Final-Project-SJaras-1

May 30, 2020

1 Title: Final Project Data Exploration and Data Analysis

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1.1 Import Libraries

Import other modules

[1]:
```
import csv
import sys
import time

import matplotlib.mlab as mlab
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import statsmodels.formula.api as smf
import yaml

%matplotlib inline
from IPython.display import set_matplotlib_formats
from scipy import stats as scistats

# iplclasses: module for classes that used in converting per match yaml files␣
↪to consolidated data frame
# pmfcdf: module to calculate PMF and CDF
# categoricalcorr: module to find correlation with categorical variables
# hypothesistest: module to test null hypothesis
from iplhelpers import categoricalcorr as cc
from iplhelpers import hypothesistest as hptest
from iplhelpers import iplclasses, pmfcdf
from iplhelpers import yamlutils as yu
from iplhelpers import ziputils as zp
```

1.2 Configurations

Configurations for pandas and matplot library

[2]:
```
pd.set_option("display.max_rows", 10000)
pd.set_option("display.max_columns", 20)
pd.set_option("display.width", None)

set_matplotlib_formats("png", "pdf")
plt.style.use(
    "seaborn-darkgrid"
)  # fivethirtyeight,ggplot,seaborn-darkgrid,seaborn-whitegrid
```

```
plt.rcParams["figure.figsize"] = [24, 12]
```

1.3 Read Yaml File

Test Yaml File Reading

[3]:
```
# yamlIn = open("392190.yaml", "r") # tie
yamlIn = open("335982.yaml", "r")  # first match
yamlFile = yaml.load(yamlIn, Loader=yaml.FullLoader)
tempDf = yu.readYamlToDataFrame(1, yamlFile)
tempDf.head()
tempGroupByInnings = tempDf.groupby(by=["MatchId", "InningNo"])
tempTeamsTotalRuns = tempGroupByInnings["TotalRuns"].sum()
```

1.4 Unzip Dataset Files

Unzip dataset file combine all files into one dataframe. Also create some dummy columns.

[4]:
```
df = zp.extractZipAndProcess("ipl.zip")
df.to_csv("all-records.csv", index=False)
# df = pd.read_csv("all-records.csv")
```

```
Done processing in 113.53016998199928 seconds
```

[5]:
```
print("Last 5 records", df.tail())
# df.to_csv('all-records.csv', index=False)
print("Shape", df.shape)
print("Columns", df.columns)
```

```
Last 5 records         MatchId        Date       City           Team1
Team2  \
179053      756  2019-05-12  Hyderabad  Mumbai Indians  Chennai Super Kings
179054      756  2019-05-12  Hyderabad  Mumbai Indians  Chennai Super Kings
179055      756  2019-05-12  Hyderabad  Mumbai Indians  Chennai Super Kings
179056      756  2019-05-12  Hyderabad  Mumbai Indians  Chennai Super Kings
179057      756  2019-05-12  Hyderabad  Mumbai Indians  Chennai Super Kings

            TossWinner TossDecision ManOfTheMatch          Winner  WonByRuns  \
179053  Mumbai Indians          bat     JJ Bumrah  Mumbai Indians          1
179054  Mumbai Indians          bat     JJ Bumrah  Mumbai Indians          1
179055  Mumbai Indians          bat     JJ Bumrah  Mumbai Indians          1
179056  Mumbai Indians          bat     JJ Bumrah  Mumbai Indians          1
179057  Mumbai Indians          bat     JJ Bumrah  Mumbai Indians          1

        …           BattingTeam       Opener1    Opener2 BallNo    Batsman  \
179053  …  Chennai Super Kings  F du Plessis  SR Watson   19.2  RA Jadeja
179054  …  Chennai Super Kings  F du Plessis  SR Watson   19.3  SR Watson
179055  …  Chennai Super Kings  F du Plessis  SR Watson   19.4  SR Watson
```

```
179056  …  Chennai Super Kings  F du Plessis  SR Watson   19.5  SN Thakur
179057  …  Chennai Super Kings  F du Plessis  SR Watson   19.6  SN Thakur

            Bowler NonStriker RunsBat RunsExtras  TotalRuns
179053  SL Malinga  SR Watson       1          0          1
179054  SL Malinga  RA Jadeja       2          0          2
179055  SL Malinga  RA Jadeja       1          0          1
179056  SL Malinga  RA Jadeja       2          0          2
179057  SL Malinga  RA Jadeja       0          0          0

[5 rows x 22 columns]
Shape (179058, 22)
Columns Index(['MatchId', 'Date', 'City', 'Team1', 'Team2', 'TossWinner',
       'TossDecision', 'ManOfTheMatch', 'Winner', 'WonByRuns', 'WonByWickets',
       'InningNo', 'BattingTeam', 'Opener1', 'Opener2', 'BallNo', 'Batsman',
       'Bowler', 'NonStriker', 'RunsBat', 'RunsExtras', 'TotalRuns'],
      dtype='object')
```

1.5 Add Dummy Columns

Add dummy columns like Season. Also data correction for city renaming etc.

[6]:
```
# added Column Season with Year of match
df["Season"] = pd.DatetimeIndex(df["Date"]).year
# replace Bangalore with Bengaluru
df.City.replace("Bangalore", "Bengaluru", inplace=True)
df.ManOfTheMatch.fillna("-", inplace=True)
```

[7]:
```
df["Fours"] = df["RunsBat"] == 4
df["Sixes"] = df["RunsBat"] == 6
groupByInnings = df.groupby(by=["MatchId", "InningNo"])
teamsTotalRuns = groupByInnings["TotalRuns"].sum()
boundriesPerInnings = groupByInnings["Fours"].sum() + groupByInnings["Sixes"].
 ↪sum()
```

[8]:
```
ballsFirst6Overs = df[df["BallNo"] < 6]
ballsLast5vers = df[df["BallNo"] > 15]
grpByInningFirst6 = ballsFirst6Overs.groupby(by=["MatchId", "InningNo"])
grpByInningLast5 = ballsLast5vers.groupby(by=["MatchId", "InningNo"])

firstSixOversTotal = grpByInningFirst6["TotalRuns"].sum()
lastFiveOvers = grpByInningLast5["TotalRuns"].sum()
```

1.6 Dataframe For Match

Create DataFrame for match Information.

[9]:
```
matchinfo = df.groupby(by=["MatchId"])
dfMatchInfo = matchinfo.head(n=1)
dfMatchInfo.shape
```

[9]:
```
(756, 25)
```

1.7 Dataframe For Batsman

Create DataFrame for batsman Information.

[10]:
```
df_batsman = pd.DataFrame.copy(df)
df_batsman = df.groupby(by=["MatchId", "InningNo", "Batsman"])
runsByBatsmanPermatch = df_batsman.agg({"RunsBat": "sum", "BallNo": "count"})
```

1.8 Dataframe For Innings

Create DataFrame for each innings Information. This dataframe is used for most of the analysis. Added following columns * opener1Runs * opener2Runs * OpenersTotalRuns * teamTotal * boundries * firstSixTotal * lastFiveTotal * boundriesGiven * firstSixTotalGiven * lastFiveTotalGiven * oppisitionTotalRuns * Won * Chasing * WonToss

[11]:
```
def getLocatedValue(dfToLocate, matchId, innings):
    result = 0
    try:
        result = dfToLocate.loc[matchId, innings]
    except KeyError:
        result = 0
    return result
```

[12]:
```
inningsInfo = groupByInnings.head(n=1)
print(inningsInfo.shape)
d = {"runsOpener1": [], "runsOpener2": []}
runsForOpener = pd.DataFrame(data=d)
for index, row in inningsInfo.iterrows():
    try:
        opener1Runs = runsByBatsmanPermatch.loc[
            row["MatchId"], row["InningNo"], row["Opener1"]
        ]["RunsBat"]
        opener2Runs = runsByBatsmanPermatch.loc[
            row["MatchId"], row["InningNo"], row["Opener2"]
        ]["RunsBat"]

    except KeyError:
        opener1Runs = 0
        opener2Runs = 0

    teamTotal = getLocatedValue(teamsTotalRuns, row["MatchId"], row["InningNo"])
```

```
    boundries = getLocatedValue(boundriesPerInnings, row["MatchId"],␣
↪row["InningNo"])
    firstSixTotal = getLocatedValue(firstSixOversTotal, row["MatchId"],␣
↪row["InningNo"])
    lastFiveTotal = getLocatedValue(lastFiveOvers, row["MatchId"],␣
↪row["InningNo"])

    if row["InningNo"] % 2 == 0:
        oppInnings = row["InningNo"] - 1
    else:
        oppInnings = row["InningNo"] + 1

    boundriesGiven = getLocatedValue(boundriesPerInnings, row["MatchId"],␣
↪oppInnings)
    firstSixTotalGiven = getLocatedValue(firstSixOversTotal, row["MatchId"],␣
↪oppInnings)
    lastFiveTotalGiven = getLocatedValue(lastFiveOvers, row["MatchId"],␣
↪oppInnings)

    oppisitionTotalRuns = getLocatedValue(teamsTotalRuns, row["MatchId"],␣
↪oppInnings)

    if row["BattingTeam"] == row["Team1"]:
        opposition = row["Team2"]
    else:
        opposition = row["Team1"]

    d = {
        "runsOpener1": [opener1Runs],
        "runsOpener2": [opener2Runs],
        "teamTotalRuns": [teamTotal],
        "opposition": [opposition],
        "boundries": [boundries],
        "firstSixTotal": [firstSixTotal],
        "lastFiveTotal": [lastFiveTotal],
        "boundriesGiven": [boundriesGiven],
        "firstSixTotalGiven": [firstSixTotalGiven],
        "lastFiveTotalGiven": [lastFiveTotalGiven],
        "oppisitionTotalRuns": [oppisitionTotalRuns],
    }
    runsForOpenerTemp = pd.DataFrame(data=d)
    runsForOpener = pd.concat([runsForOpener, runsForOpenerTemp],␣
↪ignore_index=True)

inningsInfo.reset_index(inplace=True)
```

```
inningsInfo = pd.concat([inningsInfo, runsForOpener], axis=1)
inningsInfo.reset_index(inplace=True)
# inningsInfo.join(runsForOpener)


# inningsInfo.shape
```

(1528, 25)

[13]:
```
inningsInfo["Won"] = inningsInfo["Winner"] == inningsInfo["BattingTeam"]
inningsInfo["Chasing"] = inningsInfo["InningNo"] % 2 == 0
inningsInfo["WonToss"] = inningsInfo["TossWinner"] == inningsInfo["BattingTeam"]
inningsInfo["OpenersTotalRuns"] = (
    inningsInfo["runsOpener1"] + inningsInfo["runsOpener2"]
)
inningsInfo.head(10)
```

[13]:

	level_0	index	MatchId	Date	City	\
0	0	0	1	2008-04-18	Bengaluru	
1	1	124	1	2008-04-18	Bengaluru	
2	2	225	2	2008-04-19	Chandigarh	
3	3	349	2	2008-04-19	Chandigarh	
4	4	473	3	2008-04-19	Delhi	
5	5	595	3	2008-04-19	Delhi	
6	6	692	4	2008-04-20	Kolkata	
7	7	810	4	2008-04-20	Kolkata	
8	8	932	5	2008-04-20	Mumbai	
9	9	1055	5	2008-04-20	Mumbai	

	Team1	Team2	\
0	Royal Challengers Bangalore	Kolkata Knight Riders	
1	Royal Challengers Bangalore	Kolkata Knight Riders	
2	Kings XI Punjab	Chennai Super Kings	
3	Kings XI Punjab	Chennai Super Kings	
4	Delhi Daredevils	Rajasthan Royals	
5	Delhi Daredevils	Rajasthan Royals	
6	Kolkata Knight Riders	Deccan Chargers	
7	Kolkata Knight Riders	Deccan Chargers	
8	Mumbai Indians	Royal Challengers Bangalore	
9	Mumbai Indians	Royal Challengers Bangalore	

	TossWinner	TossDecision	ManOfTheMatch	…	firstSixTotal	\
0	Royal Challengers Bangalore	field	BB McCullum	…	61.0	
1	Royal Challengers Bangalore	field	BB McCullum	…	26.0	
2	Chennai Super Kings	bat	MEK Hussey	…	53.0	
3	Chennai Super Kings	bat	MEK Hussey	…	63.0	
4	Rajasthan Royals	bat	MF Maharoof	…	40.0	

```
5              Rajasthan Royals          bat   MF Maharoof  …          55.0
6               Deccan Chargers          bat     DJ Hussey  …          39.0
7               Deccan Chargers          bat     DJ Hussey  …          26.0
8                Mumbai Indians          bat    MV Boucher  …          47.0
9                Mumbai Indians          bat    MV Boucher  …          40.0

   lastFiveTotal  boundriesGiven  firstSixTotalGiven lastFiveTotalGiven  \
0           68.0             6.0                26.0                1.0
1            1.0            29.0                61.0               68.0
2           79.0            27.0                63.0               42.0
3           42.0            36.0                53.0               79.0
4           33.0            19.0                55.0                4.0
5            4.0            17.0                40.0               33.0
6           33.0             9.0                26.0               31.0
7           31.0            12.0                39.0               33.0
8           60.0            21.0                40.0               48.0
9           48.0            23.0                47.0               60.0

  oppisitionTotalRuns    Won  Chasing WonToss OpenersTotalRuns
0                82.0   True    False   False            168.0
1               222.0  False     True    True              8.0
2               207.0   True    False    True             40.0
3               240.0  False     True   False             95.0
4               132.0  False    False    True             17.0
5               129.0   True     True   False             70.0
6               112.0  False    False    True             37.0
7               110.0   True     True   False             15.0
8               166.0  False    False    True             37.0
9               165.0   True     True   False             48.0

[10 rows x 42 columns]
```

1.9 DataFrame Batsman Info Per Match

Create dataframe for batsman for match-info. Add following dummy columns from innings DataFrame * MatchId * InningNo * Team * TotalRuns * Opposition * ManOfTheMatch * Season * TeamTotalRuns * City * Won * Chasing * Century * HalfCentury * Balls

[14]:
```
batsmanPerMatch = pd.DataFrame()
for index in runsByBatsmanPermatch.index:
    inning = inningsInfo.loc[
        (inningsInfo["MatchId"] == index[0]) & (inningsInfo["InningNo"] ==␣
↪index[1])
    ]
    batsmanTotal = runsByBatsmanPermatch.loc[index[0], index[1], index[2]]
    batsmanRun = batsmanTotal["RunsBat"]
    balls = batsmanTotal["BallNo"]
```

```
    d = {
        "MatchId": inning["MatchId"],
        "InningNo": inning["InningNo"],
        "Team": inning["BattingTeam"],
        "Batsman": [index[2]],
        "TotalRuns": [batsmanRun],
        "Opposition": inning["opposition"],
        "ManOfTheMatch": inning["ManOfTheMatch"] == index[2],
        "Season": inning["Season"],
        "TeamTotalRuns": inning["teamTotalRuns"],
        "City": inning["City"],
        "Won": inning["Won"],
        "Chasing": inning["Chasing"],
        "Century": [batsmanRun > 99],
        "HalfCentury": [(batsmanRun > 49) & (batsmanRun < 100)],
        "Balls": [balls],
    }
    dfTemp = pd.DataFrame(data=d)
    batsmanPerMatch = pd.concat([batsmanPerMatch, dfTemp], ignore_index=True)
batsmanPerMatch["StrikeRate"] = (
    100 * batsmanPerMatch["TotalRuns"] / batsmanPerMatch["Balls"]
)
```

1.10 DataFrame Batsman Info Season

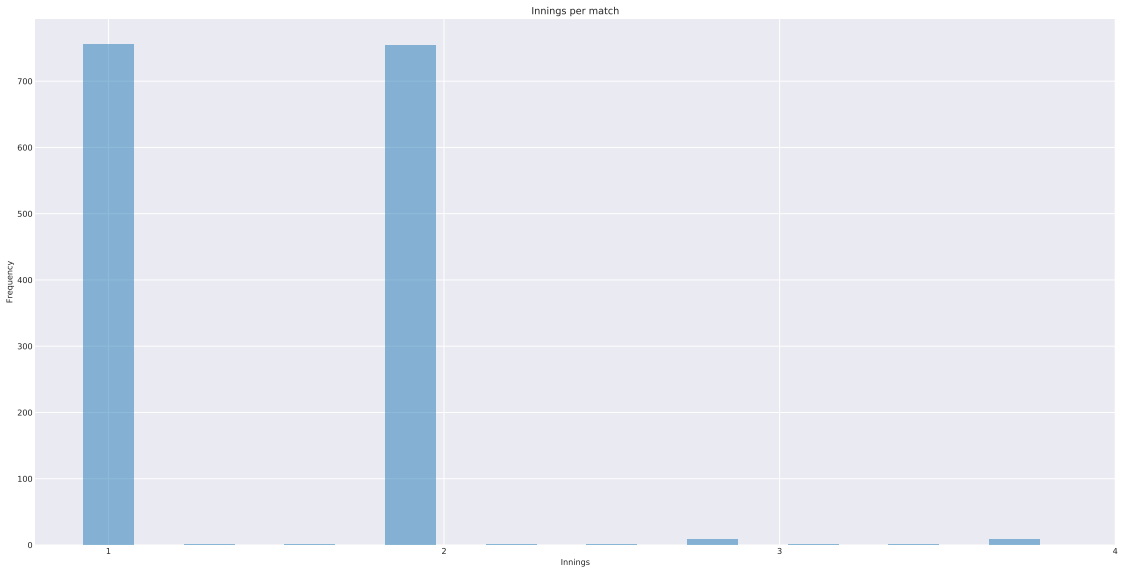
Create Dataframe for batsman information per season with following columns with different aggregate functions * TotalRuns * ManOfTheMatch * TeamTotalRuns * Won * InningNo * Century * HalfCentury * HalfCentury

[15]:
```
batsmanPerSeason = batsmanPerMatch.groupby(by=["Batsman", "Season"]).agg(
    {
        "TotalRuns": "sum",
        "ManOfTheMatch": "sum",
        "TeamTotalRuns": "sum",
        "Won": "sum",
        "InningNo": "count",
        "Century": "sum",
        "HalfCentury": "sum",
        "HalfCentury": "sum",
        "Balls": "sum",
    }
)
batsmanPerSeason["StrikeRate"] = (
    100 * batsmanPerSeason["TotalRuns"] / batsmanPerSeason["Balls"]
)
batsmanAllSeason = batsmanPerMatch.groupby(by=["Batsman"]).agg(
    {
```

```
        "TotalRuns": "sum",
        "ManOfTheMatch": "sum",
        "TeamTotalRuns": "sum",
        "Won": "sum",
        "InningNo": "count",
        "Century": "sum",
        "HalfCentury": "sum",
        "Balls": "sum",
    }
)
batsmanAllSeason["StrikeRate"] = (
    100 * batsmanAllSeason["TotalRuns"] / batsmanAllSeason["Balls"]
)
```

1.11 Histogram Innings per Match

[16]:
```
plt.title("Innings per match")
plt.hist(inningsInfo.InningNo, alpha=0.5, align="left", rwidth=0.5)
plt.xlabel("Innings")
plt.ylabel("Frequency")
plt.xticks(ticks=[1, 2, 3, 4])
plt.show()
```



1.12 Remove Outlier Innings

We remove 3rd and 4th innings as those are oh only 1 over each.

[17]:
```
inningsInfo = inningsInfo[inningsInfo.InningNo < 3]
```

1.13 Remove Outlier No-Results

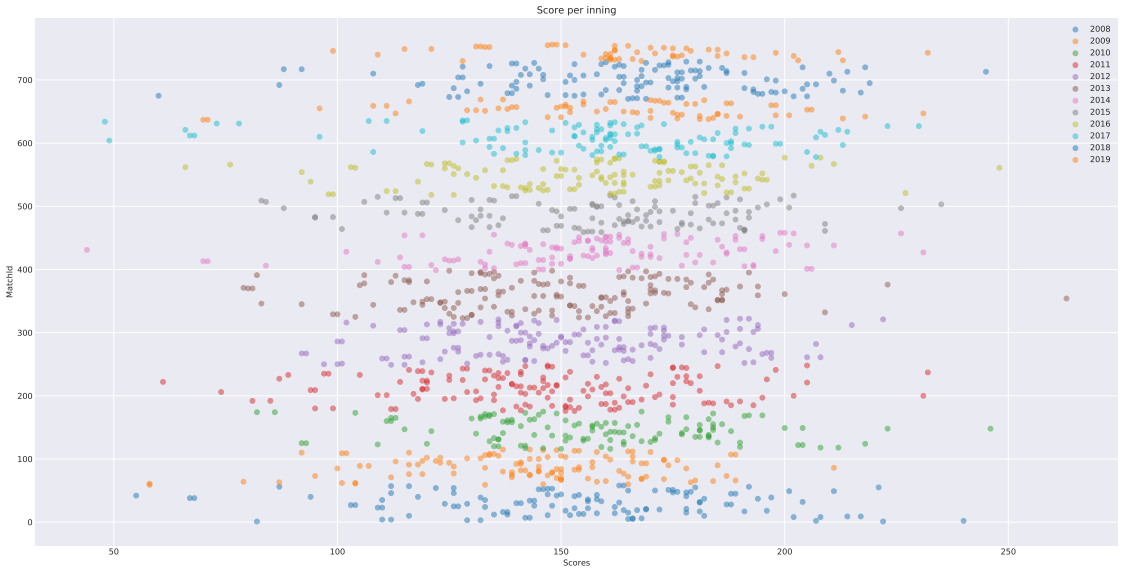
Remove innins from no-result matches those not played for full overs and do not have results

[18]:
```
inningsInfo = inningsInfo[inningsInfo.Winner != "no result"]
```

1.14 Scatter-Plot Scores Per Innings

Plot scatter for scores per innings by seasons

[19]:
```
plt.title("Score per inning")
seasons = inningsInfo.Season.unique()
seasons.sort()
for season in seasons:
    innForSeason = inningsInfo[inningsInfo.Season == season]
    plt.scatter(
        innForSeason.teamTotalRuns, innForSeason.MatchId, alpha=0.5,␣
 ↪label=season
    )

plt.legend()
plt.xlabel("Scores")
plt.ylabel("MatchId")
# plt.legend(inningsInfo.Season.unique())
plt.show()
```



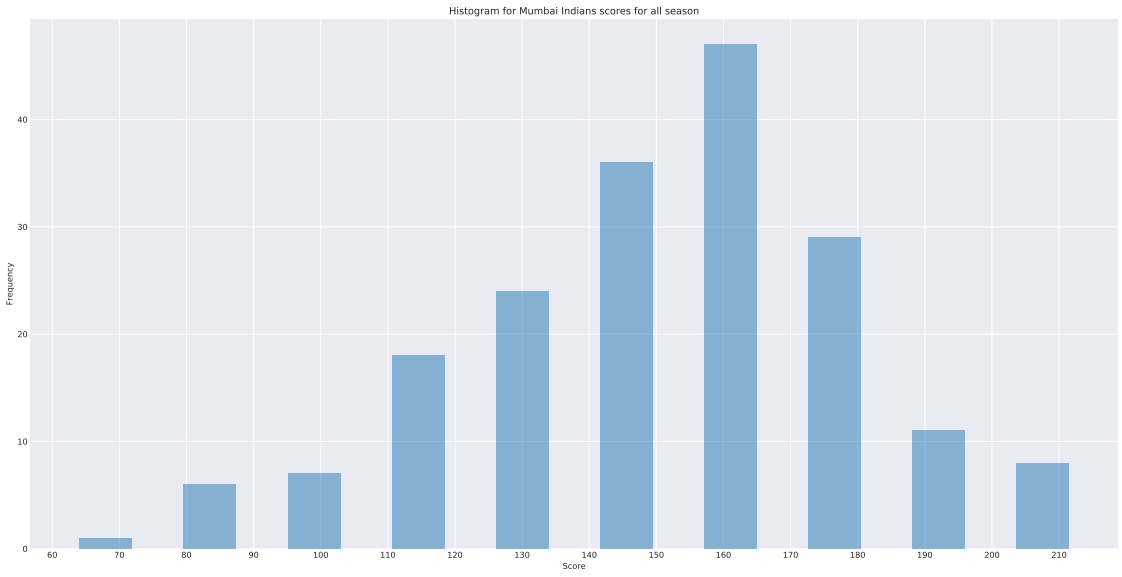
[20]:
```
inningsInfo.groupby("Season").mean()["teamTotalRuns"]
```

[20]:
```
Season
2008    154.629310
2009    143.157895
2010    157.200000
2011    146.513889
2012    151.709459
2013    148.296053
2014    157.575000
2015    157.394737
2016    157.183333
2017    159.059322
2018    165.841667
2019    163.533898
Name: teamTotalRuns, dtype: float64
```

From this scatter plot we can conclude that avg score are increasing by each season, mean stats also shows same.

1.15 Histogram Mumbai-Indians All Seasons

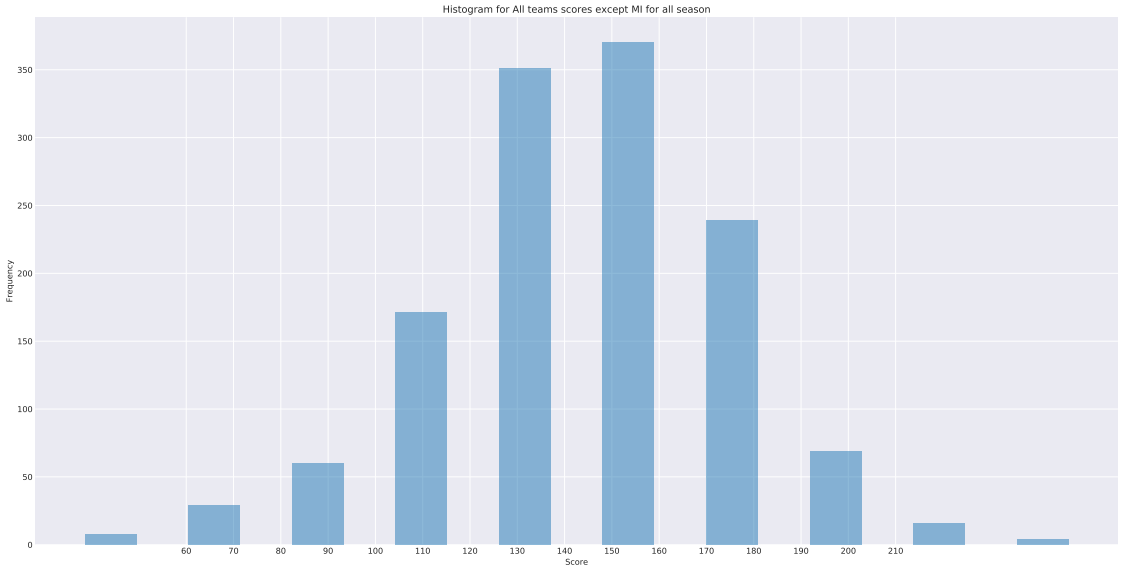
[21]:
```
innForMI = inningsInfo[inningsInfo.BattingTeam == "Mumbai Indians"]
plt.hist(innForMI.teamTotalRuns, alpha=0.5, align="left", rwidth=0.5)
plt.plot()
plt.xlabel("Score")
plt.ylabel("Frequency")
plt.title("Histogram for Mumbai Indians scores for all season")
plt.xticks(range(60, 220, 10))
plt.show()
```



This histogram shows Mumbai Indian scores mostly 160 runs per innings.

1.16 Histogram Other Teams All Seasons

[22]:
```
innForExceMI = inningsInfo[inningsInfo.BattingTeam != "Mumbai Indians"]
plt.hist(innForExceMI.teamTotalRuns, alpha=0.5, align="left", rwidth=0.5)
plt.xlabel("Score")
plt.ylabel("Frequency")
plt.title("Histogram for All teams scores except MI for all season")
plt.xticks(range(60, 220, 10))
plt.show()
```



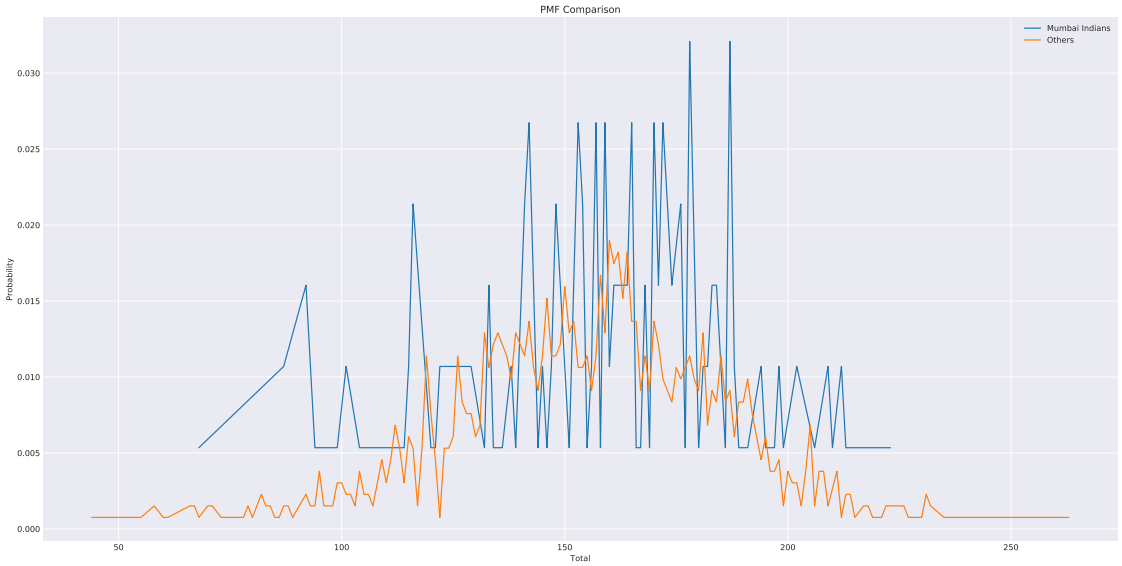
Above histograms shows other teams schores more in range of 150 runs per innings

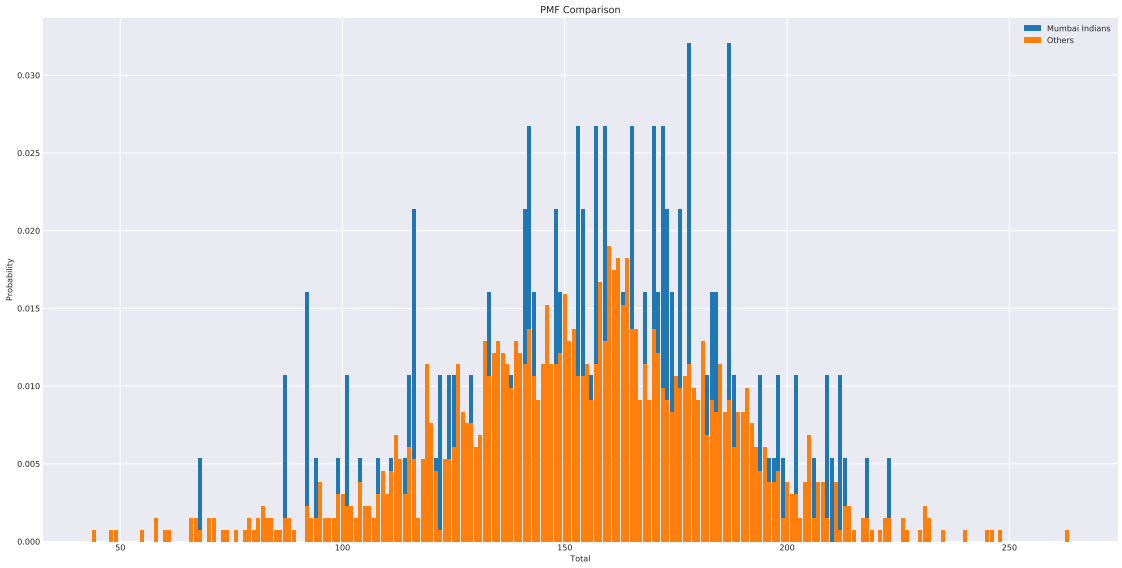
1.17 Comparison with PMF

Compare score per innings Mumbai indians vs. Other teams.### Compare PMF for scores Mumbai Indians with others

[23]:
```
pmfMi = pmfcdf.Pmf(innForMI.teamTotalRuns)
pmfMi.normalize()
xs, ys = pmfMi.render()
pmfExcMi = pmfcdf.Pmf(innForExceMI.teamTotalRuns)
pmfExcMi.normalize()
xsExc, ysExc = pmfExcMi.render()

# Line plot
plt.plot(xs, ys, label="Mumbai Indians")
plt.plot(xsExc, ysExc, label="Others")
```

```
plt.xlabel("Total")
plt.ylabel("Probability")
plt.title("PMF Comparison")
plt.legend()
plt.show()

# Bar chart
plt.bar(xs, ys, label="Mumbai Indians")
plt.bar(xsExc, ysExc, label="Others")
plt.xlabel("Total")
plt.ylabel("Probability")
plt.title("PMF Comparison")
plt.legend()
plt.show()
```





1.17.1 Comparison of Mumbia Indian Scors with Others

[24]:
```
print(
    f"Mean Mumbia Indian Score: %0.2f \t Mean Other teams Score: %0.2f"
    % (innForMI.teamTotalRuns.mean(), innForExceMI.teamTotalRuns.mean())
)
```

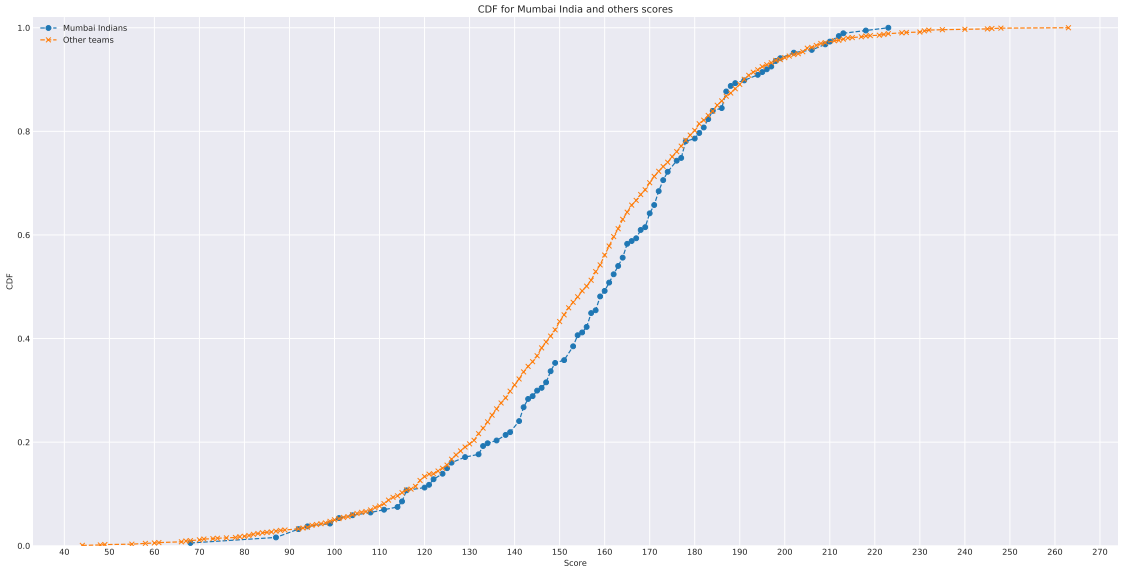
```
Mean Mumbia Indian Score: 158.03         Mean Other teams Score: 154.40
```

1.18 Comparison with CDF

Compare score per innings Mumbai indians vs. Other teams.

[25]:
```
cdfMi, bin_edgesMi = pmfcdf.getCdf(innForMI.teamTotalRuns)
cdfOther, bin_edgesOthers = pmfcdf.getCdf(innForExceMI.teamTotalRuns)

# Plot the cdf
plt.plot(bin_edgesMi[0:-1], cdfMi, linestyle="--", marker="o", label="Mumbai␣
 ↪Indians")
plt.plot(
    bin_edgesOthers[0:-1], cdfOther, linestyle="--", marker="x", label="Other␣
 ↪teams"
)

plt.ylim((0, 1.02))
plt.ylabel("CDF")
plt.xlabel("Score")
plt.title("CDF for Mumbai India and others scores")
```

```
plt.legend()
plt.xticks(range(40, 271, 10))
plt.show()
```



Above figure shows that Mumbai indians has slighlty better scores arund 130 to 185 compared to other teams

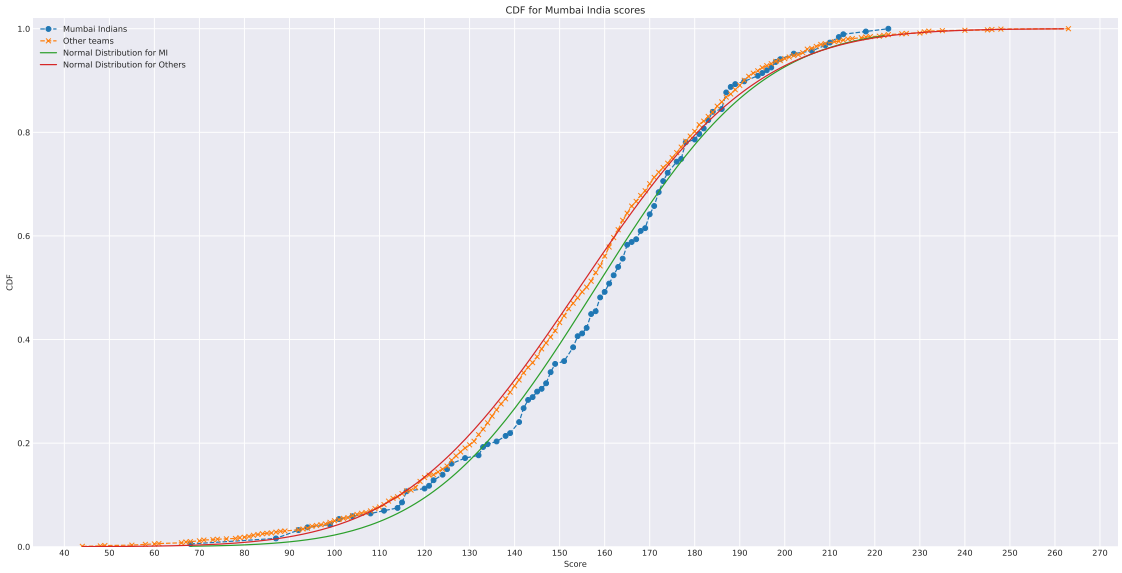
1.19 Normal Distribution CDF Comparison

Comparison of Mumbia Indians and other teams with normal dstribution by finding out mu and sigma.

[26]:
```
def plotnormalDistribution(dataset, label):
    xs = np.asarray(dataset)
    mu = xs.mean()
    ds = xs - mu
    var = np.dot(ds, ds) / (len(xs) - 0)
    sigma = np.sqrt(var)
    print(f"%s Mean:%0.2f\tVar:%0.2f\tSigma:%0.2f" % (label, mu, var, sigma))
    x = range(int(dataset.min()), int(dataset.max()))
    y = scistats.norm.cdf(x, mu, sigma)
    plt.plot(x, y, label=label)


cdfMi, bin_edgesMi = pmfcdf.getCdf(innForMI.teamTotalRuns)
cdfOther, bin_edgesOthers = pmfcdf.getCdf(innForExceMI.teamTotalRuns)

# Plot the cdf
```

```
plt.plot(bin_edgesMi[0:-1], cdfMi, linestyle="--", marker="o", label="Mumbai␣
 ↪Indians")
plt.plot(
    bin_edgesOthers[0:-1], cdfOther, linestyle="--", marker="x", label="Other␣
 ↪teams"
)
plotnormalDistribution(innForMI.teamTotalRuns, "Normal Distribution for MI")
plotnormalDistribution(innForExceMI.teamTotalRuns, "Normal Distribution for␣
 ↪Others")

plt.ylim((0, 1.02))
plt.ylabel("CDF")
plt.xlabel("Score")
plt.title("CDF for Mumbai India scores")
plt.legend()
plt.xticks(range(40, 271, 10))
plt.show()
```

```
Normal Distribution for MI Mean:158.03  Var:838.68      Sigma:28.96
Normal Distribution for Others Mean:154.40      Var:968.54      Sigma:31.12
```

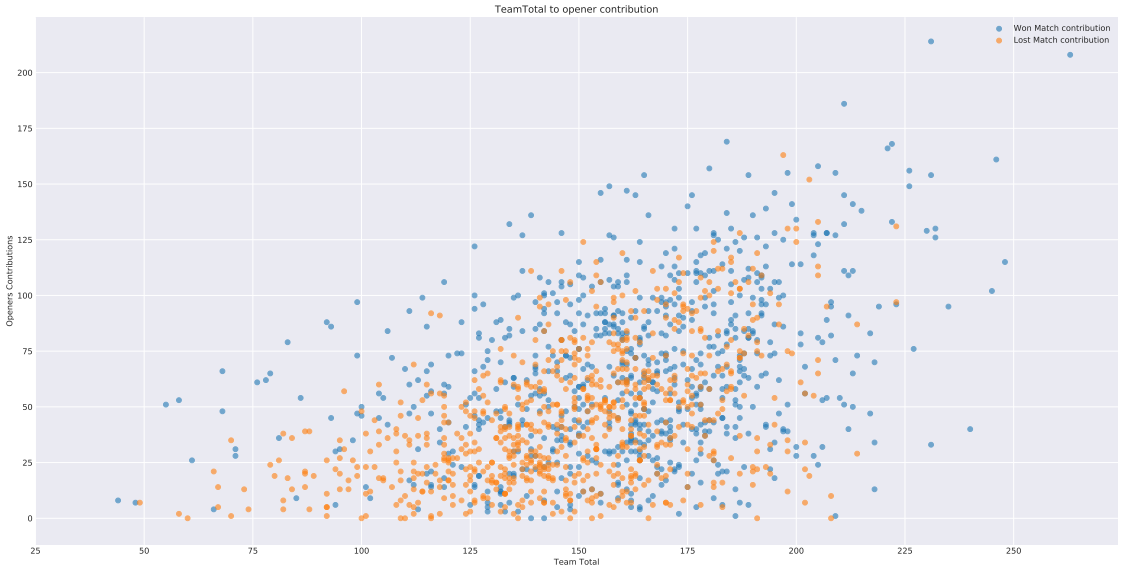


1.20 Scatter-Plot Opener Contribution

Compare opener batsman score with total team scores by innings, color by match result. Find correlation matrix.

[27]:
```
wonInns = inningsInfo[inningsInfo.Won == True]
lostInns = inningsInfo[inningsInfo.Won == False]
```

```
plt.scatter(
    wonInns.teamTotalRuns,
    wonInns.OpenersTotalRuns,
    alpha=0.6,
    label="Won Match contribution",
)
plt.scatter(
    lostInns.teamTotalRuns,
    lostInns.OpenersTotalRuns,
    alpha=0.6,
    label="Lost Match contribution",
)
plt.title("TeamTotal to opener contribution")
plt.xlabel("Team Total")
plt.ylabel("Openers Contributions")
plt.legend()
plt.xticks(range(25, 275, 25))
plt.yticks(range(0, 225, 25))
plt.show()
```



[28]:
```
tempDf = pd.concat([inningsInfo.teamTotalRuns, inningsInfo.OpenersTotalRuns],␣
↪axis=1)
print("Covariance", tempDf.cov(), end="\n\n")
print("Pearson Correlation", tempDf.corr(method="pearson"), end="\n\n")

pbc = scistats.pointbiserialr(inningsInfo.OpenersTotalRuns, inningsInfo.Won)
print(pbc)
```

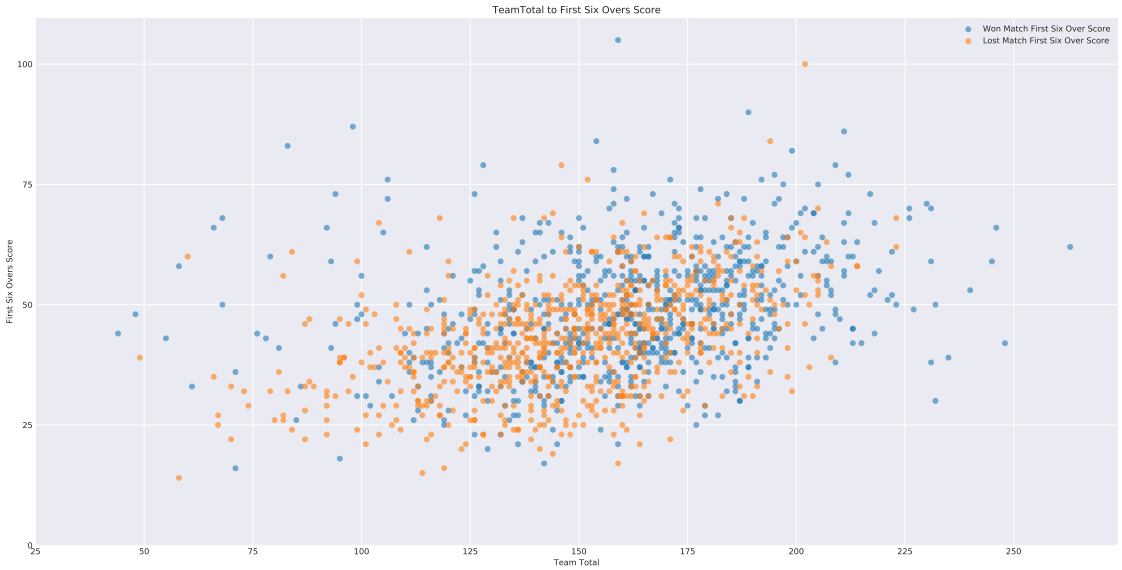
```
Covariance                    teamTotalRuns  OpenersTotalRuns
teamTotalRuns         954.461770         501.838433
OpenersTotalRuns      501.838433        1266.492625

Pearson Correlation                    teamTotalRuns  OpenersTotalRuns
teamTotalRuns              1.00000            0.45644
OpenersTotalRuns           0.45644            1.00000

PointbiserialrResult(correlation=0.3064424433593573,
pvalue=4.583588404215659e-34)
```

Correlation between teamTotal and Opener Batsmans contribution We also have correlation between Openers contribution and the winning and losing, p-value confirm this relation by rejecting null hypothesis

1.21 Scatter-Plot First Six Overs Score

Compare First 6 overs score with total team scores by innings, color by match result. Find correlation matrix.

[29]:
```
plt.scatter(
    wonInns.teamTotalRuns,
    wonInns.firstSixTotal,
    alpha=0.6,
    label="Won Match First Six Over Score",
)
plt.scatter(
    lostInns.teamTotalRuns,
    lostInns.firstSixTotal,
    alpha=0.6,
    label="Lost Match First Six Over Score",
)
plt.title("TeamTotal to First Six Overs Score")
plt.xlabel("Team Total")
plt.ylabel("First Six Overs Score")
plt.legend()
plt.xticks(range(25, 275, 25))
plt.yticks(range(0, 125, 25))
plt.show()
```



[30]:
```
tempDf = pd.concat([inningsInfo.teamTotalRuns, inningsInfo.firstSixTotal],␣
↪axis=1)
print("Covariance", tempDf.cov(), end="\n\n")
print("Pearson Correlation", tempDf.corr(method="pearson"), end="\n\n")

pbc = scistats.pointbiserialr(inningsInfo.firstSixTotal, inningsInfo.Won)
print(pbc)
```

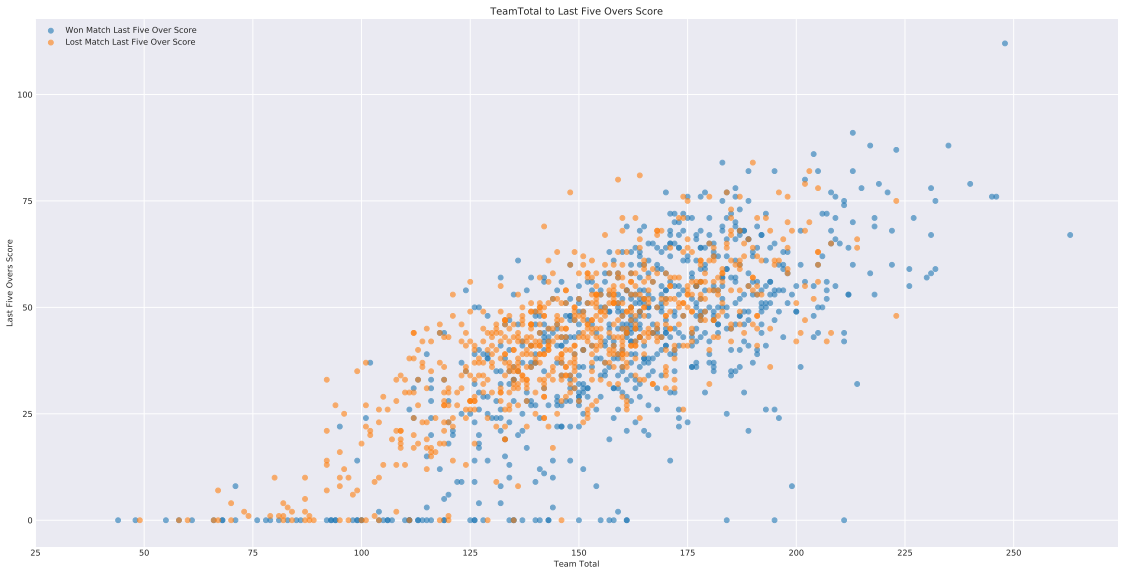
```
Covariance                teamTotalRuns  firstSixTotal
teamTotalRuns       954.46177      147.381050
firstSixTotal       147.38105      145.055839

Pearson Correlation                teamTotalRuns  firstSixTotal
teamTotalRuns         1.000000       0.396091
firstSixTotal         0.396091       1.000000

PointbiserialrResult(correlation=0.2283302908772324,
pvalue=3.066031954648354e-19)
```

Above corretion numbers show we have positive relationship between first six overs score and total team score. Point biserial Correlation values shows positive relationship as well p-value rejects null hypothesis.

1.22 Scatter-Plot Last Five Overs Score

Compare Last 5 overs score with total team scores by innings, color by match result. Find correlation matrix.

[31]:
```
plt.scatter(
    wonInns.teamTotalRuns,
    wonInns.lastFiveTotal,
    alpha=0.6,
    label="Won Match Last Five Over Score",
)
plt.scatter(
    lostInns.teamTotalRuns,
    lostInns.lastFiveTotal,
    alpha=0.6,
    label="Lost Match Last Five Over Score",
)
plt.title("TeamTotal to Last Five Overs Score")
plt.xlabel("Team Total")
plt.ylabel("Last Five Overs Score")
plt.legend()
plt.xticks(range(25, 275, 25))
plt.yticks(range(0, 125, 25))
plt.show()
```



[32]:
```
tempDf = pd.concat([inningsInfo.teamTotalRuns, inningsInfo.lastFiveTotal],␣
↪axis=1)
print("Covariance", tempDf.cov(), end="\n\n")
print("Pearson Correlation", tempDf.corr(method="pearson"), end="\n\n")

pbc = scistats.pointbiserialr(inningsInfo.Won, inningsInfo.lastFiveTotal)
print(pbc)
```

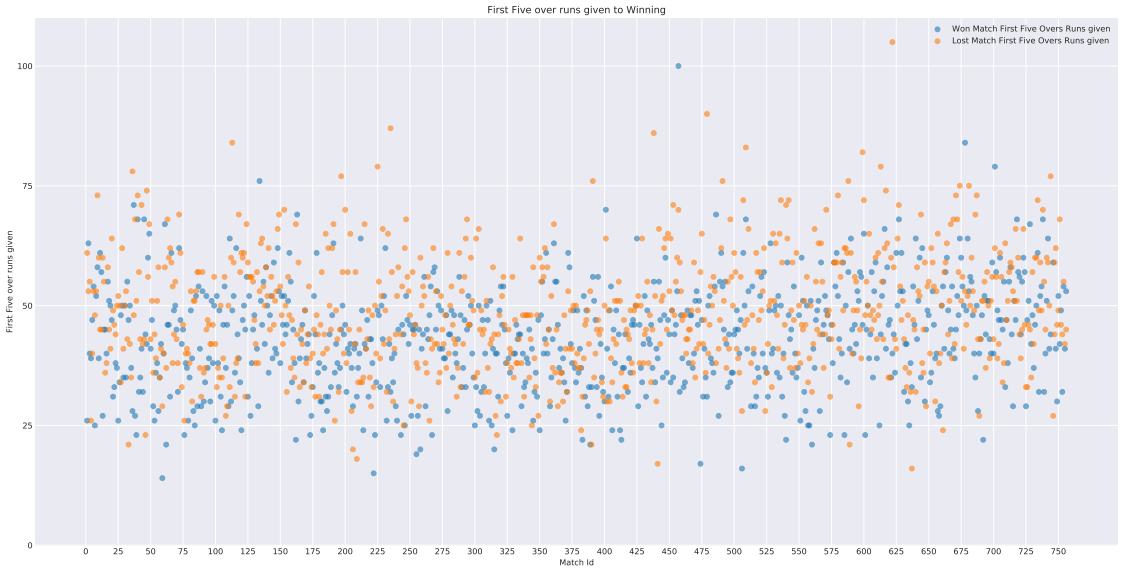
```
Covariance                teamTotalRuns  lastFiveTotal
teamTotalRuns     954.461770     418.696843
lastFiveTotal     418.696843     348.678816

Pearson Correlation                teamTotalRuns  lastFiveTotal
teamTotalRuns       1.000000       0.725784
lastFiveTotal       0.725784       1.000000

PointbiserialrResult(correlation=0.026314742201529157,
pvalue=0.30779881584986263)
```

Above corretion numbers show we have positive relationship between last five overs score and total team score. Point biserial Correlation values shows positive relationship however p-value is not rejecting null hypothesis as p-value is greater than 0.05.

1.23 Scatter-Plot Runs Conceded in First Six Overs

Compare how runs conceded in first 6 overs impact winning or losing

[33]:
```
plt.scatter(
    wonInns.MatchId,
    wonInns.firstSixTotalGiven,
    alpha=0.6,
    label="Won Match First Five Overs Runs given",
)
plt.scatter(
    lostInns.MatchId,
    lostInns.firstSixTotalGiven,
    alpha=0.6,
    label="Lost Match First Five Overs Runs given",
)
plt.title("First Five over runs given to Winning")
plt.xlabel("Match Id")
plt.ylabel("First Five over runs given")
plt.legend()
plt.xticks(range(0, 760, 25))
plt.yticks(range(0, 125, 25))
plt.show()
```



[34]:
```
pbc = scistats.pointbiserialr(inningsInfo.firstSixTotalGiven, inningsInfo.Won)
print(pbc)
```

```
PointbiserialrResult(correlation=-0.22498194053040915,
pvalue=1.0344301557061923e-18)
```

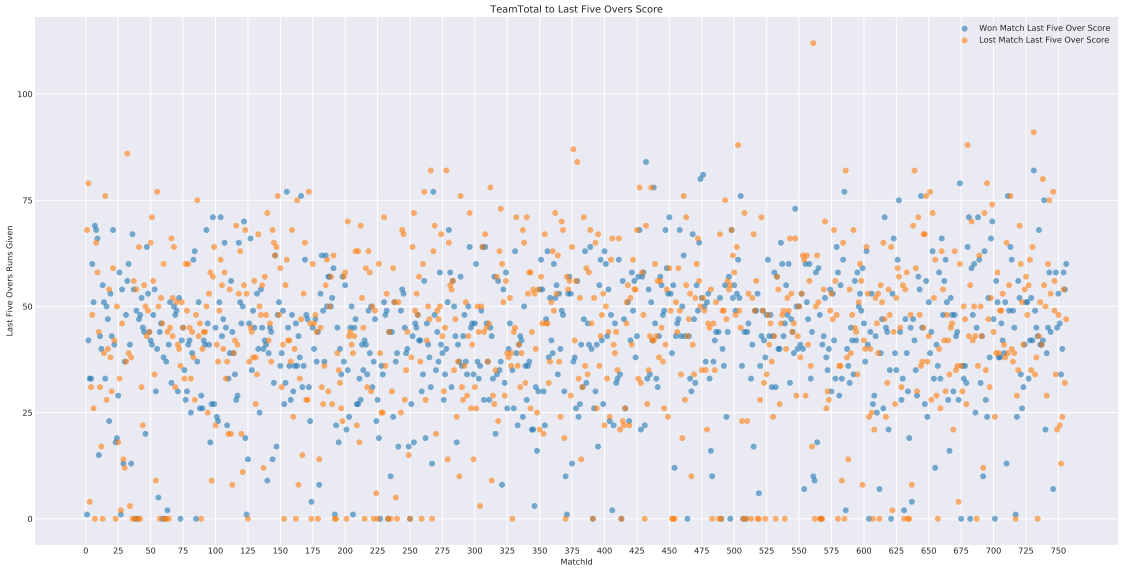
Above corretion numbers show we have negative relationship between first six overs runs given to oppenent and winning and losing. P-value is rejecting null hypothesis as p-value is very small.

1.24 Scatter-Plot Runs Conceded in Last Five Overs

Compare how runs conceded in last 5 overs impact winning or losingovers

[35]:
```
plt.scatter(
    wonInns.MatchId,
    wonInns.lastFiveTotalGiven,
    alpha=0.6,
    label="Won Match Last Five Over Score",
)
plt.scatter(
    lostInns.MatchId,
    lostInns.lastFiveTotalGiven,
    alpha=0.6,
    label="Lost Match Last Five Over Score",
)
plt.title("TeamTotal to Last Five Overs Score")
plt.xlabel("MatchId")
plt.ylabel("Last Five Overs Runs Given")
plt.legend()
```

```
plt.xticks(range(0, 760, 25))
plt.yticks(range(0, 125, 25))
plt.show()
```



[36]:
```
pbc = scistats.pointbiserialr(inningsInfo.lastFiveTotalGiven, inningsInfo.Won)
print(pbc)
```

```
PointbiserialrResult(correlation=-0.03338726466980052,
pvalue=0.19563420150438063)
```

Above numbers shows that the relationship is very weak also p-value indicates the null hypothesis is not false

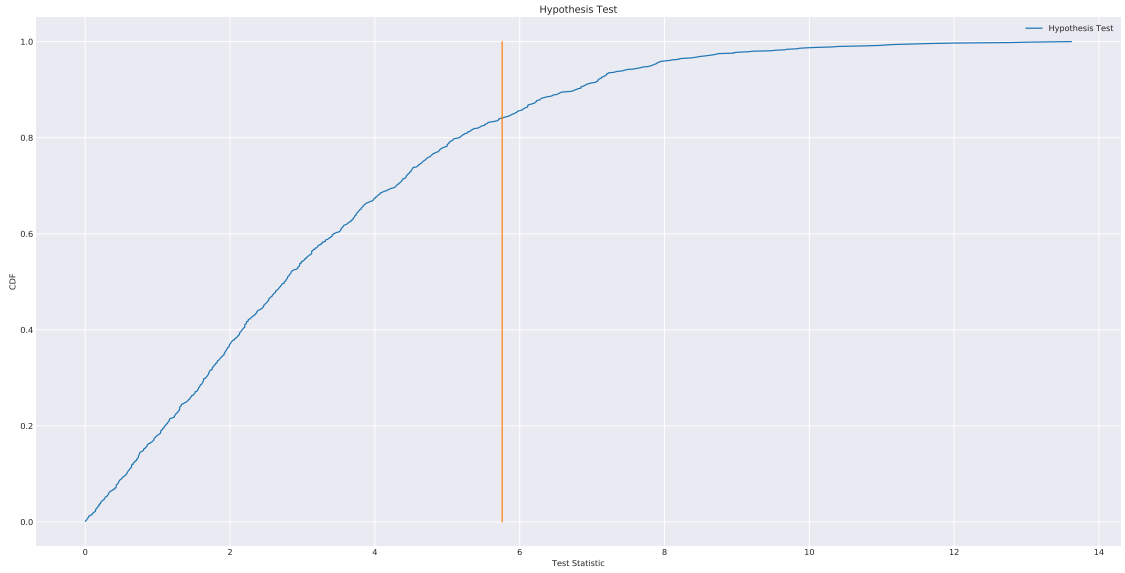
1.25 Hypothesis Test

Virat Kohli scores more runs in second innings ?

[37]:
```
allVKScores = batsmanPerMatch[batsmanPerMatch.Batsman == "V Kohli"]
vkFirstInningsScores = allVKScores[allVKScores.InningNo == 1].TotalRuns.values
vkSecondInningsScores = allVKScores[allVKScores.InningNo == 2].TotalRuns.values
obs_diff = abs(vkFirstInningsScores.mean() - vkSecondInningsScores.mean())
print(f"Observer Difference:%0.2f" % obs_diff)

groups = vkFirstInningsScores, vkSecondInningsScores

ht = hptest.ClassicHypothesisTest(groups)
pv = ht.PValue()
print(f"PValue:%0.2f" % pv)
```

```
cdfHt, bin_edgesMi = pmfcdf.getCdf(ht.test_stats)

# Plot the cdf
plt.plot(bin_edgesMi[0:-1], cdfHt, label="Hypothesis Test")
plt.plot([obs_diff, obs_diff], [0, 1])
plt.title("Hypothesis Test")
plt.xlabel("Test Statistic")
plt.ylabel("CDF")
plt.legend()
plt.show()
```

```
Observer Difference:5.76
PValue:0.16
```



The PValue is 0.16, that indicates that we can expect the difference between 2 innings score as big as the observed difference 5.76 16% of times. So from this we can conclude that this effect is not statistically significant. The CDF interesects at 0.84 which is complement of the Pvalue 0.16.

1.26 Logistic Regression

How different attributes impact winning. Find Correlations for columns.

[38]:
```
columnsNames = [
    "BattingTeam",
    "opposition",
    "City",
    "Chasing",
    "WonToss",
```

```
    "teamTotalRuns",
    "OpenersTotalRuns",
    "boundries",
    "firstSixTotal",
    "lastFiveTotal",
    "boundriesGiven",
    "firstSixTotalGiven",
    "lastFiveTotalGiven",
    "oppisitionTotalRuns",
]


for column in columnsNames:
    print("Correlation for:", column, " With Column Won")
    print(cc.theils_u(inningsInfo.Won, inningsInfo[column]))
```

```
Correlation for: BattingTeam  With Column Won
0.0170829596509302
Correlation for: opposition  With Column Won
0.01823727482468467
Correlation for: City  With Column Won
0.0004147545228560061
Correlation for: Chasing  With Column Won
0.00838744106092168
Correlation for: WonToss  With Column Won
0.0013898995082461216
Correlation for: teamTotalRuns  With Column Won
0.15013965053024567
Correlation for: OpenersTotalRuns  With Column Won
0.15514479951661883
Correlation for: boundries  With Column Won
0.08113799579311623
Correlation for: firstSixTotal  With Column Won
0.07475507117224245
Correlation for: lastFiveTotal  With Column Won
0.061600569460932154
Correlation for: boundriesGiven  With Column Won
0.08034421364316711
Correlation for: firstSixTotalGiven  With Column Won
0.0743562304391498
Correlation for: lastFiveTotalGiven  With Column Won
0.06079928227100333
Correlation for: oppisitionTotalRuns  With Column Won
0.1477723753520669
```

We will consider only columns with correlation >= .10 Following columns we will use * teamTotalRuns * OpenersTotalRuns * oppositionTotalRuns

1.27 Fitting model with all data

Create model with all the data from innigns information dataframe with above columns.

[39]:
```
inningsInfo["WonAsInt"] = inningsInfo.Won.astype("int")
formula = "WonAsInt ~ teamTotalRuns + OpenersTotalRuns + oppisitionTotalRuns"
model = smf.logit(formula, data=inningsInfo)
```

1.28 Model Accuracy with all data

[40]:
```
def printModelAndAccuracy(regModel, testDataset):
    results = regModel.fit()
    print(results.params)
    endog = pd.DataFrame(regModel.endog, columns=[regModel.endog_names])
    exog = pd.DataFrame(regModel.exog, columns=regModel.exog_names)

    actual = testDataset["WonAsInt"]
    baseline = actual.mean()

    lengthTest = len(actual)
    predict = results.predict(testDataset) >= 0.5
    true_pos = predict * actual
    true_neg = (1 - predict) * (1 - actual)
    sumTp = sum(true_pos)
    sumTn = sum(true_neg)
    print(
        "True Positives:%0.0f \t True Negatives:%0.0f \t Length Test Dataset:%d"
        % (sumTp, sumTn, lengthTest)
    )
    acc = (sumTp + sumTn) / lengthTest
    print(f"Accuracy:%0.2f%%" % acc)


printModelAndAccuracy(model, inningsInfo)
```

```
Optimization terminated successfully.
         Current function value: 0.463738
         Iterations 8
Intercept              0.264526
teamTotalRuns          0.120727
OpenersTotalRuns       0.015821
oppisitionTotalRuns   -0.128434
dtype: float64
True Positives:628       True Negatives:671      Length Test Dataset:1504
Accuracy:0.86%
```

The Accuracy for model with same training and test dataset is 86 %

1.28.1 Model fit with Splitting training and test dataset 70-30%

[41]:
```
modelDataset = pd.DataFrame.copy(inningsInfo)
trainingSet = modelDataset.sample(frac=0.70, random_state=0)
testSet = modelDataset.drop(trainingSet.index)
```

1.29 Model Accuracy with split data

Create model by splitting data into 70-30 training dataset and test dataset from innigns information dataframe with above columns.

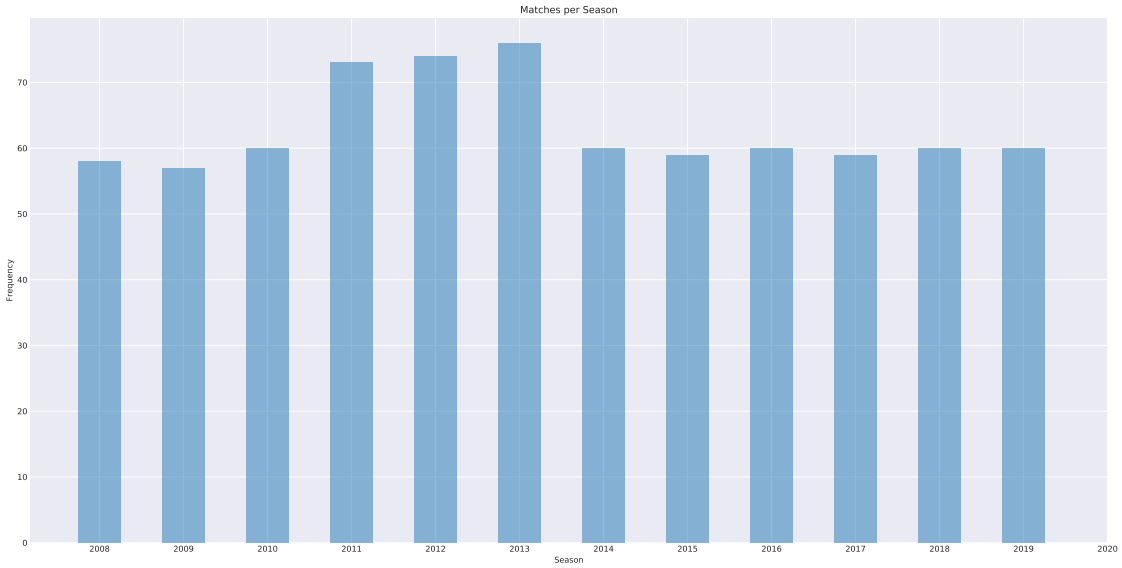
[42]:
```
model = smf.logit(formula, data=trainingSet)
printModelAndAccuracy(model, testSet)
```

```
Optimization terminated successfully.
         Current function value: 0.473392
         Iterations 8
Intercept              0.143369
teamTotalRuns          0.113018
OpenersTotalRuns       0.014804
oppisitionTotalRuns   -0.119837
dtype: float64
True Positives:196       True Negatives:201      Length Test Dataset:451
Accuracy:0.88%
```

With splitting data into training and test dataset the accuracy is 88%

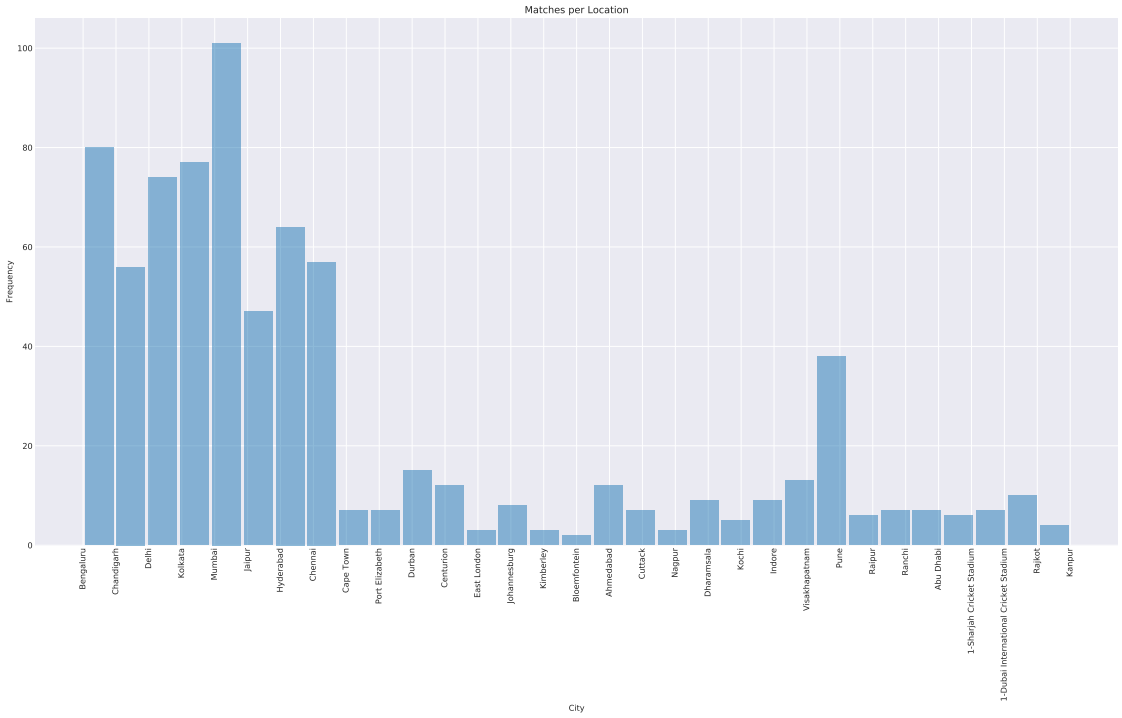
1.30 Histogram Matches Per Season

[43]:
```
bins = list(range(2008, 2021))
plt.title("Matches per Season")
plt.hist(dfMatchInfo.Season, bins=bins, alpha=0.5, align="left", rwidth=0.5)
plt.xlabel("Season")
plt.ylabel("Frequency")
plt.xticks(ticks=bins)
plt.show()
```



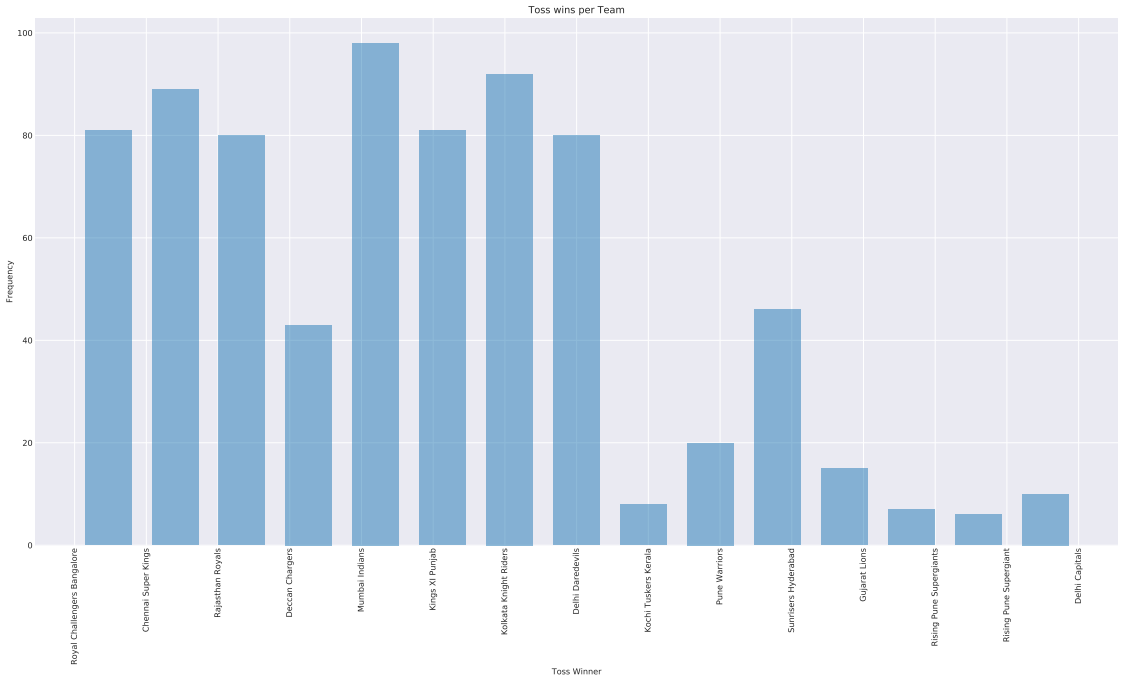
1.31 Histogram Matches Per Location

[44]:
```
cities = len(dfMatchInfo.City.unique())
plt.title("Matches per Location")
plt.hist(dfMatchInfo.City, bins=cities, alpha=0.5, align="mid", rwidth=0.9)
plt.xlabel("City")
plt.xticks(rotation=90)
plt.ylabel("Frequency")
plt.show()
```



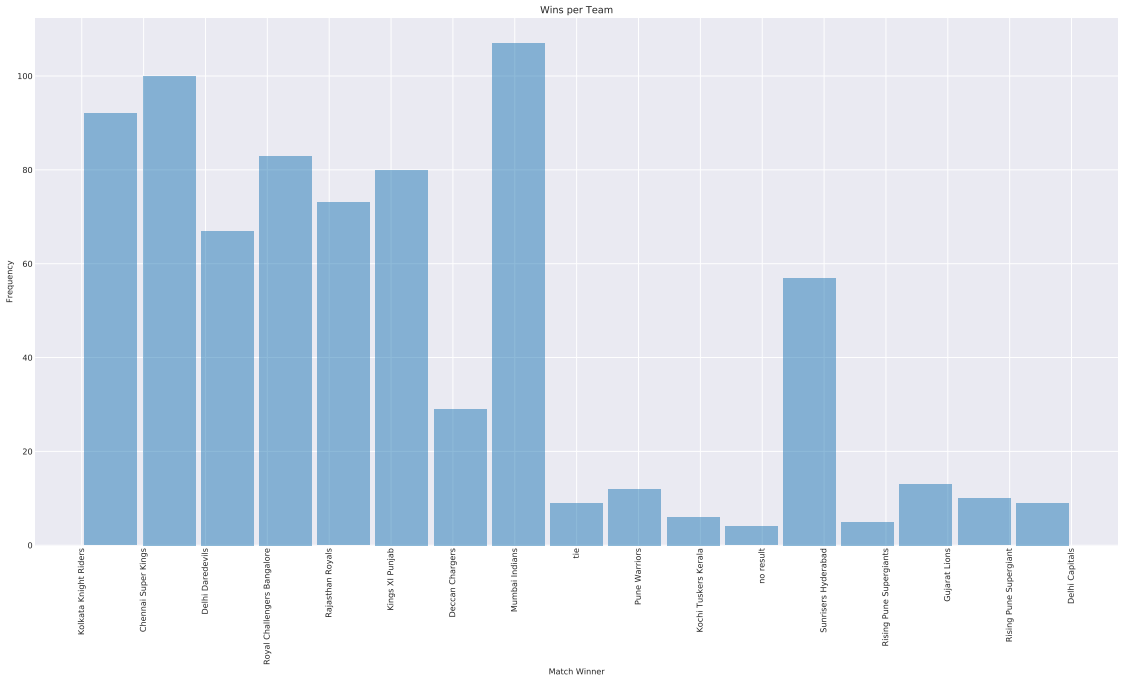
1.32 Histogram For Toss Winners

[45]:
```
bins = len(dfMatchInfo.TossWinner.unique())
plt.title("Toss wins per Team")
plt.hist(
    dfMatchInfo.TossWinner, bins=bins, alpha=0.5, align="mid", rwidth=0.7,
)
plt.xlabel("Toss Winner")
plt.xticks(rotation=90)
plt.ylabel("Frequency")
plt.show()
```



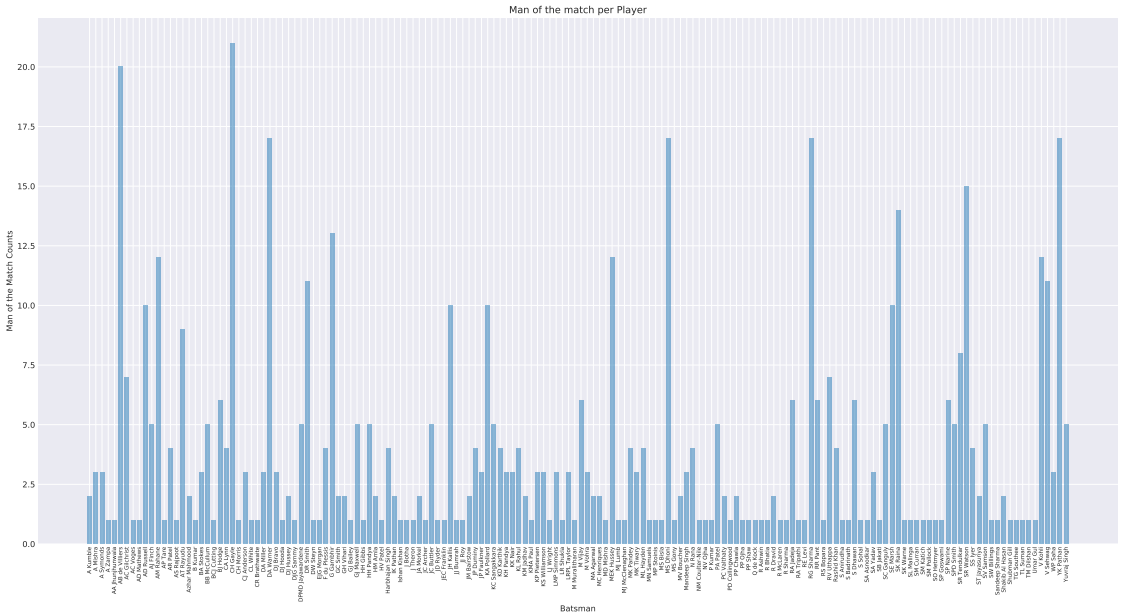
1.33 Histogram For Match Winners

[46]:
```
bins = len(dfMatchInfo.Winner.unique())
plt.title("Wins per Team")
plt.hist(dfMatchInfo.Winner, bins=bins, alpha=0.5, rwidth=0.9)
plt.xlabel("Match Winner",)
plt.xticks(rotation=90)
plt.ylabel("Frequency")
plt.show()
```



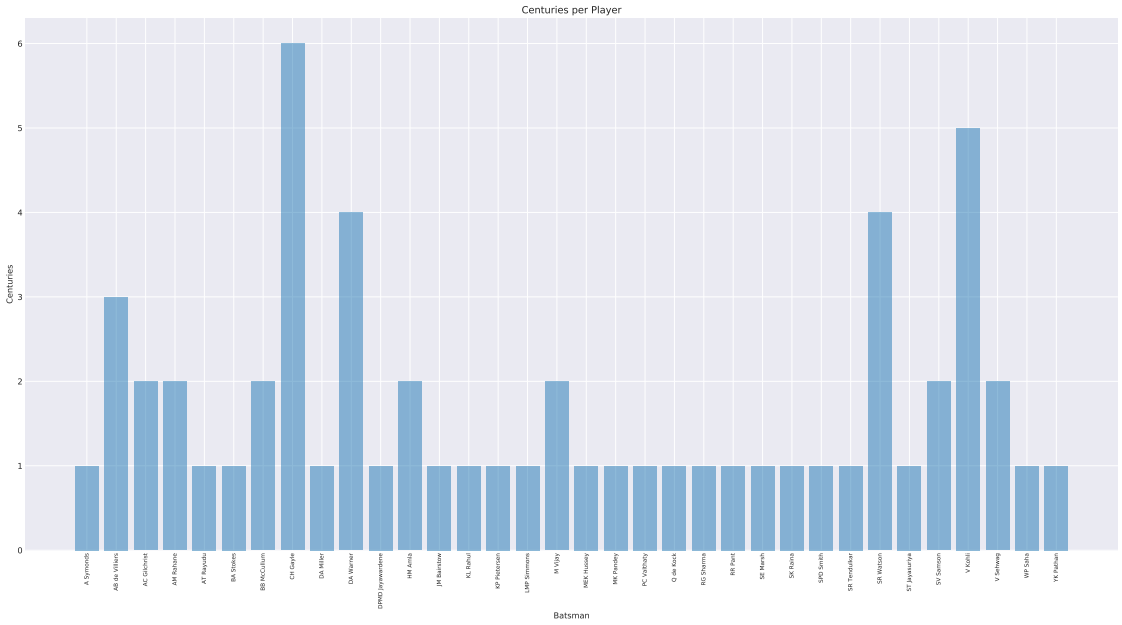
1.34 Histogram For Man-of-the-Match

[47]:
```
moms = batsmanAllSeason[batsmanAllSeason["ManOfTheMatch"] > 0]
bins = len(moms)
plt.title("Man of the match per Player")
plt.bar(x=moms.index, height=moms["ManOfTheMatch"], alpha=0.5)
plt.xlabel("Batsman",)
plt.xticks(rotation=90, fontsize=7)
plt.ylabel("Man of the Match Counts")
plt.show()
```



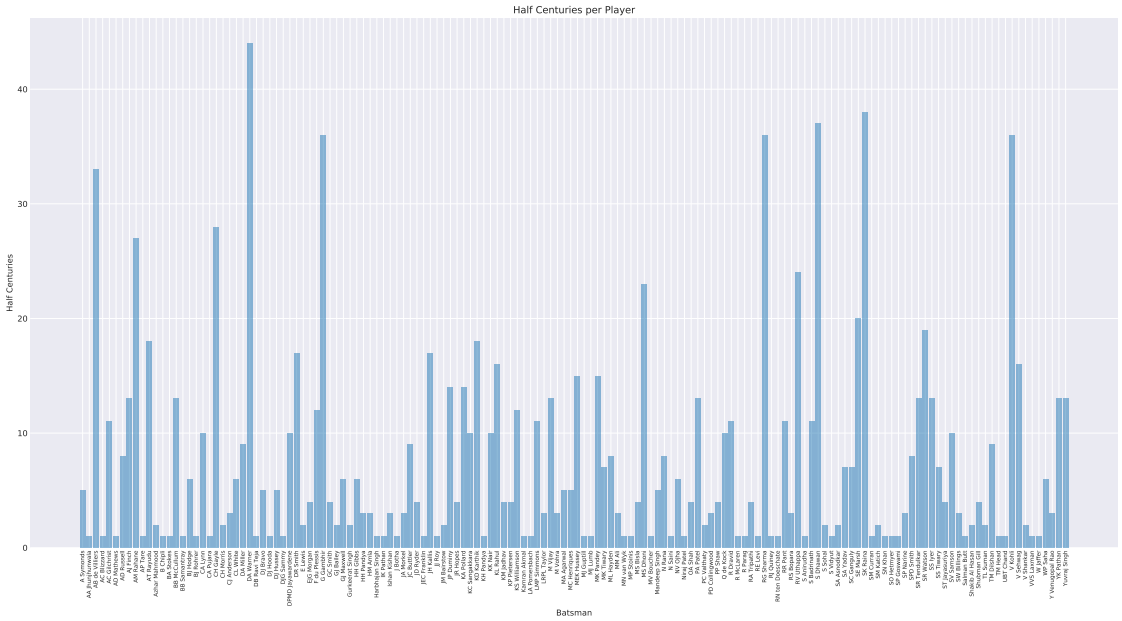
1.35 Histogram No of centuries by players

[48]:
```
centuries = batsmanAllSeason[batsmanAllSeason["Century"] > 0]
bins = len(centuries)
plt.title("Centuries per Player")
plt.bar(x=centuries.index, height=centuries["Century"], alpha=0.5)
plt.xlabel("Batsman",)
plt.xticks(rotation=90, fontsize=7)
plt.ylabel("Centuries")
plt.show()
```



1.36 Histogram No of half-centuries by players

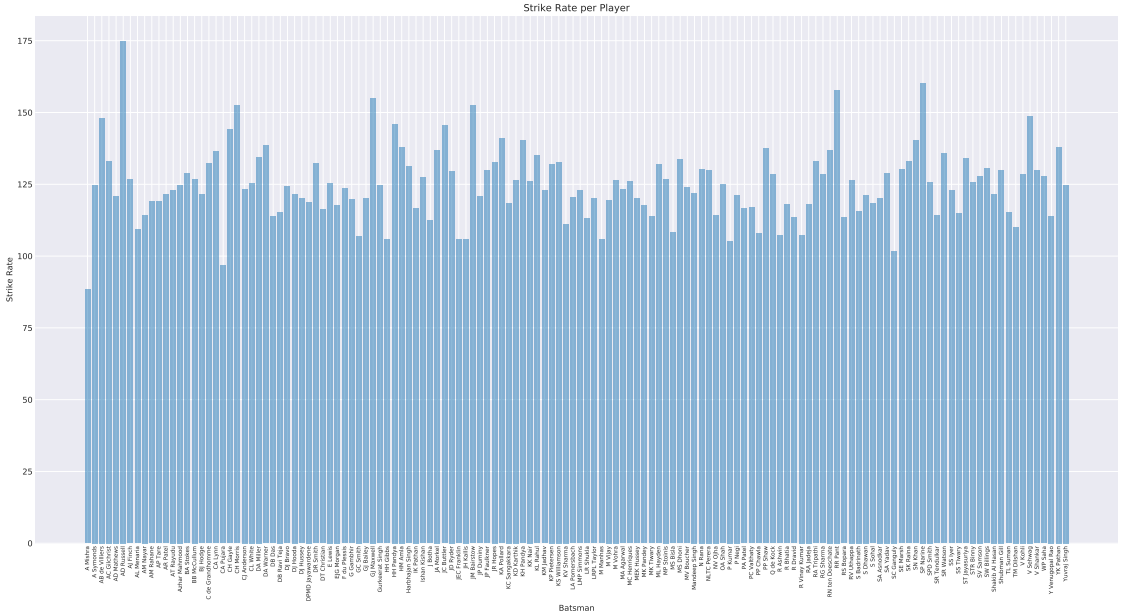
[49]:
```
halfCenturies = batsmanAllSeason[batsmanAllSeason["HalfCentury"] > 0]
bins = len(halfCenturies)
plt.title("Half Centuries per Player")
plt.bar(
    x=halfCenturies.index, height=halfCenturies["HalfCentury"], alpha=0.5,
)
plt.xlabel("Batsman",)
plt.xticks(rotation=90, fontsize=7)
plt.ylabel("Half Centuries")
plt.show()
```



1.37 Histogram for Strike Rates by Batsman

Strike Rates with > 50 and total runs > 300

[50]:
```
strkRate = batsmanAllSeason[
    (batsmanAllSeason["StrikeRate"] > 80) & (batsmanAllSeason["TotalRuns"] >␣
 ↪300)
]
bins = len(strkRate)
plt.title("Strike Rate per Player")
plt.bar(
    x=strkRate.index, height=strkRate["StrikeRate"], alpha=0.5,
)

plt.xlabel("Batsman",)
plt.xticks(rotation=90, fontsize=7)
plt.ylabel("Strike Rate")
plt.show()
```


Strike Rate per Player
Strike Rate
0
25
50
75
100
125
150
175
Batsman