TBMI26
Assignment 1

Martin Estgren <mares480>

8 februari 2017

1 Assignment 1

1.1 Overview of the data

Looking at the data from a machine learning perspective we can observe how the data is compressed from 32x32 bitmap images to 64 features with the integer range 0..16. This means that we can create a hypercube feature space with 64 dimensions. This is a significantly dimensionally reduced feature space compared to 32x32 binary dimensions.

The pre-processing of the data doesn't only reduce the number of dimensions, it also reduces the variance in small distortions.

1.2 Implementation of the kNN algorithm

1.2.1 kNN without cross-validation

The implementation of kNN is fairly straight forward.

We iterate though all the cases in the test set and calculate the distance to each point in the training set. The result is then sorted in ascending order and the 'k' first elements are counted in regards to what label they are assigned. The label with the most values are then picked to be assigned for the testing case we are currently processing. When no counted label is higher than another we pick the label with the data point which have the closest euclidean distance to the test case.

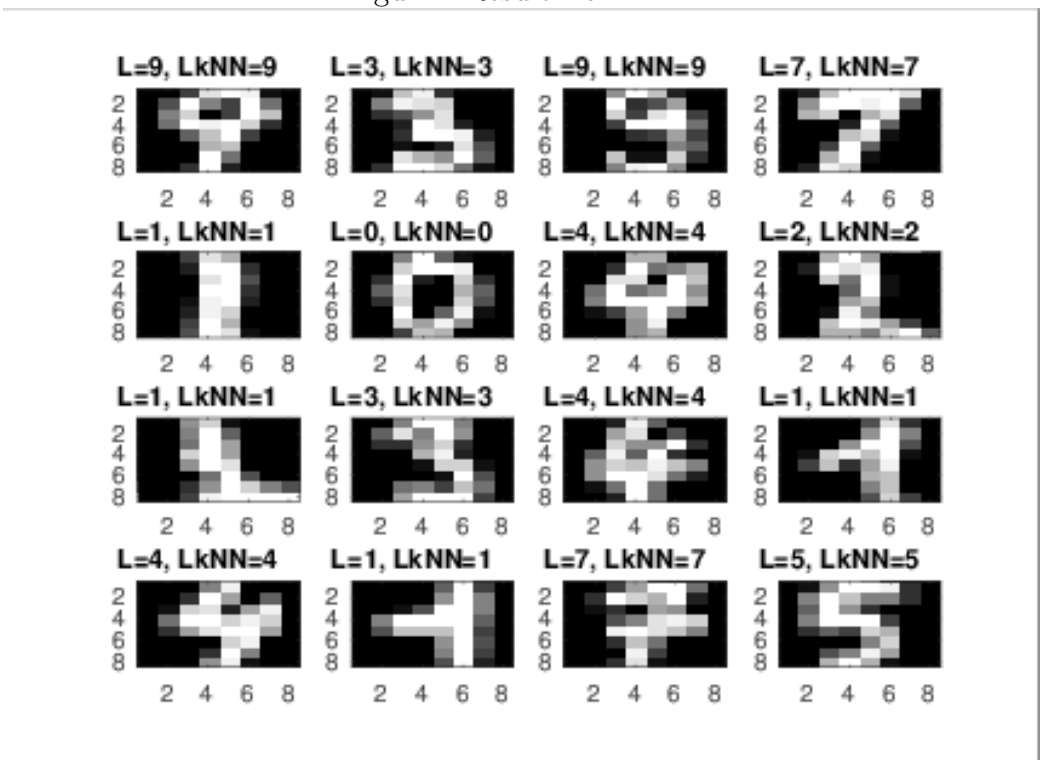
The result of our implementation of the kNN algorithm with k arbitrarily choose as 4 can be seen below.

Parameters: k = 4 Accuracy = 0.9710

```
cM =

    99     0     0     0     0     0     0     0     0     0
     0    97     1     0     0     0     0     0     2     3
     0     0    97     0     0     0     0     0     0     1
     0     1     0    98     0     0     0     0     0     3
     0     1     0     0    96     0     0     0     0     2
     0     0     0     1     0   100     0     0     0     1
     1     0     0     0     0     0   100     0     0     0
     0     0     2     0     0     0     0   100     0     0
     0     1     0     0     1     0     0     0    96     2
     0     0     0     1     3     0     0     0     2    88
```

Figur 1: Result from kNN



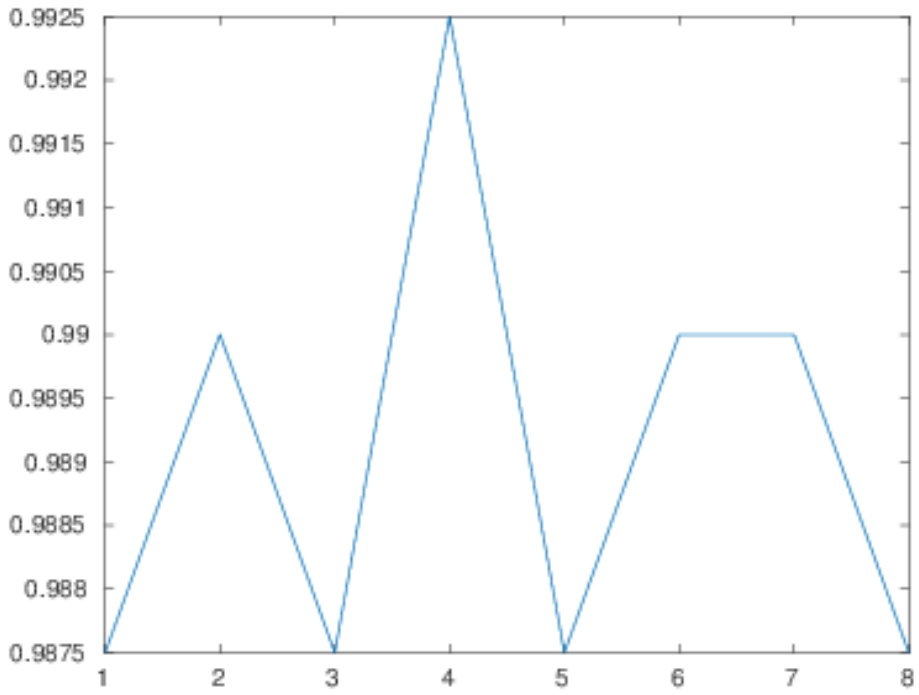
1.2.2 kNN with n-fold cross validation

For the cross validation version the n-fold cross validation algorithm was used to determine the best value for k. For all of the following results $n = 2$ was used but he algorithm implementation allow for any value of n as long as it

can evenly distribute the data set. Accuracy is used as the validation score in order to find the best value for k.

Dataset 1

Figur 2: Cross validation score



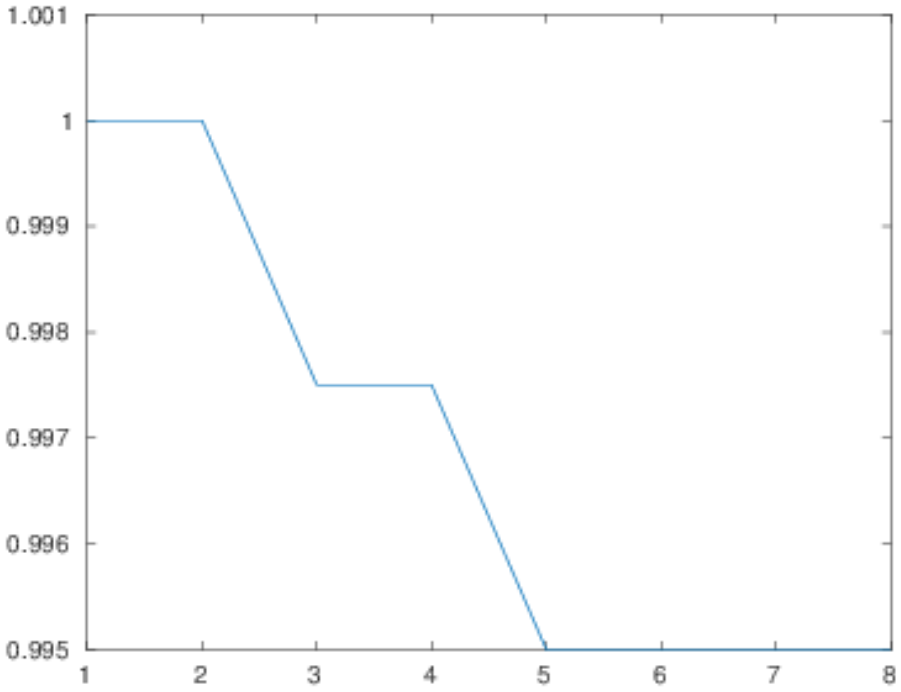
Best parameters:

- $k = 1$
- $Accuracy = 0.9900$

Figur 3: Cross validation result

Dataset 2

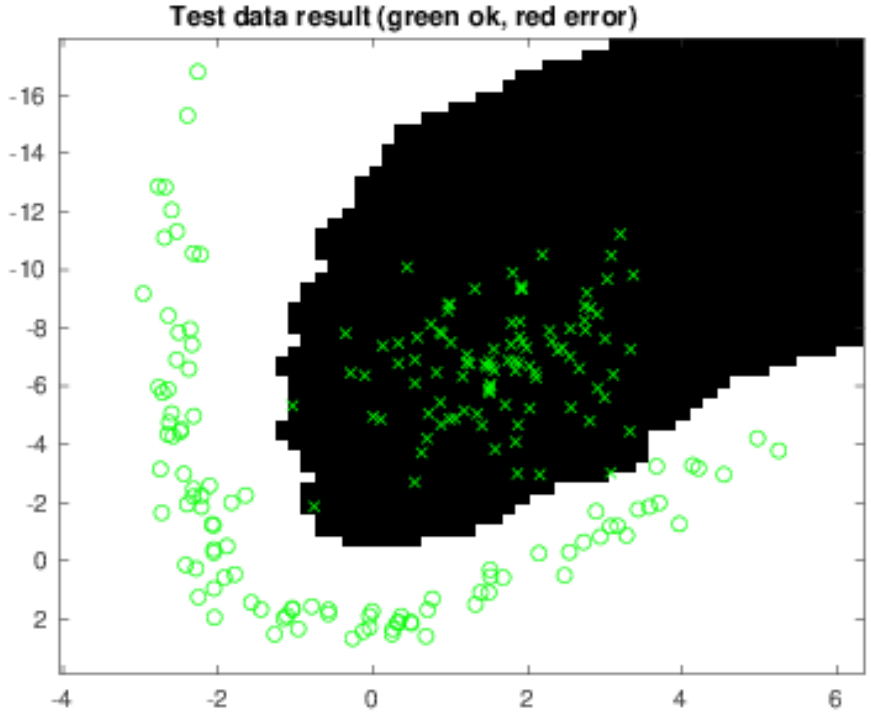
Figur 4: Cross validation score



Best parameters:

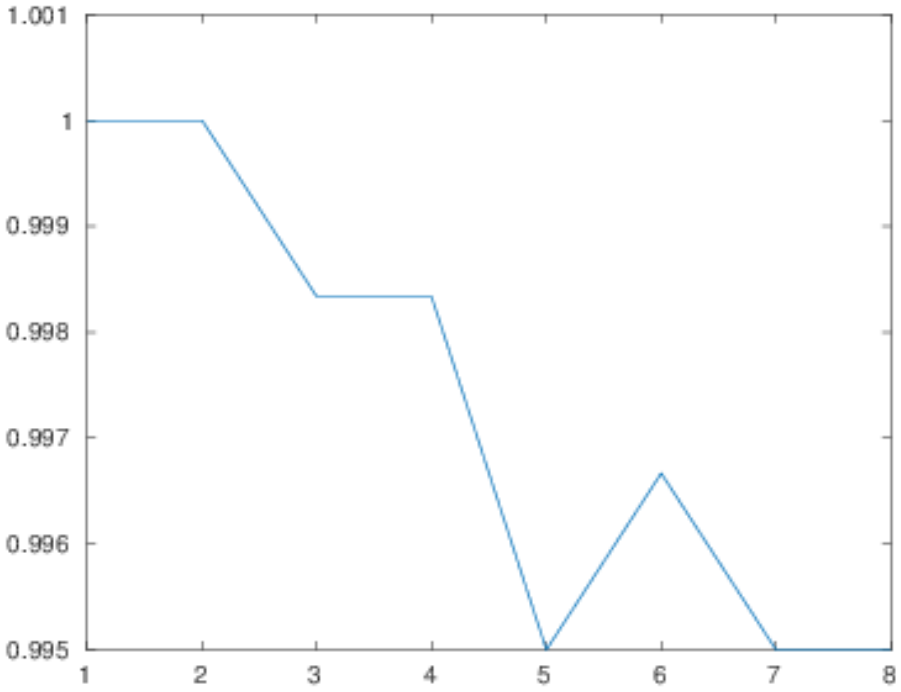
- $k = 1$
- $Accuracy = 1$

Figur 5: Cross validation result



Dataset 3

Figur 6: Cross validation score



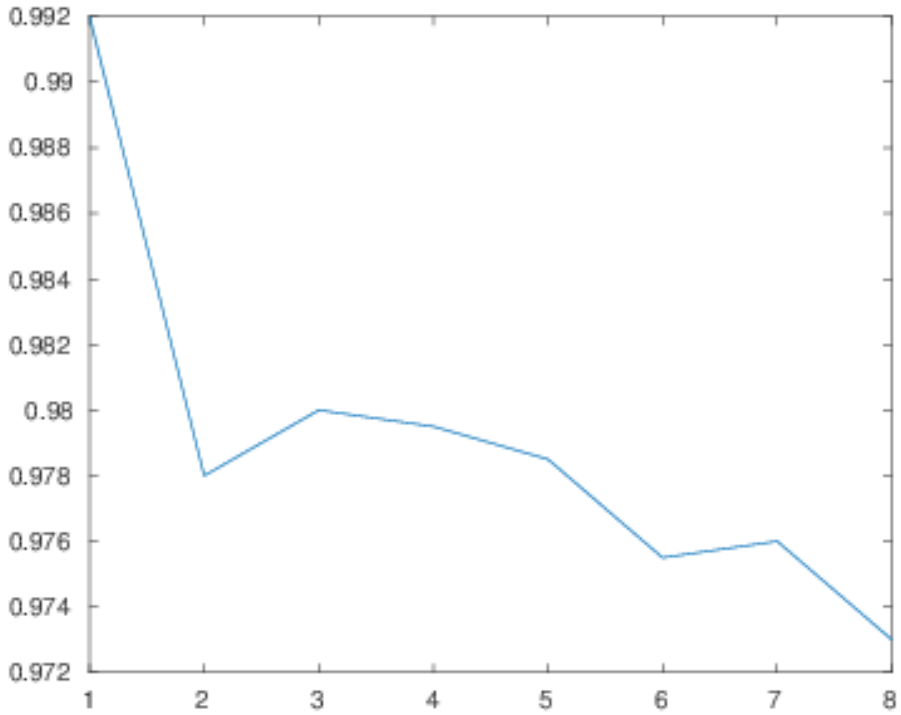
Best parameters:

- $k = 1$
- $Accuracy = 1$

Figur 7: Cross validation result

Dataset 4

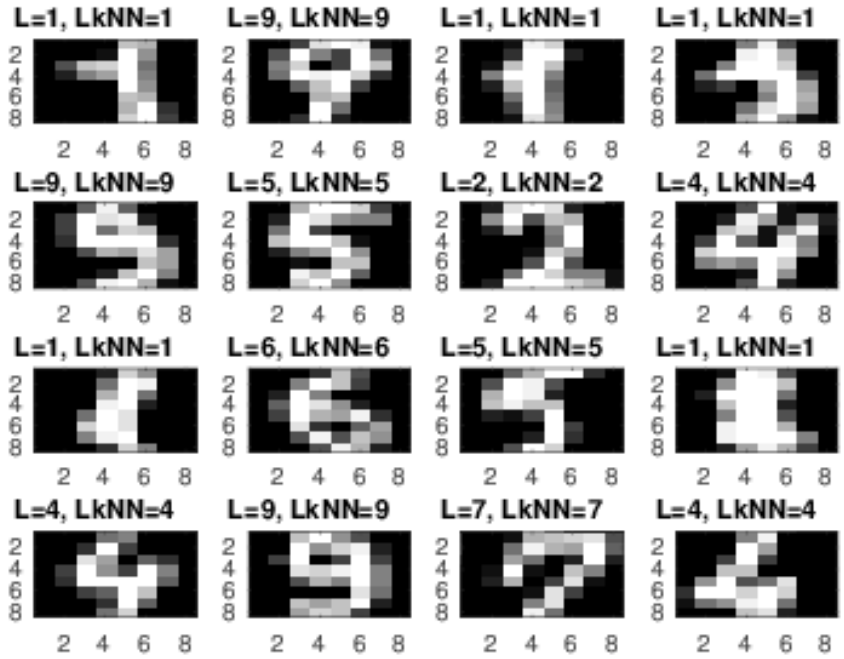
Figur 8: Cross validation score



Best parameters:

- $k = 1$
- $Accuracy = 0.9840$

Figur 9: Cross validation result



1.3 Single/Multi-layer neural network

1.3.1 Single layer backpropagation

The implementation of the single layer backpropagation algorithm we use a linear activation function and the gradient $\frac{n}{s}(Y - Dt) * Xt^t$ where n is the number of case, Y is the result from the forward propagation, Dt is the expected value for Y and Xt is a matrix with all training features.

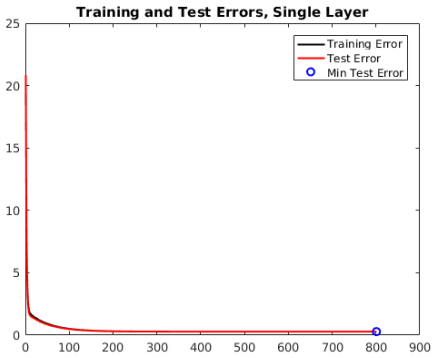
Dataset 1

This is not a large feature space meaning we don't need huge precision in our weights.

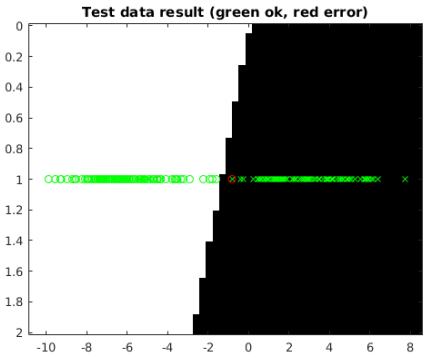
Parameters:

- $Iterations = 800$
- $learningrate = 0.005$
- $Accuracy = 0.9950$

Figur 10: Single-layer network error



Figur 11: Single-layer network result



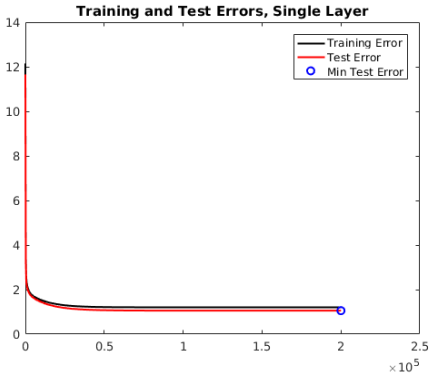
Dataset 2

For this data set we require much more precision which is why we have bumped up the number of iterations and reduced the learning rate.

