Exercise 3

Machine Learning in Graphics & Vision

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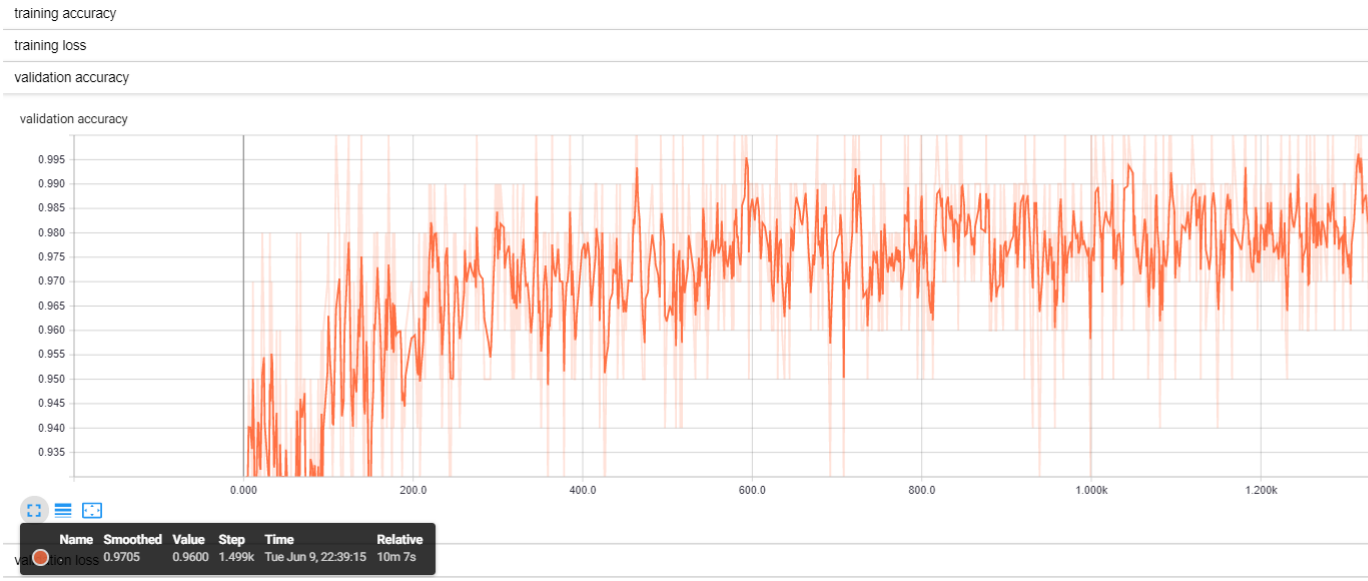
Task 1

(a) Our implementation does achieve 97.05% accuracy after 15 epochs.



According to `http://rodrigob.github.io/are_we_there_yet/build/classification_datasets_results.html#4d4e495354` the paper "Regularization of Neural Networks using DropConnect" in 2013 achieved a result of 0.21% errorrate, hence an accuracy value of 99.79%.

(b) from torchsummary import summary
summary(model, (1,28,28))

Layer (type) Output Shape Param #
==========
Conv2d-1 [-1, 32, 28, 28] 320
ReLU-2 [-1, 32, 28, 28] 0
Conv2d-3 [-1, 32, 28, 28] 9,248
ReLU-4 [-1, 32, 28, 28] 0
Conv2d-5 [-1, 32, 28, 28] 9,248
Linear-6 [-1, 256] 6,422,784
ReLU-7 [-1, 256] 0
Linear-8 [-1, 10] 2,570
==========
Total params: 6,444,170
Trainable params: 6,444,170
Non-trainable params: 0

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Input size (MB): 0.00
Forward/backward pass size (MB): 0.96
Params size (MB): 24.58
Estimated Total Size (MB): 25.55

Output of convolutional layers can be calculated with this formula:

$$[(W - K + 2P)/S] + 1$$

where W is the width(or height if the input is squared), K is the kernelsize, P is the amount of padding and S the stride.

(c) After 15 epochs training on the default network with FashionMNIST dataset, the validation(test) accuracy is about 89%.
Console output:
epoch done: 14 accuracy train 0.9082844034830729 accuracy test 0.891600112915039

We then increased the size of the network in a fashion similar to VGG network. We used stride 2 to speed up training and decrease the number of features while simultaneously incresing the number of filters. To increase the training speed we added batch normalization layers. The following network had the highest accuracy of 0.9108000755310058 on the validation set (the corresponding accuracy curves are in Figure 1):

Layer (type)	Output Shape	Param #
Conv2d-1	[-1, 32, 28, 28]	320
BatchNorm2d-2	[-1, 32, 28, 28]	64
ReLU-3	[-1, 32, 28, 28]	0
Conv2d-4	[-1, 32, 14, 14]	9,248
BatchNorm2d-5	[-1, 32, 14, 14]	64
ReLU-6	[-1, 32, 14, 14]	0
Conv2d-7	[-1, 32, 14, 14]	9,248
BatchNorm2d-8	[-1, 32, 14, 14]	64
ReLU-9	[-1, 32, 14, 14]	0
Conv2d-10	[-1, 64, 7, 7]	18,496
BatchNorm2d-11	[-1, 64, 7, 7]	128
ReLU-12	[-1, 64, 7, 7]	0
Conv2d-13	[-1, 64, 7, 7]	36,928
BatchNorm2d-14	[-1, 64, 7, 7]	128
ReLU-15	[-1, 64, 7, 7]	0
Conv2d-16	[-1, 64, 7, 7]	36,928
BatchNorm2d-17	[-1, 64, 7, 7]	128
ReLU-18	[-1, 64, 7, 7]	0
Conv2d-19	[-1, 128, 4, 4]	73,856
BatchNorm2d-20	[-1, 128, 4, 4]	256

