Computer Vision: Brain MRI Metastasis Segmentation Assignment

Objective

Demonstrate proficiency in computer vision techniques by implementing and comparing Nested U-Net and Attention U-Net architectures for brain MRI metastasis segmentation, and develop a web application to showcase your model.

Dataset

Link: https://dicom5c.blob.core.windows.net/public/Data.zip

- You will be provided with a Brain MRI dataset containing images and their corresponding metastasis segmentation masks. Ignore images incases of missing masks and viceversa

The dataset structure will be as follows:

```
TCGA_CS_4941_19960909_1_mask.tif
TCGA_CS_4941_19960909_1.tif
TCGA_CS_4941_19960909_2_mask.tif
TCGA_CS_4941_19960909_2.tif
TCGA_CS_4941_19960909_3_mask.tif
TCGA_CS_4941_19960909_3.tif
TCGA_CS_4941_19960909_4_mask.tif
TCGA_CS_4941_19960909_4.tif
TCGA_CS_4941_19960909_5_mask.tif
TCGA_CS_4941_19960909_5.tif
```

- Split the dataset into 80% training and 20% testing sets.

Assignment Details

1. Data Preprocessing

- Implement CLAHE (Contrast Limited Adaptive Histogram Equalization) preprocessing on the MRI images to enhance metastasis visibility.
- Ensure proper normalization and augmentation of the dataset, considering the specific challenges of metastasis segmentation.

2. Model Implementation

Implement the following two architectures for metastasis segmentation:
a. Nested U-Net (U-Net++)
b. Attention U-Net

3. Model Training and Evaluation

- Train both models on the preprocessed metastasis dataset.
- Use the DICE Score as the primary evaluation metric for metastasis segmentation accuracy.
- Compare the performance of both models in identifying and segmenting brain metastases.

4. Web Application Development

- Create a FAST API backend to serve your best performing metastasis segmentation model.
- Develop a Streamlit UI that allows users to upload brain MRI images and view the metastasis segmentation results.

5. Documentation

- Create a comprehensive README.md file in your GitHub repository including:
  - A brief explanation of Nested U-Net and Attention U-Net architectures and your understanding of how they apply to metastasis segmentation.

- A video demonstration of your Streamlit UI in action, showing metastasis segmentation results.
- Instructions for setting up and running your code.
- Discussion on the challenges specific to brain metastasis segmentation and how your implementation addresses them.

Deliverables

1. A GitHub repository containing:
   - All source code for data preprocessing, model implementation, training, and evaluation specific to metastasis segmentation.
   - FAST API backend code.
   - Streamlit UI code for visualizing metastasis segmentation results.
   - Trained model weights for both Nested U-Net and Attention U-Net.
   - A comprehensive README.md as described above.
2. A brief report summarizing:
   - Your approach to the brain metastasis segmentation problem.
   - Comparative results of both models (including DICE scores) in metastasis identification and segmentation.
   - Challenges encountered in metastasis segmentation and how you addressed them.
   - Potential improvements or future work in the field of automated brain metastasis detection and segmentation.

Submission Guidelines

- Ensure your GitHub repository is public and contains all required deliverables.
- Submit the link to your GitHub repository using the provided submission form.
- Deadline: Submit your work no later than 1:00 PM on the specified due date.

Additional Notes

- You may use any Python libraries or frameworks that you find appropriate for this task.
- Clearly document any third-party code or pre-trained models used in your solution.
- Ensure that your web application is easy to set up and run, providing clear metastasis visualization.
- If you make any assumptions about the data or task, clearly state them in your documentation.
- Consider discussing the clinical implications and potential applications of accurate brain metastasis segmentation in your documentation.

Good luck, and we look forward to seeing your innovative solutions in brain MRI metastasis segmentation!