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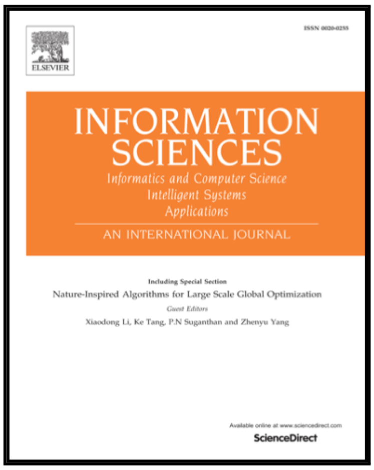

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Shexiang Hai, Zengtai Gong, Hongxia Li

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Generalized differentiability for n-dimensional fuzzy-number-valued functions and fuzzy optimization *

Shexiang Hai[a], Zengtai Gong[b†], Hongxia Li[c]
[a]School of Science, Lanzhou University of Technology, Lanzhou, 730050, P.R. China
[b]College of Mathematics and Statistics, Northwest Normal University, Lanzhou, 730070, P.R.China
[c]College of Mathematics and Statistics, Longdong University, Qingyang, 745000, Gansu, P.R.China

Abstract In this paper, we present a characteristic theorem for the generalized difference concept of n-dimensional fuzzy-numbers by means of support functions. The concepts of differentiability for n-dimensional fuzzy-number-valued functions are presented and discussed using the new generalized difference. The relationships of g-differentiability, s-differentiability, and l-differentiability are characterized. Furthermore, optimization problems with s-convex and s-differentiable fuzzy-number-valued functions are described.

Keywords : Generalized difference; Fuzzy numbers; Generalized differentiability; Fuzzy-number-valued functions

1 Introduction

Since the concept and operations of fuzzy set were introduced by Zadeh [24], many studies have focused on the theoretical aspects and applications of fuzzy sets. Soon after, Zadeh proposed the notion of fuzzy numbers in [25, 26, 27]. Since then, fuzzy numbers have been extensively investigated by many authors. Fuzzy numbers are a powerful tool for modeling uncertainty and for processing vague or subjective information in mathematical models. Their directions of development are diverse and have been applied to the very varied practical problems, for instance, in the fuzzy optimization [10, 18], fuzzy transportation problems [4], fuzzy differential equation [5, 12] and so on.

As part of the development of theories about fuzzy numbers and its applications, researchers began to study the differentiability and integrability of fuzzy mappings. Initially, the derivative for fuzzy mappings from an open subset of a normed space into the n-dimension fuzzy number space E^n was developed by Puri and Ralescu [17], which generalized and extended the concept of Hukuhara differentiability for set-valued mappings. In 1987, Kaleva [11] discussed the G-derivative, and obtained a sufficient condition for the H-differentiability of fuzzy mappings from $[a, b]$ into E^n as well as a necessary condition for the H-differentiability of fuzzy mappings from $[a, b]$ into E^1 was get. In 2003, Wang and Wu [22] proposed the directional derivative, differential and sub-differential of fuzzy mappings from R^n into E^1 using the Hukuhara difference. However, the Hukuhara difference between two fuzzy numbers exists only under very restrictive conditions [11] and the H-difference of two fuzzy numbers does not always exist [19, 20]. The g-difference proposed in [6, 20] overcomes these shortcomings of the above discussed concepts, and the g-difference of two fuzzy numbers always exists. Based on the novel generalizations of the Hukuhara difference for fuzzy sets, Bede [1] introduced and studied new generalized differentiability concepts for fuzzy-valued functions in 2013.

Motivated both by [1] and the importance of the concept of differentiability for fuzzy mappings, we introduce the concept of g-differentiability for n-dimensional fuzzy-number-valued functions, this model of g-differentiability is based on the novel generalizations of the Hukuhara difference for fuzzy sets as proposed in [20]. We also consider

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†Corresponding author. Tel.: +86 931 7971845. E-mail address: zt-gong@163.com, gongzt@nwnu.edu.cn (Z. Gong).

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