🧠 Brain Tumor MRI Classification using Deep Learning & Streamlit

An End-to-End Deep Learning Project

🎯 Problem Statement

- Manual MRI analysis for tumor detection is time-consuming and prone to human error.
- The goal is to automate tumer classification using deep learning models.
- Objective: Identify tumor type (Glioma, Meningioma, Pituitary, or No Tumor).

Dataset Overview

- Dataset: Brain MRI Images
- Four classes: Glioma, Meningioma, Pituitary, and No Tumor.
- Split: 70% Training | 20% Validation | 10% Testing.
- Around 3,000+ labeled MRI images.

Data Preprocessing & Augmentation

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- Normalized pixel values to [0, 1].
- Resized all images to 224x224 pixels.
- Applied augmentations: rotation, flip, zoom, and brightness.
- Improves generalization and prevents overfitting

🧠 Model Architectures

1️⃣ Custom CNN — built from scratch using Conv2D, MaxPooling, Dropout.
2️⃣ EfficientNetB0 — pretrained ImageNet model for transfer learning.
3️⃣ ResNet50 — deep residual network with skip connections.

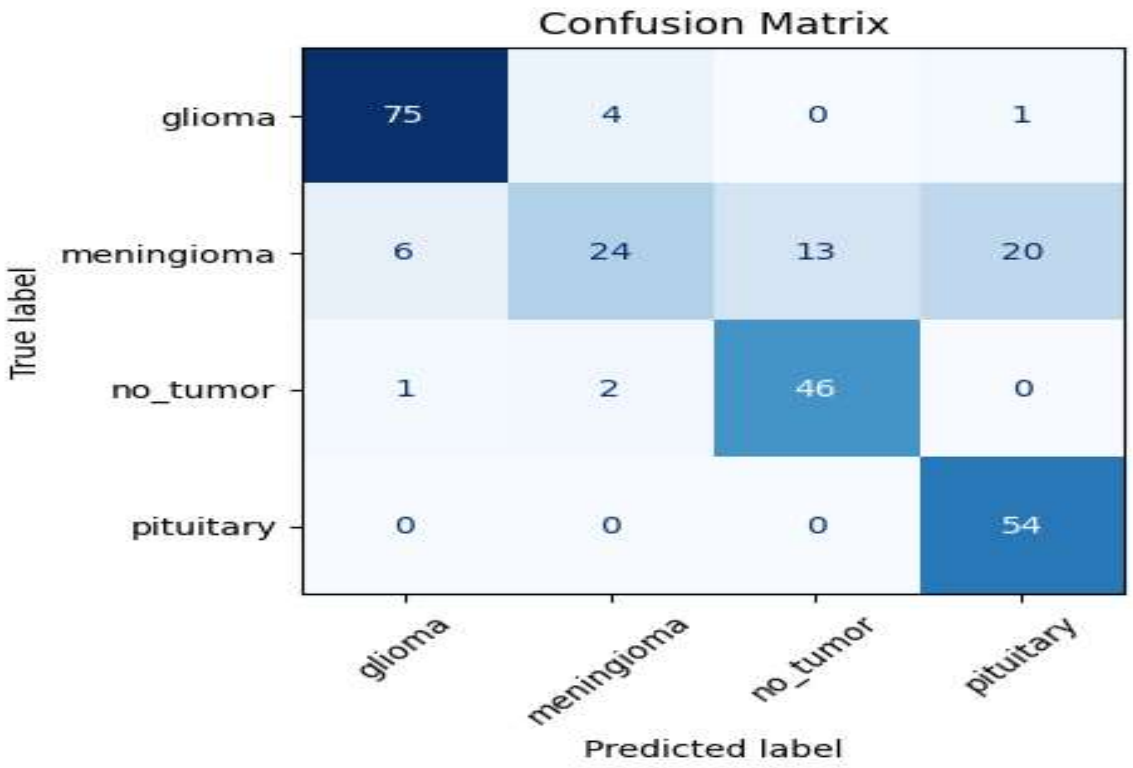
📈 Training Configuration

- Optimizer: Adam | Loss: Categorical Crossentropy.
- Epochs: 10–15 | Batch Size: 32.
- Callbacks: EarlyStopping, ModelCheckpoint, ReduceLROnPlateau.
- Environment: Google Colab (GPU).

📊 Classification Results — Custom CNN

- Accuracy: 0.81
- Precision: 0.82
- Recall: 0.81
- F1-Score: 0.79

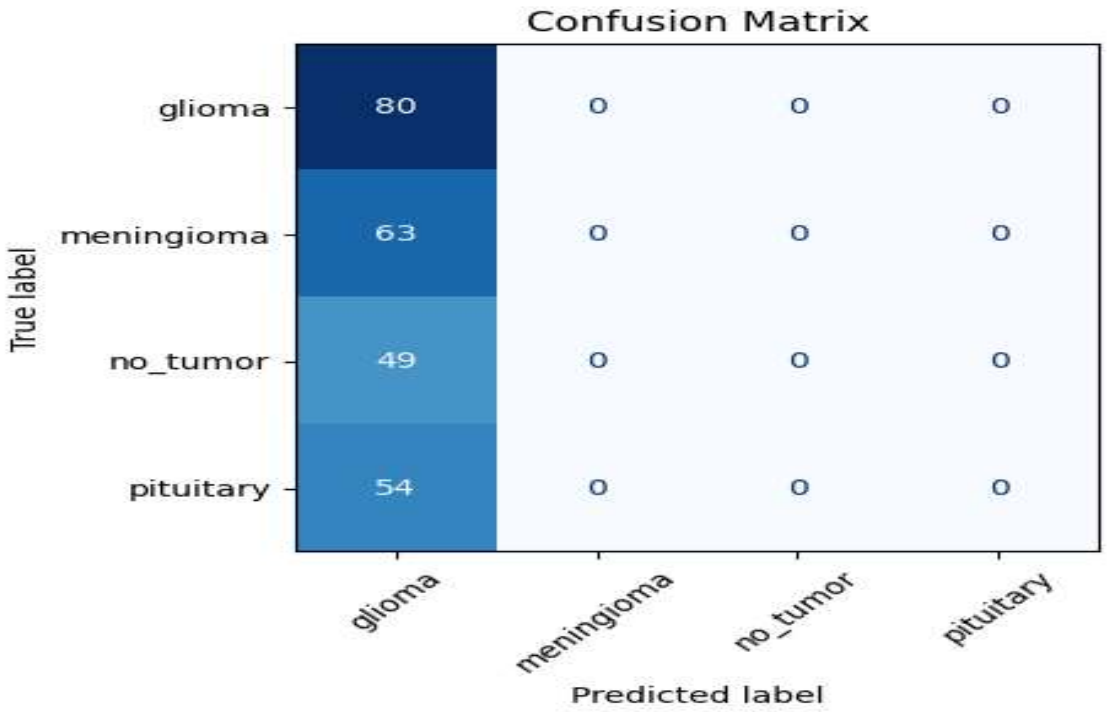
✅ Excellent performance for Glioma and No Tumor classes.
⚙️ Balanced precision and recall across categories.



📊 Classification Results — EfficientNetB0

- Accuracy: 0.33
- Precision: 0.11
- Recall: 0.33
- F1-Score: 0.16

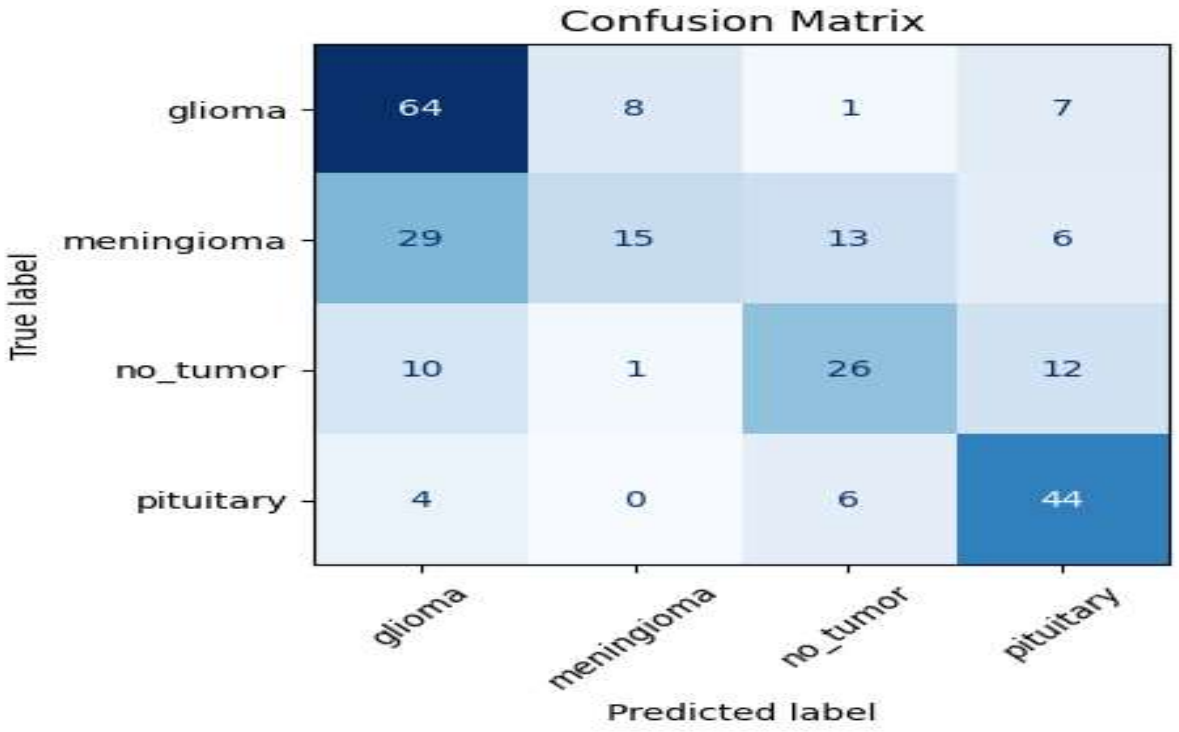
⚠️ Model underfitted — predicted majority class only.
🔧 Requires fine-tuning and unfreezing of top layers.



Classification Results — ResNet50

- Accuracy: 0.61
- Precision: 0.61
- Recall: 0.61
- F1-Score: 0.58

⚙️ Moderate results, slightly overfitting.
🚀 Potentially improved by increasing epochs and data size.



📊 Overall Model Comparison

- Model | Accuracy | Precision | Recall | F1-Score

  Custom CNN | 0.809 | 0.816 | 0.809 | 0.787
  EfficientNetB0 | 0.325 | 0.106 | 0.325 | 0.160
  ResNet50 | 0.606 | 0.607 | 0.606 | 0.577

🏆 Custom CNN performed best overall.

🌐 Streamlit Web App Overview

- Simple web interface built using Streamlit.
- Users can upload an MRI image and select model.
- Outputs tumor class prediction with confidence.
- Displays bar chart for class probabilities.

🚀 Deployment Workflow

1. Model training in Google Colab.
2. Export models (.keras) and class labels (JSON).
3. Integrate into Streamlit app for inference.
4. Deploy locally or on Streamlit Cloud.

💡 Insights & Future Work

- Custom CNN achieved the best overall performance.
- Transfer learning models require more fine-tuning.
- Future Work:
  - Grad-CAM for interpretability.
  - Dataset expansion.
  - Model ensembling.
  - Real-time web deployment.

Conclusion

- Successfully built an end-to-end Brain Tumor MRI classification pipeline.
- Achieved 81% accuracy with Custom CNN.
- Deployed an interactive Streamlit app for predictions.
- Demonstrated the power of deep learning in medical imaging.