```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sea
import sklearn
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score

import pandas as pd
data = pd.read_csv("C:/Users/TAWFEEQ/Desktop/wine dataset.csv")

data.head()

data.describe()
```

```
       fixed acidity  volatile acidity  citric acid  residual sugar  \
count    6487.000000       6489.000000  6494.000000     6495.000000
mean        7.216579          0.339691     0.318722        5.444326
std         1.296750          0.164649     0.145265        4.758125
min         3.800000          0.080000     0.000000        0.600000
25%         6.400000          0.230000     0.250000        1.800000
50%         7.000000          0.290000     0.310000        3.000000
75%         7.700000          0.400000     0.390000        8.100000
max        15.900000          1.580000     1.660000       65.800000

         chlorides  free sulfur dioxide  total sulfur dioxide
density  \
count  6495.000000          6497.000000           6497.000000
6497.000000
mean      0.056042            30.525319            115.744574
0.994697
std       0.035036            17.749400             56.521855
0.002999
min       0.009000             1.000000              6.000000
0.987110
25%       0.038000            17.000000             77.000000
0.992340
50%       0.047000            29.000000            118.000000
0.994890
75%       0.065000            41.000000            156.000000
0.996990
```

```
max       0.611000           289.000000            440.000000
1.038980

                 pH    sulphates      alcohol      quality
count  6488.000000  6493.000000  6497.000000  6497.000000
mean      3.218395     0.531215    10.491801     5.818378
std       0.160748     0.148814     1.192712     0.873255
min       2.720000     0.220000     8.000000     3.000000
25%       3.110000     0.430000     9.500000     5.000000
50%       3.210000     0.510000    10.300000     6.000000
75%       3.320000     0.600000    11.300000     6.000000
max       4.010000     2.000000    14.900000     9.000000
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6497 entries, 0 to 6496
Data columns (total 13 columns):
type                    6497 non-null object
fixed acidity           6487 non-null float64
volatile acidity        6489 non-null float64
citric acid             6494 non-null float64
residual sugar          6495 non-null float64
chlorides               6495 non-null float64
free sulfur dioxide     6497 non-null float64
total sulfur dioxide    6497 non-null float64
density                 6497 non-null float64
pH                      6488 non-null float64
sulphates               6493 non-null float64
alcohol                 6497 non-null float64
quality                 6497 non-null int64
dtypes: float64(11), int64(1), object(1)
memory usage: 659.9+ KB
```

```
data.isnull().sum()
```

```
type                     0
fixed acidity           10
volatile acidity         8
citric acid              3
residual sugar           2
chlorides                2
free sulfur dioxide      0
total sulfur dioxide     0
density                  0
pH                       9
sulphates                4
alcohol                  0
quality                  0
dtype: int64
```

```
data['fixed acidity'].value_counts()
```

```
6.80     354
6.60     326
6.40     305
7.00     282
6.90     279
7.20     273
6.70     264
7.10     257
6.50     242
7.40     238
7.30     222
6.20     210
6.30     201
7.60     199
6.00     197
7.50     174
6.10     169
7.80     146
7.70     141
5.80     125
8.00     122
7.90     116
5.90     111
8.20     101
8.30      92
5.70      90
5.60      85
8.10      82
8.40      61
8.60      52
        ...
12.60      4
12.20      4
12.40      4
13.00      3
11.70      3
11.00      3
13.30      3
4.40       3
13.20      3
6.15       2
15.50      2
12.90      2
4.20       2
15.60      2
7.15       2
13.70      2
15.00      2
```

```
4.60       2
13.40      1
13.50      1
3.80       1
4.50       1
12.10      1
14.00      1
3.90       1
14.30      1
15.90      1
13.80      1
14.20      1
6.45       1
Name: fixed acidity, Length: 106, dtype: int64
```

```
mean_fa = data['fixed acidity'].mean()
data['fixed acidity'].fillna(mean_fa, inplace = True)
data['fixed acidity'].isnull().sum()
```

```
0
```

```
data['volatile acidity'].value_counts()
```

```
0.280    286
0.240    265
0.260    255
0.250    238
0.220    235
0.270    232
0.230    221
0.200    217
0.300    214
0.320    205
0.210    197
0.180    187
0.310    178
0.290    176
0.190    171
0.340    164
0.330    154
0.160    143
0.360    142
0.170    140
0.350    107
0.380     98
0.400     96
0.390     95
0.370     89
0.150     88
0.410     87
```

```
0.430     78
0.440     69
0.420     67
         ...
0.890      1
0.135      1
0.090      1
1.115      1
1.010      1
0.215      1
0.355      1
0.955      1
1.240      1
1.070      1
0.930      1
1.580      1
1.025      1
0.920      1
0.085      1
1.035      1
0.975      1
0.845      1
1.100      1
0.905      1
0.950      1
0.825      1
0.175      1
0.895      1
0.405      1
0.805      1
1.130      1
1.185      1
0.565      1
0.865      1
Name: volatile acidity, Length: 187, dtype: int64
```

```
mean_va = data['volatile acidity'].mean()
data['volatile acidity'].fillna(mean_va, inplace = True)
data['volatile acidity'].isnull().sum()
```

```
0
```

```
data['citric acid'].value_counts()
```

```
0.30    337
0.28    301
0.32    289
0.49    283
0.26    257
0.34    249
```

```
0.29    244
0.27    236
0.24    232
0.31    229
0.33    208
0.36    197
0.25    163
0.37    153
0.35    150
0.00    150
0.40    146
0.38    136
0.22    131
0.39    129
0.42    124
0.23    108
0.21     99
0.41     98
0.20     95
0.44     86
0.18     71
0.46     70
0.19     69
0.45     68
       ...
0.66     21
0.68     18
0.11     16
0.60     15
0.62     15
0.65     15
0.64     15
0.59     14
0.63     14
0.61     11
0.71     10
0.69      9
0.67      9
0.73      8
0.72      6
1.00      6
0.70      5
0.78      3
0.76      3
0.79      3
0.80      2
0.91      2
0.81      2
0.82      2
```

```
0.88      1
1.66      1
0.75      1
0.86      1
0.99      1
1.23      1
Name: citric acid, Length: 89, dtype: int64
```

```
mean_ca = data['citric acid'].mean()
data['citric acid'].fillna(mean_ca, inplace = True)
data['citric acid'].isnull().sum()
```

```
0
```

```
data['residual sugar'].value_counts()
```

```
2.00     235
1.80     228
1.60     223
1.40     219
1.20     195
2.20     187
2.10     179
1.90     176
1.70     175
1.50     171
1.30     152
2.30     150
1.10     146
2.40     127
2.50     124
2.60     112
1.00      93
2.80      85
2.70      77
2.90      49
4.60      46
5.00      44
7.80      43
3.20      43
3.00      42
4.80      41
6.30      41
0.90      41
7.40      40
6.40      37
         ...
15.25      1
19.90      1
8.55       1
```

```
5.55        1
65.80       1
18.50       1
15.15       1
20.40       1
6.35        1
11.45       1
18.40       1
7.95        1
17.35       1
20.15       1
3.65        1
8.45        1
19.10       1
16.45       1
9.05        1
16.55       1
19.60       1
7.45        1
22.60       1
6.95        1
8.65        1
14.15       1
14.05       1
3.15        1
8.95        1
20.30       1
Name: residual sugar, Length: 316, dtype: int64
```

```
mean_rs = data['residual sugar'].mean()
data['residual sugar'].fillna(mean_rs, inplace = True)
data['residual sugar'].isnull().sum()
```

```
0
```

```
data['chlorides'].value_counts()
```

```
0.044    206
0.036    200
0.042    187
0.046    185
0.050    182
0.048    182
0.040    182
0.047    175
0.045    174
0.034    169
0.038    168
0.039    161
0.037    160
```

```
0.041    151
0.043    142
0.049    141
0.053    135
0.035    130
0.033    119
0.051    116
0.052    114
0.054    112
0.032    109
0.030    108
0.031    107
0.056     97
0.028     85
0.029     81
0.057     78
0.080     70
        ...
0.143      1
0.290      1
0.149      1
0.267      1
0.209      1
0.464      1
0.403      1
0.236      1
0.211      1
0.204      1
0.156      1
0.190      1
0.130      1
0.240      1
0.222      1
0.212      1
0.301      1
0.113      1
0.263      1
0.611      1
0.413      1
0.009      1
0.239      1
0.387      1
0.343      1
0.213      1
0.165      1
0.150      1
0.144      1
0.125      1
Name: chlorides, Length: 214, dtype: int64
```

```
mean_c = data['chlorides'].mean()
data['chlorides'].fillna(mean_c, inplace = True)
data['chlorides'].isnull().sum()
```

```
0
```

```
data['pH'].value_counts()
```

```
3.16    200
3.14    193
3.22    185
3.20    176
3.19    170
3.15    170
3.18    168
3.24    160
3.12    154
3.10    154
3.17    151
3.30    150
3.26    149
3.08    147
3.23    147
3.25    140
3.36    139
3.11    135
3.21    131
3.32    131
3.13    130
3.28    129
3.29    126
3.06    124
3.27    123
3.34    122
3.31    118
3.04    107
3.38    106
3.09    103
       ...
3.63      9
3.68      7
3.69      6
3.72      6
3.62      5
3.65      4
3.67      4
2.83      4
3.71      4
3.74      3
2.79      3
```

```
3.75      3
2.80      3
3.77      2
3.80      2
2.74      2
3.70      2
3.78      2
3.76      2
3.90      2
3.64      2
4.01      2
2.72      1
3.85      1
3.79      1
3.81      1
2.77      1
2.82      1
2.84      1
3.82      1
Name: pH, Length: 108, dtype: int64
```

```
mean_pH = data['pH'].mean()
data['pH'].fillna(mean_pH, inplace = True)
data['pH'].isnull().sum()
```

```
0
```

```
data['sulphates'].value_counts()
```

```
0.50    275
0.46    243
0.54    234
0.44    232
0.38    214
0.48    208
0.52    203
0.49    197
0.47    191
0.45    190
0.42    186
0.53    186
0.40    172
0.43    169
0.56    168
0.58    167
0.51    166
0.39    157
0.60    157
0.55    152
0.59    148
```

```
0.41    139
0.57    138
0.37    131
0.62    129
0.36    120
0.64    113
0.63     96
0.61     90
0.35     85
       ...
1.05      3
1.28      2
1.10      2
1.13      2
1.01      2
1.03      2
1.95      2
1.00      2
1.04      2
1.07      2
1.14      2
1.34      1
2.00      1
1.16      1
1.61      1
1.15      1
1.22      1
1.31      1
1.09      1
0.23      1
0.22      1
1.11      1
1.20      1
1.98      1
1.26      1
1.59      1
1.12      1
1.33      1
1.56      1
1.62      1
Name: sulphates, Length: 111, dtype: int64
```

```
mean_s = data['sulphates'].mean()
data['sulphates'].fillna(mean_s, inplace = True)
data['sulphates'].isnull().sum()
```

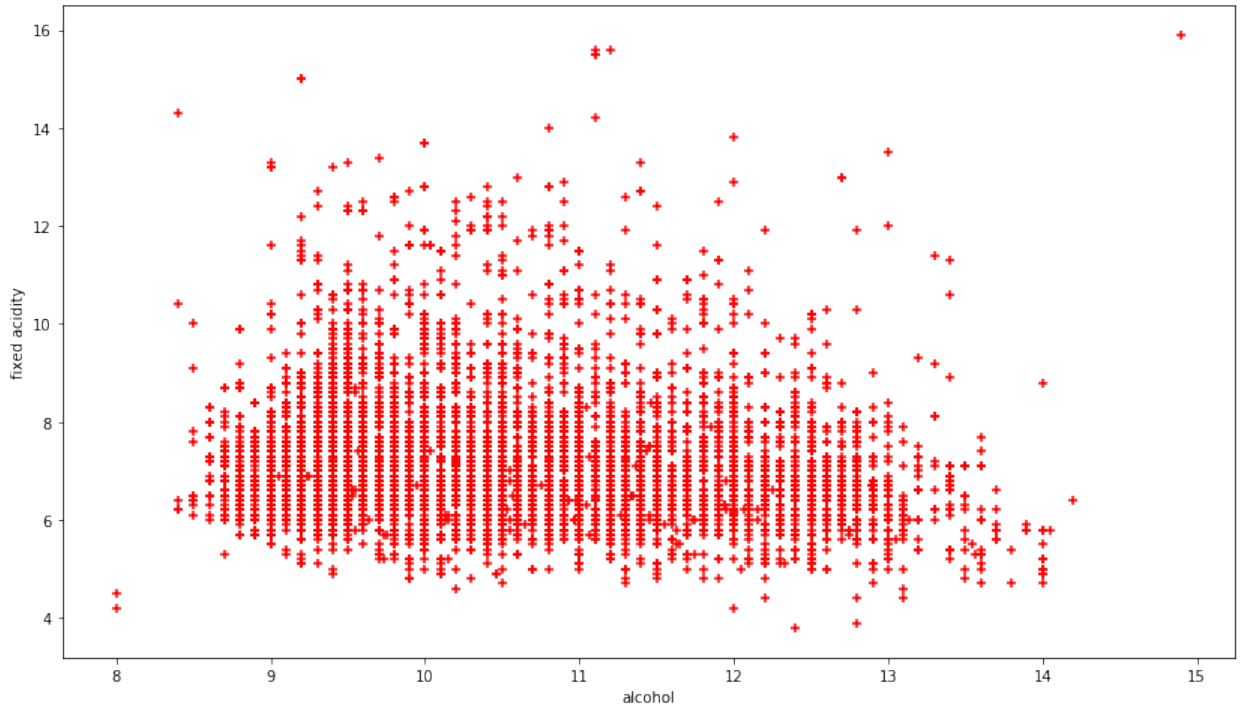
```
0
```

```
data.isnull().sum()
```

```
type                    0
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
```

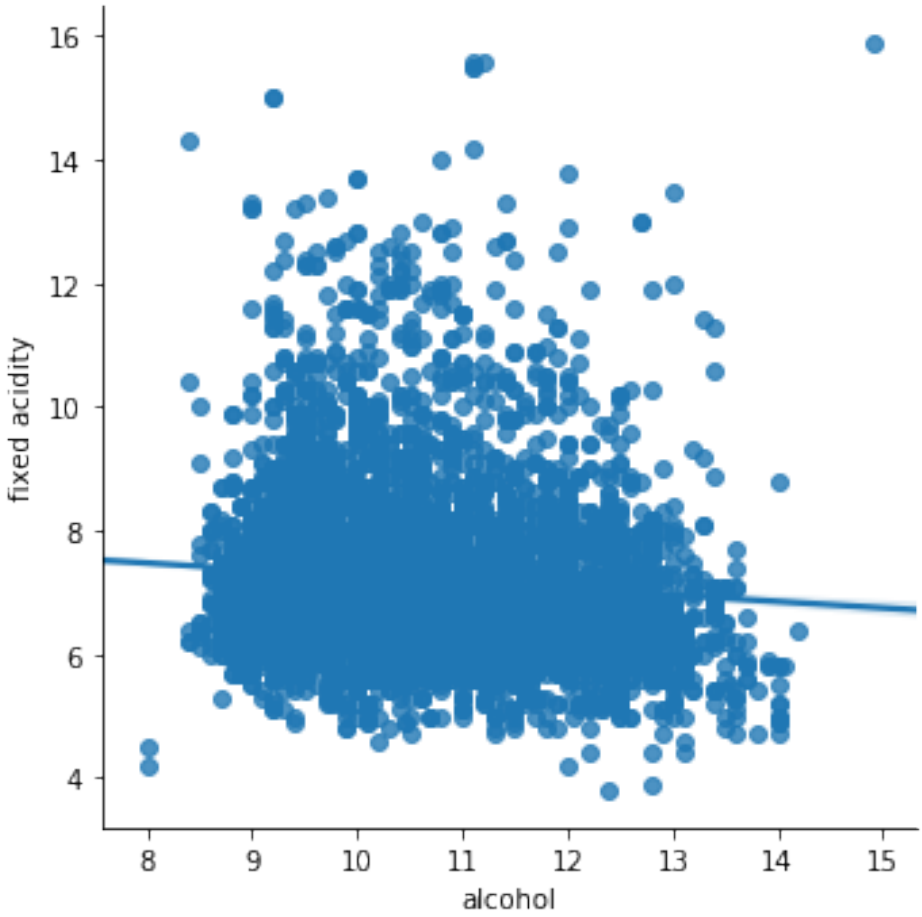
```
'''
Visualization of the data
x - alcohol
y - fixed acidity
'''
plt.figure(figsize=(14, 8))
plt.scatter(x = 'alcohol', y = 'fixed acidity', data = data, marker =
'+', c='r')
plt.xlabel('alcohol')
plt.ylabel('fixed acidity')
#plt.show()
```

```
<matplotlib.text.Text at 0x2b39aef7ef0>
```



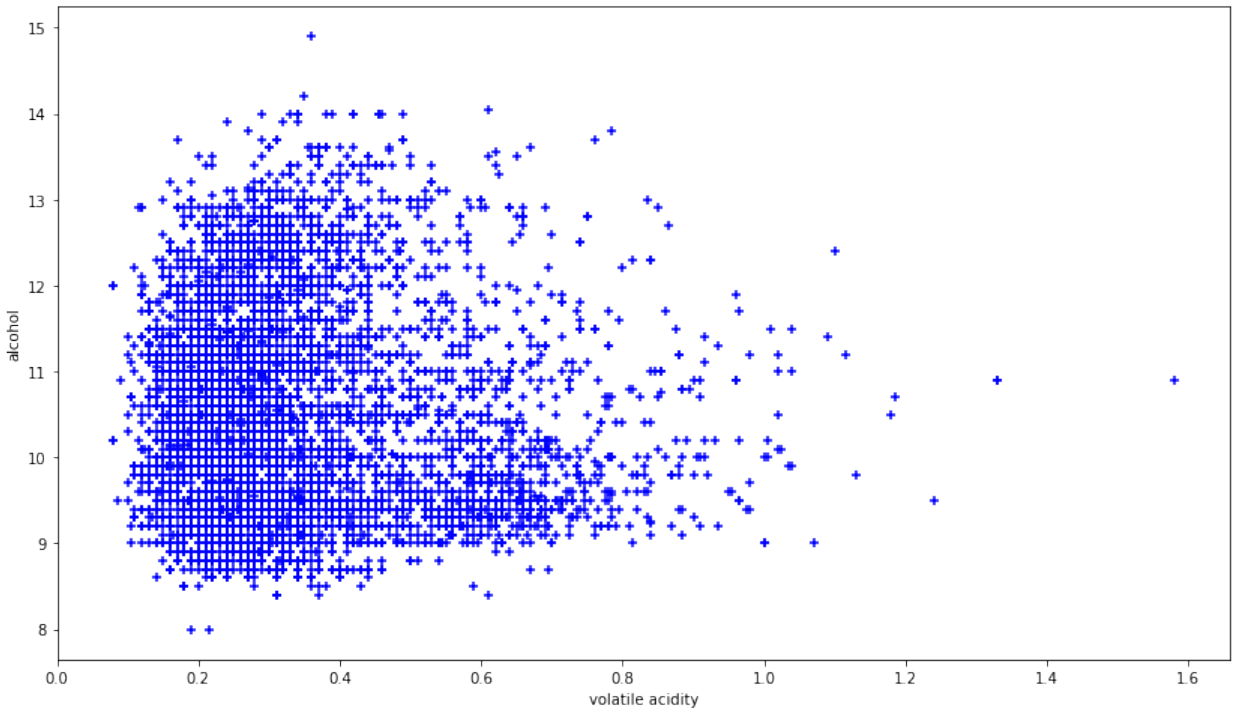
```
sea.lmplot(x='alcohol', y='fixed acidity', data = data)
#plt.show()
```

```
<seaborn.axisgrid.FacetGrid at 0x2b394faca58>
```



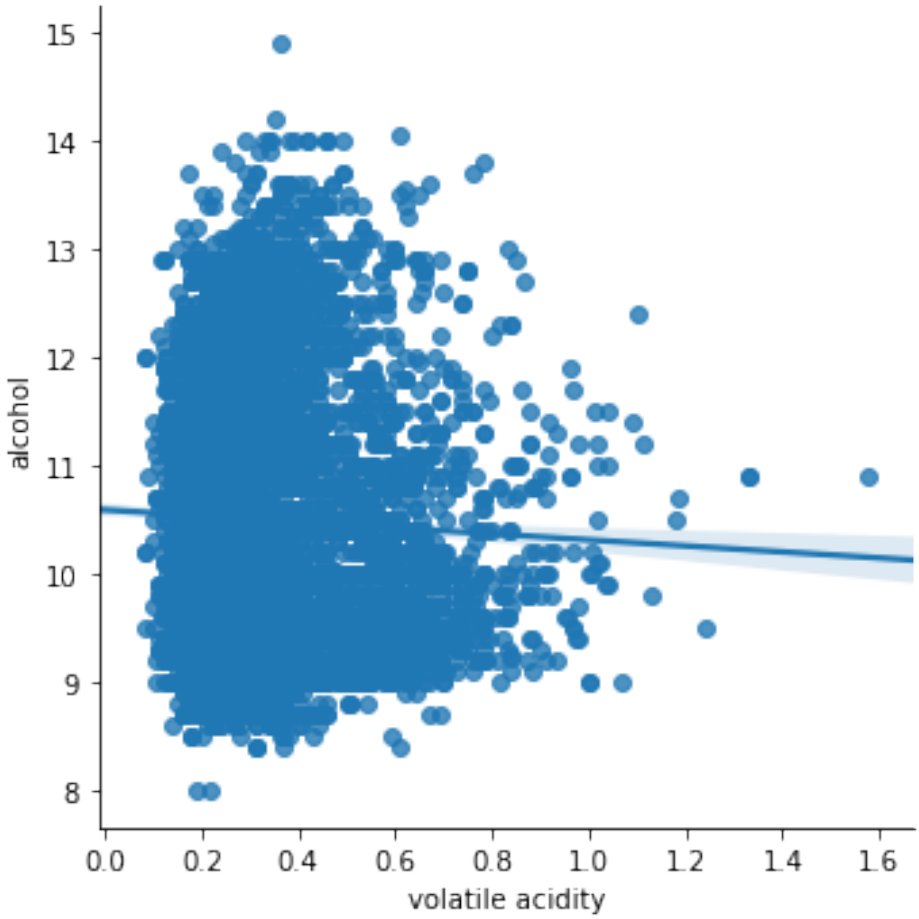

```
plt.figure(figsize=(14,8))
plt.scatter(x ='volatile acidity', y = 'alcohol', data = data, marker
= '+', c = 'b')
plt.xlabel('volatile acidity')
plt.ylabel('alcohol')
#plt.show()
```

```
<matplotlib.text.Text at 0x2b39b25ac88>
```



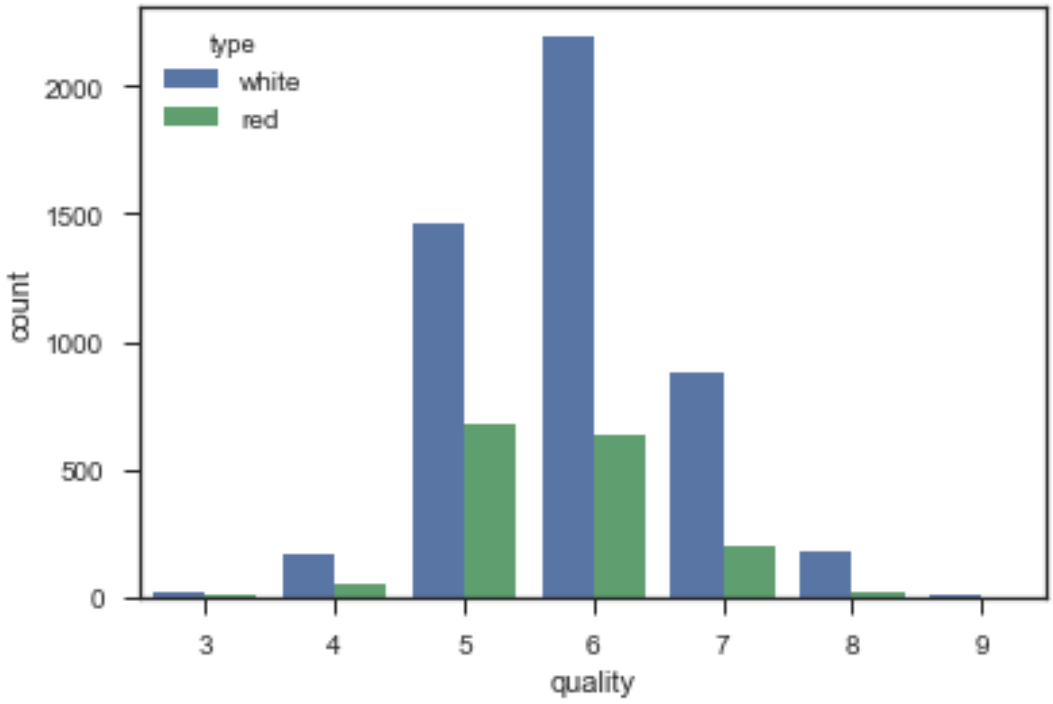

```
sea.lmplot(x='volatile acidity', y='alcohol', data = data)
#plt.plot()
```

```
<seaborn.axisgrid.FacetGrid at 0x2b39b2e7ef0>
```



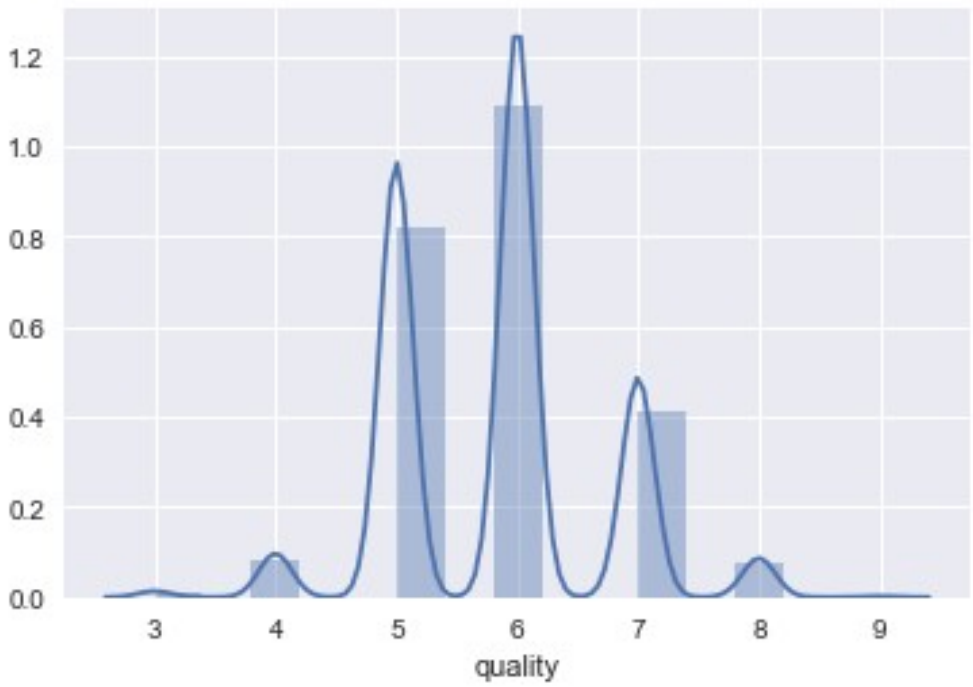

```
sea.set(style = 'ticks')
sea.countplot(data['quality'], hue = 'type', data = data)
#plt.show()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x2b39b25a828>
```



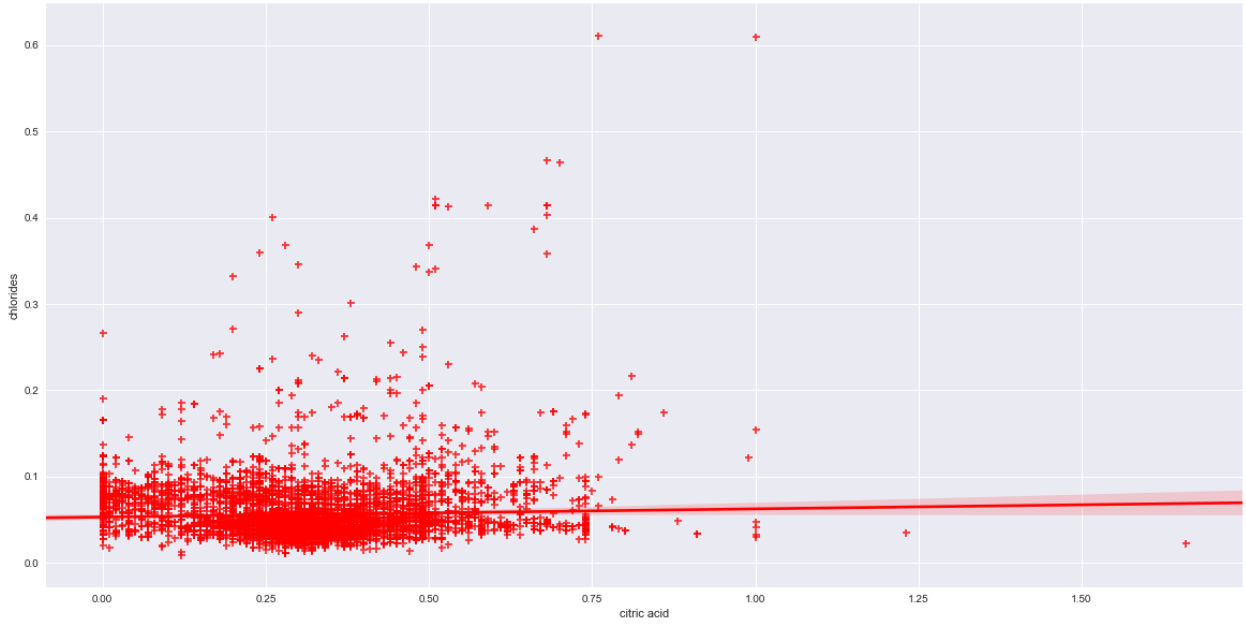

```
sea.set()
sea.distplot(data['quality'], bins = 15)
#plt.show()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x2b39b724320>
```



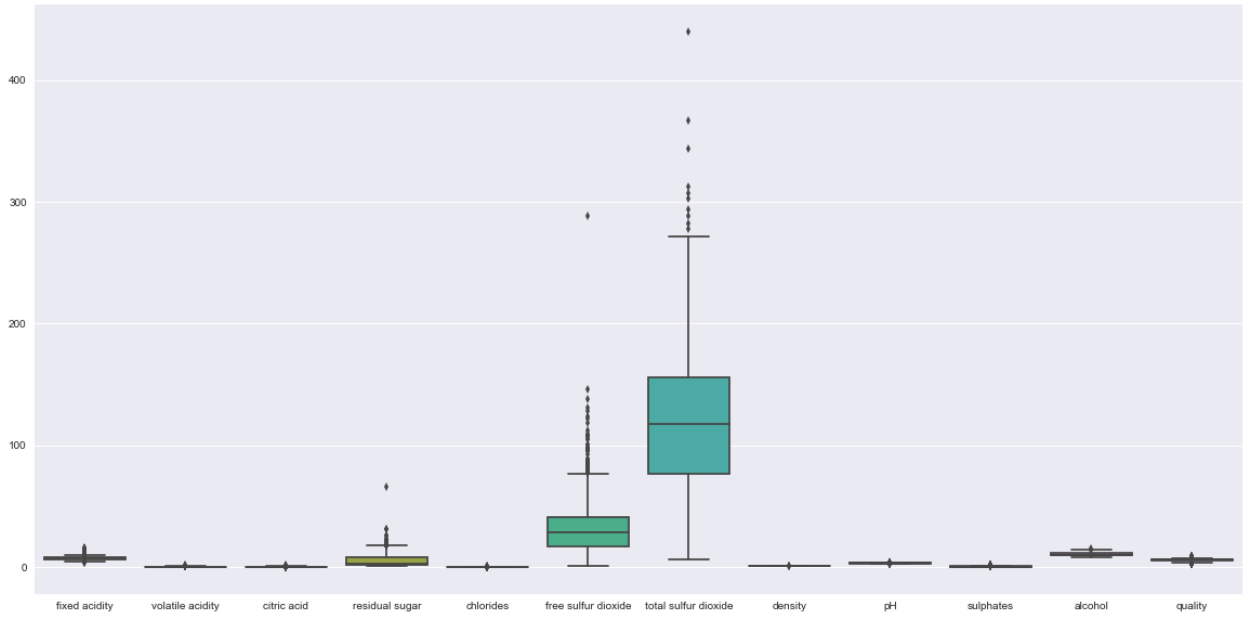
```
plt.figure(figsize = (20, 10))
sea.regplot(x = 'citric acid', y = 'chlorides', data = data, marker =
'+', color = 'r')
#plt.show()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x2b39b873d68>
```




```
sea.set()
plt.figure(figsize = (20, 10))
sea.boxplot(data = data)
#plt.show()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x2b39b878b70>
```




```
low = data['free sulfur dioxide'].mean() - 3*data['free sulfur
dioxide'].std()
high = data['free sulfur dioxide'].mean() + 3*data['free sulfur
dioxide'].std()
print('low = ', low)
print('high = ', high)
```

```
low =  -22.722879937833156
high =  83.77351869418224
```

```
data_copy = data[(data['free sulfur dioxide'] > low) & (data['free
sulfur dioxide'] < high)]
print(data_copy)
```

```
      type  fixed acidity  volatile acidity  citric acid  residual
sugar  \
0     white       7.000000          0.270000         0.36
20.70
1     white       6.300000          0.300000         0.34
1.60
2     white       8.100000          0.280000         0.40
6.90
3     white       7.200000          0.230000         0.32
8.50
4     white       7.200000          0.230000         0.32
8.50
5     white       8.100000          0.280000         0.40
6.90
6     white       6.200000          0.320000         0.16
7.00
7     white       7.000000          0.270000         0.36
```

```
20.70
8     white       6.300000          0.300000          0.34
1.60
9     white       8.100000          0.220000          0.43
1.50
10    white       8.100000          0.270000          0.41
1.45
11    white       8.600000          0.230000          0.40
4.20
12    white       7.900000          0.180000          0.37
1.20
13    white       6.600000          0.160000          0.40
1.50
14    white       8.300000          0.420000          0.62
19.25
15    white       6.600000          0.170000          0.38
1.50
16    white       6.300000          0.480000          0.04
1.10
17    white       7.216579          0.660000          0.48
1.20
18    white       7.400000          0.340000          0.42
1.10
19    white       6.500000          0.310000          0.14
7.50
20    white       6.200000          0.660000          0.48
1.20
21    white       6.400000          0.310000          0.38
2.90
22    white       6.800000          0.260000          0.42
1.70
23    white       7.600000          0.670000          0.14
1.50
24    white       6.600000          0.270000          0.41
1.30
25    white       7.000000          0.250000          0.32
9.00
26    white       6.900000          0.240000          0.35
1.00
27    white       7.000000          0.280000          0.39
8.70
28    white       7.400000          0.270000          0.48
1.10
29    white       7.200000          0.320000          0.36
2.00
...     ...             ...               ...           ...
...
6467    red       6.200000          0.510000          0.14
1.90
```

```
6468    red     6.400000        0.360000        0.53
2.20
6469    red     6.400000        0.380000        0.14
2.20
6470    red     7.300000        0.690000        0.32
2.20
6471    red     6.000000        0.580000        0.20
2.40
6472    red     5.600000        0.310000        0.78
13.90
6473    red     7.500000        0.520000        0.40
2.20
6474    red     8.000000        0.300000        0.63
1.60
6475    red     6.200000        0.700000        0.15
5.10
6476    red     6.800000        0.670000        0.15
1.80
6477    red     6.200000        0.560000        0.09
1.70
6478    red     7.400000        0.350000        0.33
2.40
6479    red     6.200000        0.560000        0.09
1.70
6480    red     6.100000        0.715000        0.10
2.60
6481    red     6.200000        0.460000        0.29
2.10
6482    red     6.700000        0.320000        0.44
2.40
6483    red     7.200000        0.390000        0.44
2.60
6484    red     7.500000        0.310000        0.41
2.40
6485    red     5.800000        0.610000        0.11
1.80
6486    red     7.200000        0.339691        0.33
2.50
6487    red     6.600000        0.725000        0.20
7.80
6488    red     6.300000        0.550000        0.15
1.80
6489    red     5.400000        0.740000        0.09
1.70
6490    red     6.300000        0.510000        0.13
2.30
6491    red     6.800000        0.620000        0.08
1.90
6492    red     6.200000        0.600000        0.08
```

```
2.00
6493    red       5.900000          0.550000         0.10
2.20
6494    red       6.300000          0.510000         0.13
2.30
6495    red       5.900000          0.645000         0.12
2.00
6496    red       6.000000          0.310000         0.47
3.60

      chlorides  free sulfur dioxide  total sulfur dioxide  density
pH  \
0         0.045                 45.0                 170.0  1.00100
3.00
1         0.049                 14.0                 132.0  0.99400
3.30
2         0.050                 30.0                  97.0  0.99510
3.26
3         0.058                 47.0                 186.0  0.99560
3.19
4         0.058                 47.0                 186.0  0.99560
3.19
5         0.050                 30.0                  97.0  0.99510
3.26
6         0.045                 30.0                 136.0  0.99490
3.18
7         0.045                 45.0                 170.0  1.00100
3.00
8         0.049                 14.0                 132.0  0.99400
3.30
9         0.044                 28.0                 129.0  0.99380
3.22
10        0.033                 11.0                  63.0  0.99080
2.99
11        0.035                 17.0                 109.0  0.99470
3.14
12        0.040                 16.0                  75.0  0.99200
3.18
13        0.044                 48.0                 143.0  0.99120
3.54
14        0.040                 41.0                 172.0  1.00020
2.98
15        0.032                 28.0                 112.0  0.99140
3.25
16        0.046                 30.0                  99.0  0.99280
3.24
17        0.029                 29.0                  75.0  0.98920
3.33
18        0.033                 17.0                 171.0  0.99170
```

```
3.12
19        0.044                  34.0                  133.0  0.99550
3.22
20        0.029                  29.0                   75.0  0.98920
3.33
21        0.038                  19.0                  102.0  0.99120
3.17
22        0.049                  41.0                  122.0  0.99300
3.47
23        0.074                  25.0                  168.0  0.99370
3.05
24        0.052                  16.0                  142.0  0.99510
3.42
25        0.046                  56.0                  245.0  0.99550
3.25
26        0.052                  35.0                  146.0  0.99300
3.45
27        0.051                  32.0                  141.0  0.99610
3.38
28        0.047                  17.0                  132.0  0.99140
3.19
29        0.033                  37.0                  114.0  0.99060
3.10
...         ...                   ...                    ...      ...
...
6467      0.056                  15.0                   34.0  0.99396
3.48
6468      0.230                  19.0                   35.0  0.99340
3.37
6469      0.038                  15.0                   25.0  0.99514
3.44
6470      0.069                  35.0                  104.0  0.99632
3.33
6471      0.075                  15.0                   50.0  0.99467
3.58
6472      0.074                  23.0                   92.0  0.99677
3.39
6473      0.060                  12.0                   20.0  0.99474
3.26
6474      0.081                  16.0                   29.0  0.99588
3.30
6475      0.076                  13.0                   27.0  0.99622
3.54
6476      0.118                  13.0                   20.0  0.99540
3.42
6477      0.053                  24.0                   32.0  0.99402
3.54
6478      0.068                   9.0                   26.0  0.99470
3.36
```

```
6479      0.053                  24.0                  32.0  0.99402
3.54
6480      0.053                  13.0                  27.0  0.99362
3.57
6481      0.074                  32.0                  98.0  0.99578
3.33
6482      0.061                  24.0                  34.0  0.99484
3.29
6483      0.066                  22.0                  48.0  0.99494
3.30
6484      0.065                  34.0                  60.0  0.99492
3.34
6485      0.066                  18.0                  28.0  0.99483
3.55
6486      0.068                  34.0                 102.0  0.99414
3.27
6487      0.073                  29.0                  79.0  0.99770
3.29
6488      0.077                  26.0                  35.0  0.99314
3.32
6489      0.089                  16.0                  26.0  0.99402
3.67
6490      0.076                  29.0                  40.0  0.99574
3.42
6491      0.068                  28.0                  38.0  0.99651
3.42
6492      0.090                  32.0                  44.0  0.99490
3.45
6493      0.062                  39.0                  51.0  0.99512
3.52
6494      0.076                  29.0                  40.0  0.99574
3.42
6495      0.075                  32.0                  44.0  0.99547
3.57
6496      0.067                  18.0                  42.0  0.99549
3.39

      sulphates  alcohol  quality
0      0.450000      8.8        6
1      0.490000      9.5        6
2      0.440000     10.1        6
3      0.400000      9.9        6
4      0.400000      9.9        6
5      0.440000     10.1        6
6      0.470000      9.6        6
7      0.450000      8.8        6
8      0.490000      9.5        6
9      0.450000     11.0        6
10     0.560000     12.0        5
```

11	0.530000	9.7	5
12	0.630000	10.8	5
13	0.520000	12.4	7
14	0.670000	9.7	5
15	0.550000	11.4	7
16	0.360000	9.6	6
17	0.390000	12.8	8
18	0.530000	11.3	6
19	0.500000	9.5	5
20	0.390000	12.8	8
21	0.350000	11.0	7
22	0.480000	10.5	8
23	0.510000	9.3	5
24	0.470000	10.0	6
25	0.500000	10.4	6
26	0.440000	10.0	6
27	0.530000	10.5	6
28	0.490000	11.6	6
29	0.710000	12.3	7
...	...	...	...
6467	0.570000	11.5	6
6468	0.930000	12.4	6
6469	0.650000	11.1	6
6470	0.510000	9.5	5
6471	0.670000	12.5	6
6472	0.480000	10.5	6
6473	0.640000	11.8	6
6474	0.780000	10.8	6
6475	0.600000	11.9	6
6476	0.670000	11.3	6
6477	0.600000	11.3	5
6478	0.600000	11.9	6
6479	0.600000	11.3	5
6480	0.500000	11.9	5
6481	0.620000	9.8	5
6482	0.800000	11.6	7
6483	0.840000	11.5	6
6484	0.850000	11.4	6
6485	0.660000	10.9	6
6486	0.780000	12.8	6
6487	0.540000	9.2	5
6488	0.820000	11.6	6
6489	0.560000	11.6	6
6490	0.750000	11.0	6
6491	0.820000	9.5	6
6492	0.580000	10.5	5
6493	0.531215	11.2	6
6494	0.750000	11.0	6
6495	0.710000	10.2	5
6496	0.660000	11.0	6

```
[6461 rows x 13 columns]
```

```
data.shape[0]
```

```
6497
```

```
data_copy.shape[0]
```

```
6461
```

```
difference = data.shape[0] - data_copy.shape[0]
difference
```

```
36
```

```
low = data_copy['total sulfur dioxide'].mean() - 3*data_copy['total
sulfur dioxide'].std()
high = data_copy['total sulfur dioxide'].mean() + 3*data_copy['total
sulfur dioxide'].std()
print('low = ', low)
print('high = ', high)
```

```
low =  -53.15243132839596
high =  283.65436601342924
```

```
data_copy2 = data_copy[(data_copy['total sulfur dioxide'] > low) &
(data_copy['total sulfur dioxide'] < high)]
print(data_copy2)
```

```
       type  fixed acidity  volatile acidity  citric acid  residual
sugar  \
0     white       7.000000          0.270000         0.36
20.70
1     white       6.300000          0.300000         0.34
1.60
2     white       8.100000          0.280000         0.40
6.90
3     white       7.200000          0.230000         0.32
8.50
4     white       7.200000          0.230000         0.32
8.50
5     white       8.100000          0.280000         0.40
6.90
6     white       6.200000          0.320000         0.16
7.00
7     white       7.000000          0.270000         0.36
20.70
8     white       6.300000          0.300000         0.34
1.60
9     white       8.100000          0.220000         0.43
1.50
```

```
10    white       8.100000          0.270000         0.41
1.45
11    white       8.600000          0.230000         0.40
4.20
12    white       7.900000          0.180000         0.37
1.20
13    white       6.600000          0.160000         0.40
1.50
14    white       8.300000          0.420000         0.62
19.25
15    white       6.600000          0.170000         0.38
1.50
16    white       6.300000          0.480000         0.04
1.10
17    white       7.216579          0.660000         0.48
1.20
18    white       7.400000          0.340000         0.42
1.10
19    white       6.500000          0.310000         0.14
7.50
20    white       6.200000          0.660000         0.48
1.20
21    white       6.400000          0.310000         0.38
2.90
22    white       6.800000          0.260000         0.42
1.70
23    white       7.600000          0.670000         0.14
1.50
24    white       6.600000          0.270000         0.41
1.30
25    white       7.000000          0.250000         0.32
9.00
26    white       6.900000          0.240000         0.35
1.00
27    white       7.000000          0.280000         0.39
8.70
28    white       7.400000          0.270000         0.48
1.10
29    white       7.200000          0.320000         0.36
2.00
...     ...            ...               ...          ...
...
6467    red       6.200000          0.510000         0.14
1.90
6468    red       6.400000          0.360000         0.53
2.20
6469    red       6.400000          0.380000         0.14
2.20
6470    red       7.300000          0.690000         0.32
```

```
2.20
6471    red         6.000000            0.580000          0.20
2.40
6472    red         5.600000            0.310000          0.78
13.90
6473    red         7.500000            0.520000          0.40
2.20
6474    red         8.000000            0.300000          0.63
1.60
6475    red         6.200000            0.700000          0.15
5.10
6476    red         6.800000            0.670000          0.15
1.80
6477    red         6.200000            0.560000          0.09
1.70
6478    red         7.400000            0.350000          0.33
2.40
6479    red         6.200000            0.560000          0.09
1.70
6480    red         6.100000            0.715000          0.10
2.60
6481    red         6.200000            0.460000          0.29
2.10
6482    red         6.700000            0.320000          0.44
2.40
6483    red         7.200000            0.390000          0.44
2.60
6484    red         7.500000            0.310000          0.41
2.40
6485    red         5.800000            0.610000          0.11
1.80
6486    red         7.200000            0.339691          0.33
2.50
6487    red         6.600000            0.725000          0.20
7.80
6488    red         6.300000            0.550000          0.15
1.80
6489    red         5.400000            0.740000          0.09
1.70
6490    red         6.300000            0.510000          0.13
2.30
6491    red         6.800000            0.620000          0.08
1.90
6492    red         6.200000            0.600000          0.08
2.00
6493    red         5.900000            0.550000          0.10
2.20
6494    red         6.300000            0.510000          0.13
2.30
```

```
6495    red       5.900000          0.645000         0.12
2.00
6496    red       6.000000          0.310000         0.47
3.60

      chlorides  free sulfur dioxide  total sulfur dioxide  density
pH  \
0         0.045                 45.0                 170.0  1.00100
3.00
1         0.049                 14.0                 132.0  0.99400
3.30
2         0.050                 30.0                  97.0  0.99510
3.26
3         0.058                 47.0                 186.0  0.99560
3.19
4         0.058                 47.0                 186.0  0.99560
3.19
5         0.050                 30.0                  97.0  0.99510
3.26
6         0.045                 30.0                 136.0  0.99490
3.18
7         0.045                 45.0                 170.0  1.00100
3.00
8         0.049                 14.0                 132.0  0.99400
3.30
9         0.044                 28.0                 129.0  0.99380
3.22
10        0.033                 11.0                  63.0  0.99080
2.99
11        0.035                 17.0                 109.0  0.99470
3.14
12        0.040                 16.0                  75.0  0.99200
3.18
13        0.044                 48.0                 143.0  0.99120
3.54
14        0.040                 41.0                 172.0  1.00020
2.98
15        0.032                 28.0                 112.0  0.99140
3.25
16        0.046                 30.0                  99.0  0.99280
3.24
17        0.029                 29.0                  75.0  0.98920
3.33
18        0.033                 17.0                 171.0  0.99170
3.12
19        0.044                 34.0                 133.0  0.99550
3.22
20        0.029                 29.0                  75.0  0.98920
3.33
```

```
21        0.038                19.0                 102.0  0.99120
3.17
22        0.049                41.0                 122.0  0.99300
3.47
23        0.074                25.0                 168.0  0.99370
3.05
24        0.052                16.0                 142.0  0.99510
3.42
25        0.046                56.0                 245.0  0.99550
3.25
26        0.052                35.0                 146.0  0.99300
3.45
27        0.051                32.0                 141.0  0.99610
3.38
28        0.047                17.0                 132.0  0.99140
3.19
29        0.033                37.0                 114.0  0.99060
3.10
...         ...                 ...                   ...      ...
...
6467      0.056                15.0                  34.0  0.99396
3.48
6468      0.230                19.0                  35.0  0.99340
3.37
6469      0.038                15.0                  25.0  0.99514
3.44
6470      0.069                35.0                 104.0  0.99632
3.33
6471      0.075                15.0                  50.0  0.99467
3.58
6472      0.074                23.0                  92.0  0.99677
3.39
6473      0.060                12.0                  20.0  0.99474
3.26
6474      0.081                16.0                  29.0  0.99588
3.30
6475      0.076                13.0                  27.0  0.99622
3.54
6476      0.118                13.0                  20.0  0.99540
3.42
6477      0.053                24.0                  32.0  0.99402
3.54
6478      0.068                 9.0                  26.0  0.99470
3.36
6479      0.053                24.0                  32.0  0.99402
3.54
6480      0.053                13.0                  27.0  0.99362
3.57
6481      0.074                32.0                  98.0  0.99578
```

```
3.33
6482      0.061                  24.0                  34.0  0.99484
3.29
6483      0.066                  22.0                  48.0  0.99494
3.30
6484      0.065                  34.0                  60.0  0.99492
3.34
6485      0.066                  18.0                  28.0  0.99483
3.55
6486      0.068                  34.0                 102.0  0.99414
3.27
6487      0.073                  29.0                  79.0  0.99770
3.29
6488      0.077                  26.0                  35.0  0.99314
3.32
6489      0.089                  16.0                  26.0  0.99402
3.67
6490      0.076                  29.0                  40.0  0.99574
3.42
6491      0.068                  28.0                  38.0  0.99651
3.42
6492      0.090                  32.0                  44.0  0.99490
3.45
6493      0.062                  39.0                  51.0  0.99512
3.52
6494      0.076                  29.0                  40.0  0.99574
3.42
6495      0.075                  32.0                  44.0  0.99547
3.57
6496      0.067                  18.0                  42.0  0.99549
3.39

      sulphates  alcohol  quality
0      0.450000      8.8        6
1      0.490000      9.5        6
2      0.440000     10.1        6
3      0.400000      9.9        6
4      0.400000      9.9        6
5      0.440000     10.1        6
6      0.470000      9.6        6
7      0.450000      8.8        6
8      0.490000      9.5        6
9      0.450000     11.0        6
10     0.560000     12.0        5
11     0.530000      9.7        5
12     0.630000     10.8        5
13     0.520000     12.4        7
14     0.670000      9.7        5
15     0.550000     11.4        7
```

```
16     0.360000      9.6         6
17     0.390000     12.8         8
18     0.530000     11.3         6
19     0.500000      9.5         5
20     0.390000     12.8         8
21     0.350000     11.0         7
22     0.480000     10.5         8
23     0.510000      9.3         5
24     0.470000     10.0         6
25     0.500000     10.4         6
26     0.440000     10.0         6
27     0.530000     10.5         6
28     0.490000     11.6         6
29     0.710000     12.3         7
...         ...      ...       ...
6467   0.570000     11.5         6
6468   0.930000     12.4         6
6469   0.650000     11.1         6
6470   0.510000      9.5         5
6471   0.670000     12.5         6
6472   0.480000     10.5         6
6473   0.640000     11.8         6
6474   0.780000     10.8         6
6475   0.600000     11.9         6
6476   0.670000     11.3         6
6477   0.600000     11.3         5
6478   0.600000     11.9         6
6479   0.600000     11.3         5
6480   0.500000     11.9         5
6481   0.620000      9.8         5
6482   0.800000     11.6         7
6483   0.840000     11.5         6
6484   0.850000     11.4         6
6485   0.660000     10.9         6
6486   0.780000     12.8         6
6487   0.540000      9.2         5
6488   0.820000     11.6         6
6489   0.560000     11.6         6
6490   0.750000     11.0         6
6491   0.820000      9.5         6
6492   0.580000     10.5         5
6493   0.531215     11.2         6
6494   0.750000     11.0         6
6495   0.710000     10.2         5
6496   0.660000     11.0         6

[6456 rows x 13 columns]
```

```
data_copy.shape[0] - data_copy2.shape[0]
```

```
5
```

```
low = data_copy2['residual sugar'].mean() - 3*data_copy2['residual
sugar'].std()
high = data_copy2['residual sugar'].mean() + 3*data_copy2['residual
sugar'].std()
print('low = ', low)
print('high = ', high)
```

```
low =  -8.835863630876144
high =  19.712440041288158
```

```
data_copy3 = data_copy2[(data_copy2['residual sugar'] > low) &
(data_copy2['residual sugar'] < high)]
print(data_copy3)
```

```
       type  fixed acidity  volatile acidity  citric acid  residual
sugar  \
1     white       6.300000          0.300000         0.34
1.60
2     white       8.100000          0.280000         0.40
6.90
3     white       7.200000          0.230000         0.32
8.50
4     white       7.200000          0.230000         0.32
8.50
5     white       8.100000          0.280000         0.40
6.90
6     white       6.200000          0.320000         0.16
7.00
8     white       6.300000          0.300000         0.34
1.60
9     white       8.100000          0.220000         0.43
1.50
10    white       8.100000          0.270000         0.41
1.45
11    white       8.600000          0.230000         0.40
4.20
12    white       7.900000          0.180000         0.37
1.20
13    white       6.600000          0.160000         0.40
1.50
14    white       8.300000          0.420000         0.62
19.25
15    white       6.600000          0.170000         0.38
1.50
16    white       6.300000          0.480000         0.04
1.10
17    white       7.216579          0.660000         0.48
1.20
```

```
18    white       7.400000          0.340000         0.42
1.10
19    white       6.500000          0.310000         0.14
7.50
20    white       6.200000          0.660000         0.48
1.20
21    white       6.400000          0.310000         0.38
2.90
22    white       6.800000          0.260000         0.42
1.70
23    white       7.600000          0.670000         0.14
1.50
24    white       6.600000          0.270000         0.41
1.30
25    white       7.000000          0.250000         0.32
9.00
26    white       6.900000          0.240000         0.35
1.00
27    white       7.000000          0.280000         0.39
8.70
28    white       7.400000          0.270000         0.48
1.10
29    white       7.200000          0.320000         0.36
2.00
30    white       8.500000          0.240000         0.39
10.40
31    white       8.300000          0.140000         0.34
1.10
...     ...            ...               ...          ...
...
6467    red       6.200000          0.510000         0.14
1.90
6468    red       6.400000          0.360000         0.53
2.20
6469    red       6.400000          0.380000         0.14
2.20
6470    red       7.300000          0.690000         0.32
2.20
6471    red       6.000000          0.580000         0.20
2.40
6472    red       5.600000          0.310000         0.78
13.90
6473    red       7.500000          0.520000         0.40
2.20
6474    red       8.000000          0.300000         0.63
1.60
6475    red       6.200000          0.700000         0.15
5.10
6476    red       6.800000          0.670000         0.15
```

```
1.80
6477    red       6.200000          0.560000         0.09
1.70
6478    red       7.400000          0.350000         0.33
2.40
6479    red       6.200000          0.560000         0.09
1.70
6480    red       6.100000          0.715000         0.10
2.60
6481    red       6.200000          0.460000         0.29
2.10
6482    red       6.700000          0.320000         0.44
2.40
6483    red       7.200000          0.390000         0.44
2.60
6484    red       7.500000          0.310000         0.41
2.40
6485    red       5.800000          0.610000         0.11
1.80
6486    red       7.200000          0.339691         0.33
2.50
6487    red       6.600000          0.725000         0.20
7.80
6488    red       6.300000          0.550000         0.15
1.80
6489    red       5.400000          0.740000         0.09
1.70
6490    red       6.300000          0.510000         0.13
2.30
6491    red       6.800000          0.620000         0.08
1.90
6492    red       6.200000          0.600000         0.08
2.00
6493    red       5.900000          0.550000         0.10
2.20
6494    red       6.300000          0.510000         0.13
2.30
6495    red       5.900000          0.645000         0.12
2.00
6496    red       6.000000          0.310000         0.47
3.60

      chlorides  free sulfur dioxide  total sulfur dioxide  density
pH  \
1         0.049                 14.0                 132.0  0.99400
3.30
2         0.050                 30.0                  97.0  0.99510
3.26
3         0.058                 47.0                 186.0  0.99560
```

```
3.19
4          0.058                47.0                186.0  0.99560
3.19
5          0.050                30.0                 97.0  0.99510
3.26
6          0.045                30.0                136.0  0.99490
3.18
8          0.049                14.0                132.0  0.99400
3.30
9          0.044                28.0                129.0  0.99380
3.22
10         0.033                11.0                 63.0  0.99080
2.99
11         0.035                17.0                109.0  0.99470
3.14
12         0.040                16.0                 75.0  0.99200
3.18
13         0.044                48.0                143.0  0.99120
3.54
14         0.040                41.0                172.0  1.00020
2.98
15         0.032                28.0                112.0  0.99140
3.25
16         0.046                30.0                 99.0  0.99280
3.24
17         0.029                29.0                 75.0  0.98920
3.33
18         0.033                17.0                171.0  0.99170
3.12
19         0.044                34.0                133.0  0.99550
3.22
20         0.029                29.0                 75.0  0.98920
3.33
21         0.038                19.0                102.0  0.99120
3.17
22         0.049                41.0                122.0  0.99300
3.47
23         0.074                25.0                168.0  0.99370
3.05
24         0.052                16.0                142.0  0.99510
3.42
25         0.046                56.0                245.0  0.99550
3.25
26         0.052                35.0                146.0  0.99300
3.45
27         0.051                32.0                141.0  0.99610
3.38
28         0.047                17.0                132.0  0.99140
3.19
```

```
29        0.033                37.0                 114.0  0.99060
3.10
30        0.044                20.0                 142.0  0.99740
3.20
31        0.042                 7.0                  47.0  0.99340
3.47
...         ...                 ...                   ...      ...
...
6467      0.056                15.0                  34.0  0.99396
3.48
6468      0.230                19.0                  35.0  0.99340
3.37
6469      0.038                15.0                  25.0  0.99514
3.44
6470      0.069                35.0                 104.0  0.99632
3.33
6471      0.075                15.0                  50.0  0.99467
3.58
6472      0.074                23.0                  92.0  0.99677
3.39
6473      0.060                12.0                  20.0  0.99474
3.26
6474      0.081                16.0                  29.0  0.99588
3.30
6475      0.076                13.0                  27.0  0.99622
3.54
6476      0.118                13.0                  20.0  0.99540
3.42
6477      0.053                24.0                  32.0  0.99402
3.54
6478      0.068                 9.0                  26.0  0.99470
3.36
6479      0.053                24.0                  32.0  0.99402
3.54
6480      0.053                13.0                  27.0  0.99362
3.57
6481      0.074                32.0                  98.0  0.99578
3.33
6482      0.061                24.0                  34.0  0.99484
3.29
6483      0.066                22.0                  48.0  0.99494
3.30
6484      0.065                34.0                  60.0  0.99492
3.34
6485      0.066                18.0                  28.0  0.99483
3.55
6486      0.068                34.0                 102.0  0.99414
3.27
6487      0.073                29.0                  79.0  0.99770
```

```
3.29
6488      0.077                 26.0                  35.0  0.99314
3.32
6489      0.089                 16.0                  26.0  0.99402
3.67
6490      0.076                 29.0                  40.0  0.99574
3.42
6491      0.068                 28.0                  38.0  0.99651
3.42
6492      0.090                 32.0                  44.0  0.99490
3.45
6493      0.062                 39.0                  51.0  0.99512
3.52
6494      0.076                 29.0                  40.0  0.99574
3.42
6495      0.075                 32.0                  44.0  0.99547
3.57
6496      0.067                 18.0                  42.0  0.99549
3.39
```

	sulphates	alcohol	quality
1	0.490000	9.5	6
2	0.440000	10.1	6
3	0.400000	9.9	6
4	0.400000	9.9	6
5	0.440000	10.1	6
6	0.470000	9.6	6
8	0.490000	9.5	6
9	0.450000	11.0	6
10	0.560000	12.0	5
11	0.530000	9.7	5
12	0.630000	10.8	5
13	0.520000	12.4	7
14	0.670000	9.7	5
15	0.550000	11.4	7
16	0.360000	9.6	6
17	0.390000	12.8	8
18	0.530000	11.3	6
19	0.500000	9.5	5
20	0.390000	12.8	8
21	0.350000	11.0	7
22	0.480000	10.5	8
23	0.510000	9.3	5
24	0.470000	10.0	6
25	0.500000	10.4	6
26	0.440000	10.0	6
27	0.530000	10.5	6
28	0.490000	11.6	6
29	0.710000	12.3	7

```
30     0.530000     10.0         6
31     0.400000     10.2         6
...         ...      ...       ...
6467   0.570000     11.5         6
6468   0.930000     12.4         6
6469   0.650000     11.1         6
6470   0.510000      9.5         5
6471   0.670000     12.5         6
6472   0.480000     10.5         6
6473   0.640000     11.8         6
6474   0.780000     10.8         6
6475   0.600000     11.9         6
6476   0.670000     11.3         6
6477   0.600000     11.3         5
6478   0.600000     11.9         6
6479   0.600000     11.3         5
6480   0.500000     11.9         5
6481   0.620000      9.8         5
6482   0.800000     11.6         7
6483   0.840000     11.5         6
6484   0.850000     11.4         6
6485   0.660000     10.9         6
6486   0.780000     12.8         6
6487   0.540000      9.2         5
6488   0.820000     11.6         6
6489   0.560000     11.6         6
6490   0.750000     11.0         6
6491   0.820000      9.5         6
6492   0.580000     10.5         5
6493   0.531215     11.2         6
6494   0.750000     11.0         6
6495   0.710000     10.2         5
6496   0.660000     11.0         6

[6430 rows x 13 columns]
```

```
data_copy2.shape[0] - data_copy3.shape[0]
```

```
26
```

```
data_copy3.isnull().sum()
```

```
type                    0
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
```

```
tmp = pd.get_dummies(data_copy3['type'], drop_first = True)

data_copy3 = pd.concat([data_copy3, tmp], axis = 1)
data_copy3.drop('type', axis = 1, inplace = True)
print(data_copy3)
print('----------')
data_copy3.head()
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
1          6.300000          0.300000         0.34            1.60
0.049
2          8.100000          0.280000         0.40            6.90
0.050
3          7.200000          0.230000         0.32            8.50
0.058
4          7.200000          0.230000         0.32            8.50
0.058
5          8.100000          0.280000         0.40            6.90
0.050
6          6.200000          0.320000         0.16            7.00
0.045
8          6.300000          0.300000         0.34            1.60
0.049
9          8.100000          0.220000         0.43            1.50
0.044
10         8.100000          0.270000         0.41            1.45
0.033
11         8.600000          0.230000         0.40            4.20
0.035
12         7.900000          0.180000         0.37            1.20
0.040
13         6.600000          0.160000         0.40            1.50
0.044
14         8.300000          0.420000         0.62           19.25
0.040
15         6.600000          0.170000         0.38            1.50
0.032
16         6.300000          0.480000         0.04            1.10
0.046
17         7.216579          0.660000         0.48            1.20
0.029
18         7.400000          0.340000         0.42            1.10
```

```
0.033
19          6.500000          0.310000          0.14             7.50
0.044
20          6.200000          0.660000          0.48             1.20
0.029
21          6.400000          0.310000          0.38             2.90
0.038
22          6.800000          0.260000          0.42             1.70
0.049
23          7.600000          0.670000          0.14             1.50
0.074
24          6.600000          0.270000          0.41             1.30
0.052
25          7.000000          0.250000          0.32             9.00
0.046
26          6.900000          0.240000          0.35             1.00
0.052
27          7.000000          0.280000          0.39             8.70
0.051
28          7.400000          0.270000          0.48             1.10
0.047
29          7.200000          0.320000          0.36             2.00
0.033
30          8.500000          0.240000          0.39            10.40
0.044
31          8.300000          0.140000          0.34             1.10
0.042
...              ...               ...           ...              ...
...
6467        6.200000          0.510000          0.14             1.90
0.056
6468        6.400000          0.360000          0.53             2.20
0.230
6469        6.400000          0.380000          0.14             2.20
0.038
6470        7.300000          0.690000          0.32             2.20
0.069
6471        6.000000          0.580000          0.20             2.40
0.075
6472        5.600000          0.310000          0.78            13.90
0.074
6473        7.500000          0.520000          0.40             2.20
0.060
6474        8.000000          0.300000          0.63             1.60
0.081
6475        6.200000          0.700000          0.15             5.10
0.076
6476        6.800000          0.670000          0.15             1.80
0.118
```

```
6477       6.200000          0.560000         0.09             1.70
0.053
6478       7.400000          0.350000         0.33             2.40
0.068
6479       6.200000          0.560000         0.09             1.70
0.053
6480       6.100000          0.715000         0.10             2.60
0.053
6481       6.200000          0.460000         0.29             2.10
0.074
6482       6.700000          0.320000         0.44             2.40
0.061
6483       7.200000          0.390000         0.44             2.60
0.066
6484       7.500000          0.310000         0.41             2.40
0.065
6485       5.800000          0.610000         0.11             1.80
0.066
6486       7.200000          0.339691         0.33             2.50
0.068
6487       6.600000          0.725000         0.20             7.80
0.073
6488       6.300000          0.550000         0.15             1.80
0.077
6489       5.400000          0.740000         0.09             1.70
0.089
6490       6.300000          0.510000         0.13             2.30
0.076
6491       6.800000          0.620000         0.08             1.90
0.068
6492       6.200000          0.600000         0.08             2.00
0.090
6493       5.900000          0.550000         0.10             2.20
0.062
6494       6.300000          0.510000         0.13             2.30
0.076
6495       5.900000          0.645000         0.12             2.00
0.075
6496       6.000000          0.310000         0.47             3.60
0.067

      free sulfur dioxide  total sulfur dioxide  density    pH
sulphates  \
1                    14.0                 132.0  0.99400  3.30
0.490000
2                    30.0                  97.0  0.99510  3.26
0.440000
3                    47.0                 186.0  0.99560  3.19
0.400000
```

```
4                    47.0                  186.0  0.99560  3.19
0.400000
5                    30.0                   97.0  0.99510  3.26
0.440000
6                    30.0                  136.0  0.99490  3.18
0.470000
8                    14.0                  132.0  0.99400  3.30
0.490000
9                    28.0                  129.0  0.99380  3.22
0.450000
10                   11.0                   63.0  0.99080  2.99
0.560000
11                   17.0                  109.0  0.99470  3.14
0.530000
12                   16.0                   75.0  0.99200  3.18
0.630000
13                   48.0                  143.0  0.99120  3.54
0.520000
14                   41.0                  172.0  1.00020  2.98
0.670000
15                   28.0                  112.0  0.99140  3.25
0.550000
16                   30.0                   99.0  0.99280  3.24
0.360000
17                   29.0                   75.0  0.98920  3.33
0.390000
18                   17.0                  171.0  0.99170  3.12
0.530000
19                   34.0                  133.0  0.99550  3.22
0.500000
20                   29.0                   75.0  0.98920  3.33
0.390000
21                   19.0                  102.0  0.99120  3.17
0.350000
22                   41.0                  122.0  0.99300  3.47
0.480000
23                   25.0                  168.0  0.99370  3.05
0.510000
24                   16.0                  142.0  0.99510  3.42
0.470000
25                   56.0                  245.0  0.99550  3.25
0.500000
26                   35.0                  146.0  0.99300  3.45
0.440000
27                   32.0                  141.0  0.99610  3.38
0.530000
28                   17.0                  132.0  0.99140  3.19
0.490000
29                   37.0                  114.0  0.99060  3.10
```

```
0.710000
30                   20.0                  142.0  0.99740  3.20
0.530000
31                    7.0                   47.0  0.99340  3.47
0.400000
...                   ...                    ...      ...   ...
...
6467                 15.0                   34.0  0.99396  3.48
0.570000
6468                 19.0                   35.0  0.99340  3.37
0.930000
6469                 15.0                   25.0  0.99514  3.44
0.650000
6470                 35.0                  104.0  0.99632  3.33
0.510000
6471                 15.0                   50.0  0.99467  3.58
0.670000
6472                 23.0                   92.0  0.99677  3.39
0.480000
6473                 12.0                   20.0  0.99474  3.26
0.640000
6474                 16.0                   29.0  0.99588  3.30
0.780000
6475                 13.0                   27.0  0.99622  3.54
0.600000
6476                 13.0                   20.0  0.99540  3.42
0.670000
6477                 24.0                   32.0  0.99402  3.54
0.600000
6478                  9.0                   26.0  0.99470  3.36
0.600000
6479                 24.0                   32.0  0.99402  3.54
0.600000
6480                 13.0                   27.0  0.99362  3.57
0.500000
6481                 32.0                   98.0  0.99578  3.33
0.620000
6482                 24.0                   34.0  0.99484  3.29
0.800000
6483                 22.0                   48.0  0.99494  3.30
0.840000
6484                 34.0                   60.0  0.99492  3.34
0.850000
6485                 18.0                   28.0  0.99483  3.55
0.660000
6486                 34.0                  102.0  0.99414  3.27
0.780000
6487                 29.0                   79.0  0.99770  3.29
0.540000
```

```
6488                   26.0                   35.0  0.99314  3.32
0.820000
6489                   16.0                   26.0  0.99402  3.67
0.560000
6490                   29.0                   40.0  0.99574  3.42
0.750000
6491                   28.0                   38.0  0.99651  3.42
0.820000
6492                   32.0                   44.0  0.99490  3.45
0.580000
6493                   39.0                   51.0  0.99512  3.52
0.531215
6494                   29.0                   40.0  0.99574  3.42
0.750000
6495                   32.0                   44.0  0.99547  3.57
0.710000
6496                   18.0                   42.0  0.99549  3.39
0.660000
```

	alcohol	quality	white
1	9.5	6	1
2	10.1	6	1
3	9.9	6	1
4	9.9	6	1
5	10.1	6	1
6	9.6	6	1
8	9.5	6	1
9	11.0	6	1
10	12.0	5	1
11	9.7	5	1
12	10.8	5	1
13	12.4	7	1
14	9.7	5	1
15	11.4	7	1
16	9.6	6	1
17	12.8	8	1
18	11.3	6	1
19	9.5	5	1
20	12.8	8	1
21	11.0	7	1
22	10.5	8	1
23	9.3	5	1
24	10.0	6	1
25	10.4	6	1
26	10.0	6	1
27	10.5	6	1
28	11.6	6	1
29	12.3	7	1
30	10.0	6	1

```
31       10.2        6      1
...       ...      ...    ...
6467     11.5        6      0
6468     12.4        6      0
6469     11.1        6      0
6470      9.5        5      0
6471     12.5        6      0
6472     10.5        6      0
6473     11.8        6      0
6474     10.8        6      0
6475     11.9        6      0
6476     11.3        6      0
6477     11.3        5      0
6478     11.9        6      0
6479     11.3        5      0
6480     11.9        5      0
6481      9.8        5      0
6482     11.6        7      0
6483     11.5        6      0
6484     11.4        6      0
6485     10.9        6      0
6486     12.8        6      0
6487      9.2        5      0
6488     11.6        6      0
6489     11.6        6      0
6490     11.0        6      0
6491      9.5        6      0
6492     10.5        5      0
6493     11.2        6      0
6494     11.0        6      0
6495     10.2        5      0
6496     11.0        6      0

[6430 rows x 13 columns]
----------

   fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
1            6.3              0.30         0.34             1.6
0.049
2            8.1              0.28         0.40             6.9
0.050
3            7.2              0.23         0.32             8.5
0.058
4            7.2              0.23         0.32             8.5
0.058
5            8.1              0.28         0.40             6.9
0.050

   free sulfur dioxide  total sulfur dioxide  density    pH  sulphates
```

```
\
1                  14.0                  132.0   0.9940  3.30       0.49

2                  30.0                   97.0   0.9951  3.26       0.44

3                  47.0                  186.0   0.9956  3.19       0.40

4                  47.0                  186.0   0.9956  3.19       0.40

5                  30.0                   97.0   0.9951  3.26       0.44


   alcohol  quality  white
1      9.5        6      1
2     10.1        6      1
3      9.9        6      1
4      9.9        6      1
5     10.1        6      1
```

```
data_copy3.quality.value_counts()
print(data_copy3)
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
1          6.300000          0.300000         0.34             1.60
0.049
2          8.100000          0.280000         0.40             6.90
0.050
3          7.200000          0.230000         0.32             8.50
0.058
4          7.200000          0.230000         0.32             8.50
0.058
5          8.100000          0.280000         0.40             6.90
0.050
6          6.200000          0.320000         0.16             7.00
0.045
8          6.300000          0.300000         0.34             1.60
0.049
9          8.100000          0.220000         0.43             1.50
0.044
10         8.100000          0.270000         0.41             1.45
0.033
11         8.600000          0.230000         0.40             4.20
0.035
12         7.900000          0.180000         0.37             1.20
0.040
13         6.600000          0.160000         0.40             1.50
0.044
14         8.300000          0.420000         0.62            19.25
0.040
```

```
15          6.600000          0.170000          0.38           1.50
0.032
16          6.300000          0.480000          0.04           1.10
0.046
17          7.216579          0.660000          0.48           1.20
0.029
18          7.400000          0.340000          0.42           1.10
0.033
19          6.500000          0.310000          0.14           7.50
0.044
20          6.200000          0.660000          0.48           1.20
0.029
21          6.400000          0.310000          0.38           2.90
0.038
22          6.800000          0.260000          0.42           1.70
0.049
23          7.600000          0.670000          0.14           1.50
0.074
24          6.600000          0.270000          0.41           1.30
0.052
25          7.000000          0.250000          0.32           9.00
0.046
26          6.900000          0.240000          0.35           1.00
0.052
27          7.000000          0.280000          0.39           8.70
0.051
28          7.400000          0.270000          0.48           1.10
0.047
29          7.200000          0.320000          0.36           2.00
0.033
30          8.500000          0.240000          0.39          10.40
0.044
31          8.300000          0.140000          0.34           1.10
0.042
...              ...               ...           ...            ...
...
6467        6.200000          0.510000          0.14           1.90
0.056
6468        6.400000          0.360000          0.53           2.20
0.230
6469        6.400000          0.380000          0.14           2.20
0.038
6470        7.300000          0.690000          0.32           2.20
0.069
6471        6.000000          0.580000          0.20           2.40
0.075
6472        5.600000          0.310000          0.78          13.90
0.074
6473        7.500000          0.520000          0.40           2.20
```

```
0.060
6474       8.000000          0.300000         0.63             1.60
0.081
6475       6.200000          0.700000         0.15             5.10
0.076
6476       6.800000          0.670000         0.15             1.80
0.118
6477       6.200000          0.560000         0.09             1.70
0.053
6478       7.400000          0.350000         0.33             2.40
0.068
6479       6.200000          0.560000         0.09             1.70
0.053
6480       6.100000          0.715000         0.10             2.60
0.053
6481       6.200000          0.460000         0.29             2.10
0.074
6482       6.700000          0.320000         0.44             2.40
0.061
6483       7.200000          0.390000         0.44             2.60
0.066
6484       7.500000          0.310000         0.41             2.40
0.065
6485       5.800000          0.610000         0.11             1.80
0.066
6486       7.200000          0.339691         0.33             2.50
0.068
6487       6.600000          0.725000         0.20             7.80
0.073
6488       6.300000          0.550000         0.15             1.80
0.077
6489       5.400000          0.740000         0.09             1.70
0.089
6490       6.300000          0.510000         0.13             2.30
0.076
6491       6.800000          0.620000         0.08             1.90
0.068
6492       6.200000          0.600000         0.08             2.00
0.090
6493       5.900000          0.550000         0.10             2.20
0.062
6494       6.300000          0.510000         0.13             2.30
0.076
6495       5.900000          0.645000         0.12             2.00
0.075
6496       6.000000          0.310000         0.47             3.60
0.067

      free sulfur dioxide  total sulfur dioxide  density    pH
```

```
sulphates  \
1                    14.0                  132.0  0.99400  3.30
0.490000
2                    30.0                   97.0  0.99510  3.26
0.440000
3                    47.0                  186.0  0.99560  3.19
0.400000
4                    47.0                  186.0  0.99560  3.19
0.400000
5                    30.0                   97.0  0.99510  3.26
0.440000
6                    30.0                  136.0  0.99490  3.18
0.470000
8                    14.0                  132.0  0.99400  3.30
0.490000
9                    28.0                  129.0  0.99380  3.22
0.450000
10                   11.0                   63.0  0.99080  2.99
0.560000
11                   17.0                  109.0  0.99470  3.14
0.530000
12                   16.0                   75.0  0.99200  3.18
0.630000
13                   48.0                  143.0  0.99120  3.54
0.520000
14                   41.0                  172.0  1.00020  2.98
0.670000
15                   28.0                  112.0  0.99140  3.25
0.550000
16                   30.0                   99.0  0.99280  3.24
0.360000
17                   29.0                   75.0  0.98920  3.33
0.390000
18                   17.0                  171.0  0.99170  3.12
0.530000
19                   34.0                  133.0  0.99550  3.22
0.500000
20                   29.0                   75.0  0.98920  3.33
0.390000
21                   19.0                  102.0  0.99120  3.17
0.350000
22                   41.0                  122.0  0.99300  3.47
0.480000
23                   25.0                  168.0  0.99370  3.05
0.510000
24                   16.0                  142.0  0.99510  3.42
0.470000
25                   56.0                  245.0  0.99550  3.25
0.500000
```

```
26                    35.0                  146.0  0.99300  3.45
0.440000
27                    32.0                  141.0  0.99610  3.38
0.530000
28                    17.0                  132.0  0.99140  3.19
0.490000
29                    37.0                  114.0  0.99060  3.10
0.710000
30                    20.0                  142.0  0.99740  3.20
0.530000
31                     7.0                   47.0  0.99340  3.47
0.400000
...                    ...                    ...      ...   ...
...
6467                  15.0                   34.0  0.99396  3.48
0.570000
6468                  19.0                   35.0  0.99340  3.37
0.930000
6469                  15.0                   25.0  0.99514  3.44
0.650000
6470                  35.0                  104.0  0.99632  3.33
0.510000
6471                  15.0                   50.0  0.99467  3.58
0.670000
6472                  23.0                   92.0  0.99677  3.39
0.480000
6473                  12.0                   20.0  0.99474  3.26
0.640000
6474                  16.0                   29.0  0.99588  3.30
0.780000
6475                  13.0                   27.0  0.99622  3.54
0.600000
6476                  13.0                   20.0  0.99540  3.42
0.670000
6477                  24.0                   32.0  0.99402  3.54
0.600000
6478                   9.0                   26.0  0.99470  3.36
0.600000
6479                  24.0                   32.0  0.99402  3.54
0.600000
6480                  13.0                   27.0  0.99362  3.57
0.500000
6481                  32.0                   98.0  0.99578  3.33
0.620000
6482                  24.0                   34.0  0.99484  3.29
0.800000
6483                  22.0                   48.0  0.99494  3.30
0.840000
6484                  34.0                   60.0  0.99492  3.34
```

```
0.850000
6485                  18.0                   28.0  0.99483  3.55
0.660000
6486                  34.0                  102.0  0.99414  3.27
0.780000
6487                  29.0                   79.0  0.99770  3.29
0.540000
6488                  26.0                   35.0  0.99314  3.32
0.820000
6489                  16.0                   26.0  0.99402  3.67
0.560000
6490                  29.0                   40.0  0.99574  3.42
0.750000
6491                  28.0                   38.0  0.99651  3.42
0.820000
6492                  32.0                   44.0  0.99490  3.45
0.580000
6493                  39.0                   51.0  0.99512  3.52
0.531215
6494                  29.0                   40.0  0.99574  3.42
0.750000
6495                  32.0                   44.0  0.99547  3.57
0.710000
6496                  18.0                   42.0  0.99549  3.39
0.660000
```

