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A Vector-Geometrical Measure of Batsmanship in Test Cricket

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Abstract

Sports enthusiasts across the globe love to argue about the greatest teams or the greatest players in just about any sports. The game of cricket is by no means an exception in that regard. Recently, a paper selected the greatest batsmen of all times with a qualification of 100 innings batted in Test cricket. As is always the case, the main criterion used was the batsman's batting average in Test cricket. However, there are two other equally important statistics in batting, viz., the aggregate runs scored and the total centuries made in Test cricket. Of these, the aggregate runs scored is the product of two quantities whose magnitude is geometrically represented by the area of the rectangle formed by the two. Its magnitude is far greater than the scoring average and is therefore incompatible with the latter for comparison. In this study, this quantity is compressed to a one-dimensional quantity by extracting its square root. The three quantities of batting average, compressed aggregate runs scored and total centuries made now represent three dimensions of batsmanship in Test cricket. Geometrically, the three quantities are represented by three orthogonal components of a vector in three-dimensional space, whose resultant represented by the space diagonal of a rectangular parallelopiped is chosen to serve as a measure of batsmanship in Test cricket. In this scheme, the 10 greatest batsmen of all time are: (1) Tendulkar; (2) Kallis; (3) Ponting; (4) Dravid; (5) Sangakkara; (6) Lara; (7) Chanderpaul; (8) Border; (9) S. Waugh; and (10) Younis Khan. This list is quite different from that determined solely by batting average. It is determined that the aggregate runs scored is more effective than the centuries made in affecting the outcome of the rankings.

Introduction

The game of ***Cricket*** is unsurpassed in terms of statistical categories recorded and easily leads all sports in terms of books and articles published on it. In the batting department, discussions and arguments frequently break out regarding selecting the greatest batsmen of say, a particular nation or the entire world; or of a particular era or of all times. For example, a recent paper in this journal selected the 93 greatest batsmen of all time with the qualification of at least 100 innings batted [1]. As is customary, in that paper, the main criterion used was the ***batting averages*** of the players in ***Test cricket***. Other important criteria such as ***aggregate runs scored*** and the ***number of centuries made*** in Test cricket are almost always overlooked because these quantities are either incompatible with the batting average and are difficult to incorporate in these discissions. In this paper, we devise mathematical schemes to incorporate all three quantities on an equal footing to determine the greatest batsmen of all time who had retired by the year 2022. We begin with the 25 of the 93 batsmen in reference [1] who were deemed to be great, namely, who had averaged at least 50.00 in their entire Test careers (Table I).

Three Important Batting Statistics

If the aggregate Test runs scored by a batsman is ρ and the ***number of times dismissed*** (***out***) is ω, then his Test batting average is defined as:

$$\alpha = \frac{\rho}{\omega} \quad \textbf{(1)}$$

Thus the batting average is a ***derived quantity***. It is however, an ***intrinsic quantity***, being unique to the player's batsmanship. Equation (1) can be re-written as:

$$\rho = \alpha\omega \quad \textbf{(2)}$$

Equation (2) now defines the aggregate runs scored as a product of two quantities α and ω. It is thus a ***two-dimensional quantity***, much like the ***area of a rectangle*** is the product of its ***length*** and ***width***. It depends upon the length of the batsman's career. Its magnitude is far greater than the batting average and is therefore incompatible for comparison with the latter. However, by taking the square root of ρ, we can compress it into a ***one-dimensional quantity*** β whose dimension is compatible with α, which can therefore represent the ***total output*** of the batsman:

$$\beta = \sqrt{\rho} \quad \textbf{(3)}$$

At this juncture, a ***geometrical construction*** may provide a suitable analogy: Given a rectangle of length a and width b, find the side of a square x having the area of the rectangle. In Fig. 1, *ABCD* is a rectangle with sides *AB* = *CD* = a; *AD* = *BC* = b. Extend *AB* to *E* such that *BE* = b. Find the mid-point *O* of *AE* such that *AO* = *OE* = $(a + b)/2$. With *O* as center, draw a semi-circular arc. Extend *BC* to intersect this arc at *F*. The *BF* = x is the required side of the square. Complete the square *BGHF* whence *BG* = *GH* = *HF* = *BF* = $x = \sqrt{(ab)}$.

Proof: Applying ***Pythagoras' Theorem*** to the right-angled triangle *OBF*:

$$BF^2 = OF^2 - OB^2 \qquad \textbf{(4)}$$

Now,

$$OF = \frac{a+b}{2} \qquad \textbf{(5)}$$

and

$$OB = \frac{a-b}{2} \qquad \textbf{(6)}$$

Substituting Eqs. (5) and (6) in Eq. (4), we get $BF = x = \sqrt{(ab)}$. Hence proved.

If we assign vectorial characteristics to α and ω, then the ***cross-product*** $\vec{\rho} = \vec{\alpha} \times \vec{\omega}$ has a ***magnitude*** equal to the area of the parallelogram formed by $\vec{\alpha}$ and $\vec{\omega}$ and and a ***direction*** perpendicular to both $\vec{\alpha}$ and $\vec{\omega}$. Equation (2) is a special case when $\vec{\alpha} \perp \vec{\omega}$. A vector $\vec{\beta}$ will have the same direction as $\vec{\rho}$.

With two of the three mutually orthogonal directions of ***three-dimensional space*** already assigned, we now assign the third direction to the number of Test centuries made by the batsman. It has been pointed out that this is one of several quirky statistics of Cricket [2, 3]. ***Centuries*** (100s) are defined as all individual innings of 100 or more runs (cf. [4]). Thus, they include ***double centuries*** (200s), ***triple centuries*** (300s), ***quadruple centuries*** (400s), and so on [4]. Likewise, double centuries include triple and quadruple centuries; triple centuries include the quadruple and ***quintuple centuries*** (if any), and so on [4]. Technically, however, double centuries consist of wo centuries, triple centuries comprise three centuries, and so on. Hence counting multiple centuries as single centuries seriously deprives the batsman of his dues. In order to correct this shortcoming and account for all centuries, it was proposed to define a new category called ***total centuries*** (Σ100s) as follows:

$$\gamma = \Sigma 100s = 100s + 200s + 300s + \cdots \qquad \textbf{(7)}$$

Along with α and β, γ now completes the triad of statistics by which batsmanship of a player is measured (cf. [5]).

Vector-Geometrical Measure of Test Batsmanship

In Fig. 2, $\vec{\alpha}$, $\vec{\beta}$ and $\vec{\gamma}$, the three ***orthogonal vectors*** form a ***rectangular parallelopiped***, the magnitude of whose ***resultant*** is the ***space diagonal*** of the parallelopiped $R_{\alpha\beta\gamma}$. This can now be taken as a ***consolidated measure of batsmanship*** incorporating three independent aspects of batting. The magnitude of this resultant is given by ***three-dimensional Pythagoras' Theorem***:

$$R_{\alpha\beta\gamma} = \sqrt{\alpha^2 + \beta^2 + \gamma^2} = \sqrt{\alpha^2 + \rho + \gamma^2} \qquad \textbf{(8)}$$

We can also define two ***face diagonals*** $R_{\alpha\beta}$ and $R_{\alpha\gamma}$ as follows. In Fig. 2, the diagonal on the bottom face of the parallelopiped is a measure of batsmanship incorporating the batting average and aggregate runs scored, whose magnitude is given by:

$$R_{\alpha\beta} = \sqrt{\alpha^2 + \beta^2} = \sqrt{\alpha^2 + \rho} \qquad \textbf{(9)}$$

The diagonal on the left face of the parallelopiped in Fig. 2, on the other hand, is a measure of batsmanship incorporating the batting average and total centuries made having a magnitude of:

$$R_{\alpha\gamma} = \sqrt{\alpha^2 + \gamma^2} \qquad \textbf{(10)}$$

Results and Discussion

The values of α, β and γ of the top 25 batsmen based on Test batting averages are taken from references [1] and [3] or calculated. The new rankings of the greatest batsmen based upon the calculated values of $R_{\alpha\beta\gamma}$ are listed in Table I. The top 10 batsmen according to the new rankings incorporating the aggregate Test runs and total Test centuries are: (1) Tendulkar; (2) Kallis; (3) Ponting; (4) Dravid; (5) Sangakkara; (6) Lara; (7) Chanderpaul; (8) Steve Waugh; (9) Border; and (10) Younis Khan. Only four of the original top 10 based solely on batting averages survived in the new ranking, of whom Tendulkar leaped from 9th to the top place; Kallis went from the 7th to the second place; Sangakkara remained in the fourth place; and Lara went from the 10th to the sixth place.

The relative effects of including the aggregate runs and total centuries on the ranking of the best batsmen are determined by calculating $R_{\alpha\beta}$ and $R_{\alpha\gamma}$ from Eqs. (9) and (10). The results are shown in Table II. According to the values of $R_{\alpha\beta}$, the top 10 batsmen are: (1) Tendulkar; (2) Kallis; (3) Ponting; (4) Dravid; (5) Sangakkara; (6) Lara; (7) Chanderpaul; (8) Border; (9) S. Waugh; and (10) Younis Khan. This includes the same batsmen from that determined by $R_{\alpha\beta\gamma}$ in Table I with the positions of Border and Waugh interchanged. This is quite surprising given that the aggregate runs can be different between two batsmen having the same batting average. The reason can be traced to the fact that α and β are correlated according to Eqs. (2) and (3).

Finally, according to the $R_{\alpha\gamma}$ values, the top 10 batsmen are ranked as: (1) Tendulkar; (2) Sangakkara; (3) Kallis; (4) Lara; (5) Ponting; (6) Dravid; (7) Younis Khan; (8) Hammond; (9) Sobers; and (10) Gavaskar (Table II). In this determination, there are three new members of this group: Hammond, Sobers and Gavaskar, who displace Chanderpaul, Border and Waugh, respectively. There are also rearrangements in the top seven positions, with the exception of Tendulkar, who retains the top position. The greater agreement between the rankings produced by $R_{\alpha\beta\gamma}$ and $R_{\alpha\beta}$ as opposed to that between $R_{\alpha\beta\gamma}$ and $R_{\alpha\gamma}$ suggests that the aggregate runs scored as represented by β has a greater effect in the comprehensive ranking than the total centuries scored γ. Lastly, in all three new ranking schemes, ***Sachin Tendulkar*** emerged as the greatest batsman of all time, having scored far more Test runs and Test centuries than any other batsman, notwithstanding ***Donald Bradman***, whose statistics, of course, represented a

mathematical singularity in the history of Cricket, and indeed, of all sports [6].

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Table I. New Measure of Batsmanship of the Greatest Batsmen in Test Cricket

Rank	Batsmen	Team	Ave. α	Runs ρ	Σ100s γ	Meas. $R_{\alpha\beta\gamma}$	New Rank
1	Barrington	E	58.67	6,806	21	103.39	21
2	Hammond	E	58.45	7,249	30	107.54	17
3	Sobers	WI	57.78	8,032	29	110.51	14
4	Sangakkara	SL	57.40	12,400	50	134.89	4
5	Hobbs	E	56.94	5,410	16	94.38	23
6	Hutton	E	56.67	6,971	24	103.72	20
7	Kallis	SA	55.37	13,289	47	136.25	2
8	G Chappell	A	53.86	7,110	28	104.42	19
9	Tendulkar	I	53.78	15,921	56	148.15	1
10	Lara	WI	52.88	11,953	46	129.87	6
11	Miandad	P	52.57	8,832	29	111.52	12
12	Dravid	I	52.31	13,288	41	133.06	5
13	Md Yousuf	P	52.29	7,530	28	105.11	18
14	Younis Khan	P	52.05	10,099	41	120.37	10
15	Ponting	A	51.85	13,378	47	135.19	3
16	Flower	Z	51.54	4,794	13	87.29	25
17	Hussey	A	51.52	6,235	19	96.18	22
18	Chanderpaul	WI	51.37	11,867	32	124.62	7
19	Gavaskar	I	51.12	10,122	38	119.08	11
20	S Waugh	A	51.06	10,927	33	120.93	9
21	Hayden	A	50.73	8,625	33	110.85	13
22	De Villars	SA	50.66	8,765	24	109.12	15
23	Border	A	50.56	11,174	29	120.71	9
24	Richards	WI	50.23	8,540	26	108.35	16
25	Compton	E	50.06	5,807	19	93.13	24

A = Australia; E = England; I = India; P = Pakistan; SA = South Africa; SL = Sri Lanka; WI = West Indies; Z = Zimbabwe

Table II. Other Measures of Batsmanship of the Greatest Batsmen in Test Cricket							
Rank	Batsmen	Team	Ave. α	$R_{\alpha\beta}$	Rank	$R_{\alpha\gamma}$	Rank
1	Barrington	E	58.67	101.23	19	62.32	11
2	Hammond	E	58.45	103.27	17	65.70	8
3	Sobers	WI	57.78	106.63	13	64.65	9
4	Sangakkara	SL	57.40	125.28	5	76.12	2
5	Hobbs	E	56.94	93.02	23	59.15	19
6	Hutton	E	56.67	100.91	20	61.54	13
7	Kallis	SA	55.37	127.89	2	72.63	3
8	G Chappell	A	53.86	100.60	21	61.59	12
9	Tendulkar	I	53.78	137.16	1	77,64	1
10	Lara	WI	52.88	121.45	6	70.09	4
11	Miandad	P	52.57	107.68	12	60.04	17
12	Dravid	I	52.31	126.59	4	66.46	6
13	Md Yousuf	P	52.29	101.31	18	59.31	18
14	Younis Khan	P	52.05	113.17	10	66.26	7
15	Ponting	A	51.85	126.75	3	69.98	5
16	Flower	Z	51.54	86.32	25	53.15	24
17	Hussey	A	51.52	94.28	22	54.91	23
18	Chanderpaul	WI	51.37	120.44	7	60.52	15
19	Gavaskar	I	51.12	112.85	11	63.70	10
20	S Waugh	A	51.06	116.34	9	60.80	14
21	Hayden	A	50.73	105.82	15	60.52	16
22	De Villars	SA	50.66	106.45	14	56.06	22
23	Border	A	50.56	117.18	8	58.29	20
24	Richards	WI	50.23	105.18	16	56.56	21
25	Compton	E	50.06	91.18	24	53.54	25
A = Australia; E = England; I = India; P = Pakistan; SA = South Africa; SL = Sri Lanka; WI = West Indies; Z = Zimbabwe							

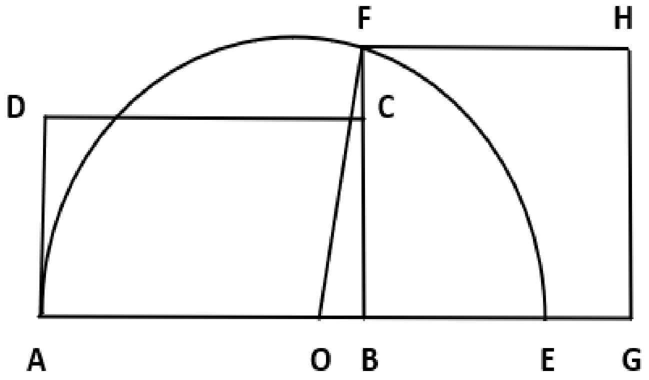

Figure. 1

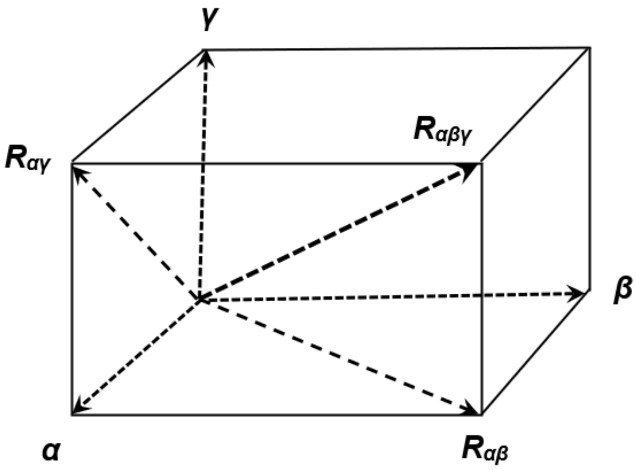

Figure. 2