 12  3 1843  7]
 [ 7  2  6 21 59 12  1 18  9 1859]]
```

Accuracy on the test dataset: 96.48039215686275%

Neural Network -2:

Epoch [1/10], Loss: 129.2615%, Accuracy: 61.9369%
Epoch [2/10], Loss: 39.6846%, Accuracy: 89.8030%
Epoch [3/10], Loss: 25.3811%, Accuracy: 93.0909%
Epoch [4/10], Loss: 19.3934%, Accuracy: 94.5985%
Epoch [5/10], Loss: 15.7319%, Accuracy: 95.5455%
Epoch [6/10], Loss: 13.1912%, Accuracy: 96.2803%
Epoch [7/10], Loss: 11.2910%, Accuracy: 96.7348%
Epoch [8/10], Loss: 9.8418%, Accuracy: 97.0985%
Epoch [9/10], Loss: 8.8016%, Accuracy: 97.4015%

Epoch [10/10], Loss: 7.8068%, Accuracy: 97.5884%

Confusion Matrix:

```
[[1981  0  2  0  4  2  4  0  6  0]
 [ 0 2270  8  3  7  3  0  8 15  4]
 [ 12  6 1972 12  9  1  5  8 19  1]
 [  2  1 221992  0 29  1 12 30 10]
 [  3  2  9  1 1883  0  9  0  4 34]
 [ 12  0  8 22  2 1746 10  0 26 15]
 [ 16  1  6  0  7  9 1993  0 22  0]
 [  2  8 20  5 21  2  0 2023  2 44]
 [  4  6 10 13  6 13  2  3 1913  8]
 [ 11  1  1  5 35 12  0 26 15 1888]]
```

Accuracy on the test dataset: 96.37745098039215%

Neural Network -3:

Epoch [1/10], Loss: 57.7638%, Accuracy: 82.7929%

Epoch [2/10], Loss: 27.0184%, Accuracy: 91.8965%

Epoch [3/10], Loss: 20.5111%, Accuracy: 93.6944%

Epoch [4/10], Loss: 16.6539%, Accuracy: 94.8586%

Epoch [5/10], Loss: 14.1979%, Accuracy: 95.6389%

Epoch [6/10], Loss: 12.0250%, Accuracy: 96.2753%

Epoch [7/10], Loss: 10.9732%, Accuracy: 96.5556%

Epoch [8/10], Loss: 9.6192%, Accuracy: 96.9899%

Epoch [9/10], Loss: 8.7211%, Accuracy: 97.1591%

Epoch [10/10], Loss: 7.9562%, Accuracy: 97.3914%

Confusion Matrix:

```
[[1943  1  6  2  1  3 36  0  6  1]
 [ 0 2296  5  1  2  3  8  1  2  0]
 [  4  7 1983 16  4  5 10  6  9  1]
 [  0  2 162010  0 38  2  7 17  7]
 [  0  5 23  0 1839  8 51  1  2 16]
 [  4  0  3 11  2 1757 51  1  5  7]
 [  6  0  1  2  0  8 2036  0  1  0]
 [  6 14 32  4 12  2  2 2020  6 29]
 [  2 14  5 26  6 34 38  5 1840  8]
 [  8  1  5  8 60 16  3 13 15 1865]]
```

Accuracy on the test dataset: 96.02450980392157%

Neural Network -4:

Epoch [1/10], Loss: 42.9401%, Accuracy: 87.2626%

Epoch [2/10], Loss: 18.4159%, Accuracy: 94.4419%

Epoch [3/10], Loss: 13.8726%, Accuracy: 95.6995%
Epoch [4/10], Loss: 11.0195%, Accuracy: 96.5884%
Epoch [5/10], Loss: 9.3447%, Accuracy: 97.0000%
Epoch [6/10], Loss: 8.3483%, Accuracy: 97.3586%
Epoch [7/10], Loss: 7.0509%, Accuracy: 97.7904%
Epoch [8/10], Loss: 6.3369%, Accuracy: 97.9773%
Epoch [9/10], Loss: 6.2790%, Accuracy: 97.9394%
Epoch [10/10], Loss: 5.4911%, Accuracy: 98.2197%

Confusion Matrix:

```
[[1951  1 17  1  3  3 20  0  0  3]
 [ 0 2306  5  1  2  0  2  1  1  0]
 [ 4  6 2011  9  2  3  2  3  4  1]
 [ 0  9  35 1998  0 20  1 10 18  8]
 [ 0  9  28  0 1873  0 19  2  2 12]
 [ 9  7 14 16  5 1734 36  2  8 10]
 [ 3  2 11  0  0  3 2033  0  2  0]
 [ 1 18 35  7 10  0  1 2036  3 16]
 [ 4 34 30 19  7  8 13  4 1852  7]
 [ 8 10  6 15 45  8  1 22 21 1858]]
```

Accuracy on the test dataset: 96.33333333333333%

Neural Network -5:

Epoch [1/10], Loss: 111.7978%, Accuracy: 66.5505%
Epoch [2/10], Loss: 36.3690%, Accuracy: 90.2677%
Epoch [3/10], Loss: 24.1871%, Accuracy: 93.2929%
Epoch [4/10], Loss: 18.1028%, Accuracy: 94.8157%
Epoch [5/10], Loss: 14.7138%, Accuracy: 95.7172%
Epoch [6/10], Loss: 12.1341%, Accuracy: 96.3813%
Epoch [7/10], Loss: 10.1456%, Accuracy: 96.9495%
Epoch [8/10], Loss: 8.7720%, Accuracy: 97.3258%
Epoch [9/10], Loss: 7.4942%, Accuracy: 97.8207%
Epoch [10/10], Loss: 6.3731%, Accuracy: 98.0631%

Confusion Matrix:

```
[[1973  0  4  2  1  3  7  3  6  0]
 [ 0 2296  5  3  2  0  3  4  5  0]
 [ 6  6 1992 24  2  0  1  8  6  0]
 [ 0  1 21 2041  0  7  1  5 17  6]
 [ 3  9 10  1 1871  0 15  4  4 28]
 [ 5  2  5 78  2 1688 18  4 27 12]
 [13  3  5  0  2  7 2008  0 16  0]
 [ 0 11 27  8  5  0  0 2054  1 21]
 [ 3 15 14 24  2  7  3  2 1902  6]
```

[6 4 2 20 28 5 0 37 16 1876]]

Accuracy on the test dataset: 96.57352941176471%

Neural Network -6:

Epoch [1/10], Loss: 52.2816%, Accuracy: 83.7879%

Epoch [2/10], Loss: 23.4369%, Accuracy: 92.8535%

Epoch [3/10], Loss: 16.3683%, Accuracy: 94.9268%

Epoch [4/10], Loss: 12.8642%, Accuracy: 95.9242%

Epoch [5/10], Loss: 10.9237%, Accuracy: 96.5328%

Epoch [6/10], Loss: 9.1579%, Accuracy: 97.0303%

Epoch [7/10], Loss: 8.1022%, Accuracy: 97.4293%

Epoch [8/10], Loss: 6.5923%, Accuracy: 97.8586%

Epoch [9/10], Loss: 5.7726%, Accuracy: 98.1035%

Epoch [10/10], Loss: 5.1498%, Accuracy: 98.3384%

Confusion Matrix:

```
[[1991  0  1  0  0  0  4  0  3  0]
 [ 0 2282 13  2  2  0  5  4  6  4]
 [ 10  2 2014  6  0  1  3  4  4  1]
 [  2  3  42 2019  0 12  0  3  9  9]
 [  4  2 15  1 1860  0 25  2  3 33]
 [  5  1  4 39  1 1697 33  2 16 43]
 [  7  0  1  1  0  4 2029  0 11  1]
 [  4  7 40  8 12  1  3 1997  3 52]
 [  2  5 16 12  3  6  6  4 1912 12]
 [  8  1  3  4 20  2  0  4 12 1940]]
```

Accuracy on the test dataset: 96.76960784313725%

Neural Network -7:

Epoch [1/10], Loss: 49.6027%, Accuracy: 85.3763%

Epoch [2/10], Loss: 19.6306%, Accuracy: 94.1894%

Epoch [3/10], Loss: 15.3300%, Accuracy: 95.3611%

Epoch [4/10], Loss: 12.1960%, Accuracy: 96.2045%

Epoch [5/10], Loss: 10.5062%, Accuracy: 96.7929%

Epoch [6/10], Loss: 9.3480%, Accuracy: 97.1364%

Epoch [7/10], Loss: 9.2245%, Accuracy: 97.1288%

Epoch [8/10], Loss: 7.3424%, Accuracy: 97.6616%

Epoch [9/10], Loss: 6.7840%, Accuracy: 97.8561%

Epoch [10/10], Loss: 6.0141%, Accuracy: 98.1010%

Confusion Matrix:

```
[[1986  0  1  1  0  5  3  3  0  0]
 [ 0 2285  6  0  1  5  2  5  5  9]]
```

```
[ 17 14 1959 11 1 9 6 20 8 0]
[ 4 1 21 1988 0 47 2 7 20 9]
[ 8 3 5 1 1814 15 25 12 5 57]
[ 5 0 1 8 0 1794 25 0 3 5]
[ 10 2 3 0 0 24 2013 0 2 0]
[ 1 8 16 4 5 2 2 2075 1 13]
[ 4 9 9 26 0 58 12 7 1846 7]
[ 17 1 0 12 13 21 1 33 11 1885]]
Accuracy on the test dataset: 96.29901960784314%
```

Neural Network -8:

Epoch [1/10], Loss: 177.3284%, Accuracy: 30.8460%
Epoch [2/10], Loss: 81.7771%, Accuracy: 77.1768%
Epoch [3/10], Loss: 43.5850%, Accuracy: 89.2247%
Epoch [4/10], Loss: 31.9339%, Accuracy: 91.7500%
Epoch [5/10], Loss: 25.9542%, Accuracy: 93.3258%
Epoch [6/10], Loss: 22.3320%, Accuracy: 94.0758%
Epoch [7/10], Loss: 19.5633%, Accuracy: 94.8081%
Epoch [8/10], Loss: 18.0681%, Accuracy: 95.0429%
Epoch [9/10], Loss: 15.9411%, Accuracy: 95.6288%
Epoch [10/10], Loss: 14.7219%, Accuracy: 95.9571%
Confusion Matrix:

```
[[1924 0 7 1 3 20 42 1 0 1]
[ 0 2270 17 0 3 0 1 16 6 5]
[ 2 25 1956 15 10 2 11 9 10 5]
[ 1 6 42 1976 0 19 1 4 41 9]
[ 0 2 14 1 1885 1 16 4 1 21]
[ 17 0 23 78 6 1649 27 3 26 12]
[ 7 1 20 1 19 13 1991 0 2 0]
[ 0 31 19 0 13 0 0 2012 2 50]
[ 3 58 28 34 4 12 6 2 1798 33]
[ 3 6 11 13 88 19 1 53 32 1768]]
Accuracy on the test dataset: 94.25980392156863%
```

Neural Network -9:

Epoch [1/10], Loss: 61.2443%, Accuracy: 80.4192%
Epoch [2/10], Loss: 26.6886%, Accuracy: 91.7601%
Epoch [3/10], Loss: 20.4467%, Accuracy: 93.6338%
Epoch [4/10], Loss: 16.1720%, Accuracy: 95.0227%
Epoch [5/10], Loss: 14.0378%, Accuracy: 95.6111%
Epoch [6/10], Loss: 12.0238%, Accuracy: 96.2551%

Epoch [7/10], Loss: 10.8565%, Accuracy: 96.5354%
Epoch [8/10], Loss: 9.2990%, Accuracy: 96.9293%
Epoch [9/10], Loss: 8.3520%, Accuracy: 97.2601%
Epoch [10/10], Loss: 7.5185%, Accuracy: 97.5354%

Confusion Matrix:

```
[[1979  0  1  0  2  4  9  0  2  2]
 [ 0 2248 11  1  4  8  5  2 38  1]
 [ 15  4 1986  7  5  3  9  4 10  2]
 [  3  1  33 1954  1 72  1  4 24  6]
 [  3  3  6  1 1893  0 11  1  7 20]
 [ 10  0  3  6  1 1783 20  2 11  5]
 [ 11  0  2  0  2 13 2017  0  9  0]
 [  2  9 56  1 14  3  1 2002 13 26]
 [  3  3 10 12  1 18 10  0 1918  3]
 [  8  2  2  9 45 23  0 18 38 1849]]
```

Accuracy on the test dataset: 96.22058823529412%

Neural Network -10:

Epoch [1/10], Loss: 45.4239%, Accuracy: 86.4066%
Epoch [2/10], Loss: 19.7122%, Accuracy: 94.0909%
Epoch [3/10], Loss: 13.8809%, Accuracy: 95.8157%
Epoch [4/10], Loss: 12.0030%, Accuracy: 96.3131%
Epoch [5/10], Loss: 10.4415%, Accuracy: 96.8131%
Epoch [6/10], Loss: 8.8742%, Accuracy: 97.3005%
Epoch [7/10], Loss: 7.9824%, Accuracy: 97.4874%
Epoch [8/10], Loss: 7.4308%, Accuracy: 97.6288%
Epoch [9/10], Loss: 6.5440%, Accuracy: 97.9167%
Epoch [10/10], Loss: 6.1362%, Accuracy: 98.0354%

Confusion Matrix:

```
[[1969  0  9  4  1  3  8  1  3  1]
 [  1 2282  4  6  2  3  9  7  2  2]
 [  4  3 1990 14  3  1  6 14  8  2]
 [  2  1  22 2015  1 23  3  7 14 11]
 [  1  2  9  1 1877  2 18  5  1 29]
 [  6  0  3 16  2 1771 24  4  6  9]
 [  8  0  1  1  2 12 2026  0  4  0]
 [  1  6 14  2  8  1  0 2075  0 20]
 [  3  7  7 25  2 24 14  6 1871 19]
 [  7  1  3  7 20 14  0 34 14 1894]]
```

Accuracy on the test dataset: 96.91176470588235%

Neural Network -11:

Epoch [1/10], Loss: 134.4665%, Accuracy: 55.1768%
Epoch [2/10], Loss: 49.1328%, Accuracy: 87.3939%
Epoch [3/10], Loss: 32.1460%, Accuracy: 91.5657%
Epoch [4/10], Loss: 25.0397%, Accuracy: 93.2702%
Epoch [5/10], Loss: 21.0289%, Accuracy: 94.2601%
Epoch [6/10], Loss: 18.1836%, Accuracy: 94.8510%
Epoch [7/10], Loss: 15.7309%, Accuracy: 95.6035%
Epoch [8/10], Loss: 14.0183%, Accuracy: 96.1212%
Epoch [9/10], Loss: 12.3058%, Accuracy: 96.5657%
Epoch [10/10], Loss: 11.1635%, Accuracy: 96.8687%

Confusion Matrix:

```
[[1955  0  4  0  2 16 19  1  1  1]
 [ 0 2287 10  4  0  1  2  7  5  2]
 [ 1  32 1939 25  5  9 11  7 14  2]
 [ 1  4  18 2008  0 32  1  3 27  5]
 [ 1  6 10  1 1857  2 25  0  1 42]
 [14  0 17 58  3 1707 17  0 11 14]
 [14  0 19  0  2  8 2008  0  3  0]
 [ 0 43 24  3 11  0  0 1981  6 59]
 [ 3 26 27 53  3 14  3  3 1833 13]
 [ 2  3  1  7 28 21  0 23  33 1876]]
```

Accuracy on the test dataset: 95.34803921568627%

Neural Network -12:

Epoch [1/10], Loss: 56.8290%, Accuracy: 82.0631%
Epoch [2/10], Loss: 23.8375%, Accuracy: 92.6187%
Epoch [3/10], Loss: 17.2391%, Accuracy: 94.7222%
Epoch [4/10], Loss: 13.9466%, Accuracy: 95.7323%
Epoch [5/10], Loss: 11.4786%, Accuracy: 96.3561%
Epoch [6/10], Loss: 10.0092%, Accuracy: 96.8157%
Epoch [7/10], Loss: 8.6670%, Accuracy: 97.2071%
Epoch [8/10], Loss: 7.4049%, Accuracy: 97.6338%
Epoch [9/10], Loss: 6.7575%, Accuracy: 97.8359%
Epoch [10/10], Loss: 5.8751%, Accuracy: 98.0328%

Confusion Matrix:

```
[[1977  0  0  0  0  4  9  3  3  3]
 [ 0 2289  7  2  2  1  3  4  8  2]
 [12  4 1966 15  3  4  5 11 24  1]
 [ 2  2 13 2013  1 21  0  3 30 14]
 [ 2  3  2  2 1880  0  5  7  3 41]
 [ 1  1  1 16  1 1769 21  2 17 12]
```

```
[ 13  2  1  1  3 12 2008  1 13  0]
[  1  7 22  9  6  0  0 2049  5 28]
[  4  9  4  9  3  6  0  2 1935  6]
[  7  1  0  6 16 14  0 21 12 1917]]
```

Accuracy on the test dataset: 97.07352941176471%

Neural Network -13:

Epoch [1/10], Loss: 74.4592%, Accuracy: 80.8359%
Epoch [2/10], Loss: 23.6234%, Accuracy: 93.3611%
Epoch [3/10], Loss: 17.3953%, Accuracy: 94.9848%
Epoch [4/10], Loss: 14.5693%, Accuracy: 95.7551%
Epoch [5/10], Loss: 12.6165%, Accuracy: 96.2449%
Epoch [6/10], Loss: 10.7966%, Accuracy: 96.8333%
Epoch [7/10], Loss: 9.5660%, Accuracy: 97.0985%
Epoch [8/10], Loss: 8.4473%, Accuracy: 97.5303%
Epoch [9/10], Loss: 7.8584%, Accuracy: 97.6515%
Epoch [10/10], Loss: 7.4899%, Accuracy: 97.7045%

Confusion Matrix:

```
[[1974  0  3  0  3  6  7  0  5  1]
 [ 12259  6  3  4  0  4  7 30  4]
 [ 11  2 1966 10  8  8  4 14 22  0]
 [  0  1 171999  1 32  0  7 29 13]
 [  0  2  5  0 1893  0  5  1  8 31]
 [  6  0  4 13  1 1769 12  0 28  8]
 [ 13  2  3  0  6 10 2009  0 11  0]
 [  4  6 16  7  9  3  0 2033 12 37]
 [  2  3 13 11  2 15  4  4 1918  6]
 [ 12  2  3  7 25 20  0 23 24 1878]]
```

Accuracy on the test dataset: 96.55882352941177%

Neural Network -14:

Epoch [1/10], Loss: 51.3666%, Accuracy: 84.4545%
Epoch [2/10], Loss: 19.5879%, Accuracy: 94.1540%
Epoch [3/10], Loss: 14.6915%, Accuracy: 95.5404%
Epoch [4/10], Loss: 12.0146%, Accuracy: 96.2980%
Epoch [5/10], Loss: 10.8243%, Accuracy: 96.5884%
Epoch [6/10], Loss: 9.9615%, Accuracy: 96.8561%
Epoch [7/10], Loss: 8.7236%, Accuracy: 97.3030%
Epoch [8/10], Loss: 7.7308%, Accuracy: 97.6187%
Epoch [9/10], Loss: 7.3505%, Accuracy: 97.6212%
Epoch [10/10], Loss: 6.4956%, Accuracy: 97.9318%

Confusion Matrix:

