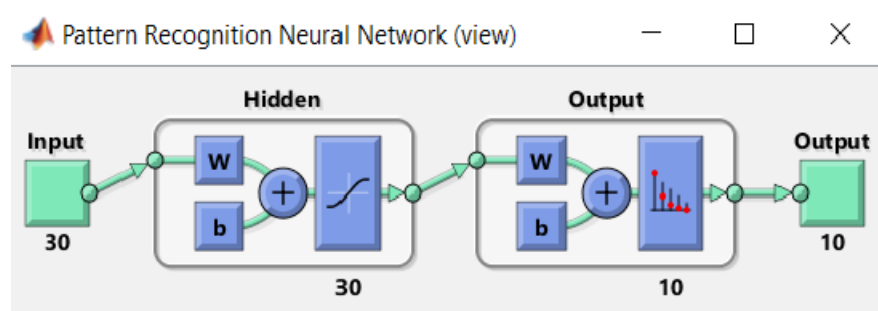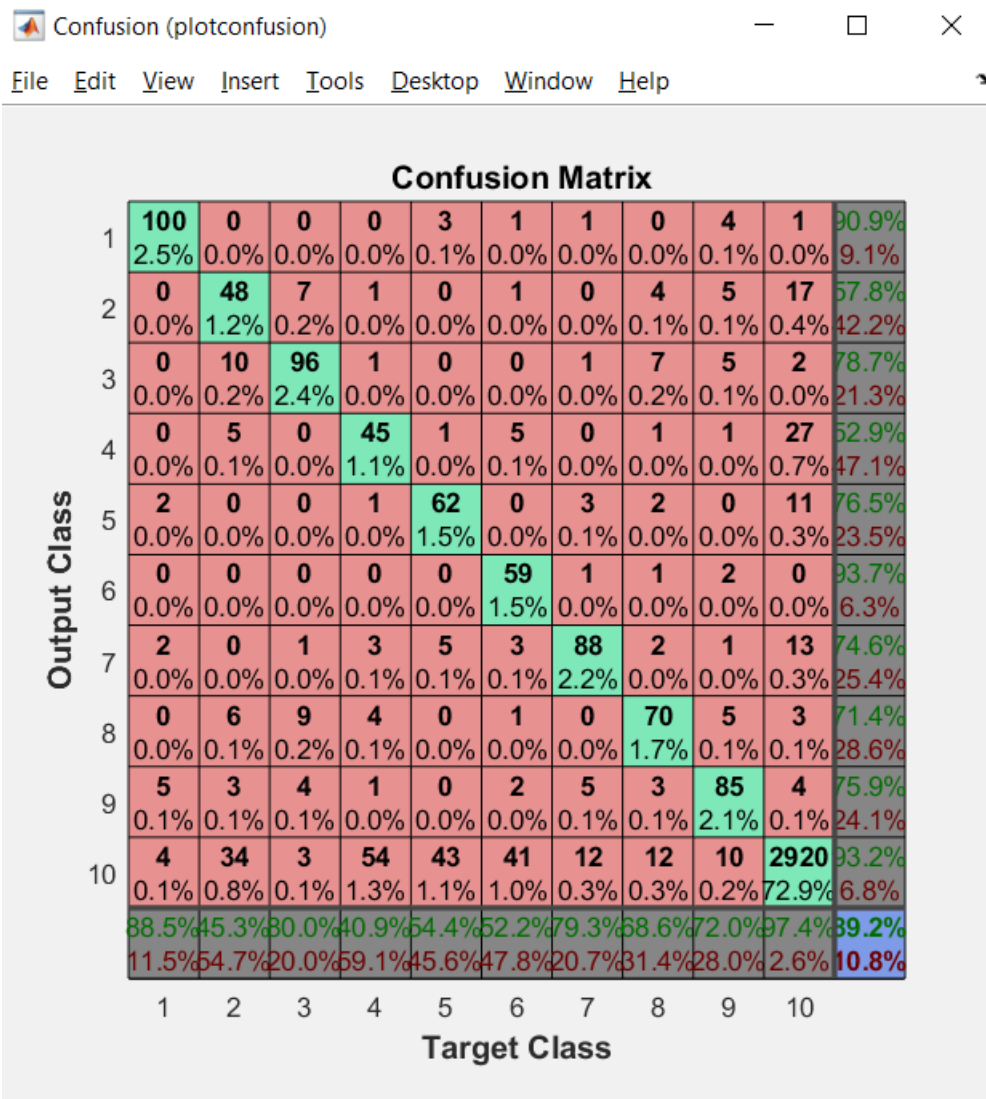# Neural Network



- Pattern recognition network
- Training: Levenberg Marquardt
- Hidden layers: 1 hidden layer with 30 neurons
- Regularization: Early stopping(randomly chosen: 60% training + 20% validation + 20% testing)
- Transfer function: tangent sigmoid
- Learning rate: 0.0001
- Performance function: Mean Squared Error
- Process functions: fixunknowns, mapminmax, label conversion from a digit into a 10 element one-hot
- Number of epochs(irrelevant): 50000

**Confusion Matrix**

|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **100** | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 4 | 1 | 90.9% |
|  | 2.5% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 9.1% |
| **2** | 0 | **48** | 7 | 1 | 0 | 1 | 0 | 4 | 5 | 17 | 57.8% |
|  | 0.0% | 1.2% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.4% | 42.2% |
| **3** | 0 | 10 | **96** | 1 | 0 | 0 | 1 | 7 | 5 | 2 | 78.7% |
|  | 0.0% | 0.2% | 2.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 0.1% | 0.0% | 21.3% |
| **4** | 0 | 5 | 0 | **45** | 1 | 5 | 0 | 1 | 1 | 27 | 52.9% |
|  | 0.0% | 0.1% | 0.0% | 1.1% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.7% | 47.1% |
| **5** | 2 | 0 | 0 | 1 | **62** | 0 | 3 | 2 | 0 | 11 | 76.5% |
|  | 0.0% | 0.0% | 0.0% | 0.0% | 1.5% | 0.0% | 0.1% | 0.0% | 0.0% | 0.3% | 23.5% |
| **6** | 0 | 0 | 0 | 0 | 0 | **59** | 1 | 1 | 2 | 0 | 93.7% |
|  | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.5% | 0.0% | 0.0% | 0.0% | 0.0% | 6.3% |
| **7** | 2 | 0 | 1 | 3 | 5 | 3 | **88** | 2 | 1 | 13 | 74.6% |
|  | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.1% | 2.2% | 0.0% | 0.0% | 0.3% | 25.4% |
| **8** | 0 | 6 | 9 | 4 | 0 | 1 | 0 | **70** | 5 | 3 | 71.4% |
|  | 0.0% | 0.1% | 0.2% | 0.1% | 0.0% | 0.0% | 0.0% | 1.7% | 0.1% | 0.1% | 28.6% |
| **9** | 5 | 3 | 4 | 1 | 0 | 2 | 5 | 3 | **85** | 4 | 75.9% |
|  | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 2.1% | 0.1% | 24.1% |
| **10** | 4 | 34 | 3 | 54 | 43 | 41 | 12 | 12 | 10 | **2920** | 93.2% |
|  | 0.1% | 0.8% | 0.1% | 1.3% | 1.1% | 1.0% | 0.3% | 0.3% | 0.2% | 72.9% | 6.8% |
|  | 88.5% | 45.3% | 80.0% | 40.9% | 54.4% | 52.2% | 79.3% | 68.6% | 72.0% | 97.4% | 89.2% |
|  | 11.5% | 54.7% | 20.0% | 59.1% | 45.6% | 47.8% | 20.7% | 31.4% | 28.0% | 2.6% | 10.8% |

Output Class (rows) / Target Class (columns)

Error confidence intervals on the testing set(using the Wilson score):

- 90%: (0.1010, 0.1150)
- 95%: (0.0997, 0.1163)
- 98%: (0.0981, 0.1179)
- 99%: (0.0970, 0.1190)