ML Project Final Report

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Github Link:https://github.com/ramanujan123/CS550_PROJECT

Project Title : Brain Tumor Segmentation using Deep Neural Networks

Data Collection and Preprocessing

We have collected data from the **BraTS2020**(Brain Tumor Segmentation 2020) dataset.

BraTS2020 Dataset:

- Used for the BraTS (Multimodal Brain Tumor Segmentation) challenge.
- Consists of MRI data from around 400 patients.

MRI Data Details:

- Each patient's MRI data comprises five images.
- Images are in .nii format, commonly used for medical imaging.

Image Aspects:

- Four of these images represent the brain structure while the fifth one is the segmentation image.
- The four images represent different aspects of the same brain.
- Fifth image is the segmentation image, which has been segmented by medical experts in that field.

Data Preprocessing:

A custom Data Generator function was used to facilitate the processing and delivery of data to the neural network.

Following are some of the preprocessing steps that have been done:

1. Retrieve the path of the images for each sample (T1CE image)
2. Retrieve the path of the segmentation image
3. Load the T1CE and segmented image into the memory
4. Create two arrays - X and y. These arrays will contain all the selected slices for the T1CE and segmented image respectively.
5. Resize each image of the slice from (240,240) to (128,128)

Work Done Till Phase-1:

- Exploratory Data Analysis
- Data Preprocessing
- Implementation of **Baseline U-Net Architecture** for baseline predictions

Work Done Till Final Completion:

- Implementation of **Attention based U-Net Architecture** to improve results
- Used **Saliency Maps** to show segmentation results
- Models comparison on the basis of accuracy, complexity and training time.

Models Built:

1. CNN Model based on **baseline U-Net Architecture** (Phase 1)
2. CNN Model based on **U-Net Architecture** with **Attention Mechanism** (Phase 2)

Comparison Among The Models Built:

	Baseline U-Net	**Attention U-Net**
Complexity	Moderate parameters , moderate memory requirement and faster training time	More parameters , more memory requirement , longer training time due to attention
Accuracy	98.12%	98.46%
Dice Coefficient	58.91%	47.26%
Training Time	1.5 hours	2 hours
Variance	High Variance due to overfitting	Relatively less variance due to attention

Comparing Results With Research Papers:

While working on this project, we have taken references from various research papers. In this section, we do a comparison of our best results with those mentioned in those research papers.

Benchmarks	Our baseline U-Net Model	Our U-Net Model with Attention	Model mentioned in a springer paper
Accuracy	98.12%	98.46%	99%
Dice Coefficient	58.91%	47.26%	76.90%
Specificity	99.64%	99.54%	98.03%
Sensitivity	98.71%	98.24%	100%

As evident from the results, the dice coefficient values obtained by our models are quite low when compared to the model discussed in the research paper. The following section outlines several factors contributing to the observed low dice coefficient.

Challenges Faced

1. **Hardware Limitations:**
    - Challenges arose due to the limited access of dedicated GPUs and limited memory in Google Colab, impacting the efficiency of model training and contributing to lower dice coefficients.

2. **Hyperparameter Tuning:**
    - Fine-tuning model hyperparameters proved challenging, requiring careful optimization to strike a balance between underfitting and overfitting.

3. **Project Timeline:**
    - Balancing project timelines with the complexity of the tasks at hand was challenging, requiring careful planning and prioritization of key project milestones.

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