Unlocking the Wine Code

A Wine Quality Study

By Chris Atwood

Introduction

What makes wine good? If you were going to make a wine, what components do you need to ensure that your wine tastes good? Can we examine the composition of wines that we enjoy and unlock the code for the perfect wine? Let’s take a look.

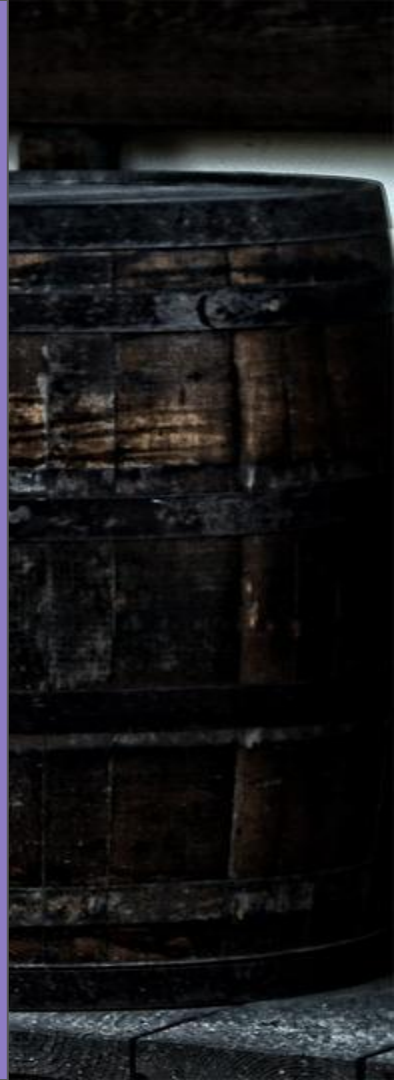
Problem Statements

- What are the most important components that determine the quality of a wine?
- How does a quality red wine differ from a quality white wine?

The Data

The wine quality dataset comes from the UCI Machine Learning Repository. It consists of 2 datasets for the Portuguese Vinho Verde wine. First is the red wine data set that has 1599 wines with quality rankings from 3 (lowest) to 8 (highest). The second set is the white wine dataset of 4898 wines with quality ranking of 3 (lowest) to 9 (highest). Each of these datasets include the quantities of 12 variables :

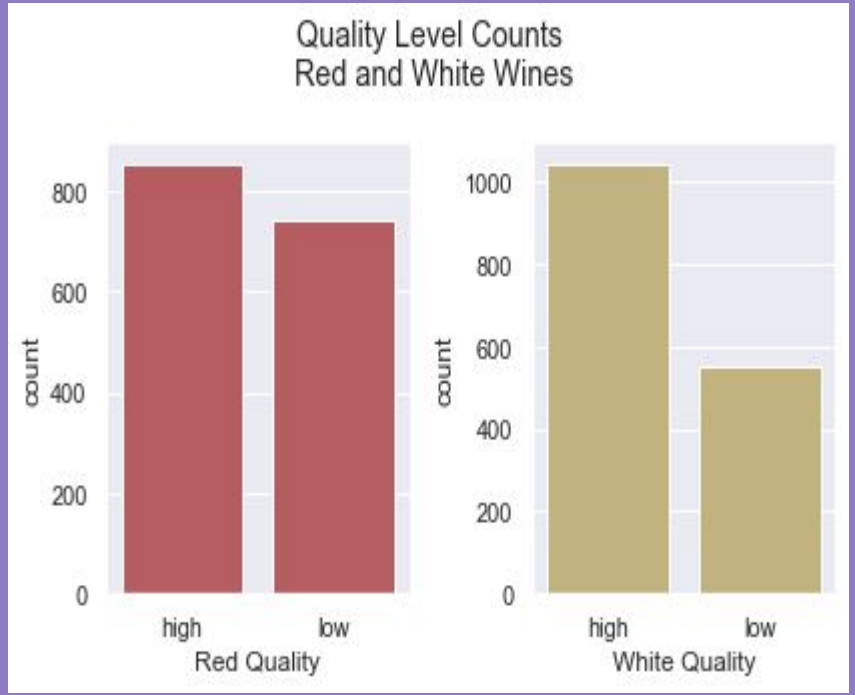
- Fixed acidity
- Volatile acidity
- Citric acid
- Residual sugar
- Chlorides
- Free sulfur dioxide
- Total sulfur dioxide
- Density
- pH
- Sulphates
- Alcohol
- Quality



