

Analysis of Senior Project Report

Project Title: AI Alzheimer's Early Detection via MRI Processing

Student Names: Lucas Frey, Arti Jain, Sid Sharma

Advisors' Names: Professor Helen Yu, Professor Richard Murray

Summary of Functional Requirements

Overall, ADetect will take in MRI brain scan images and return a diagnosis using a primary method that indicates whether the patient has Alzheimer's Disease (AD) or not. The primary method is through wavelet transformations through MATLAB, while the other method consists of analyzing convolutional neural networks through Python programming. In both methods, image processing is the key to detecting whether or not the patient at hand has AD.

Primary Constraints

ADetect is bound to have several constraints including and not limited to limited MRI scans, specification compatibility, and meeting an accuracy standard of 90% or higher. Given that there are only some databases we have access to in order to use the brain scans, our model will have to make do with these resources. This is a constraint since machine learning algorithms achieve high levels of accuracy when they are fed large sets of data. In order to boost accuracy, we would have to increase the amount of data used, which means gaining access to more MRI scans. Additionally, the amount of time the machine learning models take to give accurate results is also a constraint. Finally, this project must meet all of the marketing and engineering requirements outlined earlier while meeting or exceeding a 90% accuracy standard.

Economic

Human Capital: ADetect has the capability to disrupt the demand for human capital as it serves to automate MRI scans and deliver diagnoses, which is work that primarily radiologists and physicians do. While this allows the physicians to focus on other more critical tasks, the demand for radiologists may decrease once the product is implemented on a large scale. Additionally, given that ADetect requires monetary measures in order to be successful, hospitals will have to pay to use our service. Finally, once the product is

implemented throughout the healthcare industry, scaling up of ADetect will create jobs in disciplines like engineering, software development, technical support, marketing, sales, etc.

Financial Capital: ADetect allows hospitals to save large amounts of money as radiologists and physicians will have more time to focus on their higher priority tasks. In order for our customers to save this kind of money, they would have to invest in our product and continue to use it.

Natural Capital: Given that our product is a software package, it will be implemented within MRI scanning systems that require electrical or other forms of power.

If Manufactured on a Commercial Basis

Given that ADetect is a software package product, there are no physical and manufacturing costs to be considered in our analysis. ADetect will be a software package that hospitals will be able to install on their MRI scanning systems and computers. Hospitals can purchase this through various forms through a subscription, with options of paying per use or per month.

Manufacturability

As stated previously, ADetect is a software package that will require software development, image processing, and machine learning in order to detect AD. This means that there are no inherent manufacturing challenges that we are bound to face, especially considering that the use of the product would be through downloading our application. Although this is the case, our customers would be required to have a computer in place with MRI scanning and internet connectivity.

Environmental Impact

There are potentially several environmental impacts of ADetect, especially in the design and testing phases of the product. As we continue to train our machine learning model and use the wavelet transformation approach, significant computing and processing power are required over several hours, if not days, given the number of scans we are able to process. This computing and processing power will most likely use electrical energy that comes from nonrenewable

resources, which contributes to global warming. Once the product is designed and implemented by hospitals into their systems, using the product will require significantly less computing and processing power, although depending on factors such as the hospital's primary power use, internet download speed, and other similar factors play a role in adding on environmental effects. Our product also has the ability to reduce animal testing depending on the accuracy rate and system specifications. If our method provides high rates of accuracy, researchers and medical facilities won't have to use animal testing or other forms of testing to use subjects to find ways to detect AD. Finally, the use of MRI machines uses radiation that is emitted by magnets and metal coils within the system. These components may degrade over long periods of time and must be properly recycled in order to minimize their waste and pollution to society.

Sustainability

Once ADetect has been implemented, providing product support and maintenance to meet specifications and accuracy will be minimal. The issue regarding sustainability with ADetect comes primarily through when we would have to roll out updates of the software package, especially if our machine learning algorithms and wavelet transformation process has been tweaked. If there are changes made in the code and the model would have to be re-trained, this would require significant time and energy. One other issue is that our product is dependent on the healthcare industry continuing to use MRI systems in order to diagnose AD and other such neurodegenerative diseases. If the use of these systems decreases in industry, our customer base would also begin to decrease. Finally, MRI scanning systems use power over time and consist of several machines in itself, in addition to requiring cooling of the system.

Ethical

ADetect has a few ethical concerns regarding privacy and environmental impact. For privacy, customer data protection is of utmost importance since our product is handling people's private medical information and records. It is essential that those who use our service are assured security for their patients concerning the information that is put through our algorithm along with the results we report back. For the design, our infrastructure will need to be very secure so there is no risk of data leaks. We will need to disclose our partnerships with research clinics like Johns Hopkins Research Lab, especially if they will also be getting access to the medical information.

We will need to ensure that our customers also disclose this information to their patients. In regards to the environmental concerns, running this software will require considerable energy and power usage, as outlined earlier, which makes it important to make our algorithm as efficient as possible. Finally, this product should reflect the accuracy we claim it has to our customers. They are relying on the fact that our service will not give out false diagnoses and that they can trust our results to use to treat patients. This means that we need to be upfront about any problems with the product and any glitches that are present.

Health and Safety

Since our software package is not a product that can cause physical harm or threaten new safety features, it does come with similar considerations that must be made when our customers use their respective MRI systems. Due to large amounts of power, voltage, and currents, patients must not include any metal objects or items that may cause harm to the system in place, since the large frequencies in the system could also cause harm. Another consideration to make is that our product could play a part in providing a false negative result for the patient. If the customer does not take sufficient time to ensure the result and seek a second opinion, the wrong diagnosis could be conveyed to patients. This would create its own problems as those without AD would now believe that they do, and those with AD would believe that they don't. Although not a common case, this must be considered and communicated to the stakeholders at hand.

Social and Political

ADetect carries various potential social and political issues throughout the implementation process. Given that we would be able to detect AD in patients before they show any physical symptoms or in general, earlier on in the process, this could have repercussions for the patients and their families. Although they would now have time to make lifestyle changes, it is something that they would be wary about and carry a burden on their health and potentially their families as well. Our product simply focuses on the detection and the diagnosis, and unfortunately, there is no ultimate cure for AD as of now. Additionally, as mentioned earlier, our product plays a role in automating medical professional responsibilities, especially those of radiologists who primarily look at scans and diagnose patients. Some political considerations can be made and reviewed regarding what organizations accept donations from politicians.

Additionally, it may help to gain support and awareness from political figures in order to spread the news surrounding AD and our product.

Development

Through developing the project, we will be learning various different technologies including MATLAB for image processing, database extraction for the MRI scans, and Python programming for machine learning algorithms and diagnosis. We will also become familiar with cloud services to run our application, especially through Amazon Web Services (AWS). Through our research, we also got to read several IEEE research reports relating to similar goals in terms of furthering research in neural networks performing in the medical field.