Assignment-7: Convolutional Neural Network

Problem Statement:

A social media company wants to design a method which differentiates images uploaded by different users in the social media into one of several classes. The purpose is to identify and block malicious images uploaded by any user in the social media before it spreads. The different classes are: (a) malicious, (b) acceptable, and (c) completely safe. While collecting and labelling the dataset, the engineers want to try their method on a toy dataset (e.g., CIFAR-10) to analyse different practical issues. Develop a CNN and study the effect of various aspects of the network to help the team.

Implementation: [4+4=8]

- Implementation of a CNN (named, CNN-Vanilla).
- Implementation of a Resnet based CNN (CNN-Resnet). Note that the CNN-Vanilla must have the same architecture of CNN-Resnet, but with the residual connection removed.

**You may make use of the Pytorch library for implementation and to process and handle data.

** You may use a three level Resnet block with two fully-connected layers (each Resnet block has two CNN layers – refer to CNN slides). For the baseline network, use spatial size of CNN filters as 3X3. You may use the number of feature maps in each level that suit your system's computation power (e.g., see CNN tutorial) — but once selected, it must be kept the same for different analysis.

** For the baseline network, use ADAM optimizer, and mean and standard normalization of data (as done in CNN Tutorial).

**For training [CNN-Vanilla] and [CNN-Resnet], use a learning rate of 0.001, minibatch size of 256 and total no of epochs 50.

**Performance Metric to be used for evaluating the models is Percentage Accuracy on Test-set.

Experiments: [4+3+4+4=15]

Use the standard train and test split of CIFAR-10 (refer Dataset details and CNN Tutorial).

1. **Experiment 1:** Report and compare the performances (percentage accuracy on the test set) of [CNN-Vanilla] and [CNN-Resnet]. Also, compare the number of parameters of the two networks. Find which one is better for the given problem.

2. **Experiment 2:** *Study the Effect of Data Normalization*. For the best network found in the earlier experiment, train the network with data normalization and *without* data normalization. Compare the performances of the two cases.

3. **Experiment 3:** *Study the Effect of Different Optimizers.* Report the effect of varying the optimizers for the best network and best choice of data normalization (from Experiments1-2).

Consider the following optimizers: (a) Stochastic gradient descent, (b) Mini-batch gradient descent with no momentum, (c) Mini-batch gradient descent with momentum 0.9, and (d) ADAM optimizer. For (b-d), use a mini-batch size of 256.

4. **Experiment 4:** *Study the Effect of Network Depth:* For the Resnet network (CNN-Resnet) and best choice of normalization and Optimizer (from Experiments 2-3), change the depth of the network (i.e., from three level Resnet blocks with two fully-connected layers) as follows: (a) *Four* level Resnet block with two fully-connected layers; (b) Three level Resnet blocks with *four* fully-connected layers (Note that a & b has effectively an increase of two layers as one Resnet block has two Conv layers). Compare the change in the number of parameters and performance differences of the three networks. Next, comment on which one is better among (a-b): i.e, increasing the conv layers or increasing the fully-connected layers.

Datasets:

The CIFAR-10 dataset contains 60,000 32 x 32 color images of natural scenes in 10 different classes.

Data Overview:

- Classes: airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, and trucks. There are 6,000 images of each class..
- Train set: 50000 training images, with 5000 images from each class
- Test set: 10000 test images, with 1000 images from each class.

Problem: Predict the class in which a particular image belongs.