# Detecting and Classifying Alzheimer's Disease From MRI Scans using Convolutional Neural Networks

**Alex Burns, Isaac Burns, Allen Arani, Victor Artiles, Dr. Nouhad Rizk**

**College of Natural Sciences and Mathematics, University of Houston**

## Abstract

Alzheimer's disease is a degenerative neurological illness affecting over 7 million adults over the age of 65 in the United States. Early detection of Alzheimer's can give people the best chance of receiving effective treatment. A popular method of identifying the structural impact caused by Alzheimer's is through magnetic resonance imaging (MRI). This study proposes that machine learning, specifically Convolutional Neural Networks (CNN), can aid in the early detection of Alzheimer's by extracting features from a dataset of MRI images. The Neural network model was trained with a series of MRI images from a dataset ranging from Non-Demented to Moderate Demented. This approach resulted in a classification accuracy score of 95%. This model was compared to random forest and support vector machine models (SVM), both of which provd to be less accurate than the CNN model. This project builds off related research by also attempting to classify the stage of the disease in addition to detecting the presence of Alzheimer's, providing additional support for doctors to assign a correct diagnosis with minimal delay.

## Background

This study will incorporate machine learning as a means by which the presence and severity Alzheimer's Disease can be more readily assessed.

Alzheimer's Disease affects up to 32% of adults over age 85 and presents the following symptoms: short-term memory loss, paranoia, delusions, and aggression. Currently, there is no way to reverse the effects of Alzheimer's. Instead, treatment focuses on mitigation and prevention. To achieve best results, it is important to diagnose the condition early, but it may take years to receive an accurate diagnosis by traditional methods.

Several publications use machine learning to predict the existence of Alzheimer's Disease from MRI images, but do not attempt to classify the severity.

We've achieved a significantly high SVM accuracy score: a reproducible 99% while the next highest score in other research is approximately 95%

## Methods

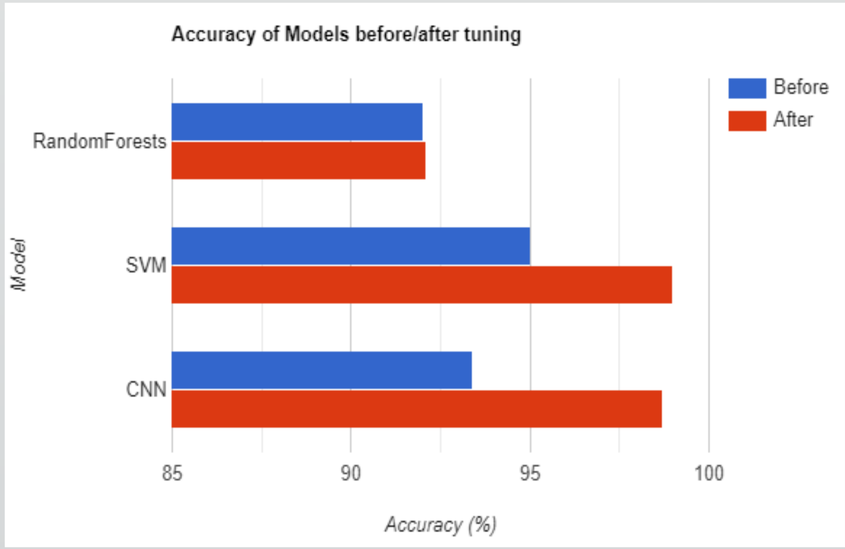
**Data Collection**
This study uses the Alzheimer's Dataset (4 Classes of Images) from Kaggle. This dataset contains 6,400 grayscale 178x206 MRI images classified by severity, ranking from Non-Demented, Very Mild Demented, Mild Demented, and Moderate Demented.

**Preprocessing**
We performed normalization on the data so that all pixel values were transformed into float values between 0-1. The data was label encoded ranging from 0-3 so as to train the model to distinguish between all classifications. We performed flattening on the data for the SVM and Random Forest models during preprocessing, while this was saved for a later step in our CNN model. For the CNN model, we performed data augmentation, though this was skipped in other models due to hardware limitations.

**Hyperparameter Tuning**
We used the Grid-Search method from the scikit library to find the best parameters for the Random Forest and SVM models. For our CNN model, we used the hyperband method to optimize the parameters. This resulted in an improvement of 4-5% for CNN and SVM respectively. No improvements were observe with tuning for RF

**Methods**

Random forests - collections of decision trees used for classification.
SVM - A flexible linear model for classifying nonlinear problems. It uses a kernel to operate in original feature space without calculating multi-dimensional space
CNN - A deep learning algorithm that assigns weights and biases to differentiate features in an image




## Results

| | Training Time | Initial Accuracy | Final Accuracy |
|---|---|---|---|
| Random Forest | 1m 22s | 92.08% | 92.08% |
| SVM | 10m 21s | 93.40% | 99.27% |
| CNN | 7m 17s | 93.40% | 98.70% |

## Conclusion

The experiment was resoundingly successful, with all models achieving over 92% accuracy. This indicates that machine learning is an extremely promising tool for detecting the presence of Alzheimer's and diagnosing the severity.

## Future Direction

We believe that future researchers would benefit from using a larger dataset, such as the ADNI Alzheimer's dataset. Likewise, we believe it would be promising to explore identifying more classifications, particularly with the goal of diagnosing preclinical Alzheimer's Disease.

## Acknowledgments

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