



Performance Evaluation: A Comparative Study of Various Classifiers

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Abstract— Real-world knowledge discovery processes typically consist of complex data pre-processing, machine learning, evaluation, and visualization steps. Hence a data mining platform should allow complex nested operator chains or trees, provide the transparent data managing, comfortable constraint handling and optimization, be flexible, extendable and easy-to-use. Modern machine learning techniques have encouraged interest in the development of various systems that ensure protected, trustworthy and many more operations in the different fields and applications. In an earlier study, many other approaches/methods were investigated to develop various applications using modern machine learning techniques and more specific classification algorithms. The Weka machine learning workbench provides a general-purpose environment for automatic classification, clustering and feature selection, and common data mining problems in bioinformatics research. Here in this Project Report paper we have used various classifiers with filters to perform classification and we have done analysis of data with different classifiers and then we have done feature selection process and during all these activities we have observed and record the various performance change and different graphs which are briefed inside this paper.

Keywords— Machine Learning, WEKA, Data mining, KDD, Classification, Filters, Feature Selection

I. INTRODUCTION

In an earlier study, many other approaches/methods were investigated to develop various applications using modern machine learning techniques and more specific classification algorithms. Modern machine learning techniques have encouraged interest in the development of various systems that ensure secure, reliable and many more operations in the different fields and applications. The Weka machine learning workbench provides a general-purpose environment for automatic classification, clustering and feature selection. Therefore Weka also contains an extensive data pre-processing methods and the experimental comparison of different machine learning techniques on the same problem. Data mining (the analysis step of the "Knowledge Discovery in Databases") is a field at the intersection of computer science and statistics is the process that attempts to discover patterns in huge data sets. It utilizes methods at the junction of artificial intelligence, machine learning, statistics, and database systems. The term Knowledge Discovery in Databases or KDD for short, refers to the broad process of finding knowledge in data, and emphasizes the "high-level" application of particular data mining methods. The unifying goal of the KDD process is to extract knowledge from data in the context of large databases. In feature selection operation we are going to find out which are the most important instances to carry out the classification to get accurate result by improving their performance. Here, in this Project Report paper we have used various classifiers with filters to perform classification and we have done analysis of data with different classifiers and then we have done feature selection process and during all these activities we have observed and record the various performance change and different graphs which are briefed inside this paper. To improve the performance we have experimented with Artificial Intelligence based (AI Classifier), a rule-based learning method using statistical analysis and also Decision tree and Support Vector Machine (SVM) based classification schemes were used to analysis and inspection of data. This selected algorithm efficiency and overall performance for the given data set (Temp.csv) are observed and calculated. This experiment/study has been conducted using six classifiers, namely SMO, REPTree, IBK, Logistic and Multilayer perceptron, with Temp.csv datasets having 41 instances. The Waikato Environment for Knowledge Analysis (WEKA) learning tool has been used in this Experiment/study.

II. METHODOLOGY

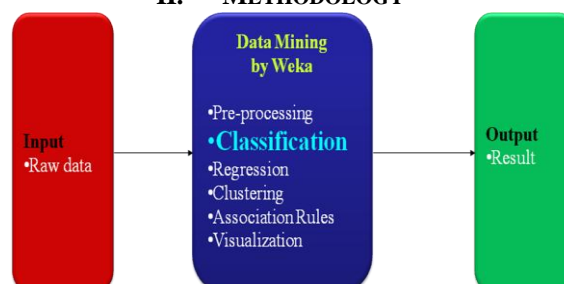


Fig 1 Flow of Methodology involved.

Using Weka tool we have executed six various classifiers algorithm on our dataset and compared the various classifiers based on the ROC Area (Weighted Average) value.

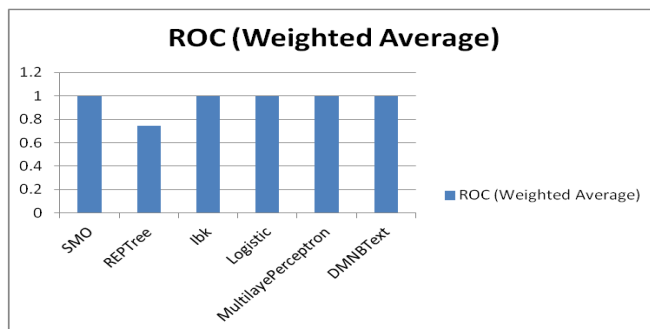


Fig 2 ROC (Weighted Average)

And also we found that out of 6 classifiers, 4 classifiers are showing 100% correctly classified instances and 2 classifiers REPTree and DMNBText are showing incorrectly classified instances, therefore next step we proceed with finding out which instances were not correctly classified. For this we have to do a tuple-wise analysis, so for the same I am taking only one classifier now i.e. DMNBText Classifier.

III. RESULTS

TABLE 1: CLASSIFIERS COMPARISON CHART

| Sl. No. | Classifiers | ROC (Weighted Average) |
|---------|----------------------|------------------------|
| 1 | SMO | 1 |
| 2 | REPTree | 0.746 |
| 3 | Ibk | 1 |
| 4 | Logistic | 1 |
| 5 | MultilayerPerceptron | 1 |
| 6 | DMNBText | 0.997 |

TABLE 2: CONSOLIDATED CLASSIFIERS SHEET USING TRAINING SET AS TEST OPTIONS

| DATA CLASSIFICATION STATISTICS | | | | | | |
|--|-----------------|---------------|---------------|-----------------------|---------------|---------|
| Data File Description | | | | | | |
| | Relation=temp | Attributes=62 | | Instances=41 | | |
| CLASSIFIER 1: | CLASSIFIER 2: | CLASSIFIER 3: | CLASSIFIER 4: | CLASSIFIER 5: | CLASSIFIER 6: | |
| AI Classifier | Tree Classifier | Ibk | Logistic | MultiLayer Perceptron | DMNBText | |
| Summary | SMO | REPTree | | | | |
| Number of Correctly Classified Instances | 41 | 28 | 41 | 41 | 41 | 35 |
| Correctly Classified Instances % | 100 | 68.2927 | 100 | 100 | 100 | 85.3659 |
| Number of Incorrectly Classified Instances | 0 | 13 | 0 | 0 | 0 | 6 |
| Incorrectly Classified Instances % | 0 | 31.7073 | 0 | 0 | 0 | 14.6341 |
| Kappa statistic | 1 | 0.4336 | 1 | 1 | 1 | 0.7681 |
| Mean absolute error | 0.2222 | 0.2969 | 0.0303 | 0 | 0.0059 | 0.2135 |
| Root mean squared error | 0.2722 | 0.3853 | 0.0321 | 0 | 0.0091 | 0.2783 |
| Relative absolute error | 55.9901 | 74.8118 | 7.635 | 0.0001 | 1.4937 | 53.7995 |
| Root relative squared error | 61.3467 | 86.8492 | 7.2447 | 0.0001 | 2.0548 | 62.7209 |
| Total Number of Instances | 41 | 41 | 41 | 41 | 41 | 41 |
| Detailed Accuracy By Class | | | | | | |
| TP Rate (weighted avg) | 1 | 0.683 | 1 | 1 | 1 | 0.854 |
| FP Rate (weighted avg) | 0 | 0.266 | 0 | 0 | 0 | 0.025 |
| Precision (weighted avg) | 1 | 0.585 | 1 | 1 | 1 | 0.927 |
| Recall (weighted avg) | 1 | 0.683 | 1 | 1 | 1 | 0.854 |
| F-measure (weighted avg) | 1 | 0.627 | 1 | 1 | 1 | 0.871 |
| ROC Area (weighted avg) | 1 | 0.746 | 1 | 1 | 1 | 0.997 |
| Confusion Matrix | | | | | | |
| a=0,b=L,c=N | | | | | | |
| a-a | 22 | 16 | 22 | 22 | 22 | 19 |
| a-b | 0 | 6 | 0 | 0 | 0 | 0 |
| a-c | 0 | 0 | 0 | 0 | 0 | 3 |
| b-a | 0 | 1 | 0 | 0 | 0 | 0 |
| b-b | 13 | 12 | 13 | 13 | 13 | 10 |
| b-c | 0 | 0 | 0 | 0 | 0 | 3 |
| c-a | 6 | 6 | 0 | 0 | 0 | 0 |
| c-b | 0 | 0 | 0 | 0 | 0 | 0 |
| c-c | 6 | 0 | 6 | 6 | 6 | 6 |

TABLE 3

ANALYSIS AND PERFORMANCE CHANGE FOR DMNBTEXT CLASSIFIERS USING CROSS-VALIDATION AS TEST OPTIONS
 From the Figure given below we can see the ROC value for DMNBText Classifier without and With the Attribute Evaluator. Thus by Calculating ROC change we can Find out the performance Change as given below.

$$\text{Performance Change} = (\text{ROC}_{\text{With Evaluator}} - \text{ROC}_{\text{Without Evaluator}}) / \text{ROC}_{\text{Without Evaluator}}$$

| CLASSIFIER NAME: DMNBText | | |
|--|-----------------------------|---|
| | Without Attribute Selection | With Attribute Selection: Attribute Evaluator: <i>na me</i> SearchMethod: <i>Ranker</i> |
| List of Selected Attributes----->> | All | RL-54, L-18, L-14, L-20, L-24, L-16, L-15, H-35, RL-60, RL-62, P-49, H-32, L-17 |
| Summary | | |
| Number of Correctly Classified Instances | 33 | 31 |
| Correctly Classified Instances % | 80.487 | 75.6098 |
| Number of Incorrectly Classified Instances | 8 | 10 |
| Incorrectly Classified Instances % | 19.512 | 24.3902 |
| Kappa statistic | 0.6439 | 0.5514 |
| Mean absolute error | 0.2455 | 0.2827 |
| Root mean squared error | 0.3339 | 0.3463 |
| Relative absolute error | 61.4542 | 70.7685 |
| Root relative squared error | 74.8162 | 77.6059 |
| Total Number of Instances | 41 | 41 |
| Detailed Accuracy By Class | | |
| TP Rate (weighted avg) | 0.805 | 0.756 |
| FP Rate (weighted avg) | 0.175 | 0.215 |
| Precision (weighted avg) | 0.829 | 0.645 |
| Recall (weighted avg) | 0.805 | 0.756 |
| F-measure (weighted avg) | 0.77 | 0.696 |
| ROC Area (weighted avg) | 0.897 | 0.909 |
| Confusion Matrix | | |
| a=O, b=L, c=N | | |
| a-a | 21 | 20 |
| a-b | 1 | 2 |
| a-c | 0 | 0 |
| b-a | 2 | 2 |
| b-b | 11 | 11 |
| b-c | 0 | 0 |
| c-a | 3 | 4 |
| c-b | 2 | 2 |
| c-c | 1 | 0 |
| Performance change(%) | | 1.34 |

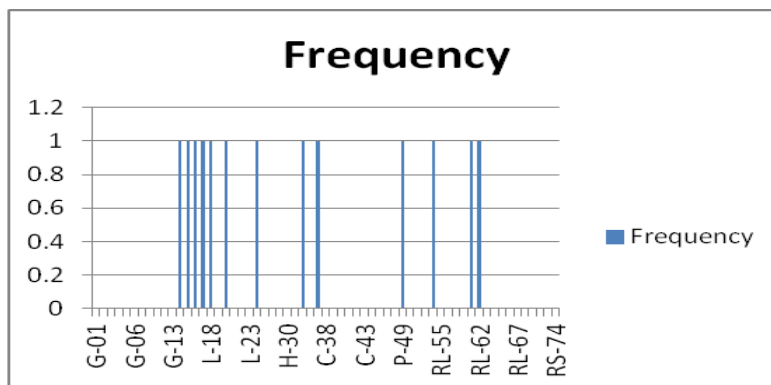


Fig 3 Frequency

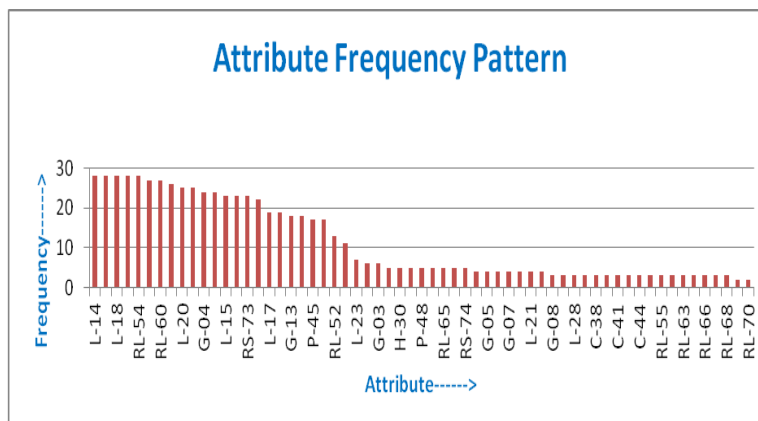


Fig 4 Attribute Frequency Pattern

TABLE 4: MULTILAYER PERCEPTRON (USING TRAINING SET)

| Classifier Name: MultiLayerPerceptron (Using Traing Set) | | |
|---|----------------------------|---|
| | With all attributes | With only selected 35 attributes |
| Summary | | |
| Number of Correctly Classified Instances | 41 | 41 |
| Correctly Classified Instances % | 100 | 100 |
| Number of Incorrectly Classified Instances | 0 | 0 |
| Incorrectly Classified Instances % | 0 | 0 |
| Kappa statistic | 1 | 1 |
| Mean absolute error | 0.0059 | 0.0075 |
| Root mean squared error | 0.0091 | 0.0119 |
| Relative absolute error | 1.4937 | 1.8879 |
| Root relative squared error | 2.0548 | 2.6893 |
| Total Number of Instances | 41 | 41 |
| Detailed Accuracy By Class | | |
| TP Rate (weighted avg) | 1 | 1 |
| FP Rate (weighted avg) | 0 | 0 |
| Precision (weighted avg) | 1 | 1 |
| Recall (weighted avg) | 1 | 1 |
| F-measure (weighted avg) | 1 | 1 |
| ROC Area (weighted avg) | 1 | 1 |
| Confusion Matrix | | |
| a=O,b=L,c=N | | |
| a-a | 22 | 22 |
| a-b | 0 | 0 |
| a-c | 0 | 0 |
| b-a | 0 | 0 |
| b-b | 13 | 13 |
| b-c | 0 | 0 |
| c-a | 0 | 0 |
| c-b | 0 | 0 |
| c-c | 6 | 6 |
| Performance change | | |
| | 0 | 0 |

TABLE 5: MULTILAYER PERCEPTRON (USING CROSS VALIDATION)

| Classifier Name: MultiLayerPerceptron (Cross-Validation) | | |
|---|----------------------------|---|
| | With all attributes | With only selected 35 attributes |
| Summary | | |
| Number of Correctly Classified Instances | 30 | 32 |
| Correctly Classified Instances % | 73.1701 | 78.0488 |
| Number of Incorrectly Classified Instances | 11 | 9 |
| Incorrectly Classified Instances % | 26.8293 | 21.9512 |
| Kappa statistic | 0.5847 | 0.6506 |
| Mean absolute error | 0.1866 | 0.1636 |
| Root mean squared error | 0.3666 | 0.3474 |
| Relative absolute error | 46.7145 | 40.9598 |
| Root relative squared error | 82.148 | 77.8538 |
| Total Number of Instances | 41 | 41 |
| Detailed Accuracy By Class | | |
| TP Rate (weighted avg) | 0.732 | 0.78 |
| FP Rate (weighted avg) | 0.101 | 0.093 |
| Precision (weighted avg) | 0.818 | 0.828 |
| Recall (weighted avg) | 0.732 | 0.78 |
| F-measure (weighted avg) | 0.754 | 0.795 |
| ROC Area (weighted avg) | 0.908 | 0.911 |
| Confusion Matrix | | |
| a=O,b=L,c=N | | |
| a-a | 15 | 16 |
| a-b | 1 | 1 |
| a-c | 6 | 5 |
| b-a | 1 | 0 |
| b-b | 10 | 12 |
| b-c | 2 | 1 |
| c-a | 1 | 2 |
| c-b | 0 | 0 |
| c-c | 5 | 4 |
| Performance change | | |
| | 0 | 0.330396476 |

IV. DISCUSSION

For the experimental analysis SMO, REPTree, IBK, Logistic and Multilayer perceptron classifiers are considered in this experiment/study. 41 instances in data sets were selected from the collected data. To cover this experimental I have taken Temp.csv datasets, and the observation and Calculation is done by considering following:

- Attribute selection
- Frequency
- ROC
- Confusion metrics

TABLE 5
COMPARISONS WITH GRAPH WITHOUT FEATURE EXTRACTION AND WITH FEATURE EXTRACTION USING DMNBTEXT CLASSIFIER

| Classifier: | Type of Search Method | ROC Area(Wt. Avg.) |
|--------------------------|----------------------------|--------------------|
| DMNBText | | |
| Attribute Evaluator: | | |
| ChiSquaredAttribute Eval | Without Feature Extraction | 0.897 |
| | Ranker | 0.909 |

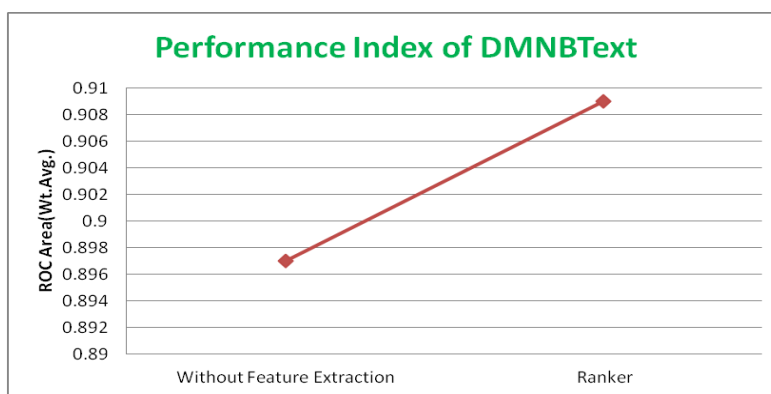


Fig 5 Performance Index for DBMNTText

V. CONCLUSION

As a conclusion we can tell that classification algorithms play a key role to solve real world problems. Selection of an application specific classifier is an emerging research area. In this paper, performance change is being evaluated and calculated using various popular classifiers. Initially, the percentage of correct classifications has been measured with the highest accuracy. Later, ranking performance has been estimated to select a suitable algorithm for this application. The ranking performance has shown that DMNBText performs the best for the given datasets. This also reduces computational complexity, and development and maintenance costs both in terms of hardware and human inspection. Based on the results obtained in the various algorithms, we can conclude that the feature selection concept played an important role and can be useful component for many classifications. This is possible due to the low computational cost of this method, which is more efficient compared to the other ones. The main advantage of this method is that it makes no assumptions and these methods, not only improved the classification speed significantly, but they also improved the accuracy rate and the reliability in most of the cases. Thus using the concept of Data Mining techniques we examine and calculate the performance using ROC Values.

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