A New Entropy-Based Approach to Determine the Weights of Decision Makers for Each Criterion With Crisp and Interval Data in Group Decision Making Under Multiple Attribute

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ABSTRACT

The aim of this article is to develop a modified version of the original entropy approach to determine weights of decision makers (DMs) in multi-attribute group decision making (MAGDM) contexts with both crisp and interval data, in which the weights of experts (or DMs) are derived from the decision matrices and DMs have different weights for different criteria. In the proposed method, the experts’ weight for each criterion depends on the uncertainty measure of DMs comparisons. In other words, the DMs who give less uncertainty judgments (or less entropy measures), will be evaluated as more importance, and vice-versa. Finally, a numerical example is given to demonstrate the feasibility of the developed method.

KEYWORDS
Crisp and Interval Data, DMs Weights, Entropy, MAGDM

1. INTRODUCTION

Due to the ever-increasing complexity of socioeconomic environment, it is very difficult for only one Decision Maker (DM) to consider all the important aspects of a problem. Thus, most decisions in an organization, whether public or private, are made by a group of people (Azadfallah, 2016). Azam et al. (2017) believe that, along with Operations Research (OR) techniques it may also deal with intricate problems to find appropriate solutions. Hence, in recent years, multi-criteria evaluation methods have been widely used in solving both theoretical and practical problems (Zavadskas et al., 2010). Multi-Attribute Decision Making (MADM) [also often called Multi-Criteria Decision Making or MCDM], is an important part of modern decision science, which contains multiple decision attributes and multiple decision alternatives. The aim is to help the decision maker take all important objective and subjective criteria/ attributes of the problem into consideration using a more explicit, rational and efficient decision process (Yue, 2012a). MCDM (or MADM) is related to the choice of the best solution from a set of alternatives in
the presence of multiple conflicting criteria (Felfel et al., 2017). Essentially, MADM models are selector models that are used for evaluating, ranking, and selecting the most appropriate alternative from among several alternatives (Azadfallah, 2017). MADM mainly consists of the following two parts (Xu, 2012): 1. Collect decision information, and 2. Aggregate the decision information through some proper approaches and then rank and select the given alternatives. A MADM problem with m alternatives and n attributes can be expressed in matrix format as follows (Yue, 2013a):

\[
X_k = (x_{ij})_{m,n} = \begin{bmatrix}
U_1 & U_2 & \cdots & U_n \\
A_1 & x_{11} & x_{12} & \cdots & x_{1n} \\
A_2 & x_{21} & x_{22} & \cdots & x_{2n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
A_m & x_{m1} & x_{m2} & \cdots & x_{mn}
\end{bmatrix}
\]

(1)

\[W = (w_1, w_2, \ldots, w_n)\]

where, \(A_1, A_2, \ldots, A_m\) are feasible alternatives, \(U_1, U_2, \ldots, U_n\) are evaluation attributes, \(x_{ij}\) is the performance rating of alternative \(A_i\) under attribute \(U_j\), and \(w_j\) is the weight of attribute \(U_j\).

Multi-Attribute Group Decision Making (MAGDM) is an important part of the MADM problems (Yue, 2013a). Simply speaking, MAGDM could be regarded as a combination of MADM and GDM [Group Decision Making] (He et al., 2016). In other words, when more than one person is interested in the same MADM problem, it then becomes a MAGDM problem (Yang et al., 2015). The definition of MAGDM is described specifically as follow: multi DMs make judgments or evaluations by virtue of respective knowledge, experience and preference for a decision space (i.e., a finite set of alternatives) under multi attributes to rank all the alternatives or give evaluation information of each alternative, and then decision results from each DM are aggregated to form an overall ranking result for all the alternatives (Pang & Liang, 2012). Yue (2012a) believe that, the MAGDM problems have three common characteristics: alternatives, multiple attributes with incommensurable units and multiple experts. More specifically, a MAGDM problem with \(t (t \geq 1)\) DMs, \(m\) alternatives and \(n\) attributes can be expressed in matrices format as follows:

\[
X_k = (x_{ij}^k)_{m,n} = \begin{bmatrix}
U_1 & U_2 & \cdots & U_n \\
A_1 & x_{11}^k & x_{12}^k & \cdots & x_{1n}^k \\
A_2 & x_{21}^k & x_{22}^k & \cdots & x_{2n}^k \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
A_m & x_{m1}^k & x_{m2}^k & \cdots & x_{mn}^k
\end{bmatrix}
\]

(2)

\[W = (w_1^k, w_2^k, \ldots, w_n^k), k = 1, 2, \ldots, t,\]

where \(x^k\) and \(w^k\) \((k = 1, 2, \ldots, t)\), respectively, are the decision matrix and weight vector of attributes, which are provided by \(k_{th}\) DM (Yue, 2013a). Moreover, in the process of MADM, the DMs are usually asked to provide their preference information on attributes, and the attribute values are not precisely known but value ranges can be obtained. Therefore, it is significative that we consider MAGDM problem with interval number.
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