

Assessment-Driven Machine Learning for Dementia: A Study on ADNI Data

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Abstract

Early dementia screening remains limited by the cost, invasiveness, and accessibility of neuroimaging and molecular biomarkers. Cognitive assessments offer a scalable alternative, but their interpretation is challenged by diagnostic uncertainty and variability across clinical visits. In this study, we present an assessment-driven machine learning framework for dementia screening based exclusively on cognitive assessments.

Using longitudinal cognitive and demographic data from the ADNI cohort, we train lightweight classification models to estimate probabilistic diagnostic states across the cognitive spectrum (cognitively normal, mild cognitive impairment, alzheimer's disease). Rather than enforcing rigid class boundaries, the proposed approach outputs diagnosis probabilities that evolve across visits, supporting dynamic clinical interpretation.

To ensure transparency and usability, we apply SHAP (SHapley Additive exPlanations) to quantify feature contributions and establish a ranking of cognitive assessments driving model predictions. Our results show that a small subset of cognitive scores consistently accounts for most of the predictive power, achieving competitive performance while reducing assessment burden.

Overall, this work demonstrates how explainable, assessment-based machine learning can be deployed as a practical decision-support tool for dementia screening and follow-up monitoring, particularly in pre-clinical settings and resource-limited environments.

Keywords

AD screening, ADNI, cognitive assessment, machine learning.