

High Performance Data mining by Genetic Neural Network

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Abstract:

Data mining in computer science is the process of discovering interesting and useful patterns and relationships in large volumes of data. Most methods for mining problems is based on artificial intelligence algorithms. Neural network optimization based on three basic parameters topology, weights and the learning rate is a powerful method. We introduce optimal method for solving this problem. In this paper genetic algorithm with mutation and crossover operators change the network structure and optimized that. Dataset used for our work is stroke disease with twenty features that optimized number of that achieved by new hybrid algorithm. Result of this work is very well in comparison with other similar method. Low present of error show that our method is our new approach to efficient, high-performance data mining problems is introduced.

Keywords: Data Mining, Neural Networks, Genetic algorithm, Stroke Disease, Prediction

1. Introduction

Data mining refers to extracting or mining knowledge from large amounts of data. Many other terms carry a similar or slightly different meaning to data mining, such as knowledge mining from data, knowledge extraction, data/pattern analysis, data archaeology, and data dredging. Knowledge discovery as a process is consists of an iterative sequence of the following steps: Cleaning, integration, selection, transformation, mining, Pattern evaluation, Knowledge presentation on data. Based on this view, the architecture of a typical data mining system may have the following major components: Database, data warehouse, WorldWideWeb. Data cleaning and data integration techniques may be performed on the data. Database or data warehouse server: The database or data warehouse server is responsible for fetching the relevant data, based on the user's data mining request. Knowledge base: This is the domain knowledge that is used to guide the search or evaluate the interestedness of resulting patterns. Such knowledge can include concept hierarchies, used to organize attributes or attribute values into different levels of abstraction. Knowledge such as user beliefs, which can be used to assess a pattern's interestedness based on its unexpectedness, may also be included. Data mining engine: This is essential to the data mining system and ideally consists of a set of functional modules for tasks such as characterization, association and correlation analysis, classification, prediction, cluster analysis, outlier analysis and evolution analysis. Pattern evaluation module: This component typically employs interestedness measures and interacts with the data mining modules so as to focus the search toward interesting patterns[1][1]. It may use interestedness thresholds to filter out discovered patterns. Alternatively, the pattern evaluation module may be integrated with the mining module, depending on the implementation of the data mining method used. For efficient data mining, it is highly recommended to push the evaluation of pattern interestedness as deep as possible into the mining process so as to confine the search to only the interesting patterns. User interface: This module communicates between users and the data mining system. From a data warehouse perspective, data mining can be viewed as an advanced stage of on-line analytical processing. However, data mining goes far beyond the narrow scope of summarization-style analytical processing of data warehouse systems by incorporating more advanced techniques for data analysis.

The problem that we want to solve it is prediction stroke disease by use of some features. In fact, our goal is design machine learning system that it can find answer of a question from large number of information. This system implement by artificial intelligence algorithms. We select two method very powerful in this category called by neural network and genetic algorithm.

A neural network (NN), in the case of artificial neurons called artificial neural network (ANN) or simulated neural network (SNN), is an interconnected group of natural or artificial neurons that uses a mathematical or computational model for information processing based on a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network. In more practical terms neural networks are nonlinear statistical data modelling or decision making tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data.

Genetic algorithm is a generalized search and optimization technique. It works with populations or chromosomes of individuals, each representing a possible solution to a given problem. Each individual is evaluated to give some measure of its fitness to the problem from the objective functions. Three basic operations namely: reproduction, crossover, and mutation are adopted in the evolution to generate new offspring. The idea of combining GA and NN was introduced in 1980s.

GA is a good method for selection and reduction of feature for our problem. Guided and random selection is main idea for this algorithm.

The idea is based on neural network by a genetic algorithm parameters are adjusted. The mutation and crossover operators can use the network to model artificial structures close to natural. In one of the papers, idea is to combine the three hidden layers with 5, 10, and 20 neuron network structure is built and optimized by genetic algorithm hidden layer with 10 neurons and 50 iterations to converge the network has high accuracy and low overfitting. The accuracy even with repeated 5 and 20 neurons in the 100 and 1000 is not convergent and efficiency as much as 90% can be achieved [2].

The use of back propagation and cross validation in neural network with optimization by genetic algorithm. The results show that this method is better than random topology [3]. One serious problem in neural networks to avoid overfitting is a generalization of the network inputs is high. The solution to this problem is to avoid non-useful data on the network is using best practices. In fact, the use of a validation set can detect any irregularities in the data and prevents the optimal weights for the network. Balance between genetic programming and neural networks, the network topology are an interesting topic. In advance of his generation program using appropriate structure for the network gets updated. Performance results on some math functions show that the algorithm has several training and testing compared to the mean value of 90.32% is reached[4]. Combinations of genetic algorithms and neural networks in another two problems in NN that are permutation and convergence are discussed. This method tested on Cloud Classification. By weights of neural network by Genetic Algorithm optimization amounts to about 3% error is reached.

A combination of genetic algorithms and multi-layer perceptron neural network to predict the performance of stroke patients with different data sets is equivalent to 89.67% [5]. An article comparing three Bayesian methods, neural networks and decision trees for problem solving is a predictor of stroke patients. The best accuracy achieved for the 91% Bayesian methods for neural networks and decision trees versus 92% against 94% [6].

We introduce a new approach on the combination of neural network and genetic algorithms. Our method is based on optimization and change on structure of NN by GA.

2. Combining GA and NN

Various methods have been proposed to combine the neural network with genetic algorithms excel each other than they are. Our simulations based on different data with different initial structures were investigated. We finally reached the conclusion that the proposed scheme is very effective for the data mining and forecasting, is accurate and robust.

The NN inputs to the forward and backward errors in the learning network and the number of turns. You can use the genetic operators and the output of the network structure was improved over generations. Also, a genetic algorithm, neural networks, thereby getting rid of the problem of local optimum and the plateau is gradient descend[7],[8]. The proposed solution is to combine these

two algorithms in neural networks evolved over generations and reaches its optimal structure. The network weights are adjusted along with the operation. This task changes the neural network is a powerful genetic algorithm

The combination ideas from nature, as human beings, their achievements and their understanding of the knowledge and experience acquired. In this work we tried to introduce a new approach for the combination of NN and GA with solving of overfitting problem. In our work, GA is a learning algorithm for NN, the structure of goal function is not important for us because that is hidden in neural network. Our solution is based on two model of genetic operator. We change mutation and crossover operators by the changes in NN weights and structure. Of course changes in structure of Neural Network have to be meaningful. We show two methods with different Challenges and results.

The combining algorithm is based on following Steps:

1. Construct NN with Input, Hidden, Output Layers
2. Adjust of NN weights by GA
3. Crossover & Mutation in NN by GA
4. Calculate Output & Error & Back propagation
5. Repeat step2 to reach end

The genetic algorithm used for optimization of neural network. The ring of algorithm finishes until reach to maximum generation number and or reach to minimum error.

3. Neural Networks

3.1. Definition

A neural network (NN), in the case of artificial neurons called artificial neural network (ANN) or simulated neural network (SNN), is an interconnected group of natural or artificial neurons that uses a mathematical or computational model for information processing based on a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network[9].

In more practical terms neural networks are nonlinear statistical data modelling or decision making tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data.

Two neurons neural network active in memory (ON or 1) or disable (Off or 0), and each edge (synapses or connections between nodes) is a weight. Edges with positive weight, stimulate or activate next active node, and edges with negative weight, disable or inhibit the next connected node (if it is active) ones.

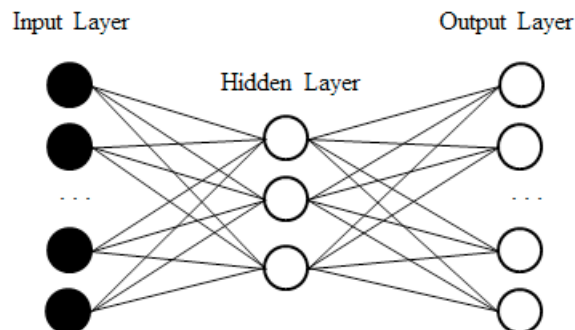


Figure 3. The Structure of Neural Network

The error in each output unit:

$$\delta_k = o_k (1-o_k)(t_k - o_k) \quad (1)$$

The error in each hidden unit:

$$\delta_h = o_h (1-o_h) \sum_k w_{kh} \delta_k \quad (2)$$

Update weights:

$$\Delta w_{ji}(n) = \eta \delta_j x_{ji} + \alpha \Delta w_{ji}(n-1) \quad (3)$$

$\alpha \Delta w_{ji}(n-1)$, with $0 \leq \alpha \leq 1$: In order to avoid oscillations for rapid learning and the acceleration of the learning speed, a modified version of the backpropagation learning algorithm may be derived using the concept of momentum term[10][11]. The effect of the momentum term for the narrow steep regions of the weight learning space is to focus the movement in a downhill direction by averaging out the components of the gradient which alternate in sign[11].

The value of weights:

$$w_{ji} = w_{ji} + \Delta w_{ji} \quad (4)$$

3.2. Overfitting Problem

One classical problem of neural networks is called overfitting, which occurs especially with noisy data. It has been observed that excessive training results in decreased generalization. Instead of finding general properties of the different input patterns that match to a certain output, the training brings the network closer to each of the given input patterns. This results in less tolerance in dealing with new patterns. One solution is using of evaluation of the network performance a different set of patterns than for the training. Hence, only networks that generate the ability to generalize are evaluated high[10].

To avoid overfitting problem, we have used a different method. When training a neural network with training data Overfitting Whenever we train stop and give the error propagates backward, and the training continues. Mean Square Error is very suitable method for this problem[14],[15].

In order to apply neural networks to data that is not yet the network architecture is very powerful. During the investigation we found that the results of large structures in many cases were successful and error trials are few. Genetic algorithm to obtain the optimal weights is very useful and convenient.

3.3. Weight Optimization

GA algorithm to adjust the weights of a back propagation neural network has a better performance than random search. Using crossover operator and without the mutation operator, better results can be achieved. Given that it is difficult to extract the function of neural network weights and may not be accurate mathematical model of it, but investigations show that such networks is a sine function. However, the GA can easily optimize this function[16][17].

Genetic algorithm combined with neural networks to solve problems with large number of features can be very effective. GA finds the optimal solution than local optimum solutions.

3.4. Feature Selection

Features that lead to abnormalities in the population should be removed. In order to find the best Features of all inputs to the neural network is given, then the inputs are removed and Education Network and error can be calculated and in after step the next feature to be removed so that the best properties at the lowest number get an error.

This is one of the approaches in this paper that the genetic algorithm is used to select the optimal features. As the number of network inputs is much the best Features permutation is equal to the factorial of a genetic algorithm to resign ourselves to this important work completed over the generations, won best feature.

4. Genetic Algorithm

4.1. Definition

Genetic algorithm is a generalized search and optimization technique. It works with populations or chromosomes of individuals, each representing a possible solution to a given problem. Each individual is evaluated to give some measure of its fitness to the problem from the

objective functions. Three basic operations namely: reproduction, crossover, and mutation are adopted in the evolution to generate new offspring [17].

One advantage of genetic algorithm to other methods, to obtain a set of optimal solutions to the stands, this can be very helpful.

4.2. Chromosome structure

We have to encode and decode phenotype patterns versus genotype; this work is need to genetic operators. The chromosome is encoded in the weights in each layer are coded with values of zero and one. In the first step of the algorithm, the values are randomly selected and completed to the best of their coming generations. We have two encoding. Model1: Index Bit and Weight Encoding Bits:

1 01000001 1 10001111 1 11100110 1 10000001 0 10110110 1 00101000.

The distinct 1 is for each Layer and distinct 0 is other layer.

Model 2: The certain numbers of NN structures the same of above with this difference that each value of genome is the number of nodes in layer.

1 00001010 1 00000011 1 00001110 1 00000001.

For example in above chromosome there are three layers in sequence ten inputs, two and six hidden layer and one output layer.

In final step we attached two string as first part is for network weights and second part is relation with structure of network.

4.3. Population

In initialization steps the population size (PS) of chromosomes assigned by 100. The repeated chromosomes are removed in the initialization phase all chromosomes are different from each other. This work decrease search space at different places randomly which increases the convergence rate. Also 100 individual of neural network structure for start add to answer pool and they were optimized by genetic operators. To avoid overpopulation, and the elitism operation after mutation and crossover operators, the percentage of the population will replace the previous population. This action was completed over generations, become more efficient solutions.

4.4. Fitness function

Genetic algorithms for each member of the population in order to assess the need for a standard fitness function is called. Selecting this function will play an important role in the design of genetic algorithms. A suitable function can reduce errors and increase the speed of the algorithm convergence. The back propagation training cycles and its maximum value are suitable for fitness function. The Evaluating function for an individual is:

$$\text{Fitness} = \text{BP Number} / \text{Max}(\text{BP Number}) * \text{Network Error}$$

To obtain the maximum number of back propagation by field surveys should be obtained from networks of different sizes.

4.5. Crossover

Guided crossover operator is based on the two point separation from parents are selected Left and right parts of them are related to each other by the condition to be meaningful With this new child of his parents is that. But a new generation of the random choice to have reached this stage. The crossover rate is fixed for our algorithm.

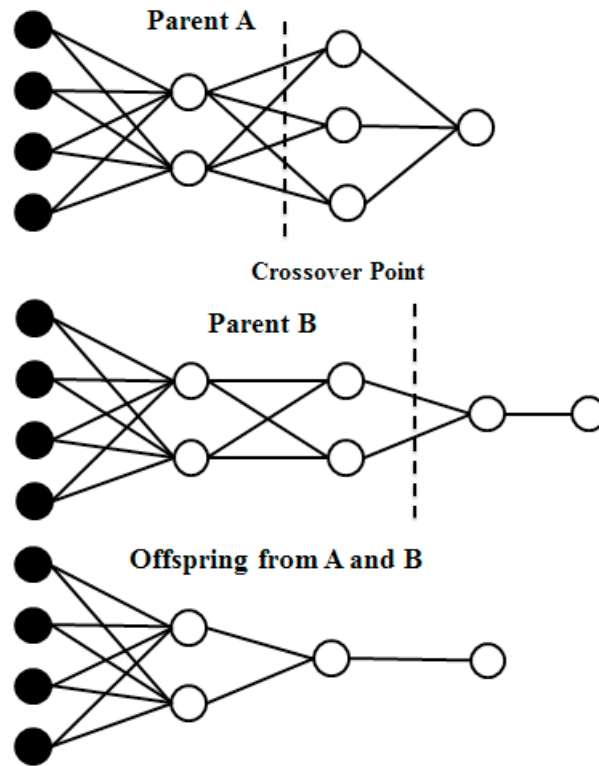


Figure 4. Structural Crossover

4.6. Mutation

Change in NN structure is other method that we used to optimization of solution[18]. Insertion a hidden layer caused to mutation operator is much natural. As connection with father and mother nodes is easily[20],[21]. Weights of node and errors automatically calculated.

For each stage of the implementation of the mutation operator in genetic algorithms, neural networks, only one of the nodes in the hidden layer is selected and inserted. These layers are inserted on condition that the definition does not harm the network structure and the action is meaningful.

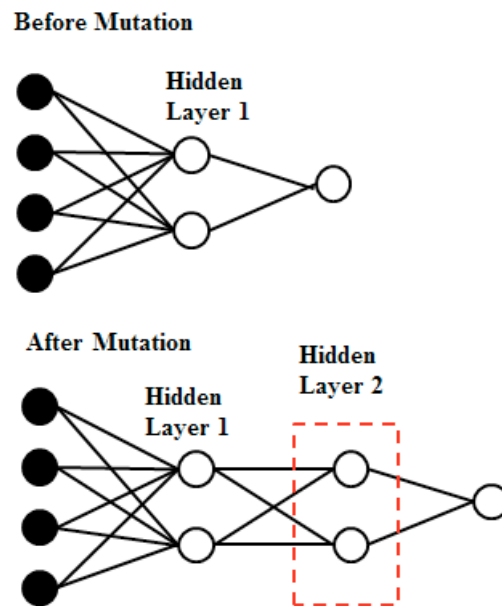


Figure 5. Insertion and Deletion Hidden Layer in NN

As an added layer can adjust the weights and the connection to the parent node of a network layer to be removed.

4.7. Elitism

The improved genetic algorithm genetic operators mutation and crossover are performed by members of the population. The new offspring replace with their parents. but the population is evaluated by the fitness function to be part of the crowd prior to being replaced by a new generation of members is better than they were before. Papers will be presented in different ways. After a review of our project, we chose the type of the data set. Select the best fitness could be useful.

5. Simulation and results

For the test of algorithm performance designed a simulator by matlab software Simulink. First we designed all of the approach that describe on above and then implemented by algorithms in the software.

We chose a data set that contains the parameters for the disease is stroke[22][22]. To suitable comparison our results with other works have used of following parameters is in Table 1.

Table 2 . The Features for Stroke Disease

Number	Features
1	Atrial fibrillation
2	Blood cholesterol
3	Cardiac failure
4	Diabetes
5	Dizz
6	Double vision
7	Giddiness
8	Headache
9	Hypertensive
10	Left arm and leg
11	Memory deficits
12	Myocardial
13	Numbness
14	Right arm and leg
15	Slurring
16	Smoking
17	Swallowing
18	Vertigo
19	Vision
20	Vomiting

The above information collected for 200 human with stroke disease as input dataset in neural network. We tried to delete error to natural experiments.

For obtain the learning parameters we used 10% of dataset records. One of main usage for this parameters is finding of stop time in algorithm. In fact this data are validation set for learning function. So dataset global divided to three parts, first part is training set by 60%, second part is validation set by 10% and tertiary part is test set by 30%. Test set help us for generalization of unseen samples.

The best values for the parameters of both algorithms based on a combination of experiments and the values obtained for the number of data mining and the features are directly compatible with We chose. The parameters of Genetic algorithm are mutation rate 0.02, cross over rate 0.40, elitism rate is 0.02 and neural network has 20 nodes in input layer, 5 nodes in hidden layer and 20 nodes in output layer that connect to one node for target value. The target value is result of algorithm.

In the structural model of GANN, we had to increment number of generations for more learning by GA. Feature selection and classification is an important part of learning problems.

There are many features will reduce the efficiency of the algorithm and its complexity. Among the methods for selecting the appropriate features, the algorithm is a GA.

One of the important parameters for testing methods is accuracy rate on progress generation. In fact accuracy is reverse error in algorithm results. As reader can compare the results of our paper with another works. Figure 4 show that accuracy present for Training step. We achieve to best answers of 800 generation to after generation.

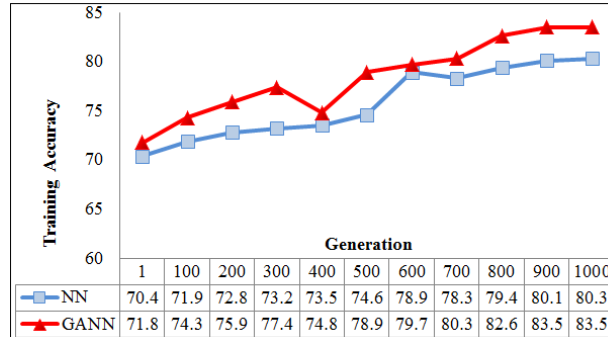


Figure 6. Training Accuracy with progress generation

In the training phase, the neural network weights errors are minimized and network design problem which the objective function to an acceptable level. In test step we have better results because weights of neural network are adjusted by genetic algorithm and back propagation method. Of course achievement to accuracy with 83.5% is reason using of good feature with minimum error.

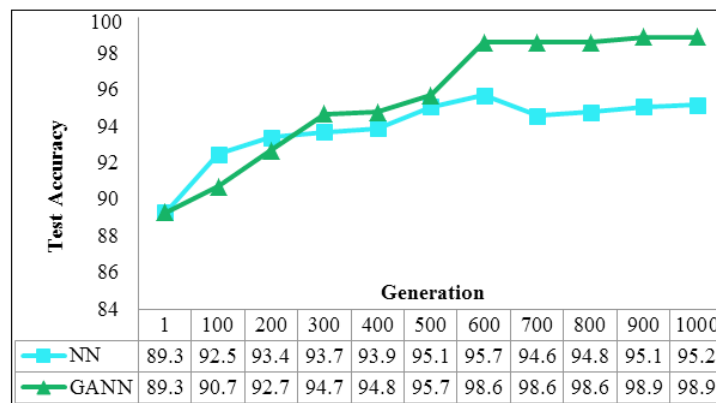


Figure 7. Test Accuracy with progress generation

As Figure 5 The number of generation that optimal answers are there equal 600 and after it. To obtain reliable results, our algorithm is about 30 times with different initial populations were studied and the results were declared out. The results obtained with the implementation of the well to prove our claim.

For another experience we considered mutation rate in genetic algorithm as descending. This work shows that fixed mutation rate for whole generations is not good selection for that. Also we did not achieved to optimal results by fixed rate for mutation operator.

We tried to test our new method with change of parameters. The simulation result with fixed and variable mutation rate show in Table 2.

Table 3. Comparison of Accuracy based on mutation rate

	Generation				Accuracy
	1	100	500	1000	
Mutation Rate	0.02	0.02	0.02	0.02	90.1
	0.02	0.01	0.005	0.001	98.9

Whatever the final generation of the genetic algorithm approach to converge to the optimal solutions are needed to reduce the rate of mutation operator. Fixed rate of generation of diversity to be the final answer does not converge.

This combination of NN, GA is the best result. We conclude that adjusting the NN parameters by GA is a good method.

The results of simulation show that our approaches are very effective in solving classification problem. Our model reach good result but structured model reaches an excellent result. We obtain this result that structured model similar to Genetic Programming caused to the algorithm converge to optimal answer with more speed.

We obtain the fitness values for selection generation after normalization and reversion. The reversion is because of reduction selection for fitness in first assumption. This results show in Table 3. Of course this is fitness value and it is not accuracy rate. For accuracy rate have to obtain error rate too.

Table 4. Fitness Values in Generation Progras

Generatio n	100	400	600	800	1000
Values	0.757	0.788	0.885	0.886	0.886

The another of parameters for algorithm comparison is times of execution. We understand that in training step more time used because of weights non accurate. After training of neural network is when using of network. For test step we obtain better time.

Figure 6 show that comparison of execution or run times.

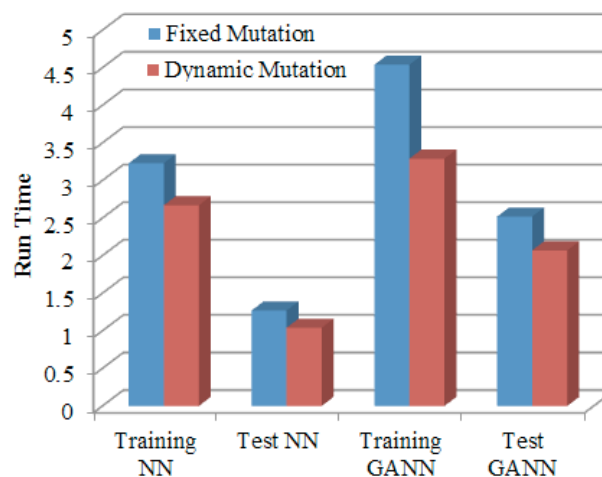


Figure 8 . The Comparision of Run Times

That is distinct that dynamic mutation rate or reduction idea for mutation operator is more better of fixed rate. In fact obtain to high accuracy is result of our idea for mutation operator.

The number of hidden layer neurone is important problem for NN. The natural selection by GA help finding the number of hidden layer neurone and it progress on duration generations.

The structured model of GANN finds better answer than NN but with much run time in simulation. The learning of GA is much better than NN with back propagation because BP is a method based on gradient descend and local optimum is a serious risk for that.

We hope that the number of training samples is more accurate without error, the new algorithm is better. Tests show that the combination of genetic algorithms and neural networks to an acceptable level solves the problem of overfitting.

6. Conclusion and discussion

Extracting knowledge from information requires a lot of data to be resistant to change. Choosing the best attributes as an important part of our work is based. The task of genetic

algorithms to select the best features and the best structure for the ANN is generational. In this paper genetic algorithm with mutation and crossover operators by two approaches on coding solutions by optimizing the weights and network structure is encoded. This two model are very important in reach best result. The grid of local optimum, plateau and also create a natural selection for problem are power point of our method. We solve overfitting problem in NN with combination of evolutionary algorithms. Adjusting algorithm parameters are very vital. The obtain network is very robust versus noisy input data.

Genetic algorithms we prove that no matter how close we are to the end of generations to converge to the optimal solutions are needed to reduce the rate of mutation operator. This technique will also lead to changes in the network structure, which is considered one of the most important features of our algorithm. The GANN method with 98.9% accuracy is more better that other introduced methods in this paper. We suggest the machine learning and soft computing methods for future work. Our proposed method can be a model for other problems in data mining. So our approach have high accuracy in prediction stroke disease , also it can be very effective for other data mining problems.

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