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Diagnosis of heart disease using genetic algorithm based trained recurrent fuzzy neural networks

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Abstract

The World Health Organization (WHO) estimated one third of all global deaths reason as cardiovascular diseases in 2015. Some computational techniques were proposed for investigation of heart diseases. This study proposes a genetic algorithm (GA) based trained recurrent fuzzy neural networks (RFNN) to diagnosis of heart diseases. The University of California Irvine (UCI) Cleveland heart disease dataset is used in this study. Out of total 297 instances of patient data, 252 are used for training and 45 of them are chosen to be the testing. The results showed that 97.78% accuracy was obtained from testing set. In addition to the accuracy, root mean square error, the probability of the misclassification error, specificity, sensitivity, precision and F-score are calculated. The results were found to be satisfying based on comparison.

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*Keywords:*Heart disease; recurrent fuzzy neural networks.

1. Introduction

The heart failure basically means that the heart isn't pumping as well as it should be (AHA, 2017). Basically most of the heart failures arise because of coronary problems, high blood pressure and diabetes that damage the heart (NHLBI, 2017). The World Health Organization (WHO, 2017) estimated that around 17.7 million people lost their lives from cardiovascular diseases in 2015. This population represents 31% of the overall deaths. It is estimated that

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7.4 million of the deaths are caused by coronary heart disease (13% of overall deaths) and 6.7 million are due to stroke.

Advances in medical field help to foresee the possibility of the heart failures that patients can come across later in their lives. It is strictly advised that all people including the ones feeling perfectly well should see a heart specialist twice a year to investigate the possible existence of any evidence that may cause a heart failure. Well-equipped health organizations can conduct many tests that include blood tests, chest X-Rays, magnetic resonance imaging (MRI) electrocardiogram, echocardiography, physical examination, exercise stress test, cardiac catheterization radionuclide ventriculography or multiple-gated acquisition scanning (MUGA) that revile various valuable information helping medical doctors in their diagnosis and their views on the patient's heart failure risk level. (AHA, 2017).

In addition to the conventional methods there are several decision support systems that uses computational techniques namely artificial neural network (ANN), fuzzy logic, neuro-fuzzy, machine learning and etc. were used for the diagnose of heart diseases. Polat et al. (2006) used fuzzy weighted pre-processing and artificial immune recognition system to diagnose the heart diseases. Das et al. (2009) developed SAS base software to diagnose heart diseases. Başçiftçi and Incekara (2011) proposed a web based medical decision support system with Boolean functions minimization to diagnose heart diseases. Anooj (2013) worked on a weighted fuzzy rule-based decision support system. Amiri and Armano (2013) proposed a method to segment heart sounds, where classification and regression trees are used. Nahar et al. (2013a) presented computational intelligence techniques to detect heart diseases. Nahar et al. (2013b) applied association rule mining to show the elements contributing to heart disease in both male and female patients. De Falco (2013) used an approach based on Differential Evolution (DE) to classify the items in medical databases. Bouktif et al. (2014) proposed a method using combination of classifiers involving Ant Colony Optimization and applies it on Bayesian classifiers to be used for heart disease and cardiotography-based predictions. Kim et al. (2014) proposed a fuzzy rule-based adaptive coronary heart disease prediction support system. Hedeshi and Abadeh (2014) used PSO algorithm including a boosting technique to extract rules to classify the coronary artery disease in a patient. Shaoa et al. (2014) proposed a hybrid model consist of logistic regression, multivariate adaptive regression splines, an ANN and a rough set technique for heart disease classification. Jabbaret al. (2014) developed a method that uses alternating decision trees for early identification of heart diseases. Alsalamah et al. (2014) introduced the radial basis function networks with a Gaussian function as a classifier of heart problem data evaluation.

Olaniyi et al. (2015) proposed model on a multilayer neural network trained with backpropagation and simulated on feedforward neural network. Jabbar et al. (2015) used feature selection methods to make improvements on accuracy of naïve bayes classification. Paul et al. (2015) proposed a DMS-PSO system where some critical attributes are selected to aid the diagnosis of heart diseases. Nguyen et al. (2015) used wavelet transformation and interval type-2 fuzzy logic system to classify medical data. Paul et al. (2016) introduced a fuzzy decision support system for the prediction of heart disease's risk level using genetic algorithms. Miao et al. (2016) proposed an ensemble machine learning technology to utilize an adaptive Boosting algorithm to diagnose heart diseases. Reddy and Khare (2017) designed a hybrid OFBAT with Rule-Based Fuzzy Logic heart disease diagnosis system. Samuel et al. (2017) present decision support system based on ANN and Fuzzy_AHP to predict possible risks of a heart failure. Sagir and Sathasivam (2017) used ANFIS Matlab's built-in model and an ANFIS model with Levenberg-Marquardt algorithm to predict the potentials of the heart diseases.

In this study, genetic algorithm (GA) based trained recurrent fuzzy neural networks (RFNN) approach expressed by Uyar (2006) and Aliev et al. (2007, 2008) was used for diagnoses of the heart diseases. The rest of this paper is organized as follows: methodology described in Section 2, the results of the study presented in Section 3 and finally the conclusion with some thoughts on the future work presented.

2. Methodology

2.1. Dataset

The Cleveland dataset (UCI, 1990) used in this study was received from the University of California Irvine (UCI) Machine Learning Repository heart disease dataset that includes four independent databases contributed by four