Significance of Components in Wine Taste

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Abstract

As the topic of this project mentions the significance of components in wine taste, the scientific literature reports a huge number of articles describing the various health benefits of moderate wine drinking. The aim of this project is to identify how of the proportions of different components has the impact on the wine. The components in the dataset used in the project will help to understand at a glance the potential effect of a component on a specific wine.

Keywords: Alcohol, Malic acid, Ash, Alkalinity of ash, Magnesium, Phenols, Flavonoids, Non flavonoid phenols, Proanthocyanins, Color intensity, Hue, OD280/OD315 of diluted wines, Proline.

Wine differs from other alcoholic drinks. Wine has been used for the medical purposes at least since 2200 BC and there is now growing evidence that correct doses of wine can be beneficial to human health. People who regularly drink wine with food have been reported to have better self-reported health, higher self-esteem, and less psychological distress than others. Wine consumers have a 25-35% lower risk of cardiovascular diseases compared to consumers of beer and spirits. The studies have shown that the polyphenols in the wine could explain the beneficial effect of wine on preventing several diseases.

Significance of Components in Wine Taste

The dataset used in this project is collected for the UCI dataset repository. The dataset is comprised of 13 variable and 1 categorical variable. The categorical variable is the set of the three different wines from the same region in Italy. The component values of the variables have be collected from the neighboring farms of the same region in Italy. The components considered to conduct this experiment are Alcohol, Malic acid, Ash, Alcalinity of ash, Magnesium, Phenols, Flavonoids, Non flavonoid phenols, Proanthocyanins, Color intensity, Hue, OD280/OD315 of diluted wines, Proline.

Alchohol

A daily dose of alcohol above 1 g/kg was established as a health risk by WHO. The average glass of wine contains around 11% to 13% alcohol, but bottles range from as little as 5.5% alcohol by volume to as much as around 20% ABV (Alcohol by Volume). Alcohol levels in wine are directly correlated with the amount of sugar that's developed in the grapes at the harvest time. The higher the sugar levels, the higher the potential alcohol. This doesn't mean higher alcohol content wines are sweeter. Rather, yeast consumes the sugar and converts into alcohol during fermentation. The style (or varietal) of wine, the climate where the grapes were grown, and the winemaking/fermentation process are all key factors in determining both the sugar content of the grapes and the amount of alcohol in a bottle.

Malic acid, Alkalinity

Malic acid is one of the principal organic acids found in wine grapes. If there is not enough, the wine tastes "flat," and is more susceptible to spoilage; if there is too much, the wine tastes "green," or "sour." So, the control of the amount of malic acid present in wine is crucial for the winemaker. All wines lie on the acidic side of the pH spectrum, pH is the measure of the degree of relative acidity versus the relativity alkalinity of any liquid, on scale of 0 to 14, with 7 being neutral. Low pH wines taste tart and crisp, while higher pH wines are more susceptible to bacterial growth. Most wine pH's fall around 3 or 4; about 3.0 to 3.4 is desirable for white wines, while about 3.3 to 3.6 is best for reds.

Phenols, Flavonoids, Non flavonoid phenols, Proanthocyanins

"*The antioxidant activity present in 1 glass of red wine is equivalent to that found in 12 glasses of white wine, 500 mL of beer, 2 cups of tea, 7 glasses of orange juice, 20 glasses of apple juice, 3.5 glasses of black currant juice, 5 apples, 5 (100 g) portions of onion, or 5.5 portions of eggplant.*"

Phenolics in wine is the fact that specific phenolic compounds were early recognized as determinants of the flavor and mouthfeel properties of red wines. The tactile sensation of astringency and the taste sensation of the bitterness in red wines were recognized again by Pasteur. Anthocyanins are red pigments responsible for the color of red wines. Flavanols are a class of flavonoids that tend not to receive as much attention as other flavonoids such as tannins and anthocyanins. Also, the amount of flavanols in wine is highly correlated with its market value. High value red wine tends to have three to four times the amount of flavanols as low value wine. The formation of these complexes pushes the anthocyanin equilibrium to produce more of the colored flavylium form. This can cause up to a tenfold increase in color absorbance, which makes wine appear purple.

