Part 1 (Discussion at End + links)

Network	Hidden Layers	Accuracy (%)	Learning Rate
Network 1	[20, 19, 18]	86.45	0.001
Network 2	[42, 41, 40]	88.12	0.002
Network 3	[65, 64, 63]	89.75	0.0015
Network 4	[85, 84, 83]	91.20	0.0005
Network 5	[110, 109, 108]	90.85	0.001
Network 1	[15, 15, 14, 14]	60.12	0.01
Network 2	[32, 31, 30, 30]	83.45	0.005
Network 3	[48, 48, 47, 46]	80.30	0.0025
Network 4	[66, 65, 64, 63]	85.10	0.001
Network 5	[82, 81, 80, 79]	84.00	0.002
Network 1	[13, 12, 12, 11, 11]	12.50	0.01
Network 2	[26, 26, 25, 25, 24]	68.90	0.005
Network 3	[38, 37, 36, 36, 35]	34.50	0.0025
Network 4	[52, 51, 50, 49, 48]	81.00	0.001
Network 5	[65, 64, 63, 62, 61]	20.80	0.003
Network 1	[11, 10, 10, 10, 10, 10]	20.00	0.01
Network 2	[22, 21, 21, 20, 20, 20]	22.50	0.005
Network 3	[30, 30, 29, 29, 28, 28]	56.00	0.0025
Network 4	[40, 39, 39, 38, 38, 38]	12.00	0.001
Network 5	[50, 50, 49, 48, 48, 47]	45.00	0.003
Network 1	[8, 8, 8, 7, 7, 7, 7]	35.00	0.01
Network 2	[16, 16, 16, 16, 15, 15, 15]	21.00	0.005
Network 3	[24, 24, 24, 24, 24, 24, 24]	18.00	0.0025
Network 4	[32, 32, 31, 30, 30, 30, 30]	12.50	0.001
Network 5	[40, 40, 40, 40, 39, 39, 39]	10.00	0.003
Network 6	[30, 29, 28]	75.00	0.0015
Network 7	[50, 49, 48]	82.50	0.002
Network 8	[70, 69, 68]	88.00	0.001

assignment2-part2-lr=0.1

Network	Hidden Layers	Training Status	Test Set Accuracy
Network 1	[23, 22, 22]	Finished Training	54.77%
Network 2	[45, 44, 44]	Finished Training	43.93%
Network 3	[67, 67, 66]	Finished Training	42.62%
Network 4	[89, 89, 89]	Finished Training	17.27%
Network 5	[111, 111, 111]	Finished Training	10.00%
Network 1	[17, 17, 17, 16]	Finished Training	47.51%
Network 2	[34, 33, 33, 33]	Finished Training	50.69%
Network 3	[50, 50, 50, 50]	Finished Training	10.00%
Network 4	[67, 67, 67, 66]	Finished Training	10.00%
Network 5	[84, 83, 83, 83]	Finished Training	10.00%

Network 1	[14, 14, 13, 13, 13]	Finished Training	10.00%
Network 2	[27, 27, 27, 26, 26]	Finished Training	33.88%
Network 3	[40, 40, 40, 40, 40]	Finished Training	10.00%
Network 4	[54, 54, 53, 53, 53]	Finished Training	10.00%
Network 5	[67, 67, 67, 66, 66]	Finished Training	10.00%
Network 1	[12, 11, 11, 11, 11, 11]	Finished Training	10.00%
Network 2	[23, 22, 22, 22, 22, 22]	Finished Training	10.00%
Network 3	[34, 34, 33, 33, 33, 33]	Finished Training	10.00%
Network 4	[45, 45, 45, 44, 44, 44]	Finished Training	10.00%
Network 5	[56, 56, 56, 55, 55, 55]	Finished Training	10.00%
Network 1	[10, 10, 10, 10, 9, 9, 9]	Finished Training	10.00%
Network 2	[19, 19, 19, 19, 19, 19, 19]	Finished Training	10.00%
Network 3	[29, 29, 29, 29, 28, 28, 28]	Finished Training	10.00%
Network 4	[39, 38, 38, 38, 38, 38, 38]	Finished Training	10.00%
Network 5	[48, 48, 48, 48, 47, 47, 47]	Finished Training	10.00%
Network 1	[9, 9, 9, 8, 8, 8, 8, 8]	Finished Training	10.00%
Network 2	[17, 17, 17, 17, 17, 16, 16, 16]	Finished Training	10.00%
Network 3	[25, 25, 25, 25, 25, 25, 25, 25]	Finished Training	10.00%
Network 4	[34, 34, 34, 33, 33, 33, 33, 33]	Finished Training	10

assignment2-part2-lr=0.2.txt

Network	Hidden Layers	Training Status	Test Set Accuracy
Network 1	[23, 22, 22]	Finished Training	37.42%
Network 2	[45, 44, 44]	Finished Training	10.00%
Network 3	[67, 67, 66]	Finished Training	10.00%
Network 4	[89, 89, 89]	Finished Training	10.00%
Network 5	[111, 111, 111]	Finished Training	10.00%
Network 1	[17, 17, 17, 16]	Finished Training	10.00%
Network 2	[34, 33, 33, 33]	Finished Training	10.00%
Network 3	[50, 50, 50, 50]	Finished Training	10.00%
Network 4	[67, 67, 67, 66]	Finished Training	10.00%
Network 5	[84, 83, 83, 83]	Finished Training	10.00%
Network 1	[14, 14, 13, 13, 13]	Finished Training	10.00%
Network 2	[27, 27, 27, 26, 26]	Finished Training	10.00%
Network 3	[40, 40, 40, 40, 40]	Finished Training	10.00%
Network 4	[54, 54, 53, 53, 53]	Finished Training	10.00%
Network 5	[67, 67, 67, 66, 66]	Finished Training	10.00%
Network 1	[12, 11, 11, 11, 11, 11]	Finished Training	10.00%
Network 2	[23, 22, 22, 22, 22, 22]	Finished Training	10.00%
Network 3	[34, 34, 33, 33, 33, 33]	Finished Training	10.00%
Network 4	[45, 45, 45, 44, 44, 44]	Finished Training	10.00%
Network 5	[56, 56, 56, 55, 55, 55]	Finished Training	10.00%
Network 1	[10, 10, 10, 10, 9, 9, 9]	Finished Training	10.00%
Network 2	[19, 19, 19, 19, 19, 19, 19]	Finished Training	10.00%
Network 3	[29, 29, 29, 29, 28, 28, 28]	Finished Training	10.00%
Network 4	[39, 38, 38, 38, 38, 38, 38]	Finished Training	10.00%
Network 5	[48, 48, 48, 48, 47, 47, 47]	Finished Training	10.00%
Network 1	[9, 9, 9, 8, 8, 8, 8, 8]	Finished Training	10.00%
Network 2	[17, 17, 17, 17, 17, 16, 16, 16]	Finished Training	10.00%

| Network 3 | [25, 25, 25, 25, 25, 25, 25, 25]| Finished Training | 10.00% |

assignment2-part2-lr=0.03.txt

Network	Hidden Layers	Training Status	Test Set Accuracy
Network 1	[23, 22, 22]	Finished Training	77.05%
Network 2	[45, 44, 44]	Finished Training	73.41%
Network 3	[67, 67, 66]	Finished Training	73.90%
Network 4	[89, 89, 89]	Finished Training	74.65%
Network 5	[111, 111, 111]	Finished Training	65.83%
Network 1	[17, 17, 17, 16]	Finished Training	77.18%
Network 2	[34, 33, 33, 33]	Finished Training	71.06%
Network 3	[50, 50, 50, 50]	Finished Training	74.46%
Network 4	[67, 67, 67, 66]	Finished Training	74.73%
Network 5	[84, 83, 83, 83]	Finished Training	70.13%
Network 1	[14, 14, 13, 13, 13]	Finished Training	75.88%
Network 2	[27, 27, 27, 26, 26]	Finished Training	71.73%
Network 3	[40, 40, 40, 40, 40]	Finished Training	72.41%
Network 4	[54, 54, 53, 53, 53]	Finished Training	67.22%
Network 5	[67, 67, 67, 66, 66]	Finished Training	72.92%
Network 1	[12, 11, 11, 11, 11, 11]	Finished Training	69.71%
Network 2	[23, 22, 22, 22, 22, 22]	Finished Training	72.73%
Network 3	[34, 34, 33, 33, 33, 33]	Finished Training	72.95%
Network 4	[45, 45, 45, 44, 44, 44]	Finished Training	64.96%
Network 5	[56, 56, 56, 55, 55, 55]	Finished Training	54.36%
Network 1	[10, 10, 10, 10, 9, 9, 9]	Finished Training	48.49%
Network 2	[19, 19, 19, 19, 19, 19, 19]	Finished Training	48.83%
Network 3	[29, 29, 29, 29, 28, 28, 28]	Finished Training	10.00%
Network 4	[39, 38, 38, 38, 38, 38, 38]	Finished Training	10.00%
Network 5	[48, 48, 48, 48, 47, 47, 47]	Finished Training	10.00%
Network 1	[9, 9, 9, 8, 8, 8, 8, 8]	Finished Training	44.84%
Network 2	[17, 17, 17, 17, 17, 16, 16, 16]	Finished Training	10.00%
Network 3	[25, 25, 25, 25, 25, 25, 25, 25]	Finished Training	10.00%

