

# CMPE 258, Spring 2018

## Assignment #3

Due 11:59pm on Monday, March 5<sup>th</sup>, 2018

### Notes

*This programming assignment should be submitted in Canvas as a format of ipython notebook (assignment\_3\_yourFirstName\_LastName.ipynb).*

*You can discuss how to solve the problem with other students or search internet or other resources, but the work should be your own.*

*The submitted ipynb should be executable without any extra work.*

***Please do not use any library except pandas, numpy, and matplotlib.pyplot.***

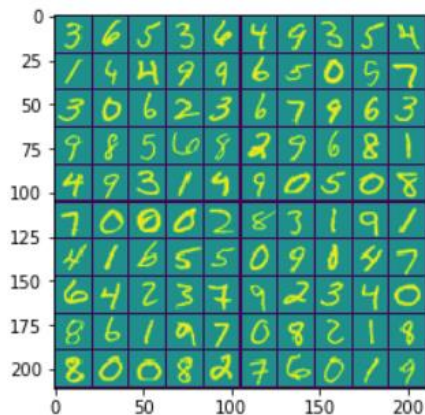
### Neural Network with one hidden layer

Download data files (ex3\_train.csv and ex3\_test.csv) from canvas/files/assignment\_3.

Using Jupyter notebook, load the data.

This data is a subset of the MNIST handwritten digit dataset (<http://yann.lecun.com/exdb/mnist/>).

Each row is a 20 pixel by 20 pixel grayscale image of the digit. Each pixel is represented by a floating point number indicating the grayscale intensity at that location.



< MNIST handwritten digit>

The 20 by 20 pixels is unrolled into a 400-dimensional vector.

The last column 'y' is the label for the row.

	0	1	2	3	4	5	6	7	8	9	...	391	392	393	394	395	396	397	398	399	y
0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	5
1	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	9
2	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	7
3	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	6
4	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	5

### 1. (40pts) Define functions

Please define the following functions.

- One-hot encoding
- Sigmoid
- Forward propagation
- Backward propagation
- Gradient descent
- Softmax

### 2. (5pts) Split data

Please split each data (Train & Test) set as input (x) and output (y) set.

Input set is the columns starting 0 to 399.

Output set is the column of 'y'.

### 3. (5pts) Initialize parameters

Please use `np.random.seed(1)` when weight coefficients is initialized.

Please set as zeros for bias terms.

### 4. (20pts) Neural Network model with 1 hidden layer

Please build neural network model using input layer (400 neurons), 1 hidden layer (25 neurons), and output layer (10 neurons) using training data set.

### 5. (10pts) Predictions

Please predict digit using softmax function.

Please calculate accuracy for the prediction using training data set and testing data set.

### 6. (20pts) Optimization

Please optimize your model using various learning rate and number of iteration.

Please plot cost versus number of iteration with different learning rate for training data set.

Please print out the optimized accuracy for testing data set.