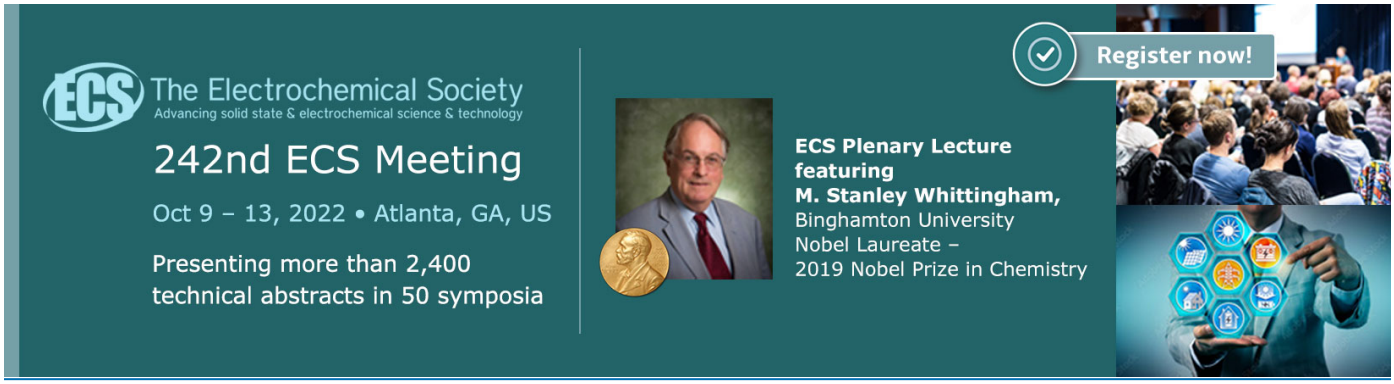
# Selection of Indian Cricket Team in ODI using Integer Optimization





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# Selection of Indian Cricket Team in ODI using Integer Optimization

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**Abstract.** The selection criterion of a cricket team depends on so many factors like average, strike rate, consistency, economy rate, etc. For every factor, it may get a different team, but consistency plays an important role in the selection process. This paper outlines the selection process of players in the Indian Cricket Team for the ODI. A criterion is proposed for the evaluation of different factors on which the selection process can be done. This evaluation describes the consistent and inconsistent players and ranks of them. The players will be chosen at different categories like batsmen, bowler, all-rounder, and wicketkeeper. The evaluation mainly based on the consistency of the player. For this measure, integer optimization programming has been applied, and data has been taken from Jan 2015 to Sept 2017 of ODI matches.

**Notations:**

- Batting Average of $k^{th}$ player : $\text{AVG}_k{}^{\text{Bat}}$
- Batting Consistency of $k^{th}$ player : $\text{CONSIST}_k{}^{Bat}$
- Bowling Average of $k^{th}$ player : $\text{AVG}_k{}^{\text{Bowling}}$
- Bowling Consistency of $k^{th}$ player : $\text{CONSIST}_k{}^{\text{Bowler}}$
- Bowling Economy rate of $k^{th}$ player : $\text{ECON}_k{}^{\text{Bowler}}$
- Batting Index of $k^{th}$ player : $BI_k{}^{Bat}$
- All-rounder Index of $k^{th}$ player : $A_k{}^{\text{all-rounder}}$

## 1. Introduction

Cricket, a bat and ball game/ high stake game, will be played between two teams and each team consists of 11 players, and the players are of different specialization of their interest like batsmen, bowler, wicketkeeper and all-rounder (possess both bowling and batting Skills). Twenty20 is the new format in which 20 overs are bowled in a match, and in one day match, 50 overs are bowled. World cup comes under one day format in which bowlers of one team bowl 50 overs to the opposition team. In this, a bowler can bowl a maximum of 10 overs(limitations of bowler, if the match applied for DL-method).

The selection procedure for team players is based on different factors like average, consistency of the player, strike rate, etc. The present paper aims at developing a programming problem method to select the team of players using players' performance indicators.

Theory of selecting or comparing the efficiency of the batsmen or bowler is in most of the research papers in detail. This section describes the research work done for selecting the optimal team for India. [1] has used multi-objective optimization, and decision making approaches for selection of cricket team and Dynamic Programming is also used in one day cricket for optimal scoring by [2].

