

BERTAN  
BAYRAK  
FANALITI  
K

Data Science Days  
12 May 2022

# About me

- Born in 1988
- Living in Ankara
- Married
- Father of a daughter and a dog
- Team Player, determinant, motivated, ambitious
- Fast learner with an analytical mind
- Meditation and Sports lover, team-sports especially
- Passionate about football analytics and technologies
- Advanced soft skills

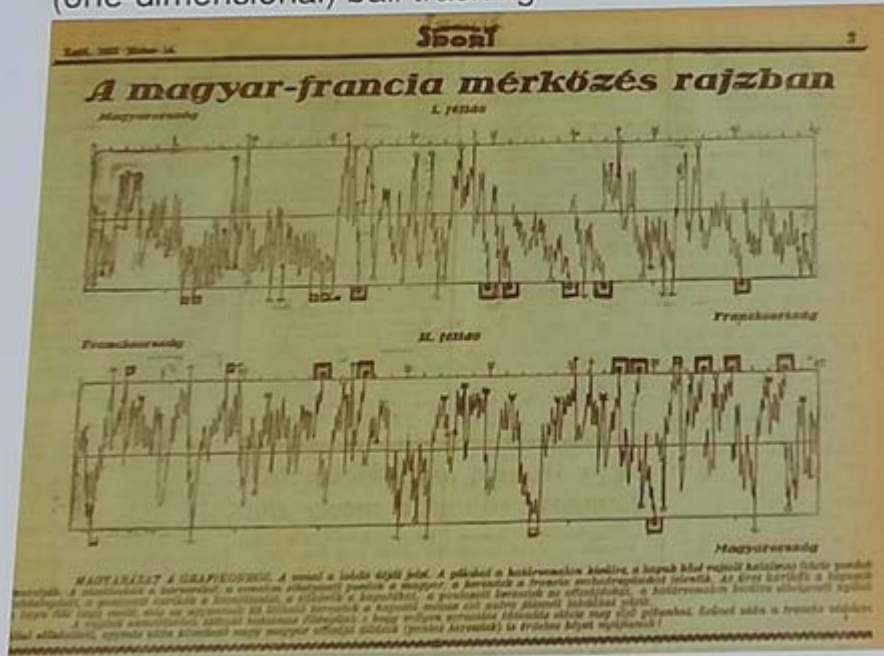
# FOOTBALL PERFORMANCE ANALYST

## PARADINE LTD.

**B**ERTAN  
**B**AYRAK  
FANALİTİK

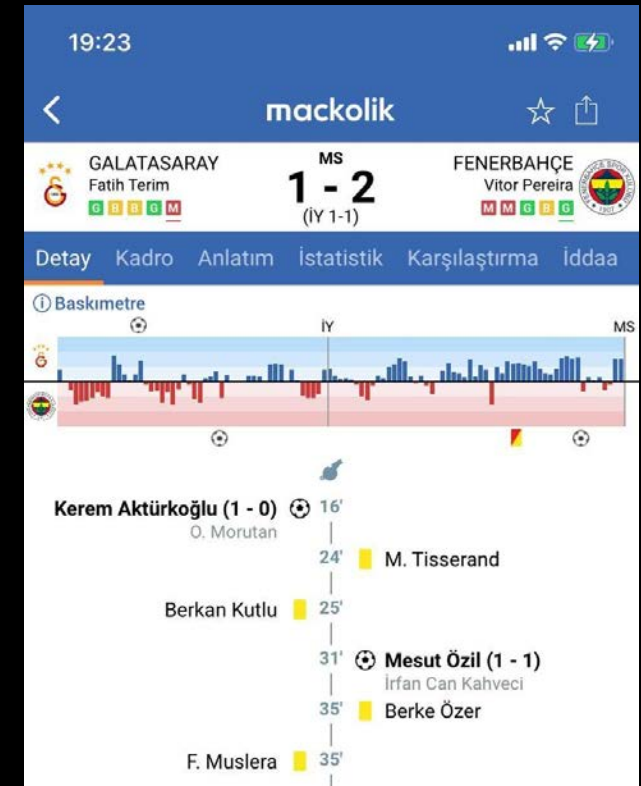
1927

(one-dimensional) ball tracking



Nemzeti Sport (14 June 1927, p. 3)

2021

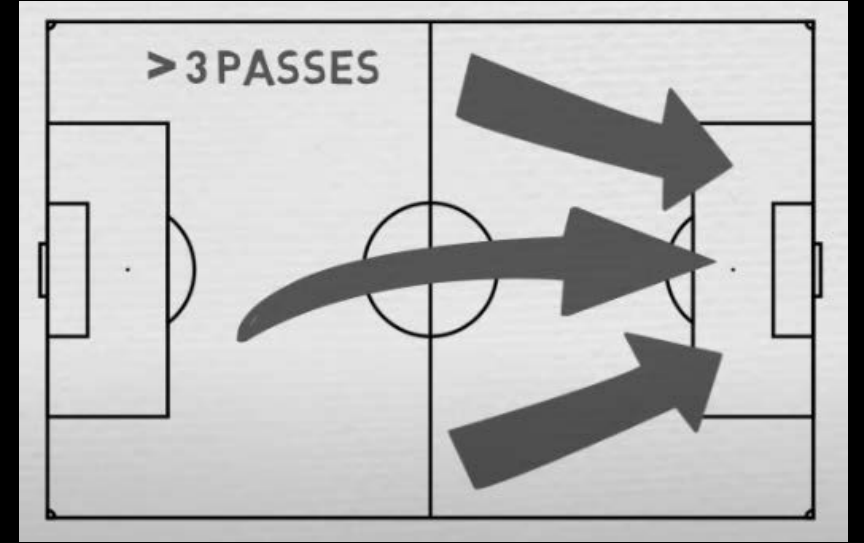
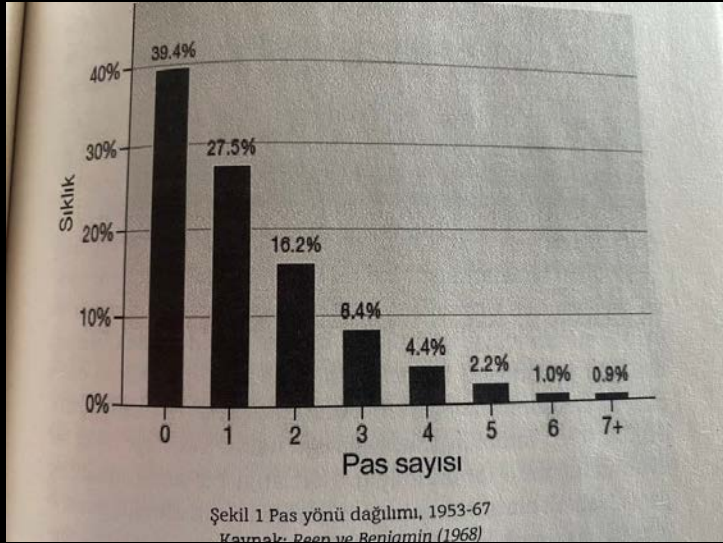


FIRST FOOTBALL DATA ANALYST  
FATHER OF FOOTBALL ANALYTICS  
ARCHITECT OF EXPECTED GOAL



CHARLES REEP

# CHARLES REEP



# NOWADAYS STATSBOMB IQ

- + Match Dashboard
- + Match Timeline
- + Race Chart
- + Shot Map
- + Flexible Tables
- + Event Location Widgets



# NOWADAYS SBG

The interface features a sidebar menu on the left with the following sections:

- Displays**
  - Video
  - Pitch
  - Eventing
  - Tags
  - Alerts
  - More...
- Matches**
  - Norwich v Swansea
  - Norwich v Millwall
  - Norwich v Wycombe
  - Bristol C v Norwich
  - Brentford v Norwich
- Collections**
- Presentations**
- Settings**
  - Tagging Enabled
  - Broadcast
  - HIDE

The main dashboard is divided into four panels:

- HOME**: A pitch heatmap showing activity in the defensive half.
- PASSES**: A pitch heatmap showing a high concentration of passes in the attacking half.
- CROSSES**: A pitch heatmap showing activity in the defensive half.
- SHOTS**: A pitch heatmap showing activity in the attacking half.

At the bottom left, there is a **Video - Broadcast** panel showing a live football match.



# FOOTBALL ANALYTICS NOWADAYS

## CIES FOOTBALL OBSERVATORY

### Weekly Post

#### Highlights

#### Projected rankings: Inter finally champions again?

Issue number 325 of the CIES Football Observatory Weekly Post presents the points projected at the end of the season for teams from 22 leagues across Europe. The projection was calculated using a statistical model taking into account shots on target and from the box attempted or conceded, ball possession, as well as teams' own passes and those of opponents in the opposite third of the pitch.



According to this projection, Inter Milan would be crowned Italian champions 11 years after their last title, ahead of Milan AC (+2 points) and Juventus (+3). The biggest surprise would come from France, where Olympique Lyonnais would total 82 points, one more than Paris St-Germain. In Spain, Atlético Madrid would have to fight up until the end of the season against Barcelona (+3 points), while Bayern Munich in Germany should have a more relaxing season end.

In the Premier League, Manchester City would outrank Manchester United by 14 points, with Liverpool at 3rd position ahead of Chelsea for the last Champions League spot. WBA would finish last, behind Sheffield United and Burnley, while Fulham would avoid relegation. Brentford and Norwich would total 89 points in the Championship, eight more than Swansea. More stats for teams from 35 European leagues are to be found in the CIES Football Observatory Performance Atlas powered by InStat data.

#### Projected rankings at the end of the season 2020/21

Projection calculated on 10/02/2021

League -> ITA

|   | Club              | Projected points |
|---|-------------------|------------------|
| 1 | +1 Internazionale | 81               |
| 2 | -1 Milan AC       | 79               |
| 3 | = Juventus FC     | 78               |
| 4 | +2 SSC Napoli     | 76               |
| 5 | -1 AS Roma        | 70               |

League -> ENG

|   | Club                | Projected points |
|---|---------------------|------------------|
| 1 | = Manchester City   | 86               |
| 2 | = Manchester United | 72               |
| 3 | +1 Liverpool FC     | 69               |
| 4 | +1 Chelsea FC       | 68               |
| 5 | -2 Leicester City   | 66               |

League -> NED

|   | Club            | Projected points |
|---|-----------------|------------------|
| 1 | = AFC Ajax      | 86               |
| 2 | = PSV Eindhoven | 72               |
| 3 | +1 AZ Alkmaar   | 65               |
| 4 | -1 SBV Vitesse  | 65               |
| 5 | = Feyenoord     | 62               |

League -> ESP

|   | Club              | Projected points |
|---|-------------------|------------------|
| 1 | = Atlético Madrid | 81               |
| 2 | +1 FC Barcelona   | 78               |
| 3 | -1 Real Madrid    | 74               |
| 4 | = Sevilla FC      | 67               |
| 5 | +1 Real Sociedad  | 64               |

League -> GER


|   | Club                 | Projected points |
|---|----------------------|------------------|
| 1 | = Bayern München     | 77               |
| 2 | = RB Leipzig         | 71               |
| 3 | +2 Bayer Leverkusen  | 62               |
| 4 | -1 VfL Wolfsburg     | 62               |
| 5 | +1 Borussia Dortmund | 59               |






# CIES FOOTBALL OBSERVATORY

## 10 FEBRUARY 2021

SPOR TOTO SÜPER LİG 25. HAFTA PUAN DURUMU

|                      | O  | G  | B | M | A  | Y  | AV | P  |
|----------------------|----|----|---|---|----|----|----|----|
| 1.GALATASARAY A.Ş.   | 23 | 15 | 3 | 5 | 47 | 18 | 29 | 48 |
| 2.BEŞİKTAŞ A.Ş.      | 23 | 15 | 3 | 5 | 50 | 26 | 24 | 48 |
| 3.FENERBAHÇE A.Ş.    | 23 | 15 | 3 | 5 | 45 | 25 | 20 | 48 |
| 4.TRABZONSPOR A.Ş.   | 23 | 12 | 6 | 5 | 30 | 24 | 6  | 42 |
| 5.AYTEMİZ ALANYASPOR | 23 | 12 | 5 | 6 | 40 | 23 | 17 | 41 |

League ->  TUR

|   | Club                                                                                                  | Projected points | Rank (10/02) | Points (10/02) |
|---|-------------------------------------------------------------------------------------------------------|------------------|--------------|----------------|
| 1 | +1  Beşiktaş JK    | 84               | 2            | 48             |
| 2 | -1  Galatasaray SK | 84               | 1            | 48             |
| 3 | =  Fenerbahçe SK   | 81               | 3            | 48             |
| 4 | +1  Alanyaspor     | 80               | 5            | 41             |
| 5 | -1  Trabzonspor    | 70               | 4            | 42             |

# FOOTBALL ANALYTICS NOWADAYS

## CIES FOOTBALL OBSERVATORY

Süper Lig puan durumu

MAÇLAR HABERLER PUAN DURUMU İSTATİSTİKLER OYUNCULAR

Sezon  
2020-21

| Takım         | OM | G  | B  | M | AG | YG | A  | P  | Son 5     |
|---------------|----|----|----|---|----|----|----|----|-----------|
| 1 Beşiktaş    | 40 | 26 | 6  | 8 | 89 | 44 | 45 | 84 | ✓ × × ✓ ✓ |
| 2 Galatasaray | 40 | 26 | 6  | 8 | 80 | 36 | 44 | 84 | ✓ ✓ ✓ ✓ ✓ |
| 3 Fenerbahçe  | 40 | 25 | 7  | 8 | 72 | 41 | 31 | 82 | ✓ × ✓ ✓ - |
| 4 Trabzonspor | 40 | 19 | 14 | 7 | 50 | 37 | 13 | 71 | ✓ - ✓ - ✓ |

League -> TUR

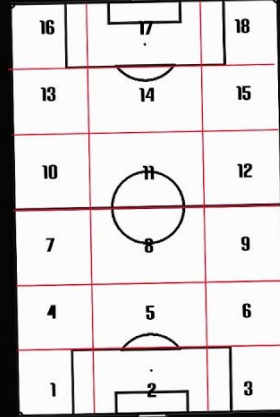
|   | Club              | Projected points | Rank (10/02) | Points (10/02) |
|---|-------------------|------------------|--------------|----------------|
| 1 | +1 Beşiktaş JK    | 84               | 2            | 48             |
| 2 | -1 Galatasaray SK | 84               | 1            | 48             |
| 3 | = Fenerbahçe SK   | 81               | 3            | 48             |
| 4 | +1 Alanyaspor     | 80               | 5            | 41             |
| 5 | -1 Trabzonspor    | 70               | 4            | 42             |

# FOOTBALL ANALYTICS NOWADAYS

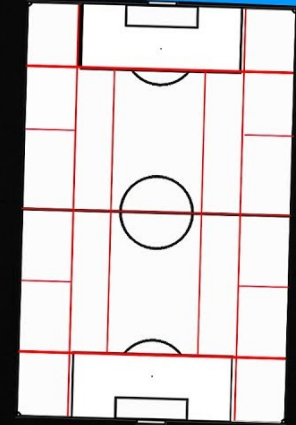
## ZONES



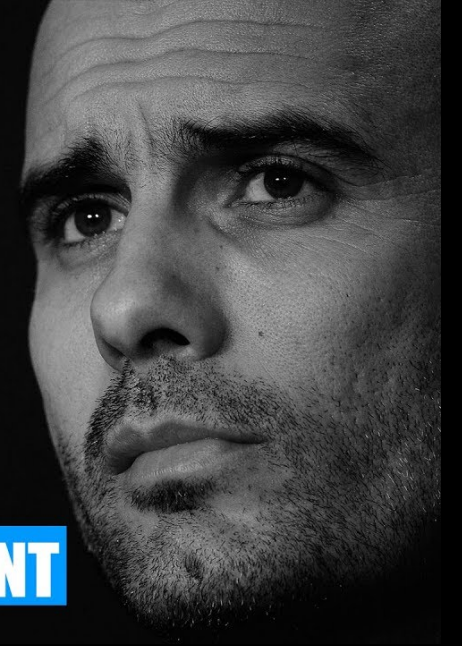
**REGULAR**



**PEP**



**WHAT MAKES PEP DIFFERENT**



# FOOTBALL ANALYTICS NOWADAYS

## SCISPORTS



**Bertan Bayrak**

Data Scientist | Football Performance Analyst at Pa...

2 ay • Düzenlendi •

This afternoon I followed a webinar which **Lotte Bransen** from **SciSports** presented her work on predicting football penalty directions using in-match performance indicators. They observed a pattern in the corners chosen related to the penalty taker's performance. The better the player is playing the more likely the taker will aim for his natural corner as opposed to his non-natural one.

In the match I just watched from the Turkish Super League, Mame Diouf(Hatayspor) performed quite well with a super volley goal today. He aimed for his natural corner (left side from his perspective) when he took the penalty kick and missed it.

Well done **Lotte Bransen** great work. ...daha fazla gör

İrmak Ulucan Bayrak ve 35 diğer kişi



Beğen



Yorum Yap



Paylaş



Gönder

Akiştaki gönderiniz için 4.389 görüntüleme



Yorum ekle...



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# FOOTBALL ANALYTICS NOWADAYS

## BRENTFORD FC

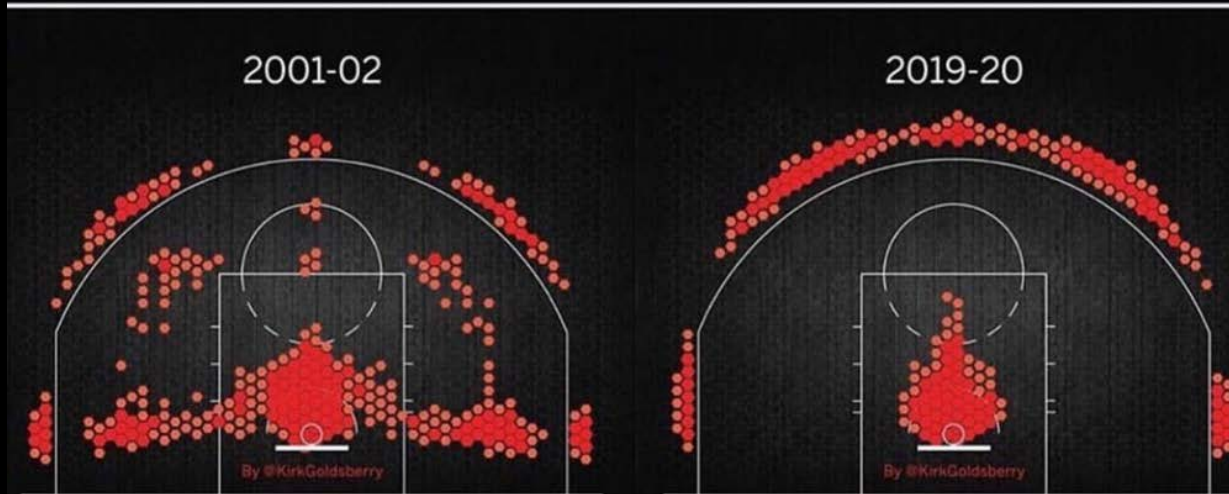


# SPORTS ANALYTICS NOWADAYS

## NBA

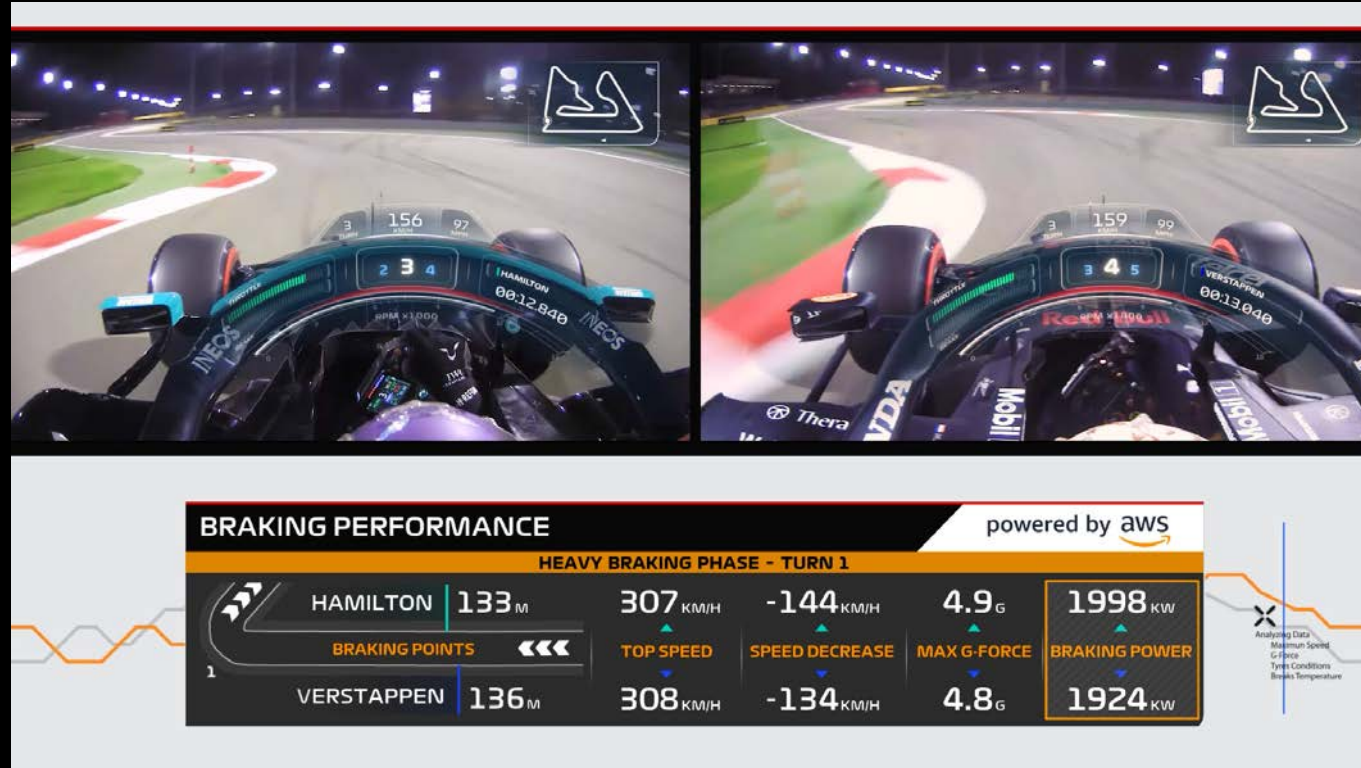
### THE GAME HAS CHANGED

Top 200 shot locations in the NBA, 2001-02 versus 2019-20



# SPORTS ANALYTICS NOWADAYS

## F1





## SPORTS DATA USAGE

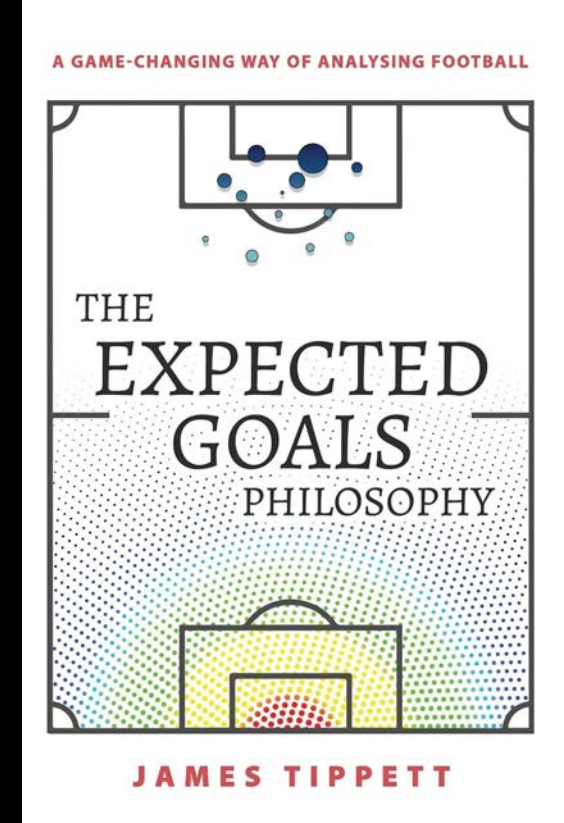
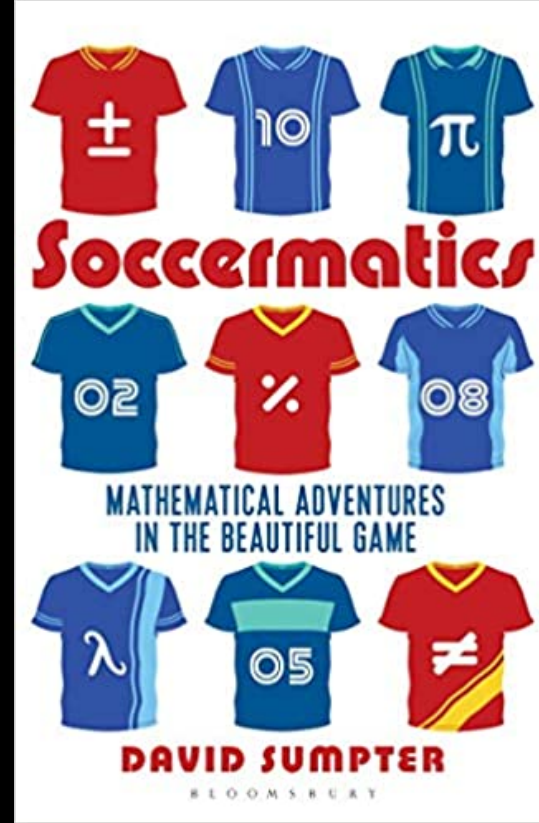
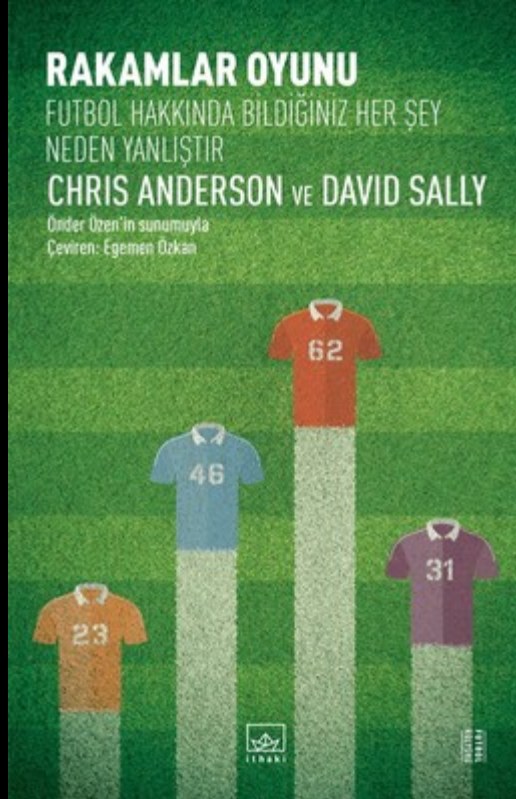
- FOR CLUBS/TEAMS
- FOR MEDIA
- FOR BETTING COMPANIES
- FOR INCREASING ATHLETE'S CONDITION/PERFORMANCE/  
TRANSFER
- FOR PREVENTING INJURIES

# SPORTS DATA PROVIDERS


- OPTA
- STATSBOMB
- INSTAT
- SCISPORTS
- METRICA SPORTS
- SYNERGY SPORTS
- SPORTRADAR
- STATS PERFORM
- MATCHSTUDY(TR)
- GENIOUS
- CATAPULT
- KINEXON
- GPEXE

# LEARNING TOOLS


# BOOKS




# YOUTUBE




**Friends of Tracking**  
15,9 B abone

ABONE OLUNDU 


ANA SAYFA VİDEOLAR OYNATMA LİSTELERİ TOPLULUK KANALLAR HAKKINDA 

**Course: mathematical modelling of football** ▶ TÜMÜNÜ OYNAT


This series of videos (combination of live videos and prerecorded) take us all the way from loading in data in to Python, through plotting data, expected goals, evaluating actions, working with tracki...




**Lecture 1: Mathematical Modelling of Football**  
Friends of Tracking  
17 B görüntüleme • 1 yıl önce yayınlandı




**Setting Up to do Data Science**  
Friends of Tracking  
10 B görüntüleme • 1 yıl önce




**Loading in and investigating World Cup data in Python**  
Friends of Tracking  
12 B görüntüleme • 1 yıl önce



**Making Your Own Shot and Pass Maps**  
Friends of Tracking  
14 B görüntüleme • 1 yıl önce



**Matplotlib: Beyond the Default**  
Good practice in data visualisation  
Friends of Tracking  
9,4 B görüntüleme • 1 yıl önce yayınlandı



**Exploring football match events in Python**  
Friends of Tracking  
13 B görüntüleme • 1 yıl önce

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# MEDIA




The Athletic

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**Tom Worville** 

Football Writer

Tom Worville is a Football Analytics Writer for The Athletic. He agrees that football isn't played on spreadsheets, but they have their uses.

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PODCAST



PODCAST

# The Football Fanalytics Podcast

The Football Fanalytics Podcast

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# MY FOOTBALL ANALYTICS WORK



# FOOTBALL ANALYTICS WORK

Recording

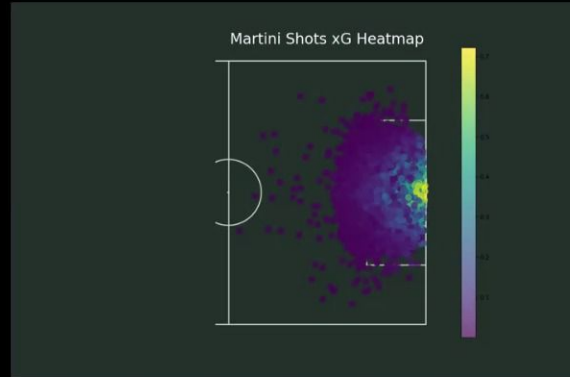
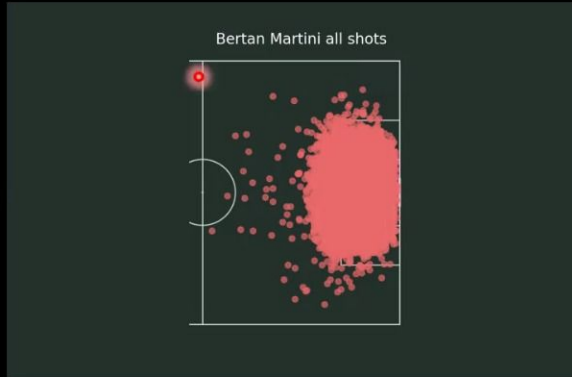
You are viewing Bertan Bayrak's screen View Options

View



ŞUTLAR

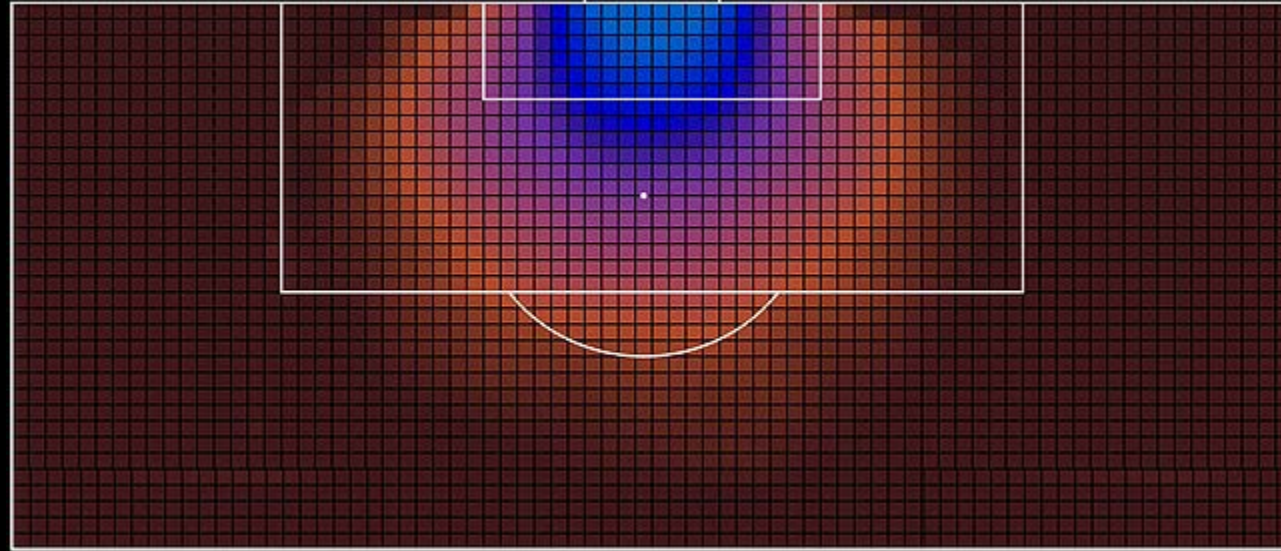
GOL BEKLENTİSİ



Unmute Stop Video Participants 146 Chat 2 Share Screen Record Reactions Apps Leave

## Expected Goal (xG) Model

GOL BEKLENTİSİ MODELİ  
EXPECTED GOAL(xG)



## iş problemi

Gol beklentisi ya da Expected Goal, oyunun belirli bir aşamasında sahadaki belirli bir konumdan atılan şutun gol olma olasılığını hesaplayarak bir ihtimalin kalitesini ölçen modeldir.

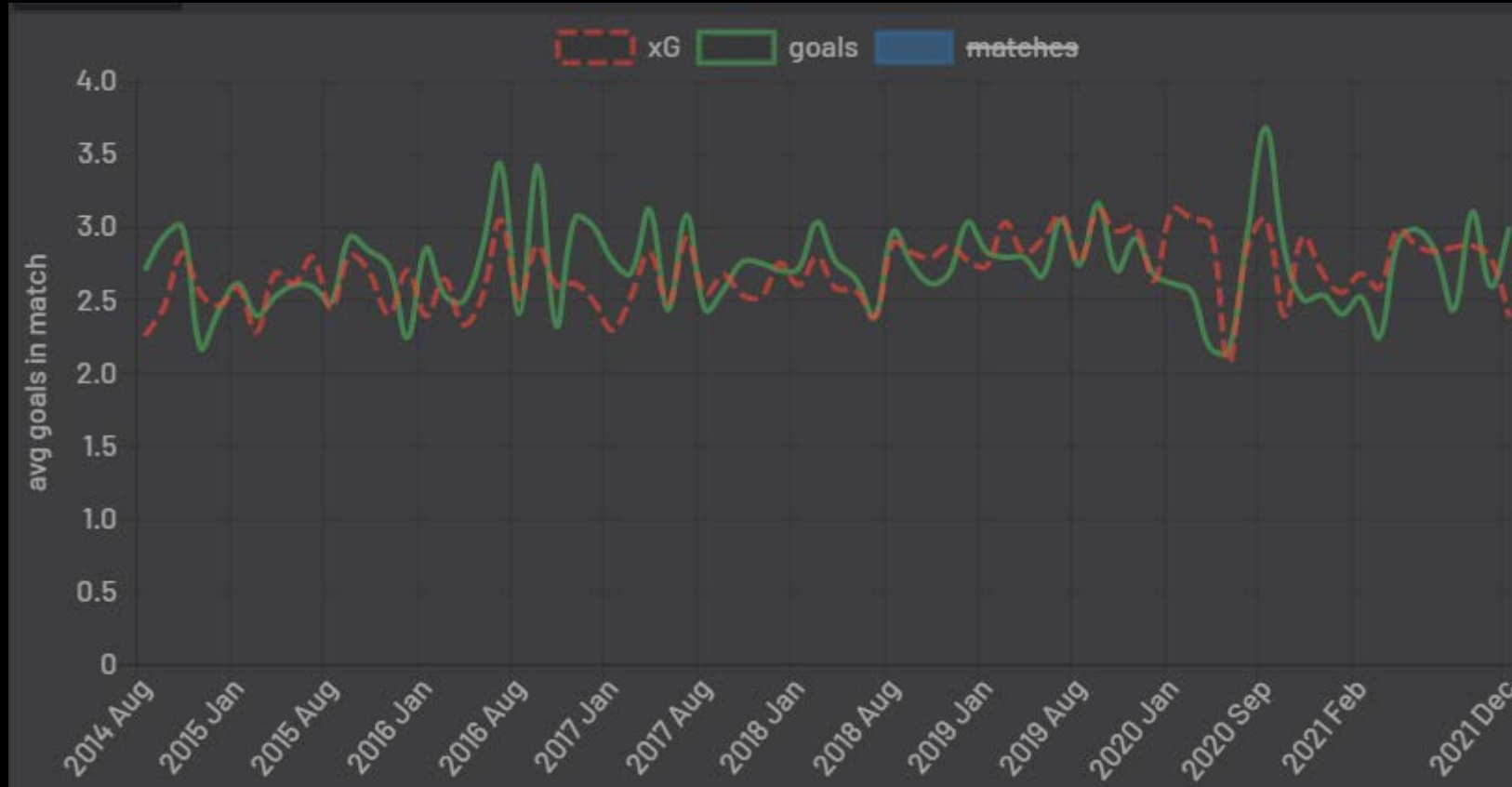


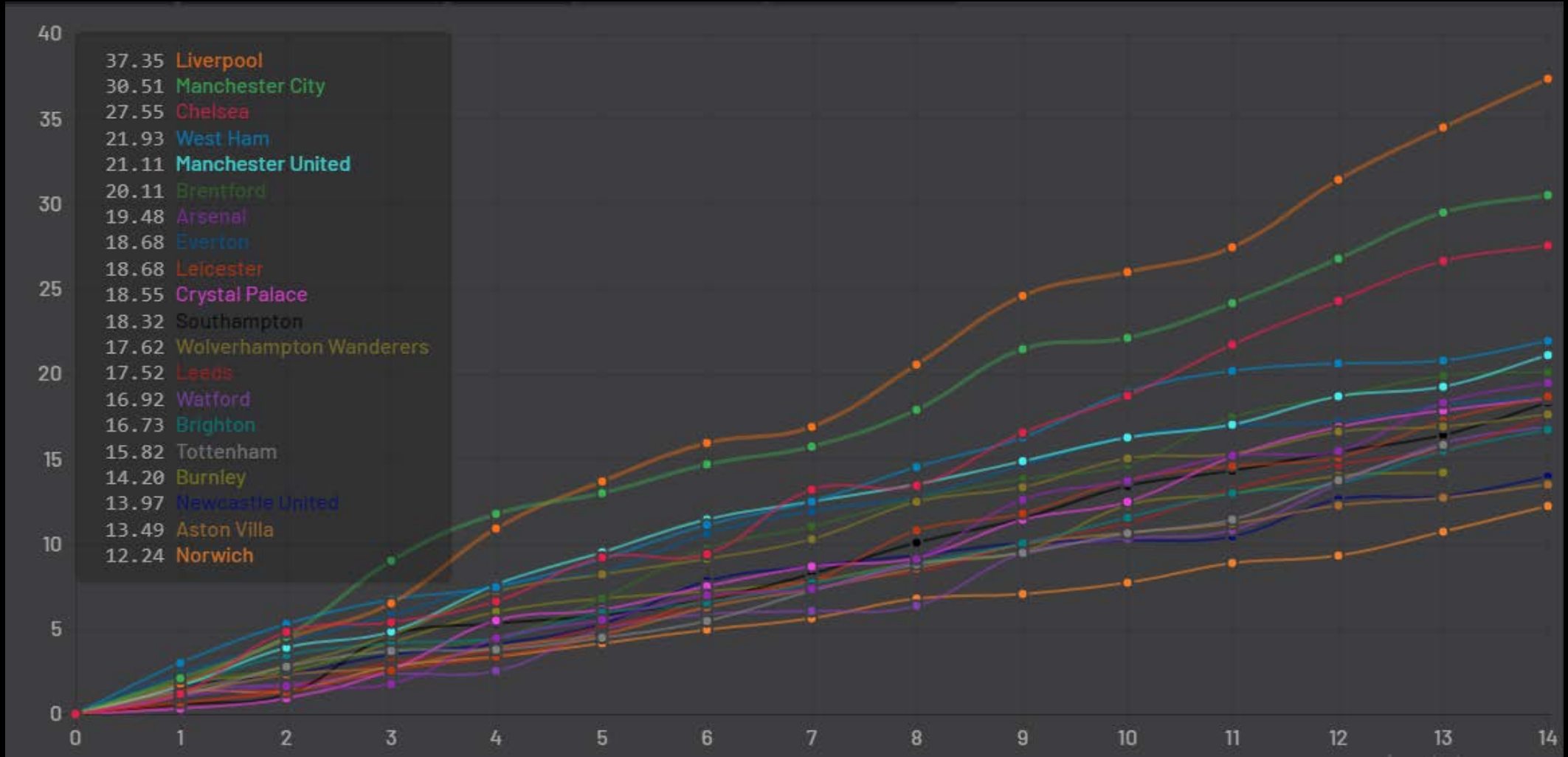
# Gol Beklentisi (xG)- SÜPER LİG

2021/22

MARTINI\_REVIEWS







| Nº | Player                    | Team              | G  | xG                     |
|----|---------------------------|-------------------|----|------------------------|
| 1  | Mohamed Salah             | Liverpool         | 13 | 10.73 <sup>-2.27</sup> |
| 4  | Sadio Mané                | Liverpool         | 7  | 7.90 <sup>+0.90</sup>  |
| 3  | Diogo Jota                | Liverpool         | 8  | 7.83 <sup>-0.17</sup>  |
| 19 | Pierre-Emerick Aubameyang | Arsenal           | 4  | 6.81 <sup>+2.81</sup>  |
| 5  | Michail Antonio           | West Ham          | 6  | 6.67 <sup>+0.67</sup>  |
| 6  | Cristiano Ronaldo         | Manchester United | 6  | 6.40 <sup>+0.40</sup>  |
| 2  | Jamie Vardy               | Leicester         | 9  | 5.91 <sup>-3.09</sup>  |
| 10 | Joshua King               | Watford           | 5  | 5.67 <sup>+0.67</sup>  |
| 11 | Callum Wilson             | Newcastle United  | 5  | 4.69 <sup>-0.31</sup>  |
| 18 | Teemu Pukki               | Norwich           | 5  | 4.69 <sup>-0.31</sup>  |



**The xG Philosophy** @xGPhilosophy · Oct 2  
Brighton (1.31) 0-0 (0.38) Arsenal

170

843

9.5K



**Brighton & Hove Albion** ✓  
@OfficialBHAFC

Replying to @xGPhilosophy

**Oh no, please not again**

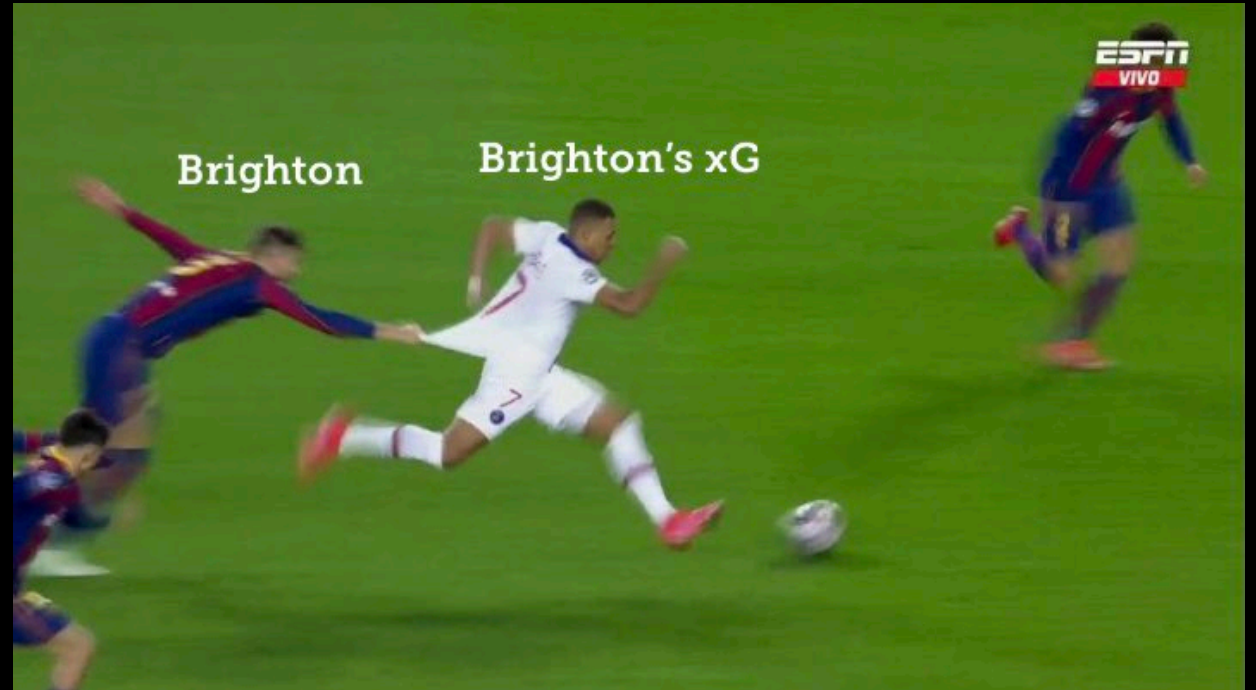
9:34 PM · Oct 2, 2021 · Twitter Web App

490 Retweets 74 Quote Tweets 14.1K Likes



Tweet your reply

Reply



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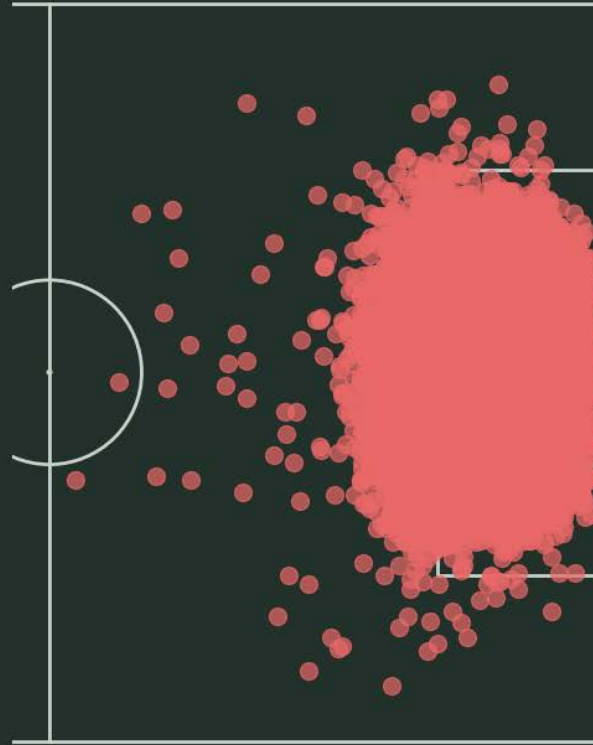


# 10165 shots

## 11 deęişken

|                              |                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------|
| Match_second                 | Şutun çekildięi dakikanın saniyesi                                                                  |
| Match_minute                 | Şutun çekildięi dakikan                                                                             |
| Player                       | Şutu çeken futbolcu                                                                                 |
| Position_x                   | Atışın metre cinsinden sahadaki konumu ( x-koordinatı )                                             |
| Position_y                   | Atışın sahadaki metre cinsinden konumu ( y-koordinatı )                                             |
| Play_type                    | Atışın yapıldığı oyun durumu (açık oyun, penaltı, direkt serbest vuruş, kornlerden direkt)          |
| BodyPart                     | Şut çekilen vücut kısmı (sol ayak, sağ ayak, kafa, dięer)                                           |
| Number_Intervening_Opponents | Şut anında hedefi engelleyen rakip oyuncuların sayısı (şutu atan oyuncunun bakış açısından)         |
| Number_Intervening_Teammates | Şut anında golü engelleyen takım arkadaşlarının sayısı (şutu atan oyuncunun bakış açısından)        |
| Interference_on_Shooter      | Defans oyuncularından şut atan oyuncuya uygulanan doğrudan müdahalenin derecesi (Düşük,Orta,Yüksek) |
| Result                       | Şutun sonucu (engellenen, kaçırılan, direktten dönen, kurtarılan, gol veya kendi kalesine gol).     |

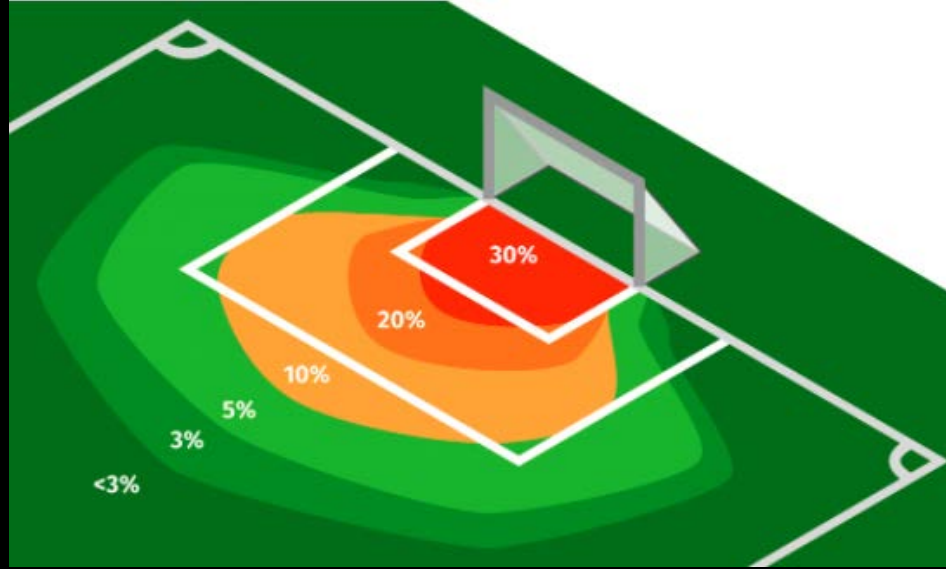
## Bertan Martini all shots



# eksik gözlem analizi

|                              |                                       |
|------------------------------|---------------------------------------|
| Match_minute                 | 0                                     |
| Match_second                 | 0                                     |
| Match_minute                 | 0                                     |
| Player                       | 0                                     |
| Position_x                   | 0                                     |
| Position_y                   | 0                                     |
| Play_type                    | 0                                     |
| BodyPart                     | 0                                     |
| Number_Intervening_Opponents | 0                                     |
| Number_Intervening_Teammates | 0                                     |
| Interference_on_Shooter      | 48 (Bu eventler verisetinden silindi) |
| Result                       | 0                                     |

# aykırı deęer analizi



Q1 = 0.01 ve Q3 = 0.99 deęerlerine gore sayısal deęiřkenlerde aykırı deęer bulunamadı

# kategorik deęişken analizi

| Number_Intervening_Opponents | TARGET_MEAN |
|------------------------------|-------------|
| 0                            | 0.697       |
| 1                            | 0.248       |
| 2                            | 0.087       |
| 3                            | 0.059       |
| 4                            | 0.044       |
| 5                            | 0.036       |
| 6                            | 0.031       |
| 7                            | 0.000       |
| 8                            | 0.000       |
| 10                           | 0.000       |

| Number_Intervening_Opponents | Ratio       |
|------------------------------|-------------|
| 2                            | 3811 37.491 |
| 3                            | 2581 25.391 |
| 1                            | 2874 28.403 |
| 4                            | 1032 10.152 |
| 5                            | 361 3.551   |
| 6                            | 131 1.289   |
| 0                            | 119 1.171   |
| 7                            | 47 0.462    |
| 8                            | 7 0.069     |
| 10                           | 1 0.010     |
| 11                           | 1 0.010     |

| BodyPart | TARGET_MEAN |
|----------|-------------|
| Head     | 0.121       |
| Left     | 0.122       |
| Right    | 0.102       |

| BodyPart | Ratio       |
|----------|-------------|
| Right    | 5013 49.316 |
| Left     | 3300 32.464 |
| Head     | 1852 18.219 |

| Interference_on_Shooter | TARGET_MEAN |
|-------------------------|-------------|
| High                    | 0.060       |
| Low                     | 0.148       |
| Medium                  | 0.106       |

| Interference_on_Shooter | Ratio       |
|-------------------------|-------------|
| Medium                  | 5116 50.330 |
| Low                     | 3375 33.202 |
| High                    | 1674 16.468 |

| Number_Intervening_Teammates | TARGET_MEAN |
|------------------------------|-------------|
| 0                            | 0.130       |
| 1                            | 0.056       |
| 2                            | 0.023       |
| 3                            | 0.078       |
| 4                            | 0.000       |
| 5                            | 0.000       |

| Number_Intervening_Teammates | Ratio       |
|------------------------------|-------------|
| 0                            | 7870 77.423 |
| 1                            | 1788 17.590 |
| 2                            | 399 3.925   |
| 3                            | 90 0.885    |
| 4                            | 15 0.148    |
| 5                            | 3 0.030     |

# özelliik mühendisliđi

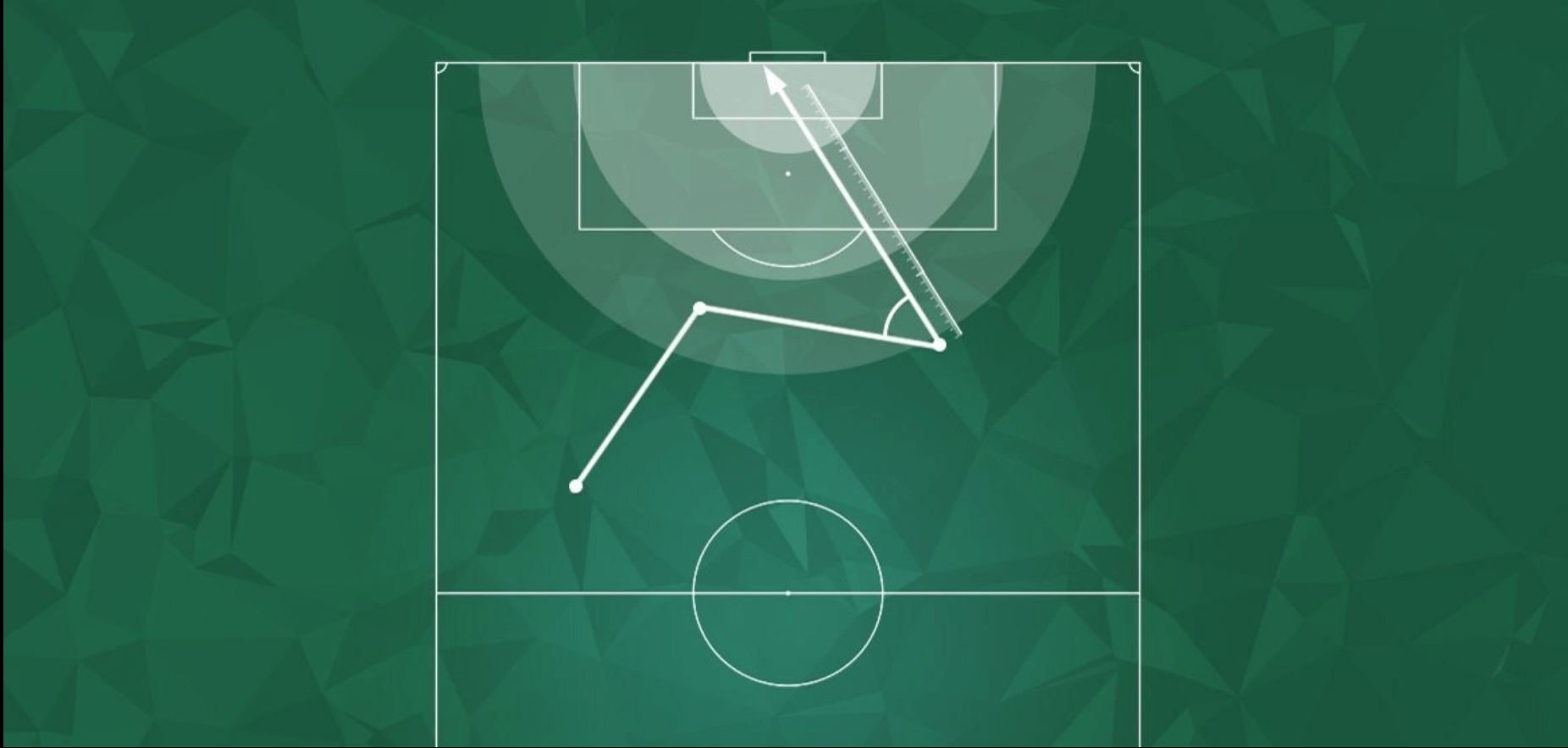
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|                          |                                       |
|--------------------------|---------------------------------------|
| isGoal                   | (1) gol (0) gol deđil                 |
| position_xM              | X lokasyonunun merkeze uzaklıđı       |
| position_yM              | Y lokasyonun kenar çizgisine uzaklıđı |
| distance_to_goalM        | Kale diređine uzaklık                 |
| distance_to_centerM      | Kale çizgisinin ortasına uzaklık      |
| angle                    | Kaleye olan açı                       |
| isFoot                   | (1) ayakla (0) diđer                  |
| isHead                   | (1) kafayla Őutu (0) diđer            |
| header_distance_to_goalM | Kafa vuruŐu kaleye uzaklık            |

ONE HOT ENCODER : BodyPart, Number\_Intervening\_Opponents, Number\_Intervening\_Teammates, Interference\_on\_Shooter  
 ROBUST SCALER : positions, position\_Xm, position\_yM, distance\_to\_goalM, distance\_to\_centerM, angle, header\_distance\_to\_goalM  
**BINARY: isHead, isFoot, isGoal**

|   | position_x                     | position_y     | position_xM                       | position_yM | isGoal                         | distance_to_goalM | distance_to_centerM            | angle  | isFoot                            | isHead | header_distance_to_goalM | \ |
|---|--------------------------------|----------------|-----------------------------------|-------------|--------------------------------|-------------------|--------------------------------|--------|-----------------------------------|--------|--------------------------|---|
| 0 | -0.937                         | 0.353          | -0.937                            | 0.353       | 0                              | 0.709             | -0.147                         | -0.769 | 1                                 | 0      | 0.000                    |   |
| 1 | -1.375                         | -0.921         | -1.375                            | -0.921      | 0                              | 1.271             | 0.587                          | -2.165 | 1                                 | 0      | 0.000                    |   |
| 2 | 0.208                          | -0.451         | 0.208                             | -0.451      | 0                              | -0.355            | -0.118                         | 0.009  | 0                                 | 1      | 11.278                   |   |
| 3 | 0.667                          | -0.491         | 0.667                             | -0.491      | 0                              | -0.683            | -0.059                         | 0.420  | 1                                 | 0      | 0.000                    |   |
| 4 | 0.375                          | -1.059         | 0.375                             | -1.059      | 0                              | -0.028            | 0.794                          | -0.045 | 1                                 | 0      | 0.000                    |   |
|   | Number_Intervening_Opponents_1 |                | Number_Intervening_Opponents_2    |             | Number_Intervening_Opponents_3 |                   | Number_Intervening_Opponents_4 |        | Number_Intervening_Opponents_5    |        | \                        |   |
| 0 | 0                              |                | 0                                 |             | 0                              |                   | 1                              |        | 0                                 |        |                          |   |
| 1 | 0                              |                | 0                                 |             | 0                              |                   | 1                              |        | 0                                 |        |                          |   |
| 2 | 0                              |                | 0                                 |             | 1                              |                   | 0                              |        | 0                                 |        |                          |   |
| 3 | 0                              |                | 1                                 |             | 0                              |                   | 0                              |        | 0                                 |        |                          |   |
| 4 | 1                              |                | 0                                 |             | 0                              |                   | 0                              |        | 0                                 |        |                          |   |
|   | Number_Intervening_Opponents_6 |                | Number_Intervening_Opponents_Rare |             | Number_Intervening_Teammates_1 |                   | Number_Intervening_Teammates_2 |        | Number_Intervening_Teammates_Rare |        | \                        |   |
| 0 | 0                              |                | 0                                 |             | 0                              |                   | 1                              |        | 0                                 |        |                          |   |
| 1 | 0                              |                | 0                                 |             | 1                              |                   | 0                              |        | 0                                 |        |                          |   |
| 2 | 0                              |                | 0                                 |             | 1                              |                   | 0                              |        | 0                                 |        |                          |   |
| 3 | 0                              |                | 0                                 |             | 0                              |                   | 0                              |        | 0                                 |        |                          |   |
| 4 | 0                              |                | 0                                 |             | 0                              |                   | 0                              |        | 0                                 |        |                          |   |
|   | BodyPartCode_2                 | BodyPartCode_3 | Interference_on_Shooter_Code_2    |             | Interference_on_Shooter_Code_3 |                   |                                |        |                                   |        |                          |   |
| 0 | 0                              | 0              | 1                                 |             | 0                              |                   |                                |        |                                   |        |                          |   |
| 1 | 0                              | 0              | 0                                 |             | 0                              |                   |                                |        |                                   |        |                          |   |
| 2 | 0                              | 1              | 0                                 |             | 1                              |                   |                                |        |                                   |        |                          |   |
| 3 | 1                              | 0              | 0                                 |             | 0                              |                   |                                |        |                                   |        |                          |   |
| 4 | 1                              | 0              | 1                                 |             | 0                              |                   |                                |        |                                   |        |                          |   |

# makine öğrenmesi modelleri

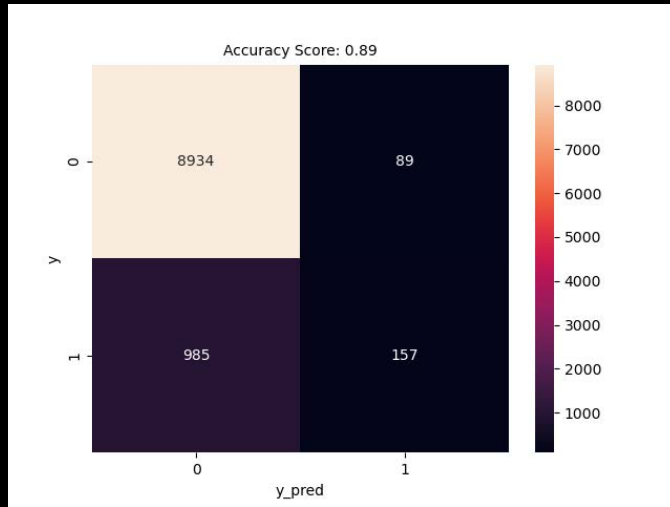




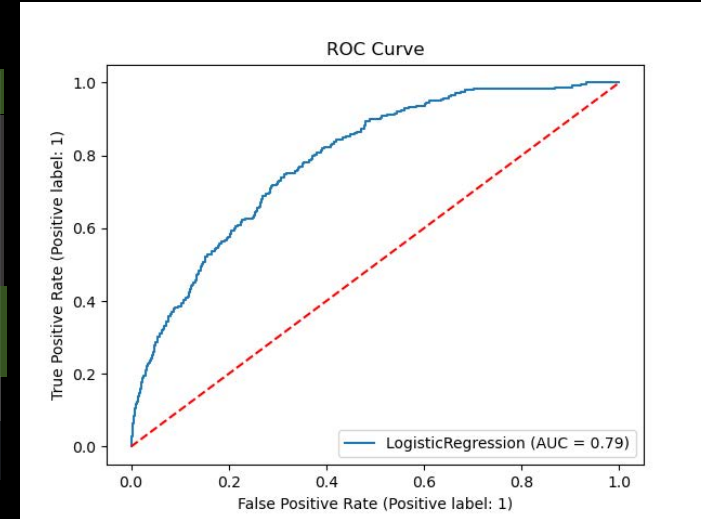
# iş problemi

Gol beklentisi ya da Expected Goal, oyunun belirli bir aşamasında sahadaki belirli bir konumdan atılan şutun gol olma olasılığını hesaplayarak bir ihtimalin kalitesini ölçen modeldir.





AUC: 0.8042 (LR)  
 AUC: 0.7003 (KNN)  
 AUC: 0.7324 (SVC)  
 AUC: 0.5934 (CART)  
 AUC: 0.7461 (RF)  
 AUC: 0.7957 (Adaboost)  
 AUC: 0.7997 (GBM)  
 AUC: 0.7759 (XGBoost)  
 AUC: 0.7869 (LightGBM)



# hiperparametre optimizasyonu

```
lr_params = {"penalty": ["l1", "l2", "elasticnet", "none"],
            "solver": ["newton-cg", "lbfgs", "liblinear", "sag", "saga"],
            "C": [100, 10, 1.0, 0.1, 0.01]}

ada_params = {"learning_rate": [0.01, 0.1],
            "n_estimators": [300, 500, 1500]}

gbm_params = {"learning_rate": [0.1, 0.01],
            "max_depth": [5, 8, 12, 20],
            "n_estimators": [100, 200]}

lightgbm_params = {"learning_rate": [0.01, 0.1],
            "n_estimators": [300, 500, 1500],
            "colsample_bytree": [0.5, 0.7, 1]}

classifiers = [('LR', LogisticRegression(), lr_params),
              ('Adaboost', AdaBoostClassifier(), ada_params),
              ('GBM', GradientBoostingClassifier(), gbm_params),
              ('LightGBM', LGBMClassifier(), lightgbm_params)]

best_models = {}

for name, classifier, params in classifiers:
    print(f"##### {name} #####")
    cv_results = cross_validate(classifier, X, y, cv=10, scoring=["roc_auc"])
    print(f"AUC (Before): {round(cv_results['test_roc_auc'].mean(), 4)}")

    gs_best = GridSearchCV(classifier, params, cv=10, n_jobs=-1, verbose=False).fit(X, y)
    final_model = classifier.set_params(**gs_best.best_params_)

    cv_results = cross_validate(final_model, X, y, cv=10, scoring=["roc_auc"])
    print(f"AUC (After): {round(cv_results['test_roc_auc'].mean(), 4)}")
    print(f"{name} best params: {gs_best.best_params_}", end="\n\n")

    best_models[name] = final_model
```

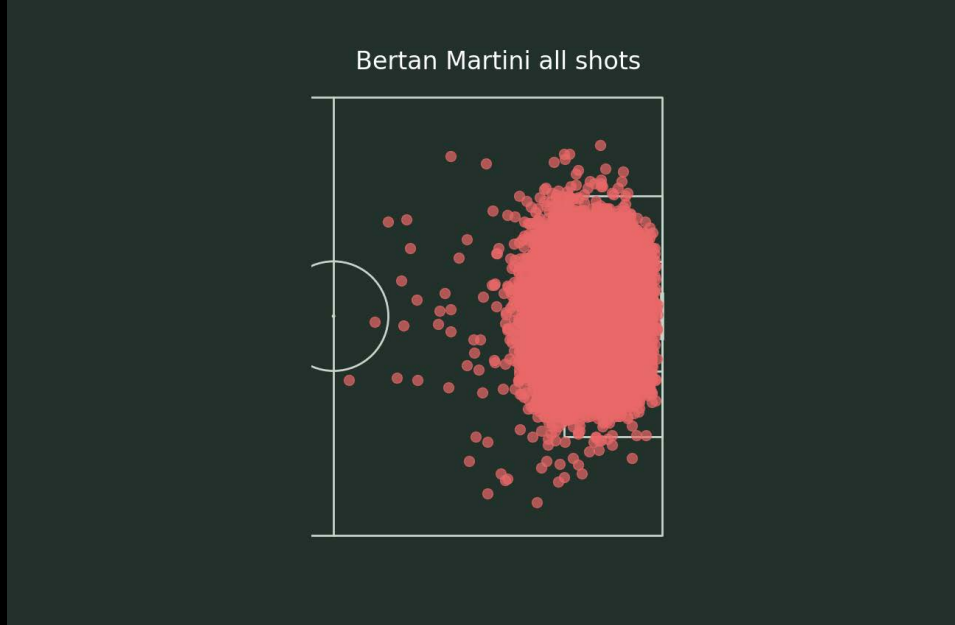
```
##### LR #####
AUC (Before): 0.8042
AUC (After): 0.8042
LR best params: {'C': 1.0, 'penalty': 'l2', 'solver': 'lbfgs'}

##### Adaboost #####
AUC (Before): 0.7957
AUC (After): 0.7994
Adaboost best params: {'learning_rate': 0.1, 'n_estimators': 500}

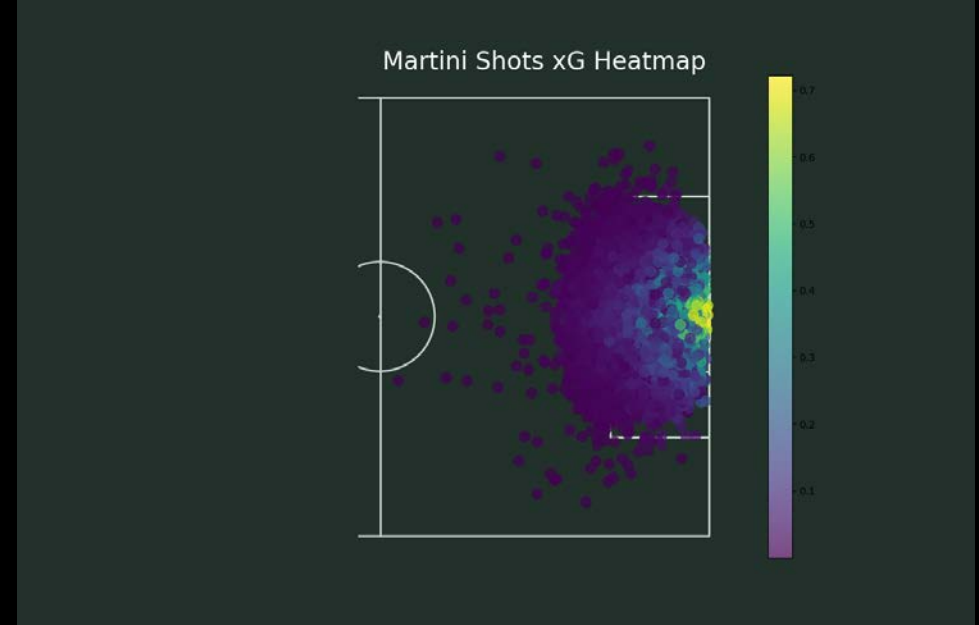
##### GBM #####
AUC (Before): 0.7997
AUC (After): 0.7821
GBM best params: {'learning_rate': 0.01, 'max_depth': 8, 'n_estimators': 200}

##### LightGBM #####
AUC (Before): 0.7869
AUC (After): 0.7938
LightGBM best params: {'colsample_bytree': 0.7, 'learning_rate': 0.01, 'n_estimators': 500}
```

# ŞUTLAR



# GOL BEKLENTİSİ



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