In [1]:

```
#Import necessary programs
import os
import sys

import pandas as pd
import numpy as np
import math
import matplotlib.pyplot as plt

import json
import csv

import os,glob

import statsmodels.api as sm
```

The data that is used in this model is from the free data source provided by StatsBomb

STATSBOMB

INSIDE EVERY PASS, EVERY SHOT, EVERY MOVE

In [2]:

```
#Read through all json files in folder and combine them
myList = []
folder_path = r'C:\Users\Yuma\Desktop\Sport Analytics\StatsBomb Data\open-data-master\data\events'
for filename in glob.glob(os.path.join(folder_path,'*.json')):
    with open(filename,'r',encoding='utf-8') as f:
        myList += json.load(f)
print(len(myList))
```

```
1904058
```

In [3]:

```
#Only get shot data from json
shot_data = []
length = len(myList)
for i in range(length):
    if myList[i]["type"]["name"] == "Shot":
        shot_data.append(myList[i])

print(len(shot_data))
```

```
12826
```

In [4]:

```
print(shot_data[162])
```

```
{'id': '423171d3-ff73-400c-9ff6-669ccf35f2ac', 'index': 2507, 'period': 2, 'timestamp': '00:16:49.931', 'mi
nute': 61, 'second': 49, 'type': {'id': 16, 'name': 'Shot'}, 'possession': 127, 'possession_team': {'id': 2
17, 'name': 'Barcelona'}, 'play_pattern': {'id': 4, 'name': 'From Throw In'}, 'team': {'id': 217, 'name':
'Barcelona'}, 'player': {'id': 5246, 'name': 'Luis Alberto Suárez Díaz'}, 'position': {'id': 23, 'name': 'C
enter Forward'}, 'location': [115.7, 39.3], 'duration': 1.335006, 'related_events': ['28820abd-b160-4729-b2
f0-cf7bde32b8c0'], 'shot': {'open_goal': True, 'statsbomb_xg': 0.645913, 'end_location': [118.8, 39.7], 'fi
rst_time': True, 'outcome': {'id': 101, 'name': 'Wayward'}, 'type': {'id': 87, 'name': 'Open Play'}, 'body_
part': {'id': 37, 'name': 'Head'}, 'technique': {'id': 95, 'name': 'Volley'}, 'freeze_frame': [{'location':
[105.0, 40.9], 'player': {'id': 6396, 'name': 'Beñat Etxebarria Urkiaga'}, 'position': {'id': 15, 'name':
'Left Center Midfield'}, 'teammate': False}, {'location': [103.6, 36.0], 'player': {'id': 6775, 'name': 'Da
niel García Carrillo'}, 'position': {'id': 13, 'name': 'Right Center Midfield'}, 'teammate': False}, {'loca
tion': [110.0, 51.0], 'player': {'id': 3023, 'name': 'Yuri Berchiche Izeta'}, 'position': {'id': 21, 'nam
e': 'Left Wing'}, 'teammate': False}, {'location': [108.3, 55.1], 'player': {'id': 6789, 'name': 'Mikel Bal
enziaga Oruesagasti'}, 'position': {'id': 6, 'name': 'Left Back'}, 'teammate': False}, {'location': [107.0,
26.0], 'player': {'id': 6390, 'name': 'Markel Susaeta Laskurain'}, 'position': {'id': 17, 'name': 'Right Wi
ng'}, 'teammate': False}, {'location': [119.6, 36.3], 'player': {'id': 11748, 'name': 'Unai Simón Mendibi
l'}, 'position': {'id': 1, 'name': 'Goalkeeper'}, 'teammate': False}, {'location': [114.3, 40.1], 'player':
{'id': 11744, 'name': 'Peru Nolaskoain Esnal'}, 'position': {'id': 5, 'name': 'Left Center Back'}, 'teammat
e': False}, {'location': [112.2, 32.1], 'player': {'id': 6877, 'name': 'Yeray Álvarez López'}, 'position':
{'id': 3, 'name': 'Right Center Back'}, 'teammate': False}, {'location': [113.8, 30.8], 'player': {'id': 66
49, 'name': 'Óscar de Marcos Arana'}, 'position': {'id': 2, 'name': 'Right Back'}, 'teammate': False}, {'lo
cation': [94.7, 32.9], 'player': {'id': 5470, 'name': 'Ivan Rakitić'}, 'position': {'id': 15, 'name': 'Left
Center Midfield'}, 'teammate': True}, {'location': [106.6, 34.6], 'player': {'id': 5503, 'name': 'Lionel An
drés Messi Cuccittini'}, 'position': {'id': 13, 'name': 'Right Center Midfield'}, 'teammate': True}, {'loca
tion': [107.4, 60.2], 'player': {'id': 5477, 'name': 'Ousmane Dembélé'}, 'position': {'id': 17, 'name': 'Ri
ght Wing'}, 'teammate': True}, {'location': [115.3, 49.2], 'player': {'id': 6374, 'name': 'Nélson Cabral Se
medo'}, 'position': {'id': 2, 'name': 'Right Back'}, 'teammate': True}, {'location': [112.1, 37.3], 'playe
r': {'id': 5213, 'name': 'Gerard Piqué Bernabéu'}, 'position': {'id': 3, 'name': 'Right Center Back'}, 'tea
mmate': True}, {'location': [115.0, 28.5], 'player': {'id': 3501, 'name': 'Philippe Coutinho Correia'}, 'po
sition': {'id': 21, 'name': 'Left Wing'}, 'teammate': True}, {'location': [95.4, 20.6], 'player': {'id': 52
11, 'name': 'Jordi Alba Ramos'}, 'position': {'id': 6, 'name': 'Left Back'}, 'teammate': True}]}}
```

In [5]:

```python
#Display elements of shot data
for i in range(len(shot_data)):
    print(shot_data[i]['shot']['statsbomb_xg'])
```

```
0.24205604
0.3879865
0.02886755
0.34475145
0.42384946
0.025973916
0.014212875
0.091666594
0.40701
0.05358443
0.12231804
0.76

0.06587295
0.038172934
0.04525756
0.13929716
0.06719286
0.040593408
0.075184904
0.2101679
```

In [6]:

```
new_shot_data = []
for i in range(len(shot_data)):
    #Get rid of PK shots because we already know PKs have a 0.76 xG
    if 'statsbomb_xg' in shot_data[i]['shot']:
        if not (shot_data[i]['shot'].get('statsbomb_xg') == 0.76):
            Dict = dict({'id': shot_data[i]['id'], 'play_pattern': shot_data[i]['play_pattern']['name'], 'lo
                         shot_data[i]['location'], 'statsbomb_xg': shot_data[i]['shot']['statsbomb_xg'], 'end_lo
                         shot_data[i]['shot']['end_location'], 'body_part': shot_data[i]['shot']['body_part']['r
                         'technique': shot_data[i]['shot']['technique']['name'], 'outcome':
                         shot_data[i]['shot']['outcome']['name'], 'under_pressure': False, 'first_time': False})
            if 'under_pressure' in shot_data[i].keys():
                Dict.update(under_pressure = shot_data[i]['under_pressure'])
            if 'first_time' in shot_data[i]['shot'].keys():
                Dict.update(first_time = shot_data[i]['shot']['first_time'])
            new_shot_data.append(Dict)

print(len(new_shot_data))
```

```
12610
```

In [7]:

```
print(new_shot_data[174])
```

```
{'id': 'ceec9e87-df47-4b25-a784-3b4b41606599', 'play_pattern': 'From Corner', 'location': [119.1, 42.6], 's
tatsbomb_xg': 0.90241957, 'end_location': [120.0, 42.9, 0.1], 'body_part': 'Right Foot', 'technique': 'Norm
al', 'outcome': 'Goal', 'under_pressure': False, 'first_time': True}
```

In [8]:

```
for i in range(len(new_shot_data)):
    print(new_shot_data[i]['location'])
#print(new_shot_data[130]['location'])
```

```
[111.7, 51.7]
[114.0, 27.0]
[92.0, 34.5]
[109.1, 38.7]
[107.0, 25.0]
[108.1, 27.4]
[112.0, 43.7]
[97.0, 54.0]
[112.3, 41.4]
[102.5, 29.2]
[109.3, 29.7]
[106.5, 33.5]
[116.9, 31.2]
[106.0, 23.0]
[111.1, 24.1]
[94.4, 24.5]
[107.4, 25.9]
[100.1, 58.1]
[100.2, 27.7]
[96.1, 45.1]
```

In [9]:

```
print(new_shot_data[0]['location'])
```

```
[111.7, 51.7]
```

In [10]:

```
#Calculate 'distance' data from 'location' data
distance = []
goal = [120,40]
for i in range(len(new_shot_data)):
    point = new_shot_data[i]['location']
    calculation = math.sqrt(((point[0]-goal[0])**2) + ((point[1]-goal[1])**2))
    distance.append(calculation)

print(distance[10000])
```

```
11.36353818139403
```

In [11]:

```
#Calculate 'angle' data from 'location' data
angle = []
pen_vect_pt = [12,0]
for i in range(len(new_shot_data)):
    shot_vector = [120-new_shot_data[i]['location'][0],abs(40-new_shot_data[i]['location'][1])]
    unit_vector_1 = pen_vect_pt / np.linalg.norm(pen_vect_pt)
    unit_vector_2 = shot_vector / np.linalg.norm(shot_vector)
    dot_product = np.dot(unit_vector_1, unit_vector_2)
    current_angle = math.degrees(np.arccos(dot_product))
    angle.append(current_angle)

print(angle)
```

```
[54.64804531609818, 65.22485943116808, 11.113040535948294, 6.801314823981564, 49.08561677997488, 46.636
57704161671, 24.820541335489118, 31.328692867804165, 10.304846468766009, 31.68051371295864 6, 43.9087837
747374, 25.709953780811272, 70.59402924599885, 50.527540151656176, 60.7621477639725 4, 31.19359510244271
4, 48.21548399174822, 42.28801653255506, 31.84905131905529, 12.045632385265794, 27.057552910841316, 5.1
11893990013171, 42.247514599731296, 44.56263613247929, 53.44036527550666, 30.85052391365481, 23.6942163
82171234, 34.01934998982646, 86.47854662307778, 50.16224027094536, 19.430335187247493, 22.0488295749256
62, 14.406685156436867, 50.85601358542897, 29.97289058597137, 49.236394799058836, 4.43266846868991, 51.
556946498163384, 57.79587107933758, 49.67416371113079, 23.678632633213386, 9.09027692082235 1, 25.324181
401947186, 41.84515713520801, 24.11101950255092, 36.86989764584398, 41.05481377096251, 50.8489216459289
5, 14.954646765153033, 47.617413363264426, 29.054604099077164, 9.865806943084365, 0.9669255716442647, 7
5.84658741214857, 36.006207601244455, 10.638766609506805, 12.587693381648801, 61.76808174133644, 74.197
48604606447, 67.54306100005792, 39.50767544287257, 34.33021719550333, 58.53049310232291, 7.507346666949
624, 75.37912601136831, 12.787972654802287, 45.75716886505853, 58.33924890336339, 59.52014901853704, 3
1.60750224624893, 20.79902840884148, 15.977729858840844, 15.945395900922879, 16.50436138175504, 2.59350
64447889484, 27.867003849656864, 17.49099731224263, 47.6324348689865, 20.052082146098535, 47.7927023657
1331, 44.28681136498241, 33.690067525979785, 38.088772880975284, 37.56859202882751, 18.019769281777187,
22.203478532057403, 45.0, 48.03939956892691, 8.64693170795306, 60.34089076400489, 28.774724638821805, 5
2.0578466498811 1, 7.125016348901757, 27.736363021554844, 1.138177007488375, 52.1250163489018, 19.718038
970379702, 5.654420822640744, 4.873896422204756, 9.490560638224673, 25.41928833890289, 29.0546040990771
```

In [12]:

```
#Create a different json for the linear regression model
# 0 means false, 1 meeans true
new_shot_data_2 = []
for i in range(len(new_shot_data)):
    Dict_2 = dict({'id': new_shot_data[i]['id'] , 'location': new_shot_data[i]['location'], 'distance': dist
                   'angle': angle[i], 'isFoot': 0, 'isHead': 0, 'isVolley': 0, 'isNormalShot': 0, 'isLobShot
                   'isCorner': 0, 'isRegularPlay': 0, 'isFreeKick': 0, 'isThrowIn': 0, 'isCounter': 0, 'from
                   'fromGK': 0, 'first_time': 0, 'under_pressure': 0, 'isGoal': 0,
                   'statsbomb_xg': new_shot_data[i]['statsbomb_xg']})

    if new_shot_data[i]['body_part'] == 'Right Foot':
        Dict_2.update(isFoot = 1)
    elif new_shot_data[i]['body_part'] == 'Left Foot':
        Dict_2.update(isFoot = 1)
    else:
        Dict_2.update(isFoot = 0)

    if new_shot_data[i]['body_part'] == 'Head':
        Dict_2.update(isHead = 1)
    else:
        Dict_2.update(isHead = 0)

    if new_shot_data[i]['technique'] == 'Half Volley':
        Dict_2.update(isVolley = 1)
    elif new_shot_data[i]['technique'] == 'Volley':
        Dict_2.update(isVolley = 1)
    else:
        Dict_2.update(isVolley = 0)

    if new_shot_data[i]['technique'] == 'Normal':
        Dict_2.update(isNormalShot = 1)
    else:
        Dict_2.update(isNormalShot = 0)

    if new_shot_data[i]['technique'] == 'Lob':
        Dict_2.update(isLobShot = 1)
    else:
        Dict_2.update(isLobShot = 0)

    if new_shot_data[i]['play_pattern'] == 'From Corner':
        Dict_2.update(isCorner = 1)
    else:
        Dict_2.update(isCorner = 0)

    if new_shot_data[i]['play_pattern'] == 'Regular Play':
        Dict_2.update(isRegularPlay = 1)

    if new_shot_data[i]['play_pattern'] == 'From Free Kick':
        Dict_2.update(isFreeKick = 1)
    else:
        Dict_2.update(isFreeKick = 0)

    if new_shot_data[i]['play_pattern'] == 'From Throw In':
        Dict_2.update(isThrowIn = 1)
    else:
        Dict_2.update(isThrowIn = 0)

    if new_shot_data[i]['play_pattern'] == 'From Counter':
        Dict_2.update(isCounter = 1)
    else:
        Dict_2.update(isCounter = 0)

    if new_shot_data[i]['play_pattern'] == 'From Keeper':
        Dict_2.update(fromKeeper = 1)
    else:
        Dict_2.update(fromKeeper = 0)

    if new_shot_data[i]['play_pattern'] == 'From Goal Kick':
        Dict_2.update(fromGK = 1)
    else:
        Dict_2.update(fromGK = 0)

    if new_shot_data[i]['under_pressure'] == True:
        Dict_2.update(under_pressure = 1)
    else:
        Dict_2.update(under_pressure = 0)

    if new_shot_data[i]['first_time'] == True:
        Dict_2.update(first_time = 1)
    else:
        Dict_2.update(first_time = 0)

    if new_shot_data[i]['outcome'] == 'Goal':
        Dict_2.update(isGoal = 1)
    else:
        Dict_2.update(isGoal = 0)

    new_shot_data_2.append(Dict_2)


print(new_shot_data_2[10000])
```

```
{'id': 'dbf2d5a1-1817-4fb4-8a79-381e9de3bac0', 'location': [108.7, 38.8], 'distance': 11.36353818139403, 'a
ngle': 6.061788788728689, 'isFoot': 1, 'isHead': 0, 'isVolley': 0, 'isNormalShot': 1, 'isLobShot': 0, 'isCo
rner': 0, 'isRegularPlay': 0, 'isFreeKick': 0, 'isThrowIn': 1, 'isCounter': 0, 'fromKeeper': 0, 'fromGK':
0, 'first_time': 0, 'under_pressure': 1, 'isGoal': 0, 'statsbomb_xg': 0.14499828}
```

