

Optimizing the Best Schedule to Watch IPL 2017

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Executive Summary

The Indian Premier League (IPL) is a Twenty20 cricket league in India that occurs every year around April-May. Each team that participates in the tournament represent their city. The IPL is the most-attended cricket league in the world and starting 2008, the craze for the game has risen each year. The game strikes a perfect balance between glamour and cricket, and is considered one of the best entertainment for a cricket crazy nation like India. The fun of watching IPL at a stadium is far richer than just watching it on TV, with many fans not wanting to miss even a single ball of live action.

The objective of this report is to highlight how optimization technique such as Linear Integer Programming can help an international TV channel reporter, who is planning to visit all the cities where IPL matches are being hosted. The objective is to plan and optimize the cost to cover IPL matches at the home ground of a particular team, per day, per city for consecutive 8 days, without visiting a particular city twice and covering all the 8 cities.

The analysis demonstrate how Travelling Salesman Problem can be extended to watch one IPL match every day in a new city at the minimum cost of travelling by plane to that city.

Further the report also highlights how the reporter can cover the entire expense of this tour by placing optimum bets on each team which will maximize the chances of winning at minimum risk. Using simulation we demonstrate the riskiness of going ahead with the proposed strategy for betting and the maximum, minimum returns

Business Objective

- Schedule 8 day plan by travelling in airplane at minimum cost to watch one IPL match at the home ground of the playing teams without visiting the same ground (same city) twice.
- Optimize the chance of winning the bet by allocating money on the team with the highest chances of winning and returning highest total expected winnings. Using risk analysis, evaluate the riskiness of placing these bets.

Data Collection and Pre-processing

1. IPL Schedule

The data for the match schedule (1st may to 8th May 2017) was developed referring to the official IPL 2017 schedule starting 5th April- <http://www.iplt20.com/schedule>. We selected the schedule as 1st to 8th May as we could collect real time flight data as well as many other details and add complexity in our problem.

The schedule used for our analysis was developed as follows

- Collate the matches into single day if there are series of days having single match. E.g. 5th, 6th and 7th April 2017 have single matches in the official schedule. These are collated together as 1st May.
- If there are multiple matches on a single day, the schedule is taken as it is. E.g. 8th April has two matches, and these are taken directly as matches on 2nd May
- Matches happening in the city of Indore (10th April) are replaced with Mohali to represent the home team for Kings XI Punjab

IPL Schedule (1st to 8th May)				
Home	Away	Home City	Day	Date
Sunrisers Hyderabad	Royal Challengers Bangalore	Hyderabad	Mon	01-May
Rising Pune Supergiant	Mumbai Indians	Pune	Mon	01-May
Gujarat Lions	Kolkata Knight Riders	Rajkot	Mon	01-May
Kings XI Punjab	Rising Pune Supergiant	Mohali	Tue	02-May
Royal Challengers Bangalore	Delhi Daredevils	Bengaluru	Tue	02-May
Sunrisers Hyderabad	Gujarat Lions	Hyderabad	Wed	03-May
Mumbai Indians	Kolkata Knight Riders	Mumbai	Wed	03-May
Kings XI Punjab	Royal Challengers Bangalore	Mohali	Thurs	04-May
Rising Pune Supergiant	Delhi Daredevils	Pune	Thurs	04-May
Mumbai Indians	Sunrisers Hyderabad	Mumbai	Thurs	04-May
Kolkata Knight Riders	Kings XI Punjab	Kolkata	Thurs	04-May
Royal Challengers Bangalore	Mumbai Indians	Bengaluru	Fri	05-May
Gujarat Lions	Rising Pune Supergiant	Rajkot	Fri	05-May
Kolkata Knight Riders	Sunrisers Hyderabad	Kolkata	Sat	06-May
Delhi Daredevils	Kings XI Punjab	Delhi	Sat	06-May
Mumbai Indians	Gujarat Lions	Mumbai	Sun	07-May
Royal Challengers Bangalore	Rising Pune Supergiant	Bengaluru	Sun	07-May
Delhi Daredevils	Kolkata Knight Riders	Delhi	Mon	08-May
Sunrisers Hyderabad	Kings XI Punjab	Hyderabad	Mon	08-May

