Brain Tumor Classification using CNN & Gradio

# Introduction

Brain tumors are abnormal growths of cells within the brain. They can be life-threatening, and early diagnosis is critical for effective treatment. This project leverages Convolutional Neural Networks (CNNs), a deep learning method effective for image classification tasks, to classify MRI images into four categories: Glioma, Meningioma, No Tumor, and Pituitary Tumor. To make the system user-friendly, a Gradio web interface is developed for real-time predictions.

# Dataset

The dataset contains MRI images categorized into four classes. The structure is as follows:  
/Training/  
├── glioma/  
├── meningioma/  
├── notumor/  
└── pituitary/  
  
Before training, images are resized to 224x224 pixels, normalized, and labels are encoded using LabelBinarizer.

# Model Architecture

The CNN model consists of the following layers:  
- Convolutional Layers (Conv2D) with ReLU activation  
- MaxPooling2D layers for downsampling  
- BatchNormalization to stabilize and accelerate training  
- Dropout layers to reduce overfitting  
- Flatten and Dense layers for classification  
  
The final layer uses Softmax activation to output probabilities for each class.

# Training Process

The dataset is split into training and validation sets. The model is compiled using the 'adam' optimizer and 'categorical\_crossentropy' as the loss function. It is trained for 10 epochs with a batch size of 32. Accuracy and loss are monitored to evaluate performance.

# Prediction Function

The prediction function takes a brain MRI image as input, resizes it to 224x224, and normalizes it. It then passes the image through the trained CNN model, which returns probabilities for each class. The class with the highest probability is selected as the prediction.

# Gradio Interface

Gradio is used to build a simple and interactive user interface. Users can upload an MRI image, and the interface displays the predicted tumor type instantly. This makes the tool accessible for medical personnel without needing programming knowledge.

# Conclusion & Future Work

This project demonstrates the feasibility of using deep learning for brain tumor classification. The model performs well on test images, but further improvements can be made by using more advanced architectures like ResNet or EfficientNet. Future work may include deploying the model on the cloud and integrating it into healthcare systems.