In [1]:
```
#(data: churn modelling and bike buyer)
#assignment-05
#D.Prudhvi Sai
```

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [2]:
```
dataset=pd.read_csv('Churn_Modelling1.csv')
```

In [3]:
```
dataset.isnull().any()
```

Out[3]:
```
RowNumber          False
CustomerId         False
Surname            False
CreditScore        False
Geography           True
Gender              True
Age                 True
Tenure             False
Balance             True
NumOfProducts      False
HasCrCard          False
IsActiveMember     False
EstimatedSalary    False
Exited             False
dtype: bool
```

In [4]:
```
dataset[dataset['Age'].isnull()].index.tolist()
```

Out[4]:
```
[4, 28, 43, 59]
```

In [5]:
```
dataset['Age'].fillna(dataset['Age'].mean(),inplace=True)
```

In [6]:
```
dataset[dataset['Gender'].isnull()].index.tolist()
```

Out[6]:
```
[6, 21, 32]
```

In [7]:
```
dataset['Gender'].fillna(dataset['Gender'].mode(),inplace=True)
```

In [8]:
```
dataset[dataset['Geography'].isnull()].index.tolist()
```

Out[8]:
```
[16, 30, 41]
```

In [12]:
```
dataset['Geography'].fillna(dataset['Geography'].mode(),inplace=True)
```

Out[12]:
```
[]
```

In [14]:
```
dataset['Balance'].fillna(dataset['Balance'].mean(),inplace=True)
```

In [13]:
```
dataset[dataset['Balance'].isnull()].index.tolist()
```

Out[13]:
```
[]
```

In [15]:
```
dataset['Gender'] = dataset['Gender'].fillna(dataset['Gender'].mode()[0])
```

In [16]:
```
dataset['Geography'] = dataset['Geography'].fillna(dataset['Geography'].mode()[0]
```

In [18]:
```
dataset.isnull().any()
```

Out[18]:
```
RowNumber          False
CustomerId         False
Surname            False
CreditScore        False
Geography          False
Gender             False
Age                False
Tenure             False
Balance            False
NumOfProducts      False
HasCrCard          False
IsActiveMember     False
EstimatedSalary    False
Exited             False
dtype: bool
```

In [19]:
```
dataset['Gender'].fillna(dataset['Gender'].mode()[0],inplace=True)
dataset['Geography'].fillna(dataset['Geography'].mode()[0],inplace=True)
```

In [20]:
```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
dataset['Gender'] = le.fit_transform(dataset['Gender'])
dataset['Geography'] = le.fit_transform(dataset['Geography'])
```

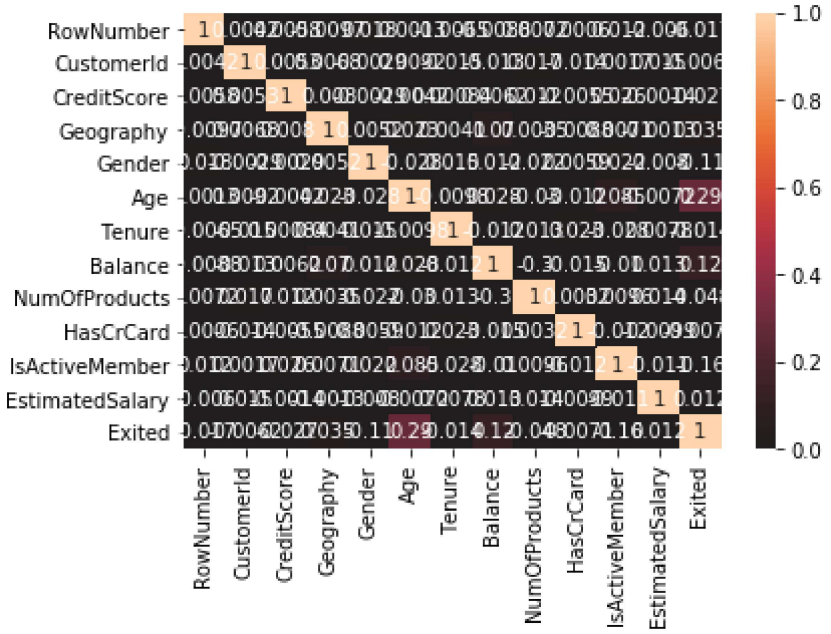
In [22]:
```
dataset.corr()
```

Out[22]:

lumber	CustomerId	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProd
000000	0.004202	0.005840	-0.009734	0.017850	0.001279	-0.006495	-0.008830	0.00
004202	1.000000	0.005308	0.006779	-0.002901	0.009184	-0.014883	-0.012525	0.01
005840	0.005308	1.000000	0.008034	-0.002887	-0.004154	0.000842	0.006215	0.01
009734	0.006779	0.008034	1.000000	0.005178	0.022713	0.004075	0.069609	0.00
017850	-0.002901	-0.002887	0.005178	1.000000	-0.027595	0.014941	0.011716	-0.02
001279	0.009184	-0.004154	0.022713	-0.027595	1.000000	-0.009790	0.028282	-0.03
006495	-0.014883	0.000842	0.004075	0.014941	-0.009790	1.000000	-0.012168	0.01
008830	-0.012525	0.006215	0.069609	0.011716	0.028282	-0.012168	1.000000	-0.30
007246	0.016972	0.012238	0.003472	-0.021697	-0.030420	0.013444	-0.304141	1.00
000599	-0.014025	-0.005458	-0.008757	0.005896	-0.011698	0.022583	-0.014858	0.00
012044	0.001665	0.025651	0.007098	0.022338	0.085395	-0.028362	-0.010136	0.00
005988	0.015271	-0.001384	-0.001339	-0.007978	-0.007239	0.007784	0.012695	0.01
016571	-0.006248	-0.027094	0.035227	-0.106616	0.285267	-0.014001	0.118609	-0.04

In [23]:
```
import seaborn as sns
sns.heatmap(dataset.corr(),annot=True,vmin=0,vmax=1,center=0)
```

Out[23]: <matplotlib.axes._subplots.AxesSubplot at 0x1f31843b2c8>



In [24]:
```
y = dataset.iloc[:,-1:].values
y
```

Out[24]:
```
array([[1],
       [0],
       [1],
       ...,
       [1],
       [1],
       [0]], dtype=int64)
```

In [25]:
```
x = dataset.iloc[:,0:-1].values
x
```

Out[25]:
```
array([[1, 15634602, 'Hargrave', ..., 1, 1, 101348.88],
       [2, 15647311, 'Hill', ..., 0, 1, 112542.58],
       [3, 15619304, 'Onio', ..., 1, 0, 113931.57],
       ...,
       [9998, 15584532, 'Liu', ..., 0, 1, 42085.58],
       [9999, 15682355, 'Sabbatini', ..., 1, 0, 92888.52],
       [10000, 15628319, 'Walker', ..., 1, 0, 38190.78]], dtype=object)
```

In [26]:
```
x = np.delete(x,0,axis=1)
x
```

Out[26]:
```
array([[15634602, 'Hargrave', 619, ..., 1, 1, 101348.88],
       [15647311, 'Hill', 608, ..., 0, 1, 112542.58],
       [15619304, 'Onio', 502, ..., 1, 0, 113931.57],
       ...,
       [15584532, 'Liu', 709, ..., 0, 1, 42085.58],
       [15682355, 'Sabbatini', 772, ..., 1, 0, 92888.52],
       [15628319, 'Walker', 792, ..., 1, 0, 38190.78]], dtype=object)
```

In [27]:
```
x = np.delete(x,0,axis=1)
x = np.delete(x,0,axis=1)
```

In [28]:
```
x
```

Out[28]:
```
array([[619, 0, 0, ..., 1, 1, 101348.88],
       [608, 2, 0, ..., 0, 1, 112542.58],
       [502, 0, 0, ..., 1, 0, 113931.57],
       ...,
       [709, 0, 0, ..., 0, 1, 42085.58],
       [772, 1, 1, ..., 1, 0, 92888.52],
       [792, 0, 0, ..., 1, 0, 38190.78]], dtype=object)
```

In [29]:
```
from sklearn.preprocessing import OneHotEncoder
oh = OneHotEncoder()
```

In [30]:
```
z = oh.fit_transform(x[:,1:2]).toarray()
z
```

Out[30]:
```
array([[1., 0., 0.],
       [0., 0., 1.],
       [1., 0., 0.],
       ...,
       [1., 0., 0.],
       [0., 1., 0.],
       [1., 0., 0.]])
```

In [31]:
```
x = np.delete(x,1,axis=1)
```

In [32]:
```
x = np.concatenate((x,z),axis=1)
```

In [33]:
```
z = oh.fit_transform(x[:,1:2]).toarray()
z
```

Out[33]:
```
array([[1., 0.],
       [1., 0.],
       [1., 0.],
       ...,
       [1., 0.],
       [0., 1.],
       [1., 0.]])
```

In [34]:
```
x = np.delete(x,1,axis=1)
x = np.concatenate((x,z),axis=1)
x.shape
```

Out[34]:
```
(10000, 13)
```

In [35]:
```
from sklearn.model_selection import train_test_split
x_train , x_test , y_train , y_test = train_test_split(x,y,test_size=0.2,random_s
```

In [36]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
x_train = sc.fit_transform(x_train)
x_test = sc.fit_transform(x_test)
```

In [38]:
```
from sklearn.tree import DecisionTreeClassifier
dtc = DecisionTreeClassifier(criterion = 'entropy' )
dtc.fit(x_train,y_train)
```

Out[38]:
```
DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='entropy',
                       max_depth=None, 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='deprecated',
                       random_state=None, splitter='best')
```

In [39]:
```
y_pred = dtc.predict(x_test)
y_pred
```

Out[39]:
```
array([1, 0, 0, ..., 0, 1, 1], dtype=int64)
```

In [40]:
```
y_test
```

Out[40]:
```
array([[0],
       [1],
       [0],
       ...,
       [0],
       [0],
       [0]], dtype=int64)
```

In [41]:
```
from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_pred)
```

Out[41]:
```
0.7985
```

In [42]:
```
from sklearn.metrics import confusion_matrix
```

In [43]:
```
cm=confusion_matrix(y_test,y_pred)
```

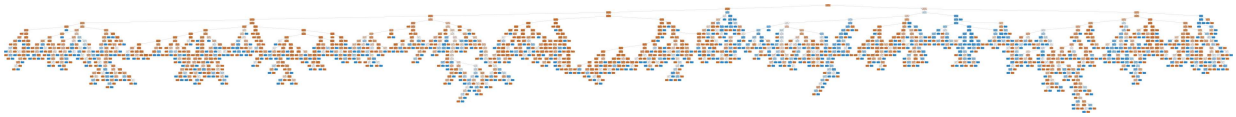
In [45]:
```
cm
dataset.head
```

Out[45]:
```
<bound method NDFrame.head of       RowNumber  CustomerId    Surname  CreditSco
re  Geography  Gender  \
0             1    15634602   Hargrave          619          0       0
1             2    15647311       Hill          608          2       0
2             3    15619304       Onio          502          0       0
3             4    15701354       Boni          699          0       0
4             5    15737888   Mitchell          850          2       0
...         ...         ...        ...          ...        ...     ...
9995       9996    15606229   Obijiaku          771          0       1
9996       9997    15569892  Johnstone          516          0       1
9997       9998    15584532        Liu          709          0       0
9998       9999    15682355  Sabbatini          772          1       1
9999      10000    15628319     Walker          792          0       0

             Age  Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0     42.000000       2       0.00              1          1               1
1     41.000000       1   83807.86              1          0               1
2     42.000000       8  159660.80              3          1               0
3     39.000000       1       0.00              2          0               0
4     38.918768       2  125510.82              1          1               1
...         ...     ...        ...            ...        ...             ...
9995  39.000000       5       0.00              2          1               0
9996  35.000000      10   57369.61              1          1               1
9997  36.000000       7       0.00              1          0               1
9998  42.000000       3   75075.31              2          1               0
9999  28.000000       4  130142.79              1          1               0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]>
```

In [47]:
```
from sklearn import tree
tree.export_graphviz(dtc)

from sklearn.externals.six import StringIO
from IPython.display import Image
from sklearn.tree import export_graphviz
import pydotplus

dot_data=StringIO()
export_graphviz(dtc,out_file=dot_data,
                filled=True,rounded=True,
                special_characters=True)

graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
Image(graph.create_png())
```

```
C:\Users\PRUDHVI\anaconda3\lib\site-packages\sklearn\externals\six.py:31: Futur
eWarning: The module is deprecated in version 0.21 and will be removed in versi
on 0.23 since we've dropped support for Python 2.7. Please rely on the official
version of six (https://pypi.org/project/six/).
  "(https://pypi.org/project/six/).", FutureWarning)

dot: graph is too large for cairo-renderer bitmaps. Scaling by 0.703834 to fit
```

Out[47]:



In [49]:
```
#random forest on churn modelling
```

In [48]:
```
from sklearn.ensemble import RandomForestClassifier
rfc = RandomForestClassifier(n_estimators=30,criterion='entropy',max_depth=15,ma
rfc.fit(x_train,y_train)
y_pred_rfc = rfc.predict(x_test)
y_pred_rfc
```

```
C:\Users\PRUDHVI\anaconda3\lib\site-packages\ipykernel_launcher.py:3: DataConve
rsionWarning: 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().
  This is separate from the ipykernel package so we can avoid doing imports unt
il
```

Out[48]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [50]:
```
accuracy_score(y_test,y_pred_rfc)
```

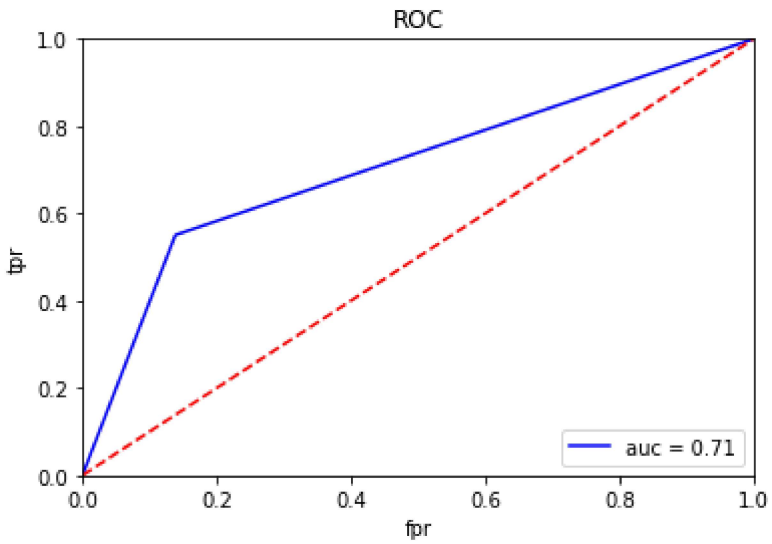
Out[50]:
```
0.8315
```

In [51]:
```
confusion_matrix(y_test,y_pred_rfc)
```

Out[51]:
```
array([[1589,    6],
       [ 331,   74]], dtype=int64)
```

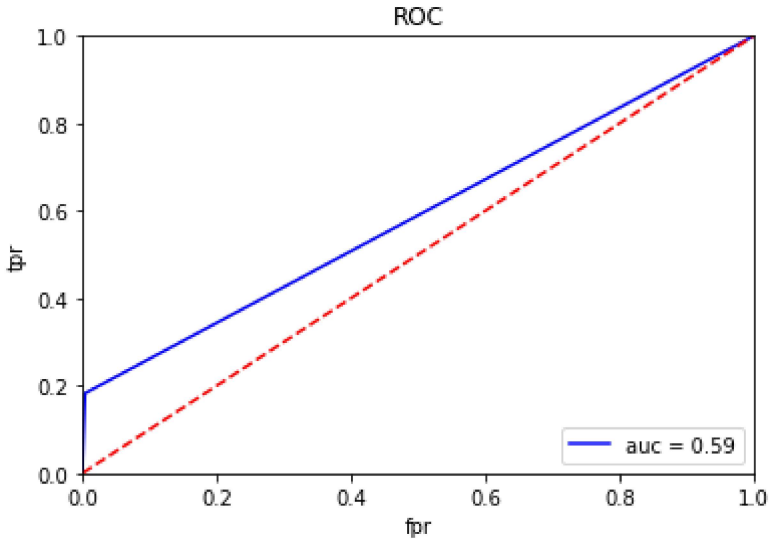
In [52]:
```
import sklearn.metrics as metrics
fpr,tpr,threshold = metrics.roc_curve(y_test,y_pred)
roc_auc = metrics.auc(fpr,tpr)

import matplotlib.pyplot as plt
plt.title("ROC")
plt.plot(fpr,tpr,'b',label = 'auc = %0.2f'%roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([0,1])
plt.ylim([0,1])
plt.xlabel('fpr')
plt.ylabel('tpr')
```

Out[52]:
```
Text(0, 0.5, 'tpr')
```



In [53]:
```
#auc, #roc
#area under curve
import sklearn.metrics as metrics
fpr,tpr,threshold = metrics.roc_curve(y_test,y_pred_rfc)
roc_auc = metrics.auc(fpr,tpr)

import matplotlib.pyplot as plt
plt.title("ROC")
plt.plot(fpr,tpr,'b',label = 'auc = %0.2f'%roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([0,1])
plt.ylim([0,1])
plt.xlabel('fpr')
plt.ylabel('tpr')
```

Out[53]: Text(0, 0.5, 'tpr')



In [ ]: