**Homework 4**

**Code**A screenshot of a social media post

Description automatically generatedA screenshot of a social media post

Description automatically generatedA screenshot of a cell phone

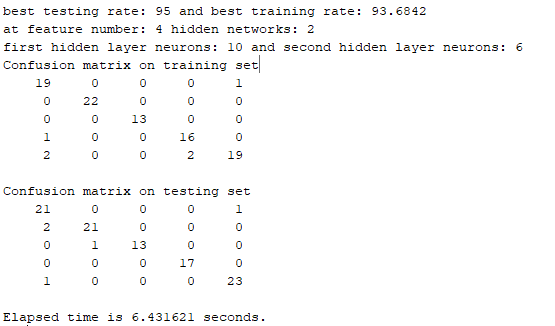
Description automatically generatedA screenshot of a social media post

Description automatically generated

Figure 1 Main code

The code above will run and test multiple neural networks with multiple levels until it finds a superb NN. If it runs through all the neural networks, then it will show the best combination like shown below. I used this in order to find general combinations that might be good for neural networks

Example of output



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 4 | [10 6] | 23 | 93.68% | 95% |

Confusion matrix on training set

19 0 0 0 1

0 22 0 0 0

0 0 13 0 0

1 0 0 16 0

2 0 0 2 19

Confusion matrix on Testing set

21 0 0 0 1

2 21 0 0 0

0 1 13 0 0

0 0 0 17 0

1 0 0 0 23

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 4 | [11 16] | 15 | 90.53% | 96% |

Confusion matrix on training set

16 0 0 0 4

0 21 1 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 2 19

Confusion matrix on Testing set

21 0 0 0 1

2 21 0 0 0

0 0 14 0 0

0 0 0 16 1

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 4 | [9 2] | 11 | 92.63% | 94% |

Confusion matrix on training set

17 0 0 0 3

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 2 19

Confusion matrix on Testing set

20 0 0 0 2

2 21 0 0 0

0 0 14 0 0

0 0 0 16 1

0 0 0 1 23

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 8 | [23 29] | 13 | 96.84% | 96% |

Confusion matrix on training set

20 0 0 0 0

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 1 20

Confusion matrix on Testing set

22 0 0 0 0

1 22 0 0 0

0 0 14 0 0

0 0 0 17 0

2 0 0 1 21

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 8 | [18 6] | 38 | 93.68% | 96% |

Confusion matrix on training set

18 0 0 0 2

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 2 19

Confusion matrix on Testing set

21 0 0 0 1

1 22 0 0 0

0 1 13 0 0

0 0 0 16 1

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 8 | [18 15] | 21 | 94.74% | 96% |

Confusion matrix on training set

18 0 0 1 1

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 1 20

Confusion matrix on Testing set

22 0 0 0 0

1 22 0 0 0

0 1 13 0 0

0 0 0 16 1

1 0 0 0 23

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 12 | [21 20] | 21 | 93.68% | 97% |

Confusion matrix on training set

19 0 0 0 1

0 21 1 0 0

0 0 13 0 0

0 0 0 16 1

2 0 0 1 20

Confusion matrix on Testing set

21 0 0 0 1

1 22 0 0 0

0 0 14 0 0

0 0 0 17 0

1 0 0 0 23

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 12 | [23 6] | 37 | 94.74% | 97% |

Confusion matrix on training set

18 0 0 0 2

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

3 0 0 0 20

Confusion matrix on Testing set

21 0 0 0 1

1 22 0 0 0

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 12 | [23 15] | 15 | 96.84% | %97 |

Confusion matrix on training set

19 0 0 0 1

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

1 0 0 1 21

Confusion matrix on Testing set

22 0 0 0 0

1 21 0 0 1

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 16 | [37 5] | 47 | 96.84% | 98% |

Confusion matrix on training set

19 0 0 0 1

0 22 0 0 0

0 1 12 0 0

0 0 0 17 0

0 0 0 1 22

Confusion matrix on Testing set

22 0 0 0 0

0 22 0 0 1

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 16 | [30 8] | 20 | 94.74% | 97% |

Confusion matrix on training set

19 0 0 0 1

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 2 19

Confusion matrix on Testing set

22 0 0 0 0

2 21 0 0 0

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 16 | 30 | 52 | 98.95% | 98% |

Confusion matrix on training set

20 0 0 0 0

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

0 0 0 1 22

Confusion matrix on Testing set

22 0 0 0 0

0 22 0 0 1

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 20 | [34 5] | 14 | 95.79% | 97% |

Confusion matrix on training set

18 1 0 0 1

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

2 0 0 0 21

Confusion matrix on Testing set

21 0 0 0 1

1 22 0 0 0

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 20 | [34 10] | 27 | 94.74% | 96% |

Confusion matrix on training set

19 0 0 0 1

0 22 0 0 0

0 0 13 0 0

0 0 0 17 0

3 0 0 1 19

Confusion matrix on Testing set

21 0 0 0 1

2 21 0 0 0

0 1 13 0 0

0 0 0 17 0

0 0 0 0 24

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Features | Network Structure | Number of Training Epochs | Correct Classification Rate on Training Set | Correct Classification Rate on Testing Set |
| 20 | [35 5] | 59 | 98.95% | 94% |

Confusion matrix on training set

20 0 0 0 0

0 22 0 0 0

0 1 12 0 0

0 0 0 17 0

0 0 0 0 23

Confusion matrix on Testing set

22 0 0 0 0

2 21 0 0 0

0 1 13 0 0

1 0 0 14 2

0 0 0 0 24

Adding in an extra layer can be super helpful or it could make the NN slower than needed. For example, w/ the tables for 16 features. There is one NN that has one hidden layer w/ 30 neurons in it. This one seemed to preform just fine without using a second layer; however, this may not be the case the next time this NN is made. As or generalizations. The only ones I suspect of generalization are any NN who’s training rate was equal to or above the testing rate. This makes me believe the AI was just remembering instead of looking at features and deciding. Finally for the most confusing class, I would say that class five is the most confusing for the NNs and class two is the seconds most confusing.