Chapter 5
Source and m-Source Distances of Fuzzy Numbers and their Properties

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ABSTRACT

In many applications of fuzzy logic and fuzzy mathematics we need (or it is better) to work with the same fuzzy numbers. In this chapter we present source distance and $m$ - source distance between two fuzzy numbers. Also some properties of parametric $m$ -degree polynomial approximation operator of fuzzy numbers. Numerical examples are solved related to the present analysis.

1. INTRODUCTION

In some applications of fuzzy logic, we need to compare two fuzzy numbers. In order to make the comparison easier we try to find some quantities related to the fuzzy numbers to use in comparison.

In (Abbasbandy & Amirfakhrian, 2006(1)) and (Abbasbandy & Amirfakhrian, 2006(2)) two nearest trapezoidal form of a fuzzy number by using a parametric form are introduced. Abbasbandy and Asadi (2004) have introduced the nearest trapezoidal fuzzy number to a fuzzy quantity by an optimization problem. Delgado, Vila and Voxman (1998), introduced a canonical representation of fuzzy numbers. A parameterized approximation of a fuzzy number with a minimum variance weighting function presented by Liua & Lin, (2007). A weighted triangular approximation of a fuzzy number is introduced in (Zeng & Li, 2007). Yeh (2007) and (2008) presented trapezoidal and triangular approximations. In (Ban, 2008) and (Ban, 2009) two types of approximation of fuzzy numbers are presented. In all of the mentioned...
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literatures the authors tried to approximate a fuzzy number by a simpler one.

Also there are some distances defined by authors to compare fuzzy numbers. Voxman (1998), Yao & Wu, (2000), Ma, Kandel & Friedman, (2000) and Ma, Kandel & Friedman, (2002) introduced some distances which are examples of these comparisons.

Obviously, if we use a defuzzification rule which replaces a fuzzy set by a single number, we generally lose too many important information. Also, an interval approximation is considered for fuzzy numbers in (Grzegorzewski, 2002), where a fuzzy computation problem is converted into interval arithmetic problem. But, in this case, we lose the fuzzy central concept. Even in some works such as (Abbasbandy & Asadi, 2004), (Ma, Kandel & Friedman, 2000) and (Ma, Kandel & Friedman, 2002) and (Zeng & Li, 2007), authors solve an optimization problem to obtain the nearest triangular or trapezoidal fuzzy number which is the nearest approximation of a fuzzy number with respect to source distance. In Section 4, $m$ – source distance and some useful lemmas, theorems and some examples are given. Some properties of $m$ – source distance are checked in Section 5. In Sections 6 and 7, two application of the source distance together with examples are given.

In this chapter we introduce source and $m$-source distances between two fuzzy numbers and we present the properties of them. Also some application of these distances are given.

The structure of this chapter is as follows. In Section 2, we introduce the some basic concepts of our work. In Section 3, we represent the source distance and near approximation of a fuzzy number which is the nearest approximation of a fuzzy number with respect to source distance. In Section 4, $m$ – source distance and some useful lemmas, theorems and some examples are given. Some properties of $m$ – source distance are checked in Section 5. In Sections 6 and 7, two application of the source distance together with examples are given.

2. PRELIMINARIES

Let $F$ be the set of all normal and convex fuzzy numbers on the real line (Zimmermann, 1991). A fuzzy number in $LR$ form is introduced by (Dubois & Prade, 1978) and (Dubois & Prade, 1980).

Definition 2.1: (Abbasbandy & Amirfakhrian, 2006(1)) A generalized $LR$ fuzzy number $\tilde{v}$ with the membership function .. can be defined as:

$$
\mu_{\tilde{v}}(x) = \begin{cases} 
 l_\tilde{v}(x), & a \leq x \leq b, \\
 1, & b \leq x \leq c, \\
 r_\tilde{v}(x), & c \leq x \leq d, \\
 0, & \text{otherwise},
\end{cases}
$$

where $l_\tilde{v}(x)$ is the left membership function which is an increasing function on $[a,b]$ and $r_\tilde{v}(x)$ is the right membership function that is a decreasing function on $[c,d]$ such that $l_\tilde{v}(a) = r_\tilde{v}(d) = 0$ and $l_\tilde{v}(b) = r_\tilde{v}(c) = 1$. In addition, if $l_\tilde{v}(x)$ and $r_\tilde{v}(x)$
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