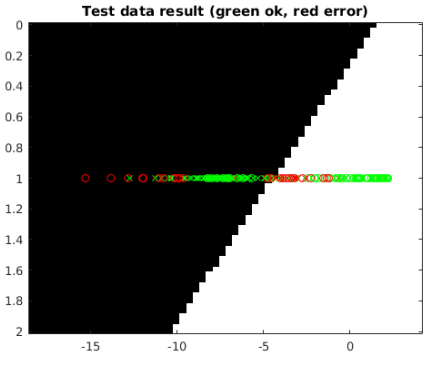
Parameters:

- $Iterations = 200000$
- $learningrate = 0.00005$
- $Accuracy = 0.8200$

Figur 12: Single-layer network error



Figur 13: Single-layer network result



Dataset 3

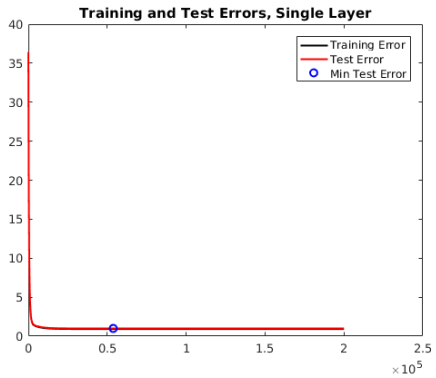
These parameters should work just fine for this data set as well since we are classifying something that is similar to the last data set.

Parameters:

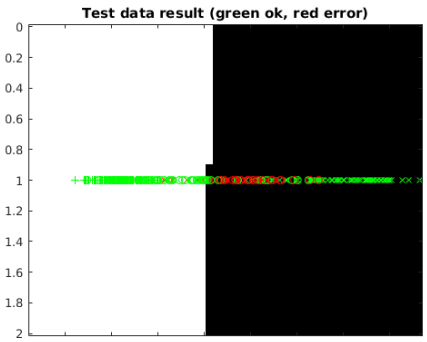
- $Iterations = 200000$

- $learningrate = 0.00005$
- $Accuracy = 0.8533$

Figur 14: Single-layer network error



Figur 15: Single-layer network result



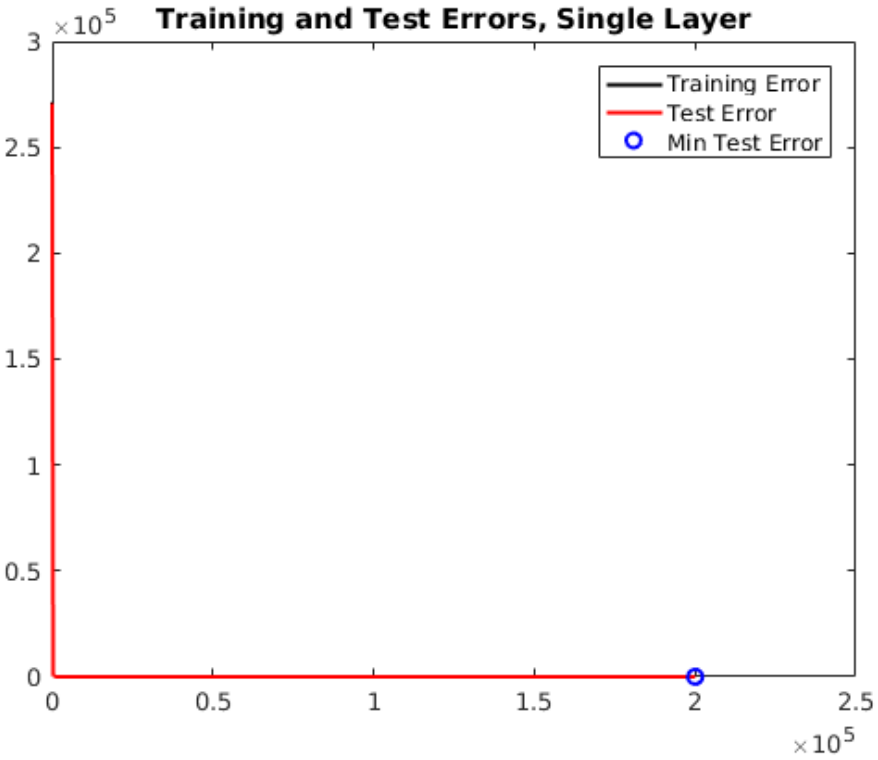
Dataset 4

This data set is much more complex compared to the other three but we are still dealing with the same number of neurons.