	alcohol	quality	white
1	9.5	6	1
2	10.1	6	1
3	9.9	6	1
4	9.9	6	1
5	10.1	6	1
6	9.6	6	1
8	9.5	6	1
9	11.0	6	1
10	12.0	5	1
11	9.7	5	1
12	10.8	5	1
13	12.4	7	1
14	9.7	5	1
15	11.4	7	1
16	9.6	6	1
17	12.8	8	1
18	11.3	6	1
19	9.5	5	1
20	12.8	8	1
21	11.0	7	1
22	10.5	8	1
23	9.3	5	1

```
24       10.0         6      1
25       10.4         6      1
26       10.0         6      1
27       10.5         6      1
28       11.6         6      1
29       12.3         7      1
30       10.0         6      1
31       10.2         6      1
...       ...       ...    ...
6467     11.5         6      0
6468     12.4         6      0
6469     11.1         6      0
6470      9.5         5      0
6471     12.5         6      0
6472     10.5         6      0
6473     11.8         6      0
6474     10.8         6      0
6475     11.9         6      0
6476     11.3         6      0
6477     11.3         5      0
6478     11.9         6      0
6479     11.3         5      0
6480     11.9         5      0
6481      9.8         5      0
6482     11.6         7      0
6483     11.5         6      0
6484     11.4         6      0
6485     10.9         6      0
6486     12.8         6      0
6487      9.2         5      0
6488     11.6         6      0
6489     11.6         6      0
6490     11.0         6      0
6491      9.5         6      0
6492     10.5         5      0
6493     11.2         6      0
6494     11.0         6      0
6495     10.2         5      0
6496     11.0         6      0

[6430 rows x 13 columns]
```

```
quality_map = { 3 : 'Low', 4 : 'Low', 5: 'Medium', 6 : 'Medium', 7:
'Medium', 8 : 'High', 9 : 'High'}
data_copy3['quality'] =  data_copy3['quality'].map(quality_map)
print(data_copy3)
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
```

1	6.300000	0.300000	0.34	1.60	0.049
2	8.100000	0.280000	0.40	6.90	0.050
3	7.200000	0.230000	0.32	8.50	0.058
4	7.200000	0.230000	0.32	8.50	0.058
5	8.100000	0.280000	0.40	6.90	0.050
6	6.200000	0.320000	0.16	7.00	0.045
8	6.300000	0.300000	0.34	1.60	0.049
9	8.100000	0.220000	0.43	1.50	0.044
10	8.100000	0.270000	0.41	1.45	0.033
11	8.600000	0.230000	0.40	4.20	0.035
12	7.900000	0.180000	0.37	1.20	0.040
13	6.600000	0.160000	0.40	1.50	0.044
14	8.300000	0.420000	0.62	19.25	0.040
15	6.600000	0.170000	0.38	1.50	0.032
16	6.300000	0.480000	0.04	1.10	0.046
17	7.216579	0.660000	0.48	1.20	0.029
18	7.400000	0.340000	0.42	1.10	0.033
19	6.500000	0.310000	0.14	7.50	0.044
20	6.200000	0.660000	0.48	1.20	0.029
21	6.400000	0.310000	0.38	2.90	0.038
22	6.800000	0.260000	0.42	1.70	0.049
23	7.600000	0.670000	0.14	1.50	0.074
24	6.600000	0.270000	0.41	1.30	0.052
25	7.000000	0.250000	0.32	9.00	0.046
26	6.900000	0.240000	0.35	1.00	

```
0.052
27          7.000000          0.280000          0.39             8.70
0.051
28          7.400000          0.270000          0.48             1.10
0.047
29          7.200000          0.320000          0.36             2.00
0.033
30          8.500000          0.240000          0.39            10.40
0.044
31          8.300000          0.140000          0.34             1.10
0.042
...              ...               ...           ...              ...
...
6467        6.200000          0.510000          0.14             1.90
0.056
6468        6.400000          0.360000          0.53             2.20
0.230
6469        6.400000          0.380000          0.14             2.20
0.038
6470        7.300000          0.690000          0.32             2.20
0.069
6471        6.000000          0.580000          0.20             2.40
0.075
6472        5.600000          0.310000          0.78            13.90
0.074
6473        7.500000          0.520000          0.40             2.20
0.060
6474        8.000000          0.300000          0.63             1.60
0.081
6475        6.200000          0.700000          0.15             5.10
0.076
6476        6.800000          0.670000          0.15             1.80
0.118
6477        6.200000          0.560000          0.09             1.70
0.053
6478        7.400000          0.350000          0.33             2.40
0.068
6479        6.200000          0.560000          0.09             1.70
0.053
6480        6.100000          0.715000          0.10             2.60
0.053
6481        6.200000          0.460000          0.29             2.10
0.074
6482        6.700000          0.320000          0.44             2.40
0.061
6483        7.200000          0.390000          0.44             2.60
0.066
6484        7.500000          0.310000          0.41             2.40
0.065
```

```
6485       5.800000          0.610000         0.11             1.80
0.066
6486       7.200000          0.339691         0.33             2.50
0.068
6487       6.600000          0.725000         0.20             7.80
0.073
6488       6.300000          0.550000         0.15             1.80
0.077
6489       5.400000          0.740000         0.09             1.70
0.089
6490       6.300000          0.510000         0.13             2.30
0.076
6491       6.800000          0.620000         0.08             1.90
0.068
6492       6.200000          0.600000         0.08             2.00
0.090
6493       5.900000          0.550000         0.10             2.20
0.062
6494       6.300000          0.510000         0.13             2.30
0.076
6495       5.900000          0.645000         0.12             2.00
0.075
6496       6.000000          0.310000         0.47             3.60
0.067

      free sulfur dioxide  total sulfur dioxide  density    pH
sulphates  \
1                    14.0                 132.0  0.99400  3.30
0.490000
2                    30.0                  97.0  0.99510  3.26
0.440000
3                    47.0                 186.0  0.99560  3.19
0.400000
4                    47.0                 186.0  0.99560  3.19
0.400000
5                    30.0                  97.0  0.99510  3.26
0.440000
6                    30.0                 136.0  0.99490  3.18
0.470000
8                    14.0                 132.0  0.99400  3.30
0.490000
9                    28.0                 129.0  0.99380  3.22
0.450000
10                   11.0                  63.0  0.99080  2.99
0.560000
11                   17.0                 109.0  0.99470  3.14
0.530000
12                   16.0                  75.0  0.99200  3.18
0.630000
```

```
13                   48.0                  143.0  0.99120  3.54
0.520000
14                   41.0                  172.0  1.00020  2.98
0.670000
15                   28.0                  112.0  0.99140  3.25
0.550000
16                   30.0                   99.0  0.99280  3.24
0.360000
17                   29.0                   75.0  0.98920  3.33
0.390000
18                   17.0                  171.0  0.99170  3.12
0.530000
19                   34.0                  133.0  0.99550  3.22
0.500000
20                   29.0                   75.0  0.98920  3.33
0.390000
21                   19.0                  102.0  0.99120  3.17
0.350000
22                   41.0                  122.0  0.99300  3.47
0.480000
23                   25.0                  168.0  0.99370  3.05
0.510000
24                   16.0                  142.0  0.99510  3.42
0.470000
25                   56.0                  245.0  0.99550  3.25
0.500000
26                   35.0                  146.0  0.99300  3.45
0.440000
27                   32.0                  141.0  0.99610  3.38
0.530000
28                   17.0                  132.0  0.99140  3.19
0.490000
29                   37.0                  114.0  0.99060  3.10
0.710000
30                   20.0                  142.0  0.99740  3.20
0.530000
31                    7.0                   47.0  0.99340  3.47
0.400000
...                   ...                    ...      ...   ...
...
6467                 15.0                   34.0  0.99396  3.48
0.570000
6468                 19.0                   35.0  0.99340  3.37
0.930000
6469                 15.0                   25.0  0.99514  3.44
0.650000
6470                 35.0                  104.0  0.99632  3.33
0.510000
6471                 15.0                   50.0  0.99467  3.58
```

```
0.670000
6472                 23.0                  92.0  0.99677  3.39
0.480000
6473                 12.0                  20.0  0.99474  3.26
0.640000
6474                 16.0                  29.0  0.99588  3.30
0.780000
6475                 13.0                  27.0  0.99622  3.54
0.600000
6476                 13.0                  20.0  0.99540  3.42
0.670000
6477                 24.0                  32.0  0.99402  3.54
0.600000
6478                  9.0                  26.0  0.99470  3.36
0.600000
6479                 24.0                  32.0  0.99402  3.54
0.600000
6480                 13.0                  27.0  0.99362  3.57
0.500000
6481                 32.0                  98.0  0.99578  3.33
0.620000
6482                 24.0                  34.0  0.99484  3.29
0.800000
6483                 22.0                  48.0  0.99494  3.30
0.840000
6484                 34.0                  60.0  0.99492  3.34
0.850000
6485                 18.0                  28.0  0.99483  3.55
0.660000
6486                 34.0                 102.0  0.99414  3.27
0.780000
6487                 29.0                  79.0  0.99770  3.29
0.540000
6488                 26.0                  35.0  0.99314  3.32
0.820000
6489                 16.0                  26.0  0.99402  3.67
0.560000
6490                 29.0                  40.0  0.99574  3.42
0.750000
6491                 28.0                  38.0  0.99651  3.42
0.820000
6492                 32.0                  44.0  0.99490  3.45
0.580000
6493                 39.0                  51.0  0.99512  3.52
0.531215
6494                 29.0                  40.0  0.99574  3.42
0.750000
6495                 32.0                  44.0  0.99547  3.57
0.710000
```

```
6496                  18.0                  42.0  0.99549  3.39
0.660000

      alcohol quality  white
1         9.5  Medium      1
2        10.1  Medium      1
3         9.9  Medium      1
4         9.9  Medium      1
5        10.1  Medium      1
6         9.6  Medium      1
8         9.5  Medium      1
9        11.0  Medium      1
10       12.0  Medium      1
11        9.7  Medium      1
12       10.8  Medium      1
13       12.4  Medium      1
14        9.7  Medium      1
15       11.4  Medium      1
16        9.6  Medium      1
17       12.8    High      1
18       11.3  Medium      1
19        9.5  Medium      1
20       12.8    High      1
21       11.0  Medium      1
22       10.5    High      1
23        9.3  Medium      1
24       10.0  Medium      1
25       10.4  Medium      1
26       10.0  Medium      1
27       10.5  Medium      1
28       11.6  Medium      1
29       12.3  Medium      1
30       10.0  Medium      1
31       10.2  Medium      1
...       ...     ...    ...
6467     11.5  Medium      0
6468     12.4  Medium      0
6469     11.1  Medium      0
6470      9.5  Medium      0
6471     12.5  Medium      0
6472     10.5  Medium      0
6473     11.8  Medium      0
6474     10.8  Medium      0
6475     11.9  Medium      0
6476     11.3  Medium      0
6477     11.3  Medium      0
6478     11.9  Medium      0
6479     11.3  Medium      0
6480     11.9  Medium      0
```

```
6481      9.8  Medium      0
6482     11.6  Medium      0
6483     11.5  Medium      0
6484     11.4  Medium      0
6485     10.9  Medium      0
6486     12.8  Medium      0
6487      9.2  Medium      0
6488     11.6  Medium      0
6489     11.6  Medium      0
6490     11.0  Medium      0
6491      9.5  Medium      0
6492     10.5  Medium      0
6493     11.2  Medium      0
6494     11.0  Medium      0
6495     10.2  Medium      0
6496     11.0  Medium      0

[6430 rows x 13 columns]
```

```
data_copy3.quality.value_counts()
```

```
Medium    5997
Low        239
High       194
Name: quality, dtype: int64
```

```
map_quality = {'Low': 0, 'Medium': 1, 'High': 2}
data_copy3['quality'] = data_copy3['quality'].map(map_quality)
print(data_copy3)
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
1          6.300000          0.300000         0.34            1.60
0.049
2          8.100000          0.280000         0.40            6.90
0.050
3          7.200000          0.230000         0.32            8.50
0.058
4          7.200000          0.230000         0.32            8.50
0.058
5          8.100000          0.280000         0.40            6.90
0.050
6          6.200000          0.320000         0.16            7.00
0.045
8          6.300000          0.300000         0.34            1.60
0.049
9          8.100000          0.220000         0.43            1.50
0.044
10         8.100000          0.270000         0.41            1.45
0.033
```

```
11          8.600000          0.230000          0.40           4.20
0.035
12          7.900000          0.180000          0.37           1.20
0.040
13          6.600000          0.160000          0.40           1.50
0.044
14          8.300000          0.420000          0.62          19.25
0.040
15          6.600000          0.170000          0.38           1.50
0.032
16          6.300000          0.480000          0.04           1.10
0.046
17          7.216579          0.660000          0.48           1.20
0.029
18          7.400000          0.340000          0.42           1.10
0.033
19          6.500000          0.310000          0.14           7.50
0.044
20          6.200000          0.660000          0.48           1.20
0.029
21          6.400000          0.310000          0.38           2.90
0.038
22          6.800000          0.260000          0.42           1.70
0.049
23          7.600000          0.670000          0.14           1.50
0.074
24          6.600000          0.270000          0.41           1.30
0.052
25          7.000000          0.250000          0.32           9.00
0.046
26          6.900000          0.240000          0.35           1.00
0.052
27          7.000000          0.280000          0.39           8.70
0.051
28          7.400000          0.270000          0.48           1.10
0.047
29          7.200000          0.320000          0.36           2.00
0.033
30          8.500000          0.240000          0.39          10.40
0.044
31          8.300000          0.140000          0.34           1.10
0.042
...              ...               ...           ...            ...
...
6467        6.200000          0.510000          0.14           1.90
0.056
6468        6.400000          0.360000          0.53           2.20
0.230
6469        6.400000          0.380000          0.14           2.20
```

```
0.038
6470        7.300000            0.690000          0.32              2.20
0.069
6471        6.000000            0.580000          0.20              2.40
0.075
6472        5.600000            0.310000          0.78             13.90
0.074
6473        7.500000            0.520000          0.40              2.20
0.060
6474        8.000000            0.300000          0.63              1.60
0.081
6475        6.200000            0.700000          0.15              5.10
0.076
6476        6.800000            0.670000          0.15              1.80
0.118
6477        6.200000            0.560000          0.09              1.70
0.053
6478        7.400000            0.350000          0.33              2.40
0.068
6479        6.200000            0.560000          0.09              1.70
0.053
6480        6.100000            0.715000          0.10              2.60
0.053
6481        6.200000            0.460000          0.29              2.10
0.074
6482        6.700000            0.320000          0.44              2.40
0.061
6483        7.200000            0.390000          0.44              2.60
0.066
6484        7.500000            0.310000          0.41              2.40
0.065
6485        5.800000            0.610000          0.11              1.80
0.066
6486        7.200000            0.339691          0.33              2.50
0.068
6487        6.600000            0.725000          0.20              7.80
0.073
6488        6.300000            0.550000          0.15              1.80
0.077
6489        5.400000            0.740000          0.09              1.70
0.089
6490        6.300000            0.510000          0.13              2.30
0.076
6491        6.800000            0.620000          0.08              1.90
0.068
6492        6.200000            0.600000          0.08              2.00
0.090
6493        5.900000            0.550000          0.10              2.20
0.062
```

```
6494       6.300000          0.510000         0.13             2.30
0.076
6495       5.900000          0.645000         0.12             2.00
0.075
6496       6.000000          0.310000         0.47             3.60
0.067

      free sulfur dioxide  total sulfur dioxide  density    pH
sulphates  \
1                    14.0                 132.0  0.99400  3.30
0.490000
2                    30.0                  97.0  0.99510  3.26
0.440000
3                    47.0                 186.0  0.99560  3.19
0.400000
4                    47.0                 186.0  0.99560  3.19
0.400000
5                    30.0                  97.0  0.99510  3.26
0.440000
6                    30.0                 136.0  0.99490  3.18
0.470000
8                    14.0                 132.0  0.99400  3.30
0.490000
9                    28.0                 129.0  0.99380  3.22
0.450000
10                   11.0                  63.0  0.99080  2.99
0.560000
11                   17.0                 109.0  0.99470  3.14
0.530000
12                   16.0                  75.0  0.99200  3.18
0.630000
13                   48.0                 143.0  0.99120  3.54
0.520000
14                   41.0                 172.0  1.00020  2.98
0.670000
15                   28.0                 112.0  0.99140  3.25
0.550000
16                   30.0                  99.0  0.99280  3.24
0.360000
17                   29.0                  75.0  0.98920  3.33
0.390000
18                   17.0                 171.0  0.99170  3.12
0.530000
19                   34.0                 133.0  0.99550  3.22
0.500000
20                   29.0                  75.0  0.98920  3.33
0.390000
21                   19.0                 102.0  0.99120  3.17
0.350000
```

```
22                    41.0                  122.0  0.99300  3.47
0.480000
23                    25.0                  168.0  0.99370  3.05
0.510000
24                    16.0                  142.0  0.99510  3.42
0.470000
25                    56.0                  245.0  0.99550  3.25
0.500000
26                    35.0                  146.0  0.99300  3.45
0.440000
27                    32.0                  141.0  0.99610  3.38
0.530000
28                    17.0                  132.0  0.99140  3.19
0.490000
29                    37.0                  114.0  0.99060  3.10
0.710000
30                    20.0                  142.0  0.99740  3.20
0.530000
31                     7.0                   47.0  0.99340  3.47
0.400000
...                    ...                    ...      ...   ...
...
6467                  15.0                   34.0  0.99396  3.48
0.570000
6468                  19.0                   35.0  0.99340  3.37
0.930000
6469                  15.0                   25.0  0.99514  3.44
0.650000
6470                  35.0                  104.0  0.99632  3.33
0.510000
6471                  15.0                   50.0  0.99467  3.58
0.670000
6472                  23.0                   92.0  0.99677  3.39
0.480000
6473                  12.0                   20.0  0.99474  3.26
0.640000
6474                  16.0                   29.0  0.99588  3.30
0.780000
6475                  13.0                   27.0  0.99622  3.54
0.600000
6476                  13.0                   20.0  0.99540  3.42
0.670000
6477                  24.0                   32.0  0.99402  3.54
0.600000
6478                   9.0                   26.0  0.99470  3.36
0.600000
6479                  24.0                   32.0  0.99402  3.54
0.600000
6480                  13.0                   27.0  0.99362  3.57
```

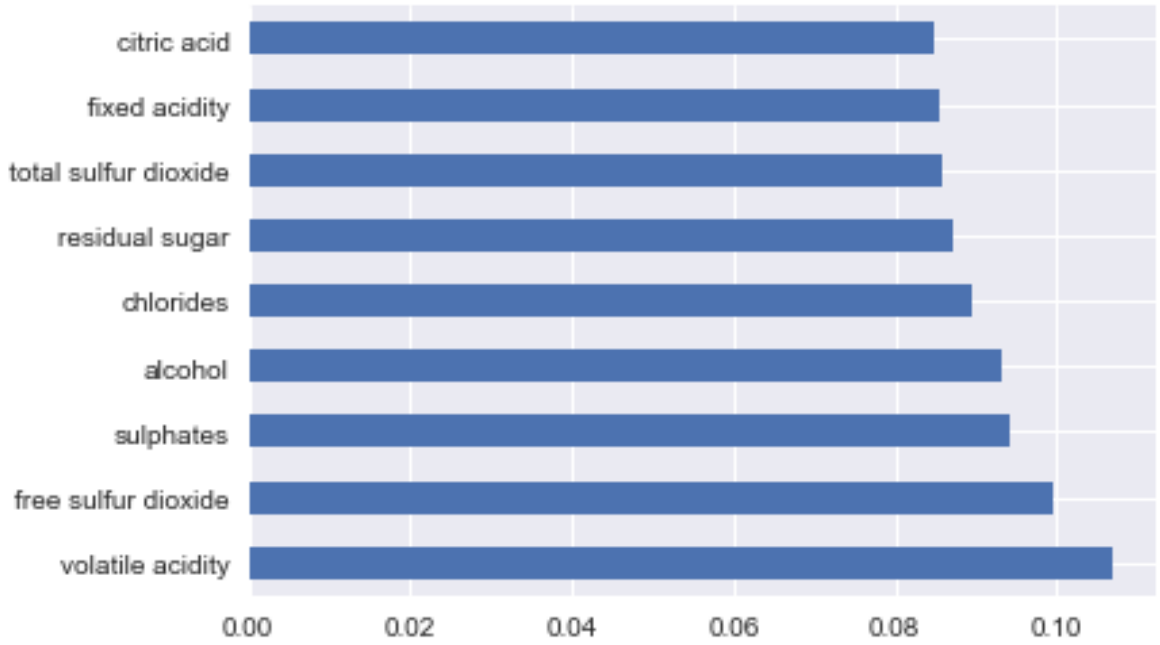
```
0.500000
6481                 32.0                  98.0  0.99578  3.33
0.620000
6482                 24.0                  34.0  0.99484  3.29
0.800000
6483                 22.0                  48.0  0.99494  3.30
0.840000
6484                 34.0                  60.0  0.99492  3.34
0.850000
6485                 18.0                  28.0  0.99483  3.55
0.660000
6486                 34.0                 102.0  0.99414  3.27
0.780000
6487                 29.0                  79.0  0.99770  3.29
0.540000
6488                 26.0                  35.0  0.99314  3.32
0.820000
6489                 16.0                  26.0  0.99402  3.67
0.560000
6490                 29.0                  40.0  0.99574  3.42
0.750000
6491                 28.0                  38.0  0.99651  3.42
0.820000
6492                 32.0                  44.0  0.99490  3.45
0.580000
6493                 39.0                  51.0  0.99512  3.52
0.531215
6494                 29.0                  40.0  0.99574  3.42
0.750000
6495                 32.0                  44.0  0.99547  3.57
0.710000
6496                 18.0                  42.0  0.99549  3.39
0.660000

      alcohol  quality  white
1         9.5        1      1
2        10.1        1      1
3         9.9        1      1
4         9.9        1      1
5        10.1        1      1
6         9.6        1      1
8         9.5        1      1
9        11.0        1      1
10       12.0        1      1
11        9.7        1      1
12       10.8        1      1
13       12.4        1      1
14        9.7        1      1
15       11.4        1      1
```

```
16        9.6         1      1
17       12.8         2      1
18       11.3         1      1
19        9.5         1      1
20       12.8         2      1
21       11.0         1      1
22       10.5         2      1
23        9.3         1      1
24       10.0         1      1
25       10.4         1      1
26       10.0         1      1
27       10.5         1      1
28       11.6         1      1
29       12.3         1      1
30       10.0         1      1
31       10.2         1      1
...       ...       ...    ...
6467     11.5         1      0
6468     12.4         1      0
6469     11.1         1      0
6470      9.5         1      0
6471     12.5         1      0
6472     10.5         1      0
6473     11.8         1      0
6474     10.8         1      0
6475     11.9         1      0
6476     11.3         1      0
6477     11.3         1      0
6478     11.9         1      0
6479     11.3         1      0
6480     11.9         1      0
6481      9.8         1      0
6482     11.6         1      0
6483     11.5         1      0
6484     11.4         1      0
6485     10.9         1      0
6486     12.8         1      0
6487      9.2         1      0
6488     11.6         1      0
6489     11.6         1      0
6490     11.0         1      0
6491      9.5         1      0
6492     10.5         1      0
6493     11.2         1      0
6494     11.0         1      0
6495     10.2         1      0
6496     11.0         1      0

[6430 rows x 13 columns]
```

```
x = data_copy3.drop('quality',axis=1)
y = data_copy3['quality']

model = ExtraTreesClassifier()
model.fit(x, y)
print(model.feature_importances_)
```

```
[ 0.08564838  0.10677143  0.08485914  0.0872269   0.08955658
0.09949098
  0.08592203  0.08216449  0.08405464  0.09414621  0.09330975
0.00684946]
```

```
imp_features = pd.Series(model.feature_importances_, index =
x.columns)
imp_features.nlargest(9).plot(kind = 'barh')
plt.show()
```




```
'''
Using SVC - Support Vector Classifier, Decision Tree Classifier,
Random Forest Classifier,
Gaussian Naive Bayes, and Logistic Regression.
'''
model_params  = {
    'svm' : {
        'model':SVC(gamma='auto'),
        'params':{
            'C' : [1,10,20],
            'kernel':['rbf']
        }
```

```
    },

    'decision_tree':{
        'model': DecisionTreeClassifier(),
        'params':{
            'criterion':['entropy','gini'],
            'max_depth':[5,8,9]
        }
    },

    'random_forest':{
        'model': RandomForestClassifier(),
        'params':{
            'n_estimators':[1,5,10],
            'max_depth':[5,8,9]
        }
    },
    'naive_bayes':{
        'model': GaussianNB(),
        'params':{}
    },

    'logistic_regression' : {
        'model' : LogisticRegression(solver='newton-cg',multi_class =
'multinomial'),
        'params': {
            "C" : [1,5,10]
        }
    }

}

score = []
for model_name,mp in model_params.items():
    clf = GridSearchCV(mp['model'],mp['params'], cv=8,
return_train_score=False, refit=True)
    clf.fit(x,y)
    score.append({
        'Model' : model_name,
        'Best_Score': clf.best_score_,
        'Best_Params': clf.best_params_
    })

print('The scikit-learn version is {}.'.format(sklearn.__version__))
```

```
The scikit-learn version is 0.18.2.
```

```
data_copy4 = pd.DataFrame(score, columns = ['Model', 'Best_Score',
'Best_Params'])
```

```
data_copy4
```

```
                  Model  Best_Score
Best_Params
0                   svm    0.932193              {'C': 1, 'kernel':
'rbf'}
1         decision_tree    0.921773  {'criterion': 'gini', 'max_depth':
5}
2         random_forest    0.932504   {'max_depth': 5, 'n_estimators':
10}
3           naive_bayes    0.726905
{}
4   logistic_regression    0.932815                                {'C':
10}
```

```
'''
Using SVM - Support Vector Machine
'''
clf_svm = SVC(kernel = 'rbf', C = 1)
scores = cross_val_score(clf_svm, x, y, cv = 8, scoring = 'accuracy')
scores
```

```
array([ 0.93167702,  0.93043478,  0.93159204,  0.93159204,
0.9340796 ,
        0.93275218,  0.93275218,  0.93266833])
```

```
scores.mean()
```

```
0.93219352133329703
```

```
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size =
0.2, random_state = 0)
print(x_train)
print('-------x_train complete---------')
print(x_test)
print('-------x_test complete---------')
print(y_train)
print('-------y_train complete---------')
print(y_test)
print('-------y_test complete---------')
```

```
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
2660            6.7             0.330         0.34            6.60
0.067
3354            5.9             0.200         0.28           12.80
0.038
1041            7.7             0.275         0.30            1.00
0.039
3490            7.6             0.310         0.24            1.80
0.037
```

2746	7.0	0.340	0.30	1.80	0.045
193	6.6	0.150	0.34	5.10	0.055
5920	7.0	0.510	0.09	2.10	0.062
6339	7.4	0.785	0.19	5.20	0.094
1391	6.2	0.160	0.47	1.40	0.029
5113	7.0	0.490	0.49	5.60	0.060
3934	7.3	0.270	0.30	1.30	0.040
3686	7.6	0.300	0.37	1.60	0.087
2025	7.5	0.300	0.71	1.30	0.160
6363	6.8	0.590	0.10	1.70	0.063
2030	9.5	0.420	0.41	2.30	0.034
2844	8.0	0.220	0.31	5.60	0.049
6018	7.9	0.540	0.34	2.50	0.076
3895	7.0	0.250	0.33	2.10	0.021
3017	5.9	0.340	0.30	3.80	0.035
4787	3.9	0.225	0.40	4.20	0.030
2036	5.7	0.270	0.32	1.20	0.046
3320	7.5	0.290	0.36	15.70	0.050
6055	5.1	0.510	0.18	2.10	0.042
3647	6.4	0.290	0.24	3.20	0.037
3576	7.4	0.280	0.36	14.60	0.048
142	7.9	0.210	0.40	1.20	0.039
1434	7.4	0.250	0.49	1.10	0.042
5373	9.6	0.680	0.24	2.20	0.087
4493	6.8	0.310	0.25	10.50	

```
0.043
2795            6.4            0.220         0.32            7.20
0.028
...             ...              ...          ...             ...
...
2027            6.9            0.320         0.15            8.10
0.046
101             7.1            0.120         0.32            9.60
0.054
2520            7.5            0.410         0.23           14.80
0.054
1889            7.6            0.150         0.40            1.30
0.036
2065            7.8            0.270         0.28            1.80
0.050
4917            7.9            0.320         0.51            1.80
0.341
5138            8.9            0.635         0.37            1.70
0.263
2183            6.3            0.300         0.24            6.60
0.040
6103            7.2            0.360         0.46            2.10
0.074
6283            8.0            0.810         0.25            3.40
0.076
2930            5.6            0.210         0.40            1.30
0.041
546             6.3            0.260         0.24            7.20
0.039
1718            9.3            0.200         0.33            1.70
0.050
2934            5.3            0.210         0.29            0.70
0.028
2242            6.1            0.230         0.45           10.60
0.094
2155            7.8            0.290         0.33            8.75
0.035
2626            8.0            0.240         0.26            1.70
0.033
715             6.2            0.210         0.27            1.70
0.038
3517            6.6            0.290         0.29            1.80
0.036
5991            9.2            0.310         0.36            2.20
0.079
5940            8.9            0.500         0.21            2.20
0.088
4436            6.7            0.280         0.28            4.50
0.051
```

```
1043             7.5             0.330         0.48            19.45
0.048
5893             7.7             0.600         0.06             2.00
0.079
4925             7.9             0.430         0.21             1.60
0.106
4997             8.1             0.545         0.18             1.90
0.080
3306             6.0             0.320         0.30             1.90
0.033
1669             7.1             0.310         0.38             1.20
0.036
2634             8.7             0.310         0.73            14.35
0.044
2764             7.9             0.160         0.30             7.40
0.050

      free sulfur dioxide  total sulfur dioxide  density    pH
sulphates  \
2660                 35.0                 156.0  0.99542  3.11
0.48
3354                 29.0                 132.0  0.99426  3.31
0.57
1041                 19.0                  75.0  0.99200  3.01
0.56
3490                 39.0                 150.0  0.99130  3.05
0.44
2746                 44.0                 142.0  0.99140  2.99
0.45
193                  34.0                 125.0  0.99420  3.36
0.42
5920                  4.0                   9.0  0.99584  3.35
0.54
6339                 19.0                  98.0  0.99713  3.16
0.52
1391                 23.0                  81.0  0.99000  3.26
0.42
5113                 26.0                 121.0  0.99740  3.34
0.76
3934                 26.0                  84.0  0.99222  3.28
0.53
3686                 27.0                 177.0  0.99438  3.09
0.50
2025                 44.0                 149.0  0.99480  3.08
0.42
6363                 34.0                  53.0  0.99580  3.41
0.67
2030                 22.0                 145.0  0.99510  3.06
0.52
```

```
2844                 24.0                  97.0  0.99300  3.10
0.42
6018                  8.0                  17.0  0.99235  3.20
0.72
3895                 17.0                  76.0  0.99021  3.26
0.45
3017                 57.0                 135.0  0.99016  3.09
0.34
4787                 29.0                 118.0  0.98900  3.57
0.36
2036                 20.0                 155.0  0.99340  3.80
0.41
3320                 29.0                 124.0  0.99680  3.06
0.54
6055                 16.0                 101.0  0.99240  3.46
0.87
3647                 31.0                  95.0  0.98942  2.90
0.66
3576                 35.0                 161.0  0.99680  3.14
0.56
142                  38.0                 107.0  0.99200  3.21
0.54
1434                 35.0                 156.0  0.99170  3.13
0.55
5373                  5.0                  28.0  0.99880  3.14
0.60
4493                 30.0                 165.0  0.99720  3.36
0.55
2795                 15.0                  83.0  0.99300  3.13
0.55
...                   ...                   ...      ...   ...
...
2027                 51.0                 180.0  0.99580  3.13
0.45
101                  64.0                 162.0  0.99620  3.40
0.41
2520                 28.0                 174.0  0.99898  3.18
0.49
1889                 24.0                 112.0  0.99320  3.14
0.76
2065                 21.0                 127.0  0.99340  3.15
0.44
4917                 17.0                  56.0  0.99690  3.04
1.08
5138                  5.0                  62.0  0.99710  3.00
1.09
2183                 38.0                 141.0  0.99500  3.22
0.47
6103                 24.0                  44.0  0.99534  3.40
```

```
0.85
6283                 34.0                  85.0  0.99668  3.19
0.42
2930                 81.0                 147.0  0.99010  3.22
0.95
546                  38.0                 172.0  0.99580  3.49
0.64
1718                 28.0                 178.0  0.99540  3.16
0.43
2934                 11.0                  66.0  0.99215  3.30
0.40
2242                 49.0                 169.0  0.99699  3.05
0.54
2155                 33.0                 181.0  0.99620  3.11
0.46
2626                 36.0                 136.0  0.99316  3.44
0.51
715                  41.0                 150.0  0.99330  3.49
0.71
3517                 38.0                 102.0  0.98819  3.08
0.42
5991                 11.0                  31.0  0.99615  3.33
0.86
5940                 21.0                  39.0  0.99692  3.33
0.83
4436                 14.0                  92.0  0.99224  3.36
0.58
1043                 55.0                 243.0  1.00100  2.95
0.40
5893                 19.0                  41.0  0.99697  3.39
0.62
4925                 10.0                  37.0  0.99660  3.17
0.91
4997                 13.0                  35.0  0.99720  3.30
0.59
3306                 41.0                 142.0  0.98912  3.29
0.42
1669                 10.0                 124.0  0.99240  3.14
0.44
2634                 27.0                 191.0  1.00013  2.96
0.88
2764                 58.0                 152.0  0.99612  3.12
0.37

        alcohol  white
2660   9.300000      1
3354  11.800000      1
1041  10.700000      1
3490  11.800000      1
```

```
2746  10.800000      1
193    9.600000      1
5920  10.500000      0
6339   9.566667      0
1391  12.200000      1
5113  10.500000      0
3934  10.700000      1
3686   9.800000      1
2025   8.900000      1
6363   9.700000      0
2030  11.000000      1
2844  10.900000      1
6018  13.100000      0
3895  12.300000      1
3017  12.000000      1
4787  12.800000      1
2036  10.200000      1
3320  10.400000      1
6055  12.900000      0
3647  12.600000      1
3576  10.600000      1
142   10.800000      1
1434  11.300000      1
5373  10.200000      0
4493  10.550000      1
2795  10.900000      1
...         ...    ...
2027   8.900000      1
101    9.400000      1
2520   9.700000      1
1889  10.000000      1
2065   9.900000      1
4917   9.200000      0
5138   9.300000      0
2183   9.500000      1
6103  11.000000      0
6283   9.200000      0
2930  11.600000      1
546    9.700000      1
1718   9.000000      1
2934   9.800000      1
2242   8.800000      1
2155  10.700000      1
2626  10.400000      1
715   10.500000      1
3517  13.700000      1
5991  12.000000      0
5940  11.100000      0
4436  11.900000      1
```

```
1043   8.800000      1
5893  10.100000      0
4925   9.500000      0
4997   9.000000      0
3306  12.800000      1
1669   9.900000      1
2634   8.700000      1
2764   9.500000      1

[5144 rows x 12 columns]
-------x_train complete---------
      fixed acidity  volatile acidity  citric acid  residual sugar
chlorides  \
1935            8.8             0.340         0.33            9.70
0.036
1106            5.2             0.240         0.45            3.80
0.027
2932            6.4             0.250         0.32           11.30
0.038
743             5.9             0.260         0.25           12.50
0.034
2230            7.1             0.200         0.36           11.60
0.042
1584            6.4             0.250         0.74            7.80
0.045
4583            6.4             0.230         0.37            7.90
0.050
567             6.0             0.260         0.50            2.20
0.048
4333            7.3             0.190         0.27           13.90
0.057
4414            7.1             0.270         0.27           10.40
0.041
4966            9.3             0.320         0.57            2.00
0.074
2992            6.6             0.200         0.27           10.90
0.038
2730            6.8             0.300         0.22            6.20
0.060
5699            8.6             0.550         0.09            3.30
0.068
3860            7.3             0.250         0.26            7.20
0.048
4397            7.4             0.270         0.26           11.80
0.053
3539            7.2             0.270         0.31            1.20
0.031
2261            6.5             0.360         0.31            4.10
0.061
```

```
1873              5.8              0.330              0.20              16.05
0.047
2671              5.9              0.300              0.30               2.00
0.030
5898              7.5              0.430              0.30               2.20
0.062
5922              7.7              0.580              0.01               1.80
0.088
476               7.4              0.280              0.36               1.10
0.028
1182              7.4              0.220              0.33               2.00
0.045
4972              9.7              0.320              0.54               2.50
0.094
4994              6.8              0.775              0.00               3.00
0.102
638               5.6              0.350              0.14               5.00
0.046
3456              6.0              0.390              0.13               1.20
0.042
4182              7.5              0.380              0.56               9.70
0.055
4315              6.7              0.410              0.24               5.40
0.035
...               ...                ...                ...                ...
...
4705              5.7              0.270              0.16               9.00
0.053
3695              6.4              0.150              0.40               1.30
0.053
6288              6.0              0.490              0.00               2.30
0.068
4615              6.1              0.440              0.28               4.25
0.032
1258              6.9              0.290              0.16               6.80
0.034
3912              6.5              0.330              0.30               3.80
0.036
406               5.8              0.280              0.34               4.00
0.031
2237              6.4              0.340              0.20              14.90
0.060
5637              9.0              0.690              0.00               2.40
0.088
1234              7.7              0.260              0.31               1.30
0.043
972               6.8              0.220              0.35              17.50
0.039
4719              6.7              0.150              0.32               7.90
```

```
0.034
4080             5.7             0.250         0.27            10.80
0.050
5876             7.0             0.400         0.32             3.60
0.061
3303             6.3             0.220         0.34             5.00
0.032
178              6.0             0.670         0.07             1.20
0.060
1216             8.2             0.370         0.36             1.00
0.034
3965             7.3             0.380         0.23             6.50
0.050
4760             6.6             0.170         0.26             7.40
0.052
2162             9.9             0.490         0.23             2.40
0.087
3859             7.3             0.250         0.26             7.20
0.048
877              6.0             0.280         0.34             1.60
0.119
4993             4.7             0.600         0.17             2.30
0.058
5865             8.5             0.660         0.20             2.10
0.097
1108             6.1             0.290         0.27             1.70
0.024
2579             6.4             0.280         0.56             1.70
0.156
5825             8.4             0.670         0.19             2.20
0.093
5782             8.8             0.610         0.19             4.00
0.094
4435             6.5             0.290         0.30             9.15
0.051
5416            10.9             0.210         0.49             2.80
0.088

      free sulfur dioxide  total sulfur dioxide  density        pH
sulphates  \
1935                 46.0                 172.0  0.99660  3.080000
0.40
1106                 21.0                 128.0  0.99200  3.550000
0.49
2932                 69.0                 192.0  0.99573  3.140000
0.50
743                  38.0                 152.0  0.99770  3.330000
0.43
2230                 45.0                 124.0  0.99700  2.920000
```

```
0.59
1584                52.0                209.0  0.99560  3.210000
0.42
4583                60.0                150.0  0.99488  2.860000
0.49
567                 59.0                153.0  0.99280  3.080000
0.61
4333                45.0                155.0  0.99807  2.940000
0.41
4414                26.0                114.0  0.99335  3.040000
0.52
4966                27.0                 65.0  0.99690  3.280000
0.79
2992                29.0                130.0  0.99496  3.110000
0.44
2730                41.0                190.0  0.99858  3.180000
0.51
5699                 8.0                 17.0  0.99735  3.230000
0.44
3860                52.0                207.0  0.99587  3.120000
0.37
4397                55.0                173.0  0.99699  3.110000
0.60
3539                27.0                 80.0  0.98892  3.030000
0.33
2261                20.0                134.0  0.99475  3.180000
0.45
1873                26.0                166.0  0.99760  3.090000
0.46
2671                38.0                142.0  0.98892  3.410000
0.41
5898                 6.0                 12.0  0.99495  3.440000
0.72
5922                12.0                 18.0  0.99568  3.320000
0.56
476                 42.0                105.0  0.98930  2.990000
0.39
1182                31.0                101.0  0.99310  3.420000
0.55
4972                28.0                 83.0  0.99840  3.280000
0.82
4994                 8.0                 23.0  0.99650  3.450000
0.56
638                 48.0                198.0  0.99370  3.300000
0.71
3456                60.0                172.0  0.99114  3.060000
0.52
4182                15.0                170.0  0.99605  3.130000
0.65
4315                33.0                115.0  0.99010  3.120000
```

```
0.44
...                   ...                   ...      ...       ...
...
4705                  32.0                  111.0  0.99474  3.360000
0.37
3695                  61.0                  146.0  0.99112  3.170000
0.68
6288                  15.0                   33.0  0.99292  3.580000
0.59
4615                  43.0                  132.0  0.99160  3.260000
0.47
1258                  65.0                  212.0  0.99550  3.080000
0.39
3912                  34.0                   88.0  0.99028  3.250000
0.63
406                   40.0                   99.0  0.98960  3.390000
0.39
2237                  37.0                  162.0  0.99830  3.130000
0.45
5637                  19.0                   38.0  0.99900  3.350000
0.60
1234                  47.0                  155.0  0.99370  3.420000
0.50
972                   38.0                  153.0  0.99940  3.218395
0.42
4719                  17.0                   81.0  0.99512  3.290000
0.31
4080                  58.0                  116.0  0.99592  3.100000
0.50
5876                   9.0                   29.0  0.99416  3.280000
0.49
3303                  36.0                   93.0  0.99012  3.270000
0.36
178                    9.0                  108.0  0.99310  3.110000
0.35
1216                  17.0                   93.0  0.99060  3.040000
0.32
3965                  18.0                  102.0  0.99304  3.100000
0.55
4760                  45.0                  128.0  0.99388  3.160000
0.37
2162                  19.0                  115.0  0.99480  2.770000
0.44
3859                  52.0                  207.0  0.99587  3.120000
0.37
877                   33.0                  104.0  0.99210  3.190000
0.38
4993                  17.0                  106.0  0.99320  3.850000
0.60
```

```
5865                 23.0                 113.0  0.99733  3.130000
0.48
1108                 13.0                  76.0  0.98930  3.210000
0.51
2579                 49.0                 106.0  0.99354  3.100000
0.37
5825                 11.0                  75.0  0.99736  3.200000
0.59
5782                 30.0                  69.0  0.99787  3.220000
0.50
4435                 25.0                 166.0  0.99339  3.240000
0.56
5416                 11.0                  32.0  0.99720  3.220000
0.68

        alcohol  white
1935  10.200000      1
1106  11.200000      1
2932  10.200000      1
743    9.400000      1
2230   9.500000      1
1584   9.200000      1
4583   9.300000      1
567    9.800000      1
4333   8.800000      1
4414  11.500000      1
4966  10.700000      0
2992  10.500000      1
2730   9.200000      1
5699  10.000000      0
3860   9.200000      1
4397   9.800000      1
3539  12.700000      1
2261   9.000000      1
1873   8.900000      1
2671  12.900000      1
5898  11.500000      0
5922  10.500000      0
476   12.400000      1
1182  11.400000      1
4972   9.600000      0
4994  10.700000      0
638   10.300000      1
3456  10.600000      1
4182   9.900000      1
4315  12.893333      1
...         ...    ...
4705  10.400000      1
3695  11.000000      1
```

```
6288  12.500000      0
4615  11.266667      1
1258   9.000000      1
3912  12.500000      1
406   12.800000      1
2237   9.000000      1
5637   9.300000      0
1234  10.100000      1
972    9.000000      1
4719  10.000000      1
4080   9.800000      1
5876  11.300000      0
3303  13.500000      1
178    8.700000      1
1216  11.700000      1
3965  11.200000      1
4760  10.000000      1
2162   9.400000      1
3859   9.200000      1
877   10.200000      1
4993  12.900000      0
5865   9.200000      0
1108  12.600000      1
2579   9.200000      1
5825   9.200000      0
5782  10.000000      0
4435  11.333333      1
5416  11.700000      0

[1286 rows x 12 columns]
-------x_test complete---------
2660    1
3354    1
1041    1
3490    1
2746    1
193     1
5920    1
6339    1
1391    1
5113    1
3934    1
3686    1
2025    1
6363    1
2030    1
2844    1
6018    2
3895    1
```

```
3017    1
4787    2
2036    1
3320    1
6055    1
3647    1
3576    1
142     1
1434    1
5373    1
4493    1
2795    2
       ..
2027    1
101     1
2520    1
1889    1
2065    1
4917    1
5138    1
2183    1
6103    1
6283    1
2930    2
546     1
1718    0
2934    1
2242    1
2155    1
2626    1
715     1
3517    1
5991    1
5940    1
4436    1
1043    1
5893    1
4925    1
4997    1
3306    1
1669    1
2634    1
2764    1
Name: quality, Length: 5144, dtype: int64
-------y_train complete---------
1935    1
1106    2
2932    1
743     1
```

```
2230    1
1584    1
4583    1
567     1
4333    2
4414    1
4966    1
2992    1
2730    1
5699    1
3860    1
4397    1
3539    1
2261    1
1873    1
2671    1
5898    1
5922    1
476     1
1182    1
4972    1
4994    1
638     1
3456    1
4182    1
4315    1
       ..
4705    1
3695    1
6288    1
4615    1
1258    1
3912    1
406     1
2237    0
5637    1
1234    1
972     1
4719    1
4080    1
5876    1
3303    1
178     0
1216    2
3965    0
4760    1
2162    1
3859    1
877     1
```

```
4993    1
5865    1
1108    1
2579    1
5825    0
5782    1
4435    1
5416    1
Name: quality, Length: 1286, dtype: int64
-------y_test complete---------
```

```
clf_svm1 = SVC(kernel='rbf', C = 1)
clf_svm1.fit(x_train, y_train)
```

```
SVC(C=1, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape=None, degree=3, gamma='auto', kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

```
y_pred = clf_svm1.predict(x_test)

accuracy = accuracy_score(y_test, y_pred)
accuracy
```

```
0.93779160186625199
```

```
'''
Testing on the split test-data
'''
accuracy_dataframe = pd.DataFrame({"y_test": y_test, "y_pred":
y_pred})
accuracy_dataframe.head(n = 100)
```

	y_pred	y_test
1935	1	1
1106	1	2
2932	1	1
743	1	1
2230	1	1
1584	1	1
4583	1	1
567	1	1
4333	2	2
4414	1	1
4966	1	1
2992	1	1
2730	1	1
5699	1	1
3860	1	1
4397	1	1
3539	1	1

```
2261       1       1
1873       1       1
2671       1       1
5898       1       1
5922       1       1
476        1       1
1182       1       1
4972       1       1
4994       1       1
638        1       1
3456       1       1
4182       1       1
4315       1       1
...      ...     ...
150        1       1
650        1       1
2863       1       1
2841       1       1
4272       1       1
5485       1       1
2669       1       1
4317       1       1
4026       1       1
5033       1       1
6474       1       1
316        1       1
210        1       1
1713       1       1
4568       1       1
5391       1       1
206        1       1
557        1       1
4053       1       1
890        1       1
5439       1       1
5386       1       1
6317       1       1
1105       1       1
1181       1       1
3039       1       1
4461       1       1
542        1       1
4517       1       1
5953       1       1

[100 rows x 2 columns]
```