Homework 5

AMATH 482/582, Winter 2024

This assignment is Option 4 of Homework 5. LATE REPORTS WILL NOT BE ACCEPTED.

Directions, Reminders and Policies

Read these instructions carefully:

You are required to upload a PDF report to Canvas along with a zip of your code.

The report should be a maximum of 6 pages long with references included. Minimum font size 10pts and margins of at least 1inch on A4 or standard letter size paper.

Do not include your code in the report. Simply create a zip file of your main scripts and functions, without figures or data sets included, and upload the zip file to Canvas.

Your report should be formatted as follows:

- Title/author/abstract: Title, author/address lines, and short (100 words or less) abstract. This is not meant to be a separate title page.
- Sec. 1. Introduction and Overview
- Sec. 2. Theoretical Background
- Sec. 3. Algorithm Implementation and Development
- Sec. 4. Computational Results
- Sec. 5. Summary and Conclusions
- Acknowledgments (no more than four or five lines, also see the point below on collaborations)
- References

LaTeX(Overleaf is a great option) is recommended to prepare your reports. A template is provided on Canvas in Homework/Files. You are also welcome to use Microsoft Word or any other software that properly typesets mathematical equations and properly allows you to include figures.

Collaborations are encouraged, however, everything that is handed in (both your report and your code) should be your work. You are welcome to discuss your assignments with your peers and seek their advice but these should be clearly stated in the acknowledgments section of your reports. This also includes any significant help or suggestions from the TAs or any other faculty in the university. You don't need to give all the details of the help you received, just a sentence or two.

Your homework will be graded based on how completely you solved it as well as neatness.

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Problem Description: Image Classification with Convolutional Neural Networks

Your goal in this assignment is similar to the goal of the previous assignment (Homework 4) in which you trained FCNs to classify images in the FashionMNIST data set. In this assignment, however, you will have a budget of weights that you can incorporate into your neural network model and you will compare FCNs vs. Convolutional Neural Networks (CNNs).

Figure 1 First 64 Images in FashionMNIST Dataset.

Some comments and hints

Here are some useful comments and facts to guide you along the way.

1. Many of the components of the previous assignment and the setup in the template HW4_HelperTemplate.ipynb will hold for this assignment as well. Changes that you will need to make will be in the network setup and input data into your network.
2. The hyperparameter tuning that you performed in the previous assignment should also be useful to guide you in creating the FCN 100K baseline.
3. You do not need to use a precise number of weights in your network variants. An approximate order of magnitude will be fine as well (e.g. 87,800 could be considered as 100K).

Tasks

Since this is the last assignment in the course, the definition of the tasks is more open-ended to allow you to design the neural networks in a less supervised way.

1. With the constraint of incorporating up to 100K weights in the design of your FCN model, perform hyperparameter tuning to achieve FCN model whose testing classification accuracy is above 88% on the testing set.
2. Reduce by half the number of weights in the FCN 100K model to create FCN 50K, and also double the number of weights to create FCN 200K. Train these models similarly to FCN 100K and study the accuracy of these models by comparing the different FCN variants.
3. Implement and train a CNN 100K model with convolutional, pooling, and FC layers with up to 100K weights. Perform hyperparameter tuning and compare the testing classification accuracy of the model with FCN variants.
4. Reduce the number of weights in the CNN 100K model to create CNN 50K, CNN 20K, and CNN 10K. Train these models similarly to CNN 100K and compare their testing classification accuracy with all CNN and FCN variants. In addition to accuracy, you may want to include efficiency, in terms of the number of weights and training time, in your discussion.
5. **Bonus (+2 points)**: Pick a CNN variant from above and then pick several input samples from different classes. Visualize some of the feature maps of the convolutional layers for these samples (e.g. display the feature maps in a grid of nxn). Explain your observations.