

Fuzzy Mathematical Approach for Selecting Candidate For Election by a Political Party

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Abstract

Generally at the time of any election at each constituency more than one persons are interested in fighting an election on behalf of the party. In such situations party authorities send committee of observers to select proper candidate as a representative of their party. The committee contains two to three members. We are proposing two different methods for this selection process.

1. Method using Statistical concepts and multi valued logic.
2. Method using fuzzy sets and operations on the fuzzy sets.

Both these methods propose a mathematical model for selection procedure. We have used multi valued logic and fuzzy trapezoidal numbers for assigning gradations to parameters. Comparison of both methods is also discussed.

Key Words : Fuzzy Logic, Trapezoidal numbers, weighted mean, fuzzy sets.

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Proposed First Method to Select a Candidate : Methodology (First Method)

In this proposed method, we have used statistical technique viz. Weighted mean to calculate. In general we have proposed following steps. When a team of observers from a party will like to select a candidate who are willing to contest the election then following steps can be followed.

- Fixing the parameters which can be used to elect a candidate.
- Assigning gradations to these parameters.
- Developing questionnaires which will help to decide gradations.
- Formation of observer's Entry Sheet.
- Devising method to calculate Index of Goodness of each candidate according to each observer.
- Calculations which will lead to selection of proper candidate who will fight election on behalf of the party.

The parameters which should be considered for each candidate by each voter can be

- Educational Qualification of a candidate (P1)
- Non Criminal and non corrupt Nature of a candidate (P2)
- Age of a candidate (P3)
- Decision making capacity and interest in social work. (P4)
- Knowledge about Constituency and legislation. (P5)
- Popularity of a candidate (P6)

Gradations :

1) Educational Qualification of a candidate :

Post Graduate	1
Graduate	0.75
HSC	0.50
SSC	0.25
Below SSC	0.0

The more the education, higher is the grade. Voters expect the educated candidate

2) Non Criminal and Non corrupted Nature :

Number of Crimes and corruption charges proved.	Gradations
0	1
1	0.75
2	0.50
3	0.25
4 or more	0

Voters prefer candidate to be of non corrupt and non criminal nature.

3) Decision Making capacity and interest in social work of a candidate will be tested by a questionnaire which will include questions formed tactically.

4) Knowledge about Constituency and Legislation will be tested by a questionnaire which will include questions about current scenario of constituency and questions about Indian Legislation. By this observers can test whether candidate has knowledge

about working and rules and regulations of democratic system of India.

5) Gradation regarding popularity of a candidate can be decided by use of appeal to people through news papers or TV channels. The popularity can be calculated in terms of percentage. The popularity of candidate also must be considered by observers.

6) Age of a candidate is most important factor.

To assign gradation we are going to use trapezoidal fuzzy numbers.

We suggest following formula

$$\text{Age gradation is} \begin{cases} 0 & \text{if age} \geq 75 \\ (75 - \text{age}) / 50 & \text{if } 25 \leq \text{age} < 75 \end{cases}$$

The more the age the lesser is the gradation. Survey conducted by us reveals the fact that Indian democracy should be in the hands of young and experienced leaders.

Gradations of first three parameters about each candidate (Age, Educational Qualification, Non Criminal and Non corrupt nature) will be already printed on observer's sheet. Naturally because the corresponding information will be constant for each of the candidates who are willing to contest the election on behalf of the party.

All the remaining gradations are to be entered by observers in case of each candidate through the results of responses given to questionnaire. Also *observers can ask oral questions*. Here also gradations can be decided by use of trapezoidal fuzzy numbers. We assume for the parameters 1) Decision Making Capacity and Interest in Social work 2) Knowledge about Constituency and Indian Legislation , the observers will judge the candidates by conducting written and oral exam in which questions can be as per the choice of observers. These tests will be of 100 marks in which there will be 60 marks written and 40 marks oral test. Each observer will have separate question paper also each observer will conduct separate oral interviews. . After tests are over, the average of marks will be calculated in case of each willing candidate as per the marks given by each observer. The gradations from these two parameters will be decided by using following formula.

Rules can be as follows :

$$\begin{cases} 0 & \text{if marks} < 50 \\ (\text{marks} - 50) / 40 & \text{if } 50 \leq \text{marks} \leq 90 \\ & \text{if marks} > 90 \end{cases}$$

The more the marks the larger gradation. Voters think that they must get knowledgeable leader who will have good understanding of problems of constituency and also he must have good decision making capacity, interest in social work, excellent knowledge of functioning of Indian democracy. So all the above rules are justified.

The last parameter is Popularity of candidate. The popularity of candidate surely helps to win the election. So we feel it is important. This popularity can be judged by various poles and the results of these poles can be studied by observers and observers can use their own experience, expertise and intuition and decide the gradation of this

parameter. All the gradations will lie [0,1]

The survey was conducted of nearly 10,000 voters all over Maharashtra and it was asked that out of the parameters fixed by us, which parameters are given importance by voters then it was found that voters give importance to the parameters in following order.

- Decision making capacity and interest in social work.
- Knowledge about Constituency and legislation.
- Educational Qualification.
- Non Criminal and non corrupt Nature of a candidate
- Age of a candidate.
- Popularity of a candidate.

These parameters are assigned with a vector containing numerical weights having values between [0,1] viz. (0.4, 0.3 , 0.1 ,0.1 ,0.05, 0.05)

An average in which each quantity to be averaged is assigned a weight. These weightings determine the relative importance of each quantity on the average. Weightings are the equivalent of having that many like items with the same value involved in the average.

When each observer will test each willing candidate with respect to all the parameters fixed then the average of the values will be calculated and final table which will decided the candidate to be selected is prepared. This table will obviously contain the average gradations obtained by each willing candidate in case of each parameter. In case of each willing candidate the grade obtained in case of each parameter will be multiplied by weight assigned to that parameter and the weighted mean will be calculated.

The candidate having largest weighted average will be selected by a party to contest election from that constituency on behalf of the party.

Here we demonstrate the procedure by a Demo example.

We assume that there are three candidates who are willing to contest an election on behalf of certain party.(Refer Table 1) Party has sent a team of four observers and they have judged each of the candidates A, B, C as per our parameters and gradations are entered as per the rules suggested. Then average of the gradations entered by each observers about each candidate in case of each parameter is calculated and the final table is as follows. Then product of gradation and corresponding weight is done and weighted mean is nothing but Acceptance Index (A.I.) of each candidate. The maximum A.I. is of candidate C and hence the candidate C should be selected by a party to fight election on behalf of the party.

Demo Example

Table 1

SN	CN	P1	P2	P3	P4	P5	P6	Total	A.I.
1	A	1	.75	.5	.6	.4	.7	.595	.099
2	B	0.75	.5	.6	.7	.5	.5	.610	.101
3	C	1	1	.5	.8	.6	.6	.755	.126
Wt.		0.1	0.1	0.05	0.4	0.3	0.05		

Proposed Second Method to select Candidate :

By use of Fuzzy sets and operations on the fuzzy sets.(Multi person Decision Making.)

We are proposing a well defined method to perform this task. We are using concepts of Fuzzy logic and Fuzzy Mathematics to achieve it. A fuzzy logic is a type of logic that recognizes more than simple true and false values. With fuzzy logic, propositions can be represented with degrees of truthfulness and falsehood. For example, the statement, *today is sunny*, might be 100% true if there are no clouds, 80% true if there are a few clouds, 50% true if it's hazy and 0% true if it rains all day.

Fuzzy logic has proved to be particularly useful in expert system and other artificial intelligence applications. It is also used in some spell checkers to suggest a list of probable words to replace a misspelled ones. It can be effectively used in any decision making situation.

The concept of Fuzzy Mathematics was proposed by Lutfi Zadeh in 1965. It provides a systematic basis for processing uncertainty due to vagueness. Classical Mathematics uses two way logic, whereas fuzzy mathematics uses multi valued logic. In Multi valued logic graded memberships are assigned which takes values between [0,1]. It is very useful to tackle uncertain data.

Fuzzy set is a function from Universe of discourse X to [0,1]. So if A is a fuzzy set then

$$A : X \rightarrow [0,1]. \text{ All the concept which are vague can be described as a fuzzy set.}$$

Example:

The set of all numbers which are near to number 4

$$\begin{array}{ll} 1 & x=4 \\ 0 & |x-4| \geq 5 \\ (5-|x-4|)/5 & 0 < |x-4| < 5 \end{array}$$

If the number is 3.8 then as , $|3.8-4|=0.2$

So, $0 < 0.2 < 5$ and hence, Gradation is $(5-0.2)/5 = 4.8/5 = 0.96$

Operations on Fuzzy sets:**Fuzzy Intersection:**

The Fuzzy intersection of two sets μ_A and μ_B is defined as , (interpreted as “ μ_A and μ_B ”)

$$(\mu_A \cap \mu_B)(x) = \mu_A(x) \wedge \mu_B(x)$$

where “ \wedge ” denotes the minimum operation.

Fuzzy Union:

The union of two Fuzzy sets μ_A and μ_B (interpreted as “ μ_A OR μ_B ”) takes the maximum value of the two maximum value of the two membership grades.

$$(\mu_A \cup \mu_B)(x) = \mu_A(x) \vee \mu_B(x)$$

where “ \vee ” denotes the maximum operator.

Fuzzy Complement:

Fuzzy complement of a Fuzzy set μ which is understood as “NOT μ ” is defined as,

$$\mu_c(x) = 1 - \mu(x) \text{ for all } x \in X$$

where “ μ_c ” stands for complement of μ

Note that , $\mu \cup \mu_c \neq X$ and $\mu \cap \mu_c \neq \emptyset$

where “ μ ” is Fuzzy set on X

(This is the main difference between Boolean Logic and Fuzzy Logic)

Approach to Membership Functions

Choice of membership function is usually problem dependent

It is often determined heuristically and subjectively

i. Statistical / Mathematical Methods

Based on Statistics available for a particular concept

ii. Expert Opinion : Sometimes expert opinion may help to fix the membership values e.g. medical diagnosis

iii. Through learning: The system is made to learn by giving some inputs

Fuzzy Sets : Definition and Notations :

Fuzzy Set is a function from Universal Set X to [0,1]. If A is a fuzzy set then $A : X \rightarrow [0,1]$

Notation :

If $X = \{ a,b,c,d,e,f \}$ And If A is a fuzzy set on X then

$$A = \{ 0.2/a + 0.5/b + 0.8/c + 0.5/d + 0.6/e \}$$

Operations On Fuzzy Sets

Union and Intersection of two Fuzzy Sets A and B defined on $X = \{ a,b,c,d,e,f \}$

Union of two fuzzy sets is performed by use of join operation and Intersection by use of meet operation. Join is equivalent to Max and meet is equivalent to Min

E.g If $A = \{ 0.2/a + 0.4/b + 0.6/c + 0.2/d + 0.4/e \}$
 And $B = \{ 0.3/a + 0.6/b + 0.3/c + 0.7/d + 0.7/e \}$
 Then Union of A and B = $\{ 0.3/a + 0.6/b + 0.6/c + 0.7/d + 0.7/e \}$
 Intersection of A and B = $\{ 0.2/a + 0.4/b + 0.3/c + 0.2/d + 0.4/e \}$

In this second method also same parameters are considered. The rules to assign the gradations are also as per the formulae described in first method. After the averages of the gradation values assigned by every observer to each candidate is calculated. Then we form fuzzy sets corresponding to each parameter. Each of the fuzzy set will have three elements in its Universe of discourse as there are three candidates in our demo example. As there are 6 parameters there will be 6 fuzzy sets. Intersection of these fuzzy sets is taken. And then max-min principle is used in case of a fuzzy set denoting intersection of fuzzy sets corresponding to each parameter. This max min value is a crisp value and the candidate having largest max-min value will be proper choice by the party.

Suppose there are more than one values which are max-min values then any one of the candidates with equal max-min values can be declared as a selected candidate or team of observers will put the outcome in front of party authorities and their expert opinion will decide final selection.

Demo Example and Mathematical Description :

The following table (Table 2) is output of average values of gradations assigned by each observer in case of each parameter to each candidate.

Demo Example :

Table 2

SN	CN	S	P1	P2	P3	P4	P5	P6
1	A		1	0.75	0.5	0.6	0.4	0.7
2	B		0.75	0.5	0.6	0.7	0.5	0.5
3	C		1	1	0.5	0.8	0.6	0.6

Here the notation and corresponding parameter is as follows .

- P1 : Educational Qualification
- P2 : Non Criminal and Non Corrupt Nature of a candidate.
- P3 : Age of a Candidate.
- P4 : Decision making capacity and interest in social work.
- P5: Knowledge about Constituency and legislation.
- P6: Popularity of a candidate.

Forming Fuzzy Sets corresponding to each Parameter

$$P1 : \{ 1/A + 0.75/B + 1/C \}$$

$$P2 : \{ 0.75/A + 0.5/B + 1/C \}$$

$$P3 : \{ 0.5/A + 0.6/B + 0.5/C \}$$

$$P4 : \{ 0.6/A + 0.7/B + 0.8/C \}$$

$$P5 : \{ 0.4/A + 0.5/B + 0.6/C \}$$

$$P6 : \{ 0.7/A + 0.5/B + 0.6/C \}$$

The gradations to the parameters are decided by Trapezoidal fuzzy numbers as defined above.

Intersection of fuzzy sets formed above :

$$P1 \square P2 \square P3 \square P4 \square P5 \square P6 :$$

$$\{ 0.4 / A + 0.5 / B + 0.5 / C \}$$

Intersection is taken by considering min value.

Now 0.5 is max value among these min values. So the proper candidate who can be selected by party for fighting elections on behalf of them is either candidate B or candidate C. The decision can be either of observers or expert opinion of Party authorities can be considered.

According to us both these methods are very useful , reliable and can be used by the parties. We know that some party and their authorities have started noticing what voters are expecting from their candidates and they have started conducting the written tests of willing candidates. We are giving two different well defined mathematical approaches to this process.

We feel following are advantages of these proposed methods.

- Each party will choose a candidate who will be non corrupt, educated, non criminal and young. We need young leaders to lead Indian democracy.
- The candidate will take care that he/she knows the details of area where they are willing to fight the election .
- Candidate will undertake projects and try to increase vote base by his work in the constituency.
- When each candidate knows that all these things will decide his/her fate in the election they have to work hard.
- This is what each party wants from their candidate.
- As we are going to get good leaders, the inert voters will also turn to voting and percentage of voting will surely increase.
- We will get educated, non corrupt, no criminal, knowledgeable leaders.

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