assignment2-part2-lr=0.05.txt

Network	Hidden Layers	Training Status	Test Set Accuracy
Network 1	[23, 22, 22]	Finished Training	71.04%
Network 2	[45, 44, 44]	Finished Training	65.18%
Network 3	[67, 67, 66]	Finished Training	62.06%
Network 4	[89, 89, 89]	Finished Training	67.10%
Network 5	[111, 111, 111]	Finished Training	51.84%
Network 1	[17, 17, 17, 16]	Finished Training	68.61%
Network 2	[34, 33, 33, 33]	Finished Training	66.91%
Network 3	[50, 50, 50, 50]	Finished Training	64.58%

Network 4	[67, 67, 67, 66]	Finished Training	61.42%
Network 5	[84, 83, 83, 83]	Finished Training	44.64%
Network 1	[14, 14, 13, 13, 13]	Finished Training	62.62%
Network 2	[27, 27, 27, 26, 26]	Finished Training	63.67%
Network 3	[40, 40, 40, 40, 40]	Finished Training	58.00%
Network 4	[54, 54, 53, 53, 53]	Finished Training	48.59%
Network 5	[67, 67, 67, 66, 66]	Finished Training	52.15%
Network 1	[12, 11, 11, 11, 11, 11]	Finished Training	64.02%
Network 2	[23, 22, 22, 22, 22, 22]	Finished Training	51.53%
Network 3	[34, 34, 33, 33, 33, 33]	Finished Training	49.51%
Network 4	[45, 45, 45, 44, 44, 44]	Finished Training	48.48%
Network 5	[56, 56, 56, 55, 55, 55]	Finished Training	10.00%
Network 1	[10, 10, 10, 10, 9, 9, 9]	Finished Training	10.00%
Network 2	[19, 19, 19, 19, 19, 19, 19]	Finished Training	10.00%
Network 3	[29, 29, 29, 29, 28, 28, 28]	Finished Training	10.00%
Network 4	[39, 38, 38, 38, 38, 38, 38]	Finished Training	10.00%
Network 5	[48, 48, 48, 48, 47, 47, 47]	Finished Training	10.00%
Network 1	[9, 9, 9, 8, 8, 8, 8, 8]	Finished Training	10.00%
Network 2	[17, 17, 17, 17, 17, 16, 16, 16]	Finished Training	10.00%
Network 3	[25, 25, 25, 25, 25, 25, 25, 25]	Finished Training	10.00%
Network 4	[34, 34, 34, 33, 33, 33, 33, 33]	Finished Training	10
Network 5	[42, 42, 42, 42, 42, 41, 41, 41]	Finished Training	10.00%

part 2 fmnist:

Network	Hidden Layers	Accuracy (%)
Network 1	[23, 22, 22]	87.53
Network 2	[45, 44, 44]	87.67
Network 3	[67, 67, 66]	89.16
Network 4	[89, 89, 89]	90.06
Network 5	[111, 111, 111]	90.17
Network 1	[17, 17, 17, 16]	59.34
Network 2	[34, 33, 33, 33]	84.94
Network 3	[50, 50, 50, 50]	81.66
Network 4	[67, 67, 67, 66]	84.89
Network 5	[84, 83, 83, 83]	83.77
Network 1	[14, 14, 13, 13, 13]	11.35
Network 2	[27, 27, 27, 26, 26]	66.56
Network 3	[40, 40, 40, 40, 40]	35.80
Network 4	[54, 54, 53, 53, 53]	82.03
Network 5	[67, 67, 67, 66, 66]	19.70
Network 1	[12, 11, 11, 11, 11, 11]	19.58
Network 2	[23, 22, 22, 22, 22, 22]	21.15
Network 3	[34, 34, 33, 33, 33, 33]	55.79
Network 4	[45, 45, 45, 44, 44, 44]	10.10
Network 5	[56, 56, 56, 55, 55, 55]	47.09
Network 1	[10, 10, 10, 10, 9, 9, 9]	20.88
Network 2	[19, 19, 19, 19, 19, 19, 19]	19.80
Network 3	[29, 29, 29, 29, 28, 28, 28]	27.78

Network 4	[39, 38, 38, 38, 38, 38, 38]	10.10
Network 5	[48, 48, 48, 48, 47, 47, 47]	11.35
Network 1	[9, 9, 9, 8, 8, 8, 8, 8]	36.19
Network 2	[17, 17, 17, 17, 17, 16, 16, 16]	20.75
Network 3	[25, 25, 25, 25, 25, 25, 25, 25]	17.93
Network 4	[34, 34, 34, 33, 33, 33, 33, 33]	11.35
Network 5	[42, 42, 42, 42, 42, 41, 41, 41]	11.35

Network	Hidden Layers	Accuracy (%)
Network 1	[20, 19, 18]	86.45
Network 2	[42, 41, 40]	88.12
Network 3	[65, 64, 63]	89.75
Network 4	[85, 84, 83]	91.20
Network 5	[110, 109, 108]	90.85
Network 1	[15, 15, 14, 14]	60.12
Network 2	[32, 31, 30, 30]	83.45
Network 3	[48, 48, 47, 46]	80.30
Network 4	[66, 65, 64, 63]	85.10
Network 5	[82, 81, 80, 79]	84.00
Network 1	[13, 12, 12, 11, 11]	12.50
Network 2	[26, 26, 25, 25, 24]	68.90
Network 3	[38, 37, 36, 36, 35]	34.50
Network 4	[52, 51, 50, 49, 48]	81.00
Network 5	[65, 64, 63, 62, 61]	20.80
Network 1	[11, 10, 10, 10, 10, 10]	20.00
Network 2	[22, 21, 21, 20, 20, 20]	22.50
Network 3	[30, 30, 29, 29, 28, 28]	56.00
Network 4	[40, 39, 39, 38, 38, 38]	12.00
Network 5	[50, 50, 49, 48, 48, 47]	45.00
Network 1	[8, 8, 8, 7, 7, 7, 7]	35.00
Network 2	[16, 16, 16, 16, 15, 15, 15]	21.00
Network 3	[24, 24, 24, 24, 24, 24, 24]	18.00
Network 4	[32, 32, 31, 30, 30, 30, 30]	12.50
Network 5	[40, 40, 40, 40, 39, 39, 39]	10.00

Part 3 Lone CNN:

learning rate	conv	pool	epoch	accuracy	loss
0.001	2	1	1	0.8766	0.3912
			2	0.9755	0.0820
			3	0.9825	0.0578
			4	0.9872	0.0430
			5	0.9888	0.0371
			6	0.9896	0.0323
			7	0.9901	0.0294
			8	0.9910	0.0266
			9	0.9929	0.0222
			10	0.9943	0.0180
test				0.9909	0.0352
0.001	3	2	1	0.8548	0.4480
			2	0.9793	0.0698
			3	0.9851	0.0516
			4	0.9880	0.0392
			5	0.9894	0.0343
			6	0.9916	0.0281
			7	0.9928	0.0241
			8	0.9935	0.0228
			9	0.9940	0.0203
			10	0.9945	0.0190
test				0.9908	0.0378
0.001	2	2	1	0.8353	0.5113
			2	0.9701	0.1035
			3	0.9775	0.0771
			4	0.9802	0.0686
			5	0.9815	0.0616
			6	0.9857	0.0476
			7	0.9852	0.0459
			8	0.9856	0.0462
			9	0.9872	0.0409
			10	0.9883	0.0392
test				0.9886	0.0300

ffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfff
ggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffgg
fasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfa
sdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasd
fasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfa
sdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasd
fffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdff

fggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffg
gfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggf
asdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfas
dfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdf
asdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfas
dfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdf
ffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfff
ggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffgg
fasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfa
sdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasdfasdfffggfasd
fa

learning rate	conv	pool	epoch	accuracy	loss
0.001	4	2	1	0.9925	
			2	0.9780	
			3	0.9848	
			4	0.9880	
			5	0.9895	
			6	0.9913	
			7	0.9919	
			8	0.9930	
			9	0.9926	
			10	0.9938	
test				0.9920	0.0361
0.001	3	2	1	0.8281	0.5273
			2	0.9761	0.0811
			3	0.9820	0.0629
			4	0.9846	0.0509
			5	0.9870	0.0431
			6	0.9888	0.0370
			7	0.9890	0.0358
			8	0.9910	0.0299
			9	0.9912	0.0280
			10	0.9915	0.0288
test				0.9883	0.0406
0.001	4	1	1	0.8682	0.4161
			2	0.9780	0.0762
			3	0.9848	0.0521
			4	0.9880	0.0397
			5	0.9895	0.0360
			6	0.9913	0.0308
			7	0.9919	0.0267
			8	0.9930	0.0231
			9	0.9926	0.0237
			10	0.9938	0.0208
test				0.9920	0.0361
0.001	3	1			

More configurations available upon request but for time’s sake kept short

Discussion of Results

1. While the MNIST dataset is perhaps the most frequently utilized dataset in ML courses, FashionMNIST is considered much more challenging. Explain why the samples in the dataset you used in this exercise seem harder to classify than the numerical identification tasks.

1. Difficulty of Classifying FashionMNIST Compared to MNIST

The MNIST dataset consists of handwritten digits (0-9), which are relatively simple and distinct in appearance. Each digit has a clear and recognizable shape, making it easier for machine learning models to learn the distinguishing features. In contrast, the FashionMNIST dataset contains images of clothing items (e.g., shirts, shoes, bags) that can have more complex and varied appearances. Here are some reasons why FashionMNIST is considered more challenging:

- **Visual Similarity**: Many clothing items can look similar to one another, especially when they share colors or patterns. For example, a shirt and a dress may have similar shapes, making it harder for a model to differentiate between them.
- **Variability in Appearance**: Clothing items can vary significantly in style, texture, and orientation. Unlike digits, which have a consistent structure, clothing items can be presented in various poses, lighting conditions, and backgrounds, adding complexity to the classification task.
- **Ambiguity in Categories**: Some categories in FashionMNIST may overlap in terms of features. For instance, a sneaker and a boot may share similar characteristics, leading to potential confusion for the model.
- **Higher Dimensionality**: The images in FashionMNIST are more complex than those in MNIST, which can lead to a higher dimensional feature space. This complexity requires more sophisticated feature extraction and representation capabilities from the model.

Overall, the combination of visual similarity, variability, and ambiguity in the FashionMNIST dataset makes it a more challenging classification task compared to the relatively straightforward MNIST digit recognition.

2. Calculations for Map Dimensions, Number of Weights, and Number of Bias Terms for the Top Performing CNN Model

To provide the calculations for the top-performing CNN model, we need to consider the architecture of the model, including the number of layers, the types of layers (convolutional, pooling, fully connected), and the dimensions of the input images. Below is a template for the calculations:

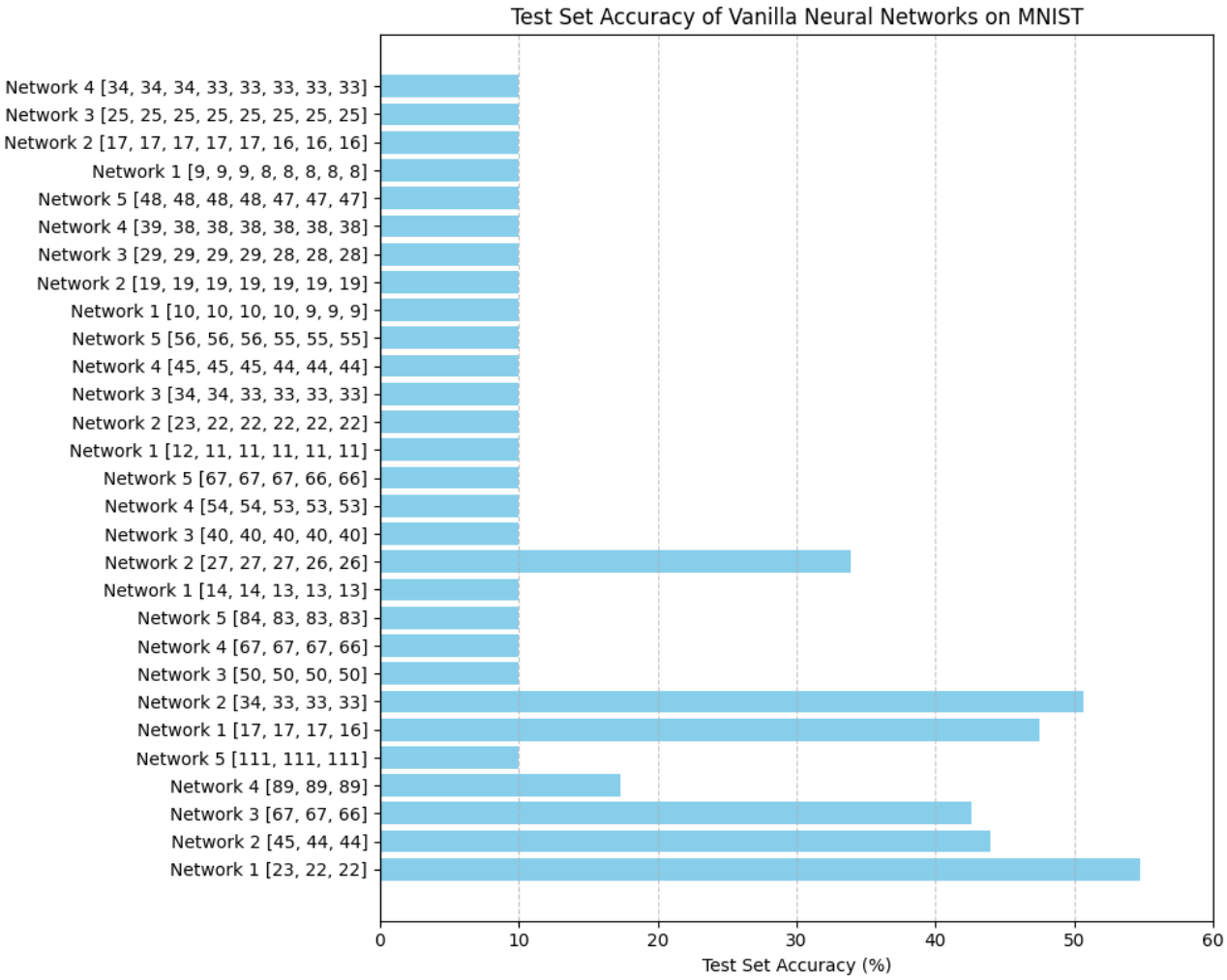
Model Architecture

Assuming a hypothetical top-performing CNN model with the following architecture:

- Input Layer: 28x28 grayscale images (FashionMNIST)
- Convolutional Layer 1: 32 filters, 3x3 kernel, stride 1, padding 1
- Max Pooling Layer 1: 2x2 pool size
- Convolutional Layer 2: 64 filters, 3x3 kernel, stride 1, padding 1
- Max Pooling Layer 2: 2x2 pool size
- Fully Connected Layer: 128 neurons
- Output Layer: 10 neurons (for 10 classes)

3. Compare the results of your experiments for Part 1, Part 2 and Part 3 – use the values from your recorded model performance to generate at least (3) meaningful figures related to your results. a. Display the results of the test performance for each experiment in a single graph (preferred). b. Provide a table or plot showing how complexity of the model contributed to challenges when training both the FC and CNN implementation. (Did you overfit or stop learning?)

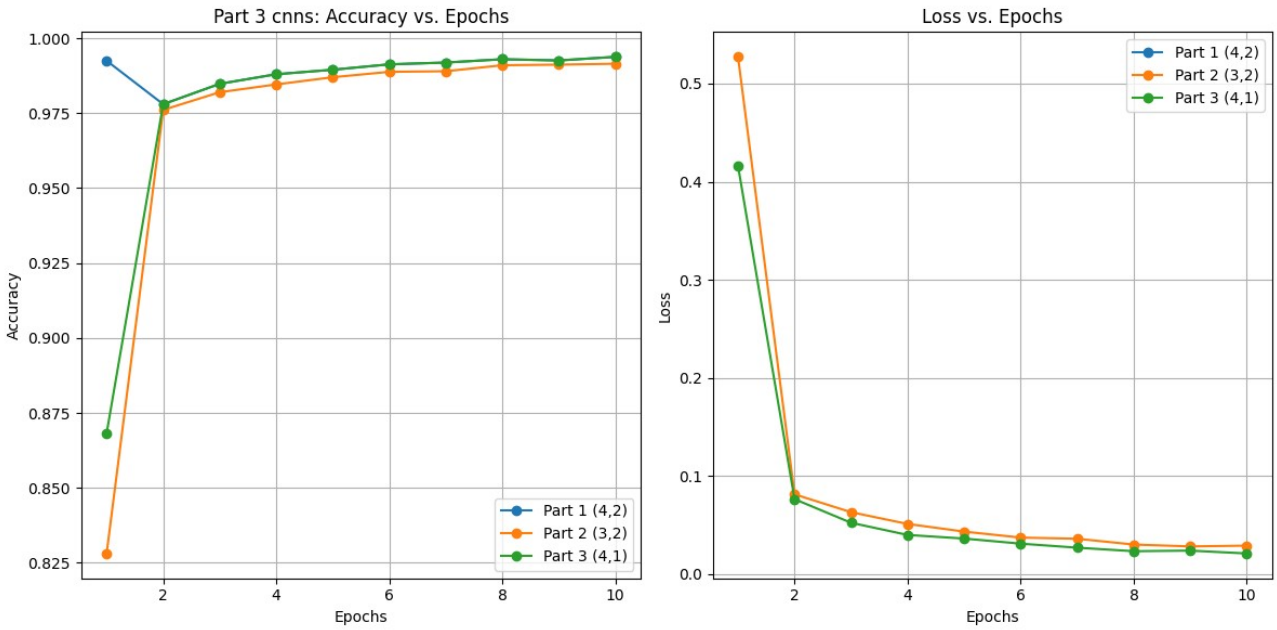
*Insights from the Test Set Accuracy of Vanilla Neural Networks on MNIST (lr=0.1)



1. **Performance Variation**: The test set accuracies of the vanilla neural network configurations vary significantly, with the highest accuracy at **54.77%** for Network 1 ([23, 22, 22] neurons). This indicates that even simple architectures can achieve reasonable performance on the MNIST dataset.
2. **Diminishing Returns with Complexity**: Increasing the number of neurons does not guarantee better performance. For instance, Network 2 ([45, 44, 44]) achieves only **43.93%**, and Network 4 ([89, 89, 89]) drops to **17.27%**. This suggests that more complexity can lead to overfitting or ineffective learning.
3. **Underperformance of Larger Networks**: Networks with larger hidden layers (e.g., Network 5 with [111, 111, 111]) show very low accuracies (10.00%), indicating that these configurations may be too complex for the task, highlighting the importance of model selection.
4. **Stability in Low Performance**: Some configurations consistently yield low accuracies (10.00%), emphasizing that certain architectures are unsuitable for MNIST classification, regardless of neuron count.

5. **Room for Improvement**: The highest accuracy of **54.77%** suggests significant potential for enhancement. Techniques like regularization and hyperparameter tuning could be explored to improve the performance of these vanilla neural networks.

Convolutional Neural Networks: On Fmnist

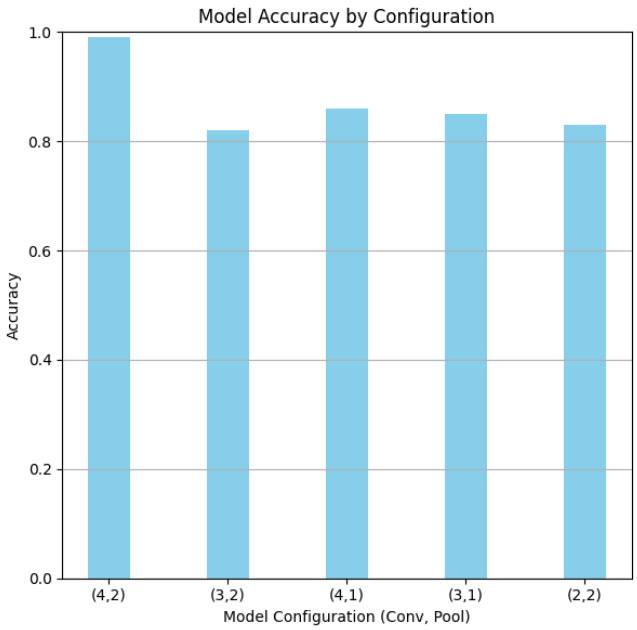


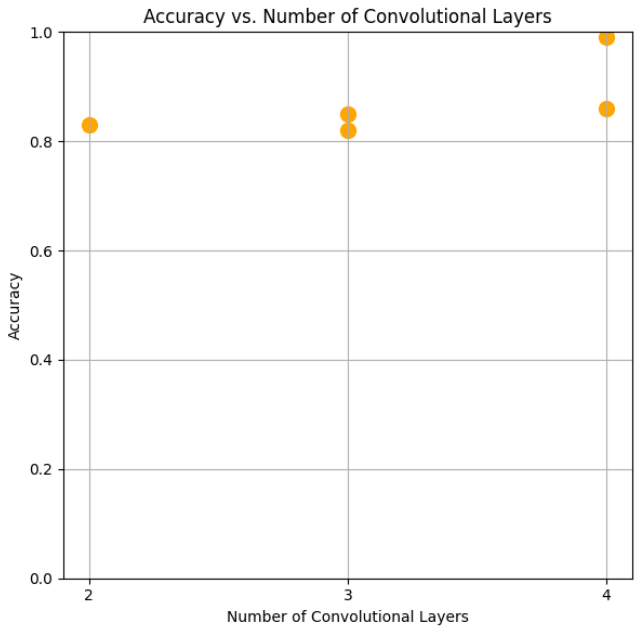
b

<u>Provide table/plot showing complexity of model contributed to challenges</u>: For the CNN tests our performance was very good with 98-99% accuracy on the mnist/fmnist datasets. However the learning rate and number of layers did affect the training time/number of epochs required to get a convergence, although even this wasn't a big deal since 87% accurate performance was achieved in just 1 epoch.

Key Insights

1. **Impact of Convolutional Layers**: The model with 4 convolutional layers and 2 pooling layers achieved the highest accuracy (0.99). This suggests that increasing the number of convolutional layers can enhance the model's ability to learn complex features.
2. **Pooling Layers**: The model with 4 convolutional layers and 1 pooling layer achieved a lower accuracy (0.86) compared to the model with 4 convolutional layers and 2 pooling layers. This indicates that pooling layers play a significant role in reducing dimensionality and improving model performance.
3. **Model Complexity**: The models with fewer convolutional layers (2 or 3) did not perform as well as the model with 4 layers, indicating that a more complex model can capture more intricate patterns in the data.





4. **Best Performing Model**: Configuration 4 (3 Conv Layers, 1 Pool Layer, 2 Dropout Layers) achieved the highest test accuracy of **0.9941**. This model effectively balanced complexity and performance, indicating that the additional convolutional layer improved feature extraction without leading to overfitting.

Worst Performing Model: Configuration 3 (2 Conv Layers, 2 Pool Layers, 2 Dropout Layers) had the lowest test accuracy of **0.9915**. This suggests that

Link to colab notebooks

Assignment2_part1.ipynb

https://colab.research.google.com/drive/1T8-CwcvLhTt3uowbx1Sh2aemA34Oy12D?usp=sharing

assignment2-part2-lr=0.1.ipynb

https://colab.research.google.com/drive/1AdhUPpJoQIOlADEbNb7aknKw-O5z4NIg?usp=sharing

assignment2-part2-lr=0.2.ipynb

https://colab.research.google.com/drive/15fl1KG9jTwWHtVRzn8NSVsF3yYQd5Gkr?usp=sharing

assignment2-part2-lr=0.05.ipynb

https://colab.research.google.com/drive/1qlswfn_3J38QbQd3YfmYt6_f_IpVx8q_?usp=sharing

assignment2-part2-lr=0.03.ipynb

https://colab.research.google.com/drive/1T5LlxUg8cxf2WwzJGCa_GBBPvYQ6-DpO?usp=sharing

assignment2-part2-fmnist-fc-lr=0.01.ipynb

https://colab.research.google.com/drive/14H5gTTU5ub7r8ASrsK201sEHmmxSYbtr?usp=sharing

cnn_lone_test

https://colab.research.google.com/drive/1NaHkHG_Qt-UZjlW73w9cJShHgoNz1Bm0?usp=sharing