Alzheimer’s disease (AD) is a progressive neurodegenerative disorder and the primary cause of dementia, impacting millions of individuals globally. Despite decades of research, the exact etiology of AD remains unclear, though it is widely believed to result from a combination of age-related brain changes, genetic predispositions (such as mutations in the APP, PSEN1, and PSEN2 genes), environmental factors, and lifestyle choices. The disease is characterized by the accumulation of amyloid plaques and tau neurofibrillary tangles, which disrupt synaptic function, lead to neuronal death, and ultimately cause cognitive decline. Early diagnosis is crucial, as AD is currently irreversible and lacks a cure.

Recent advancements in artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL), have opened new avenues for the early detection and classification of AD. Techniques such as support vector machines (SVM), random forests (RF), and convolutional neural networks (CNNs) like DenseNet-169 and ResNet-50 have demonstrated remarkable accuracy in analyzing neuroimaging data, including magnetic resonance imaging (MRI) and positron emission tomography (PET). These methods enable the identification of biomarkers and the classification of AD stages, such as mild cognitive impairment (MCI) and dementia. For example, DenseNet-169 achieved a training accuracy of 98.7% and a testing accuracy of 87.36%, outperforming ResNet-50. Additionally, wearable devices and gait analysis have emerged as non-invasive, cost-effective tools for early diagnosis, with ML models achieving up to 92% accuracy using optimized feature selection techniques like the slime mould algorithm (SMA) and particle swarm optimization (PSO).

This paper provides a comprehensive review of ML and DL approaches for AD diagnosis, emphasizing their potential to overcome limitations in traditional diagnostic methods, such as time consumption and human error. It also explores the advantages and challenges of these techniques, offering insights into future research directions. By integrating advanced algorithms with neuroimaging and gait data, this work aims to contribute to the development of efficient, real-time diagnostic tools for AD, ultimately improving patient outcomes and alleviating the global burden of this debilitating disease.