Chapter 62
Applying Fuzzy Logic and Fuzzy Methods to Marketing

Laurent Donzé
University of Fribourg, Switzerland

Andreas Meier
University of Fribourg, Switzerland

ABSTRACT

Marketing deals with identifying and meeting the needs of customers. It is therefore both an art and a science. To bridge the gap between art and science, soft computing, or computing with words, could be an option. This chapter introduces fundamental concepts such as fuzzy sets, fuzzy logic, and computing with linguistic variables and terms. This set of fuzzy methods can be applied in marketing and customer relationship management. In the conclusion, future research directions are given for applying fuzzy logic to marketing and customer relationship management.

BRIDGING ART AND SCIENCE

Marketing is "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large" (see American Marketing Association, 2011). Kotler and Keller (2006, p. 6) define marketing as "a social process by which individuals and groups obtain what they need and want through creating, offering, and freely exchanging products and services of value with others". Marketing therefore deals with identifying and meeting human and social needs.

Marketing is both an art and a science. It is the art and the knowledge to manage customer relationships, extend customer life cycles, tailor the marketing mix (product, price, place, promotion), and optimize customer equity (Blattberg et al., 2001). Robert Lauterborn (1990, p. 26) suggested connecting the company's four P's with the customers' four C's, product with customer solution, price with customer cost, place with convenience, and promotion with communication. In electronic business and commerce especially, winning companies will be those that meet customers' needs economically and with effective communication (Meier & Stormer, 2009)

Today, with Social Web and Semantic Web opportunities (Hitzler et al., 2010), companies and marketers are searching for a holistic marketing concept. This must be based on the design and implementation of marketing programs, processes, and activities that recognize the needs of online customers. The dictum that "everything matters" means that marketing and customer relationship management have to cope with complexities. Fuzzy Logic or fuzzy thinking, first established by Lotfi Zadeh's work on fuzzy sets (Zadeh, 1965), suggests that binary thought is a way of simplifying a complex world and is in most cases not adequate. Simplification distorts reality. In Zadeh's words: "As the complexity of a system increases, our ability to make precise and significant statements about its behaviour diminishes until a threshold is reached beyond which precision and significance become mutually exclusive characteristics" (Kosko, 1994, p. 148).

Fuzzy logic is an extension of classical logic with only two truth values, 'true' and 'false'. It can be considered as an infinite value logic covering the whole interval from true (1) to false (0). Fuzzy logic focuses on linguistic variables in natural languages and provides a foundation for approximate reasoning with imprecise propositions. It reflects both the rightness and vagueness of human thinking.

A holistic marketing or customer relationship management concept has to take into account approximate reasoning (Bojadziev & Bojadziev, 1997; Grint, 1997). The behavior of customers, customer communication, and customer relationships are neither 'black' nor 'white' but there are a variety of grey scales with which to differentiate marketing programs and, hopefully, to improve customer equity.

This chapter is organized as follows. First, an introduction to fuzzy and crisp sets is given followed by a discussion of fuzzy logic and linguistic variables. An overview of possible applications in marketing and customer relationship management will then be provided. Finally, future trends and research issues are outlined.

CRISP SETS VS. FUZZY SETS

The concept of a set or a collection of objects is common in marketing and relationship management. For instance, all customers with their properties, such as name, age, address, and customer value are stored in the customer database or data warehouse. The objects in the set are called the elements of the set. Traditional data sets are also called ordinary or crisp sets in order to distinguish them from fuzzy sets.

An important notion in set theory is that of membership. If an element x belongs to a set A then $x \in A$, otherwise $x \notin A$. For each element x of a set A there are only two possibilities: either x belongs to A or it does not. The membership rule that characterizes the elements of a set A can be described by the characteristic function. The characteristic function χ takes only two values 1 and 0 or 'true' and 'false'. More precisely: if X is the universal set (universe of discourse) and A is a subset $A \subset X$ then the characteristic function χ of a set A indicates whether or not x belongs to A, i.e., $\chi_A : X \rightarrow \{0,1\}$. In other words every crisp set is uniquely defined by its characteristic function.

In Figure 1, the classical set *Teenager* is described by its characteristic function. A teenager is defined by her age: if x has an age between 13 (thirteen) and 19 (nineteen) then x belongs to the class of teenagers, otherwise it does not. The characteristic function of the set *Teenager* is:

$$\chi_{\text{Teenager}}(x) = \begin{cases} 1 & for \quad 13 \leq x \leq 19 \\ 0 & for \quad x < 13 \quad and \quad x > 19 \end{cases}$$

For marketers the description of teenagers as a crisp set is not satisfactory. For instance, a young person waiting for his or her thirteenth birthday a few seconds before midnight is not yet a teenager, though a few seconds later she moves abruptly into the teenager group. Crisp sets do not allow gradation: parents or relatives of a teenager see the teenager gradually growing into

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