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An Efficient Hybrid Genetic-Grey Wolf Based Neural Network (G^2NN) for Breast Cancer Data Classification

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ABSTRACT: ***Machine learning is the one of the famous Artificial Intelligence (AI) technique. Data Mining or Machine Learning techniques are most popular in medical diagnosis, classification, forecasting etc. K-Nearest Neighbor, SVM (Support Vector Machine), DT (Decision Tree),RF (Random Forest),NN (Neural Network) are famous classification algorithms. Neural Network is one of the popular techniques, which is used to refine the verdict of breast cancer. A neural network is otherwise known as Artificial Neural Network(ANN), which is mimicking of biological neurons of human brain. Genetic Algorithm (GA) is emerged bio inspired technique. Selection, Crossover, and Mutation are three operations in Genetic Algorithm. The performance of a genetic algorithm depends on the genetic operators, particularly crossover operator. Grey Wolfoptimization algorithm is inspired from hunting of wolf strategy. Alphas, Beta, Gamma are the three levels ofprocesses. In this paper, a novel hybrid Genetic Grey Wolf based Neural Network is introduced and we named it as G^2NN. In the field of medical, we need more accuracy when compared to other field, because it relates to human life. Many researchers found new novel ideas for breast cancer data classification using neural network model. Among many diseases,Breast Cancer is one of the unsafe diseases among women in Indiaand in addition to the whole world. The early detection of cancer helps in curing the disease completely. In many research areas Genetic Algorithm and Grey wolf algorithm are used to train neurons in order to yield good accuracy. In this manuscript, a new GeneticGrey Wolf optimizer based Neural Network is introduced and we compare the proposed work with other techniques like SVM(Support Vector Machine),NN (Neural Network), Genetic based Neural Network, Grey wolf based Neural Network and the experimental results of proposed work produced better result. The proposed algorithm produces 98.9 % of accuracy on UCI Wisconsin breast cancer dataset.***

Keywords: Breast Cancer, Classification, Genetic Algorithm, Grey Wolf Optimizer, Neural Network.

I. INTRODUCTION

A. Genetic Algorithm (GA)

Genetic Algorithm (GA) is mimicking of the procedure of natural selection which relates to the larger class of evolutionary algorithms(EA).Genetic algorithms primary used in optimization and search problems.

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GA is inspired from biological operators for example selection, crossover, and mutation. In 1970,John Holland [1] introduced genetic algorithm which is based on the concept of Darwin's theory of evolution. Population is the first phase in genetic operation, which is known as set of individual. Genes are known as individual characterized by a set of parameters. The combined Genes are known as Chromosomewhich is solution. The fitness function is used to find, how fit it is when compared to other individuals and fitness score is calculated for each individual.For reproduction fitness score is used. Selection is considered as next process in the Genetic algorithm. Population produces chromosomes which will be act as parents to crossover. According to Darwin's evolution theory the finest ones should stay alive and create new children. Chromosomes can be selected in many ways. After Selection, Crossover is the most importantstage in a Genetic Algorithm. Crossover means mating the parents. A crossover point is used for in which each couple of parents to be mate at random (genes).In certain new offspring formed; some of their genes can be subjected to a mutation with a low random probability. This implies that some of the bits in the bit string can be flipped.In [2], Zhang Qiongbing et al proposed a new crossover method for genetic algorithms by means of variable –length chromosomes used for path optimization problems. "Breast cancer is the most common cancer in most cities and the second most common in rural India. Breast cancer accounts for 25% to 32 % of female cancers in all cities across India. In India, one woman is diagnosed with breast cancer every 4 minutes. One woman dies of breast cancer, every 13 minutes in India"[15].Genetic Algorithm can be applied in many domains especially in medical domain. Many researchers are contributed their genetic based research work on breast cancer detection, diagnosis and prediction.

B. Grey Wolf Optimization Algorithms

In 2014, Seyedali Mirjalili et al proposed [14] Grey Wolf optimization is introduced .It is Meta- heuristic based optimization algorithm .
Which has become more popular in recent decades because of its simplicity.
Grey Wolf lives in a group which native is Canidae family.GWO mimics the leadership hierarchy for group hunting of wolves.
It is one of the famous techniques among various Swarm Intelligent techniques.

The following is the hierarchy of Grey Wolf: 1. Alpha (α)
2. Beta (β)
3. Omega (Ω)
4. Delta (Δ)

In the above hierarchy of Grey Wolf, the Alpha (α) is the head or it has authority to take decision.