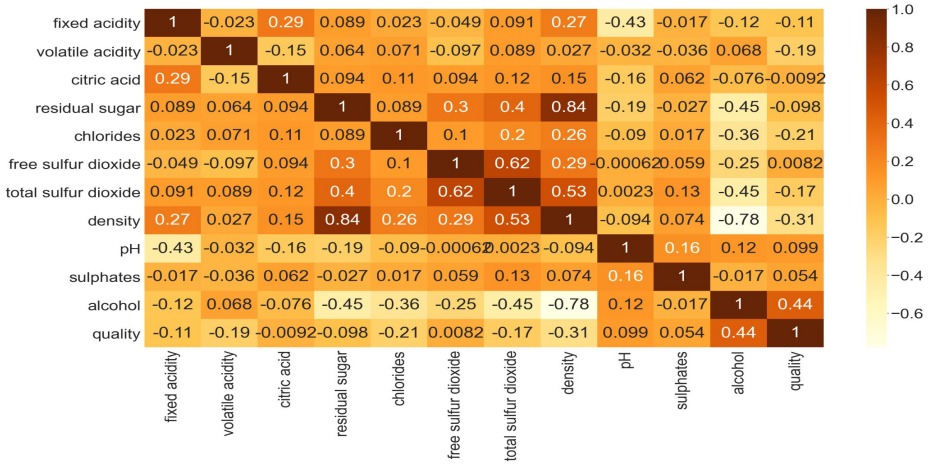
Exploratory Data Analysis

Wine Quality Groupings

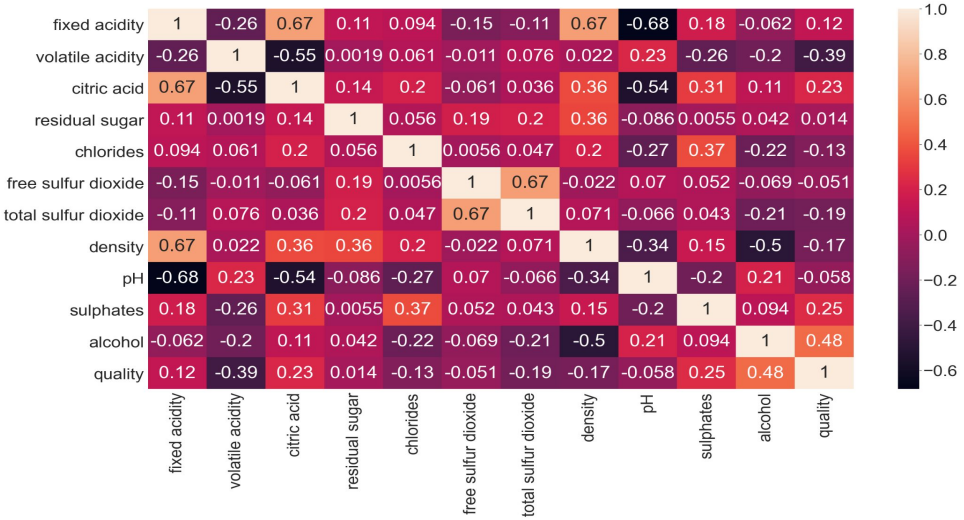
- 3,258 High Quality White Wines
- 1,640 Low Quality White Wines
- 855 High Quality Red Wines
- 744 Low Quality Red Wines



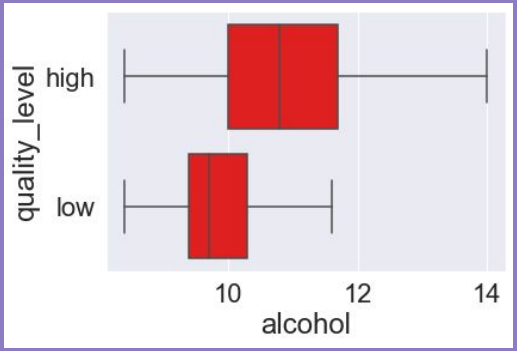
Feature Correlations

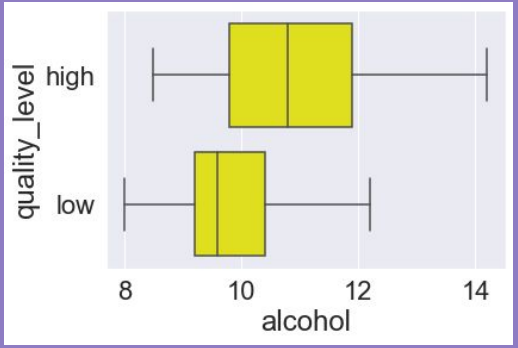


Quality level has the strongest correlation with alcohol content in both kinds of wines. Red wines also have a strong positive correlation between quality and citric acid and sulphates, and a strong negative correlation between quality and volatile acidity. White wines have a strong strong negative correlation between quality and density, chlorides, and volatile acidity.

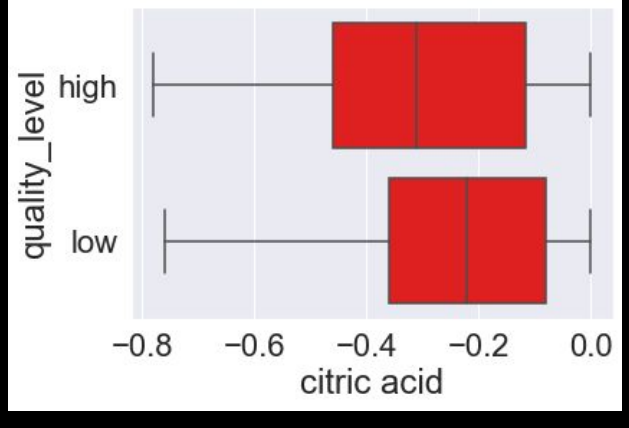


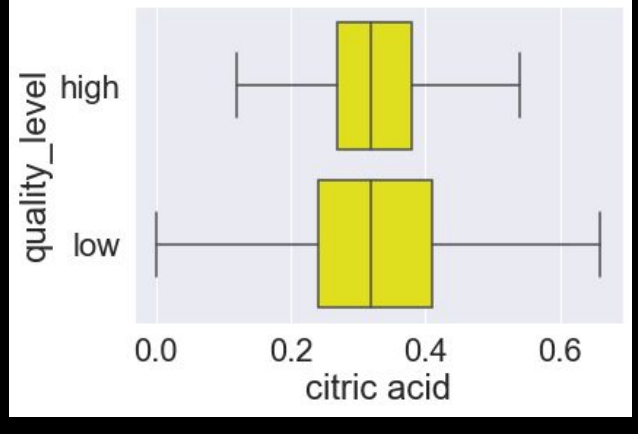
Alcohol

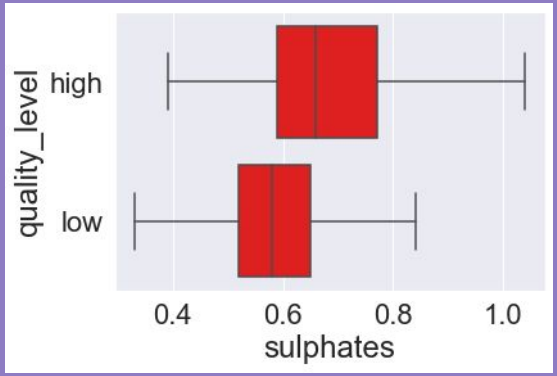

quality_level
high
low
10
12
14
alcohol


quality_level
high
low
8
10
12
14
alcohol

Citric Acid


quality_level
high
low
−0.8
−0.6
−0.4
−0.2
0.0
citric acid


quality_level
high
low
0.0
0.2
0.4
0.6
citric acid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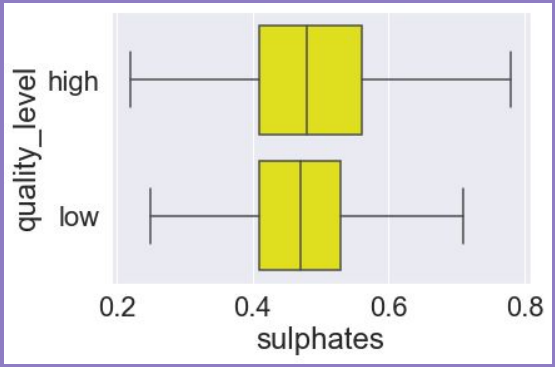
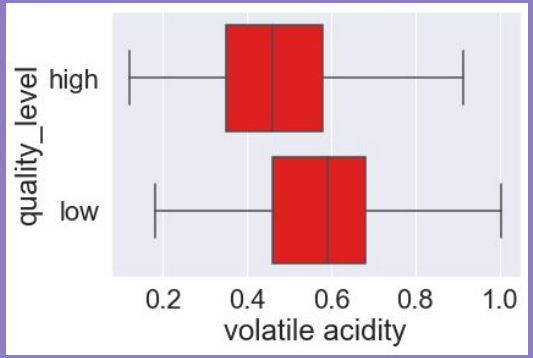
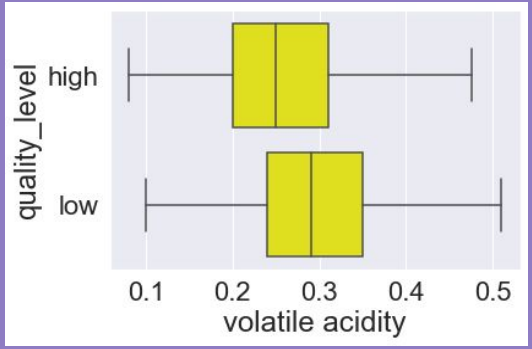
low
0.4
0.6
0.8
1.0
sulphates


quality_level
high
low
0.2
0.4
0.6
0.8
sulphates

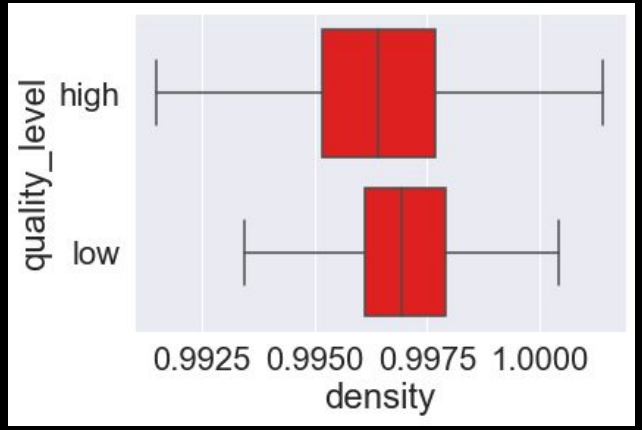
Sulphates

Volatile Acidity





Density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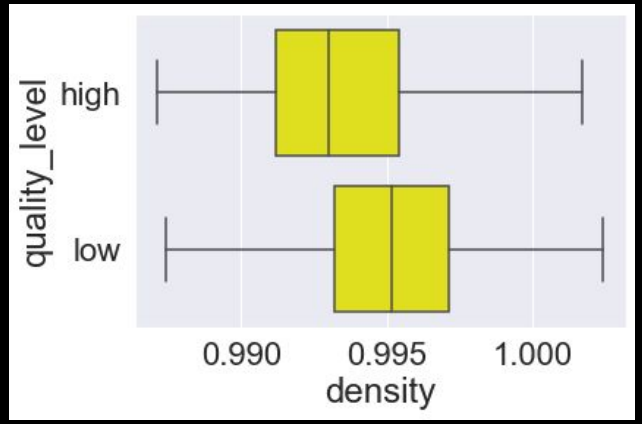
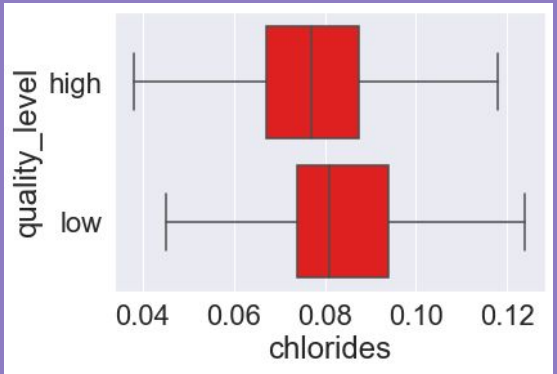
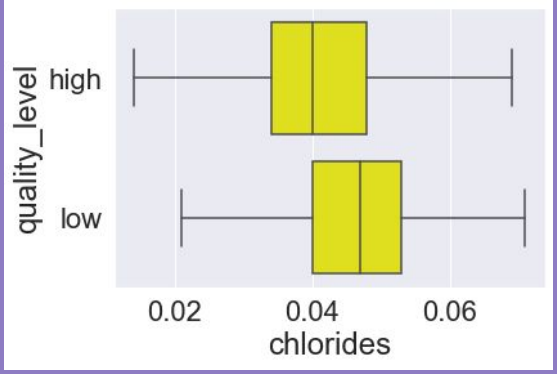
low
0.9925
0.9950
0.9975
1.0000
density


quality_level
high
low
0.990
0.995
1.000
density


quality_level
high
low
0.04
0.06
0.08
0.10
0.12
chlorides


quality_level
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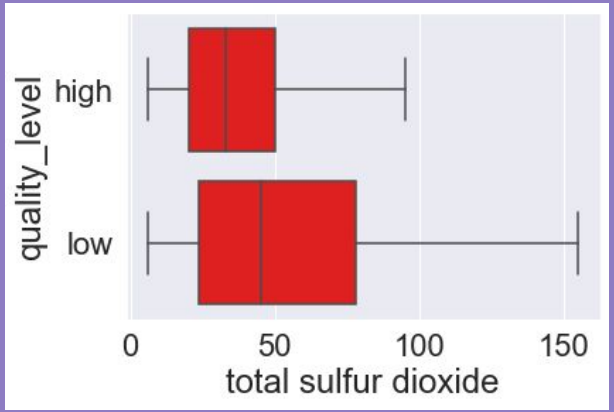
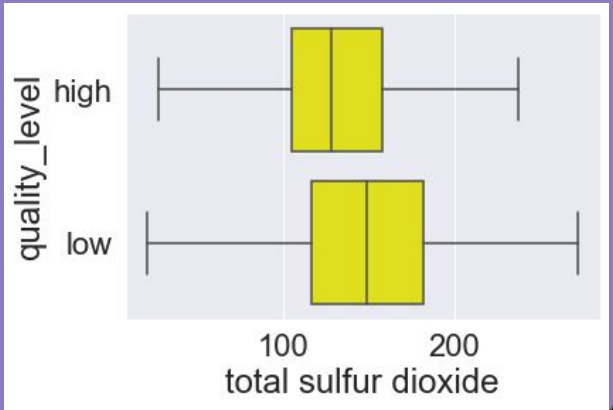
low
0.02
0.04
0.06
chlorides

Chlorides

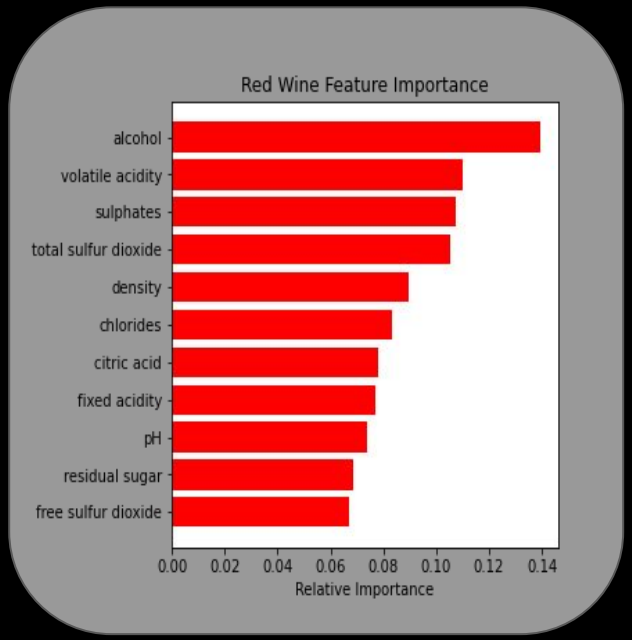
Total Sulfur Dioxide



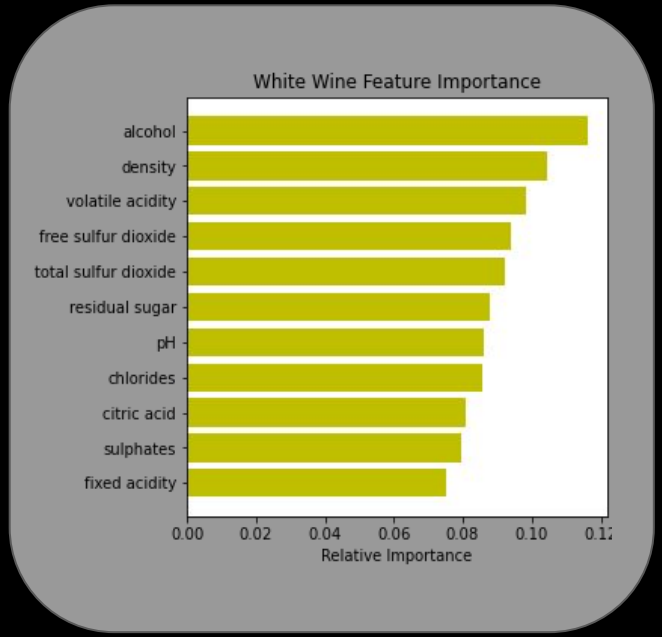


Machine Learning

Feature Importance



Using the feature importance method of the Random Forest Classifier, we see that as expected alcohol was the most important feature in predicting a wines quality level. This is followed by Volatile Acidity, Sulphates, and Total Sulfur Dioxide in Red Wine and Density and Volatile Acidity in White Wines.



Model Selection

Red Wine

Three different models were tested to best predict the quality of red wines. GridsearchCV was used to find the best parameters

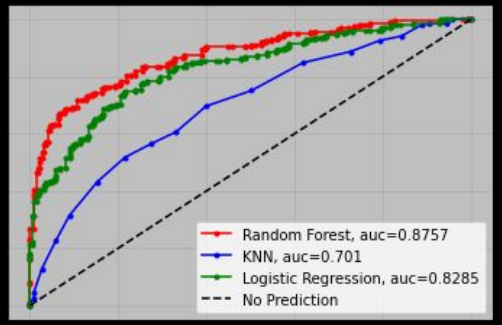
Model Selection Red WInes		
Model	ROC-AUC Score	Optimal Parameters
Random Forest	0.8239	N_estimators: 500 Max depth: 6 Min_samples_leaf: 1 Min_samples_split: 10 Bootstrap: True
K Neighbors Classifier	0.7799	N_neighbors: 324
Logistic Regression	0.8086	C: 1 Max_iter: 100

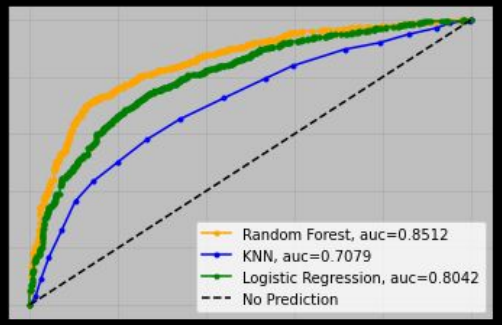
Model Selection White Wines		
Model	ROC-AUC Score	Optimal Parameters
Random Forest	0.8512	N_estimators: 500 Max depth: 10 Min_samples_leaf: 4 Min_samples_split: 2 Bootstrap: True
K Neighbors Classifier	0.7961	N_neighbors: 24
Logistic Regression	0.7999	C: 100 Max_iter: 100

Model Selection

White Wine

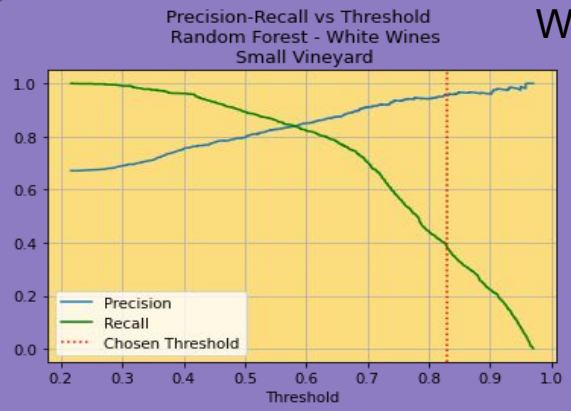
ROC/AUC Curves

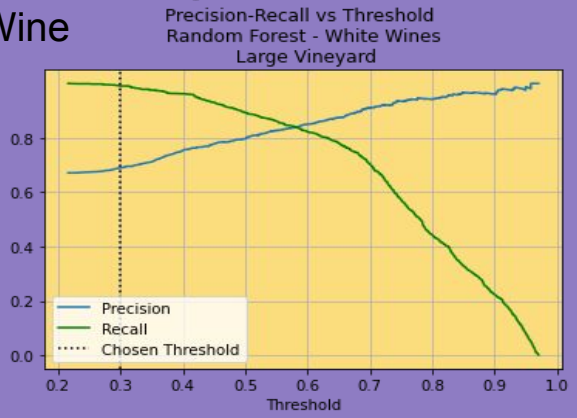




Thresholding

White Wine



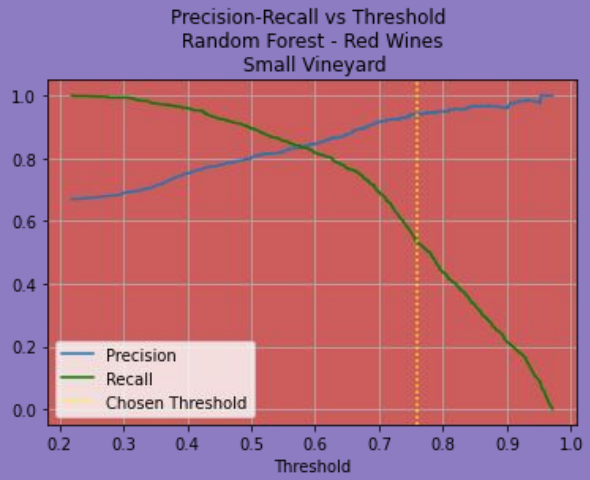


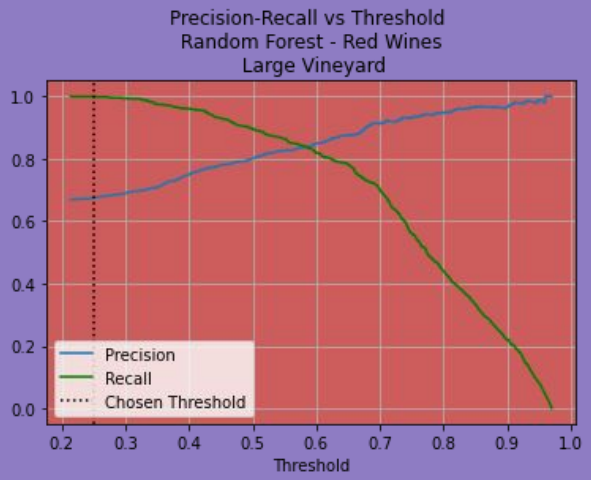
Classification Report			
Random Forest			
	Precision	Recall	Threshold
Smaller	**0.98**	**0.39**	**0.83**
Larger	**0.69**	**0.95**	**0.30**

Thresholding

Red Wine

Classification report			
Random Forest			
	Precision	Recall	Threshold
Small	0.99	0.42	0.76
Large	0.87	0.99	0.25





Conclusion

- High alcohol content is the single biggest determining feature for wine quality.
- In red wines, volatile acidity, sulphates and total sulfur dioxide are other major components that determine the quality of the wine.
- In white wines, density and volatile acidity are the next biggest determining components of its quality.