

MAIN CLASSES OF MEMBERSHIP FUNCTIONS IN INTELLECTUAL SEARCH

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ABSTRACT

Resume. Main classes of membership functions were shown which can be used for rebuilding natural language query based on linguistic variable within the theory of fuzzy sets. In our opinion, the intellectual search - fuzzy terms in query are accurate to values of numeral. Moreover, determining the corporate values of terms and recommendations of choosing respective functions are set forth. These classes help us to choose optional linguistic variable terms and create conditions for numeral dimensions of these functions.

KEYWORDS: Searching, Membership Function, Linguistic Variable, Term, Rebuilding Query, Fuzzy Sets And Logic Theory, Information Resources and Intellectual Searching

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I. INTRODUCTION

The development of information technology has influences to information infrastructure and its software. In particular, create integrations, modernizations, or new one of all system peculiarities and duties in information technologies are very important nowadays. In addition, use information technologies in any public environments, information resources that are proposed and required by users, assurances works with software comfort are spreading.

One of the main factors in the development of information technologies to meet the information needs. Intellectual searching information and rebuilt are required for meeting the information needs. Today, electron resources, information and resource centers (libraries), museums and other institutions are controlling and processing of using them to be automatized problems and in this system intellectual searching information, rebuilding, presentation them are waiting their solutions for supply the human with the best reliable and expensive information.

In our opinion The following pair determine intellectual search information system.

$$\langle q, r \rangle \tag{1}$$

Where q - query, the user's information needs, r - the query object, which is determined in accordance with the request of data collection.

Exactly, q - query was set of objects by terms form linguistic variable, where it's used L.Zade which is satisfactory to query for determining the selection of object, and this may put into practice based on mathematical apparatus of theory of fuzzy sets.

For query object selection, which submitted query by natural and artificial language, to be determined query is not constant text, maybe meaning of it should be determined by computer. For this, should use the theory of linguistic variable in fuzzy selection and main classes of membership functions for fuzzy terms selection should be investigated.

The theory and logic of fuzzy sets are supported by technical people and engineers in variety fields and use it for manage technical processes by the years 1970-1980. At present, the production of such technologies in the world occupies the first place in Japan.

Let's guess, $X = \{x_1, x_2, \dots, x_N\}$ based on the collection of basic L linguistic variable $T = \{t_1, t_2, \dots, t_N\}$ is given. In that case, according to a set of terms T, we can define A_i for suitable t_i .

$$A_i = \{(x_1, \mu_{A_i}(x_1, l_x)), (x_2, \mu_{A_i}(x_2, l_x)), \dots, (x_n, \mu_{A_i}(x_n, l_x))\}, \quad i = 1 \dots M \quad (2)$$

if x_i is discrete value, (2) we can write.

$$A_i = \sum_{j=1}^N \frac{\mu_{A_i}(x_j, l_x)}{x_j}, \quad i = 1 \dots M \quad (3)$$

if x_i is continuous value ($X \subseteq \mathbb{R}$), (2) we can write.

$$A_i = \int_{x_1}^{x_N} \frac{\mu_{A_i}(x, l_x)}{x}, \quad i = 1 \dots M \quad (4)$$

In (3) \sum and in (4) \int are joining of the elements of the collection association. $\mu_{A_i}(x_j, l_x)$, is X - the membership function of main selection of fuzzy selection of A_i for l_x linguistic variable.

Problem. According to the above information, in information resource system determining of intellectual searching information and rebuilding how can choose membership functions for linguistic variables or which classes should be used for which fuzzy terms are there.

MAIN PART

To solve the issues of the same object can be charged to enter or select different functions. Membership functions are separated from main classes and studied by scientists. But, use this class for intellectual search information, main selection for exact linguistic variable and fuzzy selection consist of terms selection, main classes of membership functions' which class for which terms or linguistic variables has not learned enough. For this we use the following membership functions.

