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jupyter 2 Pythagorean expectation and the IPL Last Checkpoint: 12/02/2020 (autosaved)

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Pythagorean Expectation and the Indian Premier League

The Indian Premier League (IPL) is the biggest cricket competition in the world, which has all of the world's best players in an eight week tournament involving eight teams playing sixty games in total. Each team plays every other team, once at home and then away, and the competition finishes with the four best teams competing in semi-finals and then a final.

Cricket, like baseball, is a bat and ball game, where teams score runs and the team scoring the highest number of runs is the winner. There are, of course, many differences, but statistically speaking, we can generate the same Pythagorean statistic that we generated for baseball. Our data here is derived from the competition that took place in 2018.

The IPL is played in the T20 format, in which each team has up to 120 balls to score as many runs as they can (the game takes less than three hours to complete). One difference from baseball is that runs are much easier to score - in the IPL an average score is 170 runs - and outs (wickets) are much more costly - each team has only ten outs(called wickets) in the entire game, and if you run out of wickets before the 120 balls have been bowled (pitched) then your inning is over.

With this background, let's construct the Pythagorean Expectation for the IPL in 2018.

In [1]:

```
# As with the previous notebook, we first important the packages we will need to process the data.

import pandas as pd
import numpy as np
import statsmodels.formula.api as smf
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```
# Now we import the data, which comes in the form of a list of games played in the 2018 season.
# We print out the list of variables names in the dataframe

IPL18 = pd.read_excel('../../Data/Week 1/IPL2018teams.xlsx')
print(IPL18.columns.tolist())
```

```
['scorecard_id', 'start_date', 'phase', 'name', 'home_team', 'away_team', 'toss_winner', 'toss_decision', 'inn1team', 'innin
gs1', 'wickets1', 'overs1', 'closure1', 'innings2', 'wickets2', 'overs2', 'closure2', 'adjusted_target_indicator', 'adjusted
_target', 'team1_overs', 'team2_overs', 'mom_player_id', 'mom_player', 'scoring_status', 'result_type', 'result_margin', 'wi
nning_team']
```

In [3]:

```
# We can see what our dataframe looks like simply by typing its name:

IPL18
```

Out[3]:

	scorecard_id	start_date	phase	name	home_team	away_team	toss_winner	toss_decision	inn1team	innings1	...	adjusted_target_in
0	1056637	2018-04-07	NaN	Wankhede Stadium, Mumbai	Mumbai Indians	Chennai Super Kings	Chennai Super Kings	f	Mumbai Indians	165	...	
1	1056638	2018-04-08	NaN	Punjab Cricket Association Stadium, Mohali	Kings XI Punjab	Delhi Daredevils	Kings XI Punjab	f	Delhi Daredevils	166	...	
2	1056639	2018-04-08	NaN	Eden Gardens, Kolkata	Kolkata Knight Riders	Royal Challengers Bangalore	Kolkata Knight Riders	f	Royal Challengers Bangalore	176	...	
3	1056640	2018-04-09	NaN	Rajiv Gandhi International Stadium, Uppal, Hyd...	Sunrisers	Rajasthan Royals	Sunrisers	f	Rajasthan Royals	125	...	
				MA								

In [4]:

```
# This cell compelete a number tasks. First we identify when the home team is the winning team, and when the visiting team
# is the winner. Next we identify the runs scored by the home team and the away team (note: unlike baseball, where there are
# nine innings for each team, in T20 cricket each team gets only one inning, and once the first completes its inning, the opp
# team has its inning). Finally, we include a counter which we can add up to give total number of games for each team.

IPL18['hwin']= np.where(IPL18['home_team']==IPL18['winning_team'],1,0)
IPL18['awin']= np.where(IPL18['away_team']==IPL18['winning_team'],1,0)
IPL18['htruns']= np.where(IPL18['home_team']==IPL18['inn1team'],IPL18['innings1'],IPL18['innings2'])
IPL18['atruns']= np.where(IPL18['away_team']==IPL18['inn1team'],IPL18['innings1'],IPL18['innings2'])
IPL18['count']=1
```

In [5]:

```
# Now we use a .groupby command to aggregate the performance of home teams during the season. Compare back to the MLB noteboo
# to see how similar the commands are.

IPLhome = IPL18.groupby('home_team')['count','hwin', 'htruns','atruns'].sum().reset_index()
IPLhome = IPLhome.rename(columns={'home_team':'team','count':'Ph','htruns':'htrunsh','atruns':'atrunsh'})
IPLhome
```

Out[5]:

	team	Ph	hwin	htrunsh	atrunsh
0	Chennai Super Kings	9	8	1577	1486
1	Delhi Daredevils	7	4	1258	1122
2	Kings XI Punjab	7	4	1188	1202
3	Kolkata Knight Riders	9	5	1468	1417
4	Mumbai Indians	7	3	1194	1171
5	Rajasthan Royals	7	5	1120	994
6	Royal Challengers Bangalore	7	4	1298	1286
7	Sunrisers	7	5	1070	1050

In [6]:

```
# Now we aggregate the performance of away teams in a different df.

IPLaway = IPL18.groupby('away_team')['count','awin', 'htruns','atruns'].sum().reset_index()
IPLaway = IPLaway.rename(columns={'away_team':'team','count':'Pa','htruns':'htrunsa','atruns':'atrunsa'})
IPLaway
```

Out[6]:

	team	Pa	awin	htrunsa	atrunsa

0	Chennai Super Kings	7	3	1264	1232
1	Delhi Daredevils	7	1	1265	1085
2	Kings XI Punjab	7	2	1124	1022
3	Kolkata Knight Riders	7	4	1326	1291
4	Mumbai Indians	7	3	1111	1186
5	Rajasthan Royals	8	2	1362	1237
6	Royal Challengers Bangalore	7	2	1097	1024
7	Sunrisers	10	5	1624	1651

In [7]:

```
# how we merge the two dfs to obtain a full record for each team across the season.

IPL18 = pd.merge(IPLhome, IPLaway, on = ['team'])
IPL18
```

Out[7]:

	team	Ph	hwin	htrunsh	atrunsh	Pa	awin	htrunsa	atrunsa
0	Chennai Super Kings	9	8	1577	1486	7	3	1264	1232
1	Delhi Daredevils	7	4	1258	1122	7	1	1265	1085
2	Kings XI Punjab	7	4	1188	1202	7	2	1124	1022
3	Kolkata Knight Riders	9	5	1468	1417	7	4	1326	1291
4	Mumbai Indians	7	3	1194	1171	7	3	1111	1186
5	Rajasthan Royals	7	5	1120	994	8	2	1362	1237
6	Royal Challengers Bangalore	7	4	1298	1286	7	2	1097	1024
7	Sunrisers	7	5	1070	1050	10	5	1624	1651

In [8]:

```
# We now aggregate the home and away data for wins, games played and runs

IPL18['W'] = IPL18['hwin']+IPL18['awin']
IPL18['G'] = IPL18['Ph']+IPL18['Pa']
IPL18['R'] = IPL18['htrunsh']+IPL18['atrunsa']
IPL18['RA'] = IPL18['atrunsh']+IPL18['htrunsa']
IPL18
```

Out[8]:

	team	Ph	hwin	htrunsh	atrunsh	Pa	awin	htrunsa	atrunsa	W	G	R	RA
0	Chennai Super Kings	9	8	1577	1486	7	3	1264	1232	11	16	2809	2750
1	Delhi Daredevils	7	4	1258	1122	7	1	1265	1085	5	14	2343	2387
2	Kings XI Punjab	7	4	1188	1202	7	2	1124	1022	6	14	2210	2326
3	Kolkata Knight Riders	9	5	1468	1417	7	4	1326	1291	9	16	2759	2743
4	Mumbai Indians	7	3	1194	1171	7	3	1111	1186	6	14	2380	2282
5	Rajasthan Royals	7	5	1120	994	8	2	1362	1237	7	15	2357	2356
6	Royal Challengers Bangalore	7	4	1298	1286	7	2	1097	1024	6	14	2322	2383
7	Sunrisers	7	5	1070	1050	10	5	1624	1651	10	17	2721	2674

In [9]:

```
# The last step in organizing the data is to create variables for win percentage (wpc) and the Pythagorean Expectation (pyth)

IPL18['wpc'] = IPL18['W']/IPL18['G']
IPL18['pyth'] = IPL18['R']**2/(IPL18['R']**2 + IPL18['RA']**2)
IPL18
```

Out[9]:

	team	Ph	hwin	htrunsh	atrunsh	Pa	awin	htrunsa	atrunsa	W	G	R	RA	wpc	pyth
0	Chennai Super Kings	9	8	1577	1486	7	3	1264	1232	11	16	2809	2750	0.687500	0.510612
1	Delhi Daredevils	7	4	1258	1122	7	1	1265	1085	5	14	2343	2387	0.357143	0.490698
2	Kings XI Punjab	7	4	1188	1202	7	2	1124	1022	6	14	2210	2326	0.428571	0.474444
3	Kolkata Knight Riders	9	5	1468	1417	7	4	1326	1291	9	16	2759	2743	0.562500	0.502908
4	Mumbai Indians	7	3	1194	1171	7	3	1111	1186	6	14	2380	2282	0.428571	0.521012
5	Rajasthan Royals	7	5	1120	994	8	2	1362	1237	7	15	2357	2356	0.466667	0.500212
6	Royal Challengers Bangalore	7	4	1298	1286	7	2	1097	1024	6	14	2322	2383	0.428571	0.487037
7	Sunrisers	7	5	1070	1050	10	5	1624	1651	10	17	2721	2674	0.588235	0.508711

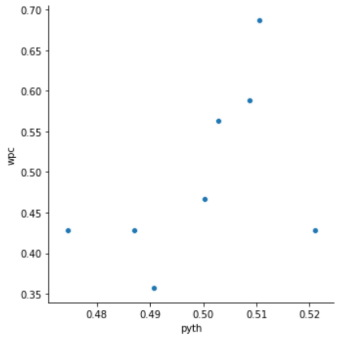
In [10]:

```
# Having prepared the data, we are now ready to examine it. First, we generate and xy plot use the Seaborn package.
# Unlike the MLB case, we can see that there is a very weak correlation between win percentage and the Pythagorean Expectatio

sns.relplot(x="pyth", y="wpc", data =IPL18)
```

Out[10]:

```
<seaborn.axisgrid.FacetGrid at 0x7ff878bac7b8>
```



Self test

run sns.relplot again, but this time write y="W" instead of y="wpc". What do you find? Does it make a difference?

Running a regression

We now run the same regression as we did for the MLB data:

wpc = Intercept + coef x pyth

This time, while coefficient on pyth is positive - implying that a higher Pythagorean Expectation leads to a large win percentage, the standard error is also very large, and the t statistic of 1.353 implies a p-value of 0.225- well above the usual threshold of 0.050, which means that the coefficient estimate is in fact insignificantly different from zero.

In [11]:

```
pyth_lm = smf.ols(formula = 'wpc ~ pyth', data=IPL18).fit()
pyth_lm.summary()
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1416: UserWarning: kurtosistest only valid for n>=20 ... continu
ing anyway, n=8
  "anyway, n=%i" % int(n))
```

Out[11]:

```
OLS Regression Results
     Dep. Variable:              wpc       R-squared:   0.234
            Model:               OLS  Adj. R-squared:   0.106
           Method:     Least Squares      F-statistic:   1.830
             Date:  Tue, 13 Jul 2021 Prob (F-statistic):  0.225
             Time:          03:59:40   Log-Likelihood:  7.9710
No. Observations:                 8              AIC:  -11.94
     Df Residuals:                6              BIC:  -11.78
         Df Model:                1
 Covariance Type:         nonrobust

              coef  std err       t   P>|t|  [0.025  0.975]
Intercept  -1.2807    1.312  -0.976   0.367  -4.491   1.929
     pyth   3.5522    2.626   1.353   0.225  -2.872   9.977

      Omnibus:  0.002   Durbin-Watson:  2.254
Prob(Omnibus):  0.999 Jarque-Bera (JB):  0.217
         Skew:  0.014        Prob(JB):  0.897
     Kurtosis:  2.193        Cond. No.   89.9
```

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Self test

Run the regression above but instead write 'wpc ~ W' instead of 'wpc ~ pyth' in the line starting pyth_lm. What difference does this make?

Conclusion

Why did the Pythagorean model produce a good fit for the baseball data but not for the cricket data? An obvious explanation is that there is some difference between the two sports which makes the model appropriate for one but not the other. For example, in cricket, the team batting second need only score one more run than the opponent to win, and so the inning ends if it reaches this milestone. If the team batting second is the winning team, then the gap in the scores will be small. However, if the team batting first can get all ten wickets cheaply, then the gap in scores could be very large. In our data the average runs difference when the team batting second won was 2, and when the team batting first won was 30. This might explain why the Pythagorean Expectation is not a good guide to winning in the IPL.

But there could be more basic statistical explanations. For MLB we had averages for 30 teams, each of which played about 160 games. Random variations are likely to be smoothed out when analyzing data on this scale. For the IPL we had only 8 teams, most of whom played only 14 games - so there is a much greater chance that random variations could have overwhelmed the Pythagorean model if it were correct.

Anyone interested in pursuing this further, might try two things. First, analyze games where the winning team bats first or second separately. Second, find data covering more seasons (not difficult to find online) in order to generate a much larger sample.

For now, however, we are going to move on and look at another sport: basketball.

In [ ]: