In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import AdaBoostClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
from sklearn.metrics import classification_report,confusion_matrix ,accuracy_score
from sklearn.metrics import precision_recall_fscore_support,average_precision_score
from sklearn.metrics import precision_score,recall_score,f1_score,precision_recall_curve
```

In [2]:

```
car_data = pd.read_csv("car.csv")
```

In [3]:

```
car_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1151 entries, 0 to 1150
Data columns (total 7 columns):
buying      1151 non-null object
maint       1151 non-null object
doors       1151 non-null int64
persons     1151 non-null int64
lug_boot    1151 non-null object
safety      1151 non-null object
class       1151 non-null object
dtypes: int64(2), object(5)
memory usage: 63.0+ KB
```

In [4]:

```
car_data.head()
```

Out[4]:

	buying	maint	doors	persons	lug_boot	safety	class
0	vhigh	vhigh	2	2	small	med	unacc
1	vhigh	vhigh	2	2	small	high	unacc
2	vhigh	vhigh	2	2	med	low	unacc
3	vhigh	vhigh	2	2	med	med	unacc
4	vhigh	vhigh	2	2	med	high	unacc

In [5]:

```
car_data.describe()
```

Out[5]:

	doors	persons
count	1151.000000	1151.000000
mean	3.501303	3.000869
std	1.118130	1.000434
min	2.000000	2.000000
25%	3.000000	2.000000
50%	4.000000	4.000000
75%	4.500000	4.000000
max	5.000000	4.000000

In [6]:

```
y=car_data['class']
y=y.to_frame()
y.head()
```

Out[6]:

	class
0	unacc
1	unacc
2	unacc
3	unacc
4	unacc

In [7]:

```
X=car_data
X= X[['buying','maint','doors','persons','lug_boot', 'safety']]
X.head()
```

Out[7]:

	buying	maint	doors	persons	lug_boot	safety
0	vhigh	vhigh	2	2	small	med
1	vhigh	vhigh	2	2	small	high
2	vhigh	vhigh	2	2	med	low
3	vhigh	vhigh	2	2	med	med
4	vhigh	vhigh	2	2	med	high

In [8]:

```
#Applying Train,Test Split
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.3,random_state=32)
```

In [9]:

```
combine=[y_train,y_test]
classmapping={'unacc':0,'acc':1,'good':2,'vgood':3}
for dt in combine:
   dt['class']=car_data['class'].map(classmapping)
y_train.head()
```

Out[9]:

	class
921	0
721	0
501	1
432	0
711	0

In [10]:

```
combine=[X_train,X_test]
classmapping={'high':0,'low':1,'med':2,'vhigh':3}
for dt in combine:
   dt['buying']=car_data['buying'].map(classmapping)
X_train.head()
```

Out[10]:

	buying	maint	doors	persons	lug_boot	safety
921	1	vhigh	5	2	med	med
721	2	med	2	2	small	high
501	0	med	5	4	big	med
432	0	med	2	2	small	med
711	2	high	5	4	small	med

In [11]:

```
combine=[X_train,X_test]
classmapping={'high':0,'low':1,'med':2,'vhigh':3}
for dt in combine:
   dt['maint']=car_data['maint'].map(classmapping)
X_train.head()
```

Out[11]:

	buying	maint	doors	persons	lug_boot	safety
921	1	3	5	2	med	med
721	2	2	2	2	small	high
501	0	2	5	4	big	med
432	0	2	2	2	small	med
711	2	0	5	4	small	med

In [12]:

```
combine=[X_train,X_test]
classmapping={'big':0,'small':1,'med':2}
for dt in combine:
   dt['lug_boot']=car_data['lug_boot'].map(classmapping)
X_train.head()
```

Out[12]:

	buying	maint	doors	persons	lug_boot	safety
921	1	3	5	2	2	med
721	2	2	2	2	1	high
501	0	2	5	4	0	med
432	0	2	2	2	1	med
711	2	0	5	4	1	med

In [13]:

```
combine=[X_train,X_test]
classmapping={'high':0,'low':1,'med':2}
for dt in combine:
   dt['safety']=car_data['safety'].map(classmapping)
X_train.head()
```

Out[13]:

	buying	maint	doors	persons	lug_boot	safety
921	1	3	5	2	2	2
721	2	2	2	2	1	0
501	0	2	5	4	0	2
432	0	2	2	2	1	2
711	2	0	5	4	1	2

In [14]:

```
#AdaBoost
clf =  AdaBoostClassifier(DecisionTreeClassifier(max_depth=1),
                         algorithm="SAMME",
                         n_estimators=200)
clf.fit(X_train, y_train)
```

Out[14]:

```
AdaBoostClassifier(algorithm='SAMME',
          base_estimator=DecisionTreeClassifier(class_weight=None, criterion='gi
ni', max_depth=1,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best'),
          learning_rate=1.0, n_estimators=200, random_state=None)
```

In [15]:

```
y_pred = clf.predict(X_test)
```

In [16]:

```
y_pred
```

Out[16]:

```
array([0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
       0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
       1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1,
       0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
       0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0,
       0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0,
       0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 0, 0,
       1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0])
```

In [17]:

```
y_test.head()
```

Out[17]:

	class
19	0
819	1
802	2
528	0
905	0

In [18]:

```
print(confusion_matrix(y_test, y_pred))
```

```
[[254   9   0   0]
 [ 11  48   0   0]
 [  0  16   0   0]
 [  0   8   0   0]]
```

In [19]:

```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.96      0.97      0.96       263
           1       0.59      0.81      0.69        59
           2       0.00      0.00      0.00        16
           3       0.00      0.00      0.00         8

   micro avg       0.87      0.87      0.87       346
   macro avg       0.39      0.44      0.41       346
weighted avg       0.83      0.87      0.85       346
```

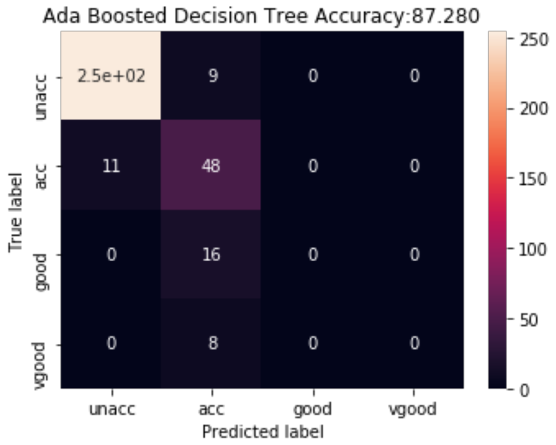
In [20]:

```
accuracy_test_ada=round(clf.score(X_test,y_test)*100,2)
accuracy_train_ada=round(clf.score(X_train,y_train)*100,2)
accuracy_ada=round(accuracy_score(y_test, y_pred)*100,2)
print('Training accuracy of Ada Boosted Decision Tree',accuracy_train_ada)
print('Testing accuracy of Ada Boosted Decision Tree',accuracy_test_ada)
print('Accuracy of Ada Boosted Decision Tree:',accuracy_ada)
```

