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Heart Disease Classification Framework Using Fuzzy and Flower Pollination Neural Network

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ABSTRACT

Heart Disease are among the leading cause of death worldwide. The application of artificial neural network as decision support tool for heart disease detection. However, artificial neural network required multitude of parameter setting in order to find the optimum parameter setting that produce the best performance. This paper proposed the heart disease classification framework using fuzzy and flower pollination neural network. Statlog heart disease dataset is used to evaluate the performance of the proposed framework. The results show that the proposed framework able to produce high classification accuracy where the overall classification accuracy for Statlog dataset ranging from 86.7% to 91.1%.

Key words : Artificial Neural Network, Heart Disease Classification, Flower Pollination Algorithm, Statlog Heart Dataset

1. INTRODUCTION

Heart disease describes a range of conditions that affect your heart. Heart disease is under umbrella of cardiovascular disease in which are the leading cause of death worldwide where more people die from cardiovascular diseases compared to any other causes annually. Mortality for heart disease is projected to be increased to reach 23.3 million by the year of 2030 where heart disease will remain to be the leading cause of death for human. It became imperative to diagnose the presence of heart disease in the early stages in order to contain the disease from worsening. The early detection of heart disease can help the patient to adjust lifestyle and also help the medical professionals to prescribe appropriate medicine. However, the diagnosing patient with the presence of heart disease can be challenging where it depends on medical professional's experience and intuition [2,3]. It is imperative for medical professionals to have a system that can help them predict and classify the patient who have high risk of getting heart disease.

The implementation of machine learning algorithm can help medical professionals in diagnosing the presence of heart disease in the patient. Machine learning algorithm have become very popular for solving classification problems where it is capable of mapping the relationship between variables or attributes with minimal human effort.

Artificial Neural Network (ANN) are among the most popular machine learning algorithm where it proves to be powerful tools for mapping nonlinear data and are known to be useful in solving nonlinear problems where the rules to solve the problem is difficult to obtain or unknown [4-5]. However, Artificial Neural Network required a lot of parameter setting where parameter tuning often been done by trial and error. Feed forward back propagation neural network is the most commonly used type of artificial neural network and it requires the users to specify several parameters including the numbers of hidden layer, the numbers of hidden nodes, training algorithm and type of transfer function (there is any reference for this point).

Presently, there are 13 types of training algorithm and 10 types of transfer function. The numbers of possible combination parameters that can be used can range from 1300 up until 130000 depending on the numbers of hidden layers specified by the users. The trial and error approach consuming enormous amount of time and does not guarantee the model to obtain the best possible classification accuracy. To solve this problems, we previously have proposed the parameter tuning framework for Artificial Neural Network for heart disease classification [6].

This paper presents the continuity of previously proposed framework [6] by integrating fuzzification process and integrating flower pollination algorithm to substitute the training algorithm in the previous framework. Statlog heart disease dataset obtain from UCI machine learning data repository are used to measure the performance of proposed the framework.

2. ARTIFICIAL NEURAL NETWORK MODEL

A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. ANN has been implemented in various fields. In healthcare, ANN is implemented for clinical diagnosis, drug development, image analysis and signal analysis [1]. ANN had proven to be useful for modeling complex relationships between inputs and outputs or to find patterns in data. Basically, feed

forward neural network consists three main layers which are input layer, hidden layer and output layer. Input and output layers are usually consisting 1 layer each and hidden layer could consist at least 1 or 2 layers. Figure 1 shows the examples of feed forward neural network architecture. The numbers of input nodes and output nodes depends on the collected data while the numbers of hidden nodes for ANN are usually based on trial and error subject to the better accuracy

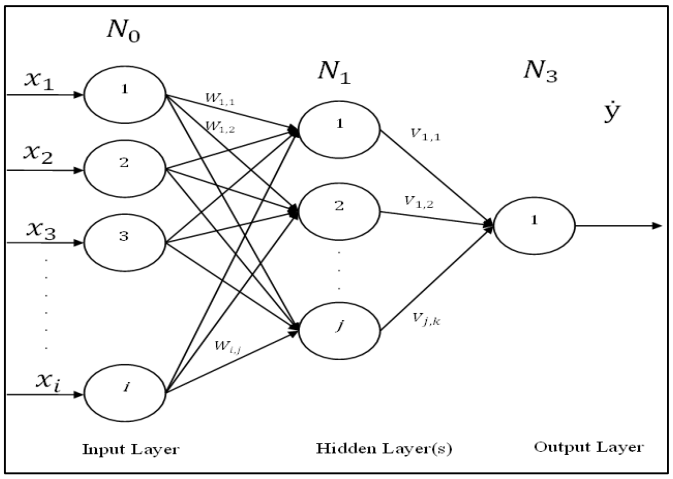

Figure 1: Basic Neural Network Architecture

Artificial Neural Network consist of several parameters that include number of hidden layers, number of hidden nodes, types of transfer function and types of training algorithm. There are no specific or recommended numbers of hidden layer or hidden neuron where some researchers use trial and error method in order to find the best combination of parameters that form the best neural network model [15]which give a better result in the output layer. In order to solve this problem, parameter tuned artificial neural network is introduced [14]. However, the performance of parameter tuned neural network could be further enhance by integrating evolutionary algorithm for optimization with neural network. Furthermore, the application of fuzzy could be used to improve the parameter tuned in the neural network.

3. PROPOSED FRAMEWORK

This paper proposed framework for heart disease classification using fuzzy and flower pollination neural network. Figure 2 shows the proposed heart disease classification framework using fuzzy and flower pollination neural network. Heart disease data was collected from machine learning repository of University of California, Irvine [17]. Statlog Heart dataset was used for this research. The data were gone through data processing process where we performed data cleaning in order to remove incomplete data. Then the data were partition into ratio of 70% for training, 15% for validation and 15% for testing. Two sets of datasets were prepared for this research. The first dataset was the original dataset obtain from UCI machine learning repository while the second dataset was the dataset that has been through fuzzification process.

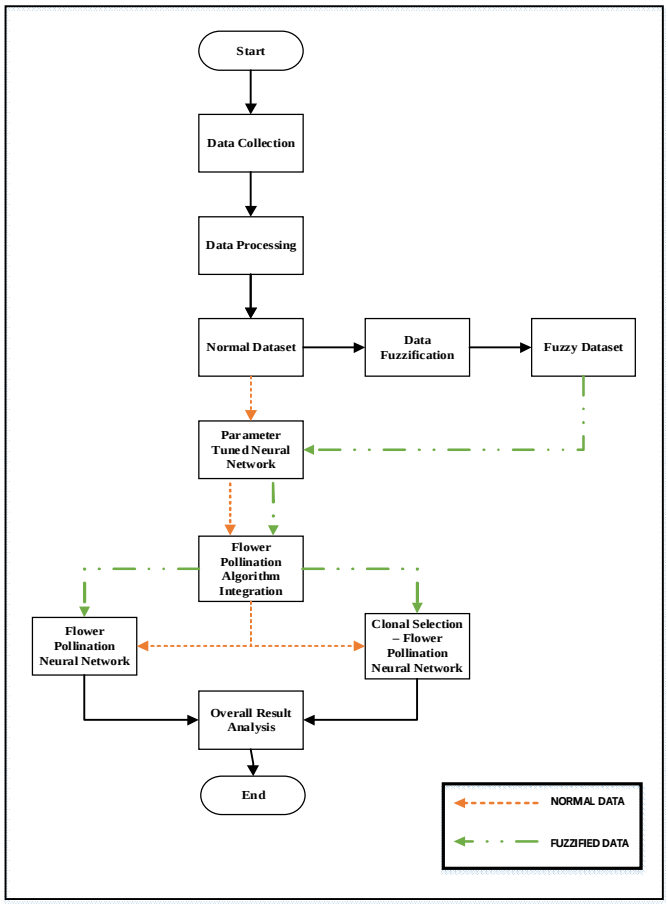

Figure 2: Heart Disease Classification Framework

Data fuzzification process is started by selecting attributes suitable for fuzzification. Statlog dataset contains 13 attributes that include:

1. Age
2. Gender
3. Chest Pain Type
4. Resting Blood Pressure
5. Serum Cholesterol
6. Fasting Blood Sugar
7. Resting ECG
8. Maximum Heart Rate Achieved
9. Exercise Induce Angina
10. ST depression old peak
11. ST segment peak exercise slope
12. The number of major vessels coloured by fluoroscopy
13. Thalassemia

Resting blood pressure, serum cholesterol, and heart rate are chosen for data fuzzification because the others 10 attributes are not suitable for data fuzzification

where 9 of the attributes are nominal data type while age does not need to be fuzzify because majority of the patients are in age range of 50-70 years old. After the completion of the data fuzzification process, the fuzzified datasets use parameter tuned neural network proposed in 2018 for heart disease classification [14]. The classification accuracy for both of datasets are obtain and compared. The classification results are shown in the following section.

The parameter tuned neural network then is modified by integrating flower pollination algorithm. Flower pollination algorithm has been proposed in 2013 by Xin-She Yang which inspired by characteristic of biological flower pollination in flowering plant. Essentially, flower pollination algorithm can be explained using following rules [12]:

1. Cross pollination and biotic is considered as global pollination process where polinators that carrying pollen performing random walk known as Levy Flight.
2. Local pollination is done by agent called abiotic
3. Flower constancy can be considered as the reproduction probability is proportional to the similarity of two flowers involved.
4. Switch probability $p \in [0,1]$ controlled local and global pollination. Local pollination can have significant fraction p in overall pollination activities because of physical proximity and factors such as local pollination and wind.

In the proposed flower pollination neural network algorithm, each best pollen represents a possible solution (the initial weight space and corresponding biases for neural network optimization). The weight optimization problem and population size represent the quality of the solution. In the first epoch, the best initial weights and biases are initialized with Flower Pollination. Subsequently, those weights are passed on to the neural network. The weights in neural network are computed and compared with the best solution. In the second cycle, the flower pollination updates the weights with the best possible solution. The flower pollination continues searching the best weights until the last cycle/epoch of the neural network is reached or the target minimum error is reached. Figure 3 shows the simplified flow of flower pollination neural network algorithm.

Two variant of flower pollination algorithm are used in this research. The first variant is using the original flower pollination proposed by Xin-She Yang in 2013 while the second variant is called clonal selection flower pollination proposed by Emad Nabil in 2015 [18]. Once the flower pollination integration is finished, the proposed flower pollination neural network is used to classify the heart disease by using the normal and fuzzified dataset. The classification results from these datasets are obtained and then are compared with the one from the parameter tuned neural network. These classification results also compared with the reported results from previous publication

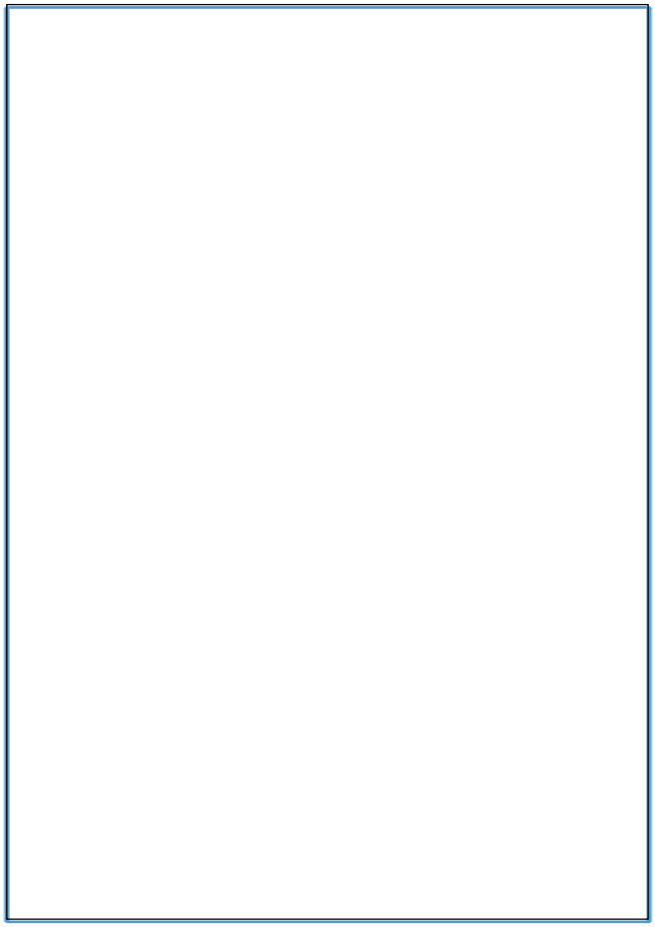

Figure 3: Flower Pollination Neural Network Workflow

4. RESULTS ANDANALYSIS

4.1. Proposed Framework Results

The following results are obtained by using the proposed algorithms. Details of each analysis are presented in the following tables. Table 1 shows the parameters that used in this neural network and table 2 shows the overall classification results from the proposed framework. Figure 4 shows the accuracy comparison between each proposed framework.

Table 1 Neural Networks Parameter Obtain by the Proposed Framework

Neural Networks Model	Training Algorithm	Hidden Layer	Hidden Nodes	Hidden Layer Transfer Function	Output Layer Transfer Function
Neural Network with Parameter Tuned	Scaled conjugate	1	20	Hardlim (Hard Limit)	Purelin (Linear)
Fuzzy Neural Network with Parameter Tuned	Scaled conjugate	1	20	Logsig (Log-Sigmoid)	Satlins (Symmetric Saturating Linear)
Flower Pollination Neural Networks	Flower Pollination	1	20	Hardlim (Hard Limit)	Purelin (Linear)

Fuzzy Flower Pollination Neural Networks	Flower Pollination	1	20	Logsig (Log-Sigmoid)	Satlins (Symmetric Saturating Linear)
Clonal Selection Flower Pollination Neural Networks	Clonal Selection - Flower Pollination	1	20	Hardlim (Hard Limit)	Purelin (Linear)
Fuzzy Clonal Selection Flower Pollination Neural Networks	Clonal Selection - Flower Pollination	1	20	Logsig (Log-Sigmoid)	Satlins (Symmetric Saturating Linear)

Table 2: Overall Classification Results Obtain by The Proposed Framework

Algorithm	Training	Validation	Test	Overall
Neural Network with Parameter Tuned	87.5	81.5	85.2	86.7
Fuzzy Neural Network with Parameter Tuned	88.4	81.5	85.2	87.4
Flower Pollination Neural Networks	89.4	92.6	88.9	89.6
Fuzzy Flower Pollination Neural Networks	91.7	88.9	88.9	91.1
Clonal Selection Flower Pollination Neural Networks	92.1	85.2	88.9	91.1
Fuzzy Clonal Selection Flower Pollination Neural Networks	89.8	88.9	92.6	90.0

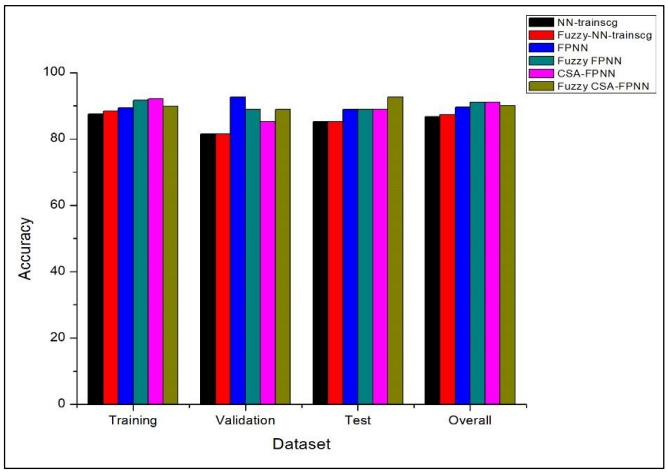

Figure 4: Classification Accuracy Comparison of the Proposed Framework

Fuzzy Flower Pollination Neural Network and Clonal Selection Flower Pollination Neural Network achieve the highest classification accuracy compared to the others proposed algorithm. The implementation of fuzzy logic on the other hand able to increase the performance of neural network.

4.2. Comparison results

The results are compared with our previous works [14]. Table 3 shows the comparison of classification accuracy for Statlog dataset between previously proposed algorithm and the proposed framework while Figure 5 shows the classification accuracy comparison between previous research.

The proposed models generally performed well compared to the others method of classification proposed by previous researchers. Fuzzy Flower Pollination Neural Network and Clonal Selection Flower Pollination Neural Network especially achieve highest classification accuracy compared to the others algorithm

Table 3: Statlog Dataset Accuracy Comparison

Algorithm	Accuracy (%)
InductH [9]	58.5
Weighted Fuzzy [2]	62.0
FOIL [9]	64.0
RBF [9]	60.0
T2 [9]	68.1
IR [9]	71.4
ANFIS_LSGD [9]	75.6
CHAID [7]	76.6
CRT [7]	76.6
ANFIS_LSLM [9]	76.7
Fuzzy neurogenetic [3]	80.0
MLP [7]	83.3
MARS-LR [4]	83.9
RBFN [7]	84.6
ANN-FNN [6]	87.0
Proposed Neural Network with Parameter Tuned	86.7
Proposed Fuzzy Neural Network with Parameter Tuned	87.4
Proposed Flower Pollination Neural Networks	89.6
Proposed Fuzzy Flower Pollination Neural Networks	91.1
Proposed Clonal Selection Flower Pollination Neural Networks	91.1
Proposed Fuzzy Clonal Selection Flower Pollination Neural Networks	90.0

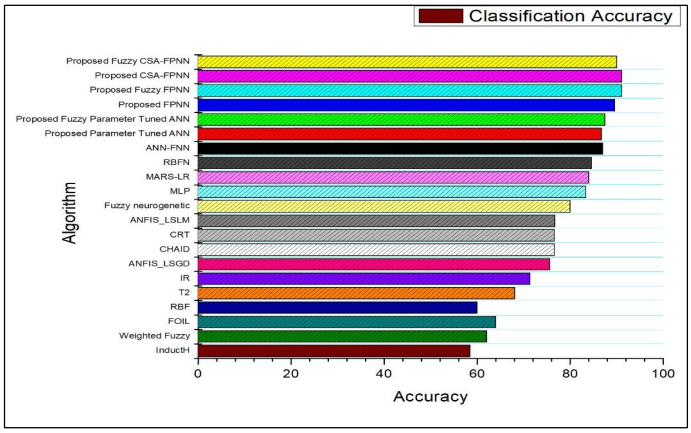

Figure 5: Classification Accuracy Comparison between previous research

5. DISCUSSION

This paper proposed the heart disease classification framework using fuzzy and flower pollination neural network. The result shows that the proposed framework is able to achieve the highest classification accuracy up to 91.1%.

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REFERENCES

1. Remzi M, Anagnostou T, Ravery V, Zlotta A, Stephan C, Marberger M, Djavan B. “An artificial neural network to predict the outcome of repeat prostate biopsies.” Urology. 2003 Sep;62(3):456-60 https://doi.org/10.1016/S0090-4295(03)00409-6
2. Anooj, P. K. "Clinical decision support system: Risk level prediction of heart disease using weighted fuzzy rules." Journal of King Saud University-Computer and Information Sciences 24, no. 1 (2012): 27-40.
3. Hedeshi, N. Ghadiri, and M. Saniee Abadeh. "Coronary artery disease detection using a fuzzy-boosting PSO approach." Computational intelligence and neuroscience 2014 (2014): 6.
4. Abdullah, Manal, et al. “Arabic Handwriting Recognition Model Based on Neural Network Approach.” International Journal of Advanced Trends in Computer Science and Engineering, vol. 8, no. 1, 2019.
5. Raju, Kachapuram Basava, et al. “Automated Age Prediction Using Wrinkles Features of Human Faces.” International Journal of Advanced Trends in Computer Science and Engineering, vol. 8, no. 1, 2019, pp. 148–53.
6. Y. E. Shao, C.-D. Hou, and C.-C. Chiu, “Hybrid intelligent modeling schemes for heart disease classification,” Applied Soft Computing Journal, vol. 14, pp. 47–52, 2014.
7. K.Vijaya,H. K.Nehemiah,A.Kannan, andN.G.Bhuvaneswari, “Fuzzy neuro genetic approach for predicting the risk of cardiovascular diseases,” International Journal of Data Mining, Modelling and Management, vol. 2, no. 4, pp. 388–402, 2010.
8. H. Kahramanli and N. Allahverdi, “Design of a hybrid system for the diabetes and heart diseases,” Expert Systems with Applications, vol. 35, no. 1-2, pp. 82–89, 2008. https://doi.org/10.1016/j.eswa.2007.06.004
9. Nahato, Kindie Biredagn, Khanna Nehemiah Harichandran, and Kannan Arputharaj. "Knowledge mining from clinical datasets using rough sets and backpropagation neural network." Computational and mathematical methods in medicine 2015 (2015).
10. Sagir, Abdu Masanawa, and Saratha Sathasivam. "A Novel Adaptive Neuro Fuzzy Inference System Based Classification Model for Heart Disease Prediction." Pertanika Journal of Science & Technology 25, no. 1 (2017).
11. Polat, K. , Sahan, S. , Kodaz, H. , & Günes, S. (2005). A new classification method to diagnosis heart disease: Supervised artificial immune system (AIRS). In Proceedings of the Turkish symposium on artificial intelligence and neural networks (TAINN).
12. Das R, Turkoglu I, Sengur A (2009) Effective diagnosis of heart disease through neural networks ensembles. Expert Syst Appl 36(4):7675–7680
13. El-Bialy R, Salamay MA, Karam OH, Khalifa ME (2015) Feature analysis of coronary artery heart disease data sets. Procedia Comput Sci 65:459–468.
14. Xu Y, Pan X, Zhou Z, Yang Z, Zhang Y (2015) Structural least square twin support vector machine for classification. Appl Intell 42(3):527–536. https://doi.org/10.1007/s10489-014-0611-4
15. Zhang, Guoqiang, B. Eddy Patuwo, and Michael Y. Hu. "Forecasting with artificial neural networks:: The state of the art." *International journal of forecasting* 14, no. 1 (1998): 35-62
16. Yazid, M. Haider Abu, Shukor Talib, Muhammad Haikal Satria,. " Artificial Neural Network Parameter Tuning Framework for Heart Disease Classification." *Proceeding of the Electrical Engineering Computer Science and Informatics* 5 (2018)
17. Zain, Azlan Mohd, Habibollah Haron, and Safian Sharif. "Prediction of surface roughness in the end milling machining using Artificial Neural Network." *Expert Systems with Applications* 37, no. 2 (2010): 1755-1768.
18. X.S. Yang, “Flower pollination algorithm for global optimization”, Unconventional Computation and Natural Computation (2012) 240–249. https://doi.org/10.1007/978-3-642-32894-7_27
19. Blake, C.L., Merz, C.J.: UCI Repository of machine learning databases. Irvine, CA (1998), http://www.ics.uci.edu/~mlearn/MLRepository.html
20. Nabil, Emad. "A modified flower pollination algorithm for global optimization." *Expert Systems with Applications* 57 (2016): 192-203 https://doi.org/10.1016/j.eswa.2016.03.047