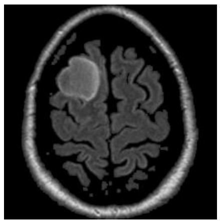
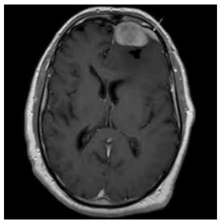
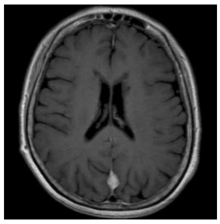
Introduction

In an effort to tackle a more challenging classification task, my team initially worked on classifying brain tumors into two categories: tumor and non-tumor.

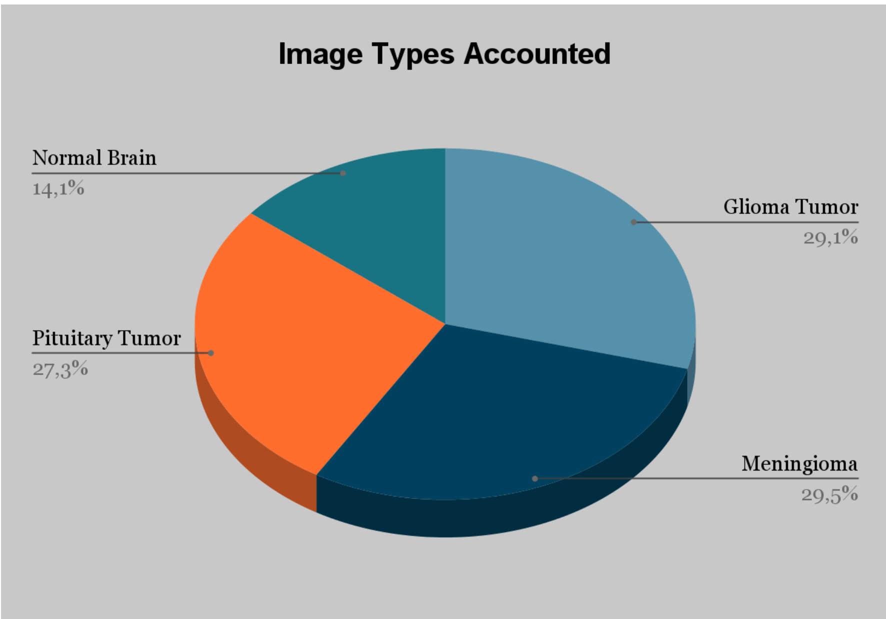
Based on feedback from our supervising professor, we decided to attempt a more complex classification involving four categories: glioma tumor, meningioma tumor, pituitary tumor, and normal. We sourced a new dataset containing these four classes and prepared it for model training, including essential image pre-processing steps.

Key Differences Between Glioma, Meningioma, and Pituitary Tumors

Meningioma Tumor: As the name suggests, meningiomas arise from the meninges, which are the protective membranes covering the brain and spinal cord.These tumors typically appear on the outer surface of the brain, near the skull, but can also be found along the spinal cord.(the red part)
Glioma Tumor: Gliomas originate from glial cells, which are found throughout the brain and spinal cord. Unlike meningiomas, gliomas develop within the brain tissue itself and can appear in various regions, including the cerebral hemispheres (the yellow part), brainstem, and cerebellum. Gliomas often involve deeper structures of the brain.
Pituitary Tumor: Pituitary tumors develop in the pituitary gland, located at the base of the brain, in a bony cavity called the sella turcica. These tumors are centralized in the brain, just beneath the hypothalamus and between the optic nerves.(the green part)

Types	Origin	Danger	Symptoms	Image
Glioma Tumor	Originates from glial cells in the brain or spinal cord.	Can be either low-grade (less aggressive) or high-grade (very aggressive, such as glioblastoma).	Often results in symptoms like headaches, seizures, or motor dysfunction due to its location within brain tissue	
Meningioma Tumor	Arises from the meninges, the protective layers surrounding the brain and spinal cord.	Mostly benign, but a small percentage can become malignant.	Symptoms usually occur due to compression of brain structures, leading to issues like vision problems, headaches, or neurological deficits.	
Pituitary Tumor	Develops from the cells of the pituitary gland, affecting hormone production.	Usually benign, but its impact on hormone levels can lead to systemic symptoms like growth abnormalities or vision issues.	Often associated with endocrine disorders depending on the type of hormones produced.	

The Quantity of the dataset

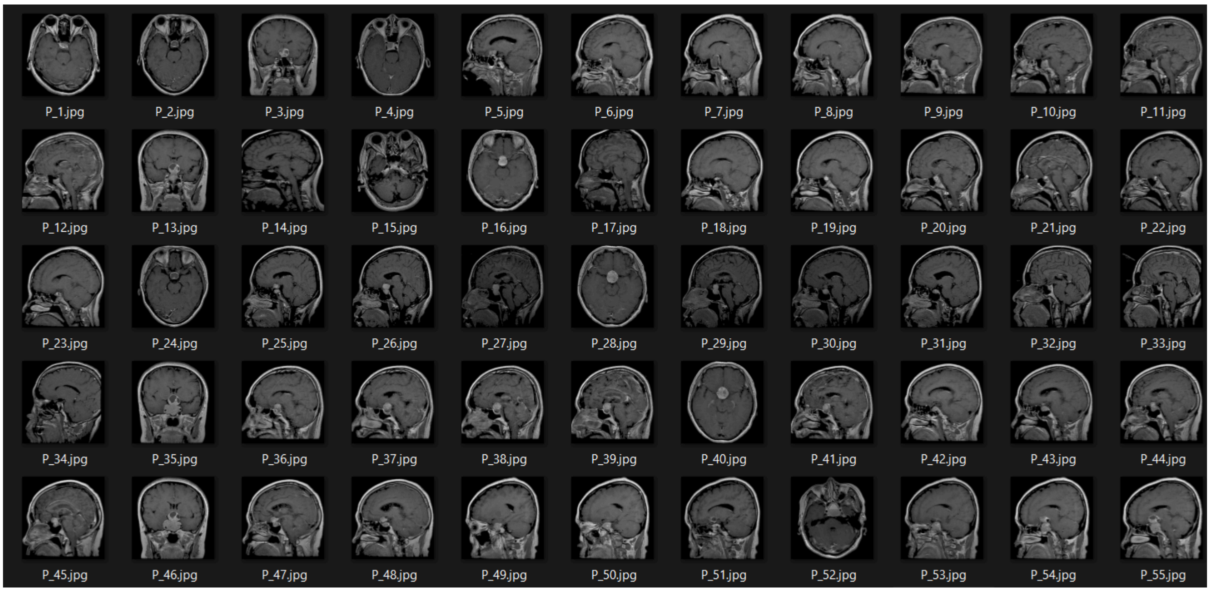


3 Types of brain tumor have around **900 images** but the normal brain images just nearly **500 images.**

The 'normal' class, as the least represented in the dataset, could play a crucial role in maintaining balanced model performance. Extra care may be required during model training to prevent bias toward the more dominant classes.

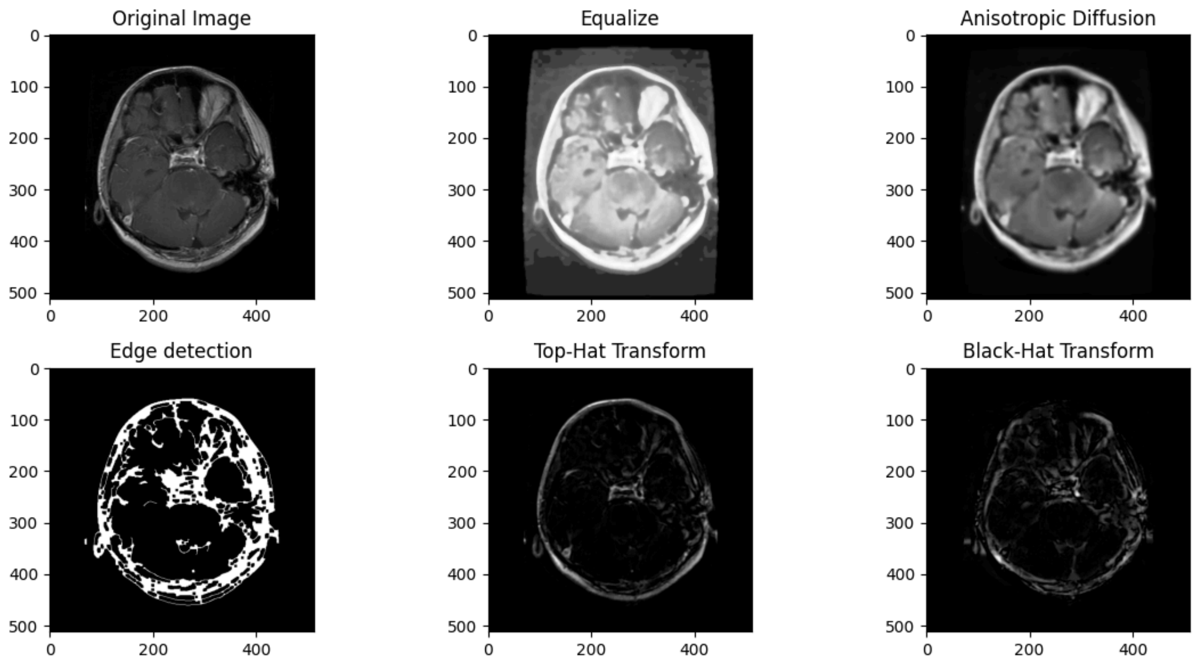
The Quality of the dataset

All images were converted and resized to 256x256 pixels, with each image being approximately 25 KB. The images were renamed based on their respective tags.



Challenges and Solutions with the Dataset

- **Quality of MRI Images**: Variations in resolution, noise, and artifacts can negatively affect the performance of CNNs, impacting the accuracy of feature extraction and overall model performance. Lower-quality images may hinder the model's ability to correctly identify key features.
  - **Solution**: Image processing techniques such as Gaussian blur and median filtering can help reduce noise, while histogram equalization can enhance image contrast, leading to improved image quality for better model performance.



- **Data Imbalance**: An unequal distribution of tumor versus non-tumor images poses the risk of producing biased models that tend to overfit to the more frequent class.
    - **Solution**: Data augmentation methods like rotating images or adjusting their quality can help create a more balanced dataset, expanding the variety of images available for training and reducing class bias.We also applied GANs technique to tackle this issues.
- **Skull Removal**: Manual techniques, such as edge detection or thresholding, can be used to separate the brain from the skull in MRI images. By applying thresholds to intensity levels or using region growing methods, regions within the brain tissue can be segmented from the skull based on pixel values and spatial similarity.We are develop to try this way by reference by 2 article MRI_Removal and Skull_Stripping