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FUZZY MATHEMATICAL MODEL FOR SELECTION OF A NURSE

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Abstract: Nurses play an essential role in society as well as in patients' life. They keep most contact with patients than a doctor. Therefore selection of a nurse is most responsible task in any hospital. In this paper we have used Multi-objective Decision Making Method in fuzzy Logic. With this method we can find an optimal solution from certain alternatives. The study conducted research in the Hospitals in Lanja Tehsil so that it chooses best nurse in target.

Keywords: Fuzzy Logic, Multi-Objective Decision Making Method, Nurses.

Introduction:

Lanja tehsil is situated on Mumbai-Goa highway and near about 45 km away from district place Ratnagiri. There are many private hospitals in this tehsil. The doctors and nurses in these hospitals are working hard and sincerely for quick recovery of patients.

In this research, we have discussed with doctors in different hospitals about the qualities they want in a nurse working in their hospitals. For example *qualification*, *experience*, *salary expectations etc.* In mathematical language we call these qualities as objectives. Later we decided the preferences of each objective by discussing with doctors. Then we have collected all information regarding to each candidate corresponding to every objective. By applying Multi-Objective Decision Making method to the collected information regarding to each candidate the best nurse is selected.

1. Theory:

1.1 Fuzzy Logic

The term "Fuzzy Logic" has been introduced by Loftie A. Zadeh in 1965. It is form of many valued logic. In binary numbers we only use 0 and 1 that is either completely true or completely false but in fuzzy logic we may use value between 0 and 1 that is partially true or partially false.

Operations on Fuzzy Sets

For all following operations we have considered U as a universal set.

1.1.1 Fuzzy Union

The union of two fuzzy sets μX and μY denoted by $\mu X \cup \mu Y$ is defined by maximum value among the two values and in fuzzy logic terms it is given by

$(\mu X \cup \mu Y)(x) = \mu X(x) \vee \mu Y(x)$

Where"$\vee$" is maximum operator.

1.1.2 Fuzzy Intersection

The intersection of two fuzzy sets μX and μY denoted by $\mu X \cap \mu Y$ is defined by minimum value out of the two values and in fuzzy logic it is given by

$(\mu X \cap \mu Y)(x)=\mu X(x) \wedge \mu Y(x)$

Where "$\wedge$" is minimum operator.

1.1.3 Fuzzy complement

The complement of fuzzy set μ denoted by $\mu^c(x)$ is defined by 1-μ(x).
Note that $\mu \cup \mu^c(x) \neq U$ and $\mu \cap \mu^c(x) \neq \emptyset$.

1.1.4 Multi-Objective Decision Making Method

In Multi-objective decision making, we use Fuzzy Logic and Fuzzy sets.
General process of the Multi-objective Decision Making involves the selection of one alternative Bi, from universe of alternatives 'A'. A given collection, or set say 'O' of objectives that are important to decision maker. We want to evaluate each alternative or choice satisfies each alternative. We wish to combine weighted objectives into overall decision function in some possible way.
Define universe of n alternatives $A= \{a_1, a_2, \dots ,a_n\}$ and set of r objectives $O= \{O_1,O_2,. . . ,O_r\}$.
Let O_i denote the i^{th} objective. The Decision function is given by intersection of all objective sets, $D= O_1 \wedge O_2 \wedge . . . \wedge O_r$.
Therefore the grade membership that decision function for each alternative 'a' is given by
$\mu D(a) = \min\{\mu O_1(a), \mu O_2(a), . . . , \mu O_r(a)\}$.
The optimum decision a^* will be the alternative satisfies $\mu D(a^*) = \max_{a \in A} (\mu D(a))$.
We define set of preferences P which we will constrain to being linear and ordinal. They could value in interval [0, 1]. These preferences will be attached to each objective to quantify the decision maker's feelings about influence that each objective should have chosen.
Let parameter b_i contained on set of preferences P, where i=1,2,..., r.
The decision function D takes each objective with associated weight expressing its importance to the decision maker. This function is represented as intersection of r-tuples denoted as decision measure $M(O_i, b_i)$ involving objectives and preferences.Thus,
$D = M(O_1, b_1) \wedge M(O_2, b_2) \wedge . . . \wedge M(O_r, b_r)$.
The decision measure of particular alternative 'a' can be replaced with classical implication of the form $M(O_i(a), b_i) = b_i O_i(a) = b_i \vee O_i(a)$.
The statement b_i implies O_i indicates an unique relationship between preferences and its associated objectives. Therefore, a reasonable decision model will be joint intersection of r decision measure and the optimal solution a^* is the alternative that maximizes D. If we define $C_i = b_i' \vee O_i$,
Hence $\mu C_i(a) = \max\{ \mu b_i'(a), O_i(a)\}$.
Then optimum solution expressed in membership form is given by
$\mu D(a^*) = \max_{a \in A}\{\min[\mu C_1(a), \mu C_2(a), . . . , \mu C_r(a)]\}$.
Then we get required result by using this method.

2. Research Methodology:

A) Identifying the problem- To select a nurse for a hospital in a Lanja tehsil is a tedious job as it is a developing town, nurses with high educational qualification expect high salaries but it is not possible to fulfill their expectations. That's why to select a skilled and qualified nurse in this town is a challenging job.

B) After identification of problem we have discussed with the doctor and decided all the skills and qualities required in a nurse. In mathematical language we named these requirements as 'objectives'. By considering doctor's opinion we have decided preferences and gradation of preferences to each objective. The list of objectives along with their gradation to preferences (i.e. weights say b_i) is given in following table. Since we require complement of weights in calculations, in table we have added third column as complement of weights say b_i', i= 1, 2,. . .,r.

Objectives	**Gradations(weights) :b_i**	**Complement of weights: b_i'**
Qualification (O_1)	0.9	0.1
Field of experience (O_2)	0.8	0.2
Experience in years (O_3)	0.8	0.2
Communication Skills (O_4)	0.7	0.3
Distance from Hospital to candidate's Home (O_5)	0.6	0.4
Willingness of work in shifts (O_6)	0.5	0.5
Salary expectation (O_7)	0.4	0.6
Age (O_8)	0.3	0.7

C) At this stage, we have collected all the information of candidates about each objective mentioned above. Then, converted that information to grade point between [0, 1].
For these conversions we have used the following formulations.

For Qualification (O_1)- If candidate has completed
ANM (Auxillary Nurse and Midwife) course- 1
Nursing Assistant Course-0.7

Experience in years (O_3)
Freshers-0.4
1 year- 0.5
2 years- 0.6
3 years- 0.7
More than 3 years- 0.8

Communication Skills (O_4)
There are lots of techniques to test communication skill. It is up to hospital's administration to decide appropriate technique. We have given marks out of 10 to communication skills and converted marks out of 10 into gradations between 0 and 1.

Distance from Hospital to candidate's Home (O_5)
Up to 2km- 1
More than 2 km and up to 5km- 0.9
More than 5km and up to 10 km with more transportation- 0.8
More than 5km and up to 10 km with limited transportation- 0.7
More than 10km and up to 15 km with more transportation - 0.6
More than 10km and up to 15 km with limited transportation - 0.5
More than 15 km - 0.

Willingness of work in shifts (O_6)
Ready to work in all three shifts (Morning, evening and night) – 1
Ready to work in two shifts:
Evening and Night – 0.9,
Morning and Night – 0.8
Morning and Evening – 0.7
Ready to work in only one shift:
Night – 0.6,
Evening – 0.5,
Morning – 0.4

Salary expectation (O_7)
Up to 3000 Rs – 1, Up to 4000 Rs – 0.9, Up to 5000 Rs – 0.8, Up to 6000 Rs – 0.7
More than 6000 Rs – 0.

Age (O_8)
Age = 1 if $18\ years \leq age \leq 20\ years$
$= \frac{40-age}{20}$ if $20\ years < age < 40\ years$
= 0 if age $>$ 40 years
(Objectives and formulation for each objective are flexible and can vary as per doctor's opinion).

E) All the information is converted into grades between 0 and 1.Finally for each objective by applying max-min principle the best candidate is selected.

As a demo example author has considered three candidates appeared for an interview of a nurse. All data corresponding to each objective for every candidate is collected. There are many techniques to measure communication skill.It is depend on hospital which method they will follow. In further part, all the collected data is converted into a number between 0 and 1 by formulation mentioned earlier.

Objectives / Candidates	O_1	O_2	O_3	O_4	O_5	O_6	O_7	O_8
A	ANM	O.T.	4	8	2	Night and Evening	7000 Rs	25
B	Nursing Assistant	Medicine	2	7	4	All three	4000 Rs	21
C	ANM	Gynecology	2	9	5	Night and morning	5000 Rs	23

The final table of calculation of gradation about each objective is

Objectives / Candidates	O_1	O_2	O_3	O_4	O_5	O_6	O_7	O_8
A	1	0.5	0.8	0.8	1	0.9	0	0.75
B	0.7	0.9	0.6	0.7	0.9	1	0.9	0.95
C	1	0.4	0.6	0.9	0.9	0.8	0.7	0.85

3. Calculations

Decision measure of candidate A

$D(A) = (b_1' \vee O_1) \wedge (b_2' \vee O_2) \wedge (b_3' \vee O_3) \wedge (b_4' \vee O4) \wedge (b_5' \vee O_5) \wedge (b_6' \vee O_6) \wedge (b_7' \vee O_7) \wedge (b_8' \vee O_8)$

$= (0.1V1)\wedge(0.2V0.5)\wedge(0.2V0.8)\wedge(0.3V0.8)\wedge(0.3V1)\wedge(0.5V0.9)\wedge(0.6V0) \quad \wedge(0.7V0.75)$

$= 1 \wedge 0.5 \wedge 0.8 \wedge 0.8 \wedge 1 \wedge 0.9 \wedge 0.6 \wedge 0.75 = 0.5$

$D(A) = 0.5$

Similarly,

$D(B) = (b_1' \vee O_1) \wedge (b_2' \vee O_2) \wedge (b_3' \vee O_3) \wedge (b_4' \vee O4) \wedge (b_5' \vee O_5) \wedge (b_6' \vee O_6) \wedge (b_7' \vee O_7) \wedge (b_8' \vee O_8)$

$= (0.1V\ 0.7)\wedge(0.2V0.9)\wedge(0.2V0.5)\wedge(0.3V0.7)\wedge(0.3V0.9)\wedge(0.5V1)\wedge(0.6V0.9) \quad \wedge(0.7V0.95)$

$= 0.7 \wedge 0.9 \wedge 0.6 \wedge 0.7 \wedge 0.9 \wedge 1 \wedge 0.9 \wedge 0.95 = 0.6$

$D(B) = 0.6$

$D(C) = (b_1' \vee O_1) \wedge (b_2' \vee O_2) \wedge (b_3' \vee O_3) \wedge (b_4' \vee O4) \wedge (b_5' \vee O_5) \wedge (b_6' \vee O_6) \wedge (b_7' \vee O_7) \wedge (b_8' \vee O_8)$

$= (0.1V1)\wedge(0.2V0.4)\wedge(0.2V0.6)\wedge(0.3V0.9)\wedge(0.3V0.9)\wedge(0.5V\ 0.8)\wedge(0.6V0.7) \quad \wedge(0.7V0.85)$

$= 1 \wedge 0.4 \wedge 0.6 \wedge 0.9 \wedge 0.9 \wedge 0.8 \wedge 1 \wedge 0.85 = 0.4$

$D(C) = 0.4$

This intersection is taken by considering minimum value.
Now maximum value among these three minimum values is 0.6.
Therefore candidate B is the best choice.
(If we get more than one equal values then any one candidate out of those candidates is suitable choice).

4. Conclusion:

i) The Multi-Objective Decision Making method is able to find the best nurse therefore selection system in hospital can use max-min principle method for selection of best nurse.

ii) In small towns educational qualification is not a major criterion, but other criterions are also important for selection of a nurse.

iii) We can apply this method to large hospitals in cities as it is easier and time saving.

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