Grapes to Greatness: Machine Learning in Wine Quality

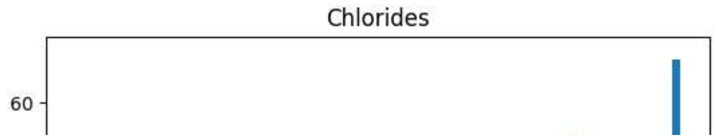
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
df=pd.read_csv('/content/winequality-red.csv')
df
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	su
0	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.99780	3.51	
1	7.8	0.880	0.00	2.6	0.098	25.0	67.0	0.99680	3.20	
2	7.8	0.760	0.04	2.3	0.092	15.0	54.0	0.99700	3.26	
3	11.2	0.280	0.56	1.9	0.075	17.0	60.0	0.99800	3.16	
4	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.99780	3.51	
...	...	...	...	...	...	...	...	...	...	
1594	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	
1595	5.9	0.550	0.10	2.2	0.062	39.0	51.0	0.99512	3.52	
1596	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	
1597	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	
1598	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	

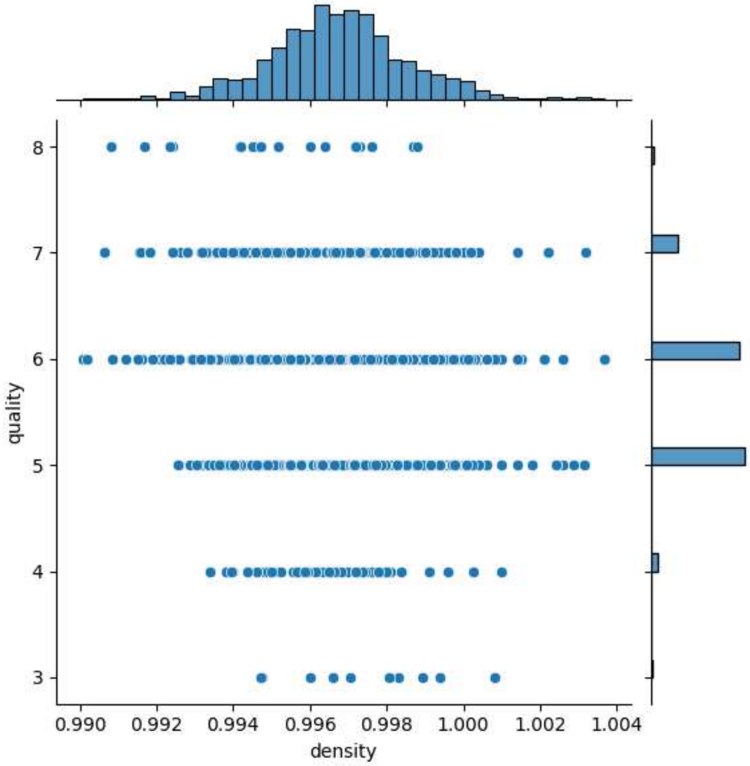
```
df.describe()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	dens
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467792	0.996
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895324	0.001
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000000	0.990
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000000	0.995
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000000	0.996
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000000	0.997
max	15.900000	1.580000	1.000000	15.500000	0.611000	72.000000	289.000000	1.003

```
plt.bar(df.chlorides.value_counts(),df.chlorides.value_counts())
plt.title("Chlorides")
plt.show()
```

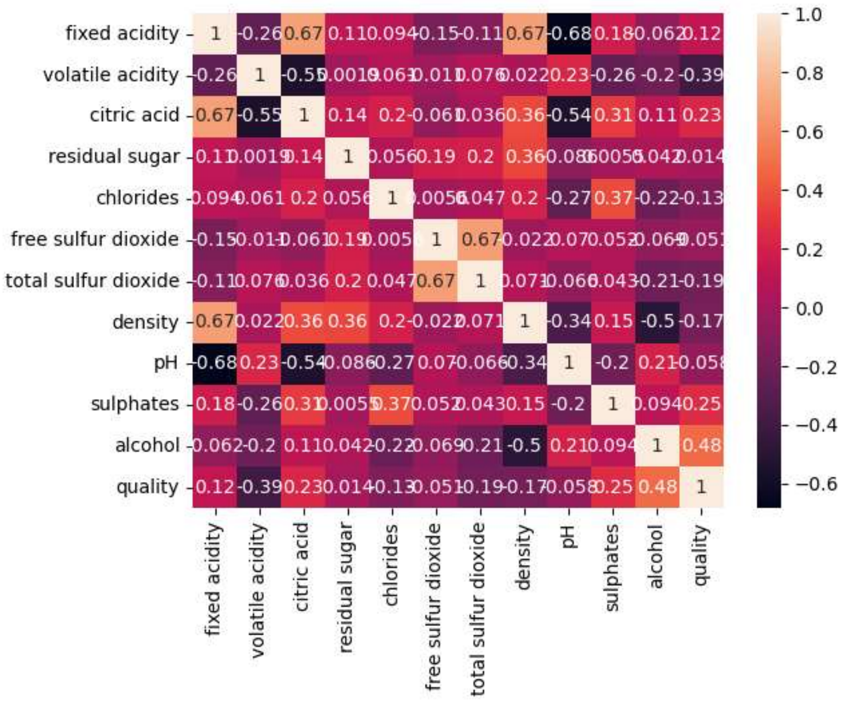


```
sns.jointplot(x="density",y="quality",data=df)
plt.show()
```



```
sns.heatmap(df.corr(),annot=True)
```

```
<Axes: >
```



```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

```
X=df.drop("quality",axis=1)
y=df["quality"]
X.head()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8

```
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)
```

```
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 ]])
```

```
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(
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]])
```

```
from sklearn.metrics import accuracy_score, confusion_matrix,classification_report,roc_auc_score,roc_curve
accuracy_score(y_test,y_pred)
```

```
0.575
```

```
pd.crosstab(y_test,y_pred)
```

```
col_0  4   5   6   7
```

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

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

```
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,
```

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

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