SVM-Based Innovative Assessment Of A Marker Of Inflammation For The Prognosis Of Mild Cognitive Impairment To Front Temporal Lobar Degeneration Dementia Disease

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ABSTRACT

Frontotemporal disorders (FTD), sometimes known as frontotemporal dementia, are instigated with damage to neurons in temporal and frontal regions of the brain. There are a wide variety of symptoms which can appear, including unusual behavior, emotional concerns, communication challenges, career difficulties, & walking difficulties. Frontotemporal dementia (FTD) is one of the most frequent types of dementia, and its symptoms and neurobiological hallmarks overlap to some extent. The proper diagnosis and identification of disease indicators is essential for effective patient monitoring. Differentiating amongst Alzheimer’s disease (AD) & FTD utilizing unsupervised as well as supervised machine learning in MRI scans of the brain. And also classifying the types of frontotemporal dementia.

Keywords— Neuro-Cognitive, Prodromal, Dementia, Neuro-Imaging, PRISMA

I. INTRODUCTION

The symptoms and brain fingerprints of Alzheimer's disease (AD) & FTD are distinct but sometimes overlap. This makes a correct diagnosis more difficult, if not impossible, to make. On the other hand, prognosis & illness monitoring need precise characterisation of longitudinal trajectories. Automated or semi-automated methods are currently being added to clinical research, showing potential for computer-aided diagnosis in the future. ML methods in this area make use of clinical & biomarker data to discover patterns which may be utilized for the differential diagnosis and follow-up of diseases.

The use of MRI for the diagnosis of neurodegenerative diseases has become commonplace. CTh & GM volume loss patterns have been documented in Alzheimer's disease (AD) & FTD utilizing structural MRI. Furthermore, in a prior work involving both disorders, we demonstrated that unique patterns of brain shrinkage might be helpful in distinguishing between AD & FTD. More recently, ML systems use measurements generated from MRI to distinguish between these conditions. The outcomes of those approaches are promising. However, because to the enormous number of characteristics required, the resulting approaches may be computationally costly and challenging to deploy in clinical situation. It may also be difficult to acquire spatial patterns of the characteristics driving categorization. Both of these problems reduce the algorithms' usefulness and their capacity to be understood by humans. Frontotemporal dementia is a collective term used to categorize dementias that primarily affect the temporal and frontal regions of the brain. The relationship between personality, conduct, and language is widely believed to be associated with specific regions of the brain. In individuals diagnosed with frontotemporal dementia, there is observed atrophy, or a reduction in size, of specific lobes within the brain. The manifestation of specific signs and symptoms is contingent upon the location of the brain that has incurred damage. Certain individuals diagnosed with Frontotemporal Dementia (FTD) may experience a decline in their ability to effectively utilize language, while others may exhibit behaviors that are socially inappropriate, impulsive, or emotionally detached. Frontotemporal dementia has the potential to be misdiagnosed as a psychiatric disorder or even Alzheimer's disease. In contrast to AD, frontotemporal dementia often manifests in younger people. Dementia of the frontal lobe often manifests around ages of forty and sixty-five, however it may manifest at any age. Ten percent to twenty percent of all instances of dementia may be attributed to
FTD. Some examples of frontal lobe tauopathies include FTD, CBD, supranuclear palsy, chronic & advanced Alzheimer's disease.

Early signs are:

- The use of profanity, theft, a rise in interest of sex, or a decline in personal cleanliness are all signs of a possible personality or behavior disorder.
- Inappropriate, erratic, or compulsive actions in social situations.
- Judgment impairment.
- Apathy.
- Unable to empathize.
- Reduced capacity for introspection.

FTD are of 2 types:

Behavioral variant FTD – when injury to prefrontal cortex is primary source of behavioral & character issues. These regions, situated below forehead, are responsible for processing data relevant to the regulation of behavior and emotion. They assist us in making plans, identifying issues, and maintaining concentration for sufficient time to complete a project.

Primary progressive aphasia (PPA) happens when language centers of brain (temporal lobes, which are located on both sides of head, next to ears) suffer injury. In brain, this region has several purposes. The left temporal lobe plays a crucial role in remembering the significance of words & names of things. Right temporal lobe is responsible for the recognition of faces & objects in most individuals.

II. RELATED WORK

Prediction of moderate cognitive impairment & dementia employing EEG technology as neural biomarker [14]. The three-way categorization of HC, MCI, & DD using discovered EEG biomarkers had an accuracy of above 70%. Impact of DD-related neurodegeneration upon EEG measures had greatest impact in parieto-occipital areas across 6 groups. The results of this research suggest that EEG may be a valuable screening tool for the early detection and assessment of MCI and DD.

Extreme-learning-machine-based multimodal data grading technique for predicting progression from mild cognitive impairment to dementia Dementia may be effectively treated earlier if doctors can determine which people with MCI have a high chance of developing the condition. Therapeutic Advances in Neurological Disorders, Volume 6: "Current and Future Treatment for Dementia Disease" In both developed and developing countries, dementia is being recognized as a major health and social issue affecting the elderly population. To yet, the only therapies for this condition are symptomatic, and they all aim to restore a healthy balance of neurotransmitters. For treating of mild to severe DD, three different CIs are now on market. ADNI subjects having MCI had their baseline as well as multiple follow-up MRI scans analyzed using high-dimensional pattern classification to explore possibility of predicting short-term converting to DD upon person-by-person basis. Those with MCI who progressed to DD (mean follow-up, 15 months) showed markedly diminished. In this work, the approach was applied to ADNI database, where it successfully segmented 145 patients with DD, 294 patients having MCI, as well as 166 aged normal participants. Segmentation was found to be satisfactory in 94% of instances using a qualitative assessment technique. We utilized gathered hippocampus volumes to automatically categorize those with DD, MCI, & elderly as a control group. When compared to elderly controls, categorization utilizing just hippocampus volume was accurate for 76% of patients with DD alongside 71% of MCI transitioning to DD before 18 months.

III. PROPOSED SYSTEM

Methods for predicting if individuals with mild cognitive impairment would progress to Dementia illness dementia or stay stable were systematically reviewed according to PRISMA standards. We started with 452 research and after deleting duplicates, narrowed it down to 116 for further review. Frontotemporal dementia subtypes, including Behavioral variant FTD & PPA, are also shown.
IV. METHODOLOGY

One popular ML method for classification & other forms of learning is support vector machines. SVM may be properly described as discriminant classifier with the help of an ideal hyperplane. The result is a support vector for ideal hyperplane, that may be used to categorize fresh data sets. This hyperplane is line that divides 2D space into two equal halves, one on each side. For instance, the square & dot datasets were used to provide a positive interpretation for multiple line data categorization. Choosing the best hyperplane to use might be challenging since it has to be able to generalize data sets without being affected by noise. Specifically, support vector machines (SVMs) seek for a hyperplane with the smallest possible distance to the training data. Linearly separable data may be represented in 2D mathematical notation by using a line. The line has the equation \( y = ax + b \). The equation becomes \( ax_1x_2 + b = 0 \) if we replace \( x \) with \( x_1 \) and \( y \) with \( x_2 \).

The equation of hyperplane is \( w \cdot x + b = 0 \), and it is obtained by specifying \( X = (x_1, x_2) \) & \( w = (a, 1) \).

This paper derives the optimization problem for SVMs.

Estimating \( w \) & \( b \) of ideal hyperplane necessitates solving a performance problem in which geometric edge of each pattern has to be more noticeable to \( M \).

Max \( w, b M \); Subject to \( y_i \geq M, i = 1 \ldots m \) (1)

If \( M = F/\|w\| \) equation is written as:

\[
\text{Max } w, b M; \text{ Subject to } y_i \geq M, i = 1 \ldots m \tag{2}
\]

In the event where \( w \) & \( b \) are rescaled, \( M \) will still be enhanced; the consequence of this enhancement will not alter. The preceding equation changes to if we rescale \( w \) and \( b \) and set \( F = 1 \).

Max \( w, b 1/\|w\| \); Subject to \( y_i \geq M, i = 1 \ldots m \) (3)

The corresponding minimization problem is proportional to this maximizing problem and may be expressed as

Min \( w, b /\|w\| \); Subject to \( y_i \leq 1, i = 1 \ldots m \) (4)

Similar to the corresponding minimization problem, which is expressed as

Min \( w, b 1/\|w\| \); Subject to \( y_i(1-wx-b)-1=0, i = 1 \ldots m \) \tag{5}

Above remark concerns the SVM optimization issue.

SVM classifier

The ultimate goal is to use hyperplane for predictive purposes once we get it. The role of hypothesis of \( H \) is:

\[
H(x) = \begin{cases} 
+1 & \text{if } w \cdot x \geq 0 \\
-1 & \text{if } w \cdot x < 0 
\end{cases}
\]

Tuning parameters

Understanding the SVM's operation requires familiarity with terms like "kernel," "regularization," & "gamma."

Kernel

Kernel is a method in machine learning for transforming data which is inherently inseparable along non-linear dimensions into dimensions which can be separated along those dimensions. The rationale behind it is that information that is not linearly segregated in N-dimensional space may be so in high M-dimensional space. Mathematically, kernel indicated as \( K(a, b) = \langle F(a), F(b) \rangle \).

Wherein \( K \): Both the kernel function and the inputs \( a, b \) have \( n \) dimensions. An N-to-M mapping is denoted by the letter \( 'F' \) (i.e., \( M > N \)).

Mapping in kernel is termed as \( K(a, b) = \emptyset (a), \emptyset (b) \).

Kernel Functions: Some of the available kernel functions are listed below.
Polynomial Type: which is a popular notation for nonlinear modeling,
\[ K(a, b) = (a, b)^d \quad (6) \]

Gaussian Radial Basis Type: Gaussian distributions dominate among the radial basis functions represented by
\[ = -k(a, b) \exp\left(-\frac{ab^2}{2\sigma^2}\right) \quad (7) \]

Exponential Radial basis: whenever discontinuity are appropriate, the function generates a bitwise linear solution.
\[ = k(a, b) \exp\left(\frac{ab}{2\sigma^2}\right) \quad (8) \]

Many more operations, including multilayer perceptron, Fourier, additive, and tensor product operations, are also available.

Regularization
Both the SVM’s optimization & fraction of outliers that manage to escape classification are clarified by regularization parameter (C). When C is high, hyperplanes used to classify training data are correct; when C is low, optimizer seeks a greater margin to separate hyperplanes, leading to more misclassifications.

Gamma
The effect of individual training data is described. Due of the high gamma, records close to the separation line are taken into account. In a similar vein, datasets with low gamma values which are far from separation line will be considered during line's computation.

Pseudocode of SVM
\[
\text{while there are violating points do} \\
\text{Find a violator} \\
\text{patientSV = patientSV S violator} \\
\text{if any qP < 0 due to addition of c to S then} \\
\text{patientSV = patientSV \ P} \\
\text{repeat till all such points are pruned} \\
\text{end if} \\
\text{end while}
\]

V. SYSTEM ARCHITECTURE

![Figure 2: System Architecture](image)

The aforementioned setup takes a patient’s brain picture in, and then uses an SVM algorithm for classification upon it. Model distinguishes between FTD, bvFTD, & PPA.
VI. RESULTS AND DISCUSSION

In previous study, Alzheimer disease is detected using machine learning algorithms, in our system frontotemporal disease is predicted using SVM classifier.

![Figure 3: Login](image)
This logins the system

![Figure 4: Menu](image)
In this system, reading the patient brain image, performing preprocessing, segmentation, feature extraction and classification

![Figure 5: Read Image](image)
This module accepts the brain image of the patient

![Preprocessing Image]

Figure 6: Preprocessing

This module removes noise and converts the image into gray color

![Threshold Image]

Figure 7: Threshold

Shows the brain image's threshold value. A straightforward technique for visually separating an image's foreground and background elements. This method of image analysis is a subset of segmentation which operates by transforming grayscale photos into binary ones.

![Prediction Image]

Figure 8: Prediction

Predicted as frontotemperal disorder (FTD)

VII. CONCLUSION

People with frontotemporal dementia need to be treated. Some of major health challenges which has stumped doctors all around globe is dementia. Furthermore, the majority of victims were above the age of 60. There are currently no effective treatments for Alzheimer's disease, and the condition may have devastating effects upon an individual's recollection and capacity to go about their everyday lives. Since the early 2000s, a sizable group of medical professionals & software engineers have been studying this issue in depth. Dementia detection prediction still relies heavily on the identification of key parameters. We used SVM technique for dementia prediction and classification and obtained optimal results using effective values. In future further additional dataset should use as well diagnosis and treatment details should add.
REFERENCES

[14] Neural biomarker diagnosis and prediction to mild cognitive impairment and Dementia disease using EEG technology
Bin Jiao, Rihui Li, Hui Zhou, Kunqiang Qing, Hui Liu, Hefu Pan, Yanqin Lei, Wenjin Fu, Xiaoaan Wang, Xuewen Xiao, Xixi Liu, Qjie Yang, Xinxin Liao, Yafang Zhou, Liangjuan Fang, Yanbin Dong, Yuanhao Yang, Haiyan Jiang, Sha Huang & Lu Shen,
[15] Predicting Dementia Disease Conversion From Mild Cognitive Impairment Using an Extreme Learning Machine-Based Grading Method With Multimodal Data [2020] Weiming Lin,1,2 Qinquan Gao,2,3 Jiangnan Yuan,1,4 Zhiying Chen,5 Chenwei Feng,1,4 Weisheng Chen,6 Min Du,2,7 and Tong Tong