PERFORMANCE EVALUATION OF MEMORY BASED CLASSIFIERS WITH CORRELATION BASED FEATURE SELECTION SUBSET EVALUATOR FOR SMART HEART DISEASE PREDICTION

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Abstract

Healthcare industries collect voluminous clinical data which are not able to process manually. Advancements in Technology played a vital role in storing and processing such huge collection of clinical data. Medical decision support systems are intended to support doctors in their diagnosis. This provides effort to widen knowledge and understanding of frequent specialists and facilitates the diagnosis process, using patients' data from clinical databases. Identification of heart disease is a momentous and difficult task in medicine. It is crucial to find the best fit classification algorithm that has greater accuracy on classification in heart disease prediction. This research work compares the competence of Memory based classifiers for prediction of heart diseases by taking several measures using open access machine learning tool.

***Keywords**—Heart Disease Prediction; Memory based Classifiers; Performance Comparison*

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1. INTRODUCTION

Medical data mining is an exploring field of data mining, where different data mining and classification techniques are used to predict the diseases based on the existing clinical data. Health care industries store huge amount of data of patients which can be used for this purpose. Even the serious diseases like 'Heart Attack' have some common symptoms which are used to predict the disease. Based on the past existing data if a classification model could be prepared, and then it is easy for the physician to predict the disease using basic clinical data and initiates the treatment without waiting for other medical modality results. Medical decision support systems use Medical data mining approach to support diagnosing process. Mainly classification algorithms play an important role for this purpose. The accuracy of the classification will be based on the accurate and enough training data available. Varieties of classification algorithms exist to predict the unknown data and Computer Science and Engineering Researchers have an opportunity to study the algorithms and suggest the best performing algorithm. This research work experiments and compares the performance of Memory based classifiers in predicting Heart Disease.

2. LITERATURE REVIEW

There are numerous works coming up for better heart disease prediction. Researchers showing interest in this area to find the better algorithms which gives superior accuracy and analyzing various measures to study the performance of different algorithms. The algorithms like neuro-fuzzy integrated approach, combined technique of Maximal Frequent Item set Algorithm+ C4.5+ K-means algorithm, Artificial Neural Network with Feature Subset Selection and Principal component Analysis are analyzed for heart disease prediction in [1], [2], [3] and [11]. SPAM algorithm with Nearest Neighbor Classifier, Genetic Algorithm for variety of Optimal Reduced Set of Attributes and Naive Bayes with Decision Tree classifier, C4.5 and C5.0 decision tree algorithm with Rule reduction are compared and analyzed for heart disease prediction in [4], [5] and [6]. Cluster based Association Rule Mining using sequence number, SMO, Logistic Function and Multilayer Perceptron, K- Nearest Neighbor Algorithm are analyzed and compared for heart disease prediction in [7] and [8], [10] and [12]. Review reports on Heart Disease data set prediction by various researchers are summarized in [9], [13], [16] and [27]. The possibilities, advantages and usage of Data Mining in Health care to predict diseases are elaborated in [14] and [22]. Adaptive Neuro-Fuzzy Inference system with Hybrid Learning algorithm, Artificial Neural Network with Multilayer Perceptron using Back Propagation algorithm, Classification and Regression Tree (CART) Model algorithms are analyzed for Heart Disease prediction is described in [15], [17], [18] and [30] and these algorithms compared the accuracy of classifiers with other classifiers in the existing literature. Cascaded Neural Network Classifier and Support vector machine algorithm, Naive Bayes, Neural Networks and Decision tree Combination, CART, ID3 and Decision Tree classifier combination are analyzed and compared for heart disease prediction in [19], [20], [22], [23] and [28]. Equal Frequency Discretization Gain Ratio Decision Tree, J48 Decision Tree classifier and Bagging algorithm, Neural Network, Support Vector Machine and K-Means Clustering combination are analyzed and compared for heart disease prediction in [21] and [24]. Web-based application entitled Decision Support in Heart Disease Prediction System is offered in [25] using data mining technique. Naive Bayes, Decision Table and J48 algorithm combination for heart disease prediction is suggested in [26]. Naive Bayes, Decision Tree with K-Means and Weighted

Associative Classifier with Apriori Algorithm combination are analyzed and compared for heart disease prediction in [29]. Naive Bayes classifier and Support Vector machine are separately assessed and compared in [31] for heart disease prediction. Naive Bayes with Jelinek-mercer smoothing combination for heart disease prediction is explained in [32]. Random Forest and J48 Classifiers are separately evaluated and compared for heart disease prediction in [33]. LMT and FT Classifiers are separately analyzed and compared for heart disease prediction in [34]. Memory Based Classifiers (without any attribute selection method) are separately analyzed and compared for heart disease prediction in [35] and [38]. ZeroR, RIDOR and PART Classifiers are separately tested and compared for heart disease prediction in [36]. Functional Tree Classifier and Random Forest Classifier are separately analyzed and compared for heart disease prediction in [37]. Memory based classifiers is used in many classification problems, its usage is explained for credit risk prediction in [39 – 43]. This work investigates the performance comparison of Memory based classifiers separately with CFS Attribute evaluation for prediction Heart Disease.

3. DATASET USED

This work uses the Statlog Heart Disease dataset from UCI machine learning repository [44] with a sum of 270 instances with 13 medical attributes. This dataset contains instances of 120 patients with heart disease and 150 patients without heart disease. The class value“1” is used to indicate the absence of heart disease and class value “2” is used to indicate the presence of heart disease. The attributes are as: age, sex, chest, trestbps, chol, fasting blood sugar, restecg, thalach, exang, oldpeak, slope, ca, and thal.

4. METHODOLOGY USED

In machine learning, memory-based learning is a family of learning algorithms that compare new problem instances with instances seen in training, which have been stored in memory. Memory based learning is a kind of lazy learning. It is called Memory based because it constructs postulates directly from the training instances. It has different advantages like, Learning complex target Functions easily, Very fast training, No information loss, and the ability to adapt its model to previously unseen data. This work compares the following memory based classification algorithms.

CFS (Correlation based Feature Selection) Subset Evaluator or Attribute Selector, assesses the worth of a subset of attributes by considering the individual foretelling ability of each attribute along with the degree of severance between them.

4.1 IBk Classifier

IBK is an employment of the k-nearest-neighbor classifier. Every instance in the dataset is deliberated as a point in multi-dimensional space and classification is done based on the class value of 'k' nearest neighbors. The value of ‘k’ decides how many neighbors can be taken for consideration to elect how to classify a new instance.

For example, for the ‘heart disease’ data, IBK would consider the 7 dimensional spaces for the 7 attributes. A new instance would be classified to the class of its closest neighbor using Euclidean distance measurement. If ‘8’ is used as the value of ‘k’, then eight closest neighbors will be considered. The class of the new instance is considered to be the class of the majority of the instances. If ‘8’ is used as the value of k and 5 or 6 of the closest neighbors are of class value ‘1’, then the class value of the test instance would be assigned as ‘1’. The time taken to classify a test instance with nearest-neighbor classifier rises linearly with the number of training cases”.

4.2 K Star Classifier

K Star is a memory-based classifier that is the class of a new instance is based upon the class of training instances similar to it, as determined by some similarity measure. The use of entropy as a similarity measure has numerous benefits in K Star. Amongst other classifiers, it provides a reliable approach to handling of real valued attributes, symbolic attributes and missing values [45].

4.3 Locally Weighted Learning Classifier

Locally Weighted Learning (LWL) is a learning model belongs to the category of memory based classifiers. LWL model with Decision Stump in combination is a classifier. Decision Stump habitually used in combination with a boosting algorithm. Boosting is most significant recent development in classification methodology. Boosting is done by sequentially applying a classification algorithm to reweighted versions of the training data, and then obtaining a weighted maximum vote of the sequence of classifiers thus created. For numerous classification algorithms, this simple strategy results in dramatic performance improvement. This apparently inexplicable phenomenon can be understood in terms of well known statistical principles, namely maximum likelihood and additive modeling. For the two-class problem, boosting can be observed as an approximation to additive modeling [46].

5. PERFORMANCE MEASURES USED

Various measures are used to gauge the performance of Memory based classifiers.

5.1 Classification Accuracy

Classification accuracy is computed as correctly classified instances by number of total instances multiplied by 100.

5.2 Cohen’s Kappa

It is a statistics which measures the inter-rate settlement between the classes. In this case, it is the inter-rate agreement between Presence of heart disease and Absence of Heart disease.

5.3 Mean Absolute Error

Mean absolute error is the average of the variance between predicted and actual value in all instances. It is a good measure to measure the performance.

5.4 Root Mean Square Error

Root mean squared error is used to scale variations between values actually professed and the values predicted by the model. It is defined by taking the square root of the mean square error.

6. RESULTS AND DISCUSSION

The performance of Memory based Classifiers with CSF attribute evaluator separately experimented for heart disease prediction using open source machine learning tool. The performance is tested out using the Training set as well as using various cross validation methods. The results are arrived by considering only resulting attributes from CSFAE method namely, chest, resting electrocardiographic results, exercise induced angina, maximum heart rate achieved, old peak, number of major vessels and thal of the dataset.

6.1 Performance of IBk Classifier with CFS Subset Evaluator

The assessment summary of IBk Classifier done with entire training set and various cross validation methods is depicted in Table I. IBk Classifier gives 100% accuracy for the training data set. Various cross validation methods (5 Fold, 10 Fold, 15 Fold, etc.) are used to check its actual performance of IBk. On an average, it gives around 77.78% of accuracy which is 3% more than the accuracy (74.75% of accuracy) got by only using IBk classifier without ant attribute selection method [35] for heart disease prediction.

IBk Classifier with CFSAE Evaluation Summary

Test Mode	Correctly Classified Instances	Accuracy	Kappa	Mean Absolute Error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	270	100%	1	0	0	0
5 FCV	207	76.6667 %	0.5263	0.2333	0.483	0
10 F CV	210	77.7778 %	0.547	0.2222	0.4714	0
15 FCV	213	78.8889 %	0.57	0.2111	0.4595	0
20 FCV	210	77.7778 %	0.547	0.2222	0.4714	0
50 FCV	210	77.7778 %	0.5462	0.2222	0.4714	0

6.2 Performance of K Star Classifier with CFS Subset Evaluator

The overall assessment summary of K Star Classifier done with entire training set and various cross validation methods is depicted in Table II. K Star Classifier gives 99.6296% accuracy for the training data set. Various cross validation methods (5 Fold, 10 Fold, 15 Fold, etc.) are used to check its actual performance of K Star. On an average, it gives around 79.18% of accuracy which is 3.28 % more than the accuracy (75.90% of accuracy) got by only using K Star classifier without ant attribute selection method [35] for heart disease prediction.

K Star Classifier with CFSAE Evaluation Summary

Test Mode	Correctly Classified Instances	Accuracy	Kappa	Mean Absolute Error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	269	99.6296 %	0.9925	0.0334	0.0804	0
5 FCV	212	78.5185 %	0.5584	0.2452	0.4043	0
10 FCV	211	78.1481 %	0.5511	0.2445	0.401	0
15 FCV	216	80 %	0.5881	0.2426	0.3961	0
20 FCV	214	79.2593 %	0.5729	0.2426	0.3967	0.05
50 FCV	216	80 %	0.5874	0.2432	0.3964	0

6.3 Performance of LWL Classifier with CFS Subset Evaluator

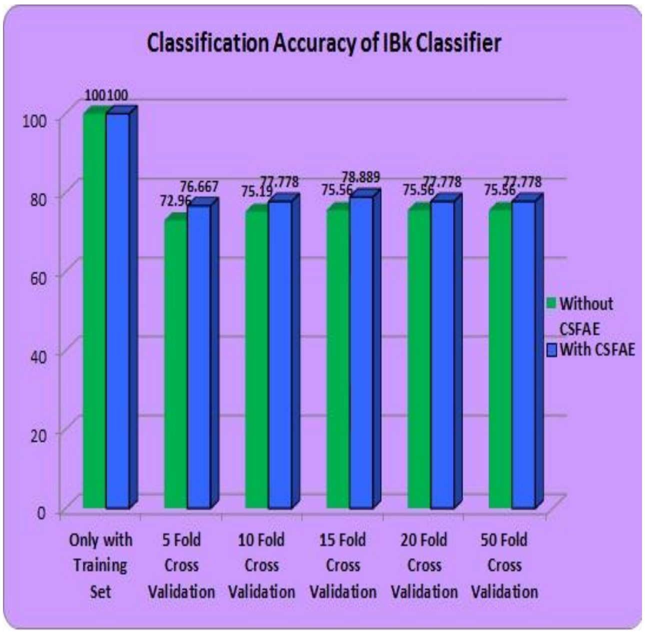
The overall assessment summary of LWL Classifier done with entire training set and various cross validation methods is depicted in Table III. LWL Classifier gives 80.7407 % accuracy for the training data set. Different cross validation methods (5 Fold, 10 Fold, 15 Fold, etc.) are used to check its actual performance of LWL. On an average, it gives around 69.037% of accuracy which is 2% less than the accuracy (71.10% of accuracy) got by only using LWL classifier without ant attribute selection method [35] for heart disease prediction.

LWL Classifier with CFSAE Evaluation Summary

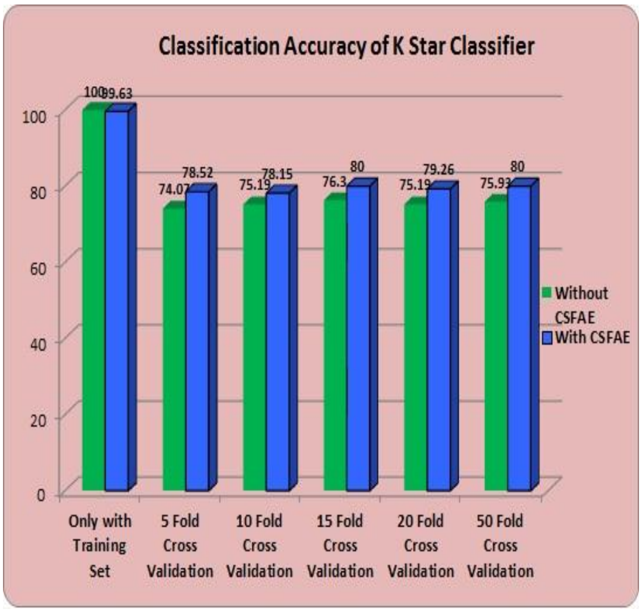
Test Mode	Correctly Classified Instances	Accuracy	Kappa	Mean Absolute Error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	218	80.7407 %	0.6139	0.3073	0.3733	0
5 FCV	192	71.1111 %	0.4227	0.3511	0.4301	0
10 FCV	189	70 %	0.399	0.358	0.4344	0
15 FCV	182	67.4074 %	0.3455	0.3697	0.4467	0
20 FCV	184	68.1481 %	0.3614	0.3676	0.4452	0
50 FCV	185	68.5185 %	0.3683	0.3664	0.4422	0

6.4 Comparison of Memory based Classifiers

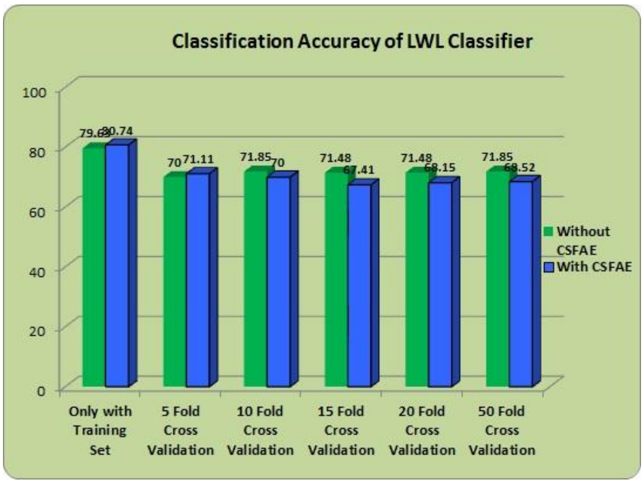
The comparison of performance of Memory based Classifiers with and without CFS attribute evaluator is depicted in Fig 1, Fig 2, and Fig 3 separately for IBk, K Star and LWL classifiers based on accuracy. Comparison of overall performance of all classifiers with CFS attribute evaluator is depicted in Fig 4 and Fig 5 in terms of Classification Accuracy and Correctly Classified Instances. The complete evaluation is done based on classification accuracy, Kappa statistics, MAE and RMSE values found using Training Set result and Cross Validation Techniques. Consequently, it is perceived that K Star classifier performs better than other classifiers followed by IBk and LWL Classifier.



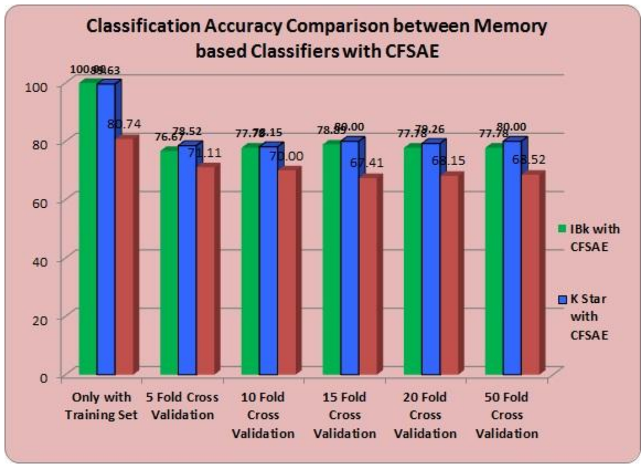
Classification Accuracy Comparison of IBK Classifier with and without CFS Attribute Selection



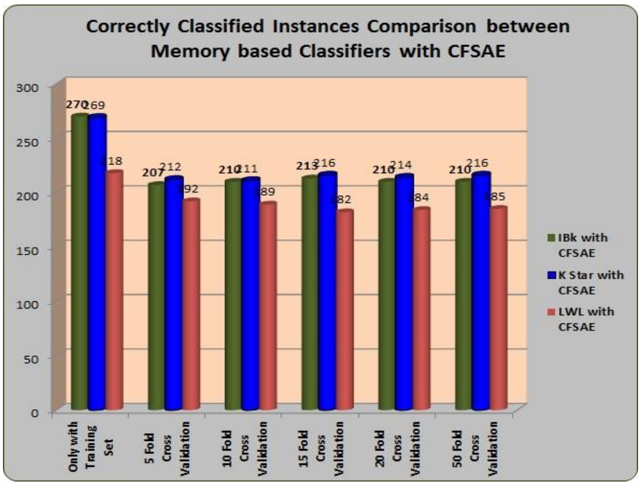
Classification Accuracy Comparison of K Star Classifier with and without CFS Attribute Selection



Classification Accuracy Comparison of LWL Classifier with and without CFS Attribute Selection



Classification Accuracy Comparison between Memory based Classifiers with CFS Attribute Selection



Correctly Classified Instances Comparison between Memory based Classifiers with CFS Attribute Selection

7. CONCLUSION

This work investigated the efficiency of Memory based classifiers namely; IBk Classifier, K Star Classifier and LWL Classifier with CFS attribute evaluator for heart disease prediction. Experiment is done using the open source machine learning tool. Also, performance evaluation of the classifiers has been done in view of various scales of performance measure. At last, it is observed that K Star classifier performs better than other classifiers followed by IBk Classifier and by LWL with very lower accuracy for heart disease prediction by taking various measures.

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