Brain Tumor Detection & Classification

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Motivation:

- Early and accurate detection of brain tumors is crucial for timely treatment and saving patients life
- Traditional diagnostic methods can be time-consuming, subjective, and prone to errors.
- Leveraging deep learning techniques can offer automated and efficient solutions for brain tumor detection and classification, enhancing diagnostic accuracy and patient care.

Problem Addressed:

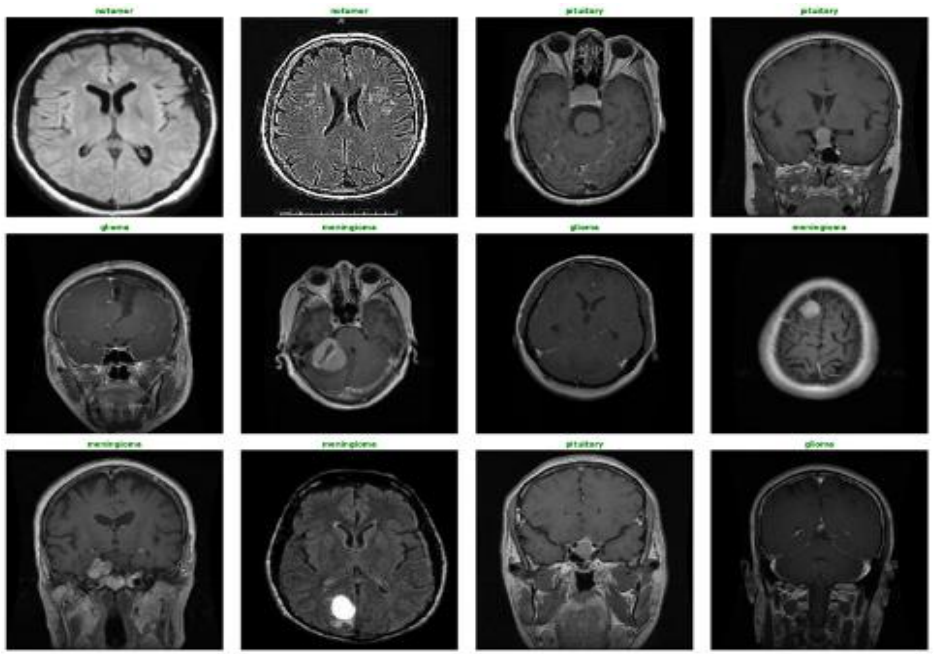
- What: Early and accurate detection of brain tumors using MRI scans.
- Why:
  - Critical Health Concern: Brain tumors pose life-threatening risks, requiring prompt diagnosis and treatment.
  - Variability in Tumor Characteristics: Brain tumors exhibit diverse morphological and textural features, posing challenges for consistent and accurate interpretation by healthcare professionals, necessitating advanced computational methods for robust analysis.
  - Need for Automation: Leveraging deep learning techniques can automate the diagnosis process, improving accuracy and efficiency.

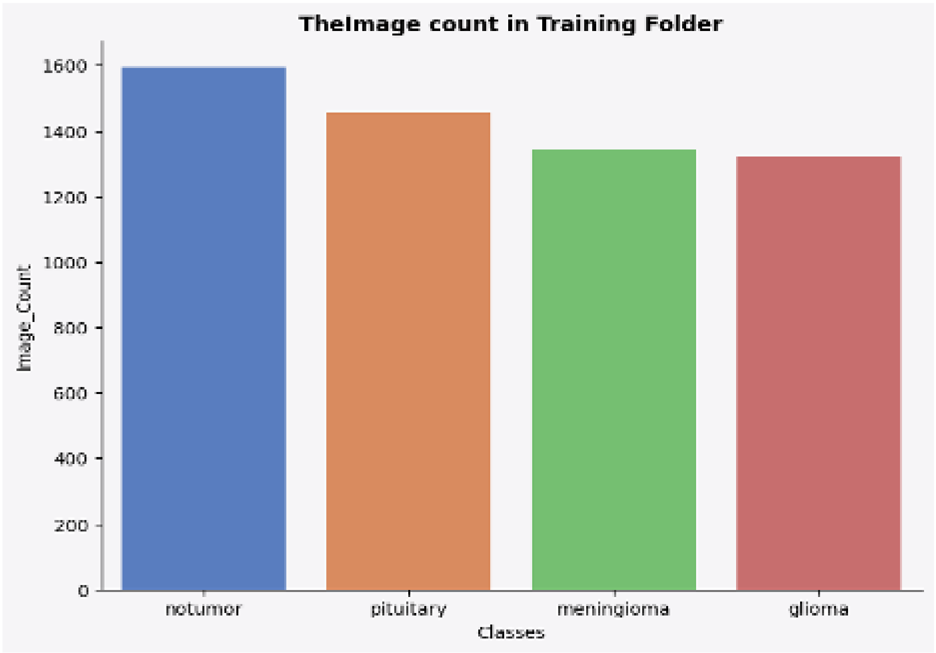
Background:

- **Evolution of Medical Imaging Techniques:** Advancements in medical imaging technologies, particularly Magnetic Resonance Imaging (MRI), have revolutionized the detection and characterization of brain tumors, enabling non-invasive visualization of internal structures with high resolution.
- **Building on Prior Research:** Our work builds upon existing research in brain tumor detection and classification using deep learning techniques.
- **Validation of Previous Findings:** Our results validate and extend findings from previous studies, demonstrating the efficacy of convolutional neural networks (CNNs) and transfer learning in this domain.
- **Methodological Innovations:** We introduce novel approaches such as image augmentation and transfer learning with pre-trained models like VGG19 and ResNet50, enhancing the performance of brain tumor classification.

About Dataset:

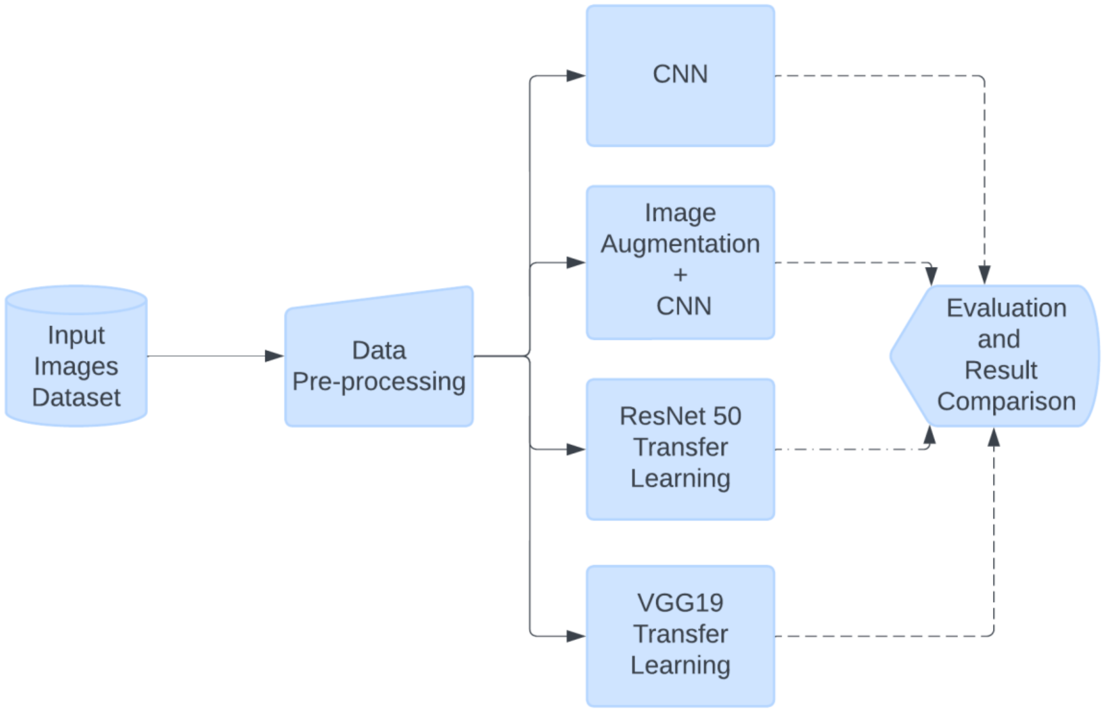
- **Dataset Used:** Brain tumor MRI dataset is a combination of three smaller datasets: figshare, SARTAJ, and Br35H. It contains 7023 MRI images of the human brain, which have been sorted into four categories: glioma, meningioma, no tumor, and pituitary.