2. Cost Matrix

This the flight cost of travelling from city A to city B. We assumed that on each day the journalist will travel in the morning and hence have chosen the cheapest flight during the morning hours. The data is obtained from <http://www.air.ircrc.co.in>. We have assumed that the user might book the schedule 3 months in advance and hence have chosen the flight prices as of 2nd August 2017

Flight Prices	(As calculated on 2nd May for 2nd Aug (Estimating the prices Prior 3 months booking))							
Venues and flight prices in Rupees	Bangalore	Delhi	Hyderabad	Kolkata	Mohali	Mumbai	Pune	Rajkot
Bangalore	0	3165	1350	3082	3999	1960	2149	8829
Delhi	3687	0	2816	2735	1499	2298	3066	9289
Hyderabad	1351	3223	0	3077	5257	1652	2183	8546
Kolkata	3246	3165	2542	0	3965	4137	4436	10576
Mohali	4844	2097	4882	5068	0	3687	5082	5103
Mumbai	2111	2655	1987	3914	3835	0	9287	6727
Pune	2066	2737	1643	3107	3537	3981	0	5189
Rajkot	10263	8998	8073	13784	15983	6374	16258	0

Flight Prices (As calculated on 2nd May for 2nd Aug (Estimating the prices Prior 3 months booking))									
Venues and flight prices in Rupees	1	2	3	4	5	6	7	8	
1	0	3165	1350	3082	3999	1960	2149	8829	Bangalore
2	3687	0	2816	2735	1499	2298	3066	9289	Delhi
3	1351	3223	0	3077	5257	1652	2183	8546	Hyderabad
4	3246	3165	2542	0	3965	4137	4436	10576	Kolkata
5	4844	2097	4882	5068	0	3687	5082	5103	Mohali
6	2111	2655	1987	3914	3835	0	9287	6727	Mumbai
7	2066	2737	1643	3107	3537	3981	0	5189	Pune
8	10263	8998	8073	13784	15983	6374	16258	0	Rajkot
Optimum path									
Day	1st May	2nd May	3rd May	4th May	5th May	6th May	7th May	8th May	
Start	Bangalore	Pune	Kolkata	Hyderabad	Mumbai	Delhi	Mohali	Rajkot	
Cities	1	7	4	3	6	2	5	8	
Cost	0	2149	3107	2542	1652	2655	1499	5103	
Total Cost									
18707									

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

\$C\$19:\$J\$19 = AllDifferent

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Objective: To visit each city at the least cost of travelling

On solving the above using Evolutionary Solver, all the cities starting from Bangalore to Rajkot can be covered at the total expense of **₹18,707**.

However, the above schedule doesn't consider the fact whether the city, which is visited, has an IPL match on that day.

E.g. according to the above schedule, the user visits Bangalore and Pune on 1st and 2nd May respectively. However there is no match on these dates with the respective teams (Royal Challengers Bangalore and Rising Pune Supergiant)

2. Extending Travelling Salesman Problem with Constraints

We now add the necessary constraint of visiting a city only if there is a match scheduled on that day. Also we ensure that each city is visited only once in the entire tour and that only one match is seen per day.

The cost matrix is the same as above. We created a schedule matrix as follows

		Rajkot	Delhi	Mohali	Kolkata	Mumbai	Pune	Bangalore	Hyderabad			
May	1	1	0	0	0	0	1	0	1	1	=	1
May	2	0	0	1	0	0	0	1	0	1	=	1
May	3	0	0	0	0	1	0	0	1	1	=	1
May	4	0	0	1	1	1	1	0	0	1	=	1
May	5	1	0	0	0	0	0	1	0	1	=	1
May	6	0	1	0	1	0	0	0	0	1	=	1
May	7	0	0	0	0	1	0	1	0	1	=	1
May	8	0	1	0	0	0	0	0	1	1	=	1
Total Matches		2	2	2	2	3	2	3	3			