Beta (β) is known to be advisor to the Alpha or in other words it is the second level leader. Third level is omega (Ω) which obeys Beta and Alpha. Delta (Δ) wolves are another type of wolves.

C.Neural Network (NN)

Artificial Neural Network (ANN) is a extremelyeasy model of the formation of the biological neural network. An ANN consists of interrelated processing units.

Processing unit consists of a summing partfollowed by an output part. The summing part receives N input values, weights each value and computes a weighted sum. The weighted sum is called activation value.

There are many types of Neural Network among them Feed Forward Neural network (FFNN) are the popular. Multi layer precepton (MLP) is the sub set of feed forward Neural Network.

II. METHODOLOGY

A. Neural Network

"Douglas A. Woten et al proposed Interpreting Artificial Neural Networks for Microwave Detection of Breast Cancer. The inherent adaptability of ANNs enables the network to be reconfigured very easily, while still providing results within milliseconds.

Additionally, by setting the cutoffs arbitrarily low, the number of false negatives can be reduced to zero, while increasing the number of false positives and undecided results.

This yielded an overall miss rate of 32%, which is comparable to the worst case scenario of mammography 34%. This is considering as a reasonable performance for a preprocessor algorithm"[17]. "John Shell et al proposed Efficient Cancer Detection Using Multiple Neural Networks. The incentive to enhance cancer detection accuracy by using neural networks based on the positive neural network implementation.

They contributed data feature selection also"[18]**.** Artificial neural network, which has input layer, output layer, and two or more trainable weight layers (consisting of perceptrons) is called multilayer perceptron or MLP.

In [3], MPANN (memetic pareto artificial neural network) is introduced for the prediction of breast cancer. In their work evolutionary artificial neural network(EANN) approach based pareto differential evolution algorithm is used.

The features were extracted by using artificial neural network algorithm called MLP which is capable to distinguish the non-tumorous and tumorous features efficiently.

B.Genetic Algorithm Based Neural Network

In 2012, Smaranda Belciug et al [4] proposed a new neural network model to classify Breast Cancer and recurrence. They approached a hybrid model which is combination of genetic and Multiple Layer perceptron (MLP).They found that w neural network performs high when trained by genetic algorithm.

A Novel Genetic –Algorithm based Neural network is introduced by S.H Ling , Frank H.F Leung in [5].They proposed SAF (Static activation function) and DAF (Dynamic activation function).

The two activation function control the input output relationships.

Hossein Ghayoumi Zadeh et al [9] proposed a mixture of genetic and Artificial Neural Network in medical infrared thermal imaging.

They used breast cancer data set. Their study is to diagnosis breast cancer throughdealing out the quantitative and qualitative information obtained from medical infrared imaging.

Artificial Neural network(ANN) is trained through Genetic Algorithm.

In [16], genetic based firefly algorithm for training neural network is introduced for breast cancer identification. The author optimized the weights between layers and biases of the neuron network.

They found that when firefly algorithm is hybridized with Genetic Algorithm is in optimizing weights.

C.Overview of Grey Wolf Algorithm

Shankho Subhra Pal et al [11] proposed "a new hybrid approach grey wolf optimized based Neural Network for breast cancer Classification in the year 2018.

they named it as GWO-FFANN. On their research they found 97 % of accuracy when Grey wolf Optimization is trained to Feed- Forward Neural Network".

Narinder Singh et al [13] introduced a new combinationGWO (Grey Wolf optimization) and PSO (Particle Swarm Optimization.

They named it as HPSOGWO. It performs well when compared to other existing algorithm like Ant colony, Fire fly, Bat algorithm.

D.HybridGenetic - Grey Wolf BasedNeuralNetwork(G^2NN)

A novel hybrid Genetic Grey Wolf based Neural Network for classifying breast cancer data is introduced in this paper. The proposed neural network is engaged to study the input-output connections using hybrid GeneticGrey Wolf technique.

Arithmetic crossover and non uniform mutation is used and for selection grey wolf optimization is used.Genetic Algorithm is used by many researchers to classify the breast cancer data and it also performed well when compared to directly implementing neural network.

In recent years a new approach called optimization algorithms grown fast and many researchers used Grey Wolf Optimization algorithm forclassification of medical data.

In this paper our novel idea is to integrate genetic and grey wolf algorithm to train neural network for breast cancer classification.

The Following diagram represents Genetic Grey wolf based neural Network.

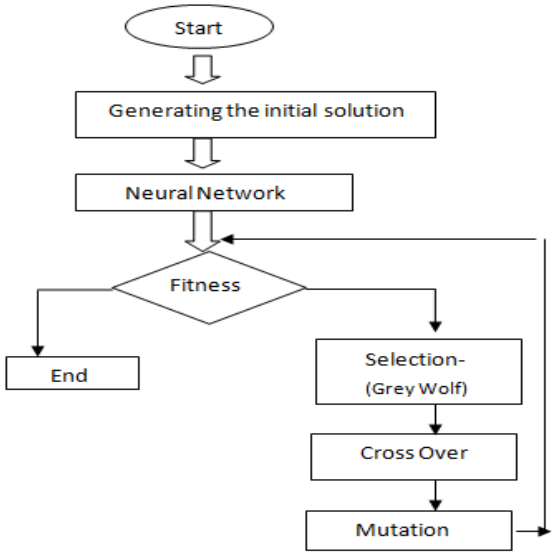

Fig 1: Flow of GeneticGrey Wolf based NN

III. EXPERIMENTAL RESULTS

A. Data Set

"'Wisconsin Breast Cancer (Diagnostic)' Data Set (WBCD) is used for the analysis. UCI Machine Learning Repository is a gathering of different databases, domain theories, and data generators that are used by the machine learning community for the empirical analysis of machine learning algorithms.

The archive was created as an ftp archive in 1987 by David Aha and fellow graduate students at UC Irvine.

The Dataset Contains569×32 where 569 are numbers of samples and 32 are number of attributes.

The analysis made to diagnosis or predicting disease such as cancer.

Thisdataset contain 2 classes one is malignant and other is benign.

Datasetcontains none missing attribute and Class distribution are 212 malignant, 357 benign" [15].

B.Evaluation Metrics

To evaluate the performance, the accuracy of the result is calculated as

Accuracy

$$\text{Accuracy} = \frac{Predicted}{Nooftest} * 100$$

F Score

$$FScore = 2 * \frac{Precision * Recall}{Precision + Recall}$$

Precision

$$\text{Precision} = \frac{TruePositive}{\text{True positive} + \text{False Positive}}$$

C.Classification Results

The following table represents the classification results.

The classification techniques are evaluated on the basis of the accuracy measures (classification metrics).

Table 1- Results

Algorithm	Accuracy	F1 Score	Precision	Recall
G^2-NN	0.989	0.987	0.995	0.998
NN	0.969	0.975	0.971	0.982
SVM	0.972	0.967	0.988	0.990
GW-NN	0.975	0.987	0.990	0.992

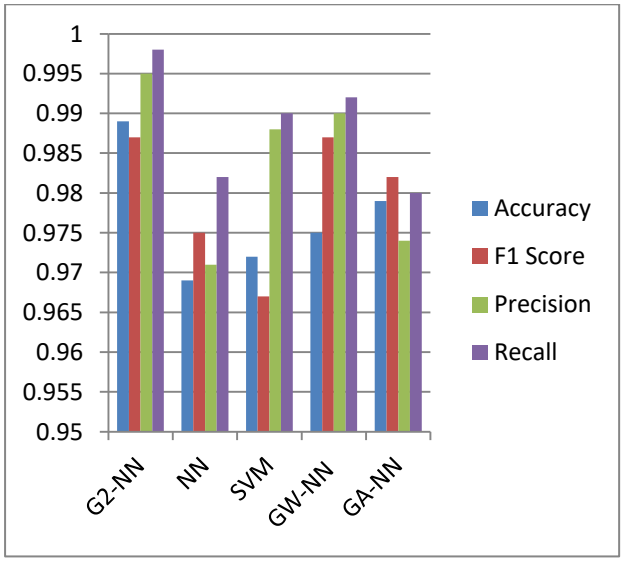

Fig 2: Classification Results

IV. CONCLUSION

In this paper, a novel technique called G^2NN is proposed for Breast Cancer data set.

The proposed technique is compared with Neural Network (NN),SVM (Support Vector Machine),Genetic Algorithm based Neural Network(GA-NN),and Grey Wolf based Neural Network(GW-NN).

The UCI Breast Cancer Data Set is used and it contains 569 records.

The tenfold cross validation methodologywas used in model building and evaluation, where we dividing the data set into 10 mutually exclusive partitions by using a stratified sampling technique. Out of tenfolds, seven is for training and the remainingfor testing.

Accuracy, Precision, Recall, F1Score, are calculated for all the sixmodels. We found that G^2NN performs well with an accuracy measure of 98.9%.

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