Sample Pictures with label from dataset

Approach:

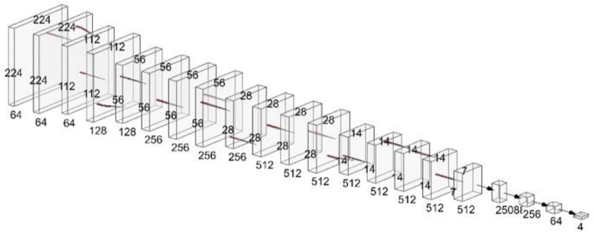


Input Images Dataset
Data Pre-processing
CNN
Image Augmentation + CNN
ResNet 50 Transfer Learning
VGG19 Transfer Learning
Evaluation and Result Comparison

Our solution unfolds through these five sequential steps outlined as follows:

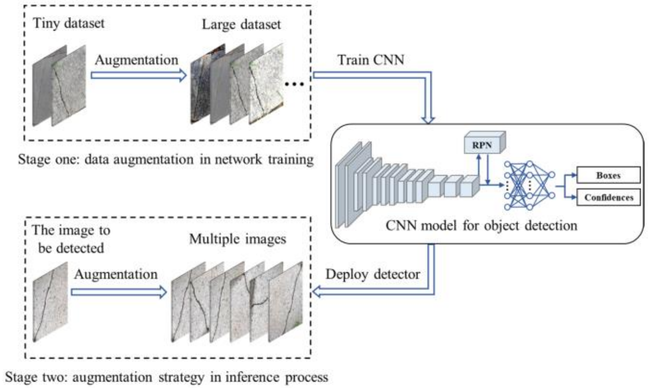
- **Utilization of Deep Learning,** leveraging CNNs for brain tumor detection and classification.
- **Preprocessing** of MRI images including normalization to scale all pixels in 0 -1 range.
- Development of a **tailored CNN architecture** optimized for brain tumor identification and classification.
- Implementation of **image augmentation** and **dropout layers** techniques such as rotation and flipping to mitigate overfitting and improve model robustness.
- Investigation of **transfer learning** techniques using pre-trained models (VGG19, ResNet50) to enhance model performance and reducing resource utilization.

CNN



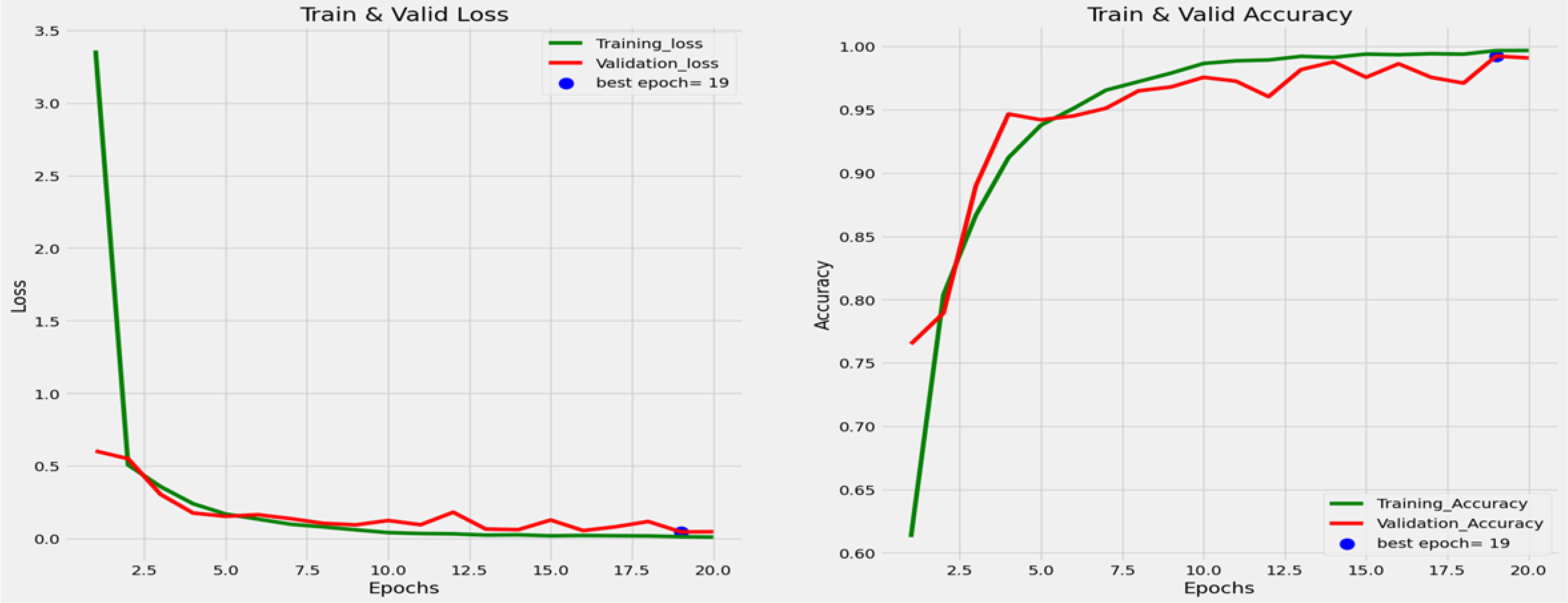
- CNNs (Convolutional Neural Networks) are powerful tools for analyzing images, capable of extracting nuanced features and patterns from complex data like MRI scans.
- Our model have 13 convolution layers, 5 max-pool layers, followed by flatten layer and fully connected layer.
- 3*3 kernels, same padding & ReLu activation for convolution layers

Image Augmentation + CNN



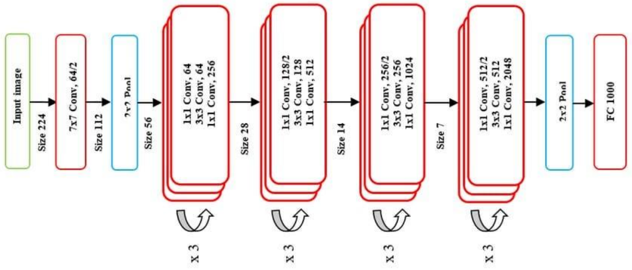
- When combined with image augmentation techniques, such as rotation and flipping, CNNs become even more effective in detecting and classifying brain tumors from MRI images, improving model performance and accuracy.
- We utilized width and height shift, zoom in-out, horizontal flipping for augmentation.

Graphs/Plots:

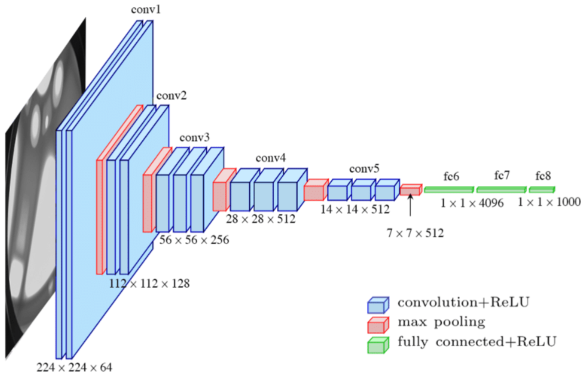


Plot of Image Augmentation of Training and Valid Loss

ResNet 50 -Transfer Learning



VGG19 -Transfer Learning



- Utilized transfer learning with ResNet50 to leverage pre-trained model for brain tumor classification, achieving reduction in resources utilization and reduction in time for training.
- Dropped fully connected layer only.
  Other model weights kept same.

- Applied transfer learning with VGG19 to enhance the classification of brain tumors from MRI scans, leveraging the model's pre-trained features for better performance.
- Unfreeze last 5 layers and trained again.

Results:

Sr. No	Model	Training Accuracy	Testing Accuracy	Validation Accuracy	Trainable parameters	Training Time (Sec)
1	CNN model	0.9961	0.9600	0.9600	21,154,180	1660
2	Image Aug. + CNN	0.9943	0.9832	0.9908	21,154,180	5740
3	VGG19 (Transfer Learning)	0.9949	0.9820	0.9800	12,651,140	800
4	ResNet50 (Transfer Learning)	0.9599	0.9420	0.9420	1,051,140	480

Conclusion:

- Our solution demonstrates improvements in performance compared to baseline models.
- Image augmentation contributes to improved model robustness and generalization.
- Transfer learning with pre-trained models yields enhanced performance, reduction of resource utilization, and reduction in training time.

Future Direction:

- **Utilizing other pretrained models:** Further exploration of utilizing transfer learning technique with other pretrained models like Inception, yolov7, yolov8, MobileNet, etc. Can improve further performance.

- **Enhanced Model Architectures**: Investigating more advanced CNN architectures designs could lead to improved performance in brain tumor classification tasks.

- **Continuous Model Improvement:** Continuously refining and updating the models with new data and insights to ensure their relevance and effectiveness in evolving healthcare scenarios.

- **Integration with Decision Support Systems**: Integrating the developed models into decision support systems to assist healthcare professionals in making accurate and timely diagnostic and treatment decisions.

Thank You!!