The selection procedure of the batsmen is done by [3], which based on the average and strike rate. Croucher [4] suggested a formula to predict the outcome of the final match and the formula applied to both batsmen and bowlers. Many researchers [5, 6, 7] proposed different techniques for selection procedure of the cricketers. Selection is based on the performance of the players in previous matches. [8,9] have used different types of parameters to evaluate the performance like as batting average, bowling average, batting strike rate, bowling economy rate, bowling strike rate etc. [8] evaluated performances for the 2007 World Cup based on the statistics and described the batting index or bowling index using these parameters.

[10] applied the integer optimization approach in selecting a team of members for a fantasy cricket league and the same idea was extended by [9] for a T20 cricket match with certain constraints.

The organization of paper as follows: The integer optimization methodology is described in Section 2 after that the performance evaluation is done in Section 3. Since the integer optimization technique is applied with the reference of [9], the model description is described in Section 4. Section 5 describes the result, while Section 6 concludes the limitation of the approach.

## 2. Methodology

A batsman always aims to score runs as many as possible while keeping the wickets in his hand whereas the strategy of a bowler is always try to find a way where he tends to snatch the maximum number of wickets while giving minimum runs.

### *2.1. Batting Performance Measure*

The strategy of batting is depending upon the match being played or the current state of play. For the player's effectiveness in the match, the batting statistics is based on two factors: batting average and consistency of the batsmen.

[9] is used batting average and batting strike rate as statistics for evaluation of the T20 team. The consistency of the batsmen narrates about the player how much he deviates from his previous performance. The batting average and consistency of the batsmen defined as

$$\mathrm{AVG}_k^{Bat} = \frac{\text{total number of runs}}{\text{total number of dismissals for player } k} \tag{1}$$

$$\mathrm{CONSIST}_k{}^{Bat} = \frac{\text{standard deviation of player } k}{\text{batting average of player } k} \tag{2}$$

Low values of $\mathrm{CONSIST}_k{}^{Bat}$ describes the most consistent player. According to [8], we approach the product of these two statistics to evaluate the batting index

$$U_k{}^{Bat} = (\mathrm{AVG}_k{}^{Bat})^{\alpha}(\mathrm{CONSIST}_k{}^{Bat})^{1-\alpha}, \quad 0 \leq \alpha \leq 1 \tag{3}$$

where $\alpha$ measures the importance of the factor.

For Further evaluation, batting index is defined as,

$$BI_k{}^{Bat} = \Big(\frac{U_k{}^{Bat}}{\sum_{k=1}^{n} U_k{}^{Bat}}\Big) \times n \tag{4}$$

where $n$ is the number of players with their batting ability. For different values of $\alpha$, low values of ${BI_k}^{Bat}$ gets the different rank position and after that, calculate the Spearman's rank correlation coefficient to know the common approach of $\alpha$ values.

*2.2. Bowling Performance Measure*

Bowling tactics and strategies will help to take more wickets and try not to give more runs.

An evaluation of bowling performance of a bowler depends upon the bowling average, consistency of bowler and bowling economy rate which are defined below

$$\mathrm{AVG}_k{}^{Bowling} = \frac{\text{Total number of runs conceded by bowler } k}{\text{Total number of wickets taken by bowler } k} \tag{5}$$

$$\mathrm{CONSIST}_k{}^{Bowler} = \frac{\text{standard deviation of bowler } k}{\text{bowling average of bowler } k} \tag{6}$$

$$\mathrm{ECON}_k{}^{Bowler} = \frac{\text{total number of runs conceded by bowler } k}{\text{total number of overs bowled by bowler } k} \tag{7}$$

High values of $\mathrm{CONSIST}_k{}^{Bowler}$ describes the most consistent bowler. Bowling ability defined as

$${V_k}^{Bowl} = (\mathrm{AVG}_k{}^{Bowling})^{\alpha_1}(\mathrm{CONSIST}_k{}^{Bowler})^{\alpha_2}(\mathrm{ECON}_k{}^{Bowler})^{(1-\alpha_1-\alpha_2)} \tag{8}$$

where

$$0 \leq \alpha_1 \leq 1, \quad 0 \leq \alpha_2 \leq 1, \quad 0 \leq \alpha_1 + \alpha_2 \leq 1$$

