**Project Proposal: Deep Learning-Based Segmentation and Multi-Class Classification of Brain Tumors Using Multi-Institutional MRI Datasets**

**ABSTRACT:**This project presents a deep learning pipeline that segments and classifies brain tumors—benign, malignant (gliomas), or metastatic—using multi-institutional datasets. The goal is to create a robust model to aid radiologists in diagnosis and triage.

**PROBLEM STATEMENT:**Manual MRI interpretation is resource-intensive and prone to variability. While AI models have focused on segmentation or grading gliomas, few combine segmentation with multi-class classification (benign, primary malignant, metastatic). A unified model could enhance diagnostics, especially in resource-limited settings.

**DATASETS(s) TO BE USED:**We utilize multi-institutional, publicly available datasets downloaded from The Cancer Imaging Archive (TCIA), including:

* BraTS-Africa and MU-Glioma: For segmentation and classification of primary brain tumors (LGG/HGG/GBM)
* BCBM, Pretreat-Mets, Yale Brain Mets: For metastatic tumors
* ReMIND and others: For benign tumors (e.g., meningiomas, pituitary tumors)

These datasets include annotated masks, MR sequences (T1, T2, FLAIR, T1ce), and clinical information.

APPROACH

**1. Segmentation:**

* Train a 3D U-Net in PyTorch on glioma cases (BraTS dataset) with annotated tumor masks.
* Fine-tune on metastatic and benign cases (if segmentations are available or via weak labels).

**2. Feature Extraction:**  Extract deep features from the segmented region using a pretrained encoder.

**3. Classification:** Build a classifier (ANN) to categorize cases into: Benign, Primary Malignant (Glioma) and Metastatic Tumor

**4. Evaluation:**

* Segmentation: Dice score, Hausdorff distance
* Classification: Accuracy, AUC, Recall and F1 score.

**5. Visualization:**  Overlay segmentation results and Grad Cams for interpretability.

Expected Outcomes

* A trained 3D U-Net model for brain tumor segmentation across diverse tumor types.
* A multi-class tumor classification model with performance metrics.