

DAT565/DIT407 Assignment 6

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This report is submitted by group 25 for **assignment six** in *Introduction to Data Science & AI*.

1 Problem 1: The dataset

We have two test sets *training* and *testing* datasets. Refer **figures 1 and 2**. During the dataset initialization we apply the transformation `transforms.Normalize((0,),(1,))` which ensures that the scale of the pixel values are between $[0, 1]$. Furthermore, we print the values and verify that images are of dimension 25×25 and the scale values are normalized in the range $[0, 1]$.

training set examples

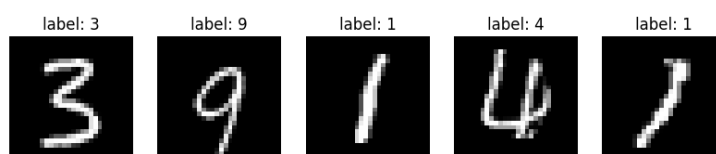


Figure 1: A random set of images from training set with **labels**

test set examples

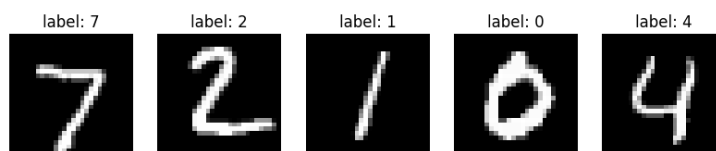


Figure 2: A random set of images from testing set with **labels**

2 Problem 2: Single hidden layer

Table 1 shows the parameters of the model with a single hidden layer. Refer to table 2 for the accuracy in 10 epoch time. The code implements a feedforward neural network with one hidden layer of 50 neurons and ReLU activation. It uses cross-entropy loss and SGD optimization with a learning rate of 0.01, and is training for 10 epochs. The validation accuracy reached 92.59% after 10 epochs.

Parameters	Value
Input Size	784 (28*28)
Hidden Layer	50
Output Size	10
Learning Rate	0.01

Table 1: Single hidden layer model accuracy in 10 epoch

Epoch	Accuracy
1	86%
2	88%
3	90%
4	90.64%
5	91.20%
6	91.48%
7	91.83%
8	92.19%
9	92.39%
10	92.59%

Table 2: Single hidden layer model accuracy in 10 epoch

3 Problem 3: Two hidden layers

Our model with two hidden layers did not achieve 98% but reached 97.51%. Table 3 shows the parameters of the model with two hidden layer. Refer to table 4 for the accuracy in 40 epoch time. The L2 regularization was selected based on trial and error by trying out different values and checking which resulted in higher accuracy in the first epoch time. The chosen value of 5e-7 for the weight_decay gave the highest initial epoch accuracy. Accuracy improved steadily across epochs, ending up at 97.51%.

4 Problem 4: Convolutional neural network

Our model with Convolutional neural network achieved a final validation accuracy of 98.07%. Slightly below the target of 99% Table 5 shows the parameters of the model with two hidden layer. Refer to table 6 for the accuracy in 40 epoch time. The first convolutional layer applies 32 filters of size 3 X 3, producing feature maps of size 32 X 26 X 26, while the second layer applies 64 filters of

Parameters	Value
Input Size	784 (28*28)
Hidden Layer One	500
Hidden Layer Two	300
Output Size	10
Learning Rate	0.01
L2 Regularization	5×10^{-7}

Table 3: Two hidden layer model parameters

the same size, resulting in feature maps of 64 X 24 X 24. These are followed by max-pooling and dropout layers to prevent over fitting. The flattened output is passed through two fully connected layers, mapping 9216 inputs to 128 neurons and then to 10 output classes.

The model was trained using SGD with a learning rate of 0.01 and an L2 regularization weight decay of 1×10^{-4} . These parameters were chosen through experimentation to balance training speed and generalization. The accuracy steadily increased during training, and stopped increasing around epoch 35. While the model performed well, reaching the target 99% accuracy may require additional improvements to the architecture. Despite falling slightly short, the model effectively showcased the strengths of CNNs for image classification.

Epoch	Accuracy
1	82.73 %
2	88.58 %
3	90.15 %
4	91.35 %
5	92.29 %
6	92.83 %
7	93.17 %
8	93.68 %
9	93.78 %
10	94.22 %
11	94.37 %
12	94.84 %
13	95.06 %
14	95.21 %
15	95.36 %
16	95.58 %
17	95.79 %
18	95.94 %
19	96.09 %
20	96.14 %
21	96.28 %
22	96.42 %
23	96.55 %
24	96.58 %
25	96.73 %
26	96.76 %
27	96.92 %
28	97.00 %
29	97.03 %
30	97.01 %
31	97.19 %
32	97.24 %
33	97.32 %
34	97.32 %
35	97.36 %
36	97.31 %
37	97.47 %
38	97.51 %
39	97.47 %
40	97.51 %

Table 4: Two hidden layer model accuracy in 40 epoch

Parameters	Value
Input Size	784 (28×28)
First Convolution Layer	$32 \times 26 \times 26$
Second Convolution Layer	$64 \times 24 \times 24$
Flatten	$64 \times 24 \times 24 \rightarrow 9216$
Fully connected layer	$9216 \rightarrow 128$
Fully connected layer	$128 \rightarrow 10$
Output Size	10
Learning Rate	0.01
L2 Regularization	1×10^{-4}
Kernel Size	3
Stride	1

Table 5: Convolutional neural network model parameters

Epoch	Accuracy
1	97.67 %
2	97.58 %
3	97.61 %
4	97.75 %
5	97.71 %
6	97.85 %
7	97.79 %
8	97.81 %
9	97.83 %
10	97.83 %
11	97.87 %
12	97.84 %
13	97.88 %
14	97.91 %
15	97.81 %
16	97.86 %
17	97.97 %
18	97.97 %
19	98.01 %
20	97.92 %
21	97.99 %
22	97.95 %
23	98.00 %
24	97.99 %
25	98.02 %
26	98.03 %
27	98.03 %
28	98.02 %
29	97.97 %
30	98.00 %
31	98.10 %
32	98.06 %
33	98.04 %
34	97.96 %
35	98.10 %
36	98.11 %
37	98.05 %
38	98.05 %
39	98.06 %
40	98.07 %

Table 6: Convolutional neural network model accuracy in 40 epoch