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```
ReLU-21              [-1, 128, 4, 4]               0
Conv2d-22            [-1, 128, 4, 4]         147,584
BatchNorm2d-23       [-1, 128, 4, 4]             256
ReLU-24              [-1, 128, 4, 4]               0
Conv2d-25            [-1, 128, 4, 4]         147,584
BatchNorm2d-26       [-1, 128, 4, 4]             256
ReLU-27              [-1, 128, 4, 4]               0
Conv2d-28            [-1, 256, 2, 2]         295,168
BatchNorm2d-29       [-1, 256, 2, 2]             512
ReLU-30              [-1, 256, 2, 2]               0
Conv2d-31            [-1, 512, 2, 2]       1,180,160
BatchNorm2d-32       [-1, 512, 2, 2]           1,024
ReLU-33              [-1, 512, 2, 2]               0
Conv2d-34            [-1, 512, 2, 2]       2,359,808
BatchNorm2d-35       [-1, 512, 2, 2]           1,024
ReLU-36              [-1, 512, 2, 2]               0
Conv2d-37            [-1, 512, 2, 2]       2,359,808
BatchNorm2d-38       [-1, 512, 2, 2]           1,024
ReLU-39              [-1, 512, 2, 2]               0
Conv2d-40            [-1, 1024, 1, 1]      4,719,616
BatchNorm2d-41       [-1, 1024, 1, 1]          2,048
ReLU-42              [-1, 1024, 1, 1]              0
Conv2d-43            [-1, 1024, 1, 1]      9,438,208
BatchNorm2d-44       [-1, 1024, 1, 1]          2,048
ReLU-45              [-1, 1024, 1, 1]              0
Conv2d-46            [-1, 1024, 1, 1]      9,438,208
BatchNorm2d-47       [-1, 1024, 1, 1]          2,048
ReLU-48              [-1, 1024, 1, 1]              0
Linear-49                  [-1, 10]           10,250
================================================================
Total params: 30,292,490
Trainable params: 30,292,490
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 1.45
Params size (MB): 115.56
Estimated Total Size (MB): 117.01
----------------------------------------------------------------
```

As we can see from the plots (Figure 1) it seems that our network overfits the data and it could benefit from early stopping.

(d)

Task 2

(a) Visualization of the image pairs. Every noisy image is located in front of the original image (Figure (2)).

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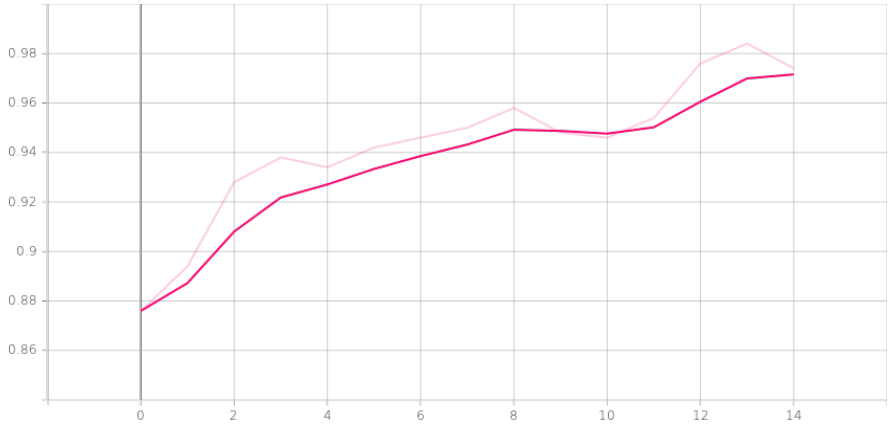
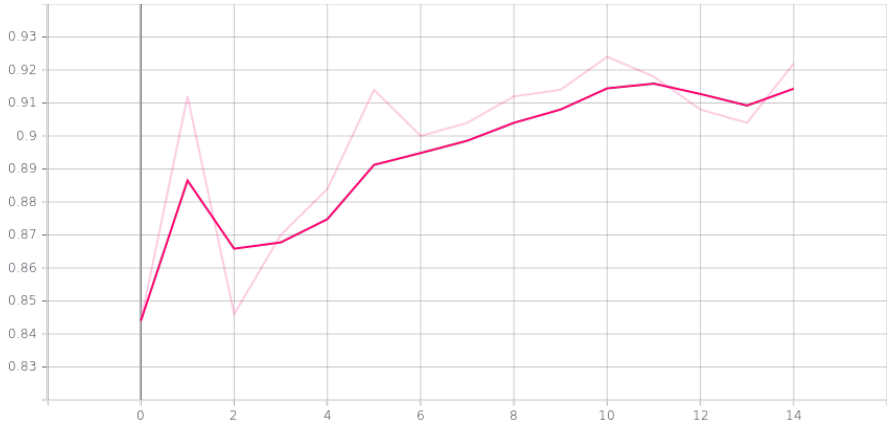


(a) Training accuracy curve



(b) Validation accuracy curve

Figure 1: Plot of results from task 3.1.c)

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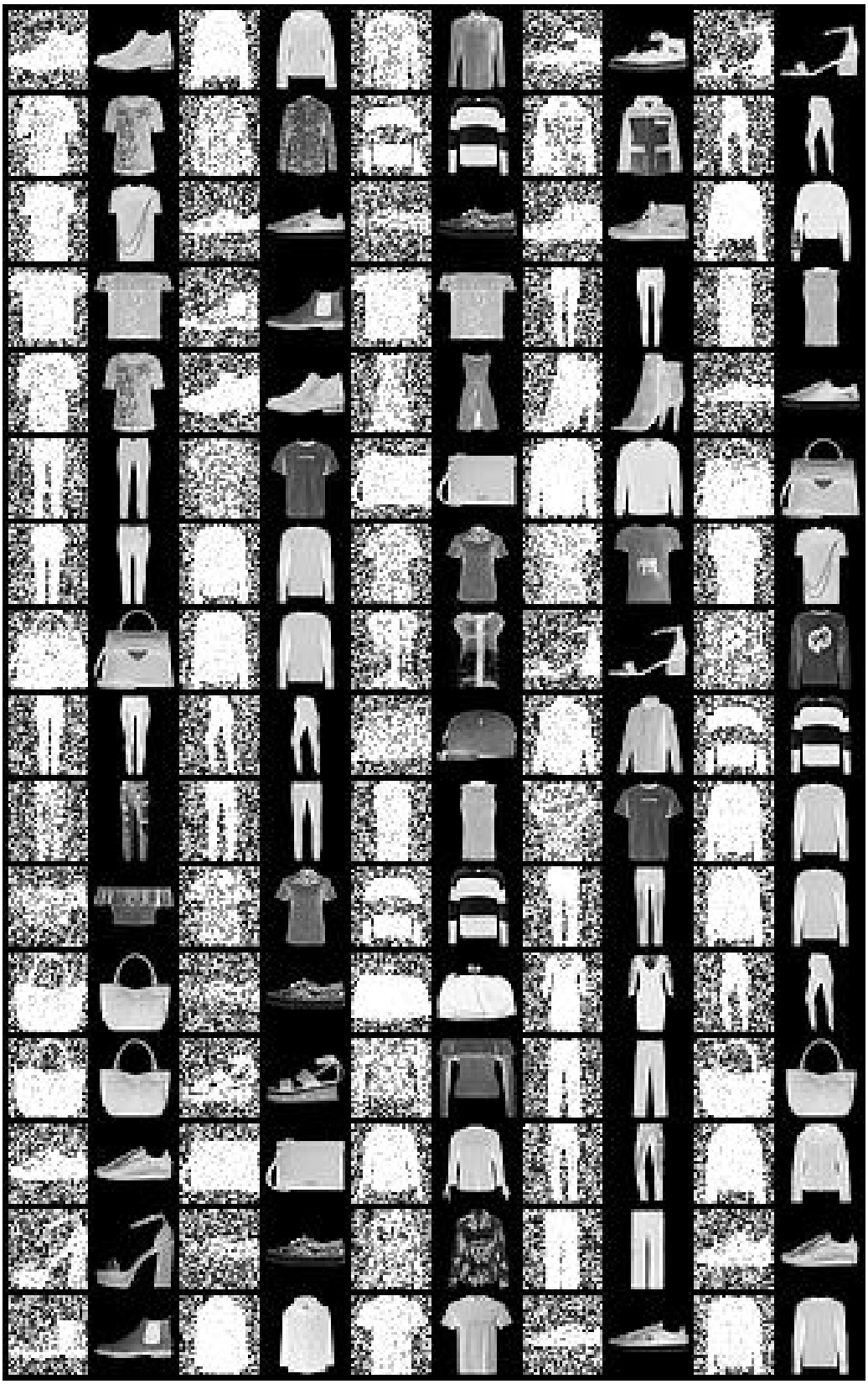

Figure 2: Sample of image pairs contained in the `NoisyFashionMNIST`