**Enhancing Brain Tumor Detection Using Vision Transformers and Generative Adversarial Networks**

**Introduction**

Automated, precise techniques can significantly enhance the diagnostic process for brain tumors. While traditional, manual examination of MRI scans is labor-intensive and prone to error. In response to this, our project harnessed deep learning capabilities to automate the detection process, thereby increasing the accuracy and efficiency of diagnoses.

**Dataset Description**

A comprehensive dataset of 7023 human brain MRI images was assembled from the figshare, SARTAJ, and Br35H datasets, offering an extensive basis for our deep learning models. The dataset contains four classifications: glioma, meningioma, no tumor, and pituitary.

**A close-up of a brain scan

Description automatically generated**

Subsequently, the dataset's images were standardized to 128x128 pixels and normalized to a [0, 1] range. This preprocessing was pivotal to successfully training the models, ensuring data inconsistencies did not hinder learning.

**Methodology**

In this study, we integrated a Vision Transformer, pre-trained on ImageNet and fine-tuned for the specific challenge of classifying brain tumors. The ViT processes the image in patches and employs self-attention to draw contextual connections between them. Concurrently, a GAN was deployed to generate synthetic MRI images, adding diversity to our training data and enhancing the supervised model's robustness.

**Results and Evaluation**

The evaluation of our models was multifaceted, focusing on accuracy, precision, recall, and F1-score. Our Vision Transformer achieved a test accuracy of approximately 88.55%, reflecting its strong performance in the classification task. Moreover, the loss curves for training and validation displayed a promising decline, indicative of the model's effective learning and generalization.

A graph of loss curves

Description automatically generated

The generated images from the GAN were visually assessed, **[TODO]**

**Challenges and Solutions**

Throughout our project, we encountered challenges such as overfitting within the ViT and mode collapse within the GAN. We combated these by introducing dropout layers, data augmentation, and diligent monitoring of training parameters, respectively. These proactive measures were critical in maintaining the integrity and efficacy of our models.

**Conclusion**

The project elucidates the potential of Vision Transformers and Generative Adversarial Networks to revolutionize brain tumor detection from MRI scans. The accuracy achieved by the ViT and the quality of the synthetic images produced by the GAN not only validate the viability of this approach but also open avenues for future enhancements in automated medical diagnostics.