In [3]:
```
import requests
import pandas as pd
from bs4 import BeautifulSoup
import re
import cProfile
from time import time
from datetime import datetime
import numpy as np
import seaborn as sns
import collections
import ast
from matplotlib import pyplot as plt
from scipy.stats import ttest_ind
```

Research Questions : Did education impact Michelle Wie's ability to play in LPGA ? What are some key parameters that impacted a player's average score ? (Use M.W. as the example)

Data Collection

Gather Michelle Wie's data from LPGA website using beautifulsoup and request module

Store the data into CSV files

Game level data (Yearly)

In [4]:
```python
# LPGA Parser for individual's historical game record - raw data (each game)
model_list_2 = []
end_year = 2023
year_list = list(range(2002,end_year))
for year in year_list:
    link_to_parse= f"https://www.lpga.com/players/michelle-wie/88106/results?
    if BeautifulSoup(requests.get(link_to_parse).content, 'html.parser').find
            #If html table is empty, no data for that player in a specific ye
        pass
    else:
        player_df = pd.read_html(link_to_parse)[0].droplevel(0, axis=1)
        for i in range(0, len(player_df.to_numpy())):
            temp_row = []
            for j in range(0, len(player_df.to_numpy()[i])):
                temp_row.append(player_df.to_numpy()[i][j])
            model_list_2.append(temp_row)
df = pd.DataFrame(model_list_2)
df.columns =['Date','Tournament Name', '1','2','3','4','Total','Final POS','T
df.to_csv("player_michelle_wie_historical_LPGA_data.csv")
```

Yearly summary data

In [5]:
```python
# LPGA parser for individual's historical game record - summary data (year su
list_of_df = []
for year in year_list:
    link_to_parse = f"https://www.lpga.com/players/michelle-wie/88106/stats?f
    pandas_table = pd.read_html(link_to_parse)[0].T
    pandas_table.columns = pandas_table.loc['Performance'].tolist()
    pandas_table.reset_index(inplace = True)
    pandas_table = pandas_table.drop(0)
    pandas_table = pandas_table.drop(columns=['index'])
    pandas_table = pandas_table.set_axis(['Year to Date', 'Ranking'], axis=0)
    pandas_table['Year'] = year
    list_of_df.append(pandas_table)

combined_df = pd.concat(list_of_df)
combined_df = combined_df.sort_index()
year_to_date_df = combined_df.loc['Year to Date']
ranking_df = combined_df.loc['Ranking']
year_to_date_df.to_csv("michelle_wie_year_to_date.csv")
ranking_df.to_csv("michelle_wie_ranking.csv")
```

Data Wrangling

Find the times when MW is studying at Stanford

In [7]:
```
Stanford_start_time = "09/01/2007"
Stanford_end_time = "06/17/2012"
Stanford_start_time = datetime.strptime(Stanford_start_time, "%m/%d/%Y")
Stanford_end_time = datetime.strptime(Stanford_end_time, "%m/%d/%Y")
```

In [8]:
```
game_level_df = pd.read_csv("player_michelle_wie_historical_LPGA_data.csv")
#Convert Date column into datetime formate
game_level_df['Date']= pd.to_datetime(game_level_df['Date'])
#Sort the games by date in ascending order
game_level_df.sort_values(by = "Date", ascending=True)
#Remove Score AVG = 0 entries
game_level_df = game_level_df[game_level_df['Score AVG'] != 0]
#Drop unnamed column
game_level_df.drop(["Unnamed: 0"], axis = 1, inplace = True)
```

Print out the dataframe

In [9]:
```
game_level_df
```

Out[9]:

	Date	Tournament Name	1	2	3	4	Total	Final POS	TOT Strokes	TOT Rounds	Score AVG	Offic Mon
0	2002-08-02	Wendy's Championship for Children at Tartan Fi...	77 (+5)	75 (+3)	-	-	152 (+8)	CUT	152	2	76.000	$0.
1	2002-05-16	Asahi Ryokuken International Championship at M...	81 (+10)	75 (+4)	-	-	156 (+14)	CUT	156	2	78.000	$0.
2	2002-02-28	LPGA Takefuji Classic	72 (+2)	74 (+4)	-	-	146 (+6)	CUT	146	2	73.000	$0.
3	2003-10-31	CJ Nine Bridges Classic Presented By Sports Today	85 (+13)	78 (+6)	70 (-2)	-	233 (+17)	69	233	3	77.667	$0.
4	2003-09-26	Safeway Classic Presented by Pepsi	69 (-3)	72 (E)	73 (+1)	-	214 (-2)	28T	214	3	71.333	$0.
...	...	...	...	...	...	...	...	...	...	...	...	
277	2021-04-21	HUGEL-AIR PREMIA LA Open	70 (-1)	77 (+6)	-	-	147 (+5)	CUT	147	2	73.500	$0.
278	2021-04-01	ANA Inspiration	70 (-2)	79 (+7)	-	-	149 (+5)	CUT	149	2	74.500	$0.
279	2021-03-25	Kia Classic	81 (+9)	74 (+2)	-	-	155 (+11)	CUT	155	2	77.500	$0.
280	2022-06-02	U.S. Women's Open presented by ProMedica	73 (+2)	74 (+3)	-	-	147 (+5)	CUT	147	2	73.500	$0.
281	2022-01-20	Hilton Grand Vacations Tournament of Champions	71 (-1)	78 (+6)	78 (+6)	81 (+9)	308 (+20)	28T	308	4	77.000	$0.

271 rows × 12 columns

Split MW's time into 3 sub categories

1 represents the time before she joined Stanford

2 represents the time when she was at Stanford

3 represents the time after she graduated from Stanford

In [10]:

```
def categorize(row):
    if pd.Timedelta(row['Date'] - Stanford_end_time).days > 0:
        return 3
    elif pd.Timedelta(row['Date'] - Stanford_start_time).days < 0 :
        return 1
    elif(pd.Timedelta(row['Date'] -  Stanford_start_time).days) > 0 :
        return 2
```

In [11]:

```
game_level_df['History'] = game_level_df.apply(lambda row: categorize(row), a
```

game_level_df.groupby(pd.Grouper(key='History', axis=0)).median()

In [12]:

```
game_level_df.groupby(pd.Grouper(key='History', axis=0)).mean()
```

Out[12]:

History	TOT Strokes	TOT Rounds	Score AVG
1	232.973684	3.236842	72.548263
2	237.690141	3.309859	72.136155
3	236.895062	3.308642	72.014920

In [13]:

```
game_level_df.groupby(pd.Grouper(key='History', axis=0)).count()
```

Out[13]:

History	Date	Tournament Name	1	2	3	4	Total	Final POS	TOT Strokes	TOT Rounds	Score AVG	Official Money
1	38	38	38	38	38	38	38	38	38	38	38	38
2	71	71	71	71	71	71	71	71	71	71	71	71
3	162	162	162	162	162	162	162	162	162	162	162	162

After data wrangling, the data shows that during her time at Stanford (2) , her score average was not higher than her other times (1, 3). Additionally, her average total rounds increased to a 3.3 compared to 3.23 before she joined Stanford. This indicates that she was able to play a few more rounds per tournament on average while she is still studying. If we look at the number of events played during her different times, the number of events played gradually increased. This is a clear evidence that she can handle both school and golf.

Read in summary data

In [14]:
```
def p2f(x):
    return float(x.strip('%'))/100
```

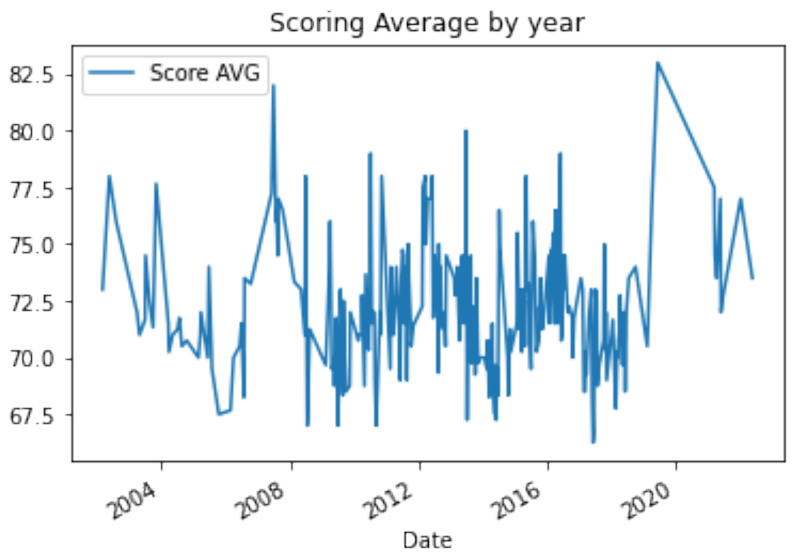
In [15]:
```
MW = pd.read_csv("michelle_wie_year_to_date.csv")
MW = MW.sort_values("Year")
MW.drop(['Unnamed: 0'], axis=1, inplace=True)
MW['Driving Accuracy'] = MW['Driving Accuracy'].str.rstrip('%').astype('float
MW['Greens in Regulation'] = MW['Greens in Regulation'].str.rstrip('%').astyp
MW['Sand Saves'] = MW['Sand Saves'].str.rstrip('%').astype('float') / 100.0
```

In [16]:
```
MW= MW[MW['Average Driving Distance'] != 0]
MW.reset_index(drop=True, inplace = True)
#Convert Year column into datetime formate
MW['Year']= pd.to_datetime(MW['Year'], format='%Y')
```

Plots for Scoring Average and Total Strokes by year

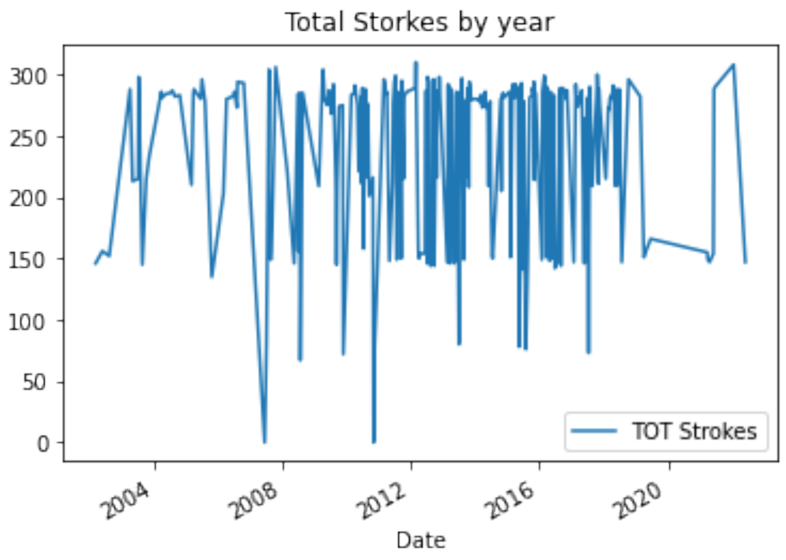
In [17]:
```
game_level_df.plot('Date','Score AVG', title="Scoring Average by year")
```

```
Out[17]: <AxesSubplot:title={'center':'Scoring Average by year'}, xlabel='Date'>
```



```
In [18]: game_level_df.plot('Date','TOT Strokes', title = "Total Storkes by year")
```

```
Out[18]: <AxesSubplot:title={'center':'Total Storkes by year'}, xlabel='Date'>
```



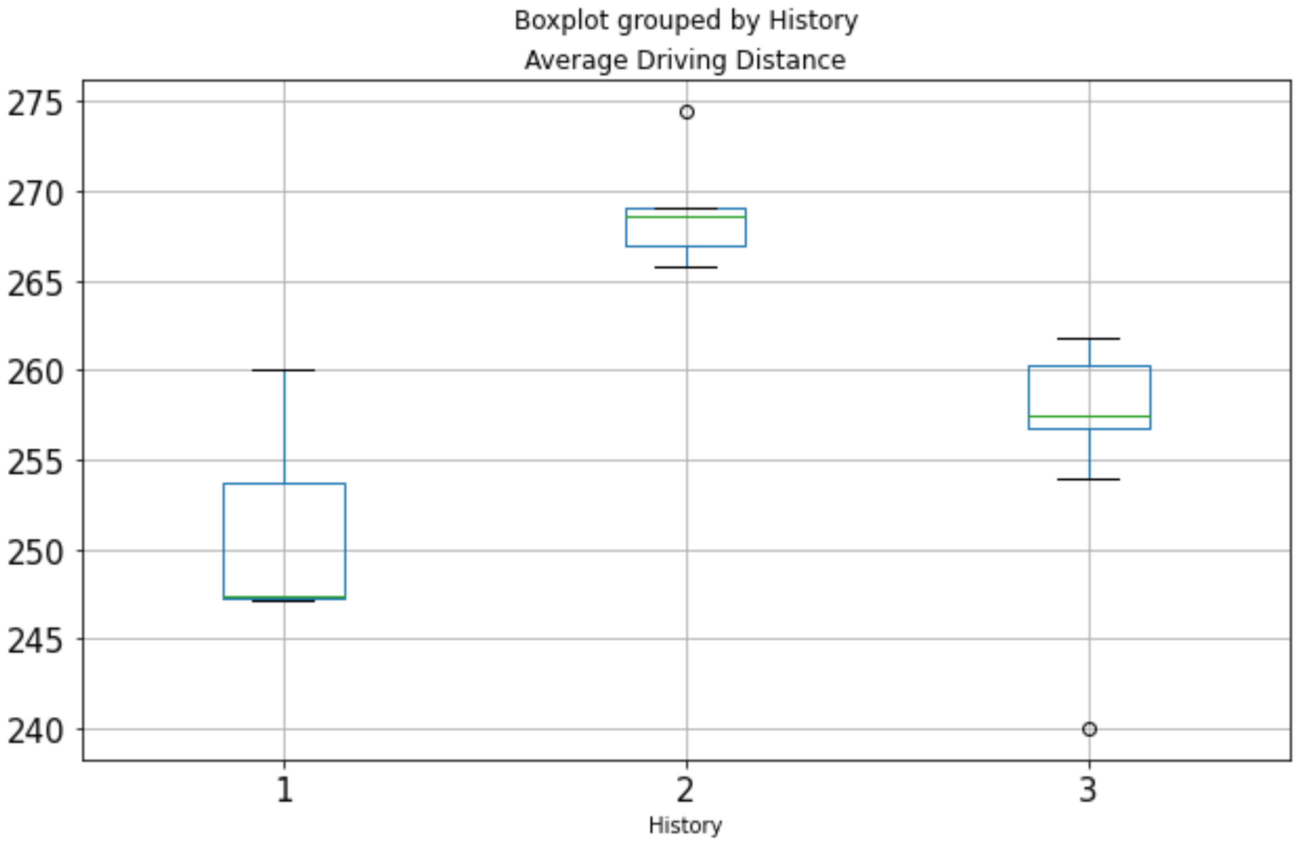
```
In [19]: def categorize(row):
             if pd.Timedelta(row['Year'] - Stanford_end_time).days > 0:
                 return 3
             elif pd.Timedelta(row['Year'] - Stanford_start_time).days < 0 :
                 return 1
             elif(pd.Timedelta(row['Year'] -  Stanford_start_time).days) > 0 :
                 return 2
```

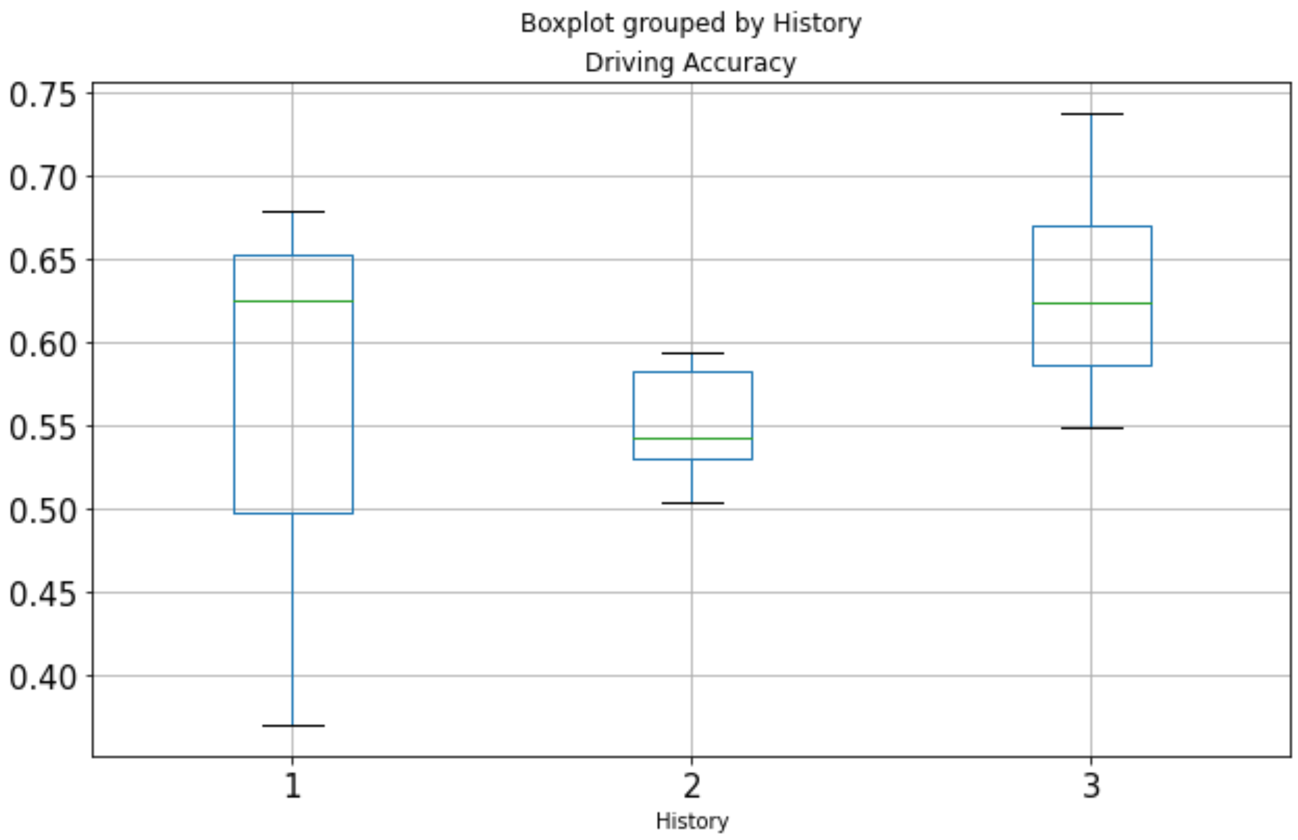
```
In [20]: MW['History'] = MW.apply(lambda row: categorize(row), axis=1)
```

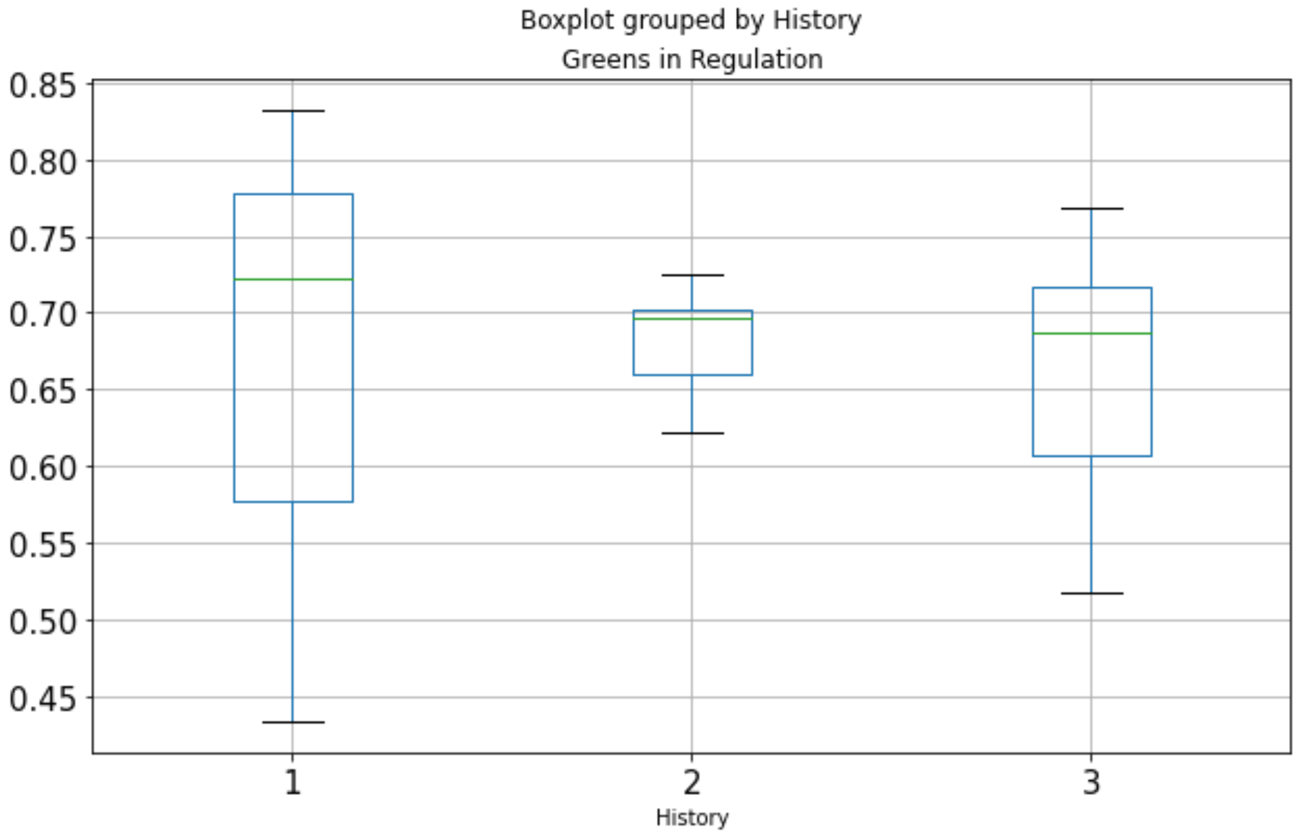
Generate Boxplots for better visualizations on some key golf performance comparisons during different times

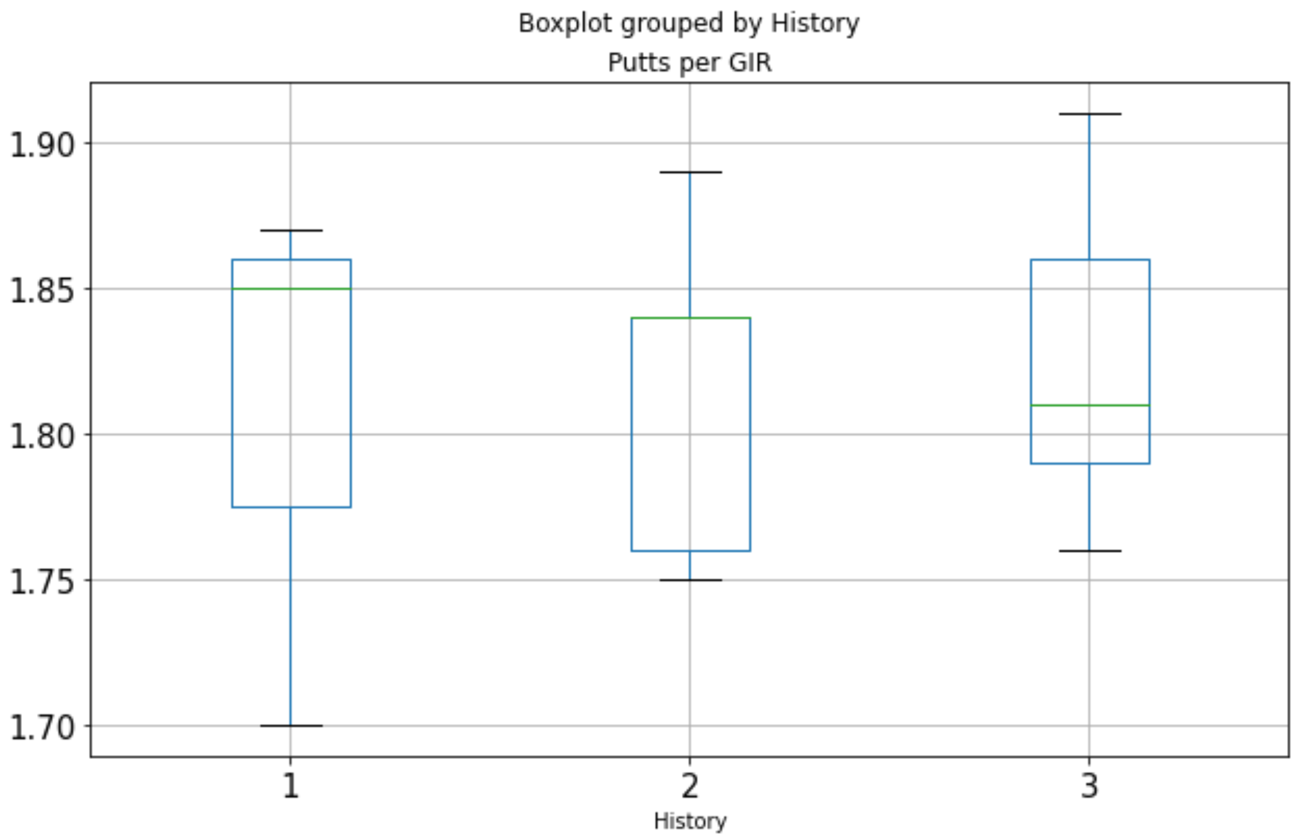
In [21]:

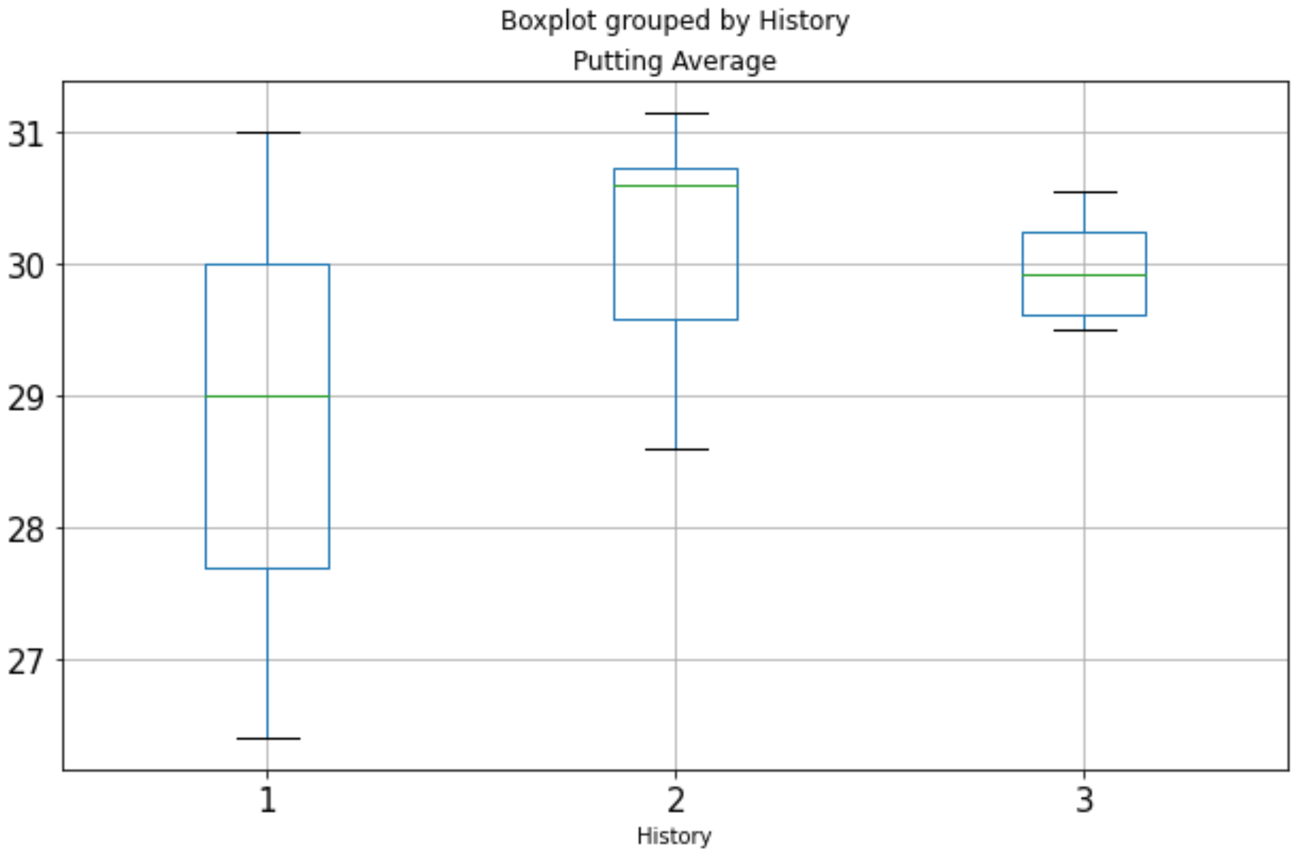
```
valid_plots = []
attributes_to_be_plotted = ["Average Driving Distance", 'Driving Accuracy',
       'Greens in Regulation', 'Putts per GIR', 'Putting Average',
       'Sand Saves', 'Scoring Average', 'Rounds Under Par', 'Birdies',
       'Eagles', "Rounds in the 60's", 'Sub Par Holes', 'Holes in One',
       'Total Rounds Played', 'Total Events Played']
for i in MW.columns:
    try:
        if i in attributes_to_be_plotted:
            valid_plots.append(MW.boxplot(column=[i],by='History', fontsize =
        else:

            pass
    except:
        continue
```

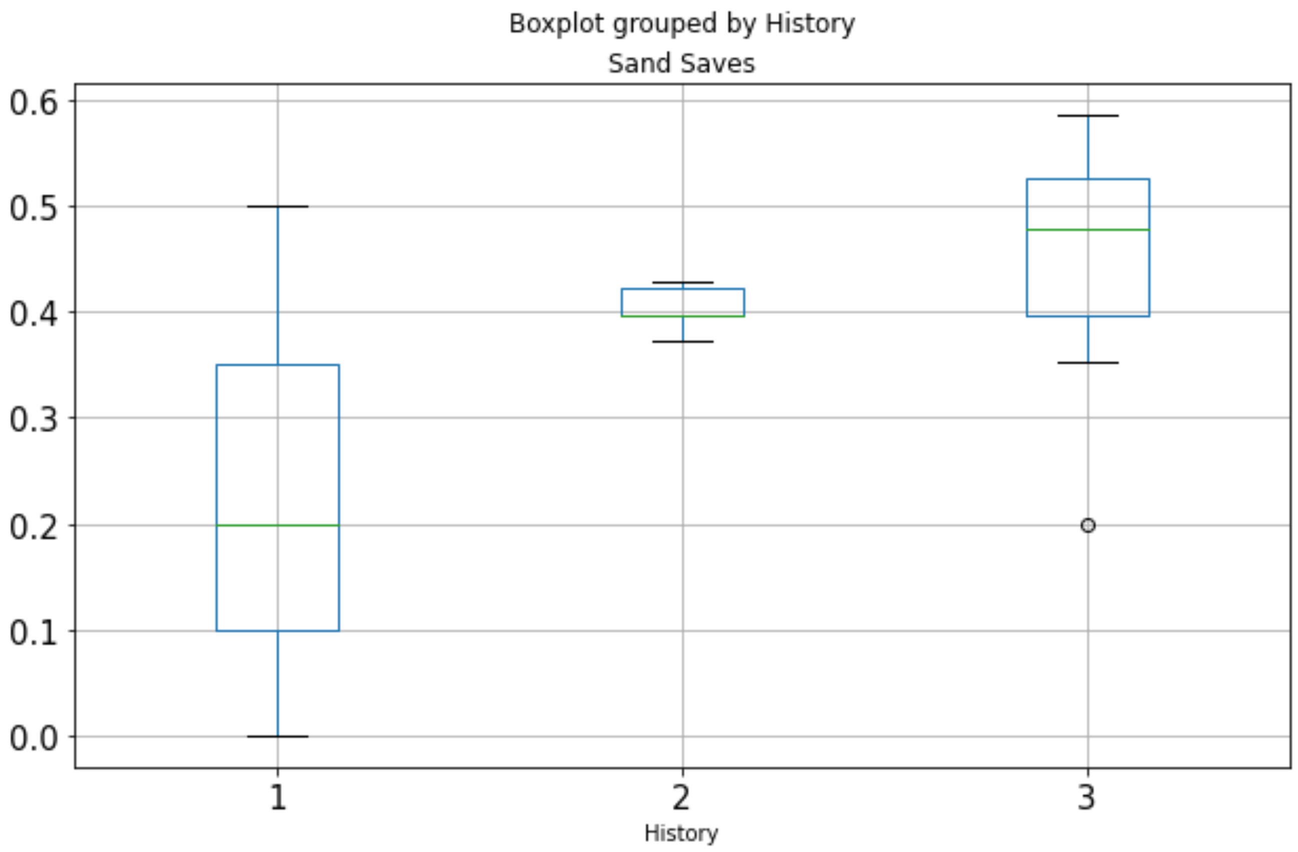


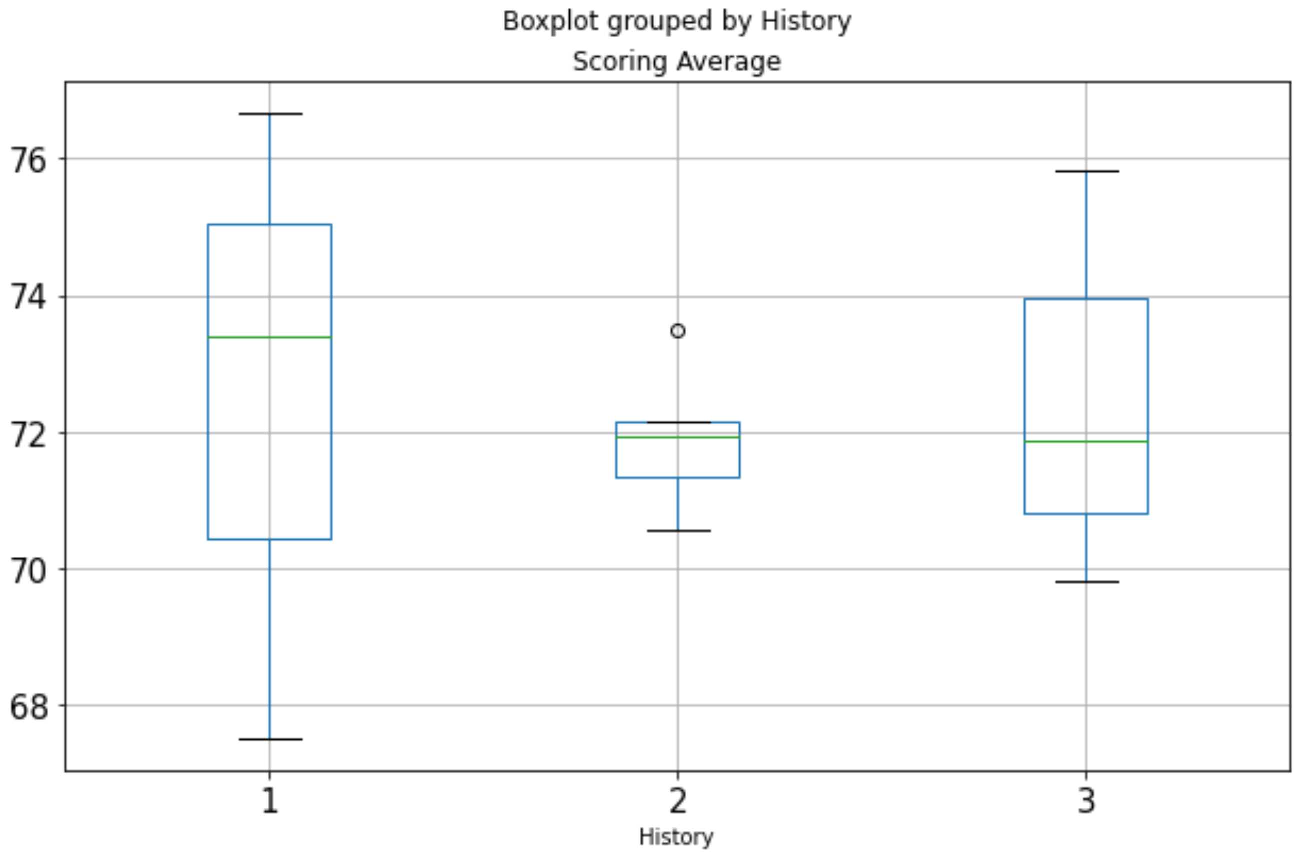

Boxplot grouped by History
Driving Accuracy
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
1
2
3
History

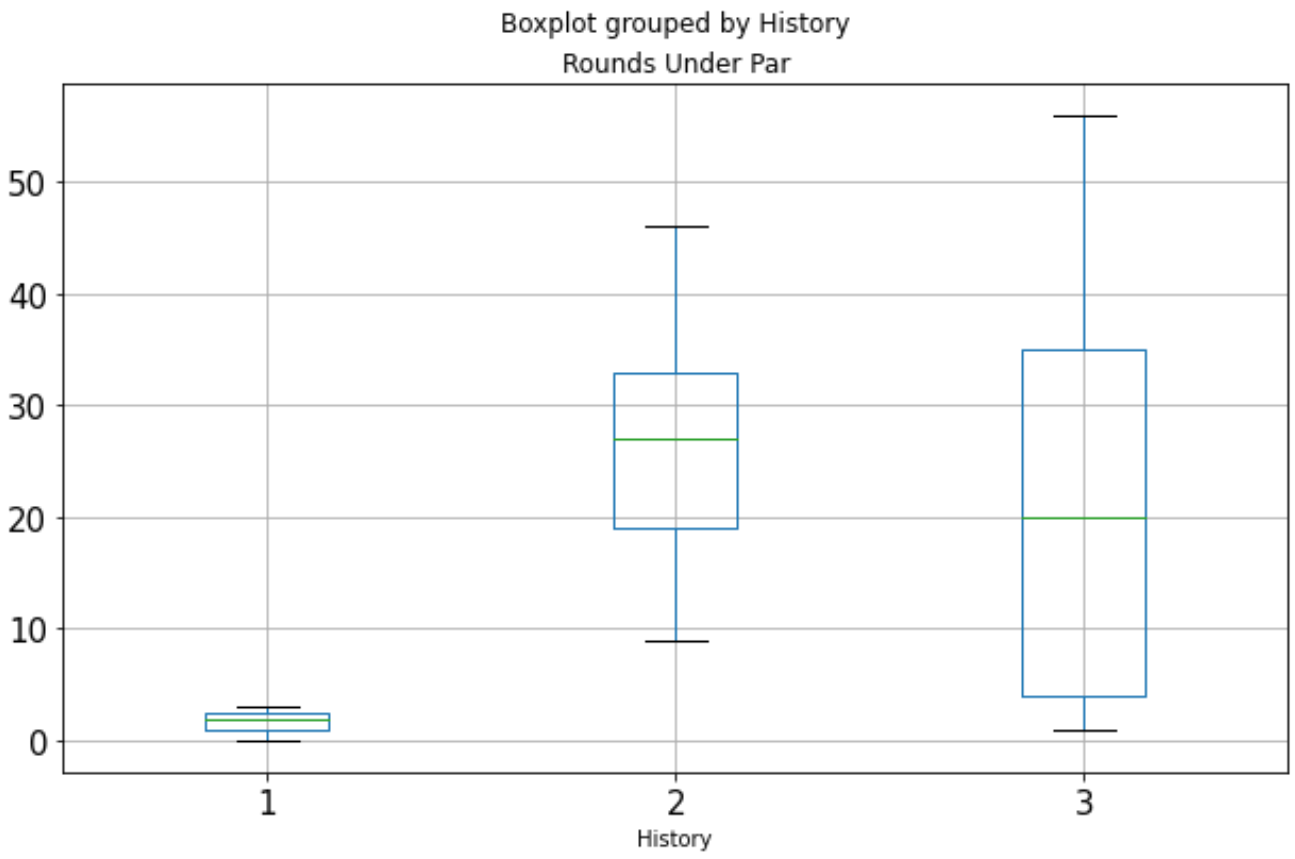

Boxplot grouped by History
Greens in Regulation
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
1
2
3
History


Boxplot grouped by History
Putts per GIR
1.90
1.85
1.80
1.75
1.70
1
2
3
History

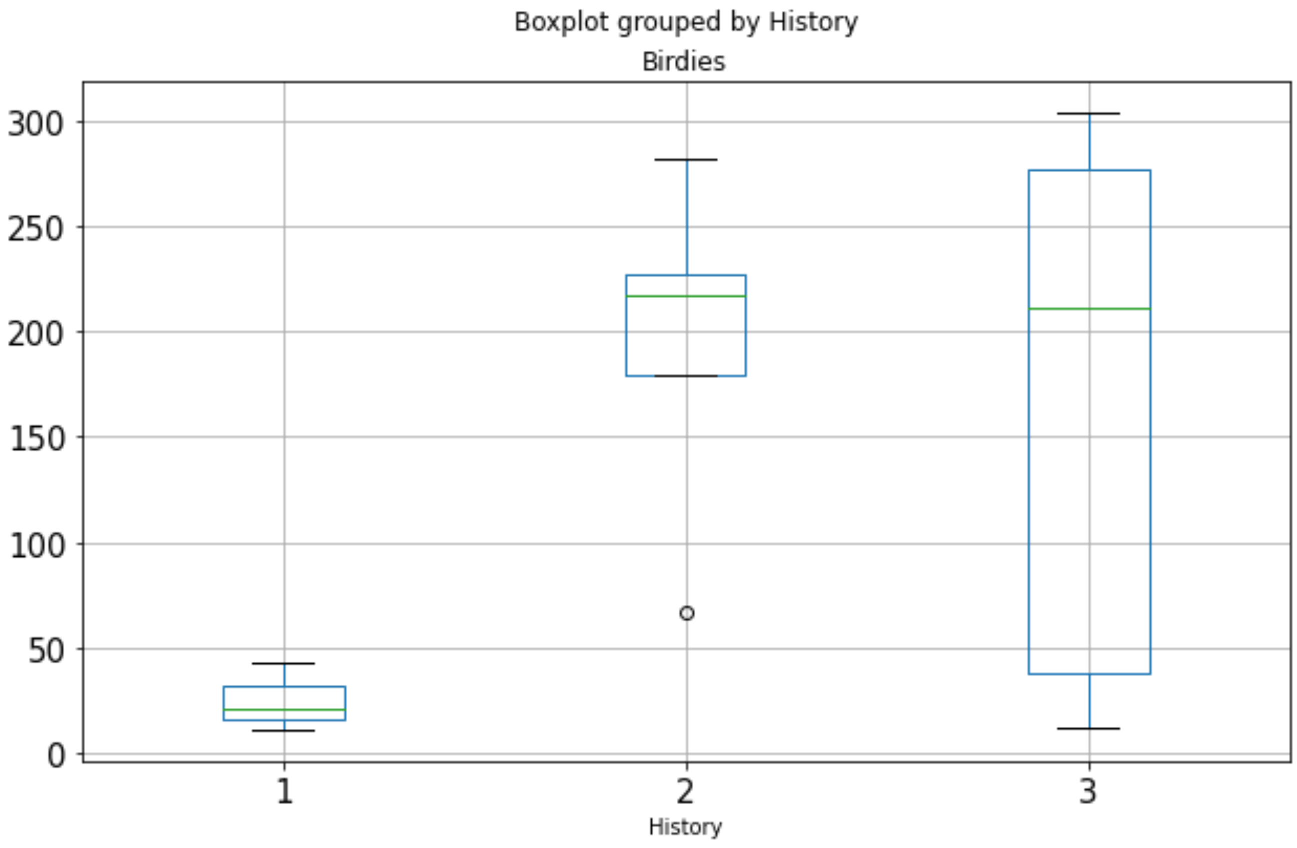

Boxplot grouped by History
Putting Average
31
30
29
28
27
1
2
3
History


Boxplot grouped by History
Sand Saves
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1
2
3
History

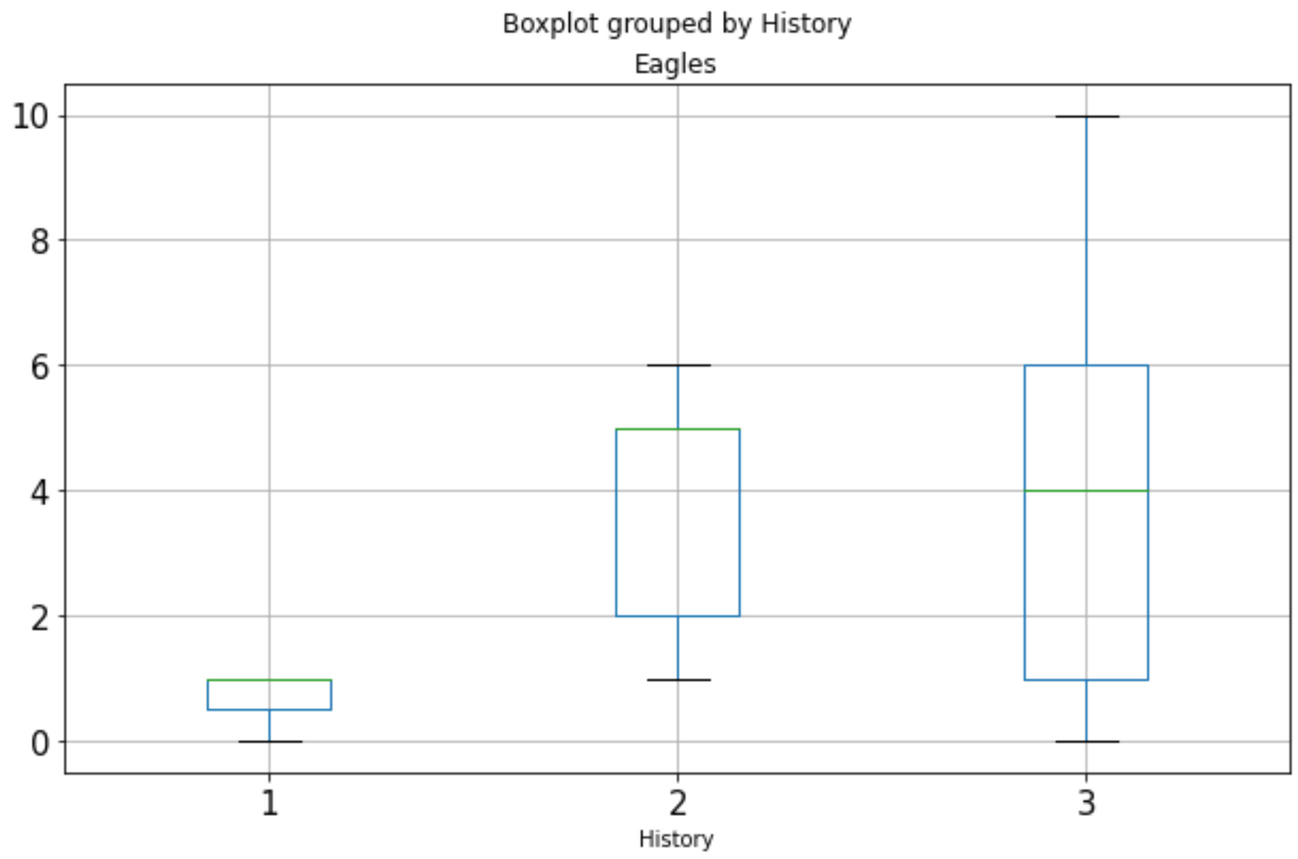

Boxplot grouped by History
Scoring Average
68
70
72
74
76
1
2
3
History

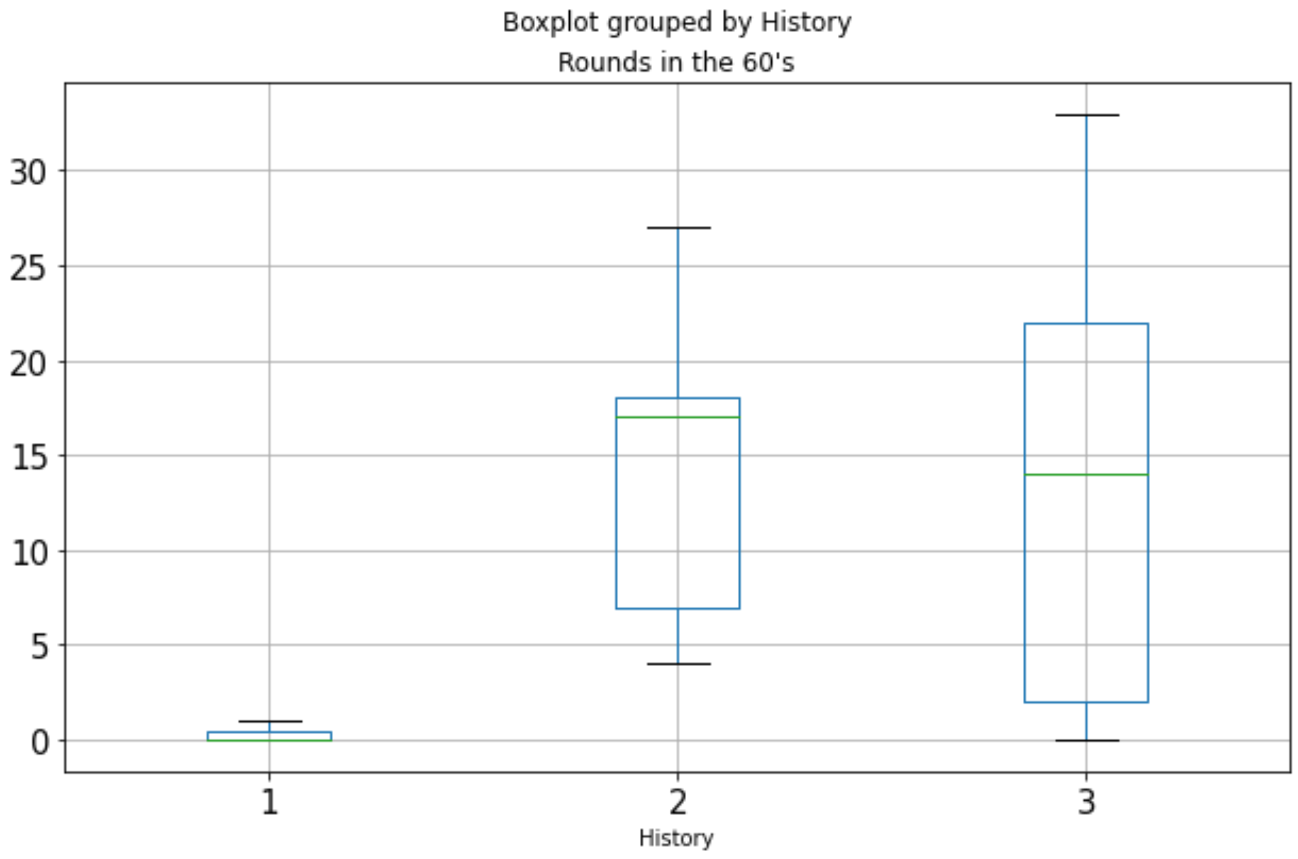


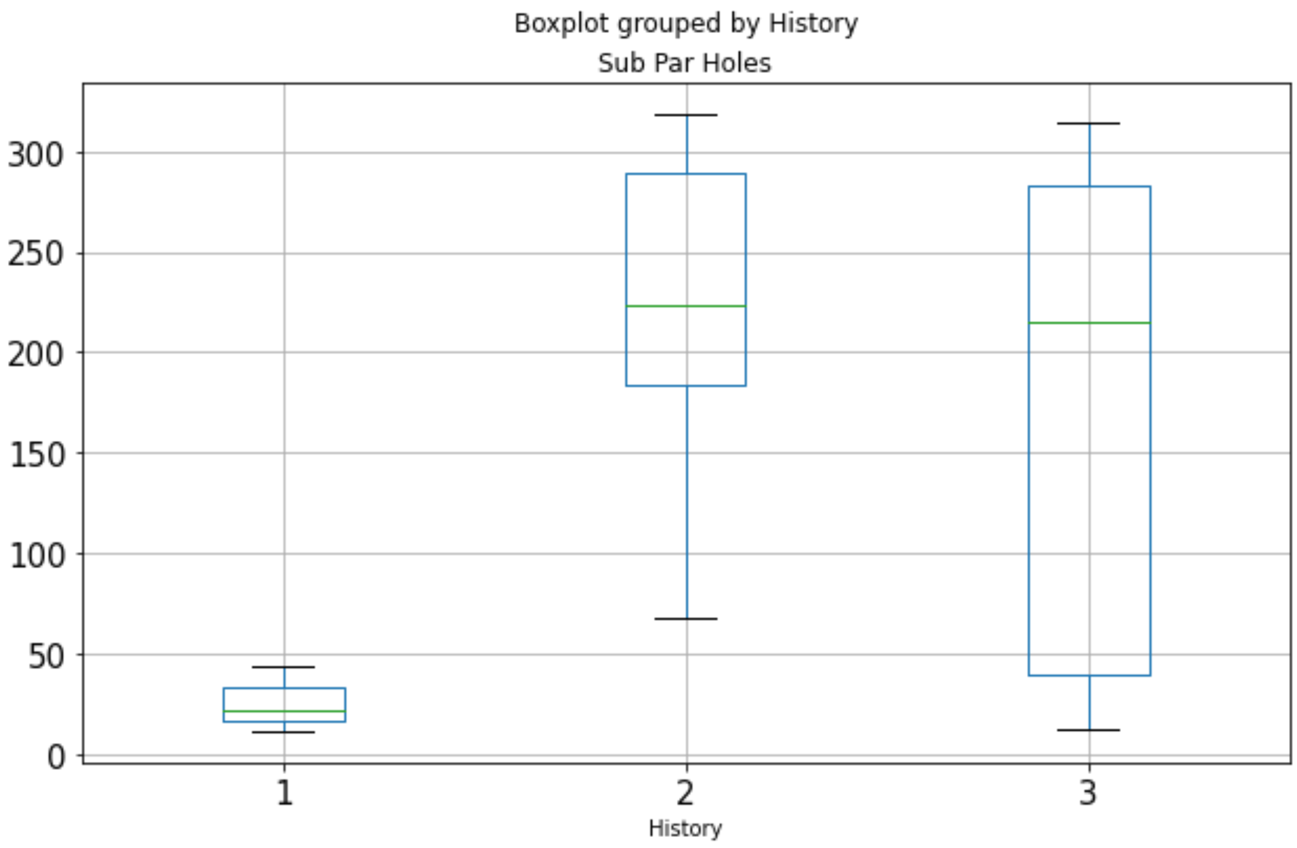
Boxplot grouped by History
Rounds Under Par
0
10
20
30
40
50
1
2
3
History

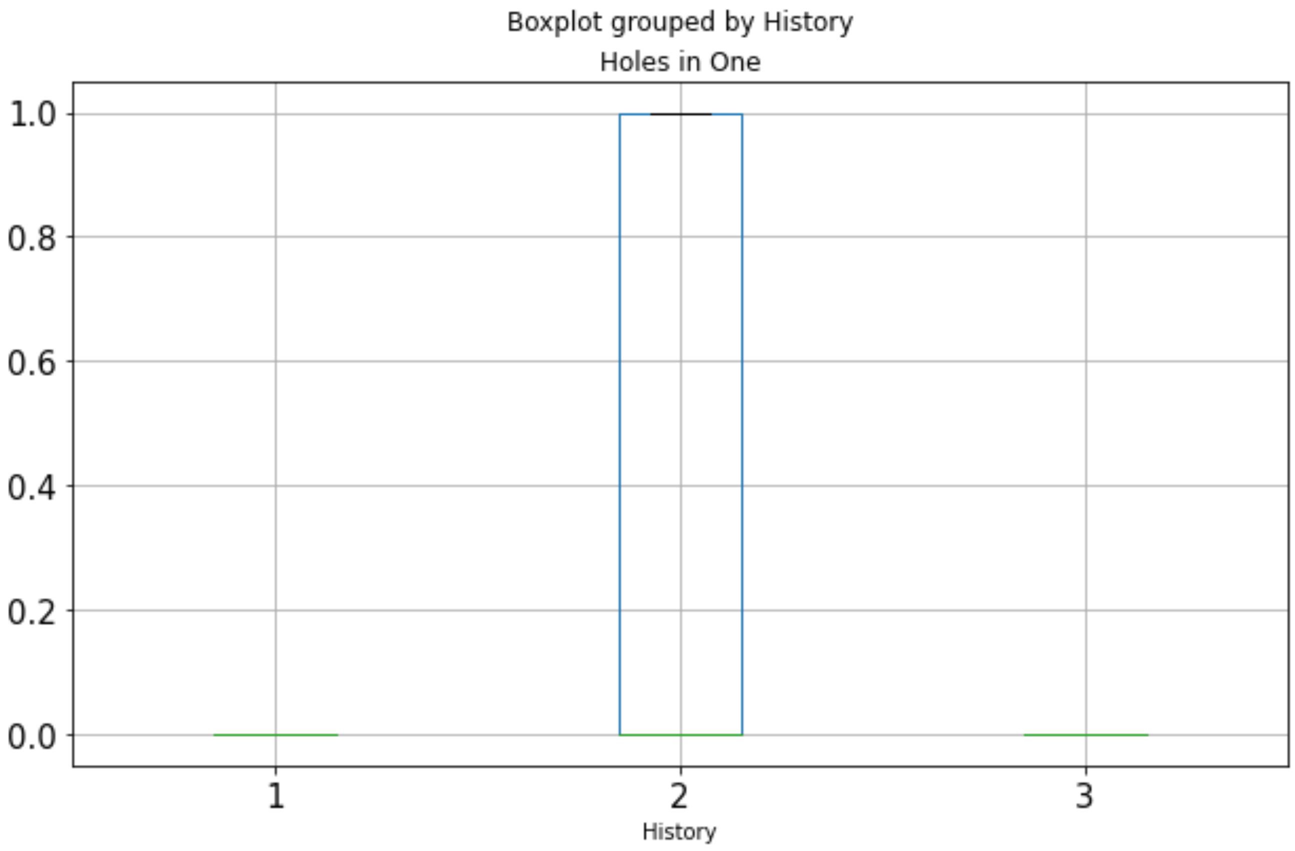


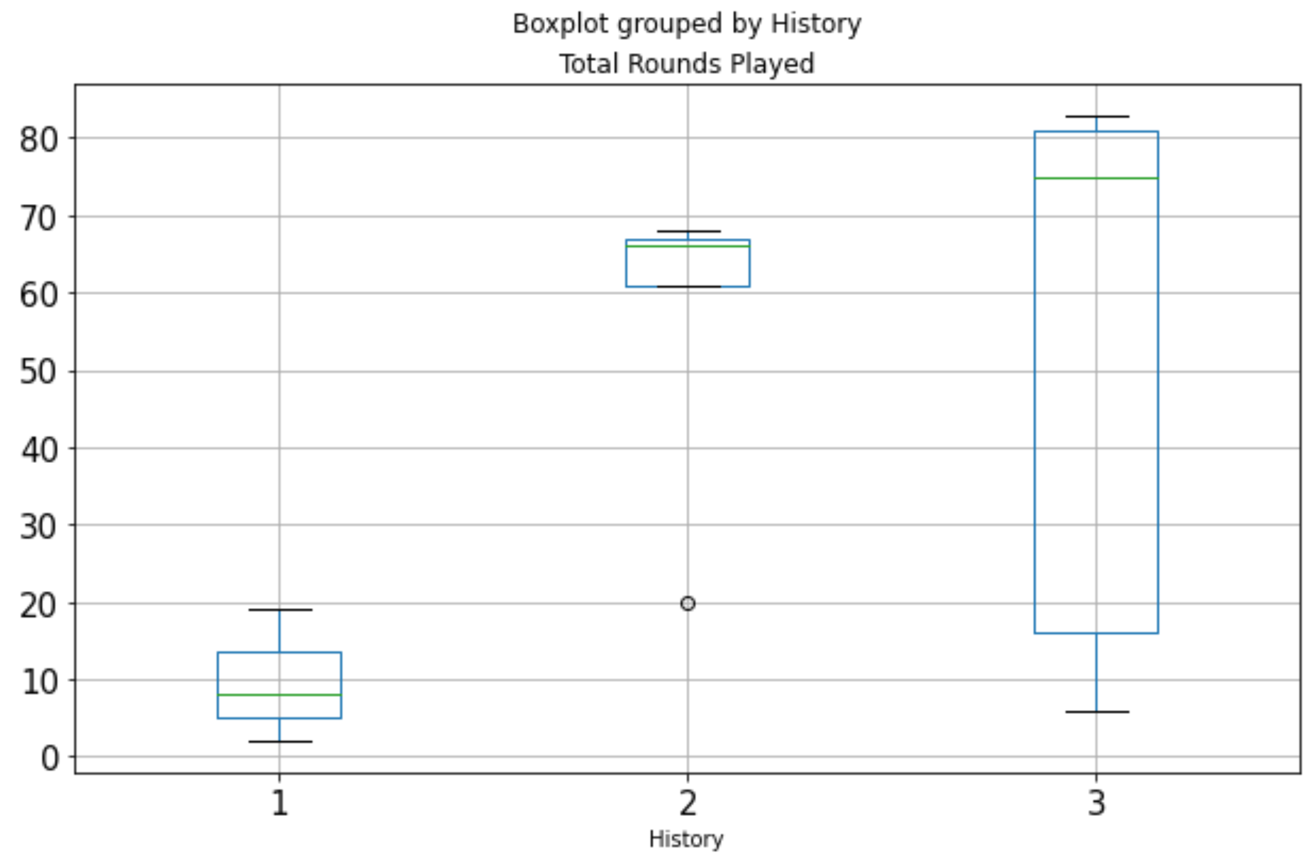
Boxplot grouped by History
Birdies
0
50
100
150
200
250
300
1
2
3
History

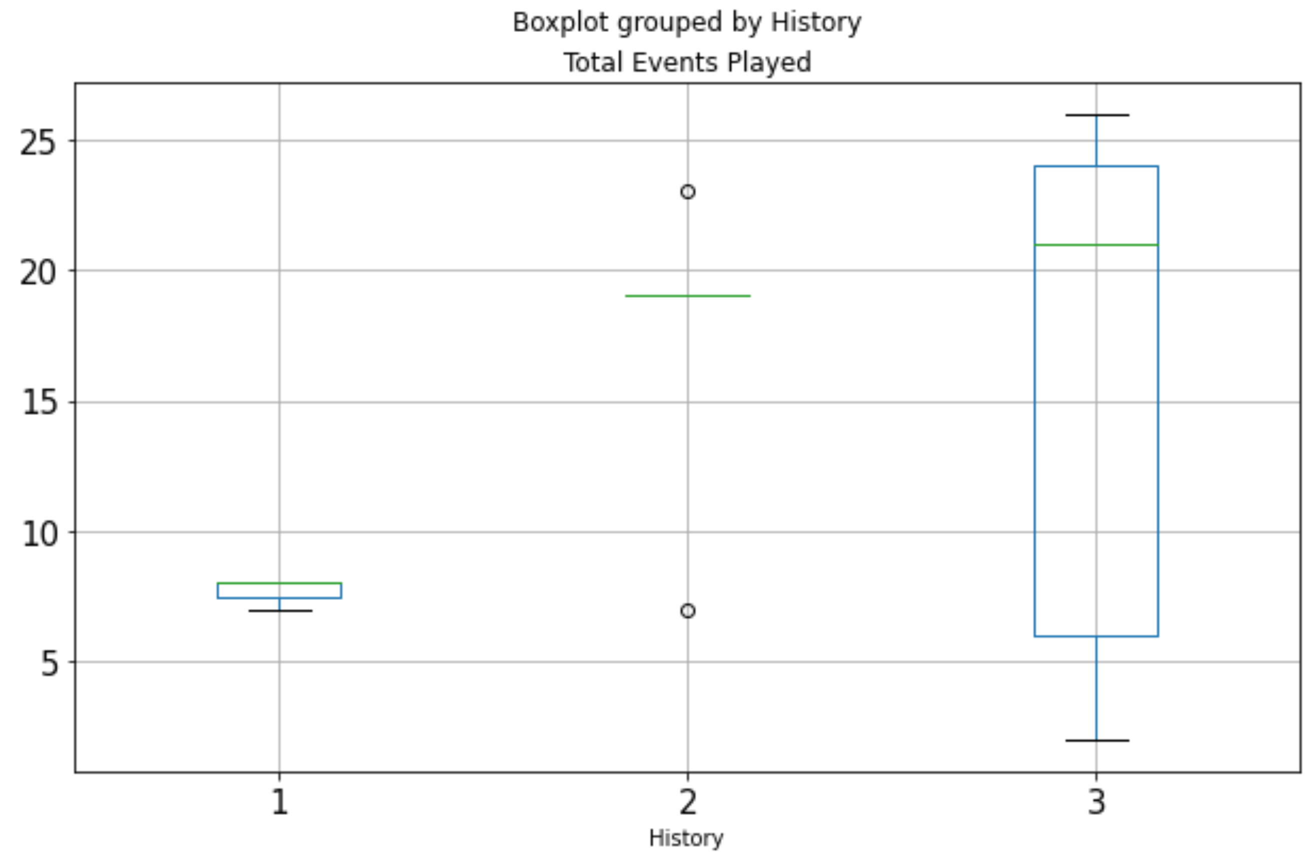

Boxplot grouped by History
Eagles
0
2
4
6
8
10
1
2
3
History


Boxplot grouped by History
Rounds in the 60's
0
5
10
15
20
25
30
1
2
3
History


Boxplot grouped by History
Sub Par Holes
300
250
200
150
100
50
0
1
2
3
History


Boxplot grouped by History
Holes in One
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
History





Perform Sample T Test on Average Driving Distance

In [22]:

```
print(ttest_ind(MW[MW['History']==1]['Average Driving Distance'], MW[MW['Hist
print(ttest_ind(MW[MW['History']==2]['Average Driving Distance'], MW[MW['Hist
```

```
Ttest_indResult(statistic=-4.740933021045971, pvalue=0.00318836315487906)
Ttest_indResult(statistic=3.893951977071066, pvalue=0.002133298709939889)
```

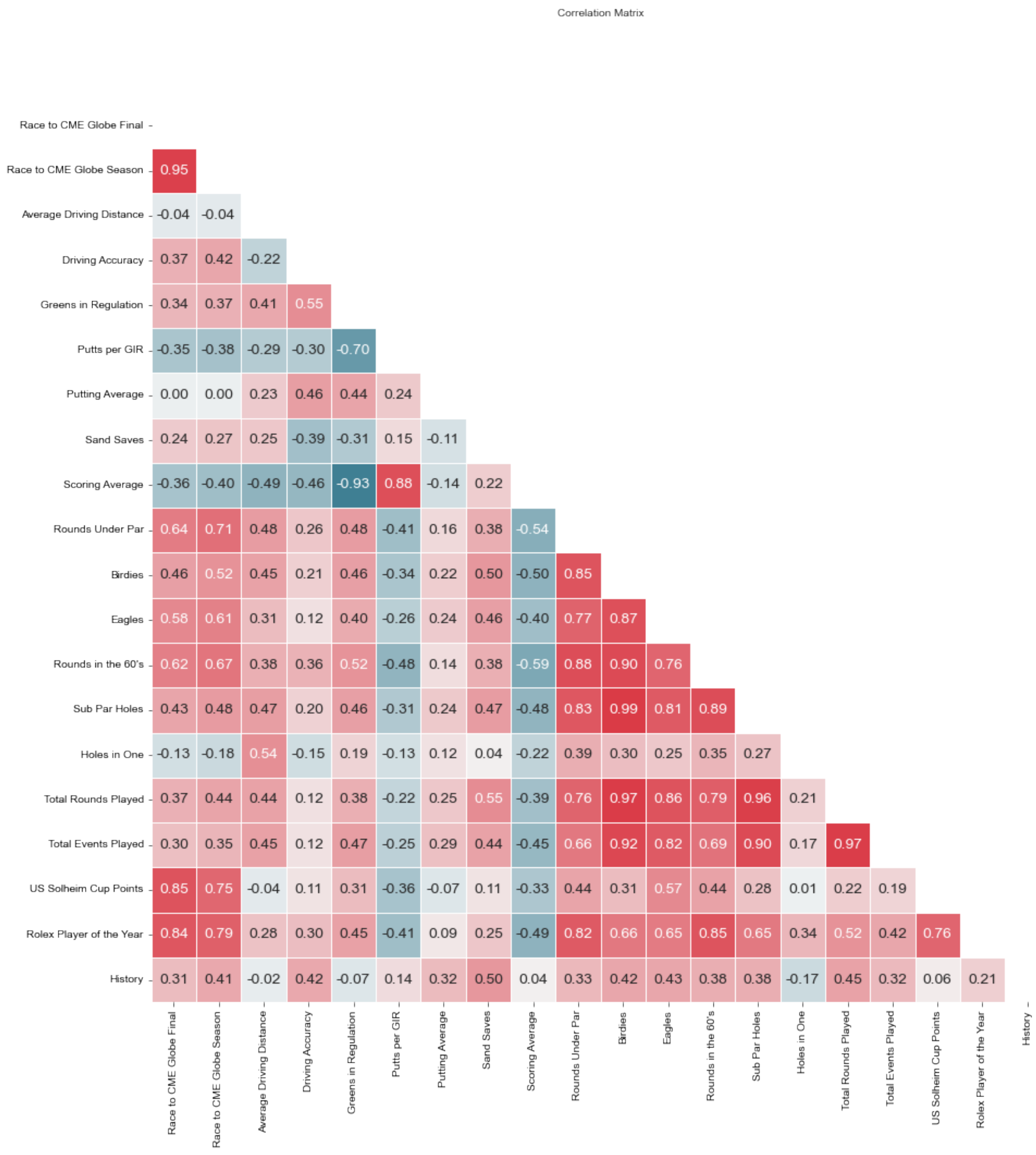
Combining the table results and plots above, sample T-test was run as an additional evidence to prove that the result is statistically significant on the average diriving distance before she attended Stanford and after she joined Stanford. In conclusion, higher education did not impact her ability to play as a professional player.

Next, I am trying to answer the 2nd research question by looking at yearly summary data and its correlation matrix

Correlation study and Scatter plots

In [23]:

```
corr = MW.corr()
fig, ax1 = plt.subplots(1,1, figsize = (26.6,15))
sns.set(font_scale = 1.15)
plt.style.use('seaborn-poster')
sns.set_style('whitegrid')
plt.suptitle('Correlation Matrix', size  = 10, ha = 'center')

sns.heatmap(corr, square = True, annot = True, linewidths = .5, cmap = sns.di
# sns.heatmap(corr[['Average Driving Distance']].sort_values(by = ['Average D

plt.tight_layout(pad = 1)
plt.subplots_adjust(top = .9)
plt.show()
```



	Race to CME Globe Final	Race to CME Globe Season	Average Driving Distance	Driving Accuracy	Greens in Regulation	Putts per GIR	Putting Average	Sand Saves	Scoring Average	Rounds Under Par	Birdies	Eagles	Rounds in the 60's	Sub Par Holes	Holes in One	Total Rounds Played	Total Events Played	US Solheim Cup Points	Rolex Player of the Year	History
Race to CME Globe Final																				
Race to CME Globe Season	0.95																			
Average Driving Distance	-0.04	-0.04																		
Driving Accuracy	0.37	0.42	-0.22																	
Greens in Regulation	0.34	0.37	0.41	0.55																
Putts per GIR	-0.35	-0.38	-0.29	-0.30	-0.70															
Putting Average	0.00	0.00	0.23	0.46	0.44	0.24														
Sand Saves	0.24	0.27	0.25	-0.39	-0.31	0.15	-0.11													
Scoring Average	-0.36	-0.40	-0.49	-0.46	-0.93	0.88	-0.14	0.22												
Rounds Under Par	0.64	0.71	0.48	0.26	0.48	-0.41	0.16	0.38	-0.54											
Birdies	0.46	0.52	0.45	0.21	0.46	-0.34	0.22	0.50	-0.50	0.85										
Eagles	0.58	0.61	0.31	0.12	0.40	-0.26	0.24	0.46	-0.40	0.77	0.87									
Rounds in the 60's	0.62	0.67	0.38	0.36	0.52	-0.48	0.14	0.38	-0.59	0.88	0.90	0.76								
Sub Par Holes	0.43	0.48	0.47	0.20	0.46	-0.31	0.24	0.47	-0.48	0.83	0.99	0.81	0.89							
Holes in One	-0.13	-0.18	0.54	-0.15	0.19	-0.13	0.12	0.04	-0.22	0.39	0.30	0.25	0.35	0.27						
Total Rounds Played	0.37	0.44	0.44	0.12	0.38	-0.22	0.25	0.55	-0.39	0.76	0.97	0.86	0.79	0.96	0.21					
Total Events Played	0.30	0.35	0.45	0.12	0.47	-0.25	0.29	0.44	-0.45	0.66	0.92	0.82	0.69	0.90	0.17	0.97				
US Solheim Cup Points	0.85	0.75	-0.04	0.11	0.31	-0.36	-0.07	0.11	-0.33	0.44	0.31	0.57	0.44	0.28	0.01	0.22	0.19			
Rolex Player of the Year	0.84	0.79	0.28	0.30	0.45	-0.41	0.09	0.25	-0.49	0.82	0.66	0.65	0.85	0.65	0.34	0.52	0.42	0.76		
History	0.31	0.41	-0.02	0.42	-0.07	0.14	0.32	0.50	0.04	0.33	0.42	0.43	0.38	0.38	-0.17	0.45	0.32	0.06	0.21	

Plotting the correlation matrix against all recorded metrics in the yearly summary data.

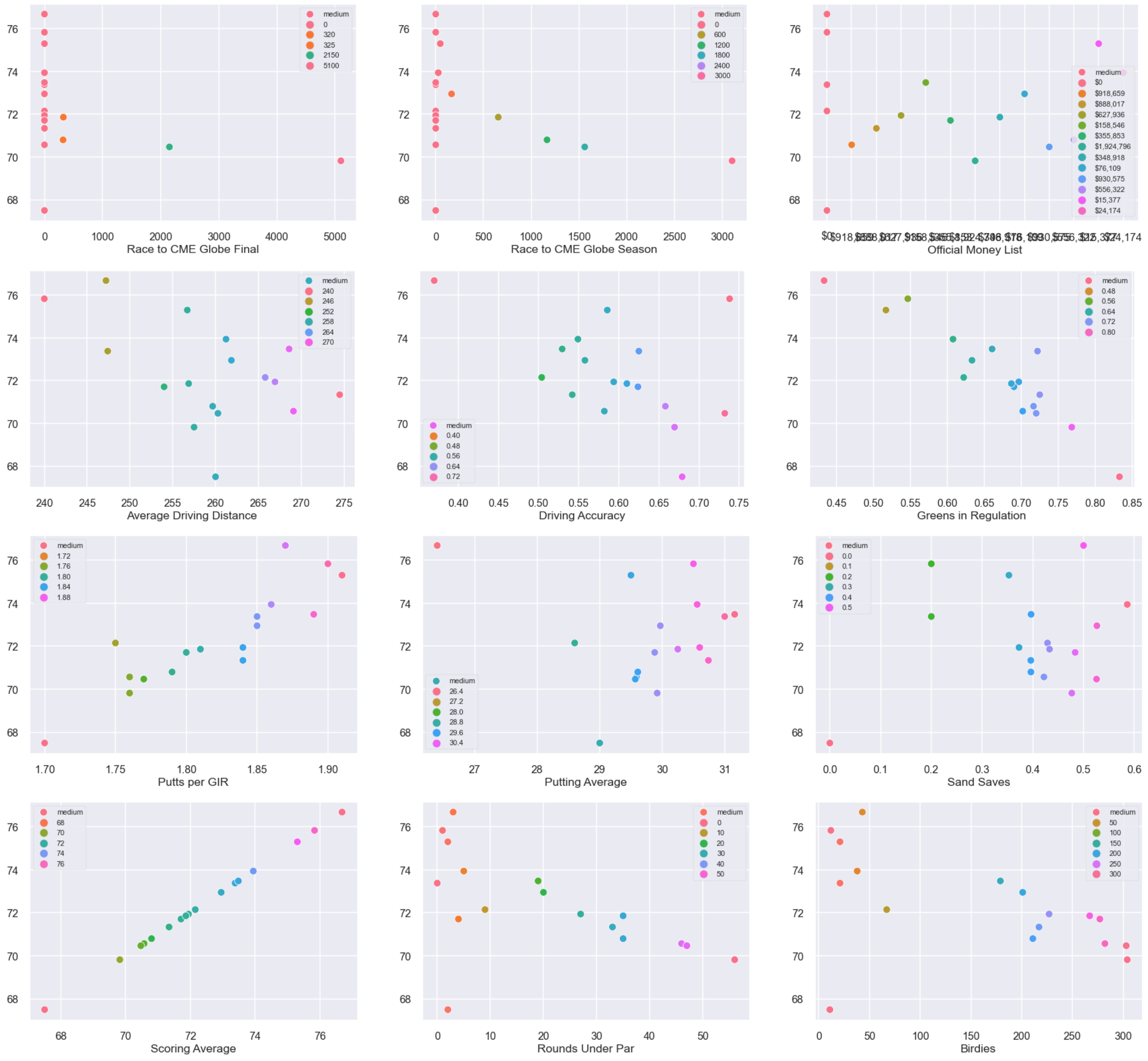
I am particularly interested in seeing what impacts scoring average. Therefore, I plotted scoring average vs all other parameters. The result is as shown below.

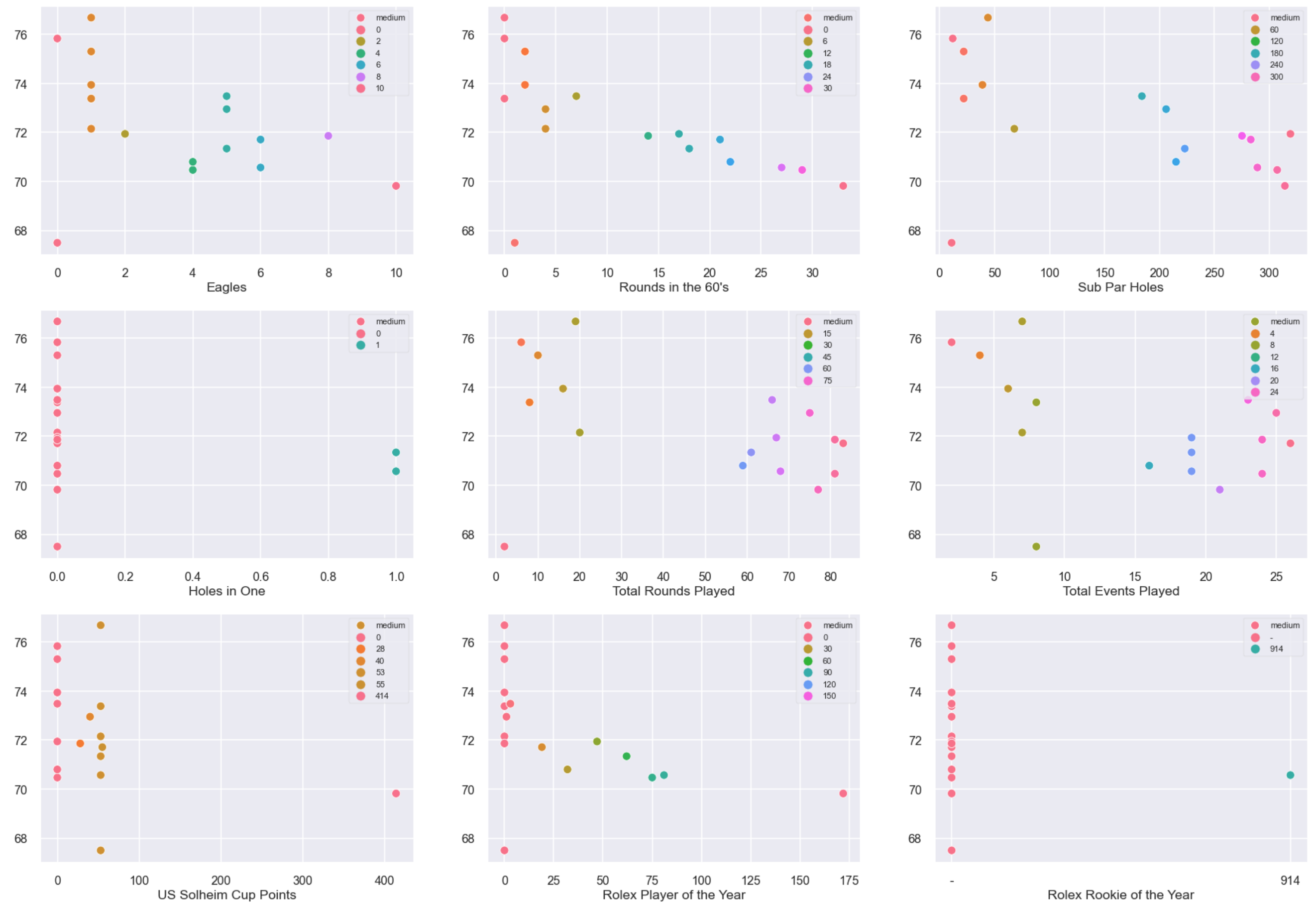
In [24]:

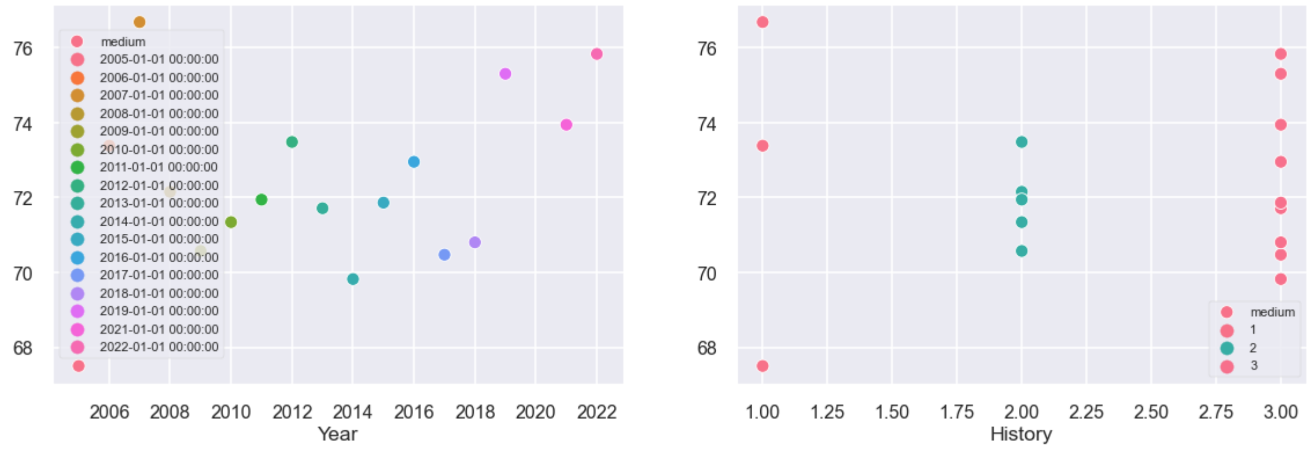
```python
def custom_scatter_plot(df, y, x_idx, plots_per_row):
    sns.set(font_scale = 1.25)
    plt.style.use('seaborn-poster')

    counter = 0

    for feature in x_idx:
        plt.figure(np.floor_divide(counter, plots_per_row), figsize = (30,6))
        plt.subplot(1 ,plots_per_row, np.mod(counter, plots_per_row) +1)
        sns.scatterplot(x = df[feature], y = df[y].values, hue = df[feature],
        plt.legend(loc = 'best', prop={'size': 11})
        counter+= 1
```

In [25]:

```python
custom_scatter_plot(MW, 'Scoring Average', MW.columns, 3)
```



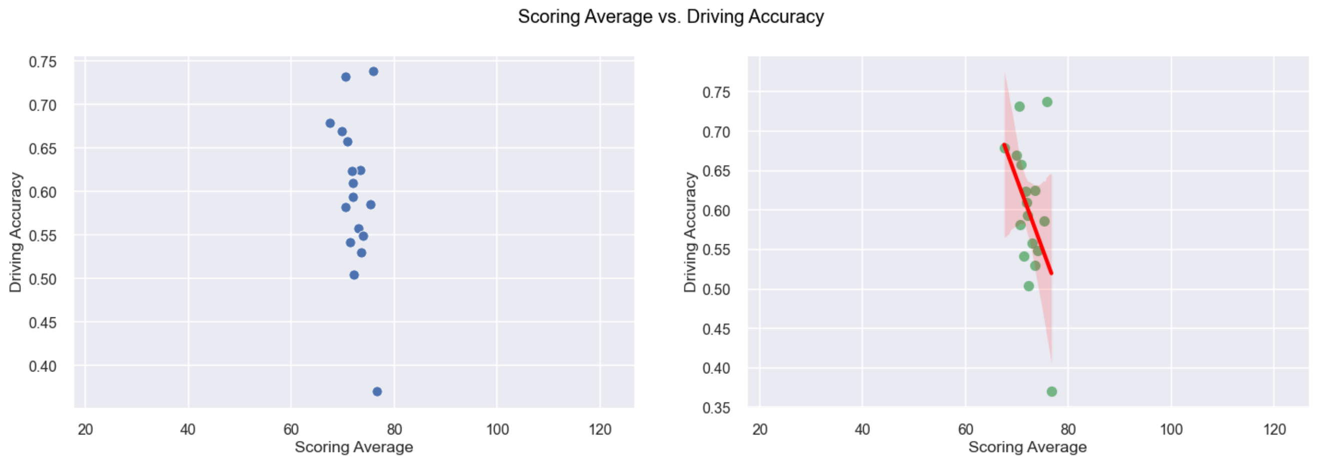




In [26]:
```
def reg_scatter(x, y, df):
    fig = plt.figure(figsize=(24, 7))
    sns.set(font_scale = 1.25)
    plt.style.use('seaborn-poster')
    plt.suptitle(f'{x} vs. {y}', size  = 20, color = 'black', ha = 'center')

    fig1 = fig.add_subplot(121); sns.scatterplot(MW[x], MW[y], data = df).set
    fig2 = fig.add_subplot(122); sns.regplot(MW[x], MW[y], data = df, scatter

    plt.show()
```

In [27]:
```
reg_scatter("Scoring Average", "Driving Accuracy", MW)
```

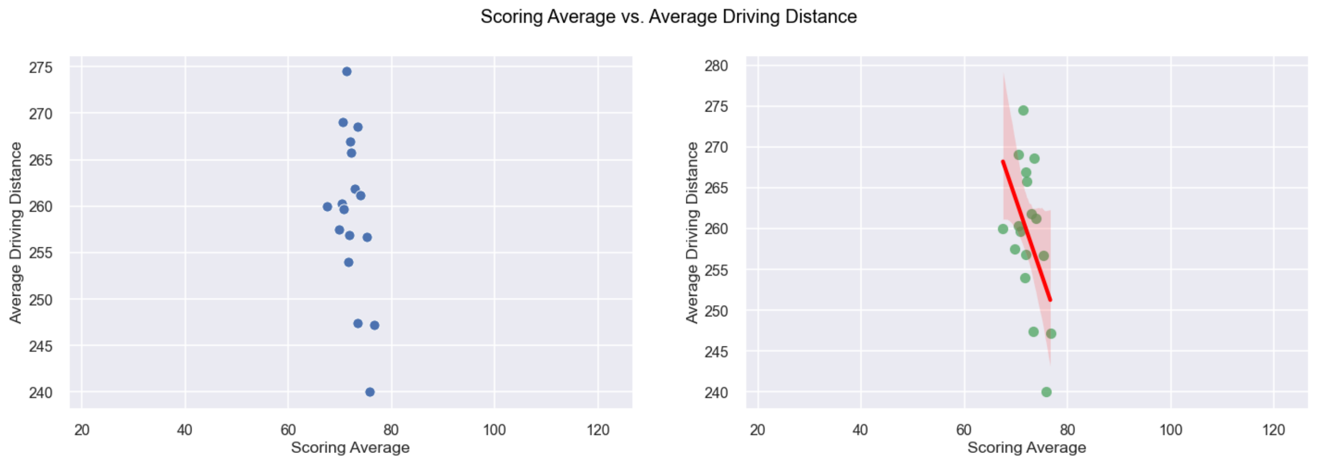
```
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



In [28]:

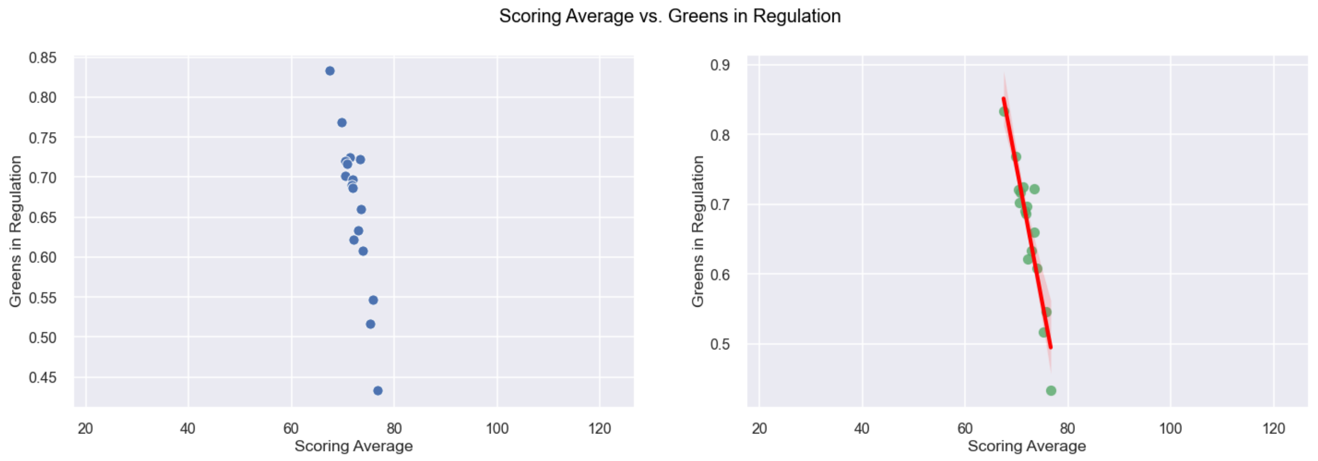
```
reg_scatter("Scoring Average", "Average Driving Distance", MW)
```

```
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



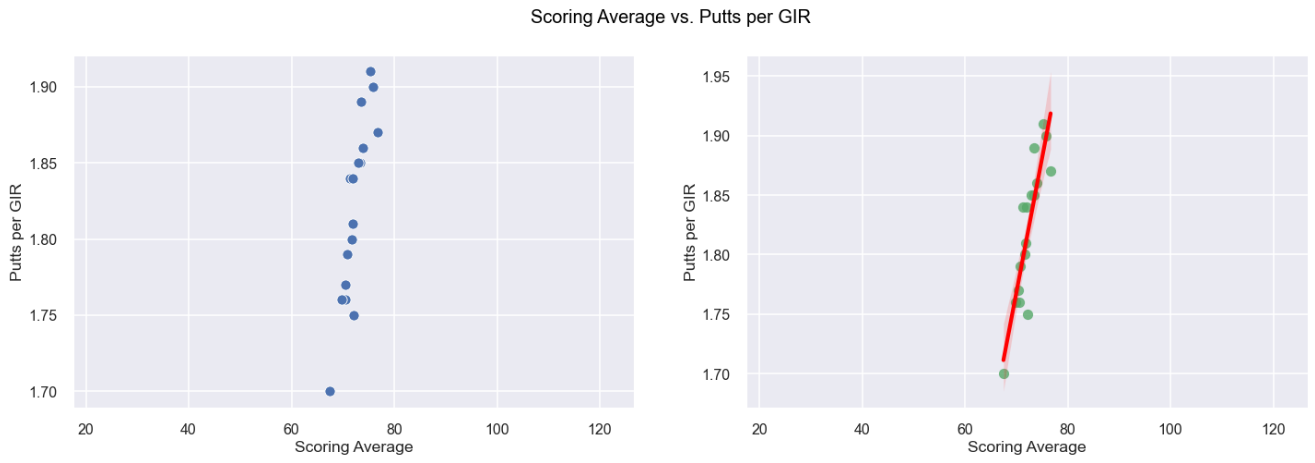
```
In [29]: reg_scatter("Scoring Average", "Greens in Regulation", MW)
```

```
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



```
In [30]: reg_scatter("Scoring Average", "Putts per GIR", MW)
```

```
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
/Users/tl164/opt/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.py:
43: FutureWarning: Pass the following variables as keyword args: x, y. From ve
rsion 0.12, the only valid positional argument will be `data`, and passing oth
er arguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



The data shows that green in regulation (GIR), driving accuracy and average driving distance have a negative correlation with Average Score. This is meaningful as player strives to increase their striking accuracy in an effort to decrease their average swing. Total rounds played and events attended have little to no correlation to the average score. This points to the fact that the more games you played, not necessarily , the better you will be from an average score persepctive. On the postivie correlation side, Putss per GIR is highly correlated to scoring average. This is because number of putts is part of scoring average's calucation. The more putts per GIR , the higher the average swings needed. Finally, all the other parameters show a weak or no correlation to scoring average at all.