Deep Learning Final Project Proposal (Title subject to change)

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1 Introduction

Alzheimer's disease (AD) is a major healthcare problem worldwide, affecting 24 million of people worldwide [4]. It is the leading cause for dementia, and the sixth leading cause for deaths in the United States [2]. Given its prevalence, detecting the disease early is critical for healthcare. Detecting Alzheimer's disease, however, is challenging because most patients experience a sporadic form, characterized by a late onset [1]. Therefore, it is important to devise different methods to identify early markers of the disease.

Recently, deep learning methods have shown significant capabilities to address several challenges in medical diagnosis, including diagnosing AD before the onset of the disease. This is the goal of our final project. Several researchers have used deep learning models to tackle this problem. For example, the authors of [2] built a 3D Convolutional neural network to diagnose mild AD, reporting an Area Under the Curve (AUC). Moreover, the authors of [5] have compared the performance of 2D, 3D convolutional networks and recurrent neural networks in diagonosing the disease from brain MRIs images. Building upon the recent work, we will also study this problem with a varienty of neural networks as we will explain later in this proposal.

2 Problem Statement

Alzheimer's Disease (AD) is a debilitating neuro-degenerative disorder affecting millions. Early detection is imperative to manage and possibly decelerate its progression [7]. We aim to leverage the OSAIS MRI dataset to develop a machine learning model capable of predicting AD onset before clinical symptoms are apparent.

3 Dataset

We will employ the OSAIS MRI dataset, consisting of more than 80,000 brain MRI images classified into four stages of AD progression. The dataset's volume and classification granularity make it great for training a deep neural network.

4 Machine Learning Model

Our model will be based on a Convolutional Neural Network(CNN), tailored to recognize patterns indicative of AD in MRI scans. We anticipate some degree of customization to adapt the CNN to the specific features of AD-related changes in brain structure.

5 Implementation Framework

- **Selection:** We will utilize PyTorch as our software framework to implement the neural network model.

- **Justification:** PyTorch offers dynamic computation graphs that facilitate more intuitive model development and debugging. It also provides a seamless experience for carrying out tensor computations with GPU acceleration, which is advantageous for handling large-scale datasets such as the OASIS MRI dataset.

6 Performance Evaluation

The model's efficacy will be measured using the following metrics:

- Accuracy
- Precision
- Recall
- F1 score

A separate set of images, not included in the training dataset, will be used to validate the model's predictive capabilities.

7 Reference Materials

To support the development and application of our neural network model, we will utilize the following key reference materials:

- "Deep Multi-Branch CNN Architecture for Early Alzheimer's Detection from Brain MRIs" by Paul K. Mandal and Rakesh Mahto. This paper provides insights into a specialized CNN architecture designed for high-accuracy Alzheimer's disease stage classification [6].
- "Preclinical Stage Alzheimer's Disease Detection Using Magnetic Resonance Image Scans" by Fatih Altay, Guillermo Ramon Sanchez, Yanli James, Stephen V. Faraone, Senem Velipasalar, Asif Salekin. This study is crucial for understanding early Alzheimer's detection approaches using MRI and applying machine learning techniques to such data [3].

8 Timeline

The project will follow this schedule:

- **Weeks 1-2:** Dataset preparation and initial exploratory data analysis.
- **Weeks 3-4:** CNN architecture selection and preliminary model training.
- **Weeks 5-6:** Model refinement and hyperparameter tuning.
- **Weeks 7-8:** Performance evaluation and model validation.
- **Week 9:** Final analysis and compilation of results for presentation.

References

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