Iran University of Science & Technology

School of Computer Engineering

Assignment #5

Neural Networks

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Due: 1403/10/07

Contents

Notes:

1. Submit the answers in a complete PDF file and the code for the questions in the .ipynb format (including the notebook cell outputs) in a compressed file named HW5_StudentID.zip by the specified deadline.
2. A total of 72 + 48 hours of delay in submitting the answers is allowed across all projects. After that, for each additional day of delay, 10% of the score will be deducted.
3. If a student submits the project earlier than the deadline and achieves 75% of the score, up to 24 hours will be added to their allowable delay time.
4. The maximum delay for submitting each assignment is 5 days, and after 5 days, submission will not be accepted.
5. It is important to note that the explanation of the code and the obtained results must be included in the PDF file. Code without a report will result in a score deduction.
6. The evaluation of the assignment will be based on the correctness of the solution and the completeness and accuracy of the report.
7. Assignments must be completed individually, and group work on assignments is not allowed.
8. Please allocate sufficient time for the assignment and avoid leaving it until the last days.
9. You can ask your questions in the relevant group.

good luck.

Problem 1

Answer following questions: **(20 points)**

a. Discuss briefly whether convolutional neural networks build view invariance or not.
b. Explain the different hyperparameters that define a convolutional layer.
c. Give three reasons to use max pooling.
d. Give two arguments against using max pooling.
e. Given the following input matrix and kernel(filter), compute the output matrix using 2D convolution with padding.

Input:

1	3	1
0	-1	1
2	2	-1

kernel:

-2	-2	1
-2	0	1
1	1	1

Problem 2

Two historians approach you for your deep learning expertise. They want to classify images of historical objects into 3 classes depending on the time they were created: **(20 points)**

- Antiquity (y = 0)
- Middle Ages (y = 1)
- Modern Era (y = 2)

(A) Class: Antiquity (B) Class: Middle Ages (C) Class: Modern Era

Figure 1: Example of images found in the dataset along with their classes

a. Over the last few years, the historians have collected nearly 5,000 hand-labelled RGB images. Before training your model, you want to decide the image resolution to be used. Why is the choice of image resolution important?
b. How would you partition your dataset? Formulate your answer in percentages. (there isn't a right answer, only give your idea)
c. After visually inspecting the dataset, you realize that the training set only contains pictures taken during the day, whereas the dev set only has pictures taken at night. Explain what is the issue and how you would correct it.
d. As you train your model, you realize that you do not have enough data. Explain what is data augmentation. Cite 3 data augmentation techniques that can be used to overcome the shortage of data.
e. The following table shows the specifications of our CNN Fill the table. The following table shows the specifications of a CNN. Fill in the table. Memory refers to the amount of information available in each layer. In convolution layers, use stride=1 and pad=2. (Imagine turned photos into black and white).

c	Learnable Parameters	Memory
Input		$32 \times 32 \times 1$
Conv5-10		
Pool2		
Conv5-10		
Pool2		
FC-10		

Problem 3

In this part, we're going to learn how to implement CNN classifier:

Part A

The "CIFAR-10" notebook, attached in the exercise file, contains the implementation of a CNN classifier for the CIFAR-10 dataset. This notebook is divided into three parts: **(10 point)**

a. Dataset review
b. CNN classifier implementation
c. CNN implementation with dropout

Review this notebook and write a document for it.

Part B

Based on what you have learned so far, by choosing a simple dataset like MNIST from the link (you are not allowed to choose CIFAR-10 or CIFAR-100), do the following: **(30 point)**

a. Review your dataset.

b. Implement a CNN classifier for the given dataset using PyTorch. Evaluate the model's performance by calculating accuracy, error rate, precision, recall, and the confusion matrix. Additionally, prepare a detailed report explaining your code, methodology, and results.

Problem 4

In this problem, we will learn how to implement CNN in Keras and also explore the concept of transfer learning.

Complete the "keras" notebook. Explain what we did with transfer learning. **(20 point)**