Continuing the Journey: Advanced Football Metrics Explored

In the earlier stages of our football statistics expedition, we embarked on a comprehensive study of xGOT (Expected Goals on Target) and delved into the intricacies of our novel metric: Shot Quality. The insights derived from that analysis provided a deeper understanding of a player's efficiency, revealing patterns often overlooked in traditional metrics.

Building on that foundation, this continuation project seeks to navigate the more nuanced territories of football analytics. As we refine our understanding and venture into new territories, we'll be leveraging Opta data, a rich source not widely accessible to the general public. Predominantly, football clubs, analytics firms, and media organizations have privileged access to this dataset. While Opta and Manchester City graciously made certain data from the 2011-12 season available to the masses, I don't possess the entire dataset. Nevertheless, Opta has shared specific match data with the public, notably Manchester City's away fixture against Bolton Wanderers in the Premier League during the 11/12 season so let’s start!

In [1]:
```
# Import necessary libraries and modules
import csv  # For reading and writing CSV files
import matplotlib.pyplot as plt  # For plotting and data visualization
import xml.etree.ElementTree as et  # For XML parsing
import numpy as np  # For numerical operations and array handling
import pandas as pd  # For structured data manipulation
from datetime import datetime as dt  # For handling date and time operations
```

In [2]:
```
# Parse the XML file named "OptaCityF24.xml"
tree = et.ElementTree(file="OptaCityF24.xml")

# Get the root element of the XML tree (top-most element in the XML structure)
games = tree.getroot()
```

In [3]:
```
# Retrieve the first child element of the root (i.e., 'games')
match_details = games[0].attrib

# Display or inspect the attributes dictionary of the first child element
match_details
```

Out[3]:
```
{'id': '360481',
 'away_team_id': '43',
 'away_team_name': 'Manchester City',
 'competition_id': '8',
 'competition_name': 'English Barclays Premier League',
 'game_date': '2011-08-21T16:00:00',
 'home_team_id': '30',
 'home_team_name': 'Bolton Wanderers',
 'matchday': '2',
 'period_1_start': '2011-08-21T16:00:38',
 'period_2_start': '2011-08-21T17:03:47',
 'season_id': '2011',
 'season_name': 'Season 2011/2012'}
```

In [4]:
```
# Parse the XML file named "OptaCityF7.xml" and create an ElementTree object
tree2 = et.ElementTree(file="OptaCityF7.xml")

# Get the root element of the newly created XML tree (tree2)
soccerfeed = tree2.getroot()
```

In [5]:
```python
# Initialize empty lists to store player IDs and names
player_ids = []
player_names = []

# Loop through each child element in the XML root ('soccerfeed')
for child in soccerfeed:
    # Loop through each grandchild element of the current child
    for grchild in child:
        # Check if the grandchild's tag is "Team"
        if grchild.tag == "Team":
            # Loop through each child element of "Team"
            for grgrchild in grchild:
                # Check if the tag is "Player" for further processing
                if grgrchild.tag == "Player":
                    # Extract the player's ID, remove any leading 'p' character, and add to the player_ids list
                    player_ids.append(grgrchild.attrib["uID"].lstrip('p'))

                    # Assume the first child's text is the first name and the last child's text is the last name
                    # Combine them and append to the player_names list
                    for grgrgrchild in grgrchild:
                        player_names.append(grgrgrchild[0].text + " " + grgrgrchild[-1].text)

# Create a dictionary mapping player IDs to their names
player_dict = dict(zip(player_ids, player_names))

# Display the resulting dictionary (useful in interactive environments)
player_dict
```

Out[5]:
```
{'1344': 'Jussi Jääskeläinen',
 '19419': 'Gary Cahill',
 '28183': 'Grétar Steinsson',
 '2004': 'Paul Robinson',
 '1587': 'Zat Knight',
 '18428': 'Chris Eagles',
 '27696': 'Fabrice Muamba',
 '14668': 'Nigel Reo-Coker',
 '10089': 'Martin Petrov',
 '9765': 'Ivan Klasnic',
 '3630': 'Kevin Davies',
 '15188': 'Darren Pratley',
 '105088': 'Adam Blakeman',
 '19958': 'David Wheater',
 '82263': 'Marcos Alonso',
 '1615': 'Robbie Blake',
 '19930': 'Mark Davies',
 '45175': 'Adam Bogdan',
 '15749': 'Joe Hart',
 '20492': 'Micah Richards',
 '17476': 'Vincent Kompany',
 '42593': 'Aleksandar Kolarov',
 '7551': 'Joleon Lescott',
 '1632': 'Gareth Barry',
 '15157': 'James Milner',
 '14664': 'Gnegneri Yaya Touré',
 '20664': 'David Silva',
 '42544': 'Edin Dzeko',
 '37572': 'Sergio Agüero',
 '20658': 'Pablo Zabaleta',
 '17336': 'Gaël Clichy',
 '42493': 'Mario Balotelli',
 '20312': 'Carlos Tévez',
 '65807': 'Stefan Savic',
 '19959': 'Adam Johnson',
 '56827': 'Costel Pantilimon'}
```

In [6]:
```
# Print the match details: home team vs away team, followed by competition and season details.
# Extract the home team name, away team name, competition name and the season name

print ("%s v %s, %s %s" % (match_details["home_team_name"],
                          match_details["away_team_name"],
                          match_details["competition_name"][8:],
                          match_details["season_name"][7:]))

# Convert the game_date from the match_details dictionary from ISO format to a human-readable date.
# Print the formatted date.
print ("Date: %s" % dt.strftime(dt.strptime(match_details["game_date"], '%Y-%m-%dT%H:%M:%S'),
                               "%A %d %B %Y"))

# Convert the game_date from the match_details dictionary to retrieve the kick-off time.
# Print the formatted kick-off time in 12-hour format, removing any leading "0" if present.
print ("Kick-off: %s" % dt.strftime(dt.strptime(match_details["game_date"], '%Y-%m-%dT%H:%M:%S'),
                                   "%I%p").lstrip("0"))
```

```
Bolton Wanderers v Manchester City, Barclays Premier League 2011/2012
Date: Sunday 21 August 2011
Kick-off: 4PM
```

In [7]:
```
# Construct a dictionary (`team_dict`) mapping team IDs to their respective team names.
# Use the home team ID as a key for the home team's name, and the away team ID as a key for the away team's name.
team_dict = {match_details["home_team_id"]: match_details["home_team_name"],
             match_details["away_team_id"]: match_details["away_team_name"]}

print (team_dict)
```

```
{'30': 'Bolton Wanderers', '43': 'Manchester City'}
```

Now let's breakdown all the shots that took place in the game

In [8]:

```python
# Lists to hold various details of shots.
shot_name = []
shot_x = []
shot_y = []
shot_min = []
shot_sec = []
shot_period = []
shot_team = []
shot_play = []
shot_player = []

# Dictionary to translate shot type IDs to descriptive names.
shot_dict = {"13": 'Shot off target',
             "14": 'Post',
             "15": 'Shot saved',
             "16": 'Goal'}

# Dictionary to translate play situation IDs to descriptive names.
shot_play_dict = {"22": 'regular play',
                  "23": 'fast break',
                  "24": 'set piece',
                  "25": 'from corner',
                  "26": 'free kick',
                  "96": 'corner situation',
                  "112": 'scramble',
                  "160": 'throw-in set piece'}

# Iterate over all games.
for game in games:
    # Iterate over each event in the current game.
    for event in game:
        # Check if the event is of the type 'Shot off target', 'Post', or 'Goal'.
        if event.attrib.get("type_id") in ['13', '14', '16']:
            # Append respective attributes for the shot to lists.
            shot_name.append(shot_dict[event.attrib.get("type_id")])
            shot_x.append(event.attrib.get("x"))
            shot_y.append(event.attrib.get("y"))
            shot_min.append(event.attrib.get("min"))
            shot_sec.append(event.attrib.get("sec"))
            shot_period.append(event.attrib.get("period_id"))
            shot_team.append(team_dict[event.attrib.get("team_id")])
            shot_player.append(player_dict[event.attrib.get("player_id")])

            # Loop through qualifiers to find the play situation of the shot and add to the shot play dict if theres a match.
            for q in event:
                qualifier = q.attrib.get("qualifier_id")
                if qualifier in shot_play_dict.keys():
                    shot_play.append(shot_play_dict[qualifier])

        # Check if the event is of the type 'Shot saved'.
        if event.attrib.get("type_id") == "15":
            # Append respective attributes for the shot to lists.
            shot_name.append(shot_dict[event.attrib.get("type_id")])
            shot_x.append(event.attrib.get("x"))
            shot_y.append(event.attrib.get("y"))
            shot_min.append(event.attrib.get("min"))
            shot_sec.append(event.attrib.get("sec"))
            shot_period.append(event.attrib.get("period_id"))
            shot_team.append(team_dict[event.attrib.get("team_id")])
            shot_player.append(player_dict[event.attrib.get("player_id")])

            # Loop through qualifiers to find the play situation of the shot and add to the shot play dict if theres a match.
            for q in event:
                qualifier = q.attrib.get("qualifier_id")
                if qualifier in shot_play_dict.keys():
                    shot_play.append(shot_play_dict[qualifier])

# Convert the individual lists into a structured 2D array.
shot_df = np.array(list(zip(shot_team, shot_player, shot_period, shot_min, shot_sec, shot_play, shot_name, shot_x, shot_y)))

# Display the structured data.
print(shot_df)

# Define column headers for exporting to CSV.
shot_fieldnames = ["team", "player", "period", "min", "sec", "shot play", "shot type", "x", "y"]

# Write the structured data to a CSV file, naming it based on teams participating.
with open("city_shot_data_%s_%s.csv" % (match_details["home_team_name"], match_details["away_team_name"]), "w",newline='') as ci
    csv_file = csv.writer(city_shot_csv)
    csv_file.writerow(shot_fieldnames)
    for i in range(len(shot_df)):
        csv_file.writerow(shot_df[i])
```

```
[['Bolton Wanderers' 'Chris Eagles' '1' '2' '59' 'free kick' 'Shot saved'
  '75.9' '66.6']
 ['Bolton Wanderers' 'Zat Knight' '1' '10' '3' 'from corner'
  'Shot off target' '87.3' '41.4']
 ['Bolton Wanderers' 'Kevin Davies' '1' '10' '39' 'regular play'
  'Shot saved' '93.0' '54.8']
 ['Manchester City' 'James Milner' '1' '14' '39' 'regular play'
  'Shot saved' '96.1' '52.5']
 ['Manchester City' 'David Silva' '1' '16' '26' 'regular play'
  'Shot saved' '81.2' '27.6']
 ['Manchester City' 'Sergio Agüero' '1' '17' '52' 'regular play'
  'Shot off target' '92.7' '56.4']
 ['Bolton Wanderers' 'Chris Eagles' '1' '21' '14' 'set piece'
  'Shot saved' '79.0' '30.1']
 ['Manchester City' 'Sergio Agüero' '1' '24' '43' 'regular play'
  'Shot saved' '89.8' '24.3']
 ['Manchester City' 'David Silva' '1' '25' '14' 'throw-in set piece'
  'Goal' '78.4' '38.2']
 ['Manchester City' 'Sergio Agüero' '1' '34' '56' 'regular play'
  'Shot off target' '92.8' '48.0']
 ['Manchester City' 'Gareth Barry' '1' '36' '59' 'from corner' 'Goal'
  '74.8' '46.4']
 ['Bolton Wanderers' 'Ivan Klasnic' '1' '38' '54' 'regular play' 'Goal'
  '91.4' '57.3']
 ['Manchester City' 'Edin Dzeko' '2' '46' '39' 'regular play' 'Goal'
  '90.6' '34.7']
 ['Manchester City' 'James Milner' '2' '49' '18' 'regular play'
  'Shot saved' '79.3' '65.9']
 ['Bolton Wanderers' 'Chris Eagles' '2' '51' '11' 'regular play'
  'Shot off target' '88.4' '70.6']
 ['Manchester City' 'James Milner' '2' '52' '36' 'regular play'
  'Shot off target' '76.5' '45.3']
 ['Manchester City' 'Edin Dzeko' '2' '58' '39' 'from corner'
  'Shot off target' '92.3' '46.4']
 ['Manchester City' 'Aleksandar Kolarov' '2' '60' '31' 'from corner'
  'Shot saved' '75.1' '74.0']
 ['Bolton Wanderers' 'Kevin Davies' '2' '62' '6' 'set piece' 'Goal'
  '90.7' '48.8']
 ['Manchester City' 'Gnegneri Yaya Touré' '2' '67' '7' 'regular play'
  'Shot off target' '71.4' '53.9']
 ['Manchester City' 'David Silva' '2' '68' '41' 'regular play'
  'Shot saved' '92.7' '56.7']
 ['Manchester City' 'Aleksandar Kolarov' '2' '75' '6' 'regular play'
  'Shot off target' '85.2' '65.1']
 ['Manchester City' 'Adam Johnson' '2' '83' '9' 'regular play'
  'Shot off target' '95.3' '35.5']
 ['Manchester City' 'Carlos Tévez' '2' '85' '41' 'regular play'
  'Shot off target' '87.5' '55.9']
 ['Manchester City' 'Carlos Tévez' '2' '91' '53' 'regular play'
  'Shot saved' '91.8' '77.2']]
```

In [9]:

```
#Create a list of our columns/lists
column_titles = ["team", "player", "period", "min", "sec", "shot play", "shot type", "x", "y"]

final_table = pd.DataFrame(data=[shot_team, shot_player, shot_period, shot_min, shot_sec, shot_play, shot_name, shot_x, shot_y],

# Create a list of shot plays to exclude since we only want data from open play
exclude_shot_plays = ["free kick", "from corner", "set piece"]

# Filter the DataFrame to exclude rows with those shot plays
final_table = final_table[~final_table['shot play'].isin(exclude_shot_plays)]

#Show us the top 30 rows
final_table.head(30)
```

	team	player	period	min	sec	shot play	shot type	x	y
2	Bolton Wanderers	Kevin Davies	1	10	39	regular play	Shot saved	93.0	54.8
3	Manchester City	James Milner	1	14	39	regular play	Shot saved	96.1	52.5
4	Manchester City	David Silva	1	16	26	regular play	Shot saved	81.2	27.6
5	Manchester City	Sergio Agüero	1	17	52	regular play	Shot off target	92.7	56.4
7	Manchester City	Sergio Agüero	1	24	43	regular play	Shot saved	89.8	24.3
8	Manchester City	David Silva	1	25	14	throw-in set piece	Goal	78.4	38.2
9	Manchester City	Sergio Agüero	1	34	56	regular play	Shot off target	92.8	48.0
11	Bolton Wanderers	Ivan Klasnic	1	38	54	regular play	Goal	91.4	57.3
12	Manchester City	Edin Dzeko	2	46	39	regular play	Goal	90.6	34.7
13	Manchester City	James Milner	2	49	18	regular play	Shot saved	79.3	65.9
14	Bolton Wanderers	Chris Eagles	2	51	11	regular play	Shot off target	88.4	70.6
15	Manchester City	James Milner	2	52	36	regular play	Shot off target	76.5	45.3
19	Manchester City	Gnegneri Yaya Touré	2	67	7	regular play	Shot off target	71.4	53.9
20	Manchester City	David Silva	2	68	41	regular play	Shot saved	92.7	56.7
21	Manchester City	Aleksandar Kolarov	2	75	6	regular play	Shot off target	85.2	65.1
22	Manchester City	Adam Johnson	2	83	9	regular play	Shot off target	95.3	35.5
23	Manchester City	Carlos Tévez	2	85	41	regular play	Shot off target	87.5	55.9
24	Manchester City	Carlos Tévez	2	91	53	regular play	Shot saved	91.8	77.2

```
# Importing the ConvexHull function from the scipy.spatial module.
# This function is used to compute the convex hull of a set of points.
from scipy.spatial import ConvexHull

# Importing the pandas library, which offers data structures and
import pandas as pd

# Importing the numpy library, which provides support for working
import numpy as np

# Importing the matplotlib library, a plotting library for the Python
import matplotlib.pyplot as plt

# Importing the Arc function from matplotlib.patches module,
# which is used for drawing arc shapes in plots.
from matplotlib.patches import Arc

# This line is a Jupyter Notebook magic command. It configures
# the notebook to display plots inline, immediately below the
# code cell that produced it.
%matplotlib inline
```

```
# # Reading data from the CSV file "city_shot_data.csv" into a DataFrame named 'shot_table_data'
city_shot_table_data = pd.read_csv("city_shot_data.csv")

# Displaying the first 5 rows of the 'shot_table_data' DataFrame for a quick overview
city_shot_table_data.head()
```

```python
# Using the 'loc' method to filter rows in the 'city_shot_table_data' DataFrame
# where the 'Player' column matches the value 'David Silva'.
# The resulting subset of data is stored in the 'David_Silva_Data' DataFrame.

David_Silva_Data = city_shot_table_data.loc[city_shot_table_data['Player'] == 'David Silva']

David_Silva_Data.head()
```

	Player	Team	Period	Min	Sec	Shot Play	Shot Type	Shot X	Shot Y
4	David Silva	Manchester City	1	16	26	regular play	Shot saved	81.2	27.6
8	David Silva	Manchester City	1	25	14	regular play	Goal	78.4	38.2
20	David Silva	Manchester City	2	68	41	NaN	Shot saved	92.7	56.7

```python
# Selecting only the 'Shot X' and 'Shot Y' columns from the 'David_Silva_Data' DataFrame.
# The resulting values are converted into a NumPy array, which is stored in the 'shot_points' variable.

shot_points = David_Silva_Data[['Shot X', 'Shot Y']].values

shot_points
```

```
array([[81.2, 27.6],
       [78.4, 38.2],
       [92.7, 56.7]])
```

A convex hull is a computational geometry concept used to describe the smallest convex polygon that can enclose a set of points. Essentially, if you were to imagine each point as a peg on a board, the convex hull would be the tight rubber band that encircles all the pegs on the outermost edge.

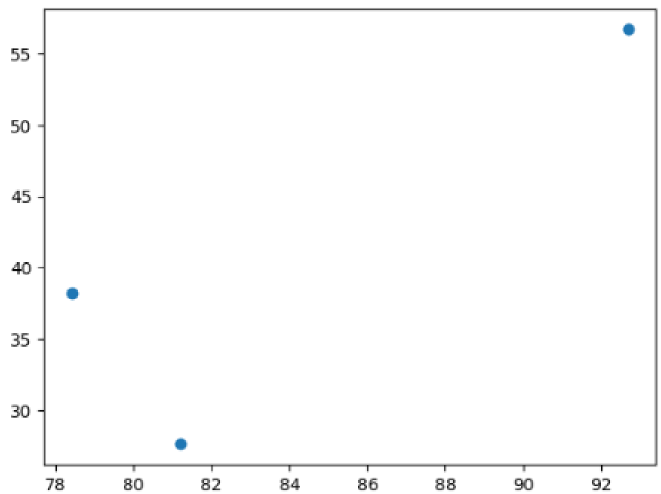
In the context of soccer analytics, convex hulls can be applied to create shot maps. By using the convex hull technique on a set of shot locations, one can visually represent the range and distribution of a player's or team's shots on the pitch. This visualization can then provide insights into shooting tendencies, preferences, and patterns, offering a deeper understanding of a player's or team's offensive strategies and for this, we require shot coordinates, and now that we have them, lets get building!

```python
# Using the ConvexHull function from the scipy.spatial module to compute the convex hull
# of the shot points (X and Y coordinates) of David Silva.
# The resulting convex hull object is stored in the 'hull' variable.

hull = ConvexHull(David_Silva_Data[['Shot X', 'Shot Y']])

hull
```

```
<scipy.spatial._qhull.ConvexHull at 0x2355fa6e860>
```

```python
# Using the 'plot' function from the matplotlib library to visualize the shot points
# of David Silva. The 'o' argument specifies that the points should be represented as circles.
# The X-coordinates come from the 'Shot X' column and the Y-coordinates from the 'Shot Y' column
# of the 'David_Silva_Data' DataFrame.

plt.plot(David_Silva_Data['Shot X'], David_Silva_Data['Shot Y'], "o")
```

```
[<matplotlib.lines.Line2D at 0x2355fbad240>]
```



```python
plt.plot(David_Silva_Data['Shot X'], David_Silva_Data['Shot Y'], "o")


# Looping through the simplices of the convex hull.
# A simplex in the context of the ConvexHull object can be thought of as an edge (in 2D).
for simplex in hull.simplices:
    #Draw a black line between each
    plt.plot(David_Silva_Data.iloc[simplex]['Shot X'], David_Silva_Data.iloc[simplex]['Shot Y'], 'k-')

# Plot and Axis Title
plt.title("Shot Locations for David Silva")
plt.xlabel("Shot X")
plt.ylabel("Shot Y")


plt.show()
```

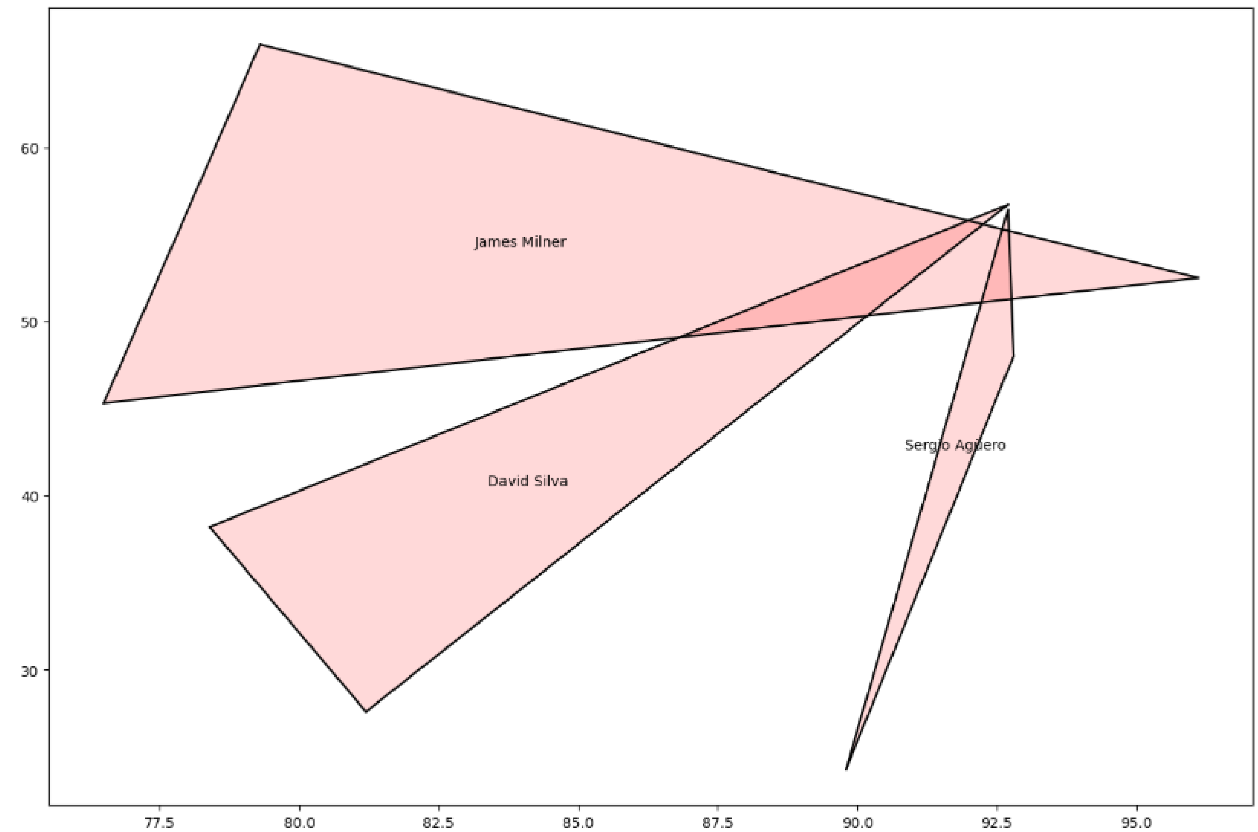
```python
plt.plot(David_Silva_Data['Shot X'], David_Silva_Data['Shot Y'], "o")

for simplex in hull.simplices:
    #Draw a black line between each
    plt.plot(David_Silva_Data.iloc[simplex]['Shot X'], David_Silva_Data.iloc[simplex]['Shot Y'], 'k-')


plt.title("Shot Locations for David Silva")
plt.xlabel("Shot X")
plt.ylabel("Shot Y")


#Fill the area within the lines that we have drawn
plt.fill(David_Silva_Data.iloc[hull.vertices]['Shot X'], David_Silva_Data.iloc[hull.vertices]['Shot Y'], 'k', alpha=0.3)

plt.show()
```

David Silva's convex hull takes the shape of a triangle due to the three shots he registered during the game. Each vertex of the triangle corresponds to the location of a shot, while the enclosed area indicates his primary shooting zones in that match. With this visualization in place for Silva, we'll proceed to construct convex hulls for the rest of the Manchester City team, showcasing their shot distributions against Bolton Wanderers.

```
# Using the 'shot_table_data' DataFrame, filter out rows where the 'Team' column value is 'Manchester City'.
# From the filtered data, select the 'Player' column and extract unique player names.
# The resulting array of unique player names is stored in the 'players' variable.
players = city_shot_table_data[city_shot_table_data['Team'] == 'Manchester City']["Player"].unique()

# Displaying the unique player names of 'Manchester City' for inspection.
print(players)
```

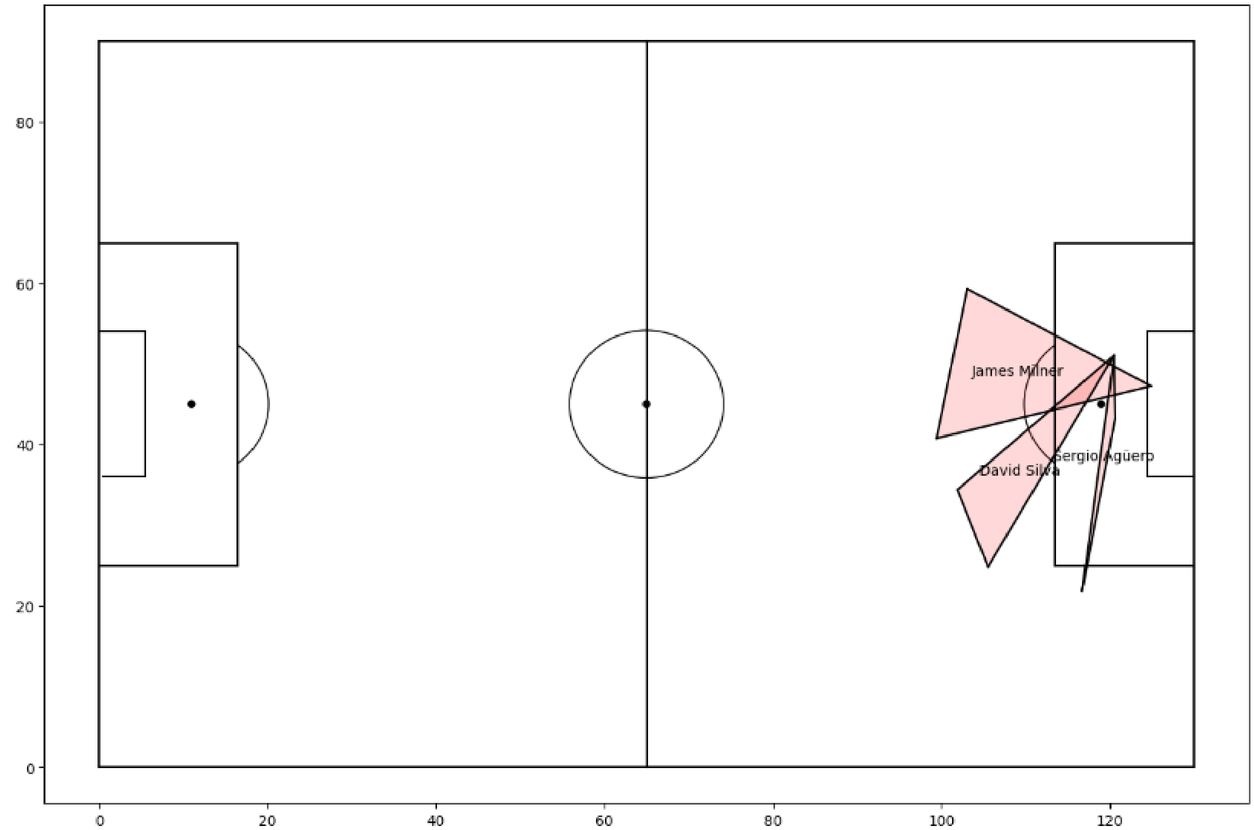
```
['James Milner' 'David Silva' 'Sergio Agüero' 'Gareth Barry' 'Edin Dzeko'
 'Aleksandar Kolarov' 'Gnegneri Yaya Touré' 'Adam Johnson' 'Carlos Tévez']
```

```
# Set the size of the plot to 15 units wide by 10 units tall
plt.figure(figsize=(15, 10))

# Loop through each unique player in the 'players' list
for Player in players:

    # Filter the 'city_shot_table_data' DataFrame to get shots taken by the current player from Manchester City
    # and store this in a new DataFrame named 'df'
    df = city_shot_table_data[(city_shot_table_data['Team'] == 'Manchester City') & (city_shot_table_data['Player'] == Player)]

    # Extract the shot coordinates (X and Y values) from the 'df' DataFrame and store them in the 'points' array
    points = df[['Shot X', 'Shot Y']].values

    # Ensure there are at least 3 shot points for the current player (requirement for constructing a convex hull)
    if len(points) >= 3:
        try:
            # Construct a convex hull for the shot points
            hull = ConvexHull(points)

            # Loop through each edge (simplex) of the convex hull
            for simplex in hull.simplices:
                # Plot each edge of the convex hull as a black line
                plt.plot(points[simplex, 0], points[simplex, 1], 'k-')

                # Fill the area inside the convex hull with a slightly transparent red color (5% opacity)
                plt.fill(points[hull.vertices,0], points[hull.vertices,1], 'red', alpha=0.05)

            # Calculate the centroid (center point) of the convex hull
            cx = np.mean(points[hull.vertices, 0])
            cy = np.mean(points[hull.vertices, 1])

            # Display the player's name at the centroid of their respective convex hull
            plt.text(cx, cy, Player, color='black', ha='center', va='center')

        except:
            # If there's an exception (error) while processing the convex hull for a player, skip to the next player
            pass

# Display the completed plot
plt.show()
```


James Milner
David Silva
Sergio Agüero
60
50
40
30
77.5
80.0
82.5
85.0
87.5
90.0
92.5
95.0

In [20]:
```
import matplotlib.pyplot as plt
from matplotlib.patches import Arc
import numpy as np
from scipy.spatial import ConvexHull

# Define a function to create a soccer pitch visualization
def createPitch(ax):

    #Pitch Outline & Centre Line
    # Creating the boundary and center line of the pitch
    ax.plot([0,0],[0,90], color="black")
    ax.plot([0,130],[90,90], color="black")
    ax.plot([130,130],[90,0], color="black")
    ax.plot([130,0],[0,0], color="black")
    ax.plot([65,65],[0,90], color="black")

    #Left Penalty Area
    # Creating the left penalty box
    ax.plot([16.5,16.5],[65,25],color="black")
    ax.plot([0,16.5],[65,65],color="black")
    ax.plot([16.5,0],[25,25],color="black")

    #Right Penalty Area
    # Creating the right penalty box
    ax.plot([130,113.5],[65,65],color="black")
    ax.plot([113.5,113.5],[65,25],color="black")
    ax.plot([113.5,130],[25,25],color="black")

    #Left 6-yard Box
    # Creating the left 6-yard box
    ax.plot([0,5.5],[54,54],color="black")
    ax.plot([5.5,5.5],[54,36],color="black")
    ax.plot([5.5,0.5],[36,36],color="black")

    #Right 6-yard Box
    # Creating the right 6-yard box
    ax.plot([130,124.5],[54,54],color="black")
    ax.plot([124.5,124.5],[54,36],color="black")
    ax.plot([124.5,130],[36,36],color="black")

    # Creating circles in the middle and penalty spots
    centreCircle = plt.Circle((65,45),9.15,color="black",fill=False)
    centreSpot = plt.Circle((65,45),0.4,color="black")
    leftPenSpot = plt.Circle((11,45),0.4,color="black")
    rightPenSpot = plt.Circle((119,45),0.4,color="black")

    # Adding the circles to the plot
    ax.add_patch(centreCircle)
    ax.add_patch(centreSpot)
    ax.add_patch(leftPenSpot)
    ax.add_patch(rightPenSpot)

    # Creating arcs for the penalty areas
    leftArc = Arc((11,45),height=18.3,width=18.3,angle=0,theta1=307,theta2=53,color="black")
    rightArc = Arc((119,45),height=18.3,width=18.3,angle=0,theta1=127,theta2=233,color="black")
```

```
    # Creating arcs for the penalty areas
    leftArc = Arc((11,45),height=18.3,width=18.3,angle=0,theta1=307,theta2=53,color="black")
    rightArc = Arc((119,45),height=18.3,width=18.3,angle=0,theta1=127,theta2=233,color="black")

    # Adding the arcs to the plot
    ax.add_patch(leftArc)
    ax.add_patch(rightArc)


# Scaling factors to convert shot data coordinates to the pitch's coordinate system since the pitch has a 130x90 dimension compar
scale_x = 130/100
scale_y = 90/100

# Creating the main plot with the pitch's size set
fig, ax = plt.subplots(figsize=(15, 10))
createPitch(ax)


#Merging the two codes, ie. the pitch and the convex hull we created prior to this

# Iterating over each player
for Player in players:

    # Extracting shot data for the specific player
    df = city_shot_table_data[(city_shot_table_data['Team'] == 'Manchester City') & (city_shot_table_data['Player'] == Player)].c

    # Scaling shot coordinates to match the pitch's dimensions
    df.loc[:, 'Scaled X'] = df['Shot X'] * scale_x
    df.loc[:, 'Scaled Y'] = df['Shot Y'] * scale_y

    # Extracting the scaled shot coordinates
    points = df[['Scaled X', 'Scaled Y']].values

    # Checking if there are enough shot points for creating a convex hull (minimum 3 required)
    if len(points) >= 3:
        try:
            # Creating a convex hull from the shot points
            hull = ConvexHull(points)

            # Drawing the convex hull and filling it with a slightly transparent red
            for simplex in hull.simplices:
                ax.plot(points[simplex, 0], points[simplex, 1], 'k-')
                ax.fill(points[hull.vertices, 0], points[hull.vertices, 1], 'red', alpha=0.05)

            # Calculating the centroid of the convex hull to label the player's name
            cx = np.mean(points[hull.vertices, 0])
            cy = np.mean(points[hull.vertices, 1])
            ax.text(cx, cy, Player, color='black', ha='center', va='center')

        except:
            # Skip the player if there's an error creating the convex hull
            pass
```



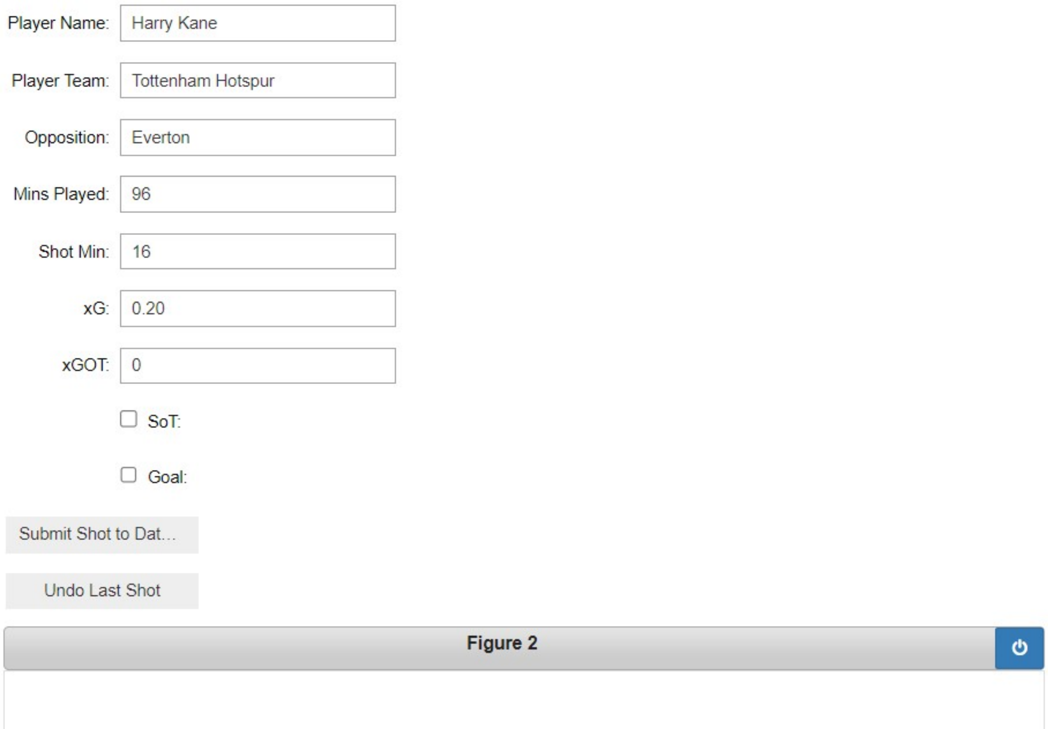
And this is how it turns out, notice Aguero's convex hull, its slim and close to the goal due to him being a striker and being proactive inside the box. Taking this a step further, let's craft convex hull visualizations for specific players using our dataset.

```python
# Use the notebook backend for interactive plotting in Jupyter Notebook
%matplotlib notebook
import matplotlib.pyplot as plt
from matplotlib.patches import Arc

# Define a function to create a visualization of a soccer pitch
def createPitch():
    # Initialize the figure and axis objects with specified size
    fig, ax = plt.subplots(figsize=(8,5))

    # Draw the pitch outline and centre line
    ax.plot([0,0],[0,90], color="black")          # Left sideline
    ax.plot([0,130],[90,90], color="black")       # Top end line
    ax.plot([130,130],[90,0], color="black")      # Right sideline
    ax.plot([130,0],[0,0], color="black")         # Bottom end line
    ax.plot([65,65],[0,90], color="black")        # Centre line

    # Draw the penalty areas and goals
    ax.plot([17,17],[75,15],color="black")        # Left penalty area vertical
    ax.plot([0,17],[75,75],color="black")         # Left penalty area top horizontal
    ax.plot([17,0],[15,15],color="black")         # Left penalty area bottom horizontal
    ax.plot([130,113],[75,75],color="black")      # Right penalty area top horizontal
    ax.plot([113,113],[75,15],color="black")      # Right penalty area vertical
    ax.plot([113,130],[15,15],color="black")      # Right penalty area bottom horizontal

    # Draw the 6-yard boxes
    ax.plot([0,6],[60,60],color="black")          # Left 6-yard box top horizontal
    ax.plot([6,6],[60,30],color="black")          # Left 6-yard box vertical
    ax.plot([6,0.5],[30,30],color="black")        # Left 6-yard box bottom horizontal
    ax.plot([130,124],[60,60],color="black")      # Right 6-yard box top horizontal
    ax.plot([124,124],[60,30],color="black")      # Right 6-yard box vertical
    ax.plot([124,130],[30,30],color="black")      # Right 6-yard box bottom horizontal

    # Create and add circles for the center of the pitch and the penalty spots
    centreCircle = plt.Circle((65,45), 9.15, color="black", fill=False)  # Centre circle
    centreSpot = plt.Circle((65,45), 0.37, color="black")                # Centre spot
    leftPenSpot = plt.Circle((11,45), 0.37, color="black")               # Left penalty spot
    rightPenSpot = plt.Circle((119,45), 0.37, color="black")             # Right penalty spot
    ax.add_patch(centreCircle)
    ax.add_patch(centreSpot)
    ax.add_patch(leftPenSpot)
    ax.add_patch(rightPenSpot)

    # Create and add arcs near the penalty areas (D-shaped regions)
    leftArc = Arc((11,45),height=18.3,width=18.3,angle=0,theta1=308,theta2=52,color="black")   # Left arc
    rightArc = Arc((119,45),height=18.3,width=18.3,angle=0,theta1=128,theta2=232,color="black") # Right arc
    ax.add_patch(leftArc)
    ax.add_patch(rightArc)

    # Return the figure and axis objects for further customization or display
    return fig, ax

# Call the createPitch function and generate the soccer pitch visualization
fig, ax = createPitch()
```

My strategy involves referencing various sources to meticulously record shot locations for six players across their most recent ten league games in the 2022-23 season. That's a deep dive into almost 60 matches!

```python
%matplotlib notebook
import pandas as pd
import ipywidgets as widgets
from IPython.display import display, clear_output

# Load existing data or create a new DataFrame
filename = 'PlayerShotsData.csv'
try:
    df = pd.read_csv(filename)
except FileNotFoundError:
    df = pd.DataFrame(columns=['Player_Name', 'Player_Team', 'Opposition', 'Mins_Played', 'Shot_Min', 'xG', 'xGOT', 'SoT', 'Goal

# Create widgets for input
player_name = widgets.Text(value='', description='Player Name:')
player_team = widgets.Text(value='', description='Player Team:')
opposition = widgets.Text(value='', description='Opposition:')
mins_played = widgets.IntText(description='Mins Played:')
shot_min = widgets.IntText(description='Shot Min:')
xg = widgets.FloatText(description='xG:')
xgot = widgets.FloatText(description='xGOT:')
sot = widgets.Checkbox(value=False, description='SoT:')
goal = widgets.Checkbox(value=False, description='Goal:')
submit_button = widgets.Button(description='Submit Shot to Dataset')
undo_button = widgets.Button(description='Undo Last Shot')  # The undo button

# Display the widgets
display(player_name, player_team, opposition, mins_played, shot_min, xg, xgot, sot, goal, submit_button, undo_button)

# Shot coordinates placeholder
shot_x = None
shot_y = None
# Store scatter plots for easy access
scatters = []

def onclick(event):
    global shot_x, shot_y, scatters
    # Store the clicked coordinates
    shot_x = event.xdata
    shot_y = event.ydata
    print(f"Shot coordinates: X = {shot_x:.2f}, Y = {shot_y:.2f}")

    # Plot the point where the user clicked
    scatter = ax.scatter(shot_x, shot_y, color='red', s=25)
    scatters.append(scatter)
    fig.canvas.draw()

def on_submit(button):
    global df, shot_x, shot_y
    sot_value = 1 if sot.value else 0
    goal_value = 1 if goal.value else 0

    df = df.append({
        'Player_Name': player_name.value,
        'Player_Team': player_team.value,
        'Opposition': opposition.value,
        'Mins_Played': mins_played.value,
        'Shot_Min': shot_min.value,
        'xG': xg.value,
        'xGOT': xgot.value,
        'SoT': sot_value,
        'Goal': goal_value,
        'Shot_X': shot_x,
        'Shot_Y': shot_y
    }, ignore_index=True)

    # Convert the 'Goal' column to integer type
    df['Goal'] = df['Goal'].astype(int)

    df.to_csv(filename, index=False)
    clear_output(wait=True)
    display(player_name, player_team, opposition,mins_played, shot_min, xg, xgot, sot, goal, submit_button, undo_button)
    display(df)

def undo_last_shot(button):
    global df, scatters
    if not df.empty:
        df.drop(df.tail(1).index,inplace=True) # drop last row
        last_scatter = scatters.pop()
        last_scatter.remove() # Remove the last scatter plot
        fig.canvas.draw()
        df.to_csv(filename, index=False)
        clear_output(wait=True)
        display(player_name, player_team, opposition,mins_played, shot_min, xg, xgot, sot, goal, submit_button, undo_button)
        display(df)

# Connect the events
submit_button.on_click(on_submit)
undo_button.on_click(undo_last_shot)

fig, ax = createPitch()
cid = fig.canvas.mpl_connect('button_press_event', onclick)
plt.show()
```

This code presents an interactive tool for capturing and visualizing football shot data. It initiates by checking for an existing dataset, 'PlayerShotsData.csv', or creating a new one if none exists. Using the ipywidgets library, I can input various details about a player's shot, such as the team, opposition, and key metrics like xG and xGOT. By clicking on a graphical representation of a football pitch, I can also plot the exact location of a shot. Once the required data is inputted, the 'Submit Shot to Dataset' button appends this data to the main dataset. For flexibility, there's an 'Undo Last Shot' button to correct any mistakes. This integrated approach offers a streamlined way to manually input, store, and visualize shot data on the pitch.


Player Name:
Harry Kane
Player Team:
Tottenham Hotspur
Opposition:
Everton
Mins Played:
96
Shot Min:
16
xG:
0.20
xGOT:
0
SoT:
Goal:
Submit Shot to Dat...
Undo Last Shot
Figure 2

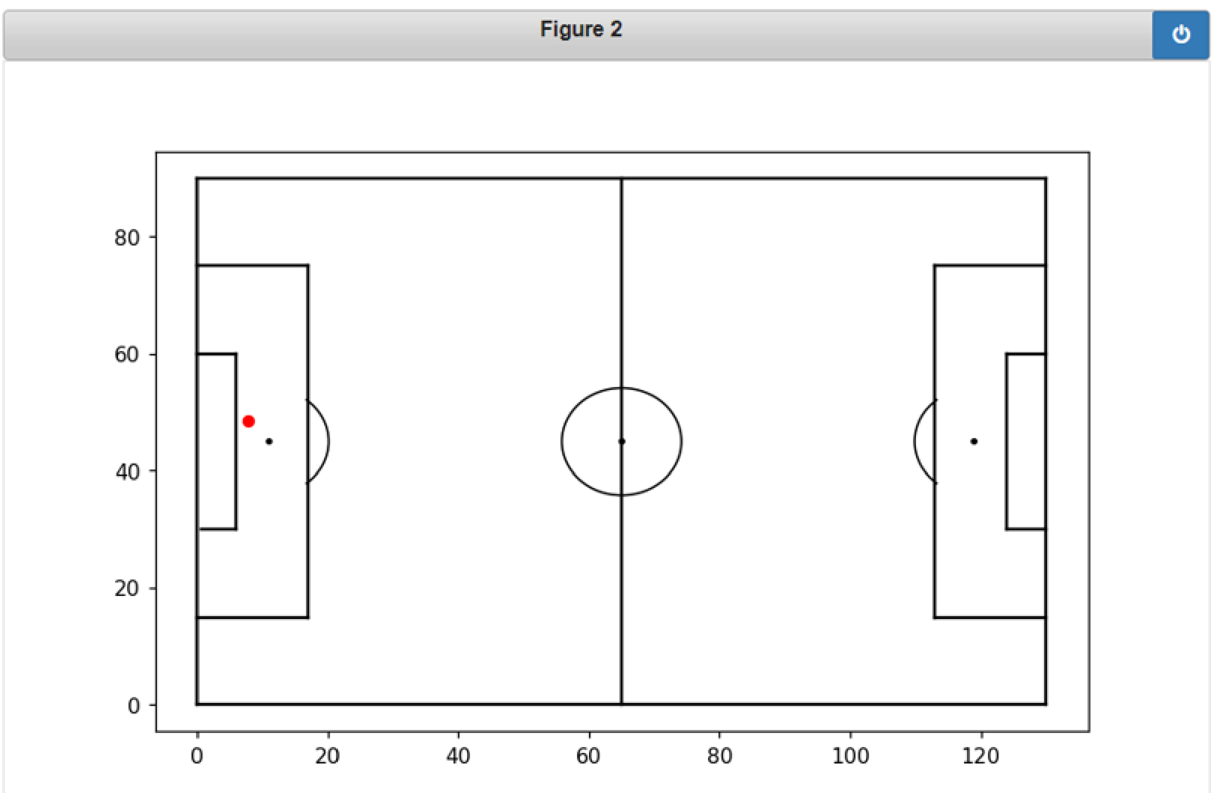


Figure 2
80
60
40
20
0
0
20
40
60
80
100
120

	Player_Name	Player_Team	Opposition	Mins_Played	Shot_Min	xG	xGOT	SoT	Goal	Shot_X	Shot_Y
140	Harry Kane	Tottenham Hotspur	Leeds United	95	2	0.33	0.73	1	1	14.415028	39.757144
141	Harry Kane	Tottenham Hotspur	Leeds United	95	26	0.06	0.07	1	0	16.260190	50.357142
142	Harry Kane	Tottenham Hotspur	Leeds United	95	69	0.56	0.95	1	1	10.494060	30.500001
143	Harry Kane	Tottenham Hotspur	Brentford	99	5	0.05	0.07	1	0	15.337609	28.414286
144	Harry Kane	Tottenham Hotspur	Brentford	99	57	0.04	0.00	0	0	19.258577	54.442859
145	Harry Kane	Tottenham Hotspur	Brentford	99	80	0.00	0.00	0	0	21.565028	56.785713
146	Harry Kane	Tottenham Hotspur	Aston Villa	91	52	0.30	0.34	1	0	15.106964	41.357142
147	Harry Kane	Tottenham Hotspur	Crystal Palace	92	45	0.11	0.28	1	1	6.803738	36.414287
148	Harry Kane	Tottenham Hotspur	Liverpool	94	40	0.37	0.20	1	1	7.265028	52.671427
149	Harry Kane	Tottenham Hotspur	Manchester United	94	40	0.05	0.00	0	0	2.190835	26.442856
150	Harry Kane	Tottenham Hotspur	Manchester United	94	55	0.26	0.00	0	0	1.498899	50.614284
151	Harry Kane	Tottenham Hotspur	Manchester United	94	62	0.04	0.00	0	0	21.103738	33.042857
152	Harry Kane	Tottenham Hotspur	Manchester United	94	75	0.03	0.09	1	0	19.258577	56.728572
153	Harry Kane	Tottenham Hotspur	Newcastle United	93	13	0.10	0.00	0	0	15.798899	51.585715
154	Harry Kane	Tottenham Hotspur	Newcastle United	93	30	0.15	0.07	1	0	9.802125	45.471427
155	Harry Kane	Tottenham Hotspur	Newcastle United	93	49	0.11	0.84	1	1	7.495673	25.900002
156	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	16	0.03	0.00	0	0	28.945673	60.157142
157	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	23	0.38	0.11	1	0	10.494060	54.985713
158	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	37	0.05	0.00	0	0	23.410190	36.471427
159	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	70	0.30	0.00	0	0	6.342448	45.214284
160	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	76	0.08	0.00	0	0	8.187609	39.042856
161	Harry Kane	Tottenham Hotspur	AFC Bournemouth	96	76	0.04	0.03	1	0	24.794060	36.471427
162	Harry Kane	Tottenham Hotspur	Brighton & Hove Albion	96	16	0.08	0.00	0	0	7.495673	61.157142
163	Harry Kane	Tottenham Hotspur	Brighton & Hove Albion	96	64	0.07	0.00	0	0	14.184383	26.185713

Having diligently gathered data for nearly 170 shots, I'm now poised to construct the convex hulls. With the precise shot coordinates and detailed statistics for each attempt in hand, we can embark on this visualization journey.

```python
import pandas as pd

# Load the original data
df = pd.read_csv('PlayerShotsData.csv')

# Players list
players = ['Karim Benzema', 'Christopher Nkunku', 'Erling Haaland', 'Kylian Mbappé', 'Phil Foden', 'Harry Kane']

# Initialize an empty list to store aggregated data for each player
stat_data_list = []

# Loop through each player and aggregate their data
for player in players:
    player_stat_data = df[df['Player_Name'] == player]

    # Calculate unique minutes played for the player (assuming he only plays each team once)
    unique_mins_played = player_stat_data.drop_duplicates(subset=['Opposition', 'Player_Team'])['Mins_Played'].sum()

    # Aggregate the data
    player_stat_data = {
        'Player_Name': player,
        'Player_Team': player_stat_data['Player_Team'].iloc[0],  # Assuming he played for one team only during this period
        'Mins_Played': unique_mins_played,
        'xG': player_stat_data['xG'].sum(),
        'xGOT': player_stat_data['xGOT'].sum(),
        'SoT': player_stat_data['SoT'].sum(),
        'Goal': player_stat_data['Goal'].sum()
    }

    stat_data_list.append(player_stat_data)

# Convert the aggregated data list to a DataFrame
stat_df = pd.DataFrame(stat_data_list)

# Save the aggregated data to a new CSV file
stat_df.to_csv('PlayerStatData.csv', index=False)
```

```python
stat_df.head(10)
```

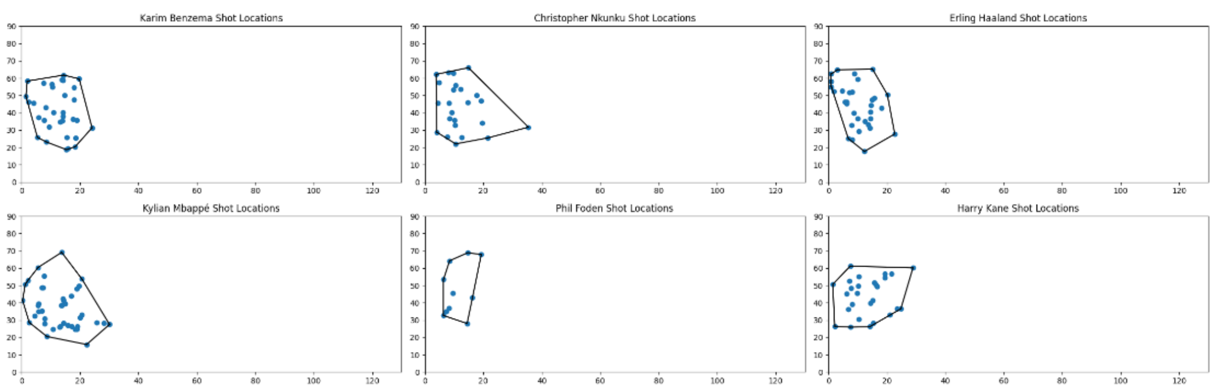
	Player_Name	Player_Team	Mins_Played	xG	xGOT	SoT	Goal
0	Karim Benzema	Real Madrid	866	6.16	6.51	16	6
1	Christopher Nkunku	RB Leipzig	611	4.59	2.82	8	3
2	Erling Haaland	Manchester City	775	7.03	5.60	14	6
3	Kylian Mbappé	Paris Saint-Germain	833	7.92	8.40	20	9
4	Phil Foden	Manchester City	531	1.29	1.99	4	2
5	Harry Kane	Tottenham Hotspur	946	4.17	4.23	13	6

```python
# Selecting data for both players using the 'players' list
selected_players_data = df.loc[df['Player_Name'].isin(players)]

# Selecting only the 'Shot X' and 'Shot Y' columns from the 'selected_players_data' DataFrame.
# The resulting values are converted into a NumPy array, which is stored in the 'shot_points' variable.
shot_points = selected_players_data[['Shot_X', 'Shot_Y']].values

shot_points
```

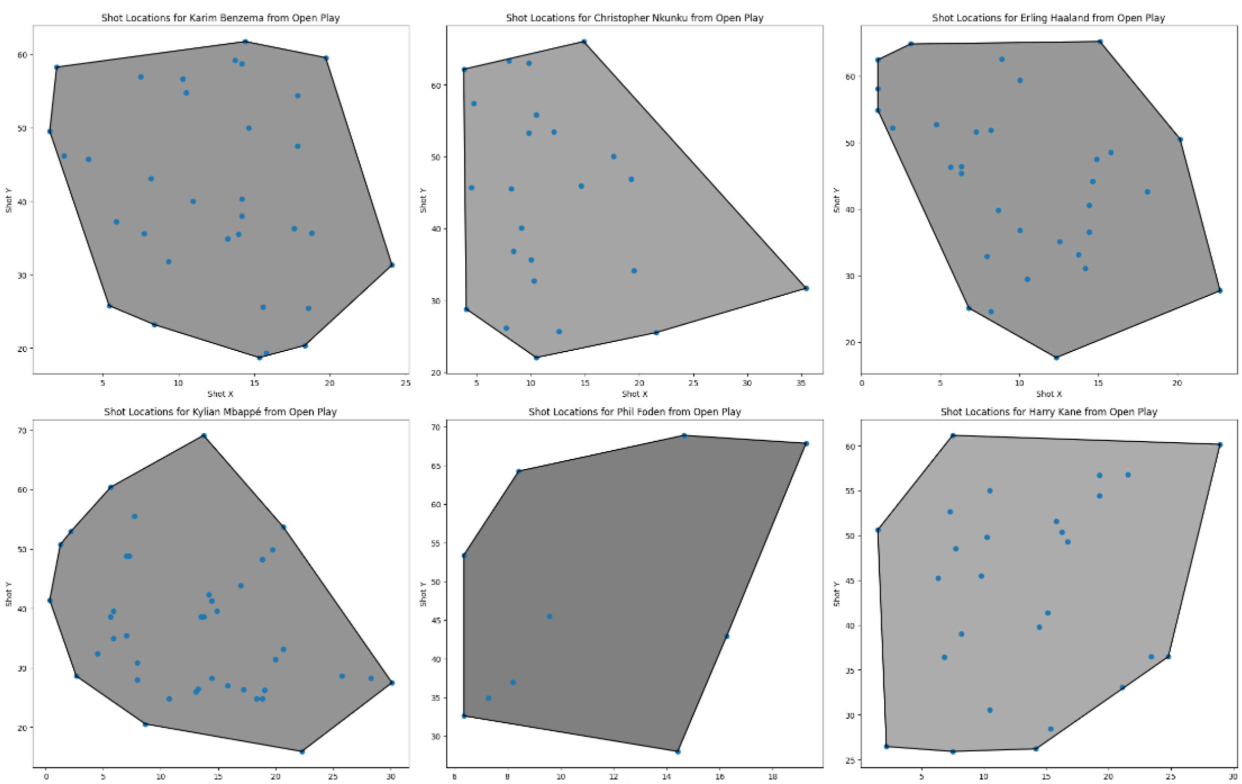
```
array([[14.64567339, 49.99999956],
       [ 1.96018952, 58.27142944],
       [ 7.72631856, 35.55714504],
       [ 4.03599598, 45.70000174],
       [14.18438307, 37.98571603],
       [ 7.49567339, 56.98571516],
       [17.87470565, 54.44285889],
       [13.72309275, 59.18571559],
       [24.10212501, 31.30000174],
       [ 5.88115727, 37.18571516],
       [17.64406049, 36.30000131],
       [10.49406049, 54.81428702],
       [15.33760888, 18.70000174],
       [ 8.18760888, 43.12857121],
       [ 8.41825404, 23.18571559],
       [13.95373791, 35.52857274],
       [10.26341533, 56.64285736],
       [14.18438307, 58.78571516],
       [ 5.41986694, 25.78571647],
       [13.26180243, 34.87142944],
       [10.95535081, 40.04285889],
       [ 1.4988992 , 49.5285723 ],
       [17.87470565, 47.50000174],
       [ 2.42147985, 46.18571516],
       [15.56825404, 25.64285889],
       [14.41502823, 61.75714417],
       [18.33599598, 20.35714417],
       [18.56664114, 25.47142901],
       [18.7972863 , 35.67143032],
       [14.18438307, 40.30000174],
       [ 9.34083469, 31.81428746],
       [15.7988992 , 19.32857274],
```

And now let’s repeat the code to plot all the points

```
%matplotlib inline
from scipy.spatial import ConvexHull
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.patches import Arc

# List of players
players = ['Karim Benzema', 'Christopher Nkunku', 'Erling Haaland', 'Kylian Mbappé', 'Phil Foden', 'Harry Kane']

# Set up subplots
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(22, 7))

for idx, player in enumerate(players):
    # Fetch data and compute convex hull
    player_data = df[df['Player_Name'] == player]
    hull = ConvexHull(player_data[['Shot_X', 'Shot_Y']])

    # Get axes
    ax = axes[idx // 3, idx % 3]

    # Plot the data and the convex hull
    ax.plot(player_data['Shot_X'], player_data['Shot_Y'], 'o')
    for simplex in hull.simplices:
        ax.plot(player_data['Shot_X'].iloc[simplex], player_data['Shot_Y'].iloc[simplex], 'k-')

    # Set title and axis limits
    ax.set_title(f'{player} Shot Locations')
    ax.set_xlim(0, 130)
    ax.set_ylim(0, 90)

# Adjust the layout and show the plot
plt.tight_layout()
plt.show()
```

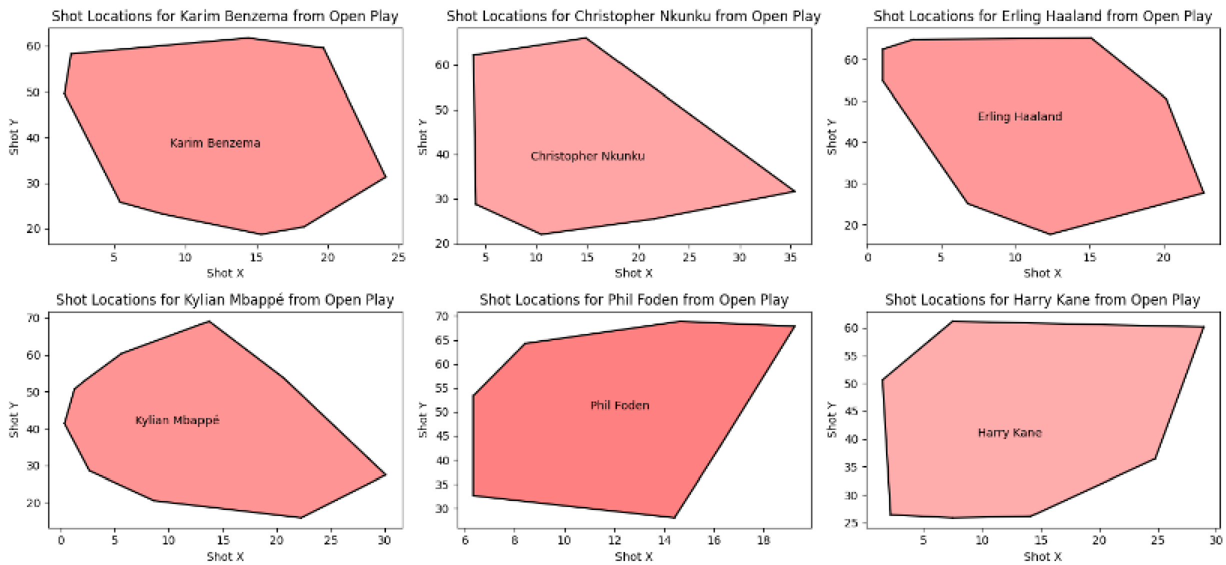


```python
%matplotlib inline
import matplotlib.pyplot as plt
from scipy.spatial import ConvexHull

# Filter data for all six players
data_map = {
    'Karim Benzema': df.loc[df['Player_Name'] == 'Karim Benzema'],
    'Christopher Nkunku': df.loc[df['Player_Name'] == 'Christopher Nkunku'],
    'Erling Haaland': df.loc[df['Player_Name'] == 'Erling Haaland'],
    'Kylian Mbappé': df.loc[df['Player_Name'] == 'Kylian Mbappé'],
    'Phil Foden': df.loc[df['Player_Name'] == 'Phil Foden'],
    'Harry Kane': df.loc[df['Player_Name'] == 'Harry Kane']
}

# Compute the convex hull for each player
hull_map = {player: ConvexHull(data[['Shot_X', 'Shot_Y']]) for player, data in data_map.items()}

# Set up subplots
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(22, 14))  # Adjusted for 6 players

for idx, (player, data) in enumerate(data_map.items()):
    ax = axes[idx//3, idx%3]

    ax.plot(data['Shot_X'], data['Shot_Y'], "o")
    for simplex in hull_map[player].simplices:
        ax.plot(data.iloc[simplex]['Shot_X'], data.iloc[simplex]['Shot_Y'], 'k-')

    transparency = stat_df[stat_df['Player_Name'] == player]['xGOT'].iloc[0] / stat_df[stat_df['Player_Name'] == player]['SoT'].i
    ax.fill(data.iloc[hull_map[player].vertices]['Shot_X'], data.iloc[hull_map[player].vertices]['Shot_Y'], 'k', alpha=transparer
    ax.set_title(f"Shot Locations for {player} from Open Play")
    ax.set_xlabel("Shot X")
    ax.set_ylabel("Shot Y")

plt.tight_layout()
plt.show()
```



Observe the variation in shading among the players; this transparency corresponds to their individual Shot Quality (xGOT/SoT) value. Players who excel in striking the ball tend to amass a higher xGOT, largely attributed to their superior shot placement and speed. Nonetheless, various elements influence this, many of which were extensively covered in our prior project.

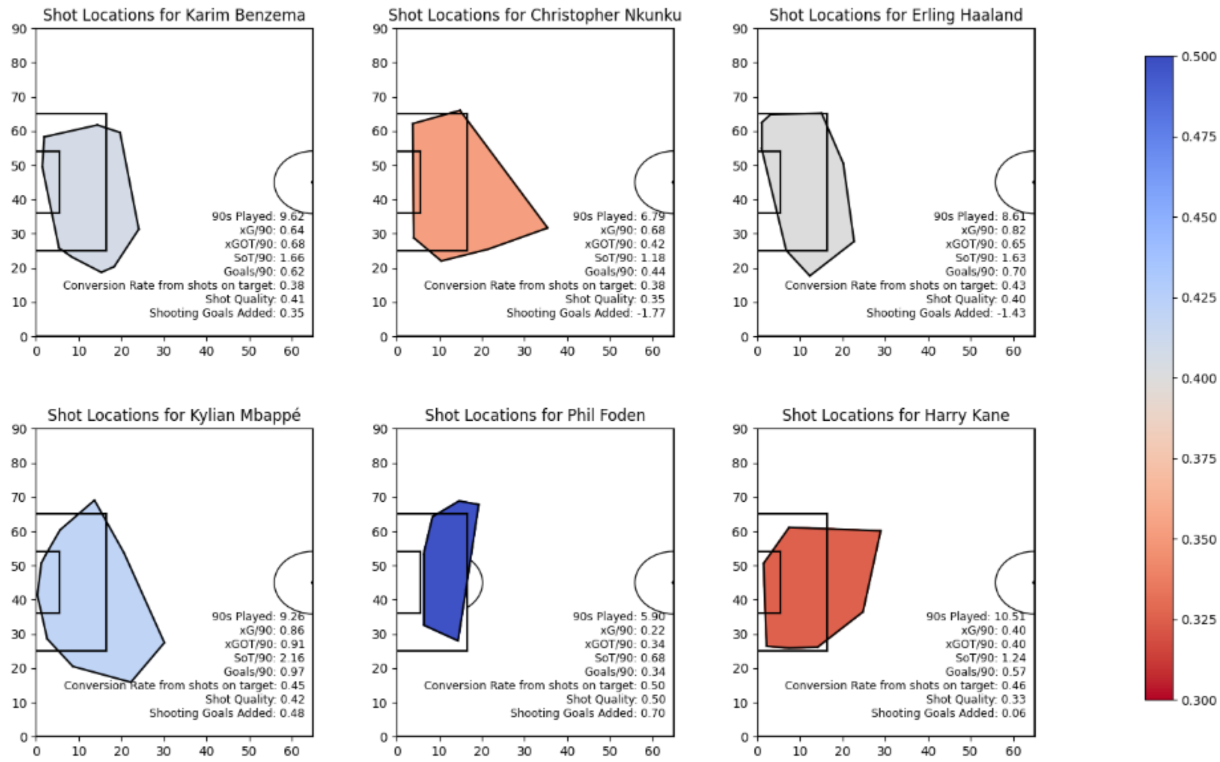
```
import matplotlib.pyplot as plt
import numpy as np
from scipy.spatial import ConvexHull
import pandas as pd

# Load the aggregated data
stat_data = pd.read_csv('PlayerStatData.csv')

# Load the shot data
shots_data = pd.read_csv('PlayerShotsData.csv')

# List of players you want to visualize
players = ['Karim Benzema', 'Christopher Nkunku', 'Erling Haaland', 'Kylian Mbappé', 'Phil Foden', 'Harry Kane']

fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(15, 7))

for idx, Player in enumerate(players):
    ax = axes[idx // 3, idx % 3]
    player_data = shots_data[shots_data['Player_Name'] == Player]
    points = player_data[['Shot_X', 'Shot_Y']].values

    if len(points) >= 3:
        try:
            hull = ConvexHull(points)

            for simplex in hull.simplices:
                ax.plot(points[simplex, 0], points[simplex, 1], 'k-')

            player_stat_data = stat_data[stat_data['Player_Name'] == Player]

            if player_stat_data['SoT'].iloc[0] != 0:
                transparency = min(player_stat_data['xGOT'].iloc[0] / player_stat_data['SoT'].iloc[0], 1)
            else:
                transparency = 0

            ax.fill(points[hull.vertices, 0], points[hull.vertices, 1], 'red', alpha=transparency)

            cx = np.mean(points[hull.vertices, 0])
            cy = np.mean(points[hull.vertices, 1])

            ax.text(cx, cy, Player, color='black', ha='center', va='center')

        except:
            pass

    ax.set_title(f"Shot Locations for {Player} from Open Play")
    ax.set_xlabel("Shot X")
    ax.set_ylabel("Shot Y")

plt.tight_layout()
plt.show()
```



Note: Players with a more pronounced shade of red have garnered a higher shot quality value.

```python
import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
from matplotlib.patches import Arc
import numpy as np
from scipy.spatial import ConvexHull
import pandas as pd

# Load the aggregated and shot data
shots_data = pd.read_csv('PlayerShotsData.csv')
stat_data = pd.read_csv('PlayerStatData.csv')  # Adjusted to a more generic filename

players = stat_data['Player_Name'].unique()

def createLeftHalfPitch(ax):
    # Creates only the left side of the pitch
    # Pitch Outline & Centre Line
    ax.plot([0, 0], [0, 90], color="black")
    ax.plot([0, 65], [90, 90], color="black")
    ax.plot([65, 65], [90, 0], color="black")
    ax.plot([65, 0], [0, 0], color="black")

    # Left Penalty Area
    ax.plot([16.5, 16.5], [65, 25], color="black")
    ax.plot([0, 16.5], [65, 65], color="black")
    ax.plot([16.5, 0], [25, 25], color="black")

    # Left 6-yard Box
    ax.plot([0, 5.5], [54, 54], color="black")
    ax.plot([5.5, 5.5], [54, 36], color="black")
    ax.plot([5.5, 0], [36, 36], color="black")

    # Add the centre spot and left penalty spot
    centreSpot = plt.Circle((65, 45), 0.4, color="black")
    leftPenSpot = plt.Circle((11, 45), 0.4, color="black")
    ax.add_patch(centreSpot)
    ax.add_patch(leftPenSpot)

    # Add left arc
    leftArc = Arc((11, 45), height=18.3, width=18.3, angle=0, theta1=307, theta2=53, color="black")
    ax.add_patch(leftArc)

    # Half Circle
    half_circle = Arc((65, 45), height=18.3, width=18.3, angle=0, theta1=90, theta2=270, color="black")
    ax.add_patch(half_circle)

# Initialize the colormap and normalization
cmap = plt.get_cmap("coolwarm").reversed()
norm = mcolors.Normalize(vmin=0.3, vmax=0.5)
```

```python
# Retrieve unique players. Limit to a maximum of 3 for visualization clarity.
players = stat_data['Player_Name'].unique()

# Setting up the figure with a fixed 2x3 structure
fig, axs = plt.subplots(2, 3, figsize=(15, 10))

def player_stats(player_row):
    #Compute per-90 minutes and other derived statistics for a given player.
    minutes = player_row['Mins_Played']
    xG = player_row['xG']
    xGOT = player_row['xGOT']
    SoT = player_row['SoT']
    goals = player_row['Goal']

    mins_90 = minutes / 90
    xG_90 = xG / mins_90
    xGOT_90 = xGOT / mins_90
    SoT_90 = SoT / mins_90
    goals_90 = goals / mins_90
    conversion_rate = goals / SoT if SoT != 0 else 0
    shot_quality = xGOT / SoT if SoT != 0 else 0
    shooting_goals_added = xGOT - xG

    return {
        '90s Played': mins_90,
        'xG/90': xG_90,
        'xGOT/90': xGOT_90,
        'SoT/90': SoT_90,
        'Goals/90': goals_90,
        'Conversion Rate from shots on target': conversion_rate,
        'Shot Quality': shot_quality,
        'Shooting Goals Added': shooting_goals_added
    }


# Iterate over each unique player and visualize their shot data
for idx, Player in enumerate(players):
    # Identify the row and column in the 2x3 grid for the current player
    row = idx // 3
    col = idx % 3
    ax = axs[row, col]

    # Draw the left half-pitch on the current axis
    createLeftHalfPitch(ax)

    # Extract the statistics for the current player
    player_row = stat_data[stat_data['Player_Name'] == Player].iloc[0]
    stats = player_stats(player_row)

    # Format and display player's stats on the subplot
    stats_text = "\n".join([f"{key}: {value:.2f}" for key, value in stats.items()])
    ax.text(63, 5, stats_text, ha='right', fontsize=8.75, color='black', verticalalignment='bottom')

    # Define axes limits for the left half-pitch
    ax.set_xlim(0, 65)
    ax.set_ylim(0, 90)

    # Extract the shot coordinates for the current player
    player_data = shots_data[shots_data['Player_Name'] == Player].copy()
    points = player_data[['Shot_X', 'Shot_Y']].values

    # Create a convex hull around shot locations if possible
    if len(points) >= 3:  # Need at least 3 points to form a hull
        try:
            hull = ConvexHull(points)
            player_stat_data = stat_data[stat_data['Player_Name'] == Player]
            ...
            # Fill and plot the convex hull based on shot quality
            ...
            ax.set_title(f"Shot Locations for {Player}")
        except:
            pass

# Create a colorbar indicating shot quality
cbar_ax = fig.add_axes([0.93, 0.15, 0.02, 0.7])
fig.colorbar(plt.cm.ScalarMappable(norm=norm, cmap=cmap), cax=cbar_ax)

# Adjust the spacing between subplots and the right margin for the colorbar
plt.subplots_adjust(right=0.85, hspace=0.3, wspace=0.3)
plt.show()
```



The color bar on the left serves as a visual representation of shot quality values, allowing us to distinguish between players. Take a moment to observe the distinctions between Foden and Kane's shot convex hulls. Foden's hue leans towards the higher end of the spectrum, while Kane's aligns more with the lower end. However, this shouldn't lead us to hastily conclude that Foden is a superior striker compared to Kane. Several factors come into play:

Kane has a significantly higher shot count than Foden. When paired with other elements, such as the quality of opposition and the challenge in achieving shots with elevated xGOT values (as discussed in our earlier project), a clearer picture emerges. It's essential to highlight that our analysis is based on the last 10 matches for these athletes. A few high xGOT value shots can notably skew this stat, as evidenced in Foden's case.

Interestingly, despite Nkunku ranking among the top 10 players for shot quality in the top five leagues the previous season, his shot quality in our current analysis is second lowest. This could stem from factors like limited playtime, exhaustion, or a temporary dip in form. Such observations underline the importance of a comprehensive, season-long analysis to truly grasp a player's shooting prowess. Thus, for my upcoming project, I intend to harness web scraping techniques. This will allow for a broader data collection over an entire season, eliminating the need for tedious manual data entry for a restricted set of players and matches.

In conclusion, while snapshots of data can provide intriguing insights, a more holistic approach ensures a nuanced understanding of player performance. Here's to diving deeper and discovering more in our subsequent analyses.