BRAIN TUMOR

Deep Learning AIE332

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Introduction

Brain tumors are abnormal growths of cells in the brain that can be benign or malignant and may cause serious neurological damage. MRI is widely used for brain tumor diagnosis; however, manual analysis is time-consuming and depends on expert interpretation. Recent advances in deep learning, particularly CNNs, provide effective solutions for automating brain tumor detection and analysis from MRI scans.

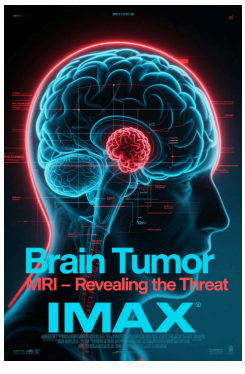
Problem Statement

Accurate detection and classification of brain tumors from MRI scans remain a challenging task due to variations in tumor size, shape, location, and intensity. Traditional diagnostic methods rely heavily on expert radiologists, making the process time-consuming and prone to human error. Furthermore, many existing deep learning approaches use separate models for tumor detection, classification, and localization, which increases computational cost and system complexity.

Therefore, there is a need for an automated and efficient deep learning framework that can simultaneously detect brain tumors, classify them based on type and grade, and identify their location from MRI images. Such a system would support medical professionals by providing faster, more accurate, and consistent diagnostic assistance, ultimately improving patient treatment planning and outcomes.

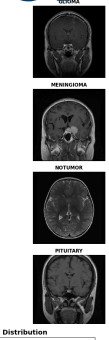
Goal

The goal of this project is to develop an automated deep learning–based system for accurate brain tumor classification from MRI images. The system aims to classify brain tumors into four categories while improving diagnostic accuracy, reducing human effort, and supporting clinical decision-making.

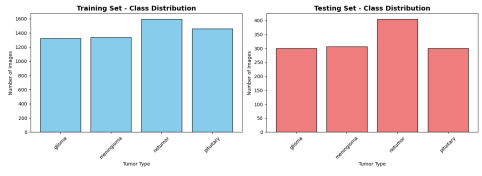


Methodology

Dataset



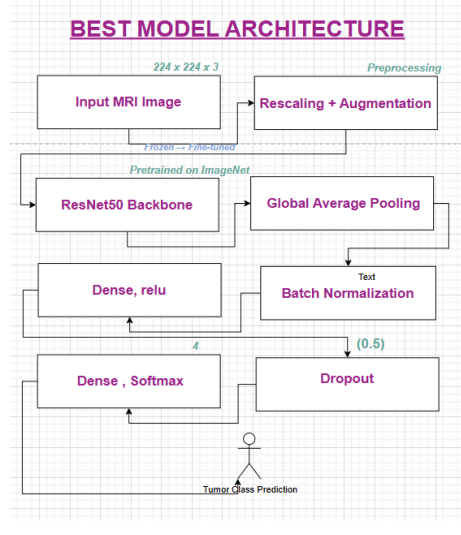
- **Total images: 7,023** brain MRI scans
- **Classes:** Glioma, Meningioma, Pituitary, No Tumor
- **Sources:** Figshare, SARTAJ, Br35H
- Misclassified glioma images from *SARTAJ* were removed and replaced with correctly labeled images from *Figshare.*
- Images were resized to **150×150** and **224×224** depending on the model.



Approach

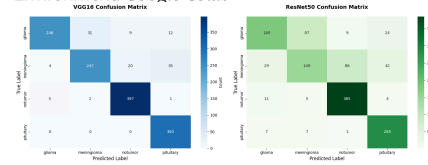
Use deep learning–based image classification
Apply data preprocessing and augmentation to improve generalization
Implement transfer learning using pretrained CNN backbones
Compare custom CNN models with pretrained architectures
Evaluate performance using multiple metrics and visualization tools

Best-performing approach:
Transfer learning with ResNet50 / VGG16, followed by fine-tuning.



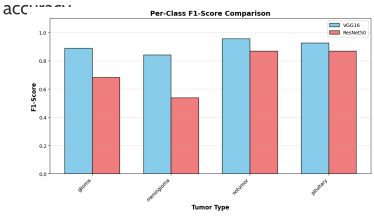
Technologies Used

- Programming Language: Python
- Frameworks: TensorFlow, Keras
- Models: Custom CNN, VGG16, ResNet50
- Preprocessing: ImageDataGenerator
- Evaluation: Accuracy, Precision, Recall, F1-score, Confusion Matrix
- Explainability: Grad-CAM
- Environment: Google Colab

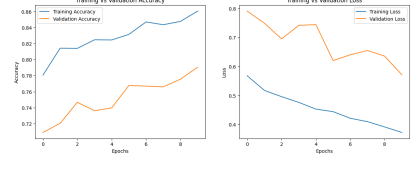


Resualts

- Transfer learning models significantly outperformed custom CNNs
- ***ResNet50*** and ***VGG16*** achieved higher validation and test acc



- Stable convergence with reduced overfitting using:
- Data augmentation
- Dropout
- Fine-tuning
- Confusion matrices show strong per-class performance
- Grad-CAM visualizations confirm that models focus on



	precision	recall	f1-score	support
glioma	0.82	0.79	0.81	300
meningioma	0.74	0.41	0.53	306
notumor	0.79	0.98	0.88	405
pituitary	0.85	0.99	0.91	300
accuracy			0.81	1311
macro avg	0.80	0.79	0.78	1311
weighted avg	0.80	0.81	0.79	1311

Conclusion

This project demonstrates that transfer learning–based CNN models can effectively classify brain tumors from MRI images with high accuracy. The proposed system reduces diagnostic complexity and provides reliable predictions that can assist radiologists. Future work may include larger datasets, advanced architectures, and clinical validation.

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