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A Real-Time Prediction of Adult Congenital Heart Disease Based On Chronic Kidney Disease Using Meta-Heuristics Algorithm

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Abstract:
Kidney damage and diminished function that lasts longer than three months is known as Chronic Kidney Disease (CKD). Identifying CKD in the initial stage is important to provide necessary treatments to prevent or cure the disease. In this research paper, a real-time prediction scheme for adult congenital heart disease (ACHD) based on chronic kidney disease (CKD) using meta-heuristics algorithm (RTPC-ACHD) is proposed. An optimal data mining technique to accurately predict the target class for each case in the data is needed. First, the chaotic fuzzy multi-model neural network is used for the early prediction of heart diseases using CKD risk factors. The present work emphasize is based on data mining and the classification techniques in health informatics to detect Chronic Kidney Disease (CKD). Self-adaptive Bat optimization algorithm is a novel meta-heuristics algorithm which selects the most optimum features which contribute more to the result which reduces the computation time and increases the accuracy. The experimental results shows that the proposed RTPC-ACHD scheme gives a better result than the other classification algorithms and produces 99.17% accuracy.

Keywords*: Chronic Kidney Disease, RTPC-ACHD, Fuzzy MM neural network, Self adaptive Bat optimization algorithm.*

1. Introduction

With increasingly successful surgical techniques and medical management, children with congenital heart disease are surviving longer, and there are now more adults than children with congenital heart disease [1][2]. Despite its rapid growth, the subspecialty of adult congenital heart disease (ACHD) lacks the broad research base common in other areas of cardiology [3].Challenges to research include the heterogeneous mix of congenital lesions seen in ACHD, the young nature of the field, and a relatively small population, as compared with those with other types of cardiac disease [4]. Although many patients with ACHD survive into adulthood, long-term survival with moderate or severe ACHD remains limited, and there are few data on risk factors for and circumstances surrounding death in this population. Congenital heart disease is, by definition, present from birth, and patients adapt daily activities to their ability,

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thus, potentially underestimating and underreporting the severity of physical limitation. Indeed, none of the available heart failure classification grading scales has been validated in ACHD patients, to date [5]. Cardiovascular disease (CVD) guidelines provide a good framework to determine screening and treatment strategies in the ACHD population. Patients with a history of coarctation of the aorta or who have had surgical coronary manipulation represent specific high-risk groups for future CVD events [6].

The mouse genetic model is used to investigate the consequences and the mechanisms associated with combined obesity and ACHD predisposition [7]. A meta-learning-based intelligent model [8] is used to train an estimator to determine optimal trileaflet parameters for customized trileaflet valve reconstruction. This estimation model overcomes the problem of empirical parameter determination. International classification of disease-9th revision (ICD-9) is used to diagnoses and the reliability of retrieval algorithms in ACHD [9]. Cardiac magnetic resonance (CMR) based method used to measures strain without the need for additional sequence acquisition which can be analyzed rapidly, opening the possibility of use in ACHD [10]. ViSiBiD accurately identify dangerous clinical events of a home-monitoring patient in advance using knowledge learned from the patterns of multiple vital signs from a large number of similar patients [11]. There is increasing evidence in the general adult population that myocardial deformation is a more sensitive, quantitative evaluation of global contractile function that can detect changes.In general, CVD is one of the most common causes of death in patients with kidney disease, so proper recognition and screening techniques are important for preventing disease progression and complications.

1.1 Contributions

In this paper, i propose a real-time prediction schemefor ACHD based on chronic kidney disease (CKD) using meta-heuristics algorithm (RTPC-ACHD).Here, we need optimal data mining technique to accurately predict the target class for each case in the data. First, the chaotic fuzzy MM neural network is used for the early prediction of heart diseases using CKD risk factors. Self-adaptive Bat optimization algorithm is novel meta-heuristics algorithm which selects the most optimum features which contribute more to the result which reduces the computation time and increases the accuracy. The simulation result shows that the proposed RTPC-ACHD scheme as feature selection increases the predictive accuracy than existing schemes.

This manuscript is organized as follows: In Section 1, I present in overview of CKD and CVD. In Section 2, proposed method and system model. In Section 3, we described briefly about proposed algorithm. Section 4 Experimental result and Section 5 concludes the paper.

2. Problem methodology and System model

This part expresses the real-time prediction scheme for ACHD based on chronic kidney disease (CKD) using meta-heuristics algorithm (RTPC-ACHD). By following this, we were described about Fuzzy multi-model neural network and self adaptive Bat optimization algorithm.

2.1 Problem methodology

İlkim Ecem EMRE et al. [27] have presented a data mining method for Acute rheumatic fever (ARF). It's a major disease in turkey regularly. To get cure from this type of disease, we used to apply data analysis model on disease. The experimental analysis conducted five various algorithm in acute rheumatic fever and analyzed

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with the setting models. The decision tree (c4.5, cart, c5.0boosted and c5.0), random forest algorithms and Bayes classifier are the algorithms used in this methodology. These algorithm performance are compared and derived. It is trusted that new information examination strategies might be connected to this infection, and this might be valuable to find already unrecognized examples. Information mining of existing records and information stores may improve information on the conclusion and the executives of ARF. In such manner, i intended to make a commitment to the advancement of new arrangements by moving toward the issue from a diverse outlook. Innocent Bayes (NB) model is a factual separating process which utilizes recently assembled information. This aides in accomplishing perform various tasks learning, as synchronous extraction of information can be accomplished while accomplishing arrangement precision [27]. The essential test in the choice tree usage is to distinguish which credits do we have to consider as the root hub and each dimension. Taking care of this is know the characteristics choice. The key contributions of proposed RTPC-ACHD scheme as follows:

1. Our proposed model RTPC-ACHD scheme is used to predict the heart disease at early stage using fuzzy multi-model neural network with chronic kidney disease risk factor.
2. For decreasing computation time and increasing the accuracy, i used self adaptive bat optimization algorithm.

2.2 System model

The system model of our proposed real time prediction scheme was shown in Fig.1. When patient consulting with doctor, the data will be stored in clinical representation like age, gender, blood pressure, sugar,..etc. From chronic kidney disease dataset, we preprocess in two ways, such as training and testing data. Then, we use data mining technique to predict accurately with target class of each term from given data. After this process, chaotic fuzzy multi-model neural network were used to predict the heart disease in early stage with the help of chronic kidney disease risk factors. The main objective of this paper is to reduce computation time and increase accuracy while prediction. These terms are done using meta-heuristics self adaptive bat optimization algorithm. Finally, the classified report were prepared

accurately, when compare to existing model.

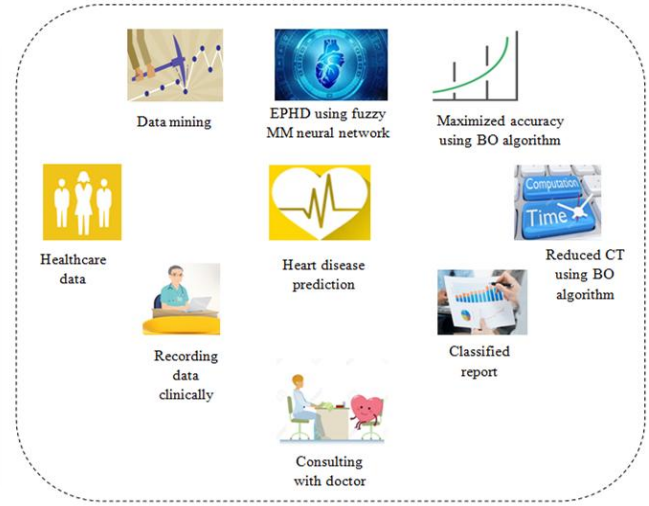

Fig. 1 Proposed RTPC-ACHD model

3 Proposed RTPC-ACHD Scheme

3.1 *Fuzzy multi-model neural network*

The fuzzy multi-model neural network implemented in this work can be represented by a one hidden layer feed forward architecture with N input units, K hidden units and M output ones.

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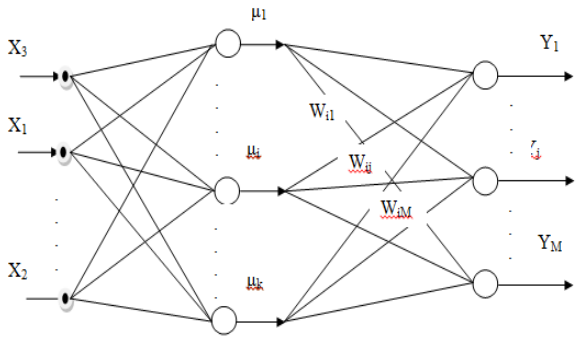

Fig.2 Fuzzy MM neural network

Each input neuron represents a crisp input value. Each connection between input and hidden units has a weight equal to 1. Each unit in the hidden layer represents a fuzzy set over the input space R^N. The output value of the i-th hidden neuron for a given input vector $X = [x_1, x_2, \ldots\ldots, x_N]^T$ can be interpreted as the degree of membership of X to the fuzzy set represented by this neuron. Neurons in the hidden layer are fully connected with neurons in the output layer. Information of the membership degree of vector X to each fuzzy set is aggregated in the output layer.

Assuming the Gaussian form of the membership function in the fuzzy sets represented by hidden neurons, the output of the ith hidden neuron given X as input is equal to:

$$\mu_i = \exp\left\{-\left(\frac{\| X - C_i \|}{\sigma_i}\right)^2\right\} \quad (1)$$

Where $\| \cdot \|$ is the Euclidian norm, $\sigma_i \in R, C_i = [c_{i1}, c_{i2}, \ldots\ldots, c_{iN}]^T \in R^N$ are parameters associated with a given neuron.

Denoting by $W = [w_{km}]^{KxM}$ the weight matrix of connections between the hidden layer and the output layer, the input value for the jth output neuron is equal to:

$$u_j = \sum_{k=1}^{K} w_{kj}\mu_k \quad (2)$$

If we denote

$$s = \sum_{k=1}^{K} \mu_k \quad (3)$$

then the output value of that neuron is defined as:

$$y_j = \frac{u_j}{s} = \frac{\sum_{k=1}^{K} w_{Kj}\mu_k}{\sum_{k=1}^{K} \mu k} \quad (7)$$

The fuzzy multi-model neural network described here can be interpreted in terms of an equivalent fuzzy system. For the i-th neuron in the input layer, a fuzzy IF-THEN rule R_i can be extracted:

R_i : IF X is μ_i Then $y_1 = w_{i1}$ AND…..AND $y_M = w_{iM}$ (8)

It is clear that fuzzy properties μi as well as the (crisp) outputs wij of the fuzzy rules are determined in the training process. Certainly the notion of μi indicates only a fuzzy set over the input space, not any linguistic value. The fuzzy rule set is then defined as: $S = \{R_i : i = 1, \overline{K}\}$ (9)

And the inference engine for such fuzzy system is specified by (7)

3.2 Self adaptive bat algorithm

The Bat algorithm is a recently introduced meta-heuristic algorithm for search and optimization, which is first proposed by Xin-She Yang in 2010. Bat optimization algorithm is based on the echolocation behavior of bats. Each bat has an interesting capability to find its prey in complete darkness. This algorithm is developed on this hunting behavior of bats. Bats are mammals with wings and they are born with the advanced capability of echolocation. Echolocation is a special type of sonar, used by the bats to avoid obstacles, detect prey, and pinpoint their location in the dark. Bats emit a high sound frequency to listen the echo that bounces back from the

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neighboring objects. The frequency is associated with their food gathering strategies.

The idealization of the echolocation of bats can be summarized as follows. Bats use echolocation to sense distance. They acknowledge the ranges/spaces between prey and surrounded barriers in some miraculous ways. Bats fly randomly with velocity v_i at position x_i with a fixed frequency f_{min} varying wavelength λ and loudness A_0 to search for prey. They can automatically adjust the wavelength of their emitted pulses and adjust the rate of pulse emission r in the range of [0, 1], depending on the proximity of their target. It is assumed that the loudness differs from a large A0 to a minimum constant value. Each step of basic bat algorithm is explained below:

Pseudo Code of the Bat Optimization algorithm

1. Objective function: f(x), x = $(x_1,x_2,x_3,\ldots\ldots\ldots,x_d)^T$
2. Initialize bat population x_i and velocity v_i; I = (1,2,……..,n)
3. Define pulse frequency f_i at x_i
4. Initialize pulse rate r_i and loudness A_i
5. While (t<maximum number of iterations)
6. Generate new solutions by adjusting frequency,
7. And updating velocities and locations
8. If(rand > r_i)
9. Select a solution among the best solutions
10. Generate a local solution around the selected best solution
11. end if
12. If (rand < A_i) and $f(x_i) < f(x^*)$
13. Accept new solutions
14. Increase r_i, reduce A_i
15. end if
16. Ranks the bats and find current best x*
17. end while
18. Display results

4. *Experimental results and discussion*

This work is implemented in Weka tool. It's a collection of machine learning algorithms for data mining tasks. This type of algorithm can apply directly to a dataset. Weka contain tools for classification, data pre-processing, visualization and regression. The proposed real-time prediction scheme for ACHD based on chronic kidney disease (CKD) using meta-heuristics algorithm (RTPC-ACHD) were used to predict the heart disease at early stage. Heart disease refers to any condition in which the heart and blood vessels are injured and do not function properly, which results in fatal health problems. Different types of heart diseases among which are congential, myocarditis, coronary, angina and rheumatic heart disease. CKD risk factors: Researchers are still unclear about specific cause of heart disease, age, family history, abnormal blood, high BP, obesity, diabetes, use of tobacco and ethnic back ground mellitus are the major risk factors of heart disease. The experimental comparison of classification algorithms are done based on the performance measures of classification accuracy, F-measure, Built time (BT), Mean square error (MSE) and Validate time (VT)

5. *Conclusion*

In this paper, i have proposed an RTPC-ACHD scheme based on chronic kidney disease using meta-heuristics algorithm. The optimal data mining technique were used to predict the target class for every terms in given data accurately. By using chaotic fuzzy multi-model neural network, we trained to predict the presence of chronic kidney disease. If the model can be well trained using a varied range of parameters, it may result in more accurate predictions. Clinics and hospitals can use this for faster and digitized methodology for prediction of chronic kidney disease. Compared to other available algorithms, the

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model i built shows better results which is implemented using self adaptive bat optimization algorithm to keep accuracy in high and reduce computation time. The experimental results shows that the proposed model increases the predictive accuracy than previous state-of-art.

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