# Detecting churn customer

In [1]:
```
import pandas as pd
from sklearn import metrics
from sklearn.linear_model import LogisticRegression
from sklearn import neighbors
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.preprocessing import LabelEncoder
import numpy as np
import os
from sklearn import tree
from dtreeviz.trees import dtreeviz # will be used for tree visualization
from matplotlib import pyplot as plt
```

In [2]:
```
pip install dtreeviz
```

```
Requirement already satisfied: dtreeviz in /Users/sameerkhan/pythonnotebook
/anaconda3/lib/python3.8/site-packages (1.3)
Requirement already satisfied: pytest in /Users/sameerkhan/pythonnotebook/a
naconda3/lib/python3.8/site-packages (from dtreeviz) (0.0.0)
Requirement already satisfied: colour in /Users/sameerkhan/pythonnotebook/a
naconda3/lib/python3.8/site-packages (from dtreeviz) (0.1.5)
Requirement already satisfied: pandas in /Users/sameerkhan/pythonnotebook/a
naconda3/lib/python3.8/site-packages (from dtreeviz) (1.1.3)
Requirement already satisfied: numpy in /Users/sameerkhan/pythonnotebook/an
aconda3/lib/python3.8/site-packages (from dtreeviz) (1.19.2)
Requirement already satisfied: matplotlib in /Users/sameerkhan/pythonnotebo
ok/anaconda3/lib/python3.8/site-packages (from dtreeviz) (3.3.2)
Requirement already satisfied: scikit-learn in /Users/sameerkhan/pythonnote
book/anaconda3/lib/python3.8/site-packages (from dtreeviz) (0.23.2)
Requirement already satisfied: graphviz>=0.9 in /Users/sameerkhan/pythonnot
ebook/anaconda3/lib/python3.8/site-packages (from dtreeviz) (0.16)
Requirement already satisfied: attrs>=17.4.0 in /Users/sameerkhan/pythonnot
ebook/anaconda3/lib/python3.8/site-packages (from pytest->dtreeviz) (20.3.0
)
Requirement already satisfied: iniconfig in /Users/sameerkhan/pythonnoteboo
k/anaconda3/lib/python3.8/site-packages (from pytest->dtreeviz) (1.1.1)
Requirement already satisfied: packaging in /Users/sameerkhan/pythonnoteboo
k/anaconda3/lib/python3.8/site-packages (from pytest->dtreeviz) (20.4)
Requirement already satisfied: pluggy<1.0,>=0.12 in /Users/sameerkhan/pytho
nnotebook/anaconda3/lib/python3.8/site-packages (from pytest->dtreeviz) (0.
13.1)
Requirement already satisfied: py>=1.8.2 in /Users/sameerkhan/pythonnoteboo
k/anaconda3/lib/python3.8/site-packages (from pytest->dtreeviz) (1.9.0)
Requirement already satisfied: toml in /Users/sameerkhan/pythonnotebook/ana
conda3/lib/python3.8/site-packages (from pytest->dtreeviz) (0.10.1)
Requirement already satisfied: python-dateutil>=2.7.3 in /Users/sameerkhan/
pythonnotebook/anaconda3/lib/python3.8/site-packages (from pandas->dtreeviz
) (2.8.1)
Requirement already satisfied: pytz>=2017.2 in /Users/sameerkhan/pythonnote
book/anaconda3/lib/python3.8/site-packages (from pandas->dtreeviz) (2020.1)
```

```
Requirement already satisfied: pillow>=6.2.0 in /Users/sameerkhan/pythonnot
ebook/anaconda3/lib/python3.8/site-packages (from matplotlib->dtreeviz) (8.
0.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in
/Users/sameerkhan/pythonnotebook/anaconda3/lib/python3.8/site-packages (fro
m matplotlib->dtreeviz) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /Users/sameerkhan/pythonnote
book/anaconda3/lib/python3.8/site-packages (from matplotlib->dtreeviz) (0.1
0.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /Users/sameerkhan/pytho
nnotebook/anaconda3/lib/python3.8/site-packages (from matplotlib->dtreeviz)
(1.3.0)
Requirement already satisfied: certifi>=2020.06.20 in /Users/sameerkhan/pyt
honnotebook/anaconda3/lib/python3.8/site-packages (from matplotlib->dtreevi
z) (2020.6.20)
Requirement already satisfied: threadpoolctl>=2.0.0 in /Users/sameerkhan/py
thonnotebook/anaconda3/lib/python3.8/site-packages (from scikit-learn->dtre
eviz) (2.1.0)
Requirement already satisfied: scipy>=0.19.1 in /Users/sameerkhan/pythonnot
ebook/anaconda3/lib/python3.8/site-packages (from scikit-learn->dtreeviz) (
1.5.2)
Requirement already satisfied: joblib>=0.11 in /Users/sameerkhan/pythonnote
book/anaconda3/lib/python3.8/site-packages (from scikit-learn->dtreeviz) (0
.17.0)
Requirement already satisfied: six in /Users/sameerkhan/pythonnotebook/anac
onda3/lib/python3.8/site-packages (from packaging->pytest->dtreeviz) (1.15.
0)
Note: you may need to restart the kernel to use updated packages.
```

In [3]:

```
data= pd.read_excel(r"CHURNDATA (1).xlsx")
```

In [4]:

```
data.isnull().sum()
```

Out[4]:
```
CIF                                  0
CUS_DOB                              0
AGE                                  0
CUS_Month_Income                    11
CUS_Gender                           2
CUS_Marital_Status                   0
CUS_Customer_Since                   0
YEARS_WITH_US                        0
# total debit transactions for S1    0
# total debit transactions for S2    0
# total debit transactions for S3    0
total debit amount for S1            0
total debit amount for S2            0
total debit amount for S3            0
# total credit transactions for S1   0
# total credit transactions for S2   0
# total credit transactions for S3   0
total credit amount for S1           0
total credit amount for S2           0
total credit amount for S3           0
total debit amount                   0
total debit transactions             0
total credit amount                  0
total credit transactions            0
total transactions                   0
CUS_Target                           0
TAR_Desc                             0
Status                               0
dtype: int64
```

In [5]:
```
data=data.dropna()
```

In [6]:
```
data.isnull().sum()
```

Out[6]:
```
CIF                                  0
CUS_DOB                              0
AGE                                  0
CUS_Month_Income                     0
CUS_Gender                           0
CUS_Marital_Status                   0
CUS_Customer_Since                   0
YEARS_WITH_US                        0
# total debit transactions for S1    0
# total debit transactions for S2    0
# total debit transactions for S3    0
total debit amount for S1            0
total debit amount for S2            0
total debit amount for S3            0
# total credit transactions for S1   0
# total credit transactions for S2   0
# total credit transactions for S3   0
total credit amount for S1           0
total credit amount for S2           0
total credit amount for S3           0
total debit amount                   0
total debit transactions             0
total credit amount                  0
total credit transactions            0
total transactions                   0
CUS_Target                           0
TAR_Desc                             0
Status                               0
dtype: int64
```

In [7]:
```
data
```

Out[7]:

| | CIF | CUS_DOB | AGE | CUS_Month_Income | CUS_Gender | CUS_Marital_Status | CU |
|---|---|---|---|---|---|---|---|
| **0** | XXXXXX | Feb 13 1970 12:00AM | 49 | 7116.64 | MALE | MARRIED | |
| **1** | XXXXXX | Sep 20 1973 12:00AM | 46 | 1500000.00 | FEMALE | SINGLE | |
| **2** | XXXXXX | Jul 18 1966 12:00AM | 53 | 5000000.00 | FEMALE | SINGLE | |
| **3** | XXXXXX | Jan 9 2004 12:00AM | 15 | 500.00 | FEMALE | SINGLE | |
| **4** | XXXXXX | Mar 7 1971 12:00AM | 48 | 9000000.00 | FEMALE | SINGLE | |
| **...** | ... | ... | ... | ... | ... | ... | |
| **1244** | XXXXXX | Sep 10 1951 12:00AM | 68 | 4500.00 | MALE | SINGLE | |
| **1245** | XXXXXX | Mar 23 1984 12:00AM | 35 | 3500000.00 | MALE | SINGLE | |
| **1246** | XXXXXX | Feb 4 1985 12:00AM | 34 | 1000.00 | MALE | SINGLE | |
| **1247** | XXXXXX | Feb 3 1950 12:00AM | 69 | 2000000.00 | MALE | SINGLE | |
| **1248** | XXXXXX | Feb 23 1961 12:00AM | 58 | 5000000.00 | FEMALE | SINGLE | |

1238 rows × 28 columns

In [8]:

```
df = pd.DataFrame(data=data, columns=data.feature_names)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-8-9296aebe68b4> in <module>
----> 1 df = pd.DataFrame(data=data, columns=data.feature_names)

~/pythonnotebook/anaconda3/lib/python3.8/site-packages/pandas/core/generic.
py in __getattr__(self, name)
   5137             if self._info_axis._can_hold_identifiers_and_holds_name
(name):
   5138                 return self[name]
-> 5139             return object.__getattribute__(self, name)
   5140
   5141     def __setattr__(self, name: str, value) -> None:

AttributeError: 'DataFrame' object has no attribute 'feature_names'
```

In [ ]:

In [ ]:

# DELETING UNNECESSARY FEATURES

quaterly data are highly used to determine churn customer and we can make total sum of quater coloumn out of it too if required where else we cannt make quater coloumns from total coloumn

In [9]:
```
data=data.drop(['total debit amount','total debit transactions','total cre
```

In [10]:
```
del data['CUS_DOB']
del data['CIF']
del data['CUS_Customer_Since']
```

In [12]:
```
data
```

Out[12]:

| | AGE | CUS_Month_Income | CUS_Gender | CUS_Marital_Status | YEARS_WITH_US | # tot trans |
|---|---|---|---|---|---|---|
| **0** | 49 | 7116.64 | MALE | MARRIED | 25 | |
| **1** | 46 | 1500000.00 | FEMALE | SINGLE | 14 | |
| **2** | 53 | 5000000.00 | FEMALE | SINGLE | 14 | |
| **3** | 15 | 500.00 | FEMALE | SINGLE | 14 | |
| **4** | 48 | 9000000.00 | FEMALE | SINGLE | 5 | |
| **...** | ... | ... | ... | ... | ... | |
| **1244** | 68 | 4500.00 | MALE | SINGLE | 14 | |
| **1245** | 35 | 3500000.00 | MALE | SINGLE | 14 | |
| **1246** | 34 | 1000.00 | MALE | SINGLE | 14 | |
| **1247** | 69 | 2000000.00 | MALE | SINGLE | 14 | |
| **1248** | 58 | 5000000.00 | FEMALE | SINGLE | 14 | |

1238 rows × 21 columns

# Using One Hot Encoding

convert the string values from some columns to numeric values which machine can understand easily and can get minimum errors

In [13]:

```
from sklearn import preprocessing

data=pd.get_dummies(data,drop_first=True)
data.head()
# Encode labels in column 'species'.
```

Out[13]:

| | AGE | CUS_Month_Income | YEARS_WITH_US | # total debit transactions for S1 | # total debit transactions for S2 | # total debit transactions for S3 | to ar |
|---|---|---|---|---|---|---|---|
| **0** | 49 | 7116.64 | 25 | 277 | 265 | 345 | 14 |
| **1** | 46 | 1500000.00 | 14 | 37 | 15 | 45 | |
| **2** | 53 | 5000000.00 | 14 | 31 | 14 | 8 | |
| **3** | 15 | 500.00 | 14 | 0 | 1 | 0 | |
| **4** | 48 | 9000000.00 | 5 | 15 | 33 | 12 | |

5 rows × 27 columns

In [14]:
```
#Splitting the Data for Training and Testing
X = data.drop(labels=['Status_CHURN'],axis=1)
y = data[['Status_CHURN']]
```

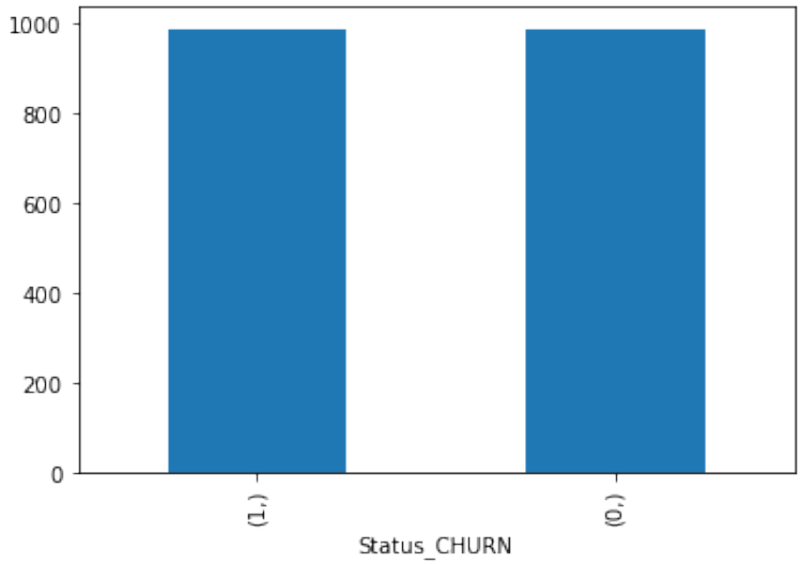
In [15]:
```
# To address class imbalance
from imblearn.combine import SMOTETomek
from collections import Counter
sm=SMOTETomek()
X,y=sm.fit_resample(X,y)
print("The number of classes before resampling {}".format(Counter(y)))
print("The number of classes after resampling {}".format(Counter(y)))
```

```
The number of classes before resampling Counter({'Status_CHURN': 1})
The number of classes after resampling Counter({'Status_CHURN': 1})
```

In [16]:
```
from sklearn.model_selection import train_test_split,GridSearchCV
X_train, X_test, y_train, y_test=train_test_split(X,y,test_size=0.2,random_
```

In [17]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [18]:
```
# checkign class imbalance
y.value_counts().plot(kind='bar');
```




In [19]:
```
x
```

Out[19]:

| | AGE | CUS_Month_Income | YEARS_WITH_US | # total debit transactions for S1 | # total debit transactions for S2 | # total debit transactions for S3 |
|---|---|---|---|---|---|---|
| **0** | 49 | 7.116640e+03 | 25 | 277 | 265 | 345 |
| **1** | 46 | 1.500000e+06 | 14 | 37 | 15 | 45 |
| **2** | 53 | 5.000000e+06 | 14 | 31 | 14 | 8 |
| **3** | 15 | 5.000000e+02 | 14 | 0 | 1 | 0 |
| **4** | 48 | 9.000000e+06 | 5 | 15 | 33 | 12 |
| **...** | ... | ... | ... | ... | ... | ... |
| **1967** | 41 | 3.000000e+06 | 14 | 5 | 1 | 0 |
| **1968** | 31 | 1.000000e+05 | 14 | 0 | 0 | 0 |
| **1969** | 53 | 3.583243e+06 | 14 | 7 | 0 | 0 |
| **1970** | 33 | 1.000000e+06 | 14 | 1 | 1 | 0 |
| **1971** | 42 | 2.184137e+03 | 14 | 43 | 36 | 0 |

1972 rows × 26 columns

# FINAL MODEL

In [20]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score,confusion_matrix,classification_
rfc=RandomForestClassifier()
rfc.fit(X_train,y_train)
y_predr=rfc.predict(X_test)
print(confusion_matrix(y_test,y_predr))
print(accuracy_score(y_test,y_predr))
print(classification_report(y_test,y_predr))
```

```
<ipython-input-20-5d17a1a5ebbf>:4: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to (n
_samples,), for example using ravel().
  rfc.fit(X_train,y_train)
[[170  32]
 [ 14 179]]
0.8835443037974684
              precision    recall  f1-score   support

           0       0.92      0.84      0.88       202
           1       0.85      0.93      0.89       193

    accuracy                           0.88       395
   macro avg       0.89      0.88      0.88       395
weighted avg       0.89      0.88      0.88       395
```

In [21]:
```
rfc1=DecisionTreeClassifier()

rfc1.fit(X_train,y_train)
y_predd=rfc1.predict(X_test)
print(confusion_matrix(y_test,y_predd))
print(accuracy_score(y_test,y_predd))
print(classification_report(y_test,y_predd))
```

```
[[164  38]
 [ 25 168]]
0.8405063291139241
              precision    recall  f1-score   support

           0       0.87      0.81      0.84       202
           1       0.82      0.87      0.84       193

    accuracy                           0.84       395
   macro avg       0.84      0.84      0.84       395
weighted avg       0.84      0.84      0.84       395
```

In [22]:
```
from sklearn.linear_model import LogisticRegression
from sklearn import neighbors
from sklearn.svm import SVC
```

In [27]:

```
rfc2=neighbors.KNeighborsClassifier()

rfc2.fit(X_train,y_train)
y_predk=rfc2.predict(X_test)
print(confusion_matrix(y_test,y_predk))
print(accuracy_score(y_test,y_predk))
print(classification_report(y_test,y_predk))


#model = neighbors.KNeighborsClassifier()
#model = SVC(kernel='poly',degree=4  C= 1)
```

```
[[164  38]
 [ 22 171]]
0.8481012658227848
              precision    recall  f1-score   support

           0       0.88      0.81      0.85       202
           1       0.82      0.89      0.85       193

    accuracy                           0.85       395
   macro avg       0.85      0.85      0.85       395
weighted avg       0.85      0.85      0.85       395

<ipython-input-27-6dce41a0e7e2>:3: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to (n
_samples, ), for example using ravel().
  rfc2.fit(X_train,y_train)
```

In [26]:

```
rfc3=LogisticRegression()

rfc3.fit(X_train,y_train)
y_predl=rfc3.predict(X_test)
print(confusion_matrix(y_test,y_predl))
print(accuracy_score(y_test,y_predl))
print(classification_report(y_test,y_predl))
```

```
[[168  34]
 [ 23 170]]
0.8556962025316456
              precision    recall  f1-score   support

           0       0.88      0.83      0.85       202
           1       0.83      0.88      0.86       193

    accuracy                           0.86       395
   macro avg       0.86      0.86      0.86       395
weighted avg       0.86      0.86      0.86       395

/Users/sameerkhan/pythonnotebook/anaconda3/lib/python3.8/site-packages/skle
arn/utils/validation.py:72: DataConversionWarning: A column-vector y was pa
ssed when a 1d array was expected. Please change the shape of y to (n_sampl
es, ), for example using ravel().
  return f(**kwargs)
```

In [28]:
```
from sklearn.metrics import roc_auc_score
from sklearn.metrics import roc_curve
fpr1, tpr1, thresh1 = roc_curve(y_test,y_predr, pos_label=1)
```

In [29]:
```
auc_score1 = roc_auc_score(y_test,y_predr)
print(auc_score1)
```

```
0.8845226491561072
```

In [30]:
```
fpr2, tpr2, thresh2 = roc_curve(y_test,y_predd, pos_label=1)
```

In [31]:
```
auc_score2 = roc_auc_score(y_test,y_predd)
print(auc_score2)
```

```
0.8411737546811676
```

In [32]:
```
fpr3, tpr3, thresh3 = roc_curve(y_test,y_predk, pos_label=1)
```

In [33]:
```
auc_score3 = roc_auc_score(y_test,y_predk)
print(auc_score3)
```

```
0.8489457754065564
```

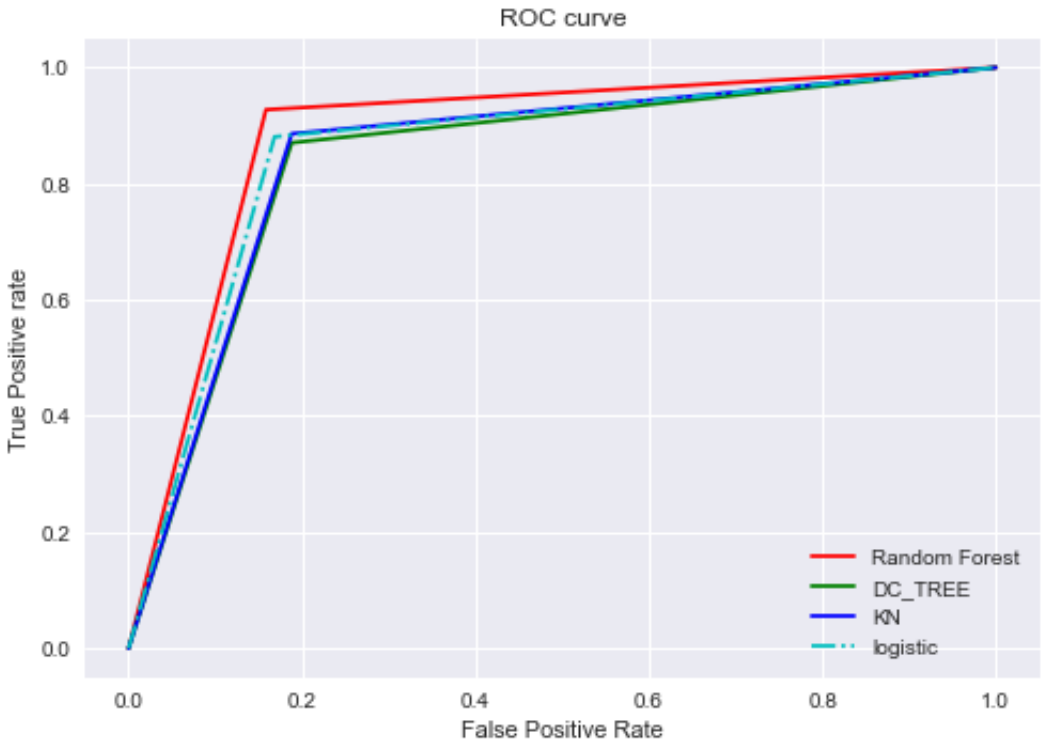
In [34]:
```
fpr4, tpr4, thresh4 = roc_curve(y_test,y_predl, pos_label=1)
```

In [35]:
```
auc_score4 = roc_auc_score(y_test,y_predl)
print(auc_score4)
```

```
0.8562560919304365
```

In [36]:

```
import matplotlib.pyplot as plt
plt.style.use('seaborn')

# plot roc curves
plt.plot(fpr1, tpr1, linestyle='-',color='RED', label='Random Forest')
plt.plot(fpr2, tpr2, linestyle='-',color='GREEN', label='DC_TREE')
plt.plot(fpr3, tpr3, linestyle='-',color='BLUE', label='KN')
plt.plot(fpr4, tpr4, linestyle='-.',color='c', label='logistic')
# title
plt.title('ROC curve')
# x label
plt.xlabel('False Positive Rate')
# y label
plt.ylabel('True Positive rate')

plt.legend(loc='best')
plt.savefig('ROC',dpi=370)
plt.show();
```




# GOING WITH RANDOM FOREST AS ITS GIVES BETTER RESULTS WHEN COMPARED TO OTHER MODELS

In [37]:

```
model=RandomForestClassifier()
```

In [38]:
```
grid_param = {
              "max_features": range(17,22,2),
               'max_depth' : range(14,23,1),
               'min_samples_leaf' : range(1,2,1),
               'min_samples_split': range(2,3,1),
               "bootstrap": [True, False],
               "n_estimators" : range(100,110,2),
               "n_jobs":[-1],
               "criterion" : ["entropy"]
}
grid_search = GridSearchCV(estimator=model,param_grid=grid_param,cv=5,n_jo
```

In [39]:
```
grid_search.fit(X_train,y_train)
```

```
Fitting 5 folds for each of 270 candidates, totalling 1350 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  16 tasks      | elapsed:    3.2s
[Parallel(n_jobs=-1)]: Done 112 tasks      | elapsed:   12.0s
[Parallel(n_jobs=-1)]: Done 272 tasks      | elapsed:   26.5s
[Parallel(n_jobs=-1)]: Done 496 tasks      | elapsed:   47.6s
[Parallel(n_jobs=-1)]: Done 784 tasks      | elapsed:  1.3min
[Parallel(n_jobs=-1)]: Done 1136 tasks      | elapsed:  2.1min
[Parallel(n_jobs=-1)]: Done 1350 out of 1350 | elapsed:  2.5min finished
/Users/sameerkhan/pythonnotebook/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_search.py:765: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
  self.best_estimator_.fit(X, y, **fit_params)
```

Out[39]:
```
GridSearchCV(cv=5, estimator=RandomForestClassifier(), n_jobs=-1,
             param_grid={'bootstrap': [True, False], 'criterion': ['entropy'],
                         'max_depth': range(14, 23),
                         'max_features': range(17, 22, 2),
                         'min_samples_leaf': range(1, 2),
                         'min_samples_split': range(2, 3),
                         'n_estimators': range(100, 110, 2), 'n_jobs': [-1]},
             verbose=3)
```

In [40]:
```
grid_search.best_params_
```

Out[40]:
```
{'bootstrap': True,
 'criterion': 'entropy',
 'max_depth': 16,
 'max_features': 17,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'n_estimators': 100,
 'n_jobs': -1}
```

In [52]:
```
rfcg=RandomForestClassifier(criterion='entropy',bootstrap=True,max_depth=1(

rfcg.fit(X_train,y_train)
y_predsmg=rfcg.predict(X_test)
print(confusion_matrix(y_test,y_predsmg))
print(accuracy_score(y_test,y_predsmg))
print(classification_report(y_test,y_predsmg))
```

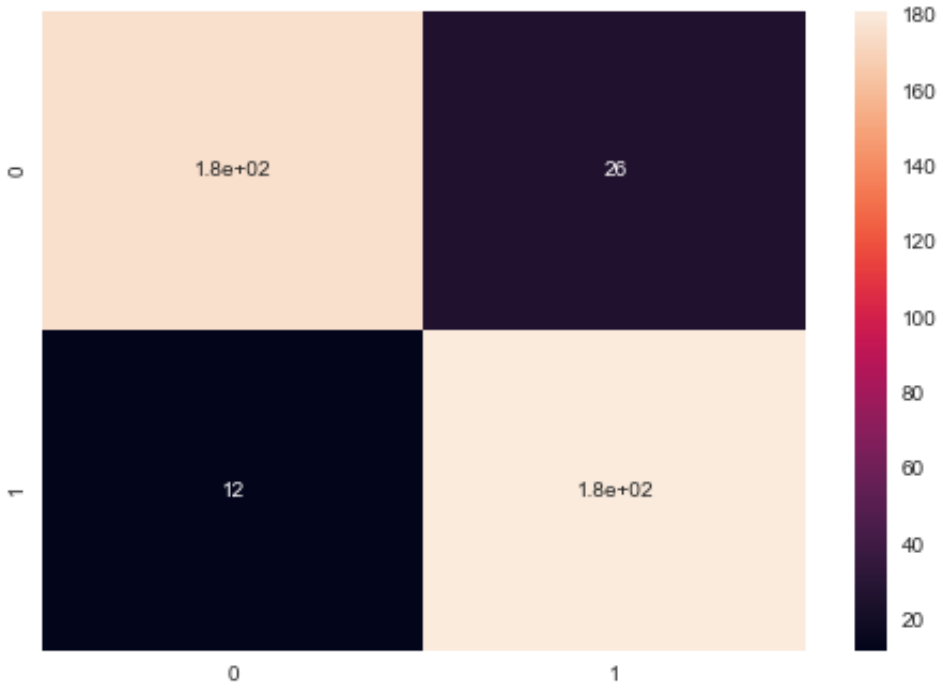
```
<ipython-input-52-acb824f2dc0c>:3: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to (n
_samples,), for example using ravel().
  rfcg.fit(X_train,y_train)
[[176  26]
 [ 12 181]]
0.9037974683544304
              precision    recall  f1-score   support

           0       0.94      0.87      0.90       202
           1       0.87      0.94      0.90       193

    accuracy                           0.90       395
   macro avg       0.91      0.90      0.90       395
weighted avg       0.91      0.90      0.90       395
```

In [53]:
```
import seaborn as sns
cm=confusion_matrix(y_test,y_predsmg)
print(cm)
```

```
[[176  26]
 [ 12 181]]
```

In [54]:
```
import seaborn as sns
sns.heatmap(cm, annot=True)
```

Out[54]: <AxesSubplot:>




In [45]:
```
labels = [‘True Neg’,’False Pos’,’False Neg’,’True Pos’]
labels = np.asarray(labels).reshape(2,2)
sns.heatmap(cm, annot=labels, fmt=’’, cmap='Blues')
```

```
  File "<ipython-input-45-d489dbf9b997>", line 1
    labels = [‘True Neg’,’False Pos’,’False Neg’,’True Pos’]
                        ^
SyntaxError: invalid character in identifier
```

In [46]:
```
from sklearn.model_selection import RandomizedSearchCV
```

In [47]:
```
from scipy.stats import uniform
```

In [48]:
```
random_grid = {'bootstrap': [True, False],
               'max_depth': [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110,
               'max_features': ['auto', 'sqrt'],
               'min_samples_leaf': [1, 2, 4],
               'min_samples_split': [2, 5, 10],
               "n_jobs":[7],
               'n_estimators': [130, 180, 230]}
rf_random = RandomizedSearchCV(estimator = model, param_distributions = ra
```

In [49]:
```
rf_random.fit(X_train,y_train)
```

```
Fitting 3 folds for each of 100 candidates, totalling 300 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 8 concurrent workers.
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed:    2.3s
[Parallel(n_jobs=-1)]: Done 146 tasks      | elapsed:   11.0s
[Parallel(n_jobs=-1)]: Done 300 out of 300 | elapsed:   21.8s finished
/Users/sameerkhan/pythonnotebook/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_search.py:765: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
  self.best_estimator_.fit(X, y, **fit_params)
```

Out[49]:

```
RandomizedSearchCV(cv=3, estimator=RandomForestClassifier(), n_iter=100,
                   n_jobs=-1,
                   param_distributions={'bootstrap': [True, False],
                                        'max_depth': [10, 20, 30, 40, 50, 60,
                                                      70, 80, 90, 100, 110,
                                                      None],
                                        'max_features': ['auto', 'sqrt'],
                                        'min_samples_leaf': [1, 2, 4],
                                        'min_samples_split': [2, 5, 10],
                                        'n_estimators': [130, 180, 230],
                                        'n_jobs': [7]},
                   random_state=96, verbose=2)
```

In [55]:

```
rf_random.best_params_
```

Out[55]:

```
{'n_jobs': 7,
 'n_estimators': 130,
 'min_samples_split': 2,
 'min_samples_leaf': 2,
 'max_features': 'auto',
 'max_depth': None,
 'bootstrap': False}
```

In [56]:

```
rf_random.best_estimator_
```

Out[56]:

```
RandomForestClassifier(bootstrap=False, min_samples_leaf=2, n_estimators=130,
                       n_jobs=7)
```

In [44]:

```
rfcr=RandomForestClassifier(criterion='entropy',bootstrap = False  ,max_dep

rfcr.fit(X_train,y_train)
y_predsmr=rfcr.predict(X_test)
print(confusion_matrix(y_test,y_predsmr))
print(accuracy_score(y_test,y_predsmr))
print(classification_report(y_test,y_predsmr))
```

```
<ipython-input-44-c98ebbdd005e>:3: DataConversionWarning: A column-vector y
was passed when a 1d array was expected. Please change the shape of y to (n
_samples,), for example using ravel().
  rfcr.fit(X_train,y_train)
[[196  15]
 [  8 170]]
0.9408740359897172
              precision    recall  f1-score   support

           0       0.96      0.93      0.94       211
           1       0.92      0.96      0.94       178

    accuracy                           0.94       389
   macro avg       0.94      0.94      0.94       389
weighted avg       0.94      0.94      0.94       389
```

In [45]:

```
fprg, tprg, threshg = roc_curve(y_test,y_predsmg, pos_label=1)
fprr, tprr, threshr = roc_curve(y_test,y_predsmr, pos_label=1)
```

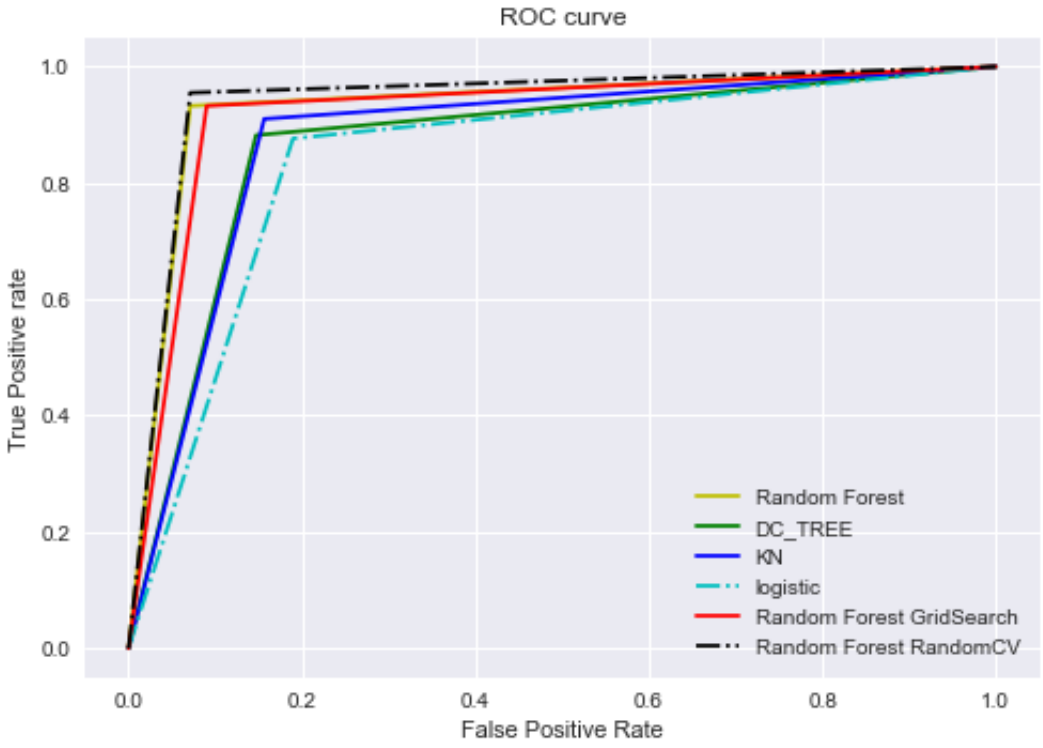
In [46]:

```
auc_scoreg = roc_auc_score(y_test,y_predsmg)
auc_scorer = roc_auc_score(y_test,y_predsmr)
print(auc_scoreg)
print(auc_scorer)
```

```
0.9212684381489962
0.941983066190958
```

In [54]:

```
import matplotlib.pyplot as plt
plt.style.use('seaborn')

# plot roc curves
plt.plot(fpr1, tpr1, linestyle='-',color='y', label='Random Forest')
plt.plot(fpr2, tpr2, linestyle='-',color='GREEN', label='DC_TREE')
plt.plot(fpr3, tpr3, linestyle='-',color='BLUE', label='KN')
plt.plot(fpr4, tpr4, linestyle='-.',color='c', label='logistic')
plt.plot(fprg, tprg, linestyle='-',color='red', label='Random Forest GridSe
plt.plot(fprr, tprr, linestyle='-.',color='k', label='Random Forest Random(

# title
plt.title('ROC curve')
# x label
plt.xlabel('False Positive Rate')
# y label
plt.ylabel('True Positive rate')

plt.legend(loc='best')
plt.savefig('ROC',dpi=770)
plt.show();
```




# FINAL MODEL IS RANDOM FOREST CAUSE IT HAS BEST ROC SCORE WHEN TUNE WITH THE HELP OF RandomCV

In [ ]: