Evaluation of Bowler's Performance in Cricket Using Fuzzy Logic

Abhinav Kathuria

abhinav.kathuria90@gmail.com

Abstract:

Today Cricket is one of most famous game of Asia sub continental. Cricket is a bat-and-ball game played between two teams of 11 players each on a field at the centre of which is a rectangular 22-yard long pitch. Each team takes its turn to bat, attempting to score runs, while the other team fields. The main objective of any team is to win the match. The result of a match is a win when one side scores more runs than the opposing side and all the innings of the team that has fewer runs have been completed. The performance evaluation in cricket is very critical issue in this game. It makes effect on international ranking of players. The evaluation of individual player performances in one-day cricket is based on measures such as batting and bowling averages, and strike and economy rates. It is accepted, within the game of cricket, that such measures have several limitations in assessing the true performances and abilities of players because it doesn't consider the factors like opposite team, weather conditions, Pitch conditions, Target Score. In this paper, we purposed a fuzzy logic based method to evaluate the performance of bowler that consider the factors missing in existing methods.

Keywords: Pitch; Strike Rate; Economy Rate; Fuzzy Logic

Introduction:

Cricket has its name derived from the old English word "cryce" which means "stick". Cricket became very popular by the 18th century and a London club was formed in 1700. Cricket is one kind of outdoor game. It is played between two teams of fifteen players each having eleven playing players at a time and four extra players. It is played with a ball, a bat and wickets. The ball, the bat and the wickets are properly sized for this game. They are called cricket-ball, cricket-bat and cricket-wickets. [1][9]

Cricket is played in a round field. A cricket-wicket is made of three stumps and two bails. They are of approved size. Each stump is 28 inches (71.1 cm) tall with maximum and minimum diameters of $1 1⁄2$ inches (3.81 cm) and $13⁄8$ inches (3.49 cm). Two wickets are correctly fixed in the middle of the cricket-field. There is a pitch between these two wickets. The objective of the game is for a team to score more runs than its opponent. In some forms of cricket as in Test Matches, it may also be necessary to dismiss the opposition in order to win the match, which would otherwise be drawn. [2] [10]

In cricket the performance of the players whether bowler or batsman is being analyzed with the help of statistical tools. The ranking of an individual bowler is on the basis of the performances of a player. The Performance of a bowler is evaluated on the basis of following factors:

Number of Match: The Total Number Match Played

Number of Balls: The Total Number of Balls have been thrown

Total Runs: The Total Number of Runs Scored against the bowler by batsmen

Wickets: The Total numbers of Wicket

Economy: Average Runs given against 6 bowles.[11][12]

Fuzzy Logic was initiated in 1965 byZadeh [3], professor for computer science at the University of California in Berkeley. Fuzzy Logic is a multivalued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no,High/low etc.fuzzy logic is a logical system, which is an extension of multivalued logic. Fuzzy inference System (FIS) is the process of formulating the mapping from a given input to an output using fuzzy logic [4]. The mapping then provides a basis from which decisions can be made, or patterns discerned. The process of fuzzy inference involves all of the pieces such as membership functions, fuzzy logic operators, and if-then rules. There are two types of fuzzy inference systems that can be implemented in the Fuzzy Logic Toolbox: **Mamdani-type**: It was proposed in 1975 by EbrahimMamdani [5] as an

attempt to control a steam engine and boiler combination by synthesizing a set of linguistic control rules obtained from experienced human operators. And Sugeno-type. *Mamdani-type inference*, as defined for the toolbox, expects the output membership functions to be fuzzy sets. After the aggregation process, there is a fuzzy set for each output variable that needs defuzzification.

Sugeno-type : It is very similar to the Mamdani method. Sugeno made a change only to a rule consequent. He used a mathematical function of the input variable instead of a fuzzy set. The format of the Sugeno-style fuzzy rule is:

IF *x* is *A* AND *y* is *B* THEN *z* is *f(x, y)*

Where*x*, *y* and *z* are linguistic variables; *A* and*B* are fuzzy sets on universe of discourses *x* and *y* respectively; and *f(x, y)* is a mathematical function.

A FCM (Fuzzy Cognitive Maps) [6] consists of factors (concepts / nodes) which represent the important elements of the mapped system. The directed lines labeled with fuzzy values show the strength of the causal conditions between the factors. A fuzzy cognitive map is a model of system structure. [7][8]

Related Work:

Gweshe and Durbach [13] developed a new technique Data Envelopment Analysis (DEA) and Stochastic Multi-criteria Acceptability Analysis (SMAA)approaches to measure the efficiency of individual cricket players in 2011 Cricket World Cup. This technique is capable to measure the efficiency ofcricket players in the limited-over format of thegame. Sharma [14] investigates the systematic co-variation among various dimensions pertaining to

batting and bowling capabilities of T20 cricket using the advanced statistical technique of factor analysis. Akhtar [15] developed a new player rating system for test cricket cricket in which performance in test matches is evaluated session by session. They then used these probabilities to measure the overall contribution of players to the match outcome based on their individual batting, bowling and fielding contributions during each session. This measure of contribution has the potential for rating players over time and for determining the 'best' player in a match, a series or a calendar year.

4. Purposed Technique:

Fuzzy control system executes in three steps: fuzzification, inference and defuzzification Fuzzification converts the crisp inputs to fuzzy sets and finally the defuzzfier converts the fuzzy output to crisp values

4.1 FIS Editor

The FIS Editor is a GUI tool which allows editing the highest level features of the fuzzy inference system, such as the number of input and outputting variables, the defuzzification method used, and so on.

4.2 I/O Components used in Fuzzy Based Cricket Player Evaluation Tool

In the fuzzy based performance appraisal, eight parameters are taken as linguistic variables that affect the ranking or performance of a cricket player. The parameters taken for the system are: opposite team, weather conditions, Target Score, Match, Wickets, Strike rate,economy . The performance has been taken as an output parameter. All these input variables affect the ranking of a player. Figure 4.1 shows the input variables and output variables.
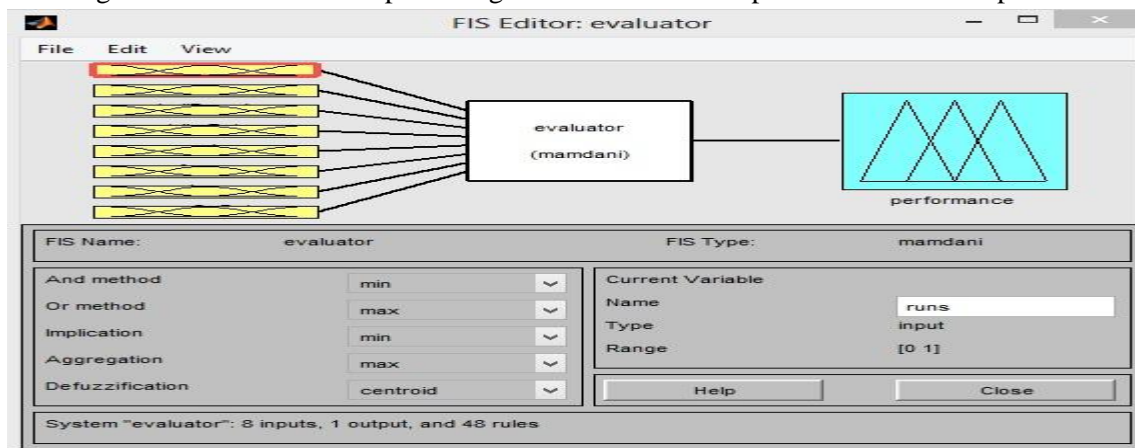

Fig. 4.1: Input/ output parameters

4.3 Parameters and their Impact Levels

It is assumed that the impact of the parameters may be different from each other, depending upon the factors considered at different situations. The impact levels for seven input variables/parameters are Low, Medium and High. The impact levels of various parameters are shown in Table 4.1.

Table 4.1: Selected Parameters and their Relative Input Levels.

Parameters	Input Levels
Match	Low, Medium, High
Wicket	Low, Medium, High
opposite team (OT)	Low, Medium, High
Pitch conditions (PC)	Low, Medium, High
Target Score (TS)	Low, Medium, High
Strike rate (SR)	Low, Medium, High
economy	Low, Medium, High

To represent these three levels, three membership functions are used. These functions are: zmf for *Low*, guassmf for *Med* and smf for *High*.

4.4 Formulae of Input Membership Functions

zmf: Z-shaped built-in membership function (zmf) is used to define the variable *Low*. The weight is calculated by the following formula:

$$f(x;0,0.5) = \begin{cases} 1, x \leq 0 \\ 1 - 2\left(\dfrac{x-0}{0.5-0}\right)^2, 0 \leq x \leq \dfrac{0+0.5}{2} \\ 2\left(\dfrac{x-0.5}{0.5-0}\right)^2, \dfrac{0+0.5}{2} \leq x \leq 0.5 \\ 0, x \geq 0.5 \end{cases}$$

equation 1

gaussmf: Gaussian curve built-in membership function is used to define the variable *Med*. The weight is calculated by the following formula:

$$f(x;0.2123,0.5) = e^{\frac{-(x-0.5)^2}{2(0.2123)^2}}$$

equation 2

smf: S-shaped built-in membership function is defined for variable *High*. The weight is calculated by the following formula:

$$f(x;0.5,1) = \begin{cases} 0, x \leq 0.5 \\ 2\left(\dfrac{x-0.5}{1-0.5}\right)^2, 0.5 \leq x \leq \dfrac{0.5+1}{2} \\ 1 - 2\left(\dfrac{x-1}{1-0.5}\right)^2, \dfrac{0.5+1}{2} \leq x \leq 1 \\ 1, x \geq 1 \end{cases}$$

equation 3

4.5 Output Membership Function

Performance is taken as an output variable which has five levels: *Very Low*, *Low*, *Neutral*, *High* and *Very High* as shown in Figure 4.11. All these five levels are defined by the membership function trimf.
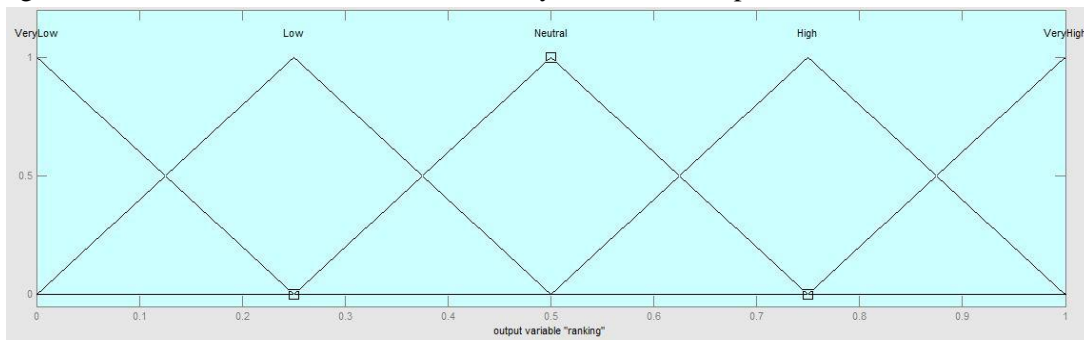

Fig. 4. 2. Membership Functions for Output Variable *perfromance*.

trimf: Triangular-shaped built-in membership function is defined for the variable *ranking*. The weight is calculated by the following formula:

$$f(x;a,b,c) = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a}, & a \le x \le b \\ \dfrac{c-x}{c-b}, & b \le x \le c \\ 0, & c \le x \end{cases}$$

equation 4

Table 4.2 shows the values of a, b & c for all five variable.

Parameters	A
Very Low	-0.25
Low	0
High	0.5
Very High	0.75

4.6   Fuzzy Rules

A fuzzy if-then rule assumes the following form:

IF *X* is *A* THEN *Y* is *B*

Where, A and B are linguistic values defined by fuzzy sets on universes of discourse X and Y, respectively. Often "X is A" is called antecedent or premise, while, "Y is B" is called consequence or conclusion.

On the basis of the description of input and output variables, 48 rules are constructed using the Mamdani fuzzy reasoning in order to adequately analyze the inputs.

Rule 1

If (match is *High*) and (Wickets is *High*) and (*TS* is *Med*) and (*OT* is *High*) and (*Pitch conditions* is *low*)

and (*SR* is *Med*) and (*ST* is *High*) and (*economy rate is low*) then (*performance* is *veryHigh*)

Rule 2

If (match is *High*) and (Wickets is *High*) and (*TS* is *High*) and (*OT* is *Low)* and (*Pitch conditions* is *low*) and (*SR* is *Med*) and (*ST* is *High*) and (*economy rate is low*) then (*performance* is *High*)

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Rule 48

If (match is *High*) and (Wickets is *Low*) and (*TS* is *High*) and (*OT* is *Low)* and (*Pitch conditions* is *High*) and (*SR* is *Low*) and (*ST* is *Low*) and (*economy rate* is *low*) then (*performance* is *Low*)

Rules are also can be extended according to various probabilities.

Conclusion

The end, it is concluded that this performance evaluation technique can be very helpful to measure the accurate performance of a bowler. This methodology can produce better and accurate result than other tradition technique through. This performance can help us to produce international ranking of players. This tool can be veryuseful for given purposes: 1) For international ranking of players 2) For team selections 3) To determine "Man of Match" and "Man of Series" .

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