```
[[1968  0  5  0  2  8  4  6  4  2]
 [ 0 2286  6  2  5  0  0  6 10  3]
 [ 3  5 1959 20  9  4  3 33  9  0]
 [ 1  3 1720 11  2 18  0 17 14 16]
 [ 0  2  7  0 1878  0  6  2  5 45]
 [ 3  2  4 14  3 1783  5  5 11 11]
 [10  5 10  0 21 24 1972  1  9  2]
 [ 0  7 11  1 13  0  0 2080  4 11]
 [ 2 15 15 30  5 24  0  6 1872  9]
 [ 4  2  1  7 14  8  0 36 15 1907]]
```

Accuracy on the test dataset: 96.6470588235294%

Neural Network -15:

Epoch [1/10], Loss: 72.8666%, Accuracy: 79.7247%
Epoch [2/10], Loss: 23.7195%, Accuracy: 93.3965%
Epoch [3/10], Loss: 17.5456%, Accuracy: 94.9242%
Epoch [4/10], Loss: 14.3110%, Accuracy: 95.9091%
Epoch [5/10], Loss: 12.4920%, Accuracy: 96.2677%
Epoch [6/10], Loss: 11.1522%, Accuracy: 96.6641%
Epoch [7/10], Loss: 10.3120%, Accuracy: 96.9874%
Epoch [8/10], Loss: 9.6864%, Accuracy: 97.0606%
Epoch [9/10], Loss: 8.1923%, Accuracy: 97.5076%
Epoch [10/10], Loss: 7.5422%, Accuracy: 97.6566%

Confusion Matrix:

```
[[1960  0  0  3  0 11 17  2  4  2]
 [ 0 2292  8  2  1  0  1  6  6  2]
 [ 7 10 1960 21  4  4  8 17 13  1]
 [ 0  5 1920 01  0 21  1  6 34 12]
 [ 3  6  9  2 1857  3 29  4  4 28]
 [ 4  2  2 29  1 1742 30  3 14 14]
 [ 4  7  0  0  1 1920 17  0  6  0]
 [ 1 10 18  1  5  1  3 2070  2 16]
 [ 3 14  4 21  2 20 16  6 1885  7]
 [10  2  2  7 35  8  0 30 15 1885]]
```

Accuracy on the test dataset: 96.4166666666667%

Specifics of the 15 different Artificial Neural Networks:

No.	No. Hidden Layer	No. Neuron	ActivationFxn1	ActivationFxn2	ActivationFxn3	Test Accuracy
0	2	100	Tanh()	Tanh()	-	96.48039215686275%
1	2	100	Sigmoid()	Sigmoid()	-	96.37745098039215%
2	2	100	ReLU()	ReLU()	-	96.02450980392157%
3	2	150	Tanh()	Tanh()	-	96.33333333333333%
4	2	150	Sigmoid()	Sigmoid()	-	96.57352941176471%
5	2	150	ReLU()	ReLU()	-	96.76960784313725%
6	3	100	Tanh()	Tanh()	Tanh()	96.29901960784314%
7	3	100	Sigmoid()	Sigmoid()	Sigmoid()	94.25980392156863%
8	3	100	ReLU()	ReLU()	ReLU()	96.22058823529412%
9	3	150	Tanh()	Tanh()	Tanh()	96.91176470588235%
10	3	150	Sigmoid()	Sigmoid()	Sigmoid()	95.34803921568627%
11	3	150	ReLU()	ReLU()	ReLU()	97.07352941176471%
12	3	100	Tanh()	Tanh()	Sigmoid()	96.55882352941177%
13	3	100	Tanh()	Tanh()	ReLU()	96.6470588235294%
14	3	100	Tanh()	ReLU()	Sigmoid()	96.41666666666667%

Results:

The best test accuracy is 97.07%, found in Model #11 in the table above. However, there is no model that is statistically significant from the others. This can be seen as the test Accuracy is in the range of 96-98% for all 15 ANNs. There is less statistical significance between them due to the large number of training samples, and large number of neurons in the hidden layers, which leads to all 15 models being trained to a similar high degree of accuracy.