In [101]:

```
#Creator: Hetul Varaiya
#University: Arizona State University
#Date: 04/13/2018 - 04/14/2018
#I am an industrial Engineering Graduate student with a deep interest in data analytics
 and machine learning

#THE APPROACH USED INCLUDES:
#SVM - LINEAR SVC - 76%
#LOGISTIC REGRESSION - 71%
#NEAREST NEIGHBOR - 60%
#XGBOOST
#RANDOM FOREST
```

In [2]:

```
#IMPORTING LIBRARY

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [3]:

```
# PREPROCESSING
#FILLING NA VALUES
#TRANSFORMING DATA


import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import xgboost as xgb
from sklearn import preprocessing

dftr =  pd.read_csv('K:/Mckinsey hackathon/without pca/train.csv')
stro1 = dftr['stroke']
del dftr['stroke']
dftst = pd.read_csv('K:/Mckinsey hackathon/without pca/test.csv')
idkey = dftst['id']

del dftr['id']
del dftst['id']
dftr.isnull().any()
dftst.isnull().any()
dftr[['smoking_status']] = dftr[['smoking_status']].fillna(value='hetul')
dftst[['smoking_status']] = dftst[['smoking_status']].fillna(value='hetul')

from sklearn import preprocessing
```

In [4]:

```
#CREATED DUMMIES TO MAKE IT SINGLE-CLASS[0,1]
p = pd.get_dummies(data= dftr, columns = ['smoking_status','ever_married','Residence
_type','work_type','gender'])
del p['smoking_status_hetul']

q = pd.get_dummies(data= dftst, columns = ['smoking_status','ever_married','Residenc
e_type','work_type','gender'])
del q['smoking_status_hetul']
```

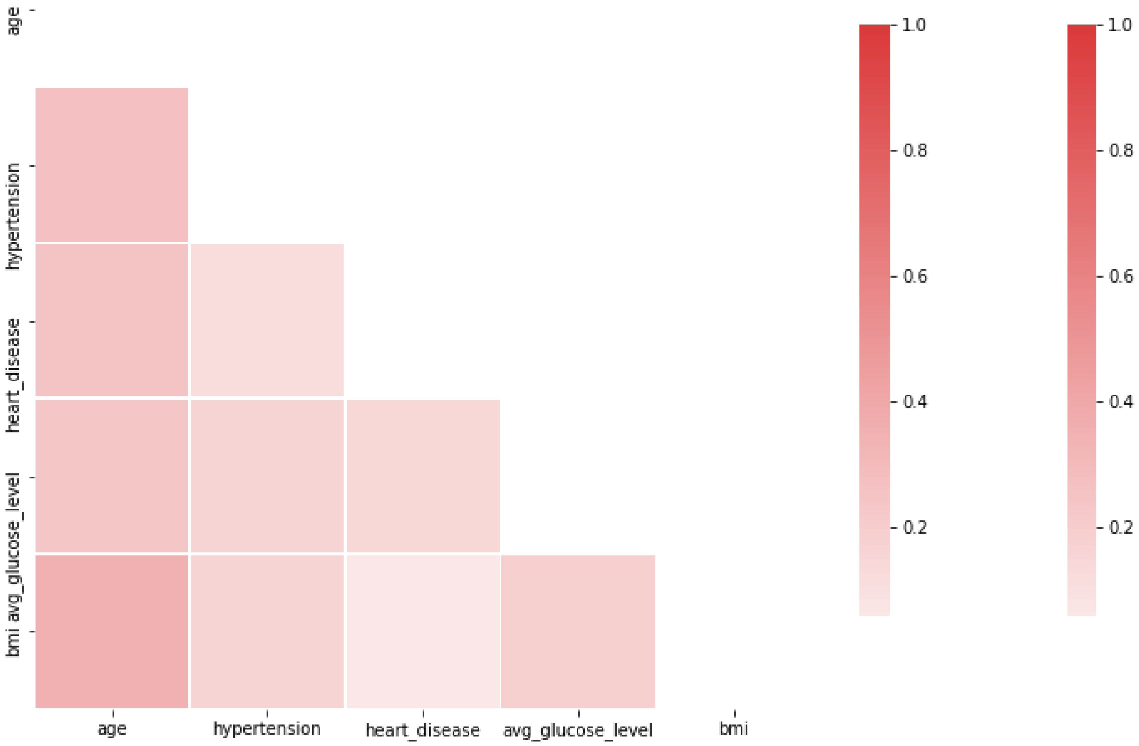
In [5]:

```
# TAKING THE MEAN BECAUSE VERY FEW VALUES OF BMI ARE NAN
p[['bmi']] = p[['bmi']].fillna(p[['bmi']].mean())
q[['bmi']] = q[['bmi']].fillna(q[['bmi']].mean())
```

In [6]:

```
#FINDING CORRELATION TO GET AN OVERVIEW OF THE RELATION BETWEEN THE COLUMNS
corrp= dftr.corr()
print(np.matrix(corrp))
mask = np.zeros_like(corrp, dtype=np.bool)
mask[np.triu_indices_from(mask)] = True
f, ax = plt.subplots(figsize=(13, 13))

cmap = sns.diverging_palette(225, 12, as_cmap=True)
sns.heatmap(corrp, mask=mask, cmap=cmap, vmax=1, center=0,
            square=True, linewidths=.5, cbar_kws={"shrink": .5})
plt.show(sns.heatmap(corrp, mask=mask, cmap=cmap, vmax=1, center=0,
            square=True, linewidths=.5, cbar_kws={"shrink": .5}))
```

```
[[1.         0.27216879 0.25018839 0.23762684 0.35889719]
 [0.27216879 1.         0.11977703 0.16021129 0.16122524]
 [0.25018839 0.11977703 1.         0.14693807 0.05767724]
 [0.23762684 0.16021129 0.14693807 1.         0.19129515]
 [0.35889719 0.16122524 0.05767724 0.19129515 1.        ]]
```



In [7]:

```
#USED STANDARDSCALER TO TRANSFORM THE DATA
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
scaler.fit(p)

scaler.mean_
p = scaler.transform(p)

scaler.fit(q)

scaler.mean_
q = scaler.transform(q)
```

In [102]:

```
# PCA

from sklearn.decomposition import PCA
pca = PCA(n_components=2)
p = pca.fit_transform(p)
p = pd.DataFrame(data = p)
q= pca.fit_transform(q)
q = pd.DataFrame(data = q)
```

In [10]:

```
p2 = p.copy()
```

In [11]:

```
X = p2
y = stro1
```

In [12]:

```
#splitting the data for validation

from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, random_state=
42)
```

In [13]:

```
#FUNCTION USED FOR ROC VALUES AND CURVE PLOT
def ROC(label,result):
    # Compute ROC curve and area the curve
    Y = np.array(label)
    fpr, tpr, thresholds = roc_curve(Y, result)
    roc_auc = auc(fpr, tpr)
    print("Area under the ROC curve : %f" % roc_auc)

    # Plot ROC curve
    #pl.clf()
    plt.plot(fpr, tpr, label='ROC curve (area = %0.2f)' % roc_auc)
    plt.plot([0, 1], [0, 1], 'k--')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.0])
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver operating characteristic')
    plt.legend(loc="lower right")
    plt.show()
```

In [62]:

```
#svm using L2 regularization using the training and testing data to do the validation

from sklearn.utils import shuffle
from sklearn.metrics import roc_curve, auc
from sklearn import svm
import numpy as np
import itertools
import matplotlib.pyplot as plt
from sklearn.utils import class_weight
from sklearn.model_selection import GridSearchCV
from sklearn.datasets import make_moons, make_circles, make_classification

linearly_separable = (X_train, y_train)
Cs = [0.001, 0.01,0.1,1]
parameters = {'C':Cs}

# svc2tr = svm.SVC(class_weight='balanced',probability = True)
# clfl2tr = GridSearchCV(svc2tr, parameters,return_train_score=True)
# clfl2tr.fit(X_train, y_train)
# # y_predsvml2tr = clfl2tr.predict(X_test)
# #print(y_predsvml2)

# # y_score = clfl2.predict_proba(X_test)[:,1]

# # ROC(y_test,y_score)
# probl2tr = clfl2tr.predict_proba(X_test)
# y_scorel2tr = clfl2tr.predict_proba(X_test)[:,1]
```

In [98]:

```
from sklearn.svm import LinearSVC
from sklearn.calibration import CalibratedClassifierCV
svml2tr = LinearSVC(class_weight='balanced')
clfl2tr = CalibratedClassifierCV(svml2tr)
clfl2tr.fit(X_train, y_train)
probl2tr = clfl2tr.predict_proba(X_test)
y_scorel2tr = clfl2tr.predict_proba(X_test)[:,1]
```

In [16]:

```
# from sklearn.metrics import roc_curve
# roc = roc_curve(y_predsvml2, y_test)
# print(roc)
```

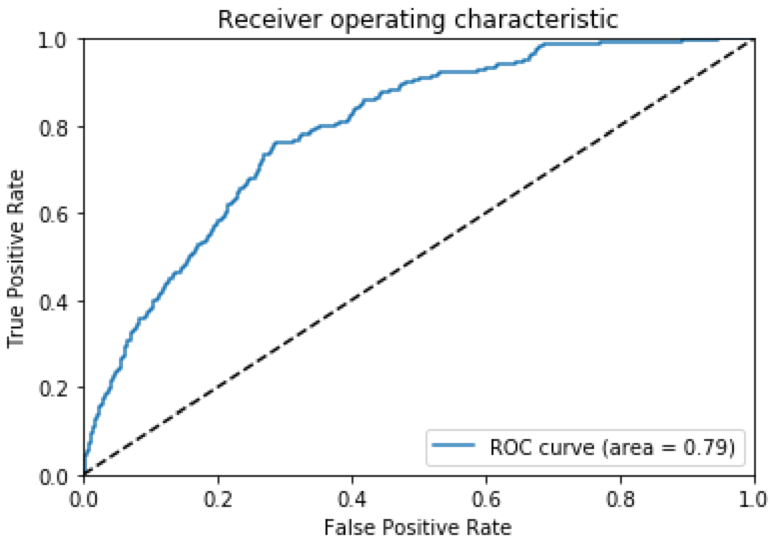
In [17]:

```
# from sklearn.cross_validation import cross_val_score
# cross_val_score(svc2tr, X_train, y_train, scoring = 'roc_auc')
```

In [99]:

```
#ROC and AUC measure using the ROC function

ROC(y_test,y_scorel2tr)
```

```
Area under the ROC curve : 0.790681
```



In [100]:

```
#svm using L2 regularization for the actual data
# SVC seems to give the best output out of all the models tried after tuning the parame
ters
# from sklearn.model_selection import train_test_split
# X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, random_stat
e=42)
from sklearn import svm
from sklearn.metrics import confusion_matrix
import numpy as np
import itertools
import matplotlib.pyplot as plt
from sklearn.utils import class_weight
# from sklearn import preprocessing
# from sklearn.metrics import accuracy_score
from sklearn.model_selection import GridSearchCV
from sklearn.datasets import make_moons, make_circles, make_classification

# n_samples=300
# linearly_separable = (X, y)
# Cs = [0.001, 0.01,0.1,1]
# parameters = {'C':Cs}

from sklearn.svm import LinearSVC
from sklearn.calibration import CalibratedClassifierCV
svml2 = LinearSVC(class_weight='balanced')
clfl2 = CalibratedClassifierCV(svml2)
clfl2.fit(X, y)
y_scorel2tr = clf.predict_proba(q)[:,1]
# svc2 = svm.LinearSVC(penalty = 'l2',class_weight='balanced')
# clfl2 = GridSearchCV(svc2, parameters,return_train_score=True)
# clfl2.fit(X, y)
# probl2 = clfl2.predict_proba(q)
# y_scorel2 = clfl2.predict_proba(q)[:,1]
# print(y_scorel2)

#np.savetxt('K:/svml2.txt',y_scorel2, delimiter="\t")



# # print('best parameters for l2:',clfl2.best_params_,',testing accuracy for l2:',clfl
2.best_estimator_.score(y_pred,y_test))
# # from sklearn.metrics import classification_report
# # print(classification_report(y_test,y_pred))
# # cm = confusion_matrix(y_test, y_pred)
# # p = plot_confusion_matrix(cm,[0,1],normalize=True)
```

In [97]:

```
np.savetxt('K:/svml2.txt',y_scorel2tr, delimiter="\t")
```

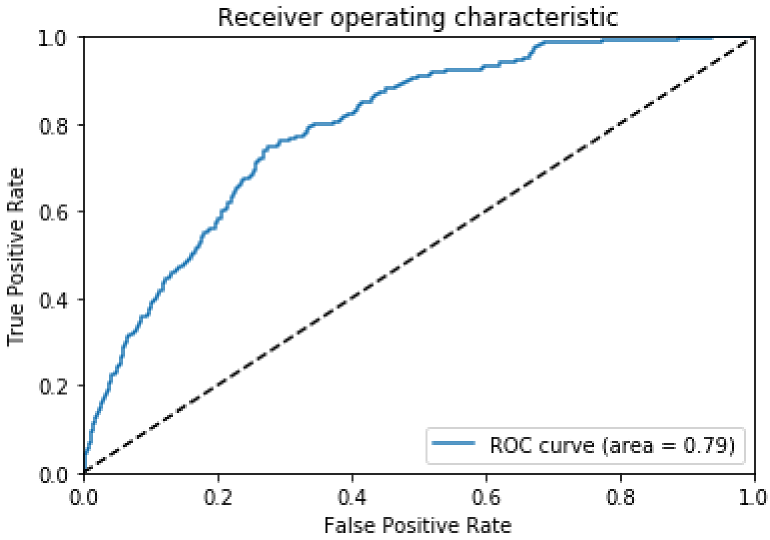
In [40]:

```
#logistic regression using the training and testing data to do the validation

import sklearn.linear_model as skl_lm
import seaborn as sns
from sklearn.utils import shuffle
from sklearn.metrics import roc_curve, auc

clflrtr = skl_lm.LogisticRegression(class_weight='balanced',solver = 'lbfgs')
clflrtr.fit(X_train,y_train)
# prob = clflr.predict_proba(q)
y_scorelrtr = clflrtr.predict_proba(X_test)[:,1]

# y_predlrtr = clflrtr.predict(X_test)
# print(y_predlrtr)

#np.savetxt('K:/logistic regression.txt',np.c_[idkey,y_predlr], delimiter="\t")
# np.savetxt('myfile.txt', np.c_[x,y,z])
```

In [42]:

```
#ROC and AUC measure using the ROC function

ROC(y_test,y_scorelrtr)
```

```
Area under the ROC curve : 0.791473
```



In [43]:

```
#logistic regression for the actual data

import sklearn.linear_model as skl_lm
from sklearn.metrics import average_precision_score
import seaborn as sns
from sklearn.utils import shuffle
from sklearn.metrics import roc_curve, auc

clflr = skl_lm.LogisticRegression(class_weight='balanced',solver = 'lbfgs')
clflr.fit(X,y)
# prob = clflr.predict_proba(q)
# y_predlr = clflr.predict(q)
# print(y_predlr)
problr = clflr.predict_proba(q)
y_scorelr = clflr.predict_proba(q)[:,1]

#np.savetxt('K:/logistic regression.txt',y_scorelr, delimiter="\t")
# np.savetxt('myfile.txt', np.c_[x,y,z])
```

In [84]:

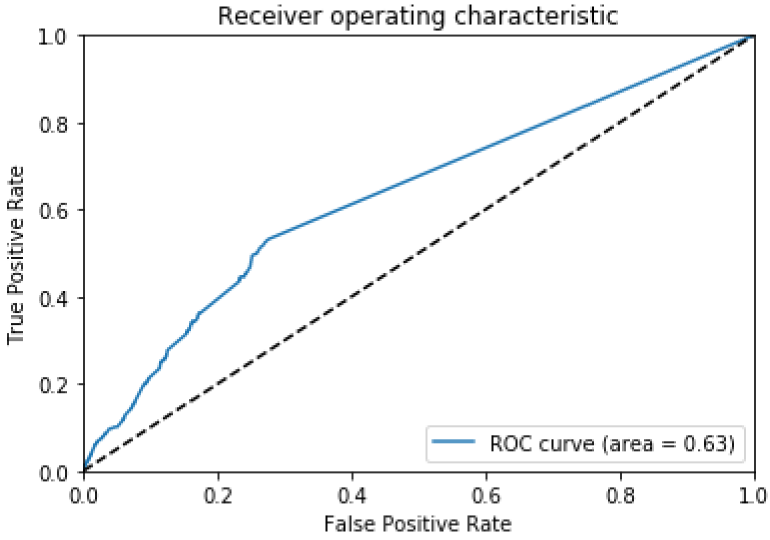
```
#Random forest using the training and testing data to do the validation



from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
# from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import classification_report
# from sklearn.metrics import matthews_corrcoef
from sklearn.metrics import roc_curve, auc

depthsi = [1,2,4,8,16,32,64]
ntrees = [1,2,4,8,16,32,64]
max_features = [0.1,0.2,0.3,0.5,0.9]

parameters = {'max_depth':depthsi, 'n_estimators':ntrees, 'max_features':max_features}

rfctr = RandomForestClassifier(class_weight='balanced',max_depth=depthsi,n_estimators =
 ntrees, max_features = max_features )
clfrftr = GridSearchCV(rfctr, parameters,return_train_score=True)
clfrftr.fit(X_train, y_train)
print('best parameters:',clfrftr.best_params_)
```

```
best parameters: {'max_depth': 32, 'max_features': 0.5, 'n_estimators': 6
4}
```

In [85]:

```
y_scorerftr = clfrftr.predict_proba(X_test)[:,1]
#print(y_predrf)

#ROC and AUC measure using the ROC function

ROC(y_test,y_scorerftr)
```

```
Area under the ROC curve : 0.631577
```



In [86]:

```
#Random forest for the actual data

from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV
# from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import classification_report
# from sklearn.metrics import matthews_corrcoef
from sklearn.metrics import roc_curve, auc

depthsi = [1,2,4,8,16,32,64]
ntrees = [1,2,4,8,16,32,64]
max_features = [0.1,0.2,0.3,0.5,0.9]

parameters = {'max_depth':depthsi, 'n_estimators':ntrees, 'max_features':max_features}

rfc = RandomForestClassifier(class_weight='balanced',max_depth=depthsi,n_estimators = n
trees, max_features = max_features )
clfrf = GridSearchCV(rfc, parameters,return_train_score=True)
clfrf.fit(X, y)
print('best parameters:',clfrf.best_params_)
```

```
----------------------------------------------------------------------
----
KeyboardInterrupt                         Traceback (most recent call l
ast)
<ipython-input-86-9556c8897df2> in <module>()
     17 rfc = RandomForestClassifier(class_weight='balanced',max_depth=
depthsi,n_estimators = ntrees, max_features = max_features )
     18 clfrf = GridSearchCV(rfc, parameters,return_train_score=True)
---> 19 clfrf.fit(X, y)
     20 print('best parameters:',clfrf.best_params_)
     21 

~\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py in fit
(self, X, y, groups, **fit_params)
    637                                   error_score=self.error_score)
    638           for parameters, (train, test) in product(candidate_pa
rams,
--> 639                                                  cv.split(X,
 y, groups)))
    640 
    641         # if one choose to see train score, "out" will contain
 train score info

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
_call__(self, iterable)
    777             # was dispatched. In particular this covers the edg
e
    778             # case of Parallel used with an exhausted iterator.
--> 779             while self.dispatch_one_batch(iterator):
    780                 self._iterating = True
    781             else:

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in d
ispatch_one_batch(self, iterator)
    623                 return False
    624             else:
--> 625                 self._dispatch(tasks)
    626                 return True
    627 

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
dispatch(self, batch)
    586         dispatch_timestamp = time.time()
    587         cb = BatchCompletionCallBack(dispatch_timestamp, len(ba
tch), self)
--> 588         job = self._backend.apply_async(batch, callback=cb)
    589         self._jobs.append(job)
    590 

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\_parallel_backen
ds.py in apply_async(self, func, callback)
    109     def apply_async(self, func, callback=None):
    110         """Schedule a func to be run"""
--> 111         result = ImmediateResult(func)
    112         if callback:
    113             callback(result)

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\_parallel_backen
ds.py in __init__(self, batch)
    330         # Don't delay the application, to avoid keeping the inp
ut
```

```
    331         # arguments in memory
--> 332         self.results = batch()
    333 
    334     def get(self):

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
_call__(self)
    129 
    130     def __call__(self):
--> 131         return [func(*args, **kwargs) for func, args, kwargs in
 self.items]
    132 
    133     def __len__(self):

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in <
listcomp>(.0)
    129 
    130     def __call__(self):
--> 131         return [func(*args, **kwargs) for func, args, kwargs in
 self.items]
    132 
    133     def __len__(self):

~\Anaconda3\lib\site-packages\sklearn\model_selection\_validation.py in
 _fit_and_score(estimator, X, y, scorer, train, test, verbose, paramete
rs, fit_params, return_train_score, return_parameters, return_n_test_sa
mples, return_times, error_score)
    490         if return_train_score:
    491             train_scores = _score(estimator, X_train, y_train,
 scorer,
--> 492                                   is_multimetric)
    493 
    494     if verbose > 2:

~\Anaconda3\lib\site-packages\sklearn\model_selection\_validation.py in
 _score(estimator, X_test, y_test, scorer, is_multimetric)
    521     """
    522     if is_multimetric:
--> 523         return _multimetric_score(estimator, X_test, y_test, sc
orer)
    524     else:
    525         if y_test is None:

~\Anaconda3\lib\site-packages\sklearn\model_selection\_validation.py in
 _multimetric_score(estimator, X_test, y_test, scorers)
    551             score = scorer(estimator, X_test)
    552         else:
--> 553             score = scorer(estimator, X_test, y_test)
    554 
    555         if hasattr(score, 'item'):

~\Anaconda3\lib\site-packages\sklearn\metrics\scorer.py in _passthrough
_scorer(estimator, *args, **kwargs)
    242 def _passthrough_scorer(estimator, *args, **kwargs):
    243     """Function that wraps estimator.score"""
--> 244     return estimator.score(*args, **kwargs)
    245 
    246 

~\Anaconda3\lib\site-packages\sklearn\base.py in score(self, X, y, samp
le_weight)
```

```
    347         """
    348         from .metrics import accuracy_score
--> 349         return accuracy_score(y, self.predict(X), sample_weight
=sample_weight)
    350 
    351 

~\Anaconda3\lib\site-packages\sklearn\ensemble\forest.py in predict(sel
f, X)
    536             The predicted classes.
    537         """
--> 538         proba = self.predict_proba(X)
    539 
    540         if self.n_outputs_ == 1:

~\Anaconda3\lib\site-packages\sklearn\ensemble\forest.py in predict_pro
ba(self, X)
    587         Parallel(n_jobs=n_jobs, verbose=self.verbose, backend
="threading")(
    588             delayed(accumulate_prediction)(e.predict_proba, X,
 all_proba, lock)
--> 589             for e in self.estimators_)
    590 
    591         for proba in all_proba:

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
_call__(self, iterable)
    777             # was dispatched. In particular this covers the edg
e
    778             # case of Parallel used with an exhausted iterator.
--> 779             while self.dispatch_one_batch(iterator):
    780                 self._iterating = True
    781             else:

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in d
ispatch_one_batch(self, iterator)
    623                 return False
    624             else:
--> 625                 self._dispatch(tasks)
    626                 return True
    627 

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
dispatch(self, batch)
    586         dispatch_timestamp = time.time()
    587         cb = BatchCompletionCallBack(dispatch_timestamp, len(ba
tch), self)
--> 588         job = self._backend.apply_async(batch, callback=cb)
    589         self._jobs.append(job)
    590 

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\_parallel_backen
ds.py in apply_async(self, func, callback)
    109     def apply_async(self, func, callback=None):
    110         """Schedule a func to be run"""
--> 111         result = ImmediateResult(func)
    112         if callback:
    113             callback(result)

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\_parallel_backen
ds.py in __init__(self, batch)
```

```
    330         # Don't delay the application, to avoid keeping the inp
ut
    331         # arguments in memory
--> 332         self.results = batch()
    333 
    334     def get(self):

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in _
_call__(self)
    129 
    130     def __call__(self):
--> 131         return [func(*args, **kwargs) for func, args, kwargs in
 self.items]
    132 
    133     def __len__(self):

~\Anaconda3\lib\site-packages\sklearn\externals\joblib\parallel.py in <
listcomp>(.0)
    129 
    130     def __call__(self):
--> 131         return [func(*args, **kwargs) for func, args, kwargs in
 self.items]
    132 
    133     def __len__(self):

~\Anaconda3\lib\site-packages\sklearn\ensemble\forest.py in accumulate_
prediction(predict, X, out, lock)
    381 
    382 def accumulate_prediction(predict, X, out, lock):
--> 383     prediction = predict(X, check_input=False)
    384     with lock:
    385         if len(out) == 1:

~\Anaconda3\lib\site-packages\sklearn\tree\tree.py in predict_proba(sel
f, X, check_input)
    820         check_is_fitted(self, 'tree_')
    821         X = self._validate_X_predict(X, check_input)
--> 822         proba = self.tree_.predict(X)
    823 
    824         if self.n_outputs_ == 1:

KeyboardInterrupt: 
```

In [218]:

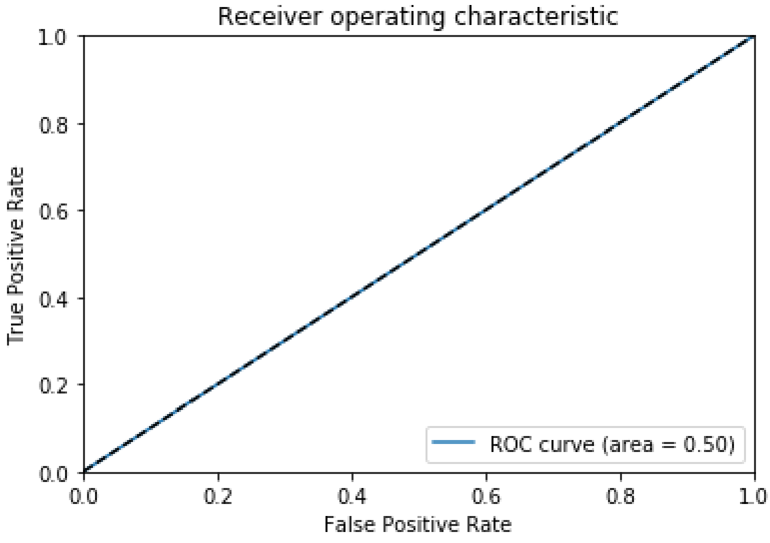
```
# y_predrf = (clfrf.predict_proba(X_test)>0.5)[:,1]
y_scorerf = clfrf.predict_proba(q)[:,1]
# print(y_predrf)

np.savetxt('K:/Mckinsey hackathon/random forest.txt',y_scorerf, delimiter="\t")
```

```
[0 0 0 ... 0 0 0]
```

In [28]:

```
#xgboost using the training and testing data to do the validation
import warnings
warnings.filterwarnings("ignore")
from xgboost import XGBClassifier
depthsi = [1,2,4,8,16]
ntrees = [1,2,4,8,16]
max_features = [0.1,0.2,0.3,0.5,0.9]

parameters = {'max_depth':depthsi, 'n_estimators':ntrees, 'max_features':max_features}
gbttr = XGBClassifier(max_depth=depthsi,n_estimators = ntrees, max_features = max_featu
res,class_weight='balanced' )
clfxgbtr = GridSearchCV(gbttr, parameters,return_train_score=True)
clfxgbtr.fit(X, y)
print('best parameters:',clfxgbtr.best_params_)
# y_score = clf.predict_proba(q)[:,1]

# y_pred = (clf.predict_proba(q)>0.5)[:,1]
y_predxgbtr = clfxgbtr.predict(X_test)
ROC(y_test,y_predxgbtr)


# np.savetxt('K:/Mckinsey hackathon/xgboost.txt',y_predxgb, delimiter="\t")
```

```
best parameters: {'max_depth': 1, 'max_features': 0.1, 'n_estimators': 1}
Area under the ROC curve : 0.500000
```



In [29]:

```
#xgboost for the actual data

import warnings
warnings.filterwarnings("ignore")
from xgboost import XGBClassifier
depthsi = [1,2,4,8,16]
ntrees = [1,2,4,8,16]
max_features = [0.1,0.2,0.3,0.5,0.9]

parameters = {'max_depth':depthsi, 'n_estimators':ntrees, 'max_features':max_features}
gbt = XGBClassifier(max_depth=depthsi,n_estimators = ntrees, max_features = max_feature
s,class_weight='balanced' )
clfxgb = GridSearchCV(gbt, parameters,return_train_score=True)
clfxgb.fit(X, y)
print('best parameters:',clfxgb.best_params_)
# y_score = clf.predict_proba(q)[:,1]

# y_pred = (clf.predict_proba(q)>0.5)[:,1]
# ROC(y_test,y_score)
y_predxgb = clfxgb.predict(q)

np.savetxt('K:/Mckinsey hackathon/xgboost.txt',y_predxgb, delimiter="\t")
```

```
best parameters: {'max_depth': 1, 'max_features': 0.1, 'n_estimators': 1}
```

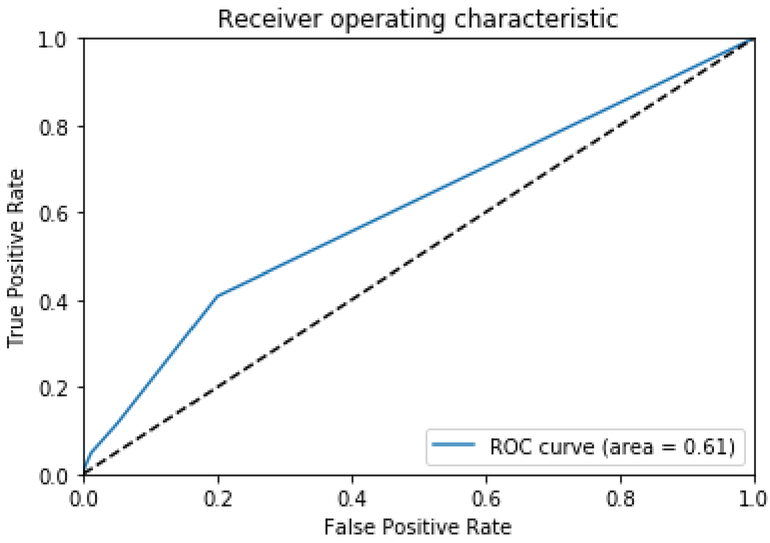
In [206]:

```
# print(y_predxgb)
```

In [92]:

```
from sklearn import neighbors
n_neighbors = 15
clfnn = neighbors.KNeighborsClassifier(n_neighbors)
clfnn.fit(X_train, y_train)

y_scorenntr = clfnn.predict_proba(X_test)[:,1]

ROC(y_test,y_scorenntr)
```

```
Area under the ROC curve : 0.606045
```



In [94]:

```
from sklearn import neighbors
n_neighbors = 15
clfnnad = neighbors.KNeighborsClassifier(n_neighbors)
clfnnad.fit(X, y)

y_scorenn = clfnnad.predict_proba(q)[:,1]
```

In [95]:

```
# np.savetxt('K:/Mckinsey hackathon/nearest neighbor.txt',y_scorenn, delimiter="\t")
```