```
Training accuracy of Ada Boosted Decision Tree 88.32
Testing accuracy of Ada Boosted Decision Tree 87.28
Accuracy of Ada Boosted Decision Tree: 87.28
```

In [21]:
```
cm=confusion_matrix(y_test, y_pred)
cm_df = pd.DataFrame(cm,
                     index = ['unacc','acc','good','vgood'],
                     columns = ['unacc','acc','good','vgood'])
```

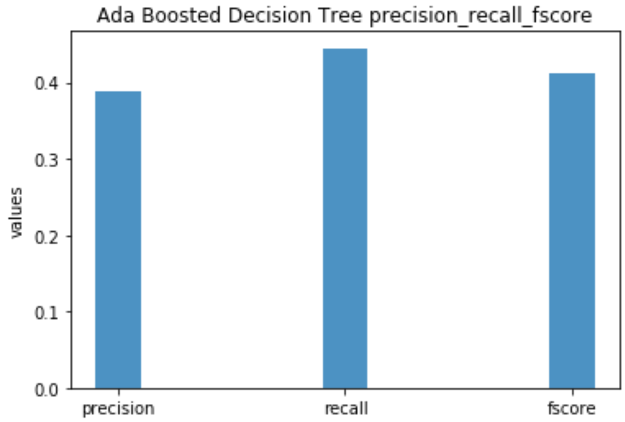
In [22]:
```
plt.figure(figsize=(5.5,4))
sns.heatmap(cm_df, annot=True)
plt.title('Ada Boosted Decision Tree Accuracy:{0:.3f}'.format(accuracy_test_ada))
plt.ylabel('True label')
plt.xlabel('Predicted label')
plt.show()
```



In [23]:
```
pprf = precision_recall_fscore_support(y_test, y_pred, average='macro')
print("Ada Boosted Decision Tree precision_recall_fscore_support ", pprf)
pps = precision_score(y_test, y_pred, labels=None, pos_label=1, average='macro', sample_weight=None)
print("Ada Boosted Decision Tree precision_score -> %.2f"%pps)
prs = recall_score(y_test, y_pred, labels=None, pos_label=1, average='macro', sample_weight=None)
print("Ada Boosted Decision Tree recall_score -> %.2f"%prs)
pf1=f1_score(y_test, y_pred, labels=None, pos_label=1, average='macro', sample_weight=None)
print("f1_score",f1_score(y_test, y_pred, labels=None, pos_label=1, average='macro', sample_weight=None))
print('Ada Boosted Decision Tree f1 score -> %.2f'%pf1)
```

```
Ada Boosted Decision Tree precision_recall_fscore_support  (0.3877707896575821,
0.4448346974286267, 0.411958874458874447, None)
Ada Boosted Decision Tree precision_score -> 0.39
Ada Boosted Decision Tree recall_score -> 0.44
f1_score 0.411958874458874447
Ada Boosted Decision Tree f1 score -> 0.41
```

In [24]:
```
plt.bar(['precision','recall','fscore'], [pps,prs,pf1], align='center', alpha=0.8,
width=.2)
plt.ylabel('values')
plt.title('Ada Boosted Decision Tree precision_recall_fscore')
plt.show()
```



In [25]:
```
clf = RandomForestClassifier(n_estimators=25)
clf.fit(X_train, y_train)
```

Out[25]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=25, n_jobs=None,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

In [26]:
```
y_pred = clf.predict(X_test)
```

In [27]:
```
y_pred
```

Out[27]:
```
array([0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2,
       0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 2, 1, 0, 0,
       1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 3, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 2, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 3, 0, 0, 1, 0, 3, 1, 1, 1,
       0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1,
       0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 3, 0, 0,
       0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 0,
       0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 3, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0,
       0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 3, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       1, 1, 0, 0, 0, 2, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0])
```

In [28]:

```
y_test.head()
```

Out[28]:

	class
19	0
819	1
802	2
528	0
905	0

In [29]:

```
print(confusion_matrix(y_test, y_pred))
```

```
[[260   3   0   0]
 [  6  50   2   1]
 [  0  12   4   0]
 [  0   3   0   5]]
```

In [30]:

```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      0.99      0.98       263
           1       0.74      0.85      0.79        59
           2       0.67      0.25      0.36        16
           3       0.83      0.62      0.71         8

   micro avg       0.92      0.92      0.92       346
   macro avg       0.80      0.68      0.71       346
weighted avg       0.92      0.92      0.91       346
```

In [31]:

```
accuracy_test_rf=round(clf.score(X_test,y_test)*100,2)
accuracy_train_rf=round(clf.score(X_train,y_train)*100,2)
accuracy_rf=round(accuracy_score(y_test, y_pred)*100,2)
print('Training accuracy of RandomForestClassifier:',accuracy_train_rf)
print('Testing accuracy of RandomForestClassifier:',accuracy_test_rf)
print('Accuracy of RandomForestClassifier:',accuracy_rf)
```

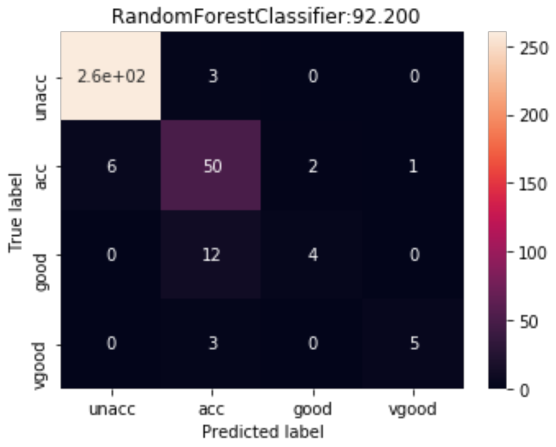
```
Training accuracy of RandomForestClassifier: 100.0
Testing accuracy of RandomForestClassifier: 92.2
Accuracy of RandomForestClassifier: 92.2
```

In [32]:

```
cm=confusion_matrix(y_test, y_pred)
cm_df = pd.DataFrame(cm,
                     index = ['unacc','acc','good','vgood'],
                     columns = ['unacc','acc','good','vgood'])
```

In [33]:

```
plt.figure(figsize=(5.5,4))
sns.heatmap(cm_df, annot=True)
plt.title(' RandomForestClassifier:{0:.3f}'.format(accuracy_test_rf))
plt.ylabel('True label')
plt.xlabel('Predicted label')
plt.show()
```



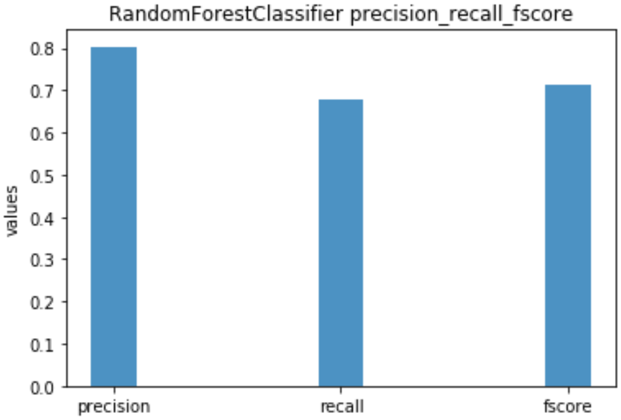
In [34]:

```
pprf = precision_recall_fscore_support(y_test, y_pred, average='macro')
print("RandomForestClassifier precision_recall_fscore_support ", pprf)
pps = precision_score(y_test, y_pred, labels=None, pos_label=1, average='macro', s
ample_weight=None)
print("RandomForestClassifier precision_score -> %.2f"%pps)
prs = recall_score(y_test, y_pred, labels=None, pos_label=1, average='macro', samp
le_weight=None)
print("RandomForestClassifier recall_score -> %.2f"%prs)
pf1=f1_score(y_test, y_pred, labels=None, pos_label=1, average='macro', sample_wei
ght=None)
print("f1_score",f1_score(y_test, y_pred, labels=None, pos_label=1, average='macro
', sample_weight=None))
print('RandomForestClassifier f1 score -> %.2f'%pf1)
```

```
RandomForestClassifier precision_recall_fscore_support  (0.8031844316674038, 0.6
77762695753045, 0.7120776050527625, None)
RandomForestClassifier precision_score -> 0.80
RandomForestClassifier recall_score -> 0.68
f1_score 0.7120776050527625
RandomForestClassifier f1 score -> 0.71
```

In [35]:

```
plt.bar(['precision','recall','fscore'], [pps,prs,pf1], align='center', alpha=0.8,
width=.2)
plt.ylabel('values')
plt.title('RandomForestClassifier precision_recall_fscore')
plt.show()
```



In [ ]: