THE USE OF FUZZY LOGIC IN THAT THE DECISION-MAKING PROCESS

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The present study is a short introduction in the theory of the fuzzy sets. It also presents some aspects of the application of the fuzzy logics in founding the decision-making process related to the firm's management. In the end there are presented some average operators that express the idea of compromise in making a decision.
Keywords: fuzzy logic, decision-making process, classical theory of the crowd.
JEL Code:L23, C02, C44.

1. Introduction

Crowds' fuzzy theory was developed from years 60, in response to poor consistency rules Deterministic type "YES" or "NO", trying the formalization of judgments such as "More or less. In classical logic, sentences can be true or false, no possibility of intermediate values. In the case of models approach concrete, real world, there was some tricky situations: not all are clear and real Deterministic (as such cannot be described accurately on the basis of classical logic), and a full description of the system requires a real range of information not known or fully supplied, and often are not understood exactly.
This came as a necessity to use fuzzy logic and resulting from the use of fuzzy instead crowds classic crisp.

2. Fuzzy crowd

Definition 1: Let X a lot nevoid. A lot fuzzy (vague) A is characterized by its membership function

$$\mu_A : X \rightarrow [0,1]$$

Where μA (x) is interpreted as the degree of membership of element x in A fuzzy crowd, for any x ϵ X.
It is clear that A is completely determined by the crowd tupelos A = {(x, μA (x)) | x ε X} and therefore we will write A (x) instead of μA (x). Family crowds all fuzzy in X us note F (x). If A = (x1... xn) is a finite lot X, we use notation

$$A= \mu_1/x_1+...+ \mu_n/x_n$$

Where the term μi / xi i = 1... N implies that μi is the degree of membership of xi in A, and is the plus sign.
Suppose that a person wants to buy a car cheap. "Cheap" can be a lot like the fuzzy world prices. For example (see fig. 1) "cheap" can interpret:
- Under $ 3000 cars can be considered cheap, and prices are not too differentiated eye purchaser;
- Between $ 3000 and $ 4500, a change in price induces a slight preference (poor) to cheaper car;
- $ 6000 beyond the costs are too high (not interested).

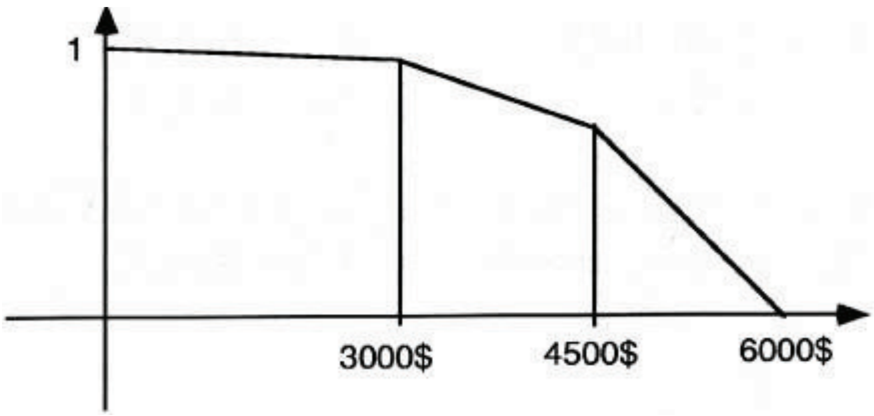

Fig.1: Discrete membership function for cheap

Definition 2: A fuzzy number A is called triangular fuzzy number with peak (center) a, left width of> 0 and right width of> 0 if its membership function has the following form:

$$A(t) = \begin{cases} 1 - \frac{a-t}{\alpha}, \text{ if } a-\alpha \le t \le a \\ 1- \frac{t-a}{\beta}, \text{ if } a \le t \le a+\beta \\ 0, \text{ otherwise} \end{cases}$$

And notes A= (a,α,β).

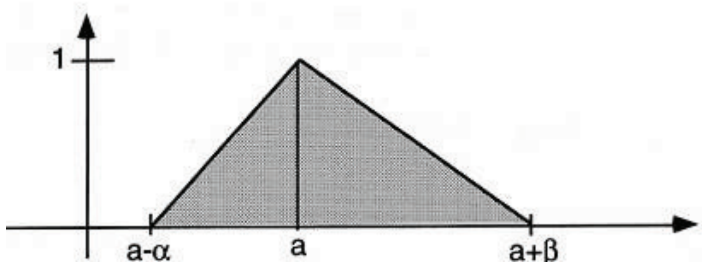

Fig.2: Triangular fuzzy number

A triangular fuzzy number with center can be seen as vague and quantity: "x is approximately equal to a".

