THE FUZZY THEORY AND LOGIC - BASIC ELEMENTS AND GENERAL FRAMEWORK

NOȚIUNI GENERALE PRIVIND TEORIA ŞI LOGICA FUZZY

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Abstract: *The paper presents a general framework about fuzzy theory and logic, more exactly it analyses the history and the development of this decisional making process.*

Rezumat: *În această lucrare sunt prezentate generalitati privind teoria si logica fuzzy, mai exact, lucrarea analizează istoria elaborării si apariției acestui proces decizional.*

Key words**:** *decision making, uncertainty, fuzzy decision making process*
Cuvinte cheie: *luarea deciziilor, incertitudine, procesul de luare a deciziilor în condiții fuzzy*

INTRODUCTION

Decision making is a part of our everyday life. One of the major issue of the decision making process is that almost all the decisional problems have various atributes and criterias, which use to be multiple and usually are generating conflicts.

The decident has to make a selection, to show his option by building a top of preferences using in establishing them a lot of alternatives.

The main purpose of the decident is to make the right choice that means to choose the best alternative which will assure them the best results in their economical activity.

The fuzzy theory and method is a perfect instrument for modelling the uncertainty which use to appear from the mental phenomena which aren't unusual and stochastic.

The fuzzy theory and logic is used in the decison making process in elaborating multiatributive decisions.

MATERIALS AND METHODS

The formal development of set theory began in the late 19th century with the work of George Cantor (1845-1918), one of the most original mathematicians in history. Set theory has been used to establish the foundations of mathematics and modern methods of mathematical Prof. Cantor's sets are crisp. Each element under consideration either belongs to a set or it does not; hence there is a line drawn between the elements of the set and those which are not. The boundary of a set is rigid and well defined. However, things are rather fuzzy than crisp.

A paradox coming from ancient Greece has caused serious problems to logicians and mathematicians. Consider a heap of grains of sand. Take a grain and the heap is still there. Take another grain, and another grain, and continue the process. Eventually ten grains are left, then nine, and so on. When one grain is left, what happens with the heap? Is it still a heap? When the last grain is removed and there is nothing, does the heap cease to be a heap? There are many paradoxes of similar nature called "sorites." This word comes from "soros" which is the Greek word for heap. For instance let us apply the above procedure to the cash (say, one million) of a rich person. He spends one dollar and is still rich; then another dollar and so on. When one hundred dollars are left, what happens to his richness? When does that person cease to be rich? In the crisp set theory such dilemmas are solved by sort of appropriate assumptions or by decree. In the case of the heap a certain natural number n is to be selected; if the number of sand grains is > n, then the grains constitute a heap; n — 1 sand grains does not form a heap

anymore. This defies common sense. Also how to select the number n? Is it 100, 1000, or 1,000,000, or larger? Common sense hints that the concept *heap* is a *vague* one. Hence a tool that can deal with vagueness is necessary. The concept of fuzzy set, a generalization of Cantor's sets, is such a tool.

The following thoughts by BERTRAND RUSSELL (1923) are quoted very often: "All traditional logic habitually assumes that precise symbols are being employed. It is therefore not applicable to this terrestrial life, but only to an imagined celestial one. The law of excluded middle is true when precise symbols are employed but it is not true when symbols are vague, as, in fact, all symbols are." "All language is vague." "Vagueness, clearly, is a matter of degree."

An important step towards dealing with vagueness was made by the philosopher MAX BLACK (1937) who introduced the concept of vague set.

The concept of fuzziness was introduced first in the form of fuzzy sets by ZADEH (1965).

According to dictionaries (see for instance *Merriam-Webster's Collegiate Dictionary* and *The Heritage Illustrated Dictionary of the English Language)* and also use in everyday language the words *fuzzy, vague, ambiguous, uncertain, imprecise,* and their adverbs, are more or less closely related in terms of meaning. This statement is supported by the following brief explanations.

Fuzzy: not sharply focused, clearly reasoned or expressed; confused; lacking of clarity; blurred.

Vague: not clearly expressed, defined, or understood; not sharply outlined (hazy); lack of definite form.

Ambiguous: capable of being understood in two or more possible ways; doubtful or uncertain (synonym: vague).

Uncertain: not certain to occur; not clearly identified or denned; lack of sureness about something; lack of knowledge about an outcome or result.

Imprecise: not precise, inexact, and vague.

