

0 Begin Imports

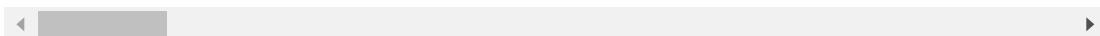
```
In [1]: 1 import numpy as np
2 import pandas as pd
3 pd.options.display.max_columns=100
4 import matplotlib.pyplot as plt
5 import seaborn as sns
6 %matplotlib inline
7
8 #set width of window to preference
9 from IPython.core.display import display, HTML
10 display(HTML("<style>.container { width:90% !important; }</style>"))
```

1 Import wrangled data

```
In [2]: 1 #year = "2019"
2 #split = "summer"
3 #infile = r"C:\Users\Triplea657\000 MSCS-335 2020\Datasets\League_
4 #inf = "-Wrangled.csv"
5 #filein = infile+year+"\\"+year+'-'+split+'-'+inf
6 #data = pd.read_csv(filein, low_memory=False)
7 #data.head(10)
8
9 #changed for submission version
10 data = pd.read_csv("Datasets/League_2019/2019-summer-Wrangled.csv",
11 data.head()
```

Out[2]:

	league_CBLoL	league_LCK	league_LCS	league_LEC	league_LMS	gamelength	res
0	0.0	0.0	1.0	0.0	0.0	35.500000	
1	0.0	0.0	1.0	0.0	0.0	35.500000	
2	0.0	0.0	1.0	0.0	0.0	29.700000	
3	0.0	0.0	1.0	0.0	0.0	29.700000	
4	0.0	0.0	1.0	0.0	0.0	31.983333	



```
In [3]: 1 inddatatxt = open("Data explanation - team stats.txt")
2 print(inddatatxt.read())
3 print('\n\n\n---\n\n\n')
4 var = []
5 for i in data:
6     var.append(i)
7 print('variables used verification: ' +str(var))
8 for i, v in enumerate(var):
9     print(i, v)
```

Data Project Data Categories

All data pulled from OraclesElixir.com.

OraclesElixir is a third party company that gathers data directly from Riot Games, the developers of League of Legends who captured the data directly from the games played.

League of Legends is a real-time strategy game in which 5 players each control a unique character with various abilities.

The goal of the game is to destroy the enemy team's nexus in the center of their base.

Killing enemy champions, minion and monsters gives you gold and experience and if you are considered "behind" your opponents you gain extra gold and experience upon champion kill or assist.

There are a number of "neutral objectives" on the map which can be killed by either team. The team that lands the death blow on these neutral objectives gains various permanent bonus

strengths based on the objective killed. These objectives are Rift Herald, Dragons, and Baron.

The map has several towers which defend their allied champions and must be destroyed to access a team's base. Between these towers there is a jungle containing monsters that can be killed by either team.

The map is covered in the fog of war, a blanket of fog that blocks vision and thus preventing knowledge of what is happening outside of the vision radius of allied champions, minions and towers. Players may buy wards that grant vision of an area or vision of enemy's invisible wards which can be destroyed.

Your refers to the team represented by the current data point.

denotes not used (due to irrelevance or to reduce variable count)
- denotes a potential independent variable
--- denotes a dependent variable

Kept variables:

ID	Title	explanation
2	league	- Which region the teams come from. This is influential because different regions have different tendencies and metas(perspectives on what strategies are strong) which influence how the various stats. (One-hot vector)
19	gamelength	- game length will influence how effective different champions/roles are at different points in the game
20	result	- Victory or Defeat for your team

- 21 k - Number of kills your team got
- 22 d - Number of times your team members died
- 23 a - Each kill multiplied by the number of players who assisted
- 30 fb - First blood. Did you r team get the first kill of the game?
- 34 kpm - Your team's total kills per minute
- 35 okpm - Enemy team's kills per minute
- 36 ckpm - Total champion kills per minute(both teams)
- 37 fd - Was the first dragon killed by your team?
- 38 fdtime - What time the first dragon was killed
- 39 teamdragkills - Times team killed a dragon
- 40 oppdragkills - Times enemy team killed a dragon
- 41 elementals - Number of dragons killed by your team were elemental dragons
- 42 oppelementals - Number of dragons killed by enemy team were elemental dragons
- 43 firedrakes - Number of dragons killed by your team were fire elemental dragons
- 44 waterdrakes - Number of dragons killed by your team were water elemental dragons
- 45 earthdrakes - Number of dragons killed by your team were earth elemental dragons
- 46 airdrakes - Number of dragons killed by your team were wind elemental dragons
- 47 elders - Number of dragons killed by elder dragons
- 48 oppelders - Number of dragons killed by elder dragons
- 49 herald - Number of rift heralds killed by your team
- 50 heraldtime - Time that the rift herald was taken
- 51 ft - Was the first tower of the game taken by your team?
- 52 fttime - What time was the first tower of the game taken
- 53 firstmidouter - Was the first mid outer tower killed by your team? This is especially significant as the midlane outer turret grants a lot of control over the map
- 54 firsttreetowers - Was your team the first to kill three towers?
- 59 teambaronkills - Number of barons killed by your team.
- 60 oppbaronkills - Number of barons killed by enemy team
- 61 dmgtochamps - Total damage dealt to enemy champions by allied champions
- 62 dmgtochampsperminute - Amount of damage dealt to enemy champions per minute

pions by allied champions per minute
 65 wards - Total number of ward
 s placed by your team
 66 wpm - Total number of ward
 s placed by your team per minute
 68 wardkills - Total number of enemy wards
 destroyed
 69 wcpm - Total number of enem
 y wards destroyed per minute
 74 totalgold - Total gold earned by your te
 am
 75 earnedgpm - Gold earned by your team per
 minute
 76 goldspent - Total gold spent by your tea
 m
 77 gspd - Percent difference i
 n gold spent between teams
 80 monstercillsownjungle - How many monsters your team killed i
 n your own side of the jungle
 81 monstercillsenemyjungle - How many monsters your team killed i
 n the enemy's side of the jungle
 82 cspm - Number of minions an
 d monsters killed by your team per minute
 83 goldat10 - Total gold earned by
 your team at 10 minutes
 84 oppgoldat10 - Total gold earned by enemy t
 eam at 10 minutes
 85 gdat10 - Difference in gold b
 etween teams at 10 minutes
 86 goldat15 - Total gold earned at
 15 minutes
 87 oppgoldat15 - Enemy gold earned at 15 minu
 tes
 88 gdat15 - Difference in gold a
 t 15 minutes
 89 xpat10 - Experience points ea
 rned at 10 minutes
 90 oppxpat10 - Enemy Experience points earn
 ed at 10 minutes
 91 xpat10 - Difference in experi
 ence earned at 10 minutes
 92 csat10 - Total minions and mo
 nsters killed at 10 minutes by your team
 93 oppcsat10 - Total minions and monsters k
 illed at 10 minutes by enemy team
 94 csdat10 - Difference in total
 minions and monsters killed at 10 minutes between teams
 95 csat15 - Total minions and mo
 nsters killed at 15 minutes by your team
 96 oppcsat15 - Total minions and monsters k
 illed at 15 minutes by enemy team
 97 csdat15 - Difference in total
 minions and monsters killed at 15 minutes between teams

#Not kept variables: #many not kept due to only applying to a singl
e player

```

#0 gameid
#1 url
#3 split
#4 date
#5 week
#6 game
#7 patchno
#8 playerid
#9 side
#10 position           # whole team, so no individual player
data
#11 player
#12 team
#13 champion          # not implemented for team statistics
- may implement being added from player statistics at a later date
#14 ban1                # too many extra variables for
almost no impact (only captures champions NOT in game)
#15 ban2
#16 ban3
#17 ban4
#18 ban5
#24 teamkills          #- superfluous
#25 teamdeaths          #- superfluous
#26 doubles              #- doublekills player got
#27 triples              #- triplekills player got
#28 quadras              #- quadrakills player got
#29 pentas              #- pentakills player got
#31 fbassist
#32 fbsvictim
#33 fbtme
#55 teamtowerkills      #too indicative of who won
#56 opptowerkills       #too indicative of who won
#57 fbaron               #missing too much data which s
ucks since baron is such an influential objective to take
#58 fbarontime          #missing too much data
#63 dmgshare
#64 earnedgoldshare
#67 wardshare
#70 visionwards
#71 visionwardbuys
#72 visiblewardclearrate
#73 invisiblewardclearrate
#78 minionkills         #basically superfluous with cs
#79 monsterkills        #basically superfluous with cs

```

More details on not kept variables at: <https://oracleselixir.com/matchdata/match-data-dictionary/> (<https://oracleselixir.com/matchdata/match-data-dictionary/>)

variables used verification: ['league_CBLoL', 'league_LCK', 'league_LCS', 'league_LEC', 'league_LMS', 'gamelength', 'result', 'k', 'd',

'a', 'fb', 'kpm', 'okpm', 'ckpm', 'fd', 'fdtime', 'teamdragkills', 'oppdragkills', 'elementals', 'oppelementals', 'firedrakes', 'waterdrakes', 'earthdrakes', 'airdrakes', 'elders', 'oppelders', 'herald', 'heraldtime', 'ft', 'fttime', 'firstmidouter', 'firsttreetowers', 'teambaronkills', 'oppbaronkills', 'dmgtochamps', 'dmgtochampsperminute', 'wards', 'wpm', 'wardkills', 'wcpm', 'totalgold', 'earnedgpm', 'goldspent', 'gspd', 'monstercillsownjungle', 'monstercillsenemyjungle', 'cspm', 'goldat10', 'oppgoldat10', 'gdat10', 'goldat15', 'oppgoldat15', 'gdat15', 'xpat10', 'oppxpat10', 'xpdat10', 'csat10', 'oppcsat10', 'csdat10', 'csat15', 'oppcsat15', 'csdat15']
0 league_CBLol
1 league_LCK
2 league_LCS
3 league_LEC
4 league_LMS
5 gamelength
6 result
7 k
8 d
9 a
10 fb
11 kpm
12 okpm
13 ckpm
14 fd
15 fdtime
16 teamdragkills
17 oppdragkills
18 elementals
19 oppelementals
20 firedrakes
21 waterdrakes
22 earthdrakes
23 airdrakes
24 elders
25 oppelders
26 herald
27 heraldtime
28 ft
29 fttime
30 firstmidouter
31 firsttreetowers
32 teambaronkills
33 oppbaronkills
34 dmgtochamps
35 dmgtochampsperminute
36 wards
37 wpm
38 wardkills
39 wcpm
40 totalgold
41 earnedgpm
42 goldspent
43 gspd
44 monstercillsownjungle
45 monstercillsenemyjungle
46 cspm

```
47 goldat10
48 oppgoldat10
49 gdat10
50 goldat15
51 oppgoldat15
52 gdat15
53 xpat10
54 oppxpat10
55 xpdat10
56 csat10
57 oppcsat10
58 csdat10
59 csat15
60 oppcsat15
61 csdat15
```

Begin looking at data

```
In [4]: 1 graphidx = [6,7,8,9,10,12,16,17,30,33,34,38,45,51,60]
2 tograph = pd.DataFrame(data)
3 tograph1 = tograph.iloc[:,graphidx]
4
5 print("I thought these variables would have interesting correlation")
6 print(tograph1.columns)
7
8 tograph1
```

I thought these variables would have interesting correlations so I wanted to graph these first:

```
Index(['result', 'k', 'd', 'a', 'fb', 'okpm', 'teamdragkills', 'oppdragkills',
       'firstmidouter', 'oppbaronkills', 'dmgtochamps', 'wardkills',
       'monstercillsenemyjungle', 'oppgoldat15', 'oppcsat15'],
      dtype='object')
```

Out[4]:

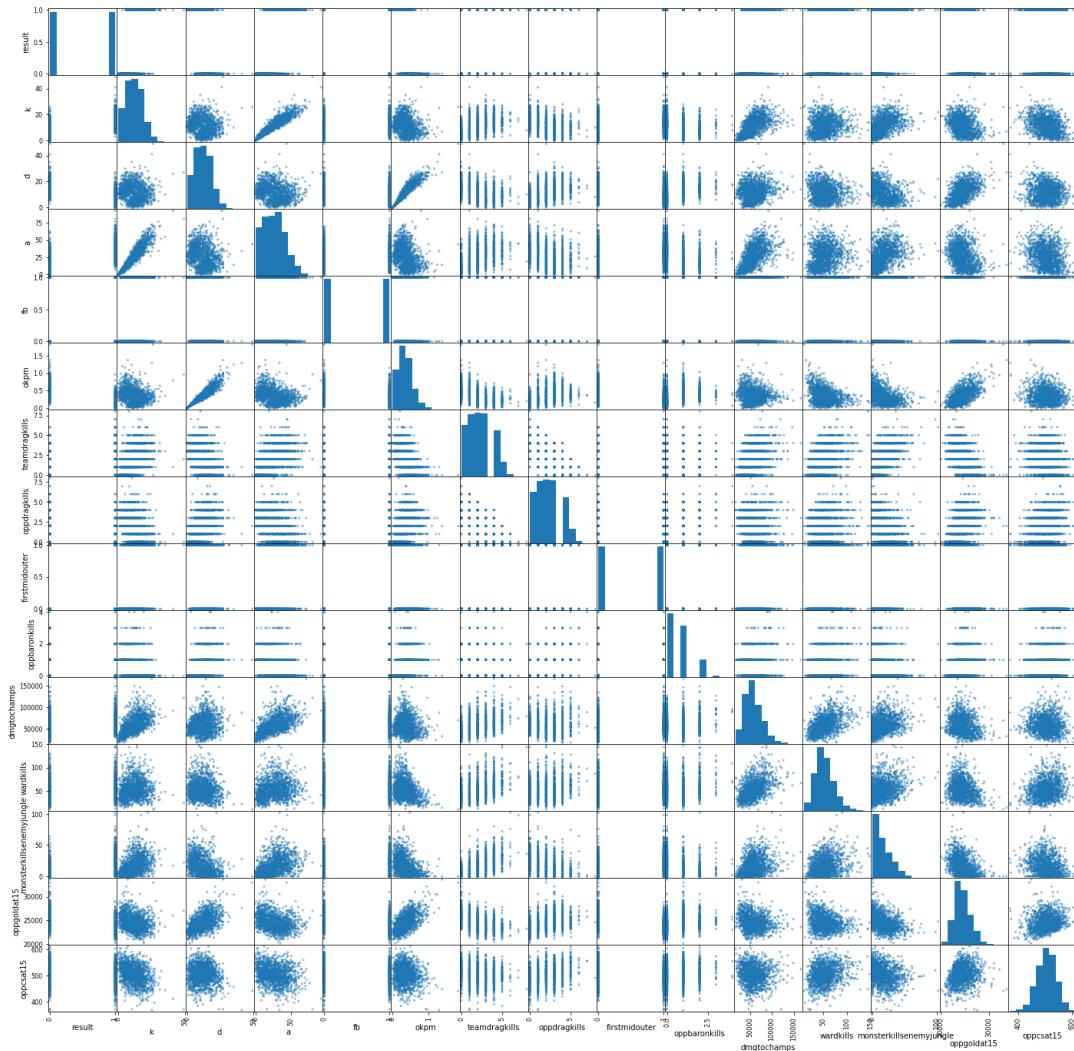
	result	k	d	a	fb	okpm	teamdragkills	oppdragkills	firstmidouter
0	1.0	21.0	14.0	52.0	0.0	0.394366	2.0	2.0	1.0
1	0.0	14.0	21.0	32.0	1.0	0.591549	2.0	2.0	0.0
2	1.0	11.0	4.0	25.0	1.0	0.134680	2.0	1.0	1.0
3	0.0	4.0	11.0	10.0	0.0	0.370370	1.0	2.0	0.0
4	1.0	12.0	3.0	26.0	1.0	0.093799	3.0	1.0	1.0
...
1439	1.0	23.0	16.0	44.0	0.0	0.535714	1.0	2.0	1.0
1440	1.0	17.0	9.0	46.0	0.0	0.362660	2.0	0.0	1.0
1441	0.0	9.0	17.0	24.0	1.0	0.685024	0.0	2.0	0.0
1442	1.0	17.0	9.0	46.0	0.0	0.362660	2.0	0.0	1.0
1443	0.0	9.0	17.0	24.0	1.0	0.685024	0.0	2.0	0.0

1444 rows × 15 columns

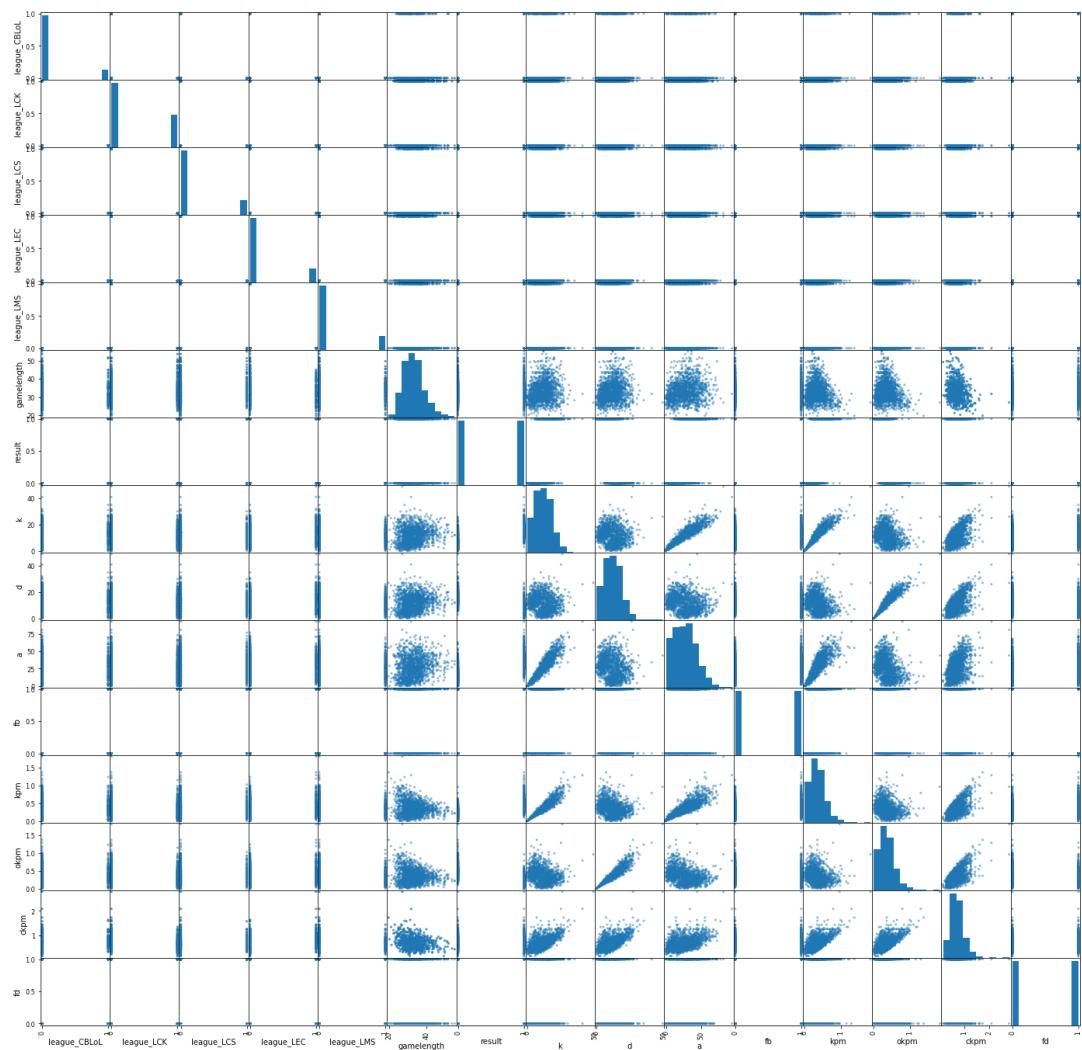


```
In [5]: 1 print("I thought that these would be interesting to plot against each other in particular")
2 pd.plotting.scatter_matrix(tograph1,figsize=(24,24))
3 plt.show()
```

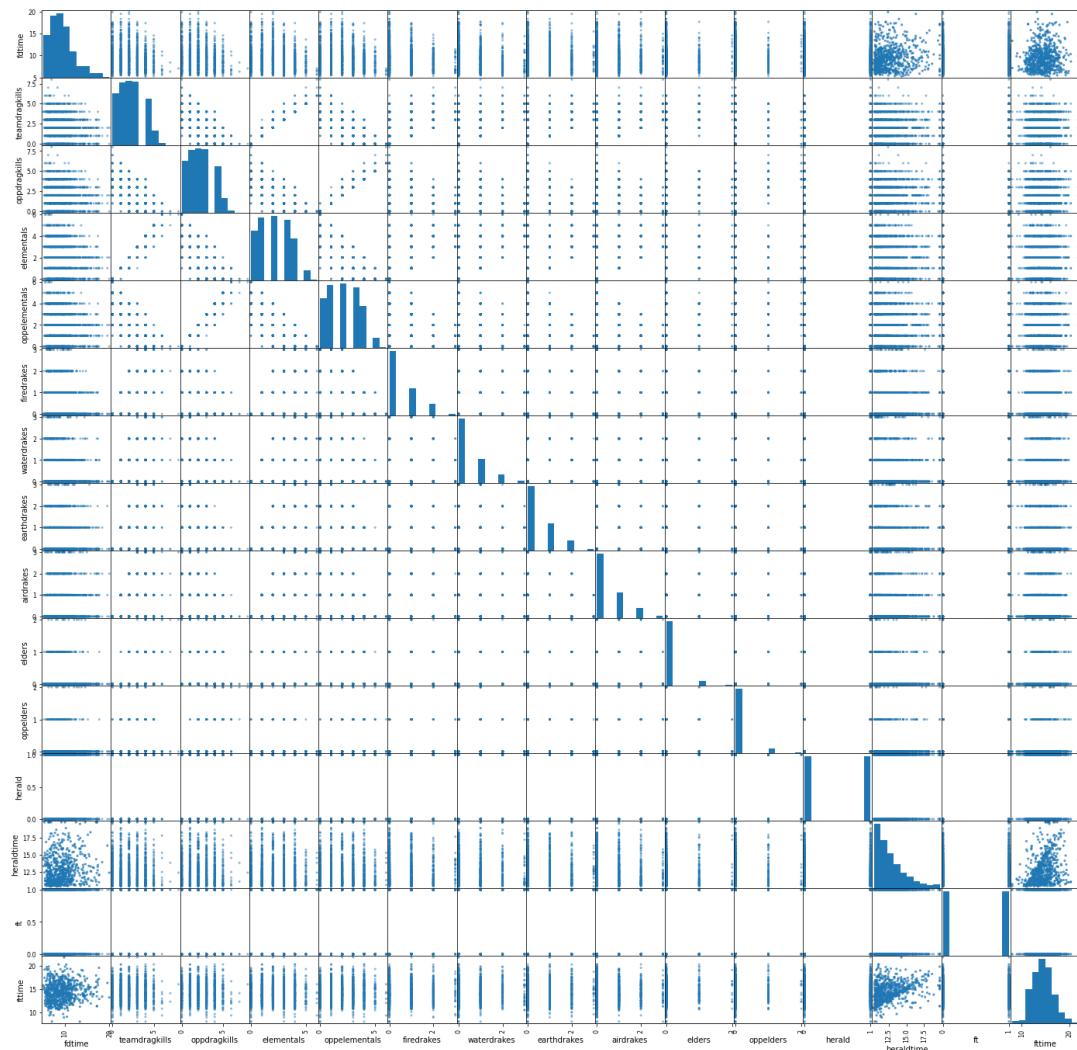
I thought that these would be interesting to plot against each other in particular



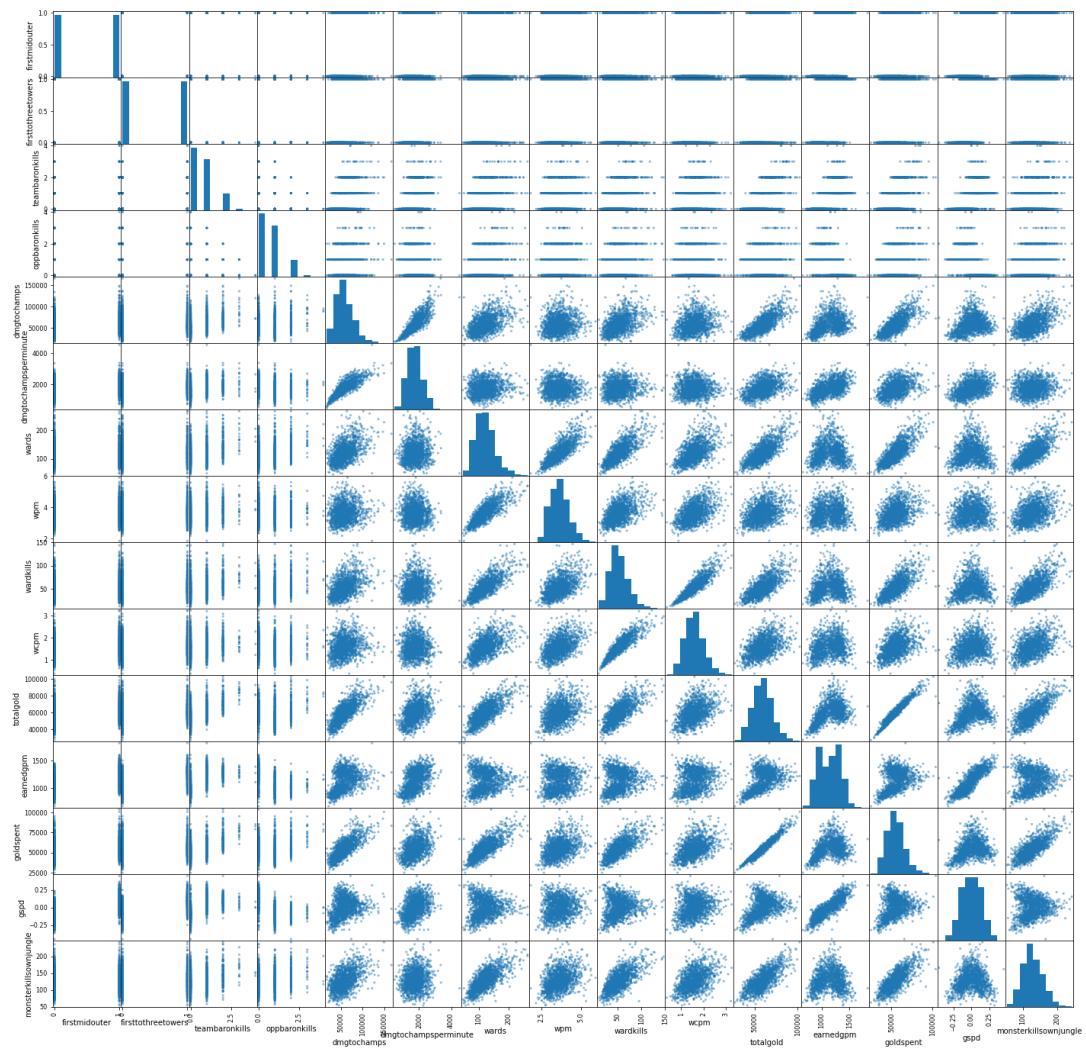
```
In [6]: 1 graph = tograph.iloc[:, :15]
2 pd.plotting.scatter_matrix(graph, figsize=(24, 24))
3 plt.show()
```



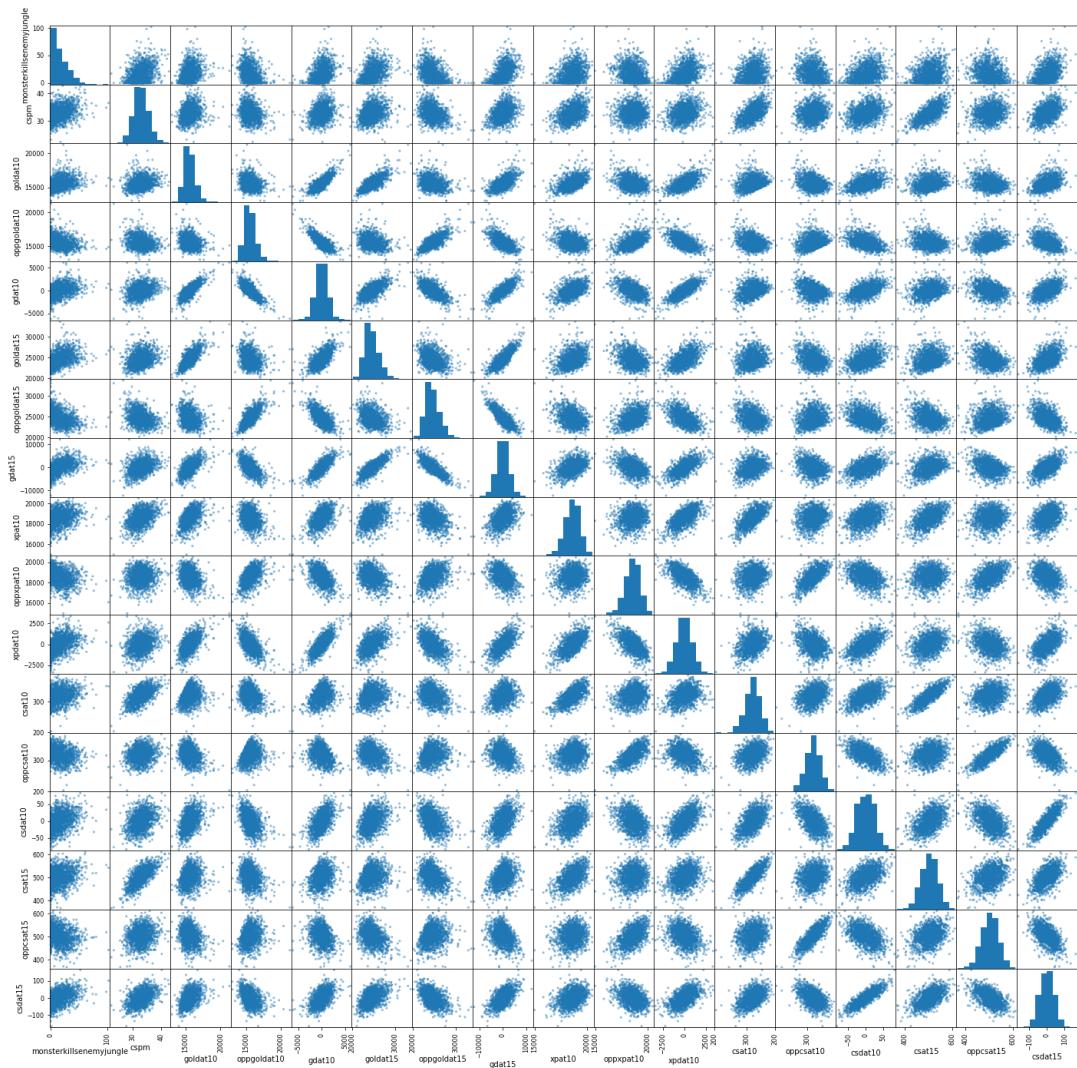
```
In [7]: 1 graph = tograph.iloc[:,15:30]
2 pd.plotting.scatter_matrix(graph,figsize=(24,24))
3 plt.show()
```



```
In [8]: 1 graph = tograph.iloc[:,30:45]
2 pd.plotting.scatter_matrix(graph,figsize=(24,24))
3 plt.show()
```



```
In [9]: 1 graph = tograph.iloc[:,45:]  
2 pd.plotting.scatter_matrix(graph,figsize=(24,24))  
3 plt.show()
```



```
In [46]: 1 # Code for the following graphs based on https://www.kaggle.com/imn
2 resultTitles = ["Loss", "Win"]
3 resultIndexs = [ 0.0, 1.0]
4 colors      = [ "r", "g"]
5 resultDict   = dict()
6 for i, ind in enumerate(resultIndexs):
7     resultDict[ind] = resultTitles[i]
8 resultLabeled = data["result"].replace(resultDict)
9
10 def violin_plot(y, title, w, h, ymin=0):
11     plt.figure(figsize=(w,h))
12     ax = sns.violinplot(x=resultLabeled,y=y,palette=colors,order=re
13     ax.set(xlabel='Game Result')
14     ax.set_ylim(ymin,)
15     plt.title(title)
16     plt.show()
17
18 def density_plot(x, title, w, h, ymin=0):
19     fig, (ax_box, ax_hist) = plt.subplots(2, sharex=True, gridspec_
20     fig.set_size_inches(w,h)
21     ax_box.set_xlim(ymin,x.max())
22     ax_hist.set_xlim(ymin,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, ymin=0, dataset=data):
32     density_plot(dataset[feature],f"Figure {fig_num}: {feature} Dis
33     violin_plot(dataset[feature],f"Figure {fig_num}: {feature} by R
```

```
In [47]: 1 kda = ["k", "d", "a"]
2 for i,var in enumerate(kda):
3     plot(var,i)
```

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)

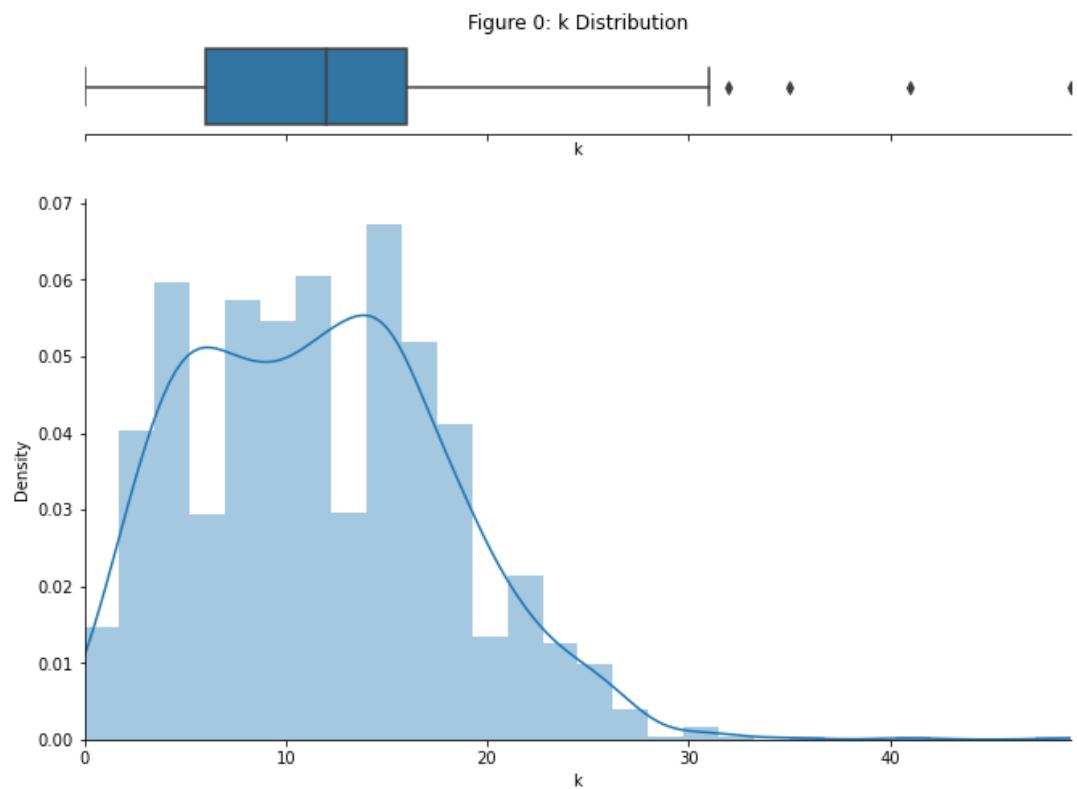
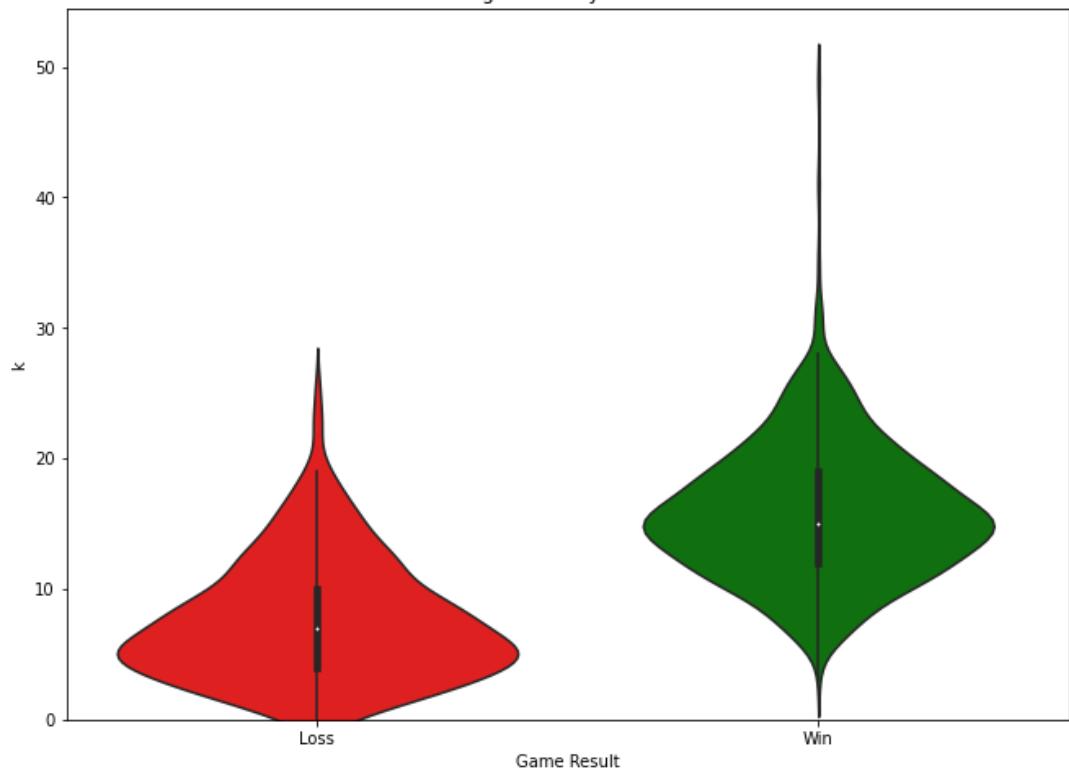


Figure 0: k by Result



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

```
t keyword will result in an error or misinterpretation.  
warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seabor  
n\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: d Distribution

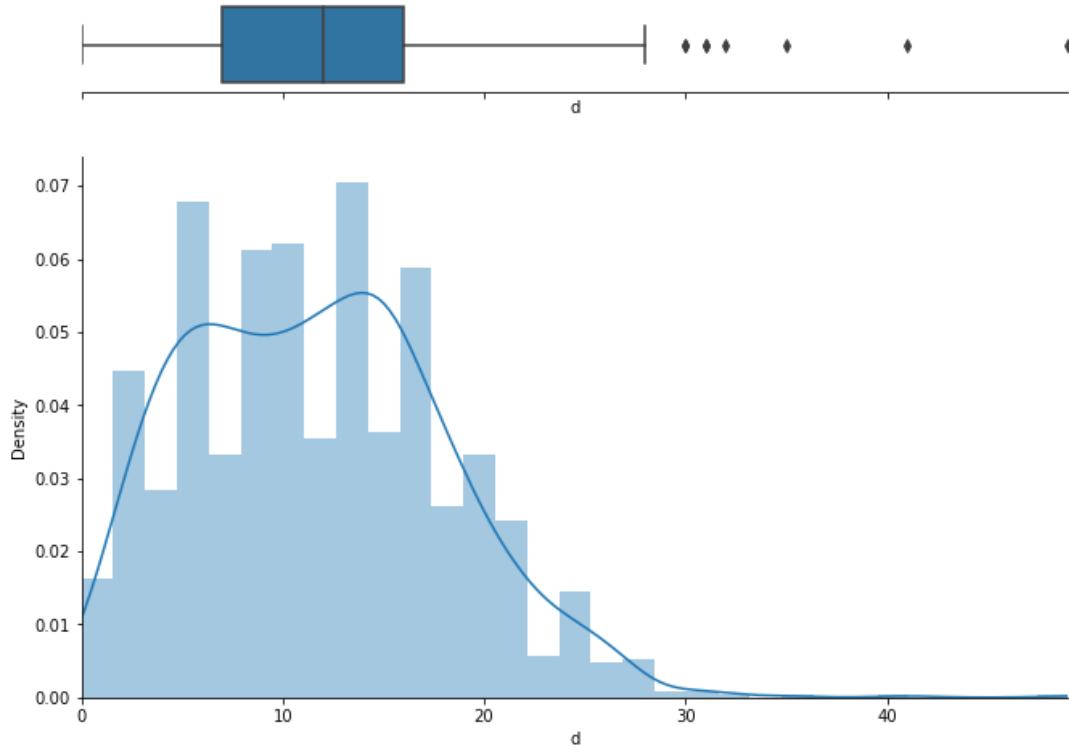
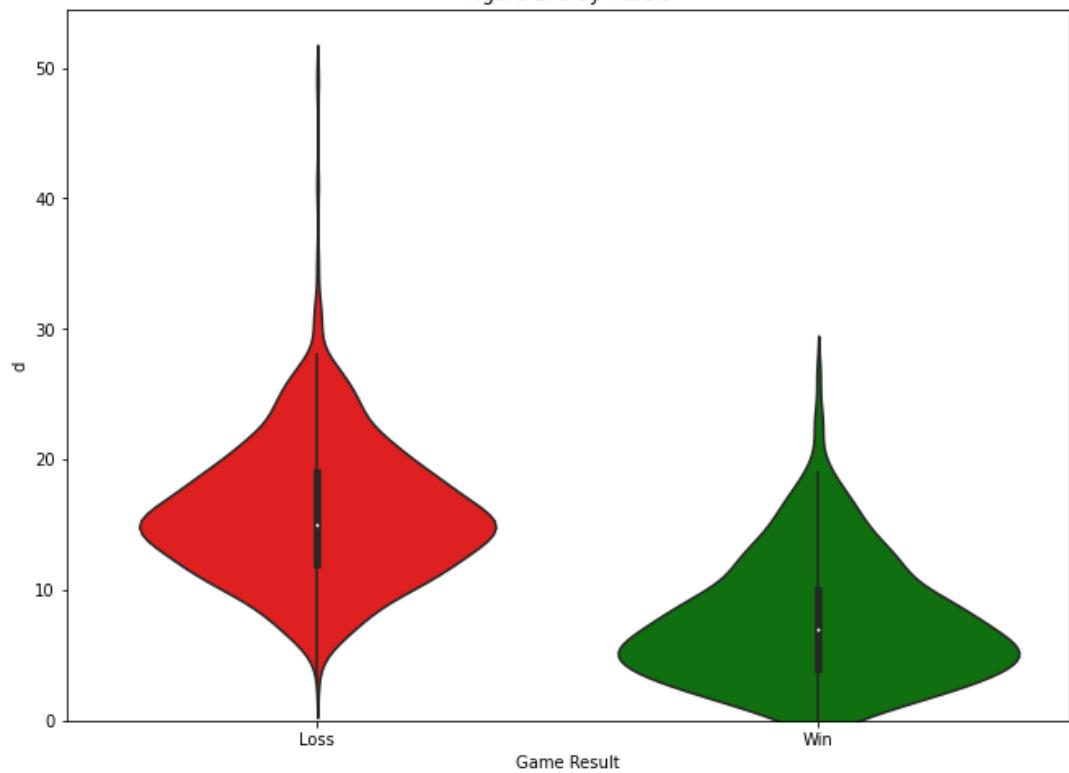


Figure 1: d by Result



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

```
    warnings.warn(
```

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

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

Figure 2: a Distribution

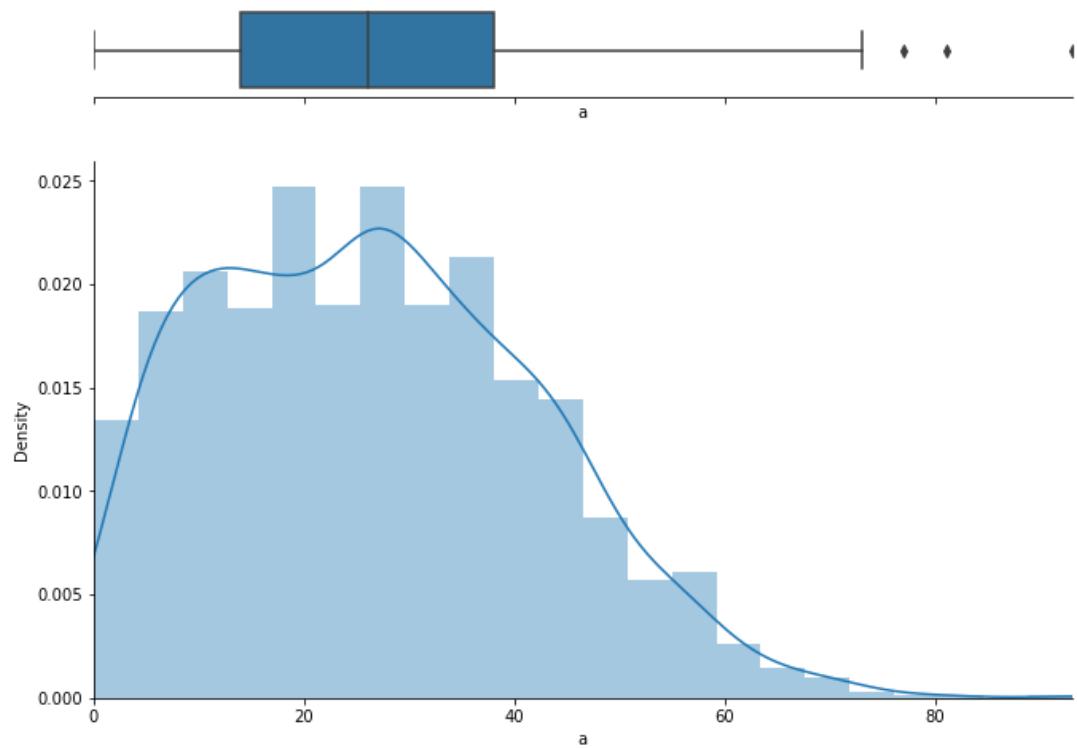
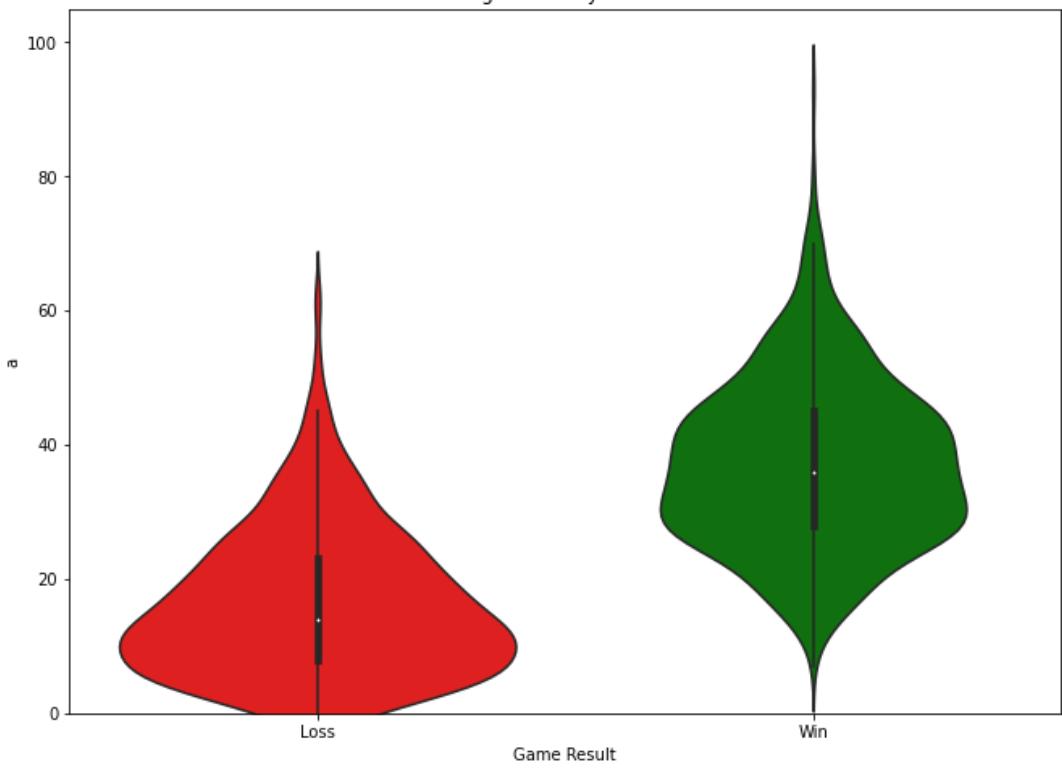


Figure 2: a by Result



```
In [16]: 1 plot("fb",3)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 3: fb Distribution

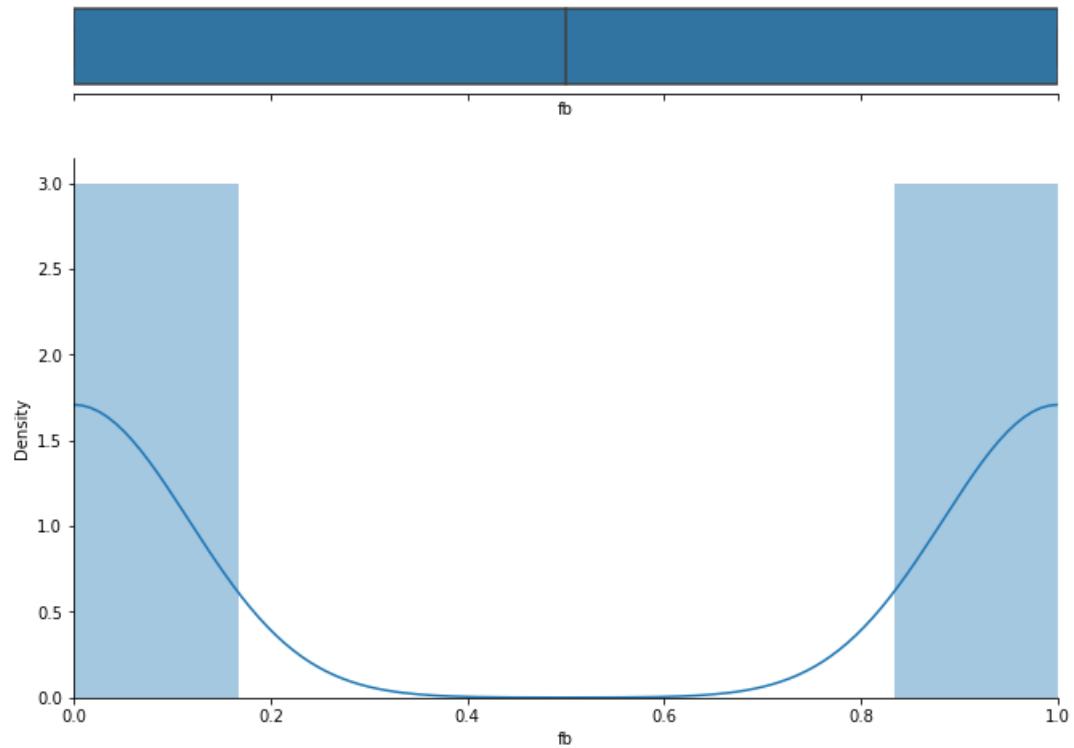
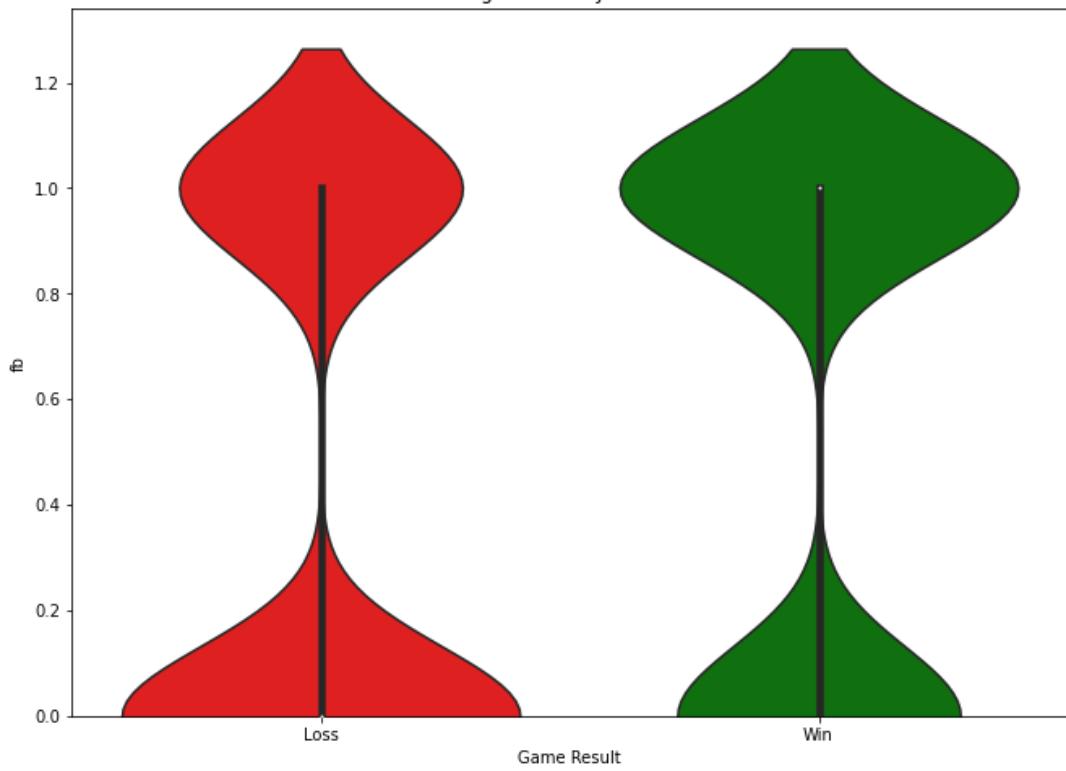


Figure 3: fb by Result



it seems that which team gets the first kill of the game doesn't have much impact on the game

```
In [20]: 1 plot("teamdragkills",4)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 4: teamdragkills Distribution

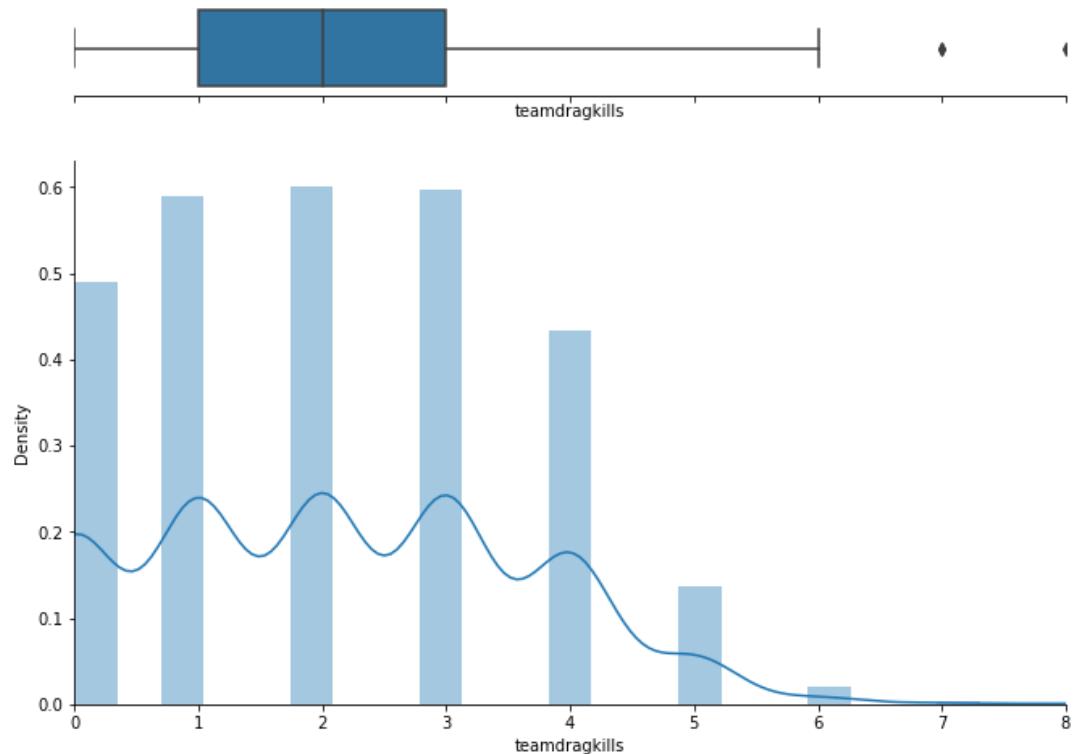
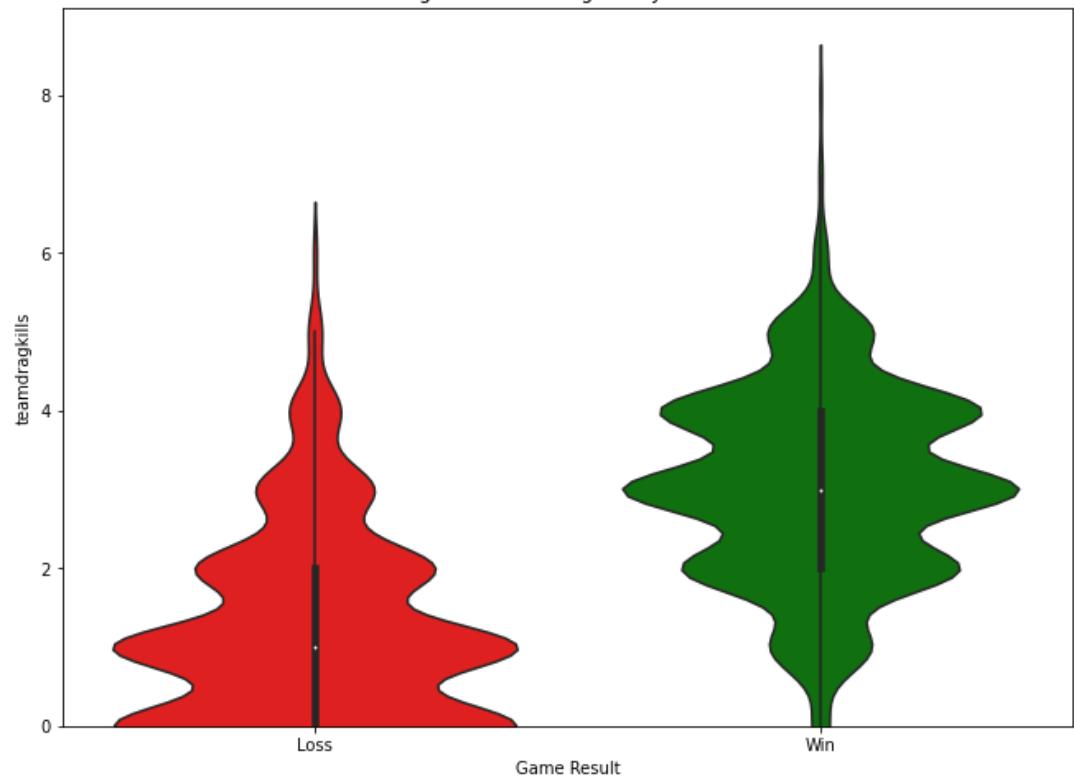


Figure 4: teamdragkills by Result



It is pretty clear that more dragons indicated a notably greater chance of winning and winning teams almost always have many dragons

```
In [23]: 1 plot("elders",5)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 5: elders Distribution

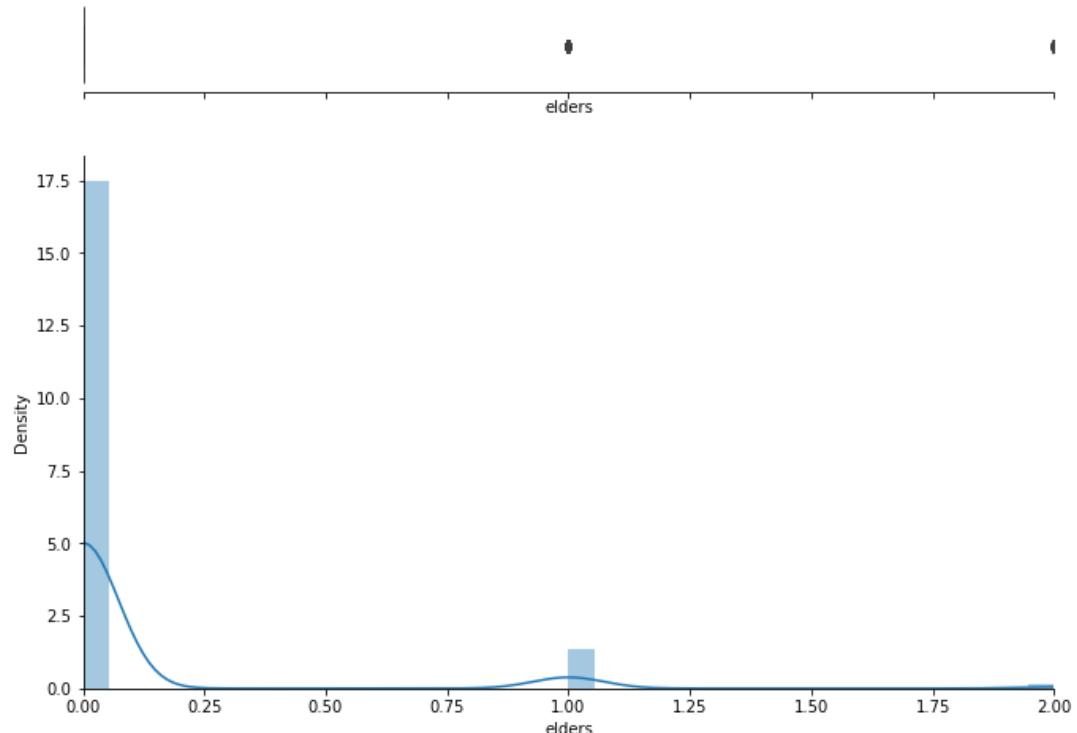


Figure 5: elders by Result



```
In [25]: 1 plot("firstmidouter",6)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 6: firstmidouter Distribution

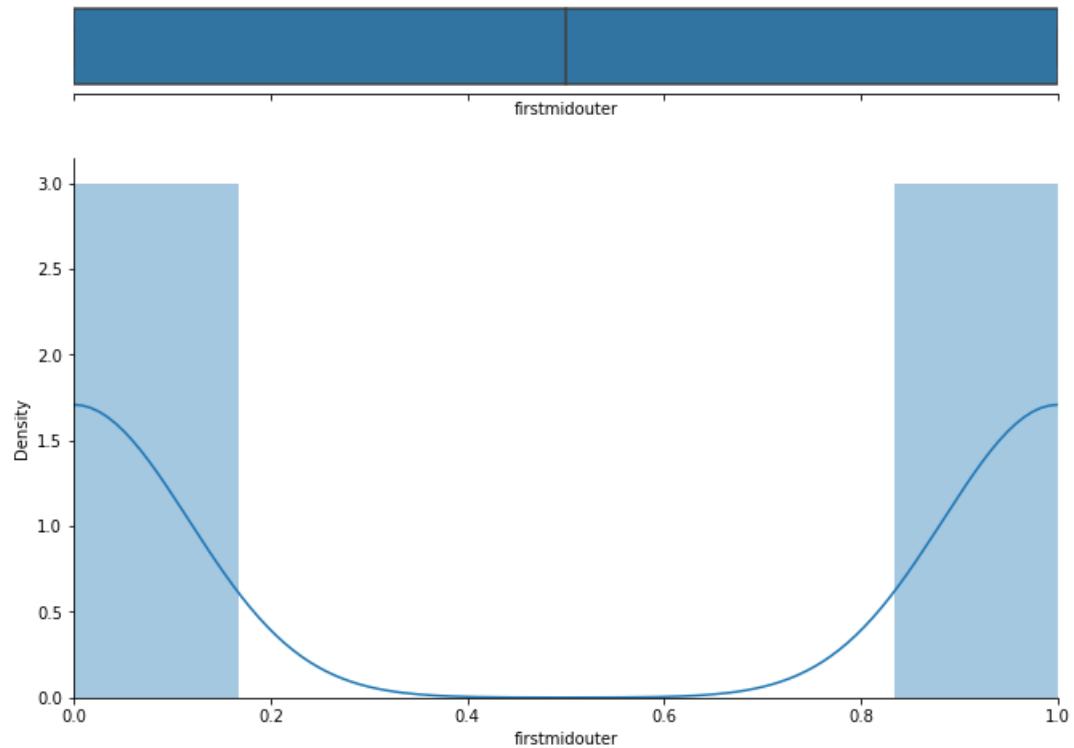
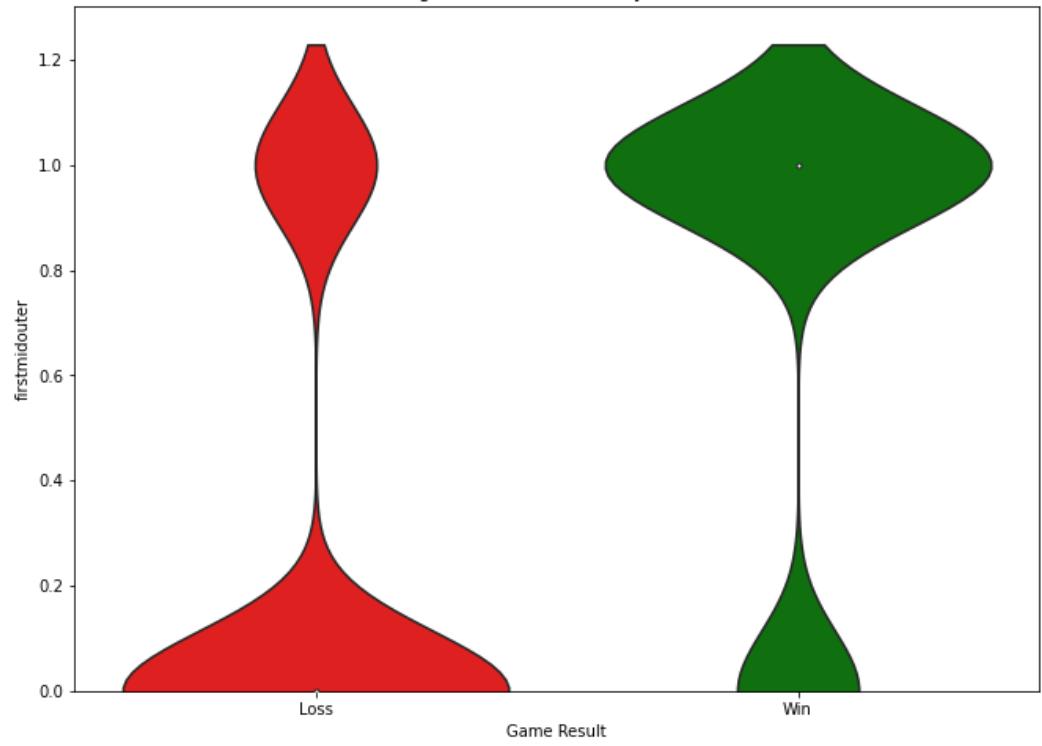


Figure 6: firstmidouter by Result



Whichever team takes the first mid-outer turret is notably more likely to win, be that because it is hard to take unless far ahead or if because taking it is so beneficial to taking control of the map, it's hard to say.

```
In [26]: 1 plot("firsttreetowers",7)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 7: firsttreetowers Distribution

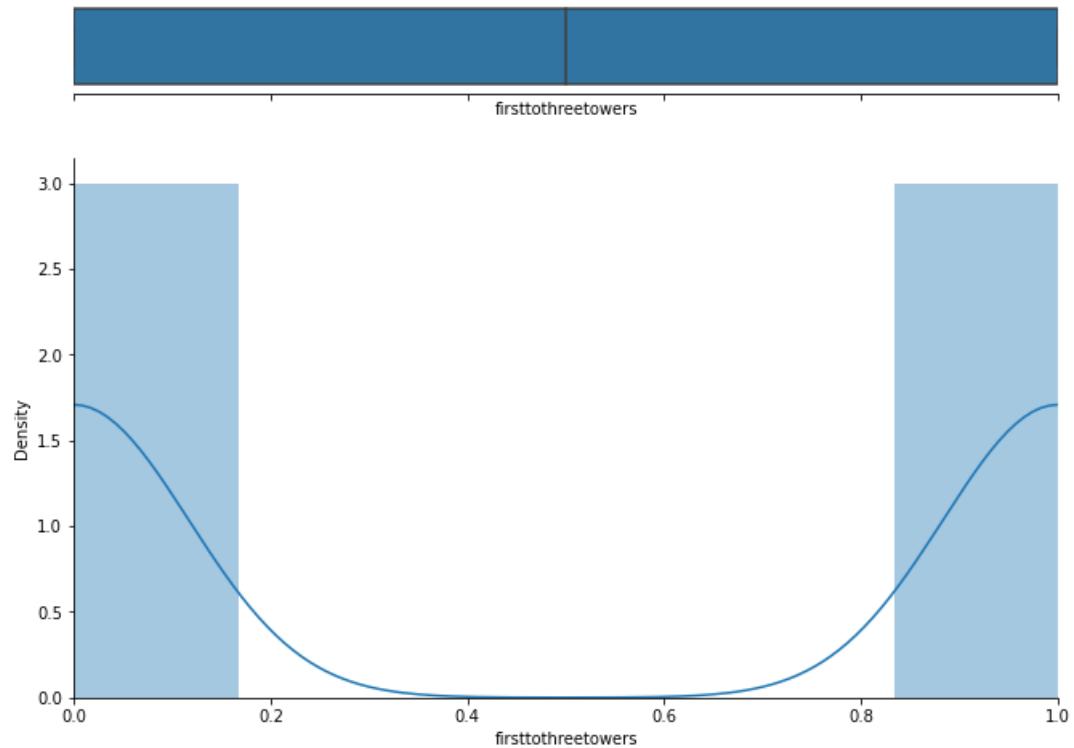
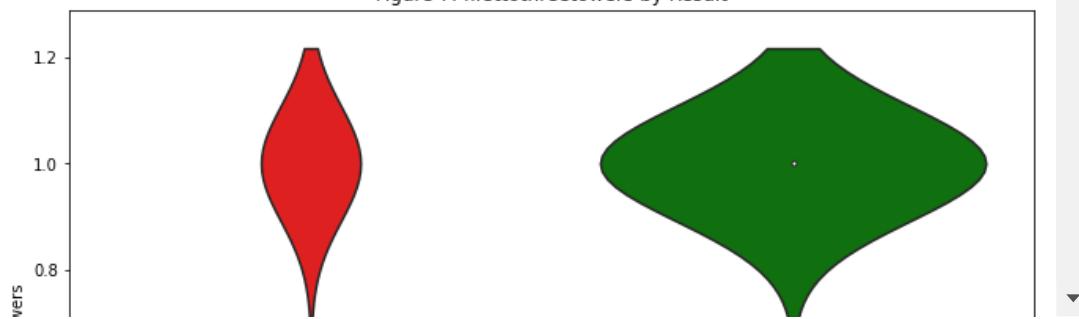


Figure 7: firsttotothree towers by Result



Similar to first mid outer, the first team to take 3 towers is notably more likely to win

```
In [27]: 1 plot("teambaronkills",8)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 8: teambaronkills Distribution

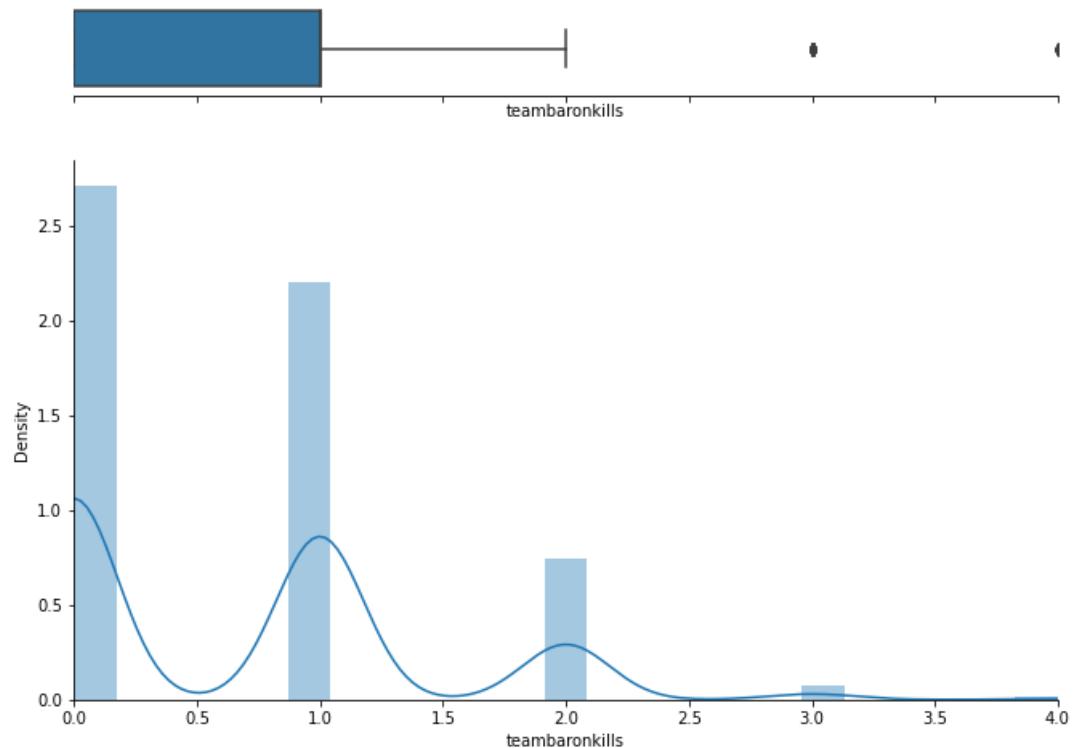


Figure 8: teambaronkills by Result



Baron is a powerful objective and whichever team manages to take it seems to be at a very large advantage

```
In [29]: 1 plot("dmgtochampsperminute",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: dmgtochampsperminute Distribution

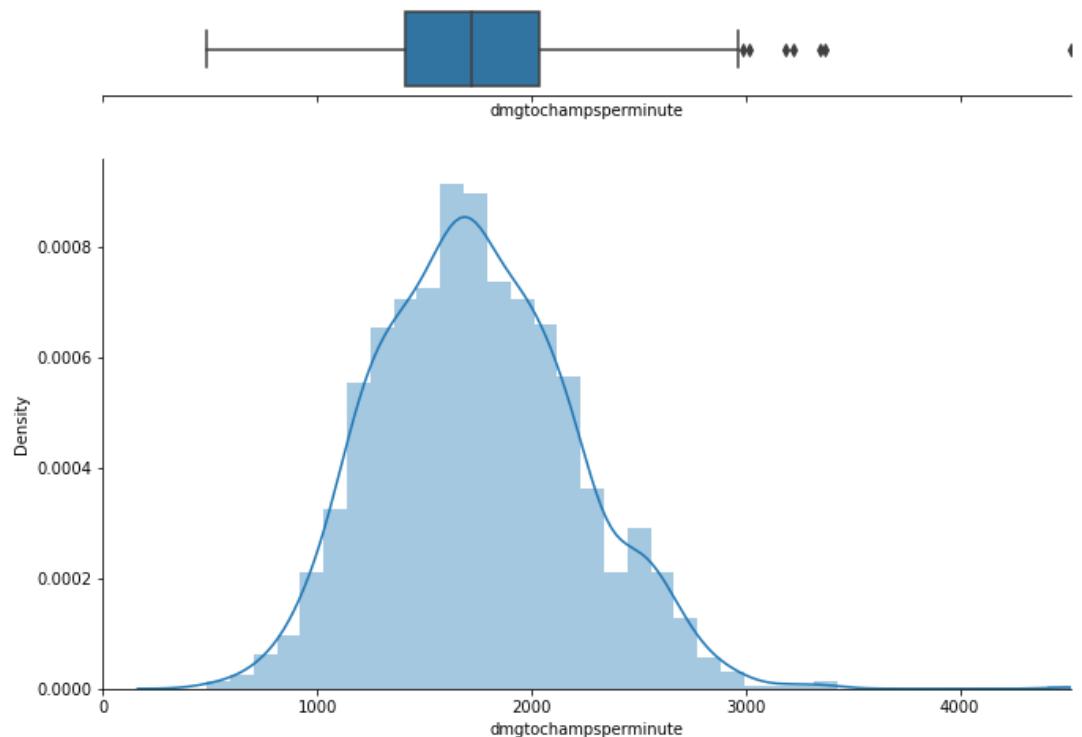
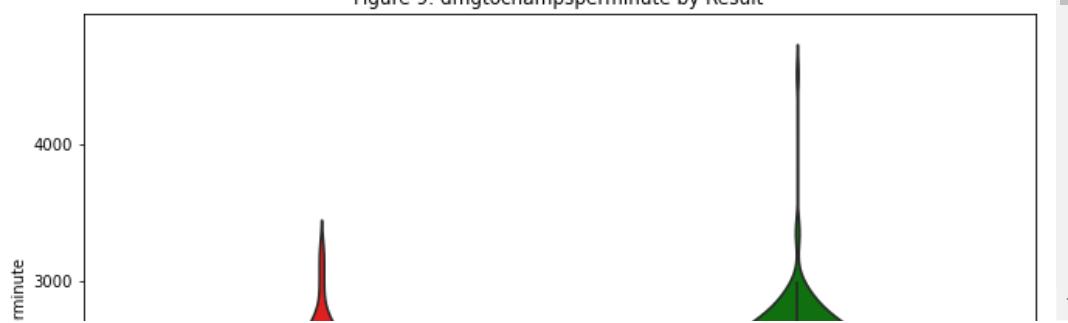


Figure 9: dmgtochampsperminute by Result



While the winning team will likely have a higher damage per minute, there's enough overlap where it will be hard to be predictive on its own

```
In [30]: 1 plot("wards",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)

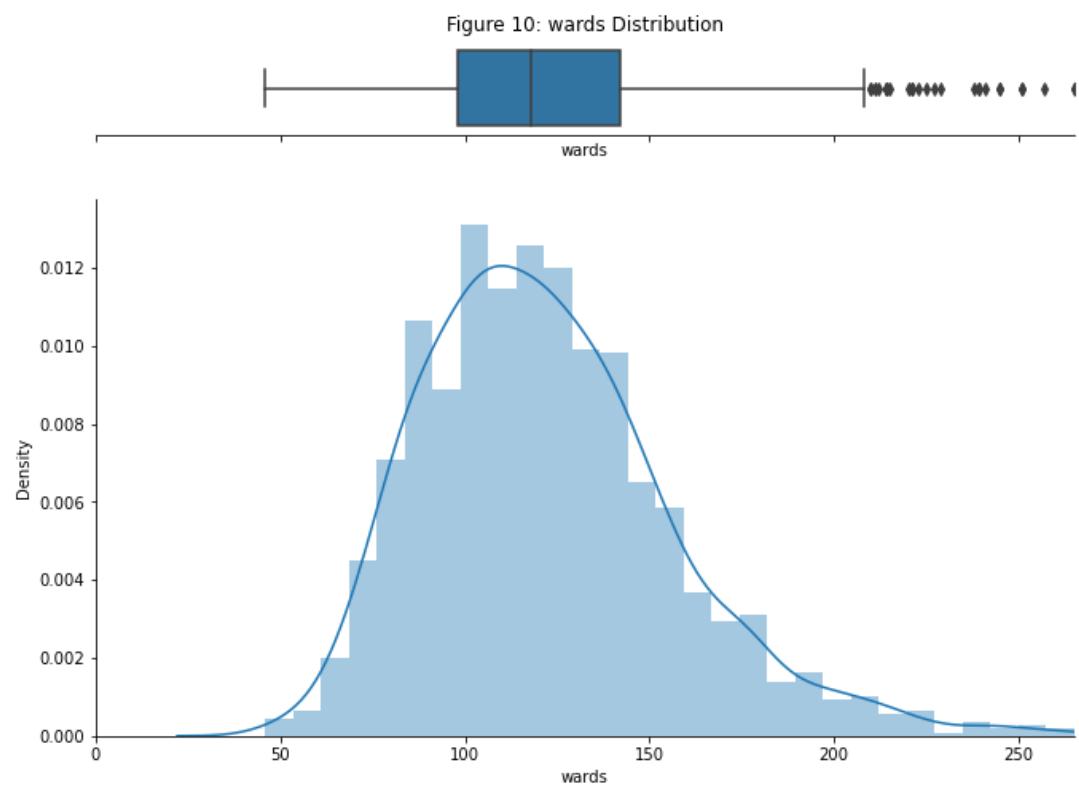


Figure 10: wards by Result



While warding is incredibly important in regards to a team winning, at the professional level very few games are decided by how many wards are placed. If the data was about lower ELO ranges, then perhaps this would be meaningful

```
In [40]:
```

```
1 plot("gdat10",11,-6000)
2 plot("gdat15",12,-6000)
```

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: gdat10 Distribution

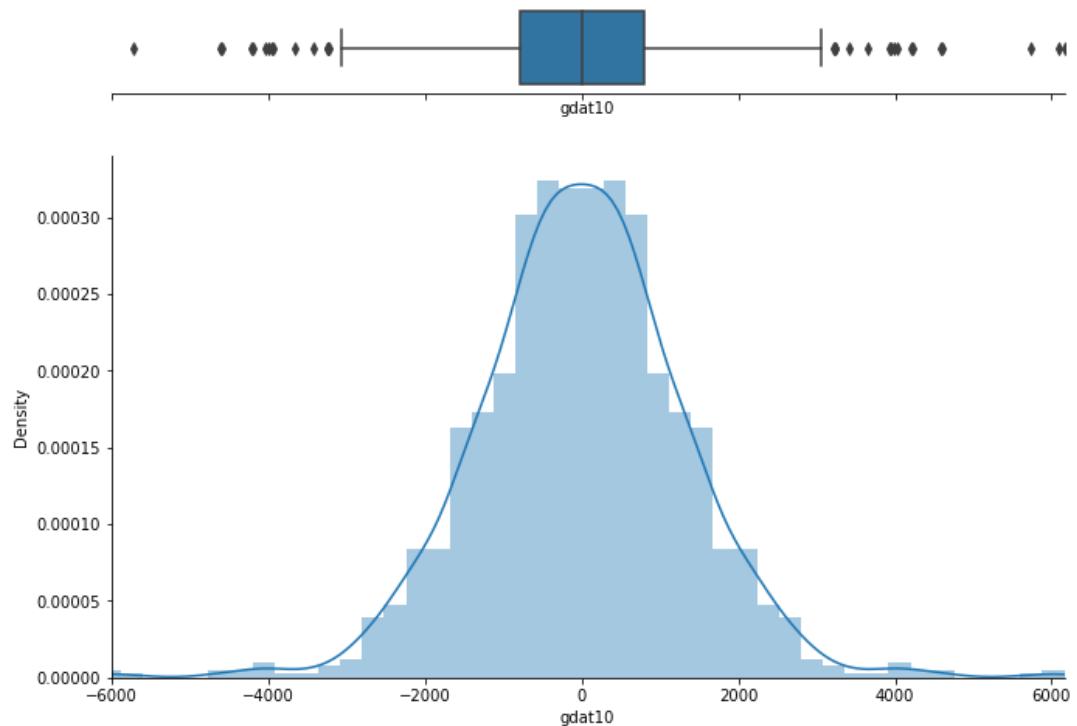
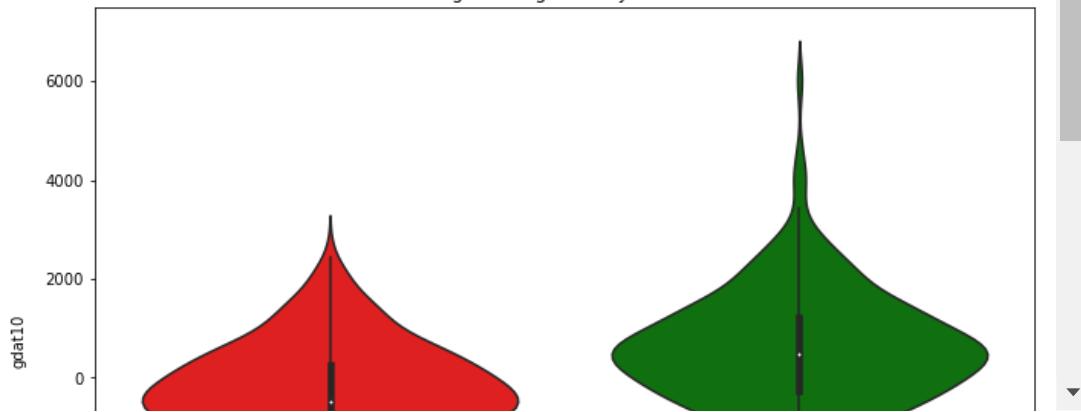


Figure 11: gdat10 by Result



```
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: gdat15 Distribution

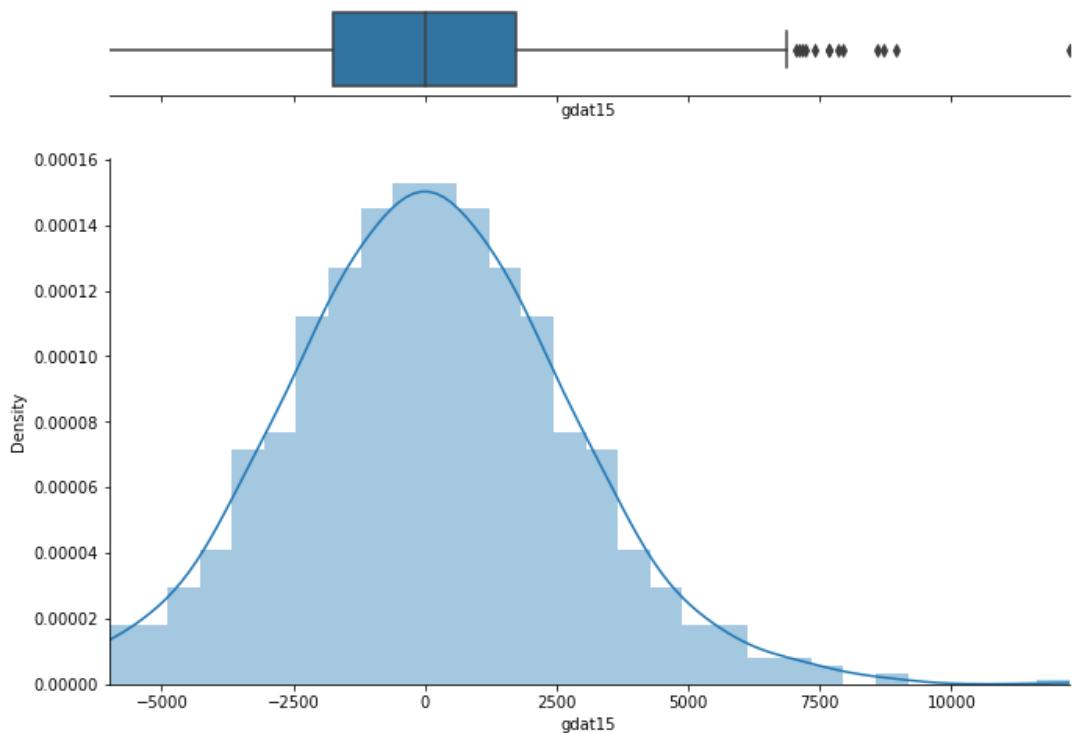
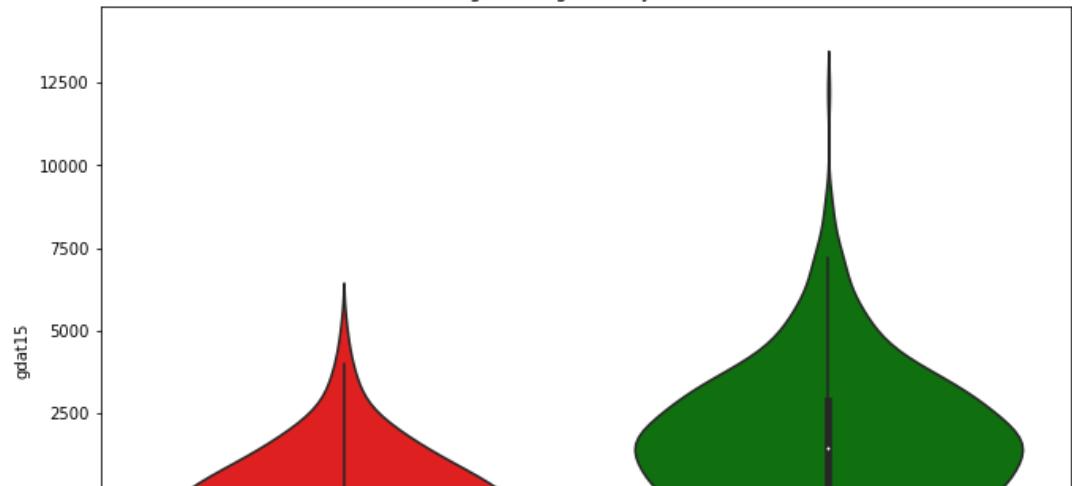


Figure 12: gdat15 by Result



While gold difference at 10 minutes doesn't reflect which team won very well, by the 15 minute mark gold difference becomes much more predictive

```
In [42]: 1 plot("xpdat10",13,-4000)
```

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)

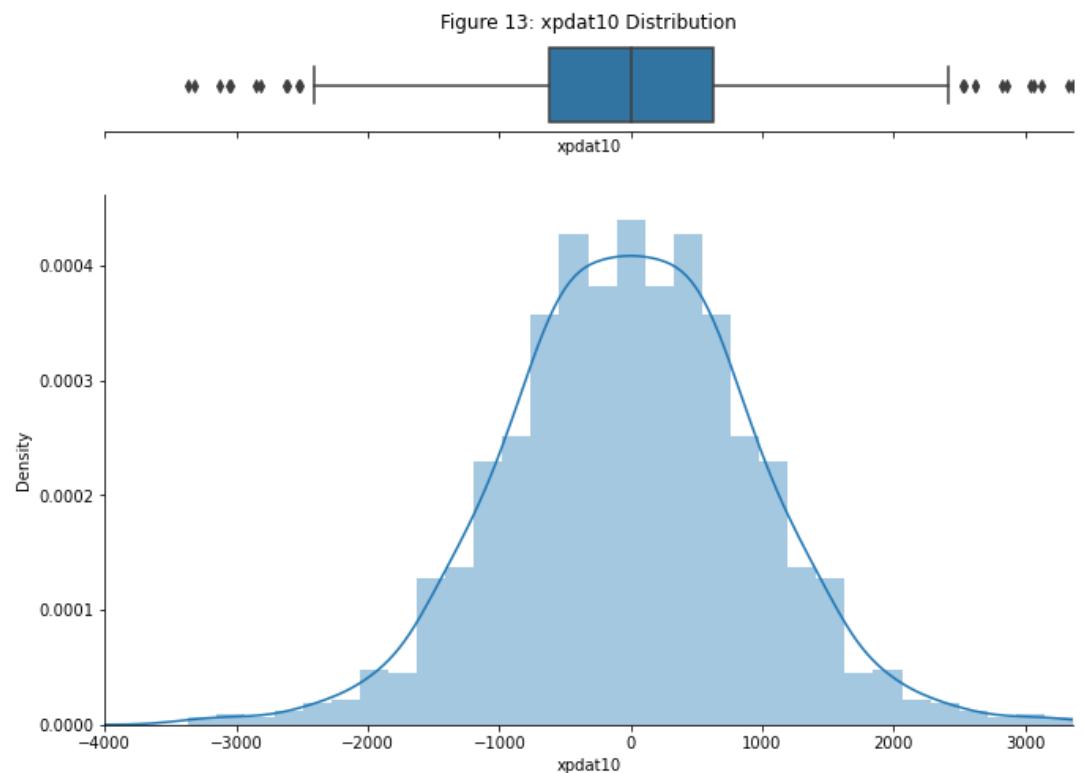
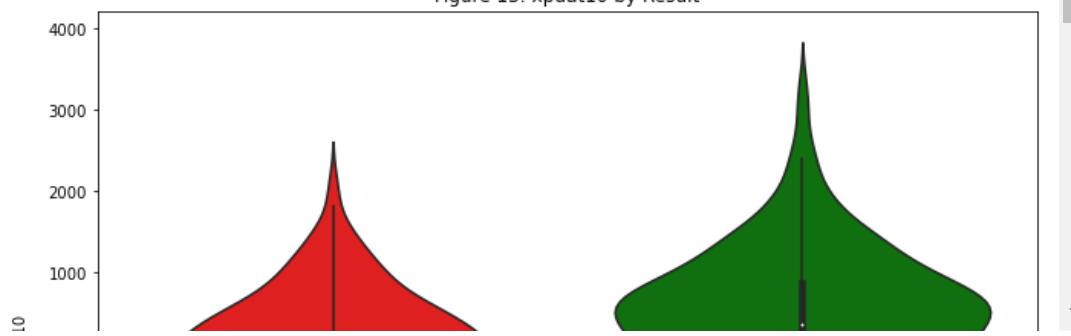


Figure 13: xpdat10 by Result



In [45]:

```
1 plot("csdat10",14,-80)
2 plot("csdat15",15,-150)
```

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: csdat10 Distribution

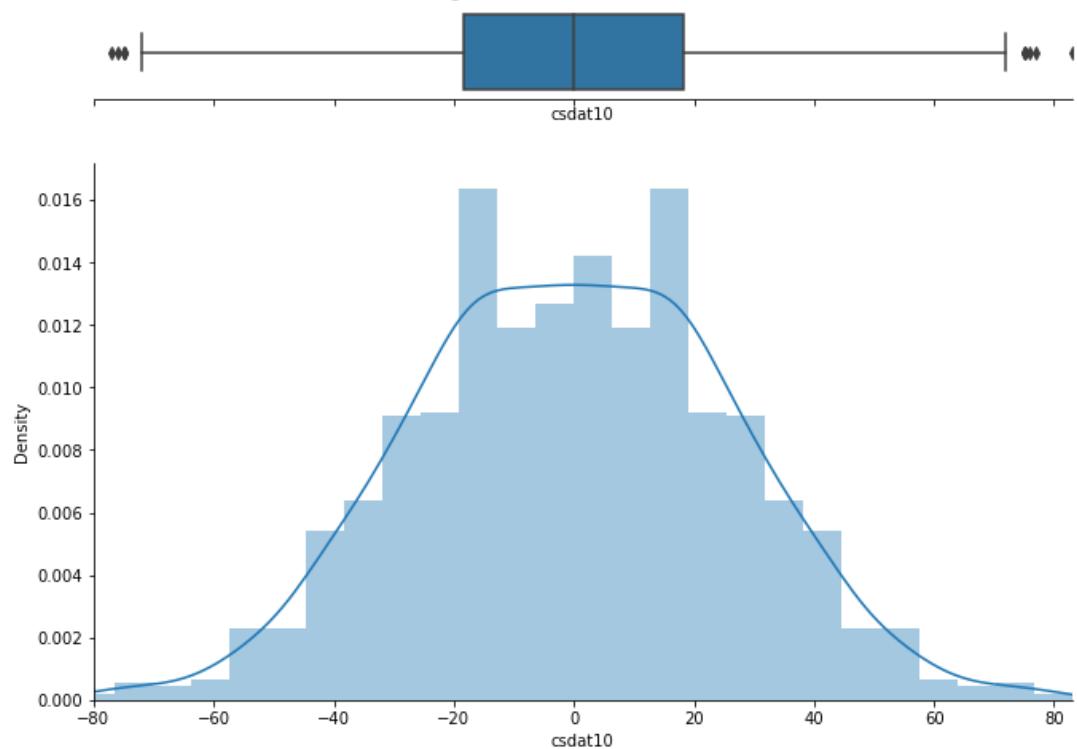
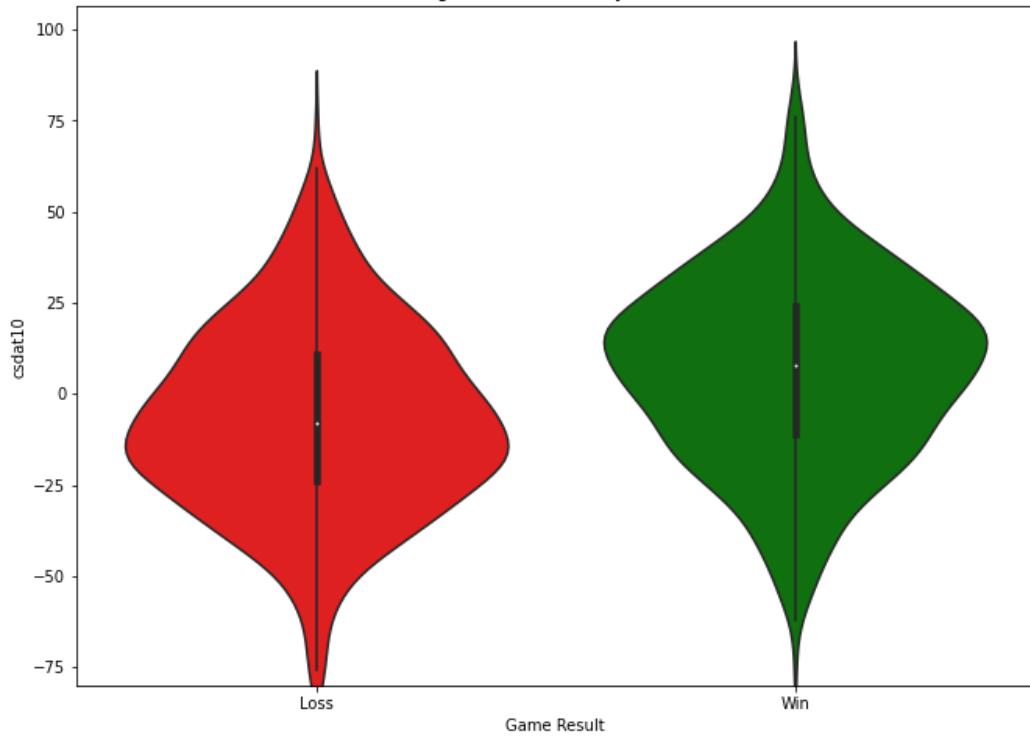


Figure 14: csdat10 by Result



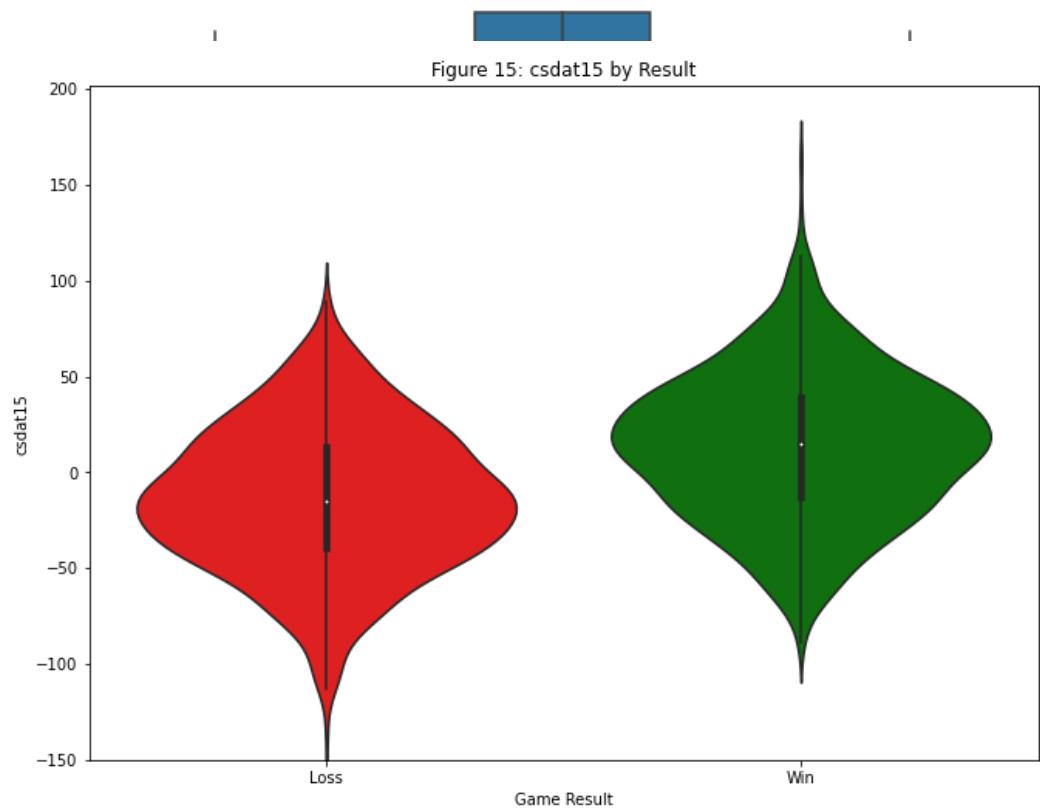
```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result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

```
    warnings.warn(
```

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

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

Figure 15: csdat15 Distribution



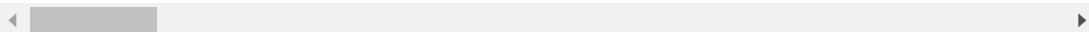
The following is mostly a curiosity to examine the differences between regions at the time of the 2019 world championship

```
In [81]: 1 ##### create dataframe containing the league in which each game was p
2 leagues = []
3 for i,col in enumerate(data):
4     if(i<5):
5         leagues.append(col)
6 print(leagues)
7 leagueIdx = pd.DataFrame(np.zeros((len(data),1)))
8 for i,val in enumerate(leagueIdx.values):
9     for j in range(len(leagues)):
10         if(data[str(leagues[j])][i] == 1.0):
11             leagueIdx[0][i] = leagues[j]
12 leagueIdxData = pd.concat([leagueIdx,data],axis=1).rename(columns={})
13 leagueIdxData.head()
```

['league_CBLoL', 'league_LCK', 'league_LCS', 'league_LEC', 'league_LMS']

Out[81]:

	league	league_CBLoL	league_LCK	league_LCS	league_LEC	league_LMS	gar
0	league_LCS	0.0	0.0	1.0	0.0	0.0	3
1	league_LCS	0.0	0.0	1.0	0.0	0.0	3
2	league_LCS	0.0	0.0	1.0	0.0	0.0	2
3	league_LCS	0.0	0.0	1.0	0.0	0.0	2
4	league_LCS	0.0	0.0	1.0	0.0	0.0	3



```
In [87]: 1 resultTitles = leagues
2 resultIndexes = leagues
3 colors      = ["b", "c", "r", "g", "y"]
4 resultDict   = dict()
5 for i, ind in enumerate(resultIndexes):
6     resultDict[ind] = resultTitles[i]
7 resultLabeled = leagueIdxData["league"].replace(resultDict)
8
9 def violin_plotLeague(y, title, w, h, ymin=0):
10    plt.figure(figsize=(w,h))
11    ax = sns.violinplot(x=resultLabeled,y=y,palette=colors,order=re
12    ax.set(xlabel='League')
13    ax.set_ylim(ymin,)
14    plt.title(title)
15    plt.show()
16
17 def density_plotLeague(x, title, w, h, ymin=0):
18    fig, (ax_box, ax_hist) = plt.subplots(2, sharex=True, gridspec_
19    fig.set_size_inches(w,h)
20    ax_box.set_xlim(ymin,x.max())
21    ax_hist.set_xlim(ymin,x.max())
22    sns.boxplot(x,ax=ax_box)
23    sns.distplot(x,ax=ax_hist)
24    ax_box.set(yticks=[])
25    sns.despine(ax=ax_hist)
26    sns.despine(ax=ax_box, left=True)
27    ax_box.set_title(title)
28    plt.show()
29
30 def plotLeague(feature, fig_num, ymin=0, dataset=data):
31     density_plotLeague(dataset[feature],f"Figure {fig_num}: {feature}
32     violin_plotLeague(dataset[feature],f"Figure {fig_num}: {feature}
```

```
In [88]: 1 kda = ["k", "d", "a"]
2 for i,var in enumerate(kda):
3     plot(var,i)
```

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)

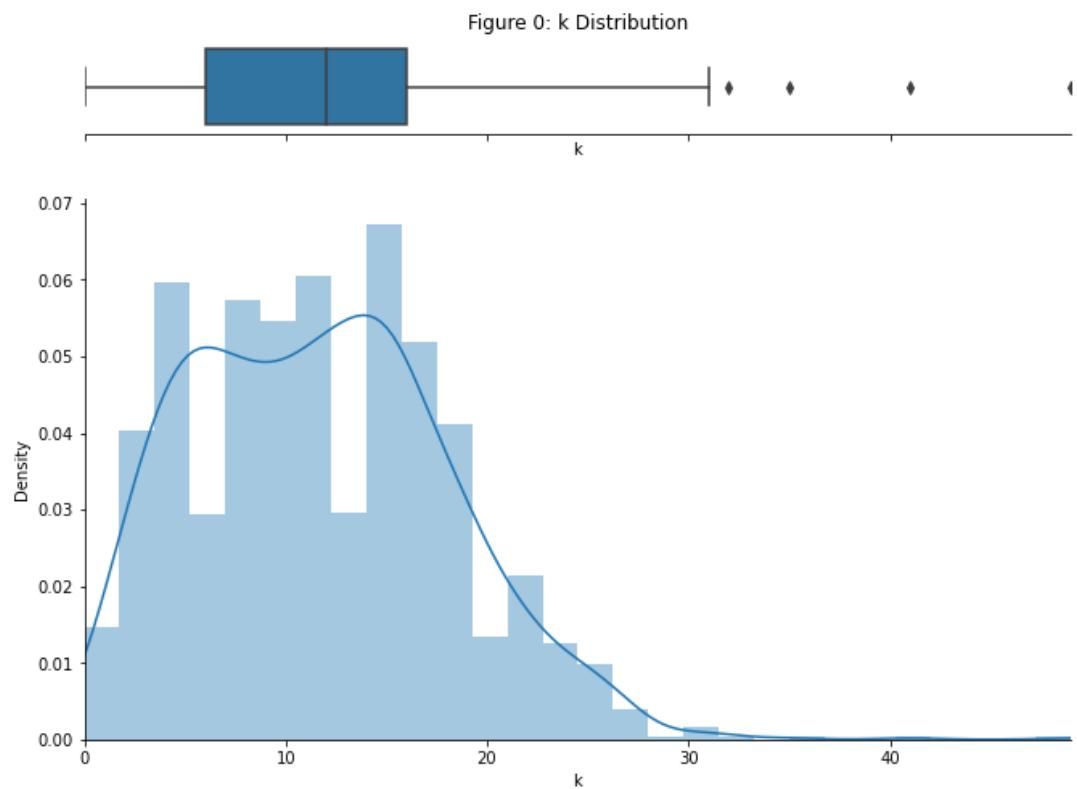
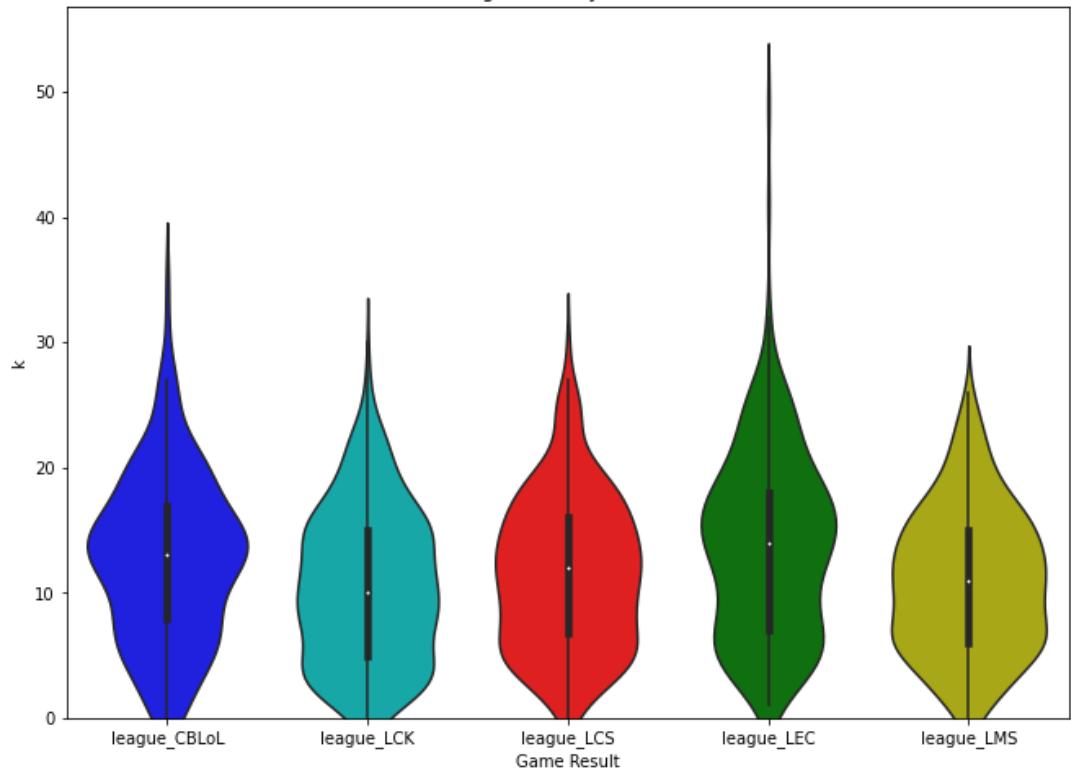


Figure 0: k by Result



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 argu

```
ment 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: d Distribution

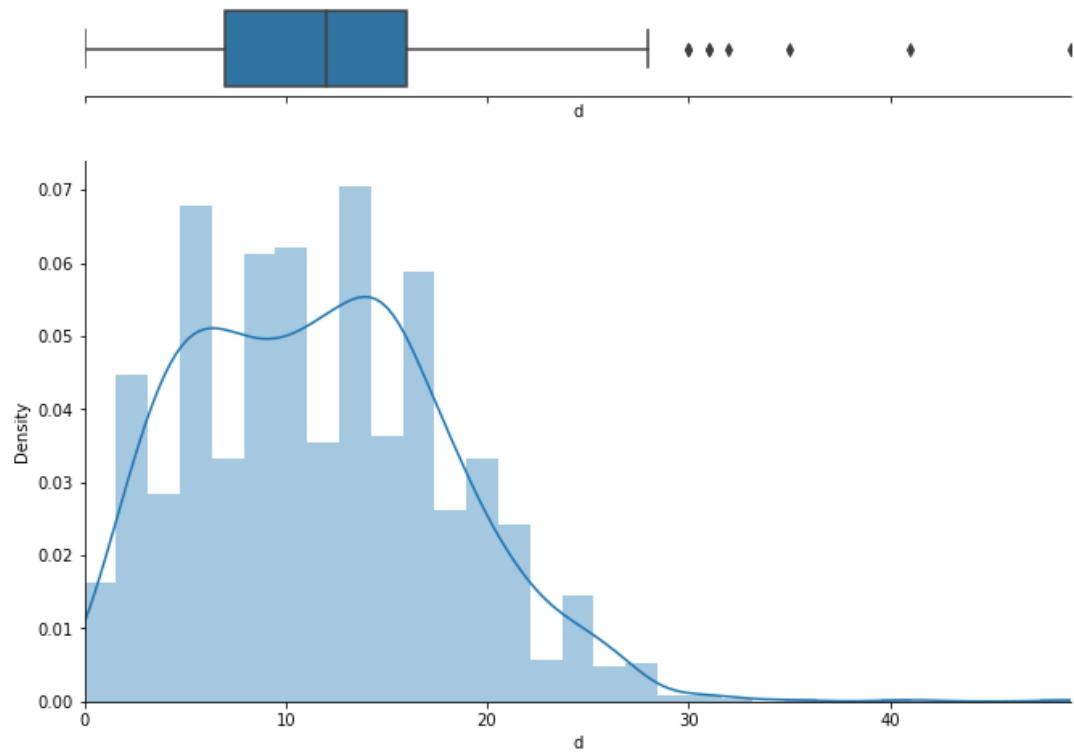
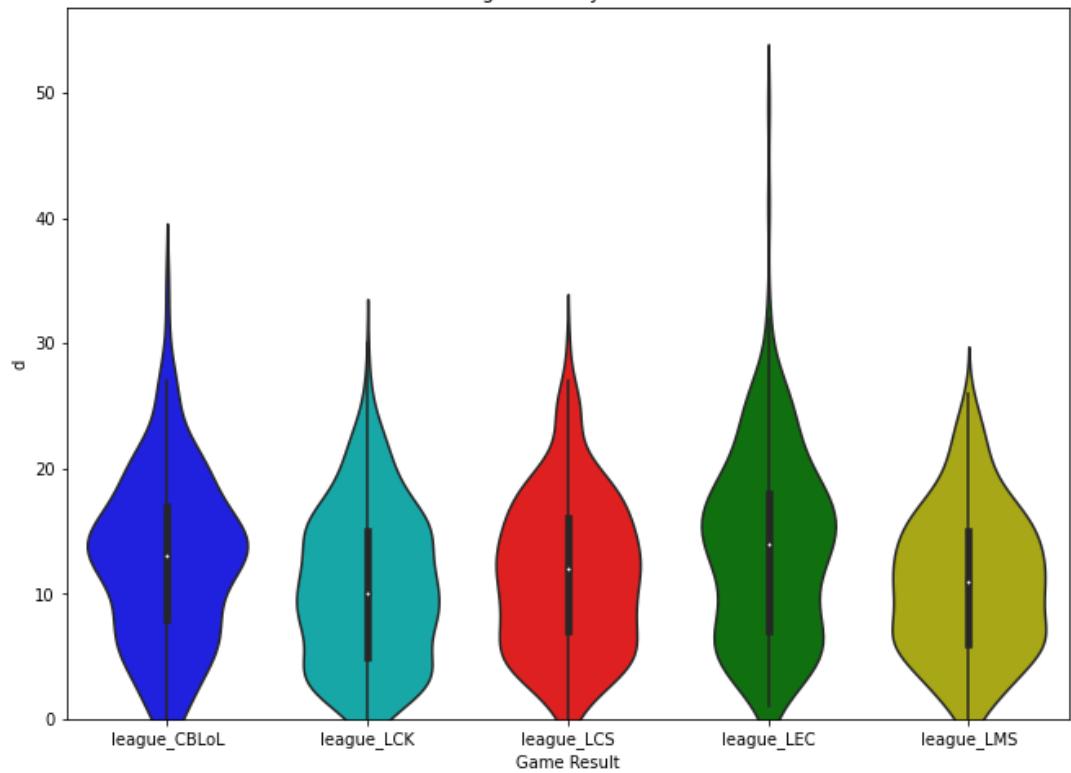


Figure 1: d by Result



```
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: a Distribution

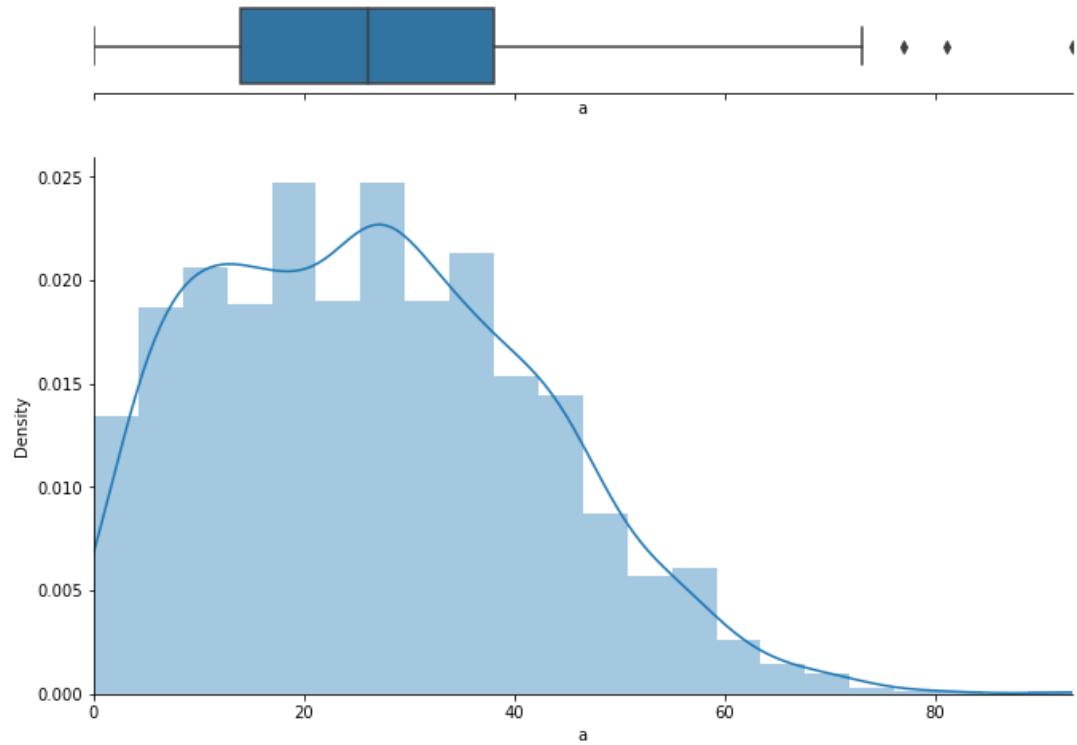
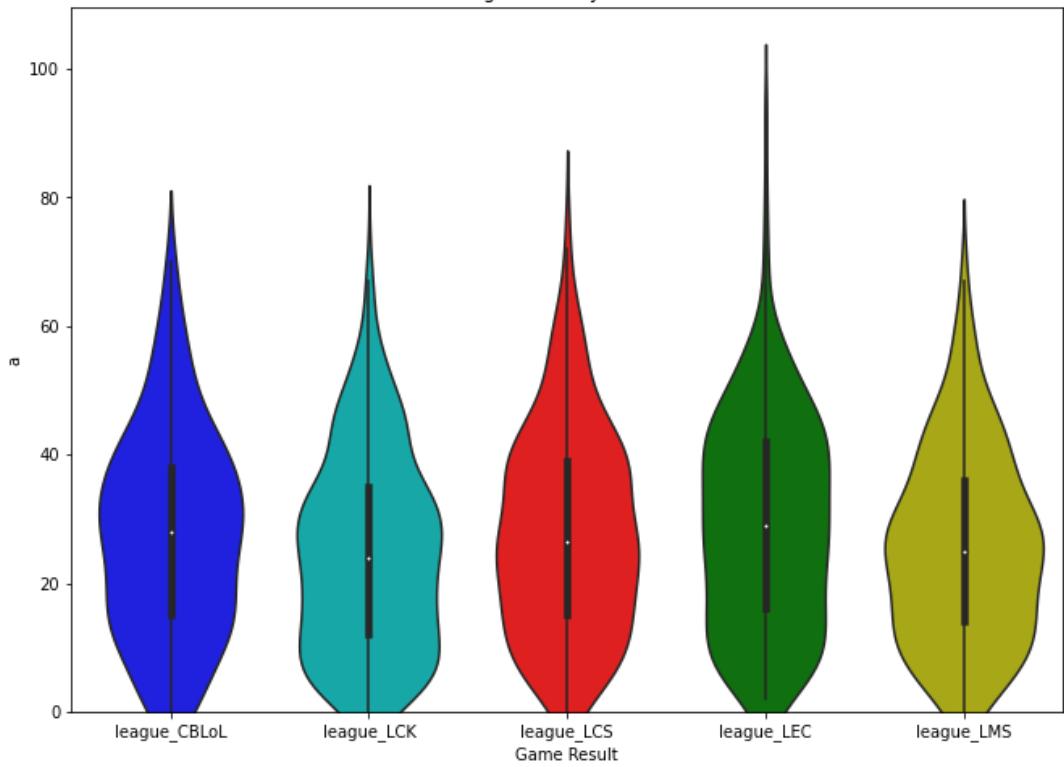


Figure 2: a by Result



```
In [89]: 1 plotLeague("kpm",3)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 3: kpm Distribution

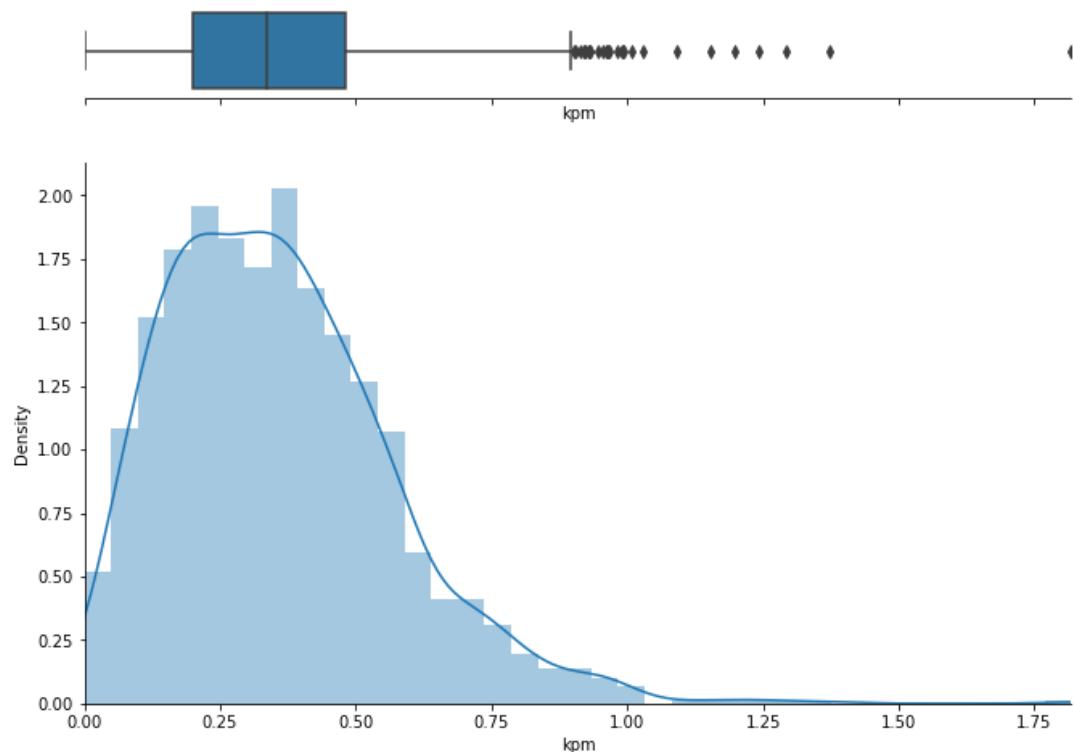
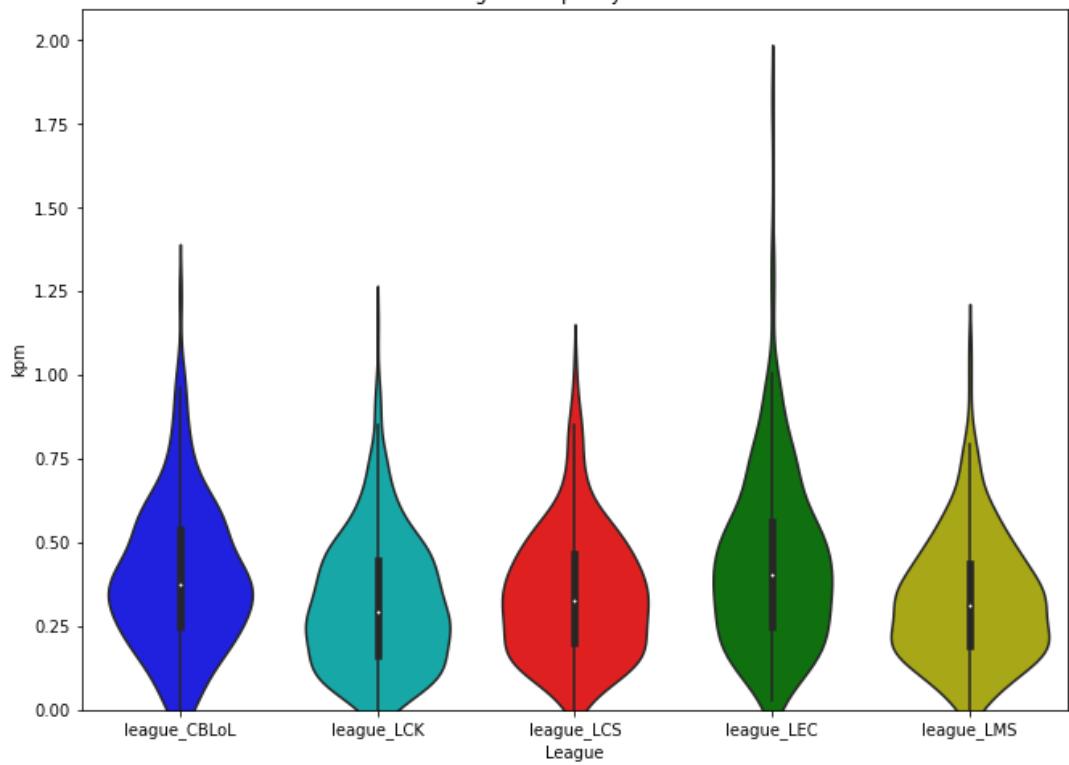


Figure 3: kpm by Result



```
In [101]: 1 plotLeague("gamelength",4)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 4: gamelength Distribution

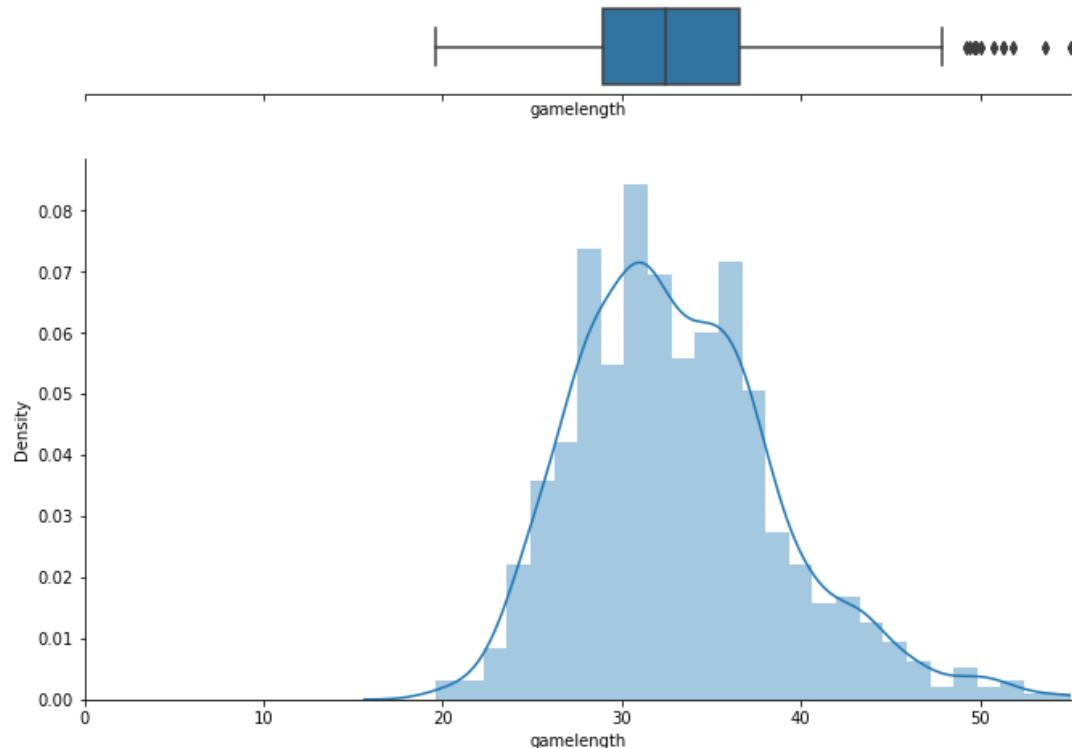
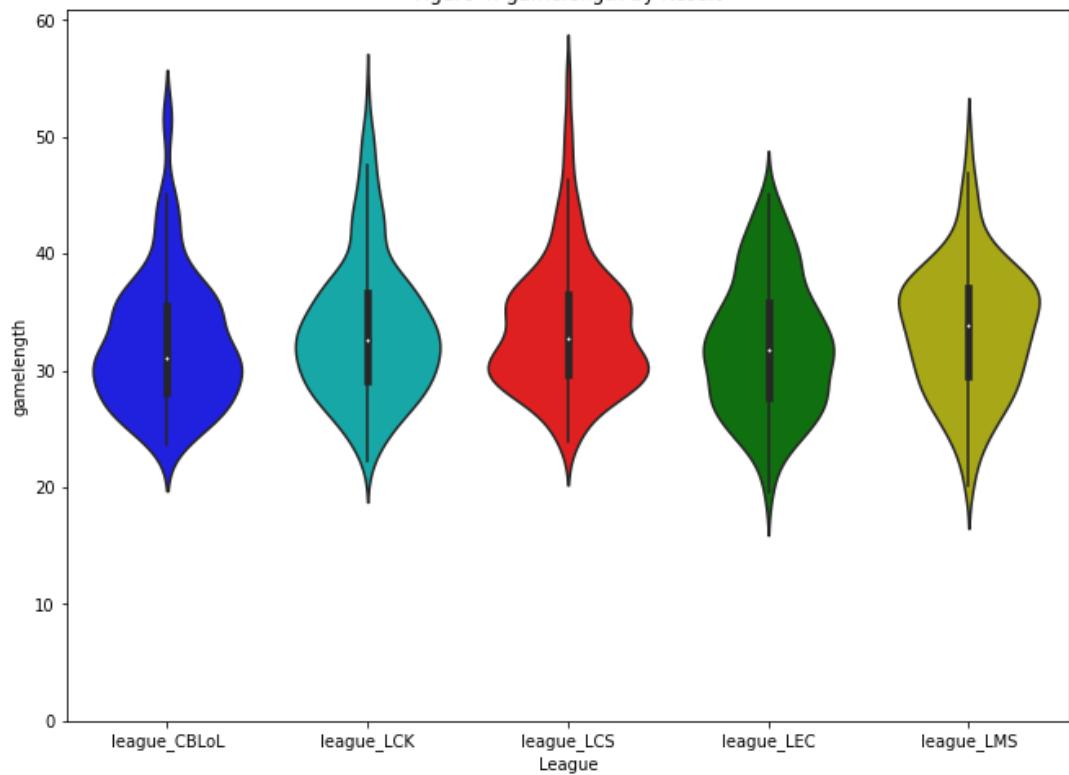


Figure 4: gamelength by Result



In [102]:

```
1 plotLeague("fdtime",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)
```

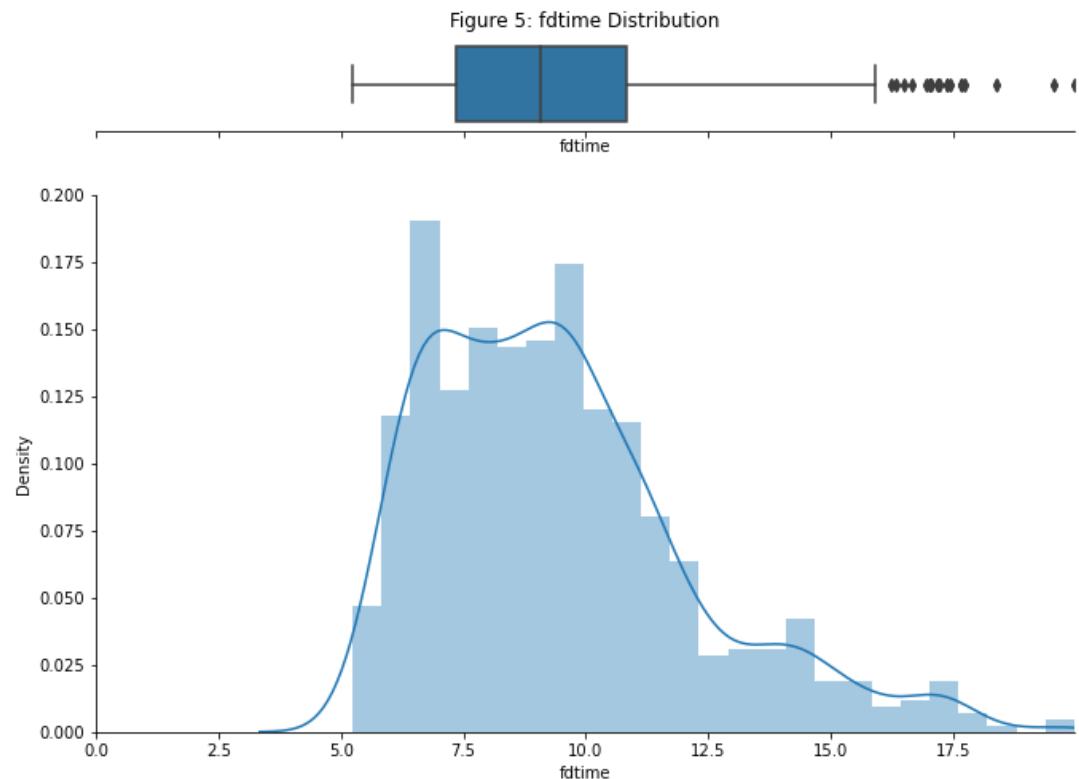
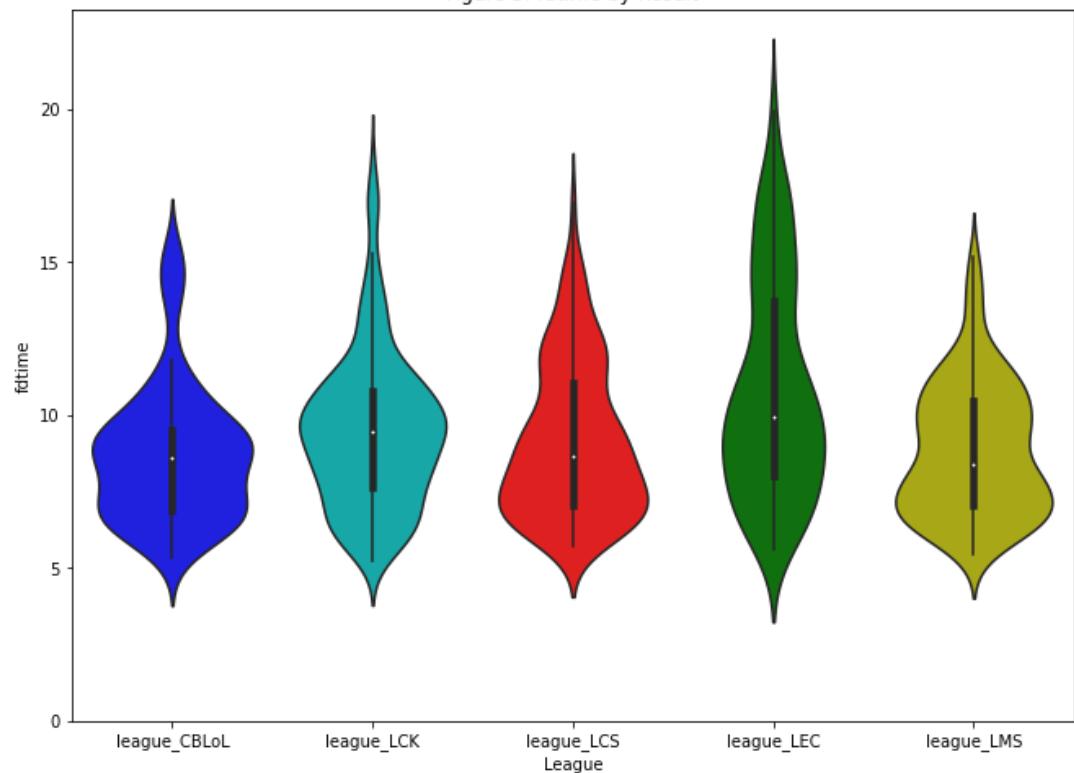


Figure 5: fdtime by Result



```
In [103]: 1 plotLeague("teamdragkills",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)

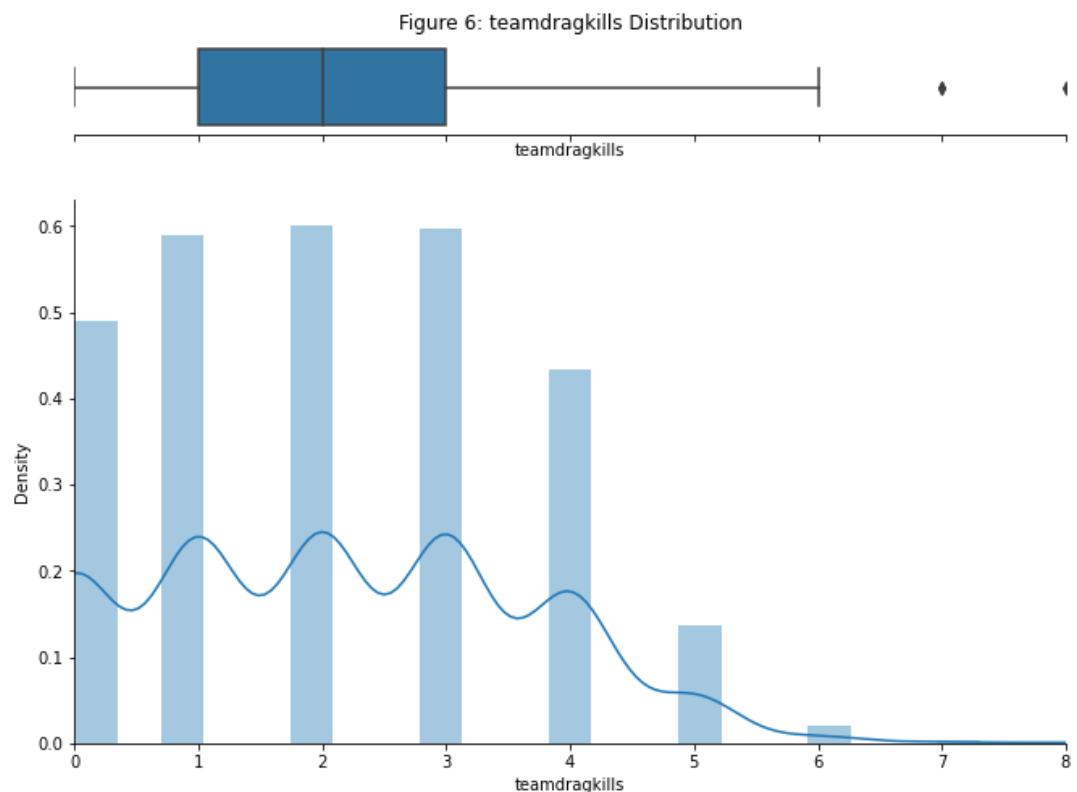
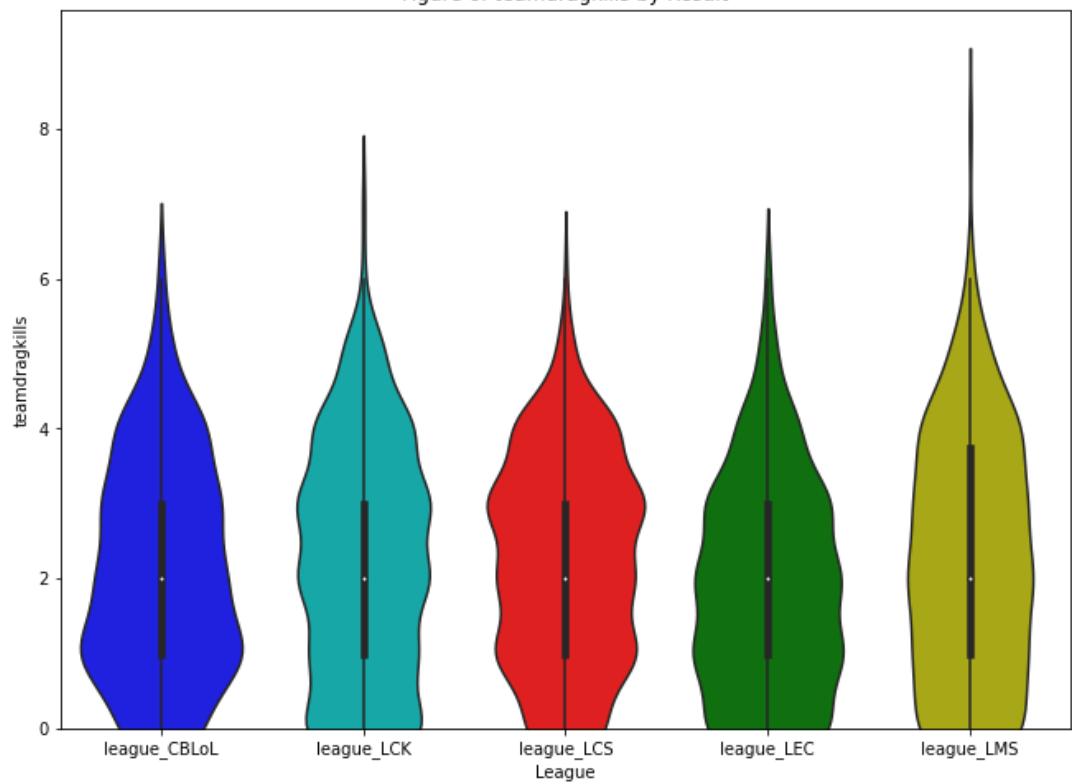


Figure 6: teamdragkills by Result



```
In [104]: 1 plotLeague("elders",7)
```

```
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\_  
decorators.py:36: FutureWarning: Pass the following variable as a keyw  
ord arg: x. From version 0.12, the only valid positional argument will  
be `data`, and passing other arguments without an explicit keyword wil  
l result in an error or misinterpretation.  
    warnings.warn(  
C:\Users\Triplea657\anaconda3\envs\MSCS335\lib\site-packages\seaborn\d  
istributions.py:2557: FutureWarning: `distplot` is a deprecated functi  
on and will be removed in a future version. Please adapt your code to  
use either `displot` (a figure-level function with similar flexibilit  
y) or `histplot` (an axes-level function for histograms).  
    warnings.warn(msg, FutureWarning)
```

Figure 7: elders Distribution

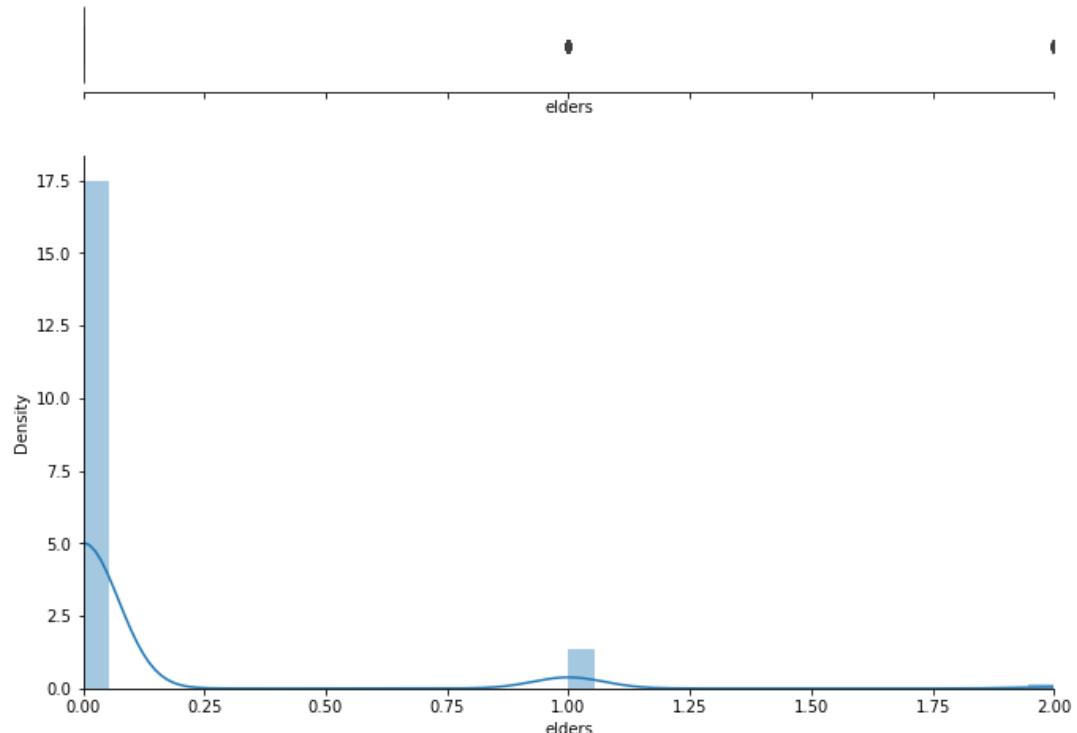
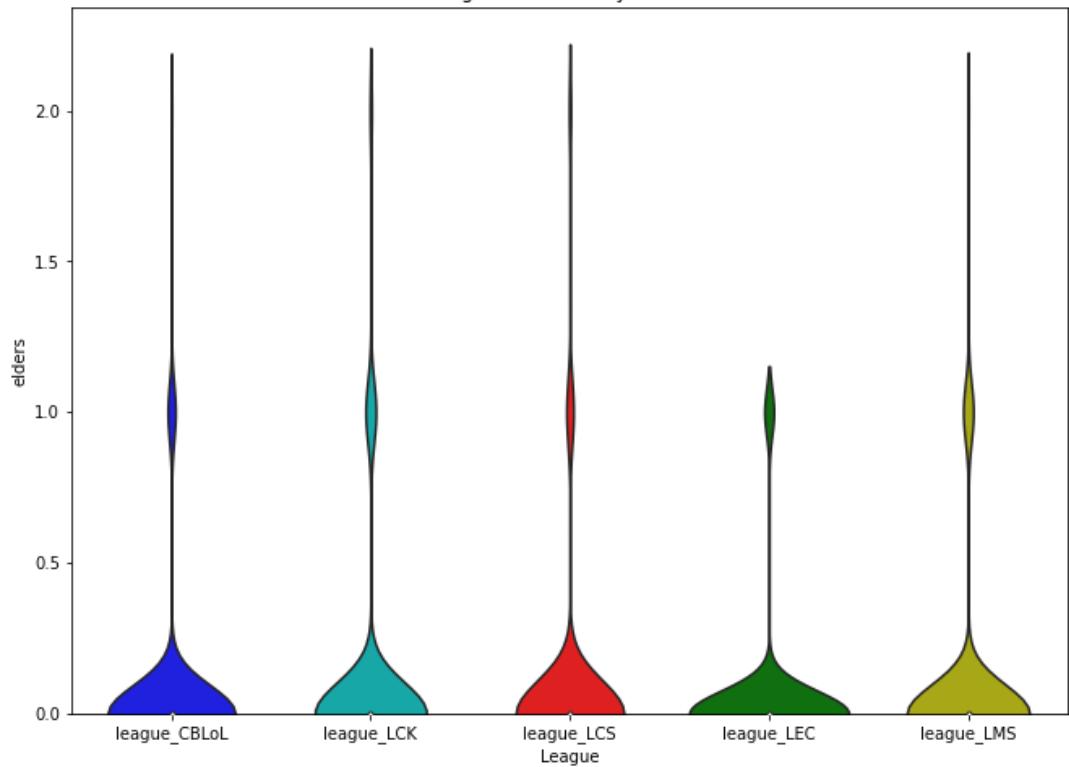


Figure 7: elders by Result



```
In [105]: 1 plotLeague("fttime",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)
```

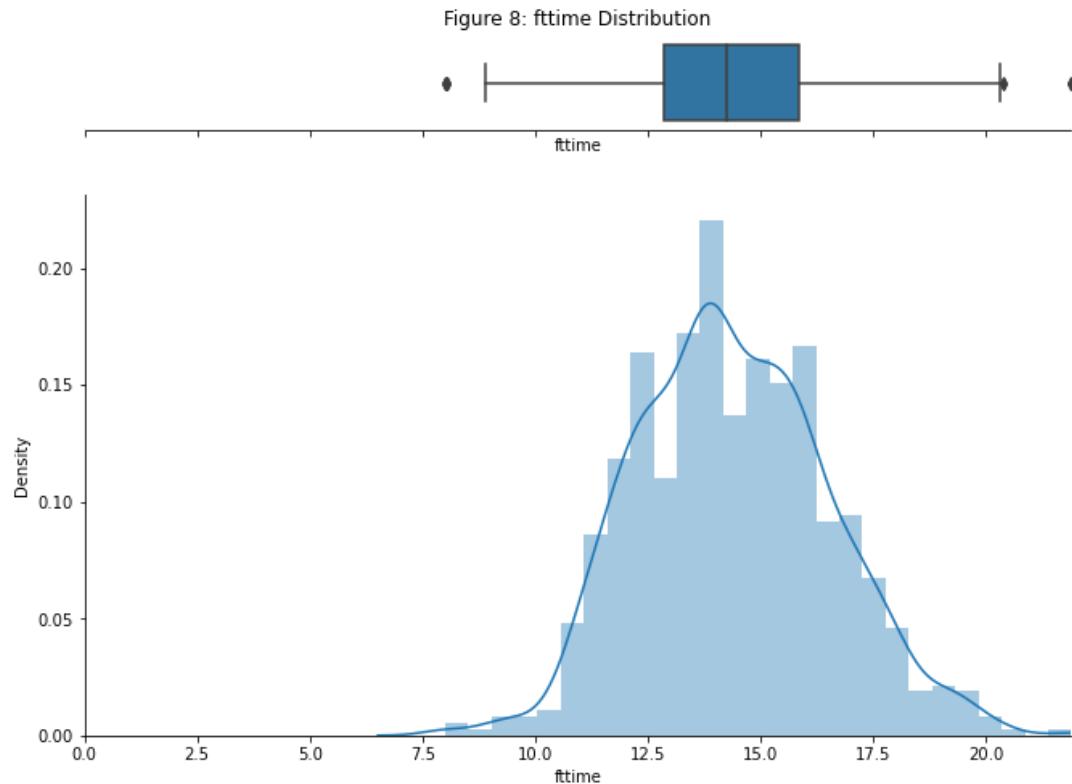
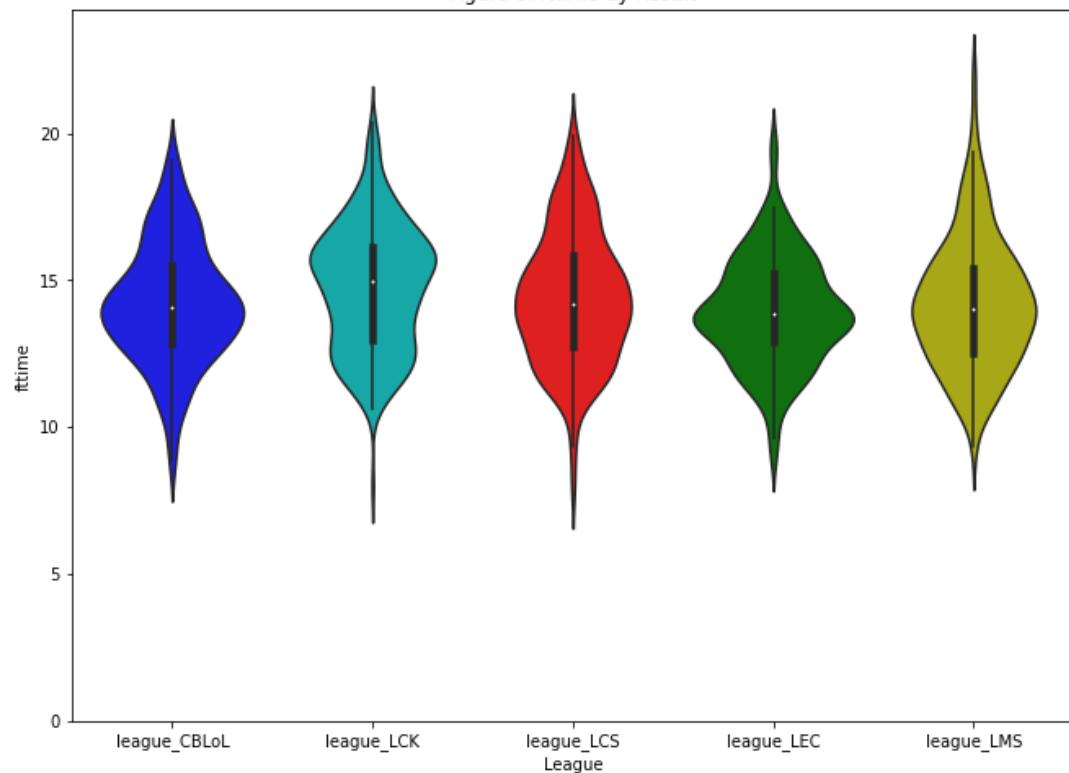


Figure 8: fftime by Result



```
In [106]: 1 plotLeague("dmgtochampsperminute", 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: dmgtochampsperminute Distribution

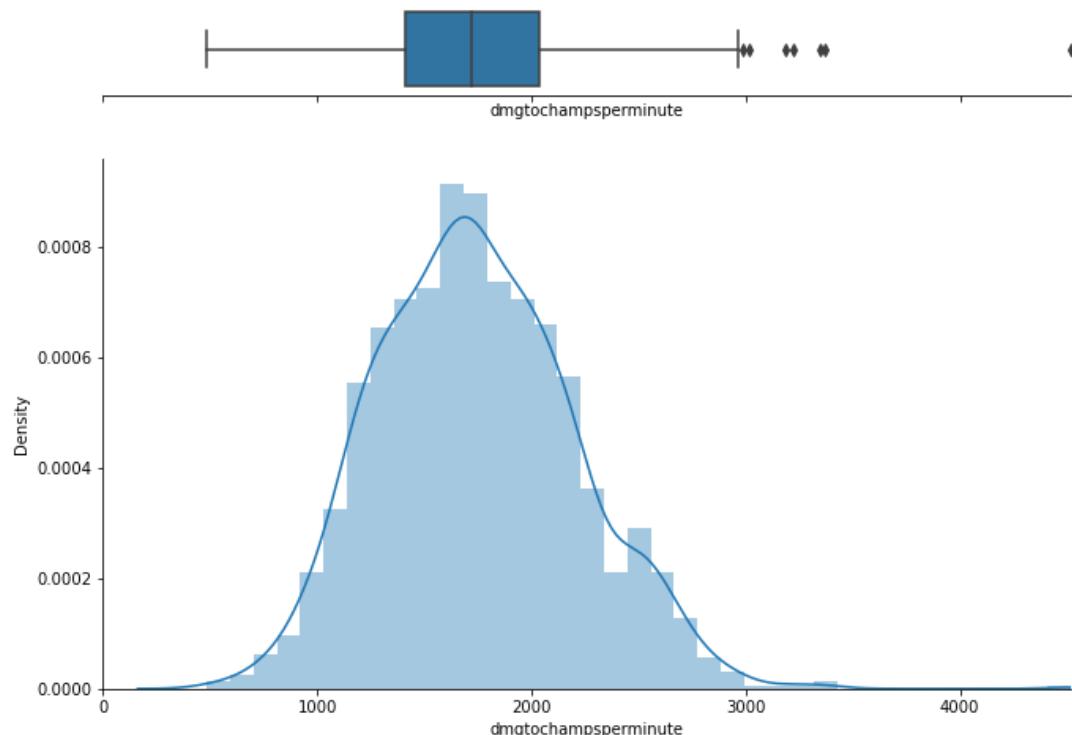
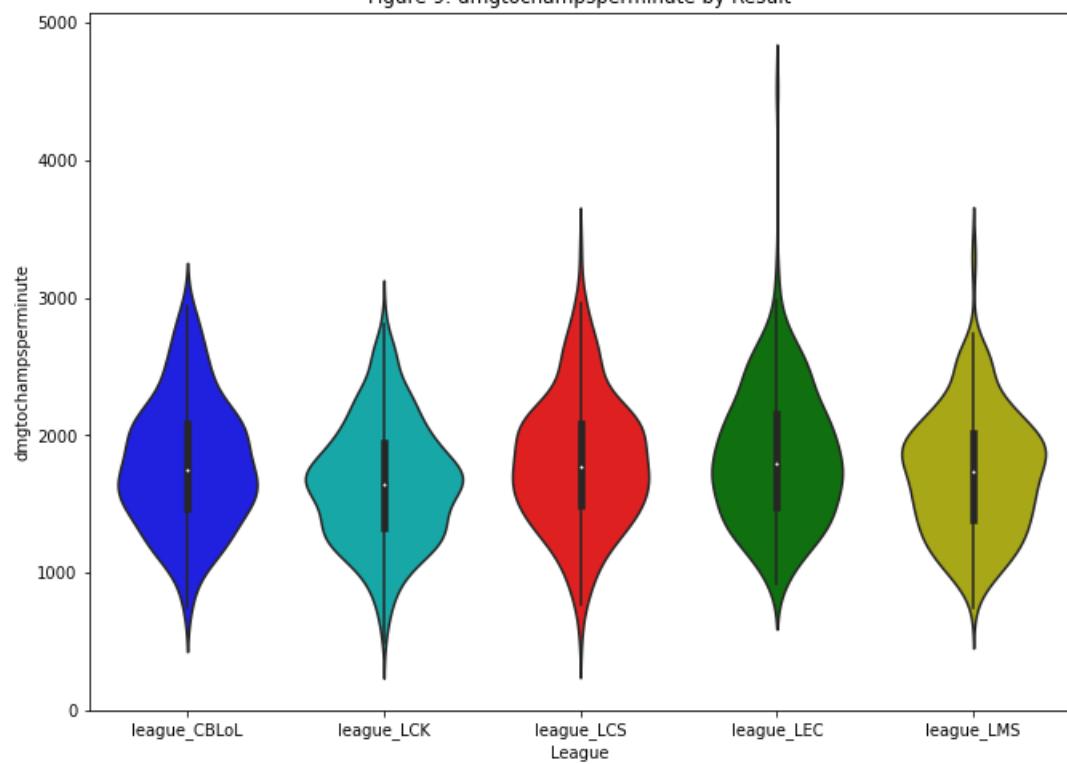


Figure 9: dmgtocampsperminute by Result



In [107]:

```
1 plotLeague("wards",10)
2 plotLeague("wpm",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 10: wards Distribution

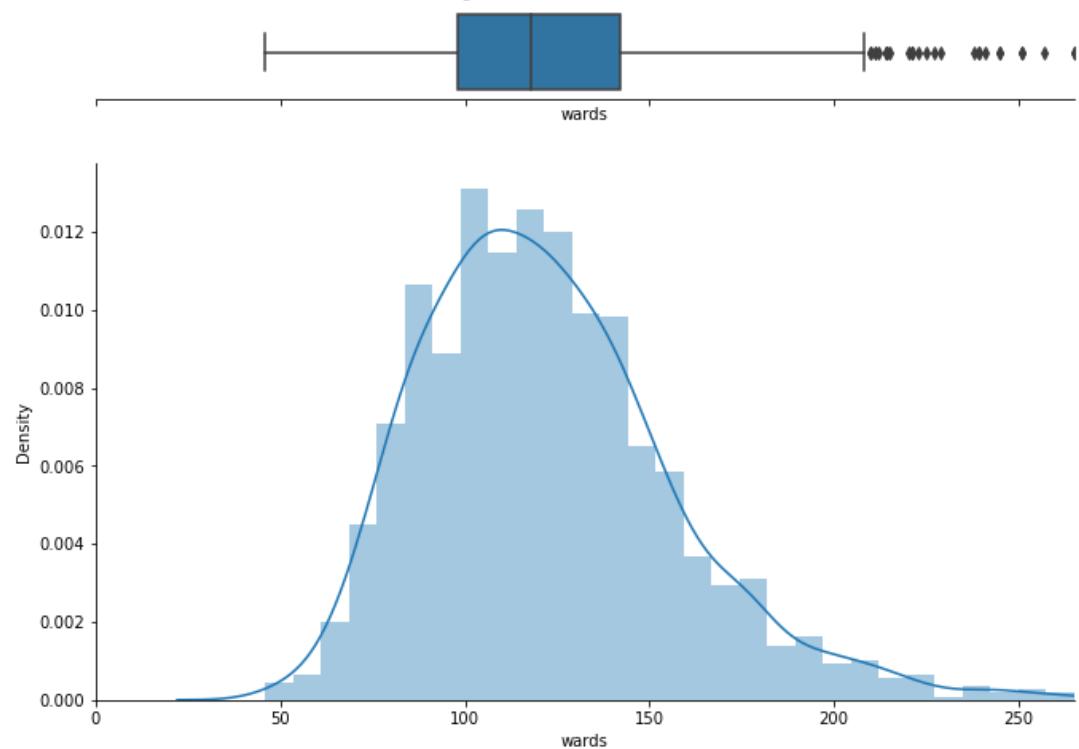
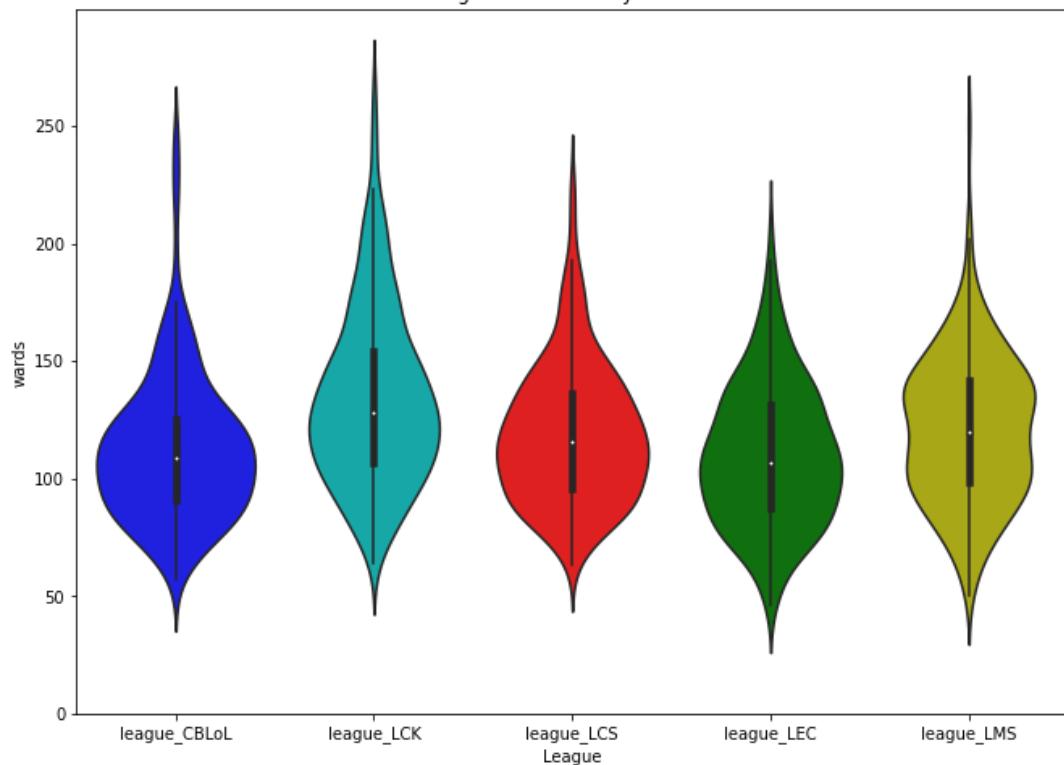


Figure 10: wards by Result



```
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: wpm Distribution

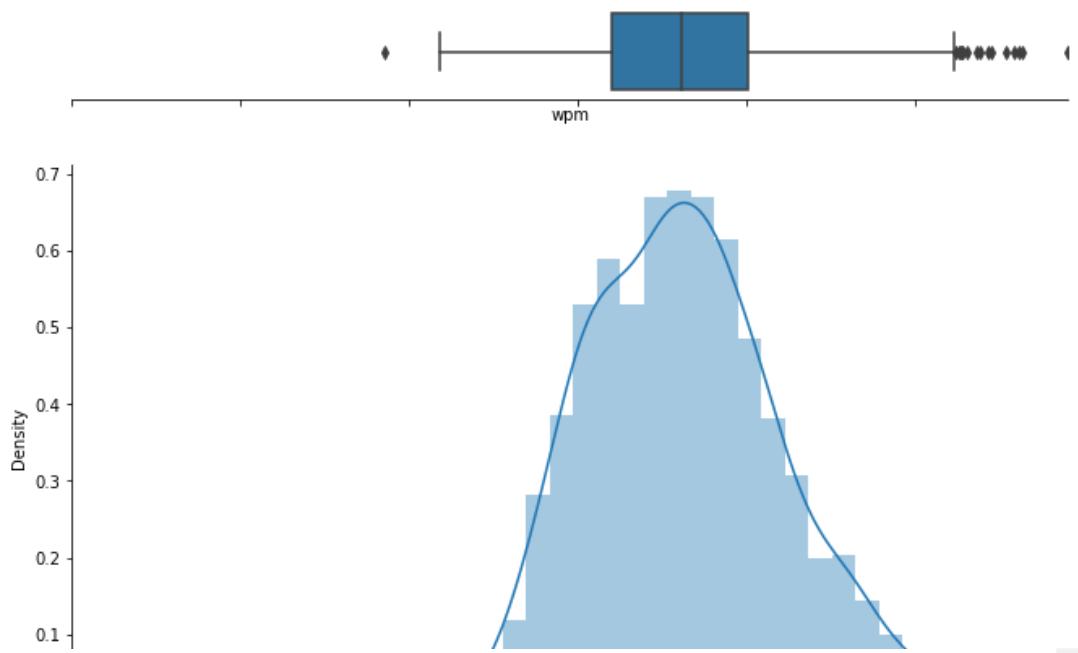
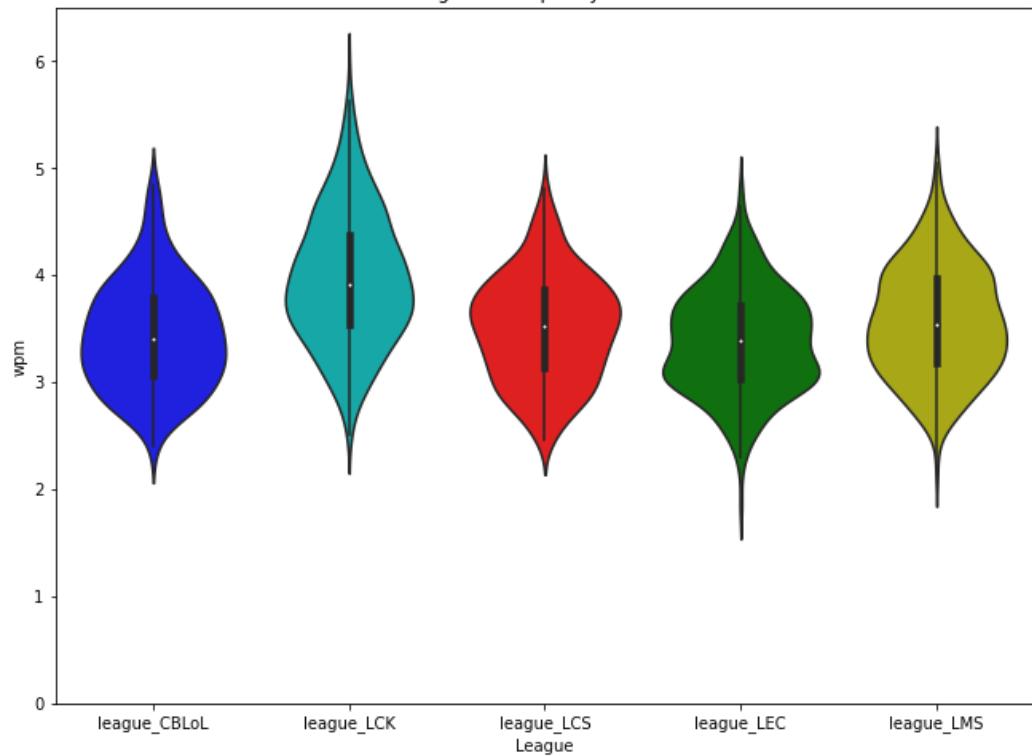


Figure 11: wpm by Result




```
In [108]: 1 plotLeague("gspd",12,-0.4)
```

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)

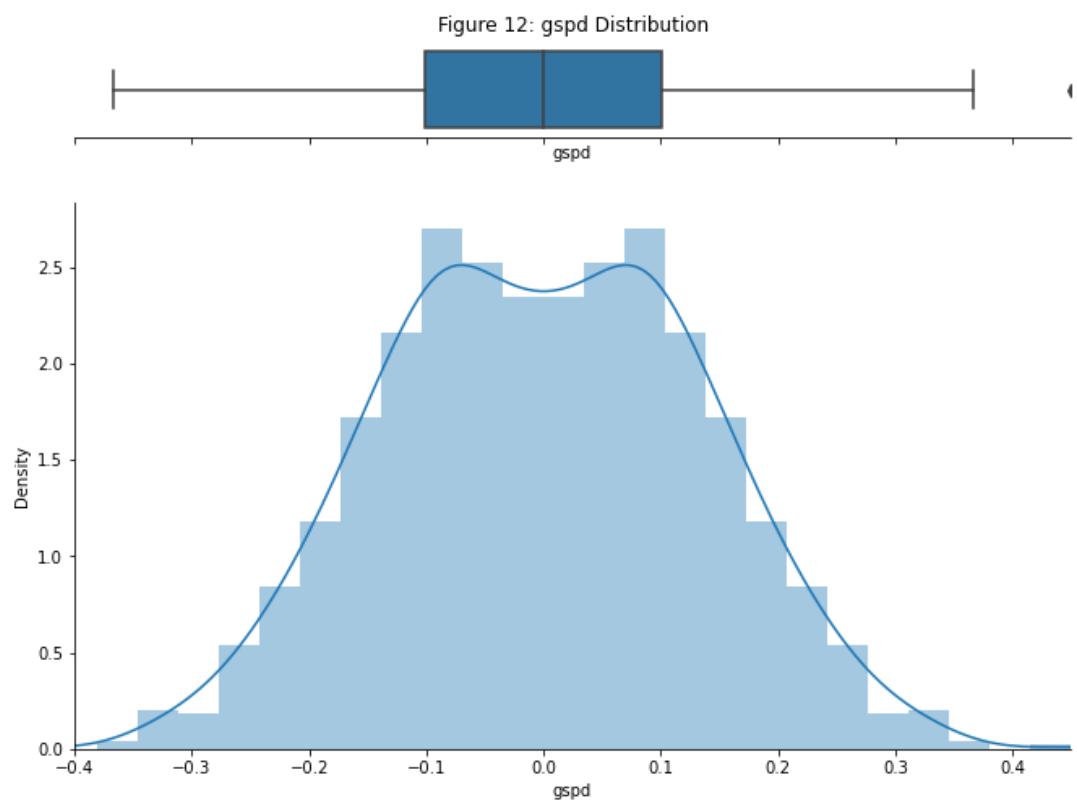
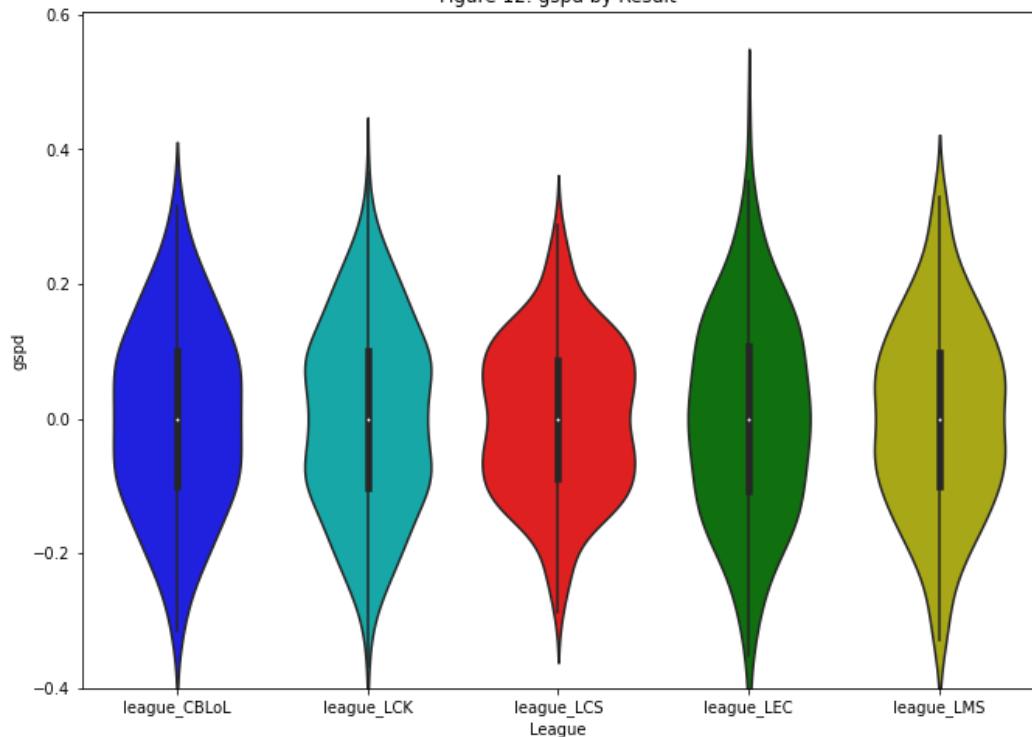


Figure 12: gspd by Result



From the above several graphs it is apparent that the LEC is the most aggressive region of the 5 listed (it's a shame that the LPL was missing too much data or else they would be an interesting case as they were well-known as being much more aggressive than any other region). LCK is somewhat slower and more controlled, but the five regions aren't vastly different.

Further data visualization in sections 3 and 5