Europe's Journal of Psychology 2/2009, pp.123-134
www.ejop.org

Role of the Fuzzy System in Psychological Research

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Abstract
A new analytical method for psychological research is being proposed. The advantages of evaluation with fuzzy statistical analysis include: (i) The evaluation process becomes robust and consistent by reducing the degree of subjectivity of the evaluator; (ii) The self-potentiality is highlighted by indicating individual distinctions and (iii) It provides the evaluators with an encouraging, stimulating, self-reliant guide that emphasizes individual characteristics. The empirical results demonstrate that the new approach is efficient and more realistic than the traditional method. To demonstrate the effectiveness and advantages of the new method, the results are presented in comparison to those obtained with the help of the traditional method. Twelve subjects were involved in this study and Sinha's Comprehensive Anxiety Test (SCAT) and Approval Motive Scale were employed. Fuzzy and traditional approaches are discussed in the end.

Keywords: Fuzzy logic, Anxiety, Motivation, Defuzzification, Fuzzyfication of variables

Introduction

Sports contain both a psychological and social dimension. It means that sports are psycho-social activity full of tension, anxiety, fear and stress. Man's interest in sports is found in all societies of the world. Most of the nations share a common attention in sports competitions, especially at certain times during Olympic Games, where people from all nations focus their attention on that drama of competition. But the quality of participation of the athletes and sportsmen is determined by their psychological factors in this modern era of competition.

Anxiety plays an important role in sports. The degree of perceived anxiety is an important variable to be considered in the performance of an individual. Several researches have shown that anxiety is present in all of us, including players, in varying degrees. But in the field of sports, certain situations produce more anxiety than others (Frost, 1971; Singer, 1972; Butt, C. 1976; Singh, 1992).

Motivation explores the capacity of work of an individual. He willingly takes and confronts challenges which may look undefeatable in absence of strong motivation. Mental excitements generated by the situational factors tend to favor a behavior that most likely is the result of an effort matching the situational demand. Motivation is instrumental in ignoring negative factors that hinder performance (Weinberg, 1979). On the other hand it promotes emotions and explores positive avenues resulting in successful performance. The motivated person is most likely to defend his personal pride and self-image which leads to greater confidence and motivation as well (Roberts, 1980; Cratty, 1989).

Motivation is closely related to arousal, attention, anxiety, and reinforcement. For example, a person needs to be motivated enough to pay attention while learning; anxiety can decrease our motivation to learn. Receiving a reward or feedback for an action usually increases the likelihood that the action will be repeated (Singer, 1977; Alderman, 1980; Roberts, 1985). Weiner points out that behavioral theories tended to focus on extrinsic motivation (i.e., rewards) while cognitive theories deal with intrinsic motivation (Weiner, 1990).

According to Hull's drive reduction theory, learning reduces drives and therefore motivation is essential for learning. The degree of the learning achieved can be manipulated by the strength of the drive and its underlying motivation.(Hull, 1943) In Tolman's theory of purposive behaviorism, primary drives create internal states (i.e., wants or needs) that serve as secondary drives and represent intrinsic motivation (Tolman,1932/1967).

In cognitive theory, motivation serves to create intentions and goal-seeking acts (Ames & Ames, 1989). One well-developed area of research highly relevant to learning is achievement motivation (Atkinson & Raynor, 1974; Weiner, 1990). Motivation to achieve is a function of the individual's desire for success, the expectancy of success, and the incentives provided. Studies show that in general people prefer tasks of intermediate difficulty. In addition, students with a high need to achieve, obtain better grades in courses which they perceive as highly relevant to their career goals (Alderman & Wood, 1976). On the other hand, according to

Rogers, all individuals have a drive to self-actualize and this motivates learning (Rogers, 1967).

Malone (1981) presented a theoretical framework for intrinsic motivation in the context of designing computer games for instruction. Malone argues that intrinsic motivation is created by three qualities: challenge, fantasy, and curiosity. Challenge depends upon activities that involve uncertain outcome due to variable levels, hidden information or randomness. Fantasy should depend upon skills required for the instruction. Curiosity can be aroused when learners believe their knowledge structures are incomplete, inconsistent, or un-parsimonious. According to Malone, intrinsically motivating activities provide learners with a broad range of challenges, concrete feedback, and clear criteria for performance.

In everyday discussion, the use of imprecise and vague terms like "It is a cold day" or "You are very good" or "The tall guy over there" are usually heard. The words such as cold, very good, and tall have no clear boundaries. Each individual has their own interpretations of the meaning (Lazim, M. A., Abdullah, W.S.W., & Abu Osman M. T. 2004). Thus, for some people, good in examination implies a total mark above 70 percent while for others, it may be 55 percent. Kantardzic (2003) tossed a slightly different example of vague phenomena in the real world. Rain is a common natural phenomenon that is difficult to describe precisely since it can rain with varying intensity, anywhere from a light shower to heavy downpour. Since the word rain does not adequately or precisely describe the wide variations in the amount and intensity of any rain event, rain is considered a vague phenomena. Very often, the concepts in the human brain for perceiving, recognising, and categorising natural phenomena are also vague and imprecise. The boundaries of these concepts are not clearly defined. Therefore, the judging and reasoning that emerge from them also become vague. In struggling to find a way of expressing succinctly the idea of vagueness in life Zadeh (1965) proposed the idea of fuzzy sets.

Fuzzy logic is an extension of Boolean logic which allows intermediate values between True and False. As in Boolean logic a true statement is expressed by the value "1" and a false statement by the value "0". However, unlike in probability theory, the value must not be interpreted as a confidence level but rather as a Membership Function (MF). Therefore, every statement is "True" to a certain degree and "False" to another. An interesting property of these MFs is that, because they vary between zero and one, they can be manipulated like probabilities; even though they are interpreted (Zétényi, 1988).

Psychology is not only a field in which profound applications of fuzzy logic are anticipated, but is also very important for the development of fuzzy set theory itself (Zétényi,1988). The interest of psychologist in fuzzy logic has visibly been growing since mid-1980s (Smithson, M. 1982; Averkin, A.N. & Tarasov, V.B, 1987; Hesketh, T., Pryor, R.& Hesketh, B. 1988).

Earlier few models of personality traits were developed that included, introverted, extroverted, open, sensitive, realistic, selfish, hostile and fuzzy logic based adaptive model of emotions (El-Nasr, M.S., Yen, J, & Loerger, T. R. 2000)

Objective

The objective of this investigation is two-fold:
(a) to examine association of anxiety level and motivational level of players with the help of fuzzy logic technique.
(d) to examine the comparison between fuzzy logic technique and conventional psychometric test.

Methodology

Subjects:
The participants were 12 players of basketball, volleyball and football, all from G. B. Pant University of Agriculture & Technology, Pantnagar. The average age of subjects ranges from 17 to 25 years.

Research Instrument:
a. Sinha's Comprehensive Anxiety Test (SCAT) developed by Sinha & Sinha (1985) to assess anxiety level of participants.
b. Approval Motive Scale (AMS) developed by Tripathi & Tripathi (1980) to assess motivation level of participants

Procedure:
Liaison with the players occurred one week prior to testing. During this period, a verbal consent of the players was received later, a written consent explaining the aims of the research was given to provide information and gain signature from the participants.

The players completed the anxiety and motivation scale within one hour.

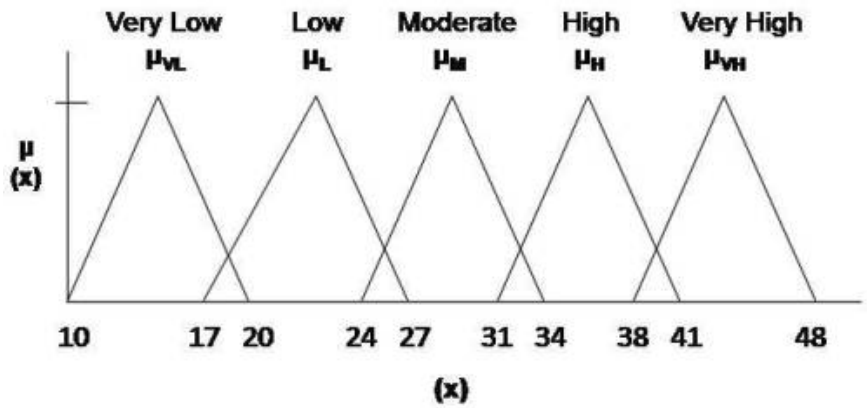

Fig. 1 Fuzzy Sets for Anxiety

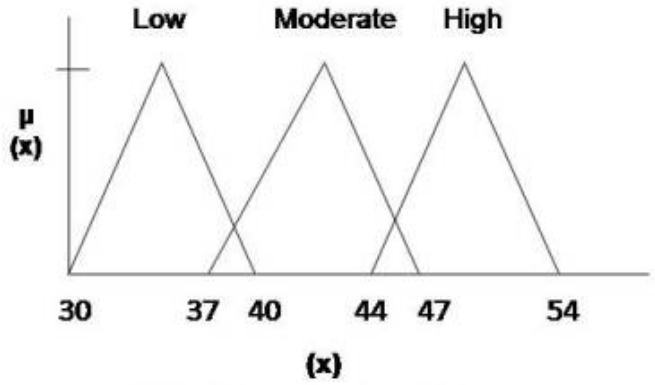

Fig. 2 Fuzzy Sets for Motivation

Every member will be attached to a set of numerical value between 0 and 1 called membership grade in the fuzzy set.

In the above model anxiety and motivation are treated as the state fuzzy variable. Fuzzyfication of variables lie under the trade off between precision in renewed decision and computation time. Each of the system states that fuzzy variables are decomposed into a reasonable number of fuzzy regions (Cox, 1992). Each region should overlap somewhat between 10% and 50% with its neighbors. The two system input state variables were fuzzified anxiety and motivation. (Oden, 1979)

Rule Base:

1. If anxiety is very low then motivation is moderate.
2. If anxiety is low then motivation is moderate.
3. If anxiety is low then motivation is high.
4. If anxiety is moderate then motivation is high.

5. If anxiety is moderate then motivation is moderate.
6. If anxiety is moderate then motivation is low.
7. If anxiety is high then motivation is moderate.
8. If anxiety is high then motivation is high.
9. If anxiety is very high then motivation is moderate.

Inference: The truth value for the premise of each rule is computed, and applied on the conclusion part of each rule. This results in one fuzzy subset to be assigned to each output variable for each rule. Usually MIN or PRODUCT are used as inference rule. In MIN inferencing, the output membership function is clipped off at a height corresponding to the rule premise's computed degree of truth (weight of the rule, a). In PRODUCT inferencing, the output membership function is scaled by the rule premise's computed degree of truth.

Composition: All of the fuzzy subsets assigned to each output variables are combined together to form a single fuzzy subset for each output variable. Usually MAX or SUM are used for composition. In MAX composition, the combined output fuzzy subset is constructed by taking point wise maximum over all of the fuzzy subsets assigned to variable by the inference rule. In SUM composition, the combined output fuzzy subset is constructed by taking the point wise sum over all of the fuzzy subsets assigned to the output variable by the inference rule.

Defuzzification: Sometimes it is useful to just examine the fuzzy subsets that are the result of the composition process, but more often; this fuzzy value needs to be converted to a crisp value. This is what the defuzzification sub process does. Two of the common techniques for defuzzification are the centroid and the maximum method. In the centroid method, the crisp value of the output variable is computed by finding the variable value of the centre of gravity of the membership function for the fuzzy value. In the maximum method, one of the variable values at which the fuzzy subset has its maximum truth value is chosen as the crisp value for the output variable.

In the present study, PRODUCT method is used for inferencing, SUM method is used for composition and CENTROID method is used for defuzzification.

Table 1. Membership grade and firing strength of the rules

S.No	x	$\mu_{VL}(x)$	$\mu_{L}(x)$	$\mu_{M}(x)$	$\mu_{H}(x)$	$\mu_{VH}(x)$	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	α_9
1	13	0.6	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	22	0.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
3	23	0.0	0.8	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8	0.0	0.0	0.0	0.0
4	27	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6
5	29	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0
6	30	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.8
7	31	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6
8	32	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4
9	33	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
10	34	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	37	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	40	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table: 2 Motivational Levels

Sr. No.	Anxiety (x)	Motivation(y)
1	13.0	42.000
2	22.0	45.497
3	23.0	45.499
4	27.0	42.000
5	29.0	42.000
6	30.0	42.000
7	31.0	42.000
8	32.0	42.000
9	33.0	43.310
10	34.0	45.499
11	37.0	45.499
12	40.0	44.429

Sample Mathematical Calculation:

For input, x = 13, output fuzzy set is given by following equation.

$$fuzzy(y) = \begin{cases} 0.6(y-37)/5,37 \le y \le 42 \\ -0.6(y-47)/5,42 \le y \le 47 \\ 0, otherwise \end{cases}$$

$$Area = \int f(y)dy = \frac{0.6}{5}\left[\int_{37}^{42}(y-37)dy - \int_{42}^{47}(y-47dy\right] = 3.0$$

$$Moment = \int yf(y)dy = \frac{0.6}{5.0}\left[\int_{37}^{42}(y^2-37y)dy - \int_{42}^{47}(y^2-47y)dy\right] = 126$$

$$Cetroid = \frac{Moment}{Area} = \frac{\int yf(y)dy}{\int f(y)dy} = \frac{126}{3} = 42.0$$

Same calculation is done for other inputs with different output fuzzy sets and following results are obtained.

Result and Discussion

Nearly all psychological study and its use of questionnaires are very common to study human behavior. In this process the biasness of the subject can never be ignored during answering the questions of any kind of questionnaire. That's why the data obtained by questionnaire are imprecise as "raw" data includes hidden uncertainties. Fuzzy logic has been recognized as an effective tool to deal with the uncertainty involved in the data. The result obtained by fuzzy method and raw score of motivation obtained by without fuzzy (conventional) are shown in the following table:

Fig. 3: Comparison of the level of motivation by conventional and fuzzy method

Table:3

S.No.	Anxiety	Motivation estimated by without fuzzy	Motivation estimated by fuzzy
1	13	43	42.000
2	22	43	45.497
3	23	47	45.499
4	27	44	42.000
5	29	43	42.000
6	30	50	42.000
7	31	38	42.000
8	32	41	42.000
9	33	38	43.310
10	34	39	45.499
11	37	48	45.499
12	40	42	44.429

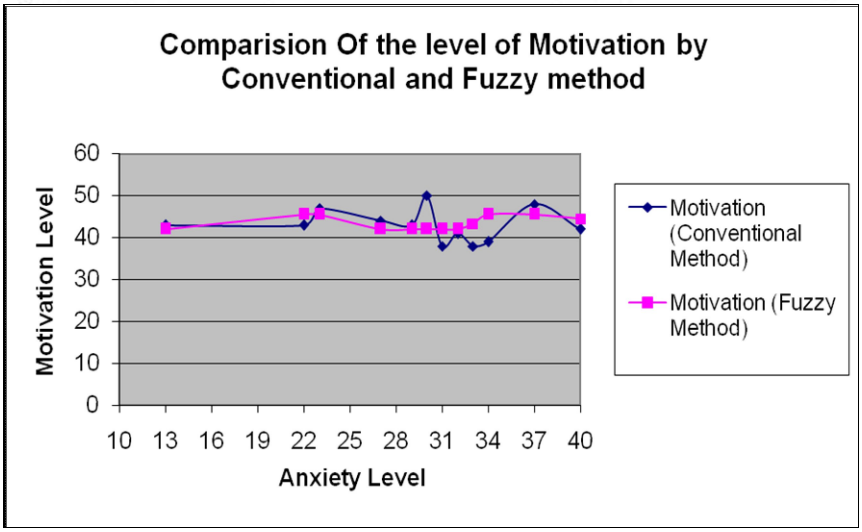

Table: 4: t-test of Motivation estimated by without fuzzy method (Conventional) and Motivation estimated by fuzzy method

Group	N	Mean	S.D	t-value
Motivation estimated by without fuzzy method (Conventional)	12	43.00	3.837	0.69786
Motivation estimated by fuzzy method	12	43.48	1.661	

The above analysis reveals that fuzzy system produce rational outcomes. The fuzzy systems predict the motivational level of players with the help of anxiety of players (Table 2) without using a psychological motivation scale. This is a unique feature of fuzzy logic. The output obtained by fuzzy method and non fuzzy method (conventional) is shown in (Table 3) and their respective graph (Fig 3) is indicate more or less by similar outcome of motivation estimated by without fuzzy method (conventional) and fuzzy method. The result of t-test are shown in (Table 4) the t-value was 0.69786 which is not significant at < 0.05 level. This shows that there was no significant difference between the motivation estimated without fuzzy method and motivation estimated by fuzzy method. But standard deviation gives some important information regarding the uncertainty in data. Motivation estimated by fuzzy method, standard deviation shows less variance in data as compared to motivation estimated by the without fuzzy method. Psychological parameter motivation estimated by the without fuzzy method and fuzzy method revealed some variations because of some hidden uncertainties in raw data of subjects. The unique feature of the fuzzy method in the present paper is that it controls the uncertainty in data collected (Smithson, M. 1982; Cox, 1992). This paper provides that the fuzzy method is used in behavioral research, beside statistical tools because fuzzy methods have more advantage over statistical analysis to control variation in data.

Conclusion

The reason for using fuzzy logic in the study of human behavior is that much of the information obtained by questionnaire is uncertain in nature. Uncertainty in the data that are related leads to the notion of imprecision. Using fuzzy data instead of raw data has an advantage of reducing uncertainty. This gives a new dimension for the study in the field of psychology. The major advantage of this modeling approach is that it enables the use of uncertainty measures to quantify the ambiguity associated with prediction of psychological parameters.

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