ECE/CS/ME 539 – Fall 2024 — Homework 9

Problem 1 (2 pts) Convolution

Given the input activation tensor A and a convolution kernel B:

$$A = \begin{bmatrix} 9 & 4 & 5 \\ 3 & 6 & 8 \\ 8 & 1 & 9 \end{bmatrix}, \quad B = \frac{1}{8} \begin{bmatrix} 0 & 1 & 0 \\ 1 & 4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Write a program to perform the convolution operation of A and B using a stride of $S = 2$ and padding of $P = 1$. You may use torch.nn.functional.conv2d.

Problem 2 (6 pts) CNN Training

We will train a simple neural network on the Fashion MNIST dataset. You can easily download the Fashion MNIST dataset using:

```
import torchvision.datasets as db
train_dataset = db.FashionMNIST(root='.', train=True, download=True)
test_dataset = db.FashionMNIST(root='.', train=False, download=True)
```

(a) (2 pts) Plot the first 25 images from the training dataset. How many images does the dataset have (in both the training and test dataset)? What is the size of each image? Also, print the list of class names, which is stored in `train_dataset.classes`.

(b) (2 pts) Develop a "sequential" CNN model with the following layers:

- A convolution layer (`Conv2D`) consisting of 16 3×3 kernels using the ReLU activation function. Stride = 1, same padding. The input shape is obtained in part (a) above.
- A `MaxPooling2D` layer with stride = 2 and kernel_size = 2.
- A second convolution layer of 32 3×3 kernels using the ReLU activation function. Stride = 1, same padding.
- A second `MaxPooling2D` layer with stride = 2 and kernel_size = 2.
- A flatten layer,
- A dense layer with 10 neurons (the number of output labels), using the softmax activation function.

Print the model to verify your model statements are correct.

(c) (2 pts) Train the model using a mini-batch size of 32 for 10 epochs to minimize the cross_entropy loss with an SGD optimizer. Evaluate the performance (accuracy and loss) of the model using the testing dataset. Print the testing accuracy and the confusion matrix. What are the two classes that the classifier has the worst prediction accuracy?