Machine Learning Homework #5

1. Implement VGG-16 network architecture

VGG-16 from Keras

The VGG-16 model was implemented from Keras with the ImageNet weights. The MNIST data and model were adapted so they could be used together.
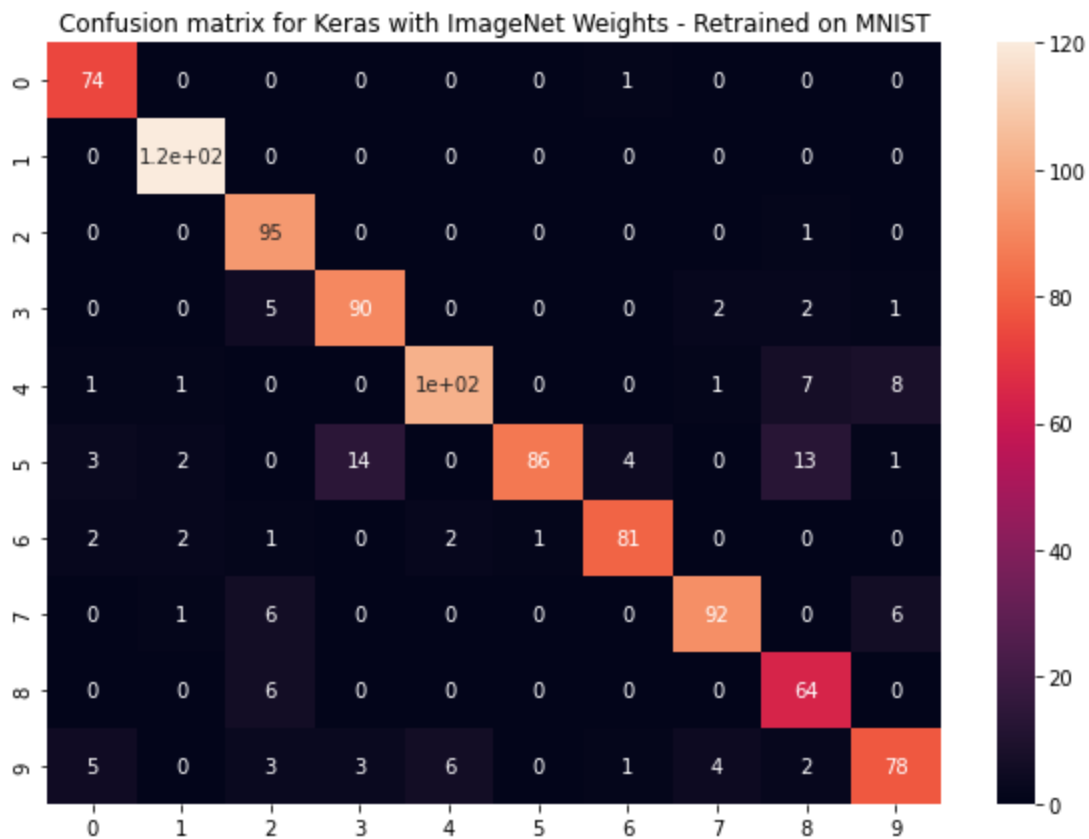
First, the MNIST data from each image was stacked to create a (28x28x3) array. Although the MNIST data is black and white, this step is necessary to recreate the dimensionality of a color image. Next, the image is reshaped into a (224x224x3) image using OpenCV. The Keras model is looking for an image of this shape.

To adapt the Keras model to have an output of 10 classes (instead of 1,000), a layer is added to the second to last layer. The input to this layer is the output of the second to last layer.

x = Dense(10, activation='softmax', name='predictions')(vgg16.layers[-2].output)

This model is run with a batch size of 13 with 10 epochs, 1000 samples of training data, 1000 samples of validation data, and 1000 samples of testing data.

Epoch	Loss	Sparse Categorical Accuracy	Validation Loss	Validation Sparse Categorical Accuracy
1	892768.7500	0.0930	2.4668	0.1070
2	2.7552	0.0990	2.3242	0.1030
3	2.5537	0.1480	2.0243	0.2310
4	2.6302	0.2150	1.5633	0.5110
5	1.8634	0.3910	0.5711	0.8070
6	1.0288	0.7600	0.4120	0.8590
7	0.6809	0.8350	0.3417	0.8950
8	0.5547	0.8710	0.9850	0.7690
9	0.5858	0.8780	0.6134	0.8170
10	0.3517	0.9060	0.5099	0.8980

Confusion matrix for Keras with ImageNet Weights - Retrained on MNIST

	0	1	2	3	4	5	6	7	8	9
0	74	0	0	0	0	0	1	0	0	0
1	0	1.2e+02	0	0	0	0	0	0	0	0
2	0	0	95	0	0	0	0	0	1	0
3	0	0	5	90	0	0	0	2	2	1
4	1	1	0	0	1e+02	0	0	1	7	8
5	3	2	0	14	0	86	4	0	13	1
6	2	2	1	0	2	1	81	0	0	0
7	0	1	6	0	0	0	0	92	0	6
8	0	0	6	0	0	0	0	0	64	0
9	5	0	3	3	6	0	1	4	2	78

Class Accuracy									
0	1	2	3	4	5	6	7	8	9
0.988	0.994	0.978	0.973	0.974	0.962	0.986	0.98	0.969	0.96

VGG-16 from scratch

Epoch	Loss	Accuracy
1	2.3340	0.0890
2	2.3044	0.0760
3	2.3034	0.0890
4	2.3031	0.1000
5	2.3028	0.1010
6	2.3030	0.0930
7	2.3029	0.1000
8	2.3028	0.0820
9	2.3029	0.1000
10	2.3029	0.1000

|	0	1	2	3	4	5	6	7	8	9
Class Accuracy	0.109	0.111	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
Loss	2.399	2.302	2.301	2.301	2.301	2.301	2.301	2.301	2.301	2.301

2. Freeze all Conv layers of the VGG-16 network and train on the MNIST dataset.
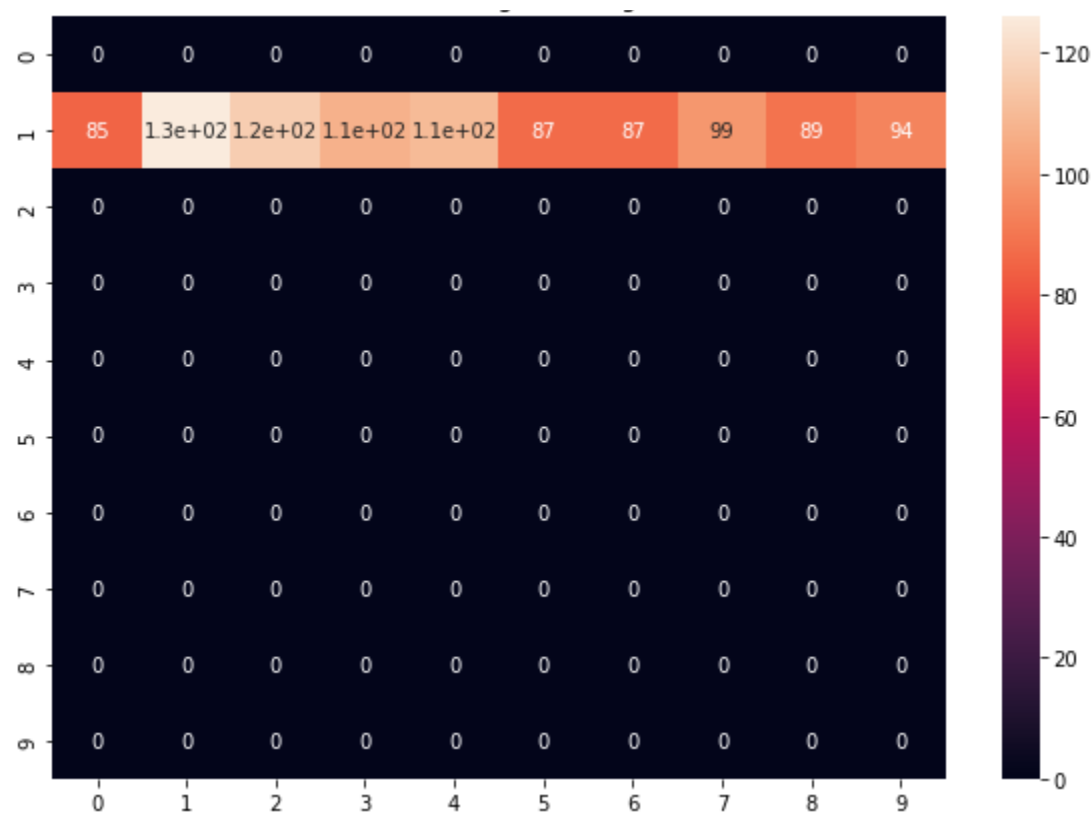
This was run with 10 epochs also. The ending result is very poor, because the model mislabels basically every piece of data.

Sparse categorical accuracy	Loss
0.0769	2.2985

3. Freeze all the FC layers of the VGG-16 network and train on MNIST.
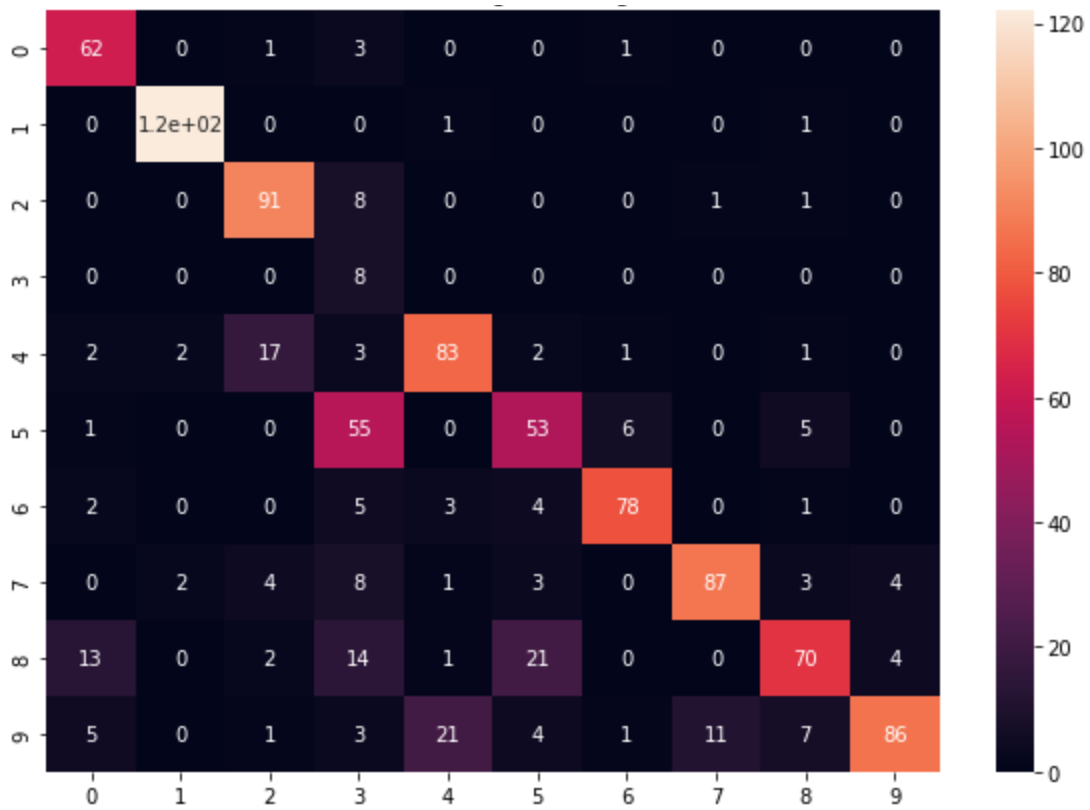
Epoch	Loss	Sparse Categorical Accuracy	Validation Loss	Validation Sparse Categorical Accuracy
1	307605.2188	0.1130	3.1297	0.0900
2	4.1837	0.0950	4.9906	0.0960
3	2.6632	0.1220	3.0578	0.0980
4	2.6603	0.0890	2.4525	0.1030
5	3.9912	0.1120	2.3175	0.0960
6	3.5432	0.1370	2.3202	0.1020
7	2.1521	0.2710	1.2588	0.6380
8	1.1842	0.6730	1.2077	0.7090
9	0.7239	0.7920	10.7070	0.3570
10	0.7972	0.8350	1.4712	0.7970