

# Application Fields and Innovative Technologies

## Deep Learning Methods for Diagnosing Mild Cognitive Impairment in the Elderly Using Multimodal Data Y Liu, Y Ai, R Wang, Z Wan. *Gerontechnology* 25(s)

**Purpose** Mild cognitive impairment (MCI) serves as a precursor to dementia, representing a common geriatric condition characterized primarily by cognitive decline. With the accelerating trend of population aging, the incidence of MCI is steadily increasing. Developing an assessment tool that combines high efficiency and sensitivity is crucial for improving early diagnosis. Traditional diagnostic methods, however, are limited by subjectivity or a single information dimension, making it difficult to comprehensively capture the complex pathological features of MCI[1]. In recent years, integrating multimodal data with deep learning methods has enabled the construction of more comprehensive disease models by combining complementary information from different modalities, significantly enhancing diagnostic efficiency[2]. The purpose of this study is twofold: (1) to propose a novel deep learning framework for integrating multimodal data to improve the automated diagnosis of MCI; (2) to compare the performance and potential advantages of this framework relative to traditional diagnostic methods. **Method** We propose a convolutional neural network (CNN)-based multimodal fusion framework. The model will be trained and tested using data from the public Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset, which includes structural MRI, neuropsychological scale scores, and clinical biomarkers from approximately 800 subjects (including both MCI patients and healthy controls). First, we utilize 3D CNN to extract high-dimensional deep features from MRI images. Subsequently, the extracted multimodal features are fused through a feature concatenation strategy. Finally, the fused features are fed into a fully connected layer for MCI diagnosis. We will use a k-fold cross-validation to ensure the robustness of the evaluation. The training process is repeated k times, and the average of the results is reported (k=5). Comprehensively evaluate the model's discriminatory performance using standard metrics including sensitivity, specificity, and the area under the receiver operating characteristic curve (AUC). Additionally, we have collected data from 70 patients with MCI for external validation of the model. To directly quantify the practical value of our deep learning-based multimodal fusion, the framework's performance will be systematically compared against three key benchmarks: MRI-only models, scale-only models, and traditional machine learning (e.g., support vector machines) applied to the same multimodal data. **Results and Discussion** Preliminary data from our study demonstrate a significant trend, with comprehensive analysis currently underway. The proposed framework is based on a comprehensive and well-designed research plan aims at achieving reliable diagnostic performance, targeting an AUC > 0.90 while aiming for high sensitivity and specificity to meet clinical screening needs. This demonstrates the value of deep learning-based multimodal fusion for capturing complex neurobiological signatures of MCI. Furthermore, this technology offers a promising adjunctive diagnostic tool for achieving low-cost, non-invasive early screening and risk stratification of MCI. In the future, through further validation and development, such models hold promise for integration into clinical workflows. They could assist physicians in early intervention decisions and drive the refinement of public health strategies.

### References

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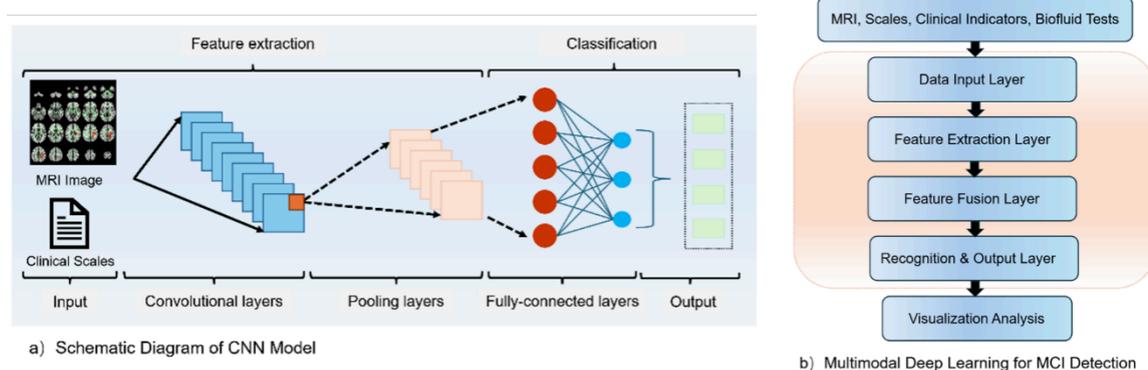


Figure 1: Architecture and Process of a CNN-Based Multimodal MCI Recognition Model