ECE 492: Artificial Intelligence Methods ----- Summer 2023

Project 2: Applying convolution neural network (CNN) in handwriting recognition

General Background:
Convolution neural network (CNN) is well used in pattern recognition and object discrimination. For example, the face recognition technology (such as: security camera used in airport, high security facility/building) is deeply involved with CNN. A simple version of such technology is the handwriting recognition.

In this project, you are given 10,000 samples of handwritten digital numbers between 0 to 10, and for each number, you will have 1,000 samples. Some of them are easily to recognize, but some of them are scratchy.

Your mission is to design a CNN, and then use partial of samples (1,000 ~ 2,000) to train your CNN (including synaptic weights and convolution filter). After the training is complete, your CNN should be able to recognize the following number, and the accuracy should be above 90%.

Project Description:
1.) The handwritten number samples are provided through a mat file "MnistConv.mat". In this file, 10,000 samples of handwritten include number between 0 to 10. For each number, it is a 28 by 28 image. You can display it through matlab command:
"Colormap(gray); pcolor(Images(:,:, 1))"

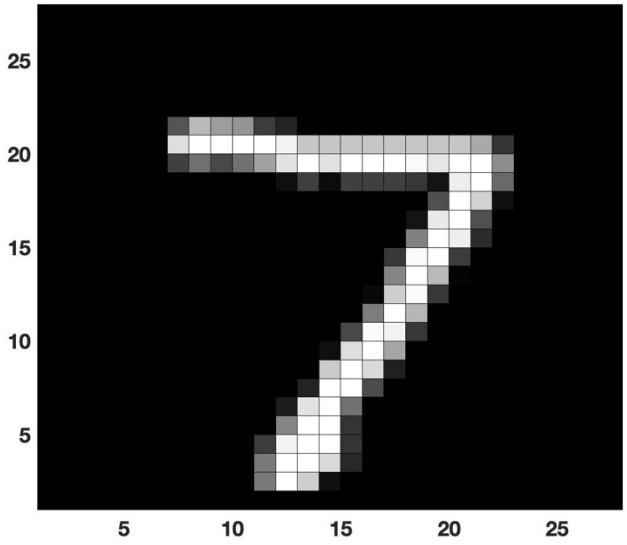

Fig 1. the image of handwritten number "7".

Fig 2. Some other image samples

The label of each number, viewed as desired response, is also included in this mat file.

The raw image (images.idx3-ubyte) and label files (labels.idx1-ubyte) are also provided if you use Java, Python, or other language to finish this project. Please feel free letting me know if you have hard time to read these files.

2.) Construct your CNN. Here are some suggestions: 1 convolution layer with filter size (3 by 3), convolution filter number (8). 1 Max pooling layer with filter size (2 by 2). Activation function (softmax). You are more than welcome to try other options, and I do appreciate that.
Note: If you really want to challenge yourself or have some fun, you can try multiple convolution layers, and multiple pooling layers, then your CNN should be do the very basic function of face recognition (only for 2D).

3.) Initializing the convolution filter, and the fully connected weights using random number generator.

4.) Choosing training data (1000) and testing data (9000).

5.) Training your neural network with steepest descent method with learning rate as 0.005. You are more than welcome to try other learning rates, and make comparison.

6.) Comparing your results with training data use the initial weight vector and well trained weight vector.
7.) Comparing your results with testing data use the initial weight vector and well trained weight vector.

8.) Plotting the MSE respect to training iterations.

Source code:
You are welcome to use any software/language your preferred. However, no libs, toolboxs, functions related to machine learning are allowed to finish this project. Other mathmatic operation tools, such as matrix multiplication, matrix inverse, convolution, and etc. are welcome to use.

Report Delivery:
A concise report includes: source code, plots, and simple discussion.

Presentation:
A PPT with: plots, major (training) part of your code, and a little introduction/discussion/equations (one or two pages will be fine). You are welcome to use my slides if needed.

Project Report Due: 06/10/2023

Project Presentation: 06/11/2023

Basic requirements for this project: have fun.