1. Line Membership Functions

This class's functions usually consist of triangle and trapezium class of membership functions. In a lot of literature, this class of membership functions t (triangle) and T (trapezium) are considered. In general, use of t class membership functions with linguistic variables searching information. We can select the following information (1).

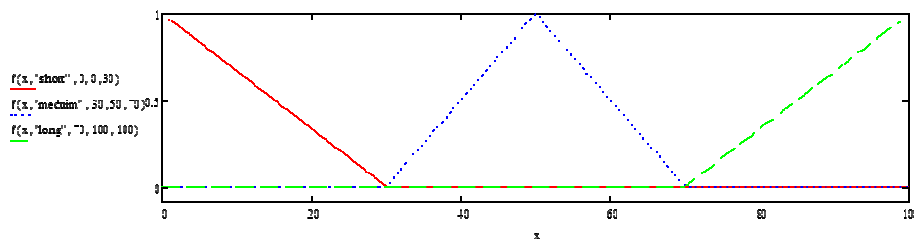
$$\mu_x^t(x, l_x, a, b, c) = \begin{cases} 0, & \text{if } x \leq a \text{ or } c \leq x \\ \frac{x-a}{b-a}, & \text{if } a \leq x \leq b, \\ \frac{c-x}{c-b}, & \text{if } b \leq x \leq c \end{cases} \tag{1}$$

Where, X - basic selection, D - is defined for l_x linguistic variable and set a, b, c - numeric for each terms ($a, b, c \in X = \{x_i\}, i = 1 \dots m$) and 1) $a < b < c$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriate to the conditions (Table 1).
 1 - comments left on the border $a \leq b < c$, right on the border with $a < b \leq c$.

Table 1: A, B, C - Agreements are Numerical Variables for Terms

X	l_x - Linguistic Variable			
	t_1	t_2	...	t_n
a	a_1	a_2	...	a_n
b	b_1	b_2	...	b_n
c	c_1	c_2	...	c_n

The following is given graphic of t class of membership functions (picture 1)



Picture 1: Graphic of T Class of Membership Functions

Use of T class membership functions with linguistic variables searching information we can select the following information (2).

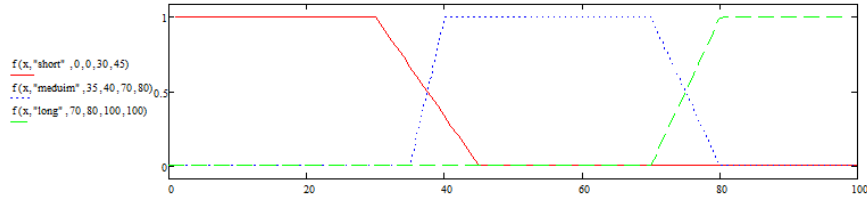
$$\mu_x^T(x, l_x, a, b, c, d) = \begin{cases} 0, & \text{if } x \leq a \text{ or } d \leq x \\ \frac{x-a}{b-a}, & \text{if } a \leq x \leq b \\ \frac{d-x}{d-c}, & \text{if } c \leq x \leq d \\ 1, & \text{if } b \leq x \leq c \end{cases} \tag{2}$$

Where, X - basic selection, D - is defined for l_x linguistic variable and set a, b, c, d numeric for each terms ($a, b, c, d \in X = \{x_i\}, i = 1 \dots n$) and 1) $a < b \leq c < d$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriate to the conditions (Table 2).
 1 - comments left on the border $a \leq b \leq c < d$, right on the border with $a < b \leq c \leq d$.

Table 2: A, B, C, D -Augments Are Numerical Variables for Terms

X	l_x - Linguistic Variable			
	t_1	t_2	...	t_n
a	a_1	a_2	...	a_n
b	b_1	b_2	...	b_n
c	c_1	c_2	...	c_n
d	d_1	d_2	...	d_n

The following is given graphic of t class of membership functions (Picture 2).



Picture 2: Graphics of T Class of Membership Functions

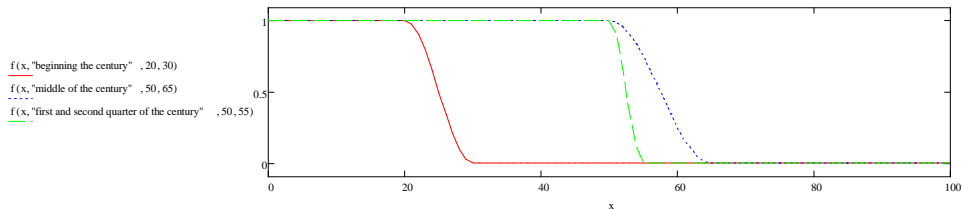
In the top of our text t class (1) and T class (2) are used as linguistic variable of intellectual searching information and rebuilding fuzzy type of “approximately equal”, “average”, “value”, “distance”, “settle down”, “similar”, “possible”, “degree of appropriate” and etc.

Z-Drawing Membership Functions (Class Z)

Class Z `s membership functions may be given kinds. Images of these functions must be as be written of letter “Z”. Usually, you can choose following variants as this class’s functions.

$$\mu_x^Z(x, l_x, a, b) = \begin{cases} 1, & \text{if } x < a \\ \frac{1}{2} + \frac{1}{2} \cos\left(\frac{x-a}{b-a} \pi\right), & \text{if } a \leq x \leq b \\ 0, & \text{if } x > b \end{cases} \tag{3}$$

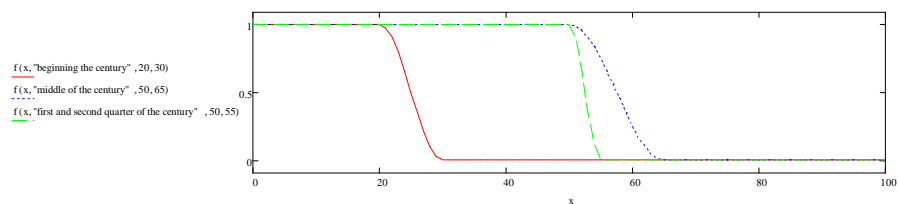
Graphical image of membership function (3) is given picture 3.



Picture 3: Graphics of Membership Functions

$$\mu_x^Z(x, l_x, a, b) = \begin{cases} 1, & \text{if } x \leq a \\ 1 - 2\left(\frac{x-a}{b-a}\right)^2, & \text{if } a < x \leq \frac{a+b}{2} \\ 2\left(\frac{b-x}{b-a}\right)^2, & \text{if } \frac{a+b}{2} < x < b \\ 0, & \text{if } x \geq b \end{cases} \tag{4}$$

Graphical image of membership function (4) is given picture 4.

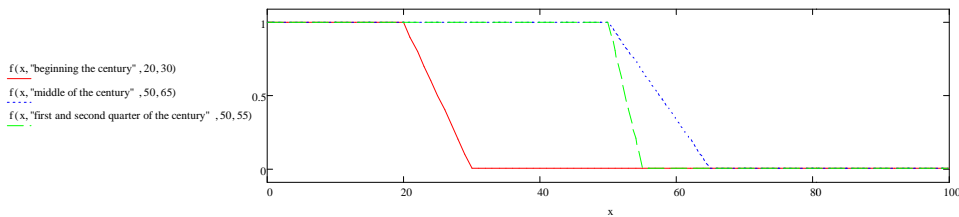


Picture 4: Graphics of Membership Functions

Membership functions of Z class may be expressed as line functions, too.

$$\mu_x^Z(x, l_x, a, b) = \begin{cases} 1, & \text{if } x \leq a \\ \frac{b-x}{b-a}, & \text{if } a \leq x \leq b, \\ 0, & \text{if } x \geq b \end{cases} \tag{5}$$

Graphical image of membership function (5) is given picture 5



Picture 5: Graphics of Membership Functions

Where, X - basic selection in (3), (4) and (5) membership functions which belong to class Z, D is defined for l_x linguistic variable and set a, b numeric for each terms $a, b \in X = \{x_i\}, i = 1 \dots m$ and 1) $a < b$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriate to the conditions a and b are count distance of terms determine.

In intellectual searching information and rebuilding (3), (4) and (5) in class Z “number of objects”, “value”, “border of value”, “value in interval”, “price”, “aim”, “relating”, “interval of belonging degree” are used for linguistic variable which has “small, till” maintenance.

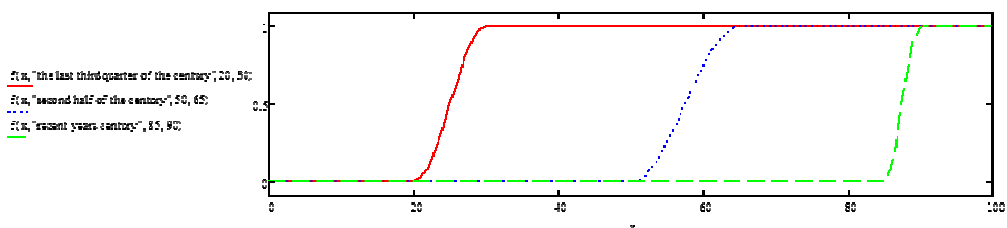
S-Graphical Membership Function (Class S)

Class S may be given kinds. Images of these functions must be written as letter “S”. Usually, these classes’ functions be chosen following (reverse of class Z, $S \leftrightarrow 1-Z$):

a.

$$\mu_x^S(x, l_x, a, b) = \begin{cases} 0, & \text{if } x < a \\ \frac{1}{2} + \frac{1}{2} \cos\left(\frac{x-b}{b-a} \pi\right), & \text{if } a \leq x \leq b, \\ 1, & \text{if } x > b \end{cases} \tag{6}$$

Graphical image of membership function (6) is given picture 6.

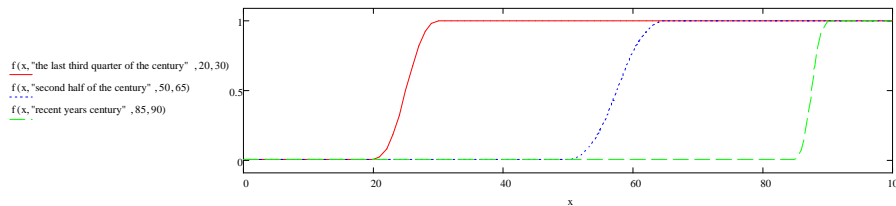


Picture 6: Graphics of Membership Functions

b.

$$\mu_x^S(x, l_x, a, b) = \begin{cases} 0, & \text{if } x \leq a \\ 2\left(\frac{x-a}{b-a}\right)^2, & \text{if } a < x \leq \frac{a+b}{2} \\ 1 - 2\left(\frac{b-x}{b-a}\right)^2, & \text{if } \frac{a+b}{2} < x < b \\ 1, & \text{if } x \geq b \end{cases}, \tag{7}$$

Graphical image of membership function (7) is given picture 7.

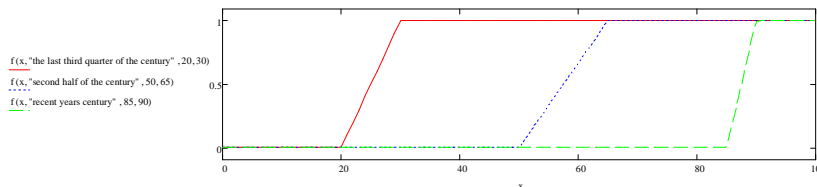


Picture 7: Graphics of Membership Functions

In addition, membership function of class S may be expressed as line function.

$$\mu_x^S(x, l_x, a, b) = \begin{cases} 0, & \text{if } x \leq a \\ \frac{x-a}{b-a}, & \text{if } a \leq x \leq b \\ 1, & \text{if } x \geq b \end{cases}, \tag{8}$$

Graphical image of membership function (8) is given picture 8.