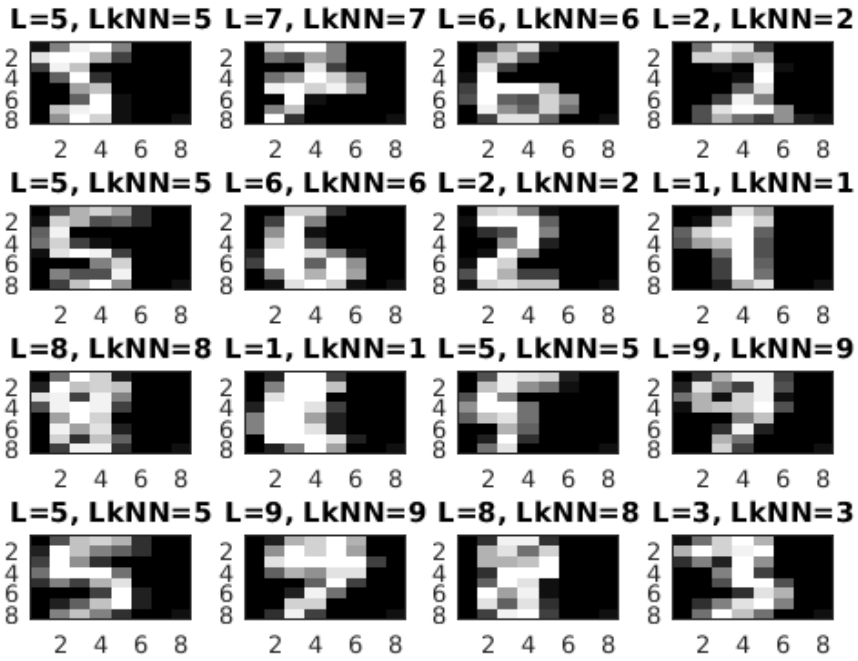
Parameters:

- $Iterations = 200000$
- $learningrate = 0.00005$
- $Accuracy = 0.9160$

Figur 16: Single-layer network error



Figur 17: Single-layer network result



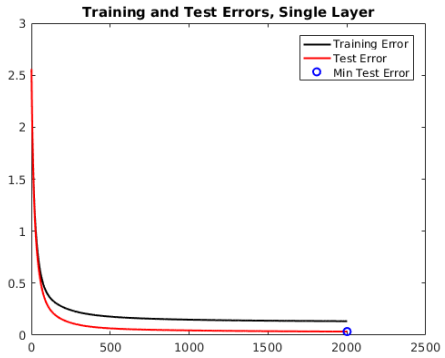
1.3.2 Multi-layer backpropagation

Dataset 1

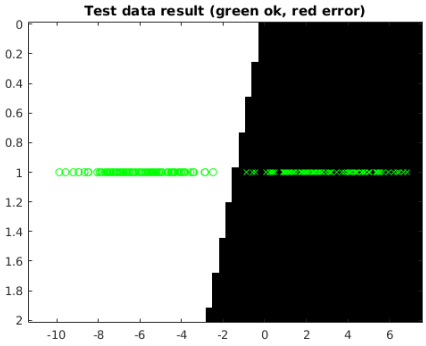
Parameters:

- $Hidden = 5$
- $Iterations = 2000$
- $learningrate = 0.01$
- $Accuracy = 0.9950$

Figur 18: Multi-layer network error



Figur 19: Multi-layer network result

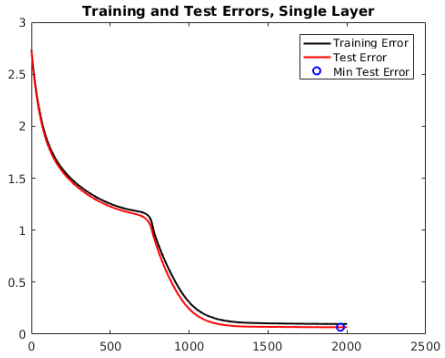


Dataset 2

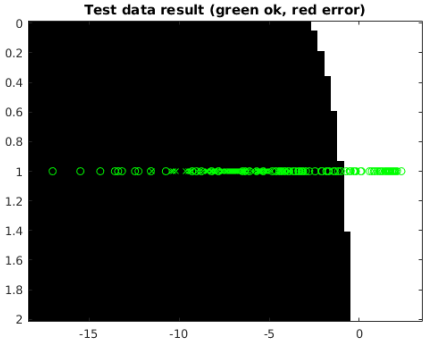
Parameters:

