Iran University of Science & Technology

School of Computer Engineering

Project

Neural Networks

DR. Marzieh Davoodabadi, Fall 2024

Teaching Assistants:

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Due: 1403/11/15

Contents

Notes:

1. **There is no option to submit this assignment after the deadline.**
2. 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 Project_StudentID.zip by the specified deadline.
3. 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.
4. The evaluation of the assignment will be based on the correctness of the solution and the completeness and accuracy of the report.
5. Assignments must be completed individually, and group work on assignments is not allowed.
6. Please allocate sufficient time for the assignment and avoid leaving it until the last days.
7. You can ask your questions in the relevant group.

good luck.

Problem 1

A Variational Autoencoder (VAE) is a type of generative model that learns to encode input data into a latent space and then reconstructs the data from this representation. Unlike traditional autoencoders, VAEs introduce randomness by learning a probabilistic distribution in the latent space, enabling the generation of new, similar data points. This makes them powerful for tasks like image synthesis, anomaly detection, and representation learning.

The goal of this project is to understand the working principles of Variational Autoencoders (VAE) and apply them to the MNIST dataset. Students will explore how VAEs encode data into a latent space, reconstruct data, and generate new samples.

In this exercise, you will complete the implementation of a Variational Autoencoder (VAE) using PyTorch. Students are required to complete the code step by step, paying close attention to all the notes provided in the 'generative_models.ipynb' notebook. Provide a detailed explanation for every part of the code you complete, ensuring you fully understand its purpose and functionality. Additionally, prepare a comprehensive report that thoroughly analyzes the code and all the results. The report should be detailed, include all outputs from the notebook, and explain the significance of each step. Ensure a deep understanding of the entire process, as you will need to answer questions about it during a presentation. **(75 point)**

Problem 2

Stable Diffusion is a technique used for generating high-quality images from text descriptions. It works by gradually adding noise to an image and then reversing the process to refine the image, guided by the text prompt. The model starts with random noise and iteratively denoises it, aligning the output with the input text. This approach allows for creating detailed and coherent images, making it popular for various creative applications. You can read more about diffusion models here.

Study the Stable Diffusion method and write a detailed summary of its approach. Afterward, complete the required sections of the notebook as instructed. For each part you complete, provide a thorough explanation, detailing the steps you followed, their purpose, and how they contribute to the overall process. **(25 point)**