Neural Networks and Deep Learning

Homework and Programming Assignment 3

**Total Points:** 100

**Deadline:** March 29, 2022

**Delayed submission will be graded as zero.**

1. [**Points 5**] Write down the differences between feed-forward neural networks and convolutional neural networks.
2. [**Points 95**] Suppose you are classifying cars, buses, and trucks images of shape 32x32, using a convolutional neural network and each image has three channels. Your convolutional neural network contains three convolutional layers, one fully connected layer, and then a SoftMax classifier. Your fully connected layer has 24 neurons. You are designing such convolutional layers so that you can get better performances. Your filter size for these layers can be any size between 1x1 to 7x7. You also apply the max-pooling layer after the second and third convolutional layer of any size between 2x2 to 5x5 that fits with your architecture. You are free to choose any number of filters (between 16 to 128) for each convolutional layer as well.
   1. Draw this convolutional neural network diagram with details parameters. **Note: Show the configuration or dimensions of each layer as you see in the lecture slides**. [**Points 10**]
   2. Compute the number of parameters in each layer and showcase the total number of parameters of your network. Compute the number of parameters, for both with and without bias in each layer. [**Points 20**]
   3. Is it possible to reduce the total number of parameters by following adding additional filters (any size of 1x1 to 7x7)? Please show your detailed calculation to showcase the lower number of parameters of such a CNN network. Also, draw the overall diagram with each layer dimension of your reduced parameter-based CNN network. **Note that you need to add additional filters to reduce the number of parameters of your initial CNN model. You cannot increase the size of the filter and/or change (decrease) the number of filters to reduce the total number of parameters. See the lecture slides to get an idea.** [**Points 30**]
   4. Compute the total number of convolutional operations for each layer of your both networks (a) and (c). Assume each pooling operations cost is 1. Show the total computational cost of your networks. **Note:** show each layer’s computation separately to be considered partial grading in case of wrong calculations. [**Points 35**]

**Submission Instructions:**

You can submit your text question answer in a PDF/Doc. Please don’t copy your homework. **In case of copying from others will be directly graded as zero without showing any reasons.** Based on the questions, everyone may have a different architecture with different filters size, numbers of filters, etc. Therefore, you would end up with different configurations and parameters, operations. **Delayed submission will be graded zero automatically**.