- $Hidden = 2$
- $Iterations = 30000$
- $learningrate = 0.005$
- $Accuracy = 1$

Figur 20: Multi-layer network error



Figur 21: Multi-layer network result



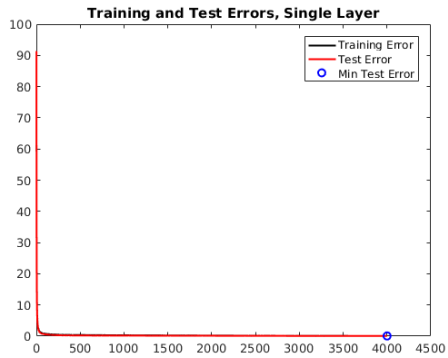
Dataset 3

Parameters:

- $Hidden = 10$
- $Iterations = 4000$

- $learningrate = 0.005$
- $Accuracy = 0.9967$

Figur 22: Multi-layer network error



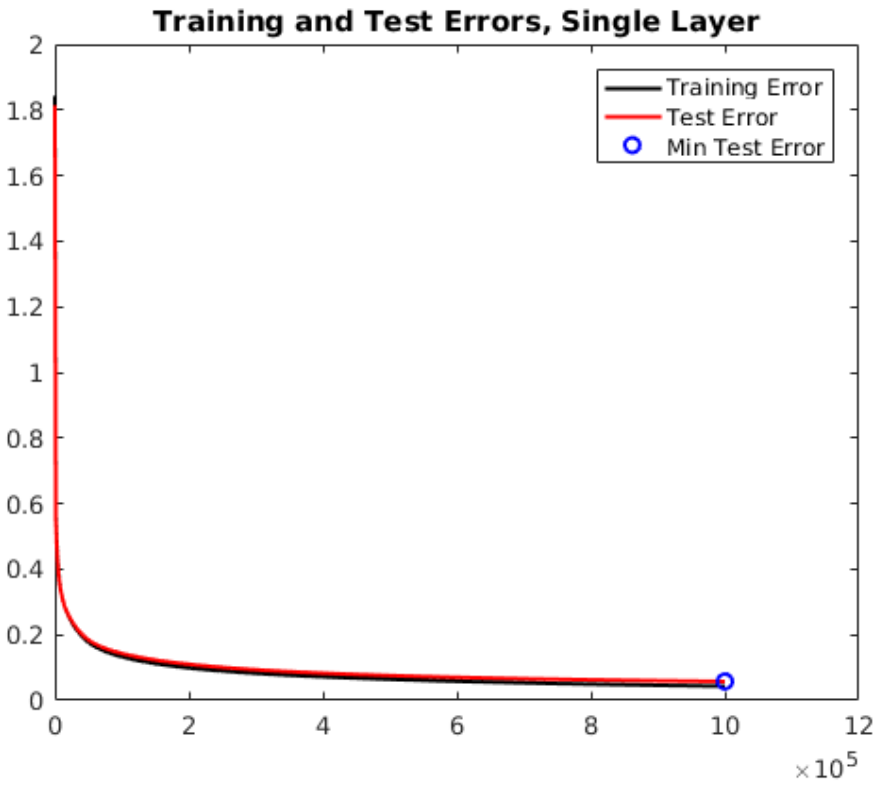
Figur 23: Multi-layer network result

Dataset 4

Parameters:

- $Hidden = 640$
- $Iterations = 400000$
- $learningrate = 0.001$
- $Accuracy = 0.9150$

Figur 24: Multi-layer network error



Figur 25: Multi-layer network result