In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split,StratifiedKFold,GridSearc
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score,log_loss
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import mean_absolute_error as mae
from sklearn.metrics import mean_squared_error as mse
from sklearn.preprocessing import StandardScaler,MinMaxScaler
from sklearn.preprocessing import LabelEncoder
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report,confusion_matrix
from sklearn.tree import DecisionTreeClassifier,plot_tree
from sklearn.svm import SVC
import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
bl=pd.read_csv("D:\\cdac\\Advance Analytics\\Practice_Datasets\\bankloan.csv",
```

In [3]:
```
bl.head()
```

Out[3]:

ID	Age	Experience	Income	ZIP.Code	Family	CCAvg	Education	Mortgage	Personal.Loan
1	25	1	49	91107	4	1.6	1	0	0
2	45	19	34	90089	3	1.5	1	0	0
3	39	15	11	94720	1	1.0	1	0	0
4	35	9	100	94112	1	2.7	2	0	0
5	35	8	45	91330	4	1.0	2	0	0

In [4]:
```
bl.isnull().sum()
```

Out[4]:
```
Age                   0
Experience            0
Income                0
ZIP.Code              0
Family                0
CCAvg                 0
Education             0
Mortgage              0
Personal.Loan         0
Securities.Account    0
CD.Account            0
Online                0
CreditCard            0
dtype: int64
```

In [5]:
```
bl.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 5000 entries, 1 to 5000
Data columns (total 13 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   Age                 5000 non-null   int64  
 1   Experience          5000 non-null   int64  
 2   Income              5000 non-null   int64  
 3   ZIP.Code            5000 non-null   int64  
 4   Family              5000 non-null   int64  
 5   CCAvg               5000 non-null   float64
 6   Education           5000 non-null   int64  
 7   Mortgage            5000 non-null   int64  
 8   Personal.Loan       5000 non-null   int64  
 9   Securities.Account  5000 non-null   int64  
 10  CD.Account          5000 non-null   int64  
 11  Online              5000 non-null   int64  
 12  CreditCard          5000 non-null   int64  
dtypes: float64(1), int64(12)
memory usage: 546.9 KB
```

In [6]:
```
x=bl.drop(['Personal.Loan','ZIP.Code'],axis=1)
y=bl['Personal.Loan']
```

In [7]:
```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.3,stratify=y,ra
```

In [ ]:
```

```

LR

In [8]:
```
lr=LogisticRegression()
lr.fit(x_train,y_train)
print(lr.coef_)
print(lr.intercept_)
```

```
[[-5.02414060e-01  4.98936693e-01  5.35236894e-02  6.73436387e-01
   7.62162369e-02  1.74707959e+00  5.11687845e-04  7.04376546e-02
   2.67680109e+00 -7.14817512e-01 -5.58285222e-01]]
[-0.4145741]
```

In [9]:
```
y_pred=lr.predict(x_test)
y_pred_prob=lr.predict_proba(x_test)
y_pred_train=lr.predict(x_train)
y_pred_prob_train=lr.predict_proba(x_train)
```

In [10]:
```
print("Train Accuracy")
print(lr.score(x_train,y_train))


print("Test Accuracy")
print("Accuracy=",accuracy_score(y_test,y_pred))
print("Log Loss=",log_loss(y_test,y_pred))
```

```
Train Accuracy
0.9474285714285714
Test Accuracy
Accuracy= 0.9493333333333334
Log Loss= 1.8262117717152693
```

In [ ]:

Tuning LR

In [11]:
```
kfold=StratifiedKFold(n_splits=5,shuffle=True,random_state=23)
params={'penalty':['l1','l2','elasticnet',None],
        'l1_ratio':np.linspace(0,1,5),
        'solver':['lbfgs','liblinear','newton-cg','newton-cholesky','sag','saga
        'multi_class':['ovr','multinomial']}
gcv=GridSearchCV(lr,param_grid=params,cv=kfold,scoring='accuracy')
gcv.fit(x,y)
print("Test tuned accuracy")
print(gcv.best_params_)
print(gcv.best_score_)
```

```
Test tuned accuracy
{'l1_ratio': 0.0, 'multi_class': 'ovr', 'penalty': None, 'solver': 'newton-cg
'}
0.952
```

In [ ]:

KNN

In [12]:
```
knn=KNeighborsClassifier()
```

In [13]:
```
knn.fit(x_train,y_train)
```

Out[13]:
```
▾ KNeighborsClassifier

KNeighborsClassifier()
```

In [14]:
```
y_pred=knn.predict(x_test)
y_pred_prob=knn.predict_proba(x_test)

print("Train Accuracy")
print(knn.score(x_train,y_train))

print("Test Accuracy")
print("Accuracy Score=",accuracy_score(y_test,y_pred))
print("Log loss=",log_loss(y_test,y_pred_prob))
```

```
Train Accuracy
0.9388571428571428
Test Accuracy
Accuracy Score= 0.908
Log loss= 0.667534097839193
```

In [ ]:

Tuning KNN

In [15]:
```
kfold=StratifiedKFold(n_splits=5,shuffle=True,random_state=23)
params={'n_neighbors':[1,3,5,7,9,11,13,15,17]}
gcv=GridSearchCV(knn,param_grid=params,cv=kfold,scoring='accuracy')
gcv.fit(x,y)
print("Tuned Test Accuracy")
print(gcv.best_params_)
print(gcv.best_score_)
```

```
Tuned Test Accuracy
{'n_neighbors': 5}
0.9122
```

In [ ]:

In [ ]:

In [ ]:

In [16]:
```
score=pd.DataFrame(gcv.cv_results_)
```

In [17]:
```
score
```

Out[17]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_neighbors	para
0	0.022110	0.004496	0.157558	0.026386	1	{'n_neighbo
1	0.023115	0.008300	0.149326	0.042160	3	{'n_neighbo
2	0.015025	0.004072	0.128939	0.030830	5	{'n_neighbo
3	0.015946	0.004042	0.119456	0.026752	7	{'n_neighbo
4	0.019247	0.006492	0.149095	0.027801	9	{'n_neighbo
5	0.016980	0.004144	0.169688	0.038722	11	{'n_neighbo
6	0.020335	0.002124	0.164036	0.025773	13	{'n_neighbo
7	0.012169	0.001468	0.106292	0.008797	15	{'n_neighbo
8	0.018573	0.003326	0.160746	0.035739	17	{'n_neighbo

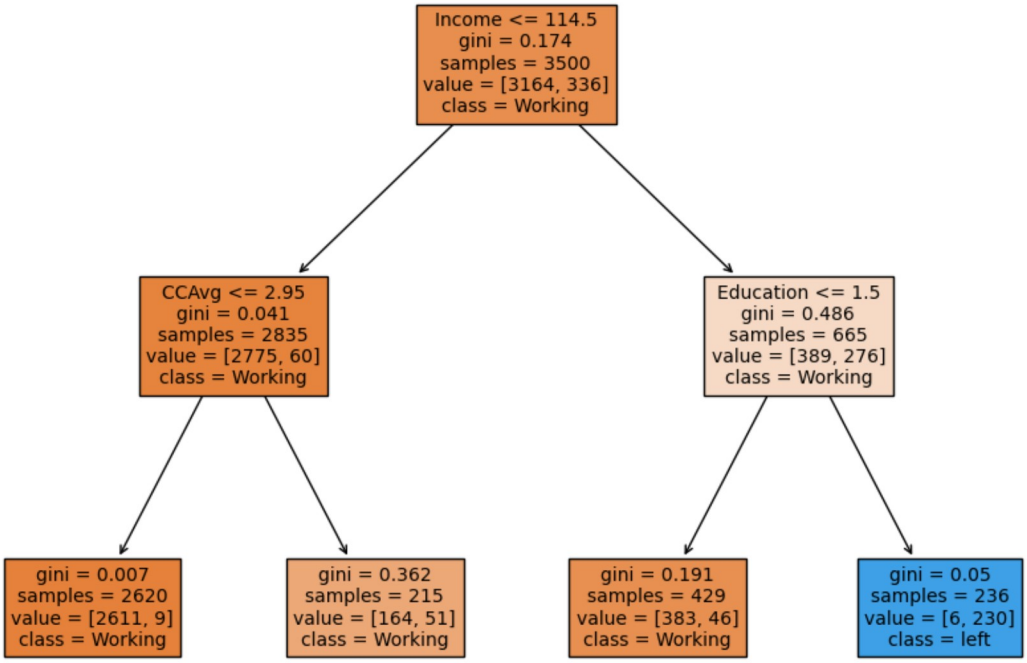
In [ ]:

DECISION TREE

In [18]:
```
dtc=DecisionTreeClassifier(random_state=23,max_depth=2)
dtc.fit(x_train,y_train)
```

Out[18]:
```
DecisionTreeClassifier
DecisionTreeClassifier(max_depth=2, random_state=23)
```

In [19]:
```
plt.figure(figsize=(11,8))
plot_tree(dtc,feature_names=list(x.columns),class_names=['Working','left'],
          filled=True,fontsize=10)
plt.show()
```



In [20]:
```
y_pred=dtc.predict(x_test)
y_pred_prob=dtc.predict_proba(x_test)
```

In [21]:
```
print("Train Accuracy")
print(dtc.score(x_train,y_train))

print("Test Accuracy")
print(accuracy_score(y_test,y_pred))
print(log_loss(y_test,y_pred_prob))
```

```
Train Accuracy
0.968
Test Accuracy
0.9653333333333334
0.10728142850682658
```

In [ ]:

Tuning Decision Tree

In [ ]:

In [22]:
```
kfold = StratifiedKFold(n_splits=5,shuffle=True,random_state=23)
```

In [23]:
```
params = {'min_samples_split':[2,5,10,20,60,80,100],
          'max_depth': [3,4,5,6,7,None],
         'min_samples_leaf':[1,5,10,20]}
gcv = GridSearchCV(dtc, param_grid = params,cv=kfold,scoring='accuracy')
gcv.fit(x,y)
print("Test tuning Accuracy")
print("Best score: ",gcv.best_score_)
print("Best params: ",gcv.best_params_)
```

```
Test tuning Accuracy
Best score:  0.9854
Best params:  {'max_depth': None, 'min_samples_leaf': 1, 'min_samples_split':
2}
```

In [24]:
```
score=pd.DataFrame(gcv.cv_results_)
score
```

Out[24]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_max_depth	param_mi
0	0.013932	0.001635	0.005470	0.000407	3	
1	0.012755	0.002111	0.003982	0.001235	3	
2	0.012818	0.003749	0.005385	0.001519	3	
3	0.012762	0.003316	0.003685	0.000991	3	
4	0.012743	0.002123	0.004058	0.000949	3	
...	...	...	...	...	...	
163	0.011396	0.000884	0.003909	0.000841	None	
164	0.010243	0.001726	0.003130	0.000663	None	
165	0.010045	0.001023	0.003516	0.001011	None	
166	0.013133	0.001210	0.004277	0.000968	None	
167	0.013841	0.001859	0.003719	0.000752	None	

168 rows × 16 columns

In [ ]:

In [ ]:

In [ ]:

Naive Bayes

In [25]:
```
nb=GaussianNB()
```

In [26]:
```
nb.fit(x_train,y_train)
```

Out[26]:
```
▾ GaussianNB

GaussianNB()
```

In [27]:
```
y_pred=nb.predict(x_test)
```

In [28]:
```
print("Train Accuracy")
print(nb.score(x_train,y_train))
print("Test Accuracy")
print("Accuracy Score=",accuracy_score(y_test,y_pred))
```

```
Train Accuracy
0.8857142857142857
Test Accuracy
Accuracy Score= 0.894
```

In [ ]:
```

```

Tuning Naive Bayes

In [29]:
```
params={'var_smoothing':np.linspace(1e-9,2,20)}
kfold=StratifiedKFold(n_splits=5,shuffle=True,random_state=23)
gcv=GridSearchCV(nb,param_grid=params,cv=kfold,scoring='accuracy')
gcv.fit(x,y)
print(gcv.best_params_)
print(gcv.best_score_)
```

```
{'var_smoothing': 1.7894736843157895}
0.9062000000000001
```

In [30]:
```
score=pd.DataFrame(gcv.cv_results_)
score
```

Out[30]:

	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_var_smoothing	
0	0.010894	0.000862	0.006397	0.001082	0.0	{'
1	0.010738	0.002053	0.006601	0.001001	0.105263	{' 0.10526
2	0.012441	0.003930	0.007014	0.001742	0.210526	{' 0.2105
3	0.008494	0.001160	0.005322	0.001173	0.315789	{' 0.3157
4	0.008472	0.000478	0.005134	0.000852	0.421053	{' 0.42105
5	0.008488	0.000437	0.004791	0.000432	0.526316	{' 0.5263
6	0.008361	0.000477	0.005325	0.000557	0.631579	{' 0.6315
7	0.008164	0.000759	0.005114	0.000493	0.736842	{' 0.7368
8	0.007266	0.000920	0.004080	0.001130	0.842105	{' 0.842
9	0.007762	0.002609	0.005403	0.000755	0.947368	{' 0.9473
10	0.008437	0.002090	0.004308	0.001206	1.052632	{' 1.0526
11	0.008378	0.001400	0.005533	0.001191	1.157895	{' 1.1578
12	0.008319	0.001208	0.004200	0.000311	1.263158	{' 1.263
13	0.008670	0.001691	0.006440	0.001239	1.368421	{' 1.3684
14	0.012111	0.002186	0.006595	0.001414	1.473684	{' 1.4736
15	0.009260	0.002653	0.006473	0.002467	1.578947	{' 1.578
16	0.013064	0.002713	0.008442	0.001245	1.684211	{' 1.6842
17	0.012513	0.001917	0.007602	0.000690	1.789474	{' 1.7894
18	0.011964	0.001713	0.007407	0.001598	1.894737	{' 1.8947
19	0.010784	0.002377	0.005924	0.002209	2.0	{'var_

In [ ]:

SVM

In [31]:
```
svm=SVC(kernel='rbf')
svm.fit(x_train,y_train)
```

Out[31]:
```
▾ SVC

SVC()
```

In [32]:
```
print("Training Score=",svm.score(x_train,y_train))
```

```
Training Score= 0.91
```

In [33]:
```
y_pred=svm.predict(x_test)
```

In [34]:
```
print("Test Score=",accuracy_score(y_test,y_pred))
```

```
Test Score= 0.91
```

In [ ]:

Tuning SVM

In [35]:
```
params={'kernel':['linear', 'poly', 'rbf'],'C':np.linspace(0.0001,10,20)}
```

In [36]:
```
kfold=StratifiedKFold(n_splits=5,shuffle=True,random_state=23)
```

In [37]:
```
gcv=GridSearchCV(svm,param_grid=params,cv=kfold,scoring='accuracy',verbose=2)
```

In [38]:
```
gcv.fit(x,y)
```

```
Fitting 5 folds for each of 60 candidates, totalling 300 fits
[CV] END ..........................C=0.0001, kernel=linear; total time=   0.
4s
[CV] END ..........................C=0.0001, kernel=linear; total time=   0.
4s
[CV] END ..........................C=0.0001, kernel=linear; total time=   0.
4s
[CV] END ..........................C=0.0001, kernel=linear; total time=   0.
2s
[CV] END ..........................C=0.0001, kernel=linear; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=poly; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=poly; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=poly; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=poly; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=poly; total time=   0.
3s
[CV] END ............................C=0.0001, kernel=rbf; total time=   0.
5s
[CV] END ............................C=0.0001, kernel=rbf; total time=   0.
5s
[CV] END ............................C=0.0001, kernel=rbf; total time=   0.
5s
[CV] END ............................C=0.0001, kernel=rbf; total time=   0.
5s
[CV] END ............................C=0.0001, kernel=rbf; total time=   0.
5s
[CV] END ..............C=0.5264105263157894, kernel=linear; total time=  11.
9s
[CV] END ..............C=0.5264105263157894, kernel=linear; total time=  14.
0s
[CV] END ..............C=0.5264105263157894, kernel=linear; total time=  16.
3s
[CV] END ..............C=0.5264105263157894, kernel=linear; total time=   9.
8s
[CV] END ..............C=0.5264105263157894, kernel=linear; total time=   9.
4s
[CV] END ................C=0.5264105263157894, kernel=poly; total time=   0.
4s
[CV] END ................C=0.5264105263157894, kernel=poly; total time=   0.
5s
[CV] END ................C=0.5264105263157894, kernel=poly; total time=   0.
5s
[CV] END ................C=0.5264105263157894, kernel=poly; total time=   0.
4s
[CV] END ................C=0.5264105263157894, kernel=poly; total time=   0.
4s
[CV] END ................C=0.5264105263157894, kernel=rbf; total time=   0.
5s
[CV] END ................C=0.5264105263157894, kernel=rbf; total time=   0.
6s
[CV] END ................C=0.5264105263157894, kernel=rbf; total time=   0.
6s
[CV] END ................C=0.5264105263157894, kernel=rbf; total time=   0.
5s
[CV] END ................C=0.5264105263157894, kernel=rbf; total time=   0.
4s
[CV] END ..............C=1.052721052631579, kernel=linear; total time=  29.
5s
```

```
[CV] END ................C=1.052721052631579, kernel=linear; total time=  33.
9s
[CV] END ................C=1.052721052631579, kernel=linear; total time=  23.
8s
[CV] END ................C=1.052721052631579, kernel=linear; total time=  29.
8s
[CV] END ................C=1.052721052631579, kernel=linear; total time=  26.
2s
[CV] END ..................C=1.052721052631579, kernel=poly; total time=   0.
6s
[CV] END ..................C=1.052721052631579, kernel=poly; total time=   0.
7s
[CV] END ..................C=1.052721052631579, kernel=poly; total time=   0.
6s
[CV] END ..................C=1.052721052631579, kernel=poly; total time=   0.
6s
[CV] END ..................C=1.052721052631579, kernel=poly; total time=   0.
7s
[CV] END ...................C=1.052721052631579, kernel=rbf; total time=   0.
6s
[CV] END ...................C=1.052721052631579, kernel=rbf; total time=   0.
6s
[CV] END ...................C=1.052721052631579, kernel=rbf; total time=   0.
6s
[CV] END ...................C=1.052721052631579, kernel=rbf; total time=   0.
3s
[CV] END ...................C=1.052721052631579, kernel=rbf; total time=   0.
2s
[CV] END ................C=1.5790315789473683, kernel=linear; total time=  32.
8s
[CV] END ................C=1.5790315789473683, kernel=linear; total time=  40.
7s
[CV] END ................C=1.5790315789473683, kernel=linear; total time=  32.
2s
[CV] END ................C=1.5790315789473683, kernel=linear; total time=  37.
4s
[CV] END ................C=1.5790315789473683, kernel=linear; total time=  33.
7s
[CV] END ..................C=1.5790315789473683, kernel=poly; total time=   0.
5s
[CV] END ..................C=1.5790315789473683, kernel=poly; total time=   0.
7s
[CV] END ..................C=1.5790315789473683, kernel=poly; total time=   0.
6s
[CV] END ..................C=1.5790315789473683, kernel=poly; total time=   0.
5s
[CV] END ..................C=1.5790315789473683, kernel=poly; total time=   0.
5s
[CV] END ...................C=1.5790315789473683, kernel=rbf; total time=   0.
4s
[CV] END ...................C=1.5790315789473683, kernel=rbf; total time=   0.
5s
[CV] END ...................C=1.5790315789473683, kernel=rbf; total time=   0.
7s
[CV] END ...................C=1.5790315789473683, kernel=rbf; total time=   0.
5s
[CV] END ...................C=1.5790315789473683, kernel=rbf; total time=   0.
6s
[CV] END ................C=2.105342105263158, kernel=linear; total time=  54.
4s
[CV] END ................C=2.105342105263158, kernel=linear; total time= 1.0m
in
[CV] END ................C=2.105342105263158, kernel=linear; total time=  43.
```

```
8s
[CV] END ................C=2.105342105263158, kernel=linear; total time= 1.3m
in
[CV] END ................C=2.105342105263158, kernel=linear; total time=  48.
2s
[CV] END ..................C=2.105342105263158, kernel=poly; total time=   0.
9s
[CV] END ..................C=2.105342105263158, kernel=poly; total time=   0.
6s
[CV] END ..................C=2.105342105263158, kernel=poly; total time=   0.
6s
[CV] END ..................C=2.105342105263158, kernel=poly; total time=   0.
7s
[CV] END ..................C=2.105342105263158, kernel=poly; total time=   0.
6s
[CV] END ...................C=2.105342105263158, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.105342105263158, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.105342105263158, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.105342105263158, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.105342105263158, kernel=rbf; total time=   0.
6s
[CV] END ................C=2.6316526315789477, kernel=linear; total time= 1.6m
in
[CV] END ................C=2.6316526315789477, kernel=linear; total time= 1.0m
in
[CV] END ................C=2.6316526315789477, kernel=linear; total time=  55.
2s
[CV] END ................C=2.6316526315789477, kernel=linear; total time=  49.
1s
[CV] END ................C=2.6316526315789477, kernel=linear; total time=  47.
9s
[CV] END ..................C=2.6316526315789477, kernel=poly; total time=   0.
7s
[CV] END ..................C=2.6316526315789477, kernel=poly; total time=   0.
6s
[CV] END ..................C=2.6316526315789477, kernel=poly; total time=   0.
7s
[CV] END ..................C=2.6316526315789477, kernel=poly; total time=   0.
6s
[CV] END ..................C=2.6316526315789477, kernel=poly; total time=   0.
6s
[CV] END ...................C=2.6316526315789477, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.6316526315789477, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.6316526315789477, kernel=rbf; total time=   0.
6s
[CV] END ...................C=2.6316526315789477, kernel=rbf; total time=   0.
6s
[CV] END ................C=3.157963157894737, kernel=linear; total time= 1.3m
in
[CV] END ................C=3.157963157894737, kernel=linear; total time= 1.4m
in
[CV] END ................C=3.157963157894737, kernel=linear; total time=  31.
2s
[CV] END ................C=3.157963157894737, kernel=linear; total time=  30.
7s
```

```
[CV] END .................C=3.157963157894737, kernel=linear; total time=  24.
4s
[CV] END ..................C=3.157963157894737, kernel=poly; total time=   0.
2s
[CV] END ..................C=3.157963157894737, kernel=poly; total time=   0.
1s
[CV] END ..................C=3.157963157894737, kernel=poly; total time=   0.
1s
[CV] END ..................C=3.157963157894737, kernel=poly; total time=   0.
1s
[CV] END ..................C=3.157963157894737, kernel=poly; total time=   0.
1s
[CV] END ...................C=3.157963157894737, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.157963157894737, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.157963157894737, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.157963157894737, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.157963157894737, kernel=rbf; total time=   0.
2s
[CV] END .................C=3.684273684210526, kernel=linear; total time=  33.
6s
[CV] END .................C=3.684273684210526, kernel=linear; total time=  31.
7s
[CV] END .................C=3.684273684210526, kernel=linear; total time=  22.
3s
[CV] END .................C=3.684273684210526, kernel=linear; total time=  33.
4s
[CV] END .................C=3.684273684210526, kernel=linear; total time=  24.
4s
[CV] END ..................C=3.684273684210526, kernel=poly; total time=   0.
3s
[CV] END ..................C=3.684273684210526, kernel=poly; total time=   0.
1s
[CV] END ..................C=3.684273684210526, kernel=poly; total time=   0.
1s
[CV] END ..................C=3.684273684210526, kernel=poly; total time=   0.
3s
[CV] END ..................C=3.684273684210526, kernel=poly; total time=   0.
1s
[CV] END ...................C=3.684273684210526, kernel=rbf; total time=   0.
2s
[CV] END ...................C=3.684273684210526, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.684273684210526, kernel=rbf; total time=   0.
2s
[CV] END ...................C=3.684273684210526, kernel=rbf; total time=   0.
1s
[CV] END ...................C=3.684273684210526, kernel=rbf; total time=   0.
2s
[CV] END .................C=4.210584210526315, kernel=linear; total time=  46.
6s
[CV] END .................C=4.210584210526315, kernel=linear; total time=  30.
2s
[CV] END .................C=4.210584210526315, kernel=linear; total time=  23.
4s
[CV] END .................C=4.210584210526315, kernel=linear; total time=  26.
6s
[CV] END .................C=4.210584210526315, kernel=linear; total time=  30.
3s
[CV] END ..................C=4.210584210526315, kernel=poly; total time=   0.
```

```
2s
[CV] END ..................C=4.210584210526315, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.210584210526315, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.210584210526315, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.210584210526315, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.210584210526315, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.210584210526315, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.210584210526315, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.210584210526315, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.210584210526315, kernel=rbf; total time=   0.
1s
[CV] END .................C=4.736894736842105, kernel=linear; total time=  33.
0s
[CV] END .................C=4.736894736842105, kernel=linear; total time=  34.
3s
[CV] END .................C=4.736894736842105, kernel=linear; total time=  25.
6s
[CV] END .................C=4.736894736842105, kernel=linear; total time=  27.
4s
[CV] END .................C=4.736894736842105, kernel=linear; total time=  30.
1s
[CV] END ..................C=4.736894736842105, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.736894736842105, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.736894736842105, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.736894736842105, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.736894736842105, kernel=poly; total time=   0.
2s
[CV] END ..................C=4.736894736842105, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.736894736842105, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.736894736842105, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.736894736842105, kernel=rbf; total time=   0.
1s
[CV] END ..................C=4.736894736842105, kernel=rbf; total time=   0.
1s
[CV] END .................C=5.263205263157895, kernel=linear; total time=  38.
9s
[CV] END .................C=5.263205263157895, kernel=linear; total time=  36.
9s
[CV] END .................C=5.263205263157895, kernel=linear; total time=  43.
7s
[CV] END .................C=5.263205263157895, kernel=linear; total time=  39.
3s
[CV] END .................C=5.263205263157895, kernel=linear; total time=  47.
3s
[CV] END ..................C=5.263205263157895, kernel=poly; total time=   0.
3s
[CV] END ..................C=5.263205263157895, kernel=poly; total time=   0.
3s
```

```
[CV] END ..................C=5.263205263157895, kernel=poly; total time=   0.
3s
[CV] END ..................C=5.263205263157895, kernel=poly; total time=   0.
3s
[CV] END ..................C=5.263205263157895, kernel=poly; total time=   0.
3s
[CV] END ...................C=5.263205263157895, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.263205263157895, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.263205263157895, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.263205263157895, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.263205263157895, kernel=rbf; total time=   0.
2s
[CV] END ................C=5.7895157894736835, kernel=linear; total time=  46.
0s
[CV] END ................C=5.7895157894736835, kernel=linear; total time= 1.2m
in
[CV] END ................C=5.7895157894736835, kernel=linear; total time=  39.
9s
[CV] END ................C=5.7895157894736835, kernel=linear; total time= 1.1m
in
[CV] END ................C=5.7895157894736835, kernel=linear; total time=  47.
0s
[CV] END ..................C=5.7895157894736835, kernel=poly; total time=   0.
2s
[CV] END ..................C=5.7895157894736835, kernel=poly; total time=   0.
2s
[CV] END ..................C=5.7895157894736835, kernel=poly; total time=   0.
3s
[CV] END ..................C=5.7895157894736835, kernel=poly; total time=   0.
2s
[CV] END ..................C=5.7895157894736835, kernel=poly; total time=   0.
2s
[CV] END ...................C=5.7895157894736835, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.7895157894736835, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.7895157894736835, kernel=rbf; total time=   0.
1s
[CV] END ...................C=5.7895157894736835, kernel=rbf; total time=   0.
2s
[CV] END ...................C=5.7895157894736835, kernel=rbf; total time=   0.
2s
[CV] END ................C=6.315826315789473, kernel=linear; total time=  46.
8s
[CV] END ................C=6.315826315789473, kernel=linear; total time= 1.5m
in
[CV] END ................C=6.315826315789473, kernel=linear; total time=  40.
7s
[CV] END ................C=6.315826315789473, kernel=linear; total time=  59.
0s
[CV] END ................C=6.315826315789473, kernel=linear; total time= 1.0m
in
[CV] END ..................C=6.315826315789473, kernel=poly; total time=   0.
3s
[CV] END ..................C=6.315826315789473, kernel=poly; total time=   0.
2s
[CV] END ..................C=6.315826315789473, kernel=poly; total time=   0.
3s
[CV] END ..................C=6.315826315789473, kernel=poly; total time=   0.
```

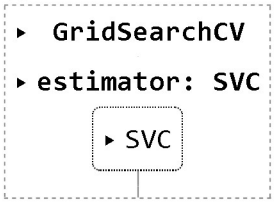
```
2s
[CV] END ..................C=6.315826315789473, kernel=poly; total time=   0.
2s
[CV] END ..................C=6.315826315789473, kernel=rbf; total time=   0.
1s
[CV] END ..................C=6.315826315789473, kernel=rbf; total time=   0.
1s
[CV] END ..................C=6.315826315789473, kernel=rbf; total time=   0.
1s
[CV] END ..................C=6.315826315789473, kernel=rbf; total time=   0.
1s
[CV] END ..................C=6.315826315789473, kernel=rbf; total time=   0.
1s
[CV] END ................C=6.842136842105263, kernel=linear; total time= 1.2m
in
[CV] END ................C=6.842136842105263, kernel=linear; total time= 1.3m
in
[CV] END ................C=6.842136842105263, kernel=linear; total time=  45.
1s
[CV] END ................C=6.842136842105263, kernel=linear; total time=  59.
1s
[CV] END ................C=6.842136842105263, kernel=linear; total time=  49.
0s
[CV] END ..................C=6.842136842105263, kernel=poly; total time=   0.
4s
[CV] END ..................C=6.842136842105263, kernel=poly; total time=   0.
4s
[CV] END ..................C=6.842136842105263, kernel=poly; total time=   0.
4s
[CV] END ..................C=6.842136842105263, kernel=poly; total time=   0.
5s
[CV] END ..................C=6.842136842105263, kernel=poly; total time=   0.
5s
[CV] END ..................C=6.842136842105263, kernel=rbf; total time=   0.
3s
[CV] END ..................C=6.842136842105263, kernel=rbf; total time=   0.
3s
[CV] END ..................C=6.842136842105263, kernel=rbf; total time=   0.
2s
[CV] END ..................C=6.842136842105263, kernel=rbf; total time=   0.
2s
[CV] END ..................C=6.842136842105263, kernel=rbf; total time=   0.
3s
[CV] END ................C=7.368447368421052, kernel=linear; total time= 1.1m
in
[CV] END ................C=7.368447368421052, kernel=linear; total time= 1.5m
in
[CV] END ................C=7.368447368421052, kernel=linear; total time=  52.
9s
[CV] END ................C=7.368447368421052, kernel=linear; total time=  51.
9s
[CV] END ................C=7.368447368421052, kernel=linear; total time=  58.
7s
[CV] END ..................C=7.368447368421052, kernel=poly; total time=   0.
6s
[CV] END ..................C=7.368447368421052, kernel=poly; total time=   0.
4s
[CV] END ..................C=7.368447368421052, kernel=poly; total time=   0.
4s
[CV] END ..................C=7.368447368421052, kernel=poly; total time=   0.
5s
[CV] END ..................C=7.368447368421052, kernel=poly; total time=   0.
4s
```

```
[CV] END ..................C=7.368447368421052, kernel=rbf; total time=   0.
3s
[CV] END ..................C=7.368447368421052, kernel=rbf; total time=   0.
3s
[CV] END ..................C=7.368447368421052, kernel=rbf; total time=   0.
3s
[CV] END ..................C=7.368447368421052, kernel=rbf; total time=   0.
3s
[CV] END ..................C=7.368447368421052, kernel=rbf; total time=   0.
4s
[CV] END .................C=7.894757894736841, kernel=linear; total time=  50.
2s
[CV] END .................C=7.894757894736841, kernel=linear; total time= 1.2m
in
[CV] END .................C=7.894757894736841, kernel=linear; total time= 1.5m
in
[CV] END .................C=7.894757894736841, kernel=linear; total time=  53.
5s
[CV] END .................C=7.894757894736841, kernel=linear; total time=  49.
7s
[CV] END ..................C=7.894757894736841, kernel=poly; total time=   0.
4s
[CV] END ..................C=7.894757894736841, kernel=poly; total time=   0.
2s
[CV] END ..................C=7.894757894736841, kernel=poly; total time=   0.
3s
[CV] END ..................C=7.894757894736841, kernel=poly; total time=   0.
2s
[CV] END ..................C=7.894757894736841, kernel=poly; total time=   0.
4s
[CV] END ..................C=7.894757894736841, kernel=rbf; total time=   0.
2s
[CV] END ..................C=7.894757894736841, kernel=rbf; total time=   0.
1s
[CV] END ..................C=7.894757894736841, kernel=rbf; total time=   0.
2s
[CV] END ..................C=7.894757894736841, kernel=rbf; total time=   0.
1s
[CV] END ..................C=7.894757894736841, kernel=rbf; total time=   0.
1s
[CV] END .................C=8.421068421052631, kernel=linear; total time= 1.0m
in
[CV] END .................C=8.421068421052631, kernel=linear; total time= 1.3m
in
[CV] END .................C=8.421068421052631, kernel=linear; total time= 2.0m
in
[CV] END .................C=8.421068421052631, kernel=linear; total time=  52.
5s
[CV] END .................C=8.421068421052631, kernel=linear; total time= 1.7m
in
[CV] END ..................C=8.421068421052631, kernel=poly; total time=   0.
4s
[CV] END ..................C=8.421068421052631, kernel=poly; total time=   0.
3s
[CV] END ..................C=8.421068421052631, kernel=poly; total time=   0.
3s
[CV] END ..................C=8.421068421052631, kernel=poly; total time=   0.
3s
[CV] END ..................C=8.421068421052631, kernel=poly; total time=   0.
4s
[CV] END ..................C=8.421068421052631, kernel=rbf; total time=   0.
1s
[CV] END ..................C=8.421068421052631, kernel=rbf; total time=   0.
```

```
1s
[CV] END ..................C=8.421068421052631, kernel=rbf; total time=   0.
1s
[CV] END ..................C=8.421068421052631, kernel=rbf; total time=   0.
2s
[CV] END ..................C=8.421068421052631, kernel=rbf; total time=   0.
1s
[CV] END .................C=8.94737894736842, kernel=linear; total time= 1.1m
in
[CV] END .................C=8.94737894736842, kernel=linear; total time=  57.
5s
[CV] END .................C=8.94737894736842, kernel=linear; total time= 2.1m
in
[CV] END .................C=8.94737894736842, kernel=linear; total time=  57.
6s
[CV] END .................C=8.94737894736842, kernel=linear; total time= 2.3m
in
[CV] END ..................C=8.94737894736842, kernel=poly; total time=   1.
3s
[CV] END ..................C=8.94737894736842, kernel=poly; total time=   1.
0s
[CV] END ..................C=8.94737894736842, kernel=poly; total time=   0.
9s
[CV] END ..................C=8.94737894736842, kernel=poly; total time=   1.
1s
[CV] END ..................C=8.94737894736842, kernel=poly; total time=   1.
5s
[CV] END ..................C=8.94737894736842, kernel=rbf; total time=   0.
7s
[CV] END ..................C=8.94737894736842, kernel=rbf; total time=   0.
6s
[CV] END ..................C=8.94737894736842, kernel=rbf; total time=   0.
7s
[CV] END ..................C=8.94737894736842, kernel=rbf; total time=   0.
6s
[CV] END ..................C=8.94737894736842, kernel=rbf; total time=   0.
6s
[CV] END .................C=9.47368947368421, kernel=linear; total time= 2.8m
in
[CV] END .................C=9.47368947368421, kernel=linear; total time= 4.5m
in
[CV] END .................C=9.47368947368421, kernel=linear; total time= 3.8m
in
[CV] END .................C=9.47368947368421, kernel=linear; total time= 2.5m
in
[CV] END .................C=9.47368947368421, kernel=linear; total time= 4.2m
in
[CV] END ..................C=9.47368947368421, kernel=poly; total time=   1.
4s
[CV] END ..................C=9.47368947368421, kernel=poly; total time=   1.
1s
[CV] END ..................C=9.47368947368421, kernel=poly; total time=   0.
8s
[CV] END ..................C=9.47368947368421, kernel=poly; total time=   1.
1s
[CV] END ..................C=9.47368947368421, kernel=poly; total time=   1.
3s
[CV] END ..................C=9.47368947368421, kernel=rbf; total time=   0.
5s
[CV] END ..................C=9.47368947368421, kernel=rbf; total time=   0.
5s
[CV] END ..................C=9.47368947368421, kernel=rbf; total time=   0.
6s
```

```
[CV] END .....................C=9.47368947368421, kernel=rbf; total time=   0.
6s
[CV] END .....................C=9.47368947368421, kernel=rbf; total time=   0.
6s
[CV] END ............................C=10.0, kernel=linear; total time= 3.3m
in
[CV] END ............................C=10.0, kernel=linear; total time= 3.6m
in
[CV] END ............................C=10.0, kernel=linear; total time= 3.3m
in
[CV] END ............................C=10.0, kernel=linear; total time= 2.4m
in
[CV] END ............................C=10.0, kernel=linear; total time= 3.6m
in
[CV] END ..............................C=10.0, kernel=poly; total time=   1.
8s
[CV] END ..............................C=10.0, kernel=poly; total time=   1.
2s
[CV] END ..............................C=10.0, kernel=poly; total time=   0.
9s
[CV] END ..............................C=10.0, kernel=poly; total time=   1.
1s
[CV] END ..............................C=10.0, kernel=poly; total time=   1.
5s
[CV] END ...............................C=10.0, kernel=rbf; total time=   0.
5s
[CV] END ...............................C=10.0, kernel=rbf; total time=   0.
6s
[CV] END ...............................C=10.0, kernel=rbf; total time=   0.
6s
[CV] END ...............................C=10.0, kernel=rbf; total time=   0.
6s
[CV] END ...............................C=10.0, kernel=rbf; total time=   0.
6s
```

Out[38]:



In [39]:
```
print(gcv.best_params_)
print(gcv.best_score_)
```

```
{'C': 8.94737894736842, 'kernel': 'linear'}
0.953
```

In [ ]:

In [ ]: