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Deep CNN ResNet-18 based model with attention and transfer learning for Alzheimer's disease detection

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Introduction: The prevalence of age-related brain issues has risen in developed countries because of changes in lifestyle. Alzheimer's disease leads to a rapid and irreversible decline in cognitive abilities by damaging memory cells.

Methods: A ResNet-18-based system is proposed, integrating Depth Convolution with a Squeeze and Excitation (SE) block to minimize tuning parameters. This design is based on analyses of existing deep learning architectures and feature extraction techniques. Additionally, pre-trained ResNet-18 models were created with and without the SE block to compare ROC and accuracy values across different hyperparameters.

Results: The proposed model achieved ROC values of 95% for Alzheimer's Disease (AD), 95% for Cognitively Normal (CN), and 93% for Mild Cognitive Impairment (MCI), with a maximum test accuracy of 88.51%. However, the pre-trained model with SE had 93.26% accuracy and ROC values of 98%, 99%, and 98%, while the model without SE had 94%, 97%, and 94% ROC values and 92.41% accuracy.

Discussion: Collecting medical data can be expensive and raises ethical concerns. Small data sets are also prone to local minima issues in the cost function. A scratch model that experiences extensive hyperparameter tuning may end up being either overfitted or underfitted. Class imbalance also reduces performance. Transfer learning is most effective with small, imbalanced datasets, and pre-trained models with SE blocks perform better than others. The proposed model introduced a method to reduce training parameters and prevent overfitting from imbalanced medical data. Overall performance findings show that the suggested approach performs better than the state-of-the-art techniques.

KEYWORDS

Alzheimer's disease, cognitive deterioration, ResNet-18, depth convolution, squeeze and excitation, transfer learning

1 Introduction

Alzheimer's disease (AD) is a severe neurological condition. A person with AD is unable to converse, retain details, make decisions, pick up new skills, and so on (Korolev, 2014; Hazarika et al., 2023). The majority of people with Alzheimer's disease are elderly or in their early 60s. The most catastrophic of all the physical alterations is damage to brain cells. The brain areas that sustain the most significant damage are the amygdala, hippocampus, and a few additional areas that control most AD symptoms. The patient is unable to perform even the most basic tasks because learning cells are first impacted, then additional gray matter cells are destroyed. Consequently, those suffering from Alzheimer's disease experience extreme behavioral and cognitive challenges in addition to memory