A Survey on Diagnosis of Heart Diseases using Data Mining Techniques

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ABSTRACT
Data mining tools are effectively used in disease diagnosis which helps health professional. From health sector a large number of data are collected, classification tools are applied on these data and discover new pattern. In this paper, heart diseases have been chosen for diagnosis and classification. An extensive analysis is performed on some popular data mining methods by using a large number of datasets in this work. To understand the major data mining techniques and select the suitable category of algorithms, the analysis result will help for heart disease analysis. Decision tree has successfully used in different research to predict disease. In this research, decision tree is applied to classify hypertension disease.

General Terms
Pattern Recognition, Algorithms

Keywords
Decision Tree, Weka tool, Naive Bayes, Cardiovascular disease, SVM

1. INTRODUCTION
The word heart disease applies to a wide range of illnesses that affect the circulatory system, which consists of heart and blood vessels. It is intended to deal only with the condition normally known as “Heart Attack” and the factors, which lead to such condition. Cardiomyopathy and Cardiovascular disease are some types of heart diseases. It is observed that CHD is the cause considered for 17.7 million deaths every year and more than twenty-four million ratio of people anticipated passing from cardiovascular sickness by the year of 2030 (Kim & Kang, 2018). CHD dominates other diseases with its severe effects on a person’s wellbeing worldwide (Wilson et al., 1998) [28]. An abrupt blockage of a coronary artery, usually due to a blood clot results in a heart attack. The purposes of this paper is to evaluate the distinct predictive/ descriptive data mining approaches proposed in current years for the diagnosis of heart disease.

2. BACKGROUND
C4.5 Decision Tree was used by Andreeva in the diagnosis of heart disease that produced accuracy of 75.73% (Andreeva 2006). The optimized K-Means algorithm was used by Shimpi et al. 2020 with precision 91% and recall of the model was 75.83%. In 2017 NN-based CHD risk prediction used by Kim and Kang where feature correlation analysis evaluated highest accuracy (82.51%) in a CHD prediction [29]. The best-performing data mining technique that the heart disease prediction model developed using the identified significant features achieves an accuracy of 87.4% was analyzed by Amin et al. in heart disease prediction (Amin, Chiam et al., 2019). SVM-Radial bias kernel technique was improved by Karthi keyan et al. which was produced accuracy of 89.9% in heart disease (Karthi keyan et al., 2020). K-Means and Artificial Neural Network techniques were combined by Amita Malav, Kalyani Kadam and Pooja Kamat to achieve higher prediction accuracy [22].

3. METHODOLOGY
Because of the limitations of resources and the characteristics of the paper itself, the main methodology used for this paper was throughout the survey of journals and publications in the areas of medicine, computer science and engineering. A range of current publications are followed in this research.

3.1 Heart disease prediction using data mining
Three different supervised machine learning algorithms: Naive Bayes, K-NN, Decision List, SVM algorithm have been used for analyzing the dataset in [4]. Tanagra tool is used to classify the data and the data is evaluated using 10-fold cross validation and the results are compared. These mentioned algorithms were applied to predict the accuracy of heart diseases.

3.1.1 Naïve bayes classifier
Naïve Bayes is a classification algorithm which follows the probability theory to detect most considerable probable classifications. It categorize by applying Bayes theorem with strong (naïve) independence predictions. In simple word, a this classifier assumes that the existence (or unavailability) of a certain characteristics of a class is independent to the existence (or unavailability) of any other characteristic. According to the pinpoint qualities of the probability model, in a supervised learning setting this classifiers can be trained more effectively.

3.1.2 K-Nearest neighbor algorithm
The k-nearest neighbor’s algorithm (k-NN) is a method for classifying objects based on closest training data in the feature space. The similarity technique can be used for regression, by allocating the property value for the item to be the mean of the values of its k nearest neighbors. It can be helpful to weight the assistances of the neighbors, so that the closer neighbors submit more to the mean than the more far ones.
3.1.3 Support vector machine
According to the hypothesis of statistical learning and the standard of structural reduction of risk, support vector machine can perform pattern recognition and regression. Support vector machine applied in weka data mining tools is Sequential Minimal Optimization that is an algorithm for effectively solving the optimization problem that appearsthrough the raining of Support Vector Machines.

3.1.4 Decision tree
Decision tree is more alike to the flowchart in which every non-leaf nodes denotes a test on a specific attribute and each branch contributes an outcome of that test and every leaf node have a class label. The top most labeled node in the tree is called root node. By applying Decision Tree, decision makers can find best alternative and traversal from root to leaf indicates exceptional class division based on highest information gain.

4. PERFORMANCE STUDY OF ALGORITHMS
Accuracy for different classification method with different attributes values.

4.1 Description of Dataset
In reference [1] they have used the dataset having the following attributes
- id: identification number of patient
- age: age of patient in year,
- sex: sex of patient (1=male; 0 = female),
- painloc: patient’s chest pain location (1 = substernal; 0 = otherwise),
- pain_exer (1 = provoked by exertion; 0 = otherwise),
- rel_rest (1 = relieved after rest; 0 = otherwise),
- cp: chest pain type
  - Value_1: typical angina
  - Value_2: atypical angina
  - Value_3: non-anginal pain
  - Value_4: asymptomatic
- trestbps: patient’s resting blood pressure
- chol: patient’s serum cholesterol
- famhist: patient’s family history of coronary artery disease (1 = yes; 0 = no)
- rest_eeg: patient’s resting electrocardiographic results
  - Value_0: is normal
  - Value_1: having ST-T wave is abnormal (T wave inversions and/or ST elevation or depression of > 0.05 mV)
  - Value_2: displaying probable or definite left ventricular hypertrophy by Estes’ criteria ekgmo (month of exercise ECG reading)
- ekgmo (month of exercise ECG reading)
- thal_dur: period of exercise test in minutes
- thal_cha: highest heart rate achieved
- Thal_rest: resting heart rate
- num: diagnosis of heart disease (angiographic disease status)
  - Value_0: < 50% narrow diameter
  - Value_1: > 50% diameter narrowing
  - (in any major vessel: attributes 59 through 68 are vessels)

In reference [3] they have used the dataset having the following attributes. Data source hsa total 909 records with 15 healthfactors which were obtained from the Cleveland Heart Disease database.
- Diagnosis(value_0: <50% diameter narrowing(no heart disease); value_1: > 50% diameter narrowing(heart disease))
- Key attribute:
  - Patient_ID- Patient’s identification number
- Input attribute:
  - Sex(value_1: Male; value_0: Female)
  - Chest pain type (value_1:typical type I angina, value_2: typical type angina, value_3: non angina pain, value_4: asymptomatic)
  - Fasting Blood Sugar(value_1: >120 mg/dl; value_0: <120 mg/dl)
  - Restregeg- resting electrographic result(value_0: normal; value_1: having ST-T wave abnormality; value_2: showing probable or definite left ventricular hypertrophy)
  - Exang- exercise induced angina(value_1:yes; value_0: no)
  - Slope- the slope of the peak exercise ST segment(value_1: unsloping; value_2: flat; value_3: downsloping)
  - CA- number of major vessels colored by floursopy(value 0-3)
• Thal (value_3: normal; value_6: fixed defect; value_7: reversible defect)
• Test Blood Pressure of patient (mm Hg on admission to the hospital)
• Serum Cholesterol (mg/dl)
• Thal_ach – highest heart rate achieved
• Old_peak- ST depression induced by exercise relative to rest
• Age of patient in Year

Table 2 contains the features of reference [8]. Data do not need of integration operations because it is collected from one resource.

Table 1: List of attributes [8]

| Sl No | Name of patient | Possible Values          |
|-------|----------------|--------------------------|
| 1     | Age of Patient | NUMERIC VALUES           |
| 2     | Chest_pain_types | ASYMPT, ATYP, ANGINA NON_ANGINAL, TYP_ANGINA |
| 3     | rest_bp_press  | NUMERIC VALUES           |
| 4     | blood_sugar    | TRUE, FALSE              |
| 5     | rest_electrocard | Normal, left_vent_hyper st_t_wave_abnormality |
| 6     | highest_heartrate | NUMERIC VALUES          |
| 7     | exercise_angina | YES, NO                  |
| 8     | Disease        | NEGATIVE, POSITIVE       |

4.2 Description of Tools

In reference [2] they have used Tanagra dataset. The Tanagra project allows to evaluate either real or synthetic data. In this study, to apply the data mining algorithms WEKA was used. In this part experimental results from implementation of different classification algorithms, j48 decision tree, Naïve Bayes, KNN and SMO on heart disease datasets are evaluated and compared.

4.3 Performance Analysis and Evaluation

Secondary values of different classifications are given in table 2. Considering these values the precision of algorithms are calculated and analyzed. Classifier has 14 attributes. According to evaluation time of calculation and the error rates, performance can be determined.

Table 2. Performance Study of Algorithm [1]

| Algorithm Used | Accuracy | Time Taken |
|----------------|----------|------------|
| Naïve Bayes    | 52.33%   | 609ms      |
| Decision List  | 52%      | 719ms      |
| KNN            | 45.67%   | 1000ms     |

Table 3. Accuracy of Different Classifiers [3]

| Techniques   | Accuracy |
|--------------|----------|
| Naïve Bayes  | 86.53%   |
| Decision Tree| 89%      |
| ANN          | 85.53%   |

4.4 Summary of Experimental Results

The records were divided equally into two datasets: training dataset with 455 records and testing dataset with 454 records. The summary of the results of all three models are shown in Table 3. Since Naïve Bayes has the highest percentage of correct predictions (86.53%) for patients with heart disease, it appears to be most effective, followed by Neural Network (with a difference of less than 1%) and Decision Trees. For predicting patients with no heart disease decision trees appears to be most effective (89%) compared to the other two models [3].

Table 4 shows accuracy for different classification method with 13 input attributes & 15 input attributes values [11].

Table 4: Comparison of data mining techniques

| Classification Techniques | Accuracy with 13 attributes | Accuracy with 15 attributes |
|---------------------------|-----------------------------|-----------------------------|
| Naïve Bayes               | 94.44%                      | 90.74%                      |
| Decision Trees            | 96.66%                      | 99.62%                      |
| Neural Networks           | 99.25%                      | 100%                        |

Table 5. Comparison between accuracies of different techniques [5]

| Techniques                | Accuracy   |
|---------------------------|------------|
| Naïve Bayes               | 78.563%    |
| Decision tree             | 75.738%    |
| Neural network            | 82.773%    |
| Kernel density [16]       | 84.449%    |
| Naïve bayes               | 95%        |
| Decision tree             | 94.93%     |
| Neural network [17]       | 93.54%     |
| Naïve bayes               | 62.03%     |
| Decision tree [18]        | 60.40%     |
| Naïve bayes               | 52.33%     |
| KNN                       | 45.67%     |
| Decision list [19]        | 52%        |
| Naïve bayes               | 84.14%     |
| One dependency augmented  | 80.46%     |
| Naïve Bayes classifier [20]|           |
| Genetic with decision tree| 99.2%      |
| Genetic with Naïve Bayes  | 96.5%      |
| Genetic with classification via clustering [21]| 88.3% |

From the Table 5, observe that Naïve Bayes’s accuracy is highest as contrast to all other classification techniques. For this reason, this technique is used in proposed system for prediction of heart disease using WSN.

5. CONCLUSION

Since worldwide one of the leading causes of death is heart disease, the early prediction of heart disease is essential. This paper reviewed some Heart Disease classification system. In this work different techniques and data mining classifiers are defined which has merged in current years for diagnosis of heart disease efficiently and effectively. The survey depict
that all the papers use different technologies with different number of attributes. So, accuracy varies with using different technologies to classify the attributes.

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