La Cueva High School

Multimodal Convolutional Neural Network for Alzheimer Detection:

Interim Report

Kyuryeon Kim, Peter Duanmu, Ishya Guha

Supercomputing 2024

22 January 2024

Alzheimer's disease, named after Dr. Alois Alzheimer, is a brain disorder that slowly destroys memory and thinking skills and, eventually, the ability to carry out the simplest tasks (National Institute on Aging 21). Alzheimer's is the most common cause of dementia and accounts for 60-80% of dementia cases. It is a chronic neurodegenerative disease that causes the brain to shrink and brain cells to die. This disrupts how electrical charges travel within cells and the activity of neurotransmitters. Experts suggest that more than 6 million Americans age 65 and older may have Alzheimer's and unless an effective treatment can be unearthed, that number will only continue to increase (Alzheimer's Association 24).

Recently, more and more machine learning has entered the biological field, specifically in detecting and classifying diseases. Particularly, for Alzheimer's disease, machine learning models such as the one created by Feng et al. propose machine learning algorithms utilizing magnetic resonance imaging (MRI) images (Feng et al. 22) to diagnose individuals. However, MRI imaging devices are not available to the general public. Thus, we propose a machine-learning model that utilizes data that is available to anybody who wishes to diagnose themselves without having to pay expensive hospital fees. The first dataset that will be used distinguishes people diagnosed with Alzheimer's and people without Alzheimer's using their handwriting. The DARWIN dataset with the handwriting data contains 174 instances of people writing (Fontanella 22). Second, we hope to use a dataset from DementiaBank that contains speech data of Alzheimer's patients. However, we are currently having trouble getting access, so we may need to alter our project heavily depending on whether or not we can access the data.

Our machine learning model will be a multimodal convolutional neural network written with PyTorch and Python in order to predict the probability of the user having Alzheimer's. We

plan on making a CNN similar to the one presented in the paper by Ma et al.'s proposed multimodal CNN (Ma et al. 15).

In order to create a modular system in which any segment could be replaced and upgraded with ease, we plan to use a three-step system where the machine learning model, the backend interface for the model, and the app are separate. For the machine learning model, we plan on using PyTorch for its portability and ease of use. For the backend interface (which we will call the API), we plan on using ExpressJS to provide a simplistic API that any users or the app itself could use. This API will be created in a way where it can be easily read and modified, to allow for easy collaboration. Although it is not yet finalized, we plan on creating an iOS app written in Swift, as the Swift language is easy to read, use, and is inherently a safe (strongly-typed) language.

Currently, we have begun progress on creating the backend of the API, and have started the progress of requesting access to the high-quality dataset. We already have access to the handwriting dataset. We hope to create a machine-learning model with >90% accuracy and an app that can be used by anybody for a quick at-home diagnosis.

References

Feng, X., Provenzano, F.A., Small, S.A. et al. A deep learning MRI approach outperforms other biomarkers of prodromal Alzheimer's disease. *Alz Res Therapy 14, 45 (2022).* https://doi.org/10.1186/s13195-022-00985-x

Fontanella, Francesco. (2022). DARWIN. *UCI Machine Learning Repository*. https://doi.org/10.24432/C55D0K.

Ma, Lin, et al. "Multimodal Convolutional Neural Networks for Matching Image and Sentence." *ArXiv.org*, 29 Aug. 2015, doi.org/10.48550/arXiv.1504.06063. Accessed 23 Jan. 2024.

What Is Alzheimer's Disease? | National Institute on Aging. (2021, July 8). National Institute on Aging. Retrieved January 22, 2024, from https://www.nia.nih.gov/health/alzheimers-and-dementia/what-alzheimers-disease

What is Alzheimer's Disease? Symptoms & Causes | alz.org. (n.d.). Alzheimer's Association. Retrieved January 22, 2024, from https://www.alz.org/alzheimers-dementia/what-is-alzheimers