

Final Exam CS4662

Due Date: 2:00PM, Friday, May 15

Instructor: Dr. Mohammad Pourhomayoun

Please note: For this exam, you are not allowed to receive/give any assistance from/to another student taking this exam (including discussing the exam with other students).

Problem1: Fashion Image Recognition using Deep CNN (50 points):

Write and submit your python codes in “Jupyter Notebook” to perform the following tasks. Make sure to provide proper descriptions as Markdown for each section of your code.

In this question, we try to improve the accuracy of the Fashion Image Recognition system that we developed in the class in Lab5. Download and open the Lab5 ipython tutorial file (it is on CSNS under Lectures). Add the following lines on the top of your code to fix random seed for reproducibility:

```
import numpy as np  
np.random.seed(0)
```

Now, Modify the CNN structure and parameters to increase the testing accuracy to **At LEAST 92% Accuracy on the TESTING Set.**

I want you to be creative and use all knowledge you have gained from this class to improve the results (don't change the dataset, you can only change the CNN structure or learning parameters). Here are some ideas that you may want to use:

- 1- Changing the structure or parameters of the CNN including all layers (Conv Layers, Pooling layers, Dropout Layers, Fully Connected Layers, ...).
- 2- Making the Network more complex (when it is underfit), or less complex (when it is overfit).
- 3- Improve the training process (e.g. changing the epochs, changing the optimization or loss)

Please Notice:

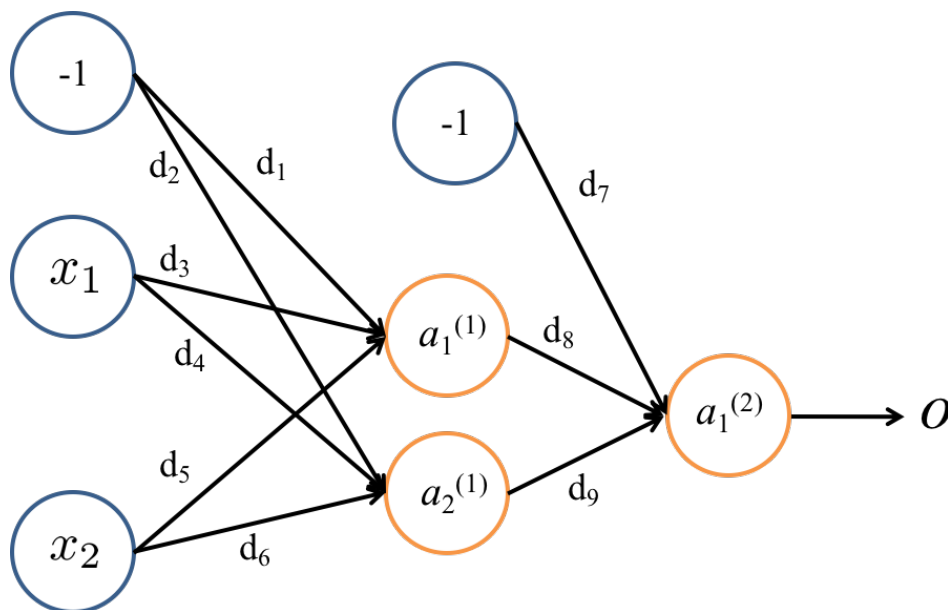
- I- It is obvious that there are infinite number ways to change the code to achieve this accuracy. **Thus, I expect to receive a Unique code from each student.**
- II- You need to do Trial & Error to achieve the desired accuracy. That is why I decided to use the Fashion Dataset since it includes small grayscale images, and everyone can process that on personal laptops. However, make sure to start early!
- III- **One student, who achieves the highest accuracy in the class, will get 10% bonus on the overall grade of the class!**

Problem2: Backpropagation (30 points)

Initialize the following neural network with the digits of your CIN number assuming that your CIN = $d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8 d_9$ (for example if your CIN = 123456789, then $d_1 = 1$ and $d_9 = 9$, If your CIN is less than 9 digits add 1's to the end to make it 9 digits). Now, Use a training sample $(X,y) = ((1,1), 0)$ to update the weights (perform one round of backpropagation using one training sample). Use learning rate parameter $\alpha = 0.1$. Note that we have bias terms with value of -1 in this network, and the activation functions are sigmoid (no need for coding for this question).

Your CIN =

$$g(z) = \frac{1}{1 + e^{-z}}$$



Problem3: Designing a Deep Neural Net (20 points):

Select an arbitrary integer number between 10 and 100. Multiply the selected number by 8 and call it z (for example if you select 40, then $z = 8 \cdot 40 = 320$). Now, assume that the following deep CNN receives a color image with the size of $(z \times z)$. Please find all of the intermediate sizes indicated with question mark (?) below.