There are various opinions on the meaning of these words and their use and misuse in common language, philosophy, and in fuzzy logic. We leave it to philosophers and linguistics to debate and deliberate on the subject if they choose to do it. POPER (1979) for instance sounds quite discouraging: "One should never quarrel about words, and never get involved in questions of terminology. One should always keep away from discussing concepts. What we are really interested in, our real problems, are factual problems, or in other words, problems of theories and their truth." There is some truth in POPER although he goes to an extreme. We think it will be useful for the better understanding of this book to provide a clarification.

Fuzzy, adv. *fuzziness,* in fuzzy logic is associated with the concept, of graded membership which can be interpreted as degree of truth. The objects under study in fuzzy logic admit of degrees expressed by the membership functions of fuzzy sets.

Problems and events in reality involving components labeled as vague, ambiguous, uncertain, imprecise are considered in this book as fuzzy problems and events if graded membership is the tool for their description. In other words, when gradation is involved, vagueness, ambiguity, uncertainty, imprecision are included into the concept of fuzziness.

Beside the fundamental volume *Fuzzy Sets and Applications: Selected Papers by L.A. ZADEH* (1987), here we list several important books dealing with fuzzy sets and fuzzy logic used in this text: KAUFMANN (1975), DUBOIS and PRADE (1980), ZIMMERMANN (1984), KANDEL (1986), KLIR and FOLGER (1988), NOVAK (1989), TERANO, ASAI, SUGENO (1992).

Fascinating popular books on fuzzy logic are written by MCNEILL and FREIBERGER (1993) and KOSKO (1993).

The notion of fuzzy set is sometimes incorrectly considered as a type of probability. Although there arc similarities and links between fuzzy sets and probability, there are also substantial differences. For instance, *grade* or *degree of membership* is not a probabilistic concept.

The concept of fuzzy number was introduced after that of fuzzy set. Valuable contributions to fuzzy numbers were made by NAHMIAS (1977), DUBOIS and PRADE (1978), and KAUFMANN and GUPTA (1985) (see also G. BOJADZIEV and M. BOJADZIEV (1995)).

In many applications both fuzzy numbers and fuzzy sets can be used equally well although presentations with fuzzy numbers are somewhat simpler. For general studies and also for facilitating fuzzy logic, fuzzy set theory is very suitable tool.

Decision making is a process of problem solving which results in an action. It is a choice between various ways of getting an end accomplished. Decision making plays an important role in business, management, social and political science, engineering and computer science, biology, and medicine. It is a difficult process due to factors like incomplete and imprecise information, subjectivity, linguistics, which tend to be presented in real-life situations to lesser or greater degree. These factors indicate that a decision-making process takes place in a fuzzy environment.

The main objective is to consider two methods for decision making based on fuzzy sets and fuzzy logic. First to be introduced is the BELLMAN-ZADEH (1970) approach, according to which decision making is defined as intersection of goals and constraints described by fuzzy sets. The second approach for making decisions combines goals and constraints using fuzzy averaging. Applications are made to various real-life situations requiring selection or evaluation type decisions and to pricing models.

CONCLUSIONS

Fuzzy logic control methodology has been developed mainly for the needs of industrial engineering.

If trying to build conventional mathematical models, a task almost impossible when complex phenomenon are under study, the presented methodology creates fuzzy logic models reflecting a given situation in reality and provides solution leading to suggestion for action.

Complex systems involve various types of fuzziness and undoubtedly represent an enormous challenge to the modelers.

The classical control methodologies developed mainly for engineering are usually based on mathematical models of the objects to be controlled. Mathematical models simplify and conceptualize events in nature and human activities by employing various types of equations which must be solved. However, the use of mathematical models gives rise to the question how accurate they reflect reality. In complicated cases the construction of such models might be impossible. This is especially true for business, financial, and managerial systems which involve a great number of interacting factors, some of socio-psychological nature.

Fuzzy logic models employ fuzzy sets to handle and describe imprecise and complex phenomena and uses logic operations to arrive to conclusion.

Fuzzy sets (in particular fuzzy numbers) and fuzzy logic applied to control problems form a field of knowledge called *fuzzy logic control* (FLC). It deals with control problems in an environment of uncertainty and imprecision; it is very effective when high precision is not required and the control objects has variables available for measurement or estimation.

However in the real world it is difficult to determine what is meant by the best.

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