Here $S_{i,j} = 1$ or 0 ;

i varies from 1 to 8 (1st to 8th May)

j varies from 1 to 8

(1 = Rajkot, 2 = Delhi, 3 = Mohali, 4 = Kolkata, 5 = Mumbai, 6 = Pune, 7 = Bangalore, 8 = Hyderabad)

In the above matrix, value =1 means that there is match in a particular city on a particular day where the home team is playing, for e.g. on May 1st there is a match between Gujarat Lions vs Kolkata Knight Riders at Rajkot (home ground for Gujarat Lions). Hence there is a value of 1 under Rajkot for May 1.

The entire problem can be formulated as below

Decision Variable

$X_{i,j} = 1$ or 0 ; (64 decision variables)

i varies from 1 to 8 (1st to 8th May),

j varies from 1 to 8

(1 = Rajkot, 2 = Delhi, 3 = Mohali, 4 = Kolkata, 5 = Mumbai, 6 = Pune, 7 = Bangalore, 8 = Hyderabad)

Objective Function

Min. $8998Y_{12} + 15983Y_{13} + 13784Y_{14} + \dots + 2149Y_{76} + 1350Y_{78}$

Where Y_{12} : represents that the person is travelling from city 1 to city 2 (here both 1, 2 are jth part of decision variable) and the value represent the cost of travelling from city 1 to city 2

Constraints

$\sum X_{1,j} = 1; j = 1$ to 8 (sum of each row = 1, i.e. watch only one match per day)

$\sum X_{2,j} = 1; j = 1$ to 8

...

$\sum X_{8,j} = 1; j = 1$ to 8

$\sum X_{i,1} = 1; i = 1$ to 8 (sum of each column = 1, i.e. watch only one match per city)

$\sum X_{i,2} = 1; i = 1$ to 8

...

$\sum X_{i,8} = 1; i = 1$ to 8

SUMPRODUCT ($S_{1,j}, X_{1,j}$) = 1; $j = 1$ to 8 (ensuring to watch a match only when it is scheduled for a day)

SUMPRODUCT ($S_{2,j}, X_{2,j}$) = 1; $j = 1$ to 8

SUMPRODUCT ($S_{3,j}, X_{3,j}$) = 1; $j = 1$ to 8

....

SUMPRODUCT ($S_{8,j}, X_{8,j}$) = 1; $j = 1$ to 8

The problem to find the optimum path with 8 cities has total 40,320 combinations possible. We assume that our starting city is Bangalore and the user visits Pune as the first city. However, Solver takes a lot of time to generate the sequence of visit because of these many combinations. Below is the complete formulation of the problem in excel

(Referring to sheet 8TeamsSolution)

Date/City	Rajkot	Delhi	Mohali	Kolkata	Mumbai	Pune	Bangalore	Hyderabad			Cost	Departure City	Game City	
May 1	0	0	0	0	0	1	0	0	1	=	2149	Bangalore	Pune	Gave a start to solver, starting from Bangalore and visiting Pune first
May 2	0	0	0	0	0	0	1	0	1	=	2066	Pune	Bangalore	
May 3	0	0	0	0	0	0	0	1	1	=	1350	Bangalore	Hyderabad	Rowsum = Per day only one match can be viewed (Any team, no repeat)
May 4	0	0	1	0	0	0	0	0	1	=	5257	Hyderabad	Mohali	Colsum = Only one match (in the entire tour) per team can be viewed
May 5	1	0	0	0	0	0	0	0	1	=	5103	Mohali	Rajkot	
May 6	0	0	0	1	0	0	0	0	1	=	13784	Rajkot	Kolkata	
May 7	0	0	0	0	1	0	0	0	1	=	4137	Kolkata	Mumbai	
May 8	0	1	0	0	0	0	0	0	1	=	2655	Mumbai	Delhi	
	1	1	1	1	1	1	1	1			36501			
	=	=	=	=	=	=	=	=						
	1	1	1	1	1	1	1	1						
May 1	1	0	0	0	0	1	0	1	1	=		1		if team has a match on this date and is playing on home ground
May 2	0	0	1	0	0	0	1	0	1	=				0 otherwise (even though the team has a match but is not playing on it's home ground)
May 3	0	0	0	0	1	0	0	1	1	=				
May 4	0	0	1	1	1	1	0	0	1	=				
May 5	1	0	0	0	0	0	1	0	1	=				
May 6	0	1	0	1	0	0	0	0	1	=				
May 7	0	0	0	0	1	0	1	0	1	=				
May 8	0	1	0	0	0	0	0	1	1	=				
Total Matches	2	2	2	2	3	2	3	3						

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:

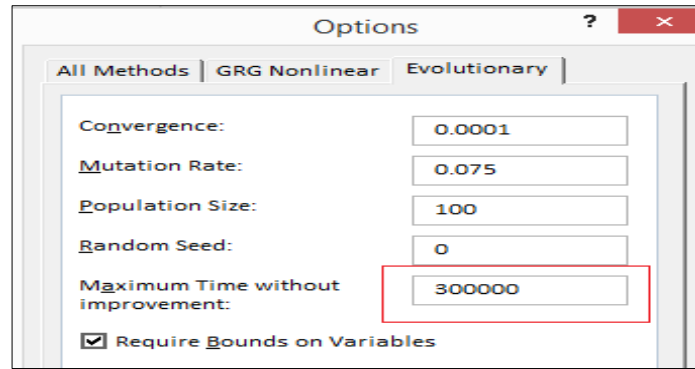
Subject to the Constraints:

\$D\$11:\$K\$11 = \$D\$13:\$K\$13
 \$D\$4:\$K\$10 = binary
 \$L\$16:\$L\$23 = \$N\$16:\$N\$23
 \$L\$3:\$L\$10 = \$N\$3:\$N\$10

☒ **Make Unconstrained Variables Non-Negative**

Select a Solving Method:

We have used Evolutionary solving method to find the optimum solution and increased the time limit of finding a solution without improvement as a very high value. Under Options -> Evolutionary



A miniature version of the above problem is demonstrated in the sheet '4TeamsSolution', which take lesser time to display the result. Here we have formulated the same problem for 4 teams and 4 days. Starting city for this problem is again Bangalore

The optimum path, covering all the 8 cities, can be achieved at the cost of **₹36501** in the order

Pune, Bangalore, Hyderabad, Mohali, Rajkot, Kolkata, Mumbai, Delhi

The following is the series of matches to be watched

IPL Schedule (1st to 8th May)				
Home	Away	Home City	Day	Date
Sunrisers Hyderabad	Royal Challengers Bangalore	Hyderabad	Mon	01-May
Rising Pune Supergiant	Mumbai Indians	Pune	Mon	01-May
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Kings XI Punjab	Rising Pune Supergiant	Mohali	Tue	02-May
Royal Challengers Bangalore	Delhi Daredevils	Bengaluru	Tue	02-May
Sunrisers Hyderabad	Gujarat Lions	Hyderabad	Wed	03-May
Mumbai Indians	Kolkata Knight Riders	Mumbai	Wed	03-May
Kings XI Punjab	Royal Challengers Bangalore	Mohali	Thurs	04-May
Rising Pune Supergiant	Delhi Daredevils	Pune	Thurs	04-May
Mumbai Indians	Sunrisers Hyderabad	Mumbai	Thurs	04-May
Kolkata Knight Riders	Kings XI Punjab	Kolkata	Thurs	04-May
Royal Challengers Bangalore	Mumbai Indians	Bengaluru	Fri	05-May
Gujarat Lions	Rising Pune Supergiant	Rajkot	Fri	05-May
Kolkata Knight Riders	Sunrisers Hyderabad	Kolkata	Sat	06-May
Delhi Daredevils	Kings XI Punjab	Delhi	Sat	06-May
Mumbai Indians	Gujarat Lions	Mumbai	Sun	07-May
Royal Challengers Bangalore	Rising Pune Supergiant	Bengaluru	Sun	07-May
Delhi Daredevils	Kolkata Knight Riders	Delhi	Mon	08-May
Sunrisers Hyderabad	Kings XI Punjab	Hyderabad	Mon	08-May

3. Making Optimum Bets with Maximum Returns and Minimum Risk

The above analysis shows that the cost of travelling by plane to the 8 cities is ₹36501. We also calculate the travelling, staying and food expenditures as follows

Average per night cost at hotel = ₹1000

Average cost of food per day = ₹400

Average cost of travelling within city = ₹200

Total average cost per city = ₹1600

Total cost of 8 cities = ₹12800

The total expenditure of this tour is around **₹50000**

For our calculations, we have assumed that the user is in the position to bet ₹1000 on any 5 out of 8 games. If the team on which the user bets wins the match, the user is paid an amount after multiplying the payoff ratio.

If the team wins a match, user wins,

Winnings = 1000 * Payoff Ratio of the team

If the team loses, user loses,

Loss = 1000

Payoff Ratio

Sort By: Favourite	bet365	sky BET	BET STARS	Chaitany HILL	BETRED	sportingbet	BETVICTOR	PADDYPOWER	StarJames.com	Ladbrokes	CORAL	BoyleSports	winner	betfair	betway	BETTING	NetBet	bwin	32Red	10 bet	MARATHON	188BET	888	BLACK TYPE	000000	betfair	BETDAQ	MATCHBOOK
Mumbai Indians	15/8	2		2	2	2	2	2	2	15/8	15/8	2	9/4	2	7/4		2	9/4	2	2		7/4	2			2	19/10	21/10
Kolkata Knight Riders	11/4	11/4		11/4	3	3	11/4	5/2	11/4	3	3	11/4	3	5/2	3		11/4	11/4	11/4	28/11		11/4	11/4			7/2	10/3	3
Hyderabad Sunrisers	7/2	11/4		3	7/2	7/2	11/4	11/4	3	7/2	7/2	10/3	10/3	11/4	7/2		7/2	7/2	11/4	7/2		3	11/4			7/2	10/3	7/2
Rising Pune Supergiants	9/2	9/2		5	9/2	9/2	5	5	5	9/2	9/2	9/2	4	5	9/2		9/2	5	9/2	9/2		9/2	9/2			24/5	24/5	23/5
Kings XI Punjab	11	12		9	10	11	10	11	10	10	10	11	10	11	10		10	10	11	10		10	11			64/5	12	64/5
Delhi Daredevils	50	40		40	33	40	40	50	33	33	33	33	33	50	33		40	10	33	40		50	33			39	35	40
Gujarat Lions	50	25		25	25	33	25	75	28	25	25	25	33	70	33		28	18	25	28		33	25			51	49	38
Royal Challengers Bangalore							80							500				50								712	620	99

The above problem in excel is as follows (considering the sequence of cities as obtained before)

If a team has lost all it's last 5 matches, we give 0.1 weight													
Expected Winnings											Riskiness		
Date	Home Team	Away	# of Games Head-To-Head (as of May 1 2017)	Home team Win %	Last 5 Win % (as of May 1 2017)	Total Home Team Win %	Payoff Ratio	Bet this game?	Bet Amount	Expected Winnings	Random Number	Win/Loss	Payoff Winnings
01-May	Rising Pune Supergiant	Mumbai Indians	4	0.75	0.8	0.6	5	1	1000	4000	0.647753	loss	-1000
02-May	Royal Challengers Bangalore	Delhi Daredevils	18	0.6111111111	0.1	0.0611111111	500	1	1000	31555.5556	0.713435	loss	-1000
03-May	Sunrisers Hyderabad	Gujarat Lions	4	1	0.5	0.5	3.5	0	0	0	0.827507	loss	0
04-May	Kings XI Punjab	Royal Challengers Bangalore	19	0.578947368	0.4	0.231578947	12.8	1	1000	3964.21053	0.110709	win	12800
05-May	Gujarat Lions	Rising Pune Supergiant	4	0.5	0.4	0.2	75	1	1000	16000	0.2463	loss	-1000
06-May	Kolkata Knight Riders	Sunrisers Hyderabad	11	0.636363636	0.6	0.381818182	3.5	0	0	0	0.190932	win	0
07-May	Mumbai Indians	Gujarat Lions	4	0.5	0.8	0.4	2.25	0	0	0	0.129468	win	0
08-May	Delhi Daredevils	Kolkata Knight Riders	20	0.35	0.2	0.07	50	1	1000	4500	0.684087	loss	-1000
								5					
								=					
								5					
Total Expected Winnings					60019.76608		Total Payoff Winnings					8800	

The terminologies and formula used for calculation are

- a. # of Games Head-To-Head (as of May 1 2017) – The total number of games the two teams have played over all seasons till 1st May 2017
- b. Home team Win % - Percentage of wins for home team. This number gives a general idea of the how teams perform when they play against each other
- c. Last 5 Win % (as of May 1 2017) – Percentage of wins in the last 5 matches of the current season (2017). This number is the indication of the current form of the team.
- d. Total Home Team Win % - Product of b and c. This number gives the probability of a team winning considering the past record of the teams against each other, as well as their current form. The chance of a team winning not only depends on its record in the past seasons, but also the current form makes a lot of difference
- e. Payoff Ratio – this is the payoff ratio as obtained from the matrix shown above
- f. Bet this game? – whether the user should bet on this game (decision variable)
- g. Bet Amount – the user bets ₹1000 for each game, if ever it bets
- h. Expected Winnings - if the user bets on this game,
Expected winnings = [(Bet Amount * Payoff Ratio) * Total Home Team Win %]

Problem formulation

Decision Variable

$X_i = 1$; if a bet is made on the home team, i varies from 1 to 8 (8 teams)
 $= 0$ otherwise

Bet Amount = $1000 * X_i$

Expected winnings = [(Bet Amount * Payoff Ratio) * Total Home Team Win %]

Total Expected Winnings = \sum (Expected winnings), from 1 to 8

Objective Function

Max. Total Expected Winnings

Constraints

$$\sum X_i = 5$$

We use Simplex algorithm to solve this problem,

Solver Parameters

Set Objective:

To: ☒ Max ☐ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Buttons: Add, Change, Delete, Reset All, Load/Save, Options

The total expected winnings is **₹60019.76608** which can be obtained on betting the following teams

Date	Home Team	Away
01-May	Rising Pune Supergiant	Mumbai Indians
02-May	Royal Challengers Bangalore	Delhi Daredevils
03-May	Sunrisers Hyderabad	Gujarat Lions
04-May	Kings XI Punjab	Royal Challengers Bangalore
05-May	Gujarat Lions	Rising Pune Supergiant
06-May	Kolkata Knight Riders	Sunrisers Hyderabad
07-May	Mumbai Indians	Gujarat Lions
08-May	Delhi Daredevils	Kolkata Knight Riders

We now evaluate the risk involved in betting on the above teams.

						Riskiness		
Last 5 Win % (as of May 1 2017)	Total Home Team Win %	Payoff Ratio	Bet this game?	Bet Amount	Expected Winnings	Random Number	Win/Loss	Payoff Winnings
0.8	0.6	5	1	1000	4000	0.530766	win	5000
0.1	0.061111111	500	1	1000	31555.5556	0.948095	loss	-1000
0.5	0.5	3.5	0	0	0	0.343141	win	0
0.4	0.231578947	12.8	1	1000	3964.21053	0.426195	loss	-1000
0.4	0.2	75	1	1000	16000	0.091241	win	75000
0.6	0.381818182	3.5	0	0	0	0.700354	loss	0
0.8	0.4	2.25	0	0	0	0.731325	loss	0
0.2	0.07	50	1	1000	4500	0.460807	loss	-1000
			5					
			=					
			5					
60019.76608						Total Payoff Winnings		77000

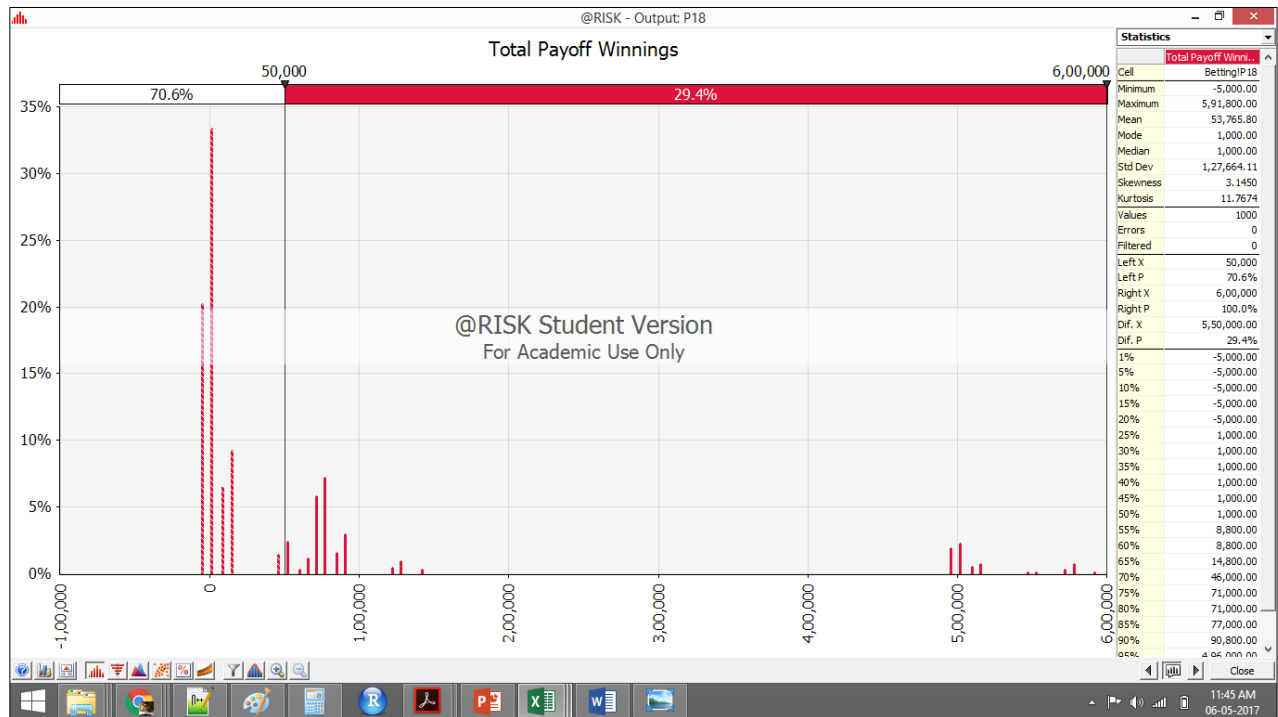
We generate random numbers between 0 and 1.

If the Total Home Team Win % is less than the random number, we mark it as 'loss' otherwise 'win'.

Payoff winnings = [Bet Amount * Payoff Ratio] * win/loss

Total Payoff Winnings = \sum Payoff winnings, from 1 to 8

Using @Risk software, we simulate the 'Total Payoff Winnings' over 1000 iterations



Minimum winnings = -₹5000 (loss)

Maximum winnings = ₹5,91,800

Mean winnings = ₹53,765

There is a 29.4% chance that the winnings will be ₹50,000 (total expenditure) and above using the methodology as explained above.

Conclusion

Using Linear Integer Programming techniques, it is possible to complete the tour of visiting 8 cities with the objective to watch one match per day in each city at the most optimum cost of ₹36501. Further the complete expenditure of the tour can be recovered by optimally betting on teams resulting in maximum expected winnings. However there is huge risk associated with this method and further analysis to take less risky approach may be used to improve the chances of win.