Hue, Color Intensity

Wine color intensity is a simplistic measure of how dark the wine is using a summation of absorbance measurements in the violet, green and red areas. Of the visible spectrum.

$$\text{Wine color intensity} = A420 + A520 + A620$$

Wine hue is a simplistic measure of the appearance of the color – a ratio of the absorbance in the violet to the absorbance in the green

Wine Hue = A420/ A520

Ash, Magnesium.

On the average about 2.5 g/L of ash are found in wine. Ash being defines as the inorganic matter that remains after evaporation and incineration. Cations - most of the ash falls into this class and includes magnesium.

Technical Approach

The main objective of this project is to prove whether the components have the significant difference in the wine taste by conducting the linear regression process and performance analytics on the components.

This project analysis includes following steps: 1) cleaning the data 2) format the categorical variable by replacing the integer values with the respected names of the wine verities. 3) perform the linear regression analysis to check whether the data has achieved the linearity, normality and homoscedasticy and homogeneity by plotting the scatter plots and normality curve. 4) perform correlation test on the components to test the positive and negative correlations (Graph 3: positive correlation are displayed in blue and negative correlation are displayed in red). 5) perform the performance analytics on each component of the data set: (Graph 4: the distribution of each variable is shown in diagonal, On the bottom of the diagonal the bivariate scatter plots with a fitted lines are displayed, On the top the diagonal the value of the correlation plus the significant level as stars , each significant level is associated to a symbol: p-value(o, 0.001, 0.05, 0.1, 1) <=> symbols(***, **, *, . , “”))

Testing and Evaluation

The process I have followed might not provide the strong and exact solution. From the experimental results through R and explanation provided in above components description, the null hypothesis that their no difference in the wine taste fails. The normality curve shows the nearly normality. From the correlation values it is clearly seen that the different type of wine has strong negative correlation with Flavonoids, alkalinity of OD280_OD315 content. light negative correlations with proline content, wine Hue, Alcohol, Proanthocyanins. Also noticed the color intensity of the wine shown negative correlation with the flavonoids. The performance analytics also shows us that the different variance of the plots. The significance of the p-value from the linear regression summary show us < 2.2e-16. From the executed results it is clearly and hence proved that the alternative hypothesis: the components have the significant difference in the wine taste.

References

Gordon Brain, ph. D, Article Title: *Wine Color Analysis using the Evolution Array UV-Visible Spectrophotometer*

Andrea Rossi,[1] Ferdinando Fusco[2], Article Title: *Wine Index of Salubrity and Health (WISH): an evidence-based instrument to evaluate the impact of good wine on well-being*

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Tables

Table 1

Summary of Linear regression

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Call:
lm(formula = Alchohol ~ Malic_acid + Ash + Alcalinity_of_ash +
    Maganesium + Total_phenols + Flavanoids + Nonflavanoid_phenols +
    Proanthocyanins + Color_intensity + Hue + OD280_OD315 + Proline +
    wine_type, data = noout)

Residuals:
     Min       1Q   Median       3Q      Max
-1.25132 -0.31810 -0.00743  0.37385  1.58453

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)          12.6358720  0.7624038  16.574  < 2e-16 ***
Malic_acid            0.1389050  0.0441476   3.146  0.00196 **
Ash                   0.0568030  0.2127036   0.267  0.78976
Alcalinity_of_ash    -0.0159968  0.0186593  -0.857  0.39253
Maganesium           -0.0002371  0.0032718  -0.072  0.94232
Total_phenols         0.1201137  0.1322138   0.908  0.36496
Flavanoids           -0.1746787  0.1192302  -1.465  0.14482
Nonflavanoid_phenols -0.3451894  0.4244582  -0.813  0.41726
Proanthocyanins      -0.1243457  0.0960666  -1.294  0.19736
Color_intensity       0.1908659  0.0281304   6.785 2.01e-10 ***
Hue                   0.1309373  0.2750282   0.476  0.63465
OD280_OD315           0.0186254  0.1158790   0.161  0.87250
Proline               0.0006123  0.0002327   2.631  0.00932 **
wine_type            -0.4921658  0.1554729  -3.166  0.00185 **
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.522 on 164 degrees of freedom
Multiple R-squared:  0.617,	Adjusted R-squared:  0.5866
F-statistic: 20.32 on 13 and 164 DF,  p-value: < 2.2e-16

Correlation of Coefficients:
                     (Intercept) Malic_acid Ash   Alcalinity_of_ash Maganesium
Total_phenols Flavanoids Nonflavanoid_phenols Proanthocyanins Color_intensity Hue
OD280_OD315 Proline
Malic_acid           -0.15
Ash                  -0.16       -0.13
Alcalinity_of_ash     0.07        0.00       -0.59
Maganesium           -0.32        0.02       -0.28  0.04
Total_phenols         0.00        0.01       -0.02  0.08              -0.04
Flavanoids           -0.16        0.06       -0.15 -0.07               0.11      -0.56
Nonflavanoid_phenols -0.24       -0.08       -0.26 -0.05               0.29      -0.09
0.26
Proanthocyanins       0.04       -0.05        0.22 -0.10              -0.19      -0.07
-0.31      -0.07
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Color_intensity       -0.05        0.08       -0.17  0.15                0.00       -0.09
-0.16      -0.05                  -0.09
Hue                   -0.42        0.39        0.01  0.00               -0.04        0.00
-0.10      -0.15                 0.00            0.42
OD280_OD315           -0.51       -0.05        0.00 -0.15                0.13       -0.22
-0.06       0.20                  -0.11            0.24            0.01
Proline               -0.29       -0.05       -0.16  0.12               -0.15       -0.13
0.23       0.11                 -0.04             -0.49          -0.11  0.14
wine_type             -0.65       -0.05        0.12 -0.37                0.02       -0.16
0.49       0.10                 -0.09             -0.31           0.10  0.39          0.55
```

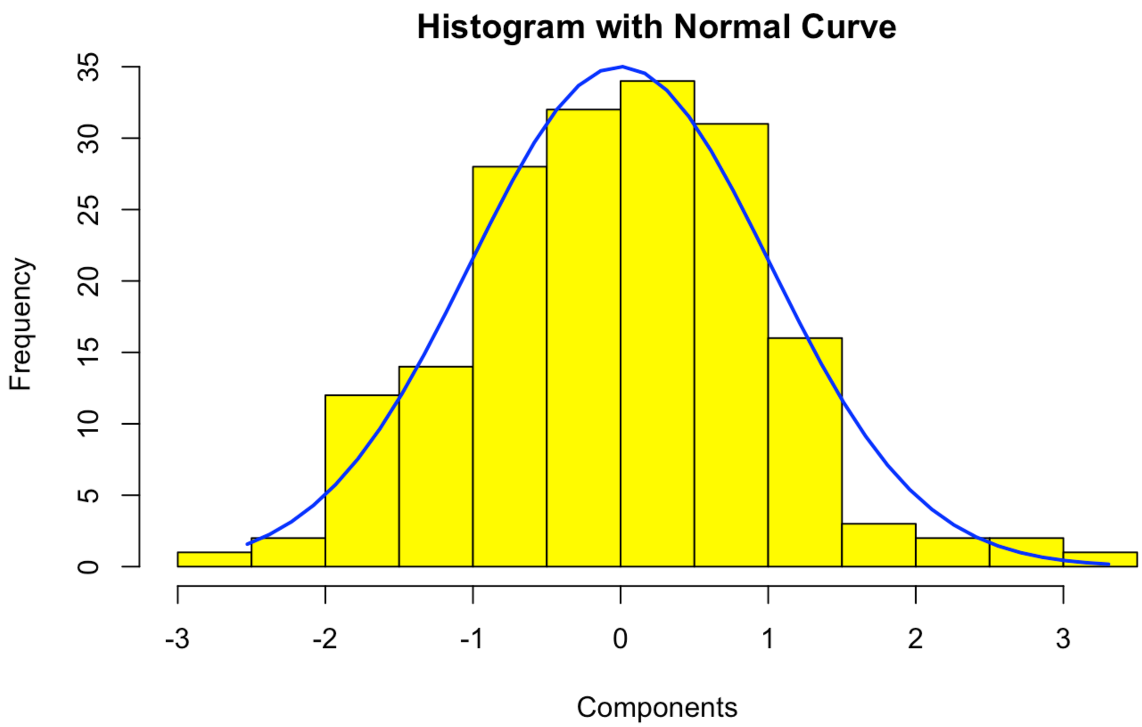

Figure 1: Normality curve

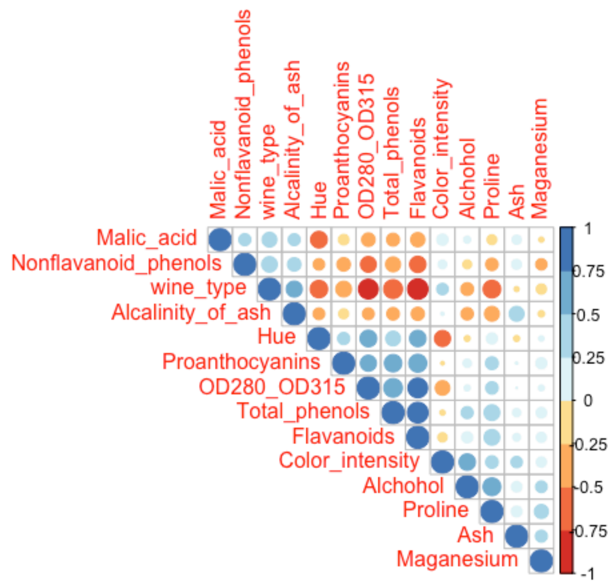

Figure 2: Correlation Plot

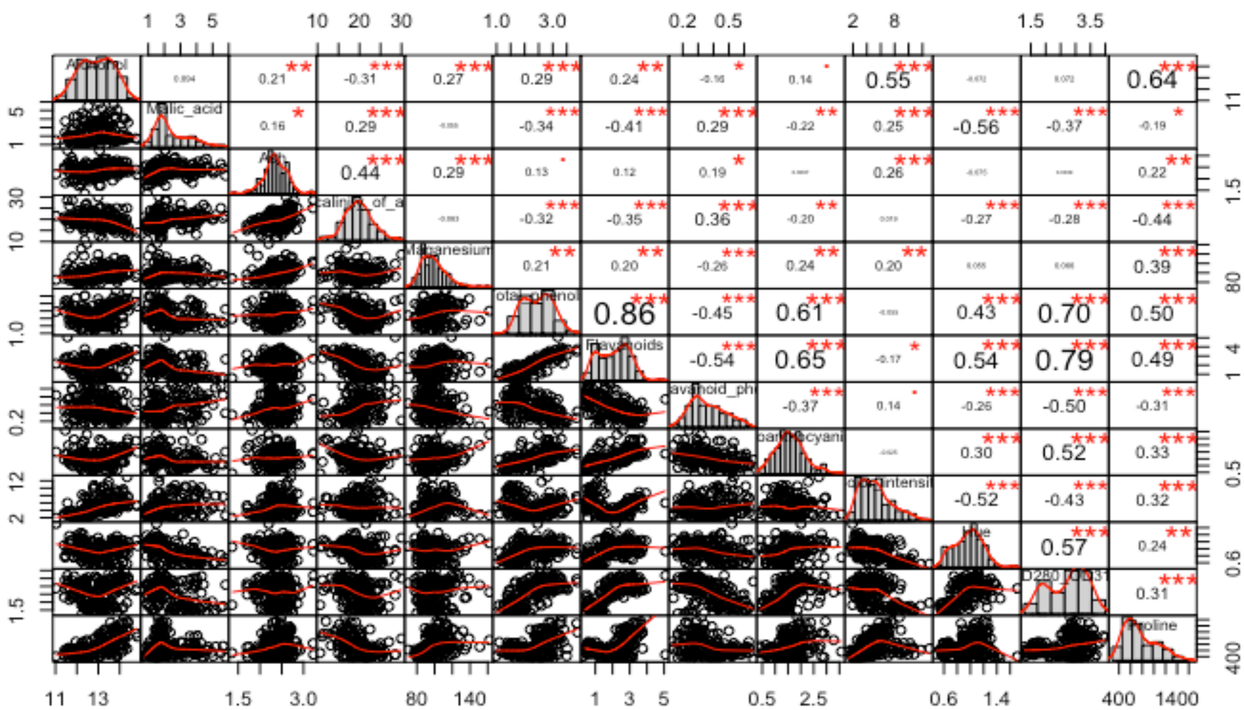

Figure 3: Performance Analytics