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On Incomplete Fuzzy and Multiplicative Preference Relations In Multi-Person Decision Making

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Abstract

Rapid changes in the business environment such us the globalization as well as the increasing necessity to make crucial decisions involving a huge range of alternatives in short period of time or even in real time have made that computerized group decision support systems become very useful tools. However in the majority of the cases the panel of experts cannot provide all the information about their preferences due to different reasons such as lack of knowledge, time etc. Therefore different approaches have been presented to deal with the missing preferences in group decision making contexts. In this paper we review and analyse the state-of-the-art research efforts carried out on this topic for incomplete fuzzy preference relations and multiplicative preference relations.

Keywords: Group decision making, GDM, incomplete information, fuzzy preference relations (APR), multiplicative preference relations (MPR)

1. Introduction

Group decision making (GDM) consist of multiple individual interacting to choose the best option between all the available ones. Each decision maker (expert) may have his/her own opinions and background, which enables them to approach the problem from different perspectives, but they share a common interest in achieving agreement on selecting the most suitable option.

In these systems experts have to express their preferences by means of a set of evaluations over a set of alternatives using different representation formats. In real world situations the expert panel is composed of diverse specialists with very different backgrounds and expertise, therefore sometimes and expert might not possess a precise or sufficient level of knowledge of part of the problem and as a consequence he/she might not give all the information that is required. Indeed, this could be due to different causes such as a high number of alternatives and limited time, experts not having

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enough knowledge of a part of the problem or are unable to discriminate the degree up to which an option is better than another, or even when conflict in a comparison situation appears which happens when each alternative outperforms the other one on some criterion and imposes a trade-off. In these sense Deparis et al. have carried out recently and empirical study in[1] which tests the hypothesis that increasing the intensity of conflict in a multicriteria comparison increases the likelihood that DMs consider two alternatives as incomparable expressing therefore incomplete preferences. Results show that depending on whether the participants are allowed to express incomplete preferences or not, attribute spread has different effects: a large attribute spread increases the frequency of incomparability statements, when available, while it increases the use of indifference statements when only indifference and preference answers are permitted.

In all these situations experts provide incomplete preference relations, that is, preference relations with some of their values missing or unknown. An extreme case happens when an expert does not provide any information about a particular alternative. This situations are called in literature *total ignorance* or simply *ignorance* situations.

The key issue in these situations is how the decision making algorithms should deal with the missing information.In the literature we can three main approaches to deal with missing judgements[2]: i. deletion, ii. using incomplete preference relations without carrying out any estimation process, iii. Carrying out a completion process prior to the aggregation.

According to the first approach the objects which contain missing values are deleted. It is also possible that attributes or fields containing many missing values are ignored. The main disadvantage of this approach is that the elimination of useful information in the data which could lead to serious biases[2]. The second one consists on using the incomplete preferences provided by the expert to reach the decision without estimating the missing values. Finally, the majority of the models in the literature follows the third approach that carry out completion methods to estimate the missing preferences. Some of these approaches use the information provided by the other experts together with aggregation procedures[3] requiring therefore several experts to estimate the missing values of a particular one and they do not take into account the differences between the experts preferences. Therefore this approach could lead to estimate missing values not naturally compatible with the opinion of the expert. Hence the majority of the estimation techniques uses only the information provided by the expert who provides the incomplete preference relation. In this paper we focus on the foundations and developments in estimation of missing additive and multiplicative preferences in GDM. Finally, several current trends and prospects about the topic are introduced.

The remainder of the paper is set out as follows: In section 2 we review the most relevant concepts in GDM including the definition of the additive fuzzy preference relation (APR), the multiplicative preference relation (MPR), and the concept of incomplete preference relation. Section 3 presents the main strategies in the literature to deal with missing judgements in the context of GDM for APR and MPR. Whereas in section 4 the approaches to deal with total ignorance situations are explained. Finally in section 5 our concluding remarks are pointed out among with some future work.

2. Frameworks for GDM with incomplete information

In the context of GDM the objective is choosing the best alternative(s) among a finite set, $X = \{x_1, \cdots, x_n\}$, $(n \geq 2)$. The alternatives will be classified from the best to worst, using the information known according to a set of m experts, i.e., $E = \{e_1, \cdots, e_m\}$, $(m \geq 2)$. Let $w = (w_1, w_2, \cdots, w_n)$ be the vector of priority, where w_i reflects the importance degree of the alternative x_i. All the $w_i (i = 1, 2, \cdots n)$ are greater than zero and sum to one, that is

$$w_i > 0,\ i = 1, 2, \cdots, n\ \sum_{i=1}^{n} w_i = 1 \tag{1}$$

Modelling how each expert $e_k \in E$ express his/her preferences is a key factor. Pair comparison of alternatives is usually used in many models since they integrate processes linked to some degree of credibility of preference of one alternative over another.According to the Millet comparatives study on different alternative preference elicitation methods[4], pairwise comparison methods are more accurate than non-pairwise methods. This is due to the fact that focusing exclusively on two alternatives at a time facilitates experts when expressing their preferences.

Preference relations are one of the most common formats to represent the information provided by the experts in the decision making context. A preference relation is a special function which can be defined as follows: