Scientific Computing II – Anh Chu

Linear Algebra and Gradient Descents in Artificial Neural Network and Deep Learning

# Problem Statement

A neural network is a powerful mathematical model combining linear algebra and statistics to solve a problem by taking a given number of inputs and then calculates a specified number of outputs aimed at targeting the actual result. Problems such as pattern recognition, classification, image processing, regression fitting and more can all be solved with a neural network.

This project will aim to answer these questions:

1. What is a neural network?

2. What are the mathematical methods used to construct a neural network? What are the roles of linear algebra and differential equations in creating and optimizing a neural network?

3. What are application of neural network in real-life?

# Proposed Research Methodology

In this project, I will introduce the intuition behind neural network and different types of the neural networks and

Then I will explore the architecture and the components of the neural network including:

* the mathematical representation of a neural net inputs in the form of a system of linear equations;
* the architecture of the similar neural network as layers of neurons that take outputs from the previous neurons layer as inputs;
* the use of sigmoid neutron (logistics function) to produce outputs with value from 0 to 1 as input to the next layer in ANN;
* the use of gradient descent in backpropagation stage as an optimization function to train neural network by finding the parameters to minimize the cost function

Next, I will implement a small neural network in Python including the sigmoid function and gradient descent function based on the mathematic model and concepts introduced in the previous section.

Then I will use this basic neural network to train and classify handwriting from MNIST data set. I will also validate and test the outcome of this neural network

Finally, I will introduce more complex neural networks such as Convolutional Neural Networks for Image Classification, and then implement PyTorch deep learning model to classify a color image dataset.

# Reference

<http://neuralnetworksanddeeplearning.com/chap1.html>