

Monte Carlo Simulation on British Premier League Outcomes

Datasets of the **previous season scoring table**: (Season 2017-2018)

	Team Name	Home Goals	Away Goals	Total Goals	Home Goals Per Game	Away Goals Per Game
0	AFC Bournemouth	26.0	19.0	45.0	1.368421	1.000000
1	Arsenal	54.0	20.0	74.0	2.842105	1.052632
2	Brighton and Hove Albion	24.0	10.0	34.0	1.263158	0.526316
3	Burnley	16.0	20.0	36.0	0.842105	1.052632
4	Chelsea	30.0	32.0	62.0	1.578947	1.684211
5	Crystal Palace	29.0	16.0	45.0	1.526316	0.842105
6	Everton	28.0	16.0	44.0	1.473684	0.842105
7	Huddersfield Town	16.0	12.0	28.0	0.842105	0.631579
8	Leicester City	25.0	31.0	56.0	1.315789	1.631579
9	Liverpool	45.0	39.0	84.0	2.368421	2.052632
10	Manchester City	61.0	45.0	106.0	3.210526	2.368421
11	Manchester United	38.0	30.0	68.0	2.000000	1.578947
12	Newcastle United	21.0	18.0	39.0	1.105263	0.947368
13	Southampton	20.0	17.0	37.0	1.052632	0.894737
14	Stoke City	20.0	15.0	35.0	1.052632	0.789474
15	Swansea City	17.0	11.0	28.0	0.894737	0.578947
16	Tottenham Hotspur	40.0	34.0	74.0	2.105263	1.789474
17	Watford	27.0	17.0	44.0	1.421053	0.894737
18	West Bromwich Albion	21.0	10.0	31.0	1.105263	0.526316
19	West Ham United	24.0	24.0	48.0	1.263158	1.263158

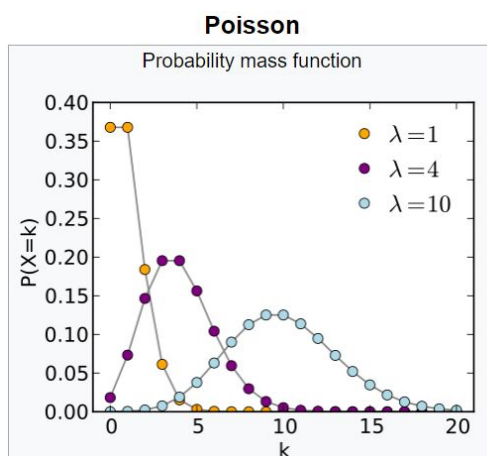
Dataset of the **FIFA BPL team ranking**:(Season 2017-2018)

	Name	ATT	MID	DEF	OVR
0	Manchester City	85	87	83	84
1	Spurs	85	83	82	83
2	Manchester Utd	85	83	81	83
3	Chelsea	84	86	82	83
4	Arsenal	84	80	81	82
5	Liverpool	85	81	80	81
6	Everton	77	80	79	79
7	Leicester City	79	79	76	78
8	West Ham	79	76	74	77
9	Watford	78	77	75	77
10	Burnley	76	77	78	77
11	Crystal Palace	79	76	76	76
12	West Brom	79	75	77	76
13	Southampton	76	77	75	76
14	Bournemouth	76	75	75	76
15	Stoke City	75	76	76	76
16	Newcastle Utd	76	75	76	75
17	Swansea City	76	75	74	75
18	Brighton	74	76	74	75
19	Huddersfield	75	73	74	74

Based on the match parameters from last season, our team implements an algorithm with the **Poisson Distribution** to calculate the goal scoring probability.

$$P(k \text{ events in interval}) = e^{-\lambda} \frac{\lambda^k}{k!}$$

In this formula, k means the goals that a team might score in one match, p(#goals) is the probability to score that many goals, for example, *Probability(1 goal) = 0.20* and we have to choose lambda cautiously:



The lambda factor in Posson Distribution can **only be less than 4**, in order for goals of a range from 0 to 10 to make sense. (It's very unlikely in a soccer game that a team would score more than 10 goals), we use the following math operation to get lambda by taking home/away differences into consideration:

$$\lambda(\text{home team}) = \text{home goals per game} * \frac{\text{home team FIFA ATT}}{\text{average ATT}} * \frac{\text{away team FIFA DEF}}{\text{average DEF}}$$

$$\lambda(\text{away team}) = \text{away goals per game} * \frac{\text{away team FIFA ATT}}{\text{average ATT}} * \frac{\text{home team FIFA DEF}}{\text{average DEF}}$$

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formula.head()
```

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]:
```

	Home Team	Away Team	Home Team Lambda	Away Team Lambda	P-Home	P-Away	Prob-Home	Prob-Away
0	Manchester City	AFC Bournemouth	3.34091	1.02967	[0.03540478826010322, 0.11828414764419592, 0.1...	[0.3571233145837561, 0.36772064104794544, 0.18...	[0.03540478826010322, 0.15368893590429916, 0.3...	[0.3571233145837561, 0.7248439556317016, 0.914...
1	Manchester City	Arsenal	3.60818	1.19796	[0.027101102672097692, 0.09778568002541065, 0....	[0.301809628151827, 0.3615555092445389, 0.2165...	[0.027101102672097692, 0.12488678269750833, 0....	[0.301809628151827, 0.6633651373963658, 0.8799...
2	Manchester City	Brighton and Hove Albion	3.29636	0.527672	[0.037017564467100965, 0.12202332111045876, 0....	[0.5899766364472965, 0.31131435354332965, 0.08...	[0.037017564467100965, 0.15904088557755972, 0....	[0.5899766364472965, 0.9012909899906261, 0.983...

Sample goal distribution:

```
formula.loc[(formula['Home Team'] == 'Manchester City') & (formula['Away Team'] == 'Arsenal'), 'P-Home'].tolist()
]: [[0.027101102672097692,
0.09778568002541065,
0.17641420966750407,
0.21217812508963627,
0.19139426261950668,
0.1381170231311615,
0.08305853328415272,
0.04281288718540448,
0.019309580028574913,
0.007741384125563063,
0.0027932314054345806]]
```

According to the fixture schedule, one team playing against a different team would have distinct goal distribution. Then the **random number is generated to get the home team goals and away team goals to determine the winner**, the simulation executes with output:

```
In [221]: simulation(fixture_schedule)

Arsenal 3 : 2 Leicester City
Watford 0 : 1 Liverpool
Chelsea 0 : 2 Burnley
Crystal Palace 0 : 0 Huddersfield Town
Everton 3 : 0 Stoke City
Southampton 0 : 0 Swansea City
West Bromwich Albion 2 : 0 AFC Bournemouth
Brighton and Hove Albion 0 : 0 Manchester City
Newcastle United 0 : 1 Tottenham Hotspur
Manchester United 5 : 1 West Ham United
Swansea City 0 : 0 Manchester United
AFC Bournemouth 0 : 0 Watford
Burnley 0 : 0 West Bromwich Albion
Leicester City 1 : 0 Brighton and Hove Albion
Liverpool 0 : 0 Crystal Palace
Southampton 0 : 0 West Ham United
Stoke City 0 : 1 Arsenal
Huddersfield Town 1 : 0 Newcastle United
Tottenham Hotspur 0 : 2 Chelsea
Manchester City 0 : 0 Everton
```

One season would consist of 380 entries like above since there are a total of 380 matches; gather matches' result to create new score table for this simulated season:

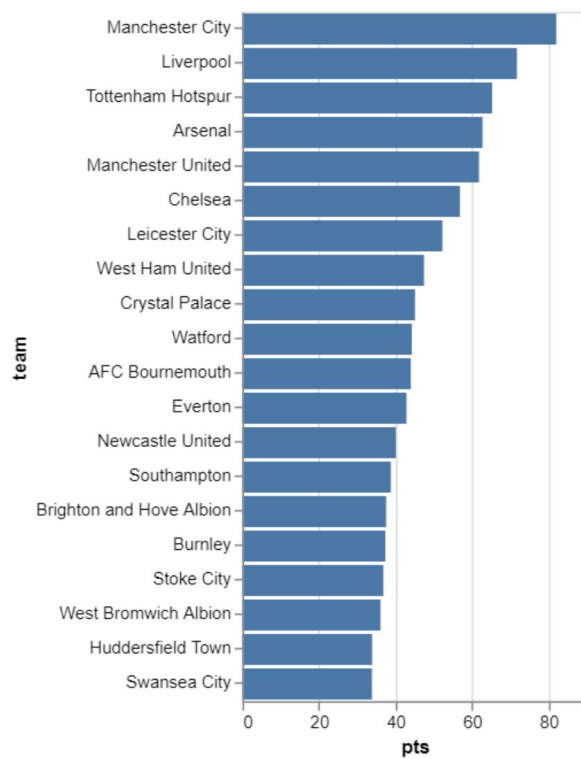
	team	w	l	gf	ga	gd	pts
11	AFC Bournemouth	7	8	16	18	-2	44
0	Arsenal	18	11	66	37	29	63
7	Brighton and Hove Albion	9	10	11	13	-2	46
12	Burnley	7	13	12	26	-14	39
2	Chelsea	11	12	26	37	-11	48
3	Crystal Palace	11	7	24	19	5	53

Limited by the computing time of our model, we only run the simulation 1000 times and get the average of each data frame cell of 1000 seasons:

team	w	l	gf	ga	gd	pts
Manchester City	24.736	5.474	77.802	25.828	51.974	81.998
Liverpool	20.351	6.979	55.374	25.455	29.919	71.723
Tottenham Hotspur	17.663	8.080	45.604	26.378	19.226	65.246
Arsenal	16.762	8.787	47.666	26.063	21.603	62.737
Manchester United	16.238	8.669	40.491	26.345	14.146	61.807
Chelsea	14.222	9.629	34.548	27.521	7.027	56.815
Leicester City	11.911	9.564	26.710	24.532	2.178	52.258
West Ham United	9.867	10.284	20.723	23.928	-3.205	47.450
Crystal Palace	9.115	11.129	19.343	25.184	-5.841	45.101
Watford	8.669	11.067	17.984	24.776	-6.792	44.271
AFC Bournemouth	8.579	11.177	17.568	24.676	-7.108	43.981
Everton	8.392	11.933	17.761	26.961	-9.200	42.851
Newcastle United	6.910	11.740	13.988	25.182	-11.194	40.080
Southampton	6.335	11.902	12.396	24.898	-12.502	38.768
Brighton and Hove Albion	5.793	12.046	11.233	24.313	-13.080	37.540
Burnley	5.782	12.217	11.819	25.996	-14.177	37.347
Stoke City	5.630	12.435	11.137	25.467	-14.330	36.825
West Bromwich Albion	5.338	12.611	10.619	26.054	-15.435	36.065
Huddersfield Town	4.173	12.463	7.561	24.181	-16.620	33.883
Swansea City	4.130	12.410	7.708	24.297	-16.589	33.850

Compare the average result with the previous season of 2017-2018:

Simulated:



Real:

