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Multi-criteria house buying decision making based on type-2 fuzzy sets

Kamala Aliyeva*

State Oil Academy, Department of Computer-Aided Control Systems, 20 Azadlig Ave., AZ1010, Baku, Azerbaijan

Abstract

Usually, when we take the decision related to house solution we deal with uncertain, vague preferences. In majority of existing works authors consider linguistic performance ratings in terms of Type-1 fuzzy numbers. In a situation with higher level of uncertainty, the use Type-2 fuzzy sets is more suitable. In this paper we apply Type-2 fuzzy sets-based approach to house selection problem.

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Keywords: Type-2 fuzzy sets; Type-1 fuzzy numbers; multiple attribute decision making.

1. Introduction

Decision making is a main human activity in business, service, manufacturing, product selection, etc. Technique for order preference by similarity to an ideal solution (TOPSIS), known as a classical multiple attribute decision making (MADM) method, has been developed by Hwang and Yoon (1981) for solving the MADM problem. It is based on the idea that the chosen alternative should have the shortest distance from the positive ideal solution, and, on the other side, the farthest distance from the negative ideal solution. Traditionally, in existing works on decision making they assumed that all the decision information is expressed by the numerical values (J. S. Dyer et al, (1992)). These works are often criticized due to the reasons that they cannot adequately handle uncertainty and imprecision

* Corresponding author. Tel.:+994 598 45 09; fax: +994 598 45 09.
E-mail address: kamalann64@gmail.com

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associated with the alternatives. In many cases preferences of a decision maker is uncertain and vague due to incomplete information and uncertainty of decision environment. In such cases the classical decision making methods are not useful for such problems. Some attempts have been carried out to handle these problems by extending classical multi-criteria decision making problem into the fuzzy one (P. Sevastjanov and P. Figat(2007), S. P.Wan. (2013), Z. P. Tian(2015), Y.Wang and T. M. S. Elhag(2006), Z. Zhang et al.(2014)). Unfortunately, fuzzy type-1 extensions of the classical multi-criteria techniques are not useful for decision problems characterized with high level of uncertainly. Taking this issue into account Wang et al. (2014) extend fuzzy Type-1 MCDM problems to fuzzy Type-2 MCDM problems.

In this paper we consider application of fuzzy Type-2 MCDM approach to homes buying decision making problem. The test of the paper is organized as follows. In Section 2 preliminary notation about fuzzy Type-1 and fuzzy Type-2 sets and numbers, expected value of a fuzzy number, operation on fuzzy Type-2 fuzzy numbers are presented. The statement of the fuzzy Type-2 multi-criteria decision problem of house selection is described in Section 3. Model of the optimization of fuzzy Type-2 MCDM for house buying is designed in Section 4. In Section 5 solution of MCDM problem is given. Section 6 concludes the paper.

2. Preliminaries

Definition 1. (L. A. Zadeh (1965))**.** A Type-1 fuzzy set on the universe of discourse X is completely characterized by crisply defined membership function $\mu_A(x)$ and represented as follows:

$$A = \{ (x, \mu_A(x)) \mid \forall_x \in X, \mu_A(x) \in [0,1]\} \quad (1)$$

Definition 2. (Mendel and John (2002)). A Type-2 fuzzy set A on the universe of discourse X can be characterized by its fuzzy membership function $\mu_A(x,u)$

$$A = \{((x,u,\mu_A(x,u)) \mid \forall_x \in X, \forall_u \in J_x \subseteq [0,1]\} \quad (2)$$

where $0 \le \mu_A(x,u) \le 1$, the subinterval J_x in the interval [0; 1] is called the primary membership of x, and $\mu_A(x,u)$ is called the secondary membership function that defines the possibilities of the primary membership.

Definition 3. (Mendel (2006)). An interval Type-2 fuzzy sets (IT2FS) A on the universe of discourse X is characterized by its upper A and lower membership function A

$$A_a = \{(x,U) \mid \mu_A(x,U) \ge a, x \in X, U \in J_x\} \quad (3)$$

Definition 4. (Wang et al. (2014)). The computational model of IT2TFNs. We now extend the computational model of T1TFNs to that of IT2TFNs.

A_1 and A_2 are non-negative IT2TFNs. Addition of them is defined as follows:

$$A_1 + A_2 = \langle A_1^U + A_2^U ; A_1^L + A_2^L \rangle$$

$$= a_{11}^U + a_{21}^U, a_{12}^U + a_{22}^U, a_{13}^U + a_{23}^U, a_{14}^U + a_{24}^U, \frac{h(A_1^U)\cdot\|A_1^U\| + h(A_2^U)\cdot\|A_2^U\|}{\|A_1^U\|\cdot\|A_2^U\|};\rangle \quad (4)$$

$$a_{11}^L + a_{21}^L, a_{12}^L + a_{22}^L, a_{13}^L + a_{23}^L, a_{14}^L + a_{24}^L, \frac{h(A_1^L)\cdot\|A_1^L\| + h(A_2^L)\cdot\|A_2^L\|}{\|A_1^L\|\cdot\|A_2^L\|};\rangle \quad (5)$$

where