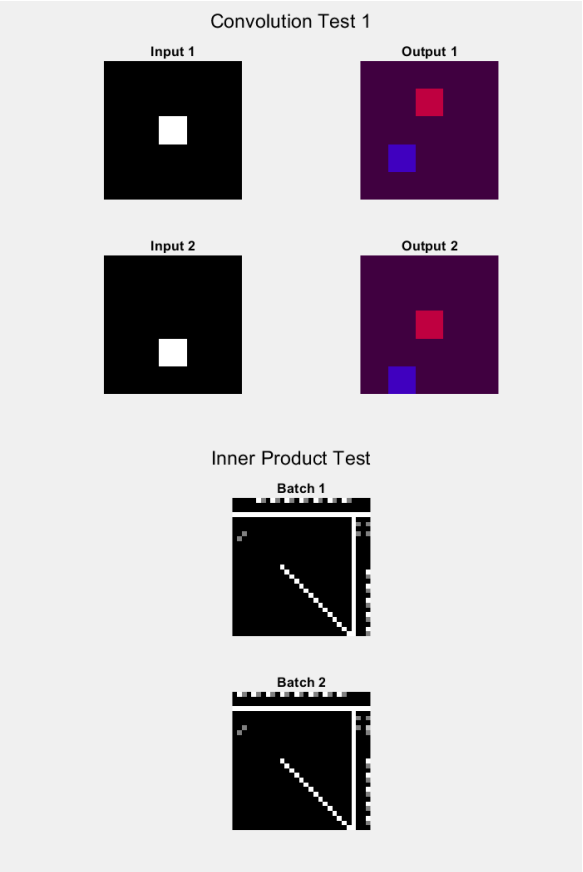
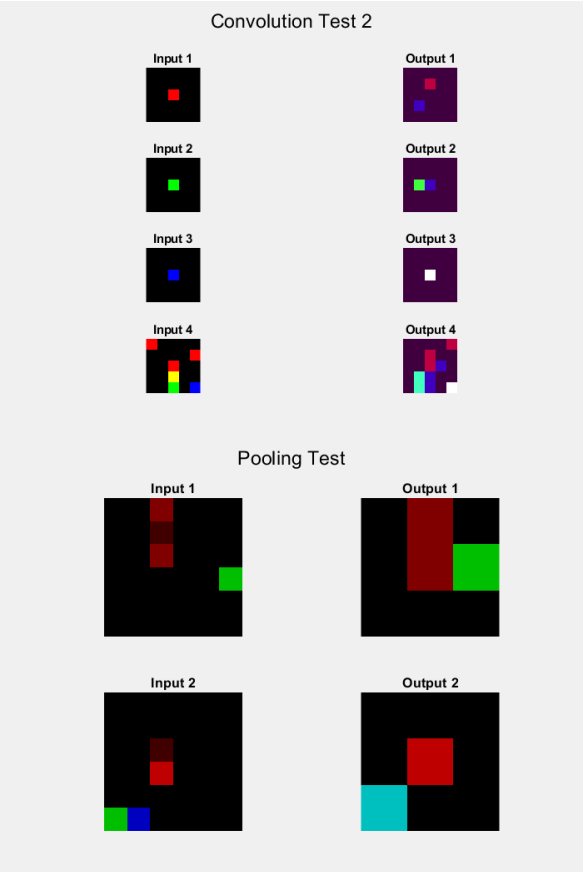
CMPT 412 Projects 1: Digit Recognition with Convolutional Neural Networks (1 late day used)

Answers for Part 1:

I first coded Inner Product Layer, then Pooling Layer, then Convolution Layer and at last I coded the ReLU. After running test_components.m I got these results:



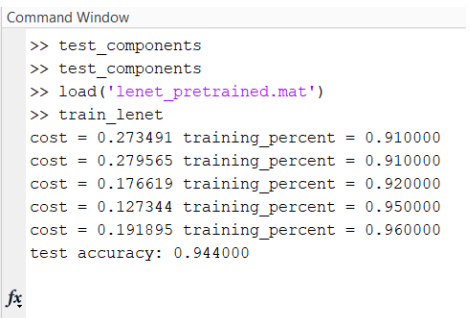


These are the results after coding the forward passing layers.

Answers for Part 3:

3.1)After running train_lenet.m the program took some time to run 3000 iteration. After 3000 iteration the program gave me an accuracy of 94.4% with cost 0.191895 and training percentage 96%.

Here is a screen shot from the matlab terminal:

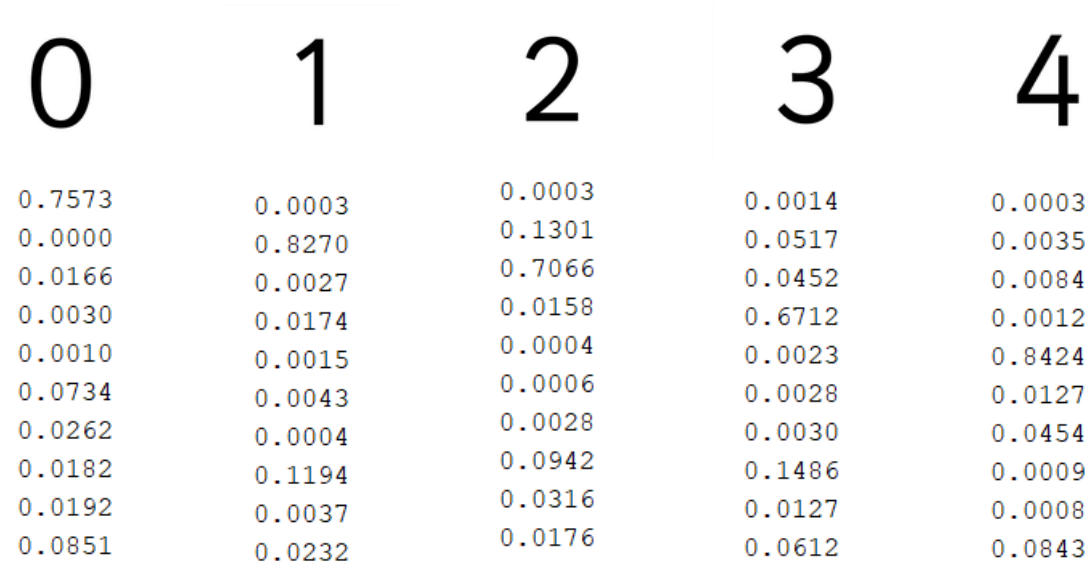


3.2) after running the test_network.m this is the resulting matrix:

```
>> test_network
    48     0     0     0     0     0     3     0     0     0
     0    64     0     0     0     0     0     0     0     0
     0     0    44     0     2     0     0     1     2     0
     0     0     2    50     0     2     0     0     3     0
     0     0     0     0    59     0     2     0     0     0
     0     0     0     0     0    25     0     0     0     0
     1     0     1     0     1     0    46     0     0     0
     0     0     0     0     0     0     0    47     0     0
     0     0     0     1     0     2     1     0    41     0
     0     0     0     0     1     0     0     2     0    49
```

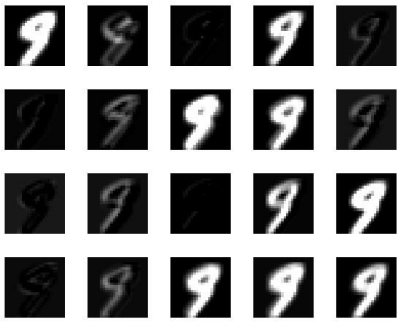
The first confusion pair from the matrix is 0 being confused with 6 we can also see this from the matrix as we get reading for the number 6 in the first column this could be because sometimes 6 and 0 can look alike as they have a similar structure. The second pair is 4 and 9, there are some more pairs that that being confused like 3 being confused for 8. Even though some digits are being confused the problem isn't that big as we are still being able to find the correct digit.

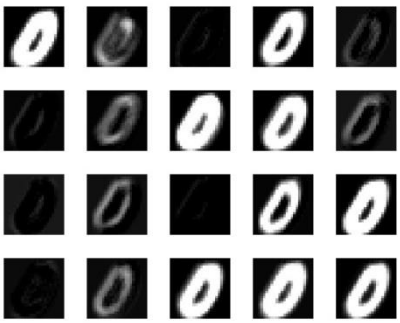
3.3) For this test I downloaded an image from the internet of the numbers and I cropped them to have single numbers. I wrote some matlab code in q3.m file to load these images and run them through the network. All the images returned correct results and was not confused but we also got a good idea of what the model could be confusing the digits with. These are the results that I got:

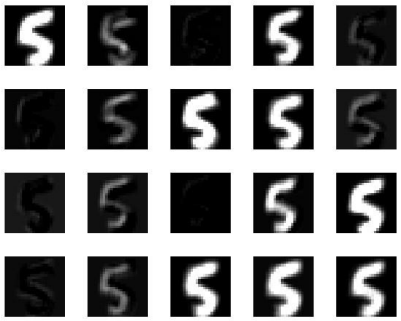


As you can see the results are correct and with a probability above 70% except for the number 3 which is 67% accurate. From these results we can also see that 4 and 9 are being confused and this could be because they both look similar and/or have a similar structure.

4.1) I got results for multiple numbers, results are provided below:







4.2) From these we can see that each of the feature map has different data from the image. Some of the feature maps got data about the edges where some of them have the data about the whole number itself. We can also see that it is trying to extract edge data in different ways. Some of them are angular which make the digit look three dimensional and some feature maps the two dimensional aspects. The third layer produced similar feature maps as the third layer is the relu feature map layer whereas the second one is the conv layer. The relu layer is just modifying the negative values and setting them to 0 hence why the feature maps are the same.