

# **Optimization of a sports team**

Sandeep Gunda

Mohit Savani

Girraj Maheshwari

## **Table of Contents**

1. Introduction: .....	2
2. Motivation: .....	3
3. Methodology:.....	3
3.1. Key performance indicators:.....	3
3.2. Constraints: .....	3
3.3. Decision variable: .....	5
4. Comparison:.....	5
5. Challenges and future work:.....	6
6. Research similar to our studies:.....	6
7. Acknowledgement:.....	7

## **1. Introduction:**

Selection of well-performing players is vital to any team. In case of premier leagues (e.g., Indian Premier League), there are a set of franchises/teams who participate in an auction to select players from the player pool, based on various parameters. To prevent exploitation by rich franchises, there is a fixed limit on the amount that could be spent for the team, thus limiting them from buying all the expensive/ best players at once.

The game of Cricket also called a gentleman's game, is played between two teams of 11 players each. While a toss decides the order of which team goes first, the first team is choosing to bat sets a score by scoring runs, while the second team bowls to take wickets (dismiss batsmen). Once they are done, the first team bowls to defend their score, while the second team bats to beat the target with wickets remaining.

There are multiple roles assigned to players in cricket. They are:

1. **Batsman:** A batsman's objective is to score runs. He faces a ball thrown by a bowler to hit it. There are two batsmen of a team on the ground at a time, on each side of the pitch of 22 yards, with a set of 3 wickets at each end. Runs are scored in 3 ways:
  - a. Hitting a ball and running between the wickets before the ball is returned to the pitch.
  - b. Hitting a ball across the field in any direction to cross the boundary in the end. If it crosses the boundary without touching the ground, then its six runs, otherwise its four runs.
  - c. When a bowler throws an invalid ball like a wide, no ball, etc. These runs are called extras.
2. **Bowler:** A bowler can only bowl for a limited number of overs in a match, where each over consists of 6 balls. His main objective is to restrict the batsmen from scoring runs and taking wickets (dismissing batsmen). A wicket is taken 3 ways:
  - a. When a batsman misses a ball, and it hits a wicket.
  - b. When the ball hit by a batsman is caught by a fielder, before hitting the ground.
  - c. When the batsman is running between the wickets after hitting the ball, and the wickets are taken down by the ball before he reaches the end of the pitch.
3. **Wicketkeeper:** A wicket keeper is from the bowling team. He stands behind the batsman and the wickets. He must catch the balls missed by the batsmen and strike the wickets if he has the ball when the batsman is not at the crease.
4. **Fielder:** All the players in the bowling team other than a bowler and the wicketkeeper are the fielders. They are placed at strategic locations across the field to stop the balls hit by the batsmen and throw them back to the bowler or the wicketkeeper as soon as possible

## 2. Motivation:

In Indian Premier League, 11 teams are competing in a round-robin tournament. Before the tournament, there is an auction to buy players based on the fixed budget for each team, with some limitation on the number of foreign players per team, number of uncapped players per team, etc.

In IPL, the franchise managers have a task of building a good team within the budget cap. The players are usually selected based on different heuristics, past experiences, or at most some crude methodologies.

*Using the player statistics, we want to build the best team possible for the lowest cost possible, using our optimization model.*

## 3. Methodology:

Each player has multiple parameters based on their role in the game, which determine the quality of the player. Batsmen have parameters like batting average, strike rate, runs scored, matches played, number of 4s and 6s, etc. Bowlers have parameters like matches played; overs bowled, maidens (overs bowled without giving and runs) bowled, wickets are taken, economy, bowling average, etc. Wicketkeepers are usually considered based on the number of catches taken.

### 3.1. Key performance indicators:

- Batting Performance: It is the sum of the batting averages of the batsmen in the team.
- Bowling Performance: It is the sum of the bowling averages of the bowlers in the team.
- Objective Function: Maximize the difference between batting performance a bowling performance.

### 3.2. Constraints:

- Is\_International  $\leq 4$ : 1 if the player is not domestic. There is an upper cap on some international players.
- Strike\_Rate: It is defined as the average number of runs scored per 100 balls faced. The higher the strike rate, the more effective is the batsman at scoring runs quickly.
- Number of Player(binary): The total number of players to be considered for a team which is 16.
- Is\_Bowler(binary): IF the player is a bowler, the value is 1, else 0. We need at least bowlers in a team.
- Is\_Batsman(binary): If the player is a bowler, the value is 1, else 0. We need at least five batsmen in a team.
- Is\_Wc(binary): We need at least one wicketkeeper-batsmen in a team. If the player is a Wicketkeeper, the value is 1, else 0. We consider, that wicketkeeper is always a batsman

- **Is\_Lefty:** For a good team, a good combination of left-handed, and right-handed batsmen is necessary as the bowler must keep switching tactics for right and left-handed batsmen. We need at least two left-handed batsmen.
  - **Is\_Righty:** For a good team, a good combination of left-handed, and right-handed batsmen is necessary as the bowler must keep switching tactics for right and left-handed batsmen. We need at least two right-handed batsmen.
  - **Is\_Spinner:** Variety in bowler types is very important, as some bowlers are weaker in facing some types of bowlers, whereas stronger in facing some bowlers. We need at least two spinners.
  - **Is\_Fast:** Variety in bowler types is very important. We need at least two fast bowlers.
  - **Is\_Senior(binary):** Every team wants to have a combination of experienced senior player and young, energetic players. The senior player knows how to face difficult moments, handles pressure and lead the team
  - **Is\_Junior(binary):** Junior Players are agile and fast learners. However, their experience is not as good as seniors. If a player played less than ten matches, he is considered a junior player. As their performance is not much tested we don't take a risk by having a more junior player, so for this problem, we want 2 Junior player exactly
  - **Is\_allrounder:** All-rounder is player who can bowl as well as bat. They can be handy in all situations. For this problem, we took at least 2 All-rounder
- Below is the full list of the constraints variable

Name of variable	Bound		Value
Will Play			
Budget	10000	>=	4530
Number of Player	16	=	16
Is_Bowler	5	<=	5
Is_Batsmen	5	<=	8
Is_Wc	1	<=	1
"Is_lefty"	2	<=	5
"Is_Righty"	2	<=	11
"Is_Spinner"	2	<=	2
"Is_Fast"	2	<=	3
"Strike Rate"	SR>Eco	SR	2855.088
Economy		ECO	2848.8

"Is_senior			
"Is_junior	4	=	4
"Is_Domestic			
"Is_international	5	>=	5
Is_AllRounder	3	>=	2
Batsmen Avg			
Bowler Avg			

*Please note that constraints bound number stated above can be changed according to the needs and situation*

- Only the performance of bowlers is considered for bowling attributes, and all player are considered for batting
- A player who has scored less than ten runs and the player with 0 wickets are not considered
- Strike rate and Economy is scaled up to 120 balls
- For a team to win Strike rate > Eco. To give equal priority, we can assign weight to this equation

### 3.3. Decision variable:

If a player plays, he will be considered 1 else 0.

- We want to maximize: Runs scored by batsmen – Runs conceded by bowlers  
Equation: **Is\_play\*Batsmen Avg - Is\_play\* Bowler Avg\*Is\_bowler**  
We are maximizing Batsmen and bowler performance with the same equation, and we have already defined a cap on bowler and batsmen so that this equation will choose the best among those categories. A higher positive number is better

### 4. Comparison:

We tried to compare our team to last year winner to check how good is our optimization:

Last year winner:

2017 Mumbai Indians

We compared our team with Mumbai Indian Tea, with the same budget

Performance Metrics	Parameters	Mumbai Indian	Our Team
High/low	Budget	2830	2830
High	SR	2249	2831
High	Batting average	325	460
Low	BowlerEco	781	707
Low	BowAverage	150	107

As we can see our new optimized team better regarding numbers. We have high batting score and low bowling score Compared to Mumbai Indian. As we know, Batting parameter should be high, and bowling parameter should be low

##### 5. Challenges and future work:

- Player base price and bidding value are different. A player who has less base price can be sold for more due to his recent performance.
- It is difficult to quantify the player's ability based on a limited set of parameters.
- Our model considers the holistic performance of the players in their careers. So, players with recent bursts in performance, and rookie players would find it tough to shine.
- Some logical parameters like inter-player relationship/synchronization, health, confidence from past victories/ or lack thereof, are hard to measure and account for as compared to empirical picking and choosing.

##### 6. Research similar to our studies:

###### Evolutionary Multi-Objective Optimization and Decision-Making Approaches to Cricket Team Selection

*By: Faez Ahmed, Kalyanmoy Deb, and Abhilash Jindal Kanpur Genetic Algorithms Laboratory (KanGAL) Indian Institute of Technology Kanpur, URL:*  
<https://www.iitk.ac.in/kangal/papers/k2011016.pdf>

Abstract: Selection of players for a cricket team within a finite budget based on the player's batting, bowling, and fielding performance. Their optimization problem was solved using a multi-objective genetic algorithm and the non-dominated sorting genetic algorithm(NSGA-II)

###### Research paper on the valuation of players: Can be used for valuation in bidding and criteria they considered for performance measure

Player valuations in the Indian Premier League

*By: DAVID PARKER, PHIL BURNS, AND HARISH NATARAJAN1*

[frontier-economics.com/documents/2008/10/player-valuations-in-the-indian-premier-league-frontier-paper.pdf](http://frontier-economics.com/documents/2008/10/player-valuations-in-the-indian-premier-league-frontier-paper.pdf)

Abstract: To decide the valuation of the bidding price

Player valuation in Indian premier league auction using data mining technique

By: [Prince Kansal](#), [Pankaj Kumar](#), [Himanshu Arya](#)

<http://ieeexplore.ieee.org/document/7019707/authors>

Abstract: Used several data mining tools for the prediction of base price group by

## **7. Acknowledgment:**

- <http://www.cricbuzz.com/cricket-series/2568/indian-premier-league-2017/stats>
- <https://www.mykhel.com/cricket/ipl-2017>
- <https://en.wikipedia.org/wiki/Cricket>
- <http://www.espnricinfo.com/>
- <https://www.iitk.ac.in/kangal/papers/k2011016.pdf>
- [frontier-economics.com/documents/2008/10/player-valuations-in-the-indian-premier-league-frontier-paper.pdf](http://frontier-economics.com/documents/2008/10/player-valuations-in-the-indian-premier-league-frontier-paper.pdf)