Application for ADHD Detection Using Machine Learning and Deep Learning Algorithms from EEG and MRI



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# Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder affecting millions of people around the world. Providing immediate intervention and assistance is critical when this condition is diagnosed early and accurately.

Deep learning and machine learning are potential approaches for enhancing the detection of ADHD disease. This project aims to create a user-friendly application that utilizes Machine Learning and Deep Learning techniques to detect ADHD and provide rapid results based on EEG signals and MRI scans.

# Problem Statement

As the worldwide prevalence rate of ADHD for school-age children is approximately 5%, Approximately 60% of preteens continue to suffer from symptoms into adulthood ADHD is characterized by developmentally inappropriate inattention, motor overactivity, and impulsiveness [[1]](#_[1]_Chen,_He,).

Normally when an EEG (electroencephalogram) or MRI test is done the data is analyzed by a neurologist and the results are finalized after 48 hours. Sometimes it takes several days for a patient to receive their results. Also, there is no platform (website/application) where users can submit their EEG/MRI data and get quick results. Using the Deep Learning technique CNN, the goal is to address these problems by reducing the time required for analyzing EEG signals and MRI reports to predict ADHD disease while achieving the highest accuracy of results and making a user-friendly platform where users can get instant results. This innovation benefits neurologists by providing them with more timely insights from EEG/MRI data and caters to the need for an accessible platform for locals to submit their data and receive results.

# Objectives of the Research/Project

The primary objective of this system is to create a machine learning algorithm that analyzes the EEG data accurately from individuals suffering from Attention Deficit Hyper Disorder (ADHD) and provides precise results taking the minimum possible time. Some of the other goals are:

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| **Objectives** | **SDGs** |
| Implementing a Machine / Deep Learning algorithm that analyzes EEG / MRI data accurately from individuals suffering from Attention Deficit Hyper Disorder (ADHD) and provide precise results taking the minimum possible time. | SDG 3: Good health and well-being |
| Train a ML / DL model to expedite ADHD diagnosis by analyzing EEG signals and MRI Scans rapidly and accurately, aiming to reduce diagnosis waiting times. | SDG 3: Good health and well-being |
| Strive for the highest accuracy in ADHD detection, minimizing false positives and false negatives to enhance diagnostic reliability. | SDG 3: Good health and well-being |
| Implement effective data pre-processing techniques to enhance EEG signal analysis quality, including noise reduction, artifact removal, and signal refinement. | SDG 3: Good health and well-being |
| Identify and deploy the most suitable machine learning algorithms for ADHD diagnosis through EEG signal analysis, rigorously assessing their performance. | SDG 3: Good health and well-being;  SDG 17: Partnerships for the goals |
| Validate the ML model's accuracy and reliability using real EEG data from individuals with and without ADHD, comparing its performance against clinical standards. | SDG 3: Good health and well-being;  SDG 17: Partnerships for the goals |
| Make the ML model accessible to healthcare professionals and patients seeking ADHD diagnosis, to significantly reduce assessment time and enable early intervention. | SDG 3: Good health and well-being;  SDG 10: Reduced inequalities |
| Collaborate with healthcare institutions, neurologists, and experts to gain insights, enhance the model, and share knowledge for the broader medical community's benefit. | SDG 17: Partnerships for the goals |

# Literature review

## Machine Learning Methods for diagnosing ADHD Disorder Using functional and Structural MRI: A Survey

This article it is discusses how ML and DL show promise in identifying ADHD and ASD, Deep Learning has overfitting issues in neuroimaging. Model opacity impedes interpretation, and clinical integration may be hampered by resource restrictions. Disparities in data distribution have an impact on model generalizability, underscoring the importance of standardized data formats such as BIDS. For 3D and 4D data, extensive training times necessitate high-performance computation. Combining sMRI and fMRI data improves performance, while data augmentation and transfer learning provide opportunities for improvement in predicting models for brain illnesses.[[2]](#_[2]_Eslami,_T.,) The dataset used in this survey was provided by the ADHD-200 consortium [[3]](#_[3]_Z._W.).

## Abnormal Functional Resting-State Networks in ADHD: Graph Theory and Pattern Recognition Analysis of fMRI Data

This study focuses on how graphs might help us comprehend ADHD, a disorder that affects youngsters. We utilized several metrics to determine if we could tell the difference between healthy children and those with ADHD based on brain scans. It wasn't very good at distinguishing between all children with ADHD and healthy children, but it did better when we looked at distinct types of ADHD. This demonstrates that ADHD does not manifest itself the same way in every child. The way we obtained the data and whom the students have affected our results significantly, therefore we must be cautious when comparing them. We also discovered that certain areas of the brain, such as those associated with movement and thinking, provided us with useful information about ADHD. This helps us better understand ADHD and encourages us to be cautious when studying the brain.

The model used is SVM for the classification and the highest achieved accuracy across multiple sites was 65%, while site-by-site accuracy was 77%.[[4]](#_[4]_Anderson_dos)

## ADHD Detection Using Machine Learning Algorithms and EEG Brain Signals

This study investigates the use of EEG to better understand ADHD and its diagnosis. The first section uses a discrete wavelet transform to extract EEG data and analyzes machine learning algorithms, with LS-SVM obtaining the highest accuracy at 96.49%. The second section highlights the necessity of early ADHD diagnosis and applies a variety of machine learning algorithms, with LS-SVM demonstrating the highest accuracy once again. These findings underline the importance of EEG and the LS-SVM algorithm in ADHD diagnosis and therapy.[[5]](#_[5]_A._T.)

# Features

## Accessibility:

The Application can be used to detect ADHD without the need for expensive equipment, making it accessible to a wider range of individuals, regardless of their location or their financial status.

## Efficiency:

The app will be using Machine Learning Models and Deep Learning algorithms to achieve high diagnostic accuracy and sensitivity, meaning it can reliably identify individuals with ADHD even in cases where the cases are mild or atypical or in the early stage.

## Feedback:

The app can provide users with timely feedback on their diagnostic predictions, allowing them to quickly and easily access the information required for them to make informed decisions about their health.

## Recommendation:

The App can also generate recommendation notes to the patient for further treatment, if necessary, in the later versions.

## Data Privacy and Security:

The App would implement strong privacy and security measures to ensure the protection of the user's (patient’s) personal/medical data.

# Research Methodology

**Agile Scrum:**

For this specific project, which involves the development of a web application for ADHD detection using Machine Learning (ML) and Deep Learning (DL) models, the Agile Scrum methodology is a strong candidate. Here's why Agile Scrum is well-suited for this project:

**Advantages:**

**Flexibility:** This project's needs will vary as we develop ML/DL models or collect additional data; the flexibility of Agile Scrum will allow us to adapt to these changes.

**Iterative Development:** We may incrementally create and improve our ADHD detection features, releasing useable versions of the program in short cycles.

**User Involvement:** A medical application requires close coordination with healthcare professionals, clinicians, and potential consumers. Agile Scrum places a premium on continuous customer feedback.

**Risk Management:** The iterative nature of Agile Scrum allows us to identify and manage issues early, which is critical when working with sensitive medical data.

**Continuous Improvement:** Agile Scrum promotes continual progress, and the project can profit from adopting new developments in ML/DL research as they become available.

**Cross-Functional Teams:** Scrum facilitates collaboration among engineers, data scientists, and domain specialists, which fits our project's multidisciplinary nature.

Agile Scrum provides a balance between flexibility and structure, making it an excellent solution for a wide range of software development projects, including medical applications such as ADHD detection.

# Contribution to the Field /Utilization of Results

The proposed project adds significant value to the field of medicine in the early detection of ADHD disease. The Convolutional neural network (CNN) is a mainstream deep learning algorithm. However, the application of deep learning techniques in attention deficit hyperactivity disorder studies is still limited [[1]](#_[2]_Eslami,_T.,). Electroencephalography (EEG) is an informative neuroimaging tool that can be used to obtain signals from the brain which we use in algorithms for the prediction of ADHD. Other Contributions to the fields are given below.

* **Accessibility for Locals:** A notable contribution of our project is the development of an accessible platform for local individuals to submit their EEG data and receive rapid results. This addresses the lack of existing applications or websites catering to the local population's needs, improving access to healthcare services.
* **Enhanced Accuracy:** By exploring various data preprocessing techniques and machine learning algorithms, our project seeks to determine the most effective methods for ADHD detection. This contribution will enhance the accuracy of diagnoses, reducing the risk of misdiagnosis and improving patient outcomes.
* **Bridging the Healthcare Gap:** By offering a platform for ADHD diagnosis tailored to the local community, our project directly addresses a gap in accessible healthcare services. It ensures that individuals and healthcare professionals in our community have a convenient and efficient means of obtaining critical diagnostic information.
* **Societal Impact:** By improving the efficiency and accuracy of ADHD diagnosis, our project has the potential to reduce the societal burden of undiagnosed or misdiagnosed cases, ultimately benefiting individuals, families, and communities.

# Work Plan

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| **Phase** | **Schedule** |
| Literature Review | 1 Week |
| Data Sets | 1 Week |
| Preprocessing | 1 Week |
| Feature Extraction Using Time Frequency Analysis | 2 Weeks |
| Model Selection | 1 Week |
| Fine Tuning | 2 Weeks |
| Model Training | 2 Weeks |
| Model Validation | 1 Week |
| Performance Analysis | 1 Week |
| Results | 1 Week |
| Front-End UI | 3 Weeks |
| Backend | 6 Weeks |
| Thesis | 17 Weeks |

# References

[1] Chen, He, Yan Song, and Xiaoli Li, "A deep learning framework for identifying children with ADHD using an EEG-based brain network," Neurocomputing, vol. 356, pp. 83-96, 2019.

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[5] A. T. Swadi and F. S. Miften, "ADHD Detection Using Machine Learning Algorithms and EEG Brain Signals," Journal of Education for Pure Science-University of Thi-Qar, vol. 13, no. 1, pp. 43-55, 2023.

**Recommendation by the Committee Members:**

1. Name

Signature\_\_\_\_\_\_\_\_\_\_

2. Name

Signature\_\_\_\_\_\_\_\_\_\_

3. Name

Signature\_\_\_\_\_\_\_\_\_\_

**Approval by the In charge of the Software Department**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_