Brain Tumor Classification Based on MRI Images

Deep Learning and Neural Network

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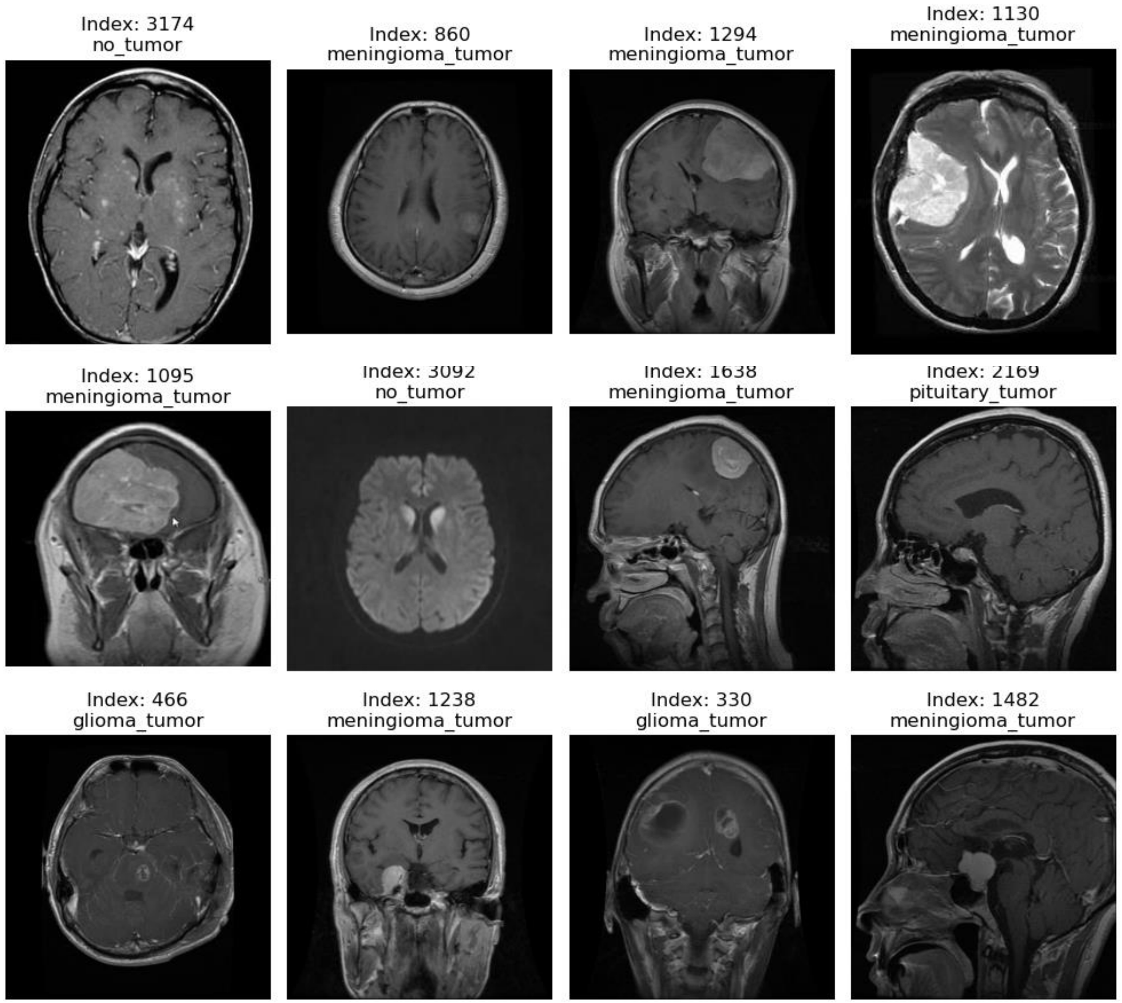
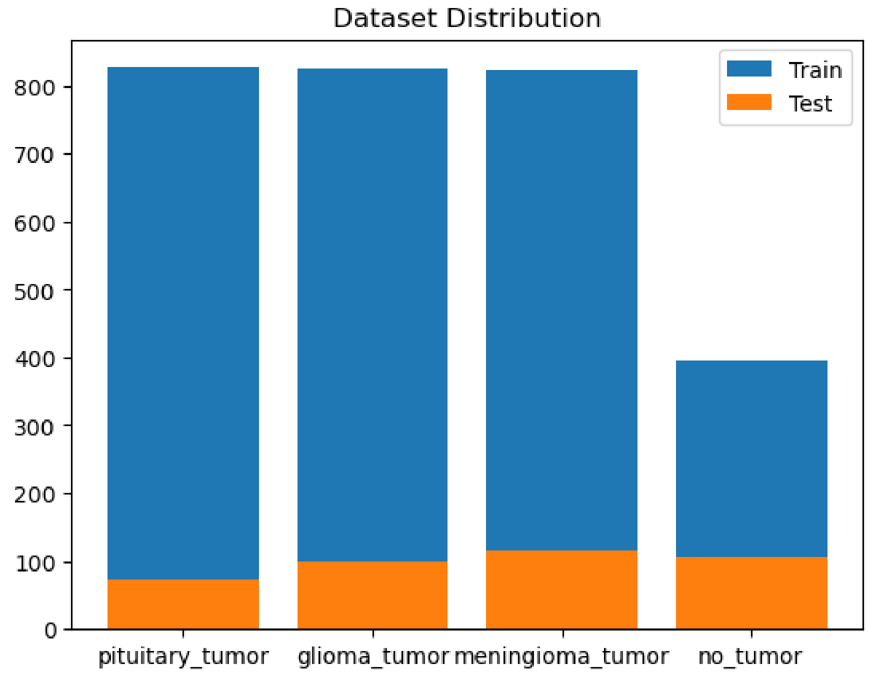
Introduction

- **Prevalence of Brain Tumors**
  - Approximately 11,700 new brain tumor diagnoses occur annually in the U.S.
  - The 5-year survival rate for brain tumor patients is around 35%.
- **Importance of Timely and Accurate Diagnosis**
  - Early and precise diagnosis can significantly improve treatment planning and outcome predictions.
- **Current Diagnostic Techniques**
  - Magnetic Resonance Imaging (MRI) is the primary method for diagnosing brain tumors.
  - MRI scans generate a vast amount of image data, posing significant challenges in analysis due to the complexity of the images and the extensive time required for manual examination by experts.
- **Advancements in Image Analysis**
  - Recent years have seen the application of deep learning techniques to enhance the analysis of MRI images, aiming to overcome limitations associated with human error and the intensive labor of manual analysis.
- **Project Focus**
  - This project develops and utilizes a deep learning-based model to classify brain tumor images, aiming to provide more accurate, efficient, and consistent diagnostic results.

Dataset

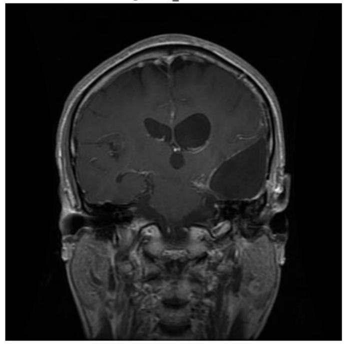




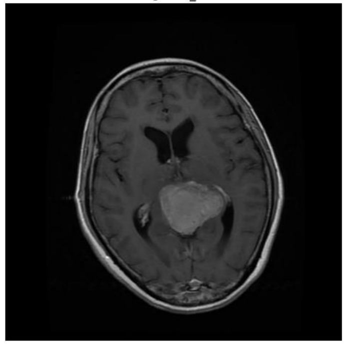
Data source: https://www.kaggle.com/datasets/sartajbhuvaji/brain-tumor-classification-mri

Image augmentation

Index: 246
glioma_tumor



Index: 1151
meningioma_tumor



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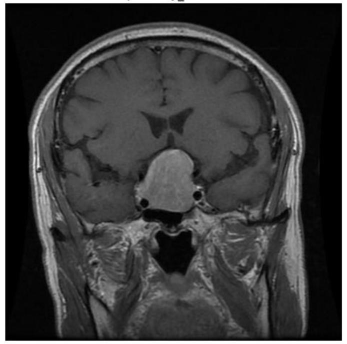
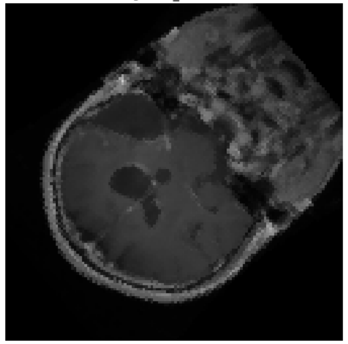
pituitary_tumor



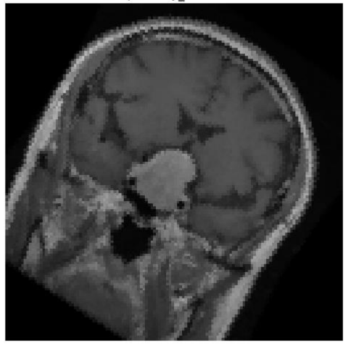
Resize to 128 x 128 pixels
50% Vertical Flip
50% Vertical Flip
50% 90º Rotation

Index: 246
glioma_tumor



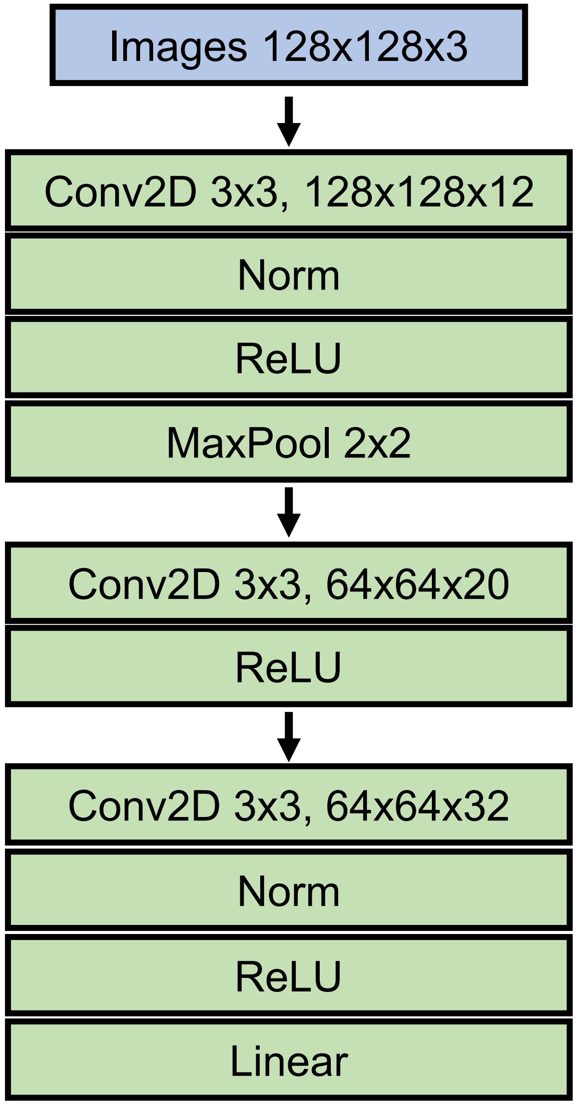
Index: 1151
meningioma_tumor

Index: 2457
pituitary_tumor

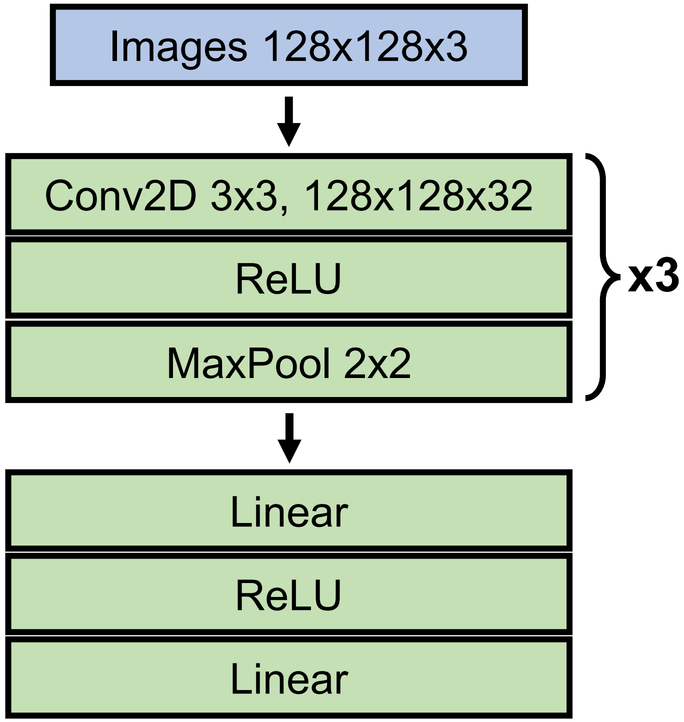


Training Models

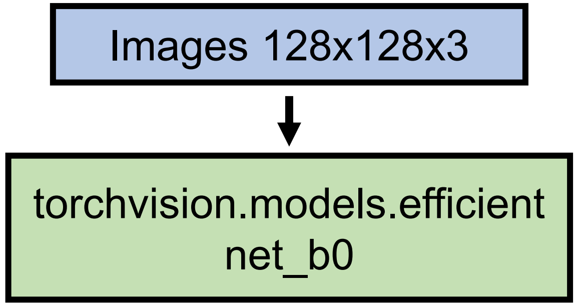
Training Model A



Training Model B

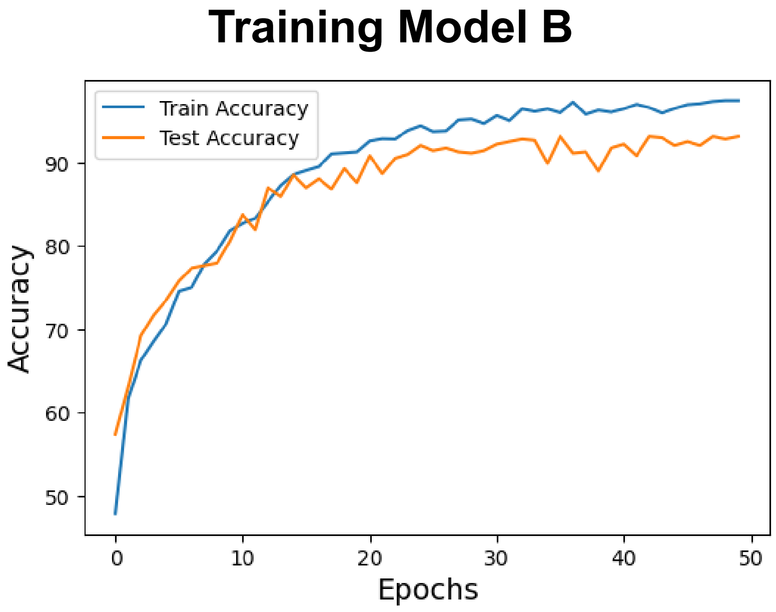


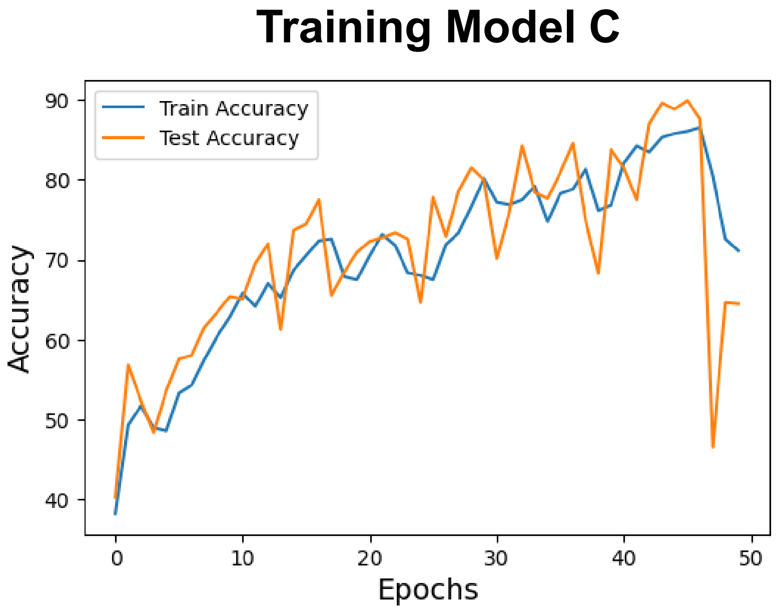
Training Model C



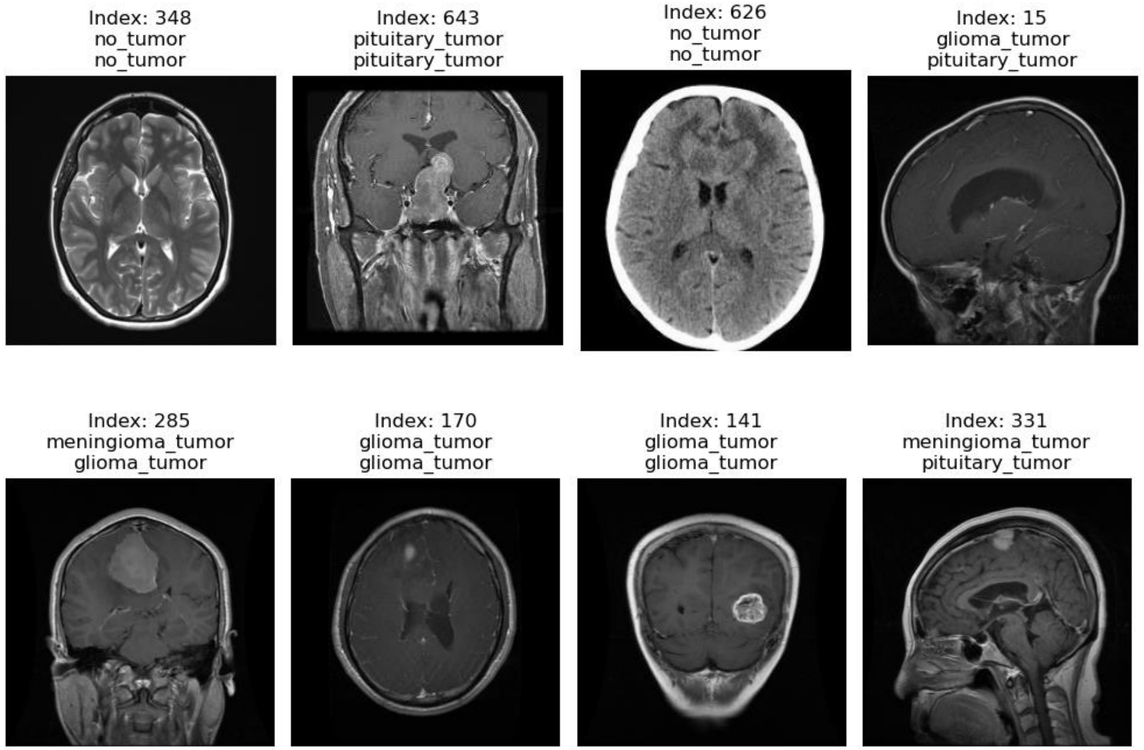
- **Model architecture:** Convolutional Neural Networks
- **Loss function:** Cross Entropy
- **Optimizer:** Adam
- **Learning step:** 0.001
- **Training time:** approx. 30 mins on GPU

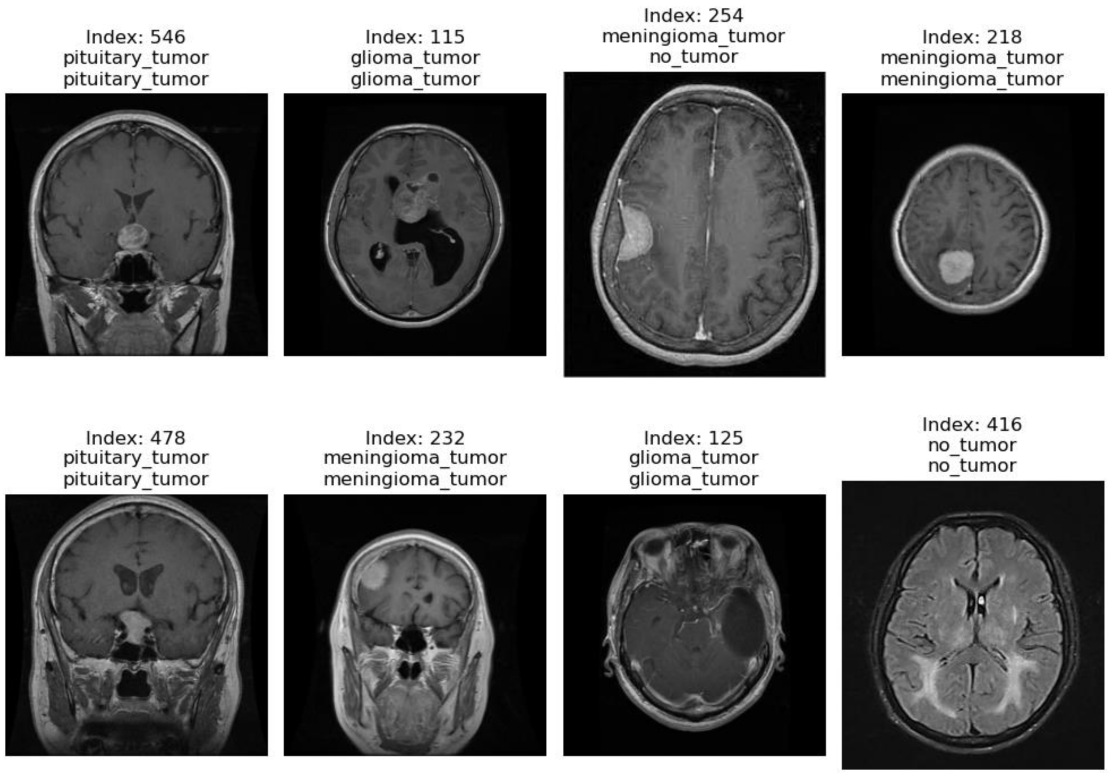
Accuracy History



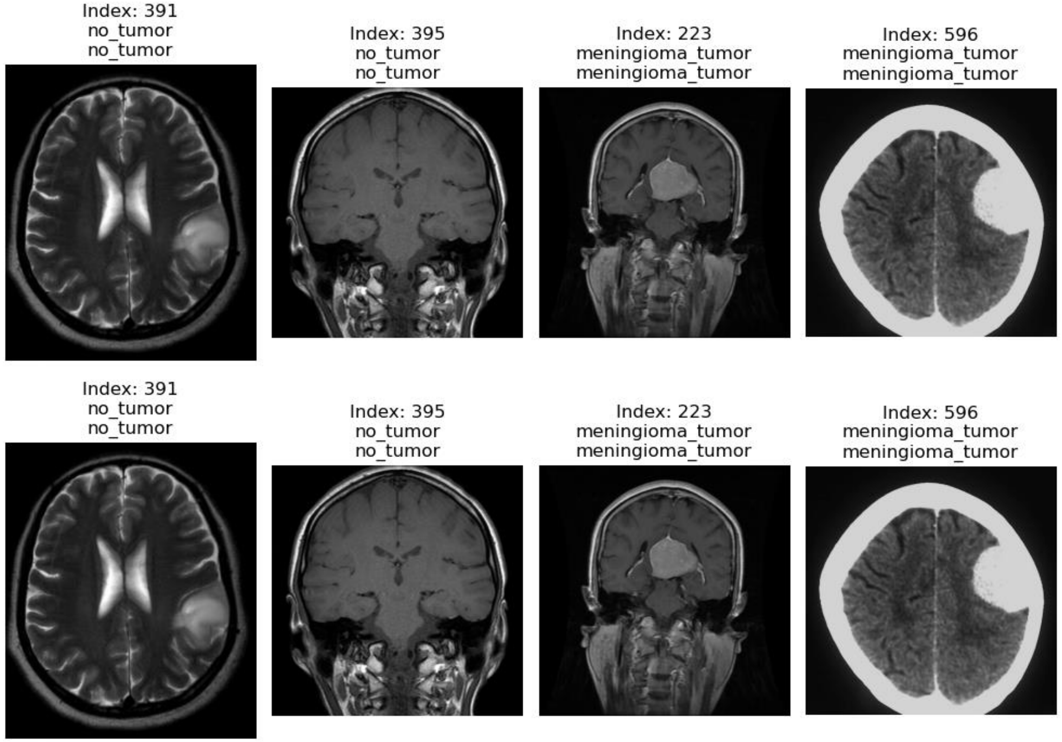


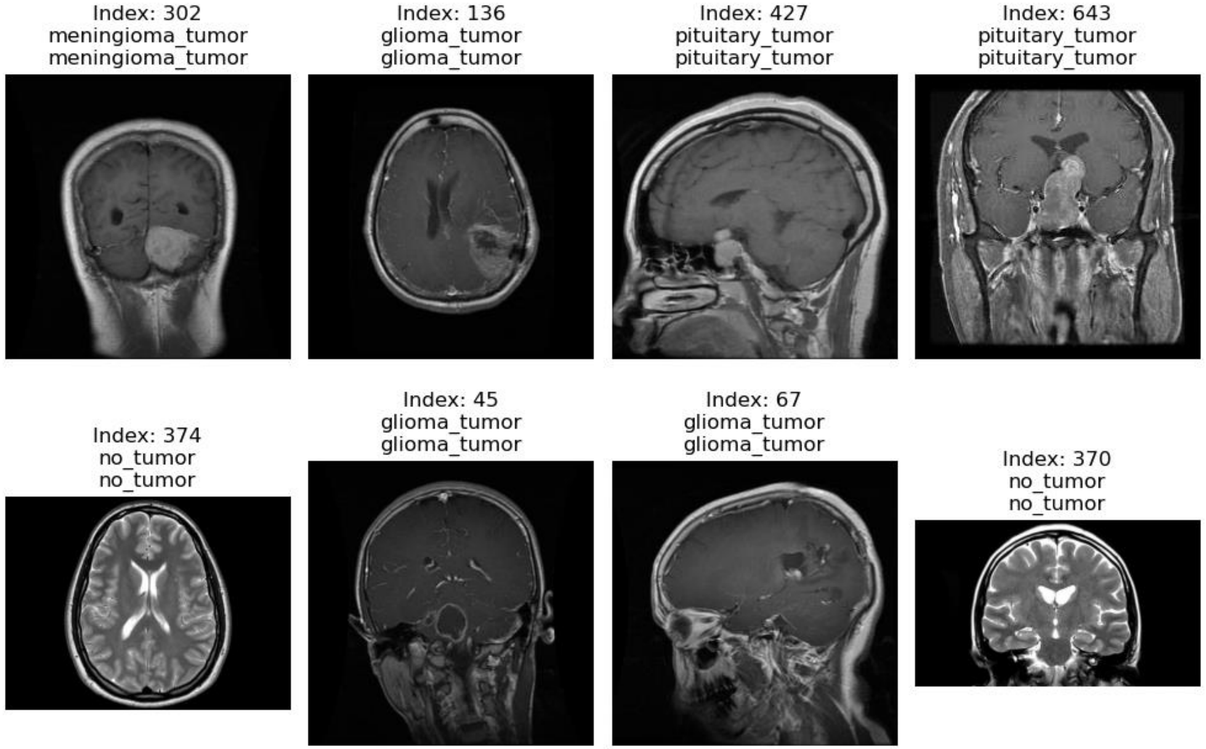
Evaluation – Model A



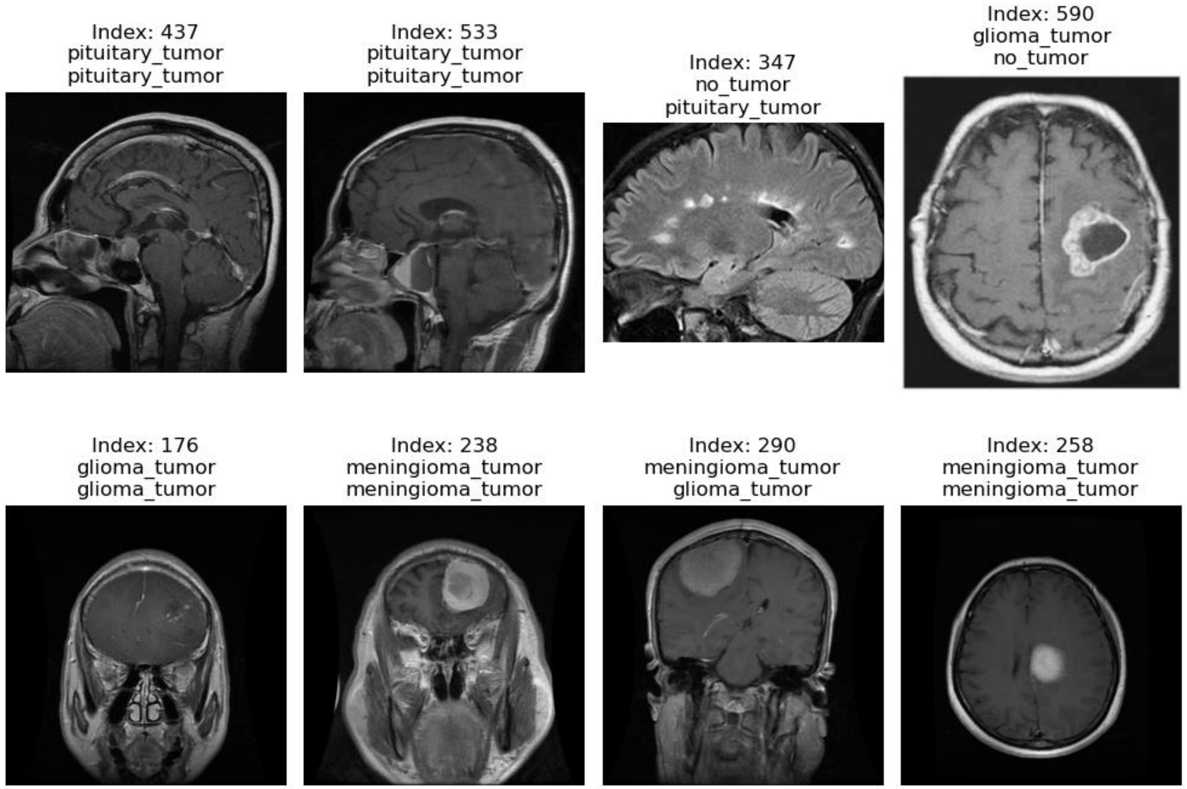


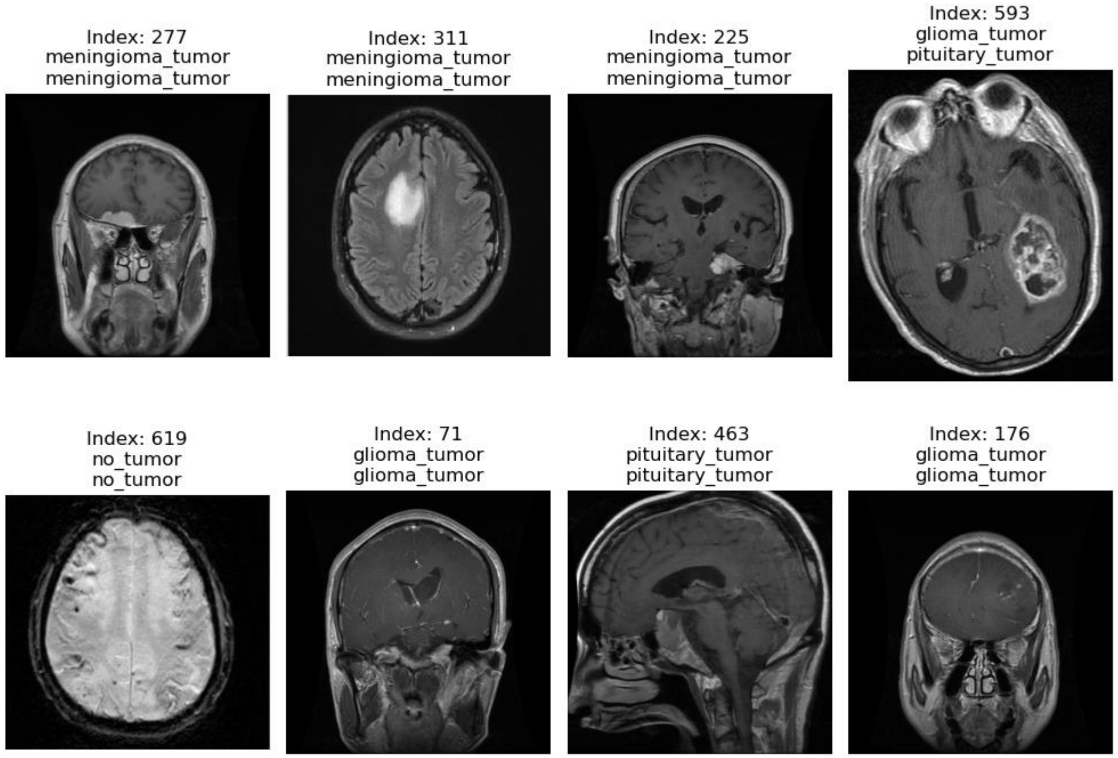
Evaluation – Model B





Evaluation – Model C





Next steps

- **Image Preprocessing**
  - **Normalization**: Standardize the intensity values across all images to reduce the variability that can negatively affect model training.
  - **Augmentation**: Techniques such as rotation, scaling, flipping, and cropping can help the model generalize better by artificially increasing the diversity of the training dataset.
  - **Noise Reduction**: Apply filters to reduce image noise that can obscure important features of brain tumors.
  - **Contrast Enhancement**: Improving the contrast of MRI scans to make tumor regions more distinguishable from normal tissue.
- **Advanced Architectures**
  - **U-Net**: Specifically designed for medical image segmentation, U-Net is a convolutional network architecture that excels in providing precise localization while classifying each pixel. This model could improve the accuracy of segmenting tumor regions from normal brain tissue.
  - **Attention Mechanisms**: Incorporate attention mechanisms within the CNN to focus more on relevant parts of the image that contain features indicative of tumors.
- **Advanced Loss Functions**: Experiment with different loss functions that might better capture the complexity of the segmentation or classification task, such as Dice loss or focal loss for handling class imbalance.