

```
In [1]: 1 import numpy as np
2 import pandas as pd
3 pd.options.display.max_columns=100
4 import matplotlib.pyplot as plt
5 import seaborn as sns
6 %matplotlib inline
7
8 from sklearn.decomposition import PCA
9
10 from IPython.core.display import display, HTML
11 display(HTML("<style>.container { width:95% !important; }</style>"))
```

```
In [2]: 1 data = pd.read_csv("Data-Prepped-ELO-3-Groups.csv",index_col=0)
2 data = data.astype(np.float32)
3 data.head()
```

Out[2]:

	Low_ELO	Med_ELO	High_ELO	GroupedLeagueIndex	LeagueIndex	Age	HoursPerWeek
0	0.0	1.0	0.0	1.0	5.0	27.0	10.0
1	0.0	1.0	0.0	1.0	5.0	23.0	10.0
2	0.0	1.0	0.0	1.0	4.0	30.0	10.0
3	1.0	0.0	0.0	0.0	3.0	19.0	20.0
4	1.0	0.0	0.0	0.0	3.0	32.0	10.0

In [3]: 1 data.info()

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 3338 entries, 0 to 3337
Data columns (total 23 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   Low_ELO                              3338 non-null   float32
1   Med_ELO                              3338 non-null   float32
2   High_ELO                             3338 non-null   float32
3   GroupedLeagueIndex                  3338 non-null   float32
4   LeagueIndex                         3338 non-null   float32
5   Age                                 3338 non-null   float32
6   HoursPerWeek                        3338 non-null   float32
7   TotalHours                          3338 non-null   float32
8   APM                                 3338 non-null   float32
9   SelectByHotkeys                     3338 non-null   float32
10  AssignToHotkeys                     3338 non-null   float32
11  UniqueHotkeys                       3338 non-null   float32
12  MinimapAttacks                      3338 non-null   float32
13  MinimapRightClicks                 3338 non-null   float32
14  NumberOfPACs                       3338 non-null   float32
15  GapBetweenPACs                     3338 non-null   float32
16  ActionLatency                       3338 non-null   float32
17  ActionsInPAC                       3338 non-null   float32
18  TotalMapExplored                    3338 non-null   float32
19  WorkersMade                         3338 non-null   float32
20  UniqueUnitsMade                     3338 non-null   float32
21  ComplexUnitsMade                    3338 non-null   float32
22  ComplexAbilitiesUsed                3338 non-null   float32
dtypes: float32(23)
memory usage: 326.0 KB
```

```
In [4]: 1 indatatxt = open("Data Explanation -- StarCraft II Ranked Players.txt")
2 print(indatatxt.read())
3 var = []
4 for i in data:
5     var.append(i)
```

Data project data categories

Data pulled from <https://www.kaggle.com/danofer/skillcraft> (<https://www.kaggle.com/danofer/skillcraft>) which pulled the data from the University of California Irvine's machine learning repository located at <http://archive.ics.uci.edu/ml/datasets/SkillCraft1+Master+Table+Dataset> (<http://archive.ics.uci.edu/ml/datasets/SkillCraft1+Master+Table+Dataset>)

This data is taken from replays of 1v1 ranked games of StarCraft II, a real time strategy game in which two or more players compete by accruing resources, building an army and wiping out the enemy.

A player loses when all of their buildings are destroyed or when they surrender.

Players each start with one base hub and a number of workers located symmetrically on a map. The map is littered with locations containing clusters of minerals and usually gas geysers.

These are the resources which the players will use to build buildings, construct new technologies and produce armies.

```
00 GameID #
01 LeagueIndex # Numerical list (1-8) based on categorical
rank. Can be considered both categorical and numerical
02 Age # Age of player
03 HoursPerWeek # Hours player plays per week
04 TotalHours # Total hours player has played
05 APM # Average number of actions per minute (actions
are commands given to units or structures)
```

```
# For the next few variables, one must understand control
groups. Control groups are hotkeys that a player can assign units to such
that when the hotkey is selected, the units and buildings assigned become
selected for quick use.
```

```
06 SelectByHotkeys # Number of units/buildings selected
with hotkeys per timestamp
07 AssignToHotkeys # Number of units/buildings assigned
to control groups per timestamp
08 UniqueHotkeys # Number of unique hotkeys used per
timestamp
09 MinimapAttacks # Number of times a player uses the
minimap to order a unit to attack anything on the way to a location per
timestamp
10 MinimapRightClicks # Number of right clicks on the minimap per
timestamp
```

```
# For the next few variables, PACs (Perception Action Cycles)
are when a player focuses on a certain area by moving their screen and
then makes an action.
```

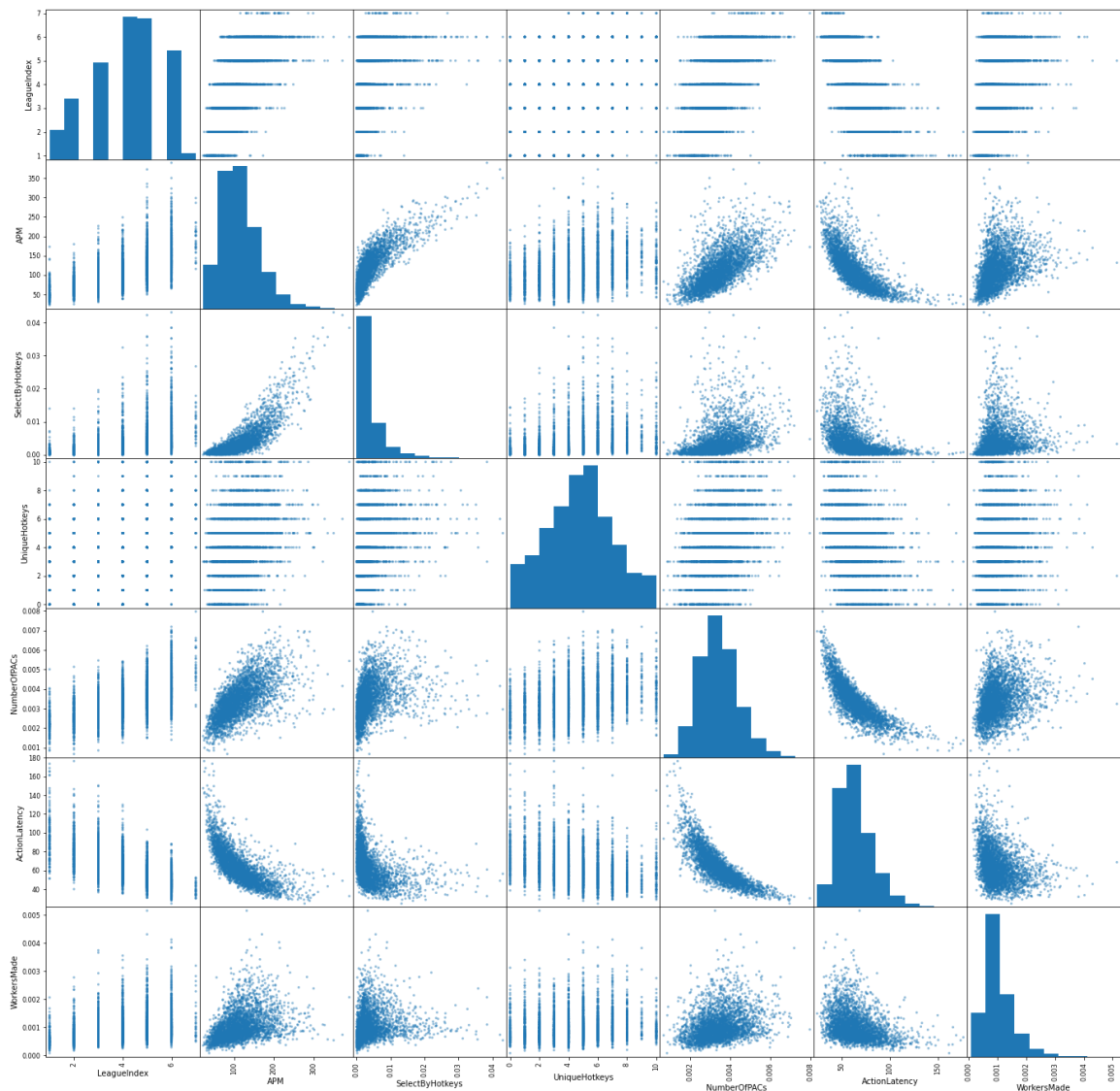
11 NumberOfPACs	# Number of PACs per timestamp
12 GapBetweenPACs	# Average number of milliseconds between PACs
13 ActionLatency	# Average time between focusing on an area and making the first action of the current PAC
14 ActionsInPAC	# Average number of actions within a PAC
15 TotalMapExplored	# The amount of the map explored by a player per timestamp
16 WorkersMade	# Number of worker units trained per timestamp
17 UniqueUnitsMade	# Number of unique units made per timestamp
18 ComplexUnitsMade	# Number of units that require direct controls to be effective trained per timestamp
19 ComplexAbilitiesUsed	# Number of times abilities from aforementioned complex units are used per timestamp

In [5]: 1 data.describe()

Out[5]:

	Low_ELO	Med_ELO	High_ELO	GroupedLeagueIndex	LeagueIndex	Average
count	3338.000000	3338.000000	3338.000000	3338.000000	3338.000000	3338.000000
mean	0.319652	0.483823	0.196525	0.876872	4.120731	21.65038
std	0.466412	0.499813	0.397429	0.707932	1.448170	4.20635
min	0.000000	0.000000	0.000000	0.000000	1.000000	16.00000
25%	0.000000	0.000000	0.000000	0.000000	3.000000	19.00000
50%	0.000000	0.000000	0.000000	1.000000	4.000000	21.00000
75%	1.000000	1.000000	0.000000	1.000000	5.000000	24.00000
max	1.000000	1.000000	1.000000	2.000000	7.000000	44.00000


```
In [7]: 1 IDs = ['LeagueIndex', 'APM', 'SelectByHotkeys', 'UniqueHotkeys', 'NumberOfP
2 pd.plotting.scatter_matrix(data[IDs],figsize=(24,24))
3 plt.show()
```

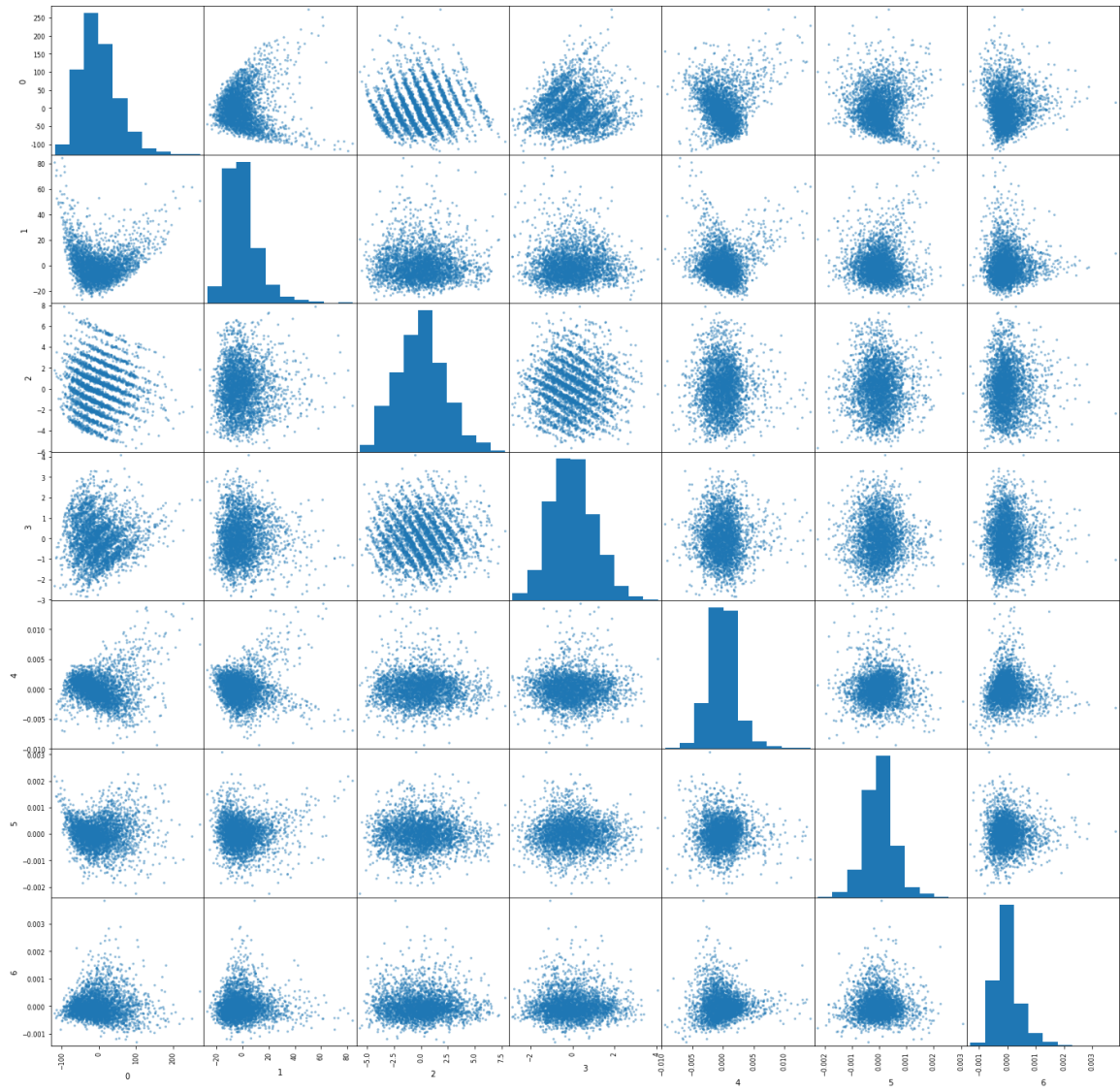


Examine variables from sklearn.decomposition.PCA

```
In [8]: 1 pca = PCA()
2 pca.fit(data[IDs])
3 data_transformed = pd.DataFrame(pca.transform(data[IDs]))
4 data_transformed.shape
```

Out[8]: (3338, 7)

```
In [9]: 1 pd.plotting.scatter_matrix(data_transformed,figsize=(24,24))  
2 plt.show()
```



```

In [10]: 1 # Code for the following graphs based on https://www.kaggle.com/immodal,
2 leagueTitles = ["Low ELO", "Med ELO", "High ELO"]
3 leagueIndexs = [ 0.0, 1.0, 2.0]
4 colors = ['darkgoldenrod', 'silver', 'gold']
5 leagueDict = dict()
6 for i, ind in enumerate(leagueIndexs):
7     leagueDict[ind] = leagueTitles[i]
8 leagueLabeled = data["GroupedLeagueIndex"].replace(leagueDict)
9
10 def violin_plot(y, title, w, h):
11     plt.figure(figsize=(w,h))
12     ax = sns.violinplot(x=leagueLabeled, y=y, palette=colors, order=leagueTitles)
13     ax.set(xlabel='ELO Group')
14     ax.set_ylim(0,)
15     plt.title(title)
16     plt.show()
17
18 def density_plot(x, title, w, h):
19     fig, (ax_box, ax_hist) = plt.subplots(2, sharex=True, gridspec_kw={'height_ratios': (1, 1)})
20     fig.set_size_inches(w,h)
21     ax_box.set_xlim(0,x.max())
22     ax_hist.set_xlim(0,x.max())
23     sns.boxplot(x, ax=ax_box)
24     sns.distplot(x, ax=ax_hist)
25     ax_box.set(yticks=[])
26     sns.despine(ax=ax_hist)
27     sns.despine(ax=ax_box, left=True)
28     ax_box.set_title(title)
29     plt.show()
30
31 def plot(feature, fig_num):
32     density_plot(data[feature], f"Figure {fig_num}: {feature} Distribution")
33     violin_plot(data[feature], f"Figure {fig_num}: {feature} by League",

```



```
In [11]: 1 plot("APM",1)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

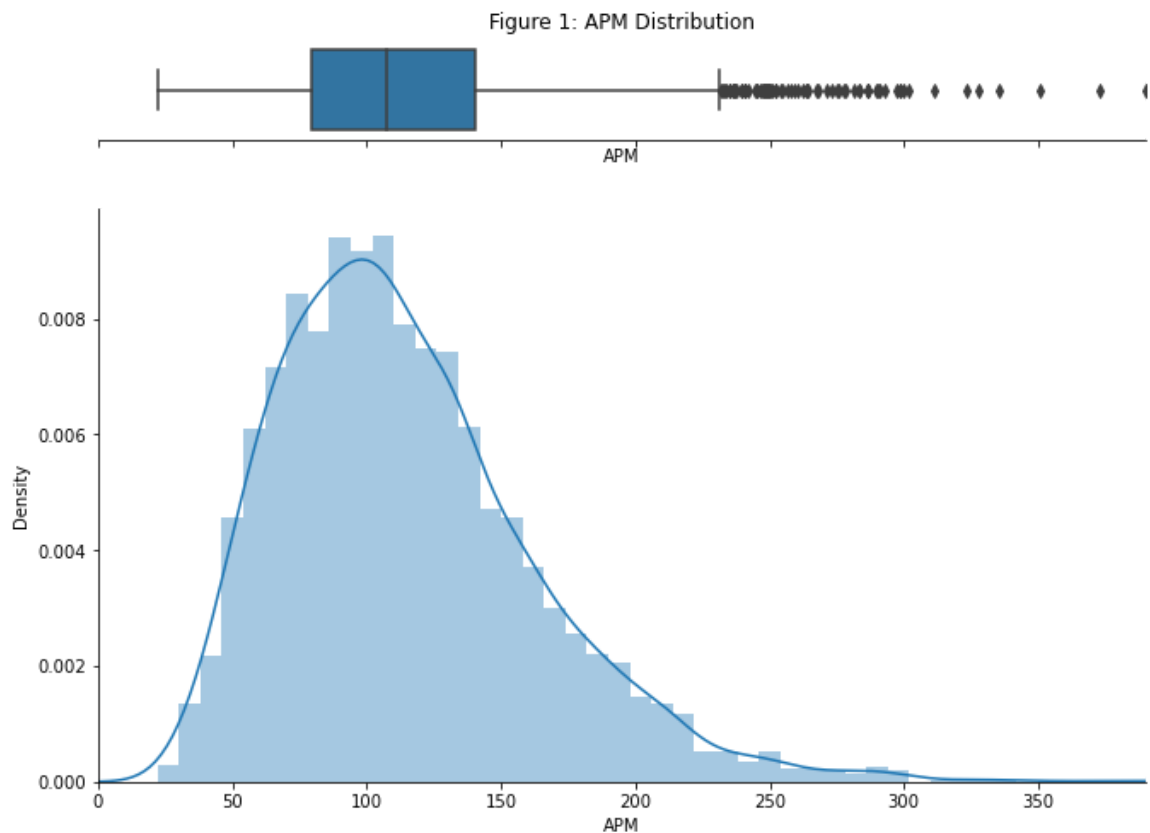
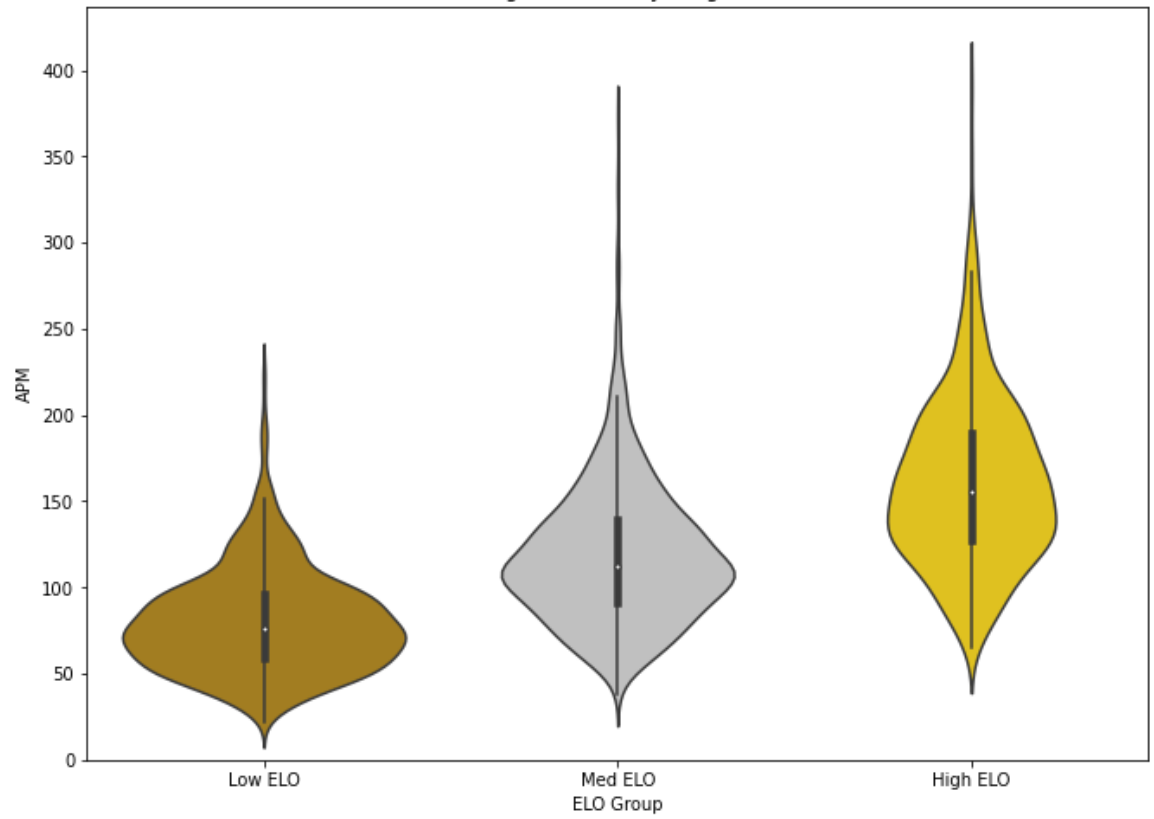


Figure 1: APM by League



```
In [12]: 1 plot("HoursPerWeek",2)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

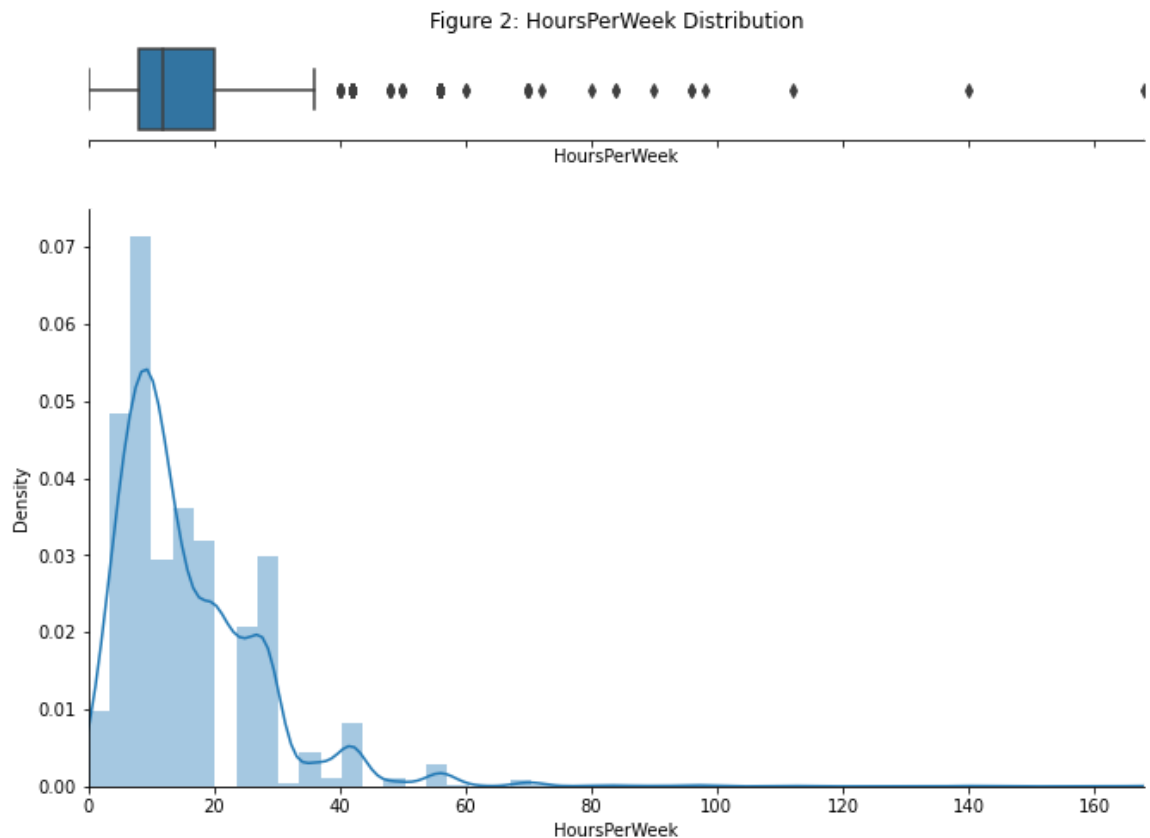
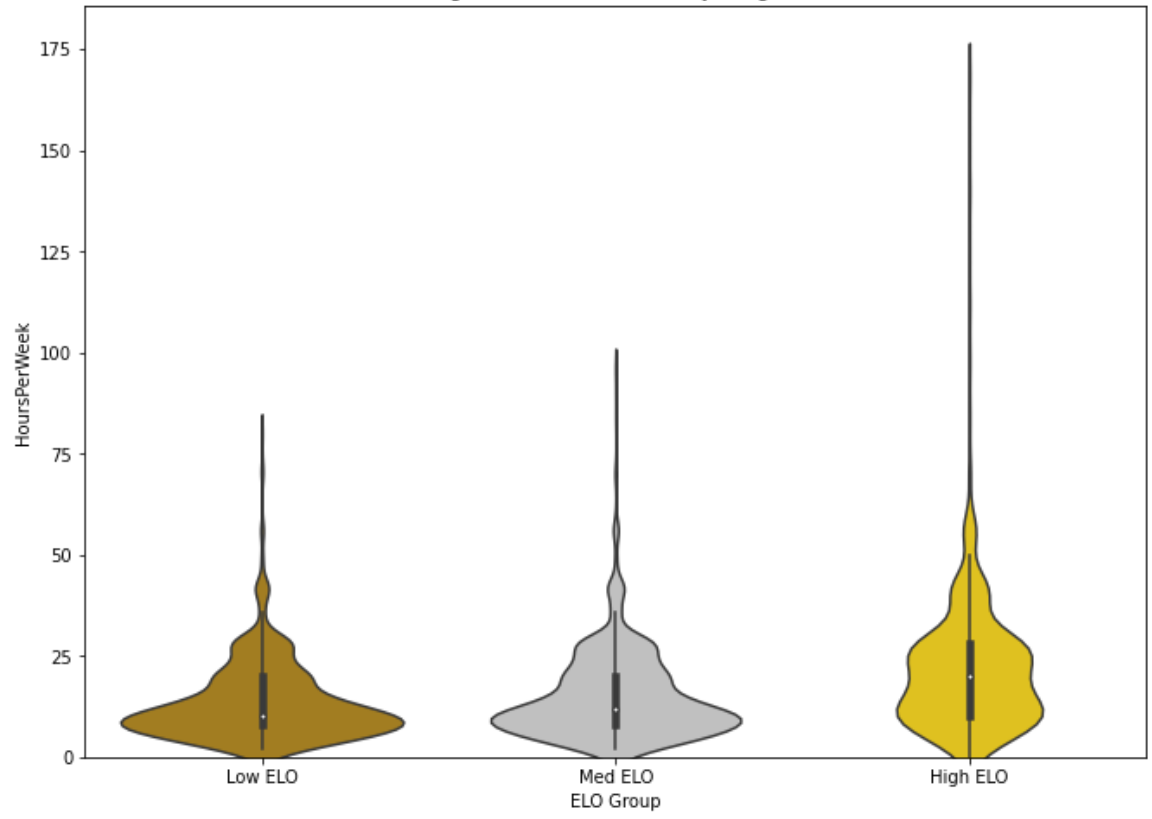


Figure 2: HoursPerWeek by League



```
In [13]: 1 plot("SelectByHotkeys",3)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

Figure 3: SelectByHotkeys Distribution

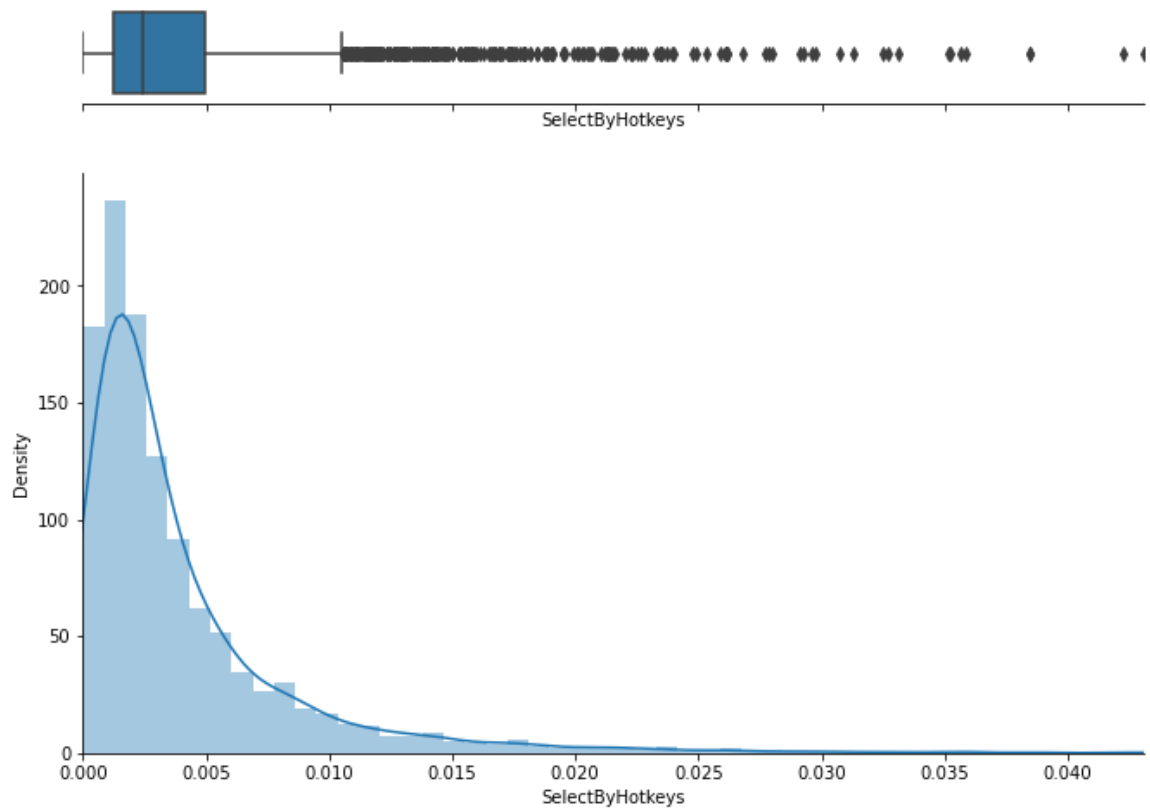
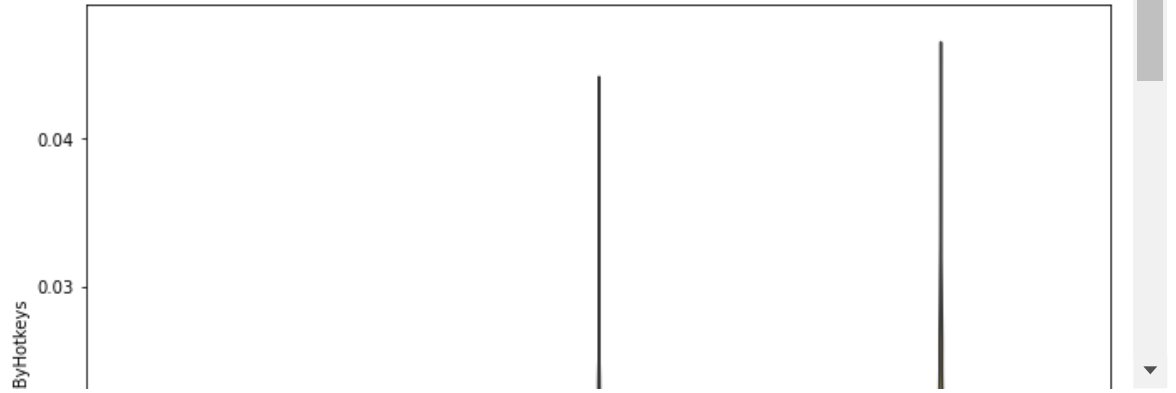


Figure 3: SelectByHotkeys by League



```
In [14]: 1 plot("AssignToHotkeys",4)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

Figure 4: AssignToHotkeys Distribution

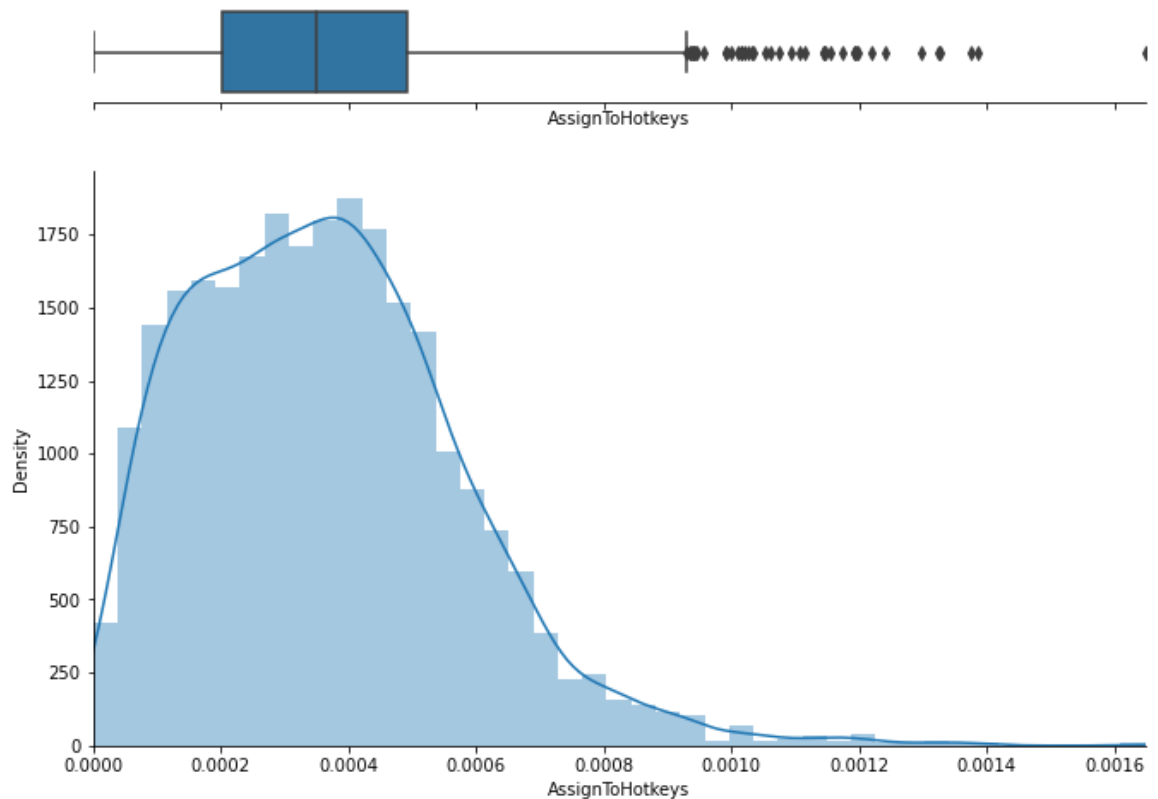
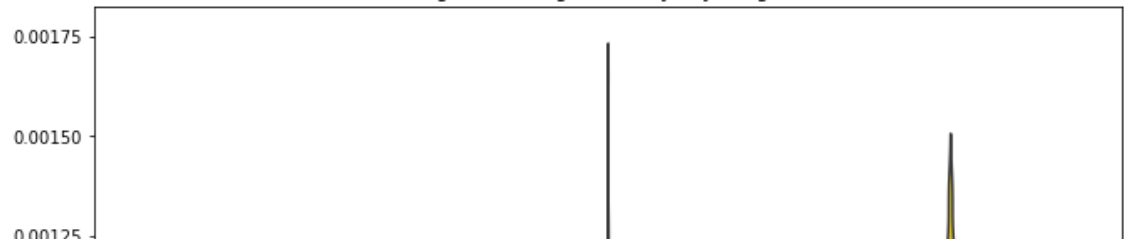


Figure 4: AssignToHotkeys by League




```
In [15]: 1 plot("UniqueHotkeys",5)
```

C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

```
warnings.warn(msg, FutureWarning)
```

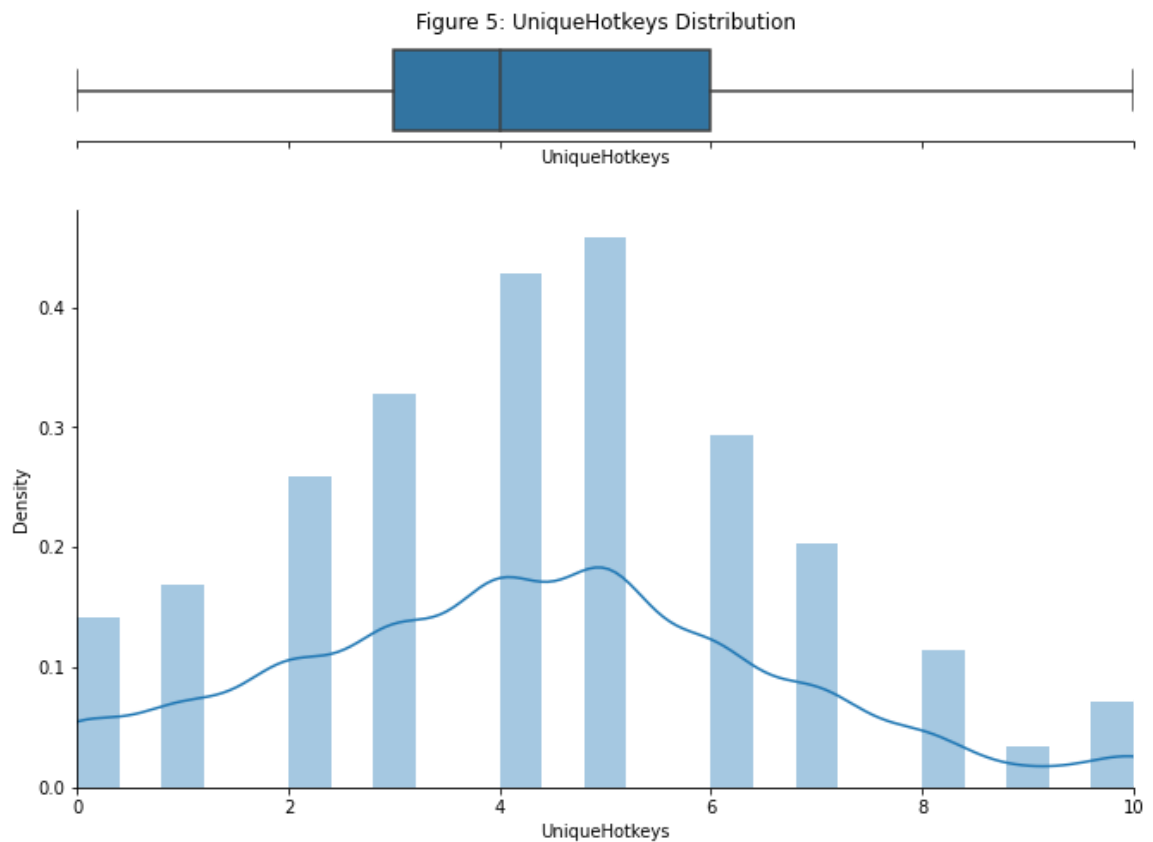
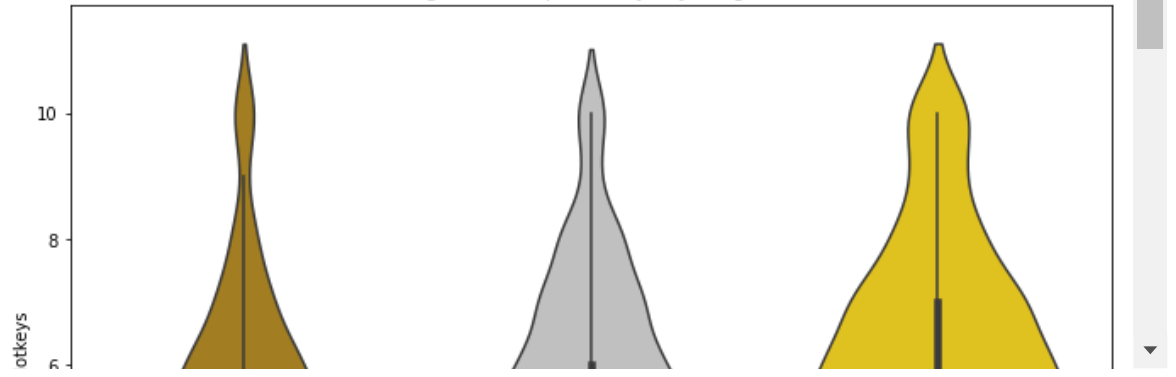


Figure 5: UniqueHotkeys by League



```
In [16]: 1 plot("MinimapAttacks",6)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

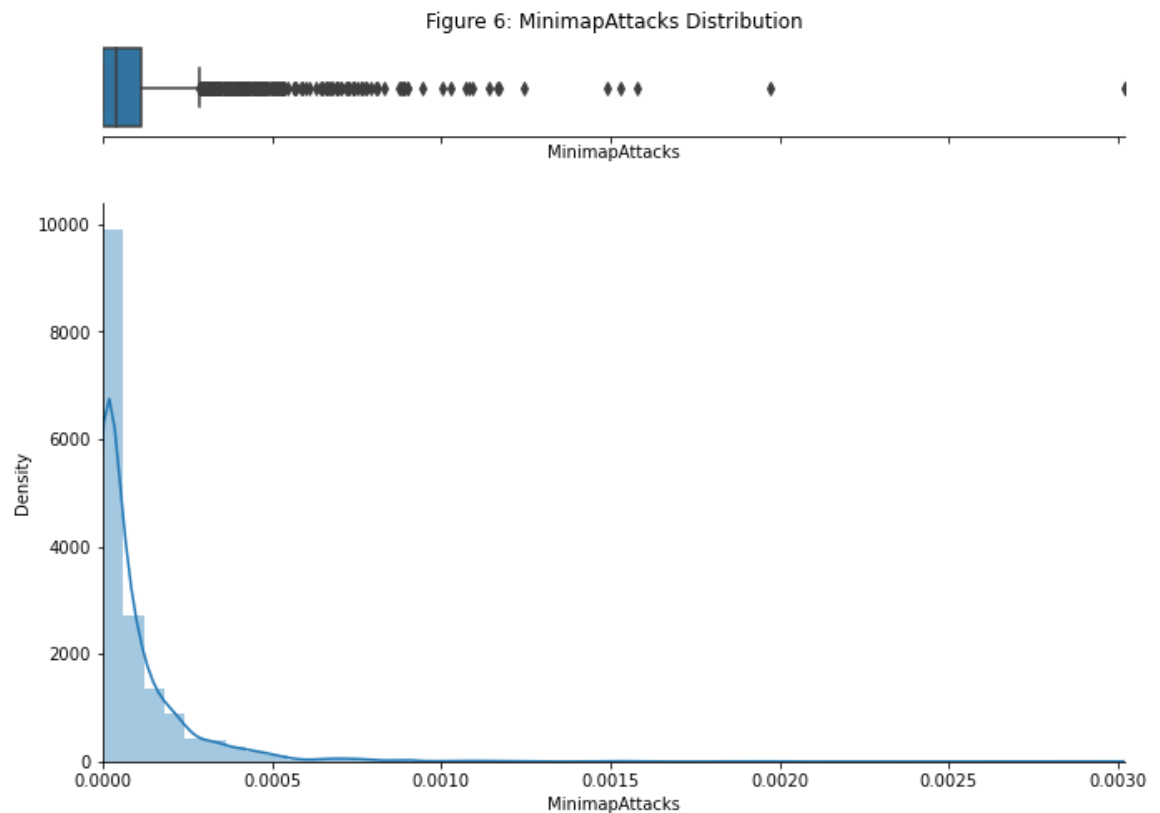


Figure 6: MinimapAttacks by League



```
In [17]: 1 plot("MinimapRightClicks",7)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

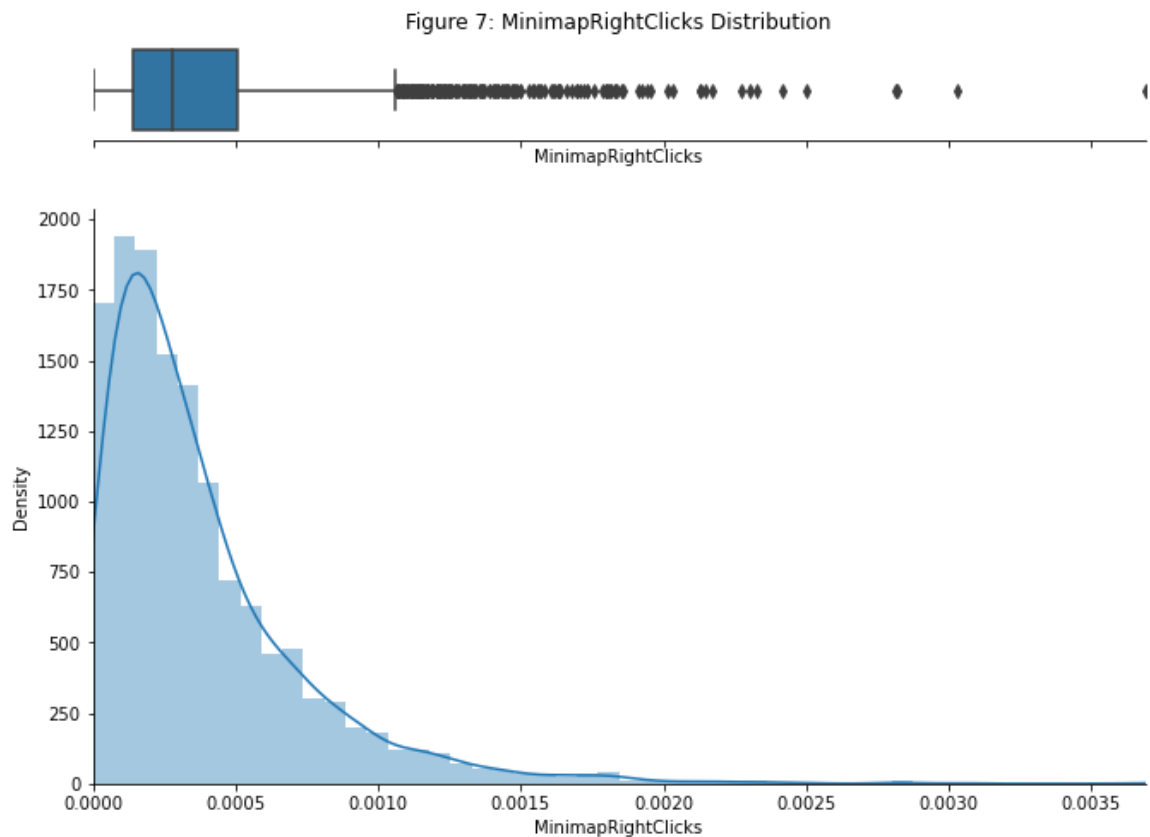
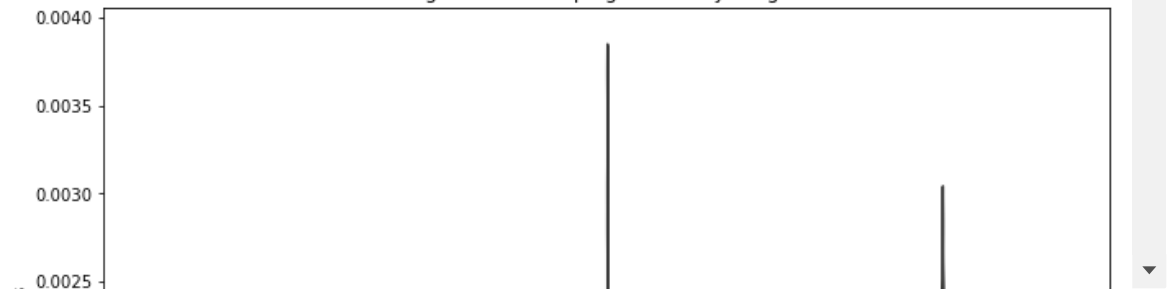


Figure 7: MinimapRightClicks by League



```
In [18]: 1 plot("NumberOfPACs",8)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

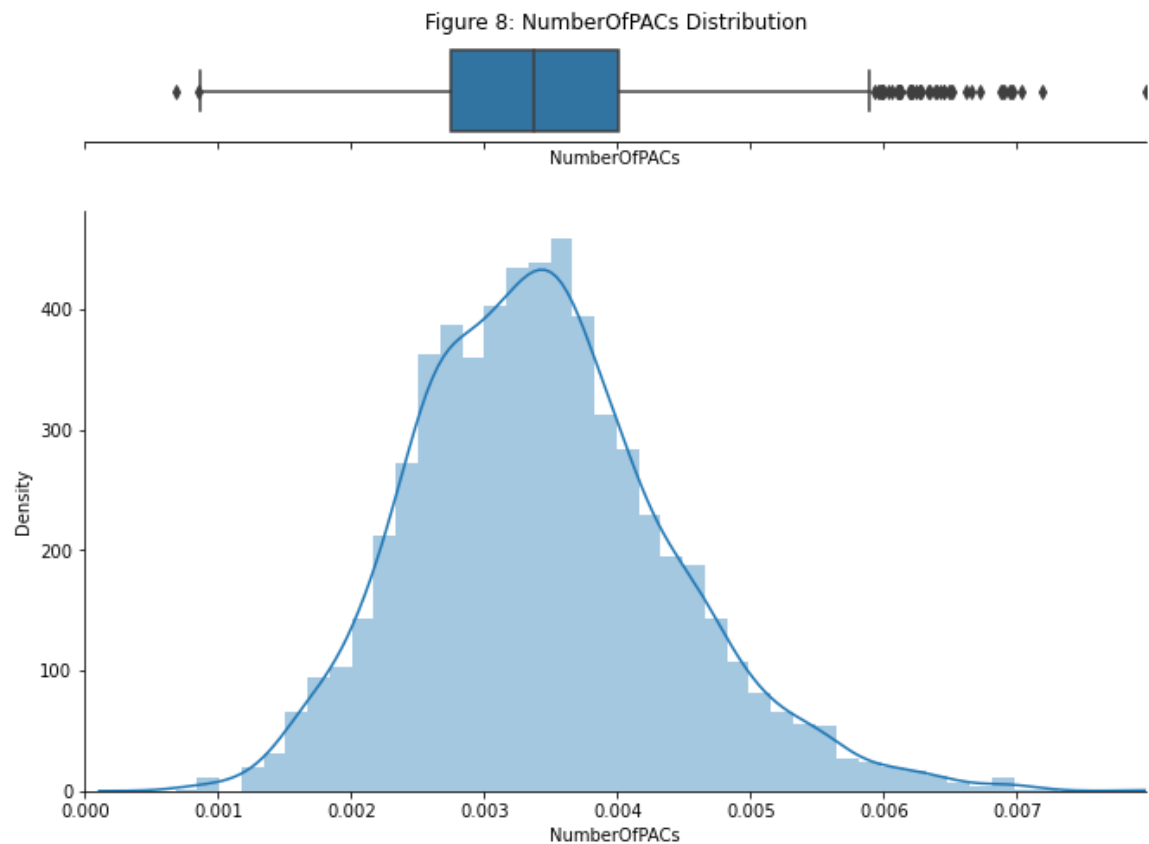
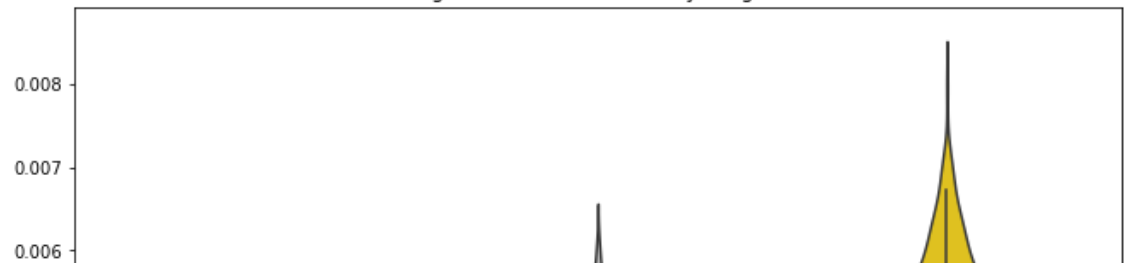


Figure 8: NumberOfPACs by League



In [19]: 1 plot("GapBetweenPACs",9)

C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.

warnings.warn(

C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).

warnings.warn(msg, FutureWarning)

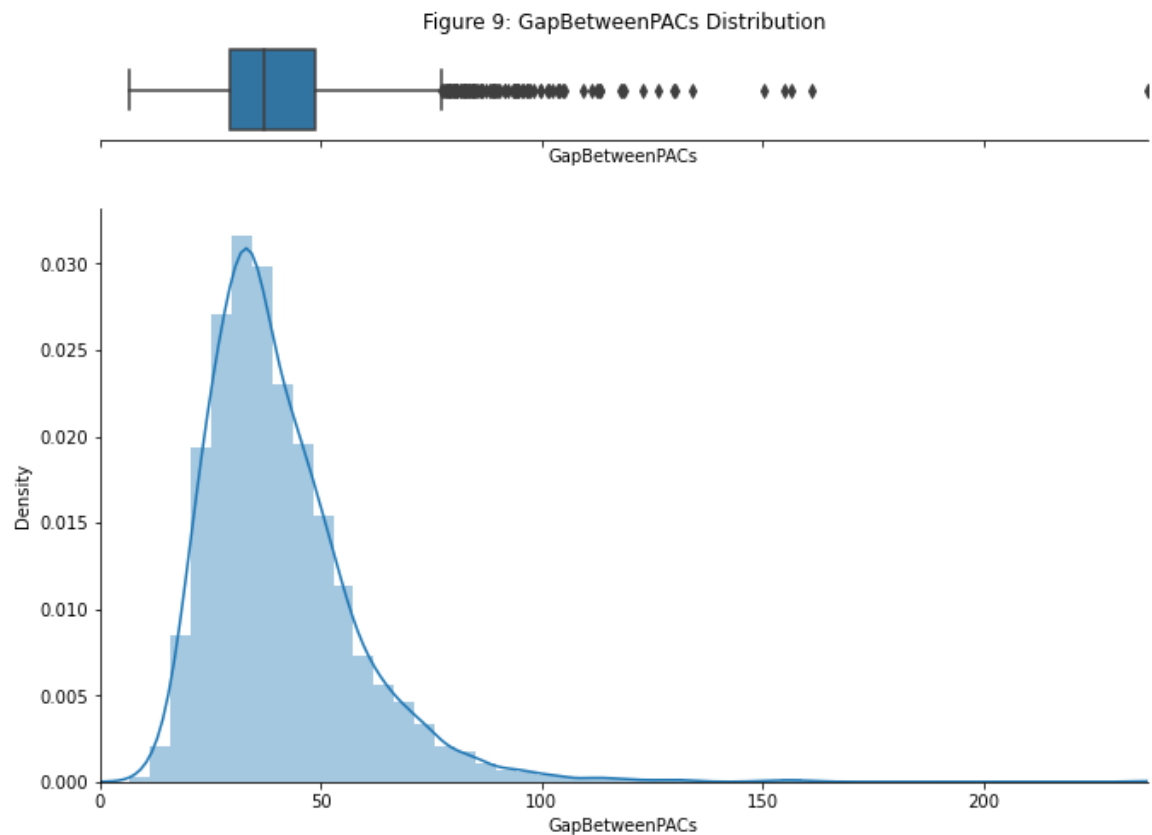


Figure 9: GapBetweenPACs by League



```
In [20]: 1 plot("ActionLatency",10)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

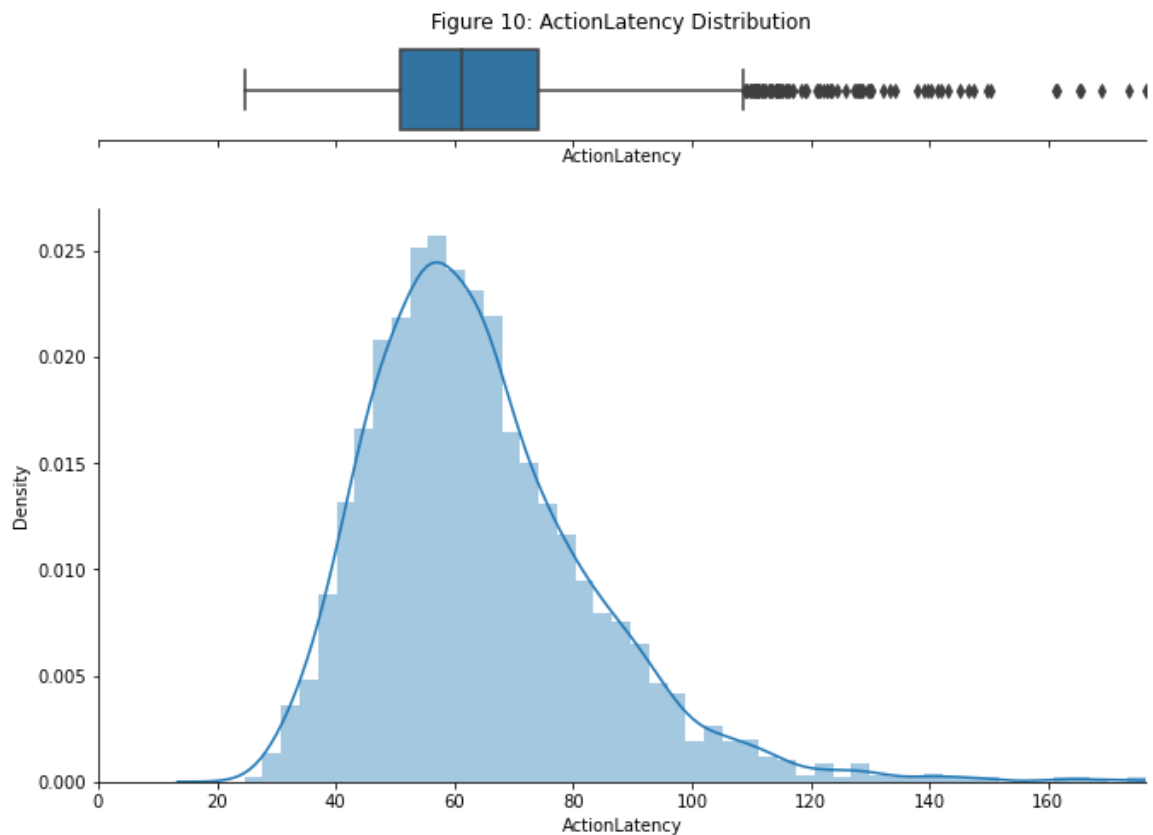


Figure 10: ActionLatency by League



```
In [21]: 1 plot("ActionsInPAC",11)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

Figure 11: ActionsInPAC Distribution

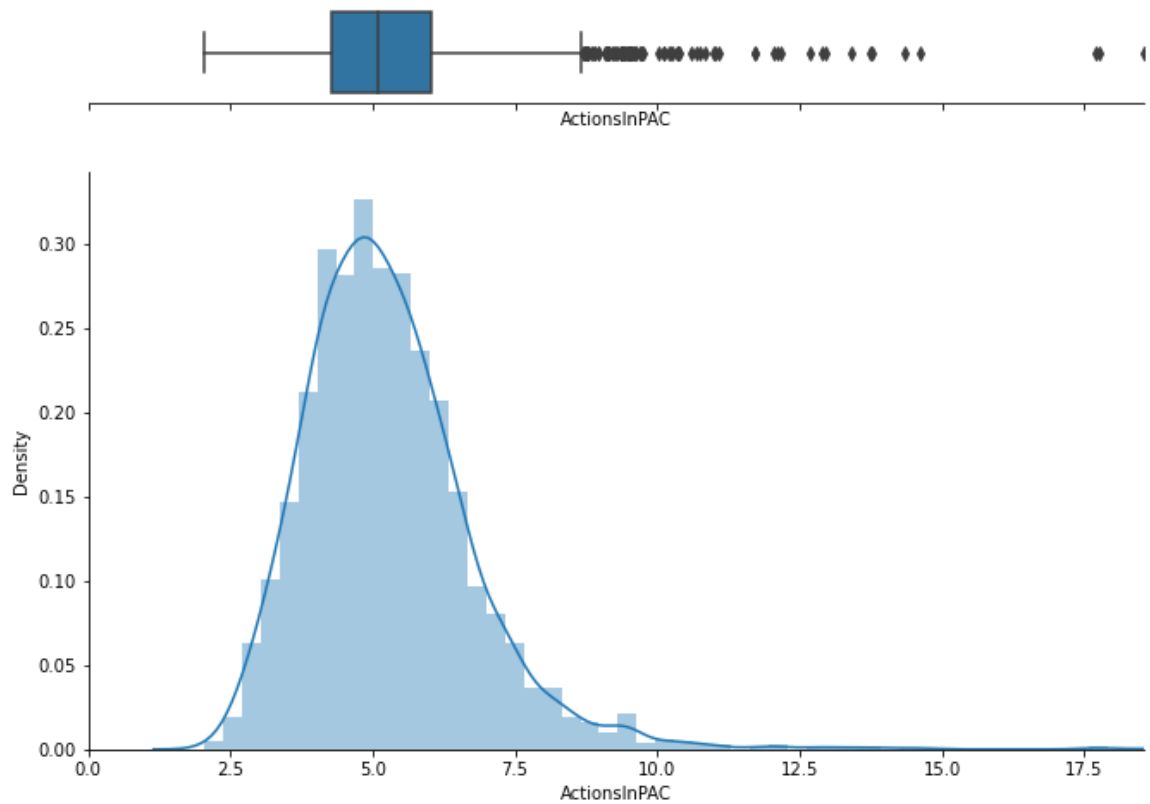
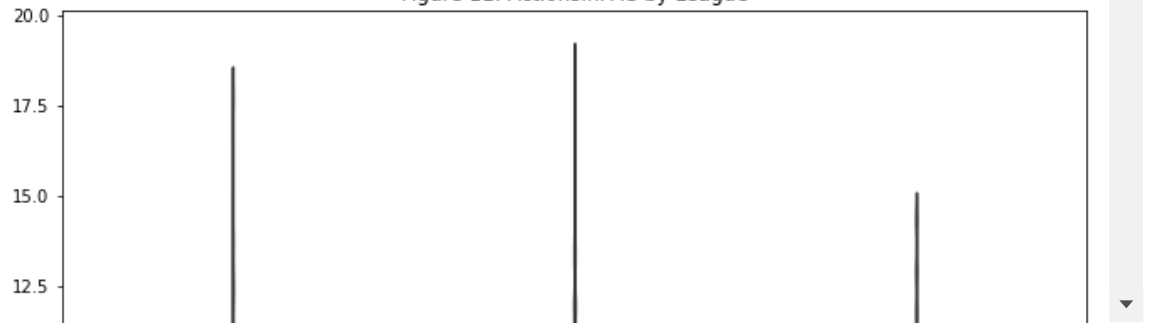


Figure 11: ActionsInPAC by League



```
In [22]: 1 plot("TotalMapExplored",12)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

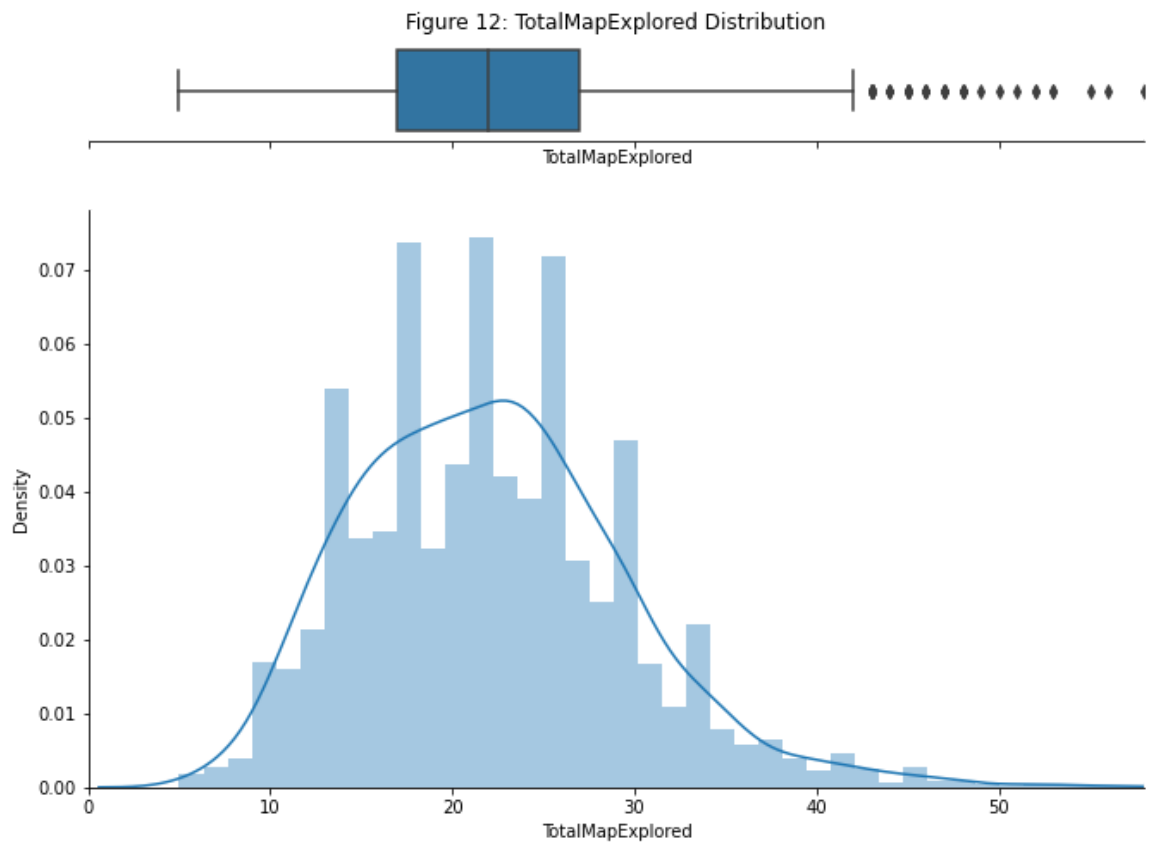
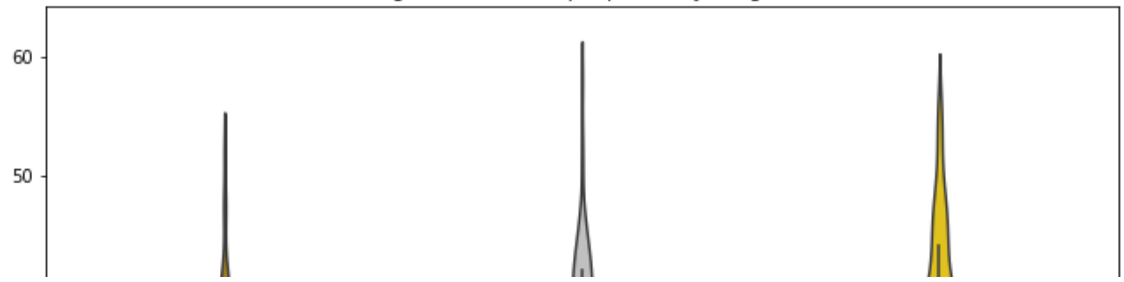


Figure 12: TotalMapExplored by League




```
In [23]: 1 plot("WorkersMade",13)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

Figure 13: WorkersMade Distribution

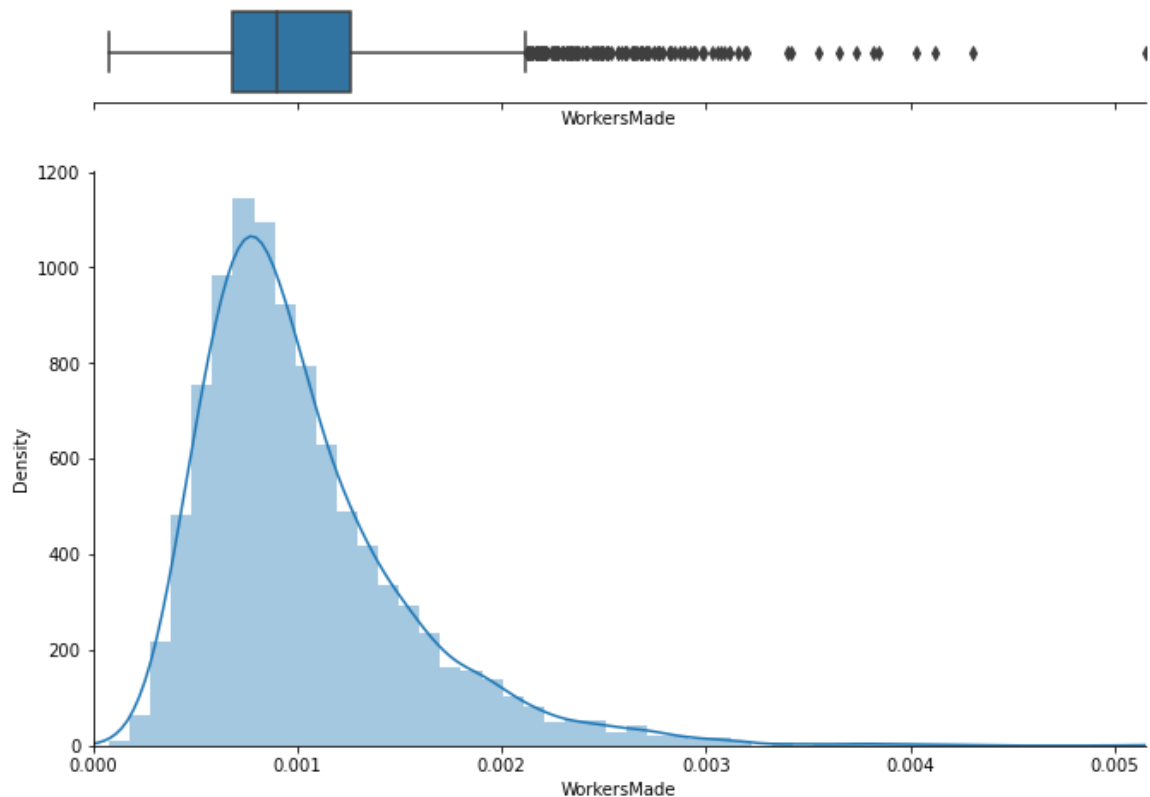


Figure 13: WorkersMade by League



```
In [24]: 1 plot("ComplexUnitsMade",14)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

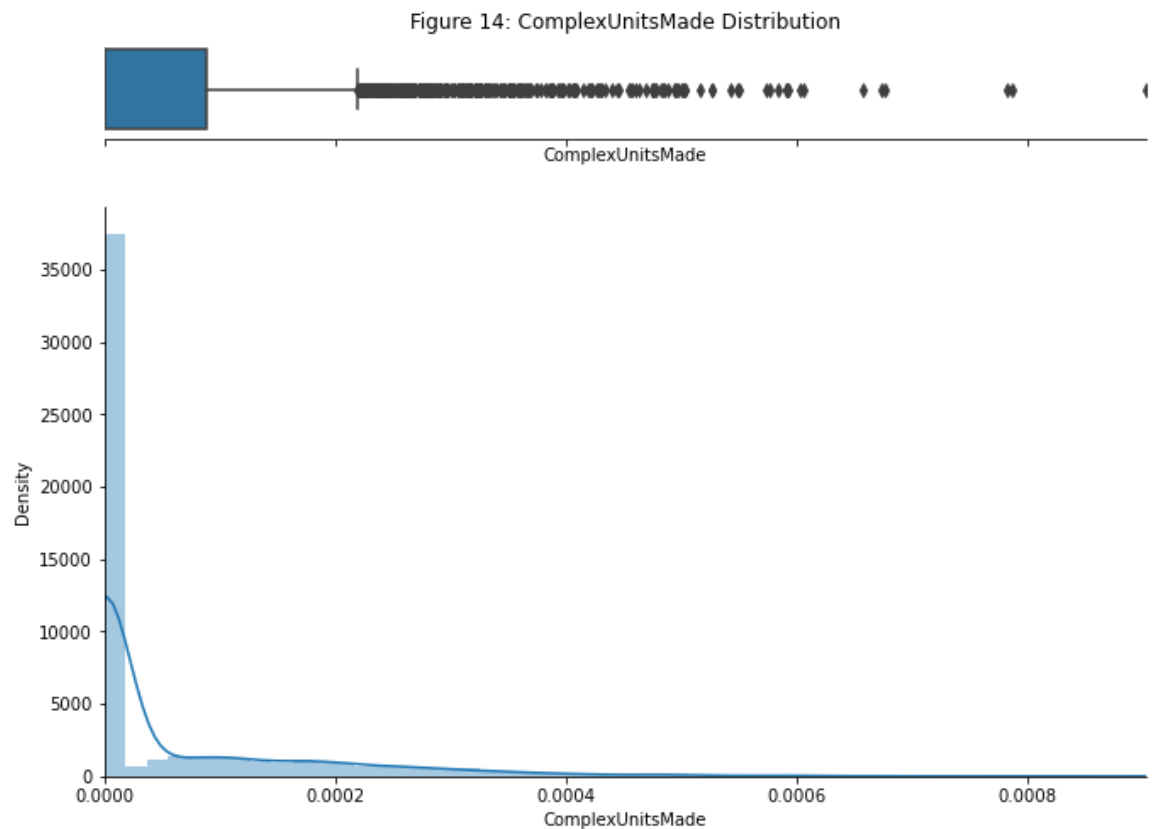
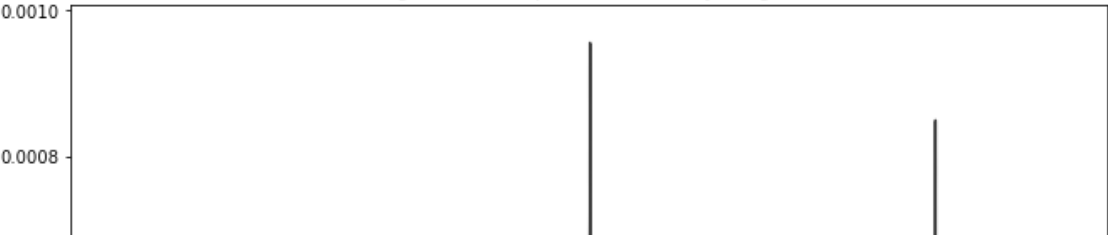


Figure 14: ComplexUnitsMade by League



```
In [25]: 1 plot("ComplexAbilitiesUsed",15)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
```

```
warnings.warn(
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\distributions.py:2557: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
warnings.warn(msg, FutureWarning)
```

Figure 15: ComplexAbilitiesUsed Distribution

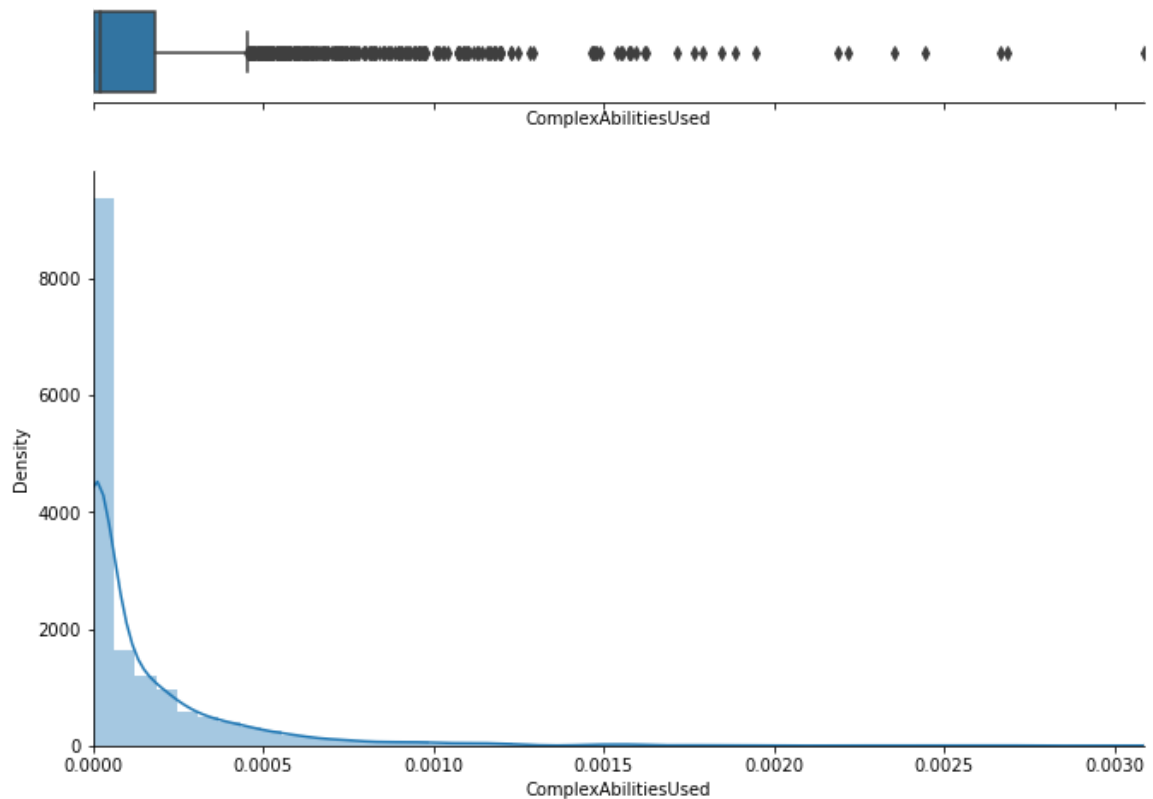


Figure 15: ComplexAbilitiesUsed by League