Picture 8: Graphics of Membership Functions

Where X- basic selection in (6), (7) and (8) membership functions which belong to class S, D is defined for l_x linguistic variable and set a, b - numeric for each terms $a, b \in X = \{x_i\}, i = 1 \dots m$ and 1) $a < b$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriate to the conditions a and b are count distance of term's determine.

In intellectual searching information and rebuilding (6), (7) and (8) in class S “number of objects”, “value”, “border of value”, “value in interval”, “price”, “aim”, ”service”, “quality”, “figure”, “relating”, “interval of belonging degree” are used for linguistic variable which has “...from, big” maintenance.

We can differ in the top, we can use Z and S membership functions to build t and T membership functions. Class t and T functions are described by class Z and S.

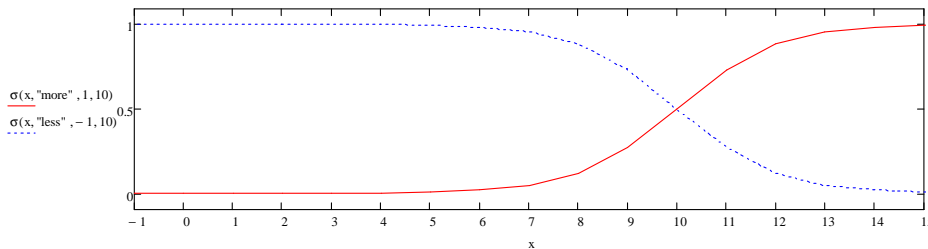
$$\mu_x^t(x, l_x, a, b, c) = \left\{ \min_{x \in X} \{ \mu_x^Z(x, l_x, a, b), \mu_x^S(x, l_x, a, b) \}, l_x \equiv \{ l_x^Z \cup l_x^S \} \right\},$$

$$\mu_x^T(x, l_x, a, b, c, d) = \left\{ \min_{x \in X} \{ \mu_x^Z(x, l_x, a, b), \mu_x^S(x, l_x, c, d) \}, l_x \equiv \{ l_x^Z \cup l_x^S \} \right\}$$

4. σ –graphical membership functions (class σ). Using this sigma membership functions is expedient if X -basic selection is symmetric. This class is belong to Z and S classes and this is following described:

$$\mu_x^\sigma(x, l_x, a, b) = \frac{1}{1 + e^{-a(x-b)}} \tag{9}$$

X symmetric basic selection in membership function which belong to class σ , D terms' selection for l_x -linguistic variable is determined and a, b numeral dimensions are entered for each terms and also, $(a, b \in X = \{x_i\}, i = 1 \dots m)$ and 1) $a < b$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ conditions must be appropriate. This σ class function if $a > 0$ S class, if $a < 0$, Z class membership function are given and its image in the bottom (picture 9).



Picture 9: Graphic of Membership Function (9)

In intellectual searching information and rebuilding which class σ includes (9) membership function using for linguistic variable of fuzzy selection which reverse each other (much-little, sweet-caustic, white-black, new-old, simple-complicated, difficult-easy) is recommended.

5. II Graphical Membership Functions (Class II)

There are kinds of opinions to choose these functions. If $a=b$ and $c=d$ in T membership function, this equality give P class. Also, class P membership functions are given following:

a. Use Class S and Z Membership Functions

$$\mu_x^\Pi(x, l_x, a, b, c, d) = \mu_x^S(x, l_x, a, b) \cdot \mu_x^Z(x, l_x, c, d), l_x^\Pi \equiv l_x^Z \cup l_x^S$$

In here X -basic selection, D terms selection is determined for l_x -linguistic variable and a, b, c, d - numeric variables are given for each terms $(a, b, c, d \in X = \{x_i\}, i = 1 \dots m)$ and 1) $a \leq |b| \leq |c| \leq d$, 2) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriated.

b. Use Class Σ Membership Function

$$\mu_x^\Pi(x, l_x, a, b, c, d) = \mu_x^\sigma(x, l_x, a, b) \cdot \mu_x^\sigma(x, l_x, c, d), l_x^\Pi \equiv l_x^\sigma$$

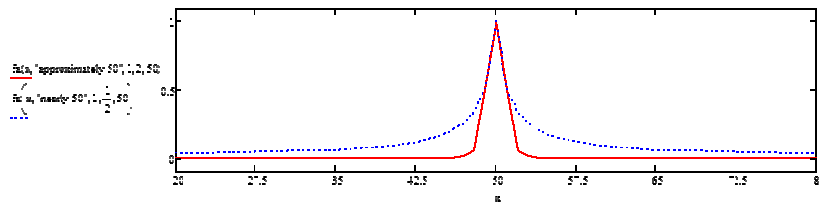
In here X - symmetric basic selection, D term's selection is determined for l_x -linguistic variable and a, b, c, d - numeric variables are given for each terms $(a, b, c, d \in X = \{x_i\}, i = 1 \dots m)$ and $a > 0$ and $c < 0$ 1) $a \leq |b| \leq |c| \leq$

$d, 2) a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriated.

c. Use Line Function

$$\mu_x^{\Pi}(x, l_x, a, b, c) = \frac{1}{1 + \left| \frac{x - c}{a} \right|^{2b}} \tag{10}$$

In here X - basic selection, D terms selection is determined for l_x -linguistic variable and a, b, c - numeric variables are given for each terms ($a, b, c \in X = \{x_i\}, i = 1 \dots m$) and 1) $a \leq b \leq c, 2) a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriated. There is image of this membership function:



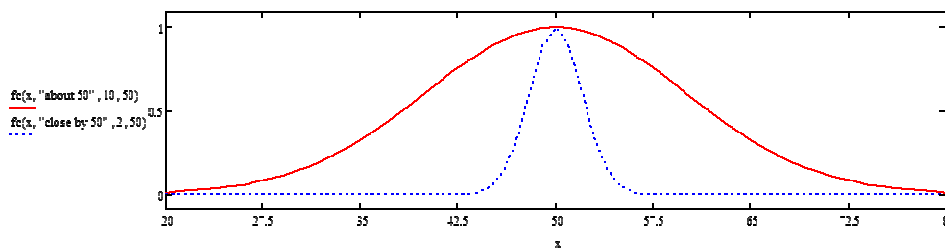
Picture 10: Graphic of Membership Function (10)

In intellectual searching information and rebuilding in Class Π (10) membership function using for linguistic variable of fuzzy type which the closest of term is recommended.

d. Use Exponential Function

$$\mu_x^{\Pi}(x, l_x, a, b, c) = e^{\frac{-(x-c)^2}{2a^2}} \tag{11}$$

In here X -basic selection, D terms selection is determined for l_x -linguistic variable and a, c (a^2 -fuzzy value of term, c – maximal value of term) numeric variables are given for each terms ($a, c \in X = \{x_i\}, i = 1 \dots m$) and 1) $a_1 \leq a_2 \leq \dots \leq a_n$ must be appropriated. There is image of this membership function:



Picture 11: Graphic of Membership Function (11)

In intellectual searching information and rebuilding in Class Π (11) membership function using for linguistic variable of fuzzy type which the closest of term is recommended.

III. CONCLUSIONS

The membership functions essential an important role in Intellectual search and processing of information. To guarantee to terms membership for linguistic variables is belong to membership function. Classes of membership functions which are given in the top, are used for all terms which be narrated in natural languages. In this pay attentions to logical

actions for elements of numeral basic selections, comparative values of term of linguistic variable evident and fuzzy selections for choosing membership function. If conditions are done which created for numeral variables selected comparative values for each terms' membership functions, it will be expedient. Also, we should note, beforehand, comparative values are determined for voluntary terms and conditions for numeral variables to be done is necessary.

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