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A Multi-Modal Approach for Early Detection and Classification of Alzheimer's Disease

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INTRODUCTION & AIM

Alzheimer's disease, a prominent type of dementia, gradually impairs cognitive and behavioral functions. There is a pressing need for diagnostic models that can detect early stages of AD with high accuracy, using subtle biomarkers and patterns that cannot be understood through traditional diagnostic methods. In order to provide predictive and suited medications, machine learning techniques are being applied more and more in the fields of disease prediction and visualization. Early diagnosis remains challenging due to subjective cognitive tests and the high cost and limited accessibility of imaging techniques. This study investigates the effectiveness of ML and DL methods in reliable multi-stage AD classification across CN, SMC, EMCI, LMCI, and AD classes.

This study aims to develop an optimized predictive framework for early and accurate Alzheimer's disease classification by:

- **Identifying the most accurate and robust modelling strategy for AD stage classification.**
- **Evaluating multiple ML and DL models using imaging and non-imaging features.**

METHOD

This paper introduces a multimodal approach where we use deep learning and machine learning techniques to acquire our desired results. The methodology consists of several sequential phases, including dataset acquisition, preprocessing of imaging and non-imaging data, model development, and comparative evaluation. The dataset used in this paper is sourced from ADNI, ADNI provides a vast database of MRI, PET, biological markers, and clinical assessments to measure the progression stages. In figure 01, proposed method is illustrated.

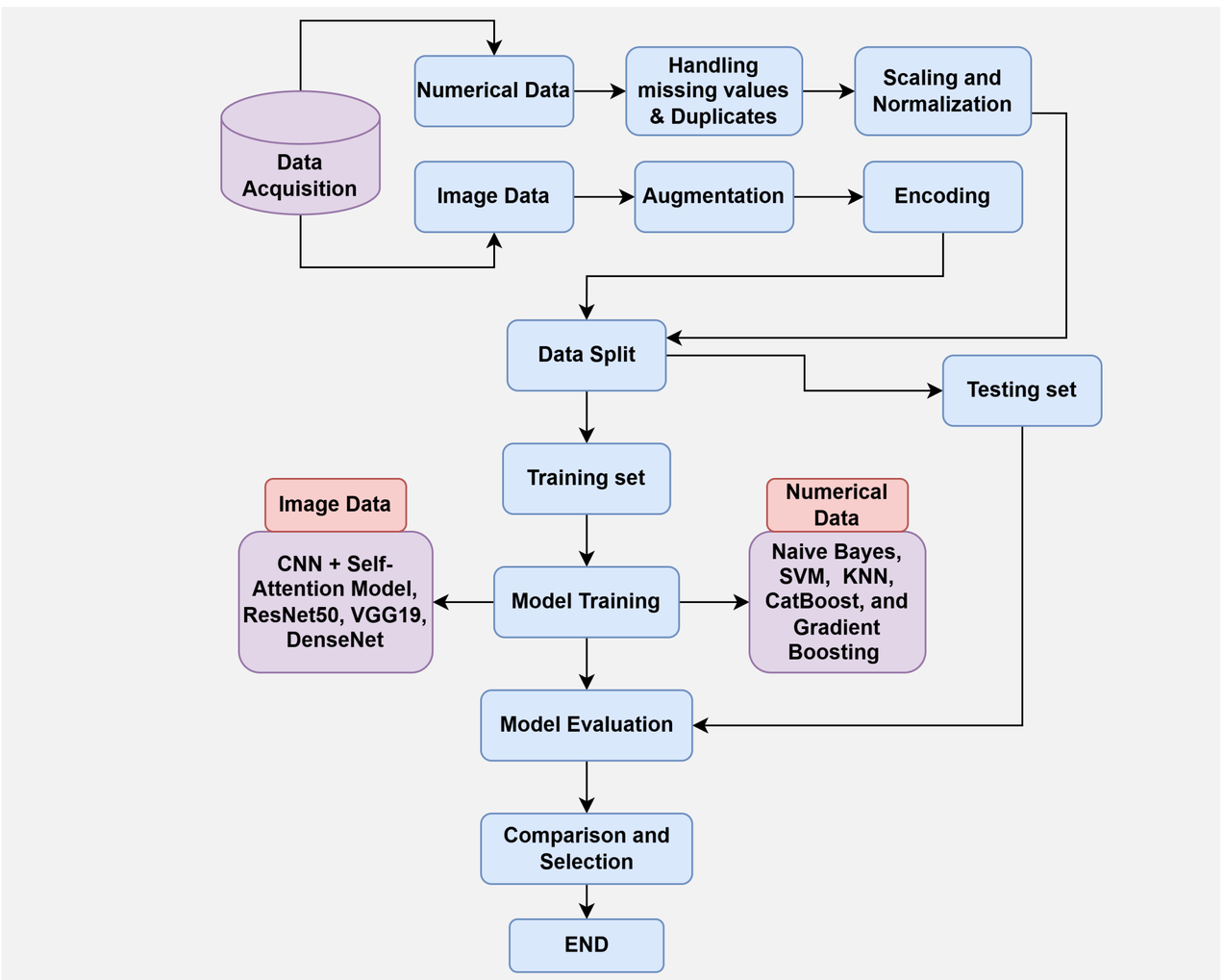

Figure 01: Proposed method

RESULTS & DISCUSSION

This section shows the result of Machine Learning and Deep Learning models, Confusion Matrix of best model.

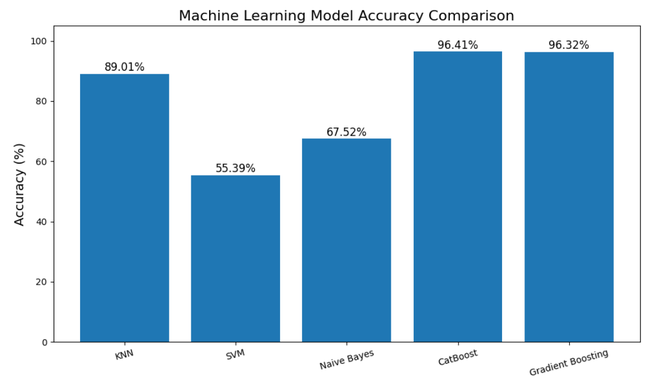

Figure 02: Accuracy Comparison of Machine Learning models

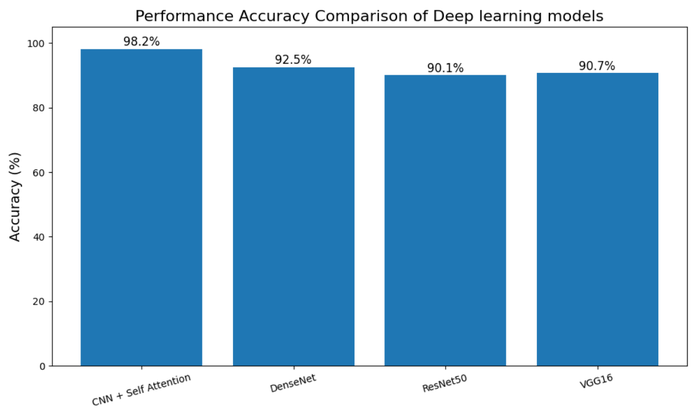

Figure 03: Accuracy Comparison of Deep Learning models

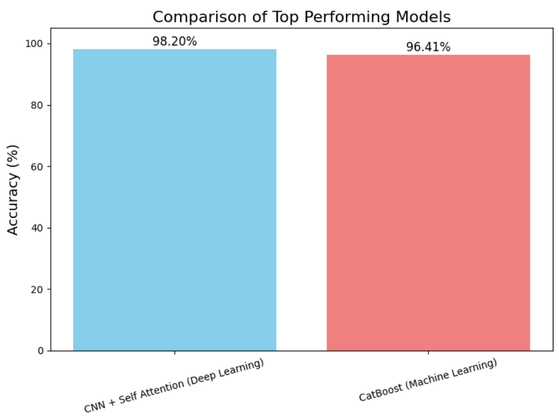

Figure 04: Comparison top performing model

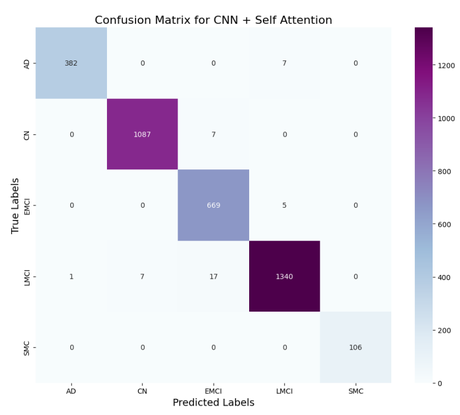

Figure 05: Confusion matrix of CNN + Self Attention Model

The results clearly highlight the advantage of adopting a multimodal approach for Alzheimer's disease classification. While traditional machine learning models performed reasonably with clinical features, they lacked the ability to capture subtle structural brain changes reflected in MRI scans. Deep learning models, especially the CNN enhanced with a self-attention mechanism, effectively captured both local and global spatial patterns in MRI slices, leading to superior performance.

CONCLUSION

The study presents a multimodal framework using ADNI data to compare machine learning and deep learning models for Alzheimer's detection. It effectively captures both spatial MRI features and longitudinal clinical information. The findings highlight AI's promising role in real-world clinical applications for early and effective AD treatment.

FUTURE WORK

Building on the integration of imaging and non-imaging data, further research could explore the incorporation of additional modalities such as genetic, lifestyle, and longitudinal clinical data. This would create a more comprehensive diagnostic system that can offer earlier and more accurate predictions of Alzheimer's disease progression, potentially leading to more personalized and effective treatment plans.