```
import pandas as pd
import numpy as np
import random
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, confusion_matrix, auc
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import svm
from sklearn.linear_model import LogisticRegression
import matplotlib.pyplot as plt
from sklearn.metrics import roc_curve


data = pd.read_csv('C:/Data analysis Project/practical/default.csv')
data['industry'] = data['industry'].str.replace('Other Services \(except Public Administratio
data['industry'] = data['industry'].str.replace('Accomodation','Accommodation')
data['industry'] = data['industry'].str.replace('Fishing or Hunting','Fishing and Hunting')
data['industry'] = data['industry'].fillna('Other Services')
data['industry'] = data['industry'].str.strip()
test = data.groupby('industry').size()

data = data.dropna(subset=['years_of_operation'], how='any')
data = data.dropna(subset=['fico_score'], how='any')
data = data[data['fico_score'] != 0]
data = data.dropna(subset=['business_employee_count'], how='any')
data = data.dropna(subset=['Homeowner'], how='any')

data['principal'] = data['principal'].str.replace('$','').str.replace(',','')
data['principal'] = data['principal'].astype(int)
data = data[data['status'] != 'current']
data['status'] = np.where(data['status'] == 'defaulted', 1, 0)


data.head(5)
```

```
#Descriptive Statistics
data.describe()
```

	years_of_operation	principal	interest_rate	term	status	fico

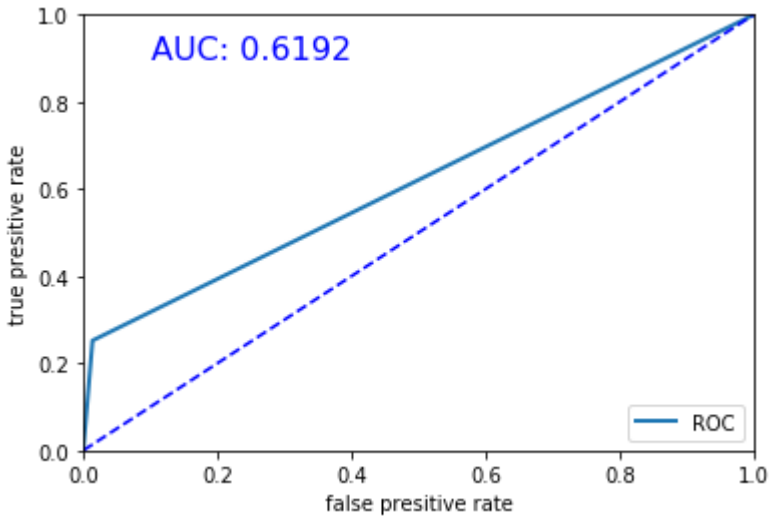
count	4709.000000	4709.000000	4709.000000	4709.000000	4709.000000	4709.0(
mean	10.649529	138240.356764	0.141907	40.885114	0.086855	706.1
std	7.991417	104803.995393	0.044720	14.908321	0.281652	44.5
min	0.000000	25000.000000	0.049900	6.000000	0.000000	604.0(
25%	5.000000	60000.000000	0.111900	36.000000	0.000000	672.0(
50%	8.600000	100000.000000	0.139900	36.000000	0.000000	703.0(
75%	13.800000	200000.000000	0.162900	60.000000	0.000000	738.0(
max	67.000000	500000.000000	0.287900	60.000000	1.000000	843.0(

```
#dummy
data = pd.get_dummies(data,columns=['credit_rating'],prefix=['credit_rating'],prefix_sep="_",
data = pd.get_dummies(data,columns=['industry'],prefix=['industry'],prefix_sep="_",dummy_na=F
data = data.reset_index(drop=True)


#split into train and test
random.seed(110)
train,test=train_test_split(data,test_size=0.3)
train_y = train['status']
train_x = train.drop(['status','state'],axis=1)
test_y = test['status']
test_x = test.drop(['status','state'],axis=1)


#Logistic regression
lm = LogisticRegression(solver='liblinear')
lm.fit(train_x,train_y)
predict_lm = lm.predict(test_x)
accuracy_lm = accuracy_score(test_y, predict_lm)
tn_lm, fp_lm, fn_lm, tp_lm = confusion_matrix(test_y, predict_lm).ravel()
sensitivity_lm = tp_lm / (tp_lm+fn_lm)
print("Accuracy is %s" %accuracy_lm)
print("Sensitivity is %s" %sensitivity_lm)
print(confusion_matrix(test_y, predict_lm))
```

```
Accuracy is 0.9285208775654635
Sensitivity is 0.25225225225225223
[[1284   18]
 [  83   28]]
```

```
#Logistic regression ROC
fpr_lm,tpr_lm,thresholds = roc_curve(test_y, predict_lm,pos_label=1)
auc_lm = round(auc(fpr_lm, tpr_lm),4)
plt.plot(fpr_lm,tpr_lm,linewidth=2,label="ROC")
plt.xlabel("false presitive rate")
plt.ylabel("true presitive rate")
```

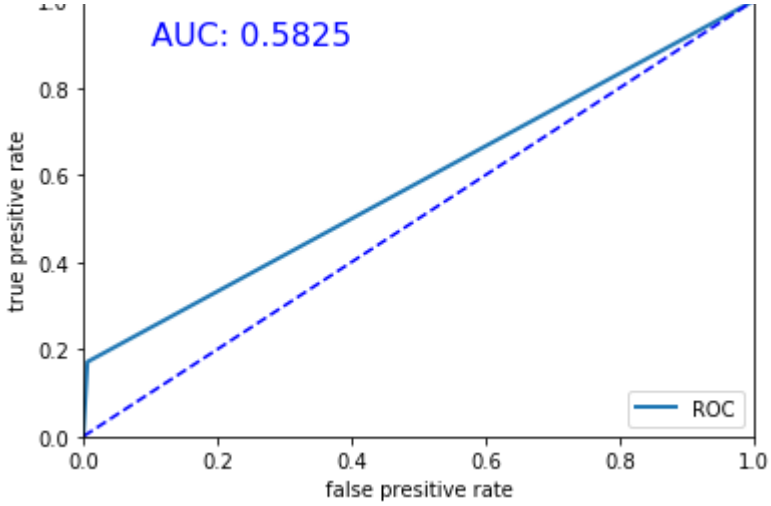
```
plt.ylim(0,1)
plt.xlim(0,1)
plt.plot([0, 1], [0, 1], '--', color=(0 , 0, 1))
plt.legend(loc=4)
plt.text(0.1,0.9,'AUC: %s' %auc_lm,fontdict={'size':'16','color':'b'})
plt.show()
```




```
#random forest
rf = RandomForestClassifier(n_estimators=1000,random_state=110)
rf.fit(train_x,train_y)
predict_rf = rf.predict(test_x)
accuracy_rf = accuracy_score(test_y, predict_rf)
tn_rf, fp_rf, fn_rf, tp_rf = confusion_matrix(test_y, predict_rf).ravel()
sensitivity_rf = tp_rf / (tp_rf+fn_rf)
print("Accuracy is %s" %accuracy_rf)
print("Sensitivity is %s" %sensitivity_rf)
print(confusion_matrix(test_y, predict_rf))
```

```
Accuracy is 0.9292285916489739
Sensitivity is 0.17117117117117117
[[1294    8]
 [  92   19]]
```

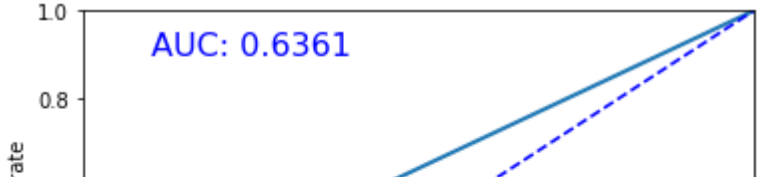
```
#random forest ROC
fpr_rf,tpr_rf,thresholds = roc_curve(test_y, predict_rf,pos_label=1)
auc_rf = round(auc(fpr_rf, tpr_rf),4)
plt.plot(fpr_rf,tpr_rf,linewidth=2,label="ROC")
plt.xlabel("false presitive rate")
plt.ylabel("true presitive rate")
plt.ylim(0,1)
plt.xlim(0,1)
plt.plot([0, 1], [0, 1], '--', color=(0 , 0, 1))
plt.legend(loc=4)
plt.text(0.1,0.9,'AUC: %s' %auc_rf,fontdict={'size':'16','color':'b'})
plt.show()
```

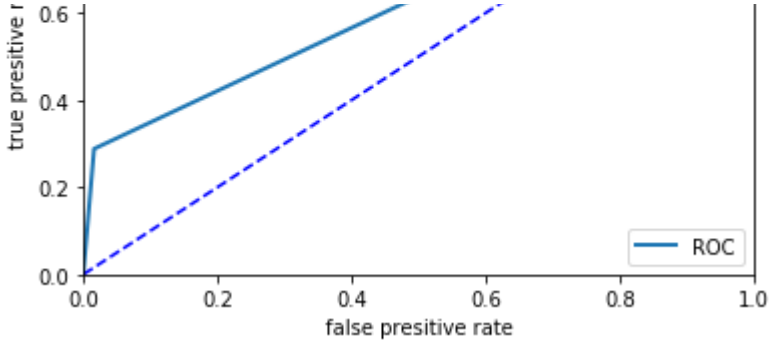



```
#bagging
tree = DecisionTreeClassifier(criterion='entropy', max_depth=None)
bag = BaggingClassifier(base_estimator=tree, n_estimators=1000, max_samples=1.0, max_features
bag.fit(train_x,train_y)
predict_bag = bag.predict(test_x)
accuracy_bag = accuracy_score(test_y, predict_bag)
tn_bag, fp_bag, fn_bag, tp_bag = confusion_matrix(test_y, predict_bag).ravel()
sensitivity_bag = tp_bag / (tp_bag+fn_bag)
print("Accuracy is %s" %accuracy_bag)
print("Sensitivity is %s" %sensitivity_bag)
print(confusion_matrix(test_y, predict_bag))
```

```
Accuracy is 0.9292285916489739
Sensitivity is 0.2882882882882883
[[1281   21]
 [  79   32]]
```

```
#bagging ROC
fpr_bag,tpr_bag,thresholds = roc_curve(test_y, predict_bag,pos_label=1)
auc_bag = round(auc(fpr_bag, tpr_bag),4)
plt.plot(fpr_bag,tpr_bag,linewidth=2,label="ROC")
plt.xlabel("false presitive rate")
plt.ylabel("true presitive rate")
plt.ylim(0,1)
plt.xlim(0,1)
plt.plot([0, 1], [0, 1], '--', color=(0 , 0, 1))
plt.legend(loc=4)
plt.text(0.1,0.9,'AUC: %s' %auc_bag,fontdict={'size':'16','color':'b'})
plt.show()
```

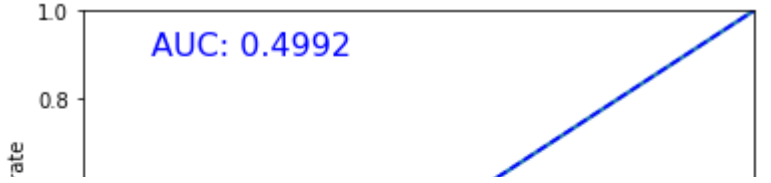


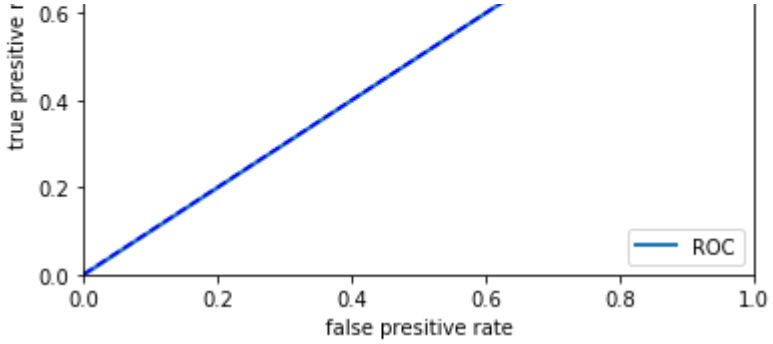



```
#svm
sv = svm.SVC(gamma='auto')
sv.fit(train_x,train_y)
predict_svm = sv.predict(test_x)
accuracy_svm = accuracy_score(test_y, predict_svm)
tn_svm, fp_svm, fn_svm, tp_svm = confusion_matrix(test_y, predict_svm).ravel()
sensitivity_svm = tp_svm / (tp_svm+fn_svm)
print("Accuracy is %s" %accuracy_svm)
print("Sensitivity is %s" %sensitivity_svm)
print(confusion_matrix(test_y, predict_svm))
```

```
Accuracy is 0.9200283085633404
Sensitivity is 0.0
[[1300    2]
 [ 111    0]]
```

```
#svm ROC
fpr_svm,tpr_svm,thresholds = roc_curve(test_y, predict_svm,pos_label=1)
auc_svm = round(auc(fpr_svm, tpr_svm),4)
plt.plot(fpr_svm,tpr_svm,linewidth=2,label="ROC")
plt.xlabel("false presitive rate")
plt.ylabel("true presitive rate")
plt.ylim(0,1)
plt.xlim(0,1)
plt.plot([0, 1], [0, 1], '--', color=(0 , 0, 1))
plt.legend(loc=4)
plt.text(0.1,0.9,'AUC: %s' %auc_svm,fontdict={'size':'16','color':'b'})
plt.show()
```





#GITHUB LINK https://github.com/13065040/Project/blob/master/project.ipynb