mhblatch - Final Tutorial FS

December 19, 2021

1 Analyzing Figure Skating Scores from 2016-2018

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[638]:
```
from bs4 import BeautifulSoup
import pandas as pd
import numpy as np
import re
from datetime import datetime
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
from sklearn.datasets import make_regression
sns.set(rc={"figure.figsize":(12, 8)})
sns.set_theme(style="whitegrid")
from scipy import stats
import statsmodels.api as sm
import statsmodels.formula.api as formula
from sklearn.preprocessing import PolynomialFeatures
from sklearn import svm
```

2 Data Collection & Parsing

This dataset was created by BuzzFeedNews, they sourced the official data from 17 ISU (International Skating Union) competitions results that occured from October 2016-December 2017. Access the dataset.

[639]:
```
url = 'https://github.com/BuzzFeedNews/figure-skating-scores/blob/master/data/
 ↪tidy/performances.csv?raw=true'
df = pd.read_csv(url,index_col=0)
```

Note about Figure Skating Programs: Figure skating competitions comprise of two parts: a short program and a free skate (also know as long program), these program differ in duration and number of moves completed in their respective program. Skaters can earn points by doing specific moves, such as jumps or spins, at different levels. Most male figure skaters that compete at the international level usually perform moves at the highest level which is level 4 spins and quad (four rotations) jumps. You can read more about figure skating scoring here.

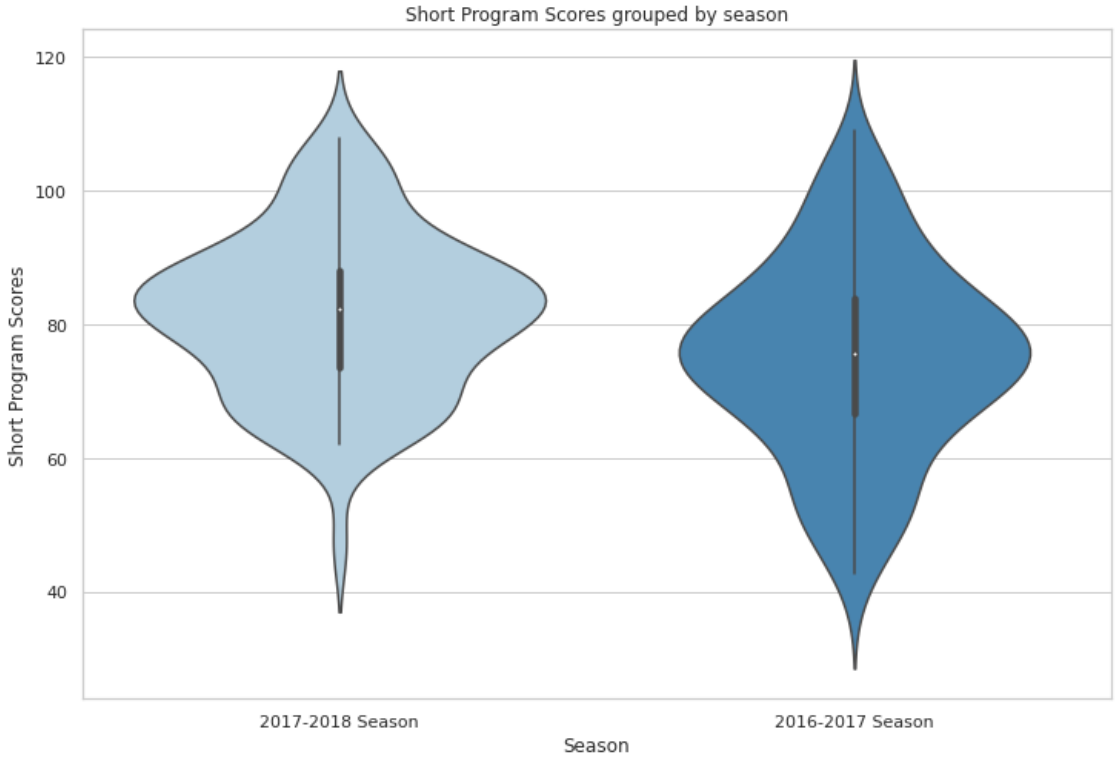
[640]:
```
#Here I am combining both the Senior Mens Short Program and Mens Free Skate and␣
 ↪also marking when the competiton
#took place in the season column
season = []
comp_2016 = ['ISU GP 2016 Progressive Skate America', 'ISU GP 2016 Skate Canada␣
 ↪International', 'ISU GP Rostelecom Cup 2016'\
            ,'ISU GP Trophee de France 2016', 'ISU GP Audi Cup of China 2016',␣
 ↪'ISU GP NHK Trophy 2016', 'ISU Grand Prix of Figure Skating Final 2016'\
            ,'ISU European Figure Skating Championships 2017', 'ISU Four␣
 ↪Continents Championships 2017', 'ISU World Figure Skating Championships␣
 ↪2017']
comps = comp_2016 + ['ISU GP Rostelecom Cup 2017', 'ISU GP 2017 Skate Canada␣
 ↪International', 'ISU GP Audi Cup of China 2017', \
                      'ISU GP NHK Trophy 2017', 'ISU GP Internationaux de␣
 ↪France de Patinage 2017', 'ISU GP 2017 Bridgestone Skate America',\
                    'Grand Prix Final 2017 Senior and Junior']
comp_order = []
for index, row in df.iterrows():
    comp_order.append(comps.index(row['competition']))
    if row['competition'] in comp_2016:
        season.append('2016-2017 Season')
    else:
        season.append('2017-2018 Season')
df['season'] = season
df['comp_order'] = comp_order
mens_fs = df.loc[df['program'] == 'MEN FREE SKATING']
mens_sp = df.loc[df['program'] == 'MEN SHORT PROGRAM']
mens = pd.concat([mens_fs, mens_sp])
print(mens.head())
```

```
                                          competition           program  \
performance_id
0c18375356      Grand Prix Final 2017 Senior and Junior  MEN FREE SKATING
08078dfa79      Grand Prix Final 2017 Senior and Junior  MEN FREE SKATING
f5afc3d8ed      Grand Prix Final 2017 Senior and Junior  MEN FREE SKATING
e5738bdb58      Grand Prix Final 2017 Senior and Junior  MEN FREE SKATING
6fb9fe45c5      Grand Prix Final 2017 Senior and Junior  MEN FREE SKATING

                          name nation  rank  starting_number  \
performance_id
0c18375356          Adam RIPPON    USA     5                1
08078dfa79       Sergei VORONOV    RUS     4                2
f5afc3d8ed          Jason BROWN    USA     6                3
e5738bdb58          Nathan CHEN    USA     2                4
6fb9fe45c5      Mikhail KOLYADA    RUS     3                5

                total_segment_score  total_element_score  \
```

```
performance_id
0c18375356                   168.14                81.78
08078dfa79                   178.82                91.90
f5afc3d8ed                   164.79                75.71
e5738bdb58                   183.19                95.75
6fb9fe45c5                   182.78                95.58

                total_component_score  total_deductions            season  \
performance_id
0c18375356                      87.36               1.0  2017-2018 Season
08078dfa79                      86.92               0.0  2017-2018 Season
f5afc3d8ed                      90.08               1.0  2017-2018 Season
e5738bdb58                      88.44               1.0  2017-2018 Season
6fb9fe45c5                      89.20               2.0  2017-2018 Season

                comp_order
performance_id
0c18375356              16
08078dfa79              16
f5afc3d8ed              16
e5738bdb58              16
6fb9fe45c5              16
```

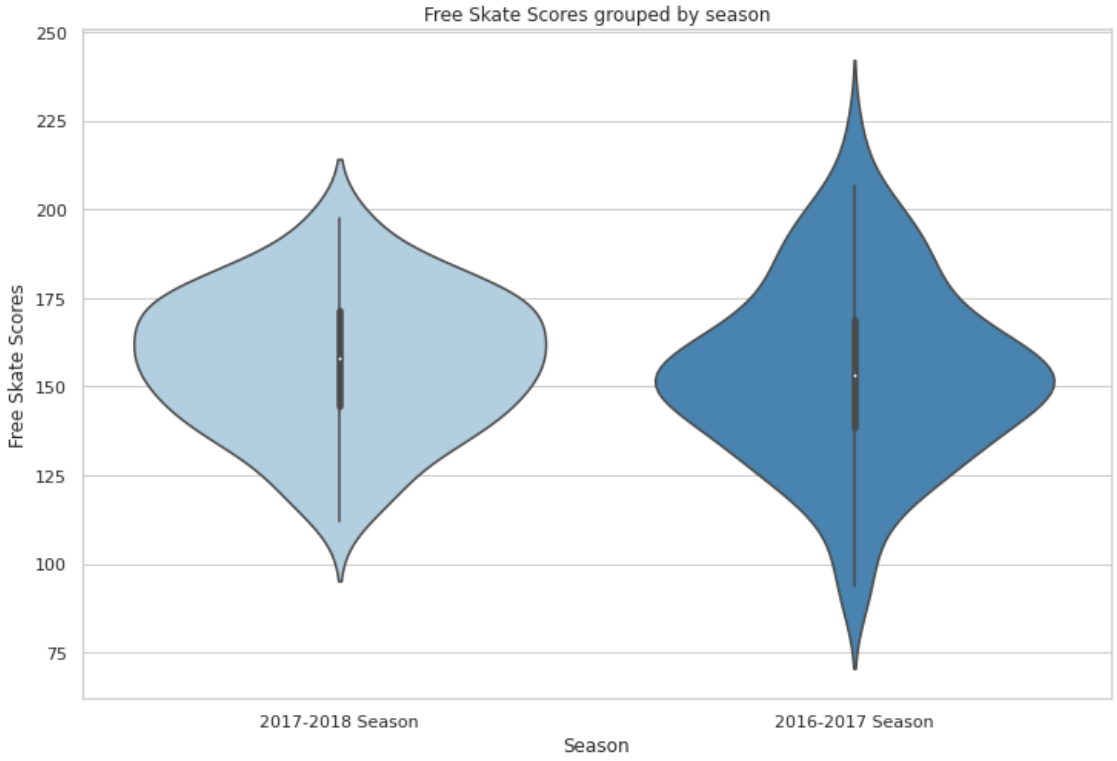
3 Data Visualization

[626]:
```
ax= sns.violinplot(x="season", y="total_segment_score", data=mens_sp,␣
 ↪palette="Blues").set( \
                  title='Short Program Scores grouped by season',␣
 ↪xlabel='Season', ylabel='Short Program Scores')
plt.show()
```



This dataset contains major ISU competitions from two seasons: the 2016-2017 season and 2017-2018 season. In this violinplot, I have plotted the distribution of short program scores grouped by the season. We can see a slight increase of the average in the 2017-2018 season compared to the 2016-2017 season. The range is also smaller in the 2017-2018 season.

[641]:
```
ax = sns.violinplot(x="season", y="total_segment_score", data=mens_fs,␣
↪palette="Blues").set( \
                  title='Free Skate Scores grouped by season', xlabel='Season',␣
↪ylabel='Free Skate Scores')
plt.show()
```



In this violinplot, I have plotted the Free Skate Scores grouped by season. The average is about the same for both seasons but in this chart, we can really see the difference between the range of scores. The 2016-2017 season has a much larger range, this may be because there were more competitons in the 2016-2017 season.

[643]:
```
mens_grouped = mens.drop(columns=['rank', 'starting_number']).\
            groupby(['name', 'competition','nation', 'comp_order']).sum()
mens_grouped = mens_grouped.sort_values(by=['total_segment_score'],␣
 ↪ascending=False).reset_index()
#Here are the top scores from the 2016-2017 season & 2017-2018 season combined
mens_grouped = mens_grouped.loc[mens_grouped['total_segment_score'] >= 200]
print(mens_grouped.head())
```

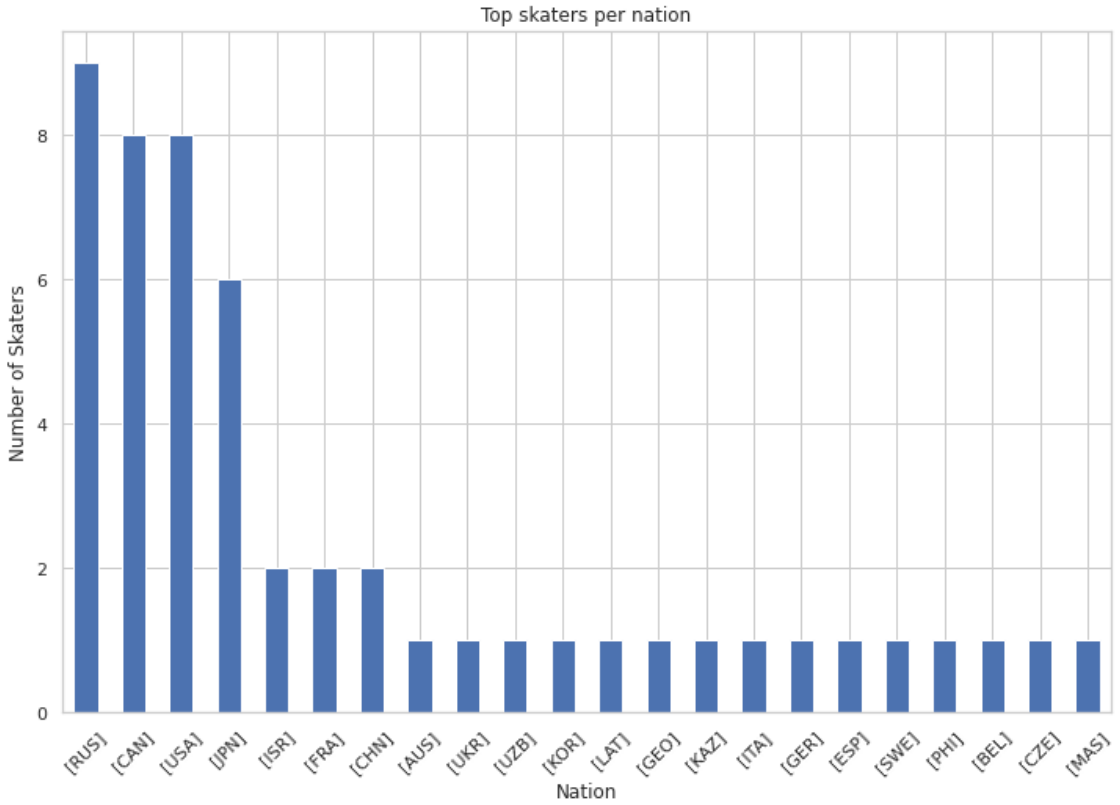
```
           name                                  competition nation  \
0  Yuzuru HANYU  ISU World Figure Skating Championships 2017    JPN
1     Shoma UNO  ISU World Figure Skating Championships 2017    JPN
2   Nathan CHEN       ISU Four Continents Championships 2017    USA
3  Yuzuru HANYU       ISU Four Continents Championships 2017    JPN
4    Boyang JIN  ISU World Figure Skating Championships 2017    CHN

   comp_order  total_segment_score  total_element_score  \
0           9               321.59               178.16
1           9               319.31               179.19
```

```
2           8               307.46                175.06
3           8               303.71                162.44
4           9               303.58                176.59
```

```
   total_component_score  total_deductions
0                 144.43               1.0
1                 140.12               0.0
2                 132.40               0.0
3                 141.27               0.0
4                 126.99               0.0
```

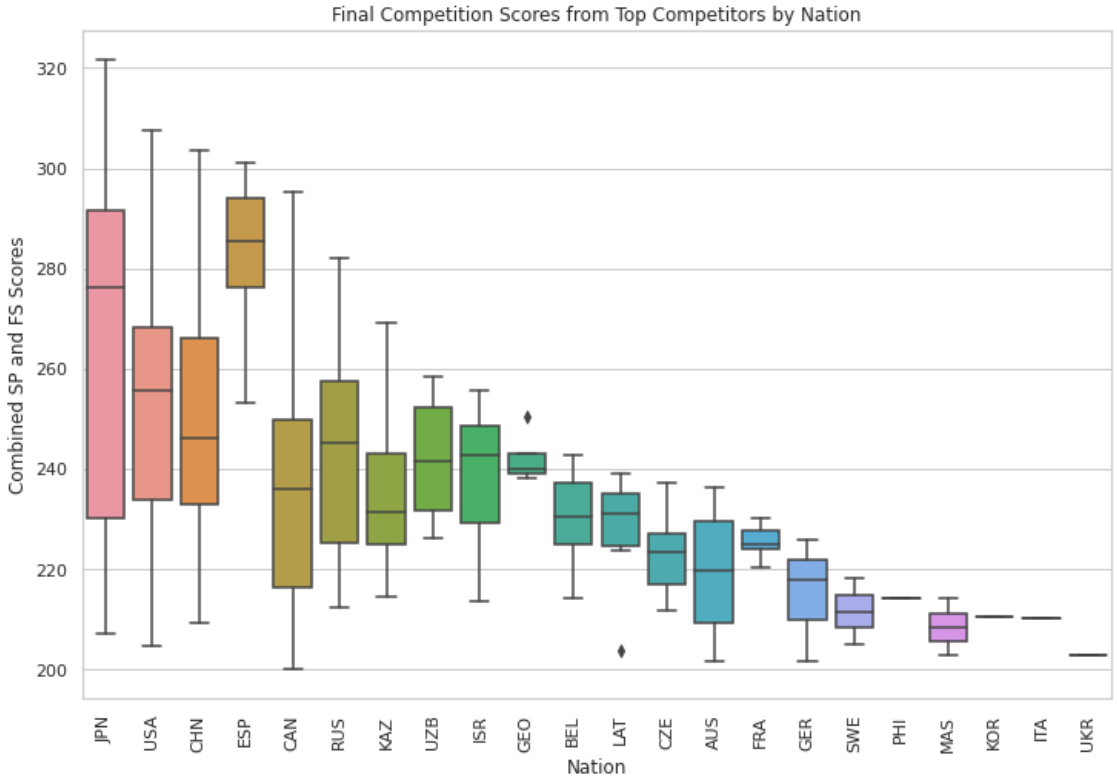
I filtered the combined scores by scores that were over 200 to eliminate some countries that are less likely to medal. Ideally, a male figure skater must score at least 300 points to to place on the podium. In this project, I want to mainly focus on the top figure skaters since they are more likely to compete in competitions and have more scores officially recorded. In this dataframe, we can see the skater, the competiton they competed at and the scores that they earned.

[644]:
```
unique_men = mens_grouped.groupby('name')['nation'].unique().reset_index()
skaters_per_country = unique_men['nation'].value_counts()
skaters_per_country.plot.bar(rot=0).set(title='Top skaters per nation', \
                            xlabel='Nation', ylabel='Number of Skaters')
plt.xticks(rotation=45)
plt.show()
```



From the bar chart above, we can see, Russia, Canada, United States and Japan have the most skaters that are consistently scoring over 200 points in competition with Russia having nine different skaters scoring over 200. Note: One of the US top skater, Nathan Chen, is currently studying statistics and data science at Yale. Check it out!

[645]:
```
tss_final = sns.boxplot(x='nation', y='total_segment_score', data=mens_grouped).
↪set(\
                            title='Final Competition Scores from Top␣
↪Competitors by Nation',  xlabel='Nation', \
                            ylabel='Combined SP and FS Scores')
plt.xticks(rotation=90)
plt.show()
```



From this boxplot, we can see the distribution of the scores that were over 200 total points over the 17 competitions grouped by nation. These scores are the combination of the short program and free skate, the final score that is used for final ranking for competiton. From the graph, we can see that that Spain has a highest average total points but the range is very small. From our bar chart, we know that Spain only has one skater that scores over 200 points in competition, so this one skater has a high average and a small range. Comparatively, Japan has a lower, but still high, average and a large range. Japan has six skaters to account for, so these skaters usually score high and one skater who earned the highest score from all the competitions.

4 Predicting Competition Scores Based on Duration of the Season

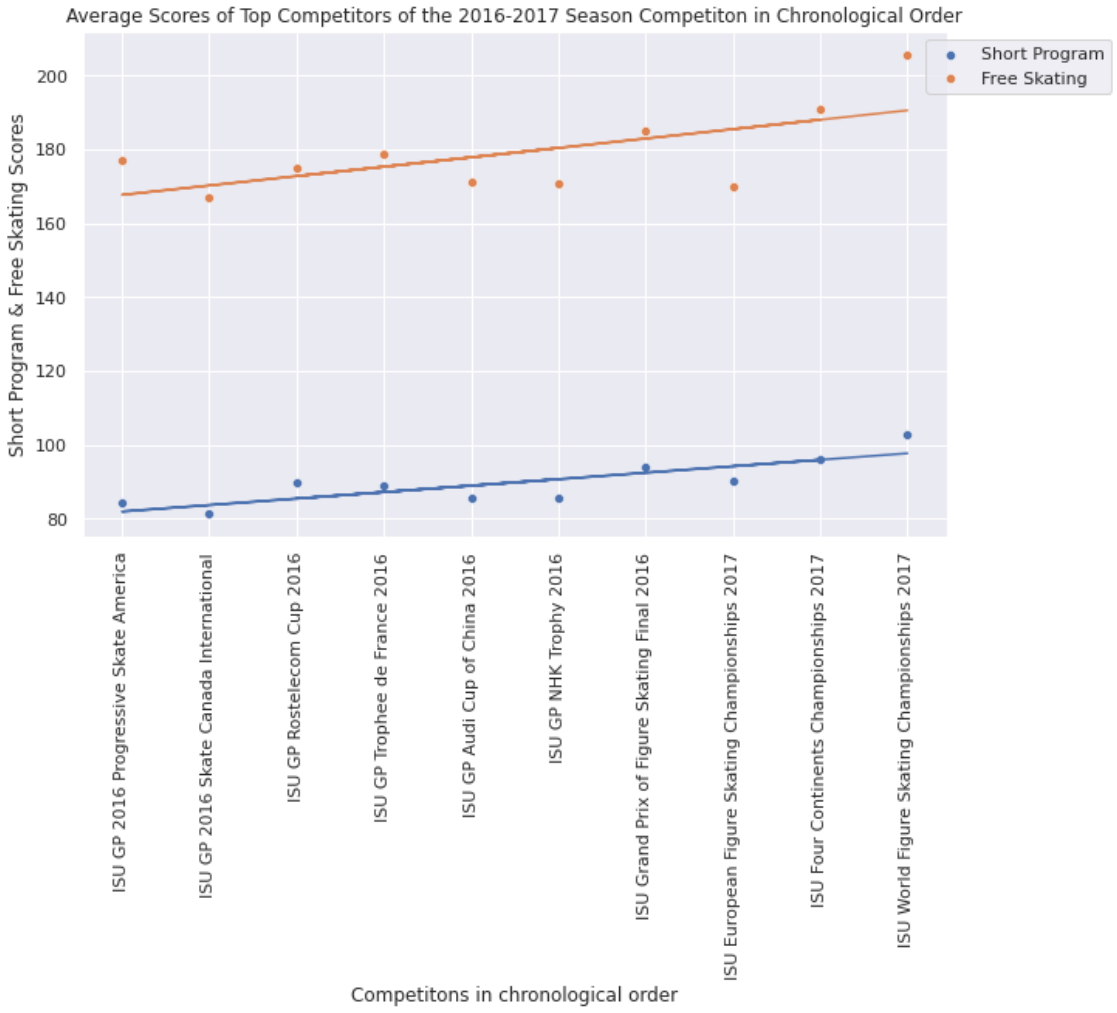
For this part, I want to see if there is a linear relationship between when a competiton took place in the season and the scores earned by the skater. For this part, I decided to use skaters who earned a rank greater or equal to 5 in competitions that were in the 2016-2017 season. Only the top 3 medal in events, although some competitions have a pewter medal for fourth place, but I wanted to have a larger dataset. I also chose to focus on compettions from the 2016-2017 season since skaters will be performing the same program throughout the season.

Null Hypothesis: Scores of either the short and free program of top Men figure skaters do not improve over the season.

[646]:
```
top_competitors = mens.loc[mens['rank']<= 5] #Filtering my dataset to hold only␣
 ↪infromation for people who rank above 5
top_competitors =  top_competitors.loc[top_competitors['season'] == '2016-2017␣
 ↪Season']
unique_men = top_competitors['name'].unique() #Contains the name of the people␣
 ↪we are going to evaluate
```

[647]:
```
#I made a scatter plot of competition order vs Short & Long scores respectively␣
 ↪and added a regression line using the
#average scores from the respective competiton
sns.set(rc={"figure.figsize":(10, 6)})
comp_avg = top_competitors.loc[top_competitors['season'] == '2016-2017 Season']
comp_avg = comp_avg.groupby(['competition','program','comp_order', 'season'],␣
 ↪as_index = False).mean()
fig, ax = plt.subplots()

ax = sns.scatterplot(data=comp_avg.loc[comp_avg['program'] == 'MEN SHORT␣
 ↪PROGRAM'], x="comp_order", \
                 y="total_segment_score", label = "Short Program").set(\
                 title='Average Scores of Top Competitors of the 2016-2017␣
 ↪Season Competiton in Chronological Order', \
                 xlabel='Competitons in chronological order', \
                 ylabel='Short Program & Free Skating Scores', xticks=␣
 ↪range(len(comp_2016)), xticklabels = comp_2016)
ax = sns.scatterplot(data=comp_avg.loc[comp_avg['program'] == 'MEN FREE␣
 ↪SKATING'], x="comp_order", \
                 y="total_segment_score", label = "Free Skating")

sp_avg = comp_avg.loc[comp_avg['program'] == 'MEN SHORT PROGRAM']
z = np.polyfit(sp_avg['comp_order'], sp_avg['total_segment_score'] , 1)
p = np.poly1d(z)
ax.plot(sp_avg['comp_order'], p(sp_avg['comp_order']))

fs_avg = comp_avg.loc[comp_avg['program'] == 'MEN FREE SKATING']
z = np.polyfit(fs_avg['comp_order'], fs_avg['total_segment_score'] , 1)
p = np.poly1d(z)
```

```
ax.plot(fs_avg['comp_order'], p(fs_avg['comp_order']))
ax.set_xticks(range(len(comp_2016)))
ax.set_xticklabels(comp_2016)

plt.legend( bbox_to_anchor=(1.2, 1))
plt.xticks(rotation=90)
plt.show()
```



I plotted the average scores of each respective programs for the competitions in chronological order. Using the line of best fit, we can see a general increase of both the short program and free skate scores over the 2016-2017 season for top competitors as the season continues. The scores at the 2017 World Figure Skating Championships are much higher than the scores at other competitons. This may be because there are more skaters that are trying harder in order to win a prestigious title.

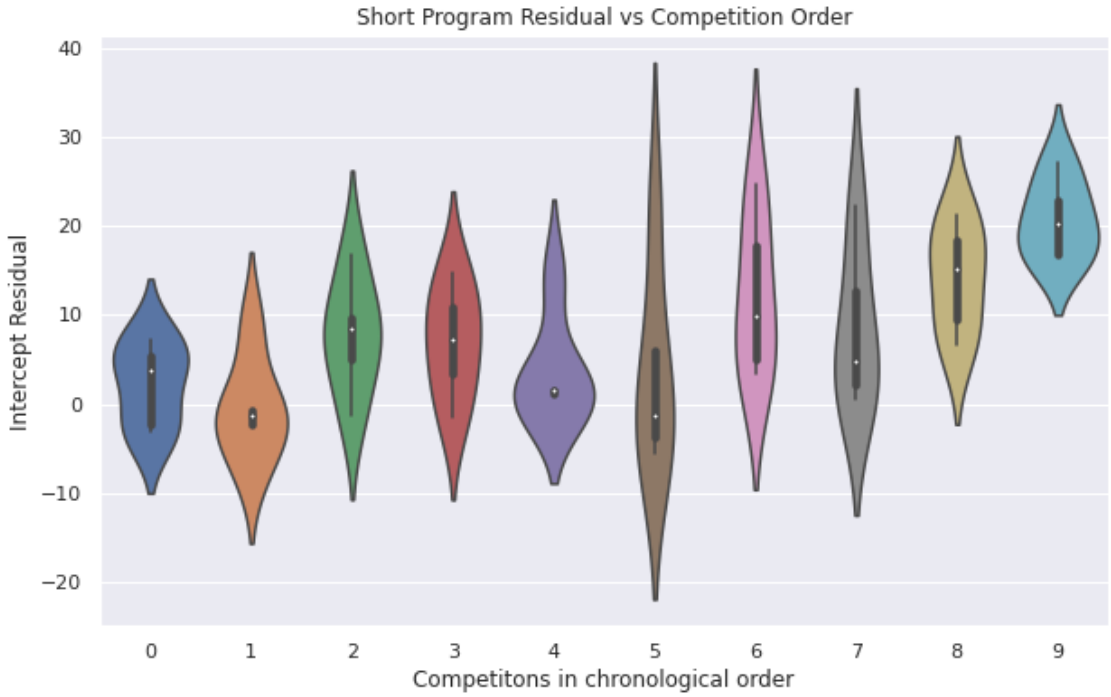
[648]:
```
#Getting short program scores from the top competitors
top_sp = top_competitors.loc[top_competitors['program'] == 'MEN SHORT PROGRAM']

Y = top_sp['total_segment_score']
X = top_sp['comp_order']
X = sm.add_constant(X)
model = sm.OLS(Y,X)
results = model.fit()
print(results.summary())
slope = results.params[1]
intercept = results.params[0]
print('Slope of linear regression: %f' %slope)
print('Intercept of linear regression: %f' %intercept)
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:     total_segment_score   R-squared:                       0.324
Model:                             OLS   Adj. R-squared:                  0.310
Method:                  Least Squares   F-statistic:                     23.00
Date:                 Sun, 19 Dec 2021   Prob (F-statistic):           1.61e-05
Time:                         20:05:35   Log-Likelihood:                -170.13
No. Observations:                   50   AIC:                             344.3
Df Residuals:                       48   BIC:                             348.1
Df Model:                            1
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         81.8999      1.950     41.999      0.000      77.979      85.821
comp_order     1.7517      0.365      4.795      0.000       1.017       2.486
==============================================================================
Omnibus:                        3.975   Durbin-Watson:                   1.748
Prob(Omnibus):                  0.137   Jarque-Bera (JB):                1.846
Skew:                           0.084   Prob(JB):                        0.397
Kurtosis:                       2.074   Cond. No.                         10.2
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
Slope of linear regression: 1.751661
Intercept of linear regression: 81.899927
```

Using the OLS linear regression model, we would except to see a 1.75 point increase on average in the short program scores as the figure skating season continues. We would reject the null hypothesis since the p-value is 0, we would state that there is a correlation between the competition order and scores, as the season continues scores of the free skating program increase.

[649]:
```
intercept_res = []
for index, row in top_sp.iterrows():
    slope = pmean.index[0]
    intercept_res.append(row['total_segment_score'] - (row['comp_order']*slope␣
 ↪+ intercept))

top_sp['intercept_res'] = intercept_res
ax = sns.violinplot(x='comp_order', y='intercept_res', data=top_sp)
ax.set_title("Short Program Residual vs Competition Order")
ax.set_ylabel("Intercept Residual")
ax.set_xlabel("Competitons in chronological order")
plt.show()
```

```
<ipython-input-649-372178d807cc>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  top_sp['intercept_res'] = intercept_res
```



From the graph above, we can see that the residual is mostly centered around zero but some competitions, mainly 6,8, and 9 are above average. The data is not very uniform, especially in competiton 1 and 4, we can see most of the data is skewed to the right.

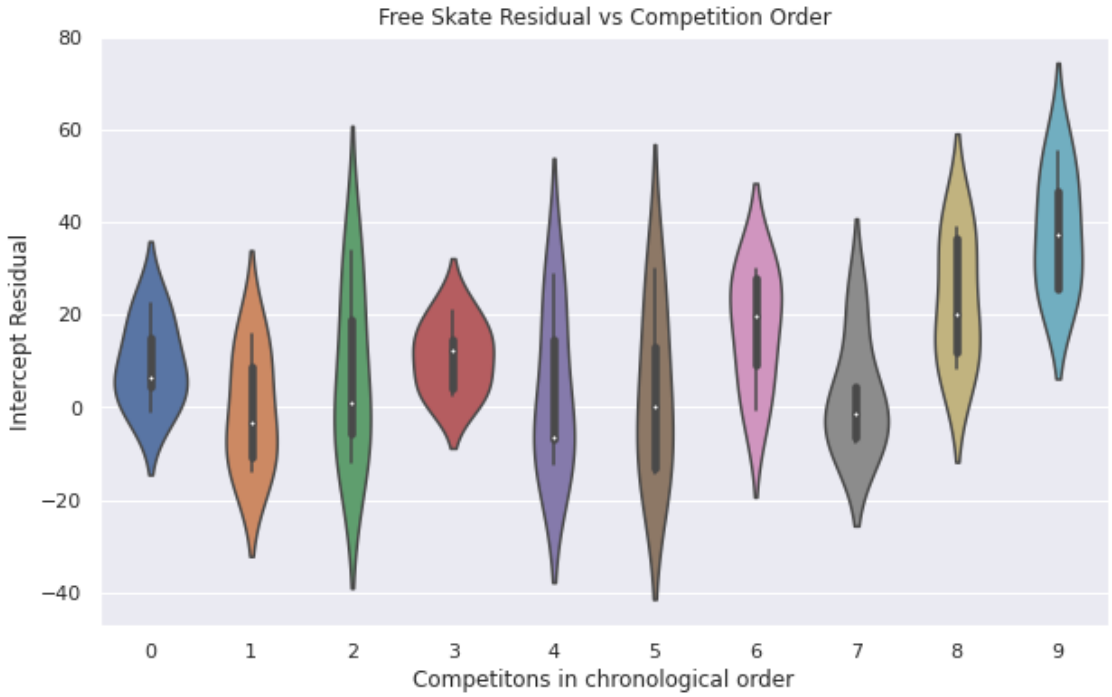
[650]:
```
#Getting free skating scores from the top competitors
top_fs = top_competitors.loc[top_competitors['program'] == 'MEN FREE SKATING']

Y = top_fs['total_segment_score']
X = top_fs['comp_order']
X = sm.add_constant(X)
model = sm.OLS(Y,X)
results = model.fit()
print(results.summary())
slope = results.params[1]
intercept = results.params[0]
print('Slope of linear regression: %f' %slope)
print('Intercept of linear regression: %f' %intercept)
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:     total_segment_score   R-squared:                       0.186
Model:                             OLS   Adj. R-squared:                  0.169
Method:                  Least Squares   F-statistic:                     10.99
Date:                 Sun, 19 Dec 2021   Prob (F-statistic):            0.00175
Time:                         20:05:40   Log-Likelihood:                -207.26
No. Observations:                   50   AIC:                             418.5
Df Residuals:                       48   BIC:                             422.3
Df Model:                            1
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        167.6898      4.098     40.918      0.000     159.450     175.930
comp_order     2.5448      0.768      3.315      0.002       1.001       4.088
==============================================================================
Omnibus:                        3.561   Durbin-Watson:                   1.323
Prob(Omnibus):                  0.169   Jarque-Bera (JB):                1.711
Skew:                           0.028   Prob(JB):                        0.425
Kurtosis:                       2.095   Cond. No.                         10.2
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
Slope of linear regression: 2.544752
Intercept of linear regression: 167.689818
```

Using the OLS linear regression model, we would except to see a 2.544 point increase on average in the free skating program scores as the figure skating season continues. We would reject the null hypothesis since our p value is below 0.005 and state that there is a correlation between the competition order and scores, as the season continues scores of the free skating program increase.

[651]:
```
intercept_res = []
for index, row in top_fs.iterrows():
    slope = pmean.index[0]
    intercept_res.append(row['total_segment_score'] - (row['comp_order']*slope␣
 ↪+ intercept))

top_fs['intercept_res'] = intercept_res
ax = sns.violinplot(x='comp_order', y='intercept_res', data=top_fs)
ax.set_title("Free Skate Residual vs Competition Order")
ax.set_ylabel("Intercept Residual")
ax.set_xlabel("Competitons in chronological order")
plt.show()
```

```
<ipython-input-651-1895585aadbe>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  top_fs['intercept_res'] = intercept_res
```



From the graph above, we can see that the residual is mostly centered around zero but some competitions, mainly 3, 6, 8, and 9 are above average. The data is more uniform than the Short Program Residual vs Competition Order, this may be because there are more opportunities to score points in the long program. A mistake in the short program would cause a significant different in

the TSS (total segment score) field.

5 Conclusion

From the residual graphs, we can see that the total segment score and competition order have some large residual errors or differences from the regression line. From our graph of top ranked competitor's averages and the line of best, there were some points that were far off from the line. I think there is improvement of top competitors as the season continues especially, we can see a large increase of average score at the 2017 World Figure Skating Championships. This may be because top skaters are trying harder to win a pretigious medal. In addition, not all skaters compete is all competitions, so I think if I were to do this project again, I might track the the progress of one skater over the season.

Learn more about Figure Skating! Visit US Figure Skating to support US Figure Skaters. Prepare for the 2022 Winter Olympics by checking out the Olympics site. My favorite program from the 2016-2017 season is Yuzuru Hanyu's.