Homework 4
Due: 11:59pm March 8

Design and implement a convolutional neural network (CNN) to recognize hand-written digits in the MNIST dataset.

1. (50 pts) Implement a convolutional neural network that has one convolutional layer, one max pooling layer and two fully-connected layers. The convolutional layer has 10 filters (or kernels with size of 5x5) and their strides are 2. The pooling is 4x4 pooling. The two full-connected layers have 100 and 10 neurons, respectively.

   a. (10 pts) Report the number of parameters you need to train.
   b. (30 pts) Train the network with the MNIST dataset
   c. (10 pts) Visualize the 10 filters.

2. (50 pts) Implement another convolutional neural network that has two convolutional layers, two max pooling layers, and two fully-connected layers.

   a. (20 pts) Report the design of your CNN (number of filters, size of the filters, stride, padding, pooling, and number of neurons in each layer)
   b. (10 pts) Report the number of parameters you need to train.
   c. (10 pts) Train the network with the MNIST dataset
   d. (10 pts) Visualize the filters for the first convolutional layer.

Dataset is available at
http://yann.lecun.com/exdb/mnist/ or
https://github.com/mnielsen/neural-networks-and-deep-learning/blob/master/data/mnist.pkl.gz?raw=true

You can download mnist.pkl.gz and then use the following code to load the data.

```
dataset = 'mnist.pkl.gz'
f = gzip.open(dataset, 'rb')
train_set, valid_set, test_set = pickle.load(f, encoding='latin1')
f.close()
```