

# ELL-409 (Machine Intelligence and Learning)

## *Assignment 1 - Back Propagation*

*15 January 2020*

### **General Instructions:**

- This assignment is to be done on an individual basis.
- The weightage of the assignment to the course will be decided later.
- Use of Python/MATLAB for implementation is encouraged. Use of neural network libraries like keras is strictly not allowed. Please convert jupyter notebook file to python file before submission.
- While coding, take care of comments and proper indentation.
- Please feel free to discuss the assignment with your classmates but the code and report must be your own. Plagiarism will be heavily penalized.
- The assignment has to be done as a **kaggle** competition.
- Name the program file as `<user_id>_<assign no>.py` / `<user_id>_<assign no>.m`. Name the report as `<user_id>_<assign no>.pdf`.
- Create a project folder namely '`<user_id>_<assign no>`'. This folder should contain the report and program file. Compress this folder and upload it to moodle for final submission.
- All the file names should be as indicated in the assignment, otherwise submissions will not be accepted because the submission will be evaluated **automatically using evaluation/plagiarism scripts**.
- The submission deadline is **February 9th, 23:59 (IST)**. Any late submissions will be penalised.
- The schedule for demos/vivas will be announced around submission date, via piazza.

## Description:

The MNIST database is a large database of handwritten digits that is commonly used for training various image processing systems. The database is also widely used for training and testing in the field of machine learning.

You have to make a multiclass neural network classifier that classifies each image as corresponding digit. Your code should be flexible enough so that it can model any specification that will be given to you during the demo of assignment. E.g. You could be asked to make a neural network of 2 layers(1 input + 1 hidden + 1 output, input layer is not counted as a separate layer and specified number of nodes(neurons) in the hidden layers say 50) with certain initial weights and then you could be asked to give the values of weight/output after ,say, 3 iteration of some given input. This will ensure correctness of your code even if your accuracy is low.

## Reading Material:

Primary reference to be followed:

**Chapter 6, Neural Networks - A Classroom Approach by Satish Kumar**

Additional References:

- <https://towardsdatascience.com/understanding-backpropagation-algorithm-7bb3aa2f95fd>
- <https://medium.com/datathings/neural-networks-and-backpropagation-explained-in-a-simple-way-f540a3611f5e>

Alternative Approach (Using Computation Graph):

[http://cs231n.stanford.edu/slides/2017/cs231n\\_2017\\_lecture4.pdf](http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture4.pdf)

Extra topics to be studied for the assignment, these topics will be subsequently introduced in class:

1. Overfitting and Underfitting  
<https://towardsdatascience.com/overfitting-vs-underfitting-a-complete-example-d05dd7e19765>  
<https://towardsdatascience.com/what-are-overfitting-and-underfitting-in-machine-learning-a96b30864690>
2. Regularization  
<https://www.analyticsvidhya.com/blog/2015/02/avoid-over-fitting-regularization/>

## Competition link:

<https://www.kaggle.com/c/ell409-assignment-1>

## Instructions for Kaggle:

- Register on kaggle.com if not already done.
- Set your team name on kaggle using entry number.
- Follow the submission guidelines on the competition page.
- You are allowed 5 submissions per day until the assignment deadline and the day resets at midnight GMT (05:30 AM IST). So, submit wisely!
- The leaderboard rankings on private data will decide the marks along with the report.

## Report:

- Report should contain analysis including graphs depicting effect of varying hyperparameters such as learning rate, batch size, error function, activation function etc on the model performance.
- You should experiment with the network by varying the number of neurons in a layer and the number of layers too. The results should be present in the report.

## Marking Scheme:

- |                                   |         |
|-----------------------------------|---------|
| • Report                          | 2 marks |
| • Code correctness and completion | 3 marks |
| • Position on Leaderboard         | 2 marks |
| • Exploration and flexibility     | 1 mark  |
| • Demo                            | 2 marks |