Alzheimer’s Disease Research using Machine Learning and Deep Learning Techniques

Student Name: Jessica Kamman

CWID: 10471924

Google Scholar: Alzheimers Disease Research , deep learning

References

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- https://pmc.ncbi.nlm.nih.gov/articles/PMC10565880/?utm_source=chatgpt.com
- https://www.nature.com/articles/s41467-022-31037-5
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Paper Summary

	Application	Research Task	DataSet	Data Processing	DL models	Performance Measure
1	Healthcare Application	Epidemiology Task	anonymized health insurance claims data from the Allgemeine Ortskrankenkassen	X	X	X
2	clinical decision support for Alzheimer's disease and dementia diagnosis	automated classification of cognitive impairment	Exact sources not given - The study utilizes routinely collected clinical data encompassing demographics, medical histories, neuropsychological assessments, neuroimaging, and functional evaluations	Detailed Processing not provided - The model processes a combination of clinical data, including demographic information, medical histories, neuropsychological test results, neuroimaging data, and functional assessments.	multimodal deep learning	Exact values not given -- comparing its diagnostic accuracy to that of experienced neurologists and neuroradiologists.

Paper Summary Continued

	Application	Research Task	DataSet	Data Processing	DL models	Performance Measure
3	clinical decision support for early Alzheimer's disease diagnosis	early detection of Alzheimer's disease (AD) and mild cognitive impairment (MCI) using deep learning on structural MRI scans. The study aims to develop a generalizable 3D convolutional neural network (CNN)	the Alzheimer's Disease Neuroimaging Initiative (ADNI) and the National Alzheimer's Coordinating Center (NACC).	The ADNI data were divided into training, validation, and internal test sets, while the NACC data served as an external independent test set	3D deep convolutional neural network designed to process volumetric MRI data.	The model's performance was evaluated using the area under the curve (AUC) metric. When distinguishing between cognitively normal subjects and those with either MCI or mild AD dementia, the model achieved an AUC of 85.12. In the more challenging task of detecting MCI, it attained an AUC of 62.45
4	enhancing the accuracy and efficiency of Alzheimer's disease diagnosis through automated deep learning systems	How different architectures are used for detection	Alzheimer's Disease Neuroimaging Initiative (ADNI) Open Access Series of Imaging Studies (OASIS)	**Normalization:** Adjusting data to a common scale without distorting differences in ranges. **Augmentation:** Techniques to artificially increase the diversity of training data, especially in imaging datasets. **Feature Extraction:** Identifying and selecting relevant features from raw	Convolutional Neural Networks (CNNs) Recurrent Neural Networks (RNNs)	Accuracy **Sensitivity and Specificity:** Measures of the model's ability to correctly identify positive cases (sensitivity) and negative cases (specificity). **Area Under the Curve (AUC):** Assesses the model's ability to distinguish between classes.

Outline

- Introduction
- Applications
- Studies Already Done
- Dataset Used
- Data Processing
- Deep Learning Models
- Performance Results
- Challenges Encountered
- Discussions
- Conclusions
- References

Introduction

- **What is Alzheimer's?**
  - Progressie neurodegenerative disorder → affecting millions of individual world wide
  - Despite extensive research , early and accurate diagnosis of Alzheimers remains a complex tax → overlapping symptoms with other neurological conditions

Traditional Diagnosis

- Cognitive assessments and neuroimaging → subject to high cost and late stage detection

Introduction Continued

How Can AI help?

- AI techniques are capable of analyzing vast and complex datasets, such as MRI Pet scans genetic information , and electronic health records to identify subtle patters that my elude human observation

Applications

- By using ML and DL techniques, we can enhance **early detection, improve diagnostic accuracy,** even predict disease progression
- **Biomarker Discovery** identifying which brain regions, geners or clinical features are most associated with Alzheimers this can eventual lead to better diagnostic and in the future targeted drug development
- **Reducing Diagnostic Error** i.e misdiagnostic rates for dementia
- **Drug Development and Clincial Trials**
    - AI models can identify ideal candiates for clinical trials

Introduction- Data and Techniques

Data

- Data was supplied by ADNI, early in the research it was iniated to contact ADNI and get approved for real human Brain Scan Images

Techniques

- **Convulational Neural Networks (CNNs)**
  - **USE Case:** Classification between AD vs MCI vs HC
  - **Why:** CNNs are excellent as identifying spatial patterns in 2D or 3D brain images

- **3D**
  - **Use Case:** Full Brain Scan classification
  - **Why:** MRI/PET data is inherently 3D and 3D CNNs can capture spatial relationsips across Slices

Introduction- Techniques

- **U-Net**
  - **Use Case:** Brain image segementation for example hippocampus, white matter, lesions
  - **Why:** U-Net is designed for biomedical image segmentation with excellent results even on small datasets

- **Autoencoders**
  - **Use Case:** Feature extraction, anomaly detection, denoising
  - **Why:** Useful in unsupervised settings or for compressing image data
- **Hybrid Models (CNN + RNN)**
  - **Use Case:** Sequental image data or progression modeling over time
  - **How:** CNN extracts spatial features where RNN/LTSM models the temporal aspects over certain years