BRAIN TUMOR SEGMENTATION

Project Results and Overview

This project focuses on **brain tumor segmentation** using a U-Net model, trained on the **BraTS dataset**. Brain tumor segmentation is a critical step in medical image analysis, aiding clinicians in diagnosis and treatment planning. The **BraTS dataset** provides annotated MRI scans across multiple modalities (T1, T1c, T2, and FLAIR), making it ideal for training deep learning models like U-Net.

Key Objectives:

1. Develop an automated segmentation pipeline using U-Net.
2. Process MRI images and generate tumor masks.
3. Here I used only T1 slice images.
4. Evaluate segmentation accuracy and efficiency.

Key Results:

- Model successfully distinguished tumor sub-regions.
- Demonstrated reproducible results using the BraTS dataset.

Final Model Performance:

- Dice Coefficient for sample 0: 0.9917
- Average Dice Coefficient: 0.9934
- Training Accuracy: 98.84%
- Training Loss: 0.0332
- Validation Accuracy: 98.68%
- Validation Loss: 0.0407

References and Documentation

- **U-Net: Convolutional Networks for Biomedical Image Segmentation by Olaf Ronneberger et al.**
- **Keras Documentation**
- **Libraries:**
    - **TensorFlow/Keras (Deep Learning Framework)**
    - **NumPy (Numerical Computing)**
    - **OpenCV (Image Processing)**

Key algorithms used:

- U-Net architecture: A deep learning architecture that combines a contracting path (encoder) and an expansive path (decoder) with skip connections for precise image segmentation.
- Dice Coefficient: A metric used for evaluating the similarity of two sets, crucial for segmentation tasks.

Future Work

1. Data Augmentation: Implementing additional data augmentation strategies could further improve model robustness, especially with a limited dataset.
2. Hyperparameter Tuning: Further fine-tuning of the model's hyperparameters to improve performance and generalization.
3. Transfer Learning: Explore transfer learning using pre-trained models to achieve faster convergence and better performance.
4. Real-Time Segmentation: Optimizing the model for faster inference to allow real-time segmentation in a clinical setting.
5. Mask Prediction Improvement: Focus on improving the accuracy of mask predictions and work on techniques to get a better Intersection over Union (IoU) score, which is a critical metric for segmentation performance.