

Assignment 1 (2025)

The wine quality dataset represents data about attributes of different variants of white wine. Each wine is described by 11 features based on physicochemical tests: fixed acidity, volatile acidity, citric acid, residual sugar, chlorides, free sulphur dioxide, total sulphur dioxide, density, pH, sulphates, alcohol. The importance of these 11 features is described below:

Chlorides

Increased chloride levels in wine can result in a salty taste, potentially detracting from its overall quality and market appeal.

Density

Increased wine density, meaning a higher concentration of dissolved solids like sugars, acids, and phenols relative to the water content, can lead to richer, fuller-bodied wines with more intense aromas and flavors.

Fixed acidity

High fixed acidity in wine refers to the presence of a higher than average level of non-volatile acids, which are primarily tartaric, malic, and citric acids. These acids contribute to a wine's structure, balance, and aging potential. While essential for a wine's character, excessive acidity can lead to a sour or tart taste.

Citric Acid

Increased citric acid content in food and beverages serves multiple purposes, including acting as a preservative, enhancing flavor, and controlling pH levels. It helps prevent spoilage by inhibiting the growth of bacteria, mold, yeast, and fungi, thus extending shelf life. Additionally, it can improve taste, provide a sour or citrusy flavor, and balance the acidity of a product.

Alcohol

Increasing wine alcohol content, or ABV (Alcohol By Volume), is primarily to influence the wine's body, mouthfeel, and flavor profile. Higher ABV wines tend to be fuller-bodied, richer in flavor, and have a more pronounced alcohol warmth. Winemakers may also choose to increase ABV to achieve a desired sweetness level, as alcohol can enhance the perception of sweetness.

Volatile Acids

Increased volatile acid content in wine, while generally considered a fault, can also contribute to complexity and perceived freshness at low levels. However, excessive volatile acidity leads to undesirable vinegary or sharp aromas and flavors, negatively impacting the wine's overall quality.

pH

An increased pH (lower acidity) can lead to several changes, not always desirable. While it can sometimes make a wine taste less harsh, it also makes the wine more susceptible to spoilage microorganisms and oxidation, potentially impacting its stability and flavor over time.

Residual Sugar

Increased residual sugar in wine is primarily used to add sweetness and balance the wine's acidity or tannins, enhancing its overall flavor profile and potentially making it more appealing to a wider audience. Residual sugar refers to the unfermented sugars remaining in the wine after fermentation, and its presence can significantly impact the wine's sweetness, mouthfeel, and complexity.

Total sulphur dioxide, Free sulphur dioxide and sulphates

Increased total sulfur dioxide (SO₂) serves multiple purposes, primarily acting as an antioxidant and antimicrobial agent. It helps prevent oxidation, which can lead to undesirable browning and changes in flavor, and inhibits the growth of spoilage bacteria and yeasts, ensuring the wine's stability and longevity. Additionally, SO₂ can help select desirable yeast strains during fermentation and stabilize color and aroma compounds.

Your task is to apply principal components analysis and interpret the results.