Knowledge Based Systems

ITCS 6155: PROJECT REPORT
SPRING-2017

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Table of Contents

CONTENTS	PAGE NO.
INTRODUCTION	**3**
DATA COLLECTION -Import.io tool -Java Code	**5**
PRICE DISCRETIZATION	**5**
MODELS USED	**10**
CONCLUSION	**15**
REFERENCES	**16**

Introduction:

The classification features describing the data related to fine art painting are as follows:

- Name of the Painting
- Artist Name
- Size of the Painting
- Price
- Number of Views
- Number of Favorites
- Date
- Subject
- Medium

New Features added:

We've derived five new attributes which are as follows:

- Painting Surface
- Artist Recognition
- Artist country
- Shipment Mode
- Keywords

- The aim of our project is to build our own database with all the attributes mentioned above (extracted from http://www.saatchiart.com/paintings/fine-art). Form all the classification features, we will consider price as decision attribute and discretize it into three intervals in such a way that the resultant classifier should have highest precision.
- In order to find which classifier has highest precision, we'll make use of few algorithms like Naive Bayes, Decision Tree, Random Forest, Logistic Regression.
- Reasons for choosing new features in this project: We found that by adding the above five new features will improve our model and precision of our model. These five new features are more important features that describes about painting and artist which helps to build our model compared to other features. Artist recognition is important because, if the artist is featured in a collection then his/her paintings have more value or price is more for that particular painting.

Algorithms Used:

1) **Naïve Bayes:**

The Naive Bayesian classifier is based on Bayes' theorem with independence assumptions between predictors. The Naive Bayes algorithm is a simple probabilistic classifier that calculates a set of probabilities by counting the frequency and combinations of values in the data set. A Naive Bayesian model is easy to build, with no complicated iterative parameter estimation which makes it particularly useful for very large datasets. Despite its simplicity, the Naive Bayesian classifier often does surprisingly well and is widely used because it often outperforms more sophisticated classification methods.

2) **Random Forest:**

A random forest is a machine learning technique used for classification, regression and feature selection. It is an ensemble technique. It means it combines the output of one weaker technique in order to get a stronger result. The weaker technique it uses is Decision tree. Random forest has a meta estimator that fits a number of decision tree classifiers on various sub-samples of the dataset and uses averaging to improve the predictive accuracy. It also controls over-fitting of data.

3) **Decision Trees:**

Decision tree builds classification or regression models in the form of a tree structure. It breaks down a dataset into smaller and smaller subsets while at the same time an associated decision tree is developed incrementally. The final result is a tree with decision nodes and leaf nodes. A decision node has two or more branches. Leaf node represents a classification or decision. The topmost decision node in a tree which corresponds to the best predictor called root node. Decision trees can handle both categorical and numerical data.

4) **Logistic Regression:**

Logistic regression is also called a logit model. It is used to model dichotomous outcome variables. In the logit model the log odds of the outcome is modeled as a linear combination of the predictor variables. Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

Data Collection:

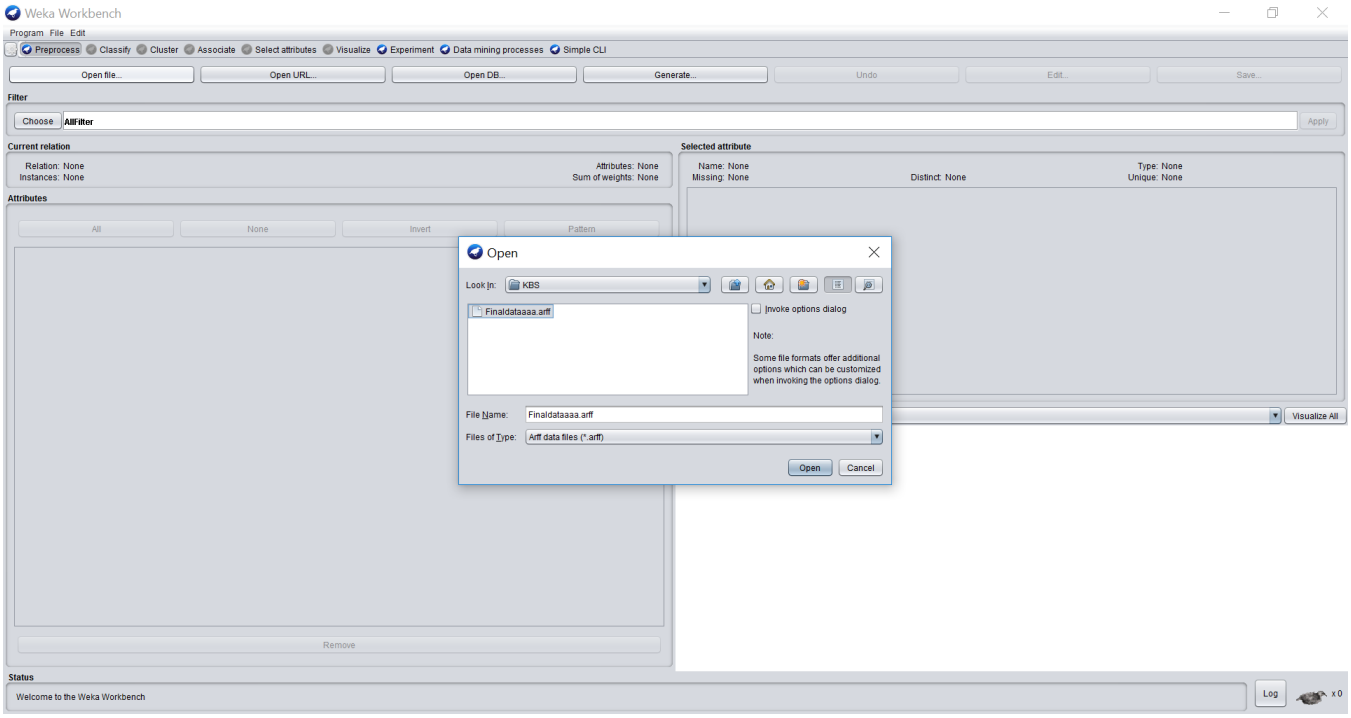
- We have used a tool called import.io to extract data related to few attributes like url, artist name, name of the painting, number of views and favorites etc., from the Saatchi art website.
- Using the url fetched using import.io, we have written a java code to fetch further attributes like medium, painting surface used, published date etc.
- The major library used in Java for web scraping is JSoup. Java code can found in the attachments.
    - Total Number of Instances: 463.
    - Attributes: 15 (Including 5 new features and url of each painting)

Price Discretization in Weka:

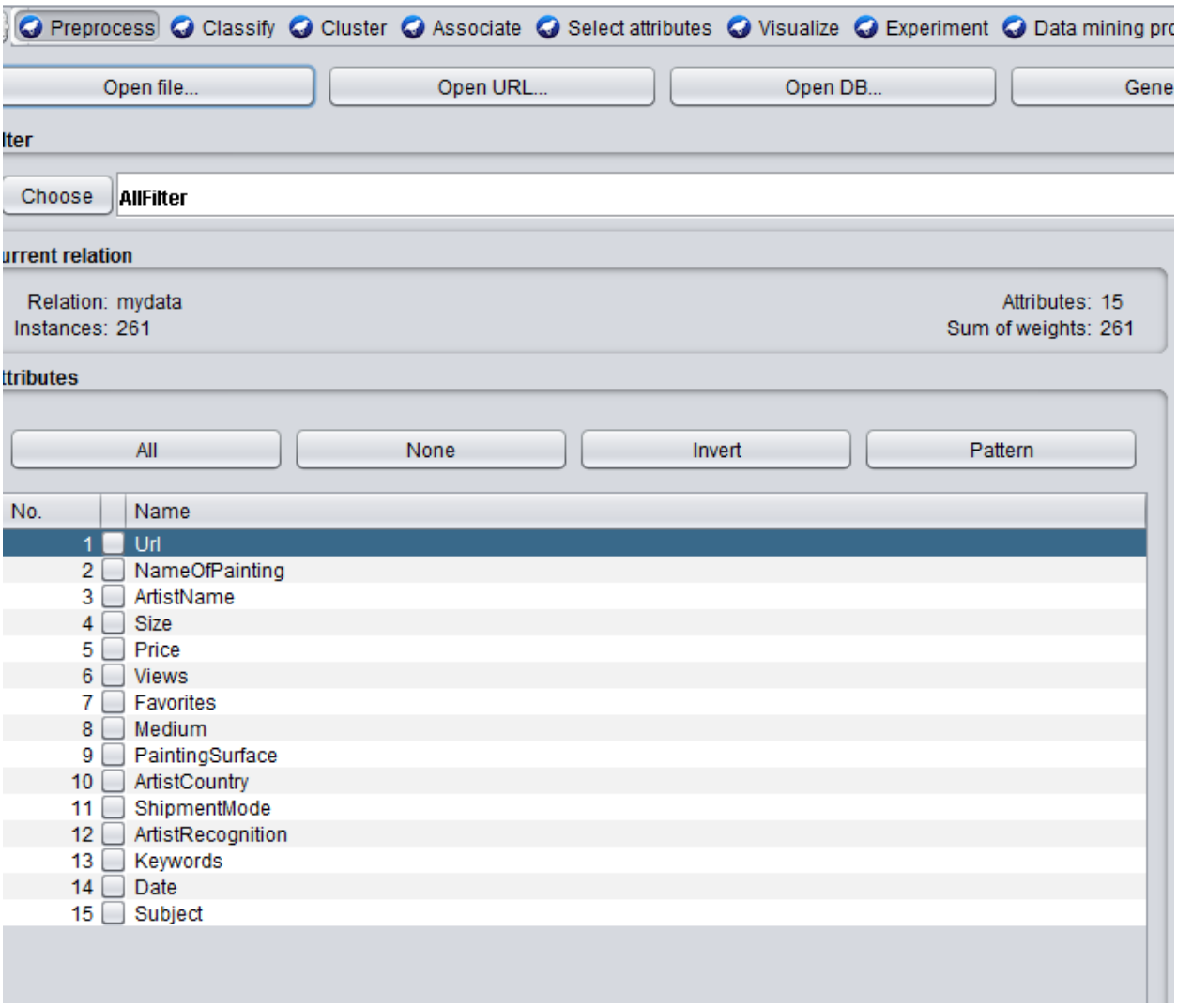
Screenshots of how the price attribute has been discretized into three intervals:

Step 1: Importing the .arff file into Weka.

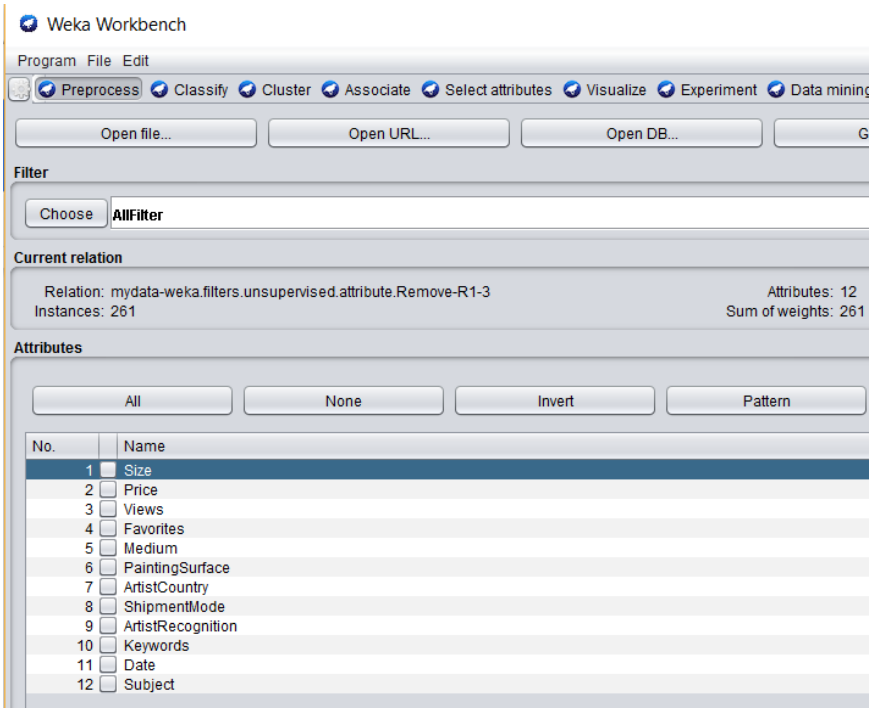
We have converted .csv file to .arff file using R language.



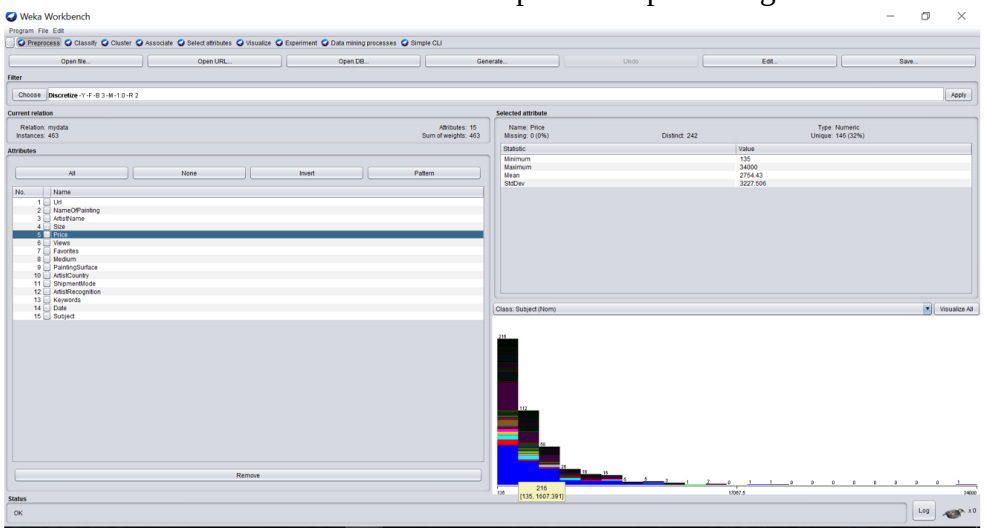
List of all 15 attributes we have extracted from the fine art paintings including new features and url of each painting:



Step 2: List of classifiers after removing unwanted attributes url, name of artist and painting name.

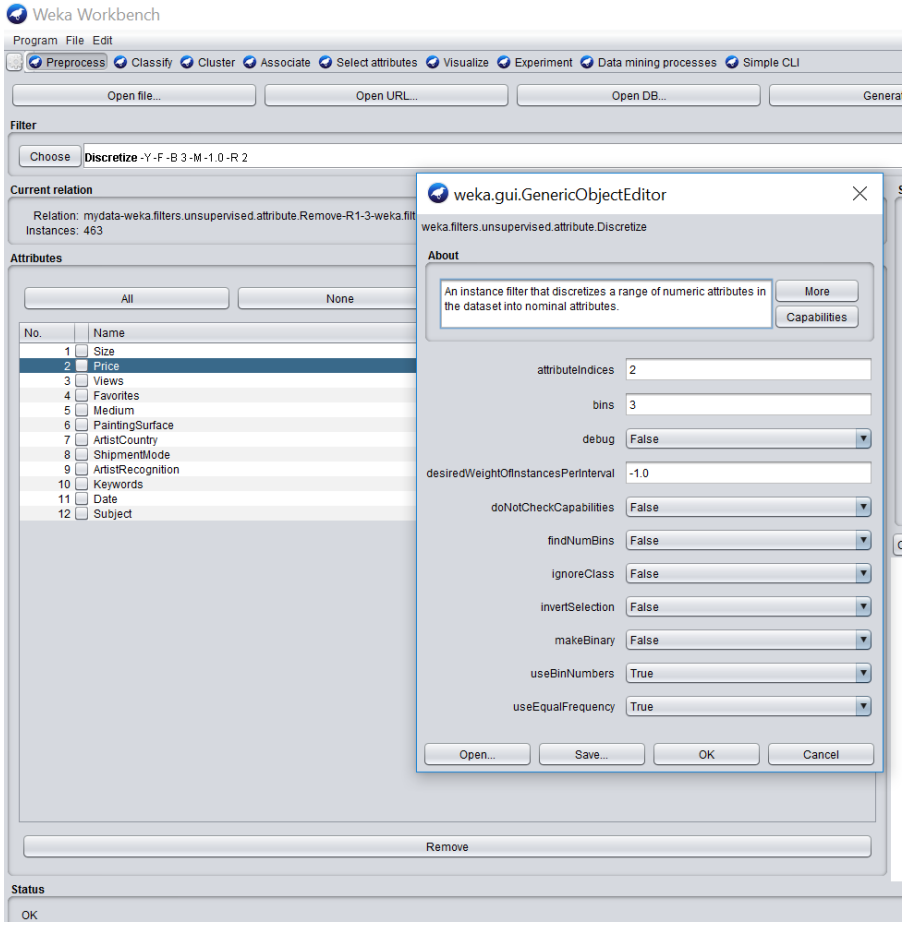


- Reason for eliminating name of painting and artist may be these two attributes are correlated or multicollinearity exists due to these attributes.If we use these two attributes model may not be significant.
- Uniqueness in price attribute is 32%.
- From the below visualization of price distribution we can say 216 instances have price from 135 - 1607.39.Price is skewed left before discretization.As we move on towards right the number of instances reduces for a particular price range.

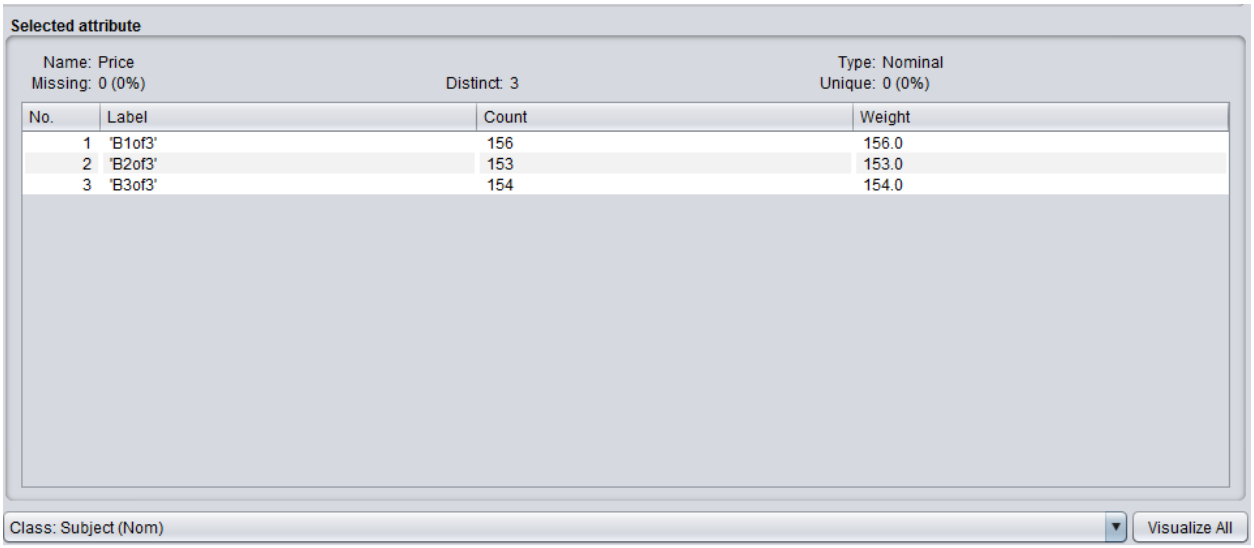


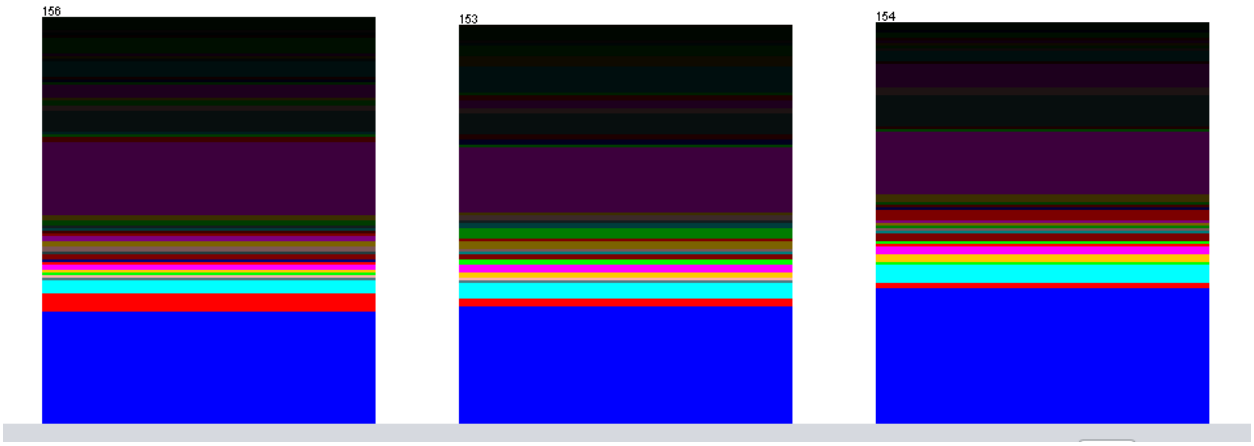
Step 3: Discretizing price feature into 3 bins by choosing unsupervised → attributes→ **Discretize** option in the preprocess tab:

- In discretization we have used Equal Frequency in order to get approximately equal distribution among the bins.



Three intervals of Price after discretization:





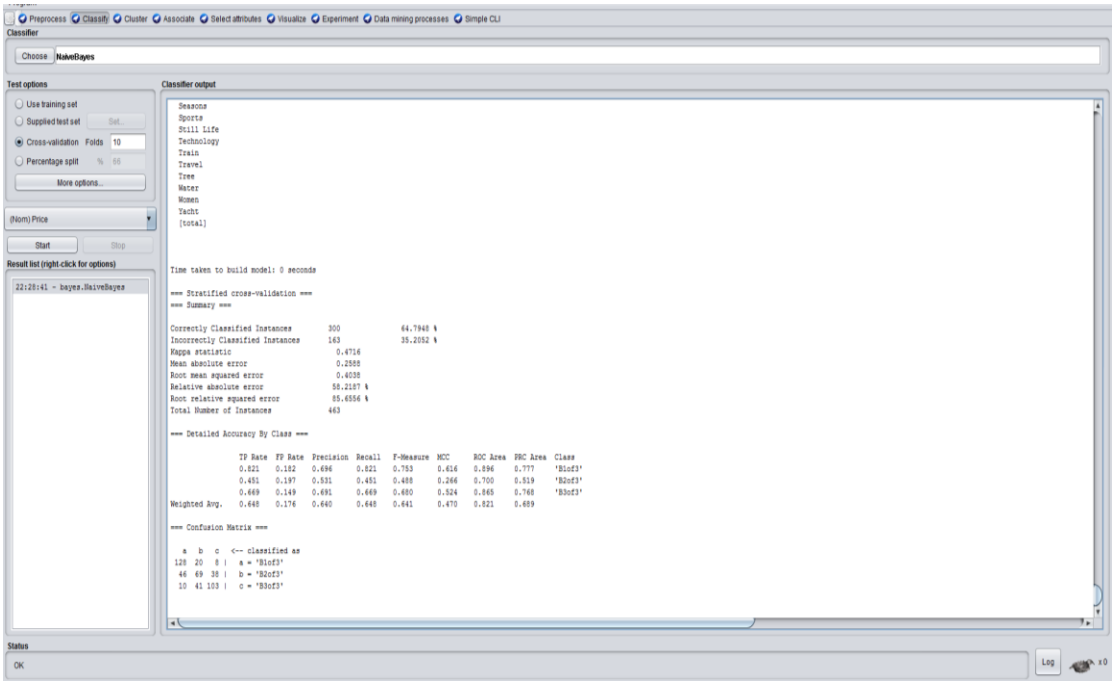
Step 4: After discretizing the price we used different models to check the precision.

Models Used:

- We have taken Cross-Validation Folds count as 10 for all models.

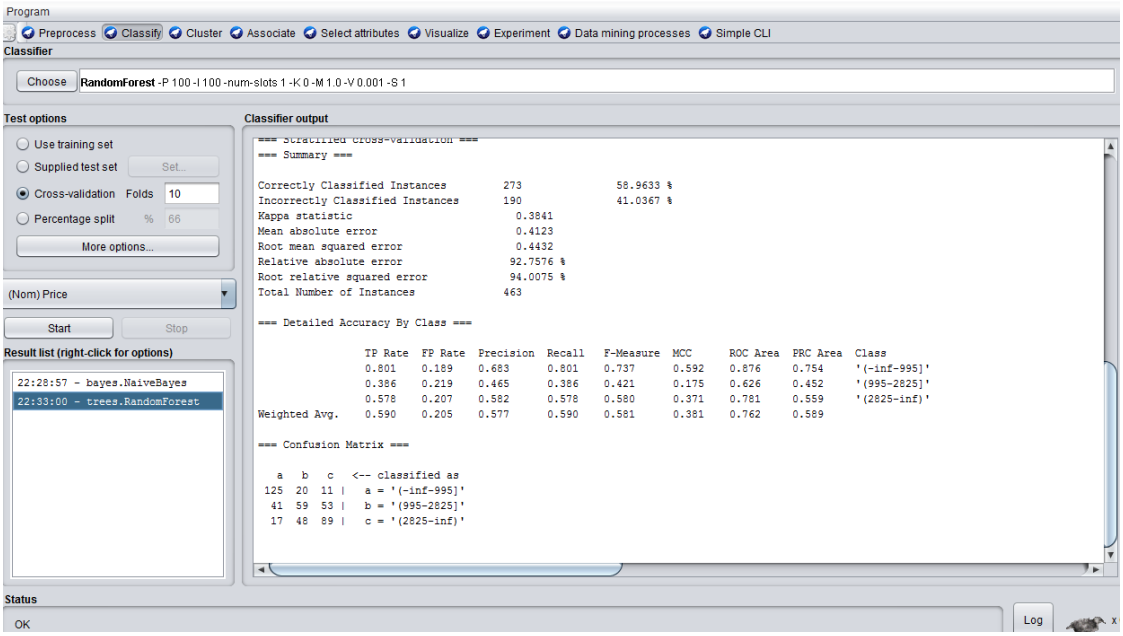
1) Naive Bayes:

- Correctly Classified Instances Precision -> 64.7948 %



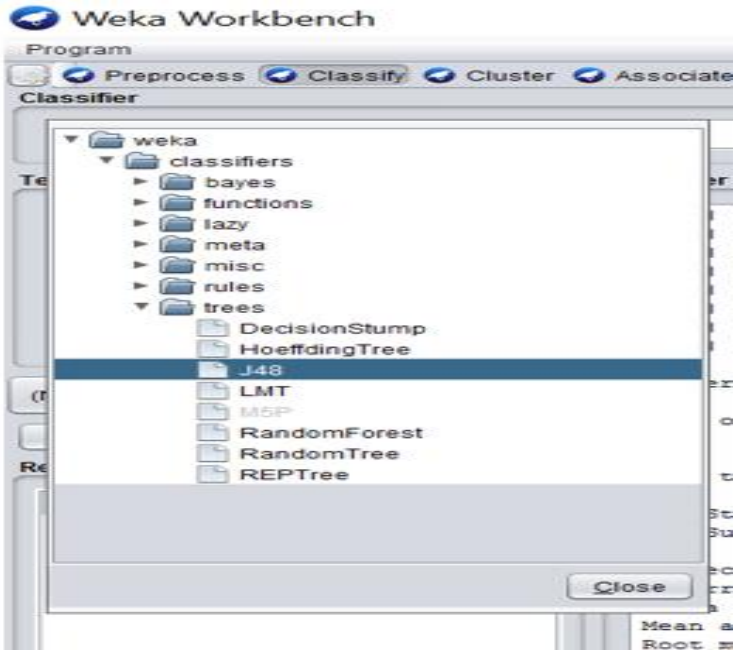
2) Random Forest:

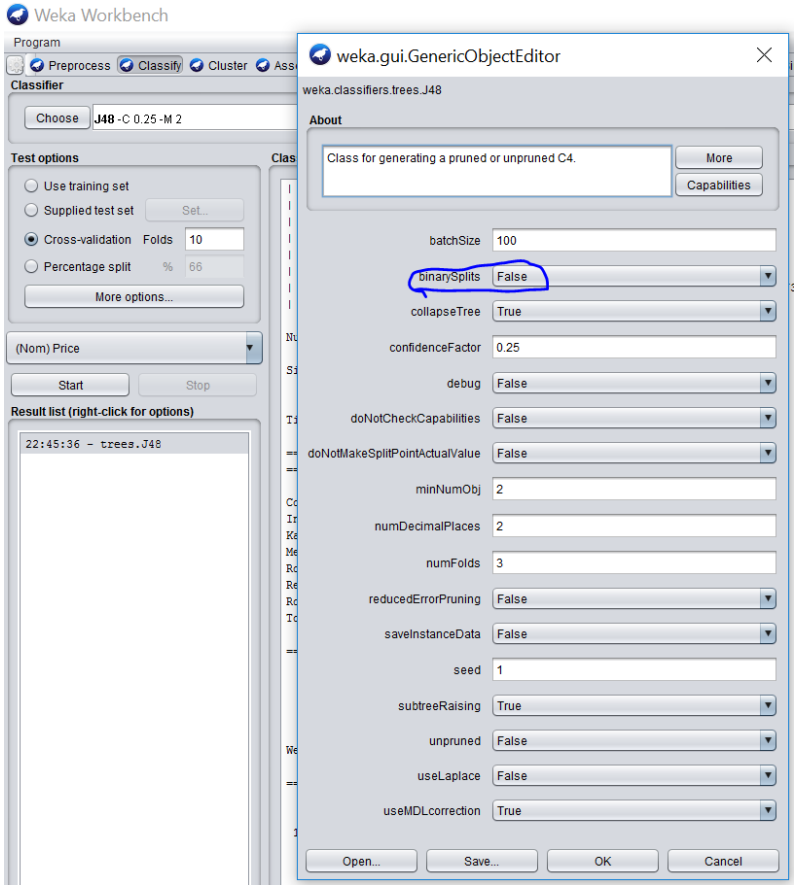
- Correctly Classified Instances Precision -> 58.9633 %



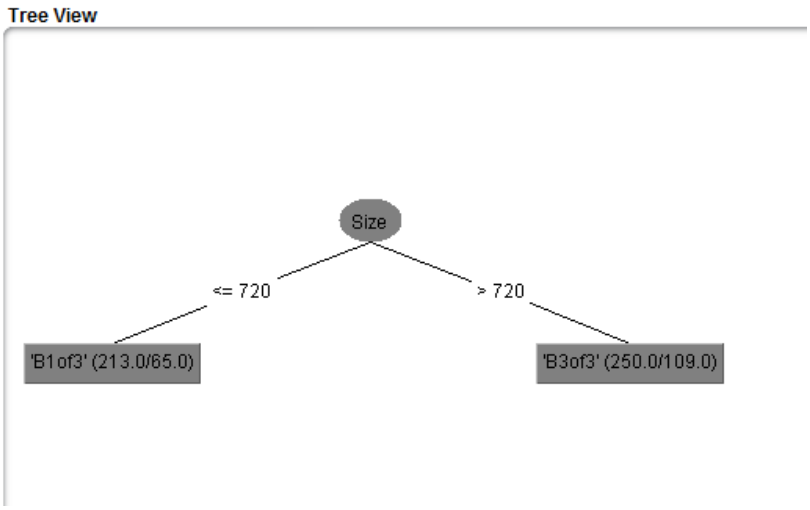
3) J48:

(a) Tree when Binary Split is “False” :

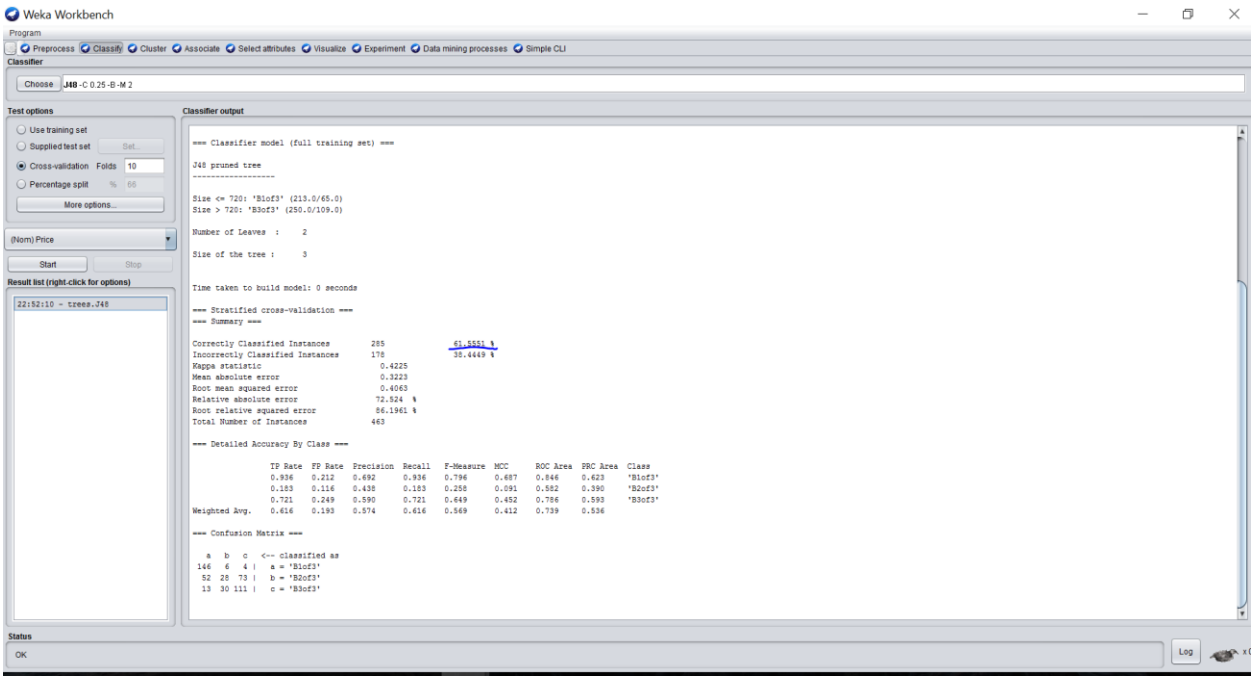




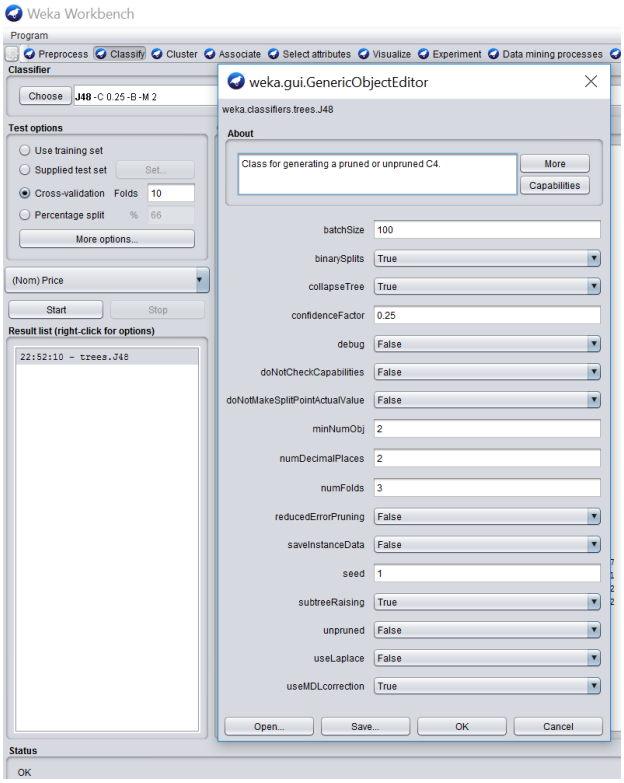
Tree looks like:



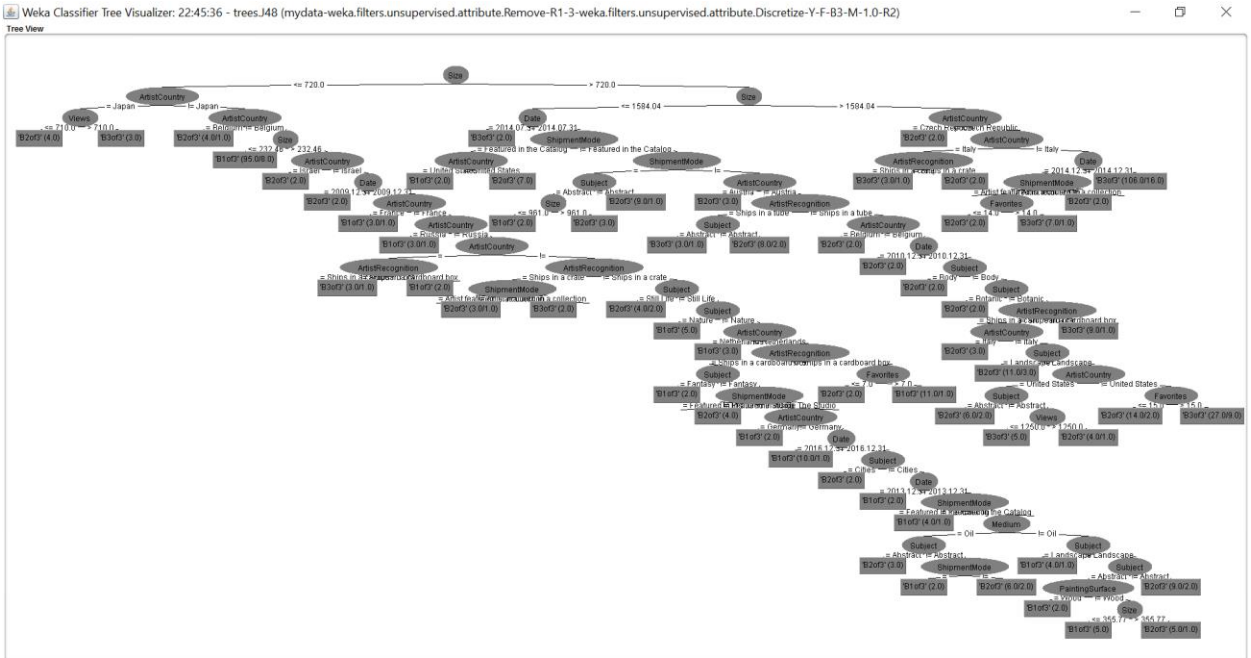
- Precession value: 61.551%
- Correctly Classified Instances : 285



(b) When we used Binary Split = “True”

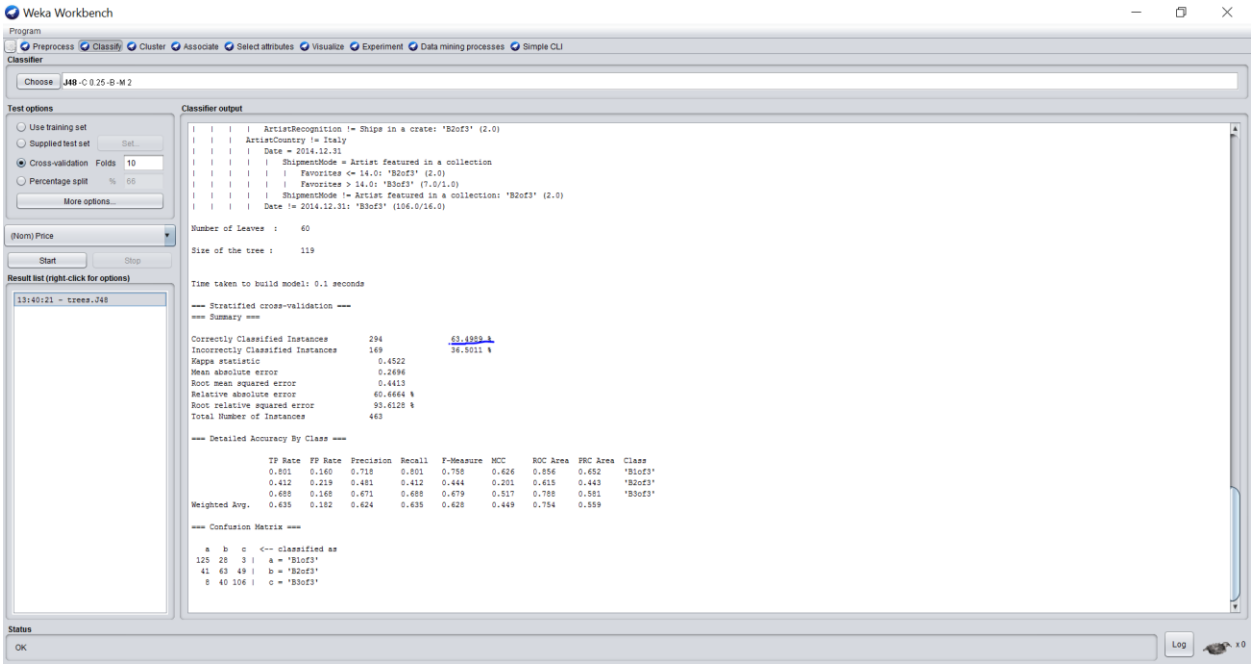


Tree Looks like:

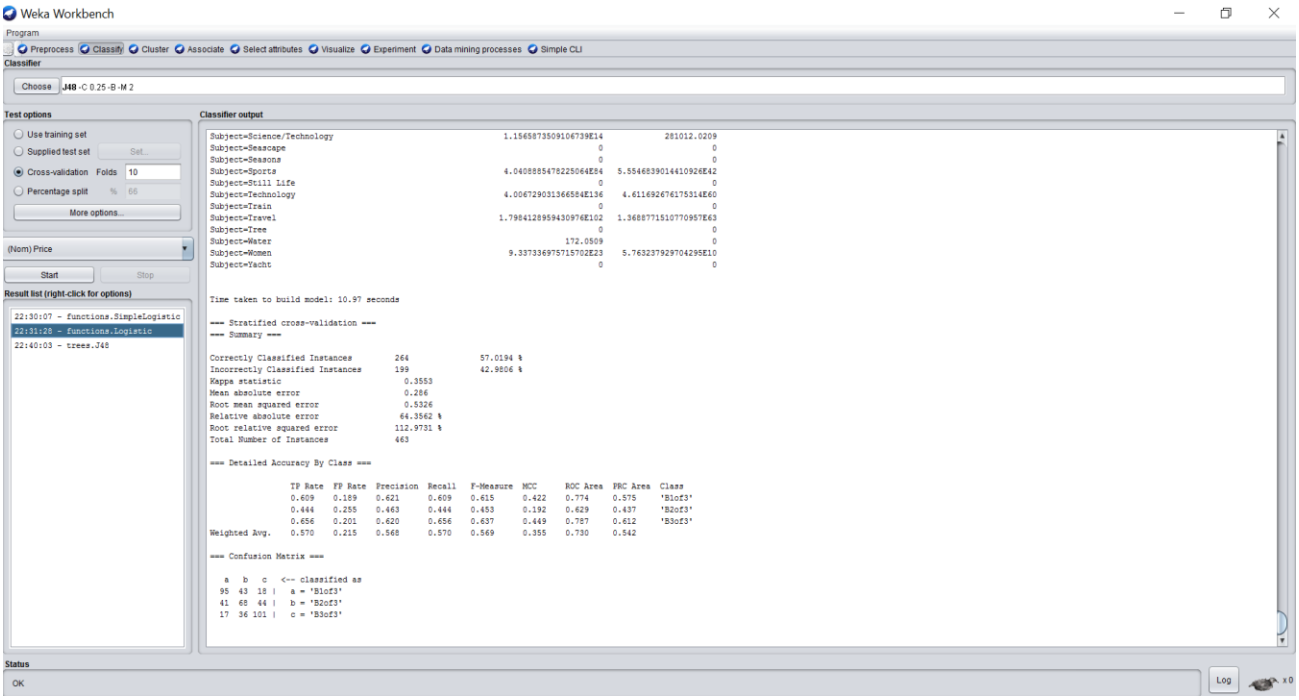


Observations from tree:

- Root node of the tree is “size” attribute.Therefore, size is the most discriminating attribute.The second most discriminating attribute is “ArtistCountry”, which is one of the new features added.In the third stage, “ShipmentMode” is most discriminating attribute.It is also one of the new features we added.
    - Precision Value = 63.4989%
    - Correctly Classified instances 294.



4) **Logistic Regression:**
   - Correctly Classified Instances - 264
   - Precision -> 57.0194 %



Conclusion:

Best Model:

- From our analysis, we found that the Naive Bayes provides the best precision results. It is simple and quicker than other discriminative models like j48, Logistic Regression and Random Forest. We have implemented all the models discussed above with different number of bins and folds. From the results obtained, we found that Naive Bayes has optimal results with 3 bins and 10 folds and thus, it is the best model for our data.
- Compared to other classifiers, we found that logistic function takes more time to build the model.

Detailed accuracy from Naive Bayes:

```
=== Detailed Accuracy By Class ===

                TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                0.821    0.182    0.696      0.821    0.753      0.616    0.896     0.777     'B1of3'
                0.451    0.197    0.531      0.451    0.488      0.266    0.700     0.519     'B2of3'
                0.669    0.149    0.691      0.669    0.680      0.524    0.865     0.768     'B3of3'
Weighted Avg.   0.648    0.176    0.640      0.648    0.641      0.470    0.821     0.689
```

- We have also observed that, ROC area of the Naive Bayes model is more when compared to the ROC areas of other models.

- The ROC area for weighted Average for Naive Bayes is 0.821.

Confusion Matrix:

```
  a   b   c   <-- classified as
128  20   8 |   a = 'B1of3'
 46  69  38 |   b = 'B2of3'
 10  41 103 |   c = 'B3of3'
```

References:

- **https://en.wikipedia.org/wiki/Naive_Bayes_classifier**
- **http://scikit-learn.org/stable/modules/generated/sklearn.ensemble.RandomForestClassifier.html**
- **https://en.wikipedia.org/wiki/Decision_tree_learning**
- **http://ufldl.stanford.edu/tutorial/supervised/LogisticRegression/**
- **http://www.statisticssolutions.com/what-is-logistic-regression/**