```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

1. Load the Dataset

```
df = pd.read_csv('winequality-red.csv')
df.head()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulph
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	

```
df.shape
```

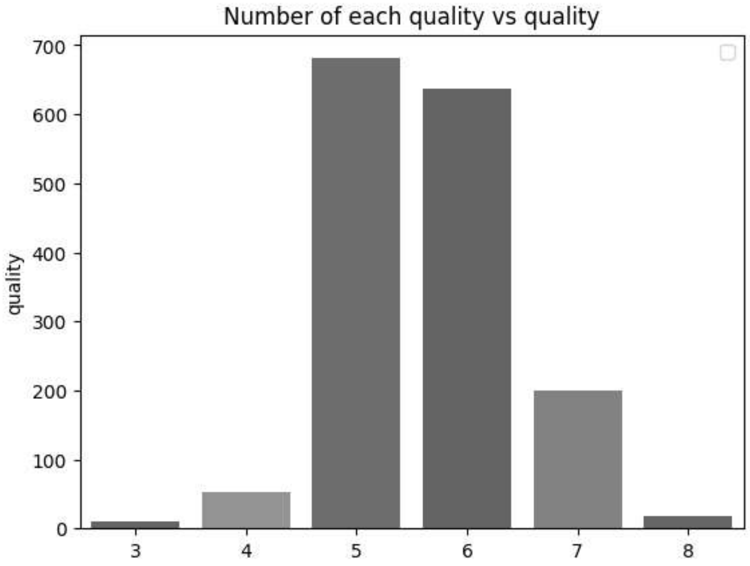
```
(1599, 12)
```

2. Data PreProcessing including Visualizations

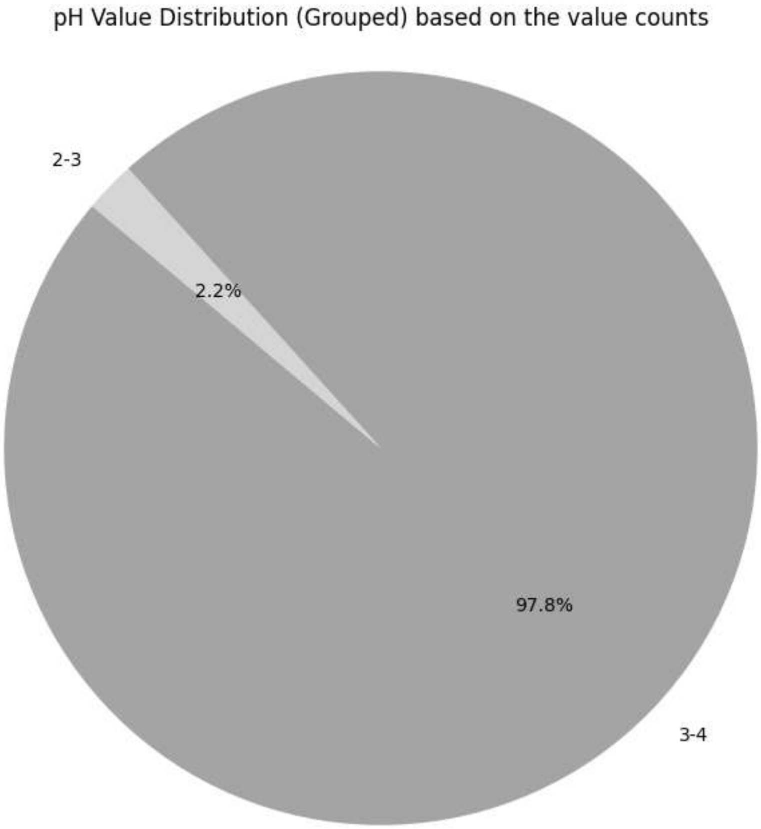
Univariate

```
sns.barplot(x =df["quality"].value_counts().index,y =df["quality"].value_counts())
plt.title('Number of each quality vs quality')
plt.legend()
plt.show()
```

```
WARNING:matplotlib.legend:No artists with labels found to put in legend.  Note that artists
```

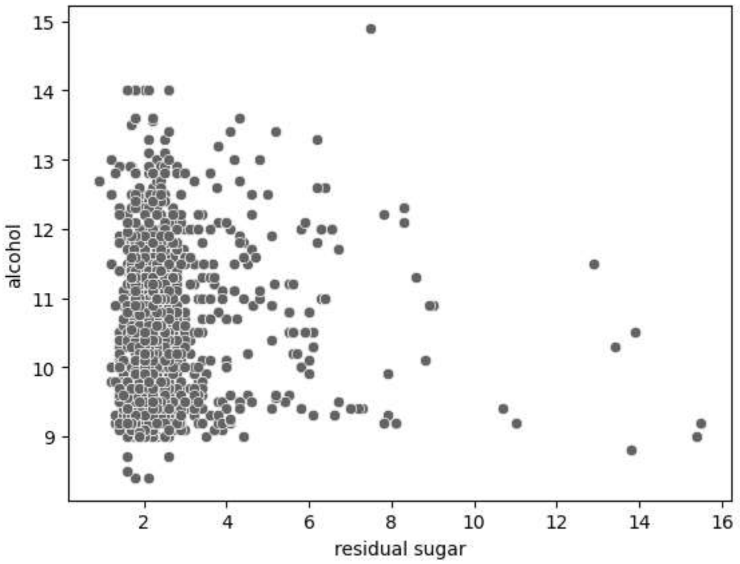


```
df['pH_category'] = pd.cut(df['pH'], bins=[2, 3, 4], labels=['2-3', '3-4'], include_lowest=True)
pH_category_counts = df['pH_category'].value_counts()
plt.figure(figsize=(8, 8))
plt.pie(pH_category_counts, labels=pH_category_counts.index, autopct='%1.1f%%', startangle=140, colors=['#66b3ff', '#99ff99'])
plt.title('pH Value Distribution (Grouped) based on the value counts')
plt.axis('equal')
plt.show()
df = df.drop(columns=['pH_category'])
```

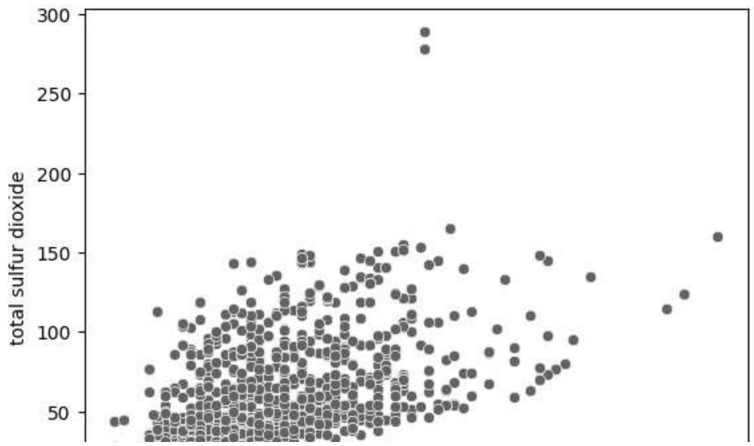


Bivariate

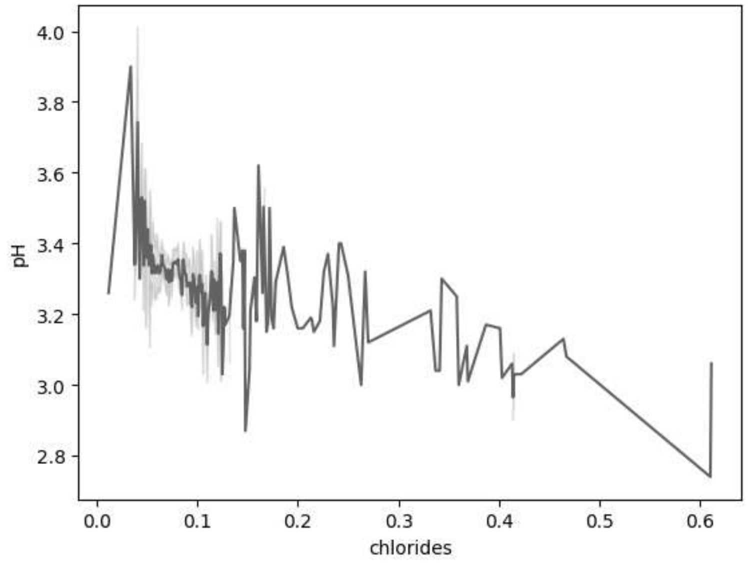
```
sns.scatterplot(x='residual sugar', y='alcohol', data=df)
plt.show()
```



```
sns.scatterplot(x='free sulfur dioxide', y='total sulfur dioxide', data=df)
plt.show()
```



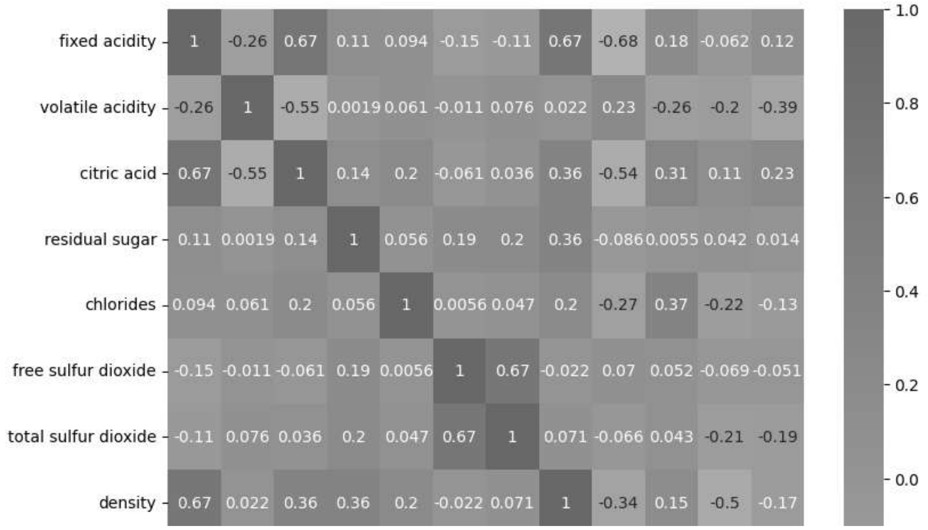
```
sns.lineplot(x='chlorides', y='pH', data=df)
plt.show()
```



▾ Multivariate

```
plt.figure(figsize=(9,9))
sns.heatmap(df.corr(),cmap="cool",annot=True)
```

```
<Axes: >
```

