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RESEARCH ARTICLE

Fuzzy Modelling for Selection of Overall Best Performer

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ABSTRACT

The overall best/high performer selection has to be done considering the internal marks, external marks, attendance and all other parameters of academics and non-academics. A Best Performer (BP) is an all-round student and can be identified when all characteristics of the student are considered, which includes I.Q, time management, presentation skills, behaviour, health, moral responsibilities, etc. To perform the selection of an overall best performer out of all the best performers, it is necessary to calculate the Total Performance Impact Value (TPIV) of all the best performers and recuperate them with their average B.Tech as well as placement performance. Here, most of the data are not always crisp or numeric but rather linguistic like highly intelligent, good managerial capacity, good writing or presentation skills, highly sincere, good communication skills, adequate moral values etc., which are fuzzy in nature. Thus vagueness is the vital component of appraisal. All expert observations based on their expertise for giving their choice deviate according to the nature of the parameters. Considering the vagueness involved in the selection of overall best performer out of all the best performers of a college or colleges in an area, a Fuzzy model is presented in this paper.

Keywords: Best performer, Fuzzy decision, Intuitionistic fuzzy sets, Mean fuzzy set, Total impact value.

1. INTRODUCTION

For selection of overall best performer, the concept is that the student has to be efficient in different parameters. In practice, it is often found that a student of a particular college may be efficient in both academics and other parameters but may not be declared as the best even though the entire Best Performers (BP) group may follow same syllabus and academic regulations. So, it is very complex for an expert to arrive at a conclusion for choice of the overall best performer specifically out of the entire best performers group.

Every decision maker hesitates on every assessment activity because some component of the estimate contributes to truthfulness and some part of the evaluation contributes to falseness. Thus vagueness play a major role in the expert's insight which can be minimized using fuzzy logic of [1] and it's higher order fuzzy logic of [2].

According to fuzzy logic, a fuzzy set A is defined as a set of ordered pairs like, $A = \{(x_1, \mu_A(x_1)),(x_2, \mu_A(x_2)),\ldots,(x_n, \mu_A(x_n))\}$,where $\mu_A(x_n)$ is the degree of truth membership value of element x_n and $[1- \mu_A(x_n)]$ is the false membership value $\nu_A(x_n)$ [1, 2].

But in many cases of judgement, the fuzzy logic is not sufficient to tackle the uncertainty and to overcome this problem, [2] introduced a new concept of Intuitionistic Fuzzy Sets (IFS) by bifurcating the Zadeh's false membership value into two separate parts i.e. purely false $[\nu_A(x)]$ and purely indeterministic or hesitation $[\pi_A(x)]$ so that $[\mu_A(x) + \nu_A(x) + \pi_A(x)] = 1$ [2].

[3] proposed a multi criteria analysis in ranking the quality of teaching using fuzzy rule and approximate reasoning in deciding the

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ranking of the quality of teaching in several courses.

[4] proposed a new performance evaluation method based on fuzzy logic systems. Student performance of Control Technique Laboratory in Marmara University Technical Education Faculty, Electricity Education Department, was carried out with fuzzy logic and it was compared with classical evaluating method. Study samples are notes which twenty students took as the control technique laboratory course. Evaluation of the results showed variations between the classical and fuzzy logic methods. Although performance evaluation using fuzzy logic is complicated and requires additional software, it provides some evaluation advantages. Fuzzy logic evaluation is flexible and provides many evaluation options while the classical method adheres to constant mathematical calculation.

[5] proposed a Fuzzy Expert System (FES) for student academic performance evaluation based on fuzzy logic techniques. A suitable fuzzy inference mechanism and associated rule has been introduced behind fuzzy logic and illustrated how these principles could be applied by educators to evaluate the student academic performance. [6] explored the applicability of fuzzy C-means clustering technique to student allocation problem that allocates new students to homogenous groups of specified maximum capacity and analyzes the effects of such allocations on the academic performance of students. The author also presents a fuzzy set and regression analysis based fuzzy expert system model which is capable of dealing with imprecision and missing data that is commonly inherited in the student academic performance evaluation and the model automatically converts crisp sets into fuzzy sets by using C-Means clustering technique for academic performance evaluation.

Using fuzzy inference technique, [7] performed the classification of student scores data according to the level of their performance using a combination of two membership functions (trapezoidal and triangular). The experimental results are compared with traditional evaluation method which helped in identifying students lying at the overlapping section of the two class distribution. The results helped the educators to monitor the progress and provide timely guidance to students to achieve better performance score.

[8] discusses an application of fuzzy measure and corresponding fuzzy integral for the evaluation of students failure reasons. From the result it is clearly seen that choquet integral has a good choice in decision making.

[9] presents a design and implementation of a performance appraisal system using fuzzy logic. The system contains step by step inference engine processes demonstrating several calculation details in relations composition and aggregation methods such as min operator, algebraic product, sup-min and sup-product. The system has foundation to add-on analysis module to analyze and report the final result using various similarity measures.

[10] is the first study which uses fuzzy apriori and feature selection techniques in credit scoring. Four different feature selection methods over three credit datasets are used and compared which are stepwise regression, Classification and Regression Tree (CART), correlation matrix and Principle Component Analysis (PCA). Accuracy, number of rules and number of extracted features are used to evaluate and compare the results. Feature selection on fuzzy apriori, shows better results in the number of rules and number of features used.

[11] discussed the selection of an economical green building in its essence out of n-alternatives based on the assessment of Total Environmental Impact Values (TEIV) of all buildings which are then optimized with respect to their constructional cost and cost of land.

In this paper we used composed fuzzy model of IFS and fuzzy decision to minimize the uncertainty involved in the selection of overall best performer out of the entire best performers group. For identifying the overall best performer, main concept should always be borne in mind that the performer has to be efficient in both academics and other parameters.

2. METHODOLOGY

Suppose n be the number of students of the same college of different branches B_1, B_2, B_3, B_4. B_5,...B_n, whose total performance impact value (TPIV) is assessed as E_1, E_2, E_3, E_4,…E_n respectively. Consider that the B.Tech and placement performances are not same for

all the students. To select the overall best performer out of the entire best performers group, the TPIV, B.Tech and placement performance has an enormous responsibility to influence the uncertainty in the perception of decision makers or experts. To reduce this vagueness, here we use 'Intuitionistic Fuzzy Sets Theory (IFS)' of [2] and Fuzzy Decision (FD) with a very reasonable treatment for overall assessment of the best performers.

2.1. Basic definitions

2.1.1. Parameters of the selection

Parameters are fuzzy information for which membership value of either degree of truthfulness or degree of falseness lying within [0, 1] is collected from every expert. As for example, for the study "measurement of 'TPIV' of a best performer (BP)", some applicable parameters could be highly intelligent, good managerial capacity, good writing or presentation skills, highly sincere, good communication skills, adequate moral values, etc.

2.1.2. Mean fuzzy set of Intuitionistic Fuzzy Set (IFS)

Collection of all elements of the selection is called universe of the selection. Let $U = \{x_1, x_2 \ldots \ldots \ldots, x_n\}$ be discrete universe of the parameters x_i, $i = 1, 2, \ldots, n$. and X be an IFS of U. The mean fuzzy set of IFS X is a fuzzy set m of U given by the membership function such that $\mu(x)m = \frac{\mu_A(x) + 1 - \nu_A(x)}{2}$

2.1.3. Total Performance Impact Value (TPIV)

Let m be a mean fuzzy set of a finite set X and for each element $x \in X$, there is a related weight $W_x \in R^+$ (set of all non-negative real numbers), then the TPIV of the fuzzy set m is the non-negative number given by $TPIV(m) = \sum_i [\mu(x_i) m W_i]$, i = 1, 2, 3,……, n. A best performer with highest TPIV will indicate plausibly more degree of sureness in support of overall best performance of the student.

2.1.4. Fuzzy Decision (FD)

All decision makers are indecisive more or less on every evaluation commotion due to restraint knowledge. The Fuzzy Decision (FD) is an apt means to attain the besieged objective with B.Tech performance and placement performance of a student as the two constraints to achieve the purpose of selecting the overall best performer.

Let us consider a group of Best Performers as BP where, $BP = \{BP_1, BP_2, BP_3, \ldots \ldots, BP_k\} = \{BP_i\}$, for $i = 1, 2, 3, \ldots, k$.

Let G be a fuzzy set describing the goals associated with each Best Performer (BP_i) such that $G = \{\mu(g_1/BP_1), \mu(g_2/BP_2), \mu(g_3/BP_3), \ldots\ldots, \mu(g_k/BP_k)\} = \{\mu(g_i/BP_i)\}$, for i = 1, 2, 3, …, k.

Now, if the two fuzzy sets C_1 and C_2 describe the two constraints associated with each Best Performer (BP_i) such that $C_1 = \{\mu_1(c_1/BP_1), \mu_1(c_2/BP_2), \mu_1(c_3/BP_3), \ldots\ldots, \mu_1(c_k/BP_k)\} = \{\mu_1(c_i/BP_i)\}$, for i = 1, 2, 3, …, k and $C_2 = \{\mu_2(c_1/BP_1), \mu_2(c_2/BP_2), \mu_2(c_3/BP_3), \ldots\ldots, \mu_2(c_k/BP_k)\} = \{\mu_2(c_i/BP_i)\}$, for i = 1, 2, 3, …,k, then the Fuzzy Decision (FD) will be given by

$FD = Max\{D(BP_i)\}$, where $D(BP_i) =$ [sub set-G $\cap$ sub set-C_1 $\cap$ subset-C_2] = Min $\{\mu(g_i/BP_i), \mu_1(c_i/BP_i), \mu_2(c_i/BP_i)\}$. Now to validate the fuzzy model, a case study is presented below.

3. CASE STUDY

For the "choice of overall best performer out of the entire best performers group" under different branches with same syllabus, we make use of IFS tool for estimation of TPIV of each best performer and then apply FD-model to come to a decision who is the overall best performer out of all. We consider only ten best performers (BP) of five different branches and for evaluation of fuzzy data the ten favourable parameters which have been considered for assessment are x_1 = High IQ, x_2 = Good subject concept, x_3 = Good time management, x_4 = Good writing or presentation skill, x_5 = Good lab attendance, x_6 = Good theory attendance, x_7 = Good spoken or communication skills, x_8 = Adequate moral values, x_9 = Low health problems, x_{10}= Good behaviour. The information from five expert's observation regarding the listed parameters are composed with all plausible decisions. In this, the data leads to the fuzzy set X of the universe U, where $U = \{x_1, x_2 \ldots \ldots \ldots, x_{10}\}$.

Next we assign the values of these parameters for best performer by collecting observations from 5 experts from the college, Aditya Institute of Technology and Management, who have good acquaintance individually with the BP's. The best

performance-BP_1 of Branch-B_1 is presented in table A1. The average observation of all experts is clearly the element of fuzzy subset $BP_1 \in U$, where, BP_1={(x_1, 0.76, 0.10), (x_2, 0.81, 0.09), (x_3, 0.76, 0.10), (x_4, 0.69, 0.11), (x_5, 0.71, 0.10), (x_6, 0.62, 0.09), (x_7, 0.62, 0.15), (x_8, 0.56, 0.13), (x_9, 0.62, 0.50), (x_{10}, 0.79, 0.09)}.

Now suppose weight of each parameter of BP_1 are prefixed by the five experts of AITAM college like for x_1 = 90, for x_2 = 85, for x_3 = 70, for x_4 = 60, for x_5 = 65, for x_6 = 90, for x_7 = 50, for x_8 = 60, for x_9 = 75 and for x_{10} = 75 respectively, then the TPIV of BP1 of AITAM College is calculated by the definition 2.1.3 and is given under table A2. Similarly, the TPIVs of other best performers of other branches are calculated based on the data collected from the five experts of AITAM college which are as follows,

BP_2={(x_1, 0.68, 0.1), (x_2, 0.77, 0.11), (x_3, 0.65, 0.11), (x_4, 0.62, 0.09), (x_5, 0.77, 0.12), (x_6, 0.63, 0.13), (x_7, 0.63, 0.13), (x_8, 0.60, 0.12), (x_9, 0.57, 0.11), (x_{10}, 0.70, 0.12)} and TPIV = 558.825

BP_3={(x_1, 0.66, 0.1), (x_2, 0.76, 0.10), (x_3, 0.69, 0.12), (x_4, 0.56, 0.09), (x_5, 0.85, 0.07), (x_6, 0.75, 0.09), (x_7, 0.65, 0.13), (x_8, 0.77, 0.12), (x_9, 0.59, 0.13), (x_{10}, 0.84, 0.11)} and TPIV = 579.625

BP_4={(x_1, 0.72, 0.11), (x_2, 0.80, 0.08), (x_3, 0.71, 0.12), (x_4, 0.65, 0.11), (x_5, 0.80, 0.11), x_6, 0.68, 0.11), (x_7, 0.66, 0.11), (x_8, 0.72, 0.11), (x_9, 0.62, 0.11), (x_{10}, 0.76, 0.12)} and TPIV = 559.627

BP5={(x_1, 0.73, 0.09), (x_2, 0.82, 0.07), (x_3, 0.68, 0.11), (x_4, 0.67, 0.13), (x_5, 0.77, 0.11), (x_6, 0.69, 0.11), (x_7, 0.63, 0.14), (x_8, 0.72, 0.12), (x_9, 0.56, 0.10), (x_{10}, 0.79, 0.12)} and TPIV = 579.025

BP_6={(x_1, 0.68, 0.12), (x_2, 0.76, 0.12), (x_3, 0.62, 0.11), (x_4, 0.59, 0.15), (x_5, 0.74, 0.13), (x_6, 0.65, 0.12), (x_7, 0.64, 0.09), (x_8, 0.72 ,0.12), (x_9, 0.54, 0.11), (x_{10}, 0.76, 0.11)} and TPIV = 573.37

BP_7={(x_1, 0.72, 0.08), (x_2, 0.76, 0.10), (x_3, 0.67, 0.13), (x_4, 0.66, 0.11), (x_5, 0.77, 0.11), (x_6, 0.71, 0.11), (x_7, 0.66, 0.11), (x_8, 0.75, 0.10), (x_9, 0.61, 0.10), (x_{10}, 0.80, 0.11)} and TPIV = 579.22

BP_8={(x_1, 0.75, 0.1), (x_2, 0.84, 0.06), (x_3, 0.70, 0.11), (x_4, 0.66, 0.12), (x_5, 0.76, 0.11), (x_6, 0.70, 0.10), (x_7, 0.65, 0.13), (x_8, 0.75, 0.12), (x_9, 0.62, 0.12), (x_{10}, 0.79, 0.14)} and TPIV = 572.13

BP_9={(x_1, 0.73, 0.09), (x_2, 0.80, 0.11), (x_3, 0.68, 0.11), (x_4, 0.63, 0.12), (x_5, 0.77, 0.10), (x_6, 0.68, 0.11), (x_7, 0.62, 0.11), (x_8, 0.75, 0.13), (x_9, 0.57, 0.10), (x_{10}, 0.77, 0.14)} and TPIV = 580.185

BP_{10}={(x_1, 0.76, 0.10), (x_2, 0.84, 0.09), (x_3, 0.72, 0.08), (x_4, 0.67, 0.09), (x_5, 0.74, 0.12), (x_6, 0.65, 0.10), (x_7, 0.65, 0.10), (x_8, 0.73, 0.12), (x_9, 0.59, 0.10), (x_{10}, 0.77, 0.14)} and TPIV = 589.775.

Next to follow the algorithm is Fuzzy Decision (FD) considering the TPIVs and B.Tech and placement performance which ultimately concludes which student is the overall best performer out of 10 best performers (BP) considered of AITAM college. All the data of the B.Tech and placement performance of students (Table A3) are accurate and will not deviate by the expert's observation.

For the selection of overall best performer, the 'TPIV' will be the goal, i.e. G and if we consider 'B.Tech performance' and 'placement performance' as the two constraints, i.e. C_1 and C_2, then the fuzzy sets for each options will be as follows

$G=\mu(g_i/BP_i)$=[.963/BP_1, .960/BP_2, .996/BP_3, .962/BP_4, .995/BP_5, .985/BP_6, .996/BP_7, .983/BP_8, .997/ BP_9, 1.0/BP_{10}]

$C_1=\mu(C_1/BP_i)$=[1.0/BP_1, .99/BP_2, .92/BP_3, .95/BP_4, .96/BP_5, .98/BP_6, .92/BP_7, .99/BP_8, .97/BP_9, .97/BP_{10}]

$C_2=\mu(C_2/BP_i)$=[.94/BP_1, .89/BP_2, .94/BP_3, .92/ BP_4, .94/BP_5, 1.0/BP_6, .95/BP_7, .95/BP_8, .94/ BP_9, .95/BP_{10}]

Therefore, $D(BP_i)=\mu(g/BP_i) \cap \mu(C_1/BP_i) \cap \mu(C_2/BP_i)$=[.94/$BP_1$, .89 / BP_2, .92/BP_3, .92/BP_4, .94 / BP_5, .98 / BP_6, .92/BP_7, .95/ BP_8, .94/ BP_9, .95 / BP_{10}]

Then the overall best performer given by FD = Max $\{D(BP_i)\}$ = 0.98/GB_6.

Thus, results expose that in the college the overall best performer is BP_6 who belongs to the branch of computer science and engineering among the ten best performers of civil, mechanical, computer science and engineering, electrical and electronics, electrical and communications branches.

4. CONCLUSION

Proper selection of the branch has to be done by the student in initial stages i.e. during the admission to a B. Tech program for consideration of best performers concepts. Placement coaching of the performers is also

under similar conditions. For choice of overall best performer out of the entire best performers group, no crisp data is available to assist decisions but personal opinion of the experts has to be considered. The vagueness in expert observation plays a key role in judging the problem to the director of a college because the vital parameters are, "TPIV", "B.Tech performance" and "placement performance" and are not equal for all the performers. Hence to reduce the vagueness involved in the choice of experts, the self-possessed model of IFS and fuzzy decision can only give further more accurate results than any other tool so far available to the present day authorities/ directors of a college/ institution.

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APPENDIX A

Table A1.Average perceptions of five experts for BP1

Experts Attributes	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average perception
x1	(x_1,0.70,0.15)	(x_1,0.70,0.10)	(x_1,0.80,0.05)	(x_1,0.90,0.05)	(x_1,0.70,0.15)	(x_1,0.76,0.10)
x2	(x_2,0.80,0.15)	(x_2,0.80,0.10)	(x_2,0.80,0.05)	(x_2,0.85,0.00)	(x_2,0.80,0.15)	(x_2,0.81,0.09)
x3	(x_3,0.75,0.15)	($x_3$0.70,0.10)	(x_3,0.80,0.10)	($x_3$0.80,0.05)	(x_3,0.75,0.10)	(x_3,0.76,0.10)
x4	($x_4$0.65,0.15)	(x_4,0.65,0.10)	(x_4,0.70,0.05)	($x_4$0.80,0.10)	(x_4,0.65,0.15)	(x_4,0.69,0.11)
x5	(x_5,0.70,0.15)	($x_5$0.70,0.10)	(x_5,0.75,0.10)	(x_5,0.72,0.05)	(x_5,0.71,0.10)	(x_5,0.71,0.10)
x6	(x_6,0 .65,0.15)	(x_6,0 .60,0.05)	(x_6,0 .60,0.10)	(x_6,0 .60,0.05)	(x_6,0 .65,0.10)	(x_6,0 .62,0.09)
x7	(x_7, 0.65,0.15)	(x_7, 0.60,0.15)	(x7, 0.60,0.15)	(x_7 ,0.65,0.15)	(x_7, 0.60,0.15)	(x_7 ,0.62,0.15)
x8	(x_8, 0.60,0.1)	(x_8 , 0.65,0.10)	(x_8 ,0.55,0.10)	(x_8, 0.5,0.15)	(x_8 , 0.5,0.20)	(x_8, 0.56,0.13)
x9	(x_9, 0.60,0.5)	(x_9 ,0.60,0.05)	(x_9, 0.65,0.05)	(x_9,0.60,0.05)	(x_9 ,0.65,0.05)	(x_9,0.62,0.05)
x10	(x_{10},0.70,0.15)	(x_{10},0.75,0.10)	(x_{10},0.85,0.05)	(x_{10},0.8,0.05)	(x_{10},0.85,0.10)	(x_{10},0.79,0.09)

Table A2.Overall TPIV of BP1

Attribute name	In support of Truthiness μ(x)	In support of falseness ν (x)	In deterministic Part π(x)	Weight of Attributes (w_x)	TPIV for BP1
X1	0.76	0.10	0.14	80	560.07
X2	0.81	0.09	0.10	90	
X3	0.76	0.10	0.14	55	
X4	0.69	0.11	0.20	40	
X5	0.71	0.10	0.19	15	
X6	0.62	0.09	0.29	35	
X7	0.62	0.15	0.23	50	
X8	0.56	0.13	0.31	70	
X9	0.62	0.05	0.33	80	
X10	0.79	0.09	0.09	95	

Table A3.Individual data of ten best students

Best Performer(BP)	TPIV	B. Tech performance (C_1)	Placement performance(C_2)
BP1	560.07 (.963)	99(1.0)	45(.94)
BP2	558.825 (.96)	98(.99)	43(.89)
BP3	579.625 (.996)	91(.92)	45(.94)
BP4	559.627 (.962)	94(.95)	44(.92)
BP5	579.025 (.995)	95(.96)	45(.94)
BP6	573.37 (.985)	97(.98)	48(1.0)
BP7	579.22 (.996)	91(.92)	46(.95)
BP8	572.13 (.983)	98(.99)	46(.95)
BP9	580.185 (.997)	96(.97)	45(.94)