

## Project 2

### CAP 4453: Robot Vision

Programming language for the assignment is Python and you will use PyTorch framework for deep learning.

Deliver the project as a colab note.

The colab note must include your code (properly run), and a short write-up about the results and your observations from each task. For each task, you should report the training/testing accuracy for the best model. Analyze the variation in training/testing loss as you train your network and discuss what you observe. Also, discuss the time required for training your network.

#### Part 1. Neural Networks

Your goal in this assignment is to train neural networks for digit classification. You will use MNIST dataset which has around 70K images of handwritten digits. You will be provided the template code for this assignment, and you must make some changes to the network and analyze the results after these changes.

Your tasks:

1. [15%] Simple neural network: In this task, your goal is to design a neural network with 3 layers (input, hidden, and output) and in each layer you should use less than 20 neurons. There should be NO activation functions in your network. There are 10 classes in MNIST dataset corresponding to each digit, so this will be a 10-way classification network.
2. [15%] Activation function: In this task, you will add activation function to your network. Use ReLU activation in all your layers from the previous task.
3. [20%] Deep network: In this task, your goal is to increase the size of the network. Your new network should have more than 4 layers and each layer should have more than 200 neurons. Use ReLU activation in all the layers. Note that the last layer will still have only 10 neurons as this is a 10-way classification network.

#### Part 2. Convolutional Neural Network

Your goal in this assignment is to train convolutional neural networks for image classification. You will use CIFAR-10 dataset, which has 60K color images (each has size 32x32 pixels) from 10 classes. You will be provided the template code for this assignment, and you have to make some changes to the network and analyze the results after these changes. For each of these tasks, use learning rate of 0.1 and batch size of 100 and train them for 10 epochs each.

Your tasks:

4. [20%] Simple CNN: In this task, your goal is to design a convolutional neural network with 2 convolutional layers (Conv2d) layers and 2 pooling layers, followed by 2 fully connected layers. Both Conv2d layers should have 10 filters (output channels). The second Conv2d layer's input channels should match first Conv2d layer's output channels. Use a kernel size of 3 for all convolutional layers. Apply ReLU activation to each Conv2d. Each Conv2d layer should be followed by max\_pool2d layer with kernel size of 2. The output features from convolution after flattening will be 360, so set the input features in fully connected layer accordingly (You can use fc1\_model1) for this). There are 10 classes in CIFAR-10 dataset, so this will be a 10-way classification network. You can use model\_0 from the template and modify that to fit this task.
5. [15%] Increase filters: In this task, you will increase the filters in each Conv2d layer in your network. Learn 20 kernels for the first Conv2d layer(set output channels to 20). For the second Conv2d layer learn 40 kernels (set the output channels to 40). Match input channels for second Conv2d layer with output channels of first Conv2d layer. Since this will change output feature size after second Conv2d layer, use fc1\_model2 with 1440 input features for this task.
6. [15%] Large CNN: In this task, your goal is to increase the size of the network. Take the network from previous task and add one more Conv2d layer with 40 filters (set both input and output channels to 40). Do not add a max pooling layer after this third convolution layer. Use fc1\_model3 with 640 input features for this task.