In [15]:

```
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.tree import DecisionTreeClassifier
from sklearn.naive_bayes import GaussianNB
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
from sklearn.model_selection import cross_val_score
import warnings
warnings.filterwarnings('ignore')
```

In [16]:

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

In [17]:

```
sonar.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 208 entries, 0 to 207
Data columns (total 61 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   V1      208 non-null    float64
 1   V2      208 non-null    float64
 2   V3      208 non-null    float64
 3   V4      208 non-null    float64
 4   V5      208 non-null    float64
 5   V6      208 non-null    float64
 6   V7      208 non-null    float64
 7   V8      208 non-null    float64
 8   V9      208 non-null    float64
 9   V10     208 non-null    float64
 10  V11     208 non-null    float64
 11  V12     208 non-null    float64
 12  V13     208 non-null    float64
 13  V14     208 non-null    float64
 14  V15     208 non-null    float64
 15  V16     208 non-null    float64
 16  V17     208 non-null    float64
 17  V18     208 non-null    float64
 18  V19     208 non-null    float64
 19  V20     208 non-null    float64
 20  V21     208 non-null    float64
 21  V22     208 non-null    float64
 22  V23     208 non-null    float64
 23  V24     208 non-null    float64
 24  V25     208 non-null    float64
 25  V26     208 non-null    float64
 26  V27     208 non-null    float64
 27  V28     208 non-null    float64
 28  V29     208 non-null    float64
 29  V30     208 non-null    float64
 30  V31     208 non-null    float64
 31  V32     208 non-null    float64
 32  V33     208 non-null    float64
 33  V34     208 non-null    float64
 34  V35     208 non-null    float64
 35  V36     208 non-null    float64
 36  V37     208 non-null    float64
 37  V38     208 non-null    float64
 38  V39     208 non-null    float64
 39  V40     208 non-null    float64
```

```
 39  V40     208 non-null    float64
 40  V41     208 non-null    float64
 41  V42     208 non-null    float64
 42  V43     208 non-null    float64
 43  V44     208 non-null    float64
 44  V45     208 non-null    float64
 45  V46     208 non-null    float64
 46  V47     208 non-null    float64
 47  V48     208 non-null    float64
 48  V49     208 non-null    float64
 49  V50     208 non-null    float64
 50  V51     208 non-null    float64
 51  V52     208 non-null    float64
 52  V53     208 non-null    float64
 53  V54     208 non-null    float64
 54  V55     208 non-null    float64
 55  V56     208 non-null    float64
 56  V57     208 non-null    float64
 57  V58     208 non-null    float64
 58  V59     208 non-null    float64
 59  V60     208 non-null    float64
 60  Class   208 non-null    int64
dtypes: float64(60), int64(1)
memory usage: 99.2 KB
```

In [18]:

```
sonar
```

Out[18]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V52	V53	V54	V55	V56	V57
0	0.0200	0.0371	0.0428	0.0207	0.0954	0.0986	0.1539	0.1601	0.3109	0.2111	...	0.0027	0.0065	0.0159	0.0072	0.0167	0.0180
1	0.0453	0.0523	0.0843	0.0689	0.1183	0.2583	0.2156	0.3481	0.3337	0.2872	...	0.0084	0.0089	0.0048	0.0094	0.0191	0.0140
2	0.0262	0.0582	0.1099	0.1083	0.0974	0.2280	0.2431	0.3771	0.5598	0.6194	...	0.0232	0.0166	0.0095	0.0180	0.0244	0.0316
3	0.0100	0.0171	0.0623	0.0205	0.0205	0.0368	0.1098	0.1276	0.0598	0.1264	...	0.0121	0.0036	0.0150	0.0085	0.0073	0.0050
4	0.0762	0.0666	0.0481	0.0394	0.0590	0.0649	0.1209	0.2467	0.3564	0.4459	...	0.0031	0.0054	0.0105	0.0110	0.0015	0.0072
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
203	0.0187	0.0346	0.0168	0.0177	0.0393	0.1630	0.2028	0.1694	0.2328	0.2684	...	0.0116	0.0098	0.0199	0.0033	0.0101	0.0065
204	0.0323	0.0101	0.0298	0.0564	0.0760	0.0958	0.0990	0.1018	0.1030	0.2154	...	0.0061	0.0093	0.0135	0.0063	0.0063	0.0034
205	0.0522	0.0437	0.0180	0.0292	0.0351	0.1171	0.1257	0.1178	0.1258	0.2529	...	0.0160	0.0029	0.0051	0.0062	0.0089	0.0140
206	0.0303	0.0353	0.0490	0.0608	0.0167	0.1354	0.1465	0.1123	0.1945	0.2354	...	0.0086	0.0046	0.0126	0.0036	0.0035	0.0034
207	0.0260	0.0363	0.0136	0.0272	0.0214	0.0338	0.0655	0.1400	0.1843	0.2354	...	0.0146	0.0129	0.0047	0.0039	0.0061	0.0040

208 rows × 61 columns

In [19]:

```
sonar.columns
```

Out[19]:

```
Index(['V1', 'V2', 'V3', 'V4', 'V5', 'V6', 'V7', 'V8', 'V9', 'V10', 'V11',
       'V12', 'V13', 'V14', 'V15', 'V16', 'V17', 'V18', 'V19', 'V20', 'V21',
       'V22', 'V23', 'V24', 'V25', 'V26', 'V27', 'V28', 'V29', 'V30', 'V31',
       'V32', 'V33', 'V34', 'V35', 'V36', 'V37', 'V38', 'V39', 'V40', 'V41',
       'V42', 'V43', 'V44', 'V45', 'V46', 'V47', 'V48', 'V49', 'V50', 'V51',
       'V52', 'V53', 'V54', 'V55', 'V56', 'V57', 'V58', 'V59', 'V60', 'Class'],
      dtype='object')
```

In [20]:

```
sonar.dtypes
```

Out[20]:

```
V1        float64
```

```
V2       float64
V3       float64
V4       float64
V5       float64
          ...
V57      float64
V58      float64
V59      float64
V60      float64
Class      int64
Length: 61, dtype: object
```

In [21]:

```
sonar.describe()
```

Out[21]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	
count	208.000000	208.000000	208.000000	208.000000	208.000000	208.000000	208.000000	208.000000	208.000000	208.000000	...	20
mean	0.029164	0.038437	0.043832	0.053892	0.075202	0.104570	0.121747	0.134799	0.178003	0.208259	...	
std	0.022991	0.032960	0.038428	0.046528	0.055552	0.059105	0.061788	0.085152	0.118387	0.134416	...	
min	0.001500	0.000600	0.001500	0.005800	0.006700	0.010200	0.003300	0.005500	0.007500	0.011300	...	
25%	0.013350	0.016450	0.018950	0.024375	0.038050	0.067025	0.080900	0.080425	0.097025	0.111275	...	
50%	0.022800	0.030800	0.034300	0.044050	0.062500	0.092150	0.106950	0.112100	0.152250	0.182400	...	
75%	0.035550	0.047950	0.057950	0.064500	0.100275	0.134125	0.154000	0.169600	0.233425	0.268700	...	
max	0.137100	0.233900	0.305900	0.426400	0.401000	0.382300	0.372900	0.459000	0.682800	0.710600	...	

8 rows × 61 columns

In [22]:

```
sonar.skew()
```

Out[22]:

```
V1       2.131088
V2       2.155644
V3       2.652518
V4       3.401697
V5       2.018141
           ...
V57      1.653090
V58      2.098330
V59      1.737506
V60      2.775754
Class    0.135903
Length: 61, dtype: float64
```

In [31]:

```
for col in sonar.columns:
    if sonar.skew().loc[col]>0.55:
        sonar[col]=np.log1p(sonar[col])
```

In [32]:

```
#reduced skewness
sonar.skew()
```

Out[32]:

```
V1       2.036001
V2       1.969917
V3       2.344713
V4       2.818320
```

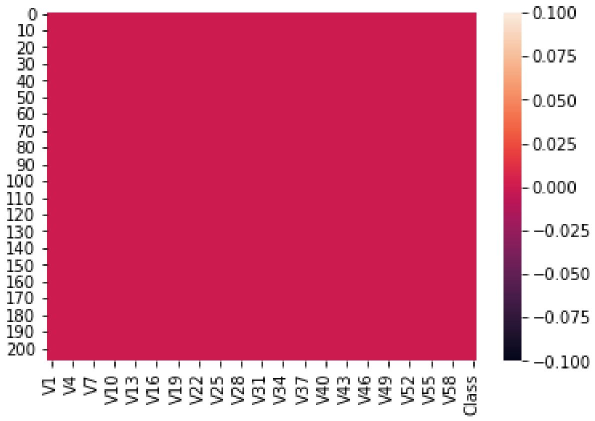
```
V5       1.698684
           ...
V57      1.629182
V58      2.058207
V59      1.713349
V60      2.711412
Class    0.135903
Length: 61, dtype: float64
```

In [24]:

```
sns.heatmap(sonar.isnull())
```

Out[24]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x20568d05fa0>
```



In [33]:

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

```
(208, 61)
(173, 61)
```

In [34]:

```
sonar_df
```

Out[34]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V52	V53	
0	0.019803	0.036428	0.041909	0.020489	0.091120	0.094037	0.143148	0.148506	0.270714	0.191529	...	0.002696	0.006479	0.015
1	0.044304	0.050978	0.080935	0.066630	0.111810	0.229762	0.195238	0.298696	0.287957	0.252469	...	0.008365	0.008861	0.004
3	0.009950	0.016955	0.060436	0.020293	0.020293	0.036139	0.104180	0.120091	0.058080	0.119027	...	0.012027	0.003594	0.014
4	0.073436	0.064476	0.046979	0.038644	0.057325	0.062881	0.114132	0.220500	0.304834	0.368732	...	0.003095	0.005385	0.010
5	0.028199	0.044304	0.027323	0.017250	0.037681	0.094401	0.113418	0.168307	0.191033	0.265360	...	0.004490	0.001399	0.003
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
203	0.018527	0.034015	0.016660	0.017545	0.038547	0.151003	0.184652	0.156491	0.209288	0.237756	...	0.011533	0.009752	0.019
204	0.031789	0.010049	0.029365	0.054867	0.073250	0.091485	0.094401	0.096945	0.098034	0.195073	...	0.006081	0.009257	0.013
205	0.050883	0.042772	0.017840	0.028782	0.034498	0.110736	0.118405	0.111362	0.118494	0.225461	...	0.015873	0.002896	0.005
206	0.029850	0.034691	0.047837	0.059023	0.016562	0.126985	0.136714	0.106430	0.177728	0.211395	...	0.008563	0.004589	0.012
207	0.025668	0.035657	0.013508	0.026837	0.021174	0.033241	0.063444	0.131028	0.169152	0.211395	...	0.014494	0.012818	0.004

173 rows × 61 columns

In [35]:

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

Out[35]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V52	V53	
0	0.019803	0.036428	0.041909	0.020489	0.091120	0.094037	0.143148	0.148506	0.270714	0.191529	...	0.002696	0.006479	0.015
1	0.044304	0.050978	0.080935	0.066630	0.111810	0.229762	0.195238	0.298696	0.287957	0.252469	...	0.008365	0.008861	0.004
3	0.009950	0.016955	0.060436	0.020293	0.020293	0.036139	0.104180	0.120091	0.058080	0.119027	...	0.012027	0.003594	0.014
4	0.073436	0.064476	0.046979	0.038644	0.057325	0.062881	0.114132	0.220500	0.304834	0.368732	...	0.003095	0.005385	0.010
5	0.028199	0.044304	0.027323	0.017250	0.037681	0.094401	0.113418	0.168307	0.191033	0.265360	...	0.004490	0.001399	0.003
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
203	0.018527	0.034015	0.016660	0.017545	0.038547	0.151003	0.184652	0.156491	0.209288	0.237756	...	0.011533	0.009752	0.019
204	0.031789	0.010049	0.029365	0.054867	0.073250	0.091485	0.094401	0.096945	0.098034	0.195073	...	0.006081	0.009257	0.013
205	0.050883	0.042772	0.017840	0.028782	0.034498	0.110736	0.118405	0.111362	0.118494	0.225461	...	0.015873	0.002896	0.005
206	0.029850	0.034691	0.047837	0.059023	0.016562	0.126985	0.136714	0.106430	0.177728	0.211395	...	0.008563	0.004589	0.012
207	0.025668	0.035657	0.013508	0.026837	0.021174	0.033241	0.063444	0.131028	0.169152	0.211395	...	0.014494	0.012818	0.004

173 rows × 61 columns

In [38]:

```
#x and y values allocation for training and testing
x=sonar_df.iloc[:,0:-1]
```

In [39]:

```
x
```

Out[39]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V51	V52	
0	0.019803	0.036428	0.041909	0.020489	0.091120	0.094037	0.143148	0.148506	0.270714	0.191529	...	0.022935	0.002696	0.006
1	0.044304	0.050978	0.080935	0.066630	0.111810	0.229762	0.195238	0.298696	0.287957	0.252469	...	0.012423	0.008365	0.008
3	0.009950	0.016955	0.060436	0.020293	0.020293	0.036139	0.104180	0.120091	0.058080	0.119027	...	0.023814	0.012027	0.003
4	0.073436	0.064476	0.046979	0.038644	0.057325	0.062881	0.114132	0.220500	0.304834	0.368732	...	0.015480	0.003095	0.005
5	0.028199	0.044304	0.027323	0.017250	0.037681	0.094401	0.113418	0.168307	0.191033	0.265360	...	0.010346	0.004490	0.001
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
203	0.018527	0.034015	0.016660	0.017545	0.038547	0.151003	0.184652	0.156491	0.209288	0.237756	...	0.020097	0.011533	0.009
204	0.031789	0.010049	0.029365	0.054867	0.073250	0.091485	0.094401	0.096945	0.098034	0.195073	...	0.005087	0.006081	0.009
205	0.050883	0.042772	0.017840	0.028782	0.034498	0.110736	0.118405	0.111362	0.118494	0.225461	...	0.015381	0.015873	0.002
206	0.029850	0.034691	0.047837	0.059023	0.016562	0.126985	0.136714	0.106430	0.177728	0.211395	...	0.004191	0.008563	0.004
207	0.025668	0.035657	0.013508	0.026837	0.021174	0.033241	0.063444	0.131028	0.169152	0.211395	...	0.017938	0.014494	0.012

173 rows × 60 columns

In [40]:

```
x.shape
```

Out[40]:

```
(173, 60)
```

In [41]:

```
pca=PCA(n_components=15)
```

In [42]:

```
x=pca.fit_transform(x)
```

In [43]:

```
x.shape
```

Out[43]:

```
(173, 15)
```

In [44]:

```
y=sonar_df.iloc[:,-1]
```

In [45]:

```
y
```

Out[45]:

```
0      1
1      1
3      1
4      1
5      1
      ..
203    0
204    0
205    0
206    0
207    0
Name: Class, Length: 173, dtype: int64
```

In [46]:

```
y.shape
```

Out[46]:

```
(173,)
```

In [47]:

```
sonar.corr()
```

Out[47]:

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V52	V53	
V1	1.000000	0.735222	0.570685	0.485743	0.336469	0.244380	0.260978	0.351766	0.348769	0.312130	...	0.353387	0.312563	0.3
V2	0.735222	1.000000	0.773040	0.590833	0.404392	0.334846	0.278614	0.337122	0.318649	0.269347	...	0.434345	0.348536	0.3
V3	0.570685	0.773040	1.000000	0.765006	0.524464	0.351185	0.192678	0.246778	0.263476	0.226283	...	0.396473	0.335055	0.3
V4	0.485743	0.590833	0.765006	1.000000	0.708444	0.362016	0.252227	0.260257	0.252504	0.242135	...	0.379065	0.370981	0.3
V5	0.336469	0.404392	0.524464	0.708444	1.000000	0.605497	0.340052	0.212995	0.188492	0.194106	...	0.267553	0.315872	0.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
V57	0.316519	0.286026	0.388956	0.351808	0.216137	0.164213	0.183444	0.259359	0.179931	0.128099	...	0.190659	0.306836	0.3

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	...	V52	V53	
V58	0.3715[illegible]	0.3585[illegible]	0.3422[illegible]	0.3572[illegible]	0.2367[illegible]	0.2089[illegible]	0.2412[illegible]	0.2834[illegible]	0.2231[illegible]	0.203[illegible]	...	0.309[illegible]	0.369[illegible]	0.4
V59	0.358920	0.354793	0.431001	0.430703	0.288460	0.224321	0.179633	0.186581	0.082903	0.052438	...	0.297710	0.346919	0.4
V60	0.348455	0.358427	0.375295	0.400941	0.247061	0.183374	0.220841	0.142316	0.082875	0.093219	...	0.196169	0.282185	0.2
Class	-0.272710	-0.232735	-0.194547	-0.257889	-0.227755	-0.141348	-0.120424	-0.196120	-0.337322	-0.354554	...	-0.289856	-0.141687	0.1

61 rows × 61 columns

In [48]:

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

In [49]:

```
lr=LogisticRegression()
```

In [50]:

```
lr.fit(x_train,y_train)
lr.score(x_train,y_train)
pred=lr.predict(x_test)
print(accuracy_score(y_test,pred))
print(confusion_matrix(y_test,pred))
print(classification_report(y_test,pred))
```

```
0.7692307692307693
[[17  3]
 [ 6 13]]
              precision    recall  f1-score   support

           0       0.74      0.85      0.79        20
           1       0.81      0.68      0.74        19

    accuracy                           0.77        39
   macro avg       0.78      0.77      0.77        39
weighted avg       0.77      0.77      0.77        39
```

In [51]:

```
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))
```

```
0.6923076923076923
[[10 10]
 [ 2 17]]
              precision    recall  f1-score   support

           0       0.83      0.50      0.62        20
           1       0.63      0.89      0.74        19

    accuracy                           0.69        39
   macro avg       0.73      0.70      0.68        39
weighted avg       0.73      0.69      0.68        39
```

In [52]:

```
dtc=DecisionTreeClassifier()
dtc.fit(x_train,y_train)
dtc.score(x_train,y_train)
preddtc=dtc.predict(x_test)
```

```
preddtc=dtc.predict(x_test)
print(accuracy_score(y_test,preddtc))
print(confusion_matrix(y_test,preddtc))
print(classification_report(y_test,preddtc))
```

```
0.6410256410256411
[[11  9]
 [ 5 14]]
              precision    recall  f1-score   support

           0       0.69      0.55      0.61        20
           1       0.61      0.74      0.67        19

    accuracy                           0.64        39
   macro avg       0.65      0.64      0.64        39
weighted avg       0.65      0.64      0.64        39
```

In [53]:

```
rf=RandomForestClassifier()
rf.fit(x_train,y_train)
rf.score(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))
```

```
0.7948717948717948
[[16  4]
 [ 4 15]]
              precision    recall  f1-score   support

           0       0.80      0.80      0.80        20
           1       0.79      0.79      0.79        19

    accuracy                           0.79        39
   macro avg       0.79      0.79      0.79        39
weighted avg       0.79      0.79      0.79        39
```

In [54]:

```
from sklearn.ensemble import AdaBoostClassifier
ad=AdaBoostClassifier()
ad.fit(x_train,y_train)
ad.score(x_train,y_train)
predad=ad.predict(x_test)
print(accuracy_score(y_test,predad))
print(confusion_matrix(y_test,predad))
print(classification_report(y_test,predad))
```

```
0.6666666666666666
[[15  5]
 [ 8 11]]
              precision    recall  f1-score   support

           0       0.65      0.75      0.70        20
           1       0.69      0.58      0.63        19

    accuracy                           0.67        39
   macro avg       0.67      0.66      0.66        39
weighted avg       0.67      0.67      0.66        39
```

In [55]:

```
#AdaBoostClassifier is the model among all models

import joblib
joblib.dump(ad,'sonar.pkl')
```

Out[55]:

```
['sonar.pkl']
```