

Fuzzy quantifiers in sensitivity analysis of OWA operator

Mahdi Zarghami ^{a,*}, Ferenc Szidarovszky ^b

^a Faculty of Civil Engineering, Tabriz University, Tabriz 51664, Iran

^b Systems and Industrial Engineering Department, University of Arizona, Tucson, AZ 85721-0020, USA

Received 2 March 2007; received in revised form 20 September 2007; accepted 26 November 2007

Available online 4 December 2007

Abstract

The efficient use of the Ordered Weighted Averaging (OWA) operator in decision making problems depends on the choice of the order weights. Using fuzzy quantifiers is one of the most popular methods to obtain them. In this study, a new method will be introduced for determining the order weights from the quantifiers, which is especially useful in the case of unimodal quantifiers. The new method is generic and has better computational efficiency in comparison to the previously applied methods. In addition, a new measure for sensitivity analysis on the outputs of OWA operator will be introduced. The theoretical results will be illustrated by a Ph.D. student selection problem discussed earlier in the literature.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: OWA operator; Fuzzy quantifiers; Unimodal quantifiers; Sensitivity analysis

1. Introduction

The model of Ordered Weighted Averaging (OWA) operator has been in focus of research in the last two decades. OWA as an aggregation operator was initiated by Yager (1988) and has been applied in many fields including Multi Criteria Decision Making (MCDM). An n -dimensional OWA operator is a mapping $F: I^n \mapsto I$ defined as:

$$F(a_1, a_2, \dots, a_n) = \sum_{j=1}^n w_j b_j = w_1 b_1 + w_2 b_2 + \dots + w_n b_n, \quad (1)$$

where b_j is the j th largest element in the set of inputs $\{a_1, a_2, \dots, a_n\}$, n being the number of the inputs and $\{w_1, w_2, \dots, w_n\}$ are the order weights. It is usually assumed that $w_j \geq 0$ for all j , and $\sum_{j=1}^n w_j = 1$. Vector $\underline{w} = (w_1, w_2, \dots, w_n)$ is called the order weights vector. F is the combined goodness measure of a decision alternative if the inputs are its evaluations with respect to n criteria. Any alternative with the highest F value

* Corresponding author. Tel.: +98 914 317 7721; fax: +98 411 334 4287.

E-mail address: mzarghami@tabrizu.ac.ir (M. Zarghami).

will be considered the most preferred decision. Note that the components of the input vector have been ordered before multiplying them by the order weights.

The OWA operator encompasses several operators, since it can implement different aggregation rules by changing the order weights. Indeed the OWA category of operators allows easy adjustment of the ANDness and ORness degrees embedded in the aggregation. This scheme is improved newly by the Unified AND–OR operator introduced by Khan and Engelbrecht (2007).

The order weights of OWA depend on the optimism degree (also known as the ORness degree) of the decision maker (DM). The greater the weights at the beginning of the weight vector, the higher the optimism degree (risk acceptance). Yager (1988) has defined the optimism degree, θ , as:

$$\theta = \frac{1}{n-1} \sum_{j=1}^n (n-j)w_j. \quad (2)$$

The well-known methods to obtain the OWA weights are listed in Table 1. The main conceptual difference among these methods is the way how they reflect the preferences of the DM (e.g. to be risk prone or risk averse).

Some of the methods listed in Table 1 are already compared in the literature. Zarghami, Ardakanian, and Szidarovszky (2007) showed the different behavior of fuzzy linguistic quantifiers and the minimal variability method. Wang, Luo, and Liu (2007) have compared the weights obtained by the maximum entropy, minimal variability, minimax disparity, least-squares deviation and χ^2 models by a numerical example. Liu (2007) showed the equivalence of the solutions of the minimax disparity approach and the minimal variability method.

This paper discusses the method of fuzzy quantifiers and then will apply it to the sensitivity analysis of the OWA operator. Due to the drawbacks of the existing methods, we will introduce a new measure to obtain the order weights of any type of quantifiers.

Sensitivity analysis is an important tool to gain deeper insight into the behavior of the mathematical models and their solutions. A comprehensive review of the sensitivity analysis for MCDM models can be found in the literature (e.g. Triantaphyllou & Sanchez, 1997). Torra (2001) analyzed the sensitivity of the OWA operator concerning the weights of the criteria and the evaluations of the alternatives. Wang and Lin (2003) analyzed

Table 1
Major methods to obtain the OWA weights

Method	Approach	Reference
Fuzzy linguistic quantifiers	Using the fuzzy linguistic quantifiers to characterize the aggregation inputs	Yager (1988)
Maximum entropy	Maximizing the entropy measure of Shannon (1948) for the order weights for a given ORness degree	O'Hagan (1988)
S-OWA	Defining two specific equations for OR-like and AND-like OWA operators	Yager (1993)
Neat OWA	Using the BADD (BASic Defuzzification Distribution transformation) OWA operator in which the weights depend on the inputs and the results are neat OWA	Yager (1993) and Yager and Filev (1994)
Learning method	Obtaining the weights by minimizing the distance of outputs of OWA operator from the real data	Filev and Yager (1998)
Exponential OWA	Defining two specific graphs to obtain the weights for optimistic and pessimistic OWA operators	Filev and Yager (1998)
Minimal variability	Minimizing the variance of the weights for a given ORness degree	Fullér and Majlender (2003)
Minimax disparity	Minimizing the maximum difference between any two adjacent weights for a given ORness degree	Wang and Parkan (2005) and Amin and Emrouznejad (2006)
Least squares deviation and χ^2 models	Producing as equally important OWA operator weights as possible for a given ORness degree	Wang et al. (2007)
Gaussian method	Obtaining the weights by the Normal distribution	Xu (2005) and Yager (2007)

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات