

Heart disease prediction using SVM based neuro-fuzzy technique in the cloud computing

Dr. M. Sadish Sendil *

Assistant Professor, Department of Information Systems and Technology, Sur University College, Sur, Sultanate of Oman

*Corresponding author E-mail: sadish@suc.edu.om

Abstract

Cloud computing is a technique for conveying on information development benefits in resources are recovered from the Internet through online based device and applications, as opposed to a speedy association with a server. Cloud has numerous applications in the meadows of education, social networking, and medicine. But the benefit of the cloud for medical reasons is seamless, specifically an account of the huge data generated by the healthcare industry. Heart disease diagnosis determination strategy is essential and significant issue for the patient's wellbeing. Furthermore, it will help to decrease infection to a more specific level. Computer-aided decision support method performs a vital task in medical line. Data mining gives the system and innovation to change these heaps of data into effective information for decision-making. When applying data mining techniques it carries shorter time for the prediction of the disease with more exactness. The hybrid work of preprocessing, feature selection using SVM and SVM based Neuro-Fuzzy data mining strategies utilizing as a part of the determination of the heart disease is incredibly impressive. The framework is to build up a technique for arranging for heart level of the patient relies upon highlight information utilizing Neuro-Fuzzy surmising system. The experiment is done with two different analysis that is one with preprocessed data alone and applied SVM based Neuro Fuzzy Technique and the second one is accomplished with feature selection done data and applied SVM based Neuro Fuzzy Technique. The results prove that the system result of the first one gives 92% accuracy in the heart disease prediction. The second one is giving 95.11% accuracy in the heart disease prediction.

Keywords: Cloud; Data Mining; Heart Disease Prediction; Preprocessing; SVM Based Feature Selection; SVM Based Neuro-Fuzzy Technique.

1. Introduction

Cloud computing is service offering an on-demand distribution of Information Technology (IT) and application through the internet. It accompanies a pay as you go costing model. Cloud saves huge in advance investments by speeding up the supplying of needed computing resources that are necessary to power up the desired system. It is focused on the efficient optimization of the shared resources. The approaching of administration dissemination can genuinely be progressive by cloud, empowering a talented method to meet the innovation needs of the association, which is the reason for its bringing use up when all is said in done spaces of training, business, and medicinal services. As compared to remaining industries, it has been seen that the health care industry is under using the technology and is not able to proficiently increase its operational efficiency. Most of the medical records are on paper, which inhibits information sharing. A cloud based application can help the sharing of the information allowing everyone to be hosted at the same place. This would permit practitioners to easily update the medical charts and input the test result.

In the lab, this is the time as in remodeling of healthcare IT, and cloud computing supplies one of the best methods for this complete change. It can support big datasets containing various X-Ray, CT scan and additional radiology images and genome datasets. It allows on-demand access to huge storage and computing facilities dissimilar the contemporary methods. Inclined that the cloud applications for the health care industry needs high level of security, availability and privacy, private or hybrid clouds come as a handy alternative to act as the root for its implementation. Ex-

cluding all the advantage that the cloud can offer, health care sector can take advantage the cloud services for its specific uses. The Relevance in data and increasing importance of biologics makes cloud-based computing an increasing research and growth topic. As of late, it has been utilized for various wellbeing applications, for example, diabetes, growth, and heart ailment forecast.

This paper is focusing on applying various data mining technique to the medical data set to find out heart disease, the techniques are namely, preprocessing, support vector machine and Neuro fuzzy technique. The dataset consists of necessary set of elements. The investigation technique and the test outcomes are given in the specific division. In view of the outcomes Neuro-Fuzzy method is as a decent and versatile anticipating method for coronary illness expectation. They went with investigation procedure and the test outcomes are slanted in the separate segment. Relies upon the outcomes, SVM and Neuro Fuzzy strategy remains as a decent and versatile foreseeing system for the heart disease expectation.

Then the rest of the paper is organized as follows, section 2 analyze different researches works based on the heart disease prediction in cloud. Section 3 discusses the proposed SVM based Neuro-fuzzy technique. Section 4 examines the proposed systems experimental results and concludes in section 5.

2. Related works

Beforehand, different research considers have focused on heart disease recognition. These examinations describe the utilization of cluster of machine learning method for forecast and have gotten greatest arrangement exactnesses. The detail review of the re-

search work in the field of heart disease expectation utilizing information mining has been made.

Rahul S. Belli et. al., [9] proposed a framework to keep private information locally on versatile and required for heart disease expectation is transferred to server. Logistic regression and naive Bayes algorithm has been connected in coronary heart disease detection. The authors have been executed a rule based model to differentiate the precision of applying rules with the individual eventual outcomes of the naive bayes and logistics regression on the wellbeing application database to demonstrate an exact model of reckoning heart disease.

Geetika Sunil Agrawal et. al., [3] proposed a different data mining procedure to bring best outcomes to anticipate heart disease in social insurance ventures. The data mining strategies has connected specifically choice trees, gullible bayes, neural systems, affiliated illumination, and genetic algorithm. The strategy connected in patient's medicinal dataset has brought about developments, benchmarks and choice emotionally supportive network that have critical accomplishment in enhancing the soundness of patients and the general nature of restorative administrations.

P Sai Chandrasekhar Reddy et. al., [7] proposed a work to enhance exactness in heart disease forecast isolates in two sections, for example, execution model and expectation demonstrate. Execution display is intended to assess the general execution of the application. Expectation demonstrate is utilized to foresee the state of the patient after assessment based on different parameters like heart beat rate, circulatory strain, cholesterol and so forth the exactness of the framework is demonstrated in java.

Keerthana [5] presented a HDPS in view of three unique information mining systems to discover coronary illness. The different information mining strategies utilized are Naive Bayes, Decision tree (J48), Random Forest and WEKA API. The framework can foresee the probability of patients getting a coronary illness by utilizing medicinal profiles, for example, age, sex, circulatory strain, cholesterol and glucose. Likewise, the execution will be analyzed by estimation of perplexity network. The work helps to compute exactness, accuracy, and review. The general framework gives superior and better precision.

Mythili T et. al.,[6] described a structure utilizing blends of support vector machines, logistic regression and decision trees to touch base at a precise forecast of heart disease. Utilizing the Cleveland Heart Disease database, this paper provided for get ready and test the structure and consequently accomplish the most capable model of the different oversee based techniques. Further, thusly the paper proposed a close examination of the various results, which consolidate affectability, specificity, and precision. Moreover, the best and most estimated model can be found.

Shantakumar and Kumaraswamy [12] proposed an innovative strategy that utilized the K-means clustering algorithm calculation in mix with the Maximal Frequent Item set Algorithm (MAFIA) calculation. The strategy was connected on preprocessed information, with the imperative examples being picked on premise of the critical weightage and serious calculation. From there on, a neural system was prepared with the chosen imperative examples. Das, Sengur, and Turkoglu [10] found that used SAS base software having Artificial Neural Network (ANN) at the core to predict diseases.

Palaniappan and Awang [8] developed an Intelligent Heart Disease Prediction System by utilizing machine learning techniques such as decision tree, ANN, and Naïve Bayes, but they have not compared and ensemble best of the models. Colombet, Ruelland, Chatellier, and Gueyffier [2] predicted the potential risks of cardiovascular disease by evaluating performance of ANN and Classification and Regression Trees (CART) in comparison to a Linear Regression (LR) model, but they have not utilized big data.

3. Proposed work

For assessment of threat of heart disease utilizing a relationship of models, the proposed structure showed up in figure 1. This ap-

proach is disengaged into a couple of modules including preprocessing, training, testing with singular models, usage of standards, and at last, capability of results and the gauge of heart disease. The modules have been accounted for beneath.

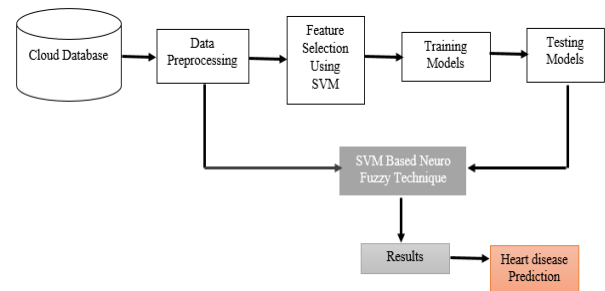


Fig. 1: Proposed Framework.

3.1. Data preprocessing

Data Preprocessing [14] assumes a crucial part in data mining. The training stage in the DM all through learning disclosure will be extremely intense if the information comprise of random or copious data or additionally penetrating and untrustworthy information. The medicinal information comprise of numerous missing values. In this manner, preprocess is an essential advance before preparing the medicinal information.

Data preprocessing is a data mining method used to change test crude information into a comprehensible organization. Real world data might be conflicting, fragmented or contains a mistake. This paper proposes preprocessing and planning models united together to process on existing patient data and load it into recuperating office server database.

The data processing procedures are mentioned below.

Heart disease is determined to have the assistance of some convoluted neurotic information. The heart disease dataset utilized as a part of this test is the Heart Disease database taken from UCI machine learning dataset vault.

This cloud database comprise of 14 properties as following:

- 1) Period of patient.
- 2) Sex of patient.
- 3) Chest torment compose.
- 4) Resting circulatory strain.
- 5) Serum cholesterol.
- 6) Fasting glucose.
- 7) Resting ECG comes about.
- 8) Greatest heart rate accomplished.
- 9) Exercise incited angina.
- 10) ST dependency incited by practice with respect to rest.
- 11) Slant of the pinnacle practice ST section.
- 12) Number of significant vessels hued by flourosopy.
- 13) Thal.
- 14) Determination of heart disease.

The proposed approach for preprocessing is as come after:

- 1) Initially the informational collection preprocessed by utilizing numeric to nominal and supplant missing quality framework.
- 2) Thereafter, check the data set is prepared for exactness.
- 3) The subsequent stage is the extract feature for prediction.
- 4) The feature is imposed by support vector machine with Neuro-fuzzy method.
- 5) The data set is approved to accomplish the ideal redundant highlight for forecast.

The figure 2 depicts the proposed system.

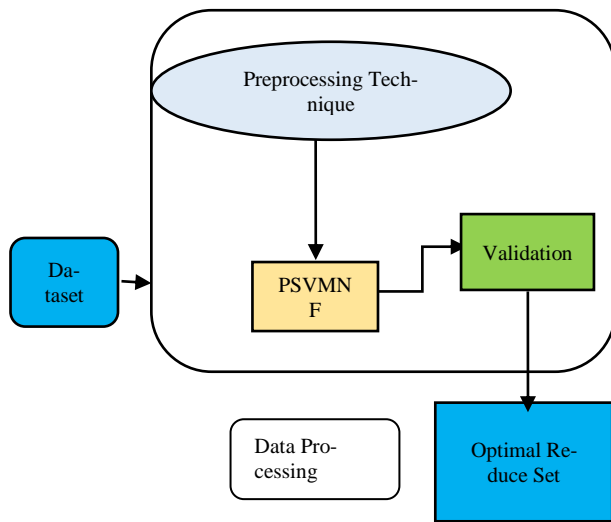


Fig. 2: Preprocessing Data.

3.2. Feature selection-using SVM

Feature selection tends to the dimensionality lessening issue by choosing a subset of accessible highlights to construct a decent model for arrangement or expectation, which is combinative issue in the quantity of essential highlights. Support Vector Machines (SVMs) is an effective method, for an example the nonattendance of neighborhood minima, an adequate speculation to new questions, and a portrayal that in light of a few parameters. Here we apply a component determination technique for parallel grouping SVM for patient's information coronary illness forecast. It starts with every accessible component and decides each element's contribution to the individual classifier.

The one with minimal effect on the order execution in an autonomous approval subset will be expelled in every cycle until the point that ceasing model shows that a better solution has been found. In the wake of giving the applicable documentation, highlight determination which in this way will be identified with elective procedures toward the end.

The component wise vector product operator * is defined as

$$a * b = (a_1 b_1, \dots, a_n b_n)$$

The binary vector $\sigma, \sigma \in \{0,1\}^n$, acts as an indicator for feature selection that will be multiplied component wise with input objects. Thus the kernel function as explained becomes

$$K_\sigma(X_i X_s) \equiv K(\sigma * X_i, \sigma * X_s)$$

This vector r as a parameter for feature selection and, for a given r , solved the dual formulation of SVM in which mathematical derivation shows in the following

$$\text{Max}_\alpha \sum_{i=1}^m \alpha_i \alpha_s y_i y_s K_\sigma(X_i X_s)$$

Subject to

$$\sum_{i=1}^m \alpha_i y_i = 0,$$

$$0 \leq \alpha_i \leq C, i = 1 \dots m$$

The fundamental thought of this technique is to expel features whose disposal infers just few blunders in a validation subset free of the preparation information. This is accomplished by the accompanying iterative calculation:

- 1) Model Selection
- 2) Initialization
- 3) Repeat
 - a) Random Spilt of the training data
 - b) SVM training

- c) For each feature p with $\alpha_p = 1$, do determine $E_{(-p)}(\alpha, \sigma)$ the number of classification errors when feature removed
- d) Remove feature j with the smallest value of $E_{(-p)}(\alpha, \sigma)$
- 4) Until the smallest value of $E_{(-p)}(\alpha, \sigma)$ is greater than $E(\alpha, \sigma)$, which is the number of errors in the validation subset using all the feature as indicated by the current vector σ that is without removing any further feature.

3.3. Support vector machine based neuro fuzzy technique

SVM (Support Vector Machine) is a class of FFN (Feed Forward Networks) like outspread premise Function systems, established by vaprnik. Support vector machine can be used for design order additionally nonlinear regression. SVM is nearly accurate execution of the arrangement of compositional hazard decrease. This standard is relies upon the truth of the blunder rate of a learning machine on the test information is compassed by the expansion of the preparation mistake rate and term that relies upon the vaprnik chervonenkis (VC) measurement. The SVM can offer fine speculation accomplishment on design order debate.

Optimal hyperplane for designs [1]: Consider the training model $\{(X_i, Y_i)\}_{i=1}^N$ where X_i is the intake pattern for the i th example and y_i is the equivalent target output. Along with pattern corresponding by the subset $Y_i = +1$ and the pattern exemplified by the subset $Y_i = -1$ are linearly distinguishable.

A hyperplane segregation is

$$W^T X + m = 0 \tag{1}$$

Where X is an input vector, W is an adjustable weight vector, and m is a bias. Therefore,

$$W^T X_i + m \geq 0 \text{ for } Y_i = +1 \tag{2}$$

$$W^T X_i + m < 0 \text{ for } Y_i = -1 \tag{3}$$

For a predetermined weight vector W and a predisposition m , the isolation among the hyperplane set apart in eq. (1) and inexact information point is known as the edge of detachment, showed by as illustrated.

The separation work plays out a mathematical measure of the separation from x to the ideal hyperplane for the ideal estimations of the weight vector and inclination, particularly,

$$G(x) = W_0^T x + b_0 \tag{4}$$

3.4. Neuro fuzzy

The Neuro-fuzzy system is a blend of a fuzzy system and an Artificial Neural Network, a purported agreeable Neuro-fuzzy framework. Neuro-Fuzzy frameworks consolidate the capacities of neural systems. (Example: The capacity to learn and fluffy frameworks (interpretability)). Here, the fuzzy system empowers the meaning of beginning model parameters by utilization of earlier pro information. For example, terms as hard, delicate, low damping or exceptionally flexible can be used definition introductory of model conduct. The neural system is utilized to upgrade these parameters or take in all parameters if no fitting expert information is available. In the resulting, a short foundation to repetitive and vectorised neural systems is given and the standard thoughts of model structure for recognizable proof of dynamic frameworks and blend with fluffy frameworks are introduced to anticipate heart disease prediction.

Neuro-fuzzy system (the more supported term is utilized from now on) incorporates the human-like thinking style of fuzzy system by method for the utilization of fluffy sets and an etymological model containing of an arrangement of IF-Then fluffy standards. The critical quality of Neuro-fuzzy frameworks is that they

are general approximators with the ability to request interpretable IF-Then principles.

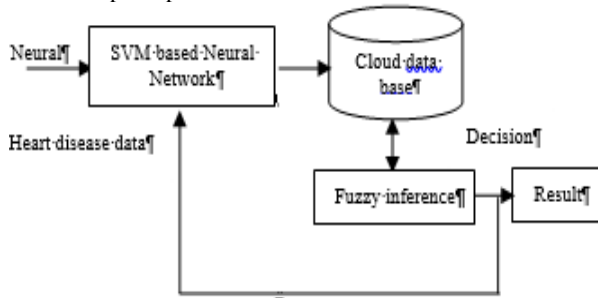


Fig. 3: Neuro-Fuzzy Inference Model.

4. Experiments and results

At the preliminary stage, our crisp data of heart disease dataset which was gathered from the hospital and changed in sequence to be utilized in MATLAB environment and after preprocessed the data then applied hybrid support vector machine and Neuro-fuzzy technique to heart disease prediction.

At first, system size, sample volume, model collection also feature extraction are examined as key parameters for the investigation of workable system design problems associated with learning and abstraction throughout examination. It is inspected that, accurate and absolute collection of data method is the actual direction for the selection of finest classifier. For assessing generalization execution with respect to exactness, sensitivity and particularly dataset is divided into number of subsets (that is training and test sets). Our network assumption parameters are and subsequent parameters for the network architecture shown in fig 3. In this work, we utilized MATLAB device to create SVM and Neuro Fuzzy model, at the initial step, it is vital to preprocess information at that point apply SVM along these lines to produce a fluffy deduction framework for the coronary illness. To make an underlying arrangement of participation capacities we used framework parceling strategy. Initial training, this system separates the information space into rectangular sub-spaces utilizing access parallel segment relies upon foreordained number of participation capacities and they composes in each measurement.

Various variables used with their enlistment limits. In the preparation methodology, coming to fruition parameters are learnt all through forward pass, when most diminutive squared error figure for the most part approach is used and begin parameters are learnt, while edge drop system is associated through in invert pass. In the wake of rehashing forward and in reverse passes, supposition and resulting parameters are resolved. In view of investigation of the heart disease dataset and target of this exploration, they have been assessed against prepared models. Results show that the models has accomplished the expressed objectives, proposing that they could give choice help to specialists to diagnosing patients and finding restorative variables associated with heart disease.

Given patient's medicinal profiles, anticipate the individuals who are probably going to be determined to have coronary illness. The model has possessed the capacity to answer this inquiry utilizing expectation join question. Medicinal credits to determine patients to have coronary illness. For example age, CA, chest torment, Sex, slant and that into SVM based Neuro fuzzy system connected at that point it's delivered an outcomes with 93% and when connected on SVM utilized component segmented information the precision is 96.4%.

The basic requirement has been used to execute algorithms on heart patient's data with the goal of extracting knowledge latent in the data below investigation. Hereof, field of diagnosis including category model label was considered as the output. The model data was separated into two clusters which are for 70% training and 30% testing.

Table 1: Performance of the System

| Dataset | Algorithm Name | Accuracy |
|----------------------------------|---------------------------|----------|
| Preprocessed data | Naïve bays | 68% |
| Preprocessed data | ANN | 83% |
| Preprocessed data | SVM Neuro fuzzy technique | 93% |
| SVM based feature selection data | SVM Neuro fuzzy technique | 96.4% |

The above table 1 is demonstrate the performance analysis of our work model and compared with the existing few results. When compare to existing works our system is produced efficient results to predict heart disease of the patient. The fig. 4 displays about the overall performance of the accuracy and sensitivity of the table values. The image has a diagonal line which denotes the linear accuracy values. X axis denotes the different techniques along with SVM based Neuro fuzzy technique which is applied in the pre-processed data as well as feature selection data by using SVM.

PERFORMANCE ANALYSIS

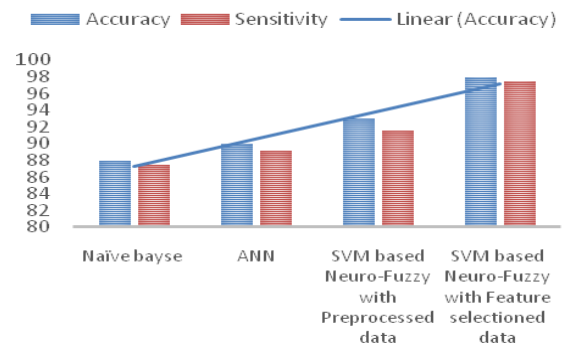


Fig. 4: Overall Performance Analysis Evaluation.

Consequently the outcomes communicate all through normal execution accuracy of help vector machine based Neuro-Fuzzy subsets of preparing and test sets. Neuro fuzzy deduction framework is a type of neural systems that are practically comparing to fuzzy induction framework. The SVM based Neuro fuzzy techniques gives maximum accuracy than the preprocessed data approach. Calculating the results gained from Neuro fuzzy model causes the model to be made better and usable. There are different parameters that are sensitivity, specificity, and accuracy and precision to calculate the classifications techniques, which are evaluated in conformity with the consecutive 1 to 4 formula, we can utilize some matrix functions to compute the indices which are useful to check the performance of the classification techniques in data finding or observation of different categories. Perfectly, a huge amount of data relevant to observation should be placed on the main diagonal matrix and the resting values of matrix are near zero or zero. The exactness of the created models was evaluated to better model for knowledge as demonstrated in the figure 4.

Hence the model created by the SVM based Neuro fuzzy algorithm had the highest accuracy, this system was selected to extract knowledge

TC = number of certain data labels, which have been appropriately classified,

FC = number of uncertain data labels, which have been falsely classified as certain,

FU = number of data certain data labels, which have been falsely classified as uncertain,

TU = Number of uncertain data labels, which have been appropriately classified.

$$\text{Specificity} = \text{TC} / \text{TC} + \text{FU} \quad (1)$$

$$\text{Sensitivity} = \text{TU}/(\text{TU} + \text{FU}) \quad (2)$$

$$\text{Accuracy} = \text{TC} + \text{TU}/(\text{TC} + \text{TN} + \text{FU} + \text{FN}) \quad (3)$$

$$\text{Precision} = \text{TC}/(\text{TC} + \text{FU}) \quad (4)$$

The following figures 4(a), (b), (c), & (d) demonstrates the efficiency and performance of the SVM based Neuro fuzzy technique when applied to SVM based feature selection data. It has been retrieved from True certain data labels along with falsely classified and falsely classified as certain also then falsely uncertain and truly uncertain classified formulas are used to evaluate the sensitivity, specificity, accuracy and precision. The results were compared with ANN and Naïve bayes works which has already done to detect the heart disease. Our approach is giving the best results with maximum accuracy which has evaluated by five different classes as 0-4.

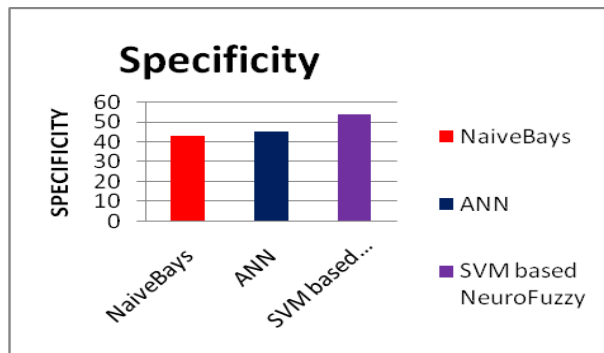


Fig. 4: A) Specificity.

The above figure 4(a) shows efficiency of the SVM based Neuro fuzzy techniques specificity which is performing well than existing Naïve bayes and ANN. It denotes about the heart patients data with classified with certain and uncertain data labels. The average of the system specificity is evaluated by confusion matrix. Since, thus the error rate of the system is 53.14% and this rate indicates a rather good specificity.

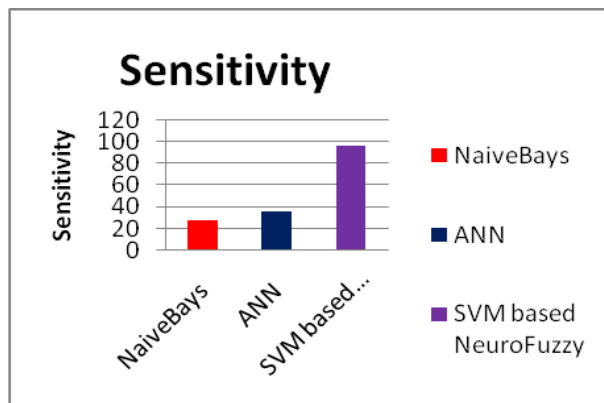


Fig. 4: B) Sensitivity.

The above figure 4(b) shows performance of the SVM based Neuro fuzzy technique's sensitivity which is working well than existing Naïve bayes and ANN. It denotes about the heart disease data with classified with certain and uncertain data labels. The average of the system sensitivity is evaluated by the confusion matrix. Since, thus the error rate of the system is 96.4% and this rate indicates a rather better sensitivity.

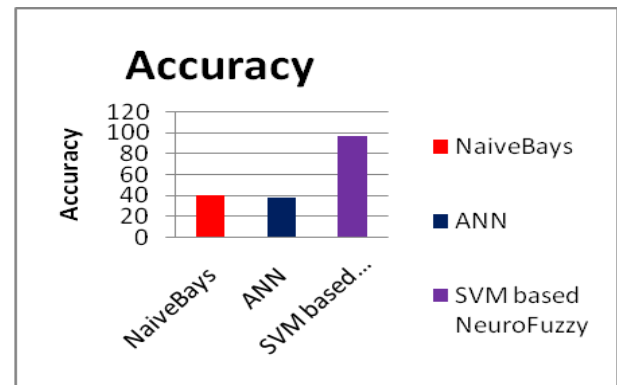


Fig. 4: C) Accuracy.

The above figure 4(c) shows performance of the SVM based Neuro fuzzy technique's accuracy which is working well than existing Naïve bayes and ANN. It denotes about the heart disease data with classified with certain and uncertain data labels. The average of the system accuracy is calculated by confusion matrix. Since, thus the error rate of the system is 96.4% and this rate indicates a rather good accuracy.

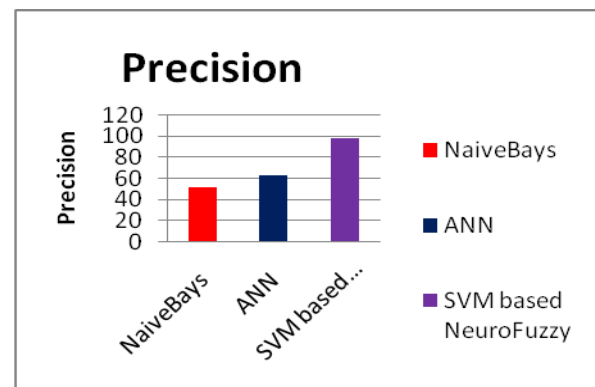


Fig. 4: D) Precision.

The above figure 4(d) shows performance of the SVM based Neuro fuzzy technique's precision which is working well than existing Naïve bayes and ANN. It denotes about the heart disease data with classified with certain and uncertain data labels. The average of the system precision is calculated by confusion matrix. Since, thus the error rate of the system is 93.4% and this rate indicates a rather good precision.

The value of 96.4% for accuracy, 93.66% for precision, 53.4 for specificity and 94.4% for sensitivity evaluated by SVM based Neuro fuzzy demonstrate that the existing algorithms could present comprehensive rules for predicting the future of patients. The rules have been demonstrated in the above table and chart and class 0 is associated with heart disease

5. Conclusion

Clinical diagnosis has evolved into highly ascribed with the progress of technology recently. In addition, the computer and transmission instruments have enhanced the clinical practice and execution to a larger extends and also medical field is fastly moving towards cloud storage. This paper proposed a method for heart disease prediction through preprocessed data and applied SVM based Neuro fuzzy technique. The results of the results compared merely preprocessed data and feature selected data. The distinction in the exactness is calculable. Indeed, even the execution time is amazing. The information is preprocessed and given as info is performed to complete great outcomes. The classification exactness, sensitivity, also uniqueness of the support vector machine based Neuro fuzzy technique have been established the great results. Therefore, creating it an alternative for the heart disease prediction is good. The experiment is done with two different

analysis that is one with preprocessed data alone and applied SVM based Neuro Fuzzy Technique and the second one is accomplished with feature selection done data and applied SVM based Neuro Fuzzy Technique. The results prove that the system result of the first one gives 93% accuracy in the heart disease prediction. The second one is giving 96.4% accuracy in the heart disease prediction

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