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APPLICATION OF NATURE INSPIRED META-HEURISTIC ALGORITHM ON DIAGNOSIS OF PARKINSON DISEASE

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Abstract: This research uses speech and gait to perform a study of Egyptian Vulture Optimization nature inspired algorithm for diagnosis of the Parkinson Disease. To classify and predict non PD patients from PD an optimal feature set is selected and then classification is performed. Two datasets of speech and gait were used and thee datasets contains the information of PD and non PD patients. Egyptian Vulture Optimization Algorithm is used for optimal feature selection. ANN classifier was used with the optimal feature set then dataset is classified. EVOA performed well in the feature subset selection process. So it can be concluded that the new EVOA meta-heuristic algorithm has a potential of performing better than traditional algorithms and it can be used in diagnosis of PD patients and all this can be helpful in reducing the suffering of the patients.

Key Words: ***Egyptian Vulture Optimization Algorithm (EVOA), Parkinson Disease (PD), Artificial Neural Network (ANN)***

1. INTRODUCTION

There is a chronic disorder of central nervous system known as Parkinson Disease(PD) and mainly motor system of the human body is affected by it. There is region of mid brain termed as substantia nigra and due to the death of dopamine generating cells, PD occurs. It is common in people having age more than 50 [1].

A non-invasive way is investigated to easily diagnose and the method seems to be very accurate. James Parkinson, an english doctor first proposed a detail description of Parkinson Disease [2]. In order to evaluate the method of Parkinson's disease human expertise is largely required. Unified Parkinson Disease Rating Scale (UPDRS) [3] is heavily used for diagnosis of Parkinson disease. Support Vector Machines (SVM) is proposed by Jian et al. [4] for gait recognition. Width and angle information were used for human movement image sequence. Intelligent technologies were used in 2013 by JochenKlucken, et al. [5] for Embedded Gait Analysis (eGait) using biosensors. In recent years a research for developing a telediagnostic tool for speech pattern analysis of PD patients is triggered.

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Wide ranges of speech samples were collected by Erdogdu Sakar et al. [6] and it also contains the sentences compiled from People with Parkinson (PWP) and various sound types like sustained vowel. The department of Neurology, Istanbul University conducted this study and developed a computer software for easy diagnosis of PD patients.

Filter approach and wrapper approach are the two approaches for feature construction and it is decided on the basis whether the classification method is present in the fitness evaluation [7]. An approach will be called wrapper approach if the fitness evaluation function contains the classification or learning algorithm. Classification algorithm contains the wrapper of the feature selection method. Better results are produced by wrapper algorithms. Computational expensiveness is one of the main drawback of this method. Classification algorithm doesn't have any dependence on the selection process and this is the main idea of filter approach. Statistical analysis is used for feature selection. Computational time required in this method is lesser than wrapper approach but accuracy is lesser than wrapper method. For feature construction algorithm, particle swarm optimization technique was discussed by Bing Xue et al [8]. Original low level features were used and PSO is proposed for feature construction and high level feature were constructed for binary classification problems.

2. PROPOSED ALGORITHM

Physionet gait database of PD patients is used for prediction and an optimal feature selection and classification algorithm is applied on the database and a performance is obtained. There are 93 idiopathic PD patients and 73 healthy controls. Force as a function of time is measured by the seven sensors underneath each foot. There were 20 healthy and 20 PWP (Patients with Parkinson) in the UCI speech training data. There were 10 healthy female and 10 healthy male and 6 PD female, 14 PD male patients. There were 0 to 6 years people and they were suffering from Parkinson. There were 28 PD patients in test data. For the purpose of classification ANN is used and for optimal feature selection Egyptian Vulture optimization algorithm (EVOA) is used and in the next subsections we proposed a brief description of the algorithms.

2.1. Artificial Neural Network –

Artificial Neural Network(ANN) is a man-made representation of human cerebrum which studies and tries to mimic the studying process. ANN is a system of interconnected aggregation of reproduced neurons that uses a computational model for data handling backed on the connectionist approach to computation. It is made up of fake neurons which have a few lands of human neural systems. ANN is a modifying framework which conforms its structure on the groundwork of the outer or inner data coursing through the system. Like human, ANN studies by sample. The fundamental reason for utilizing FF BPA within neural system for detection of Parkinson illness is its efficiency/dependability. The single layered neural system has numerous confinements like it is limited to do restricted no. of undertakings .by back propagation algorithm we have the capacity to alter the weights of preparing units i.e. neuron so as to make all the more figuring out how to our neural network. The output of back propagation system is taken as an order choice. Figure 1 shown the general structure of a feed forward back propagation neural network.

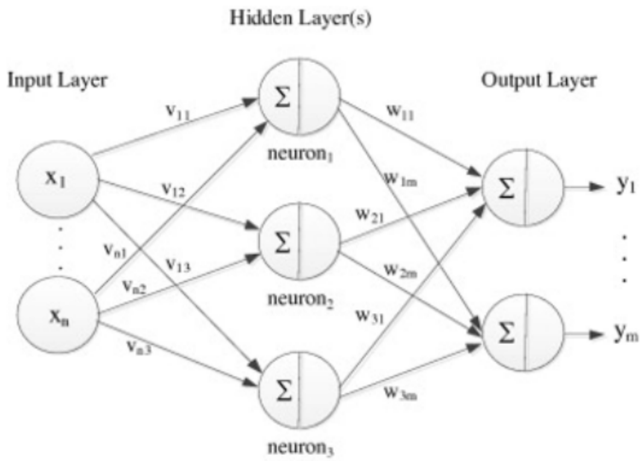

Figure 1. Multi Layered Feed Forward Back Propagation Network

2.2. Egyptian Vulture optimization Algorithm –

Egyptian Vulture optimization algorithm is a meta-heuristic algorithm that was acquainted principally to tackle the combinatorial issues. The process of obtaining the sustenance by Egyptian vulture created this algorithm.

Hard optimization problem can be solved if we use the wise conduct of this creature as an algorithm. These versatile, creative demonstrations of Egyptian vulture make it as a standout amongst the bird species.

This meta-heuristics can be applied for global solutions of the combinatorial optimization problems [9] and has been considered on the customary 0/1 Knapsack Problem (KSP) and tried for a few datasets of various measurements. The algorithm performed very well when it was applied on problems like KSP and TSP[10] and the results obtained were close to ideal value and give the extent of use in comparable problems like path planning and various combinatorial optimization problems.

The EVOA meta-Heuristics Algorithm has been depicted here in steps, representation through illustrations and clarifications. The Capacity of moving things with twigs and Tossing of stones are two fundamental exercises of the Egyptian Vulture and these steps are moved into algorithm and that algorithm is known as EVOA. These are the steps of general EVOA and due to the constraints of the problem some of the stages can be twisted or restricted for adaptation.

Step 1: Solution set or strings are initialized which have the representations of parameters and it is in the form of variables. A single state of allowable solution is represented by the string that shows a set of parameters.

Step 2: Representative variables are refined, superimposed constraints and conditions are checked.

Step 3: Stones are tossed at selected or random points.

Step 4: Rolling of Twigs operation is performed on entire string or selected part of it.

Step 5: Selective part of the solution is reversed using change of angle.

Step 6: Evaluation of fitness.

Step 7: Stopping criteria should be checked.

The figure 2 represents the block diagram of EVOA and the next subsection explains the functioing of EVOA.

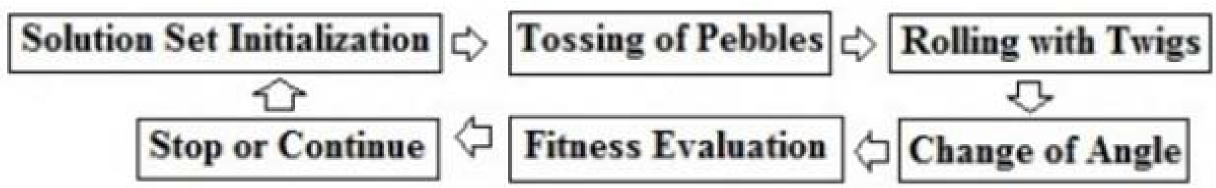

Figure 2. Block Diagram of EVOA

2.2.1 Pebble Tossing –

The Vulture breaks the harder eggs of another bird and get the nourishment inside by utilizing the stones for breaking it. In order to determine the extent of operation the two variables are used:

PS = Pebble Size (occupancy level) where PS ≥ 0

FT = Force of Tossing (removal level) where FT ≥ 0.

Hence, If PS › 0 then “Get In” Else “No Get In”.

Also, if FT › 0 Then “Removal” else “No Removal”.

For removing there is “Removal” and occupancy is denoted by “Get In”. How many solutions should a pebble contain and in the solution set they must be introduced forcefully and it is denoted by level of occupancy. Level of removal implies the number of solution that should be removed.

To deliver a new solution set the combination of stones containing PS number of nodes is created randomly and both are created arbitrarily inside a specific certain limit. Number of nodes that are expelled from either side of point hitting are denoted by FT.

2.2.2 Rolling with Twigs–

Egyptian Vulture has another bewildering expertise which is moving with twigs, for the purpose of movement objects can be rolled or other actions can be performed like finding the position of feeble points or other part can be be observed which is confronting the floor. Power is required in moving of the items also there is a need of the strong hold on the stick using the beak and best possible stick should be used. To control the implementation of "Rolling with Twigs" there is a need of two parameters which will be helpful in the mathematical formulation of the event. In order to determine the degree of operation these are the following two criteria.

DS = Degree of Roll, where DS ≥ 0 number of rolls are denoted by DS. Direction of rolling is denoted by DR, where probabilistically we have:

DR = 0 for right Rolling or Shift

= 1 for left Rolling or Shift

Deterministically the equation can be framed in following manner and 0 and 1 are randomly generated.

DR = Left Rolling/Shift for RightHalf > LeftHalf

= Right Rolling/Shift for RightHalf < LeftHalf

2.2.3 Change of Angle–

To explore different avenues of tossing of stones and increment the shot of breakage of the hard eggs Egyptian Vulture can perform an operation of change of angle and this increases the chances of breaking the eggs. Mutation step is represented as change of angle and in order to achieve a complete node sequence unconnected link nodes can be turned for the desire of being connected.

2.2.3 Fitness Calculation–

For the selected feature we are using the F1 score generated using the ANN classifier. To find the optimal feature subset EVOA algorithm is used in particular for feature selection. Binary string containing 1's and 0's is used for implementing the binary version of the algorithm. We have to select an optimal feature subset out of the 2n feature subsets present for an n-feature dataset. For all features that are used in the subset, in the binary string '1' is assigned to that position otherwise '0' if the feature is not used. The pseudocode of the algorithm is as follows.

Algorithm 1 **Egyptian Vulture Optimization Algorithm for Feature Selection**
Input: Training Data
Output: Feature String

```
procedure EVOA
    Randomly initialize a sequence of particles.
    Initialize fitness of each particle.
    i ← 0
    while i < Maximumiterations do
        Perform pebble tossing operation.
        Perform rolling twigs operation.
        Perform change of angle operation.
        for eachparticle do
            if fitness >fitness of the particle then
                fitness of the particle ← fitness
                particle's best position ← present position
            if gbest <fitness then
                gbest ← fitness
        i ← i + 1
    return the set of selected feature string.
```

3. EXPERIMENT AND RESULT

Pyhton 2.7 and pycharm IDE was used in the entire experiment for the purpose of feature selection. Relevant features were selected and artificial neural network was used for classification purpose. Wrapper method was used for feature selection and dataset is reduced. ANN algorithm from the scikit was used in wrapper method. F1 score was used as the performance metric and scikit library was used for it [11]. 2GB of RAM and Intel core 3 CPU was used in conducting the entire experiment of classification and feature selection. Dimensionality reduction is done and the 14 features were obtained from a total of 19 when EVOA is applied on gait dataset 5 features were achieved from a total of 26 features of speech dataset. EVOA performed well on these datasets and can later be used as a replacement of others.

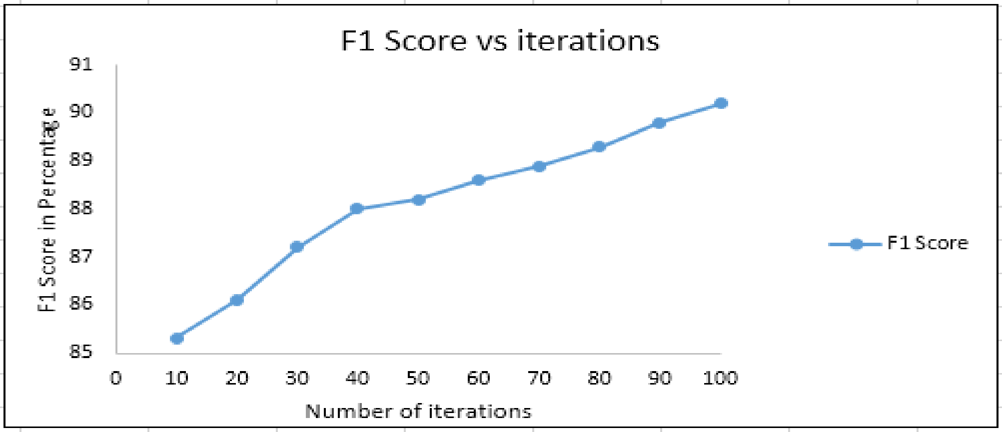

Figure 3. F1 score vs Number of Iteration: Gait Dataset

In fig 3, we used gait dataset and number of iteration vs accuracy is plotted and the swarm size is taken as constant 20 and number of iterations ranges from 10 to 100. For all iteration (10- 100) F1 score of EVOA is 80 percent. A good accuracy is obtained by EVOA in very lesser number of iteration. A F1 score of 90.2 is obtained after 100 iterations and this shows a good performance of the algorithm.

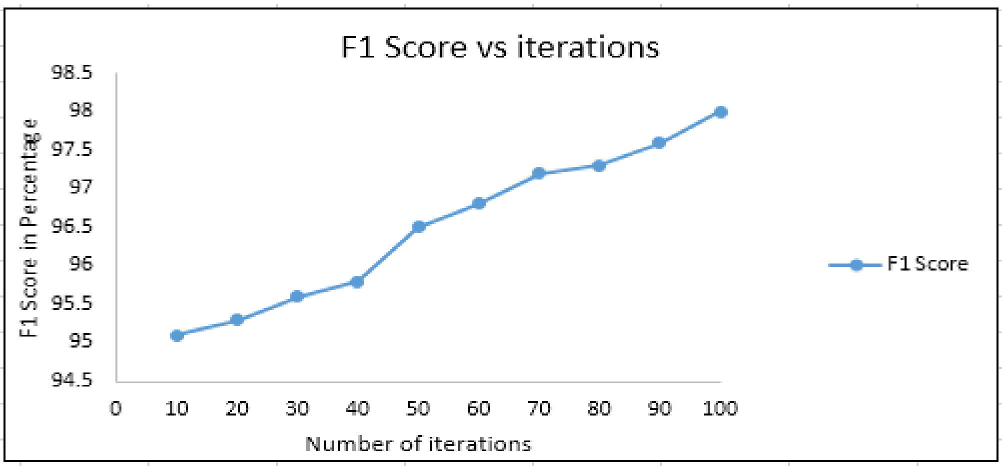

Figure 4. Accuracy vs Number of Iteration: Speech Dataset

In fig 4, we used speech dataset and number of iteration vs accuracy is plotted and the swarm size is taken as constant 50 and number of iterations ranges from 10 to 100. For all iteration (10 – 100), the F1 score of EVOA is above 90 percent. A good accuracy is obtained by EVOA in very lesser number of iteration. A F1 score of 98.0 is obtained after 100 iterations and this shows a good performance of the algorithm.

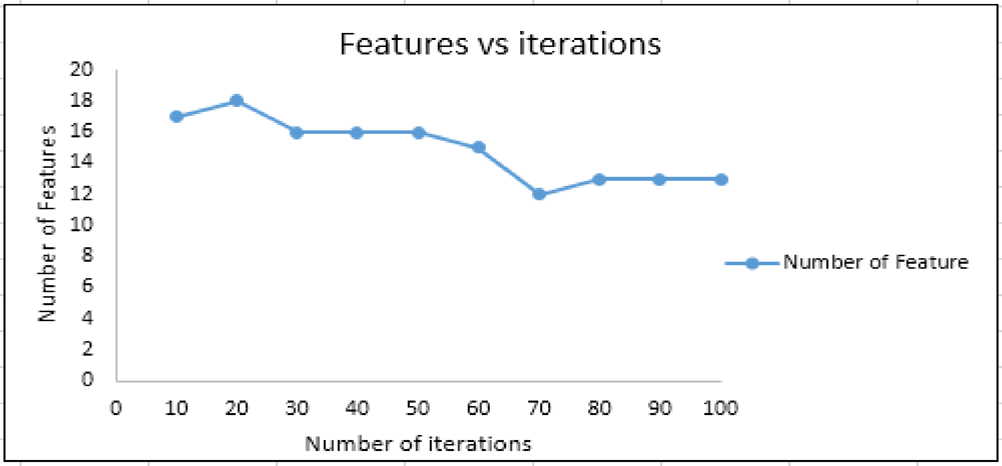

Figure 5. Number of feature vs number of iteration: Gait Dataset

In fig 5, we used gait dataset and number of iteration vs number of features are plotted and the swarm size is taken as constant 50 and number of iterations ranges from 10 to 100. A good dimensionality reduction is obtained by EVOA in very lesser number of iteration. After 100 iterations 13 features were selected from EVOA from a total of 19 and this shows a good performance of the algorithm.

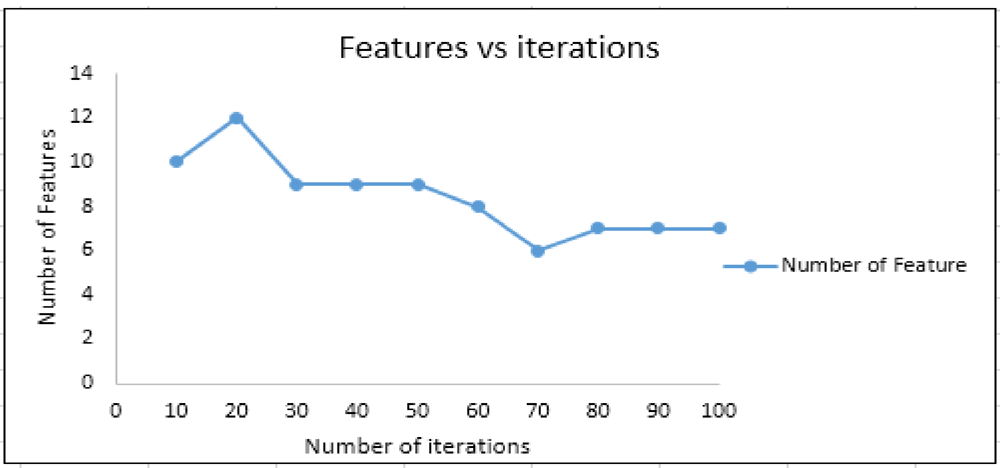

Figure6. Number of feature vs number of iteration: Speech Dataset

In fig 6, we used speech dataset and number of iteration number of features are plotted and the swarm size is taken as constant 50 and number of iterations ranges from 10 to 100. A good dimensionality reduction is obtained by EVOA in very lesser number of iteration. After 100 iterations 7 features were selected from EVOA from a total of 26 and this shows a good performance of the algorithm.

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