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Explainable Deep Learning for Neuroimaging: A Generalizable Approach for Differential Diagnosis of Brain Diseases

Authors : Nighat Bibi

Abstract : The differential diagnosis of brain diseases by magnetic resonance imaging (MRI) is a crucial step in the diagnostic process, and deep learning (DL) has the potential to significantly improve the accuracy and efficiency of these diagnoses. This study focuses on creating an ensemble learning (EL) model that utilizes the ResNet50, DenseNet121, and EfficientNetB1 architectures to concurrently and accurately classify various brain conditions from MRI images. The proposed ensemble learning model identifies a range of brain disorders that encompass different types of brain tumors, as well as multiple sclerosis. The proposed model was trained on two open-source datasets, consisting of MRI images of glioma, meningioma, pituitary tumors, and multiple sclerosis. Central to this research is the integration of gradient-weighted class activation mapping (Grad-CAM) for model interpretability, aligning with the growing emphasis on explainable AI (XAI) in medical imaging. The application of Grad-CAM improves the transparency of the model's decision-making process, which is vital for clinical acceptance and trust in AI-assisted diagnostic tools. The EL model achieved an impressive 99.84% accuracy in classifying these various brain conditions, demonstrating its potential as a versatile and effective tool for differential diagnosis in neuroimaging. The model’s ability to distinguish between multiple brain diseases underscores its significant potential in the field of medical imaging. Additionally, Grad-CAM visualizations provide deeper insights into the neural network’s reasoning, contributing to a more transparent and interpretable AI-driven diagnostic process in neuroimaging.

Keywords : brain tumour, differential diagnosis, ensemble learning, explainability, grad-cam, multiple sclerosis
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