# Brain Tumor Classification

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# Problem Statement

- Manual interpretation
    - time-consuming
    - prone to errors

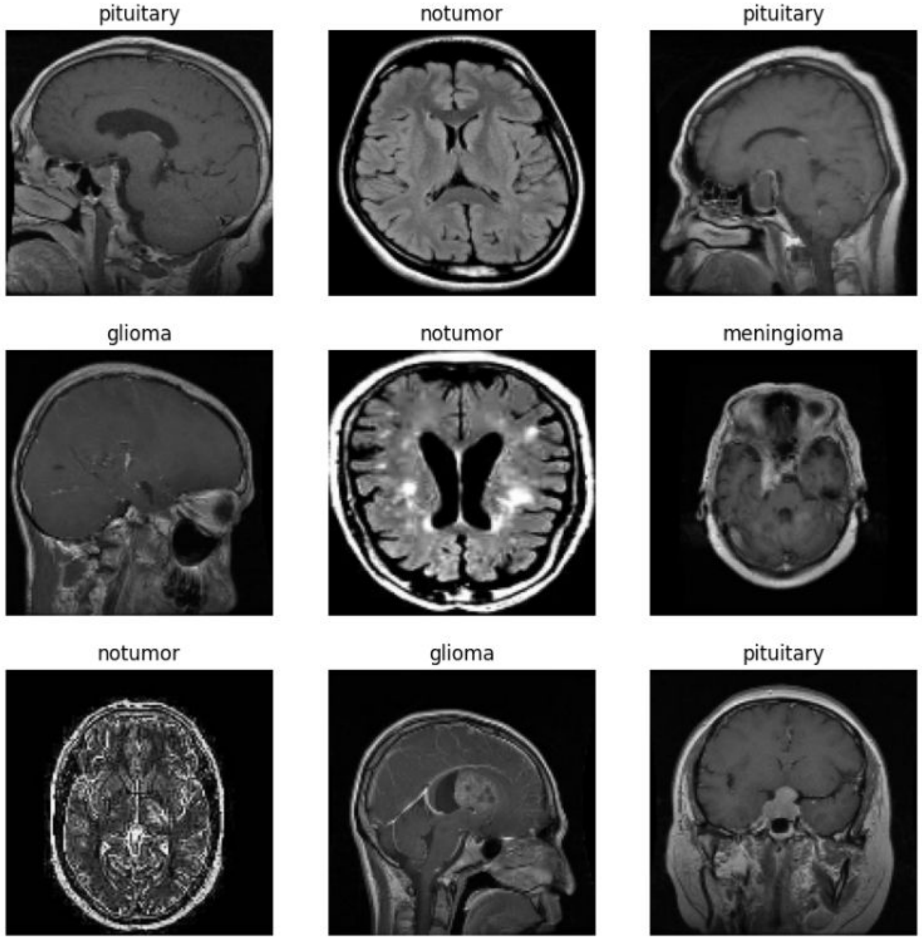
- Increasing number of MRI scans → **Automated solution**

**Develop a deep learning-based model that can automatically classify brain tumors into multiple categories to assist in the early detection, diagnosis, and treatment planning for patients**

