ELEC4840: Assignment 03

Task Description: You are required to submit a PDF file to answer the following questions. The possible hints of the following questions are in the lecture slides. You can review lecture slides as a starting point for your answers, and search for additional papers to complete the task.

Format Requirements: Page limit: 2-5 pages. Your answers should be understandable to layman. Times New Roman font size 12, single line spacing, single column. You can answer questions by citing papers or websites and rephrasing the answers in your own words, but it is important to ensure you understand the information correctly. If you referred to external papers, please cite them properly in your answers, and provide references. *Proper formatting and citations will account for 5% of your score.*

Problem 1. Imaging principles of X-ray and CT.

1.) [10%] Explain the imaging principles of X-ray and filtered back projection.

2.) [10%] Explain the connection between X-ray imaging and Computed Tomography (CT).

Problem 2. Eye anatomical structures and eye diseases fundamentals.

1.) [15%] Explain how humans can perceive objects via eye structures. Then, select one of the ophthalmology diseases from [Glaucoma, Diabetic Retinopathy, Macular Degeneration], and then briefly explain the cause of the disease. You can explain this by indicating which part of the normal perception process as you answered above goes wrong.

2.) [10%] Explain the functionality of Fundus camera and Optical Coherence Tomography. What kinds of diseases they can detect, and how do they achieve the goal of detection?

3.) [5%] Explain how the ophthalmology inspection device you choose can help detect the disease you choose to explain.

Problem 3. Unsupervised Learning.

1.) [10%] Compare supervised learning with unsupervised learning and describe the purpose of unsupervised learning.
2.) [10%] What are the differences between an Autoencoder and a Variational Autoencoder?
3.) [10%] Given a set of fundus photos without labels, how can you learn the representation of the given images? Please describe the representation learning pipeline and design loss functions. (Hint: contrastive learning is a useful paradigm to train the model to learn

representations of input data. In case you prefer to use contrastive learning, you can explain how to implement on the given input and provide the loss function. Other algorithms can also be utilized.)

Problem 4. The basic principles of Pathology.

1.) [10%] Explain one of the difficulties in applying AI models to the Whole Slide Image.
2.) [10%] Describe how to adjust WSIs as the input for deep learning methods in training and test stage.