

A Robust Uncertainty Based Animals Migration Optimization Based Clustering for Alzheimer Disease Prediction

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Abstract- In the advanced environment the health information is maintained and the diseases are predicted using machine learning models. One of the primary neurodegenerative disorders which affects the life quality of the elderly persons is Alzheimer, diagnosing its presence in its earlier stages may help the medical experts to slow down the aggressiveness of the disease. In this paper, a novel uncertainty-based clustering model is developed to handle the vagueness in selection of centroids to overcome the problem of outliers and noisy instances which affect the performance of the prediction model. The unknown patterns are very challenging while using the unsupervised learning algorithms, hence in this work an uncertainty-based optimization algorithm is used to handle the unknown pattern of Alzheimer Disease (AD) patients. Initially, the instances in AD dataset is converted to the membership value of the dependent variable to exactly define the belongingness of them as AD patterns or non-AD patterns. To overcome the outliers during the process of similar patterns clustering, in this proposed work animal migration optimization algorithm is induced based on their migration behavior, the best instances are selected as centroids while a new instance is considered for clustering. Each instance is validated based on their fitness value and the instances with best fitness value is considered as centroids. The fuzzy euclidean distance is used for handling the uncertainty in handling the outliers. The simulation results on OASIS dataset proved that the proposed uncertainty-based Animal Migration optimization algorithm (UAMO) produced better results compared to other state of arts clustering models.

Keywords : Alzheimer, outliers, uncertainty, animal migration optimization, unsupervised, clustering,

Introduction

Alzheimer Disease (AD) is a consistent dementia category, a distinct syndrome which changes decline in intellectual skills and consistent activities of elderly population [1]. In recent years, there is a steady growth in peoples affected from AD. In India, nearly 20% of the elderly people above 80 years suffers from dementia due to Alzheimer's Disease [2]. A stimulating feature of AD is though irredeemable, early detection and appropriate treatment of AD disease can rheostat neurons degeneration. In general, alzheimer's disease is detected often in mild dementia stage, but in this stage most of the cortex is seriously damaged. Widespread cell death causes the brain to shrink dramatically. The person's mental function continues to deteriorate, and he or she loses the ability to converse rationally [3].

Diagnosing Alzheimer at its preliminary stage is very essential to avoid its severity. Alzheimer prediction models works on health profile data which comprised of age, education, sex known as socio demographic details, physical activity, blood pressure, BMI, level of cholesterol and other cognitive information. The digitalization of health records may increase such data enormously and it acts as a testing scale for predictive models [4]. Researchers have made necessary efforts to offer a system which can discover the mechanism and source of the disease and prevent its further development as soon as possible. This research work focuses on precise investigation of alzheimer presence by tackling the problem of uncertainty, outliers and increasing the accurate prediction rate by developing robust model using animal migration based clustering method.

Related Works

Zhu et al [5] in their work created an anomaly discovery approach by employing sensor module to provide an intellectual living environment for the elderly persons. The anomalies are identified based on their timing, position, activity type, activity transition and duration. For anomaly detection, they utilized a maximum likelihood semi-supervised learning model with Laplace filtering.

Jyoti Islam and Yanqing [6] developed a neural network model for multiclass AD detection. They used OASIS dataset for simulation analysis. The MR images are used to detect presence of AD.

Ramesh et al [7] focused on ageing related issues by comparing performance of various data mining models for AD prediction. They collected daily activities of elderly persons without disturbing their routines. Based on the observation of abnormalities their cognitive impairment is detected in its primary stage.

Neelaveni and Devasana [8] detect the presence of alzheimer using different machine learning models. This work used the demographic and clinical dataset of the patients to diagnose them at its early stages to improve the life quality of them by controlling their aggressiveness with the help of experts.

Dan et al [9] designed a learning algorithm to predict the presence of Alzheimer using features extracted from MR images. Using the grading score of features the most relevant features are selected as input. The grading classification model is used to discover presence or absence of Alzheimer's disease.

Abdulhamit Et al [12] developed an AI model to detect the presence of alzheimer disease. The AI methods are applied in medical images for early discovery. The deep learning algorithms are used for understanding the depth pattern of individuals and the classification rate is increase with the help of artificial intelligence models.

Methodology: Uncertainty based Animals Migration Optimization based clustering for Alzheimer Disease prediction

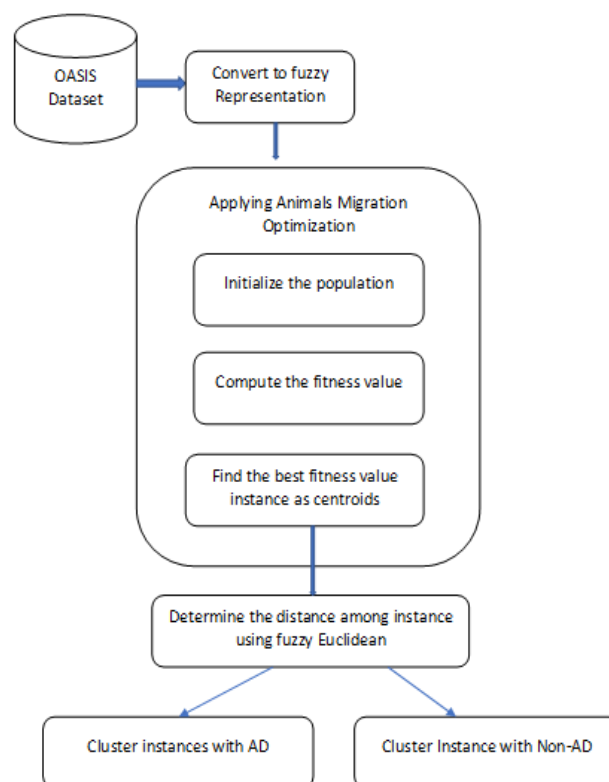


Figure 1: Overall Architecture of Uncertainty based Animals migration optimization based clustering for AD Prediction

The figure 1 illustrated the overall flow of the proposed uncertainty-based animal migration optimization algorithm for predicting the presence of AD in OASIS dataset [10]. The oasis dataset comprised of 386 instances with 12 attributes which explores the personal and medical data. The dataset is initially converted to fuzzy representation to represent each instance in terms of membership to handle the uncertainty. Then, animal migration optimization algorithm is applied to determine the best centroids and based on the fuzzy euclidean distance, the instance with highest similarity are clustered together and the outliers are handled with the membership degree value. Thus, the clustering process improves the performance in AD prediction.

Animals Migration Algorithm

Animal migration process and animal updating process are two subsets of the animal migration algorithm. The algorithm replicates how animal groups migrate from their present location to a new location throughout the migration process [11]. The method replicates how animals are updated using the probabilistic method throughout the population updating process.

Process of Animal Migration Algorithm

An animal must follow three rules when migrating: stay near to your neighbours, migrate in the same direction as your neighborhood, and avoid collisions with them. We chose a neighbor length of five for each of the various dimensions to keep things simple. Be aware that our technique defines the neighbor topology on a collection of vector indices and that this definition is static. If an animal has an index of 1, then its neighbor also consists of animals with indices, and so on. If an animal has an index of, then its neighbor also consists of animals with indices. Once the cluster topology has been created, choose one neighborhood at random and update the individual's location to reflect this neighbor, as shown in the equation below.

$$y_{i,K+1} = y_{i,K} + \alpha \cdot (y_{ng,K} - y_{i,K})$$

Where $y_{ng,K}$ is the present location of the neighborhood instance, α is generated by arbitrary controller using gaussian distribution, $y_{i,k}$ is the present position of i th instance and $y_{i,K+1}$ is the new position of i th instance.

Population Updating Process

The method simulates the process of updating the population by simulating how certain animals depart from the group and others join the newly formed population. With a likelihood of P_{ba} , some new animals will take the place of individuals. The likelihood is applied in accordance with the fitness level. Algorithm 1 demonstrates how this is done by sorting fitness in descending order, where the probability of the entity with the highest fitness value and the probability of the entity with the lowest fitness is 1.

In Animal Migration optimization, R_1 , R_2 are arbitrarily chosen integers, $R_1 \neq R_2 \neq i$. It generates new solution $y_{i,k+1}$, which will be assessed and related with the $Y_{i,k}$, and individual with best objective value is selected. $y_{i,K} + \alpha \cdot (y_{ng,K} - y_{i,K})$

$$y_i = \begin{cases} y_{i,K} & \text{if } F(y_{i,K}) \text{ is better than } y_{(i,K+1)} \\ y_{i,K+1} & \text{else} \end{cases}$$

Uncertainty based Animal Migration Optimization Algorithm

In the UAMO method, a good resolution is found through the employment of migration and population update processes. In order to replicate animal migration, the proposed algorithm used a novel method of setting up a living area by the leader animal (those with the highest fitness value). From there, animals migrated from their existing places into the new living area. Initially N number of animals present in the living area, moving around, consumption, reproducing, drinking and so forth. Some of these animals move arbitrarily, updating their positions, and then determine the optimal position of the animals based on fitness function and track it. Nevertheless, as time passed, the availability of food and water steadily decreased, and some creatures began to move from their existing habitats devoid of food and water to new habitats rich in both.

Animals can dwell in the green regions, which are areas with plenty of food and water. Also, the yellow areas stand for those that are devoid of food or water; as a result, animals are forced to migrate to new habitats. Animals will then continuously move to the new living area as the existing one is shrunk over time. As a general rule, the globally optimal solution is always close by and is the current best solution in the algorithm UAMO, the animals' living area is reduced after each iteration and the individuals get closer and closer to the globally optimal solution; as a result, we can somewhat speed up the algorithm's convergence velocity and precision.

Living area boundary is defined as

$$L = y_{bst} - rd,$$

$$U = y_{bst} + rd,$$

$$rd = D \cdot rd$$

where Y_{bst} is represented s leader for the present position, the lower and upper boundaries of living area is signified using L and U respectively. The radius of the living area is denoted by rd and the coefficient of shrinkage is represented using $D \in (0, 1)$.

Typically, the size of the search space affects the original value of rd . As iterations continue, a high value of rd enhances the algorithm's capacity to explore, while a low value of rd enhances its ability to exploit.

Uncertainty based Animal Migration optimization for Alzheimer Disease Detection

Algorithm 1: Updating the process of population

For $i = 1$ to N

{

For $j = 1$ to E

{

If $rnd > Pop_a$ then

$$y_{i,K+1} = y_{i,K} + rnd_{y_{bst,K}-y_{i,K}} + rnd(y_{rd2,K} - y_{i,K})$$

}}

Algorithm 2: Uncertainty based Animal Migration Optimization

Input: AD dataset

Initialize K = population generator, rd = radius of living area, coefficient for shrinkage D , arbitrarily initialize Y_i with N number of animals

Procedure

Begin

{

Compute fitness value of each individual Y_i using membership value and mark the best ones as Y_{bst}

While termination condition is not met

Create a new living are by computing

$$L = y_{bst} - rd,$$

$$U = y_{bst} + rd,$$

$$rd = D.rd$$

For $i = 1$ to N

{

For $j = 1$ to E

{

If $rnd > Pop_a$ then

$$y_{i,K+1} = y_{i,K} + rnd_{y_{bst,K} - y_{i,K}} + rnd(y_{rd2,K} - y_{i,K})$$

}}

For $i = 1$ to N

Compute the descendants $y_{i,K+1}$

If $y_{i,K+1}$ is better than y_i

$$y_i = y_{i,K+1}$$

Save the most successful solution thus far. $Rd = rd$. D

}}

Output: Clusters of AD and Non-AD Instances

We calculate the distance between cluster centers using fuzzy euclidean distance measure

$$Dist = \sum_{i=1}^n |\mu y_i - \mu y_j|^{rd}$$

Where the membership value of two animals is considered for finding the fuzzy euclidean distance with in the radius rd .

Experimental Results and Discussions

The proposed model UAMO for Alzheimer Disease Prediction is deployed using python software. The dataset for alzheimer disease detection is collected form OASIS dataset. The simulation results are compared with the three different clustering models namely K-Means, DBSCAN and Fuzzy C Means. The evaluation metrics used to analyse the performance of each of these classifications model is computed using their correctly clustered, incorrectly clustered, specificity and sensitivity.

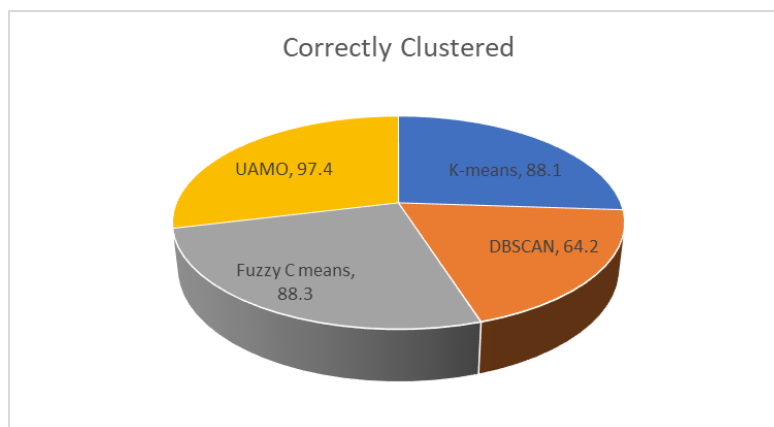


Figure 2: Performance comparison based on correctly clustered

Figure 2 illustrate Alzheimer prediction using OASIS dataset is compared with four different clustering models based on correctly based instances. It is observed that UAMO produce high correctly clustered rate compared to DBSCAN, K-Means and Fuzzy C Means Clustering. This is selection of centroids using animal migration optimization algorithm highly influence correctly clustering process. Thus, proposed UMO algorithm is clustered based on uncertainty yields 97.4% as correctly clustered instances for prediction of AD dataset.

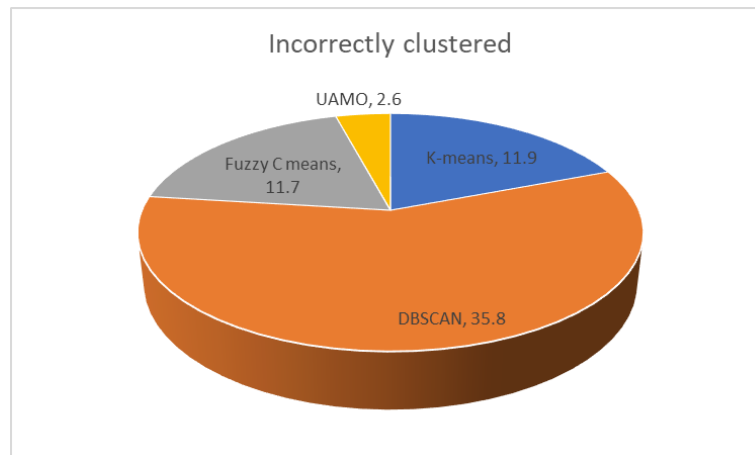


Figure 3: Performance comparison based on incorrectly clustered

It is observed from the figure 3 UAMO produced lowest incorrectly clustered rate compared to K-Means, DBSCAN and Fuzzy C Means. This is animal migration optimization algorithm is used to select the centroids in OASIS dataset which highly influence incorrectly clustering process. The UAMO is clustered with the local and global optimization for reducing incorrectly clustering rate of instances in AD dataset.

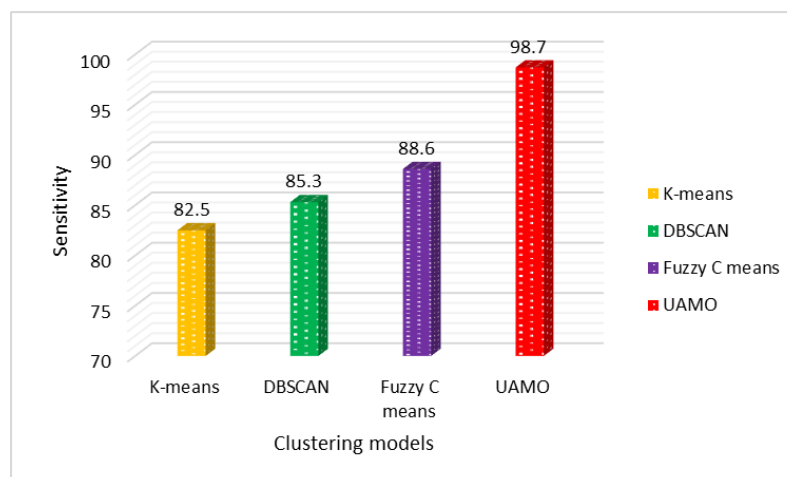


Figure 4 : Performance comparison based on sensitivity

The figure 4 displays the performance analysis of the four different clustering models based on sensitivity. The UAMO achieves highest precision rate compared to K-Means, DBSCAN and FCM. The significant feature selection and the clustering based on the Animal migration behavior optimization handles the uncertainty and outlier very prominently to accomplish higher efficiency in AD prediction.

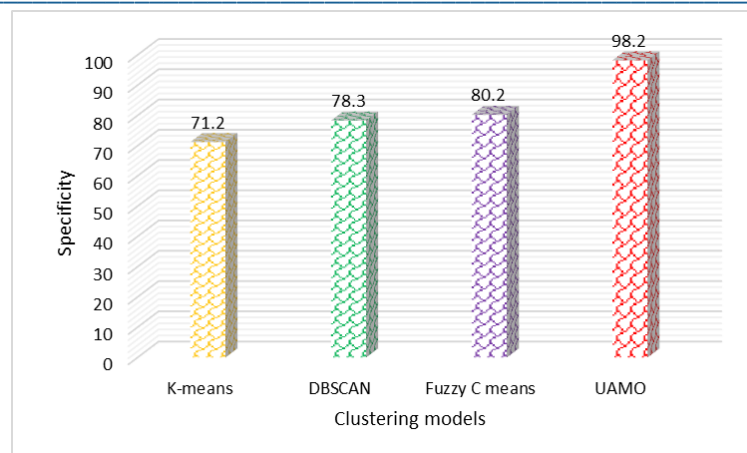


Figure 5 : Performance comparison based on specificity

The figure 5 portraits specificity value obtained by four different clustering models for predicting the presence of AD. From the obtained results it is proved the newly constructed model of this research work produced highest rate of specificity while comparing with other clustering models. The reason is, impreciseness and outliers are the major issue in standard clustering. The uncertainty-based animal migration optimization clustering represents each instance in terms of membership degree to accurately polarize the imprecise and outliers.

Conclusion

In this paper, a robust clustering model is devised to handle uncertainty due to the presence of outliers in AD dataset. The instances are represented using fuzzy membership value to determine the belonging of them with each cluster. The clusters are formed by applying the behavioral model of animal migration optimization algorithm. It determines the centroid based on the fitness value and the best ones are considered as centroids. The distance among the centroid and other instances are discovered using fuzzy euclidean distance. The local optima is highly handle by the proposed UAMO algorithm and thus it produced better result compared to kmeans, DBSCAN and FCM.

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