In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
wine=pd.read_csv('wine.csv')
```

In [3]:

```
wine.head()
```

Out[3]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines	Pr
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	

In [4]:

```
wine.shape
```

Out[4]:

```
(178, 14)
```

In [5]:

```
wine.dtypes
```

Out[5]:

```
Class                   int64
Alcohol               float64
Malic acid            float64
Ash                   float64
Alcalinity of ash     float64
Magnesium               int64
Total phenols         float64
Flavanoids            float64
Nonflavanoid phenols  float64
Proanthocyanins       float64
Color intensity       float64
Hue                   float64
diluted wines         float64
Proline                 int64
dtype: object
```

In [6]:

```
wine.columns
```

Out[6]:

```
Index(['Class', 'Alcohol', 'Malic acid', 'Ash', 'Alcalinity of ash',
       'Magnesium', 'Total phenols', 'Flavanoids', 'Nonflavanoid phenols',
       'Proanthocyanins', 'Color intensity', 'Hue', 'diluted wines',
       'Proline    '],
      dtype='object')
```

In [7]:

```
wine.describe()
```

Out[7]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanin
count	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.00000
mean	1.938202	13.000618	2.336348	2.366517	19.494944	99.741573	2.295112	2.029270	0.361854	1.59089
std	0.775035	0.811827	1.117146	0.274344	3.339564	14.282484	0.625851	0.998859	0.124453	0.57235
min	1.000000	11.030000	0.740000	1.360000	10.600000	70.000000	0.980000	0.340000	0.130000	0.41000
25%	1.000000	12.362500	1.602500	2.210000	17.200000	88.000000	1.742500	1.205000	0.270000	1.25000
50%	2.000000	13.050000	1.865000	2.360000	19.500000	98.000000	2.355000	2.135000	0.340000	1.55500
75%	3.000000	13.677500	3.082500	2.557500	21.500000	107.000000	2.800000	2.875000	0.437500	1.95000
max	3.000000	14.830000	5.800000	3.230000	30.000000	162.000000	3.880000	5.080000	0.660000	3.58000

In [8]:

```
wine.Class.unique()
```

Out[8]:

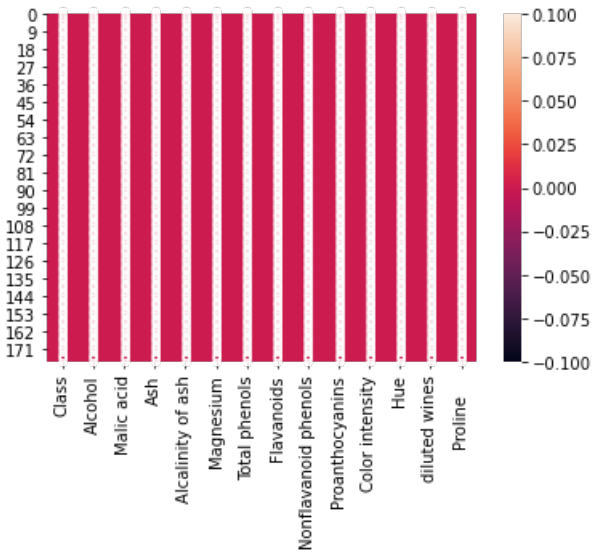
```
array([1, 2, 3], dtype=int64)
```

In [9]:

```
sns.heatmap(wine.isnull(),annot=True)
```

Out[9]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1f8ddd24430>
```



In [10]:

```
wine.corr()
```

Out[10]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins
Class	1.000000	-0.328222	0.437776	-0.049643	0.517859	-0.209179	-0.719163	-0.847498	0.489109	-0.499130
Alcohol	-0.328222	1.000000	0.094397	0.211545	-0.310235	0.270798	0.289101	0.236815	-0.155929	0.136698
Malic acid	0.437776	0.094397	1.000000	0.164045	0.288500	-0.054575	-0.335167	-0.411007	0.292977	-0.220746
Ash	-0.049643	0.211545	0.164045	1.000000	0.443367	0.286587	0.128980	0.115077	0.186230	0.009652
Alcalinity of ash	0.517859	-0.310235	0.288500	0.443367	1.000000	-0.083333	-0.321113	-0.351370	0.361922	-0.197327
Magnesium	-0.209179	0.270798	-0.054575	0.286587	-0.083333	1.000000	0.214401	0.195784	-0.256294	0.236441
Total phenols	-0.719163	0.289101	-0.335167	0.128980	-0.321113	0.214401	1.000000	0.864564	-0.449935	0.612413
Flavanoids	-0.847498	0.236815	-0.411007	0.115077	-0.351370	0.195784	0.864564	1.000000	-0.537900	0.652692
Nonflavanoid phenols	0.489109	-0.155929	0.292977	0.186230	0.361922	-0.256294	-0.449935	-0.537900	1.000000	-0.365845
Proanthocyanins	-0.499130	0.136698	-0.220746	0.009652	-0.197327	0.236441	0.612413	0.652692	-0.365845	1.000000
Color intensity	0.265668	0.546364	0.248985	0.258887	0.018732	0.199950	-0.055136	-0.172379	0.139057	-0.025250
Hue	-0.617369	-0.071747	-0.561296	-0.074667	-0.273955	0.055398	0.433681	0.543479	-0.262640	0.295544
diluted wines	-0.788230	0.072343	-0.368710	0.003911	-0.276769	0.066004	0.699949	0.787194	-0.503270	0.519067
Proline	-0.633717	0.643720	-0.192011	0.223626	-0.440597	0.393351	0.498115	0.494193	-0.311385	0.330417

In [11]:

```
plt.figure(figsize=(10,6))
```

Out[11]:

```
<Figure size 720x432 with 0 Axes>
```


```
<Figure size 720x432 with 0 Axes>
```


In [12]:

```
wine.skew()
```

Out[12]:

```
Class                 0.107431
Alcohol              -0.051482
Malic acid            1.039651
Ash                  -0.176699
Alcalinity of ash     0.213047
Magnesium             1.098191
Total phenols         0.086639
Flavanoids            0.025344
Nonflavanoid phenols  0.450151
Proanthocyanins       0.517137
Color intensity       0.868585
Hue                   0.021091
diluted wines        -0.307285
```

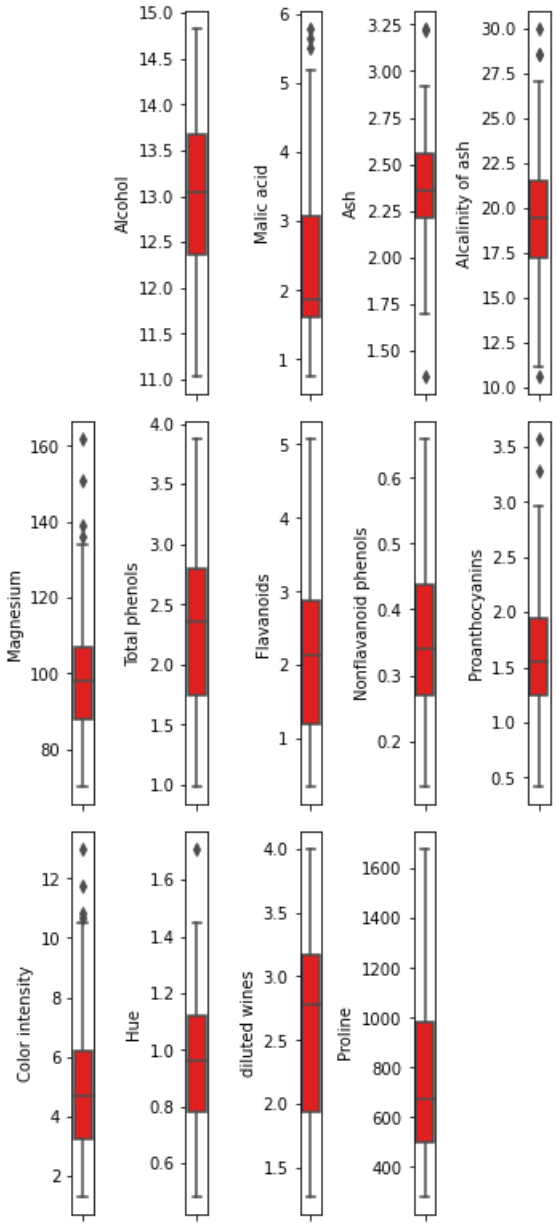
```
Proline                 0.767822
dtype: float64
```

In [13]:

```
col=wine.columns.values
ncol=5
nrow=7
```

In [14]:

```
plt.figure(figsize=(ncol,5*ncol))
for i in range(1,len(col)):
    plt.subplot(nrow,ncol,i+1)
    sns.boxplot(wine[col[i]],color='red',orient='v')
    plt.tight_layout()
```



In [15]:

```
from scipy.stats import zscore
z_score=abs(zscore(wine))
print(wine.shape)
wine_df=wine.loc[(z_score<3).all(axis=1)]
print(wine_df.shape)
```

```
(178, 14)
```

(168, 14)

In [16]:

```
wine_df
```

Out[16]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 14 columns

In [17]:

```
wine_df=pd.DataFrame(data=wine_df)
```

In [18]:

```
wine_df
```

Out[18]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 14 columns

In [19]:

```
x=wine_df.iloc[:,1:-1]
```

In [20]:

```
x
```

Out[20]:

	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...
173	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 12 columns

In [21]:

```
x.shape
```

Out[21]:

```
(168, 12)
```

In [22]:

```
y=wine_df.iloc[:,0]
```

In [23]:

```
y
```

Out[23]:

```
0      1
1      1
2      1
3      1
4      1
      ..
173    3
174    3
175    3
176    3
177    3
Name: Class, Length: 168, dtype: int64
```

In [24]:

```
y.shape
```

Out[24]:

```
(168,)
```

In [25]:

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=.22,random_state=50)
```

In [26]:

```
```

```
from sklearn.neighbors import KNeighborsClassifier
knn=KNeighborsClassifier()
knn.fit(x_train,y_train)
knn.score(x_train,y_train)
predknn=knn.predict(x_test)
print(accuracy_score(y_test,predknn))
print(confusion_matrix(y_test,predknn))
print(classification_report(y_test,predknn))
```

```
0.8648648648648649
[[10  1  1]
 [ 0 11  0]
 [ 2  1 11]]
              precision    recall  f1-score   support

           1       0.83      0.83      0.83        12
           2       0.85      1.00      0.92        11
           3       0.92      0.79      0.85        14

    accuracy                           0.86        37
   macro avg       0.87      0.87      0.87        37
weighted avg       0.87      0.86      0.86        37
```

In [28]:

```
rf=RandomForestClassifier(n_estimators=100,random_state=42)
rf.fit(x_train,y_train)
predrf=rf.predict(x_test)
print(accuracy_score(y_test,predrf))
print(confusion_matrix(y_test,predrf))
print(classification_report(y_test,predrf))
```

```
0.972972972972973
[[12  0  0]
 [ 1 10  0]
 [ 0  0 14]]
              precision    recall  f1-score   support

           1       0.92      1.00      0.96        12
           2       1.00      0.91      0.95        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [30]:

```
gnb=GaussianNB()
gnb.fit(x_train,y_train)
gnb.score(x_train,y_train)
predgnb=gnb.predict(x_test)
print(accuracy_score(y_test,predgnb))
print(confusion_matrix(y_test,predgnb))
print(classification_report(y_test,predgnb))
```

```
0.972972972972973
[[12  0  0]
 [ 1 10  0]
 [ 0  0 14]]
              precision    recall  f1-score   support

           1       0.92      1.00      0.96        12
           2       1.00      0.91      0.95        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [31]:

```
dtc=DecisionTreeClassifier()
dtc.fit(x_train,y_train)
dtc.score(x_train,y_train)
preddtc=dtc.predict(x_test)
print(accuracy_score(y_test,preddtc))
print(confusion_matrix(y_test,preddtc))
print(classification_report(y_test,preddtc))
```

```
0.972972972972973
[[11  1  0]
 [ 0 11  0]
 [ 0  0 14]]
              precision    recall  f1-score   support

           1       1.00      0.92      0.96        12
           2       0.92      1.00      0.96        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [32]:

```
import joblib
joblib.dump(rf,'wine.pkl')
```

Out[32]:

```
['wine.pkl']
```

In [ ]:

```

```