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New centroid index for ordering fuzzy numbers

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Abstract— Ranking fuzzy numbers is an important tool in decision process. In fuzzy decision analysis, fuzzy quantities are used to describe the performance of alternative in modeling a real-world problem. Most of the ranking procedures proposed so far in literature cannot discriminate fuzzy quantities and some are counterintuitive. As fuzzy numbers are represented by possibility distributions, they may overlap with each other, and hence it is not possible to order them. It is true that fuzzy numbers are frequently partial order and cannot be compared like real numbers which can be linearly ordered. So far, more than 100 fuzzy ranking indices have been proposed since 1976 while the theory of fuzzy sets was first introduced by Zadeh. The most commonly used approached for ranking fuzzy numbers is ranking indices based on centroid of fuzzy numbers. Ever since Yager presented the centroid concept in the ranking techniques using the centroid concept have been proposed and investigated. In a paper by Cheng, a centroid-based distance method presented. The method utilized the Euclidean distances from the origin to the centroid point of each fuzzy numbers to compare and rank the fuzzy numbers. Chu and Tsao found that the distance method could not rank fuzzy numbers correctly if they are negative and therefore, suggested using the area between centroid point and the origin to rank fuzzy numbers. Deng et al. utilized the centroid point of a fuzzy number and presented a new area method to rank fuzzy numbers with the radius of gyration (ROG) points to overcome the drawback of the Cheng's distance method and Tsao's area method when some fuzzy numbers have the same centroid point. However, ROG method cannot rank negative fuzzy numbers. Recently, Wang et al. pointed out that the centroid point formulas for fuzzy numbers provided by Cheng are incorrect and have led to some misapplication such as by Chu and Tsao, Pan and Yeh and Deng et al.. They presented the correct centroid formulae for fuzzy numbers and justified them from the viewpoint of analytical geometry. Nevertheless, the main problem, about ranking fuzzy numbers methods, which used the centroid point, was reminded. In 2008, Wang and Lee revised Chu and Tsao's method and suggested a new approach for ranking fuzzy numbers based on Chu and Tsao's method in away to similar original point. However, there is a shortcoming in some situations. In 2011, Abbasbandy and Hajjari improved cheng's distance method. Afterward, Pani Bushan Rao et al. presented a new method for ranking fuzzy numbers based on the circumcenter of centroids and used an index of optimism to reflect the decision maker's optimistic attitude and also an index of modality that represented the neutrality of the decision maker. However, there are some weaknesses associated with these indices. This paper proposes a new centroid index ranking method that is capable of effectively ranking various

types of fuzzy numbers. The contents herein present several comparative examples demonstrating the usage and advantages of the proposed centroid index ranking method for fuzzy numbers.

Index Terms— Centroid points, Comparison, Decision-making, Defuzzification, Fuzzy numbers, Ordering;