Information Fusion 29 (2016) 120–131

Contents lists available at ScienceDirect

Information Fusion

journal homepage: www.elsevier.com/locate/inffus

Fusion of preferences from different perspectives in a decision-making context

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ARTICLE INFO

Article history:
Available online 29 July 2015

Keywords:
Decision-making unit
Different perspectives
Multilevel fusion
Preference modeling
Recursive LSP

ABSTRACT

Solving a decision-making problem about a brand-new product might include preferences from a high number of potential customers (e.g., followers of a company on social media) and managerial constraints (or preferences) given by corporate managers with regard to different aspects (i.e., economical, technical, environmental, etc.) over multiple criteria (e.g., weight, capacity, color, or usefulness of a product). These give us some new insights on fusing preferences given by persons having different perspectives (e.g., economical, technical, environmental, etc.), including decision-makers, and aimed to be suitable for different organizational structures (e.g., multilevel structures). Herein, a proper representation is needed to merge preferences from each perspective, enabling their propagation, throughout an organizational structure until the level in which a decision is made. This representation is presented as a *decision-making unit (DMU)*, and is used as the primary component of our decision-making model. In this paper, we propose a novel decision-making model that recursively merges the preferred criteria from different DMUs using the *logic scoring of preference (LSP) method*. An illustrative example demonstrating the applicability of the proposed model, in the context of a new product design, is included in the paper.

1. Introduction

Nowadays, several businesses use social media as a strategy to gather a high number of opinions from potential customers with regard to their products (e.g., opinions collected through a product's fan page). Furthermore, opinions given by their members and their corporate managers could also be taken into account in a decision-making context. However, these opinions will be given by different perspectives according to their knowledge, experience or area of expertise.

Let us consider, for instance, that a company has to decide the proper combination of features (criteria) – like capacity, weight and color – during the design of a brand-new model of "hand luggage" (product). Herein, a proper combination of features takes into account the preferences given by its potential customers, and the managerial constraints (or preferences) given by the company's managers as well. If we focus on a feature like "capacity", it is possible that *a group of users* who mostly travel for short periods using only hand luggage (i.e., business trips), might prefer a "medium capacity". Meanwhile, a *marketing manager* might prefer a "small capacity" with the purpose of promoting that the product will be neither measured at the aircraft entrance nor placed in the aircraft hold for an specific flyer profile like the economy class. If the decision involves the whole organization, other perspectives (from other managers) might be present in addition to the one given by the marketing manager. Moreover, depending on the organizational structure of the company, those perspectives might have different importance degrees (e.g., a horizontal company treats the opinions of its managers as equally important).

It is worth to notice that the opinions considered in the example will be given by users with different levels of knowledge (students, non-experts and professionals), areas of expertise (engineering, marketing, design, among others) and personal profiles (single, married, parents, etc.). Moreover, these will be gathered through different sources (fan pages, surveys, polls and social network applications). Therefore, these opinions might differ somehow in their *relevance* from a decision-maker's point of view when he/she performs a fusion with his/her preferences or constraints in order to reach a decision (e.g., to determine the viability of a product). Hence, solving a decision-making problem might include preferences from a large group of people offering different points of view

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http://dx.doi.org/10.1016/j.inffus.2015.07.006
1566-2535/

over multiple criteria. But, *how do we attempt to reach a decision taking into account what potential customers preferred, while being limited by what is considered possible in a business environment?*

Heretofore, several steps in that direction have been followed. One of them allows us to simplify the complexity of the problem by reducing a large number of opinions to a smaller group of opinions' trends as described in [1]. That method uses the agglomerative hierarchical clustering with the single linkage rule (i.e., shape-similarity measure) as merge criterion [2]. The method is considered to be insensitive to minor mistakes made by experts – herein, by potential customers – while expressing their preferences. Another method proposed in [3] takes into account a decision-maker's point of view when evaluating relevant opinions. However, a missing link is to perform a fusion among the preferences given by the potential customers and the managerial constraints (or preferences) throughout the organizational structure of a company. To provide the missing link, in this paper we propose a decision-making model that aims the following:

- to perform the fusion of preferences from potential customers and preferences from corporate managers (managerial constraints);
- to be suitable for different organizational structures (multilevel); and,
- to reflect each decision-maker's point of view according to their knowledge, experience or area of expertise.

Herein, we consider situations that involve different domains of knowledge (i.e., different perspectives given by persons with different areas of expertise), where it is possible to distribute the tasks related to a holistic decision taking into account its constituents. For example, a decision-making problem in a multinational corporation with operations in more than one country, where the headquarters take into account the opinions given by the regional (and subregional) organizational units and their respective customers. In this example, each regional (or subregional) manager may include in his/her perspective the regional constraints (e.g., cultural, environmental, financial, etc.) related to his/her competence area.

Therefore, the decision-making model presented in this paper requires a concept that allows us to perform the fusion of preferences from each perspective. This concept is presented as a *decision-making unit (DMU)* where a single decision-maker is able to fuse his/her preferences (or constraints) with the ones received as inputs. The latter might come from a large group of persons (e.g., potential customers) whose preferences may have been gathered from different sources, or other DMUs in a hierarchical structure.

This model uses recursively the *logic scoring of preference (LSP)* method [4], based on the Generalized Conjunction/Disjunction (GCD) [5] aggregators, which allows to divide a complex problem in manageable subproblems in a hierarchical fashion. Additionally, LSP allows to reflect relative importance among criteria through weights, and to combine the proper aggregation operators reflecting a decision-maker's needs [6]. In this way, it is an advantage to reflect the decision-maker's point of view through formal logic components expressing the desired logic relationship among criteria (e.g., the level of simultaneity or replaceability), and semantic components (like the importance of criteria).

In this paper we have selected LSP considering the aforementioned characteristics, however other well known multicriteria methods may be subject to further study. For a comparative study on different multicriteria methods, including the simple additive scoring (SAS), multiattribute value technique (MAVT), multiattribute utility technique (MAUT), analytic hierarchy process (AHP), ordered weighted average (OWA), outranking methods (ELECTRE and PROMETHEE), and logic scoring of preferences (LSP), we refer the interested reader to [7].

An advantage of our decision-making model is that it handles a large group of opinions obtained from different sources (including social media), where all the company managers contribute to some extent to the final decision. Furthermore, it evaluates different perspectives (e.g., economical, technical, environmental, etc.) separately and it permits a decision-maker to obtain a solution that best suits his/her constraints (or preferences) and the preferences given by a group of potential customers. Here, it is a challenge to fuse preferences from different perspectives, while reflecting each decision-maker's point of view according to their knowledge, experience or area of expertise.

There are some related work on merging expert opinions [8–12], how experts select an alternative from a group of previously generated alternatives [13–18], and several models for fuzzy multicriteria decision-making [19]. Another work presents a general framework regarding the aggregation of expert opinions [20]. Although consensus models are not considered to be related to this proposal, it is important to mention the consensus model presented in [21] due to its applicability in Web 2.0 communities and the model described in [22] where large groups of decision makers participate in a consensus process. Additional research on large scale decision making can be found in [23] including a graphical interface as the one described in [24] that allows a decision-maker to visualize a large group of experts' preferences. In this paper, we study to design the best alternative(s) taking into account preferences given by a large group of people (e.g., potential customers) and preferences from different perspectives given by corporate managers.

The remainder of this paper is structured as follows. The next section includes some preliminary concepts. Section 3 presents the core of our proposal, which provides details over the fusion of preferences from different perspectives. Section 4 includes an example, in the context of a new product design, to illustrate the applicability of our model. Finally, Section 5 concludes the paper and presents some opportunities for future work.

2. Preliminaries

This section defines preliminary concepts required to properly understand the following sections. These include representing expert opinions by means of fuzzy sets, the logic scoring of preference (LSP) method, clustering similar opinions and selecting relevant opinions within a large group.

2.1. Representing expert opinions

In a decision making context, from the preference point of view [25], a membership function $f_A(x)$ allows an expert to express his/her preference level (or preference in favor) of a decision variable x of a universe X. A membership function is formally defined as follows:

Definition 1 ([26])**.** A membership function f_A is a mapping $f_A : X \mapsto [0, 1.]$ that associates each $x \in X$ with a real number $f_A(x)$ in the unit interval $[0, 1.]$ to represent the grade of membership of x in A. Values that are closer to 1 denote higher grades of membership, while values that are closer to 0 denote lower grades of membership.

A membership function f_A represents a fuzzy set A [26]. Fuzzy sets allow us to represent linguistic concepts expressed in natural language [27–29] due to their gradual transitions from