ELEC-4840 Assignment 2

In this assignment, students are required to complete two questions and write a summary report. The summary report should include: the required output results stipulated in the following problems and required additional discussions about your work. Students need to submit **the code project with readme files** (.zip) and **the short summary report** (.pdf) containing required results in Canvas by **18 March 2024 23:59:59**.

We provide a coding example for you to start up your work. You can modify the codes to complete your homework. The hints are in the Canvas assignment page. You can still use Google Colaboratory to run the notebook.

Problem 1. Skin Lesion Classification (50%)

Skin lesions are areas of your skin that are different from the skin around them. They can be a lump, bump, sore, ulcer, or an area of skin with an abnormal color or texture. Skin lesions can be benign (non-cancerous) or malignant (cancerous). Generally, benign skin lesions are not harmful and don't spread to other parts of the body, while malignant skin lesions are cancerous growths that can invade nearby tissues and spread to other parts of the body. Differentiating between benign and malignant skin lesions is crucial for ensuring appropriate treatment, preventing unnecessary interventions for harmless conditions, and promptly addressing cancerous growths to improve outcomes.

In this problem, you are required to implement a classification network (*e.g.* ResNet-50) to predict lesion disease state of benign or malignant. The dataset is from ISIC Challenge 2016, which includes 900 training images (image link, annotation link) and 379 test images (image link, annotation link).

The requirements are listed as follows:

1. Implement a classification network for the skin lesion classification task, including the model, dataloader and training-validation-test procedures. **(15%)**
2. Report accuracy and AUC on the test set, and achieve at least 60% accuracy and 60% AUC. **(15%)**
3. Plot the training & test loss curves, training & test accuarcy curves. **(10%)**
4. This dataset has a class imbalance issue, which refers to a situation where **the distribution of classes or categories is highly uneven**. In such cases, one or more classes have significantly fewer instances compared to others. Try to give a solution to the class imbalance problem of this dataset. Show the accuracy and AUC of your solution. **(10%)**

Problem 2. Spleen CT Segmentation (50%)

The spleen is an essential organ involved in immune function and blood filtration. Accurate segmentation of the spleen from thorax-abdomen CT scans is crucial for various clinical applications. For example, in cases of splenomegaly (enlarged spleen), accurate segmentation helps determine the severity and guide treatment decisions. Computed Tomography (CT) plays a crucial role in inspecting abdominal organs, and it can provide detailed images of the organ by radioactive waves. Its high resolution allows it to pick up even small abnormalities. Doctors can evaluate the organ’s location, size, and other characteristics based on aquired CTs. This information is vital for treatment planning.

NIfTI (.nii.gz) file is a type of file format for storing and exchanging neuroimaging data, such as 3D MRI scans. NIfTI files are widely used in neuroscience and neuroradiology research, as well as in some software tools for image processing and analysis. The 3D image stored in NIfTI format can be visualized via ITK-SNAP.

In this problem, you will need to segment 3D abdomen CT images that contains spleen using 3D-UNet. All images are provided in '.nii.gz' format. The dataset can be assessed here (Dataset).

The requirements are listed as follows:

1. Implement a 3D segmentation network, 3D UNet, including the model, dataloader, and train-validation-test procedure(15%).
2. Report 4 evaluation metrics on the test set: dice (≥ 60%), jaccard, the average surface distance (ASD), and the 95% Hausdorff Distance (95HD); (15%)
3. Logging the training & test loss curves, training & test dice curves using Tensorboard or Wandb; (10%)
4. Show at least 4 segmentation results compared with the ground-truth label (i.e., 4 slices with GT and predictions) using ITK-SNAP. (10%)

In the short report, you should include: a table that report the four required metrics; clear screenshots from Wandb or Tensorboard that shows the required curves; 4 exported results (i.e., 4 slices with GT and predictions) from ITK-SNAP.