BME69500DL ECE695DL
Spring 2020

Homework 4

Deadline : Thursday, March 12, 2020 , 11:00 am

1 Introduction

The goal of this homework is to gain an appreciation of the power of skip connections in deep networks.

Your instructor's `SkipBlock` as shown in class and how it was used in the `BMEnet` network, while serving as a good educational example in a classroom setting, is not the last word on how skip connections are used in the world out there. For you to go beyond the material we covered in the Week 7 lecture, this homework requires you to analyze and understand the famous ResNet architecture and use the insights thus gained for doing this homework.

It'll be a good idea to review the Week 7 slides dealing with skip connections and vanishing gradients before you start working on this homework.

Our expectation is that you will start programming this homework and get it to work with the CIFAR-10 dataset while the TA is trying to create a relatively small-sized dataset from the ImageNet archive. Should this other dataset materialize in the next few days, you'll be asked to also show results on that dataset.

2 Tasks

Task 1: After you have reviewed Week 7 lecture material, start this homework by digging into the literature related to ResNet. The first thing to do would be to understand the paper "Deep Residual Learning for Image Recognition" by He, Zhang, Ren, and Sun. Just Googling the title of this paper will take you to the PDF. For an overview of such architectures, you might also like to visit Vincent Fung's blog "An Overview of ResNet and its Variants".

Next, download the ResNet code from GitHub and get a general idea of the architecture of ResNet.

You will discover that, in addition to the ResNet variants mentioned in the blog by Vincent Fung, there also exist several variants of the basic ResNet architecture. These have names such as: `resnet18`, `resnet50`, etc. You will also discover the basic building block used in these different network is different. For example, the name of the building block used in `resnet18` is `BasicBlock`, and the one used in `resnet50` is `BottleNeck`.

If you wish, you can also download pretrained models of ResNet from Torchvision and try them out on, say, the CIFAR-10 dataset. All of the pretrained models that Torchvision knows about are accessible through the link:

`https://pytorch.org/docs/stable/torchvision/models.html`

After you are done with what's mentioned above, it's time to sit down and create your own code.

Task 2: Create your variants of the skip-connection building-block `SkipBlock` that you will find in the inner class `SkipConnections` of your instructor's `DLStudio` module (version 1.0.6 or above). Try these out on the CIFAR-10 dataset to see what variants result in higher classification accuracy. Obviously, you will have to create a network

based on your own variants of `SkipBlock`. If you wish, you can use the `BMEnet` as a starting point for that purpose.

3 Output Format

After experimenting with different implementations for a skip-connection building-block, pick one that gave you the best classification accuracy. Then print out the loss as a function of epochs followed by the classification accuracy. Redirect the output of your program to a file named "output.txt". You can use the following format to structure your output:

```
Epoch 1: <loss value 1>
Epoch 2: <loss value 2>
.
.
.
Epoch n: <loss value n>
Classification Accuracy: <classification accuracy percentage>
```

In addition to that, write some descriptions about all the variants of skip-connection building-blocks that you've tried and include them in the comment section of your code in hw04.py.

4 Submission

- Make sure to submit your code in Python 3.x and not Python 2.x.
- Name your main Python file as hw04.py
- All homework to be submitted on-line through the *turnin* command on the min.ecn.purdue.edu[1][2] server.
- Log into min.ecn.purdue.edu server using your Purdue career account.
- From min.ecn.purdue.edu, go to the directory where your homework files are. e.g., if your files are at /home/hw1 directory then go to /home/hw1. Obviously, if you don't have your files on the server, move them there using, for example, the *scp* command.
- Type in the following command:

  ```
  turnin -c ecedl -p hw<double digits hw#> <your files separated by a space>
  ```

- As an example, for this homework you will enter the command:

  ```
  turnin -c ecedl -p hw04 hw04.py output.txt
  ```

- You should get a statement that says "Your files have been submitted to ecedl, hw04 for grading". You can verify your submission by typing:

  ```
  turnin -c ecedl -p hw<double digits homework number> -v .
  ```

[1] If you are an undergraduate student, use the shay.ecn.purdue.edu server instead of the **min** server
[2] If you registered this class as the BME695 course then use the weldon.ecn.purdue.edu server