1. Load the data from the “nflstats.csv” file into a DataFrame.

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
from yellowbrick.features import Rank2D
from yellowbrick.style import set_palette
from yellowbrick.features import ParallelCoordinates
import numpy as np

df = pd.read_csv('nflstats.csv')

# Reads in our data.
```

1. Display the dimensions of the file.

In [2]:
```
print('Dimensions of file: ', df.shape)

# Prints the dimensions of the data.
```

```
Dimensions of file:  (1578, 33)
```

1. Display the first 5 rows.

In [3]:
```
df.head()
# Head shows the first 5 rows.
```

Out[3]:

	Year	League	TeamName	WonSB	W	L	T	DivPlace	DivMax	DivTotal	...	DefYardsRank
0	2019	NFL	Arizona Cardinals	0	5	10	1	4	4	4th of 4	...	32
1	2018	NFL	Arizona Cardinals	0	3	13	0	4	4	4th of 4	...	20
2	2017	NFL	Arizona Cardinals	0	8	8	0	3	4	3rd of 4	...	6
3	2016	NFL	Arizona Cardinals	0	7	8	1	2	4	2nd of 4	...	2
4	2015	NFL	Arizona Cardinals	0	13	3	0	1	4	1st of 4	...	5

5 rows × 33 columns

1. Look at summary information about your data (total, mean, min, max, freq, unique, etc.) Does this present any more questions for you? Does it lead you to a conclusion yet?

In [4]:
```
print('Describe data:\n',df.describe())

print('Summary: \n',df.describe(include = ['O']))

# This lets us take a look at our categorical and numerical variables and thei
r stats.
```

```
Describe data:
               Year        WonSB            W            L            T  \
count   1578.000000  1578.000000  1578.000000  1578.000000  1578.000000
mean    1993.712928     0.033587     7.675539     7.675539     0.110266
std       15.502264     0.180220     3.079982     3.074418     0.369075
min     1966.000000     0.000000     0.000000     0.000000     0.000000
25%     1980.000000     0.000000     5.000000     5.000000     0.000000
50%     1994.500000     0.000000     8.000000     8.000000     0.000000
75%     2007.000000     0.000000    10.000000    10.000000     0.000000
max     2019.000000     1.000000    16.000000    16.000000     3.000000

           DivPlace       DivMax  PlayoffsResultNumerical    PointsFor  \
count   1578.000000  1578.000000              1578.000000  1578.000000
mean       2.731939     4.477820                 0.857414   323.847275
std        1.304985     0.600002                 1.364213    74.217167
min        1.000000     4.000000                 0.000000   103.000000
25%        2.000000     4.000000                 0.000000   275.000000
50%        3.000000     4.000000                 0.000000   321.000000
75%        4.000000     5.000000                 2.000000   372.000000
max        8.000000     8.000000                 5.000000   606.000000

       PointsAllowed  ...  DefYardsRank          T/G   PointsRank  \
count    1578.000000  ...   1578.000000  1578.000000  1578.000000
mean      323.847275  ...     14.821293    14.453739    14.791508
std        68.443814  ...      8.679220     8.647435     8.683339
min       128.000000  ...      1.000000     1.000000     1.000000
25%       281.000000  ...      7.000000     7.000000     7.000000
50%       325.000000  ...     14.000000    14.000000    14.000000
75%       371.000000  ...     22.000000    22.000000    22.000000
max       533.000000  ...     32.000000    32.000000    32.000000

          YardsRank     MaxTeams          MoV          SoS          SRS  \
count   1578.000000  1578.000000  1578.000000  1578.000000  1578.000000
mean      14.825095    28.657795     0.000127     0.000127     0.000253
std        8.680247     4.567482     6.547290     1.610161     6.281144
min        1.000000     9.000000   -20.500000    -6.300000   -19.700000
25%        7.000000    28.000000    -4.400000    -1.100000    -4.200000
50%       14.000000    29.000000     0.000000     0.000000    -0.100000
75%       22.000000    32.000000     4.600000     1.100000     4.400000
max       32.000000    32.000000    19.700000     5.100000    20.100000

               OSRS         DSRS
count   1578.000000  1578.000000
mean       0.000380    -0.000824
std        4.139455     3.722509
min      -12.300000   -13.700000
25%       -2.900000    -2.500000
50%       -0.100000     0.150000
75%        2.700000     2.500000
max       15.900000    10.600000

[8 rows x 24 columns]
Summary:
       League        TeamName  DivTotal PlayoffsResult Coaches        AV  \
count    1578            1578      1578           1578    1578      1578
unique      2              41        28              6     323       606
top       NFL  Dallas Cowboys  2nd of 4           Miss   Shula  Williams
```

```
freq     1540               54       222            1013       34          29

          Passer  Rusher  Receiver
count       1578    1578      1578
unique       314     398       419
top      Manning   Smith   Johnson
freq          40      44        47
```

1. Make some histograms of your data (“A picture is worth a thousand words!”)

In [5]:

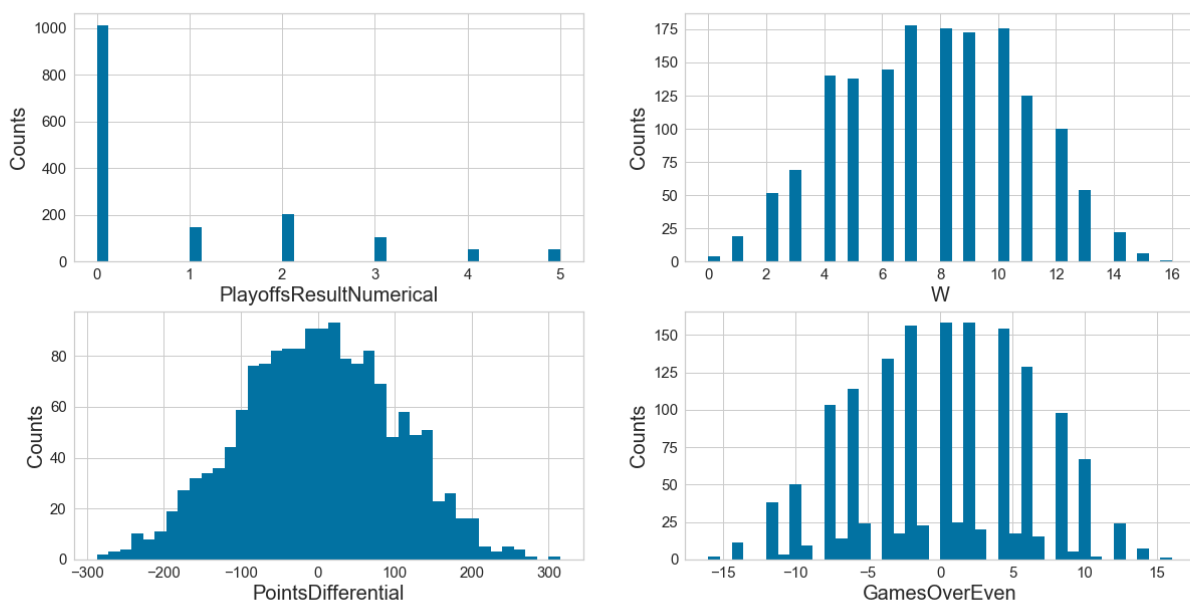
```python
plt.rcParams['figure.figsize'] = (20, 10)
fig, axes = plt.subplots(nrows = 2, ncols = 2)

df['GamesOverEven'] = df['W'] - df['L']

# Creates a new column for their win differential.

num_features = ['PlayoffsResultNumerical','W', 'PointsDifferential', 'GamesOve
rEven']
xaxes = num_features
yaxes = ['Counts', 'Counts', 'Counts', 'Counts']

axes = axes.ravel()
for idx, ax in enumerate(axes):
    ax.hist(df[num_features[idx]].dropna(), bins=40)
    ax.set_xlabel(xaxes[idx], fontsize=20)
    ax.set_ylabel(yaxes[idx], fontsize=20)
    ax.tick_params(axis='both', labelsize=15)
```



1. Make some bar charts for variables with only a few options.

In [6]:
```
plt.rcParams['figure.figsize'] = (20, 10)

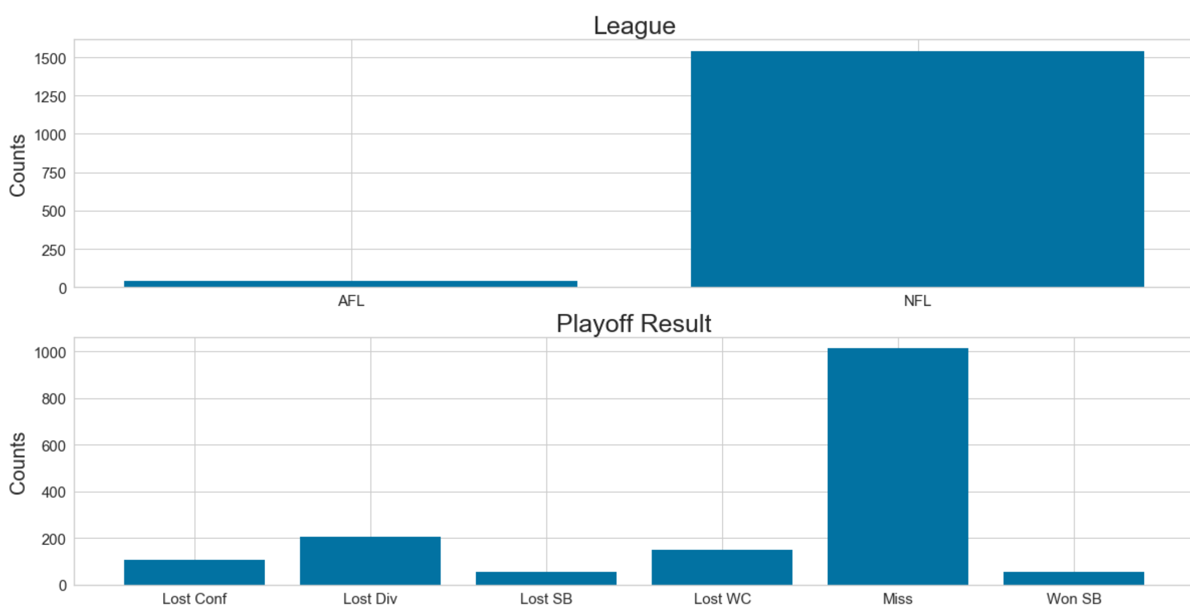
# make subplots
fig, axes = plt.subplots(nrows = 2, ncols = 1)

# make the data read to feed into the visulizer
X_League = df.replace({'League': {1: 'NFL', 0: 'AFL'}}).groupby('League').size
().reset_index(name='Counts')['League']
Y_League = df.replace({'League': {1: 'NFL', 0: 'AFL'}}).groupby('League').size
().reset_index(name='Counts')['Counts']

# make the bar plot
axes[0].bar(X_League, Y_League)
axes[0].set_title('League', fontsize=25)
axes[0].set_ylabel('Counts', fontsize=20)
axes[0].tick_params(axis='both', labelsize=15)

# make the data read to feed into the visulizer
X_Playoff = df.replace({'PlayoffsResult': {0: 'Miss', 1: 'Lost WC', 2: 'Lost D
iv', 3: 'Lost Conf', 4: 'Lost SB', 5: 'Won SB'}}).groupby('PlayoffsResult').si
ze().reset_index(name='Counts')['PlayoffsResult']
Y_Playoff = df.replace({'PlayoffsResult': {0: 'Miss', 1: 'Lost WC', 2: 'Lost D
iv', 3: 'Lost Conf', 4: 'Lost SB', 5: 'Won SB'}}).groupby('PlayoffsResult').si
ze().reset_index(name='Counts')['Counts']

# make the bar plot
axes[1].bar(X_Playoff, Y_Playoff)
axes[1].set_title('Playoff Result', fontsize=25)
axes[1].set_ylabel('Counts', fontsize=20)
axes[1].tick_params(axis='both', labelsize=15)
```



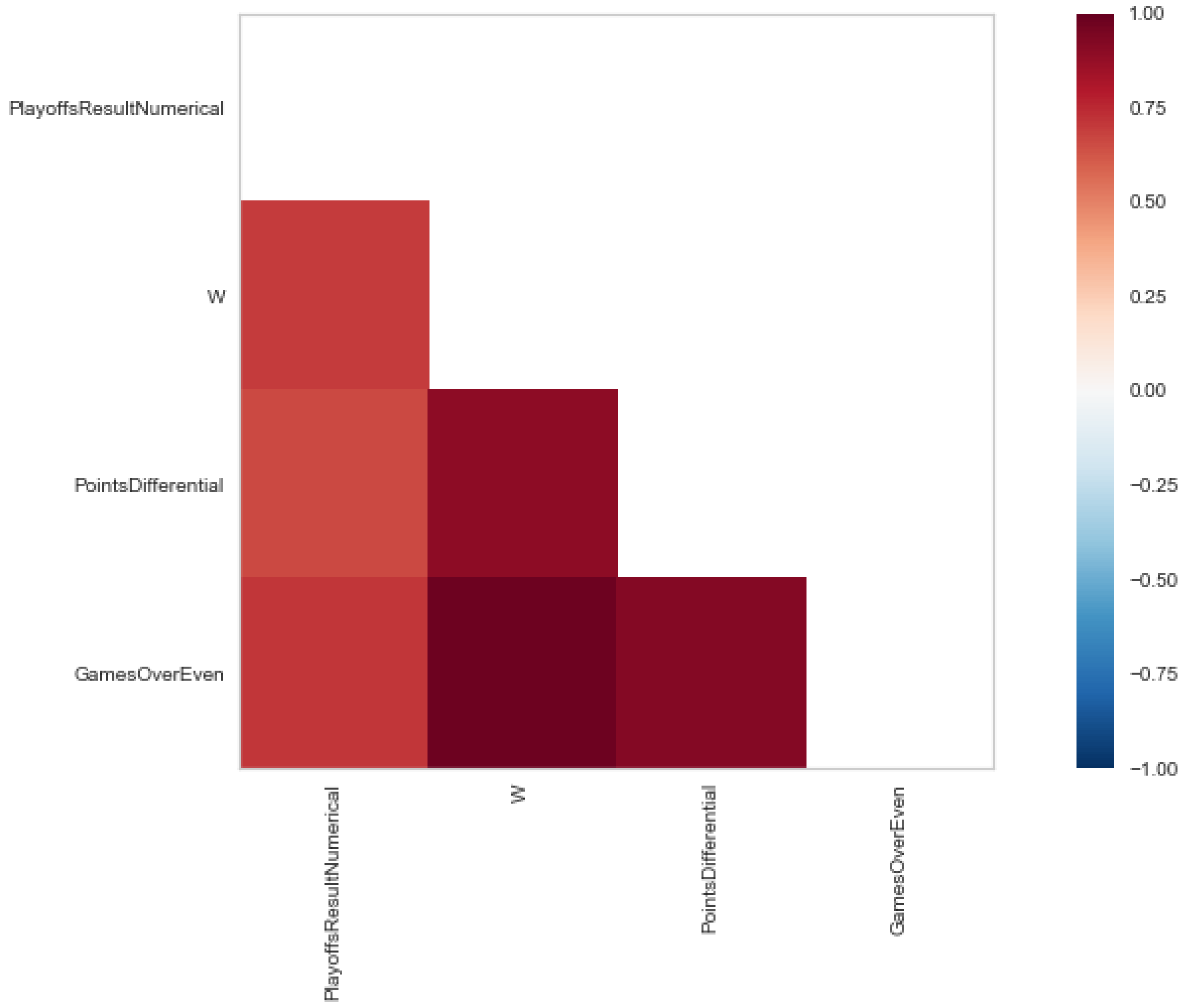
1. To see if the data is correlated, make some Pearson Ranking charts

In [7]:
```
plt.rcParams['figure.figsize'] = (15, 7)

X = df[num_features].values

visualizer = Rank2D(features=num_features, algorithm='pearson')
visualizer.fit(X)                # Fit the data to the visualizer
visualizer.transform(X)             # Transform the data
```

Out[7]:
```
array([[   0,    5,  -81,   -5],
       [   0,    3, -200,  -10],
       [   0,    8,  -66,    0],
       ...,
       [   0,    5, -109,   -4],
       [   0,    5,   -6,   -1],
       [   0,    7,   -4,    0]], dtype=int64)
```



1. Use Parallel Coordinates visualization to compare the distributions of numerical variables between team records and playoff success.

In [8]:
```
plt.rcParams['figure.figsize'] = (15, 7)
plt.rcParams['font.size'] = 50

# setup the color for yellowbrick visulizer

set_palette('sns_bright')

classes = ['Missed Playoffs', 'Lost WC', 'Lost Divisional', 'Lost Conference',
'Lost SB', 'Won SB']

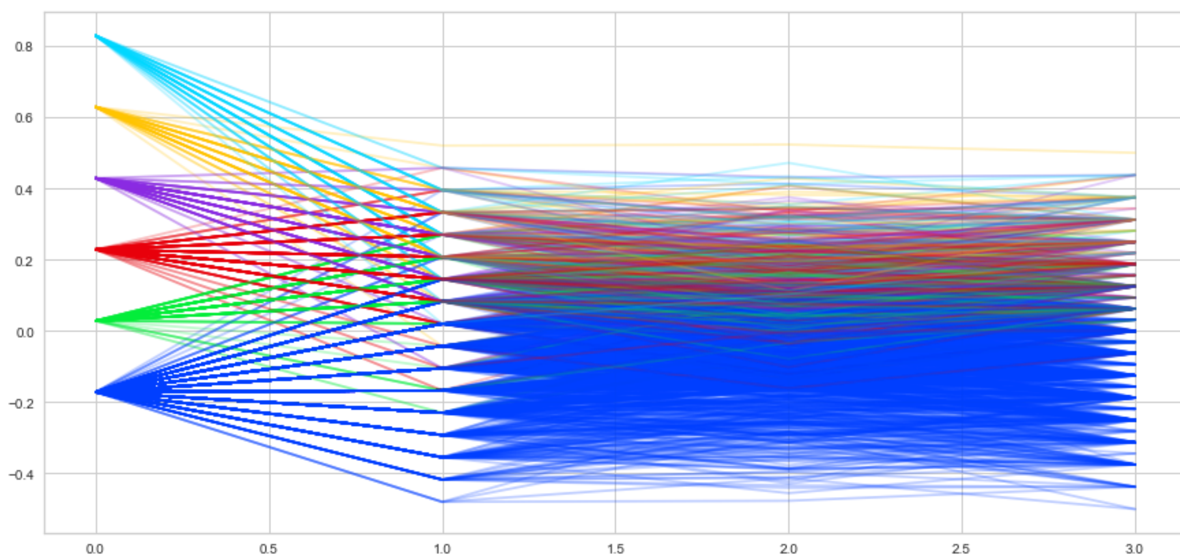

# copy data to a new dataframe
df_norm = df.copy()
# normalize data to 0-1 range
for feature in num_features:
    df_norm[feature] = (df[feature] - df[feature].mean(skipna=True)) / (df[fea
ture].max(skipna=True) - df[feature].min(skipna=True))

X = df_norm[num_features].values
y = df.PlayoffsResultNumerical.values

visualizer = ParallelCoordinates(classes=classes, features=num_features)

visualizer.fit(X, y)      # Fit the data to the visualizer
visualizer.transform(X)   # Transform the data
```

Out[8]:
```
array([[-0.17148289, -0.16722117, -0.1345515 , -0.15625   ],
       [-0.17148289, -0.29222117, -0.33222591, -0.3125    ],
       [-0.17148289,  0.02027883, -0.10963455,  0.        ],
       ...,
       [-0.17148289, -0.16722117, -0.18106312, -0.125     ],
       [-0.17148289, -0.16722117, -0.00996678, -0.03125   ],
       [-0.17148289, -0.04222117, -0.00664452,  0.        ]])
```



1. Use Stack Bar Charts to compare teams who made it far in the playoffs to teams who didn't make it based on the other variables.

In [9]:
```
plt.rcParams['figure.figsize'] = (20, 10)


fig, axes = plt.subplots(nrows = 1, ncols = 2)



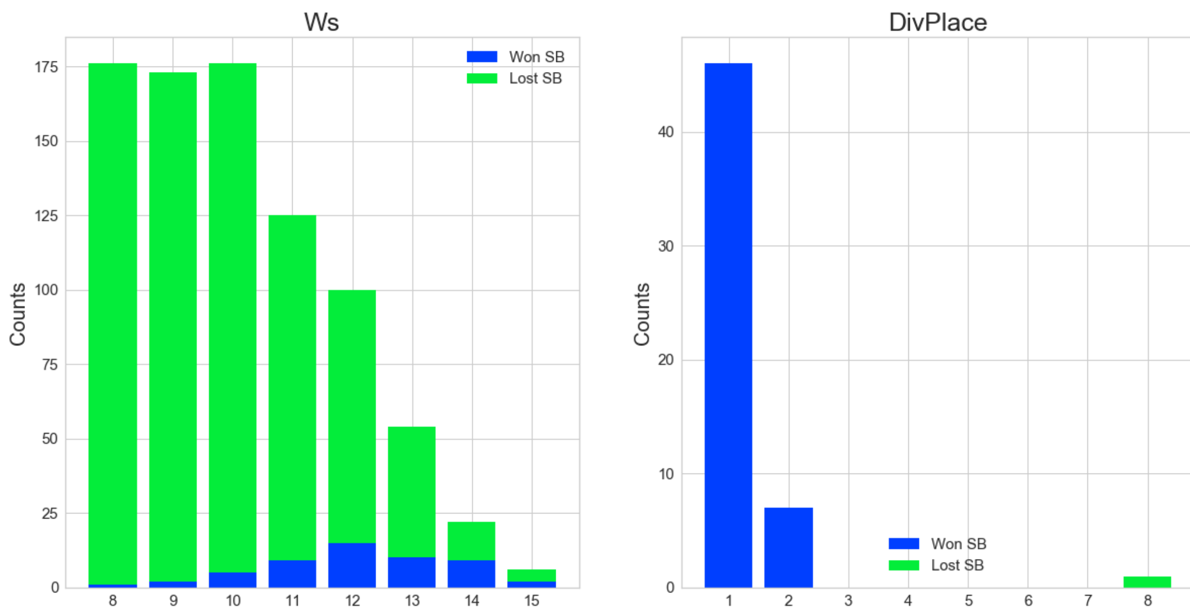
# make the data read to feed into the visulizer
W_MadePlayoffs = df.replace({'WonSB': {1: 'Yes', 0: 'No'}})[df['WonSB']==1][
'W'].value_counts()
W_NoPlayoffs = df.replace({'WonSB': {1: 'Yes', 0: 'No'}})[df['WonSB']==0]['W']
.value_counts()
W_NoPlayoffs = W_NoPlayoffs.reindex(index = W_MadePlayoffs.index)
# make the bar plot

p1 = axes[0].bar(W_MadePlayoffs.index, W_MadePlayoffs.values)
p2 = axes[0].bar(W_NoPlayoffs.index, W_NoPlayoffs.values, bottom=W_MadePlayoff
s.values)
axes[0].set_title('Ws', fontsize=25)
axes[0].set_ylabel('Counts', fontsize=20)
axes[0].tick_params(axis='both', labelsize=15)
axes[0].legend((p1[0], p2[0]), ('Won SB', 'Lost SB'), fontsize = 15)


# make the data read to feed into the visulizer
DivPlace_MadePlayoffs= df.replace('WonSB')[df['WonSB']==1]['DivPlace'].value_c
ounts()
DivPlace_NoPlayoffs = df.replace('WonSB')[df['WonSB']==0]['DivPlace'].value_co
unts()
DivPlace_NoPlayoffs = DivPlace_NoPlayoffs.reindex(index = W_MadePlayoffs.index
)
# make the bar plot

p3 = axes[1].bar(DivPlace_MadePlayoffs.index, DivPlace_MadePlayoffs.values)
p4 = axes[1].bar(DivPlace_NoPlayoffs.index, DivPlace_NoPlayoffs.values)
axes[1].set_title('DivPlace', fontsize=25)
axes[1].set_ylabel('Counts', fontsize=20)
axes[1].tick_params(axis='both', labelsize=15)
axes[1].legend((p3[0], p4[0]), ('Won SB', 'Lost SB'), fontsize = 15)
```

Out[9]: <matplotlib.legend.Legend at 0x28dda53b3c8>



1.
   - Now it’s time to reduce some of the features so we can concentrate on the things that matter! There features we will get rid of are: "DivTotal" (it's redundant), "Coaches", "AV", "Passer", "Rusher", "Receiver". (Names don't really tell us performance and there are hundreds of unique values.
   - We can also fill in missing values if there were any. In this case, we don't, but it would have been something to try. Maybe we can fill in the NAs for playoff results if we hadn't already.

In [10]:
```
def fill_na_median(data, inplace=True):
    return data.fillna(data.median(), inplace=inplace)
# This function fills NAs with the median.

# fill with the most represented value
def fill_na_most(data, inplace=True):
    return data.fillna('S', inplace=inplace)
# This one fills it with the most representative value.
```

1. If you go back and look at the histograms of MadePlayoffs, you’ll see that it is very skewed. Most teams don't make the playoffs or even make it very far.Let's try a Log Transformation: it is a good method to use on highly skewed data.

In [11]:
```
# log-transformation
def log_transformation(data):
    return data.apply(np.log1p)

df['PlayoffResults_log1p'] = log_transformation(df['PlayoffsResultNumerical'])

# check the data
print(df.describe())
```

```
              Year        WonSB            W            L            T  \
count  1578.000000  1578.000000  1578.000000  1578.000000  1578.000000   
mean   1993.712928     0.033587     7.675539     7.675539     0.110266   
std      15.502264     0.180220     3.079982     3.074418     0.369075   
min    1966.000000     0.000000     0.000000     0.000000     0.000000   
25%    1980.000000     0.000000     5.000000     5.000000     0.000000   
50%    1994.500000     0.000000     8.000000     8.000000     0.000000   
75%    2007.000000     0.000000    10.000000    10.000000     0.000000   
max    2019.000000     1.000000    16.000000    16.000000     3.000000   

          DivPlace       DivMax  PlayoffsResultNumerical    PointsFor  \
count  1578.000000  1578.000000              1578.000000  1578.000000   
mean      2.731939     4.477820                 0.857414   323.847275   
std       1.304985     0.600002                 1.364213    74.217167   
min       1.000000     4.000000                 0.000000   103.000000   
25%       2.000000     4.000000                 0.000000   275.000000   
50%       3.000000     4.000000                 0.000000   321.000000   
75%       4.000000     5.000000                 2.000000   372.000000   
max       8.000000     8.000000                 5.000000   606.000000   

       PointsAllowed  ...   PointsRank    YardsRank     MaxTeams          MoV  
\
count    1578.000000  ...  1578.000000  1578.000000  1578.000000  1578.000000   
mean      323.847275  ...    14.791508    14.825095    28.657795     0.000127   
std        68.443814  ...     8.683339     8.680247     4.567482     6.547290   
min       128.000000  ...     1.000000     1.000000     9.000000   -20.500000   
25%       281.000000  ...     7.000000     7.000000    28.000000    -4.400000   
50%       325.000000  ...    14.000000    14.000000    29.000000     0.000000   
75%       371.000000  ...    22.000000    22.000000    32.000000     4.600000   
max       533.000000  ...    32.000000    32.000000    32.000000    19.700000   

               SoS          SRS         OSRS         DSRS  GamesOverEven  \
count  1578.000000  1578.000000  1578.000000  1578.000000    1578.000000   
mean      0.000127     0.000253     0.000380    -0.000824       0.000000   
std       1.610161     6.281144     4.139455     3.722509       6.010243   
min      -6.300000   -19.700000   -12.300000   -13.700000     -16.000000   
25%      -1.100000    -4.200000    -2.900000    -2.500000      -4.000000   
50%       0.000000    -0.100000    -0.100000     0.150000       0.000000   
75%       1.100000     4.400000     2.700000     2.500000       4.000000   
max       5.100000    20.100000    15.900000    10.600000      16.000000   

       PlayoffResults_log1p  
count           1578.000000  
mean               0.415090  
std                0.594730  
min                0.000000  
25%                0.000000  
50%                0.000000  
75%                1.098612  
max                1.791759  

[8 rows x 26 columns]
```

1. Convert your categorical data into numbers (TeamName, Playoffs Result)

In [17]:
```
#get the categorical data
cat_features = ['TeamName']
print(cat_features)
df_cat = df[cat_features]
df_cat = df_cat.replace({'TeamName': {1: 'Arizona Cardinals', 1: 'Phoenix Card
inals', 1: 'St. Louis Cardinals', 2: 'Atlanta Falcons',         3: 'Baltimore
 Ravens',       4: 'Buffalo Bills',     5: 'Carolina Panthers',         6: 'Ch
icago Bears',   7: 'Cincinnati Bengals',        8: 'Cleveland Browns',  9: 'Da
llas Cowboys',  10: 'Denver Broncos',   11: 'Detroit Lions',    12: 'Green Bay
Packers',       13: 'Houston Texans',   14: 'Indianapolis Colts',       14: 'B
altimore Colts',        15: 'Jacksonville Jaguars',     16: 'Kansas City Chief
s',     17: 'Los Angeles Chargers',     17: 'San Diego Chargers',       18: 'L
os Angeles Rams',       18: 'St. Louis Rams',   19: 'Miami Dolphins',   20: 'M
innesota Vikings',      21: 'New England Patriots',     21: 'Boston Patriots',
22: 'New Orleans Saints',       23: 'New York Giants',  24: 'New York Jets',
25: 'Oakland Raiders',  25: 'Los Angeles Raiders',      26: 'Philadelphia Eagl
es',    27: 'Pittsburgh Steelers',      28: 'San Francisco 49ers',      29: 'S
eattle Seahawks',       30: 'Tampa Bay Buccaneers',     31: 'Tennessee Titans'
,       31: 'Tennessee Oilers',         31: 'Houston Oilers',   32: 'Washingto
n Redskins'}})
# One Hot Encoding
df_cat_dummies = pd.get_dummies(df_cat)
# check the data
print(df_cat_dummies)
```

```
['TeamName']
      TeamName_Arizona Cardinals  TeamName_Atlanta Falcons  \
0                              1                         0
1                              1                         0
2                              1                         0
3                              1                         0
4                              1                         0
5                              1                         0
6                              1                         0
7                              1                         0
8                              1                         0
9                              1                         0
10                             1                         0
11                             1                         0
12                             1                         0
13                             1                         0
14                             1                         0
15                             1                         0
16                             1                         0
17                             1                         0
18                             1                         0
19                             1                         0
20                             1                         0
21                             1                         0
22                             1                         0
23                             1                         0
24                             1                         0
25                             1                         0
26                             0                         0
27                             0                         0
28                             0                         0
29                             0                         0
...                          ...                       ...
1548                           0                         0
1549                           0                         0
1550                           0                         0
1551                           0                         0
1552                           0                         0
1553                           0                         0
1554                           0                         0
1555                           0                         0
1556                           0                         0
1557                           0                         0
1558                           0                         0
1559                           0                         0
1560                           0                         0
1561                           0                         0
1562                           0                         0
1563                           0                         0
1564                           0                         0
1565                           0                         0
1566                           0                         0
1567                           0                         0
1568                           0                         0
1569                           0                         0
1570                           0                         0
1571                           0                         0
```

```
1572                 0                0
1573                 0                0
1574                 0                0
1575                 0                0
1576                 0                0
1577                 0                0

      TeamName_Baltimore Colts  TeamName_Baltimore Ravens  \
0                            0                          0
1                            0                          0
2                            0                          0
3                            0                          0
4                            0                          0
5                            0                          0
6                            0                          0
7                            0                          0
8                            0                          0
9                            0                          0
10                           0                          0
11                           0                          0
12                           0                          0
13                           0                          0
14                           0                          0
15                           0                          0
16                           0                          0
17                           0                          0
18                           0                          0
19                           0                          0
20                           0                          0
21                           0                          0
22                           0                          0
23                           0                          0
24                           0                          0
25                           0                          0
26                           0                          0
27                           0                          0
28                           0                          0
29                           0                          0
...                        ...                        ...
1548                         0                          0
1549                         0                          0
1550                         0                          0
1551                         0                          0
1552                         0                          0
1553                         0                          0
1554                         0                          0
1555                         0                          0
1556                         0                          0
1557                         0                          0
1558                         0                          0
1559                         0                          0
1560                         0                          0
1561                         0                          0
1562                         0                          0
1563                         0                          0
1564                         0                          0
1565                         0                          0
```

```
1566                 0                    0
1567                 0                    0
1568                 0                    0
1569                 0                    0
1570                 0                    0
1571                 0                    0
1572                 0                    0
1573                 0                    0
1574                 0                    0
1575                 0                    0
1576                 0                    0
1577                 0                    0

      TeamName_Boston Patriots  TeamName_Buffalo Bills  \
0                            0                       0
1                            0                       0
2                            0                       0
3                            0                       0
4                            0                       0
5                            0                       0
6                            0                       0
7                            0                       0
8                            0                       0
9                            0                       0
10                           0                       0
11                           0                       0
12                           0                       0
13                           0                       0
14                           0                       0
15                           0                       0
16                           0                       0
17                           0                       0
18                           0                       0
19                           0                       0
20                           0                       0
21                           0                       0
22                           0                       0
23                           0                       0
24                           0                       0
25                           0                       0
26                           0                       0
27                           0                       0
28                           0                       0
29                           0                       0
...                        ...                     ...
1548                         0                       0
1549                         0                       0
1550                         0                       0
1551                         0                       0
1552                         0                       0
1553                         0                       0
1554                         0                       0
1555                         0                       0
1556                         0                       0
1557                         0                       0
1558                         0                       0
1559                         0                       0
```

```
1560                      0                        0
1561                      0                        0
1562                      0                        0
1563                      0                        0
1564                      0                        0
1565                      0                        0
1566                      0                        0
1567                      0                        0
1568                      0                        0
1569                      0                        0
1570                      0                        0
1571                      0                        0
1572                      0                        0
1573                      0                        0
1574                      0                        0
1575                      0                        0
1576                      0                        0
1577                      0                        0

      TeamName_Carolina Panthers  TeamName_Chicago Bears  \
0                              0                       0
1                              0                       0
2                              0                       0
3                              0                       0
4                              0                       0
5                              0                       0
6                              0                       0
7                              0                       0
8                              0                       0
9                              0                       0
10                             0                       0
11                             0                       0
12                             0                       0
13                             0                       0
14                             0                       0
15                             0                       0
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      TeamName_Cincinnati Bengals  TeamName_Cleveland Browns  ...  \
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      TeamName_Pittsburgh Steelers  TeamName_San Diego Chargers  \
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      TeamName_San Francisco 49ers  TeamName_Seattle Seahawks  \
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      TeamName_St. Louis Cardinals  TeamName_St. Louis Rams  \
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      TeamName_Tampa Bay Buccaneers  TeamName_Tennessee Oilers  \
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      TeamName_Tennessee Titans  TeamName_Washington Redskins
0                             0                             0
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1548	0	1
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1568	0	1
1569	0	1
1570	0	1
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1573	0	1
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1575                    0                       1
1576                    0                       1
1577                    0                       1

[1578 rows x 41 columns]
```

1. Training - Split your data into two sets: Training and Testing.

In [18]:
```
# here we will combine the numerical features and the dummie features together
features_model = ['W', 'PointsDifferential']
df_model_X = pd.concat([df[features_model], df_cat_dummies], axis=1)

# create a whole target dataset that can be used for train and validation data splitting
df_model_y = df.replace({'WonSB': {0: 'No', 1: 'Yes'}})['WonSB']
# separate data into training and validation and check the details of the data sets
# import packages
from sklearn.model_selection import train_test_split

# split the data
X_train, X_val, y_train, y_val = train_test_split(df_model_X, df_model_y, test_size =0.3, random_state=15)
```

In [19]:
```
print("No. of samples in training set: ", X_train.shape[0])
print("No. of samples in validation set:", X_val.shape[0])

# Playoff results.
print('\n')
print('Playoff results in the training set:')
print(y_train.value_counts())

print('\n')
print('Playoff results in the validation set:')
print(y_val.value_counts())
```

```
No. of samples in training set:  1104
No. of samples in validation set: 474


Playoff results in the training set:
No     1067
Yes      37
Name: WonSB, dtype: int64


Playoff results in the validation set:
No     458
Yes     16
Name: WonSB, dtype: int64
```

Evaluation – We are trying to predict if a team will win the Super Bowl. We will start with linear regression.

Metrics for the evaluation:

- Confusion Matrix (you should get 84% - pretty good) (84.3% yeah, pretty good)
- Precision, Recall & F1 score (all 3 were very good) (I can see that)
- ROC curve (the dotted line is the randomly guessed so anything above that is good metric) (Way above that line.)

In [20]:
```
print(X_train)
```

```
        W  PointsDifferential  TeamName_Arizona Cardinals  \
405     6                  81                           0
1258   10                 147                           0
1567   10                  74                           0
412    10                  82                           0
147     9                 111                           0
723     2                -124                           0
669     8                  97                           0
1344    7                  47                           0
274     4                 -73                           0
884    11                 118                           0
1466   10                  36                           0
1129    9                  23                           0
1165    6                  10                           0
32      7                  -6                           0
827     6                 -48                           0
336     3                -258                           0
296    12                 119                           0
1092   10                 116                           0
15      6                 -38                           1
58      8                  -6                           0
36      8                 -54                           0
1577    7                  -4                           0
1514   10                  67                           0
159    11                  98                           0
434     7                 -89                           0
1375    8                 104                           0
479     9                 -12                           0
1058    4                -110                           0
185     9                 103                           0
739     4                 -78                           0
...    ..                 ...                         ...
824    10                  30                           0
1039    5                -107                           0
102     7                  -3                           0
1359   10                  75                           0
1181    5                -122                           0
956    12                 155                           0
717     6                  19                           0
812     6                -106                           0
19      3                -233                           1
1063    6                 -20                           0
873     8                 -48                           0
196     8                   7                           0
143     7                  -6                           0
778     6                 -37                           0
318     7                 -33                           0
416    11                 184                           0
1047    3                -104                           0
927    10                  76                           0
749     9                 106                           0
17      5                -155                           1
221     7                 -48                           0
943    12                 128                           0
630     1                -238                           0
85      5                 -71                           0
1223    7                  36                           0
```

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667    5              -65                          0
156   10               15                          0
384   10               29                          0
645   11              171                          0
1480   8              -48                          0

      TeamName_Atlanta Falcons  TeamName_Baltimore Colts  \
405                          0                         0
1258                         0                         0
1567                         0                         0
412                          0                         0
147                          0                         0
723                          0                         0
669                          0                         0
1344                         0                         0
274                          0                         0
884                          0                         0
1466                         0                         0
1129                         0                         0
1165                         0                         0
32                           0                         0
827                          0                         0
336                          0                         0
296                          0                         0
1092                         0                         0
15                           0                         0
58                           1                         0
36                           0                         0
1577                         0                         0
1514                         0                         0
159                          0                         0
434                          0                         0
1375                         0                         0
479                          0                         0
1058                         0                         0
185                          0                         0
739                          0                         0
...                        ...                       ...
824                          0                         0
1039                         0                         0
102                          1                         0
1359                         0                         0
1181                         0                         0
956                          0                         0
717                          0                         0
812                          0                         0
19                           0                         0
1063                         0                         0
873                          0                         0
196                          0                         0
143                          0                         0
778                          0                         0
318                          0                         0
416                          0                         0
1047                         0                         0
927                          0                         0
749                          0                         0
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17                            0                           0
221                           0                           0
943                           0                           0
630                           0                           0
85                            1                           0
1223                          0                           0
667                           0                           0
156                           0                           0
384                           0                           0
645                           0                           1
1480                          0                           0

      TeamName_Baltimore Ravens  TeamName_Boston Patriots  \
405                           0                         0
1258                          0                         0
1567                          0                         0
412                           0                         0
147                           0                         0
723                           0                         0
669                           0                         0
1344                          0                         0
274                           0                         0
884                           0                         0
1466                          0                         0
1129                          0                         0
1165                          0                         0
32                            0                         0
827                           0                         0
336                           0                         0
296                           0                         0
1092                          0                         0
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36                            0                         0
1577                          0                         0
1514                          0                         0
159                           0                         0
434                           0                         0
1375                          0                         0
479                           0                         0
1058                          0                         0
185                           0                         0
739                           0                         0
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824                           0                         0
1039                          0                         0
102                           0                         0
1359                          0                         0
1181                          0                         0
956                           0                         0
717                           0                         0
812                           0                         0
19                            0                         0
1063                          0                         0
873                           0                         0
196                           0                         0
143                           0                         0
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778                           0                          0
318                           0                          0
416                           0                          0
1047                          0                          0
927                           0                          0
749                           0                          0
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221                           0                          0
943                           0                          0
630                           0                          0
85                            0                          0
1223                          0                          0
667                           0                          0
156                           0                          0
384                           0                          0
645                           0                          0
1480                          0                          0

      TeamName_Buffalo Bills  TeamName_Carolina Panthers  \
405                        0                           0
1258                       0                           0
1567                       0                           0
412                        0                           0
147                        1                           0
723                        0                           0
669                        0                           0
1344                       0                           0
274                        0                           0
884                        0                           0
1466                       0                           0
1129                       0                           0
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1092                       0                           0
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1577                       0                           0
1514                       0                           0
159                        1                           0
434                        0                           0
1375                       0                           0
479                        0                           0
1058                       0                           0
185                        1                           0
739                        0                           0
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824                        0                           0
1039                       0                           0
102                        0                           0
1359                       0                           0
1181                       0                           0
956                        0                           0
717                        0                           0
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812                  0                       0
19                   0                       0
1063                 0                       0
873                  0                       0
196                  0                       1
143                  1                       0
778                  0                       0
318                  0                       0
416                  0                       0
1047                 0                       0
927                  0                       0
749                  0                       0
17                   0                       0
221                  0                       0
943                  0                       0
630                  0                       0
85                   0                       0
1223                 0                       0
667                  0                       0
156                  1                       0
384                  0                       0
645                  0                       0
1480                 0                       0

      TeamName_Chicago Bears  ...  TeamName_Pittsburgh Steelers  \
405                        0  ...                             0
1258                       0  ...                             0
1567                       0  ...                             0
412                        0  ...                             0
147                        0  ...                             0
723                        0  ...                             0
669                        0  ...                             0
1344                       0  ...                             0
274                        0  ...                             0
884                        0  ...                             0
1466                       0  ...                             0
1129                       0  ...                             0
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827                        0  ...                             0
336                        0  ...                             0
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1577                       0  ...                             0
1514                       0  ...                             0
159                        0  ...                             0
434                        0  ...                             0
1375                       0  ...                             0
479                        0  ...                             0
1058                       0  ...                             0
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739                        0  ...                             0
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824                        0  ...                             0
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1039                         0  ...                                 0
102                          0  ...                                 0
1359                         0  ...                                 0
1181                         0  ...                                 0
956                          0  ...                                 0
717                          0  ...                                 0
812                          0  ...                                 0
19                           0  ...                                 0
1063                         0  ...                                 0
873                          0  ...                                 0
196                          0  ...                                 0
143                          0  ...                                 0
778                          0  ...                                 0
318                          0  ...                                 0
416                          0  ...                                 0
1047                         0  ...                                 0
927                          0  ...                                 0
749                          0  ...                                 0
17                           0  ...                                 0
221                          1  ...                                 0
943                          0  ...                                 0
630                          0  ...                                 0
85                           0  ...                                 0
1223                         0  ...                                 0
667                          0  ...                                 0
156                          0  ...                                 0
384                          0  ...                                 0
645                          0  ...                                 0
1480                         0  ...                                 0

      TeamName_San Diego Chargers  TeamName_San Francisco 49ers  \
405                             0                             0
1258                            0                             0
1567                            0                             0
412                             0                             0
147                             0                             0
723                             0                             0
669                             0                             0
1344                            0                             1
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1577                            0                             0
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1375                            0                             1
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479                 0                    0
1058                0                    0
185                 0                    0
739                 1                    0
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824                 0                    0
1039                0                    0
102                 0                    0
1359                0                    1
1181                0                    0
956                 0                    0
717                 0                    0
812                 0                    0
19                  0                    0
1063                0                    0
873                 0                    0
196                 0                    0
143                 0                    0
778                 1                    0
318                 0                    0
416                 0                    0
1047                0                    0
927                 0                    0
749                 1                    0
17                  0                    0
221                 0                    0
943                 0                    0
630                 0                    0
85                  0                    0
1223                0                    0
667                 0                    0
156                 0                    0
384                 0                    0
645                 0                    0
1480                0                    0

      TeamName_Seattle Seahawks  TeamName_St. Louis Cardinals  \
405                           0                             0
1258                          0                             0
1567                          0                             0
412                           0                             0
147                           0                             0
723                           0                             0
669                           0                             0
1344                          0                             0
274                           0                             0
884                           0                             0
1466                          0                             0
1129                          0                             0
1165                          0                             0
32                            0                             1
827                           0                             0
336                           0                             0
296                           0                             0
1092                          0                             0
15                            0                             0
58                            0                             0
```

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36                       0                              1
1577                     0                              0
1514                     0                              0
159                      0                              0
434                      0                              0
1375                     0                              0
479                      0                              0
1058                     0                              0
185                      0                              0
739                      0                              0
...                    ...                            ...
824                      0                              0
1039                     0                              0
102                      0                              0
1359                     0                              0
1181                     0                              0
956                      0                              0
717                      0                              0
812                      0                              0
19                       0                              0
1063                     0                              0
873                      0                              0
196                      0                              0
143                      0                              0
778                      0                              0
318                      0                              0
416                      0                              0
1047                     0                              0
927                      0                              0
749                      0                              0
17                       0                              0
221                      0                              0
943                      0                              0
630                      0                              0
85                       0                              0
1223                     0                              0
667                      0                              0
156                      0                              0
384                      0                              0
645                      0                              0
1480                     0                              0

      TeamName_St. Louis Rams  TeamName_Tampa Bay Buccaneers  \
405                         0                              0
1258                        0                              0
1567                        0                              0
412                         0                              0
147                         0                              0
723                         0                              0
669                         0                              0
1344                        0                              0
274                         0                              0
884                         0                              0
1466                        0                              1
1129                        0                              0
1165                        0                              0
32                          0                              0
```

```
827                  0                            0
336                  0                            0
296                  0                            0
1092                 0                            0
15                   0                            0
58                   0                            0
36                   0                            0
1577                 0                            0
1514                 0                            0
159                  0                            0
434                  0                            0
1375                 0                            0
479                  0                            0
1058                 0                            0
185                  0                            0
739                  0                            0
...                ...                          ...
824                  0                            0
1039                 0                            0
102                  0                            0
1359                 0                            0
1181                 0                            0
956                  0                            0
717                  0                            0
812                  1                            0
19                   0                            0
1063                 0                            0
873                  0                            0
196                  0                            0
143                  0                            0
778                  0                            0
318                  0                            0
416                  0                            0
1047                 0                            0
927                  0                            0
749                  0                            0
17                   0                            0
221                  0                            0
943                  0                            0
630                  0                            0
85                   0                            0
1223                 0                            0
667                  0                            0
156                  0                            0
384                  0                            0
645                  0                            0
1480                 0                            0

      TeamName_Tennessee Oilers  TeamName_Tennessee Titans  \
405                           0                          0
1258                          0                          0
1567                          0                          0
412                           0                          0
147                           0                          0
723                           0                          0
669                           0                          0
1344                          0                          0
```

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274                       0                           0
884                       0                           0
1466                      0                           0
1129                      0                           0
1165                      0                           0
32                        0                           0
827                       0                           0
336                       0                           0
296                       0                           0
1092                      0                           0
15                        0                           0
58                        0                           0
36                        0                           0
1577                      0                           0
1514                      0                           0
159                       0                           0
434                       0                           0
1375                      0                           0
479                       0                           0
1058                      0                           0
185                       0                           0
739                       0                           0
...                     ...                         ...
824                       0                           0
1039                      0                           0
102                       0                           0
1359                      0                           0
1181                      0                           0
956                       0                           0
717                       0                           0
812                       0                           0
19                        0                           0
1063                      0                           0
873                       0                           0
196                       0                           0
143                       0                           0
778                       0                           0
318                       0                           0
416                       0                           0
1047                      0                           0
927                       0                           0
749                       0                           0
17                        0                           0
221                       0                           0
943                       0                           0
630                       0                           0
85                        0                           0
1223                      0                           0
667                       0                           0
156                       0                           0
384                       0                           0
645                       0                           0
1480                      0                           1

      TeamName_Washington Redskins
405                              0
1258                             0
```

```
1567    1
412     0
147     0
723     0
669     0
1344    0
274     0
884     0
1466    0
1129    0
1165    0
32      0
827     0
336     0
296     0
1092    0
15      0
58      0
36      0
1577    1
1514    0
159     0
434     0
1375    0
479     0
1058    0
185     0
739     0
...    ..
824     0
1039    0
102     0
1359    0
1181    0
956     0
717     0
812     0
19      0
1063    0
873     0
196     0
143     0
778     0
318     0
416     0
1047    0
927     0
749     0
17      0
221     0
943     0
630     0
85      0
1223    0
667     0
156     0
384     0
```

```
645                                0
1480                               0

[1104 rows x 43 columns]
```

In [21]:
```
from sklearn.linear_model import LogisticRegression

from yellowbrick.classifier import ConfusionMatrix
from yellowbrick.classifier import ClassificationReport
from yellowbrick.classifier import ROCAUC

# Instantiate the classification model
model = LogisticRegression()

#The ConfusionMatrix visualizer taxes a model
classes = ['Yes', 'No']
cm = ConfusionMatrix(model, classes=classes, percent=False)


#Fit fits the passed model. This is unnecessary if you pass the visualizer a p
re-fitted model
cm.fit(X_train, y_train)

#To create the ConfusionMatrix, we need some test data. Score runs predict() o
n the data
#and then creates the confusion_matrix from scikit learn.
cm.score(X_val, y_val)

# change fontsize of the labels in the figure
for label in cm.ax.texts:
    label.set_size(20)

#How did we do?
cm.poof()

# Precision, Recall, and F1 Score
# set the size of the figure and the font size
#%matplotlib inline
plt.rcParams['figure.figsize'] = (15, 7)
plt.rcParams['font.size'] = 20

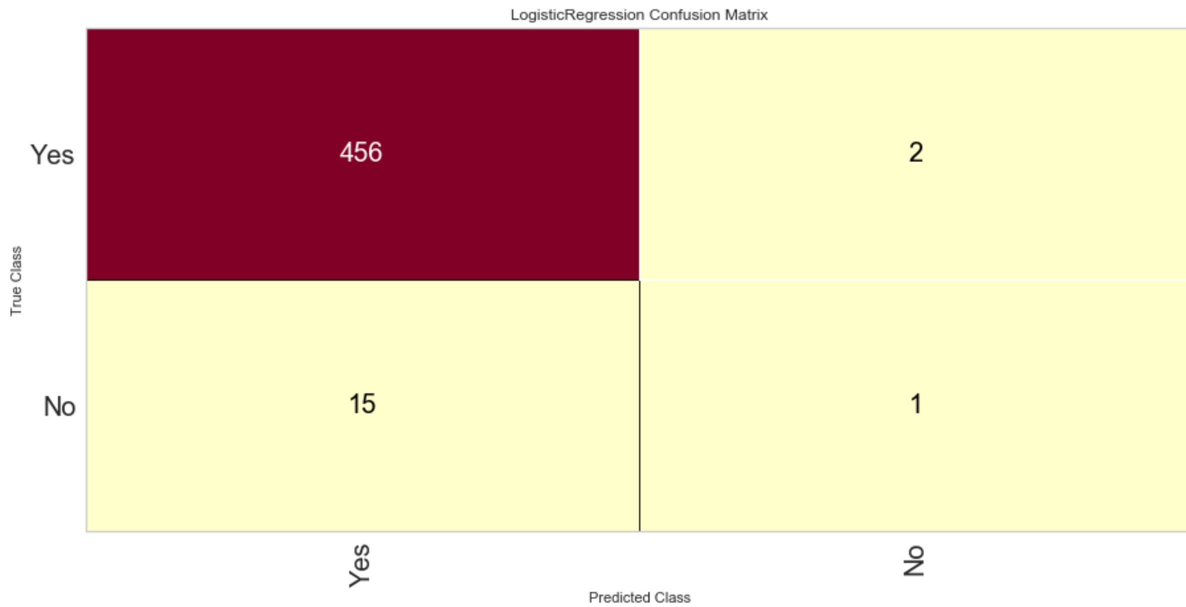
# Instantiate the visualizer
visualizer = ClassificationReport(model, classes=classes)

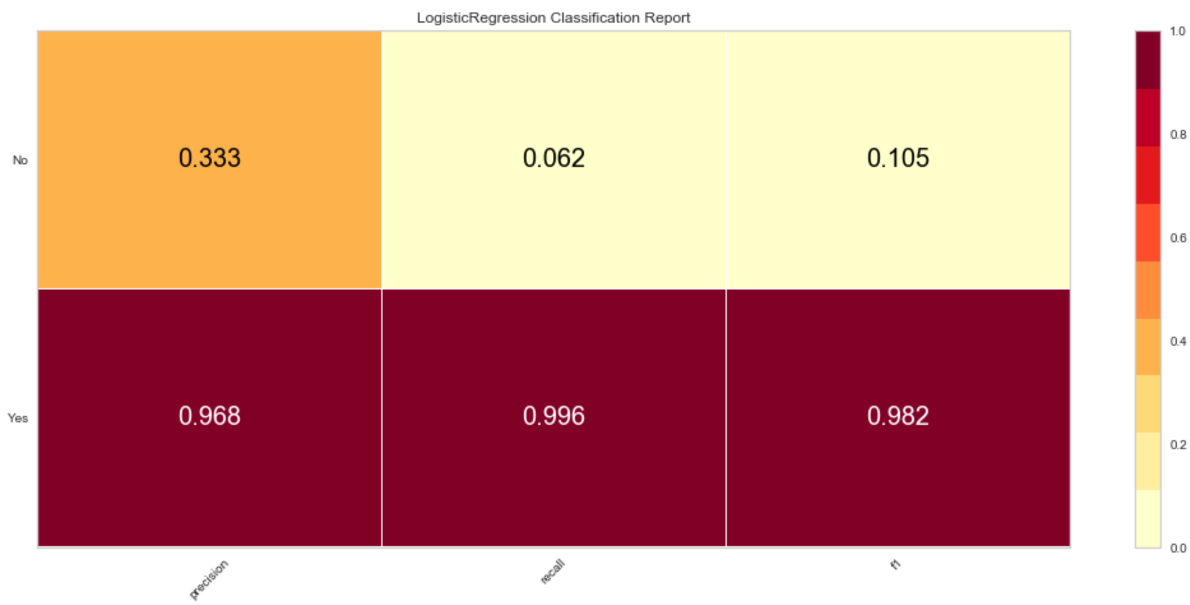
visualizer.fit(X_train, y_train)  # Fit the training data to the visualizer
visualizer.score(X_val, y_val)  # Evaluate the model on the test data
g = visualizer.poof()

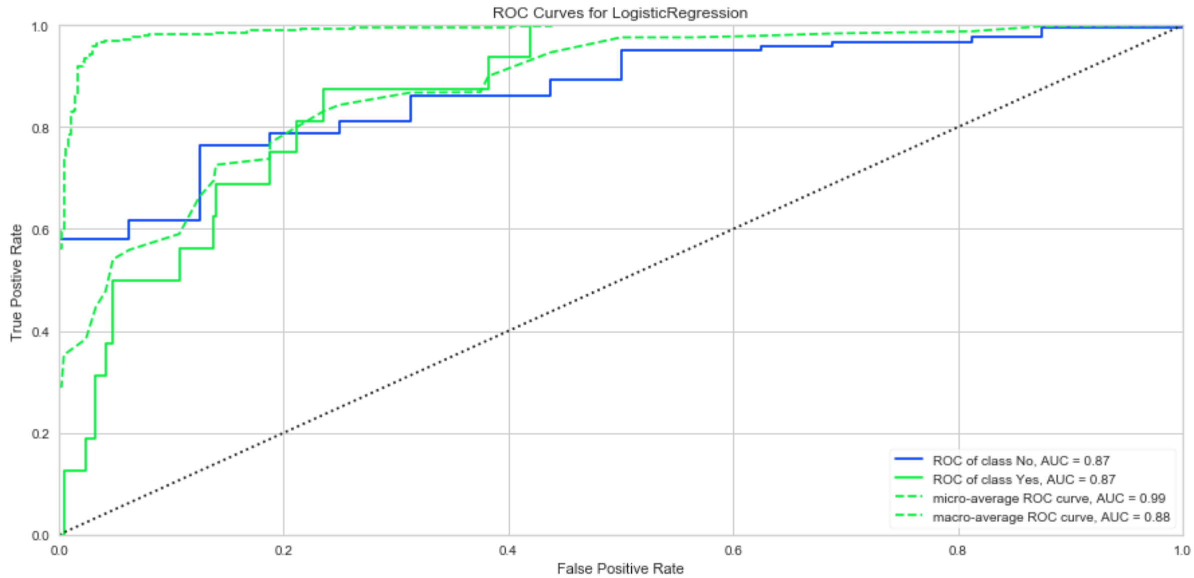
# ROC and AUC
#Instantiate the visualizer
visualizer = ROCAUC(model)

visualizer.fit(X_train, y_train)  # Fit the training data to the visualizer
visualizer.score(X_val, y_val)  # Evaluate the model on the test data
g = visualizer.poof()
```

```
C:\Users\Kyle Morris\Anaconda3\lib\site-packages\sklearn\linear_model\logisti
c.py:432: FutureWarning: Default solver will be changed to 'lbfgs' in 0.22. S
pecify a solver to silence this warning.
  FutureWarning)
```






ROC Curves for LogisticRegression
True Postive Rate
False Positive Rate
ROC of class No, AUC = 0.87
ROC of class Yes, AUC = 0.87
micro-average ROC curve, AUC = 0.99
macro-average ROC curve, AUC = 0.88
0.0
0.2
0.4
0.6
0.8
1.0

In [ ]: