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ORIGINAL ARTICLE

Team selection after a short cricket series

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Abstract

The selection of a cricket team cannot be fair unless the best available performance measures are used. The traditional batting average can be very unrealistic, especially in the case of a small number of scores with a high proportion of not out scores. In the present study the focus is on using the most suitable measures for the selection of a team after a small number of matches had been played. Provision is made for the fact that match conditions may influence the scoring rate of batsmen. These measures are used for illustration purposes to select a team from the players who played in the International Cricket Council (ICC) Champions Trophy 2009 One-Day International (ODI) Series. It is shown how an integer programming method can be used for the selection process. The approach is that a well balanced cricket team should include different kinds of specialists, namely batsmen, bowlers, all-rounders and a wicket-keeper. A selection committee may be able to rank batsmen in order of batting ability and bowlers according to bowling ability, but when it comes to all-rounders it is not so simple. The fact that an all-rounder is, by definition, a good batsman and also a good bowler, makes it difficult to rank all-rounders. Furthermore, how many of each specialist type should be selected? The purpose of this paper is to show how integer optimisation, an objective scientific method, can be used to aid in selecting a cricket team. Guidelines are also given for the selection of a team if career performance data have to be used.

Keywords: *Dismissal rate, integer programming, performance index, sport*

Introduction

A lot of subjectivity is involved in the selection of a cricket team. Selectors have players' performance statistics at their disposal, but many other factors play a role in the selection process. Expectations regarding the pitch and weather conditions have an influence on the question whether one or more spin bowlers should be included, how many batsmen, bowlers and all-rounders should be included, is it desirable that an experienced player who is out of form, be given another chance, etc. Answers to such questions are very subjective and can lead to lengthy discussions among selectors. The approach in this paper is that objective scientific methods should be used to aid selectors in their attempt to select the best team. The most appropriate batting and bowling performance measures for the specific circumstances should be used, e.g. it should be decided whether a team should be selected after a short series or whether a squad should be selected based on performances over a longer period. The next step is to decide on the

composition of the team in terms of batsmen, bowlers, all-rounders, etc. By using the statistics of the International Cricket Council (ICC) Champions Trophy 2009 Series, it will be shown which performance measures are the best for this situation where players have played in a very small number of matches. An objective selection procedure will be explained and used to select the 'best' team.

Performance measures

The ordinary average $AVE = R/m$, where R denotes the number of runs scored and m the number of times the batsman was out, is a popular but insufficient measure of batting performance. The strike rate should also be taken into account. Basevi and Binoy (2007) used $CALC = R^2/(m \times B)$, where B is the total number of balls faced. Hence $CALC = (R/m) \times (R/B) = AVE \times (SR/100)$ with $SR = 100 \times R/B$ the strike rate. Lemmer (2008a) concluded that $CALC$ weights SR too highly. Barr and Kantor (2004) proposed a criterion $BK = AVE^{1-\alpha} SR^\alpha$ where $0 \leq \alpha \leq 1$ is a

measure of balance between average and strike rate. The subjective choice of the value of α is not an attractive feature of this measure. See also Barr, Holdsworth, and Kantor (2008). Their choice of $\alpha = 0.5$ (which is the same weighting as in CALC) is unacceptable and $\alpha = 0.75$ accentuates SR even more. All these methods use AVE, which can be unreliable in the present context.

Lemmer (2008b) showed that the traditional average, AVE, is not reliable as an estimator of the average in the case of a high proportion of not out scores, especially if a small number of innings have been played. In Lemmer (2008a) formula e_{26} has been shown to be a much better estimator than AVE. The formula is

$$e_{26} = (\text{sumout} + (2.1 - 0.005 \times \text{avno}) \times \text{sumno})/n \quad (1)$$

with n the number of innings played, 'sumout' the sum of the out scores, 'sumno' the sum of the not out scores and 'avno' the average of the not out scores of the batsman. In a further development the present author, in a conference lecture, introduced the single match approach which was motivated by the fact that batting conditions may differ substantially between matches and the importance that a score obtained under difficult conditions should count more than the same score obtained under good conditions. This is achieved by using a strike rate adjustment which compares the batsman's match strike rate (MSR) with the overall or global match strike rate (GMSR) of all the batsmen in the whole match. Here $\text{MSR} = 100 \times R/B$ denotes the batsman's match strike rate with B the number of balls he faced. The formula of the global strike rate GMSR is similar to MSR, but R then denotes the total number of runs scored and B the total number of balls faced by all batsmen in the match. The strike rate adjustment is $\text{RP} = (\text{MSR}/\text{GMSR})^{0.50}$ which is similar to that of BP_{26} in Lemmer (2008a), where $\text{BP}_{26} = e_{26} \times \text{RP}$ with $\text{RP} = (\text{SR}/124.03)^{0.50}$ in the latter case. After each match the batsman's score R is replaced by his adjusted score $T = R \times (\text{MSR}/\text{GMSR})^{0.50}$. The formula of the batting performance measure then has the same structure as e_{26} and is

$$\text{ET} = (\text{sumouta} + (2.1 - 0.005 \times \text{avnoa}) \times \text{sumnoa})/n \quad (2)$$

with 'sumouta' now the sum of the *adjusted* out scores, 'sumnoa' the sum of the *adjusted* not out scores and 'avnoa' the average of the *adjusted* not out scores of the batsman. In the present study ET is the appropriate measure to use because every batsman had at most five scores in the series consisting of only 15 matches between eight teams.

As far as bowling is concerned, let O denote the number of overs bowled by a bowler, R the number of

runs conceded and W the number of wickets taken. Each of the traditional bowling measures, namely the average $A = R/W$, the economy rate $E = R/O$ and the strike rate $S = B/W$ where B indicates the number of balls bowled, is useful in its own right, but more comprehensive measures are available in the literature. Barr, Holdsworth, and Kantor (2008) defined *their* strike rate as $\text{SB} = W/B$ and *their* average as $\text{AB} = W/R$. They used, as a measure of bowling performance, a weighted product of their strike rate and average, namely $\text{BHK} = \text{SB}^\alpha \text{AB}^{1-\alpha}$, $0 \leq \alpha \leq 1$. By using different values of α , the importance of the strike rate relative to the average can be varied. They used $\alpha = 0.50$ and $\alpha = 0.75$ for illustrative purposes. If $\alpha = 0.75$ the measure is $(\text{SB})^{0.75}(\text{AB})^{0.25}$ which accentuates the strike rate much more than the average. Croucher (2000) defined the bowling index $\text{BI} = A \times S$ and used it to rank bowlers. It is related to BHK in the sense that if $\alpha = 0.50$, $\text{BHK} = (1/S)^{0.5} \times (1/A)^{0.5} = (1/\text{BI})^{0.5}$. Basevi and Binoy (2007) used a simple measure which can be written as $\text{CLC} = R^2/(W \cdot B) = A \cdot E/6$. Here A and E are weighted equally with no reference to S . A comprehensive measure that has been designed to take A , E and S deliberately into account is $\text{CBR} = 3R/(W + O + W \cdot R/B)$ – see Lemmer (2002). For the case of a small number of matches it has been adjusted (Lemmer, 2005) to take the weights of the wickets taken by the bowler into account. Then $\text{CBR}^* = 3R/(W^* + O + W^* \cdot R/B)$ where W^* indicates the sum of the weights of the wickets taken by the bowler. CBR^* is the measure used in the present study. All other measures only count the number of wickets taken.

In the case of wicket-keepers a logical measure of performance is the dismissal rate which is defined as the number of dismissals (catches and stumpings) divided by the number of matches acting as wicket-keeper.

The optimisation model

The selection of a team is done by using an integer linear programming model. The theory is described in chapter 8 of Taha (2003) and applications in cricket are given in Gerber and Sharp (2006) and Sharp, Brettenny, Gonsalves, Lourens, and Stretch (2011). The team is selected according to various abilities (batting, bowling, all-rounder and wicket-keeping). The procedure requires that all abilities should be measured on the same scale in order to avoid a situation where the ability with the largest range overshadows the rest. This is done by transforming the different measures to indices. Denote the batting performances of the specialist batsmen by B_i , $i = 1, \dots, n_1$. Let the batting index of batsman i be $c_{i1} = B_i/\text{AVE}(B)$, $i = 1, \dots, n_1$ with $\text{AVE}(B)$ the average of the B_i values. Let D_i be the bowling performance measure of the i -th specialist bowler, $i = 1, \dots, n_2$. Care should be taken that large values of D_i indicate good performances. The bowling index is defined by $c_{i2}^0 = D_i/$

AVE(D), $i = 1, \dots, n_2$. In order to ensure that the batting and bowling indices are comparable the scale adjustment of Lemmer (2004, p. 59) is used. Let $s_1 = \text{STD}(c_{i1}, i = 1, \dots, n_1)$ where STD denotes the standard deviation, and $s_2 = \text{STD}(c_{i2}^0, i = 1, \dots, n_2)$. The adjusted bowling indices are obtained iteratively: Let $c'_{i2} = (c_{i2}^0)^e$ where $e = s_1/s_2$. Let $s'_2 = \text{STD}(c'_{i2}, i = 1, \dots, n_2)$ and $c''_{i2} = (c'_{i2})^e$ where $e = s_1/s'_2$. After a few iterations, for each i , the c'_{i2}, c''_{i2}, \dots converge to a final value which is indicated by c_{i2} .

For all-rounders those players who qualify both as batsmen and bowlers are considered. The all-rounder index is defined as $c_{i3}^0 = c_{i1}^\alpha c_{i2}^{1-\alpha}$, $i = 1, \dots, n_3$ with $0 < \alpha < 1$. In the present study $\alpha = 0.5$ which gives equal weight to batting and bowling, as in Sharp et al. (2011). This is the safest choice, but in any selection process α can be changed after consultation with the selectors. The scale adjustment method is again used to bring the all-rounder indices c_{i3} , $i = 1, \dots, n_3$ in line with the batting and bowling indices. The wicket-keeper indices c_{i4} , $i = 1, \dots, n_4$ are also determined by means of the same procedure. Many more abilities can be considered – cf. Gerber and Sharp (2006) – but in the present case four are considered to be sufficient. Note that Gerber and Sharp (2006) did not apply a scale adjustment based on standard deviations.

Define the decision variables as

$x_{ij} = \text{Ind}\{\text{Player } i \text{ is selected for ability } j\}$, $i = 1, \dots, q$, $j = 1, \dots, p$, where the indicator function $\text{Ind}\{A\} = 1$ if A is true and $\text{Ind}\{A\} = 0$ otherwise. The objective function is $Z = \sum_{j=1}^p \sum_{i=1}^q d_{ij} x_{ij}$ where the d_{ij} represent the indices c_{ij} renumbered in such a way that each player's indices are attached to his indicator variables – see Table V. Z has to be maximised subject to certain constraints. For the present problem the following constraints are used:

$$\begin{aligned} \sum_{j=1}^4 \sum_{i=1}^q x_{ij} &= 11 \text{ to ensure that} \\ &11 \text{ players are selected,} \\ \sum_{j=1}^4 x_{ij} &\leq 1 \text{ for all } i \text{ to ensure that a player} \\ &\text{is not selected more than once,} \\ \sum_{i=1}^q (x_{i1} + x_{i3}) &\geq 5 \text{ to ensure that} \\ &\text{at least five batsmen are selected,} \\ \sum_{i=1}^q (x_{i2} + x_{i3}) &\geq 5 \text{ to ensure that at} \\ &\text{least five bowlers are selected,} \\ \sum_{i=1}^q x_{i3} &\geq 1 \text{ to ensure that at least} \\ &\text{one all-rounder is selected and} \\ \sum_{i=1}^q x_{i4} &= 1 \text{ to ensure that exactly} \\ &\text{one wicket-keeper is selected.} \end{aligned}$$

Calculation of performance measures

The purpose of this study is to show how an integer optimisation procedure, applied to the player data of the ICC Champions One-Day International (ODI) Series of 2009, obtained from Cricinfo (2009), can be used to determine the best batsmen, bowlers, all-rounders, wicket-keepers and finally the best team. The series consisted of only 15 matches with the result that individual players had each played a very small number of matches. The batting performance measures have been computed for all the players who had batted in at least three matches and had averages above 20. The requirement of at least three scores is based on the reasoning that one or two scores cannot be considered sufficient for comparative purposes. The requirement of averages above 20 aims to reduce a list of 107 players to a smaller number who can more realistically be considered as reasonable batsmen. The results (of 25 from the top 36 batsmen) are given in Table I where batsmen have been ranked according to ET. Note that p_0 denotes the proportion of not out scores.

Morkel, who ranks 12th, would rank fifth according to AVE. This is due to his unrealistic AVE = 65 which is much higher than the more realistic estimate of his average $e_{26} = 37.35$. He had three scores and was out only once, so $p_0 = 0.67$. Note the large differences between AVE and e_{26} for players with large proportions of not out scores, e.g. Kulasekara, Akmal, Franklin and Vettori. These cases clearly illustrate that measures based on AVE are unreliable.

In the case of bowlers the requirement was that a bowler should have bowled at least 12 overs, which seems reasonable for comparative purposes, because some bowlers had bowled more than 45 overs. The results (of 25 from the 33 who qualified) are given in Table II where the bowlers have been ranked according to the measure CBR*.

The values of the bowling measure CLC are also given. According to this measure Tonge, who ranked fourth, would only rank seventh. His better ranking according to CBR* is due to the fact that he took the wickets of top order batsmen (1, 1, 2, 3, 4). His five wickets ($W = 5$) gave him a wicket weight of $W^* = 6.80$. Steyn, on the other hand, took the wickets of top and lower order batsmen. This resulted in $W = 6$ and $W^* = 6.19$. According to CLC he ranked 11th, but 16th according to the better measure CBR*. A ranking of the bowlers according to BI (equivalently BHK with $\alpha = 0.50$) differs drastically from that according to CBR* simply because BI is not specifically designed for the case of a small number of overs. According to BI, Broad would be first, Parnell second, Nehra third, etc.

Table I. Ranking of batsmen according to ET.

Rank	Name	n	p ₀	AVE	c ₂₆	SR	ET	Index c ₁₁
1	S Watson	5	0.40	88.33	76.98	91.07	81.26	2.14
2	G Smith	3	0.00	68.67	68.67	107.29	72.82	1.92
3	R Ponting	5	0.20	72.00	69.70	78.69	68.95	1.81
4	AB de Villiers	3	0.33	65.00	60.83	83.87	61.63	1.62
5	M Jayawardene	3	0.00	54.33	54.33	103.16	57.28	1.51
6	E Morgan	4	0.25	49.00	49.00	79.89	55.02	1.45
7	T Dilshan	3	0.00	49.67	49.67	110.37	54.89	1.44
8	P Collingwood	4	0.00	50.50	50.50	86.70	52.31	1.38
9	M Yousuf	4	0.00	50.00	50.00	75.19	50.35	1.32
10	K Kulasekara	3	0.67	75.00	47.57	92.59	48.49	1.28
11	S Malik	4	0.00	45.00	45.00	86.12	47.15	
12	A Morkel	3	0.67	65.00	37.35	108.33	41.26	
13	M Guptill	5	0.00	38.20	38.20	82.68	40.35	
14	M Hussey	4	0.00	37.00	37.00	84.57	39.93	
15	U Akmal	4	0.50	49.00	35.17	80.33	38.71	
16	O Shah	4	0.00	36.25	36.25	82.86	36.54	
17	G Elliott	5	0.20	31.50	36.08	72.41	36.38	
18	C White	4	0.25	35.33	34.59	64.63	35.18	
19	J Franklin	3	0.67	63.00	31.25	91.30	34.76	
20	N Miller	3	0.33	36.00	29.75	82.76	34.30	
21	B McCullum	5	0.00	31.00	31.00	74.16	33.15	
22	D Vettori	4	0.50	50.00	27.95	104.17	32.26	
23	J Kallis	3	0.00	29.67	29.67	86.41	29.50	
24	T Samaraweera	3	0.00	28.00	28.00	74.34	26.28	
25	T Paine	5	0.00	24.60	24.60	73.65	24.47	

There were only eight players who qualified as all-rounders and their figures are given in Table III.

According to ET, Watson was by far the best batsman. Among the all-rounders he was second

as bowler. In the same group Vettori was the best bowler.

The ranking according to the dismissal rate of wicket-keepers who had stood in at least two matches each, is given in Table IV.

Table II. Ranking of bowlers according to CBR*.

Rank	Name	O	R	W	A	E	S	CLC	W*	CBR*	Index c ₁₂
1	S Ajmal	30.83	117	8	14.62	3.79	23.10	9.23	8.04	7.99	1.99
2	M Aamer	25	102	6	17.00	4.08	25.00	11.56	7.56	8.12	1.91
3	D Vettori	31.17	124	7	17.71	3.97	26.70	11.72	7.99	8.37	1.77
4	G Tonge	30	116	5	23.20	3.86	36.00	14.93	6.80	8.45	1.73
5	A Nehra	26	124	8	15.50	4.76	19.50	12.30	10.04	8.45	1.73
6	N Hauritz	30.83	116	5	23.20	3.76	37.00	14.54	4.72	9.04	1.47
7	K Mills	48.17	206	9	22.88	4.27	32.10	16.28	10.57	9.32	1.36
8	S Broad	28.17	155	10	15.50	5.50	16.90	14.21	11.16	9.38	1.34
9	P Siddle	33	146	6	24.33	4.42	33.00	17.92	7.41	9.55	1.28
10	J Anderson	38.33	163	7	23.28	4.25	32.80	16.49	7.41	9.59	1.27
11	S Watson	33.67	151	6	25.16	4.48	33.60	18.79	7.40	9.72	
12	B Lee	37	162	6	27.00	4.37	37.00	19.67	7.33	9.78	
13	A Mathews	22	102	4	25.50	4.63	33.00	19.68	5.21	9.80	
14	S Afridi	38.5	166	5	33.20	4.31	46.20	23.85	6.22	10.12	
15	I Butler	27	128	5	25.60	4.74	32.40	20.22	5.70	10.32	
16	D Steyn	28.83	138	6	23.00	4.78	28.80	18.32	6.19	10.36	
17	W Parnell	28	196	11	17.81	7.00	15.20	20.78	12.92	10.50	
18	B Mendis	25	114	3	38.00	4.56	50.00	28.88	4.08	10.63	
19	M Johnson	40	185	4	46.25	4.62	60.00	35.61	5.70	11.08	
20	D Sammy	27	107	1	107.00	3.96	162.00	70.62	0.98	11.21	
21	S Bond	49	242	6	40.33	4.93	49.00	33.14	7.98	11.42	
22	U Gul	31.83	169	5	33.80	5.30	38.20	29.86	6.27	11.62	
23	D Bernard	20	113	3	37.66	5.65	40.00	35.46	4.18	12.06	
24	J Franklin	32	146	2	73.00	4.56	96.00	55.48	2.38	12.10	
25	J Hopes	20	105	2	52.50	5.25	60.00	45.94	2.85	12.43	

Table III. Ranking of all-rounders according to all-rounder indices.

Rank	Name	ET	CBR*	Index c_{13}
1	S Watson	81.26	9.72	2.09
2	D Vettori	32.26	8.37	1.43
3	A Mathews	23.20	9.80	0.86
4	K Kulasekara	48.49	13.35	0.83
5	P Collingwood	52.31	14.01	0.80
6	J Franklin	34.76	12.10	0.78
7	D Sammy	23.66	11.21	0.68
8	N Ul-Hasan	21.34	12.74	0.51

Only one wicket-keeper has to be selected, so it was sufficient to use only five in the selection process.

The selection process

The Excel add-in 'Solver' is used to select a team by maximising Z subject to the constraints given. After calculating the batting indices (from ET) of the 36 batsmen who passed the minimum requirements, the top ten (cf. Table I) are drawn into the selection process. Similarly, for the 33 bowlers who qualified, the bowling indices were calculated by first inverting the CBR* values, and those of the top ten are given in Table II. Note that small values of CBR* (equivalently, large values of $1/\text{CBR}^*$) indicate good performances. In the maximisation process all the indices must be such that large values indicate good performances. All eight players who qualified as all-rounders are drawn into the selection process. Seven wicket-keepers qualified and after calculating their indices, those of the top five are listed in Table IV.

The results of the selection model are given in Table V. Note that only a limited number of the top performers in each category have been included in the selection process because those not included would not come into consideration.

The indicator variables x_{ij} in the last four columns indicate which players are selected and in which categories. The team selected according to the constraints set is given in Table VI.

Note that Watson, who ranked first among the batsmen with index 2.14, has not been selected as

batsman, but as all-rounder where his index was 2.09. This illustrates that the selection procedure amounts to more than just picking the top performers from each category. The integer programming model maximises the overall performance, Z , of the eligible players by taking into account all possible selections.

Walton, who was selected as wicket-keeper, had only played two matches and faced only three balls as batsman. If it was required that the wicket-keeper should have an average of at least 20, T. Paine would have been selected as wicket-keeper. If batsmen had been selected according to AVE, Kulasekara would have been in the second place due to the fact that he had an average of 75 based on the 75 runs he scored in three innings which included two not-out scores. He would replace Jayawardene in the selected team, with the other batsmen unchanged. He would not have been selected as all-rounder. If bowlers had been selected according to CLC, Broad would replace Tonge.

Discussion

The scale adjustment method of Lemmer (2004) is crucial whenever different measures are compared or combined into joint measures. It is essential that the measures should firstly be standardised in order to avoid the situation where the one with the largest range overshadows the others. The traditional Z standardisation is unsuitable in the present study because it leads to positive and negative values alike. According to the Lemmer (2004) method, each measure is firstly transformed through division by the average. But the variances of the resulting sets $\{c_{11}\}$ and $\{c_{12}^0\}$ may still differ. Then the scale adjustment described in the text is used to transform the set $\{c_{12}^0\}$ to the set $\{c_{12}\}$ having the same variance as the set $\{c_{11}\}$.

The performance measures used here are the most appropriate for the identification of the best players after a series of matches. After an ODI or World Cup Series it is typical that players have a small number of scores. It is essential that measures specifically designed for this case should be used, as has been done in this study. In a similar study Sharp et al.

Table IV. Ranking of wicket-keepers according to dismissal rate.

Rank	Name	Dismissals	Matches	Dismissal rate	Index c_{14}
1	C Walton	7	2	3.50	2.52
2	T Paine	11	5	2.20	1.44
3	M Dhoni	5	3	1.67	1.03
4	B McCullum	8	5	1.60	0.98
5	E Morgan	3	2	1.50	0.90
6	K Akmal	5	4	1.25	
7	K Sangakkara	2	3	0.67	

Table V. Selection procedure output.

Number	Name	d_{i1}	d_{i2}	d_{i3}	d_{i4}	x_{i1}	x_{i2}	x_{i3}	x_{i4}
1	Watson	2.14		2.09		0	0	1	0
2	Smith	1.92				1	0	0	0
3	Ponting	1.81				1	0	0	0
4	de Villiers	1.62				1	0	0	0
5	Jayawardene	1.51				1	0	0	0
6	Morgan	1.45			0.90	0	0	0	0
7	Dilshan	1.44				0	0	0	0
8	Collingwood	1.38		0.80		0	0	0	0
9	Yousuf	1.32				0	0	0	0
10	Kulasekara	1.28		0.83		0	0	0	0
11	Ajmal		1.99			0	1	0	0
12	Aamer		1.91			0	1	0	0
13	Vettori		1.77	1.43		0	1	0	0
14	Tonge		1.73			0	1	0	0
15	Nehra		1.73			0	1	0	0
16	Hauritz		1.47			0	0	0	0
17	Mills		1.36			0	0	0	0
18	Broad		1.34			0	0	0	0
19	Siddle		1.28			0	0	0	0
20	Anderson		1.27			0	0	0	0
21	Mathews			0.86		0	0	0	0
22	Franklin			0.78		0	0	0	0
23	Sammy			0.68		0	0	0	0
24	Ul-Hasan			0.51		0	0	0	0
25	Walton				2.52	0	0	0	1
26	Paine				1.44	0	0	0	0
27	Dhoni				1.03	0	0	0	0
28	McCullum				0.98	0	0	0	0

(2011) used traditional measures which are unsuitable in the author's opinion. Their wicket-keeper measure (the batting index) is also not convincing.

Players' career performance measures give the best indication of their abilities. For team selection purposes, the measures BPW and CBPW given in Lemmer (2007, pp. 82–83) should firstly be used to identify the best players. Secondly, it is necessary to judge the players' present form by using their latest figures and applying the method of the present study for the final selection. After conclusion of a series, the same can be done to select a team for the next series.

Conclusion

Close cooperation between selectors and the cricket statistician can be very useful. Very often selectors have to base their selection of players on performances in a small number of matches. Then the measures e_{26} (or ET) for batting and CBR* for bowling are the most suitable measures to use because other measures are not specifically designed for this situation. After ranking the players within each category, the selectors can be asked to delete those names not to be considered. They can then decide how the constraints should be set up, e.g. at least how many batsmen, fast bowlers, all-rounders, spin bowlers, etc. to be fed into the programme.

These constraints will often be influenced by considerations like pitch and weather conditions and also the opposing team. It is ironical that the (conceptually) best team can fail dismally. The best batsman or bowler will have bad days. Despite using the best selection criteria there is never a guarantee that the team will perform well in the next match. But it remains the selectors' duty to always select the 'best' team. It is hoped that this paper can aid selectors in their task.

A challenging problem for further research is to determine how best the results of this study can be used to predict the outcomes of games to follow after the knock-out phase of a series. A second problem, on which good progress has been made, was to

Table VI. Selected team.

Number	Name	Ability
1	S Watson	All-rounder
2	G Smith	Batsman
3	R Ponting	Batsman
4	AB de Villiers	Batsman
5	M Jayawardene	Batsman
6	C Walton	Wicket-keeper
7	S Ajmal	Bowler
8	M Aamer	Bowler
9	D Vettori	Bowler
10	G Tonge	Bowler
11	A Nehra	Bowler

construct a measure of wicket-keeper performance by taking the dismissal rate and also a measure of batting performance into account.

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