21bce5283-agginment-4

September 27, 2023

1 Grapes to Greatness: Machine Learning in Wine Quality

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
df=pd.read_csv('/content/winequality-red.csv')
df
```

[1]:
```
      fixed acidity  volatile acidity  citric acid  residual sugar  chlorides  \
0               7.4             0.700         0.00             1.9      0.076
1               7.8             0.880         0.00             2.6      0.098
2               7.8             0.760         0.04             2.3      0.092
3              11.2             0.280         0.56             1.9      0.075
4               7.4             0.700         0.00             1.9      0.076
…               …                 …            …               …        …
1594            6.2             0.600         0.08             2.0      0.090
1595            5.9             0.550         0.10             2.2      0.062
1596            6.3             0.510         0.13             2.3      0.076
1597            5.9             0.645         0.12             2.0      0.075
1598            6.0             0.310         0.47             3.6      0.067

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

      alcohol  quality
0         9.4        5
```

```
1          9.8        5
2          9.8        5
3          9.8        6
4          9.4        5
…        …      …
1594      10.5        5
1595      11.2        6
1596      11.0        6
1597      10.2        5
1598      11.0        6

[1599 rows x 12 columns]
```

[11]:
```python
df.describe()
```

[11]:

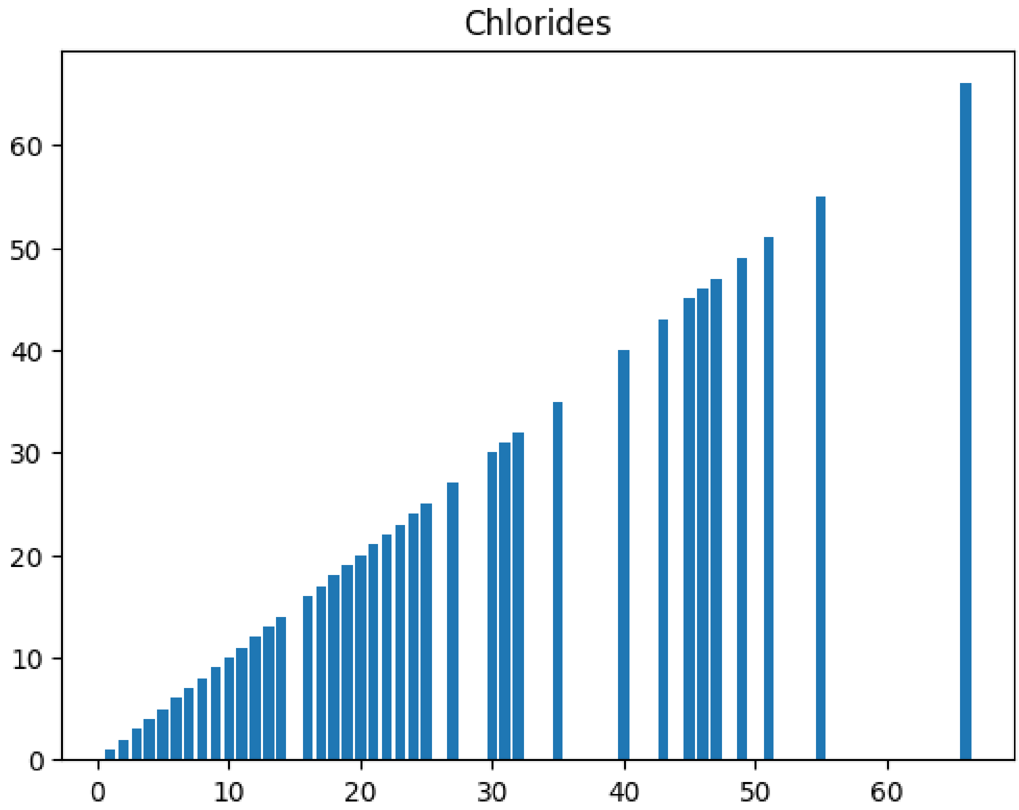
	fixed acidity	volatile acidity	citric acid	residual sugar	\
count	1599.000000	1599.000000	1599.000000	1599.000000	
mean	8.319637	0.527821	0.270976	2.538806	
std	1.741096	0.179060	0.194801	1.409928	
min	4.600000	0.120000	0.000000	0.900000	
25%	7.100000	0.390000	0.090000	1.900000	
50%	7.900000	0.520000	0.260000	2.200000	
75%	9.200000	0.640000	0.420000	2.600000	
max	15.900000	1.580000	1.000000	15.500000	

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

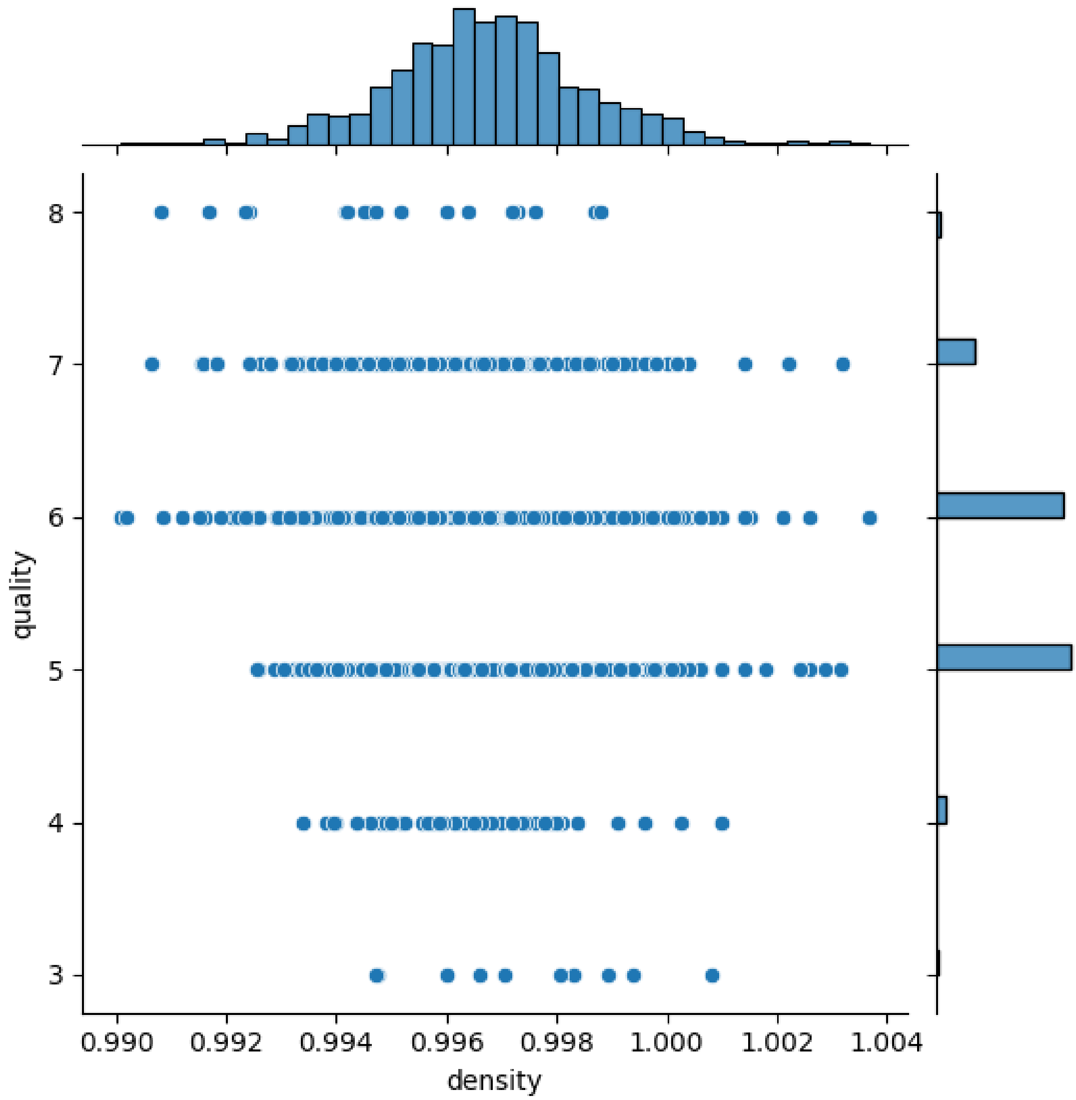
	pH	sulphates	alcohol	quality
count	1599.000000	1599.000000	1599.000000	1599.000000
mean	3.311113	0.658149	10.422983	5.636023
std	0.154386	0.169507	1.065668	0.807569
min	2.740000	0.330000	8.400000	3.000000
25%	3.210000	0.550000	9.500000	5.000000
50%	3.310000	0.620000	10.200000	6.000000
75%	3.400000	0.730000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

[35]:
```python
plt.bar(df.chlorides.value_counts(),df.chlorides.value_counts())
plt.title("Chlorides")
```

```
plt.show()
```

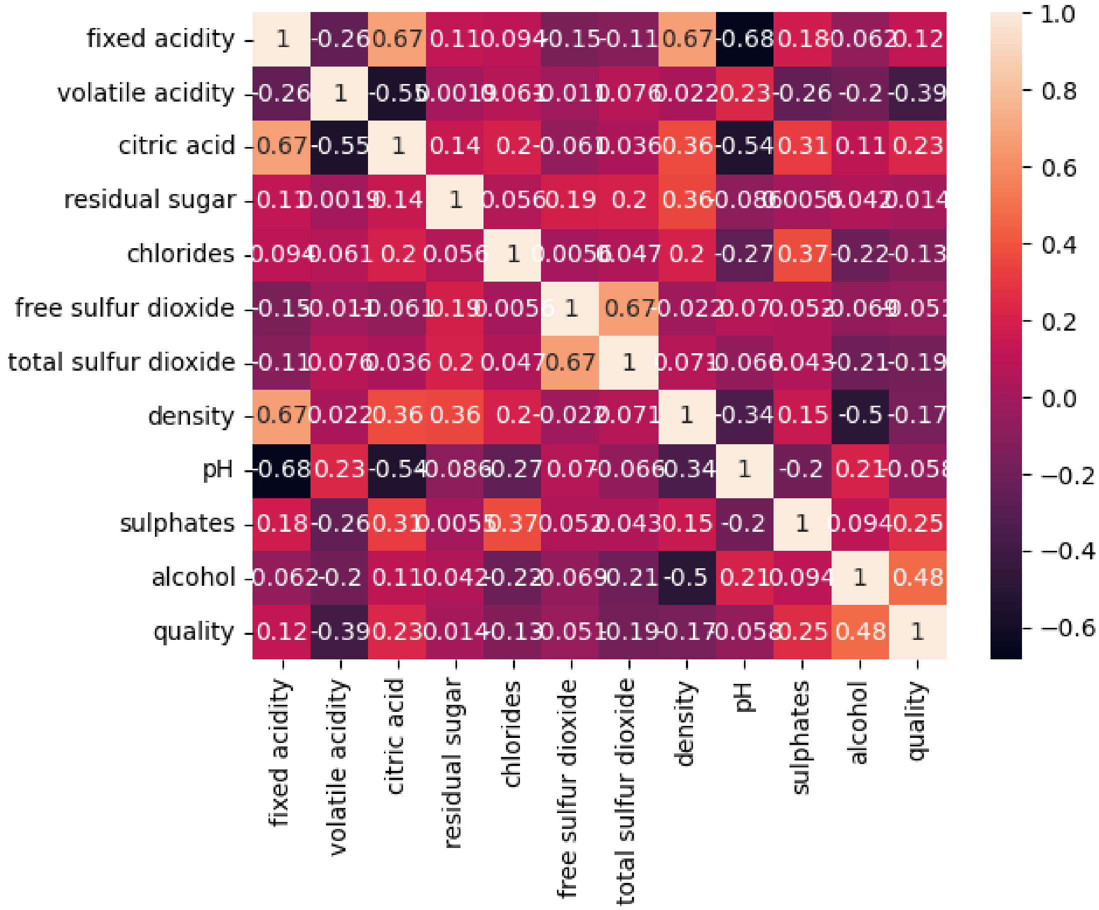


[7]:
```
sns.jointplot(x="density",y="quality",data=df)
plt.show()
```



[10]:
```
sns.heatmap(df.corr(),annot=True)
```

[10]: `<Axes: >`




```
[14]: from sklearn.model_selection import train_test_split
      from sklearn.preprocessing import StandardScaler
      X=df.drop("quality",axis=1)
      y=df["quality"]
      X.head()
```

```
[14]:    fixed acidity  volatile acidity  citric acid  residual sugar  chlorides  \
      0            7.4              0.70         0.00             1.9      0.076
      1            7.8              0.88         0.00             2.6      0.098
      2            7.8              0.76         0.04             2.3      0.092
      3           11.2              0.28         0.56             1.9      0.075
      4            7.4              0.70         0.00             1.9      0.076

         free sulfur dioxide  total sulfur dioxide  density    pH  sulphates  \
      0                 11.0                  34.0   0.9978  3.51       0.56
      1                 25.0                  67.0   0.9968  3.20       0.68
      2                 15.0                  54.0   0.9970  3.26       0.65
      3                 17.0                  60.0   0.9980  3.16       0.58
```

```
4                 11.0                    34.0    0.9978   3.51       0.56

   alcohol
0      9.4
1      9.8
2      9.8
3      9.8
4      9.4
```

[15]:
```
sc=StandardScaler()
X_scaled=sc.fit_transform(X)
X_train,X_test,y_train,y_test=train_test_split(X_scaled,y,test_size=0.
↪2,random_state=42)
```

[15]:
```
array([[ 0.21852997,  0.90601191,  0.20039205, …,  1.09426457,
         0.48302886,  1.10483337],
       [-1.27524919, -1.77549685,  0.66254621, …, -0.39596939,
        -0.40216729,  1.38643512],
       [ 1.48249695, -0.76993107,  1.02199944, …, -0.07200549,
         0.54204194, -0.58477711],
       …,
       [-0.6432657 ,  0.51495855, -1.08336951, …,  1.28864292,
        -0.69723268, -0.86637886],
       [-0.24109439, -1.83136161,  0.4057939 , …,  0.05758008,
         0.83710732,  1.38643512],
       [-1.44760832, -1.32857872, -0.05636026, …,  0.51112954,
        -0.69723268,  2.8883111 ]])
```

[19]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import confusion_matrix
le=LogisticRegression()
model=le.fit(X_train,y_train)
y_pred = model.predict(X_test)
cm = confusion_matrix(y_test, y_pred)
cm
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_logistic.py:458:
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
```

[19]:
```
array([[ 0,  0,  1,  0,  0,  0],
       [ 0,  1,  7,  2,  0,  0],
       [ 0,  0, 98, 32,  0,  0],
       [ 0,  0, 46, 76, 10,  0],
       [ 0,  0,  3, 30,  9,  0],
       [ 0,  0,  0,  1,  4,  0]])
```

[21]:
```
from sklearn.metrics import accuracy_score,␣
↪confusion_matrix,classification_report,roc_auc_score,roc_curve
accuracy_score(y_test,y_pred)
```

[21]: 0.575

[22]:
```
pd.crosstab(y_test,y_pred)
```

[22]:
```
col_0    4   5   6   7
quality
3        0   1   0   0
4        1   7   2   0
5        0  98  32   0
6        0  46  76  10
7        0   3  30   9
8        0   0   1   4
```

[25]:
```
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       1.00      0.10      0.18        10
           5       0.63      0.75      0.69       130
           6       0.54      0.58      0.56       132
           7       0.39      0.21      0.28        42
           8       0.00      0.00      0.00         5

    accuracy                           0.57       320
   macro avg       0.43      0.27      0.28       320
weighted avg       0.56      0.57      0.55       320
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
```

```
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

[27]:
```python
probability  = model.predict_proba(X_test)[:,1]
probability
```

[27]:
```
array([0.02483477, 0.02249377, 0.01574946, 0.01134614, 0.03202448,
       0.01491135, 0.00750669, 0.11853224, 0.02170618, 0.04960947,
       0.01348905, 0.13794541, 0.02885185, 0.02524655, 0.02042773,
       0.00977959, 0.03329229, 0.01903721, 0.00330975, 0.03185402,
       0.1797074 , 0.03375518, 0.06405695, 0.01701967, 0.07199606,
       0.03828524, 0.00477106, 0.08112635, 0.04058424, 0.01038622,
       0.03132   , 0.04077697, 0.01130467, 0.04878004, 0.02851514,
       0.02944521, 0.01913737, 0.06835138, 0.03249786, 0.02057124,
       0.02567618, 0.02042431, 0.006988  , 0.01425204, 0.01374079,
       0.03947643, 0.00374969, 0.01676378, 0.08833596, 0.07250037,
       0.01094354, 0.02734811, 0.09025171, 0.01177792, 0.04743786,
       0.01557644, 0.02994908, 0.09684315, 0.02995632, 0.06248571,
       0.01361311, 0.02148332, 0.03028016, 0.04898658, 0.00497826,
       0.01510166, 0.01183327, 0.04781076, 0.00504487, 0.01450206,
       0.00975868, 0.08957871, 0.0110487 , 0.03338539, 0.02254037,
       0.04057309, 0.00302335, 0.00481278, 0.02595905, 0.00514559,
       0.06328622, 0.00571601, 0.02323339, 0.03167214, 0.02807292,
       0.00498152, 0.01519544, 0.071952  , 0.00589653, 0.10965556,
       0.00579155, 0.04130017, 0.09166548, 0.0216257 , 0.00971574,
       0.01430115, 0.02018015, 0.02031068, 0.15743163, 0.02627518,
       0.1286683 , 0.03879046, 0.01325419, 0.10345292, 0.04510503,
       0.01106421, 0.01385973, 0.00778097, 0.03758517, 0.03038102,
       0.00631245, 0.00592356, 0.00255582, 0.0085207 , 0.02894913,
       0.01094736, 0.06563413, 0.01373076, 0.05589608, 0.01637058,
       0.01182063, 0.0395007 , 0.01413268, 0.02768522, 0.0678964 ,
       0.04112568, 0.00826422, 0.02335786, 0.03401157, 0.02896179,
       0.0110487 , 0.11028868, 0.03168882, 0.00694686, 0.07250037,
       0.06947725, 0.03621314, 0.00512094, 0.01887089, 0.0232298 ,
       0.01022772, 0.00711342, 0.00791129, 0.05265072, 0.01430848,
       0.03762969, 0.05080835, 0.13812178, 0.00655973, 0.01417962,
       0.01731361, 0.02659349, 0.03403913, 0.01742294, 0.0110487 ,
       0.00525754, 0.05574201, 0.01837955, 0.02863305, 0.02180492,
       0.00855826, 0.01296316, 0.00719941, 0.02473188, 0.02877727,
       0.01831045, 0.11902339, 0.03350339, 0.00606012, 0.01003063,
       0.01231073, 0.07909799, 0.01248025, 0.00938227, 0.00922779,
       0.00984898, 0.00563226, 0.01627412, 0.01257727, 0.26411334,
```

```
       0.09242519, 0.00722218, 0.00895868, 0.0108839 , 0.09369835,
       0.00256229, 0.14726728, 0.013673  , 0.00316726, 0.00938227,
       0.05751076, 0.00648566, 0.01672627, 0.00407532, 0.01105994,
       0.04465489, 0.13261131, 0.01265878, 0.02343221, 0.01106421,
       0.04312645, 0.00825491, 0.02558483, 0.04303992, 0.00167707,
       0.06365584, 0.02879044, 0.02108765, 0.02017862, 0.00209676,
       0.04510175, 0.00560467, 0.01235811, 0.00154654, 0.01053313,
       0.03851546, 0.07504775, 0.01853088, 0.04535837, 0.03899463,
       0.0425178 , 0.00846753, 0.0104536 , 0.00717051, 0.23341551,
       0.04884486, 0.04044068, 0.00566036, 0.00527932, 0.10618048,
       0.00553059, 0.03591392, 0.01170368, 0.03609803, 0.00592857,
       0.01106421, 0.06540582, 0.02807292, 0.06035659, 0.0120259 ,
       0.04567327, 0.04198665, 0.06234175, 0.0061261 , 0.03219853,
       0.02733513, 0.02068696, 0.04479066, 0.00227449, 0.00794547,
       0.00523833, 0.0414681 , 0.04079487, 0.02742506, 0.35729187,
       0.02987603, 0.02290243, 0.03998963, 0.01302718, 0.00323973,
       0.01024649, 0.08956821, 0.01627412, 0.00917579, 0.04400462,
       0.00749356, 0.03743595, 0.01220615, 0.00907912, 0.00546852,
       0.0184154 , 0.00756899, 0.01566495, 0.01252444, 0.02138715,
       0.04502192, 0.01317294, 0.00726284, 0.00533177, 0.05413836,
       0.00522663, 0.12843439, 0.0386677 , 0.02689816, 0.01919488,
       0.02910286, 0.03470307, 0.00711342, 0.03192086, 0.21076717,
       0.0268413 , 0.01016235, 0.00992186, 0.01227231, 0.01608297,
       0.00649988, 0.04338943, 0.00832624, 0.0088752 , 0.00587206,
       0.00899913, 0.02178773, 0.00842123, 0.01201218, 0.04519739,
       0.05589983, 0.01363781, 0.0050594 , 0.03334108, 0.00328764,
       0.03285411, 0.03042666, 0.02367536, 0.04470886, 0.04878004,
       0.0542435 , 0.02056979, 0.04453912, 0.00576608, 0.05107761])
```

[34]:

```python
model.predict([[7.4, 0.700, 0.00, 1.9, 0.076, 11.0, 34.0, 0.99780, 3.51, 0.56,␣
 ↪9.4]])
```

[34]:

```
array([5])
```