ECS795P Deep Learning and Computer Vision, 2024

Course Work 2 Guideline: Diffusion models

Introduction

Teamwork:
In groups of 3 students (grouped automatically by surname alphabetical order).

Aim:
The assignment is to implement a diffusion model using PyTorch. The objectives are
(1) to obtain practical knowledge and hands-on understanding of the basic concepts in Diffusion models;
(2) to obtain practical experience on how to implement Diffusion models using PyTorch.

Start: Download and install PyTorch from its official website:
For Linux: https://pytorch.org/get-started/locally/#linux-installation .;
For Mac: https://pytorch.org/get-started/locally/#mac-installation ;
For Windows: https://pytorch.org/get-started/locally/#windows-installation .

Tasks: You are required to perform three subtasks:

1. Coding (group submission): to add your code blocks in the required sections. Note code is in Python format and needs GPU to run. Please log in to Jupyter Hub with your QM account, choose the ECS795P module and upload the *.ipynb file to run it; (50% credit of this CW2)
2. Report (group submission – maximum 4 pages): to complete the questions in your report; to state the assignment of roles to each individual in each team; (35% credit of this CW2)
3. Self-reflection report (individual submission – up to 300 words): each individual to describe the work you carried out in your team in relation to the questions and exercises in the group report and coding; to describe the challenge and your contribution to the team-work; to describe what you have learned from the team-work. (15% credit of this CW2)

The group submission will be assessed based on contributions in a team collaboration (requires a brief declaration on who contributed what in each group), clarity, explanations, references, and coding. The individual submissions will be assessed for clarity and consistency of each member's contribution to the team effort.

Platform: python + PyTorch

Basic material:
Some of online materials for PyTorch-code may help you better complete this coursework (if you are not familiar with PyTorch, you can follow this step by step)
https://pytorch.org/tutorials/
https://github.com/yunjey/pytorch-tutorial
https://github.com/MorvanZhou/PyTorch-Tutorial/blob/master/tutorial-contents-notebooks/404_autoencoder.ipynb

1. Understanding basic concepts in Diffusion models

Objective: To become familiar with the basic knowledge of the Diffusion model and its basic usages.

1.1 The questions to remind yourself and help you to construct your report (no need to write down in your report):
Reference: https://lilianweng.github.io/posts/2021-07-11-diffusion-models/
Read the above blog and answer the below questions.:

1. What are the two processes in Diffusion models?
2. What are the specific objectives of these two processes?
3. What is the basic loss function of Diffusion models?
4. What is the training process of Diffusion models?

2. Diffusion model in PyTorch

Objective: To become familiar with Diffusion model and the sampling process.

2.1 The questions to refresh (no need to write down in your report):

What is the sampling process and how does it work? What are the equations used during the sampling process?
(Note: You can find the mathematical derivation in the provided paper *WK07-8_Ho_Diffusion_NIPS2020.pdf* , or in the reference link here: https://lilianweng.github.io/posts/2021-07-11-diffusion-models/.)

2.2 The coding exercise:

[Coding] Open the Jupyter notebook named *CW2_Handout_Template_code.ipynb* and finish the exercise.