

Brain Tumor Classification Using CNN

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Abstract

Accurate classification of brain tumors is pivotal for precise medical interventions and patient care. Convolutional Neural Networks (CNNs) have emerged as instrumental tools in image analysis, particularly in medical imaging tasks. This study investigates the application of the ResNet-50, EfficientNet architectures, and DenseNet a deep CNN model, for brain tumor classification. By harnessing the architectural advancements of ResNet-50, this research automates the extraction of intricate features from magnetic resonance imaging (MRI) scans. The model exploits its depth and skip connections to effectively discern complex patterns indicative of various tumor types. The dataset employed encompasses a comprehensive range of brain MRI images, encompassing both healthy brain scans and diverse tumor categories. Experimental findings underscore the model's prowess in achieving remarkable precision, sensitivity, and specificity when distinguishing between different tumor classes. Thus, the utilization of ResNet-50 underscores its potential as a robust and efficient approach for precise brain tumor classification, contributing to heightened diagnostic accuracy and tailored medical strategies.

1 Introduction

This project focuses on brain tumor classification using the ResNet-50, efficient-Net, architecture and data augmentation techniques. By leveraging deep learning, we aim to accurately identify tumor types from MRI scans. The ResNet-50 model's depth and skip connections enable effective feature extraction, and data augmentation enhances model robustness. Our approach includes class-specific weights for balanced training and early stopping to prevent overfitting. The project's objectives encompass implementing the pipeline, evaluating accuracy, and contributing to medical image analysis advancements.

2 Data preparation

The dataset consists of brain MRI scans from diverse sources. Preprocessing involves resizing and data augmentation techniques such as flipping and grayscale

conversion. The dataset is split into training, validation, and test sets to ensure reliable evaluation. In this research paper, we utilized the brain tumor dataset introduced by Cheng, Jun, et al. The dataset comprises 3064 MRI images of the brain, acquired using T1 weighted and contrast-enhanced techniques. It encompasses three distinct categories: glioma, meningioma, and pituitary tumor. Each image within the dataset is comprehensively described, accompanied by extensive information. This includes attributes such as the patient’s identification (PID), the tumor mask, tumor border delineation, and the assigned class label. Notably, the most crucial information following the class label pertains to the lesion mask, which is crucial for isolating the region of interest (ROI) containing the tumor. For a visual illustration, refer to Figure 2 which exhibits a cropped sample.

2.1 Table 1: Summary of Used Image Dataset

class	No Images
Glioma	1321
Meningioma	1339
notumor	1595
pituitary	1457

3 Methodology

The ResNet-50, EfficientNet and DenseNet architectures are chosen for its proficiency in medical image analysis. Data augmentation techniques like resizing, flipping, and grayscale conversion enhance model generalization. Class weights are computed to address class imbalance. The training strategy includes loss functions, optimizers, and learning rates.

4 Experimental results

The model’s performance is evaluated using accuracy, but also precision, recall, and F1-score metrics. Validation and test sets can be used for assessment. Confusion matrices and ROC curves provide visualization of model behavior. Performance is compared with existing studies. The study successfully demonstrates the effectiveness of the ResNet-50 architecture and achieves accuracy of 97.5/100 , 98.5/100 using efficientNet , 98.4 /100 using DenseNet on validation, data augmentation, and class weighting in brain tumor classification. The methodology contributes to accurate medical image analysis and diagnosis.

5 Related work

Previous studies have used various deep learning architectures, data augmentation, and class imbalance handling techniques for brain tumor classification.

This project builds upon this foundation by focusing on the ResNet-50, efficientNet and DenseNet architectures, which is known for its feature extraction capabilities. Data augmentation and class weighting strategies are employed to improve model robustness.

6 Main Contribution

1.Introduction of an enhanced model to improve brain tumor diagnosis. 2.Proposal of a Brain Tumor Classification Model (BCM-CNN) based on an advanced 3D model using the ResNet-50, EfficientNet and DenseNet architectures. 3The proposed Brain Tumor Classification Model (BCM-CNN) consists of two sub-modules: (i) CNN hyperparameters optimization using an adam optimizer followed by model training, and (ii) Implementation of a segmentation model
you can find the notebook here

References

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