The powers describes the importance of the factors to evaluate bowling index. The bowling index defined as

$${BI_k}^{Bowl} = \left(\frac{{V_k}^{Bat}}{\sum_{k=1}^{m} {V_k}^{Bowl}}\right) \times m \tag{9}$$

where $m$ is number of players whose bowling ability is available. Higher values of ${BI_k}^{Bowl}$ get the highest rank for different values of $\alpha_1$ and $\alpha_2$. For different values of $\alpha_1$, $\alpha_2$ high values of ${BI_k}^{Bowl}$ get the different rank position and after that, calculate the Spearman's rank correlation coefficient to know the common approach of $\alpha_1$ and $\alpha_2$ values.

*2.3. All-rounder Performance Measure*

If a player has the abilities of batting and bowling will consider as an all-rounder. It can be categorized into two types, which are Batting all-rounder (player have more batting ability than bowling) and Bowling all-rounder (player have more bowling ability than batting). For evaluation of all-rounder performance, the all-rounder index defined as

$${A_k}^{\text{all-rounder}} = ({U_k}^{Bowl})^{\beta}({V_k}^{Bowl})^{1-\beta}, 0 \leq \beta \leq 1 \tag{10}$$

$\beta$ determines the important factor for both the abilities.

## 3. An Illustration

To explain the model for which data is collected from One Day International matches from Jan 2015 to Sept 2017. For any cricket match, a squad of 15 members will be selected, and according to the gameplay, 11 players will be allowed for every game. Evaluating the performance of each kind of player, so that, a prominent list of players can be obtained for the Indian cricket team for ODI.

*3.1. Batting Statistics*
The Batting statistics shown in Table 1, in which batting index defined as

$$BI_k{}^{Bat} = \left(\frac{U_k{}^{Bat}}{\sum_{k=1}^{n} U_k{}^{Bat}}\right) \times n \tag{11}$$

For different values of $\alpha$ gives the importance of the factors. The choices for weighting $\alpha$ can be considered by the ratio of 1:3, 1:4, 1:5 because consistency of the player is more considerable than the batting average. In Table 1, batting index calculated for $\{\alpha$=1/3, 1/4 and 1/5$\}$ and after that, the players get the rank position according to their batting index. To meet the common approach of different values of $\alpha$, Spearman's rank correlation coefficient has been applied. $\rho_{ab}$, $\rho_{bc}$, $\rho_{ca}$ indicates the rank correlation coefficients between the ranks for $\alpha$=1/3 and $\alpha$=1/4; $\alpha$=1/4 and $\alpha$=1/5; $\alpha$=1/5 and $\alpha$=1/3 respectively and $\alpha$=1/4 and $\alpha$=1/5 rank correlation approaches to unity.

More batting average and less batting index give the best result. In Table 1, R A Jadeja gets the $1^{st}$ rank as batting index is lower than the others , but his batting average is meager. Players whose batting average is high and batting index is low for Virat Kohli, M K Pandey, Shikhar Dhawan, R G Sharma, A M Rahane. These players are considered in the batsman category.

*3.2. Bowling Statistics*
In bowling statistics, the bowling index calculated by

$$BI_k{}^{Bowl} = \left(\frac{V_k{}^{Bat}}{\sum_{k=1}^{m} V_k{}^{Bowl}}\right) \times m \tag{12}$$

For a good bowler, low values of bowling average, bowling economy rate and high values of consistency of a player are considered. The parameters $\alpha_1$, $\alpha_2$, $1-\alpha_1-\alpha_2$ are taken in the ratio of 1:2:1, 1:3:1, 1:4:1. Table 2 mentioned bowling index for $\alpha_1 = 1/5$, $\alpha_2 = 3/5$ and $\alpha_1 = 1/6$ and $\alpha_2 = 2/3$ are more correlated than the others. By this evaluation J J Bumrah, Mohd Shami, Kuldeep Yadav, Y S Chahal considered to be best bowlers.

