Deep Learning Fall 2023

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- You are encouraged to discuss ideas with each other. But you **must acknowldge** any collaborators, including students, ChatGPT, books, online sources, etc. and you **must** write up your own solutions individually.
- We **require** answers to theory questions to be writen in LaTeX. Figures can be drawn by hand, but **must** be scanned and inserted into your document. We will not accept hand-written answers.
- We **require** code for programming questions to be submitted as a Jupyter notebook. It is important to include sufficient documentation so that the grader can understand your code. Use the text cells in Jupyter notebook to provide explanations.
- Upload your .pdf, .ipynb and any other files to Gradescope in a single PDF.
- Due Date is *Friday, December 8th at 11:59pm.*

Problem 1: CNNs vs RNNs (20 pts)

CNNs vs RNNs. Until now we have seen examples on how to perform image classification using both convolutional (CNN) architectures as well as recurrent (RNN) architectures.

(a) Give two benefits of CNN models over RNN models for image classification.

(b) Now, give two benefits of RNN models over CNN models.

Problem 2: Recurrences using RNNs(20 pts)

Consider the recurrent network architecture below in Figure 1. All inputs are integers, hidden states are scalars, all biases are zero, and all weights are indicated by the numbers on the edges. The output unit performs binary classification. Assume that the input sequence is of even length. What is computed by the output unit at the final time step? Be precise in your answer. It may help to write out the recurrence clearly.

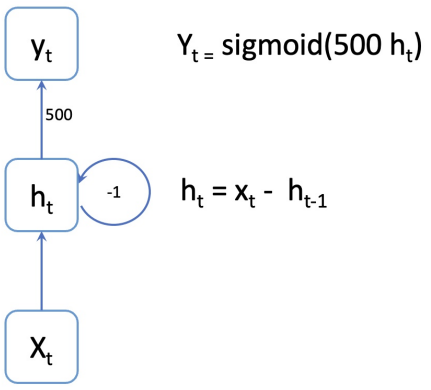

Figure 1: RNN

Problem 3: Attention! My code takes too long(20 pts)

Attention! My code takes too long. In class, we showed that a computing a regular self-attention layer takes O(T 2) running time for an input with T tokens. Propose two different ways to reduce this running time to O(T), and comment on their possible pros vs cons.

Problem 4: Training GANs (40 pts)

In this problem we will modify the demo from the Friday recitation class to train a GAN on FashionMNIST. The demo from class is available at the Demo github We will use the same architecture as in the demo, but we will modify the code to:

(a) Generated images of FashionMNIST (instead of MNIST) and

(b) Use a GAN (instead of a Conditional GAN).

(c) Research some of the measures of GAN quality and report them for your trained GAN if applicable.

Finally, comment on the difference in quality of the fake images from your FashionMNIST GAN and the MNIST Conditional GAN we wrote in class.