ML Algorithm Selection

Selections on Vinho Verde Red Wine

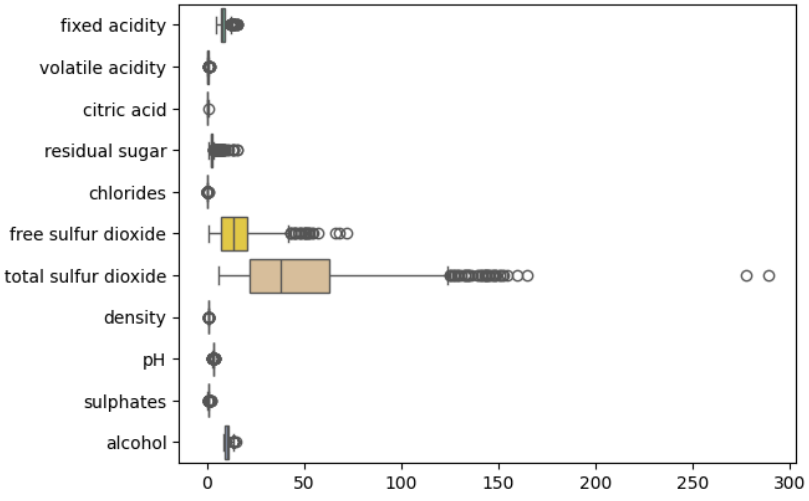
Maxie Machado
University of Wyoming

1 Introduction

The exercise being performed is ML Algorithm Selection on the red wine quality dataset. As it's in the name we will have a collection of red wines from vinho verde which are rooted from Northern Portugal, and will be looking at different factors which will affect the quality of the red wine positively or negatively. Different machine learning algorithms will be done on the dataset, and will have an accuracy score done on them and be visualized using heatmaps. This dataset will be put through three different ML algorithms including, decision tree classifier, random forest classifier, and logistic regression.

2 Description and Cleaning of Red Wine Dataset

The red wine dataset consists of 1599 observations. Another thing which is important to note is the amount of features there are within the dataset and what they are. Within the red wine dataset there are 11 features, which include the following:



- Fixed Acidity
- Volatile Acidity
- Citric Acid
- Residual Sugar
- Chlorides
- Free Sulfur Dioxide
- Total Sulfur Dioxide
- Density
- pH
- Sulphates
- alcohol

In examining the data type of the red wine it will be shown all of these are float64 or int which mean we will not need to worry about converting objects. Although the dataset still needs to be cleaned. For this the first step is checking to see if the dataset of red wine has any missing values. For this particular dataset there are no missing values which need to be taken care of. Moving on, the dataset will be checked for duplicates. As shown the dataset does indeed have some duplicates, 240 to be exact. Once the duplicates are handled the untouched data will be visualized using a simple boxplot [fig 1]. Once the duplicates are handled we will look at the amount of observations and features again. As suspected, removing the duplicates has the amount of observations changed from 1599 to 1359 observations. This cleaned data is what we

will be using to split and train the data. Although before splitting and training the data , list comprehension will be used to create the binarization of the target variable, quality. How this will be done is by taking the quality(s) that is greater than or less than seven and grouping them into binary number one. Meaning any quality(s) that is less than seven will be grouped into the binary number 0. Once this is completed the dataset will be split and trained. The way it was done is by creating a new dataframe called X that contains all observations except for quality which is the target variable. Then creating a series called y that will hold the target variable 'quality'. Then X_train and y_train will be created to train the machine learning models and X_test and y_test will be created to evaluate how well the model performs on unseen data. Once this is completed the method train_test_split will be used on the data having 25% of the data reserved specifically for testing and the rest will be used for training. Once this is completed the application of different machine learning algorithms will take place.

3 Processes Performed of Red Wine Dataset

Now that the red wine data has been cleaned the different ML algorithms can be performed. The first ML algorithm that will be performed is the decision tree classifier. The accuracy of this will be calculated to see how well this method works on the dataset. Then it will be visualized using a heatmap from a confusion matrix. Next random forest classifier will be performed on the dataset. Like before, the accuracy of this will be calculated to see how well this method works on the dataset. Then it will be visualized using a heatmap from a confusion matrix. Lastly, logistic regression will be performed on the dataset. And just like the previous Ml algorithms, the accuracy of this will be calculated to see how well this method works on the dataset. Then it will be visualized using a heatmap from a confusion matrix.

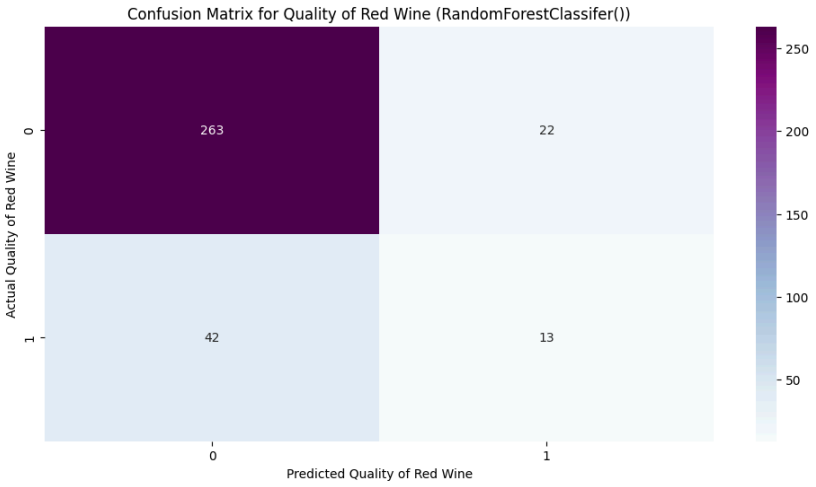
3.1 Decision Tree Classifier on Red Wine Dataset

254	31
39	16

The first Ml algorithm to be performed is the decision tree classifier. For this we will be using the cleaned data that is split and trained. We will then do a prediction using the decision tree classifier. Once this is completed the accuracy score of this will be calculated. As shown, the calculation is 79.41%. Meaning that the decision tree classifier and the predictions from it is about 79% accurate. Now from this the confusion matrix will be created [fig. 3] . Now to better visualize this a heatmap will be used [fig. 4]. Out of all the ML algorithms being performed on the red wine dataset, this is the weakest when it comes to accuracy.

3.2 Random Forest Classifier on Red Wine Dataset

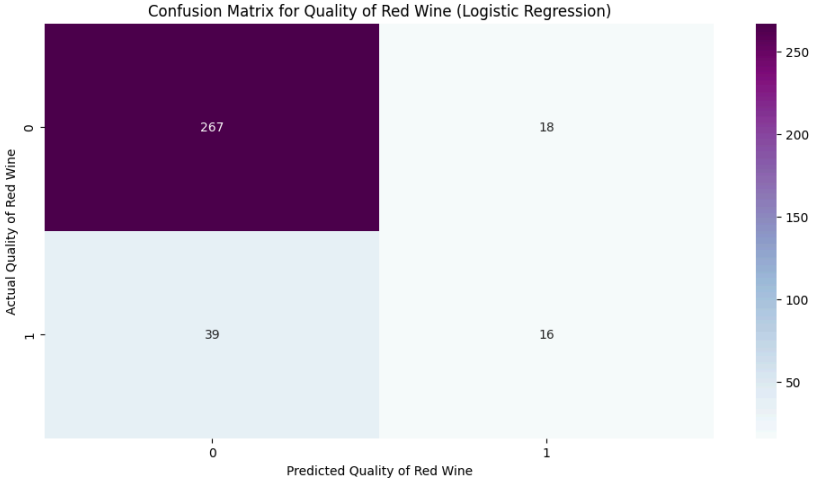
263	22
42	13



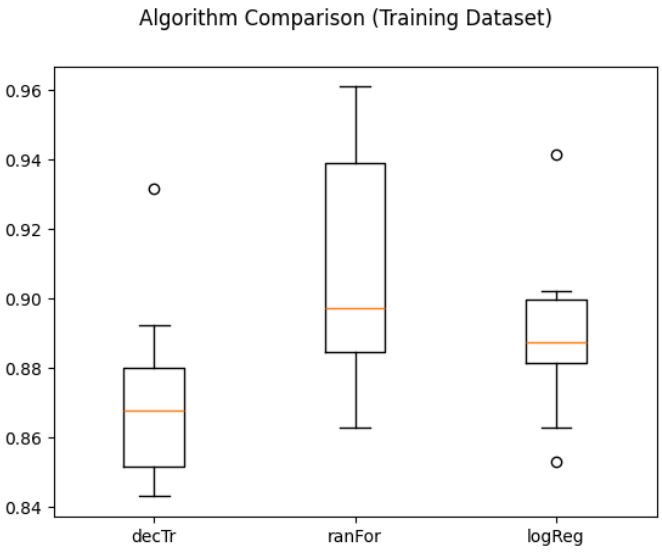
The second Ml algorithm to be performed is the random forest classifier. For this we will be using the cleaned data that is split and trained. We will then do a prediction using the random forest classifier. Once this is completed the accuracy score of this will be calculated. As shown, the calculation is 81.18%. Meaning that the random forest classifier and the predictions from it is about 81% accurate. Now from this the confusion matrix will be created [fig. 5] . Now to better visualize this a heatmap will be used [fig. 6]. Out of all the ML algorithms being performed on the red wine dataset, this is the most moderate when it comes to accuracy.

3.3 Logistic Regression on Red Wine Dataset

267	18
39	16



Lastly, the Ml algorithm to be performed is logistic regression. For this we will be using the cleaned data that is split and trained. We will then do a prediction using logistic regression. Once this is completed the accuracy score of this will be calculated. As shown, the calculation is 83.24%. Meaning that logistic regression and the predictions from it is about 83% accurate. Now from this the confusion matrix will be created [fig. 7] . Now to better visualize this a heatmap will be used [fig. 8]. Out of all the ML algorithms being performed on the red wine dataset, this is the strongest when it comes to accuracy.



4 Results

With the information above we can now analyze and compare all three of the methods being used. For this, the accuracy of each model type will be compared. As a reminder the methods being used were decision tree classifier, random forest classifier, and logistic regression. The first task was to analyze the accuracy and the standard deviation accuracy of all three methods, using scikit-learn. We will be looking specifically at the training dataset and the testing dataset separately. Starting off the training dataset will be looked at. The decision tree classifier will be using the shorthand of "decTr", the accuracy was given at 87.04% and standard deviation accuracy is 2.56%. The random forest classifier will be using the shorthand of "ranFor", the accuracy was given at 90.87% and standard deviation accuracy is 3.29%. Lastly, logistic regression will be using the shorthand of "logReg", the accuracy was given at 88.91% and the standard deviation accuracy is 2.28%. Once this has been analyzed it will be visualized using a boxplot [fig. 9]. Moving on, looking at the testing dataset, the decision tree classifier's accuracy was given at 76.76% and standard deviation accuracy is 8.37%. The random forest classifier accuracy was given at 83.24% and standard deviation accuracy is 4.57%. Lastly logistic regression accuracy was given at 81.18% and the standard deviation accuracy is 3.77%. Again, this will be visualized using a boxplot [fig. 10].