

## *INTRODUCTION*

## INTRODUCTION

Fuzzy set theory is a recently developed field of mathematics that introduces sets of objects whose boundaries are not sharply defined. Whereas in ordinary Boolean algebra an element is either contained or not contained in a given set, in fuzzy set theory the transition between membership and non-membership is gradual. The theory aims at modeling situations described in vague or imprecise terms, or situations that are too complex or ill-defined to be analyzed by conventional methods. The superiority of the human brain results from its capacity of handling fuzzy statements and decisions, by adding to logic parallel and simultaneous information sources and thinking processes, and by filtering and selecting only those that are useful and relevant to its purposes. The human brain has many more thinking processes available and has developed a far greater filtering capacity than the machine. A group of individuals is able to resolve the command "tall people in the back, short people in the front", a machine is not. Fuzzy set theory explicitly introduces vagueness in the reasoning, hoping to provide decision-making procedures that are closer to the way the human brain performs. Fuzzy set theory attempts to modelize imprecise expressions like "more or less young", "neither overweight nor underweight", "in the neighbourhood of", "in principle". In retreating from precision in the face of overpowering complexity, the theory explores the use of what might be called linguistic variables, that is, variables whose values are not numbers but words or sentences. In summary, fuzzy set theory endorses Bertrand Russell's opinion that "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 existence" and rejects Yves Le Dantec's aphorism "That only is science which deals with the measurable". Insurance executives and actuaries, much better trained to deal with

uncertainty than with vagueness, have often transformed imprecise statements into "all-or-nothing" rules. Hence there was necessity to apply the fuzzy theory in actuarial science and in insurance frame work.

In 1990 Lemaire [40] presented the basic concepts of fuzzy theory in an insurance frame work. He had used the fuzzy application developed then such as Game theory (Aubin (1981) [2], Butnariu (1978, 1980) [10, 11]), Economics (Chang (1977) [14], Chen (1980) [15]) and utility theory (Matheu Nicot (1986) [42]) for actuarial science. Following him there were many articles written on fuzzy insurance in the two decades.

The main aim of this thesis is to study the application of Fuzzy set theory and Fuzzy logic to insurance. The articles taken for the study are the following:

1. "Fuzzy insurance" by Jean Lemaire [40]
2. "The Application of Fuzzy sets to Group Health Underwriting" by Virginia R.Young [52]
3. "An overview of an insurance using fuzzy logic" by Arnold F. Sharpiro [1]

Chapter 1 deals with the insurance uses of fuzzy logic which starts with a schematic representation of fuzzy uses in insurance. Fuzzy sets describe collections of objects whose boundaries are not precisely defined. Indeed, a fuzzy set is a mapping  $f$ , from the universe of discourse,  $X$ , to the unit interval  $I = [0, 1]$ . The value  $f(x)$  represents the degree, to which  $x$  is a member of the fuzzy set given by  $f$ . In section 1.1, the insurance application area like classification, underwriting, projected liabilities, ratemaking and pricing, and asset allocations and investments are described briefly. In section 1.2 Linguistic variables are defined, the linguistic values are interpreted as a label of fuzzy subset and presented an overview of some insurance applications of linguistic variables and fuzzy set theory.

Section 1.3 deals with fuzzy number, fuzzy arithmetic and their applications to compute fuzzy premium for pure endowment policy. In Section 1.4 the fuzzy inference system which is a methodology for applying fuzzy logic and its applications are discussed. In section 1.5 fuzzy clustering, which is used to cluster the data and its application in insurance area like estimating cluster, risk classification in both life and non life insurance, is discussed. Section 1.6 deals with fuzzy programming and its application in insurance area like asset allocation insurance pricing. In section 1.7 Fuzzy regressions and its applications are discussed. Section 1.8 deals with soft computing and its applications.

Chapter 2 is a study of the article “Fuzzy insurance” by J. Lemaire [40]. In this chapter the basic concepts of the theory in an insurance framework is presented. Fuzzy logic is applied to provide a flexible definition of a “preferred policy holder” in life insurance. Next fuzzy decision-making procedures are illustrated by a reinsurance application, and theory of fuzzy numbers is extended to define fuzzy insurance premiums. In section 2.1 three problems are introduced in the insurance theory as

Problem 1 - Definition of the preferred policy holder in life insurance.

Problem 2 - Selection of an optimal excess of retention.

Problem 3 - Computation of the fuzzy premium of a pure endowment policy.

In section 2.2 Fuzzy set approach is used for the problem 2.1(a) and constructing decision rules using operators and obtained a better model of the problem. In section 2.3 Fuzzy set approach is used for the problem 2.1(b) to characterize retention of loss reinsurance program to construct decision rules using operators and obtain a better model of the problem. Section 2.4 deals with the

application of Fuzzy arithmetic to problem 2.1(c) which is straight forward generalization of BUCKLEY (1987) [9] to an insurance problem.

Chapter 3 is a study of the article “The application of Fuzzy sets to group Health Underwriting” by Virginia R. young [52]. To model the selection process in group Health insurance, the Fuzzy set theory is used in this chapter. In section 3.1 the underwriting a group of employees covered by a single plan of health insurance is examined. In section 3.2 the work with single plan is extended to the group selection in a multichoice environment since more employees offer multiple plans to their employees, an underwriting scheme for such situations becomes important.