Linguistic Multi-Expert Decision Making Involving Semantic Overlapping

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Abstract. This paper presents a probabilistic model for linguistic multi-expert decision making (MEDM), which is able to deal with vague concepts in linguistic aggregation and decision-makers’ preference information in choice function. In linguistic aggregation phase, the vagueness of each linguistic judgement is captured by a possibility distribution on a set of linguistic labels. A confidence parameter is also incorporated into the basic model to model experts’ confidence degree. The basic idea of this linguistic aggregation is to transform a possibility distribution into its associated probability distribution. The proposed linguistic aggregation results in a set of labels having a probability distribution. As a choice function, a target-oriented ranking method is proposed, which implies that the decision-maker is satisfactory to choose an alternative as the best if its performance is as at least “good” as his requirements.

1 Introduction

Multi-expert decision making (MEDM) is a common and important human activity. In practice, the uncertainty, constraints, and even the vague knowledge of the experts imply that the information cannot be assessed precisely in quantitative form, but may be in a qualitative one [7]. A possible way to solve such situation is the use of the fuzzy linguistic approach [19]. Also, the process of activities or decisions usually creates the need for computing with words. One linguistic computational approach is making use of the associated membership function for each label based on the extension principle [4]. Another approach is the symbolic one [5] by means of the convex combination of linguistic labels. In these two approaches, however, the results usually do not match any of the initial linguistic labels, hence an approximation process must be developed to express the result in the initial expression.
domain. This produces the consequent loss of information and lack of precision. To overcome this limitation, a 2-tuple fuzzy linguistic representation model is proposed in [7]. Although such an approach has no loss of information, it does not directly take into account the underlying vagueness of the linguistic labels, i.e., it assumes that any neighboring linguistic labels have no semantic overlapping.

Two approaches have been proposed in an attempt to involve the underlying vagueness of the words in linguistic MEDM problems. Ben-Arieh & Chen [1] have proposed a fuzzy linguistic OWA (FLOWA) operator, which assigns fuzzy membership functions to all linguistic labels by linearly spreading the weights from the labels to be aggregated. The aggregating result changes from a single label to a fuzzy set with membership levels of each label. Tang [17] has introduced a collective linguistic MEDM model to capture the underlying vagueness of linguistic labels based on the semantic similarity relation [18], in which the similarities among linguistic labels are derived from fuzzy relation of linguistic labels. However, such an approach violates the bounded property of the linguistic aggregation. For more detail of the properties of linguistic aggregation, see [5]. Moreover, it assumes that the same label assessed by different experts has the same label overlapping.

According to the epistemic stance interpretation in linguistic modeling by Lawry [12], when an expert assesses some alternatives (options) with a linguistic label, it is assumed that he will probably choose other linguistic labels to describe the option. Possibility theory [6] provides a convenient tool to represent experts’ uncertain assessments. Furthermore, even if two different experts have assessed an option with the same linguistic label, the appropriateness degree of other linguistic labels may be different according to experts’ confidence degree, i.e., to what extent the experts are sure that other linguistic labels are appropriate to describe the option. Finally, our another motivation comes from the fact that experts are not necessarily the decision-makers, but only provide an advice [15]. The decision-makers’ preference information plays an important role in choice of alternatives, which is missed in most research.

In light of the above observations, we summarize our main contributions as follows. First, we assume that the appropriate labels are linearly distributed around the linguistic label provided by the expert with a possibility distribution. The label provided by the expert will be called prototype label. And then based on the basic mass function, we can obtain the probability distribution on the linguistic labels as the aggregation result. Fuzzy modifiers [19] are also used to model some expert’s confidence quantifying how he is sure of the appropriateness of other linguistic labels. Second, we propose a target-oriented ranking method incorporating decision-makers’ preferences. It is well-known that human behavior should be modeled as satisficing instead of optimizing [16]. Intuitively, the satisficing approach has some appealing features because thinking of targets is quite natural in many situations.

The rest of this paper is organized as follows. Section 2 proposes a probabilistic approach to linguistic aggregation involving vague concepts. Section 3 proposes a ranking procedure based on target-oriented decision model, in which decision-makers’ preferences are considered. Section 4 provides an illustrative example.