Principles of Data Science - Edward St John (210018085)

Table of Contents

Chapter 1 - Data Preparation

1.1 - Extraction of Data

In [58]:
```
# Data initially scraped from understat.com using script from:
# https://github.com/harryrgrove/understat_scrape/blob/master/init_data.py
# Script has been amended in order to only capture Premier League data from 2014 to 2020
```

In [299…
```
import os
import numpy as np
import itertools as it
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from mplsoccer import Pitch, VerticalPitch
```

In [12]:
```
# Data currently in multiple csv's split by team + year, need to create one csv containing all data
root_dir = os.getcwd()
leagues, seasons = ['epl'], np.arange(2014, 2021)

dfs = []
```

In [13]:
```
# Adding all shot data to one big csv
for league, season in it.product(leagues, seasons):
    path = '{}/raw_data/{}/{}'.format(root_dir, league, season)
    for sub_dir, dirs, files in os.walk(path):
        for file in files:
            if file.endswith('shot_df.pickle'):
                all_shots = pd.read_pickle(os.path.join(sub_dir, file))
                dfs.append(all_shots)

all_shots = pd.concat(dfs)
# Taking out penalties from shot data as not representative of finishing skill for this model
all_shots = all_shots[all_shots['situation'] != 'Penalty']
print(all_shots)
```

```
       shot_type   situation       result        xG minute team_score  \
14429   RightFoot    OpenPlay  BlockedShot  0.007046     33          1
14430        Head  FromCorner         Goal  0.076413     34          1
14435    LeftFoot    OpenPlay  BlockedShot  0.018911     56          1
14436    LeftFoot    OpenPlay    SavedShot  0.055782     56          1
14717    LeftFoot   SetPiece  MissedShots  0.021474     46          1
...           ...         ...          ...       ...    ...        ...
424117       Head   SetPiece  MissedShots  0.086541     61          0
424099   LeftFoot    OpenPlay    SavedShot  0.017523      2          0
424102   LeftFoot    OpenPlay    SavedShot  0.021521      9          0
```

```
424110   LeftFoot    OpenPlay    SavedShot  0.052311     43          0
424103  RightFoot  FromCorner  MissedShots  0.076302     10          0

       opponent_score                    name understat_id location  \
14429               2         Marouane Chamakh          905        a
14430               2          Brede Hangeland          933        a
14435               2           Jason Puncheon          514        a
14436               2           Jason Puncheon          514        a
14717               3           Damien Delaney          511        h
...               ...                      ...          ...      ...
424117              1          James Tarkowski         1665        a
424099              1  Johann Berg Gudmundsson         1663        a
424102              1            Dwight McNeil         6756        a
424110              1            Dwight McNeil         6756        a
424103              1              Jimmy Dunne         8481        a

                 team          opponent            assist  \
14429   Crystal Palace           Arsenal              None
14430   Crystal Palace           Arsenal    Jason Puncheon
14435   Crystal Palace           Arsenal  Marouane Chamakh
14436   Crystal Palace           Arsenal  Marouane Chamakh
14717   Crystal Palace          West Ham              None
...                ...               ...               ...
424117         Burnley  Sheffield United   Ashley Westwood
424099         Burnley  Sheffield United              None
424102         Burnley  Sheffield United              None
424110         Burnley  Sheffield United         Jack Cork
424103         Burnley  Sheffield United              None

                     date match_id season  \
14429  2014-08-16 17:30:00     4755   2014
14430  2014-08-16 17:30:00     4755   2014
14435  2014-08-16 17:30:00     4755   2014
14436  2014-08-16 17:30:00     4755   2014
14717  2014-08-23 15:00:00     4761   2014
...                    ...      ...    ...
424117 2021-05-23 15:00:00    14812   2020
424099 2021-05-23 15:00:00    14812   2020
424102 2021-05-23 15:00:00    14812   2020
424110 2021-05-23 15:00:00    14812   2020
424103 2021-05-23 15:00:00    14812   2020

                                      position
14429    (0.5679999923706055, 0.3370000076293945)
14430    (0.9619999694824218, 0.4470000076293945)
14435    (0.769000015258789, 0.29100000381469726)
14436                 (0.8080000305175781, 0.49)
14717    (0.8869999694824219, 0.2560000038146973)
...                                           ...
424117   (0.9530000305175781, 0.5279999923706055)
424099  (0.8009999847412109, 0.27399999618530274)
424102                (0.84, 0.23899999618530274)
424110               (0.82, 0.40400001525878904)
424103  (0.9019999694824219, 0.39799999237060546)

[66423 rows x 17 columns]
```

In [14]:

```
# Exporting new data to csv
all_shots.to_csv('all_data.csv')
```

Run code from here (after importing libraries above)

In [99]:

```
# Importing csv so code can run starting at this cell, otherwise would create file again if run from beginning
all_shots = pd.read_csv('all_data.csv')
```

1.2 - Data Analysis & Cleaning

1.2.1 - Investigating Structure of Data

In [100…

```
# Looking at the structure of our data
# Note: xG = Expected Goals, i.e. the probability of a shot going in the goal. Elaborated more in the report
print("{} rows, {} columns".format(all_shots.shape[0], all_shots.shape[1]))
display(all_shots.head())
```

```
66423 rows, 18 columns
```

	Unnamed:	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	or

	0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	op
0	14429	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	905	a	Crystal Palace	
1	14430	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	933	a	Crystal Palace	
2	14435	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	514	a	Crystal Palace	
3	14436	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	514	a	Crystal Palace	
4	14717	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	511	h	Crystal Palace	

In [101…

```
# Checking all columns are interpreted corrrectly (i.e. numerical columns identified as numerical etc)
all_shots.dtypes
```

Out[101…

```
Unnamed: 0          int64
shot_type          object
situation          object
result             object
xG                float64
minute              int64
team_score          int64
opponent_score      int64
name               object
understat_id        int64
location           object
team               object
opponent           object
assist             object
date               object
match_id            int64
season              int64
position           object
dtype: object
```

In [102…

```
# See how many unique values in each column
all_shots.nunique(axis=0)
```

Out[102…

```
Unnamed: 0        66423
shot_type             4
situation             4
result                6
xG                65873
minute              105
team_score           10
opponent_score       10
name               1202
understat_id       1204
location              2
team                 31
opponent             31
assist             1195
date               1595
match_id           2660
season                7
position          45960
dtype: int64
```

All looks correct from above, e.g. right number of seasons, shot type, location (home or away) etc

In [103…

```
# Summarise data (with extra formatting)
all_shots.describe().apply(lambda s: s.apply(lambda x: format(x, 'f')))
```

Out[103…

	Unnamed: 0	xG	minute	team_score	opponent_score	understat_id	match_id	season
count	66423.000000	66423.000000	66423.000000	66423.000000	66423.000000	66423.000000	66423.000000	66423.000000
mean	194610.208602	0.101159	48.834425	1.528627	1.265255	1932.522861	7123.300619	2016.954157

std	134384.443486	0.143893	26.541148	1.323074	1.188578	2270.326816	4750.391826	2.000397
min	14424.000000	0.000000	0.000000	0.000000	0.000000	12.000000	81.000000	2014.000000
25%	58355.500000	0.024683	26.000000	1.000000	0.000000	606.000000	3411.000000	2015.000000
50%	182791.000000	0.051152	49.000000	1.000000	1.000000	782.000000	7283.000000	2017.000000
75%	324079.500000	0.094480	72.000000	2.000000	2.000000	1740.000000	11714.000000	2019.000000
max	424195.000000	0.979887	104.000000	9.000000	9.000000	9524.000000	14814.000000	2020.000000

1.2.2 - Identifying Missing Values

In [104…
```
# Surprising to find xG values with a probability of 0 above in the 'min' column, need to investigate further
all_shots.loc[all_shots['xG'] == 0]
```

Out[104…

	Unnamed: 0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	tea
505	15179	RightFoot	OpenPlay	OwnGoal	0.0	10	4	2	John Terry	917	h	Chels
1040	15400	OtherBodyPart	SetPiece	OwnGoal	0.0	81	2	2	Harry Kane	647	a	Tottenha
1485	21965	OtherBodyPart	OpenPlay	OwnGoal	0.0	85	0	3	Jan Vertonghen	640	a	Tottenha
1722	18547	Head	FromCorner	OwnGoal	0.0	68	1	4	Jonjo Shelvey	769	a	Swans
2647	16072	LeftFoot	OpenPlay	OwnGoal	0.0	55	1	2	Kieran Gibbs	545	h	Arser
...	...	...	...	...	...	...	...	...	...	...	...	
64692	387142	LeftFoot	FromCorner	OwnGoal	0.0	9	0	2	Federico Fernández	708	h	Newcas Unit
64746	394234	Head	FromCorner	OwnGoal	0.0	41	1	1	Matt Ritchie	461	h	Newcas Unit
64902	409684	LeftFoot	OpenPlay	OwnGoal	0.0	85	1	1	Ciaran Clark	875	h	Newcas Unit
65235	402477	LeftFoot	OpenPlay	OwnGoal	0.0	33	0	9	Jan Bednarek	6042	a	Southampt
66045	378289	LeftFoot	OpenPlay	OwnGoal	0.0	49	2	4	Erik Pieters	887	a	Burnl

239 rows × 18 columns

In [106…
```
# These are all attributed to own goals, which won't have an affect on a player's finishing
# ability. We can take this data out.

# Removing own goals data
all_shots = all_shots.drop(all_shots[all_shots.xG == 0].index)
# Checking all values correctly removed
all_shots.loc[all_shots['xG'] == 0].head()
```

Out[106…

	Unnamed: 0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	opponent	assist	date

In [107…
```
# Dealt with '0' values, now need to investigate missing data
all_shots.isnull()
```

Out[107…

	Unnamed: 0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	opponent	assi
0	False	False	False	False	False	False	False	False	False	False	False	False	False	Tru
1	False	False	False	False	False	False	False	False	False	False	False	False	False	Fals
2	False	False	False	False	False	False	False	False	False	False	False	False	False	Fals

3	False	False	False	False	False	False	False	False	False	False	False	False	False	Fals
4	False	False	False	False	False	False	False	False	False	False	False	False	False	Tru
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
66418	False	False	False	False	False	False	False	False	False	False	False	False	False	Fals
66419	False	False	False	False	False	False	False	False	False	False	False	False	False	Tru
66420	False	False	False	False	False	False	False	False	False	False	False	False	False	Tru
66421	False	False	False	False	False	False	False	False	False	False	False	False	False	Fals
66422	False	False	False	False	False	False	False	False	False	False	False	False	False	Tru

66184 rows × 18 columns

In [108…

```
# Further investigation into missing values, searching by column
print(all_shots.isnull().any())
print(all_shots.isnull().sum().sum())
```

```
Unnamed: 0        False
shot_type         False
situation         False
result            False
xG                False
minute            False
team_score        False
opponent_score    False
name              False
understat_id      False
location          False
team              False
opponent          False
assist             True
date              False
match_id          False
season            False
position          False
dtype: bool
16625
```

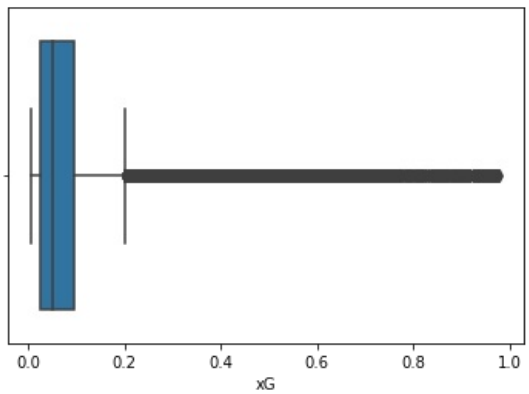
We can see there are a total of 16,625 missing values in this dataset. However, these all come under the 'assist' column which is expected to have some missing values given not every goal attempt has someone who assisted it.

1.2.3 - Identifying Outliers

In [109…

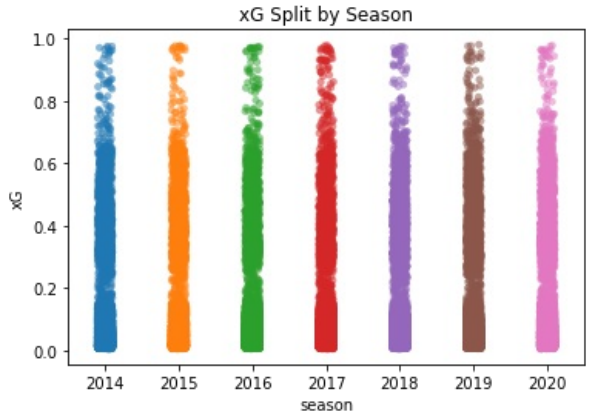
```
# Visualisting xG as a boxplot to detect outliers
sns.boxplot(x=all_shots['xG'])
```

Out[109… <AxesSubplot:xlabel='xG'>



In [110…

```
# Dataset too big to gain any value from a boxplot, need to split by different years
xG_Year = sns.stripplot(y='xG', x='season',
                        data=all_shots,
                        jitter=True,
                        marker='o',
                        alpha=0.5,).set(title='xG Split by Season')
```



All distributions look similar across the years which is a good sign, no outliers stick out. The summary statistics in Section 1.2.1 show there are no values below 0 or above 1 which would classify as outliers as it's impossible for xG (which is a measure of probability) to be below 0 or above 1.

Chapter 2 - Data Derivation

2.1 - Extracting Important Variables

In [111…

```
# Some of the variables in the data won't be useful at all for out analysis on finishing skill,
# so they are going to be removed

# First column isn't needed (this is just acting like an index when we already have our own)
del all_shots['Unnamed: 0']

# This is just the id understat use to identify the event on their end
del all_shots['understat_id']

# Date can be removed as we already have the season year and the match id to identify the specific match
del all_shots['date']

# Note: assist data is being left in which may not be used for this finishing skill analysis, but
# may potentially be used as additional analysis later on

all_shots.head()
```

Out[111…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

2.2 - Adding Distance to Goal Variable

In [112…

```
# Removing brackets from position variable to split x and y values easier
# Taking away first character
all_shots['position'] = all_shots['position'].apply(lambda x : x[1:])
# Taking away last character
all_shots['position'] = all_shots['position'].apply(lambda x : x[:-1])
all_shots.head()
```

Out[112…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4

4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

In [113…

```
# Splitting x and y values using the comma in the middle
x = []
y = []

for row in all_shots['position']:
    x.append(row.split(',')[0])
    y.append(row.split(',')[1])

# Adding columns to data
all_shots['x'] = x
all_shots['y'] = y

all_shots.head()
```

Out[113…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

In [114…

```
# Checking datatype of new columns
all_shots.dtypes
```

Out[114…

```
shot_type          object
situation          object
result             object
xG                float64
minute              int64
team_score          int64
opponent_score      int64
name               object
location           object
team               object
opponent           object
assist             object
match_id            int64
season              int64
position           object
x                  object
y                  object
dtype: object
```

In [115…

```
# Need to convert x and y to numerical columns
all_shots['x'] = pd.to_numeric(all_shots['x'])
all_shots['y'] = pd.to_numeric(all_shots['y'])
all_shots.dtypes
```

Out[115…

```
shot_type          object
situation          object
result             object
xG                float64
minute              int64
team_score          int64
opponent_score      int64
name               object
location           object
team               object
opponent           object
assist             object
match_id            int64
season              int64
position           object
x                 float64
```

```
y                 float64
dtype: object
```

In [116…

```
# Converting x and y values into distances from goal
# i.e. x needs to be (1-x) as currently a value of 0.9 means it is 0.1 away from the goal
# y needs to be the distance from 0.5 as the value of 0.5 is where the goal is (in the middle of the line)

all_shots['x'] = 1 - all_shots['x']
all_shots['y'] = all_shots['y'] - 0.5
all_shots.head()
```

Out[116…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

In [117…

```
all_shots.dtypes
```

Out[117…

```
shot_type          object
situation          object
result             object
xG                float64
minute              int64
team_score          int64
opponent_score      int64
name               object
location           object
team               object
opponent           object
assist             object
match_id            int64
season              int64
position           object
x                 float64
y                 float64
dtype: object
```

In [118…

```
# Adding distance column using Pythagoras

all_shots['distance'] = np.sqrt((np.square(all_shots['x']) + np.square(all_shots['y'])))
all_shots.head()
```

Out[118…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

2.3 - Adding Long Shot Variable

In [119…

```
# Defining long shot as anything past the penalty arc outside the 18-yard box

# Need to calculate a scale for converting yards to our distance values
# A penalty is taken at 12 yards, which equals an x position value of 0.885 from our data (or 0.115 away from goa
```

```
scale = 0.115 / 12
scale
```

Out[119… 0.009583333333333334

In [120…
```
# Penalty arc is 22 yards away from goal, need to convert to our distance values
arc_distance = 22 * scale
arc_distance
```

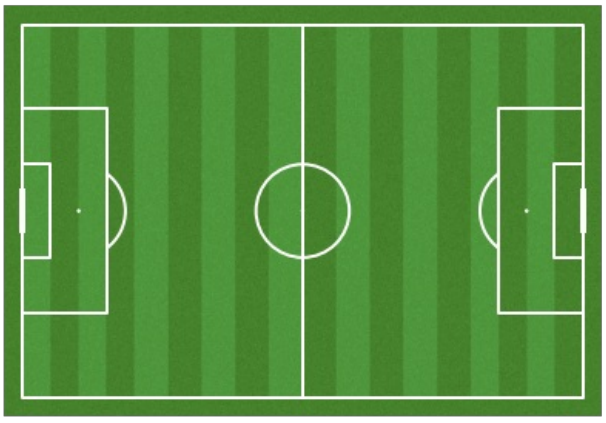
Out[120… 0.21083333333333334

In [121…
```
# Generating long_shot variable using arc distance above
longshot = []
for value in all_shots['distance']:
    if value >= 0.21083333333333334:
        longshot.append(1)
    else:
        longshot.append(0)

all_shots['long_shot'] = longshot
all_shots.head()
```

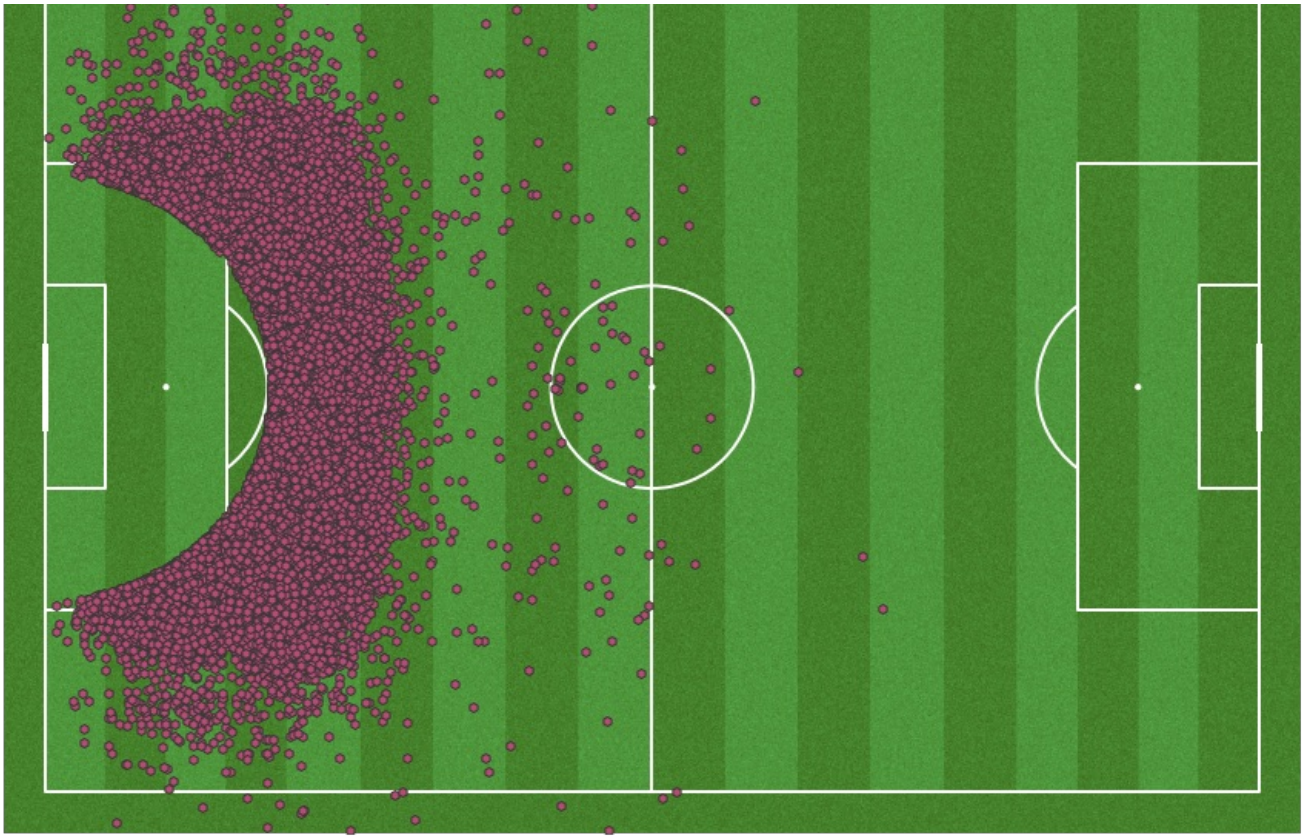
Out[121…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Marouane Chamakh	a	Crystal Palace	Arsenal	NaN	4
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon	4
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh	4
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN	4

In [301…
```
# Visualising pitch to show what is defined as a long shot

pitch = Pitch(pitch_color='grass', line_color='white',
              stripe=True, pitch_length=105, pitch_width=68)
fig, ax = pitch.draw()
```



In [343…
```
# Plotting long shots on pitch
# Unfortunately unable to standardise data as mplsoccer library doesn't support Understat data, so we
# have to roughly guess the scale factors

fig, ax = pitch.draw(figsize=(12, 10))
sc = pitch.scatter(long_shots.x*106, long_shots.y*100+40,
                   c='#b94b75',  # color for scatter in hex format
                   edgecolors='#383838',
                   marker='h',
                   ax=ax)
```



2.4 - Slicing Shot Data by Player

In [122…

```
# Slicing data frame based on unique player names

UniquePlayers = all_shots.name.unique()

# Dictionary to store all player names in
PlayerDict = {name : pd.DataFrame for name in UniquePlayers}

# For loop to return the shot data when name input equals name column in all_shots
for name in PlayerDict.keys():
    PlayerDict[name] = all_shots[:][all_shots.name == name]
```

In [123…

```
# Testing dictionary works
PlayerDict['Neal Maupay'].head()
```

Out[123…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	r
54989	LeftFoot	OpenPlay	Goal	0.394656	76	3	0	Neal Maupay	a	Brighton	Watford	Lewis Dunk	
54998	RightFoot	FromCorner	MissedShots	0.058196	90	1	1	Neal Maupay	h	Brighton	West Ham	Florin Andone	
54999	RightFoot	OpenPlay	MissedShots	0.461642	71	1	1	Neal Maupay	h	Brighton	West Ham	Glenn Murray	
55007	RightFoot	OpenPlay	SavedShot	0.076787	5	0	2	Neal Maupay	h	Brighton	Southampton	Leandro Trossard	
55008	Head	FromCorner	BlockedShot	0.311387	6	0	2	Neal Maupay	h	Brighton	Southampton	Leandro Trossard	

2.5 - Adding Goal Variable

In [125…

```
# Finding where goals were scored

# Adding G column for goals (1 for a goal, 0 for not)
all_shots['G'] = 0
# Setting value of 1 where there is a goal
all_shots.loc[all_shots['result'] == 'Goal', 'G'] = 1
all_shots.head()
```

Out[125…

	shot_type	situation	result	xG	minute	team_score	opponent_score	name	location	team	opponent	assist	match
								Marouane		Crystal			

0	RightFoot	OpenPlay	BlockedShot	0.007046	33	1	2	Chamakh	a	Palace	Arsenal	NaN
1	Head	FromCorner	Goal	0.076413	34	1	2	Brede Hangeland	a	Crystal Palace	Arsenal	Jason Puncheon
2	LeftFoot	OpenPlay	BlockedShot	0.018911	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh
3	LeftFoot	OpenPlay	SavedShot	0.055782	56	1	2	Jason Puncheon	a	Crystal Palace	Arsenal	Marouane Chamakh
4	LeftFoot	SetPiece	MissedShots	0.021474	46	1	3	Damien Delaney	h	Crystal Palace	West Ham	NaN

Chapter 3 - Construction of Models

3.1 - Creating General Model

In [124…

```
# Simple indicator of finishing skill is to assess over / underperformance of xG compared to actual goals
# Small sample sizes can be far too skewed doing this, a constant needs to be added to smooth the sample to
# provide better predictions

# Need to find the optimal constant, not too small to have unreasonable results and not too big as that it
# would show roughly xG = G meaning everyone has the same average finishing skill

# Constructing our simple model (G = Goals)
# simple = (G  + c) / (xG + c)
```

In [219…

```
# Grouping xG by season
xGbySeason = all_shots.groupby(['name', 'season'])[['xG','G']].sum()

# Taking out seasons with < 3 xG to just have reasonable samples
xGbySeason = xGbySeason.loc[xGbySeason['xG'] >= 3]
xGbySeason.head()
```

Out[219…

		xG	G
name	**season**		
Aaron Connolly	**2019**	4.553526	3
	2020	4.464137	2
Aaron Ramsey	**2014**	6.636926	6
	2015	8.614329	5
	2016	3.505755	1

In [204…

```
# Iterating predictions through each player + each value of c, adding results to a df called error_df

error_df = pd.DataFrame(columns=["player", "train_season", "test_season", "c", "sq_error"])

for player in xGbySeason.index.get_level_values("name"):
    for season_x, season_y, c in it.product(xGbySeason.xs(player).index, xGbySeason.xs(player).index, range(0, 15
        if season_x != season_y:
            row = {
                    "player": player,
                    "train_season": season_x,
                    "test_season": season_y,
                    "c": c,
                    "sq_error": (xGbySeason.loc[(player, season_y), "G"] - (((xGbySeason.loc[(player, season_x),
                }
            error_df.loc[len(error_df)] = row
```

In [205…

```
error_df
```

Out[205…

	player	train_season	test_season	c	sq_error
0	Aaron Connolly	2019	2020	0	0.885685
1	Aaron Connolly	2019	2020	10	3.950593
2	Aaron Connolly	2019	2020	20	4.759757
3	Aaron Connolly	2019	2020	30	5.123114
4	Aaron Connolly	2019	2020	40	5.329072
...	...	...	...	...	...
117775	Álvaro Morata	2018	2017	100	7.400210

117776	Álvaro Morata	2018	2017	110	7.486630
117777	Álvaro Morata	2018	2017	120	7.559766
117778	Álvaro Morata	2018	2017	130	7.622460
117779	Álvaro Morata	2018	2017	140	7.676798

117780 rows × 5 columns

In [206…
```
# Collating average of errors for each value of c to find minimum (and therefore optimal c value)
average_c = error_df.groupby(['c'])[['sq_error']].mean()
average_c
```

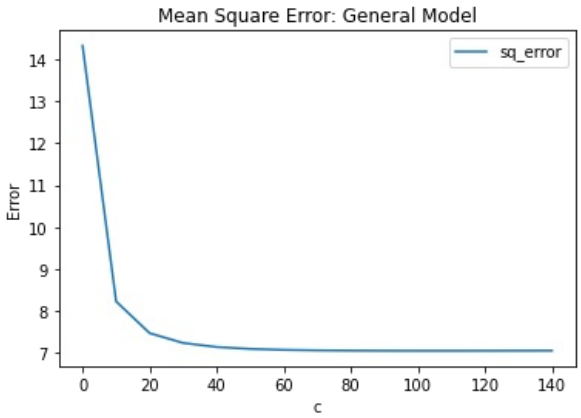
Out[206…

c	sq_error
0	14.321574
10	8.226923
20	7.471128
30	7.236911
40	7.140887
50	7.095662
60	7.072746
70	7.060794
80	7.054652
90	7.051755
100	7.050736
110	7.050825
120	7.051573
130	7.052710
140	7.054068

Optimal value of c for general model = 100

In [290…
```
# Creating plot showing optimal c value
general_plot = error_df.groupby(['c'])[['sq_error']].mean().plot(kind='line', title='Mean Square Error: General M
general_plot.set_ylabel('Error')
```

Out[290… `Text(0, 0.5, 'Error')`



3.2 - Creating Long Shot Model

In [222…
```
# New dataframe just including long shots
long_shots = all_shots.loc[all_shots['long_shot'] == 1]

# Grouping xG by season to ignore seasons with less than 3 xG total (too small a sample size)
xGbySeason_long = long_shots.groupby(['name', 'season'])[['xG','G']].sum()

# Taking out seasons with < 0.5 total long shot xG to just have reasonable samples
```

```
xGbySeason_long = xGbySeason_long.loc[xGbySeason_long['xG'] >= 0.5]
xGbySeason_long
```

Out[222…

		xG	G
name	**season**		
Aaron Cresswell	**2015**	0.769186	2
	2017	0.586581	1
	2020	0.604298	0
Aaron Mooy	**2017**	0.533629	0
	2018	0.990780	1
...	**...**	...	...
Yves Bissouma	**2018**	0.522795	0
	2020	0.791500	1
Zlatan Ibrahimovic	**2016**	1.763802	5
Álvaro Morata	**2017**	0.586336	0
Ángel Di María	**2014**	1.230301	1

634 rows × 2 columns

In [227…

```
# Iterating predictions through each player + each value of c, adding results to a df called error_df_long
# Lower test values of c (with smaller steps) used as xG is a lot lower for all players meaning a lower optimal
# smoothing constant is expected

error_df_long = pd.DataFrame(columns=["player", "train_season", "test_season", "c", "sq_error"])

for player in xGbySeason_long.index.get_level_values("name"):
    for season_x, season_y, c in it.product(xGbySeason_long.xs(player).index, xGbySeason_long.xs(player).index, r
        if season_x != season_y:
            row = {
                    "player": player,
                    "train_season": season_x,
                    "test_season": season_y,
                    "c": c,
                    "sq_error": (xGbySeason_long.loc[(player, season_y), "G"] - (((xGbySeason_long.loc[(player, s
                }
            error_df_long.loc[len(error_df_long)] = row
```

In [228…

```
error_df_long.head()
```

Out[228…

	player	train_season	test_season	c	sq_error
0	Aaron Cresswell	2015	2017	0	0.275836
1	Aaron Cresswell	2015	2017	2	0.023318
2	Aaron Cresswell	2015	2017	4	0.068663
3	Aaron Cresswell	2015	2017	6	0.094103
4	Aaron Cresswell	2015	2017	8	0.109619

In [229…

```
# Collating average of errors for each value of c to find minimum (and therefore optimal c value)
average_c_long = error_df_long.groupby(['c'])[['sq_error']].mean()
average_c_long
```

Out[229…

	sq_error
c	
0	2.293442
2	1.177577
4	1.113307
6	1.101956
8	1.100488
10	1.101534
12	1.103220
14	1.104982
16	1.106641

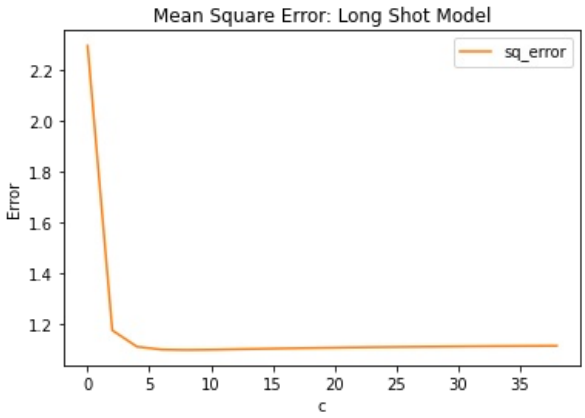
18	1.108146
20	1.109494
22	1.110697
24	1.111771
26	1.112732
28	1.113595
30	1.114373
32	1.115077
34	1.115717
36	1.116300
38	1.116834

Optimal value of c for long shot model = 8

In [298…

```
# Creating plot showing optimal c value
long_plot = error_df_long.groupby(['c'])[['sq_error']].mean().plot(kind='line', title='Mean Square Error: Long Sh
long_plot.set_ylabel('Error')
```

Out[298… `Text(0, 0.5, 'Error')`



3.2 - Creating Short Shot Model

In [232…

```
# New dataframe just including short shots
short_shots = all_shots.loc[all_shots['long_shot'] == 0]

# Grouping xG by season to ignore seasons with less than 3 xG total (too small a sample size)
xGbySeason_short = short_shots.groupby(['name', 'season'])[['xG','G']].sum()

# Taking out seasons with < 2 total short shot xG to just have reasonable samples
xGbySeason_short = xGbySeason_short.loc[xGbySeason_short['xG'] >= 2]
xGbySeason_short
```

Out[232…

		xG	G
name	**season**		
Aaron Connolly	**2019**	4.123171	2
	2020	4.198505	2
Aaron Lennon	**2015**	2.035972	4
Aaron Mooy	**2019**	2.013157	2
Aaron Ramsey	**2014**	5.893585	6
...	**...**	...	...
Zanka	**2017**	2.244065	0
Zlatan Ibrahimovic	**2016**	10.590658	10
Álvaro Morata	**2017**	13.318368	11
	2018	6.141232	5
Álvaro Negredo	**2016**	6.844914	7

847 rows × 2 columns

In [242…

```
# Iterating predictions through each player + each value of c, adding results to a df called error_df_short
# Higher test values of c (with a larger step) used as xG is a higher for all players meaning a higher optimal
# smoothing constant is expected

error_df_short = pd.DataFrame(columns=["player", "train_season", "test_season", "c", "sq_error"])

for player in xGbySeason_short.index.get_level_values("name"):
    for season_x, season_y, c in it.product(xGbySeason_short.xs(player).index, xGbySeason_short.xs(player).index,
        if season_x != season_y:
            row = {
                    "player": player,
                    "train_season": season_x,
                    "test_season": season_y,
                    "c": c,
                    "sq_error": (xGbySeason_short.loc[(player, season_y), "G"] - (((xGbySeason_short.loc[(player,
                }
            error_df_short.loc[len(error_df_short)] = row
```

In [243…

```
error_df_short.head()
```

Out[243…

	player	train_season	test_season	c	sq_error
0	Aaron Connolly	2019	2020	0	0.001335
1	Aaron Connolly	2019	2020	20	3.345163
2	Aaron Connolly	2019	2020	40	3.985917
3	Aaron Connolly	2019	2020	60	4.241494
4	Aaron Connolly	2019	2020	80	4.378721

In [244…

```
# Collating average of errors for each value of c to find minimum (and therefore optimal c value)
average_c_short = error_df_short.groupby(['c'])[['sq_error']].mean()
average_c_short
```

Out[244…

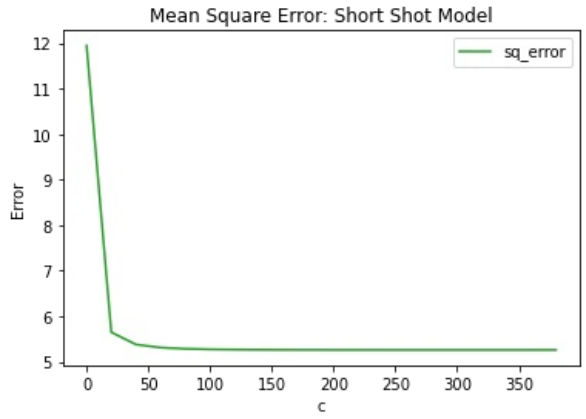
	sq_error
c	
0	11.944561
20	5.649059
40	5.379894
60	5.311906
80	5.286179
100	5.274313
120	5.268169
140	5.264749
160	5.262757
180	5.261569
200	5.260856
220	5.260436
240	5.260201
260	5.260088
280	5.260053
300	5.260070
320	5.260123
340	5.260198
360	5.260288
380	5.260387

Optimal value of c for short shot model = 280

In [297…

```
# Creating plot showing optimal c value
short_plot = error_df_short.groupby(['c'])[['sq_error']].mean().plot(kind='line', title='Mean Square Error: Short
short_plot.set_ylabel('Error')
```

Out[297… Text(0, 0.5, 'Error')



Chapter 4 - Predicting on New Data

4.1 - Importing 2021 Data

In [245…

```
# Importing new 2021 data (as at GW18) for assessing performance of all 3 models
all_shots_2021 = pd.read_csv('all_shots_2021.csv')
all_shots_2021.head()
```

Out[245…

	Unnamed: 0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	oppo
0	425981	RightFoot	FromCorner	MissedShots	0.013682	19	0	3	Lukas Rupp	62	h	Norwich	Live
1	426009	LeftFoot	OpenPlay	MissedShots	0.027758	89	0	3	Lukas Rupp	62	h	Norwich	Live
2	425990	Head	OpenPlay	BlockedShot	0.026904	44	0	3	Lukas Rupp	62	h	Norwich	Live
3	426007	RightFoot	OpenPlay	MissedShots	0.009881	86	0	3	Max Aarons	7688	h	Norwich	Live
4	426005	LeftFoot	SetPiece	BlockedShot	0.133259	86	0	3	Grant Hanley	7690	h	Norwich	Live

In [246…

```
# Adding goals column to 2021 data

# Adding G column for goals (1 for a goal, 0 for not)
all_shots_2021['G'] = 0
# Setting value of 1 where there is a goal
all_shots_2021.loc[all_shots_2021['result'] == 'Goal', 'G'] = 1
all_shots_2021.head()
```

Out[246…

	Unnamed: 0	shot_type	situation	result	xG	minute	team_score	opponent_score	name	understat_id	location	team	oppo
0	425981	RightFoot	FromCorner	MissedShots	0.013682	19	0	3	Lukas Rupp	62	h	Norwich	Live
1	426009	LeftFoot	OpenPlay	MissedShots	0.027758	89	0	3	Lukas Rupp	62	h	Norwich	Live
2	425990	Head	OpenPlay	BlockedShot	0.026904	44	0	3	Lukas Rupp	62	h	Norwich	Live
3	426007	RightFoot	OpenPlay	MissedShots	0.009881	86	0	3	Max Aarons	7688	h	Norwich	Live
4	426005	LeftFoot	SetPiece	BlockedShot	0.133259	86	0	3	Grant Hanley	7690	h	Norwich	Live

4.2 - Model Prediction

In [253…
```
# Grouping 2021 xG and G
xG_2021 = all_shots_2021.groupby(['name'])[['xG','G']].sum()
xG_2021
```

Out[253…

name	xG	G
Aaron Connolly	0.599489	0
Aaron Cresswell	0.448853	1
Aaron Lennon	0.082107	0
Aaron Wan-Bissaka	0.062908	0
Abdoulaye Doucouré	1.609352	2
...	...	...
Yerry Mina	0.043036	0
Yoane Wissa	0.701886	2
Youri Tielemans	1.952338	4
Yves Bissouma	0.420949	0
Zanka	0.142173	1

384 rows × 2 columns

In [255…
```
# Separating 2020 data for testing
all_shots_2020 = all_shots.loc[all_shots['season'] == 2020]
xG_2020 = all_shots_2020.groupby(['name'])[['xG','G']].sum()
xG_2020
```

Out[255…

name	xG	G
Aaron Connolly	4.464137	2
Aaron Cresswell	0.883464	0
Aaron Wan-Bissaka	0.932454	2
Abdoulaye Doucouré	2.369523	2
Aboubakar Kamara	0.654920	0
...	...	...
Xherdan Shaqiri	0.424721	0
Yan Valery	0.292914	0
Yerry Mina	1.749434	2
Youri Tielemans	2.645866	4
Yves Bissouma	1.076823	1

432 rows × 2 columns

In [261…
```
# Finding players who played in both 2020 and 2021 to make a sample:

# Appending both dfs together, note removed columns / new variables made above won't be present in both
# we only need the xG, G, season and name variables
xG_2020_2021_df = all_shots_2020.append(all_shots_2021)
xG_2020_2021 = xG_2020_2021_df.groupby(['name', 'season'])[['xG','G']].sum()
xG_2020_2021
```

Out[261…

name	season	xG	G
Aaron Connolly	**2020**	4.464137	2
	2021	0.599489	0
Aaron Cresswell	**2020**	0.883464	0
	2021	0.448853	1
Aaron Lennon	**2021**	0.082107	0
...	**...**	...	...

Youri Tielemans	**2020**	2.645866	4
	2021	1.952338	4
Yves Bissouma	**2020**	1.076823	1
	2021	0.420949	0
Zanka	**2021**	0.142173	1

816 rows × 2 columns

In [272…

```
error_df_test = pd.DataFrame(columns=["player", "train_season", "test_season", "c", "sq_error"])

for player in xG_2020_2021.index.get_level_values("name"):
    for season_x, season_y, c in it.product(xG_2020_2021.xs(player).index, xG_2020_2021.xs(player).index, (100, 8
        if season_x == 2020:
            if season_y == 2021:
                row = {
                    "player": player,
                    "train_season": season_x,
                    "test_season": season_y,
                    "c": c,
                    "sq_error": (xG_2020_2021.loc[(player, season_y), "G"] - (((xG_2020_2021.loc[(player, season_
                    }
                error_df_test.loc[len(error_df_test)] = row
```

In [274…

```
# Collating average of errors for each model to find minimum (and therefore optimal model)
average_c_test = error_df_test.groupby(['c'])[['sq_error']].mean()
average_c_test
```

Out[274…

c	sq_error
8	1.041262
100	0.941822
280	0.938917

We can see a c value of 280 provides the lowest MSE, showing the short shot model seeming to be the best predictor surprisingly.

In [ ]: