ECBM E4040 Neural Networks and Deep Learning
2016 Fall
HOMEWORK #0

INSTRUCTIONS: It is recommended that you solve this homework using a GPU instance (as opposed to a CPU instance) on Amazon EC2. Instructions on how to use Amazon EC2 and Jupyter notebooks are available in this webpage. Information on how to use Amazon EC2 will also be covered in Lecture #1.

If you have access, on your personal computer, to a fast GPU that supports CUDA, then you can also use your own computer. You can find information on installing Theano on on your computer here. Make sure that you install CUDA and cuDNN and enable GPU for Theano. If you are not able to install GPU-enabled Theano in a timely fashion on your computer, still consider using Amazon EC2 service with the provided machine image.
The submission for this homework should be a single Jupyter notebook file called **E4040_HW0_CUID#.ipynb** (you will submit/push this into the bitbucket repository- see submission instructions at the bottom)

PROBLEM #1:
(a) In the Jupyter notebook, execute the following two python code examples from the Deep Learning Tutorials, using a GPU:

- code/logistic_sgd.py
- code/convolutional_mlp.py

Documents on how to use Jupyter notebooks are available here. Some basic git commands can be found here.

(b) Repeat the same using a CPU. See this link for how to switch between using GPU and CPU. A suggested way is to use the following command in the Jupyter notebook

%env THEANO_FLAGS=device=cpu

To check the current configuration of the ENVIRONMENT FLAGS, execute
%env
in the Jupyter Notebook, you need to restart notebook kernel(menu bar Kernel→ Restart) and load Theano with the new configuration.

Save generated outputs for (a) and (b) in the Jupyter notebook and document any differences in execution time between the two using “markdown” cells in the Jupyter notebook. (If you do not want to wait until the end of execution for the CPU version, you can stop the execution by using the menu bar Kernel → Interrupt. How many training iterations has each example finished?)

PROBLEM #2: Read this tutorial (http://deeplearning.net/software/theano/tutorial/examples.html) on how Theano defines functions, shared variables and random numbers. For this course, you will run Theano code/functions inside the Jupyter notebook.

Perform the following operations in the Jupyter notebook:

1. Create a Theano single precision floating point vector **x**.
2. Create a RandomStream with a seed in theano, define a random 10 × 1 vector **a** and a random 10 × 1 vector **b** using this RandomStream, both from a uniform distribution.
3. Create a Theano function that performs the inner product **<x + a, b>**, use one shared variable in this function to record the randomly generated value of **a** and another shared variable to record the value of **b**.
4. Evaluate the above function one time using a 10 × 1 numpy vector of your choice as input **x**, and show that you can use the shared variables to evaluate the output of the function.
5. For verification repeat the same procedure using numpy operations (without using shared variables) and show that both methods give the same result.

PROBLEM#3: Define a function in python fib(n) which returns the n^{th} fibonacci number in the fibonacci sequence.
The function definition should be as follows:

```
def fib(n):
    #theano code
    #theano code
    #theano code
```

HINT: Use theano function with updates to shared variable

Save your code and the generated output for each step in the Jupyter notebook.

SUBMISSION INSTRUCTIONS:

1. Create a free BitBucket account (https://bitbucket.org) if you do not already have one. Add your details and Bitbucket username in the google document (editable by students) called ”BitbucketAccountDatabase” (here) found in the google drive by 9/12 noon 12:01pm. After that each student will be given write access to an individual repository created by the instructional staff.

2. Upload E4040_HW0.ipynb Jupyter notebook file into the repository above.

IF YOU NEED HELP:

If you have any questions you are advised to use Piazza forum which is accessible through courseworks. Announcements related to the course will also be posted there. For anything else email to Raghavendra(rs3603@columbia.edu) or Yuxiang(yc3096@columbia.edu).

GOOD LUCK!