In [13]:

```
#Save data as a csv file so we don't have to parse through original data over and again
headers = ['id', 'location', 'distance', 'angle', 'isFoot', 'isHead', 'isVolley', 'isNormalShot', 'isLobShot
           'isRegularPlay', 'isFreeKick', 'isThrowIn', 'isCounter', 'fromKeeper', 'fromGK', 'first_time', 'u
          'isGoal', 'statsbomb_xg']

filename = "shot_data.csv"

with open(filename, 'w') as csvfile:
    writer = csv.DictWriter(csvfile, fieldnames = headers)
    writer.writeheader()
    writer.writerows(new_shot_data_2)
```

In [14]:

```
#Read json through pandas dataframe
df = pd.DataFrame(new_shot_data_2, columns=['id','location','distance', 'angle','isFoot','isHead','isVolley'
                                            'isLobShot', 'isCorner','isRegularPlay','isFreeKick','isThrowIn'
                                            'fromKeeper', 'fromGK','first_time','under_pressure','isGoal','s

print(df)
```

```
                                         id       location   distance  \
0      65f16e50-7c5d-4293-b2fc-d20887a772f9  [111.7, 51.7]  14.345034
1      b0f73423-3990-45ae-9dda-3512c2d1aff3  [114.0, 27.0]  14.317821
2      13b1ddab-d22e-43d9-bfe4-12632fea1a27   [92.0, 34.5]  28.535066
3      391bfb74-07a6-4afe-9568-02a9b23f5bd4  [109.1, 38.7]  10.977249
4      5e55f5a5-954f-4cc4-ba6e-a9cf6d6e249e  [107.0, 25.0]  19.849433
...                                     ...            ...        ...
12605  c0090be3-7f39-4653-b535-dbaa01b5639a  [100.5, 39.8]  19.501026
12606  786c2e5c-7a14-407c-81cb-16bf3e4ec34b   [91.8, 53.6]  31.308146
12607  31b998c0-f889-43ee-a215-0f1e1273c76b  [103.1, 47.2]  18.369812
12608  a586c569-474f-4c70-a7de-0364824de189  [104.8, 51.7]  19.181502
12609  b642d77d-582e-4ebb-849e-44202b65df1a  [106.9, 60.1]  23.992082

           angle  isFoot  isHead  isVolley  isNormalShot  isLobShot  isCorner  \
0      54.648045       1       0         1             0          0         0
1      65.224859       1       0         1             0          0         0
2      11.113041       1       0         0             1          0         0
3       6.801315       0       1         0             1          0         0
4      49.085617       1       0         0             1          0         1
...          ...     ...     ...       ...           ...        ...       ...
12605   0.587628       1       0         1             0          0         1
12606  25.746596       1       0         0             1          0         1
12607  23.075726       1       0         0             1          0         0
12608  37.586804       1       0         0             1          0         0
12609  56.906052       1       0         1             0          0         0

       isRegularPlay  isFreeKick  isThrowIn  isCounter  fromKeeper  fromGK  \
0                  1           0          0          0           0       0
1                  1           0          0          0           0       0
2                  0           0          0          0           1       0
3                  1           0          0          0           0       0
4                  0           0          0          0           0       0
...              ...         ...        ...        ...         ...     ...
12605              0           0          0          0           0       0
12606              0           0          0          0           0       0
```

```
12607              1           0          0          0          0       0
12608              1           0          0          0          0       0
12609              0           1          0          0          0       0

       first_time  under_pressure  isGoal  statsbomb_xg
0               1               0       0      0.095480
1               1               0       0      0.047924
2               0               0       0      0.018477
3               0               1       0      0.137954
4               0               0       0      0.036229
...           ...             ...     ...           ...
12605           1               0       0      0.038873
12606           0               1       0      0.017531
12607           1               0       0      0.079473
12608           0               0       0      0.145874
12609           0               0       0      0.020496

[12610 rows x 20 columns]
```

In [15]:

```
#Eliminate duplicate data
df.drop_duplicates(subset = 'id', keep = False, inplace = True)
print(len(df))
```

```
12610
```

In [16]:

```
print(df[['isFoot', 'isVolley']])
```

```
       isFoot  isVolley
0           1         1
1           1         1
2           1         0
3           0         0
4           1         0
...       ...       ...
12605       1         1
12606       1         0
12607       1         0
12608       1         0
12609       1         1

[12610 rows x 2 columns]
```

In [17]:

```
#Logistic Regression Calculation
#Got rid of 'isNormalShot', 'isCounter', 'fromKeeper', 'fromGK' because the p-value was too high
x = df[['distance', 'angle', 'isHead', 'isVolley', 'isLobShot', 'isNormalShot', 'isFreeKick', 'isCorner',
        'under_pressure', 'first_time']]
y = df['isGoal']

model = sm.Logit(y,x).fit()
predictions = model.predict(x)
print(model.summary2())
```

```
Optimization terminated successfully.
         Current function value: 0.310837
         Iterations 7
                         Results: Logit
================================================================
Model:              Logit            Pseudo R-squared: 0.163
Dependent Variable: isGoal           AIC:              7859.3028
Date:               2020-09-02 12:13 BIC:              7933.7252
No. Observations:   12610            Log-Likelihood:   -3919.7
Df Model:           9                LL-Null:          -4682.0
Df Residuals:       12600            LLR p-value:      0.0000
Converged:          1.0000           Scale:            1.0000
No. Iterations:     7.0000
----------------------------------------------------------------
                 Coef.  Std.Err.    z     P>|z|   [0.025  0.975]
----------------------------------------------------------------
distance        -0.1640   0.0052 -31.4653 0.0000 -0.1742 -0.1538
angle           -0.0129   0.0015  -8.7771 0.0000 -0.0158 -0.0100
isHead          -1.3571   0.1068 -12.7052 0.0000 -1.5665 -1.1478
```

The next two sets of code are taken from Peter McKeever's Expected Goals Model program. It can be found here: http://petermckeever.com/2019/01/building-an-expected-goals-model-in-python/ (http://petermckeever.com/2019/01/building-an-expected-goals-model-in-python/)

McKeever, Peter. “Building an Expected Goals Model in Python.” Peter McKeever, 2 Jan. 2019, petermckeever.com/2019/01/building-an-expected-goals-model-in-python/.

In [18]:

```
#Split and randomise our data into training and testing sets and see how accurate the model is on the test a
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split

log_r = LogisticRegression()

x_train, x_test, y_train, y_test = train_test_split(x,y, test_size = 0.3, random_state = 52)

log_r.fit(x_train, y_train)
print("Log Regression test set accuracy {:.3f}".format(log_r.score(x_test,y_test)))
```

```
Log Regression test set accuracy 0.889
```

```
C:\Users\Yuma\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432: FutureWarning: Default solv
er will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

In [19]:

```
prediction = log_r.predict(x_test)

from sklearn.metrics import confusion_matrix
confusion_matrix = confusion_matrix(y_test, prediction)
print(confusion_matrix)
```

```
[[3319   31]
 [ 390   43]]
```

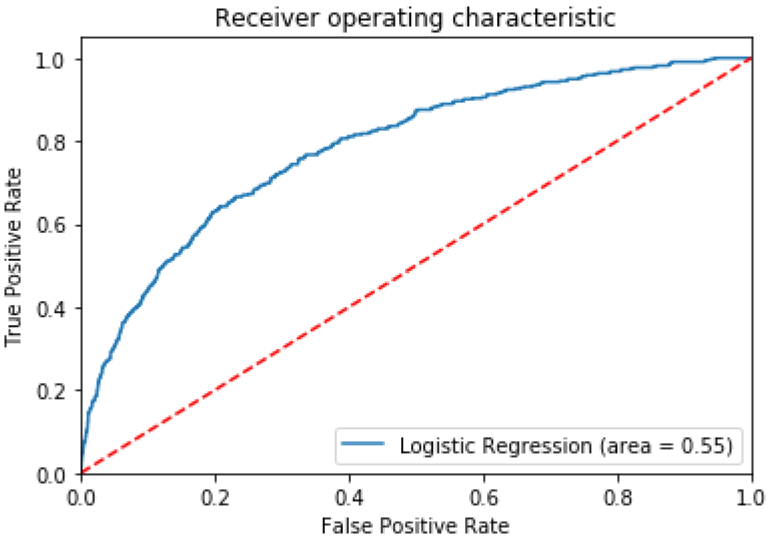
The below program comes from Susan Li's article on "Building A Logistic Regression in Python, Step by Step" and can be found here: https://towardsdatascience.com/building-a-logistic-regression-in-python-step-by-step-becd4d56c9c8 (https://towardsdatascience.com/building-a-logistic-regression-in-python-step-by-step-becd4d56c9c8)

Li, Susan. “Building A Logistic Regression in Python, Step by Step.” Medium, Towards Data Science, 27 Feb. 2019, towardsdatascience.com/building-a-logistic-regression-in-python-step-by-step-becd4d56c9c8.

In [20]:

```
#Draw a ROC curve to better understand our Logistic regression model
from sklearn.metrics import roc_auc_score
from sklearn.metrics import roc_curve

logit_roc_auc = roc_auc_score(y_test, log_r.predict(x_test))
fpr, tpr, thresholds = roc_curve(y_test, log_r.predict_proba(x_test)[:,1])
plt.figure()
plt.plot(fpr, tpr, label='Logistic Regression (area = %0.2f)' % logit_roc_auc)
plt.plot([0, 1], [0, 1],'r--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.savefig('Log_ROC')
plt.show()
```



In [21]:

```
#Output of xG values
xg_model = log_r.predict_proba(x)
for i in range(len(xg_model)):
    print(xg_model[i][1])
```

```
0.08864628683535408
0.07796117811561555
0.031601262486231935
0.11403332128112793
0.04928633927944569
0.05157740183906458
0.08344223721832308
0.04027812129095747
0.21176396519841614
0.0917468312941906
0.34857576322202866
0.22800095991271843
0.25923561161570413
0.02313148688439111
0.08390507218149527
0.019305773200561246
0.0958620826659622
0.014317567488569797
0.0600772795850543
0.07624377963768247
```

Below is where you can apply the expected goals model to new datasets.

In [22]:

```
#Import dataset and calculate distance and angle
test_df = pd.read_csv(r'C:\Users\Yuma\Desktop\Sport Analytics\xG_Model_Data.csv')
distance = []
goal = [120,40]
for i in range(len(test_df)):
    point_x = test_df.loc[i]['x_location']
    point_y = test_df.loc[i]['y_location']
    calculation = math.sqrt((point_x-goal[0])**2) + ((point_y-goal[1])**2)
    distance.append(calculation)

angle = []
pen_vect_pt = [12,0]
for i in range(len(test_df)):
    shot_vector = [120-test_df.loc[i]['x_location'],abs(40-test_df.loc[i]['y_location'])]
    unit_vector_1 = pen_vect_pt / np.linalg.norm(pen_vect_pt)
    unit_vector_2 = shot_vector / np.linalg.norm(shot_vector)
    dot_product = np.dot(unit_vector_1, unit_vector_2)
    current_angle = math.degrees(np.arccos(dot_product))
    angle.append(current_angle)

test_df['distance'] = distance
test_df['angle'] = angle
print(test_df)
```

```
   x_location  y_location  isHead  isVolley  isLobShot  isNormalShot  \
0       114.0        40.0       0         1          0             0

   isFreeKick  isCorner  under_pressure  first_time  distance  angle
0           0         0               0           0       6.0    0.0
```

In [23]:

```
test_x = test_df[['distance', 'angle', 'isHead', 'isVolley', 'isLobShot', 'isNormalShot', 'isFreeKick', 'isC
        'under_pressure', 'first_time']]
test_xG = log_r.predict_proba(test_x)
print("The probability that the shot is a goal is: ")
print(test_xG[0][1])
```

```
The probability that the shot is a goal is: 
0.4285524750325052
```