*3.3. All-rounder statistics*
For all-rounder statistics, the all-rounder index is calculated by

$$A_k{}^{\text{all-rounder}} = (U_k{}^{Bowl})^{\beta}(V_k{}^{Bowl})^{1-\beta}, 0 \leq \beta \leq 1 \tag{13}$$

by setting $\beta$=1/2 because bowling and batting both are equally important for all-rounders.

From Table 3, R A Jadeja, A B Patel, H H Pandya, K M Jhadav, S K Raina, R Ashwin, and B Kumar are in this category according to the rank position. For Wicketkeeper M S Dhoni is the only one player who played ODI's from Jan 2015 to Sept 2017. He has taken 51 catches and 19 stumps.

## 4. Model Description
The programming model for the selection process is defined by the integer optimization techniques in [9]. In this paper, integer linear objective function and linear integer constraint are required, and the decision variable is unit function type, which is defined as follows:

$$y_{1k} = \begin{cases} 1, & \text{if the } k^{th} \text{ player is considered for batting and all-rounder} \\ 0, & \text{otherwise.} \end{cases}$$

**Table 1.** For Batting Statistics

| S.No. | Player Name | Matches | Runs | $AVG_k^{Bat}$ | $CONSIST_k^{Bat}$ |
|---|---|---|---|---|---|
| 1 | R G Sharma | 38 | 1926 | 56.65 | 0.856 |
| 2 | Shikhar Dhawan | 32 | 1568 | 50.58 | 0.875 |
| 3 | Virat Kohli | 45 | 2267 | 66.68 | 0.744 |
| 4 | A M Rahane | 33 | 1423 | 41.85 | 0.668 |
| 5 | S K Raina | 10 | 325 | 25.00 | 1.293 |
| 6 | M S Dhoni | 38 | 1425 | 38.51 | 0.824 |
| 7 | R A Jadeja | 15 | 180 | 10.00 | 0.877 |
| 8 | R Ashwin | 9 | 48 | 2.53 | 2.520 |
| 9 | B Kumar | 13 | 152 | 6.61 | 2.528 |
| 10 | A B Patel | 12 | 125 | 6.94 | 1.625 |
| 11 | K M Jhadav | 23 | 747 | 31.13 | 1.093 |
| 12 | M K Pandey | 16 | 430 | 35.83 | 0.811 |
| 13 | K L Rahul | 8 | 148 | 18.50 | 1.026 |
| 14 | H H Pandya | 16 | 530 | 23.04 | 1.219 |
| 15 | Yuvraj Singh | 10 | 372 | 37.20 | 1.092 |

| $BI_k^{Bat}$ | | | Rank | | |
|---|---|---|---|---|---|
| $\alpha$=1/3 (a) | $\alpha$=1/4 (b) | $\alpha$=1/5 (c) | For (a) | For (b) | For (c) |
| 1.140 | 1.032 | 0.967 | 12 | 9 | 8 |
| 1.113 | 1.019 | 0.962 | 11 | 8 | 7 |
| 1.096 | 0.968 | 0.893 | 9 | 6 | 5 |
| 0.873 | 0.794 | 0.746 | 4 | 2 | 2 |
| 1.143 | 1.146 | 1.142 | 13 | 14 | 13 |
| 0.977 | 0.911 | 0.868 | 7 | 5 | 4 |
| 0.650 | 0.681 | 0.697 | 1 | 1 | 1 |
| 0.830 | 1.066 | 1.232 | 2 | 10 | 14 |
| 1.146 | 1.359 | 1.496 | 14 | 15 | 15 |
| 0.868 | 0.988 | 1.061 | 3 | 7 | 10 |
| 1.099 | 1.067 | 1.043 | 10 | 11 | 9 |
| 0.944 | 0.884 | 0.845 | 6 | 3 | 3 |
| 0.886 | 0.894 | 0.894 | 5 | 4 | 6 |
| 1.069 | 1.075 | 1.072 | 8 | 12 | 11 |
| 1.166 | 1.116 | 1.081 | 15 | 13 | 12 |

| Rank Correlation coefficient ($\rho$) | $\rho_{ab}$=0.735 | $\rho_{bc}$=0.928* | $\rho_{ca}$=0.492 |
|---|---|---|---|

$$y_{2k} = \begin{cases} 1, & \text{if the } k^{th} \text{ player is considered for bowling and all-rounder} \\ 0, & \text{otherwise.} \end{cases}$$

$$y_{3k} = \begin{cases} 1, & \text{if the } k^{th} \text{ player is considered for wicketkeeping} \\ 0, & \text{otherwise.} \end{cases}$$

Objective function is given by

**Table 2.** For Bowling Statistics

| S.No. | Player Name | Matches | Wickets | Over | $AVG_k^{Bowling}$ | $CONSIST_k^{Bowl}$ |
|---|---|---|---|---|---|---|
| 1 | S K Raina | 8 | 5 | 43 | 43.20 | 0.501 |
| 2 | R A Jadeja | 23 | 18 | 203.4 | 59.61 | 0.299 |
| 3 | R Ashwin | 20 | 29 | 187.4 | 32.72 | 0.670 |
| 4 | Moh. Shami | 8 | 15 | 74 | 24.33 | 1.022 |
| 5 | B Kumar | 28 | 34 | 221.2 | 33.44 | 0.661 |
| 6 | A B Patel | 16 | 19 | 140.8 | 31.74 | 0.456 |
| 7 | K M Jhadav | 17 | 16 | 76.5 | 24.81 | 0.512 |
| 8 | J J Bumrah | 24 | 42 | 203.6 | 23.57 | 1.076 |
| 9 | Y S Chahal | 10 | 16 | 87 | 25.63 | 0.765 |
| 10 | H H Pandya | 25 | 29 | 179.2 | 34.45 | 0.373 |
| 11 | Kuldeep Yadav | 10 | 18 | 91.4 | 24.39 | 0.959 |

| $ECON_k^{Bowler}$ | $BI_k^{Bowl}$ | | | Rank | | |
|---|---|---|---|---|---|---|
| | $\alpha_1$= 1/4 and $\alpha_2$=1/2 (d) | $\alpha_1$= 1/5 and $\alpha_2$=3/5 (e) | $\alpha_1$= 1/6 and $\alpha_2$=2/3 (f) | For(d) | For(e) | For(f) |
| 5.023 | 0.951 | 0.906 | 0.877 | 7 | 7 | 7 |
| 5.275 | 0.806 | 0.716 | 0.661 | 10 | 11 | 11 |
| 5.064 | 1.027 | 1.022 | 1.017 | 5 | 5 | 5 |
| 4.932 | 1.170 | 1.234 | 1.277 | 2 | 2 | 2 |
| 5.140 | 1.030 | 1.021 | 1.014 | 4 | 6 | 6 |
| 4.283 | 0.807 | 0.780 | 0.761 | 9 | 9 | 9 |
| 5.190 | 0.843 | 0.827 | 0.815 | 8 | 8 | 8 |
| 4.862 | 1.187 | 1.261 | 1.311 | 1 | 1 | 1 |
| 4.713 | 1.014 | 1.038 | 1.053 | 6 | 4 | 4 |
| 5.575 | 0.795 | 0.740 | 0.705 | 11 | 10 | 10 |
| 4.803 | 1.127 | 1.182 | 1.219 | 3 | 3 | 3 |
| Rank Correlation coefficient ($\rho$) | | $\rho_{de}$=0.954 | $\rho_{ef}$=1* | | $\rho_{df}$=0.954 | |

**Table 3.** Table for All-rounder statistics

| S.No. | Players Name | Overs | Runs | $BI_k^{Bat}$ | $BI_k^{Bowl}$ | $A_k^{all\text{-}rounder}$ | Rank |
|---|---|---|---|---|---|---|---|
| 1 | S K Raina | 43 | 325 | 1.146 | 0.906 | 1.019 | 5 |
| 2 | R A Jadeja | 203.4 | 180 | 0.681 | 0.716 | 0.699 | 1 |
| 3 | R Ashwin | 187.4 | 48 | 1.066 | 1.022 | 1.044 | 6 |
| 4 | B Kumar | 221.2 | 152 | 1.359 | 1.021 | 1.178 | 7 |
| 5 | A B Patel | 140.8 | 125 | 0.988 | 0.780 | 0.877 | 2 |
| 6 | K M Jhadav | 76.5 | 747 | 1.067 | 0.827 | 0.939 | 4 |
| 7 | H H Pandya | 179.2 | 530 | 1.075 | 0.740 | 0.892 | 3 |

Minimization or Maximization

$$z = \sum_{k=1}^{n} w_{1k}y_{1k} + \sum_{k=1}^{m} w_{2k}y_{2k} + \sum_{k=1}^{p} w_{3k}y_{3k} \tag{14}$$

Subject to

$$0 < \sum_{k=1}^{n} y_{1k} \leq 7 \tag{15}$$

$$0 < \sum_{k=1}^{m} y_{2k} \leq 6 \tag{16}$$

$$1 \leq \sum_{k=1}^{p} y_{3k} \leq 2 \tag{17}$$

$$y_{1k},\ y_{2k},\ y_{3k}\ \geq 0 \tag{18}$$

Here,

$$\sum_{k=1}^{n} y_{1k} + \sum_{k=1}^{m} y_{2k} + \sum_{k=1}^{p} y_{3k} = 15 \tag{19}$$

where $p$ denotes the number of wicketkeepers. Constraint 1 indicates that the number of batsmen and batting all rounder is not more than 7 that means 5 players may consider in batsmen category and rest of 2 players for batting all-rounder. Similarly, constraint 2 is for bowlers and bowling all-rounders such that 4 players may select for bowlers and 2 are for bowler all-rounder. Since World cup is of 50 overs matches implies every player can bowl a maximum of 10 overs. And the constraint 3 is for wicketkeeper which implies at least one wicketkeeper must be there.

## 5. Results and Discussion

The data collected from howstat.com of each player who played in ODI from Jan 2015 to Sep 2017. Table 4 shows that 5 players in batsman's category, 4 players in bowler's category, 2 players in batting all-rounder's category, 2 Players in bowling all-rounder's category and 2 in wicket keeper's category. R A Jadeja gets the 1st rank position in batting statistic and 12th rank position in bowling statistic, he will consider in batting all rounder's category. Similarly, H H Pandya gets 8th in batting and 11th in bowling so he will also consider in batting all rounder's category. From table M S Dhoni is in the wicketkeeper's category and Rishab Pant* will even in this category. Rishab Pant did not play any matches in ODI, and we can't find any data regarding this.

## 6. Conclusion

[9] has been used integer programming for selection the T20 cricket team with the parameters batting strike rate and bowling strike rate. Besides of these parameters the consistency of batsmen, bowler and all-rounder has been calculated according to their performances. Based on these performances, the players for the cricket team has been estimated. Limitations to this paper are the lack of data for wicketkeepers. By the state level performance Rishab Pant may consider as another wicketkeeper substitute to M S Dhoni. Finally selection has given for 15 players in which 4 players are alternatives players because any player may be injured at the spot or they have some kind of emergency. For the future study, the methodology can be applied to different type of sports such as 5-Day Test Cricket Matches, Football Match etc. to select the players for team.

**Table 4.** Optimal Indian Cricket team of 15 players

| S.No. | Player Name | Rank | Category |
|---|---|---|---|
| 1 | Virat Kohli | 6 | Batsman |
| 2 | Shikhar Dhawan | 7 | Batsman |
| 3 | R G Sharma | 9 | Batsman |
| 4 | A M Rahane | 2 | Batsman |
| 5 | M K Pandey | 3 | Batsman |
| 6 | R A Jadeja | 1 | Bating All-rounder |
| 7 | H H Pandya | 8 | Bating All-rounder |
| 8 | M S Dhoni | * | Wicket-keeper |
| 9 | J J Bumrah | 1 | Bowler |
| 10 | Mohd. Shami | 2 | Bowler |
| 11 | Kuldeep Yadav | 3 | Bowler |
| 12 | Y S Chahal | 4 | Bowler |
| 13 | B Kumar | 7 | Bowling All-rounder |
| 14 | K M Jhadav | 9 | Bowling All-rounder |
| 15 | Rishab Pant | * | Wicket-keeper |

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