Analysis of the Alzheimer's Disease: Stages, Challenges, Risk Factors, and Soft Computing Methods: A Review

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***Abstract*—**Alzheimer's disease (AD) is a syndrome that reasons the disintegration of brain cells and it is the central origin of dementia, which is considered a failure in rational and liberation in individual day-to-day activities. Alzheimer's disease is investigated by using soft computing methods. This article discusses soft computing as an intelligent method utilized in every field. Also, numerous causes of this disease and risk factors such as old age, chromosomal factors, family history of head damage, vascular illnesses, impurities, and ecological factors show a part in the syndrome. In soft computing, detection methods such as heuristic and meta-heuristic optimization methods are described. Furthermore, several advantages and disadvantages of these methods also represent analyzed the results of the specific method.

Keywords*—Alzheimer's Disease; Brain Cells; Soft Computing; Challenges.*

I. INTRODUCTION

Alzheimer's syndrome was exposed by a German Neurobiologist and Psychoanalyst named Alois Alzheimer in 1906. Earlier Alzheimer's innovation in 1906, experts and the nonscience public observed dementia as a "normal" movement of the stage of development, and senility was recognized as old, according to Natalie Whaley. Alzheimer's syndrome was detected in August by a 51-year-old female in the maximum time. Her family members observed rare behavioral variations in her nature and approved her to Dr. Alois for Alzheimer's in 1901. The personnel described difficulties with memorial damage, talking effort, lack of decent judgment, incomprehension with interval and place, and sophisticated logical thinking. Advanced Dr. Alzheimer described that female has a deadly form of dementia, remembrance deficiency, and difficulty with linguistic and behavioral variations. He also distinguished numerous other irregular indications, comprising fast disposition fluctuations, natural variations, loss of initiative, and long-time sleeping compared to normal. Dr. Alois trailed her for around five years till she expired in 1906. After passing away, he accomplished an analysis and originated a theatrical reduction of the intellectual cortex, statement of heavy figures in body fluid containers, and atrophied brain tissues [1].

Alzheimer's Disease (AD), a practice of dementia, is considered through advanced, sophisticated, and behavioral difficulties that initiate in middle or old age. The pathological features are neuritic signs in the Human Brain and the collapse of unambiguous brain cells [2]. Dementia is a disorder that grows mainly in grown-up or grown people and disturbs brain functionality, regular activities, and conveying productivity [3]. Alzheimer's infection signifies the general procedure of adults beginning dementia [4]. In 1907, Alois Alzheimer initially addressed a case of intelligent descent using the histological results of disorientated signs and neurofibrillary masses [1]. A projected around 4.5 million cases of this Disease in America and, as the aging people stay to produce, the incidence could rise threefold to 13.2 million in 2050 [5].

In figure 1, two images are shown first as the healthy Brain not affected by Alzheimer's Illness and second (b) showing the consequence of Alzheimer's Disease on the Brain. The development appears more shocking. According to the observation, in 2020, around 70% of the people sixty years old in the world are alive in rising nations, with 14.2% in India. Earlier information proposes that this disease's old age familiar occurrence is 1.91% of the population in the south Indian area of Kerala, as a portion of the reasoning in older adults in the Trivandrum learning [6]. The informed occurrence rates for this disease have been subordinate in Asian nations than in the developed domain [7]. The influence of this disease on healthcare expenditures, containing direct and indirect health and social facilities, are presently projected to be better than $100 billion annually [1]. In accumulation, there is presently no treatment for this disease. So, the main challenges for the near upcoming will be the development of novel treatments and beneficial goals for disease adjustment and avoidance. The symptoms grow gradually and become serious adequate to delay regular life.

Various existing methods are developed with soft computing for Alzheimer's disease prediction. Dr. B. Geethavni et al., [8] offered a soft computing model based on the DL model for Alzheimer's disease prediction. That was offered DL methods such as CNN, probabilistic autoencoder, and the composition of these binary CNN and probabilistic autoencoder. This model utilized an MRI image dataset termed Alzheimer's-disease Neuroimaging Initiative (ADNI) for this disease. I.A. Illán et al., [9] proposed a fully automatic CAD structure for refining the precision in the initial AD analysis. The estimated scheme is constructed on automatic feature selection, a combination of component-based SVM classification, and a pasting elections method of gathering SVM classifiers.

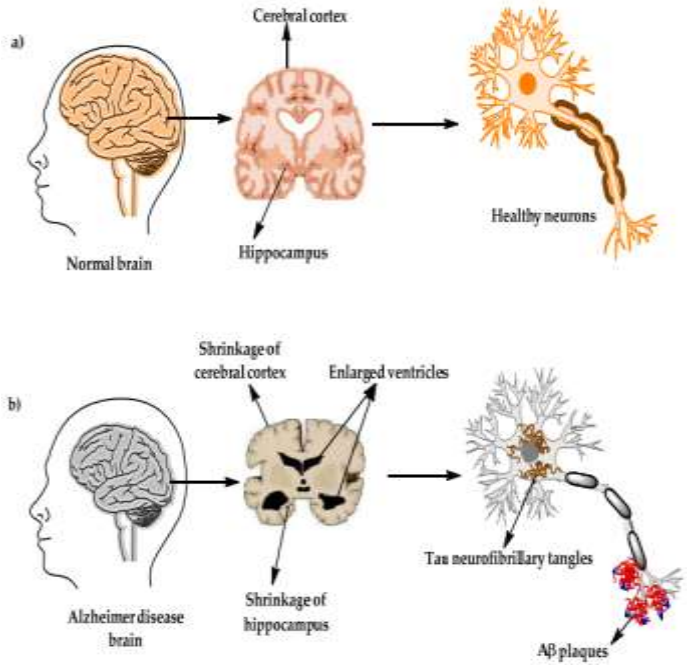

Fig. 1 Healthy and Alzheimer's diseased Brain [2]

The further partition of this paper is organized subsequently. Section 2, Related work with existing work. Section 3, stages of Alzheimer's Disease, and section 4 defines the causes and risk factors of AD. 5. Advantages and disadvantages. In section 6 conclusion of the paper.

II. RELATED WORK

This section contains various existing methods, tools, and models developed for predicting and detecting AD. It is a very dangerous infection that generally exists in aging people. So, the need is required to eliminate the risk and effects of Alzheimer's Disease. For this reason, existing methods and models are reviewed to develop an accurate model. **C. Kavitha et al., (2022) [10]** described Alzheimer's Disease as the major reason for Dementia in old age people. A lot of attention was spread over machine learning (ML) to catch metabolic illnesses such as Alzheimer's. Diabetes that was disturbs a huge number of people in the domain. The human brain was affected by neurodegenerative variations. This type of illness widely exists in aging people, their family members, and healthcare practice illnesses that were major harmful to memory and operation. This paraphernalia was deep on the public, commercial, and cost-effective faces. Alzheimer's infection was not easy to predict at the initial stages. A cure specified at the initial phase of Alzheimer's infection was further active, and it reasons less minor harm as compared to management completed at the advanced phase. So, the authors projected a classification method to diagnose Alzheimer's infection. Numerous methods as Gradient Boosting (GB), DT, RF, SVM, and Elective classifiers, were used to identify the best parameters for AD prediction. The projected classification method utilized by experts to create diagnoses of these syndromes. In a crucial analysis of these ML procedures, it was very productive to inferior annual report death rates of this illness. The projected method achieved an accuracy of 83%. **P C Muhammed Raees et al., (2021) [11]** described Alzheimer's syndrome advanced psychological drop and inveterate neurodegenerative illness that happens in internal or old age, payable to widespread brain deterioration. The initial identification of Alzheimer's syndrome was a massive experimental, common, and commercial essential due to the irreparable nature of the development of this method of illness. This research productivity offered an advanced, informal, and initial automatic deep learning (DL) based scheme to forecast Alzheimer's syndrome from a huge MRI dataset of standard and unhealthy difficulties. It categorized the database of 111 matters into Mild Cognitive Impairment (MCI), Alzheimer's syndrome, and Standard periods. Classification approaches such as SVM and several simulations of DNN methods was verified. DL methods were presented with great accuracy of approximately 80-90% on the Alzheimer's syndrome forecast. The forecast of several illnesses, for example, Alzheimer's, Dementia, and Parkinson's spread over perfect computing automatic ML implements were supported to identify the illness in the initial phase and deliver an improved scientific, community, and financial product. **J.Neelaveni et al., (2020) [12]** described Alzheimer's illness as one of the neurodegenerative sicknesses. Although the indications were benign originally, they developed further severe over intervals. Alzheimer's illness was considered a wide-ranging classification of Dementia. This syndrome was challenging because there was no cure for the infection. Analysis of the sickness was completed at a later phase individual. So the infection had projected the development or the signs of the infection reduced. Machine learning method was utilized to predict Alzheimer's infection with ML methods that were effectively applied and gave superior prediction accuracy. The proposed mode was capable of predicting the patient's illness and distinguishing. The composition of human brain MRI images and the psychosomatic parameters to forecast the illness using advanced precision with ML methods in further investigation. **Saman Sarraf et al. (2016) [13]** described ML methods, mainly analytical modeling and pattern detection in biological learning, from medicine supply systems to health imaging. That was developed as one of the utmost significant procedures to support investigators in acquiring a profound acceptance of issues and solving difficult health problems. DL method was a dominant ML method in classification that abstracts small to great-level features. The authors proposed to hire a CNN to differentiate an Alzheimer's skull from a standard, strong Brain. The reputation of classifying this category of health statistics exists in perspective to progress an analytical prototype or organization to identify the signs of Alzheimer's infection associated with standard issues and to evaluate the phases of the infection. Arrangement of practical information for health disorders such as Alzheimer's was continuously challenging, and the utmost difficult feature was selecting the robust discriminative features. The authors utilized the CNN and LeNet-5 models to classify available MRI statistics of Alzheimer's matters from standard switches. The proposed method achieved around

96.85%. **Janani Venugopalan et al., (2021) [14]** described highly dangerous Alzheimer's infection and minor mental illnesses were required the evidence modality to develop forecasts such as Alzheimer's infection stages. Fusing numerous statistics modalities can offer a complete vision of Alzheimer's infection performance investigation. The authors utilized DL to essentially examine imaging such as MRI and genetic and scientific test statistics to categorize patients into Alzheimer's infection. Also utilized the weighted denoising auto-encoders for feature extraction from scientific and genetic data and used 3D-CNN for imaging information. The authors also proposed an innovative statistics analysis method to recognize top-performing structures trained through deep models by collecting and disconcertion analysis. For this purpose, AD neuroimaging initiative (ADNI) dataset was utilized, and it determined that deep simulations outperform surface prototypes, SVM, DTs, random forests, and KNN. The proposed method achieved better performance in accuracy, precision, recall, and mean F1 scores. **Eugene Lin et al., (2021) [15] d**escribed budding body signs that DL methods could be crucial for identifying and predicting Alzheimer's sickness. Because of the modern improvements in neuroimaging and genomics, many DL models were exploited to differentiate Alzheimer's sickness from standard panels and to discriminate Alzheimer's sickness from minor reasoning injury in current investigative pieces of training. The authors proposed modern improvements for Alzheimer's sickness and forecast DL methods in assisting through the values of neuroimaging and genomics. The proposed investigation narrates numerous research using DL procedures to find an Alzheimer's sickness prediction using genomics or neuroimaging data. Above all, we describe appropriate integrative neuroimaging genomics examinations that leverage DL procedures to predict Alzheimer's sickness based on included the composition of neuroimaging and genomics data. Furthermore, there were restrictions concerning the current Alzheimer's sickness surveys of DL using neuroimaging and genomics.

III. STAGES OF ALZHEIMER'S DISEASE

Alzheimer's sickness is a very serious disease. It has several stages represented in figure 2. The clinical stages of Alzheimer's infection can be categorized mainly as preclinical or pre-symptomatic, lasting some years or further. This stage uses mild memory damage and initial uncontrolled variations in the cortex and hippocampus, through no functional loss in the everyday happenings and lack of clinical symbols and symptoms of Alzheimer's sickness. The second stage is milder or primary stage of Alzheimer's sickness, where numerous indicators initiate to appear in patients, The trouble in the regular lifespan of the patient through damage of attention and memory, sensing the confusion, domicile and interval, emotions, and progress of despair. Moderate Alzheimer's sickness stage, in which the infection spreads to the intellectual cortex parts, results in augmented memory damage, care distinguishing family and helpers, damage to instinct regulator, and effort analysis, writing, and language. Severe Alzheimer's sickness or late-stage, which contains the range of the illness to the complete cortex area with a simple growth of neuritic signs and [2] neurofibrillary masses, ensuing in an advanced useful and mental injury where the patients cannot identify their personal at entirely and developed disabled with problems in accepting and urination, and ultimately foremost to the patient's passing away through these difficulties.

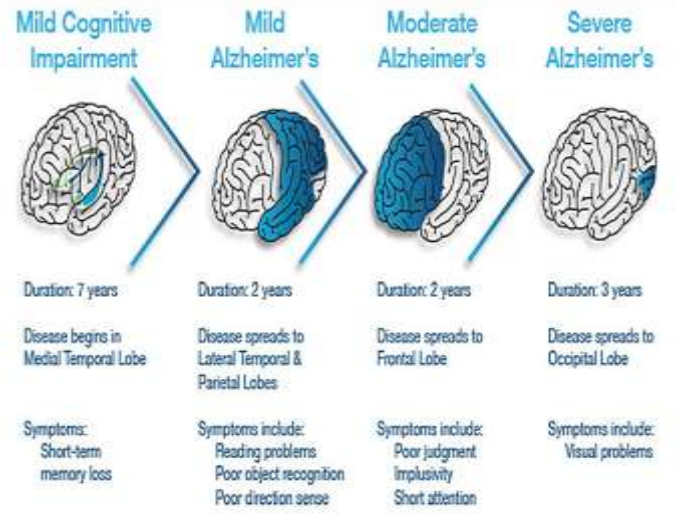

Fig. 2 Stages and Symptoms of Alzheimer's Disease [16]

IV. RISK FACTORS AND CHALLENGES OF ALZHEIMER'DISEASES

This section discusses the causes and risk factors of AD. Alzheimer's disease is an acute disease that mostly disturbs old aged people. Some of the causes and risks are described as;

A. Causes of Alzheimer's Disease [17]

The Brain covers millions of neurons or brain cells. These brain cells classify the process in which Brain stocks memories, acquires behaviors, and forms a human being's nature. Signals are sent beside the associates between brain cells through substances called neurotransmitters. In societies with Alzheimer's illness, several processes disturb these cells and compounds. These contain amyloid plaque deposits and neurofibrillary tangles. Various causes of this disease are detailed as;

- ***Amyloid plaques:***

There are credits *external* to the brain cells or neurons. They block the neurons or brain cells from transitory indications appropriately.

- ***Neurofibrillary tangles:***

There are credits *exclusive* to the brain cells or neurons. They destroy the cells using blocks of nutrition and energy.

- *Neuronal death:*

It causes a reduction in the cortex or Brain's outside layer**.** The cortex is dynamic to memory, vernacular, and decision. Other suspected causes of this disease are difficulties using blood vessels, chromosomal relations, hormonal variations, etc.

B. Risk Factors of Alzheimer's Disease

Despite this fact, experts distinguish that alteration of nerve cells in case of Alzheimer's infection happens. The process by which this happens is still unidentified. But, they have exposed certain risk factors that raise the probability of emerging Alzheimer's disease in figure 3. Some of the risk factors are described as;

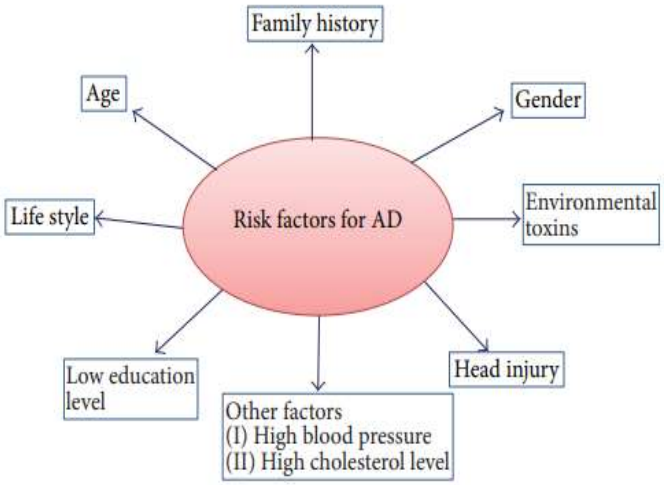

Fig. 3 Risk Factor for Alzheimer's Disease (AD) [1]

1) Age

Accumulative age develops the hazard of evolving Alzheimer's disease develops sophisticated. Maximum patients progress this disease after the stage of 65 years. The risk of this disease rising spreads by 50% for personalities above the stage for eighty-five years. Statistically, around 5% of males and females between sixty-five to seventy-four years old have this sickness, and almost a part of those eighty-five and older may have the sickness. Despite its prevalence, AD is not a standard part of advanced years. It specifies frequency degrees of Alzheimer's illness demonstrate an expanding occurrence for approximately every six years of additional life, indicating an exponentially cumulative risk with the collective stage of persons. This exponential hazard is fairly comparable to the training, irrespective of physical area, even if the fundamental entire occurrence ratio differs.

2) Family background or history

This risk factor includes family background or history. Investigators have exposed that those with a parent, colleague, or family participant using Alzheimer's are further prospective to grow the illness than personalities of a first-degree compared Alzheimer's illness. Most Alzheimer's illness cases are not natively genetic, though certain genetic factors may act as risk factors. The risk rises if greater than a single intimate member has the disease. Natively recognized arrangements of Alzheimer's illness commonly initiated at age 65 are recognized as an excuse for 0.1% of illness cases. Experts have recognized three genetic factors that describe persons that grow Alzheimer's, but only an identically insignificant ratio of personalities using Alzheimer's illness, around 1%, transmit these genetic factors. Other significant risk factors that might subsidize Alzheimer's illness risk. In this context, several encouraging investigations, recommend that policies for the care and existing healthy ageing may assist in preserving brain health and deliver specific protection despite Alzheimer's illness. These factors embrace consumption behaviors, a good physical lifestyle, staying informally and bodily energized, and avoiding the use of alcohol and tobacco.

V. SOFT COMPUTING TECHNIQUES

Soft computing is a collection of computational methods constructed on AI and natural collection that delivers rapid and economical resolutions to specific, compound difficulties for which logical hard-calculating measures do not exist. Zadeh invented the period of soft computing. Soft computing intentions to search precise approximation give a strong, computationally productive, economical solution that protects the computation period. Most of these techniques are inspired by biologically inspired occurrences and social and behavioral designs [18]. Soft computing inspires the combination of methods that intend to project solutions to actual difficulties that are tough to prototype. Soft computing methods are the mixing of different methods considered to solve multi-layered real World difficulties such as health science, supervision, cultivation, and finances inflexible to solve than others. This method's main properties are ambiguity, fuzziness, and estimate acceptance. It consumes widely planned and functional for engineering and health diagnosis computing. Mainly, soft computing consists of five types of methods as Fuzzy logic, ANN, PSO, ACO, and Genetic method [19].

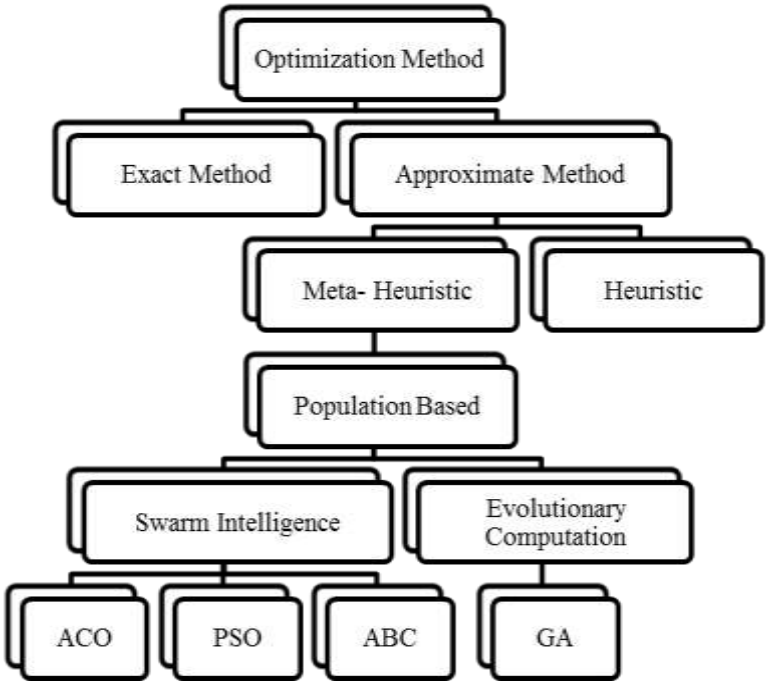

Fig. 4 Sub-Categories of Soft Computing [19]

Normally, soft computing methods are considered precise and estimated optimization methods. Figure. 4 signifies the sub-categories of soft computing methods. Optimization methods are a subtype of soft computing methods. It is further segmented into two parts, such as the exact and approximate methods. The meta-heuristic and the heuristic method are two forms of the approximate method. The meta-heuristic method is further divided into population-based classification as swarm intelligence and evolution. These sub-types are described below:

A. Genetic Algorithm (GA)

This method, commonly termed GA, is a projecting evolutionary method. John Holland projected the wide-ranging beginning of this method. These search procedures are unambiguously projected to reproduce the normal organic development procedure rule. This method derives its crucial features from accepting inheritances. A stochastic technique lays a depressed decent quality explanation using small time difficulty. It approvals a person of several discrete genetic materials to progress under defined selection guidelines to variety a public that enhances the objective function (OF). This method cost-effectively activates people of resolutions than a particular solution. It normally works with specific heuristics, such as assortment, edge and alterations, to grow improved resolutions [20]. GA method is used for feature selection. GA method is utilized for Alzheimer's illness later. It significantly chooses the finest feature subclass in higher dimensional datasets. GA made an initial local of genetic material covering casual feature sets. The capability of the genetic material is assessed by relating their skill to sense Alzheimer's illness issues appropriately. Provisional on the attained suitability mark, the development stops if the genetic material score exceeds the pre-defined objective and this genetic material is selected.

The process remains: the genetic material population is computer-generated, the genetic material limits and mutates in this method, and the appropriate genetic material produces next-generation issues. This stage is repetitive until a genetic material that encounters the earlier recognized standards creates. The GA parameters are considered in table 5.1.

Table 1. Parametric Analysis of GA Method [21]

Method	**Parameters**	**values**
GA	Classifier	SVM
	Genetic material size	5
	Maximum solution	300
	Maximum Generations	200
	Goal Fitness	0.9

B. Evolutionary And Swarm Intelligence

These methods are the main people constructing meta-heuristic methods. Swarm Intelligence is a state-of-the-art optimization method encouraged by the natural behavior of

wildlife, birds, and fish. The stimulation frequently derives from vertebrates' swarming, gathering, and driving occurrences. Swarms are specific negotiators interacting with single another and their situation. They track the fair law of not consuming the central regulator construction, which is important for the appearance of difficult universal behavior. It is recycled to put on the automatic managers' self-organizing performance concluded adjacent neighbor interface. The communal swarm intelligence methods are ant colony optimization (ACO) and particle swarm optimization (PSO).

C. PSO Method

It is an active optimization method that can resolve the issues in the composition of the decision tree (DT) method. This method is a form of optimization method developed in 1995. The way of life of the activities of animals and fish encourages this algorithm. The benefit of this method is that it has a modest conception, is informal to the device, and is a further more effective design than other accurate procedures. The practice of swarm intelligence is protracted from predictable optimization difficulties to optimization-based statistics removal to resolve isolated and constant optimization difficulties. The feature or characteristic selection is accomplished with the PSO method, and the outcomes of the feature or characteristic selection disturb the classification of Alzheimer's disease. Table 2 analysis results are predicted using the PSO method.

Table 2. Result analysis using PSO Method [22]

Method (PSO)	Accuracy	Kappa
C4.5	90.36%	0.826
ID3	89.55%	0.808
CHAID	89.55%	0.808
RF	93.56%	0.884

D. ABC Method

The Artificial Bee Colony (ABC) method was presented by Dervis Karaboga in 2005, inspired by the hunting behavior of honey bees. Bees intend to detect the spaces of nutrition foundations with maximum liquid aggregate. The colony of bees is considered to be a triple-occupied design. The bees presently manipulating the nutrition foundations are engaged bees; the bees in the making at the store are observers and persons who have the authority to store the discover novel nutrition foundations are engaged bee scouts. The employer bees segment the evidence of food foundations with the observers consuming wag hop. Once the nutrition is collected from a source, it becomes unusable and scout bee jump, penetrating the novel source. Nutrition foundation locations are the probable results of the difficulty. The volume of liquid in nutrition signifies the class of resolution.

E. Fuzzy Logic Method [23]

Fuzzy logic is an accurate method for calculating and conclusion that simplifies standard judgment and traditional theory using the perception of a fuzzy conventional. The fuzzy implication procedure contains all the parts designated in association tasks, logical tasks, and if-then directions. A fuzzy inference structure is a structure that practices a fuzzy established model to diagram inputs to outputs or features or classes. In a perception fuzzy logic system, single desires are in excellent arithmetical involvement variables, which is difficult, and explain their collections for each term. Then, during the gas phase, the communication concerning the effort values and each fuzzy traditional is precise. This is completed with the support involvement roles, which signify the grace of affiliation of the limited value to every class. Subsequently, the conventional fuzzy guidelines define decisions of the fuzzy logic model using analytical operatives. The rule defined for combining fuzzy outputs from each rule should be defined.

In conclusion, the output dispersal from a grouping of fuzzy instructions must be found and measured through defuzzification to get the hard classification consequence. Table 3 describes the test practice of the normal ADNI dataset, which is the greatest influence health dataset to the project, and tests automatic approaches for identifying AD. MRI dataset developed from above 65-year-old patients' data is utilized. MRI dataset incorporated images of 302 individuals under 75. This group included 211 patients with Alzheimer's sickness and 91 well personalities. Factual matters were perused at several intervals, and their imaging statistics were measured distinctly in the trials. Estimating accuracy, precision, and recall standards were used to assess the projected model.

Table 3. Result analysis using PSO Method [24]

Parameters	Fuzzy Classification	Hybrid Fuzzy method
Accuracy	88.35%	99.61%
Recall	86.65%	95.32%
F-measure	85.43%	95.61%
Precision	87.23%	96.91%

Table 3, describes the resultant analysis of fuzzy classification and hybrid fuzzy method using the PSO method. Different parameters are achieved performance shown in table 3 with parameters.

Table 4. Advantages And Disadvantages Of Soft Computing Methods [25] [26]

Methods	Advantages	Disadvantages
SC	Soft computing is an intelligent method.	It has no any shortcoming.

GA	The GA method is decent at discovering the global optimal of an enormously non-linear and non-convex without receiving stuck-in local minima.	It is moral to find the global optimum of an exceedingly non-linear and non-convex without getting stuck in native minima.
Fuzzy Logic	In the Fuzzy Logic method, humans should have comprehensive fuzzy logic 'if-then' directions.	The random choice of the involvement signs skews the results, although the triangular shape is most often recycled.
Fuzzy Logic	It has not identical great computational requests.	The difficulty is the excess of selections for involvement outlines, connectives for indistinct groups, and defuzzification operatives.
ACO	Building a route and making a cluster is easy in the ACO method.	It is a time-consuming method.
PSO	The PSO method is widely used for engineering and scientific investigation.	It has no mutation consist.
	PSO accepts the real number encryption, which is decided straight by the solution.	The method cannot solve scattering and optimization difficulties and slow convergence in the refined search stage.

VI. Conclusion and Future Scope

Alzheimer's disease is currently a universal health concern. Alzheimer's Disease. Alzheimer's Disease (AD), a form of dementia, is considered through progressive, sophisticated and behavioral difficulties that initiate in middle or old age. The pathological features are neuritic signs in the Human Brain and the collapse of unambiguous brain cells. Dementia is a disorder that grows mainly in older adults and disturbs brain functionality, regular actions, and communication products. Alzheimer's infection signifies the general procedure of adults beginning dementia. In this paper, Alzheimer's Disease. The detection process causes and risk factors are described under soft computing. Soft computing is an intelligent method utilized in every field. Also, numerous causes of this disease and risk factors such as old age, chromosomal factors, family history of head injuries, vascular illnesses, infections, and ecological factors show a part in the disease. In soft computing, detection methods such as heuristic and meta-heuristic optimization is described. Furthermore, several advantages and disadvantages of these approaches also represent the results of the specific method. In the future, develop an efficient model using optimization methods to improve the performance metrics.

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