FinalProject_SDA.ipynb

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0.0.1 Jake Dineen and Mason David

0.0.2 Scripting For Data Analysis

0.0.3 Final Project

Preface This project will center around collections of baseball data ranging from 1871 - 2014, essentially encompassing all recorded statistics over the course of the history of Major League Baseball. Sean Lahman and a group of reasearchers are responsible for the collection and storage of most of the main files we will be working with, although there have been some crowdsourcing attempts at expanding the original sets to include such things as college statistics.

Data All data is available to us via a github repository. To explore some of text mining/web scraping tactics, and to exemplify some additional learned skills, we will aggregate the CSV links in using urllib and Beautfiul Soup. This will be an exercise of munging semi-structured HTML while the rest of our task involves structured, tabular data. As seen below, there are 27 different data sets available to us, but not all of them will be relevant for our project's goals.

Our Goal(s) We have a number of goals associated with the project: - Read in data directly from the web - Parse CSV links from HTML and automate a process for storing data. - Work to map datasets together based on certain metadata. The CSV files work similar to a sql db, so we'll need to merge on keys/indices. - Summarize descriptive statistics in a variety of ways: - Print out single season record holders for major statistics, along with the corresponding metrics - Print out All Time record holders for major statistics, along with the corresponding metrics - Visualize and decribe through tables/charts the way statistics and salries have changed over time * This work will likely focus on the use of pandas and numpy - Potentially roll this up into a mini chatbot that requests a user input and outputs a result. - Create a heirarchical binary classification problem centered on hall of fame candidacy: - Data munging for cleanup, as well as feature distributions. - Statistical Measures (Chi Square/Correlation/Multicollinearity) for dimensionality reduction - Function Approximation via Gradient Boosted Trees/Logit/Random Forests - Utilize a sigmoid or softmax activation function to output probability distribtuion for class mapping. - Using an interpretable model to understand feature importance/ranking/information gain. - Display what drives hall of fame potential with a meaningful metric associated with it. - Potentially roll this up into a mini chatbot that requests a user input (statistics) and outputs the probability that they will make it to the Hall of Fame.

Store data sources in Variables

```
In [6]: #link to gdoc: https://docs.google.com/document/d/1PJ1KdNt6EOcvMgaZidQbFdKrhnalx2JvQxE
        #https://stackoverflow.com/questions/15517483/how-to-extract-urls-from-an-html-page-in
        url = 'https://github.com/chadwickbureau/baseballdatabank/tree/master/core'
        base_url_csv = 'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/mast
```

Extract information from HTML page

- The goal here is to pull out all of the CSVs that we'll eventually read into a structured format. It could have been done manually, but shows an understanding of webcrawling and HTML scraping. The final variable has a list of stored links containing all of the data in csv format.

```
In [7]: #from utils import get_csv_links
        import urllib
        from bs4 import BeautifulSoup
        from IPython.core.display import display
        import warnings
        warnings.filterwarnings("ignore")

        #from utils import get_csv_links. Stored in current working dir
        # ^^ Wrap this up in a separate .py file and import it. Helper functions/Wrappers to b


        def get_csv_links(url, base_url_csv):
            print('Scraping Webpage:', url)
            link_storage = []
            html = urllib.request.urlopen(url)
            html = html.read()
            soup = BeautifulSoup(html, "lxml")
            links = soup.find_all('a')  #Find all href
            #Introduce logic to parse links containing .csv
            try:
                for tag in links:
                    link = tag.get('href', None)
                    if link is not None:
                        if '.csv' in link:
                            link_storage.append(link)
                clean_urls = []  #instantiate
                #Looping through and adding the root URL
                clean_links = []
                #Need to extract after the last backslash
                for i in link_storage:
                    clean_links.append(i.rsplit('/', 1)[-1])
                #Piecing URL strings together
                for i in clean_links:
                    clean_urls.append(base_url_csv + i)
                print('Number of datasets: {}'.format(len(clean_urls)))
                return clean_urls
```

```
    except:
        print('Something went wrong')


#URL is the page that we're scraping. Base URL is the root of the final URL
data_links = get_csv_links(url, base_url_csv)
data_links
```

```
Scraping Webpage: https://github.com/chadwickbureau/baseballdatabank/tree/master/core
Number of datasets: 27
```

```
Out[7]: ['https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Allstar
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Appeara
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/AwardsM
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/AwardsP
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/AwardsS
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/AwardsS
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Batting
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Batting
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/College
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Fieldin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Fieldin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Fieldin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Fieldin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/HallOfF
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/HomeGam
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Manager
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Manager
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Parks.c
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/People
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Pitchin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Pitchin
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Salarie
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Schools
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/SeriesP
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/Teams.c
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/TeamsFr
         'https://raw.githubusercontent.com/chadwickbureau/baseballdatabank/master/core/TeamsHa
```

```
In [83]: #Need positions to act as a heirarchical filter
         import pandas as pd
         position = pd.read_csv('https://raw.githubusercontent.com/chadwickbureau/baseballdatab
         position.columns
         positions= position[['playerID', 'POS']]
         positions.drop_duplicates(subset = 'playerID', inplace= True)
```

Reading in all necessary data & Munging

```
In [84]: #Reading in batting csv
         import pandas as pd
         batting = pd.read_csv(data_links[6]) #index 6
         batting.drop_duplicates(inplace = True) #No duplicate playerIDs
         print('Batting dataset is {} rows by {} columns'.format(
             batting.shape[0], batting.shape[1]))
         batting.head(5)
```

```
Batting dataset is 104324 rows by 22 columns
```

```
Out[84]:     playerID  yearID  stint teamID lgID   G   AB   R   H  2B  ...    RBI   SB  \
         0  abercda01    1871      1    TRO  NaN   1    4   0   0   0  ...    0.0  0.0
         1   addybo01    1871      1    RC1  NaN  25  118  30  32   6  ...   13.0  8.0
         2  allisar01    1871      1    CL1  NaN  29  137  28  40   4  ...   19.0  3.0
         3  allisdo01    1871      1    WS3  NaN  27  133  28  44  10  ...   27.0  1.0
         4  ansonca01    1871      1    RC1  NaN  25  120  29  39  11  ...   16.0  6.0

             CS  BB   SO  IBB  HBP  SH  SF  GIDP
         0  0.0   0  0.0  NaN  NaN NaN NaN   0.0
         1  1.0   4  0.0  NaN  NaN NaN NaN   0.0
         2  1.0   2  5.0  NaN  NaN NaN NaN   1.0
         3  1.0   0  2.0  NaN  NaN NaN NaN   0.0
         4  2.0   2  1.0  NaN  NaN NaN NaN   0.0

         [5 rows x 22 columns]
```

```
In [10]: #Reading in pitching csv
         pitching = pd.read_csv(data_links[-8]) #index 8
         pitching.drop_duplicates(inplace = True) #no dupes
         print('Pitching dataset is {} rows by {} columns'.format(
             pitching.shape[0], pitching.shape[1]))
         pitching.head(5)
```

```
Pitching dataset is 45806 rows by 30 columns
```

```
Out[10]:     playerID  yearID  stint teamID lgID   W   L   G  GS  CG ...   IBB  WP  \
         0  bechtge01    1871      1    PH1  NaN   1   2   3   3   2 ...   NaN   7
         1  brainas01    1871      1    WS3  NaN  12  15  30  30  30 ...   NaN   7
         2  fergubo01    1871      1    NY2  NaN   0   0   1   0   0 ...   NaN   2
         3  fisheche01   1871      1    RC1  NaN   4  16  24  24  22 ...   NaN  20
         4  fleetfr01    1871      1    NY2  NaN   0   1   1   1   1 ...   NaN   0

            HBP  BK     BFP  GF    R  SH  SF  GIDP
         0  NaN   0   146.0   0   42 NaN NaN   NaN
         1  NaN   0  1291.0   0  292 NaN NaN   NaN
         2  NaN   0    14.0   0    9 NaN NaN   NaN
         3  NaN   0  1080.0   1  257 NaN NaN   NaN
         4  NaN   0    57.0    0   21 NaN NaN    NaN

         [5 rows x 30 columns]
```

```
In [11]: #Need people csv for mapping to player names
         people = pd.read_csv(data_links[-9])
         print('People dataset is {} rows by {} columns'.format(people.shape[0],
                                                                 people.shape[1]))
         people.head(5)

         #This is where we pull in/map player names form.
```

```
People dataset is 19598 rows by 24 columns
```

```
Out[11]:     playerID  birthYear  birthMonth  birthDay birthCountry birthState  \
         0  aardsda01     1981.0        12.0      27.0          USA         CO
         1  aaronha01     1934.0         2.0       5.0          USA         AL
         2  aaronto01     1939.0         8.0       5.0          USA         AL
         3   aasedo01     1954.0         9.0       8.0          USA         CA
         4   abadan01     1972.0         8.0      25.0          USA         FL

             birthCity  deathYear  deathMonth  deathDay    ...     nameLast  \
         0      Denver        NaN         NaN       NaN    ...      Aardsma
         1      Mobile        NaN         NaN       NaN    ...        Aaron
         2      Mobile     1984.0         8.0      16.0    ...        Aaron
         3      Orange        NaN         NaN       NaN    ...         Aase
         4  Palm Beach        NaN         NaN       NaN    ...         Abad

                 nameGiven weight height bats throws       debut   finalGame   retroID  \
         0     David Allan  215.0   75.0    R      R  2004-04-06  2015-08-23  aardd001
         1     Henry Louis  180.0   72.0    R      R  1954-04-13  1976-10-03  aaroh101
         2      Tommie Lee  190.0   75.0    R      R  1962-04-10  1971-09-26  aarot101
         3  Donald William  190.0   75.0    R      R  1977-07-26  1990-10-03  aased001
         4   Fausto Andres  184.0   73.0    L      L  2001-09-10  2006-04-13  abada001

              bbrefID
         0  aardsda01
         1  aaronha01
         2  aaronto01
         3   aasedo01
         4   abadan01

         [5 rows x 24 columns]
```

```
In [85]: #Merging batting and peiple on playerID. This gives player metadata
         import os
         import sys
         current_working_dir = os.getcwd()  #Get working dir
```

```
batting_merged = pd.merge(
    batting, people, how='left', on='playerID')  #pandas merge

batting_merged = pd.merge(batting_merged, positions, on = 'playerID')

batting_cols = batting_merged.columns  #store var for column names. Will need for dim

#Save csv in working dir
batting_merged_filename = 'batting_merged.csv'
batting_merged.to_csv(batting_merged_filename)
#Print Logs
print('File saved to {}:'.format(current_working_dir))
print('File name: {}'.format(batting_merged_filename))
print('{} has {} rows and {} columns'.format(
    batting_merged_filename, batting_merged.shape[0], batting_merged.shape[1]))
print('------------------------------------')
print('\033[1m' + 'NA Count Distribution by Column' +
      '\033[0m')  #Display text output
print(batting_merged.isna().sum(axis=0))

#We want to get rid of all of the observations where a given name is not present.
print('------------------------------------')
print(
    ' \033[1m Dropped {} observations where nameGiven was not registered \033[1m'.
    format(batting_merged['nameGiven'].isna().sum(axis=0)))

#Create a column that merges nameFirst and nameLast
batting_merged[
    'FullName'] = batting_merged['nameFirst'] + ' ' + batting_merged['nameLast']

#Want to drop some unnecessary columns
cols_to_drop = [
    'birthMonth', 'birthDay', 'birthState', 'birthCity', 'deathYear',
    'deathMonth', 'deathDay', 'deathState', 'deathCountry', 'deathCity',
    'finalGame', 'retroID', 'bbrefID'
]
print('------------------------------------')
print('Dropping Unnecessary Columns')
batting_merged.drop(columns=cols_to_drop, inplace=True)
print('------------------------------------')
#print('Filtering on Position Players Only')
#batting_merged = batting_merged[batting_merged['POS'] != 'P']
print('------------------------------------')
print('Displaying Cleaned Batting Data')
display(batting_merged.head(5))  #Display tail of df
```

```
File saved to C:\Users\jdine\Desktop\SYracuse\Term 7\Scripting for Data Analysis\FinalProject:
File name: batting_merged.csv
```

```
batting_merged.csv has 104113 rows and 46 columns
-----------------------------------
NA Count Distribution by Column
playerID            0
yearID              0
stint               0
teamID              0
lgID              738
G                   0
AB                  0
R                   0
H                   0
2B                  0
3B                  0
HR                  0
RBI               756
SB               2368
CS              23408
BB                  0
SO               6341
IBB             36459
HBP              2817
SH               6069
SF              35926
GIDP            25310
birthYear         157
birthMonth        511
birthDay          864
birthCountry       78
birthState       2928
birthCity         412
deathYear       59093
deathMonth      59094
deathDay        59096
deathCountry    59095
deathState      59290
deathCity       59112
nameFirst          38
nameLast            0
nameGiven          38
weight           1143
height           1065
bats             1922
throws           1471
debut               9
finalGame           9
retroID             0
bbrefID             0
```

```
POS                   0
dtype: int64
-----------------------------------
  Dropped 38 observations where nameGiven was not registered -----------------------------------

    playerID  yearID  stint teamID lgID   G   AB   R   H  2B  \
0  abercda01    1871      1    TRO  NaN   1    4   0   0   0
1   addybo01    1871      1    RC1  NaN  25  118  30  32   6
2   addybo01    1873      1    PH2  NaN  10   51  12  16   1
3   addybo01    1873      2    BS1  NaN  31  152  37  54   6
4   addybo01    1874      1    HR1  NaN  50  213  25  51   9

         ...          nameFirst     nameLast          nameGiven  weight  \
0        ...              Frank  Abercrombie  Francis Patterson     NaN
1        ...                Bob         Addy      Robert Edward   160.0
2        ...                Bob         Addy      Robert Edward   160.0
3        ...                Bob         Addy      Robert Edward   160.0
4        ...                Bob         Addy      Robert Edward   160.0

   height  bats  throws       debut  POS           FullName
0     NaN   NaN     NaN  1871-10-21   SS  Frank Abercrombie
1    68.0     L       L  1871-05-06   2B           Bob Addy
2    68.0     L       L  1871-05-06   2B           Bob Addy
3    68.0     L       L  1871-05-06   2B           Bob Addy
4    68.0     L       L  1871-05-06   2B           Bob Addy

[5 rows x 34 columns]
```

```
In [90]: #Merging batting and peiple on playerID. This gives player metadata
         pitching_merged = pd.merge(pitching, people, how='left', on='playerID')
         pitching_merged = pd.merge(pitching_merged, positions, on = 'playerID')
         pitching_merged = pitching_merged[pitching_merged['POS'] == 'P']

         pitching_cols = pitching_merged.columns

         #Save csv in working dir
         pitching_merged_filename = 'pitching_merged.csv'
         pitching_merged.to_csv(pitching_merged_filename)
         #Print Logs
         print('File saved to {}:'.format(current_working_dir))
         print('File name: {}'.format(pitching_merged_filename))
         print('{} has {} rows and {} columns'.format(pitching_merged_filename,
                                                      pitching_merged.shape[0],
                                                      pitching_merged.shape[1]))
         print('-----------------------------------')
         print('\033[1m' + 'NA Count Distribution by Column' +
               '\033[0m')  #Display text output
```

```
print(pitching_merged.isna().sum(axis=0))

#We want to get rid of all of the observations where a given name is not present.
print('-----------------------------------')
print(
    ' \033[1m Dropped {} observations where nameGiven was not registered \033[1m'.
    format(pitching_merged['nameGiven'].isna().sum(axis=0)))
pitching_merged.dropna(subset=['nameGiven'], inplace=True)

#Create a column that merges nameFirst and nameLast
pitching_merged[
    'FullName'] = pitching_merged['nameFirst'] + ' ' + pitching_merged['nameLast']

#Want to drop some unnecessary columns
cols_to_drop = [
    'IBB', 'SH', 'SF', 'GIDP', 'birthMonth', 'birthDay', 'birthState',
    'birthCity', 'deathYear', 'deathMonth', 'deathDay', 'deathCountry',
    'deathCity', 'finalGame', 'retroID', 'bbrefID', 'deathState'
]
print('-----------------------------------')
print('Dropping Unnecessary Columns')
pitching_merged.drop(columns=cols_to_drop, inplace=True)
print('-----------------------------------')
print('Displaying Cleaned Pitching Data')
display(pitching_merged.tail(5))  #Display tail of df
```

```
File saved to C:\Users\jdine\Desktop\SYracuse\Term 7\Scripting for Data Analysis\FinalProject:
File name: pitching_merged.csv
pitching_merged.csv has 43146 rows and 54 columns
-----------------------------------
NA Count Distribution by Column
playerID            0
yearID              0
stint               0
teamID              0
lgID               43
W                   0
L                   0
G                   0
GS                  0
CG                  0
SHO                 0
SV                  0
IPouts              0
H                   0
ER                  0
HR                  0
BB                  0
```

```
SO                 0
BAOpp           1260
ERA               79
IBB            12364
WP                 0
HBP              202
BK                 0
BFP                5
GF                 0
R                  0
SH             16879
SF             16879
GIDP           17999
birthYear         11
birthMonth        48
birthDay          84
birthCountry       7
birthState       835
birthCity         78
deathYear      27299
deathMonth     27299
deathDay       27299
deathCountry   27299
deathState     27344
deathCity      27301
nameFirst          3
nameLast           0
nameGiven          3
weight           299
height           226
bats             480
throws           178
debut              1
finalGame          1
retroID            0
bbrefID            0
POS                0
dtype: int64
-----------------------------------
```

Dropped 3 observations where nameGiven was not registered -----------------------------------

```
        playerID  yearID  stint teamID lgID  W  L   G  GS  CG  \
45801  wilkeaa01    2017      1    MIL   NL  1  0   3   2   0
45802  willita01    2017      1    MIL   NL  0  0   5   0   0
45803   woodhu01    2017      1    TBA   AL  0  0   1   0   0
45804  woodrbr01    2017      1    MIL   NL  2  3   8   8   0
45805  yacabji01    2017      1    BAL   AL  2  0  14   0   0
```

```
             ...        nameFirst   nameLast     nameGiven  weight  height  \
45801        ...            Aaron  Wilkerson  Aaron Daniel   190.0    75.0
45802        ...           Taylor   Williams  Taylor Grant   195.0    71.0
45803        ...           Hunter       Wood  Hunter Blake   165.0    73.0
45804        ...          Brandon   Woodruff  Brandon Kyle   215.0    76.0
45805        ...            Jimmy  Yacabonis   James Allin   205.0    75.0

       bats  throws       debut  POS          FullName
45801     R       R  2017-09-15    P   Aaron Wilkerson
45802     B       R  2017-09-06    P   Taylor Williams
45803     R       R  2017-05-30    P       Hunter Wood
45804     L       R  2017-08-04    P  Brandon Woodruff
45805     R       R  2017-06-11    P   Jimmy Yacabonis

[5 rows x 38 columns]
```

Writing a program that outputs record holders for desired statistics

- Singe function for batters and pitchers
- Added support for timeslices - Done
- Basic error handling - Done
- Moved column slice out of params/arg
- Maybe add support for by player

```
In [91]: # Want a program that outputs all time records
         import numpy as np


         def fetch_records(category, keystatistic, n=5, year=None):
             '''
             category == 'pitching' or 'hitting' str
             key statistic= Filterable stats. Ultimately ranked on this column. str dtype requ
             n = Number of samples to display. Numeric value passed through.
             year = Defaults to none, meaning records are all time. Can set a numeric range be
             '''
             try:
                 if 'batting' in category:
                     #columns = The columns that run through this program. Defaults to a fixed
                     columns = [
                         'playerID', 'FullName', 'yearID', 'G', 'AB', 'R', 'H', '2B',
                         '3B', 'HR', 'RBI', 'SB', 'CS', 'BB', 'SO'
                     ]
                     batting_copy = batting_merged.copy()  #Create copy of df
                     sliced = pd.DataFrame(
                         batting_copy[columns])  #Slice df on default cols
                     #Introduce Error Handling
                     try:
```

```
            if year is not None:
                sliced = sliced[sliced['yearID'] == year]
        except:
            if type(year) != int:
                return (
                    'TypeError: Please Enter a Numeric value for the year argumen
                )
            if year > 2017 or year < 1871:
                return (
                    'Please enter a valid year between 1871 & 2017, inclusive'
                )

        group = sliced.groupby(['playerID', 'FullName']).sum()
        #Have to manually create a BA column
        group['BattingAverage'] = np.round(group['H'] / group['AB'], 3)
        sort = group.sort_values(by=keystatistic, ascending=False)

        if keystatistic == 'BattingAverage':
            print('Need to reconcile this with an atbat threshold')
        sort.drop(columns=['yearID'], inplace=True)
        sort_indexed = sort[:n]
        #Deoending on parameter entry - These are print logs
        if year is None:
            timeslice = 'Alltime'
        else:
            timeslice = int(year)
        print(
            '\033[1m Displaying top 5 players sorted by {}, Timeslice = {}  \033[
            format(i, timeslice))
        print(
            '------------------------------------------------------------------'
        )
        return sort_indexed
    elif 'pitching' in category:
        #columns = The columns that run through this program. Defaults to a fixed
        columns = [
            'playerID', 'yearID', 'W', 'L', 'G', 'GS', 'CG', 'SHO', 'SV',
             'BAOpp', 'ERA', 'FullName'
        ]
        pitching_copy = pitching_merged.copy()  #Create copy of df
        pitching_copy.drop_duplicates(inplace=True)  #Remove duplicates
        sliced = pd.DataFrame(
            pitching_copy[columns])  #Slice df on default cols
        try:
            if year is not None:
                sliced = sliced[sliced['yearID'] == year]
        except:
            if type(year) != int:
                return (
                    'TypeError: Please Enter a Numeric value for the year argumen
                )
            if year > 2017 or year < 1871:
                return (
                    'Please enter a valid year between 1871 & 2017, inclusive'
                )
            #Agg lets us take different measures against different vars in a grou
        group = sliced.groupby(['playerID', 'FullName']).agg({
            'W': 'sum',
            'L': 'sum',
            'G': 'sum',
            'GS': 'sum',
            'CG': 'sum',
            'SHO': 'sum',
            'SV': 'sum',
            'BAOpp': 'mean',
            'ERA': 'mean',
        })
        sort = group.sort_values(by=keystatistic, ascending=False)
        sort_indexed = sort[:n]
        if year is None:
            timeslice = 'Alltime'
        else:
            timeslice = int(year)
        print(
            '\033[1m Displaying top 5 players sorted by {}, Timeslice = {}  \033[
            format(i, timeslice))
        print(
            '------------------------------------------------------------------'
        )
        return sort_indexed

except:
    if KeyError:
        print('Please Check Arguments')
```

0.0.4 Testing our Batting Program

In [148]:
```
#test output
keystats = ['H', 'HR', 'RBI']
#iterate through list of keystats
for i in keystats:
    display(fetch_records(category='batting',keystatistic=i, n=5, year = 2017))
```

```
 Displaying top 5 players sorted by H, Timeslice = 2017  -------------------------------------

                              G   AB      R    H  2B   3B  HR     RBI     SB     CS   \
playerID  FullName
blackch02 Charlie Blackmon  159  644  137  213  35  14  37  104.0  14.0  10.0
altuvjo01 Jose Altuve       153  590  112  204  39   4  24   81.0  32.0   6.0
gordode01 Dee Gordon        158  653  114  201  20   9   2   33.0  60.0  16.0
inciaen01 Ender Inciarte    157  662   93  201  27   5  11   57.0  22.0   9.0
hosmeer01 Eric Hosmer       162  603   98  192  31   1  25   94.0   6.0   1.0

                            BB     SO  BattingAverage
playerID  FullName
blackch02 Charlie Blackmon  65  135.0           0.331
altuvjo01 Jose Altuve       58   84.0           0.346
gordode01 Dee Gordon        25   93.0           0.308
inciaen01 Ender Inciarte    49   94.0           0.304
hosmeer01 Eric Hosmer       66  104.0           0.318
```

```
 Displaying top 5 players sorted by HR, Timeslice = 2017  ------------------------------------

                              G   AB    R    H  2B  3B  HR    RBI   SB   CS  \
playerID  FullName
stantmi03 Giancarlo Stanton  159  597  123  168  32   0  59  132.0  2.0  2.0
judgeaa01 Aaron Judge        155  542  128  154  24   3  52  114.0  9.0  4.0
martijd02 J. D. Martinez     119  432   85  131  26   3  45  104.0  4.0  0.0
daviskh01 Khris Davis        153  566   91  140  28   1  43  110.0  4.0  0.0
gallojo01 Joey Gallo         145  449   85   94  18   3  41   80.0  7.0  2.0

                              BB     SO  BattingAverage
playerID  FullName
stantmi03 Giancarlo Stanton   85  163.0           0.281
judgeaa01 Aaron Judge        127  208.0           0.284
martijd02 J. D. Martinez      53  128.0           0.303
daviskh01 Khris Davis         73  195.0           0.247
gallojo01 Joey Gallo          75  196.0           0.209
```

```
 Displaying top 5 players sorted by RBI, Timeslice = 2017  -----------------------------------

                              G   AB    R    H  2B  3B  HR    RBI    SB   CS  \
playerID  FullName
stantmi03 Giancarlo Stanton  159  597  123  168  32   0  59  132.0   2.0  2.0
arenano01 Nolan Arenado      159  606  100  187  43   7  37  130.0   3.0  2.0
ozunama01 Marcell Ozuna      159  613   93  191  30   2  37  124.0   1.0  3.0
goldspa01 Paul Goldschmidt   155  558  117  166  34   3  36  120.0  18.0  5.0
cruzne02  Nelson Cruz        155  556   91  160  28   0  39  119.0   1.0  1.0

                             BB     SO  BattingAverage
playerID  FullName
stantmi03 Giancarlo Stanton  85  163.0           0.281
arenano01 Nolan Arenado      62  106.0           0.309
```

```
ozunama01 Marcell Ozuna      64  144.0           0.312
goldspa01 Paul Goldschmidt   94  147.0           0.297
cruzne02  Nelson Cruz        70  140.0           0.288
```

0.0.5 Testing our Pitching Program

```
In [95]: keystats = ['W', 'L']
         #iterate through list of keystats
         for i in keystats:
             display(fetch_records(category='pitching',keystatistic=i, n=5, year=None))
```

```
 Displaying top 5 players sorted by W, Timeslice = Alltime  ------------------------------------

                                W    L    G   GS   CG  SHO  SV     BAOpp  \
playerID  FullName
youngcy01 Cy Young            511  316  906  815  749   76  17  0.240000
johnswa01 Walter Johnson      417  279  802  666  531  110  34  0.226667
mathech01 Christy Mathewson   373  188  635  551  434   79  28  0.241176
alexape01 Pete Alexander      373  208  696  599  437   90  32  0.253810
spahnwa01 Warren Spahn        363  245  750  665  382   63  29  0.245909

                                   ERA
playerID  FullName
youngcy01 Cy Young            2.713043
johnswa01 Walter Johnson      2.348095
mathech01 Christy Mathewson   2.648889
alexape01 Pete Alexander      2.972381
spahnwa01 Warren Spahn        3.277727


 Displaying top 5 players sorted by L, Timeslice = Alltime  ------------------------------------

                             W    L    G   GS   CG  SHO  SV     BAOpp       ERA
playerID  FullName
youngcy01 Cy Young         511  316  906  815  749   76  17  0.240000  2.713043
ryanno01  Nolan Ryan       324  292  807  773  222   61   3  0.208778  3.694074
johnswa01 Walter Johnson   417  279  802  666  531  110  34  0.226667  2.348095
niekrph01 Phil Niekro      318  274  864  716  245   45  29  0.257038  4.098462
perryga01 Gaylord Perry    314  265  777  690  303   53  11  0.253960  3.396000
```

0.0.6 On to Modeling

- Here we want to merge the hall of fame data with the batting data.
-
  - Typically train test split. Analyze model/model results
- Show which features are driving hall of fame propensity.

- Build a lightweight function w/ fuzzy matching on user input. User will enter a player name, and the we'll test that player's data using our trained model. Output will be probability dist.

Upsampling minority Class

```
In [165]: import sklearn

          #This step joins the hall of fame data with the batting data from above. We only nee

          hof = pd.read_csv(data_links[13]) #read in HOG
          hof.head(5)
          np.shape(hof)

          columns = ['playerID', '2B', '3B', 'AB', 'BAOpp', 'BB',  'CG', 'ERA',\
                 'FullName', 'G', 'GS', 'H',  'HR',  'R', 'RBI', 'SB',  'SHO', 'SO', 'SV', 'W'
                     ]

          merged = pd.concat(
              [batting_merged, pitching_merged], axis=0, ignore_index=True)
          merged.drop_duplicates(inplace=True)

          merged = pd.DataFrame(merged[columns]) #Only take relevant columns
          #Group by for data aggregation
          merged = merged.groupby(['playerID', 'FullName']).agg({
              '2B': 'sum',
              '3B': 'sum',
              'AB': 'sum',
              'BAOpp': 'mean',
              'BB': 'sum',
              'CG': 'sum',
              'ERA': 'mean',
              'G': 'sum',
              'GS': 'sum',
              'H': 'sum',
              'HR': 'sum',
              'R': 'sum',
              'RBI': 'sum',
              'SB': 'sum',
              'SHO': 'sum',
              'SO': 'sum',
              'SV': 'sum',
              'W': 'sum',
              'L': 'sum',
          })
          merged.reset_index(inplace=True)

          #Clean/Binarize/Merge HOF data with our position player data
```

```
inducted = hof[hof['inducted'] == 'Y']
players_inducted = inducted[inducted['category'] == 'Player']
players_cols = ['playerID', 'inducted']
players_inducted = players_inducted[players_cols]

hall_merged = pd.merge(merged, players_inducted, how='left', on='playerID')
hall_merged['inducted'].fillna(0, inplace=True)
hall_merged['inducted'].replace('Y', 1, inplace=True)
hall_merged.fillna(0, inplace=True)

#We notice that we have a severe class imbalance problem. Only 230 players are hall
#stratified sampling to ensure we put an equal dist. of each class in our train test
#hall_merged[hall_merged['inducted'] == 1].head(5)

#We bring in upsampling techniques to create class balance. In other words, we are r
#or our hall of fame class, with replacement, until the number of samples in class =
#This prevents us from building a model that randomly guesses the majority class eac
#https://elitedatascience.com/imbalanced-classes

#We actually shift to downsampling the majority class so that when we predict later,
#That's memorized the entirety of the training data.
df_majority = hall_merged[hall_merged.inducted == 0]
df_minority = hall_merged[hall_merged.inducted == 1]

from sklearn.utils import resample

df_minority_upsampled = resample(
    df_majority,
    replace=True,  # sample without replacement
    n_samples=len(df_minority),  # to match minority class
    random_state=123)  # reproducible results

df_upsampled = pd.concat([df_minority, df_minority_upsampled])

X = df_upsampled.copy()
X.drop(columns=['inducted', 'playerID', 'FullName'], inplace=True)
y = df_upsampled['inducted']
```

Train Test Splits + Grid Searching hyperparams.

```
In [97]: from sklearn.model_selection import train_test_split
         from sklearn.grid_search import GridSearchCV
         from sklearn.metrics import confusion_matrix, classification_report
         import warnings

         xtrain, xtest, ytrain, ytest = train_test_split(
             X, y, test_size=0.5, stratify=y)
```

```python
#Item freq tells us that we are stratified. We have an equal proportion of each class
from scipy.stats import itemfreq
print('Frequency in Training Set')
print('-------------------------')
print(itemfreq(ytrain))
print('Frequency in Training Set')
print('-------------------------')
print(itemfreq(ytest))

from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import GradientBoostingClassifier

model = GradientBoostingClassifier()

#instantiate parm grid
ex_param_grid = {
    "loss": ['deviance', 'exponential'],
    "learning_rate": [0.001, 0.01, 0.1, 1],
    'n_estimators': [100, 200, 300],
    'max_depth': [3, 5, 7, 9]
}

#Grid Search
gsExtC = GridSearchCV(
    model,
    param_grid=ex_param_grid,
    cv=5,
    scoring="accuracy",
    n_jobs=4,
    verbose=1)

#Fit model / Print Score
gsExtC.fit(xtrain, ytrain)
ExtC_best = gsExtC.best_estimator_
```

```
Frequency in Training Set
-------------------------
[[  0 115]
 [  1 115]]
Frequency in Training Set
-------------------------
[[  0 115]
 [  1 115]]
Fitting 5 folds for each of 96 candidates, totalling 480 fits


[Parallel(n_jobs=4)]: Done  52 tasks      | elapsed:    2.8s
[Parallel(n_jobs=4)]: Done 388 tasks      | elapsed:    9.1s
```

```
[Parallel(n_jobs=4)]: Done 480 out of 480 | elapsed:    9.8s finished
```

Showing Our Best Model

```
In [98]: print('----------------------------------------------')
         print('Below is the grid searched best estimator:')
         print('----------------------------------------------')
         print(gsExtC.best_estimator_)
```

```
----------------------------------------------
Below is the grid searched best estimator:
----------------------------------------------
GradientBoostingClassifier(criterion='friedman_mse', init=None,
              learning_rate=0.01, loss='deviance', max_depth=3,
              max_features=None, max_leaf_nodes=None,
              min_impurity_decrease=0.0, min_impurity_split=None,
              min_samples_leaf=1, min_samples_split=2,
              min_weight_fraction_leaf=0.0, n_estimators=100,
              presort='auto', random_state=None, subsample=1.0, verbose=0,
              warm_start=False)
```

```
In [99]: print('-------------------------')
         print('Model Score on test set:', np.round(ExtC_best.score(xtest, ytest), 4))
         print('-------------------------')
```

```
-------------------------
Model Score on test set: 0.9043
-------------------------
```

```
In [276]: #Here we want to merge our feature importances and features to output feat. ranking

          features = list(np.round(clf.feature_importances_, 5))
          column_names = ['2B', '3B', 'AB', 'BAOpp', 'BB', 'CG', 'ERA', 'G', 'GS', 'H', 'HR',
                 'RBI', 'SB', 'SHO', 'SO', 'SV', 'W', 'L']

          #merge lists
          dictionary = dict(zip(column_names, features))

          print('\tReturning Feature Ranking')
          #Sort Dictionary on values
          for w in sorted(dictionary, key=dictionary.get, reverse=True):
              print (w, dictionary[w])
```

```
        Returning Feature Ranking
H 0.62934
R 0.28017
```

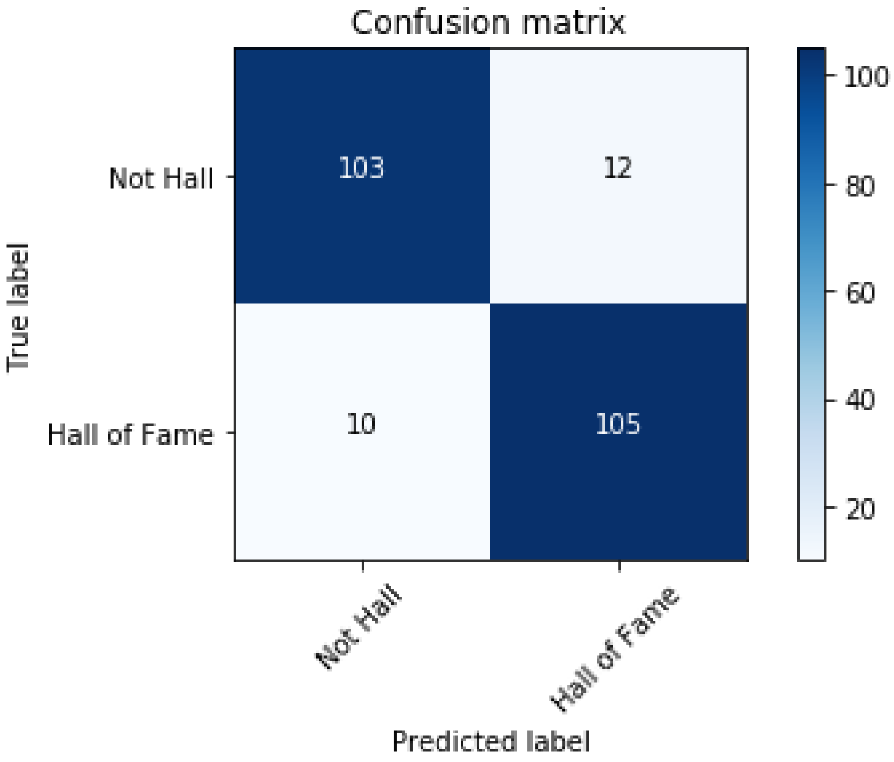
```
G 0.03247
RBI 0.01193
HR 0.01179
AB 0.01093
SV 0.01089
BB 0.00344
3B 0.00308
2B 0.00181
SO 0.00152
SB 0.00114
ERA 0.00073
BAOpp 0.00042
GS 0.00036
CG 0.0
SHO 0.0
W 0.0
L 0.0
```

```
In [101]: ypred = ExtC_best.predict(xtest)

          print('Classification Report')
          print('-------------------------')
          confusion_matrix(ytest, ypred)
          print(classification_report(ytest, ypred))
```

```
Classification Report
-------------------------
             precision    recall  f1-score   support

          0       0.91      0.90      0.90       115
          1       0.90      0.91      0.91       115

avg / total       0.90      0.90      0.90       230
```

```
In [102]: import itertools
          import matplotlib.pyplot as plt

          #Borrowed from Sklearn Docs
          def plot_confusion_matrix(cm,
                                    classes,
                                    normalize=False,
                                    title='Confusion matrix',
                                    cmap=plt.cm.Blues):
              """
              This function prints and plots the confusion matrix.
```

```
    Normalization can be applied by setting `normalize=True`.
    """
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(
            j,
            i,
            cm[i, j],
            horizontalalignment="center",
            color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')


confusion_mtx = confusion_matrix(ytest, ypred)
# plot the confusion matrix
plot_confusion_matrix(confusion_mtx, classes=['Not Hall', 'Hall of Fame'])
```



Using Pickle to dump Model. This is useful so we don't have retrain our model each time we load this notebook.

```
In [103]: import pickle
          # now you can save it to a file
          with open('ensemble_new.pkl', 'wb') as f:
              pickle.dump(ExtC_best, f)
```

```
In [104]: # and later you can load it
          with open('ensemble_new.pkl', 'rb') as f:
              clf = pickle.load(f)
```

Now we want to create a function that takes user input on a player and outputs their probability of making the hall of fame

```
In [149]: #!pip install fuzzywuzzy
          from fuzzywuzzy import fuzz
          from fuzzywuzzy import process
          import time


          #Helper Function
          def fuzzymatching_player(player):
              '''
```

```
    input:: User input Movie Title
    returns:: Closest Match to user input
    '''
    name = hall_merged['FullName']
    potential_matches = process.extractOne(player, name) #Takes the highest likeliho
    return str(potential_matches[0])


def hall_of_fame_projection(userinput=True, player_search=None):
    print(
        '---------------------------------------------------------------------------
    )
    print(
        'This program takes a player name as an input, and outputs the players probal
    )
    print(
        '---------------------------------------------------------------------------
    )
    try:
        #User input parm
        if userinput == True:
            print('----------------------------')
            player = input('Please Enter a PlayerName:')
            print('----------------------------')
            playername_stringmatch = fuzzymatching_player(player)
            print('-----------------------')
            print('Predicting HOF propensity for {}'.format(
                playername_stringmatch))
            print('----------------------------')
            time.sleep(.1)

        else:
            #Manual parm entry in function instantiatiation
            player = player_search
            playername_stringmatch = fuzzymatching_player(player)
            print('Predicting HOF propensity for {}'.format(
                playername_stringmatch))
            time.sleep(.1)
        if playername_stringmatch is not None:
            with open('ensemble_new.pkl', 'rb') as f:
                clf = pickle.load(f)
            X = hall_merged.copy()
            X = hall_merged[hall_merged['FullName'] == playername_stringmatch]
            X.drop(columns=['inducted', 'playerID', 'FullName'], inplace=True)
            prob = clf.predict_proba(X)[0][1] * 100
            print('-----------------------------------')
            print(
                '\n {} has a {}% chance of making the Baseball Hall of Fame,based on
                format(playername_stringmatch, np.round(prob, 2)))

        print('\t Returning career Statistics through 2017')
        return display(
            hall_merged[hall_merged['FullName'] == playername_stringmatch])

    except:
        print('Something went wrong')
```

Using our Model for Inference

Testing chatbox user input

- This works pretty well. Due to the downsampling of the majority class we performed above, this is a more viable representation of how good our model really is, since we aren't training it on the entire dataset.

```
In [150]: hall_of_fame_projection(userinput=True, player_search=None)
```

```
----------------------------------------------------------------------------------------------
This program takes a player name as an input, and outputs the players probability of being ele
----------------------------------------------------------------------------------------------
----------------------------
Please Enter a PlayerName:Jim Abbot
----------------------------
-----------------------
Predicting HOF propensity for Jim Abbott
----------------------------
-----------------------------------


 Jim Abbott has a 80.19% chance of making the Baseball Hall of Fame,based on stats through 201
         Returning career Statistics through 2017


     playerID    FullName   2B   3B    AB     BAOpp   BB    CG       ERA    G  \
14  abbotji01  Jim Abbott  0.0  0.0  21.0  0.280364  620  31.0  4.496364  526

      ...    HR    R  RBI   SB  SHO     SO   SV     W      L  inducted
14    ...   154  880  3.0  0.0  6.0  898.0  0.0  87.0  108.0         0

[1 rows x 22 columns]
```

Testing iteration

```
In [151]: players = ['Barry Bonds', 'Cy Young', 'Mike Trout', 'Bryce Harper']

          for i in players:
              hall_of_fame_projection(userinput=False, player_search=i)
```

```
----------------------------------------------------------------------------------------------
This program takes a player name as an input, and outputs the players probability of being ele
----------------------------------------------------------------------------------------------
Predicting HOF propensity for Barry Bonds
-----------------------------------

 Barry Bonds has a 80.62% chance of making the Baseball Hall of Fame,based on stats through 20
         Returning career Statistics through 2017


       playerID     FullName     2B    3B      AB  BAOpp    BB   CG  ERA  \
1552  bondsba01  Barry Bonds  601.0  77.0  9847.0    0.0  2558  0.0  0.0

         G    ...      HR     R     RBI     SB  SHO      SO   SV    W    L  \
1552  2986    ...     762  2227  1996.0  514.0  0.0  1539.0  0.0  0.0  0.0

      inducted
1552         0

[1 rows x 22 columns]


----------------------------------------------------------------------------------------------
This program takes a player name as an input, and outputs the players probability of being ele
----------------------------------------------------------------------------------------------
Predicting HOF propensity for Cy Young
-----------------------------------

 Cy Young has a 81.53% chance of making the Baseball Hall of Fame,based on stats through 2017
         Returning career Statistics through 2017


        playerID  FullName    2B    3B      AB  BAOpp    BB     CG       ERA  \
18810  youngcy01  Cy Young  87.0  35.0  2960.0   0.24  1298  749.0  2.713043

          G    ...      HR     R    RBI    SB   SHO      SO    SV      W  \
18810  1824    ...     156  3492  290.0  29.0  76.0  3007.0  17.0  511.0

           L  inducted
18810  316.0         1

[1 rows x 22 columns]


----------------------------------------------------------------------------------------------
This program takes a player name as an input, and outputs the players probability of being ele
----------------------------------------------------------------------------------------------
Predicting HOF propensity for Mike Trout
-----------------------------------
```

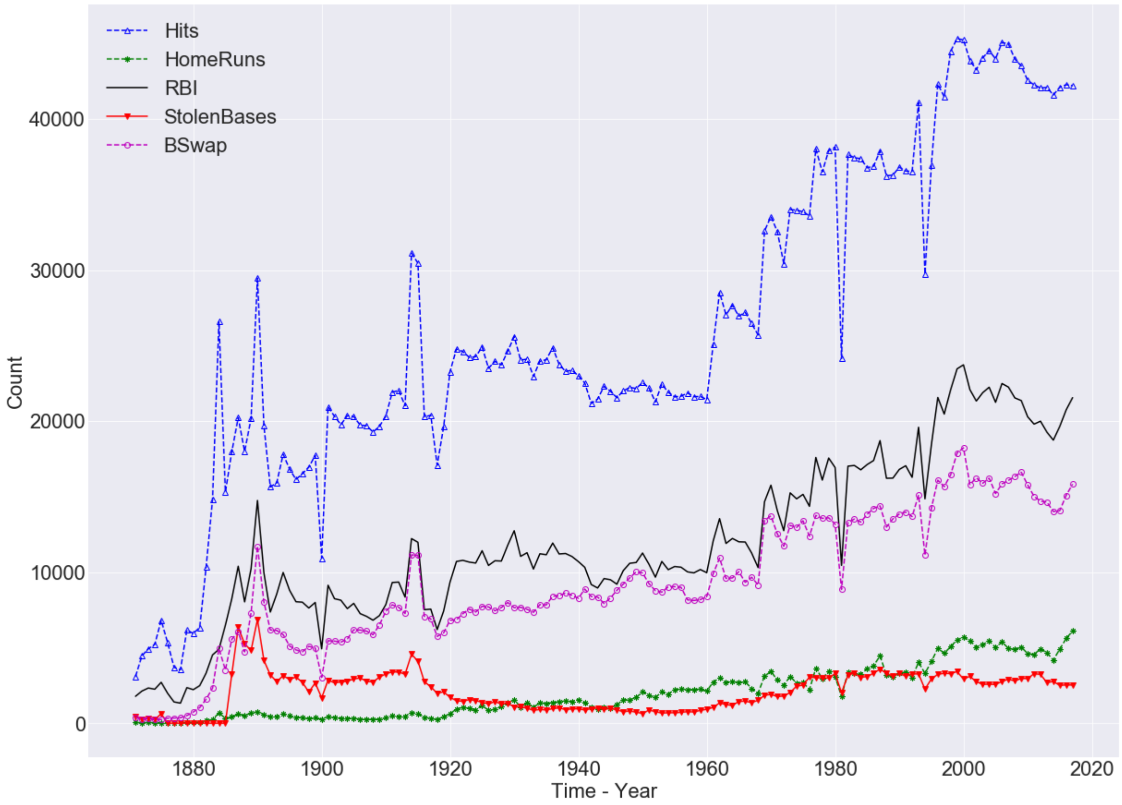
```
 Mike Trout has a 46.56% chance of making the Baseball Hall of Fame,based on stats through 201
         Returning career Statistics through 2017


        playerID    FullName     2B    3B      AB  BAOpp   BB   CG  ERA    G  \
17298  troutmi01  Mike Trout  200.0  40.0  3399.0    0.0  571  0.0  0.0  925

         ...      HR    R    RBI     SB  SHO     SO   SV    W    L  inducted
17298    ...     201  692  569.0  165.0  0.0  874.0  0.0  0.0  0.0         0

[1 rows x 22 columns]


-----------------------------------------------------------------------------------------------
This program takes a player name as an input, and outputs the players probability of being ele
-----------------------------------------------------------------------------------------------
Predicting HOF propensity for Bryce Harper
-----------------------------------

 Bryce Harper has a 35.5% chance of making the Baseball Hall of Fame,based on stats through 20
         Returning career Statistics through 2017


       playerID      FullName     2B    3B      AB  BAOpp   BB   CG  ERA    G  \
7086  harpebr03  Bryce Harper  149.0  18.0  2756.0    0.0  455  0.0  0.0  768

        ...      HR    R    RBI    SB  SHO     SO   SV    W    L  inducted
7086    ...     150  507  421.0  62.0  0.0  665.0  0.0  0.0  0.0         0

[1 rows x 22 columns]
```

0.0.7 Visualizations

```
In [163]: viz = batting_merged.groupby(['yearID']).sum()
          viz.reset_index(inplace=True)
          viz
          import matplotlib.pyplot as plt
          import matplotlib
          import numpy as np
          import seaborn as sns
          import matplotlib.pyplot as plt
          plt.rcParams["figure.figsize"] = (20, 15)
          matplotlib.rcParams.update({'font.size': 22})
          sns.set_style("darkgrid")
          x = np.arange(6)

          fig = plt.figure()
```

```
fig.show()
ax = fig.add_subplot(111)

ax.plot(
    viz.yearID,
    viz.H,
    c='b',
    marker="^",
    ls='--',
    label='Hits',
    fillstyle='none')
ax.plot(viz.yearID, viz.HR, c='g', marker=(8, 2, 0), ls='--', label='HomeRuns')
ax.plot(viz.yearID, viz.RBI, c='k', ls='-', label='RBI')
ax.plot(viz.yearID, viz.SB, c='r', marker="v", ls='-', label='StolenBases')
ax.plot(
    viz.yearID,
    viz.BB,
    c='m',
    marker="o",
    ls='--',
    label='BSwap',
    fillstyle='none')

plt.legend(loc=2)
plt.xlabel('Time - Year')
plt.ylabel('Count')
plt.draw()
```

```
C:\Users\jdine\Documents\Anaconda3\envs\tensorflowlatest\lib\site-packages\matplotlib\figure.py
  "matplotlib is currently using a non-GUI backend, "
```



```
In [248]: columns = [
              'playerID', 'FullName', 'yearID', 'G', 'AB', 'R', 'H', '2B', '3B', 'HR',
              'RBI', 'SB', 'CS', 'BB', 'SO'
          ]
          test = batting_merged.groupby(['playerID', 'FullName']).sum()

          test.reset_index(inplace=True)
          test = test[columns]

          hall_merged = pd.merge(test, players_inducted, how='left', on='playerID')
          hall_merged['inducted'].fillna(0, inplace=True)
          hall_merged['inducted'].replace('Y', 1, inplace=True)
          hall_merged.fillna(0, inplace=True)
          hall_merged = hall_merged.groupby(['inducted']).mean()
          hall_merged.reset_index(inplace=True)
          hall_merged.drop(columns='yearID', inplace=True)

          display(hall_merged)
```

```
   inducted            G           AB           R            H          2B  \
0         0   265.251937   716.501950   92.931713   185.080684   31.375047
1         1  1673.930435  5854.856522  947.791304  1727.195652  295.178261
```

```
          3B          HR         RBI          SB         CS          BB  \
0   6.230510   13.870745   83.447181   14.350735   4.797863   64.727117
1  74.734783  155.691304  874.286957  158.017391  36.847826  643.804348

           SO
0  100.328720
1  583.021739
```