Definition 3: A fuzzy number A is said trapezoidal fuzzy number with the tolerance *[a,b]* width to the left and right width, 8 if its membership function has the following form

$$A(t) = \begin{cases} 1 - \frac{a-t}{\alpha}, \text{ if } a-\alpha \le t \le a \\ 1, \text{ if } a \le t \le b \\ 1- \frac{t-a}{\beta}, \text{ if } a \le t \le a+\beta \\ 0, \text{ otherwise} \end{cases}$$

A trapezoidal fuzzy number can be seen as the vague "x is approximately in the range [a, b].

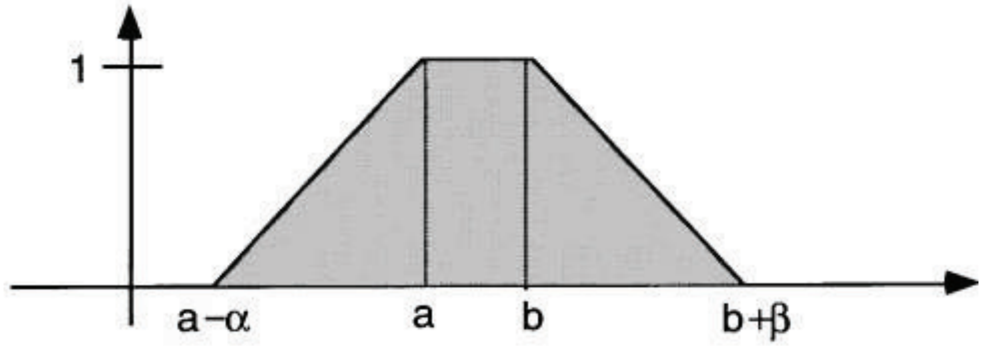

Fig. 3: Trapezoidal fuzzy number

3. Operations with fuzzy crowd

In this section expand the operations of the classical theory of the crowd. To note that all operations that are extensions of crisp concepts are reduced to their usual meaning when they under the crowds have fuzzy degrees of membership in the crowd {0.1}. Therefore, when expanding operations in fuzzy variety, use the same symbols as in theory crowds crisp. In what follows, A and B are two fuzzy under-lots same lot of classical X.

Definition 4: Say that A is a under-lots of B if A (t) ≤ B (t), whatever the t ε X.
Definition 5: The crossing of A and B is defined as *(A∩B)(t)=min{A(t),B(t)} =A(t)^B(t),* for all t ε X.
A ∩ B can be construed as "x is close to x and is close to b".

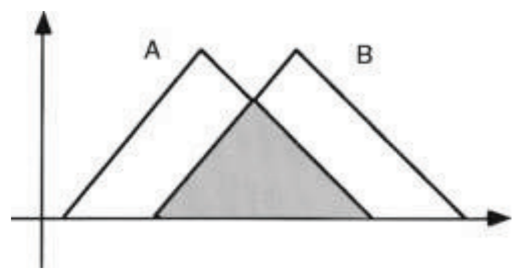

Fig. 4: Intersection of two triangular fuzzy numbers

Definition 6: The meeting of A and B is defined as (AUB) (t) = max (A (t), B (t)) = A (t) ∨ B(t) for all t ε X.

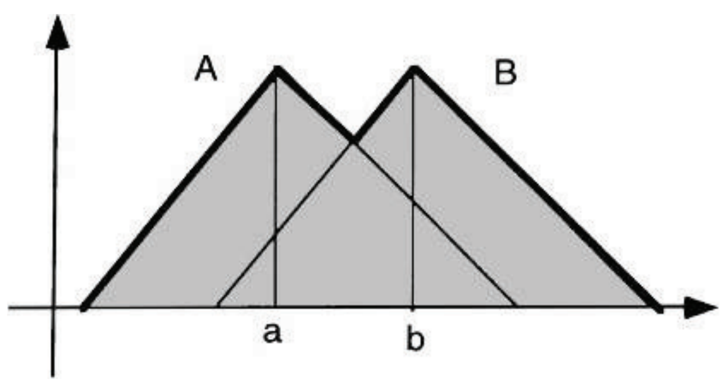

Fig.5: Meeting the second triangular fuzzy numbers

Definition 7: A complementary fuzzy set is defined as $(\neg A)(t) = 1 - A(t)$ for all $t \varepsilon X$.
It can be construed as "x is close to", and $\neg$ A can be read as "x is not close to" or "x is far from".

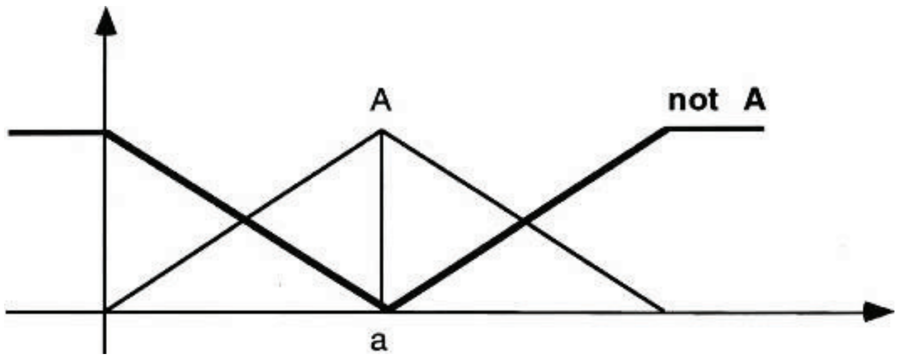

Fig. 6: Crowds vague A and A

Definition 8: A fuzzy under-lot and B are equal say, A = B, if $A \subset B$ and $B \subset A$ if A(t) = B(t) for any $t \varepsilon X$.
An under-lot fuzzy blank of X is defined as $\phi: X \rightarrow [0, 1]$, $\phi(t)=0$, for any $t \varepsilon X$.
I can see that $\phi \subset A$ for any vague under-lot A of X.
Universal fuzzy under-lot of X is defined as l_x: X → [0.1], lx (t) = 1, ε t to X.
It is noted that the l_x is most vague under-lot of X, $A \subset l_x$ for any vague under-lot A of X.
Moreover, $l_x=\phi$ *and* $\phi=l_x$. However, unlike the classical theory of the crowd, and the third non-compliance and the third excluded are not satisfied, meaning $A \wedge A \neq \phi$, and $A \vee A \neq l_x$.
De Morgan's laws are satisfied by the fuzzy under-lot X, meaning

$$(A \wedge B) = A \vee B$$
$$(A \vee B) = A \wedge B$$

4. That the fuzzy logic and decision-making process

Crowds fuzzy theory was developed by L. Zadeh [Zad75], who noted that the mathematical models and various classical methods in that the present flawed decision-making process and are difficult to apply the complex reality of economical factors .As increasing complexity as an economic process can reach a critical point, the accuracy and significance of claims about the incompatibility incompatible. The incompatibility process are defined by Zadeh, converge to vague statements (fuzzy) and fuzzy logic tries to establish a formalism for uncertainty and ambiguity specific natural language. And this new language, to shape the natural language, created a new type of mathematical model. Reporting on fuzzy logic is always time for a decision-making process; values are associated with membership in the [0.1]. Adoption and complex decisions based education becomes possible through the various methods and techniques that facilitate decision-making choice optimal variant, each of which is falling in a given decision-making model. Depending on volume, structure and quality of information they receive may be making Models: Deterministic, centered on information with high precision, complete indeterminists and probabilistic. Using these methods and techniques result in a decision to increase the degree of rigor and, implicitly, the effectiveness of decisions, varied in relation to the typology of decision-making situations involved. Correspondence between the quality of information - as expressed by the parameters of accuracy and completeness - and decision-making models (economic or economic-mathematical) was suggestive graphic stressed by some experts as Fig. 7:

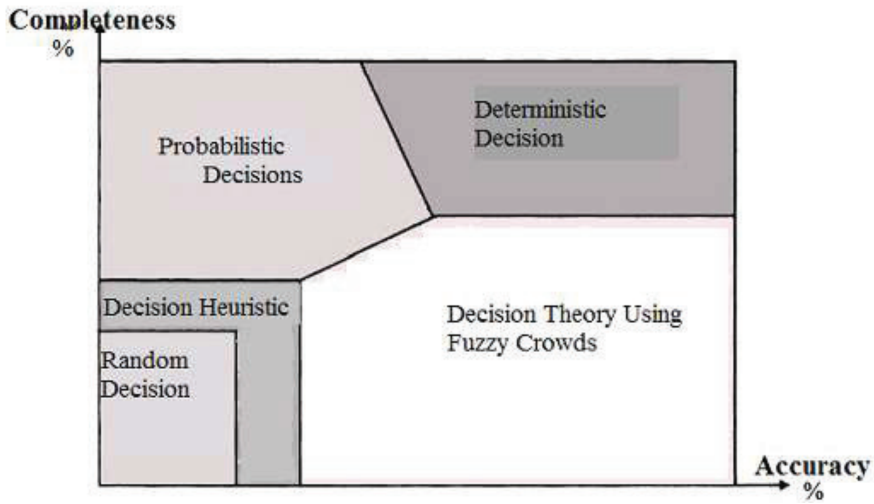

Fig. 7: Completeness and accuracy in decision-making models

The examination of the graph that the two characteristics of information (and not only them) determining one or other methods of decision theory that management put them in practice disposal economy. Thus, if a low degree of accuracy and completeness corresponds Heuristic and random decisions based on intuition, reasoning and decision-experience, as information is more complete and more precise, the possibility of using methods and techniques focused on algorithmic procedures, which allow adoption of decisions with high background.

Models based on theory crowds vague (fuzzy), the information transmitted for the substantiation of the decisions are highly completeness, but least accurate, probabilistic models used in the existence of accurate information, but less complete, and Deterministic models are in our opinion, the most significant.

Besides these there are many methods and techniques, among which we mention methods of operational research, provided by mathematical programming, inventory theory, graphs theory, theory of firms' waiting game theory, simulation decision theory equipment that can be used with successful business practice.

Methods and techniques to group decision making, depending on the type of decision-making situations involved in 3 categories:

- Methods and techniques to optimize decisions, conditions certainty: Electric, the global utility, the additive, Deutch's algorithm-Martin, decision table, decision simulation;
- Methods and techniques for optimizing decisions under uncertainty: technical optimistic, pessimistic technique (A. Wald), the technique optimum (C. Hurwicz), the technique of proportionality (Bayes-Laplace) technique to minimize regrets (L. Savage);
- Methods and techniques for optimizing decisions in conditions of risk : decision tree, the mathematical expectancy.

Techniques for optimizing decisions under uncertainty, which included those related to fuzzy crowds through their Heuristic generates obtain different optimal choices. Emphasize that some experts in management recommended that the use of one or another of these techniques to consider the habit decision to operate with a technical manager and psychology and, especially, the economic-financial company. The firm has an economic and financial situation better, so it is possible to assume risks higher, so much more optimistic view on the probability of obtaining superior results for resources is that there is compensation in case of failure.

5. Average operators

In a decision process, the idea of compromise corresponds to an overall view assessment as an action between the worst and the best evaluation. This occurs in the presence of conflicting objectives, where compensation is allowed between proper compatibility. Operators' average achieved compromise between objectives, allowing a positive compensation between their assessments.

Definition 9: An average operator M is a function

$$M: [0, 1] \times [0, 1] \rightarrow [0, 1]$$

Satisfying the following properties:

M1. M (x, x) = x, x [0.1]. *(Idempotenţă)*
M2. M (x, y) = M (y, x) x [0.1]. *(Switching)*
M3. M (0.0) = 0, M (1.1) = 1 *(Extreme conditions)*
M4. M (x, y) ≤ M (x ', y') if x ≤ x '≤ y and y' *(Sameness)*
M5. M is continuous.

If M is a mean operator, then
min (x, y) ≤ M (x, y) ≤ max (x, y), x ε [0.1]
In fact, the monotony idempotenţa and that of M
min (x, y) = M (min (x, y), min (x, y)) ≤ M (x, y) and
M (x, y) ≤ M (max (x, y), max (x, y)) = max (x, y)
An important family of operators is the average time to the quasi-arithmetic:

$M(a_1, a2... an) = f^{-1}\left(\frac{1}{n}\sum_{i=1}^{n} f(a_i)\right)$

Kolmogorov characterized this family as all the class average and decomposable.

Examples: quasi-arithmetic average of a1 and a2 is defined as:

$$M(a_1, a_2) = f^{-1}\left(\frac{f(a1)+f(a2)}{2}\right)$$

The uses of average operators are:

- *Media harmonic:* $\frac{2xy}{x+y}$
- *Geometric Average:* $\sqrt{xy}$
- *Media arithmetic:* $\frac{x+y}{2}$
- *Duala geometric average:* $1-\sqrt{(1-x)(1-y)}$
- *Duala average harmonic*: $\frac{x+y-2xy}{2-x-y}$
- *Median:* $med(x,y,\alpha) = \begin{cases} y, & if\ x \le y \le \alpha \\ \alpha, & if\ x \le \alpha \le y \\ x, & if\ \alpha \le x \le y \end{cases}$
- *P-average general:* $[(x^p+y^p)/2]^{1/p}$

The aggregation of information occurs in many applications related to the development of intelligent systems: neural networks, fuzzy logic controllers with, vision systems, expert systems, multi-criteria decisions, etc.

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