A Fuzzy Mathematics Based Approach for Poor Household Identification

Supratim Mukherjee, Amitava Chatterjee, Rupak Bhattacharyya, and Samarjit Kar

Abstract— **Economists as well as Mathematicians consider poverty as a multidimensional problem. In this paper, the fuzzy membership functions for some of the attributes regarding poverty are proposed to determine using mathematical tools like interpolation. Also the poverty index is proposed to constitute by some novel aggregation techniques. The tractability and effectiveness of the proposed approach is established by a rural life household example.**

Index Terms— **Fuzzy logic, Fuzzy sets, Membership functions, Poor household identification.**

MSC 2010 Codes — **03H10, 91B14, 91B15, 91B82.**

I. Introduction

IT has been a long time to identify a poor person in a community by two valued logic approach. The problem is very much context dependent and it should not be considered as a global one because the attributes deviate for different places and different phases of society. In his pioneering contribution Sen (1976) rolled over the problem of poverty index in two ways: poor household identification and aggregation of the attributes of the poor in an overall indicator which quantifies the poverty index. The transfer axiom proposed by Sen stipulates that a transfer of income from a poor to a rich person certainly increases the poverty degree when other attributes are fixed. Another axiom in this context is population monotonicity axiom which states that an addition of a person below the poverty line should increase the poverty degree and the addition of a person above the poverty line should decrease the degree when other attributes are fixed. The introduction of these two axioms leads to a certain anomaly regarding the possibility of any poverty index.

In this contribution the authors are mainly interested in the problem of identifying a poor household in a society. The poverty index of a society certainly depends on the individual poverty degree of each household. So this problem has been taken into consideration with great importance. In section 2 some preliminaries about fuzzy sets and membership function evaluation by interpolation have been discussed. In section 3, a brief review on the existing approaches towards identification of poor and poverty degree has been given. In section 4, the methodology is proposed. A real life example is demonstrated to show the effectiveness of the proposed approach in section 5. Finally, section 6 concludes the paper.

II. Preliminaries

A. Some Definitions

Let us have a quick view of the following definitions:

Let X is a collection of objects called the universe of discourse. A fuzzy set denoted by $\tilde{A}$ on X is the set of ordered pairs $\tilde{A} = \{(x, \mu_{\tilde{A}}(x)): x \in X\}$ where $\mu_{\tilde{A}}(x)$ is the grade of membership of x in $\tilde{A}$ and the function $\mu_{\tilde{A}}(x): X \rightarrow [0, 1]$ is called the membership function.

The support of a fuzzy set $\tilde{A}$ on X denoted by supp ($\tilde{A}$) is the set of points in X at which $\mu_{\tilde{A}}(x)$ is positive, i.e., supp ($\tilde{A}$) = $\{ x \in X : \mu_{\tilde{A}}(x) > 0\}$.

The core of a fuzzy set $\tilde{A}$ on X denoted by core ($\tilde{A}$) is the set of points in X at which $\mu_{\tilde{A}}(x)$ equals 1, i.e., core ($\tilde{A}$) = $\{ x \in X : \mu_{\tilde{A}}(x) = 1\}$.

The height of a fuzzy set $\tilde{A}$ on X denoted by height ($\tilde{A}$) is defined by height ($\tilde{A}$) = sup $\mu_{\tilde{A}}(x)$.

B. Membership Function Evaluation by Interpolation

Let us consider a univariate existence population S and let the population S is determined by the values of the random variable X.

Let the random variable X take values in the interval $S = [a, b]$. Let us chose and fix the $(n+1)$ points $x_0, x_1, x_2, \ldots, x_{n-1}, x_n$ such that $(a=)\ x_0 < x_1 < x_2 < \ldots < x_{n-1} < x_n\ (=b)$.

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Now we consider the *(n+1)* events $(X = x_0)$, $(X = x_1)$, $(X = x_2)$, … , $(X= x_n)$.

Let *E* be the random experiment of selecting a source at random and collect data from that source about the probable grade of these happenings $(X= x_0)$, $(X= x_1)$, $(X=x_2)$, … ,$(X= x_n)$. Let *E* be repeated *m (> 1)* times.

Then for each event $(X = x_i)$ we get a sample $\{z_1^{(i)}, z_2^{(i)}, z_3^{(i)}, \dots, z_m^{(i)}\}$ of size m; i = 0,1,2,…,n; $0< z_1^{(i)} <1$.

Let $y_i = \frac{(z_1^{(i)} + z_2^{(i)} + z_3^{(i)} + \dots + z_m^{(i)})}{m}$ be the arithmetic mean of the sample data. Thus we have the following *(n+1)* nodes: (x_0, y_0), (x_1, y_1), …, (x_n, y_n) where each $y_i \in [0, 1]$ $(i= 1, 2, \dots, n)$. In [8], two methods of interpolation have been used. Among these we here use Newton's divided difference interpolation formula and obtain the required membership function $\mu(x)$ as

$\mu(x) = \phi(x) + R_{n+1}(x)$ where

$$\phi(x) = \mu(x_0) + (x-x_0)\mu(x_0,x_1) + (x-x_0)(x-x_1)\mu(x_0,x_1,x_2) + \dots + (x-x_0)(x-x_1)\dots(x-x_{n-1})\mu(x_0,x_1,x_2\dots,x_n)$$

$$R_{n+1}(x) = (x-x_0)(x-x_1)\dots(x-x_n)\mu(x,x_0,x_1,\dots,x_n),$$

and $\mu(x_0,x_1) = \frac{\sum_{j=1}^{m}\{z_j^{(0)} - z_j^{(1)}\}}{m(x_0 - x_1)}$,

$$\mu(x_0,x_1,x_2) = \sum_{j=1}^{m}\frac{\{(x_1-x_2)(z_j^{(0)}-z_j^{(1)}) - (x_0-x_1)(z_j^{(1)}-z_j^{(2)})\}}{m(x_0-x_1)(x_1-x_2)(x_2-x_3)}$$

and so on.

Thus in this method, we can construct an approximate membership polynomial function as well as can find out the functional value or the membership grade for any particular instance. We can apply these methods to different types of problems and get approximate needful results. The same formulation can be done by the help of Modified Lagrange's Method. The corresponding algorithms are given in [8].

III. Review of Some Approaches

Normally in literature the approaches for identifying poor households are classified in two ways: traditional head count ratio approach and totally fuzzy relative approach. Some poverty models are also proposed on the basis of these methods, e.g., the logit model, conditional income distribution model, fuzzy set theoretic model, etc. The logit poverty model deals with a household's (j^{th}) equalized annual income (or expenditure) $\frac{z_j}{g} = y_j$ where z_j the income (or expenditure) is and g is a specific value of an equivalence scale. If the c.d.f. (cumulative distribution function) of y is denoted by F_y and the relative poverty line estimated from data following a specific standard is denoted by h, then they are connected by $h = a \times F_y^{-1}(b)$ where *a* and *b* are parameters to be estimated. Now the poverty indicator $I_j = 1$ if $y_j \le h$ and $= 0$ if $y_j > h$.

In Dagum poverty model the same evaluation is followed by the distribution function $F(y) = \frac{1}{(1+\lambda y^{-a})^b}$ where *a* and *b* are the shape parameters and λ is a scale parameter.

F. Bourguignon and S.R. Chakravarty proposed a simpler way to identify a poor household in a community by the poverty indicator variable

$\rho(x_i; z) = 1$ if there exists $j \in (1,2,\dots,m) : x_{ij} < z_j$

$= 0$ otherwise

where z_j is the line of separation for the j^{th} attribute and hence the total number of poor households is simply given by $H = \sum_i \rho(x_i; z)$.

The third type of approach is Fuzzy Set theoretic approach. S. R. Chakravarty contributed an important methodology in this context. In his method the membership function $\mu_j(x_{ij})$ depends on the quantity m_j at or above which a household is regarded as non poor with certainty with respect to the jth attribute, i.e.,

$\mu_j(x_{ij}) = 1$ if $x_{ij} = 0$

$= 0$ if $x_{ij} \ge m_j$.

In the mid values the membership function is $\mu_j(x_{ij}) = \left(\frac{m_j - x_{ij}}{m_j}\right)^{\theta_j}$ where $\theta_j \ge 1$ is a parameter. The assumptions made in this method are m_j coincides with one of the x_{ij} values and a rise in x_{ij} decreases the possibility of i^{th} household's being poor for the j^{th} attribute.

J. Vero's approach is also a significant contribution in this type of literature. Following Cerioli and Zani (1990) he introduced the membership function $\mu_j(x_{ij})$ to the poor for the attribute 'income', defined by

$\mu_j(x_{ij}) = 1$ if $0 < y_i < z'$

$= \frac{z'' - y_i}{z'' - z'}$ if $z' \le y_i \le z''$

$= 0$ if $y_i > z''$

where y_i is the income of the i^{th} household, z' is a value up to which a household is definitively poor and z'' is a value above which a household is definitively not poor. The poverty index is obtained by aggregating all the membership values corresponding to all the attributes. For each household the membership frequency f_i are calculated as the number of households having at least the same deprivations on the basis of each attribute. A two-step membership function is then constituted by the following manner:

$m_p(i) = ln(\frac{1}{f_i}) \Big/ \sum_i ln(\frac{1}{f_i})$ and

$$\mu_P(i) = \frac{m_p(i) - Min[m_p(i)]}{Max[m_p(i)] - Min[m_p(i)]}.$$

Sometimes the problem of poverty is linked with the minimum calorie norm. But different Planning Commissions and different authors in several times have characterized different amount of calories for an average adult for a day. The difference between these amounts appears awkward in this theory. The following table shows some of them in the context of India.

TABLE I
MINIMUM CALORIE NORM PRESCRIBED BY DIFFERENT PLANNING COMMISSION/ INSTITUTION

Name of the Planning Commissions/ Authors	Amount of Calorie/ adult/ day
Central Govt. Employees' 2nd Pay Commission (1957-59)	2700 cal and 55 gms
Dandekar and Rath (1971)	2250 cal
Nutrition Expert group of ICMR (1968)	For rural area = 2435 cal For urban area = 2095 cal
WHO (1985)	2700 cal
Asian Development Bank	1800 cal

The problem in this type of estimation is its lack of association with the other attributes – both theoretically and practically and for that reason it has been noticed that the calorie deprivation is increasing during a certain time interval whereas the rural population below the poverty line is said to be decreasing rapidly as stated by the UN World Food Programme.

As we have stated earlier the problem of understanding poverty and its dynamics is mainly characterized into two parts: identification of poor and setting poverty index of a society. Lot of other studies is also there, but to some extent they are related to these two. The attributes for determining poor households are different from those for defining poverty index, both in nature and expression.

The failure of different methods regarding poverty has been discussed in some literatures. Some common reasons are really there to find out the correct figure. Here we discuss some of those.

There may be some intra-household factors which cannot be summed up by the surveyor, but it certainly has some influence in the result.

The monetary position of a household may fluctuate in short time and it is not realistic that a surveyor picks each of them in the time concerned.

There may be some sort of information gap between the surveyor and the household.

The choice of attributes may vary from different places and also for different times. The interdependence between some of those attributes may mislead the computation procedure.

In our proposed method the problem of identification of poor household has logically been treated from two views: the status of the household with respect to all the socio-economic attributes and the deprivation of the household with respect to other households in the same society. This dual approach philosophically covers the whole space of deprivation. Various methods mentioned earlier in this section have handled this particular problem from a single view. Our proposed approach is thus new and novel.

IV. POVERTY MEASUREMENT IN FUZZY FRAMEWORK

There are few methods for multidimensional poverty evaluation in literature. Some of them are based on classical two valued logic, i.e., only black and white cases are considered there. The problem in these approaches is that some of the linguistic terms used to construct the attributes are fuzzy in the sense that *0* or *1* answers to them really do not help to solve the issue fully. For example, consider the case of 'education'. A person may have completed his education up to a certain level or he is in the middle of his educational life. The degree of membership of belongingness to the fuzzy set 'educated persons' cannot be only *0* and *1* in any sense. Certainly it lies in $[0, 1]$. This implies that a person who has not completed his education up to a certain standard is of membership grade *0* and a person with a membership grade *1* must have at most completed a certain level of education. The middle valued persons are educated in between these two levels. The membership functions required to determine this attribute is increasing but not strictly. So the importance of including fuzzy logic is really there in this type of problems.

On the other hand most of the methods where fuzzy logic is involved have used linear membership functions to determine the attributes. It does not always mean that when certain information is not available in the mid-points, the membership degrees should increase or decrease in linear sense. Because linearity is not general, rather the whole world is non linear.

Let $X_1, X_2, \ldots, X_n$ be n households and $T_1, T_2, \ldots, T_m$ be *m* attributes which may be a mixture of crisp and non crisp terms. For example consider the case of the attribute set: {income, education, having car, having bathroom, clothing status, happiness}. We certainly feel that the attributes 'having car' and 'having bathroom' are crisp terms and the others have answers in fuzzy sense. The remaining attributes are again classified in two categories. Some attributes give direct numeric values in answer, like 'income' here and others do not. Lastly mentioned attributes' answers are grouped and certain membership degrees are sought from experts for each group; for example, 'clothing status' in our example. It is easier for us to group the answers of 'clothing status' in five groups: very bad (*VB*), bad (*B*), medium (*M*), good (*G*) and very good (*VG*). The surveyor exactly finds out the group in which the household falls for this attribute. Experts' assigned membership degrees for these different groups are assembled and next we will deal with their mean. So without any loss of generality, we can consider $T_1, T_2, \ldots, T_k$ be k attributes which gives direct numeric values, $T_{k+1}, T_{k+2}, \ldots, T_u$ be $(u - k)$ attributes which are grouped in five categories and the remaining $(m - u)$ attributes $T_u, T_{u+1}, \ldots, T_m$ give crisp values *0* or *1* for different households. The choice of experts is very important here, because on their view depend the membership degrees. We show some information of the whole community to the experts to extract their correct opinions. For example, we may seek for the membership degrees for some monthly incomes, e.g., *2000, 3000, 6000, 8000, 10000* in INR. Since we are in hunt of poverty measurement we impose some conditions on the experts while assigning membership grades:

i) up to certain value of the attribute, the membership grades should be zero
ii) the membership grades should continuously be 1 after some certain value of the attribute

iii) the membership grades should be either decreasing or in creasing

Satisfying all these conditions the experts E_k give the membership grades for T_j for some points x^j_q ($k = 1, 2, \ldots, p$; $q = 1, 2, \ldots, l$). We construct a polynomial membership curve using these points by modified Newton's divided formula [8]. For this we collect data for all x^j_q from all experts and deal with the averages. Let $y^{T_j}_{qE_i}$ be the membership grade given by the expert E_i for the attribute T_j at the point $x^{T_j}_q$ where $j \in \{1,2,\ldots,k\}$. Now we evaluate $\mathrm{M}[y^{T_j}_q] = \frac{\sum_{i=1}^{p} y^{T_j}_{qE_i}}{p}$ for $j = 1, 2, \ldots, m$ and $q = 1, 2, \ldots l$. Thus for the attribute T_j we can get l number of ordered pairs $(x^{T_j}_q, \mathrm{M}[y^{T_j}_q])$ for $q \in \{1,2,\ldots,l\}$, i.e., the following table is formed:

TABLE II
DISCRETE DATA FOR THE ATTRIBUTE 'INCOME'

$\otimes x_j$:	$x^{T_j}_1$	$x^{T_j}_2$	$x^{T_j}_3$	. . .	$x^{T_j}_l$
$\otimes y_j$:	$\mathrm{M}[y^{T_j}_1]$	$\mathrm{M}[y^{T_j}_2]$	$\mathrm{M}[y^{T_j}_3]$	. . .	$\mathrm{M}[y^{T_j}_l]$

In the next step we interpolate the given nodes and get a membership curve in polynomial shape for the j^{th} attribute T_j for a certain interval. This curve must fulfill the following properties:

[1] It should be piecewise continuous.

As the experts are directed to give grade 0 upto a fixed point of a certain domain and 1 from another fixed point of another domain, at the points of the break the curve may be discontinuous, but being a polynomial it is meanwhile continuous and thus piecewise continuous through the whole domain.

[2] It should be increasing throughout the whole domain. For this reason the curve cannot be convex.

[3] It should be normal as it attains maximum grade 1 for some points.

Let us denote this curve by $\mu(T_j)$ for $j = 1, 2, \ldots, k$. Now while taking a survey a household is asked to submit numeric data for the attributes, then after strictly verifying those data by the surveyor and editing them we can have a household-attribute value matrix (HAVM) as described in table III.

TABLE III
HOUSEHOLD ATTRIBUTE WEIGHTED VALUE MATRIX

X_i \ T_j	T_1	T_2	. . .	T_k	T_{k+1}	T_{k+2}	. . . . . .	T_m
X_1	z_{11}	z_{12}	. . .	z_{1k}	z_{1k+1}	z_{1k+2}	. . . . .	z_{1m}
X_2	z_{21}	z_{22}	. . .	z_{2k}	z_{2k+1}	z_{2k+2}	. . . . .	z_{2m}
. . .	....							
X_n	z_{n1}	z_{n2}	. . .	z_{nk}	z_{nk+1}	z_{nk+2}	. . . . .	z_{nm}

Now the problem is to combine these poverty grades into one index, called poverty index (P.I.) for each household. Next we consider the weights w_j we want to impose on the attributes T_j, $j = 1, 2, \ldots, m$ and $\sum_{j=1}^{m} w_j = 1$. Each column of HAVM is multiplied by their corresponding weights and we can have a new matrix HAWVM (household attribute weighted value matrix) as shown in table IV, where $z'_{ij} = w_j z_{ij}$.

We define $\mu_A(X_i) = \sum_{j=1}^{m} z'_{ji}$. Certainly $0 \le \mu_A(X_i) \le 1$.

The combination of the membership degrees of the attributes for each household will represent the P.D. So we extract some more characteristics of the whole community. For each household X_i we search for the number of households than whom X_i is in better position or equal position with respect to each household T_j. We sum up these m numbers for each household and the degree of betterness is defined for X_i by dividing the sum by mn and it is denoted by $\mu_B(X_i)$. Now again the experts (in case, may be the Govt. officials) are requested to submit their valuable 'weights' for importance of the membership degrees $\mu_A(X_i)$ and $\mu_B(X_i)$. Taking the weighted mean between these two, we define P.D. of for X_i as P.D. $(X_i) = \frac{v_1 \mu_A(X_i) + v_2 \mu_B(X_i)}{v_1 + v_2}$, where v_1 and v_2 are the average weights given by the experts for average attribute membership value and degree of betterness.

TABLE IV
HOUSEHOLD ATTRIBUTE WEIGHTED VALUE MATRIX

X_i \ T_j	T_1	T_2	. . .	T_k	T_{k+1}	T_{k+2}	. . . .	T_m
X_1	z'_{11}	z'_{12}	. . .	z'_{1k}	z'_{1k+1}	z'_{1k+2}	. . . .	z'_{1m}
X_2	z'_{21}	z'_{22}	. . .	z'_{2k}	z'_{2k+1}	z'_{2k+2}	. . . .	z'_{2m}
. . .	....							
X_n	z'_{n1}	z'_{n2}	. . .	z'_{nk}	z'_{nk+1}	z'_{nk+2}	. . . .	z'_{nm}

Now the Policy makers can fix a line, called FPL (Fuzzy Poverty Line) here to below membership valued numbers of which should be considered as poor and the others are non-poor. Here we propose another step where the persons in the community can be divided in more levels like Very Poor, Poor, Not so poor, Rich and Very Rich persons. The advantage of dividing in these levels is that the Policy Makers can take different positive steps to each level to the betterment of the community and it may lead to the real progress of the community as a whole.

V. EXAMPLE

We illustrate our method by an example where we consider 5 households and 7 attributes. The attributes are:

1. T_1: Housing Condition
2. T_2: Clothing Status

3. T_3: Educational Status
4. T_4: Average monthly income per capita
5. T_5: Having special vulnerability of any member
6. T_6: Food Security
7. T_7: Having Electricity

Now for different places on this Earth the choice of attributes can be different. Our example is just to show the applicability of our proposed approach. Now it can be easily seen that the attributes T_5 and T_7 give outputs 0 or 1, the other attributes are fuzzy. Among these, the fuzzy attributes T_1, T_2, T_3 and T_6 are classified in some groups. T_1, T_2, and T_6 are grouped as: Very Bad (VB), Bad (B), Medium (M), Good (G), and Very Good (VG). T_3 is grouped as: No education (NE), I-IV, V-VIII, IX & X, XI &XII, Graduation (G), and Post Graduation (PG). More division of these fuzzy sets will represent more realistic measure. In this problem five households have been selected from a rural community, the status of these households has been investigated by a surveyor and we have collected and assembled those data in table V.

TABLE V
STATUS OF THE HOUSEHOLD OBTAINED FROM THE SURVEYOR

T_j / X_i	T_1	T_2	T_3	T_4	T_5	T_6	T_7
X_1	*B*	*VB*	*III*	*1250*	*Y*	*M*	*N*
X_2	*M*	*B*	*N*	*700*	*N*	*M*	*Y*
X_3	*VB*	*B*	*IV*	*800*	*N*	*B*	*N*
X_4	*G*	*G*	*XII*	*1500*	*N*	*G*	*N*
X_5	*B*	*B*	*X*	*550*	*N*	*VB*	*Y*

For this particular problem, we have sought their valuable numeric comments from three experts and after noticing the overall positions of the households with respect to all the attributes, we have collected the table VI.

Now according to our proposed approach the membership function for the 'income' attribute is evaluated by the use of interpolation as illustrated in [8] from the table VII.

We now compute the membership degrees of the attribute T_4 by using the formula derived in [8]. The membership degrees corresponding to all the attributes of each household weighted by the w_j's. The value matrices HAVM and HAWVM are shown in tables VIII and IX.

Now we move onto the rest part where the task is to combine these membership grades into one index and to draw the line of poverty. According to the proposed approach the weights of importance of the 'sum of membership grades' and the 'degree of betterness' have been suggested here in this example as *0.75* and *0.25* respectively, but it may vary for different selections. The computation of combining these two degrees is illustrated in the table X.

Now it is the responsibility of the policy makers to draw the line of separation. We propose here to divide the range *[0, 1]* of membership values in some intervals like *[0, 0.2), [0.2, 0.4), [0.4, 0.7), [0.7, 0.9) and [0.9, 1]* and separately economic policies should be applied on them. We call the household individuals of these classes as Very Poor, Poor, Not so poor, Rich and Very Rich respectively.

TABLE VI
NUMERIC COMMENTS OF THE EXPERTS ON ATTRIBUTE VALUES AND WEIGHTS

	Group	E_1	E_2	E_3	Average
T_1	VB	0.1	0.2	0.15	0.15
	B	0.3	0.35	0.25	0.3
	M	0.6	0.6	0.5	0.57
	G	0.8	0.85	0.9	0.85
	VG	0.9	0.95	1	0.95
	Weight(w_1)	0.2	0.1	0.1	0.14
T_2	VB	0.15	0.2	0.25	0.2
	B	0.2	0.3	0.35	0.28
	M	0.4	0.5	0.55	0.48
	G	0.6	0.75	0.7	0.68
	VG	0.8	0.9	0.85	0.85
	Weight(w_2)	0.1	0.05	0.05	0.07
T_3	NE	0	0	0	0
	I-IV	0.3	0.3	0.4	0.33
	V-VIII	0.5	0.5	0.55	0.52
	IX, X	0.65	0.6	0.7	0.65
	XI, XII	0.7	0.7	0.8	0.73
	G	0.9	0.95	1	0.95
	PG	1	1	1	1
	Weight(w_3)	0.05	0.1	0.05	0.07
T_4	500	0	0.05	0.05	0.03
	700	0.1	0.2	0.1	`0.13
	900	0.25	0.25	0.3	0.27
	1100	0.35	0.3	0.45	0.37
	1300	0.5	0.6	0.6	0.57
	1500	0.65	0.75	0.75	0.72
	1700	0.8	0.85	0.8	0.82
	1900	0.9	0.95	0.95	0.93
	2100	0.95	0.95	1	0,97
	Weight(w_4)	0.45	0.5	0.55	0.5
T_5	Weight(w_5)	0.05	0.05	0.05	0.05
T_6	VB	0.1	0.05	0.1	0.08
	B	0.3	0.2	0.25	0.25
	M	0.5	0.65	0.45	0.53
	G	0.8	0.85	0.75	0.8
	VG	1	1	0.9	0.97
	Weight(w_6)	0.1	0.1	0.15	0.08
T_7	Weight(w_7)	0.05	0.1	0.05	0.08

TABLE VII
DISCRETE DATA FOR THE ATTRIBUTE T1

$\otimes x_4$	$\otimes y_4$
500	0.03
700	0.13
900	0.27
1100	0.37
1300	0.57
1500	0.72
1700	0.82
1900	0.93
2100	0.97

TABLE VIII
HAVM

T_j \ X_i	T_1	T_2	T_3	T_4	T_5	T_6	T_7
X_1	0.3	0.2	0.33	0.611	0	0.53	0
X_2	0.57	0.28	0	0.13	1	0.53	1
X_3	0.15	0.28	0.33	0.195	1	0.25	0
X_4	0.85	0.68	0.73	0.93	1	0.8	0
X_5	0.3	0.28	0.65	0.051	1	0.08	1

TABLE IX
HAWVM

T_j \ X_i	T_1	T_2	T_3	T_4	T_5	T_6	T_7
X_1	0.042	0.014	0.026	0.306	0	0.042	0
X_2	0.080	0.020	0	0.065	.05	0.042	0.08
X_3	0.021	0.020	0.026	0.098	.05	0.02	0
X_4	0.119	0.048	0.058	0.465	.05	0.064	0
X_5	0.042	0.020	0.052	0.026	.05	0.006	0.08

TABLE X
COMPUTATION OF AGGREGATING MEMBERSHIP DEGREES AND DEGREE OF BETTERNESS

Households	*Sum of the Membership grades*	*Degree of betterness*	*Poverty degree*	*Rank*
X_1	0.430	0.514	0.45	4
X_2	0.337	0.714	0.43	3
X_3	0.235	0.600	0.32	1
X_4	0.804	0.943	0.84	5
X_5	0.276	0.628	0.36	2

VI. CONCLUSION

The introduction of fuzzy logic has created a new scope of research in the field of poverty. In our paper an algorithmic approach is proposed from the philosophical view that the problem of identifying poor household should be taken as a combination of household capabilities and social ranking. There are no logical obstacles for aggregating these two types of poverty degrees by some weights. It may seem that the method is too much dependent on the experts' weights. But this will enrich the process of evaluation to some extent. The membership functions for the attributes considered here are sometimes discrete and sometimes continuous. The 'income' attribute has been proposed to determine by the use of numerical interpolation. Some other techniques like regression analysis etc may also be used in this context. The usefulness of applying these techniques has been illustrated by a real life example.

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