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Proficiency Comparison of ZeroR, RIDOR and PART Classifiers for Intelligent Heart Disease Prediction

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Abstract: Medical data mining is an emerging field which helps physicians to diagnose patients well in advance. In modern days, the clinical data of patients are stored for future use. And this clinical data grow exponentially during the time period. Processing this mass patient data needs information technology and computing algorithms to play an vital role. Many data mining especially different classification techniques are used to extract hidden information and to predict diseases. Heart disease is the leading cause of death all over the world and risk of heart disease increases as age grows. Classification algorithms are the superior choice for predictive analysis like predicting heart disease of the patient, whether he/she has the disease or not. Finding the outstanding classifier is a hard-hitting assignment for the physician. This gives opportunity to computer science researchers to drill down well-organized research works through evaluating different classifiers and identifying the finest classifier for such predictive problems. This research work inspects the effectiveness of different Rule Based Classifiers (RIDOR, ZeroR and PART Classifiers) for the Heart Disease prediction and evaluates their strength through various measures. Heart disease dataset from UCI data set has been taken and used to predict the heart disease existence using open source machine learning tool.

Keywords: Hear Disease Prediction, PART Classifier, Proficiency Comparison, RIDOR Classifier, ZeroR Classifier.

INTRODUCTION

The gigantic volume of clinical data of patients enforce information processing automation an revitalizing factor for high quality standards, cost diminution, with high speed results in prediction of diseases. Automated data analysis and result of the relevant successes formed by state-of-the art computer algorithms have modified the opinions of many misanthropists. Earlier, people thought that medical data analysis necessitates intuition, knowledge and experience and wondered how this job could be automated using computer algorithms. On the contrary, growth of scientific and technological ability, achieved the automatic prediction of diseases and automatic medical analysis. In modern days, Heart disease becomes one of the most dangerous disease one of the dangerous disease which is the leading cause for death in all around the world. Automated processing of existing heart disease prediction can be attained using classification techniques. Identifying the classifier, which predicts Heart Disease in an proficient manner, is an crucial and decisive task. Rule based classifiers are human understandable and easy to interpret, it easily handle missing values and numeric attributes, so, in this research work three rule based classifiers are randomly selected and compared. This research work judges the Heart Disease performance of three rule based classifiers, namely, RIDOR, ZeroR and PART Classifier and compares their accuracy in Heart Disease prediction.

LITERATURE REVIEW

There are many research works proposed to predict heart disease using extensive computing techniques. An neuro-fuzzy integrated approach of two levels is implemented in [1] to predict the Heart Disease. A combined technique of Maximal Frequent Item set Algorithm, C4.5, K-means is used to extract and predict Heart Disease is presented in [2] and [11]. In [3], a combined approach of Artificial Neural Network and Feature Subset Selection with Principal component Analysis is applied to predict Heart Disease. In [4], SPAM algorithm using Nearest Neighbor Classifier is proposed to predict Heart Diseases. Prediction of Heart Disease which applies Genetic Algorithm for assortment of Optimal Reduced Set of Attributes and then uses Naive Bayes and Decision Tree classifiers are presented in [5]. Performance Comparison of C4.5 and the C5.0 decision tree algorithms is done and how the rules can be used in evidence based medicine is explained in [6]. Heart attack prediction using Cluster based Association Rule Mining using sequence number is described in [7] and [8]. Literature survey on Heart Disease prediction is summarized in [9], [13], [16] and [27]. Comparison of SMO, Logistic Function and Multilayer Perceptron on Heart Disease prediction is presented in [10]. Heart Disease prediction using K- Nearest Neighbors is presented in [12]. The possibilities, advantages and uses of Data Mining in Health care to predict diseases is elaborated in [14] and [22]. Adaptive Neuro-Fuzzy Inference system with Hybrid Learning algorithm for Heart Disease prediction is described in [15]. Heart Disease classification and prediction using Artificial Neural Network with Multilayer Perceptron using Back Propagation algorithm is described in [17] and [30]. Heart disease prediction using Classification and Regression Tree Model is explained in [18] and the results are compared with existing research papers. Heart Disease prediction using Cascaded Neural Network Classifier is proposed in [19] and the same is compared with the performance of Support vector machine algorithm. Prediction of Heart Diseases in advance using Data Mining Techniques like Naive Bayes, Neural Networks and Decision tree are explained in [20] and [28] and the same

using CART, ID3 and Decision Tree classifiers are summarized in [23].Nine Voting Equal Frequency Discretization Gain Ratio Decision Tree is proposed in [21] for Heart disease prediction and compared with J48 Decision Tree classifier and Bagging algorithm. Comparative analysis of Neural Network, Support Vector Machine and K-Means Clustering are elaborated in [24]. Web-based application named Decision Support in Heart Disease Prediction System using data mining technique is proposed in [25]. Comparative study of Naive Bayes, Decision Table and J48 algorithms for heart disease prediction is presented in [26]. Evaluation of Heart disease prediction using Naive Bayes, Decision Tree with K-Means and Weighted Associative Classifier with Apriori Algorithm is presented in [29]. This research work scrutinizes the efficiency of different Tree Based Classifiers (RIDOR, ZeroR and PART Classifiers) for Heart Disease prediction.

DATASET USED

The Heart Disease dataset [31] is used to assess the performance of RIDOR, ZeroR and PART Classifiers for Heart Disease prediction. It has total of 270 instances with 13 medical attributes. This dataset contains 150 patients without heart disease and 120 patients with heart disease. The attributes has acronym as: age, sex, cp, trestbps, chol, fbs, restecg, thalach, exang, oldpeak, slope, ca, and thal. The data set has 270 instances of patient clinic data with appropriate class. It categorizes the records into two classes, namely, Present and Absent.

METHODOLOGY USED

In this research work, different Rule Based Classifiers (RIDOR, ZeroR and PART Classifiers) are compared for ability assessment of Heart Disease prediction.

ZeroR Classifier

ZeroR is the simplest of the rule based classifiers which relies on the target and ignores all predictors. It simply predicts the majority class. It is based on Frequency Table. The ZeroR classifier takes a look at the target attribute and its possible values. It constructs the frequency table and select its most frequent value. It will ever output the value that is most frequently found for the target attribute in the given dataset. ZeroR as its names suggests; it does not include any rule that works on the non target attributes. So more specifically it predicts the mean (for a numeric type target attribute) or the mode (for a nominal type attribute).

RIDOR Classifier

Ripple Down Rule learner (RIDOR) is also a direct classification method. RIDOR learns rules with exceptions by generating the default rule, using incremental reduced-error pruning to find exceptions with the smallest error rate, finding the best exceptions for each exception, and iterating. It generates a default rule first and then the exceptions for the default rule with the least (weighted) error rate. Then it generates the "best" exceptions for each exception and iterates until pure. Thus it performs a tree-like expansion of exceptions. The exceptions are a set of rules that predict classes other than the default. IREP is used to generate the exceptions. Incremental Reduced Error Pruning IREP is used to create the exceptions. [32] [33] [34].

RIpple-DOwn Rule learner first generates the default rule. The exceptions are generated for the default rule with the lowest (weighted) error rate. Then it generates the "best" exceptions for each exception. Thus it carries out a tree-like expansion of exceptions and its leaf has only default rule without exceptions.

Five inner classes are defined in this class. RIDOR_node class, which implements one node in the RIDOR tree. It's basically built up of a default class and its exception rules. RIDORRule class, which implements a single exception rule using REP.

The rest of the three classes are only used in RIDORRule namely Antd, NumericAntd and NominalAntd. The abstract class Antd class has two subclasses, NumericAntd and NominalAntd, to implement the corresponding abstract functions. These two subclasses implement the functions related to an antecedent with a nominal attribute and a numeric attribute respectively.

PART Classifier

This is a class for generating a PART decision list. It uses separate-and-conquer approach and builds a partial C4.5 decision tree in each iteration and makes the "best" leaf into a rule [33].

PART Classifier Algorithm steps:

1. Build a partial decision tree on the current set of instances
2. Create a rule from the decision tree
– The leaf with the largest coverage is made into a rule
3. Discarded the decision tree
4. Remove the instances covered by the rule
5. Go to step one

PERFORMANCE MEASURES USED

Various scales are used to gauge the performance of the classifiers.

Classification Accuracy

Any classifier could have an error rate and it may fail to categorize correctly. Classification accuracy is calculated as Correctly classified instances divided by Total number of instances multiplied by 100.

Mean Absolute Error

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

Root Mean Square Error

Root mean squared error is used to scale dissimilarities between values actually perceived and the values predicted by the model. It is determined by taking the square root of the mean square error.

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Confusion Matrix

A confusion matrix encompasses information about actual and predicted groupings done by a classification system.

RESULTS AND DISCUSSION

Open source machine learning tool is used to experiment the performance of different Rule based Classifiers (RIDOR, ZeroR and PART) for Heart Disease Prediction. The performance is tested out using the Training set as well as using different Cross Validation methods. The class is arrived by considering all 13 attributes of the dataset.

Performance of ZeroR Classifier

The overall assessment summary of ZeroR Classifier using training set and different cross validation methods is given in Table 1. The performance of ZeroR Classifier in terms of Correctly Classified Instances and Classification Accuracy is shown in Fig. 1 and Fig. 2. The confusion matrix for different test mode is given in Table 2 to Table 6. ZeroR Classifier gives 55.56% accuracy for the training data set. Various cross validation methods are used to check its actual performance. On an average, it gives around 55.56% of accuracy for Heart Disease estimation.

Table 1: ZeroR Classifier Complete Evaluation Summary

Test Mode	Correctly Classified Instances	Incorrectly Classified Instances	Accuracy	Mean absolute error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	150	120	55.56%	0.4939	0.4969	0
5 Fold CV	150	120	55.56%	0.4939	0.4969	0
10 Fold CV	150	120	55.56%	0.4939	0.4969	0
15 Fold CV	150	120	55.56%	0.4939	0.4969	0
20 Fold CV	150	120	55.56%	0.4939	0.4969	0

Table 2: Confusion Matrix – ZeroR Classifier (On Training Dataset)

	Absent	Present	Actual (Total)
Absent	150	0	150
Present	120	0	120
Predicted (Total)	270	0	270

Table 3: Confusion Matrix – ZeroR Classifier (5 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	150	0	150
Present	120	0	120
Predicted (Total)	270	0	270

Table 4: Confusion Matrix – ZeroR Classifier (10 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	150	0	150
Present	120	0	120
Predicted (Total)	270	0	270

Table 5: Confusion Matrix – ZeroR Classifier (15 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	150	0	150
Present	120	0	120
Predicted (Total)	270	0	270

Table 6: Confusion Matrix – ZeroR Classifier (20 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	150	0	150
Present	120	0	120
Predicted (Total)	270	0	270

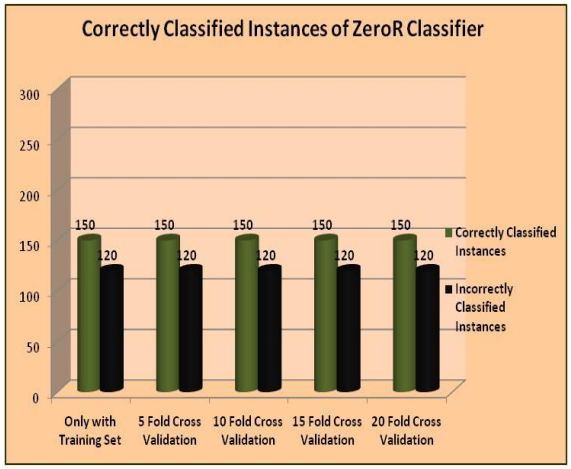

Fig. 1 Correctly Classified instances of ZeroR Classifier for Heart Disease estimation

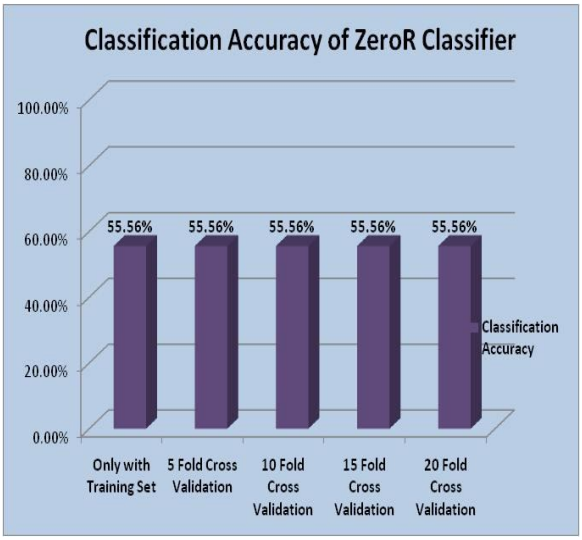

Fig. 2 Classification Accuracy of ZeroR Classifier for Heart Disease estimation

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Performance of RIDOR Classifier

RIDOR created 6 rules for Heart Disease prediction. The overall assessment summary of RIDOR Classifier using training set and different cross validation methods is given in Table 7. The performance of RIDOR Classifier in terms of Correctly Classified Instances and Classification Accuracy is shown in Fig. 3 and Fig. 4. The confusion matrix for different test mode is given in Table 8 to Table 12. RIDOR Classifier gives 85.56% accuracy for the training data set. Various cross validation methods are used to check its actual performance. On an average, it gives around 77.56% of accuracy for Heart Disease estimation.

Table 7: RIDOR Classifier Overall Evaluation Summary

Test Mode	Correctly Classified Instances	Incorrectly Classified Instances	Accuracy	Mean Absolute Error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	231	39	85.56%	0.144	0.3801	0.06
5 Fold CV	205	65	75.93%	0.2407	0.4907	0.02
10 Fold CV	211	59	78.15%	0.2185	0.4675	0
15 Fold CV	210	60	77.78%	0.2222	0.4714	0.02
20 Fold CV	212	58	78.52%	0.2148	0.4635	0.02

Table 8: Confusion Matrix – RIDOR Classifier (On Training Dataset)

	Absent	Present	Actual (Total)
Absent	120	30	150
Present	9	111	120
Predicted (Total)	129	141	270

Table 9: Confusion Matrix – RIDOR Classifier (5 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	119	31	150
Present	34	86	120
Predicted (Total)	153	117	270

Table 10: Confusion Matrix – RIDOR Classifier (10 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	124	26	150
Present	33	87	120
Predicted (Total)	157	113	270

Table 11: Confusion Matrix – RIDOR Classifier (15 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	124	26	150
Present	34	86	120
Predicted (Total)	158	112	270

Table 12: Confusion Matrix – RIDOR Classifier (20 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	126	24	150
Present	34	86	120
Predicted (Total)	160	110	270

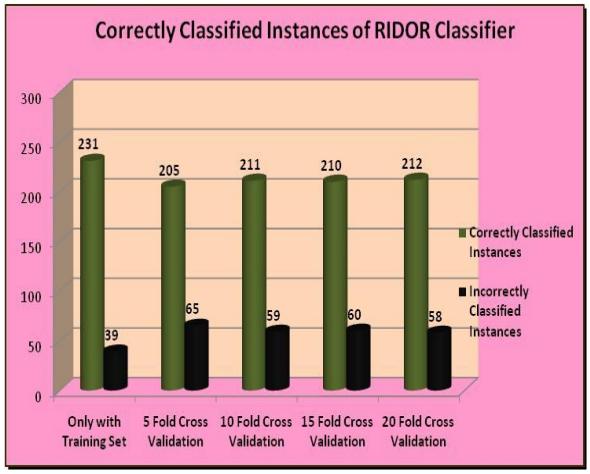

Fig. 3 Correctly Classified instances of RIDOR Classifier for Heart Disease estimation

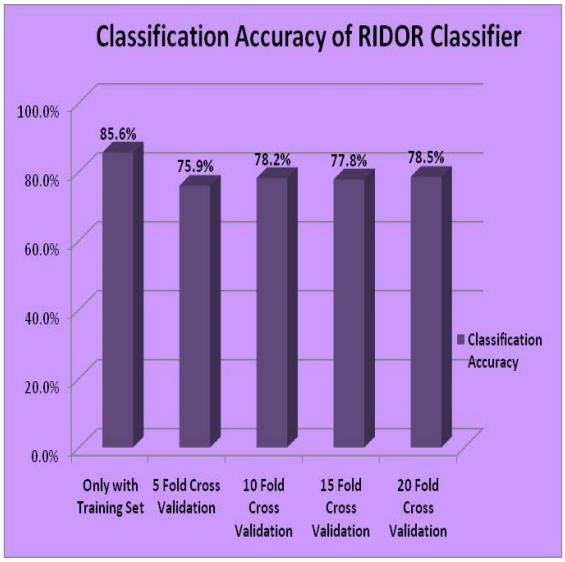

Fig. 4 Classification Accuracy of RIDOR Classifier for Heart Disease estimation

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Performance of PART Classifier

PART created 24 Rules for Heart Disease prediction. The overall assessment summary of PART Classifier using training set and different cross validation methods is given in Table 13. The performance of PART Classifier in terms of Correctly Classified Instances and Classification Accuracy is shown in Fig. 5 and Fig. 6. The confusion matrix for different test mode is given in Table 14 to Table 18. PART Classifier gives 94.44% accuracy for the training data set. Various cross validation methods are used to check its actual performance. On an average, it gives around 76.48% of accuracy for Heart Disease estimation.

Table 13: PART Classifier Overall Evaluation Summary

Test Mode	Correctly Classified Instances	Incorrectly Classified Instances	Accuracy	Mean Absolute Error	Root Mean Squared Error	Time Taken to Build Model (Sec)
Training Set	255	15	94.44%	0.0915	0.2139	0.06
5 Fold CV	205	65	75.93%	0.253	0.4754	0.03
10 Fold CV	198	72	73.33%	0.2764	0.4931	0.02
15 Fold CV	213	57	78.89%	0.2233	0.4322	0.02
20 Fold CV	210	60	77.78%	0.2365	0.4497	0.02

Table 14: Confusion Matrix – PART Classifier (On Training Dataset)

	Absent	Present	Actual (Total)
Absent	143	7	150
Present	8	112	120
Predicted (Total)	151	119	270

Table 15: Confusion Matrix – PART Classifier (5 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	119	31	150
Present	34	86	120
Predicted (Total)	153	117	270

Table 16: Confusion Matrix – PART Classifier (10 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	115	35	150
Present	37	83	120
Predicted (Total)	152	118	270

Table 17: Confusion Matrix – PART Classifier (15 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	119	31	150
Present	26	94	120
Predicted (Total)	145	125	270

Table 18: Confusion Matrix – PART Classifier (20 Fold Cross Validation)

	Absent	Present	Actual (Total)
Absent	119	31	150
Present	29	91	120
Predicted (Total)	148	122	270

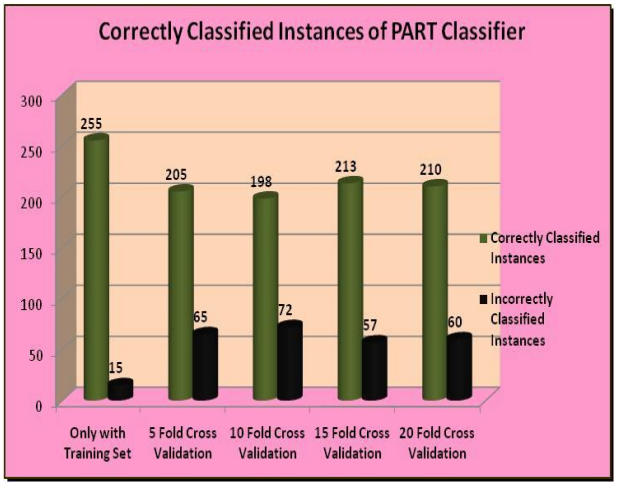

Fig. 5 Correctly Classified instances of PART Classifier for Heart Disease estimation

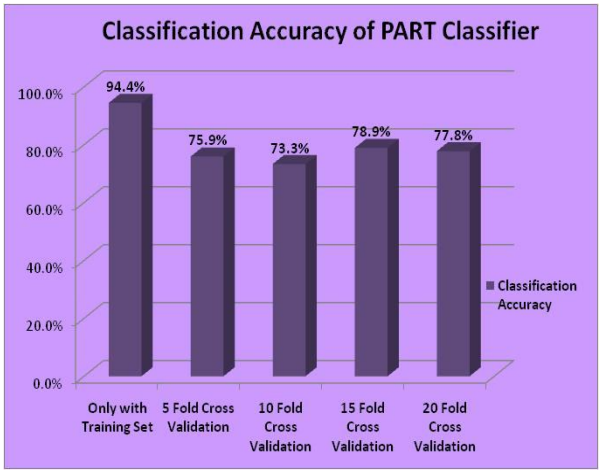

Fig. 6 Classification Accuracy of PART Classifier for Heart Disease estimation

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Comparison of RIDOR, ZeroR and PART Classifiers

The comparison of performance between RIDOR, ZeroR and PART Classifiers is depicted in Fig 7, and Fig. 8 in terms of Correctly Classified Instances and Classification Accuracy. The complete ranking is prepared based on correctly classified instances, classification accuracy, MAE and RMSE values and other statistics found using Training Set result and Cross Validation Techniques. Consequently, it is perceived that RIDOR classifier outperforms the other two Classifiers for Heart Disease estimation.

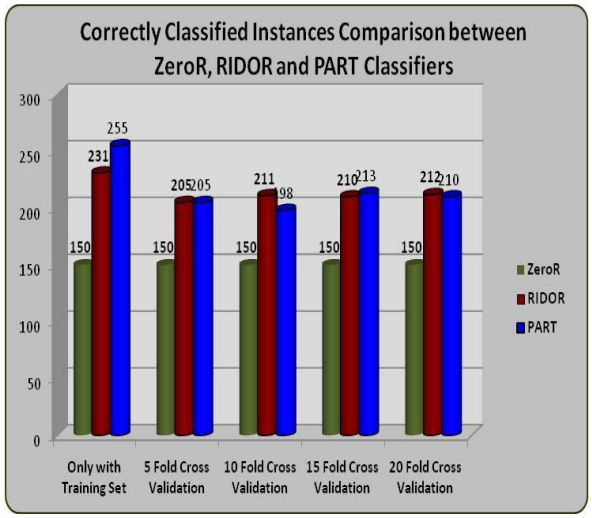

Fig. 7 Correctly Classified Instances Comparison between RIDOR, ZeroR and PART Classifiers for Heart Disease estimation

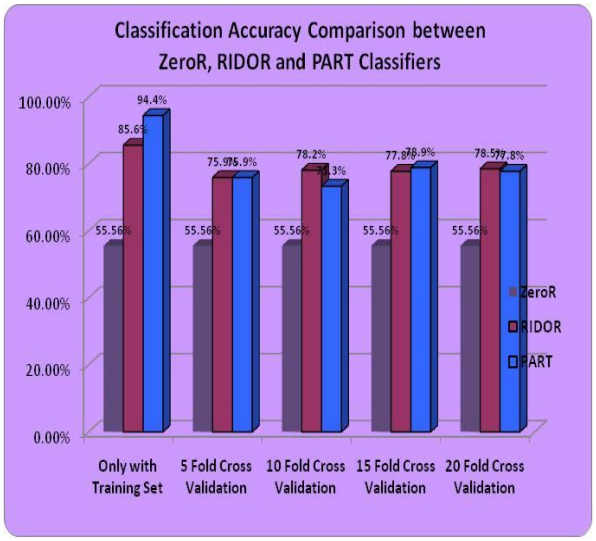

Fig. 8 Classification Accuracy Comparison between RIDOR, ZeroR and PART Classifiers for Heart Disease estimation

CONCLUSION

This work investigated the efficiency of three different classifiers namely, RIDOR, ZeroR and PART Classifiers for Heart Disease prediction. Testing is accomplished using the open source machine learning tool. Also, effectiveness comparison of both the classifiers has been done in view of different scales of performance evaluation. At last, it is observed that RIDOR Classifier performs best, followed by PART Classifier and then lastly by ZeroR Classifier for Heart Disease prediction by taking various measures including Classification accuracy, Mean Absolute Error and Time taken to build the model.

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