# Dataset

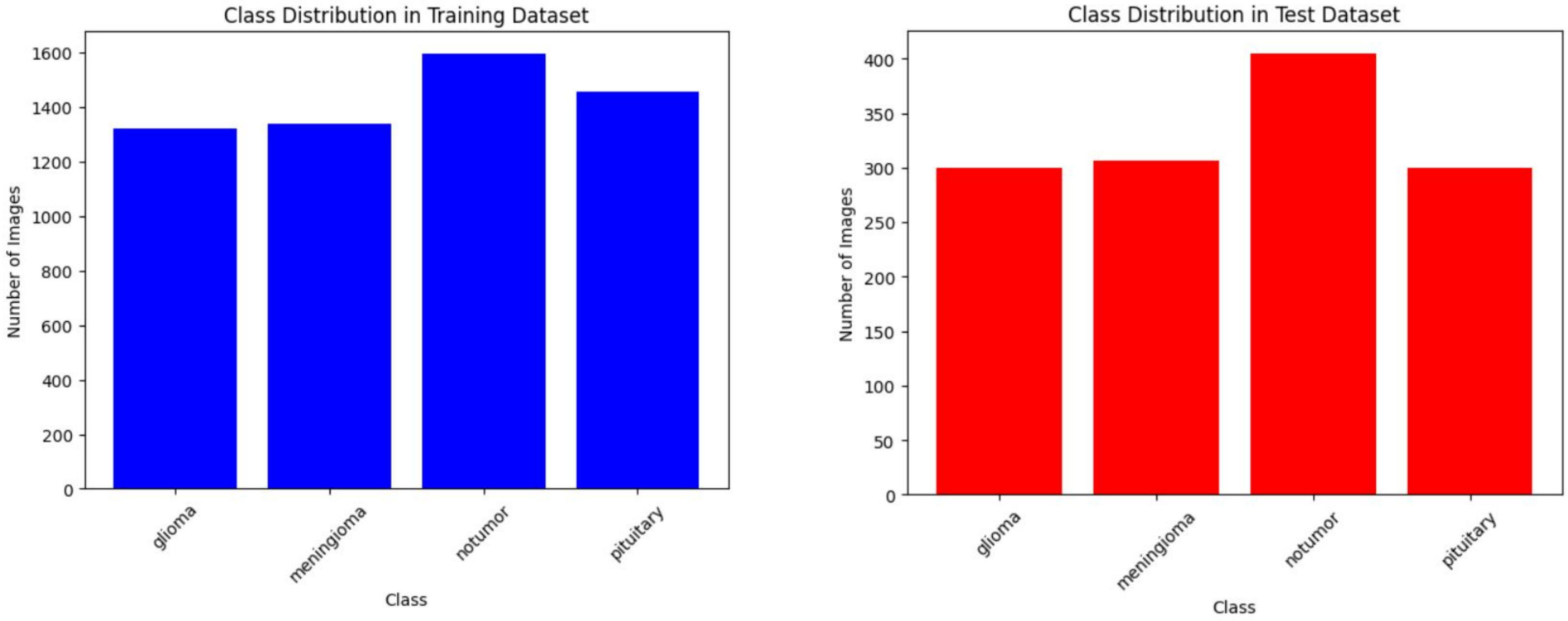
- Dataset : 7023 human brain MRI images
    - Training dataset: 5712 images
    - Testing dataset: 1311 images

- 4 classes :
    - Glioma
    - Meningioma
    - Pituitary
    - No tumor



# Exploratory Data Analysis

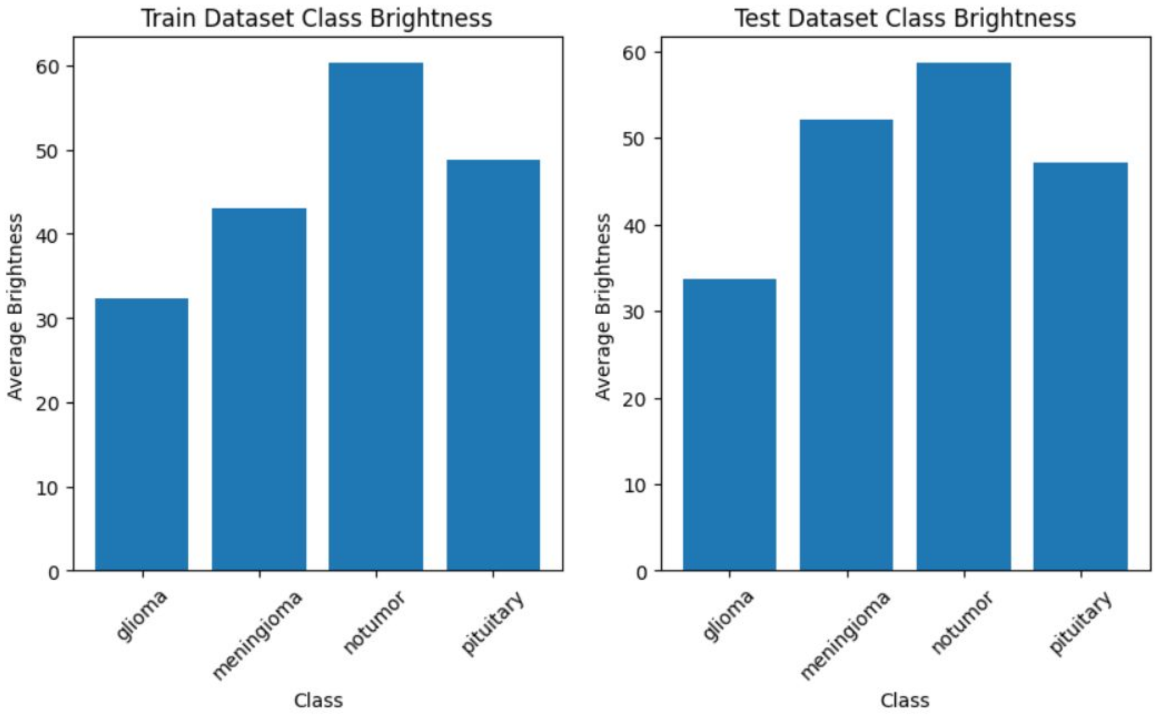
## **Class distribution**



# Exploratory Data Analysis

**Image brightness**

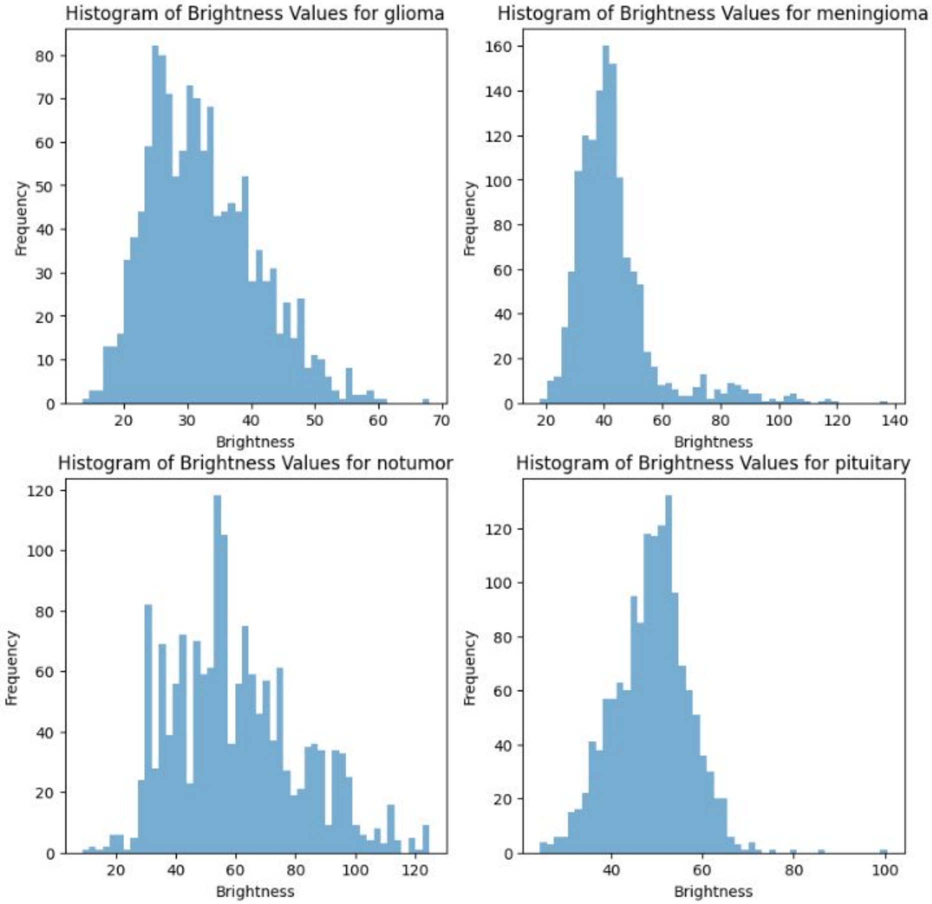
Images in the glioma class are darker than the other classes



# Exploratory Data Analysis

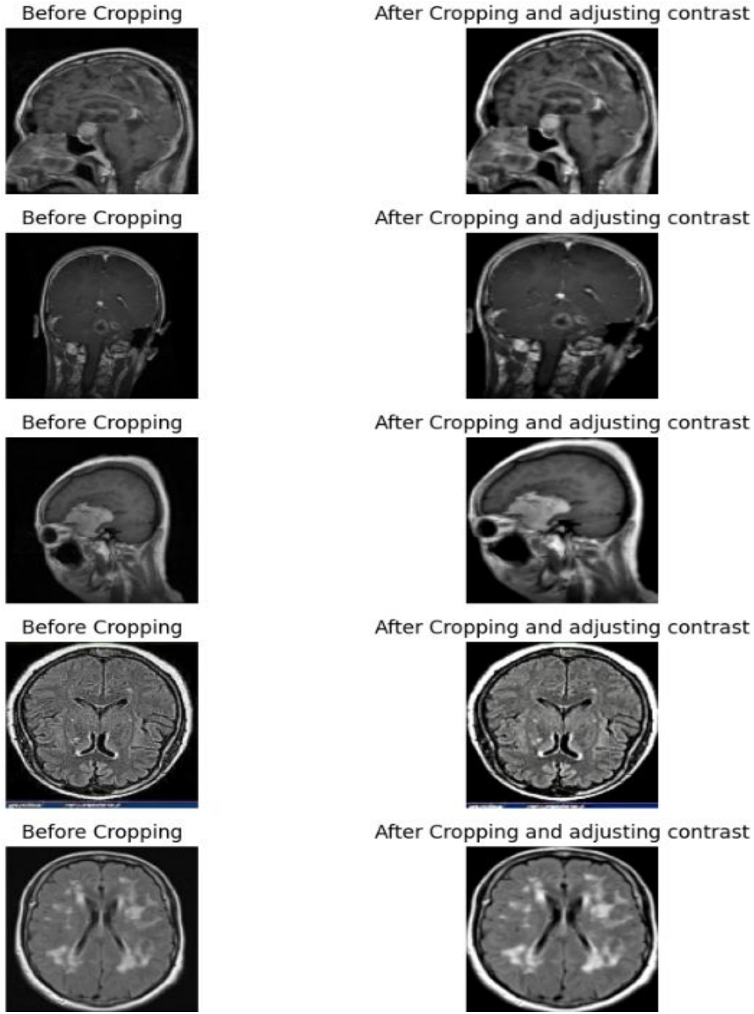
**Histogram of brightness**

Poor contrast for the Meningioma and pituitary classes

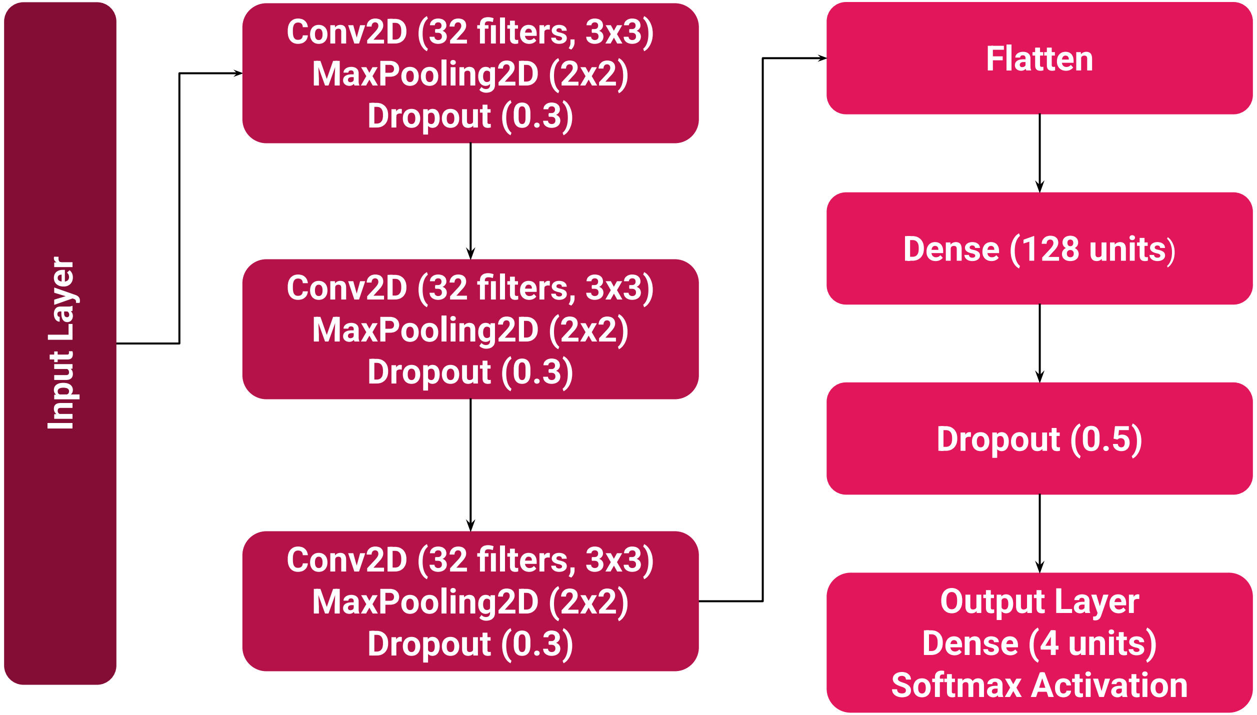


# Preprocessing

- One hot encoding labels
- Filter images : 5x5 Gaussian filter to reduce noise
- Cropping images: focus on the brain area
- Adjusting contrast: enhance the image quality
- Normalize image to [0,1]
- Resizing images to 150x150

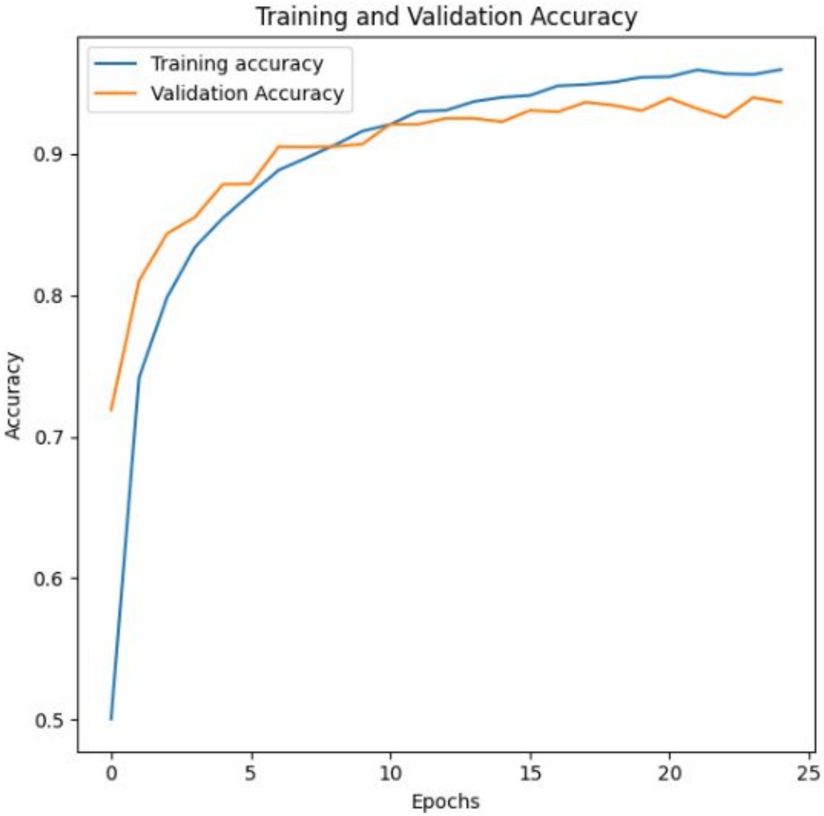


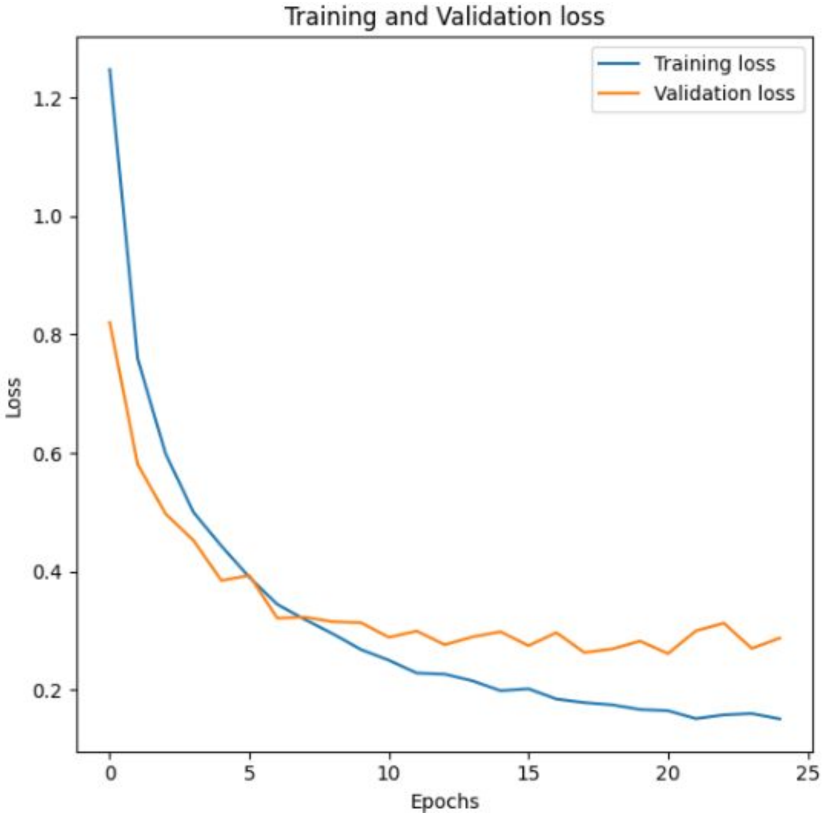
# Modeling



Input Layer
Conv2D (32 filters, 3x3)
MaxPooling2D (2x2)
Dropout (0.3)
Conv2D (32 filters, 3x3)
MaxPooling2D (2x2)
Dropout (0.3)
Conv2D (32 filters, 3x3)
MaxPooling2D (2x2)
Dropout (0.3)
Flatten
Dense (128 units)
Dropout (0.5)
Output Layer
Dense (4 units)
Softmax Activation

# Modeling


Training and Validation Accuracy
Training accuracy
Validation Accuracy
Accuracy
0.5
0.6
0.7
0.8
0.9
0
5
10
15
20
25
Epochs


Training and Validation loss
Training loss
Validation loss
Loss
0.2
0.4
0.6
0.8
1.0
1.2
0
5
10
15
20
25
Epochs

# Evaluation

- The test set was preprocessed similarly to the training set
- Results

```
Test Loss: 0.2509309947490692
Test Accuracy: 0.9320312738418579
```

# Hyperparameter tuning

The tuned parameters are:

- The number of filters in the 3 convolutional blocks
- The dimensionality of the output space in the dense layer
- The learning rate of the optimizer “adam”

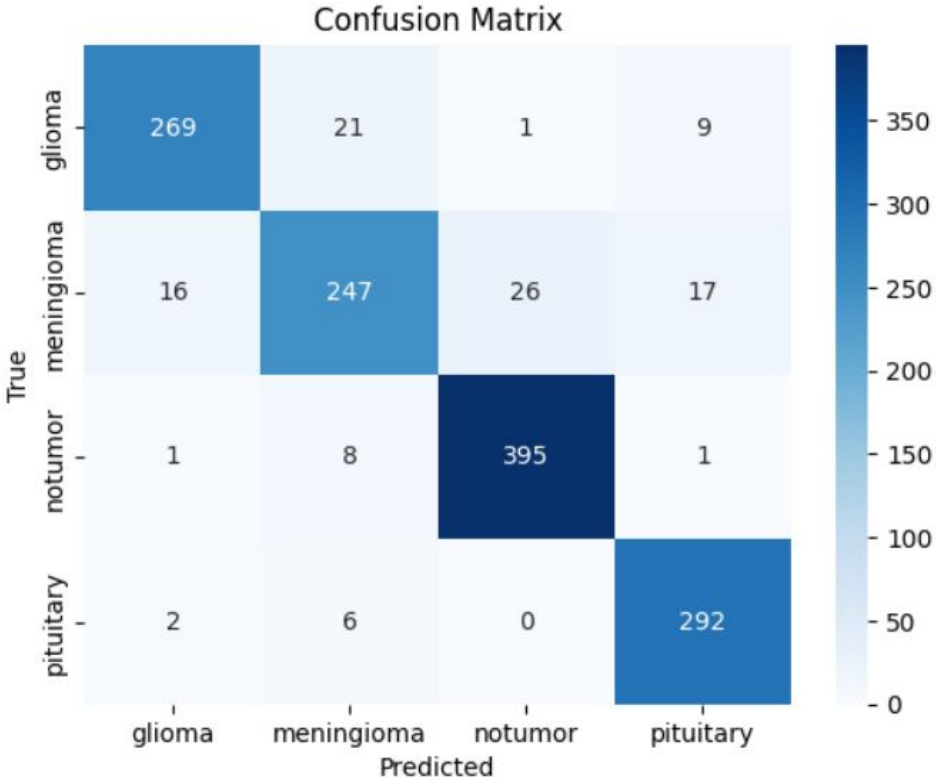
The best parameters are:

- 'filters_1': 64, 'filters_2': 64, 'filters_3': 512,
- 'dense_units': 192,
- 'learning_rate': 0.000675

| Mean validation accuracy cross folds | Standard deviation of validation accuracy across folds |
|---|---|
| 0.96 | 0.024 |

# Evaluation of the best model

| Metric | Value |
| --- | --- |
| Precision | 0.915 |
| Recall | 0.913 |
| F1 score | 0.913 |
| AUC-ROC | 0.985 |



# Conclusion

- Objective: classify brain Tumor MRI into 4 classes
- Trained CNN model:
    - 3 convolutional blocks with progressively increasing filter sizes and depths containing
        - Convolutional layer,
        - A max pooling layers to reduce spatial dimensions and retain important features.
        - A dropout layers to help mitigate overfitting
    - A layer to  flatten the features into a one-dimensional vector
    - A dense layer with ReLU activation.
    - A softmax output layer is used for classification
- Results after tuning
    - High accuracy rate of 91%.
    - High recall rate 91%

# Future work

- Generate more data: use data augmentation techniques (Rotating, shifting, flipping, Shearing, etc)
- Increase model complexity: adding more layers or more neurons in the dense layers.
- Tune more hyperparameters (batch size, dropout rate, etc)

# Thank You!