Vidul Garg

Project Title:

Grapes to Greatness: Machine Learning in Wine Quality Prediction

Description:

Predicting wine quality using machine learning is a common and valuable application in the field of data science and analytics. Wine quality prediction involves building a model that can assess and predict the quality of a wine based on various input features, such as chemical composition, sensory characteristics, and environmental factors.

Tasks:

Load the Dataset, Data preprocessing including visualization, Machine Learning Model building, Evaluate the model, Test with random observation

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.metrics import classification_report

df=pd.read_csv(r"D:\MachineLearning\DataScienceCourse\winequality-
red.csv")
df
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
0               7.4             0.700         0.00             1.9
0.076
1               7.8             0.880         0.00             2.6
0.098
2               7.8             0.760         0.04             2.3
0.092
3              11.2             0.280         0.56             1.9
0.075
4               7.4             0.700         0.00             1.9
0.076
...             ...               ...          ...             ...
...
```

```
1594            6.2             0.600         0.08             2.0
0.090
1595            5.9             0.550         0.10             2.2
0.062
1596            6.3             0.510         0.13             2.3
0.076
1597            5.9             0.645         0.12             2.0
0.075
1598            6.0             0.310         0.47             3.6
0.067

      free sulfur dioxide  total sulfur dioxide  density    pH
sulphates  \
0                    11.0                  34.0  0.99780  3.51
0.56
1                    25.0                  67.0  0.99680  3.20
0.68
2                    15.0                  54.0  0.99700  3.26
0.65
3                    17.0                  60.0  0.99800  3.16
0.58
4                    11.0                  34.0  0.99780  3.51
0.56
...                   ...                   ...      ...   ...
...
1594                 32.0                  44.0  0.99490  3.45
0.58
1595                 39.0                  51.0  0.99512  3.52
0.76
1596                 29.0                  40.0  0.99574  3.42
0.75
1597                 32.0                  44.0  0.99547  3.57
0.71
1598                 18.0                  42.0  0.99549  3.39
0.66

      alcohol  quality
0         9.4        5
1         9.8        5
2         9.8        5
3         9.8        6
4         9.4        5
...       ...      ...
1594     10.5        5
1595     11.2        6
1596     11.0        6
1597     10.2        5
1598     11.0        6

[1599 rows x 12 columns]
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
 11  quality               1599 non-null   int64  
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
```

Checking null values

```
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
```

```
df.describe()
```

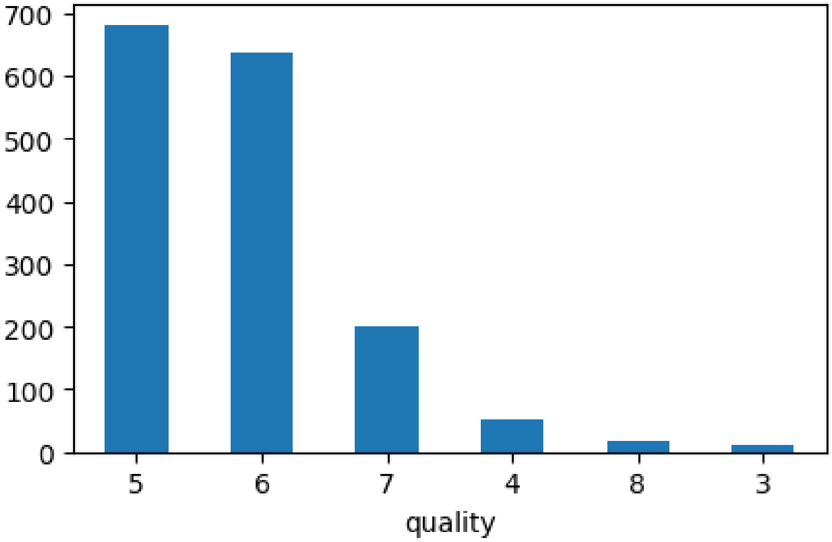
```
       fixed acidity  volatile acidity  citric acid  residual sugar  \
count    1599.000000       1599.000000  1599.000000     1599.000000   
mean        8.319637          0.527821     0.270976        2.538806   
std         1.741096          0.179060     0.194801        1.409928   
min         4.600000          0.120000     0.000000        0.900000   
25%         7.100000          0.390000     0.090000        1.900000   
50%         7.900000          0.520000     0.260000        2.200000   
75%         9.200000          0.640000     0.420000        2.600000   
```

```
max        15.900000          1.580000     1.000000       15.500000

         chlorides  free sulfur dioxide  total sulfur dioxide  
density  \
count  1599.000000          1599.000000           1599.000000  
1599.000000   
mean      0.087467            15.874922             46.467792  
0.996747   
std       0.047065            10.460157             32.895324  
0.001887   
min       0.012000             1.000000              6.000000  
0.990070   
25%       0.070000             7.000000             22.000000  
0.995600   
50%       0.079000            14.000000             38.000000  
0.996750   
75%       0.090000            21.000000             62.000000  
0.997835   
max       0.611000            72.000000            289.000000  
1.003690   

                pH    sulphates      alcohol      quality  
count  1599.000000  1599.000000  1599.000000  1599.000000  
mean      3.311113     0.658149    10.422983     5.636023  
std       0.154386     0.169507     1.065668     0.807569  
min       2.740000     0.330000     8.400000     3.000000  
25%       3.210000     0.550000     9.500000     5.000000  
50%       3.310000     0.620000    10.200000     6.000000  
75%       3.400000     0.730000    11.100000     6.000000  
max       4.010000     2.000000    14.900000     8.000000  
```

Data Visualization

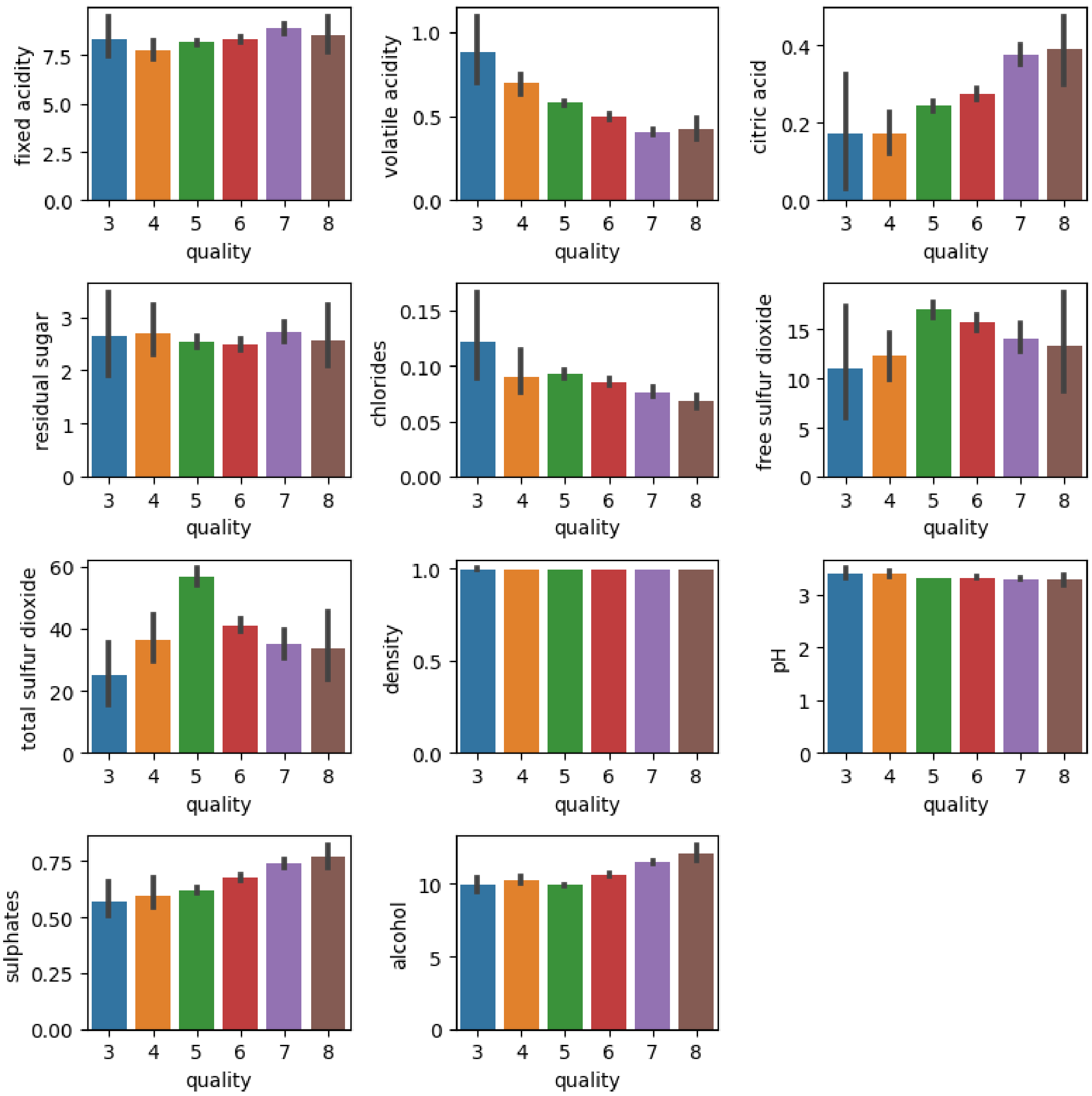
```
plt.figure(figsize=(5,3))
df["quality"].value_counts().plot(kind='bar')
plt.xticks(rotation=0)
```

```
(array([0, 1, 2, 3, 4, 5]),
 [Text(0, 0, '5'),
  Text(1, 0, '6'),
  Text(2, 0, '7'),
  Text(3, 0, '4'),
  Text(4, 0, '8'),
  Text(5, 0, '3')])
```



Wines with quality '5' and '6' are more!!

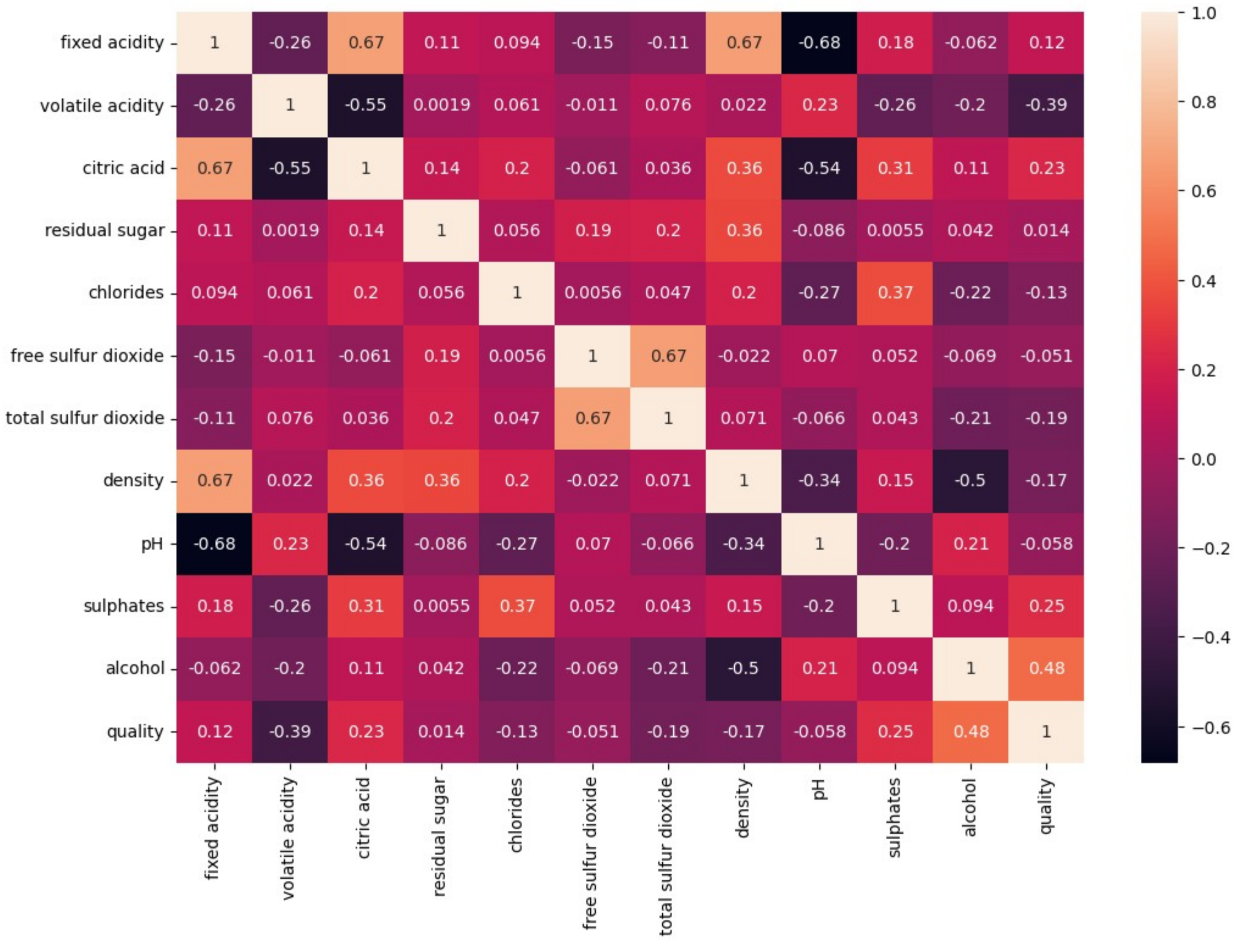
```
plt.figure(figsize=(8,8))
l=["fixed acidity","volatile acidity","citric acid","residual
sugar","chlorides","free sulfur dioxide","total sulfur
dioxide","density","pH","sulphates","alcohol"]
for i in l:
    plt.subplot(4, 3, l.index(i) + 1)   # 4 rows, 3 columns
    sns.barplot(x=df["quality"],y=df[i])
plt.tight_layout()


# sns.barplot(x=df["quality"],y=df["alcohol"])
```



Correlation Check

```
plt.figure(figsize=(12, 8))
cor=df.corr()
sns.heatmap(cor,annot=True)
```

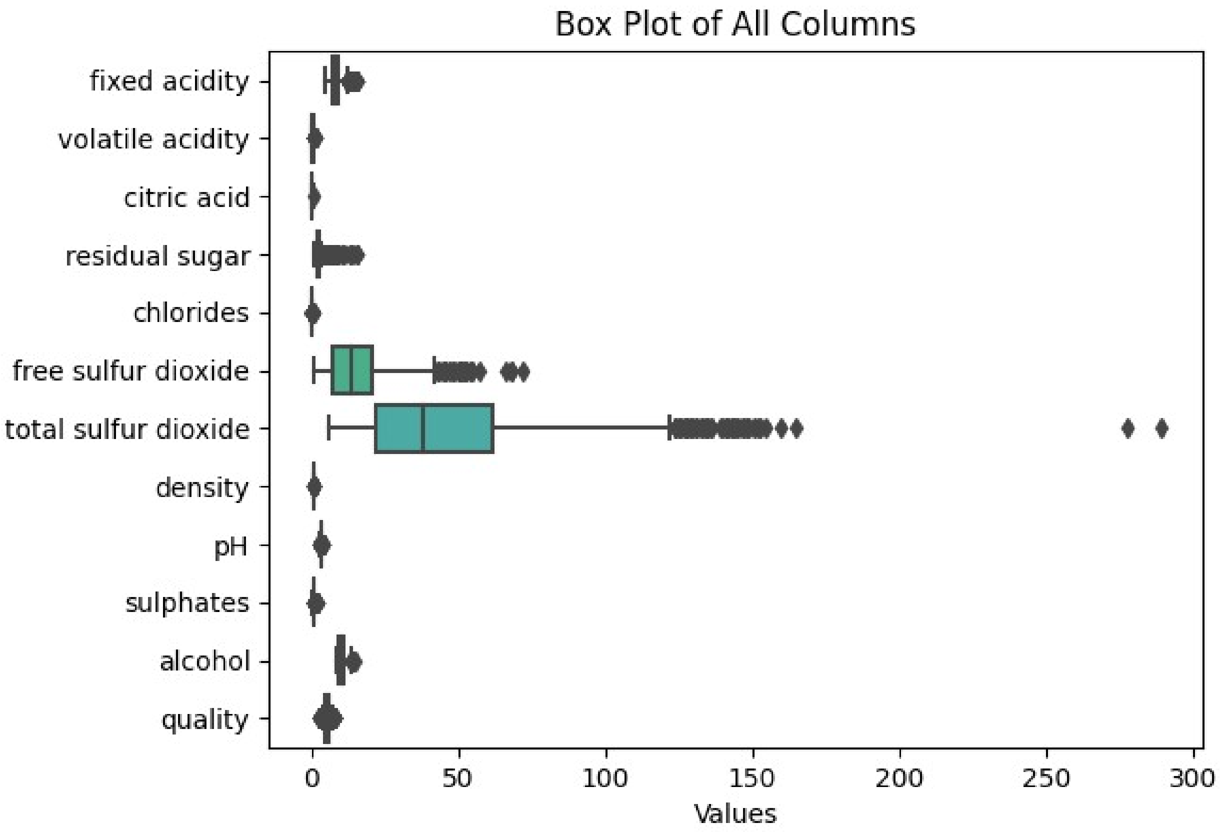
```
<Axes: >
```



As we can see there is no such correlated features in the dataset

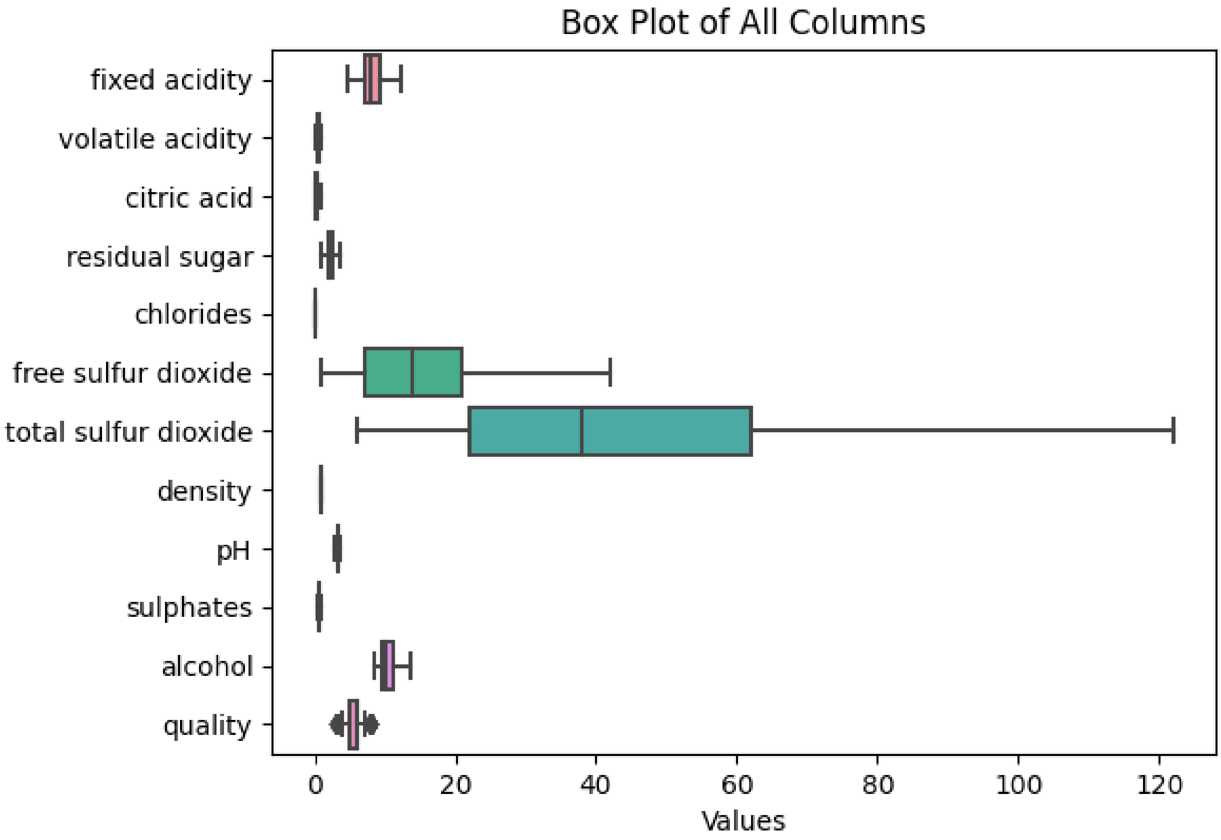
Checking outliers

```
sns.boxplot(data=df, orient='h')  # 'orient' is set to 'h' for
horizontal box plots

plt.xlabel('Values')
plt.title('Box Plot of All Columns')

Text(0.5, 1.0, 'Box Plot of All Columns')
```



There are so many outliers present in the dataset !

```
l1=["fixed acidity","volatile acidity","citric acid","residual
sugar","chlorides","free sulfur dioxide","total sulfur
dioxide","density","pH","sulphates","alcohol"]
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])
)

sns.boxplot(data=df, orient='h')  # 'orient' is set to 'h' for
horizontal box plots

plt.xlabel('Values')
plt.title('Box Plot of All Columns')

Text(0.5, 1.0, 'Box Plot of All Columns')
```



```
df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
 11  quality               1599 non-null   int64  
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
```

Splitting the data into dependent and independent variables

```
x=df.iloc[:,:11]
y=df.iloc[:,-1]
x.info()
y.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 11 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
dtypes: float64(11)
memory usage: 137.5 KB
<class 'pandas.core.series.Series'>
RangeIndex: 1599 entries, 0 to 1598
Series name: quality
Non-Null Count  Dtype
--------------  -----
1599 non-null   int64
dtypes: int64(1)
memory usage: 12.6 KB
```

Train, Test, Split

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,rando
m_state=32)
```

Model Training

KNN Classifier

```
model1=KNeighborsClassifier(n_neighbors=3)
model1.fit(x_train, y_train)
y_pred1 = model1.predict(x_test)
```

```
print(classification_report(y_test, y_pred1))
print(confusion_matrix(y_test,y_pred1))

              precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.00      0.00      0.00         8
           5       0.46      0.58      0.51       120
           6       0.54      0.44      0.48       146
           7       0.38      0.30      0.33        40
           8       0.00      0.00      0.00         5

    accuracy                           0.46       320
   macro avg       0.23      0.22      0.22       320
weighted avg       0.47      0.46      0.46       320

[[ 0  0  1  0  0  0]
 [ 2  0  3  2  1  0]
 [ 0  6 70 37  7  0]
 [ 1  9 62 64 10  0]
 [ 0  0 15 13 12  0]
 [ 0  0  1  2  2  0]]

C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Logistic Regression

```
model2=LogisticRegression(max_iter=5000)
model2.fit(x_train, y_train)
y_pred2 = model2.predict(x_test)
print(classification_report(y_test, y_pred2))
print(confusion_matrix(y_test,y_pred2))
```

```
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.00      0.00      0.00         8
           5       0.60      0.77      0.67       120
           6       0.55      0.56      0.56       146
           7       0.41      0.17      0.25        40
           8       0.00      0.00      0.00         5

    accuracy                           0.57       320
   macro avg       0.26      0.25      0.25       320
weighted avg       0.53      0.57      0.54       320

[[ 0  0  1  0  0  0]
 [ 0  0  2  6  0  0]
 [ 0  0 92 28  0  0]
 [ 0  0 57 82  7  0]
 [ 0  0  2 31  7  0]
 [ 0  0  0  2  3  0]]

C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\metrics\_classification.py:1469:
UndefinedMetricWarning: Precision and F-score are ill-defined and
being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Decision Tree Classifier

```
model3=DecisionTreeClassifier()
model3.fit(x_train, y_train)
y_pred3 = model3.predict(x_test)
print(classification_report(y_test, y_pred3))
print(confusion_matrix(y_test,y_pred3))
```

```
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.12      0.12      0.12         8
           5       0.62      0.75      0.68       120
           6       0.66      0.53      0.59       146
           7       0.36      0.40      0.38        40
           8       0.20      0.20      0.20         5

    accuracy                           0.58       320
   macro avg       0.33      0.33      0.33       320
weighted avg       0.59      0.58      0.58       320

[[ 0  0  0  1  0  0]
 [ 1  1  3  2  1  0]
 [ 1  4 90 22  3  0]
 [ 0  3 45 77 21  0]
 [ 0  0  7 13 16  4]
 [ 0  0  0  1  3  1]]
```

Accuracy Check

```
print("KNN Classifier Accuracy:", accuracy_score(y_test, y_pred1)*100)
print("Logistic Regression Accuracy:", accuracy_score(y_test,
y_pred2)*100)
print("Decision Tree Accuracy:", accuracy_score(y_test, y_pred3)*100)

KNN Classifier Accuracy: 45.625
Logistic Regression Accuracy: 56.56250000000001
Decision Tree Accuracy: 57.8125
```

Predicting with random values

```
sample_check=[[6.5, 0.6, 0.3, 2.2, 0.07, 15.0, 40.0, 0.996, 3.4, 0.6,
9.5],
             [8.0, 0.4, 0.4, 2.8, 0.085, 22.0, 55.0, 0.998, 3.2, 0.55,
11.2],
             [6.8, 0.55, 0.15, 2.4, 0.075, 25.0, 62.0, 0.9962, 3.1,
0.75, 9.0],
             [7.5, 0.45, 0.35, 2.5, 0.09, 30.0, 70.0, 0.9978, 3.5,
0.6, 11.5],
             [7.0, 0.5, 0.2, 2.5, 0.08, 20.0, 60.0, 0.997, 3.3, 0.7,
10.0]
             ]

for i in sample_check:
    x=model2.predict([i])
    if(x>=6):
        print(x, "--> Good" )
    elif(x<6):
        print(x, "--> Not Good")
```

```
[5] --> Not Good
[6] --> Good
[5] --> Not Good
[6] --> Good
[5] --> Not Good

C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\base.py:464: UserWarning: X does not have valid
feature names, but LogisticRegression was fitted with feature names
  warnings.warn(
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\base.py:464: UserWarning: X does not have valid
feature names, but LogisticRegression was fitted with feature names
  warnings.warn(
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\base.py:464: UserWarning: X does not have valid
feature names, but LogisticRegression was fitted with feature names
  warnings.warn(
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\base.py:464: UserWarning: X does not have valid
feature names, but LogisticRegression was fitted with feature names
  warnings.warn(
C:\Users\Vidul\AppData\Local\Programs\Python\Python311\Lib\site-
packages\sklearn\base.py:464: UserWarning: X does not have valid
feature names, but LogisticRegression was fitted with feature names
  warnings.warn(
```