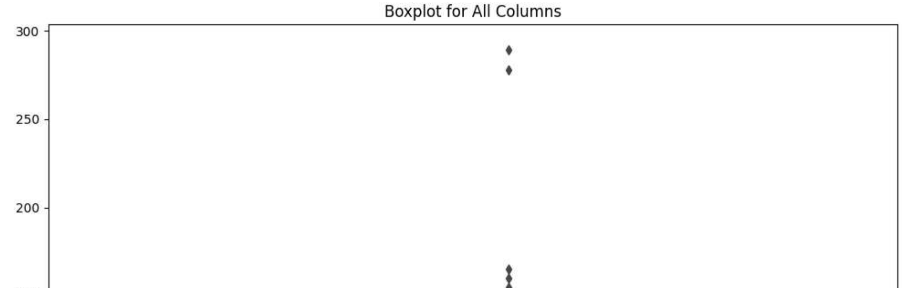


Preprocessing

```
df.isnull().sum()
```

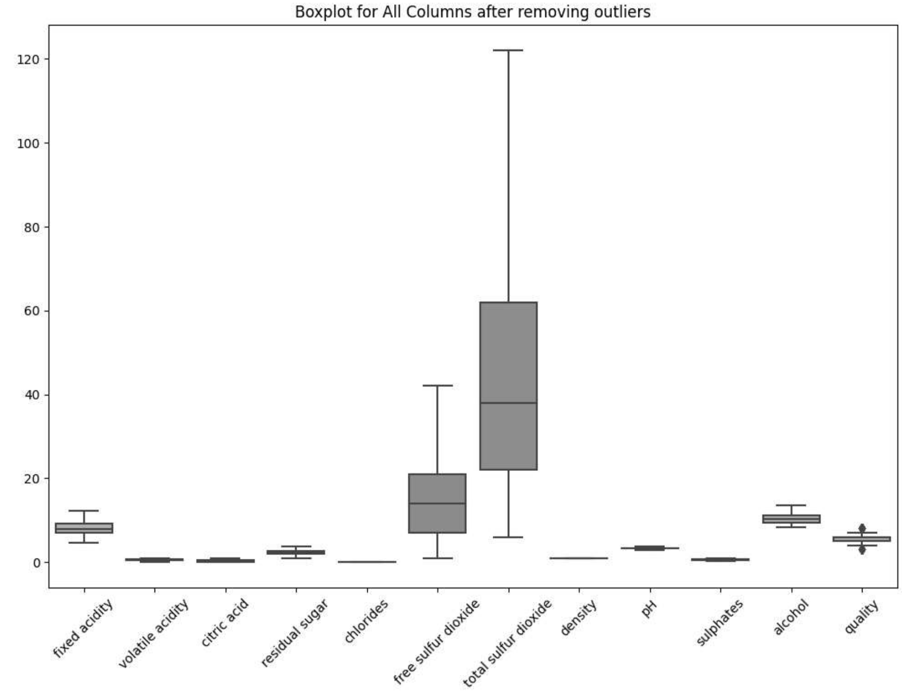
```
fixed acidity           0
volatile acidity        0
citric acid             0
residual sugar          0
chlorides               0
free sulfur dioxide     0
total sulfur dioxide    0
density                 0
pH                      0
sulphates               0
alcohol                 0
quality                 0
dtype: int64
```

```
plt.figure(figsize=(12, 8))
sns.boxplot(data=df)
plt.xticks(rotation=45)
plt.title('Boxplot for All Columns')
plt.show()
```



```
l=["fixed acidity","volatile acidity","citric acid","residual sugar","chlorides","free sulfur dioxide","total sulfur dioxide","density","pH",
for i in l:
    q1=df[i].quantile(0.25)
    q3=df[i].quantile(0.75)
    iqr=q3-q1
    upperL=q3+1.5*iqr
    lowerL=q1-1.5*iqr
    df[i]=np.where(df[i]>upperL,upperL,np.where(df[i]<lowerL,lowerL,df[i]))
```

```
plt.figure(figsize=(12, 8))
sns.boxplot(data=df)
plt.xticks(rotation=45)
plt.title('Boxplot for All Columns after removing outliers')
plt.show()
```



```
X = df.drop(columns=['quality'], axis=1)
y = df['quality']
```

```
print(X.shape)
print(y.shape)
```

```
(1599, 11)
(1599,)
```

```
from sklearn.preprocessing import StandardScaler
scale = StandardScaler()
X_scaled= pd.DataFrame(scale.fit_transform(X),columns =X.columns)
X_scaled.head()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	
0	-0.538197	0.997591	-1.392540	-0.693182	-0.291550	-0.476813	-0.385806	0.585705	1.33
1	-0.296555	2.032132	-1.392540	0.455672	0.943237	0.946759	0.700988	0.031853	-0.73
2	-0.296555	1.342438	-1.186940	-0.036694	0.606477	-0.070078	0.272857	0.142624	-0.33
3	1.757401	-1.416339	1.485857	-0.693182	-0.347676	0.133289	0.470456	0.696475	-1.00

```
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(X_scaled,y,test_size=0.3,random_state=10)
```

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(1119, 11)
(480, 11)
(1119,)
(480,)
```

3. ML Model Building

```
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.metrics import classification_report
```

Logistic Regression

```
logReg=LogisticRegression(max_iter=500)
logReg.fit(X_train, y_train)
y_pred = logReg.predict(X_test)
print(y_pred)
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test,y_pred))
```

```
[6 5 5 6 5 7 6 6 5 5 6 5 5 5 5 4 6 6 5 5 5 6 6 5 5 6 6 6 6 5 5 5 6 6 6 5 7
 5 6 5 6 6 5 6 5 6 5 6 6 5 6 7 6 7 6 7 6 5 5 5 6 5 7 6 5 5 6 6 5 6 6 5 6 5
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 6 5 5 6 5 5 7 5 6 5 5 6 5 6 6 6 6 5 6 7 7 6 6 6 7 5 5 5 5 7 5 5 5 5 5 5]
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         2
           4       0.00      0.00      0.00        16
           5       0.67      0.67      0.67       210
           6       0.48      0.57      0.52       183
           7       0.42      0.34      0.38        58
           8       0.00      0.00      0.00        11

    accuracy                           0.55       480
   macro avg       0.26      0.27      0.26       480
weighted avg       0.53      0.55      0.54       480
```

```
[[  0   0   1   1   0   0]
 [  0   0  11   5   0   0]
 [  0   1 141  68   0   0]
 [  0   1  55 105  22   0]
 [  0   0   2  36  20   0]
 [  0   0   0   5   6   0]]
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision and F-score are ill-c
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision and F-score are ill-c
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision and F-score are ill-c
  _warn_prf(average, modifier, msg_start, len(result))
```

4. Evaluate Model

```
y_pred_train = logReg.predict(X_train)
print('Testing Accuracy for LogisticRegression = ', accuracy_score(y_test,y_pred))
print('Training Accuracy for LogisticRegression = ', accuracy_score(y_train,y_pred_train))
```

```
Testing Accuracy for LogisticRegression =  0.5541666666666667
Training Accuracy for LogisticRegression =  0.6184092940125112
```

```
print("classification report for Logistic regression Classifier ")
print(classification_report(y_test,y_pred))
```

```
classification report for Logistic regression Classifier 
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         2
           4       0.00      0.00      0.00        16
           5       0.67      0.67      0.67       210
           6       0.48      0.57      0.52       183
           7       0.42      0.34      0.38        58
           8       0.00      0.00      0.00        11

    accuracy                           0.55       480
   macro avg       0.26      0.27      0.26       480
weighted avg       0.53      0.55      0.54       480

/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision and F-score are ill-c
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/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision and F-score are ill-c
  _warn_prf(average, modifier, msg_start, len(result))
```

5. Test with random Observation

```
predicting_sample = [[8.9,  0.38, 0.40,  2.2,   0.068,  12.0,   28.0,   0.99486,    3.27,   0.75,   12.6],
                    [8.1,   0.38, 0.28,  2.1,   0.066,  13.0,   30.0,   0.99680,    3.23,   0.73,   9.7],
                    [12.35, 0.300, 0.31, 1.80,  0.078,  18.0,   88.0,   0.99590,    3.44,   0.78,   12.3],
                    [7.5,0.5,0.36,1.8,  0.068,  6.0 ,   12.0,   0.99516,    3.35,   0.69,   11.7],
                    [8.9,0.62,0.19,3.9,0.17,    15.0,   48.0,   0.99680,    3.21,   0.59,   10.0],
                    [8.8,   0.600, 0.29, 2.2,   0.098,  5.0 ,   15.0,   0.99880,    3.36,   0.49,   9.1]]
```

```
for i in predicting_sample:
    x=logReg.predict([i])
    print(x)
```

```
[5]
[5]
[5]
[7]
[5]
[7]
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but LogisticRegression wa
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but LogisticRegression wa
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but LogisticRegression wa
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/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but LogisticRegression wa
  warnings.warn(
```