Assessment Assignment

In this assignment, you are supposed to work with the BraTS2021 dataset and the UNETR model.

The BraTS (Brain Tumor Segmentation) dataset is a collection of MRI images used for brain tumor segmentation. It includes four types of MRI scans—T1, T1Gd, T2, and FLAIR—from patients with different grades of glioma tumors. The dataset provides detailed labels for tumor regions, helping researchers develop AI models that can accurately detect and segment brain tumors. You can read more information about the BraTS dataset in this link.

UNETR (U-Net Transformer) is a model designed for 3D medical image segmentation, combining the strengths of Transformers with the U-Net architecture. In UNETR, Transformers capture long-range dependencies in the image by processing the entire 3D volume, while the U-Net structure refines local details through its encoder-decoder pathway. You can find more about this model in this link.

The main objective of this assignment is to become familiar with medical images and the related libraries and frameworks used to process them.

Your report should include answers to the following questions, an explanation of your modifications in the source code or new codes, and the final code files.

*** Please note that you can use AI tools; however, you must understand your answers thoroughly.

*** Please note that you can use Google Colab, Kaggle, or any other platform to run the code.

Resources:

- dataset
- Source code
- Paper

1- Select a random sample from the dataset and answer the following questions:

   - What is the shape of each modality? How about the shape of the label?
   - What is the range of voxel value in each modality? (for example, between 0-10)
   - What values does the label include?
   - Display the middle slices of the sagittal cut from the 3D MRI image.
   - In continuation of the previous part, display the corresponding label for the cut. You may need to display multiple images, each corresponding to a label value.

2- Based on the provided paper, what is the input shape of the UNETR model for the brain tumor segmentation problem? What does output shape? Please state the number of input channels and output channels. Also, the batch size is not necessary.

3- Do you think about why the input size of the model is different from the MRI image size?

4- Train the UNETR model on the BraTS2021 dataset. Please note that the main objective of this question is not to fully train the model on the dataset. So, training the model on 2 or 3 epochs would be enough. Moreover, the accuracy or the loss value in this question does not matter. For this question, you should do the following steps:

   - Create an appropriate metadata/json file for the dataset. You should split data into train, validation, and test sets.

- Modify the dataloader transformations. Current configuration is for BTCV dataset. You should add, change, or delete some of the transformation so they would be appropriate for the BraTS dataset. You can get help this link. You can also get help by other projects of this repository.

- Modify some runtime arguments (e.g., data_dir). Please note that due to hardware resource limitations, you can use a different model input size than the one in the paper.

If you have any question, please contact this email:
Mohammadhossein.ahmadi@students.mq.edu.au