Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 91 (2016) 715 – 724

Procedia Computer Science

Information Technology and Quantitative Management (ITQM 2016)

Group decision making in linguistic contexts: an information granulation approach

F.J. Cabrerizo[a,*], W. Pedrycz[b], I.J. Pérez[c], S. Alonso[d], E. Herrera-Viedma[a]

[a]*Department of Computer Science and Artificial Intelligence, University of Granada, Granada 18071, Spain*
[b]*Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Alberta T6G 2G7, Canada*
[c]*Department of Computer Sciences and Engineering, University of Cádiz, Cádiz 11519, Spain*
[d]*Department of Software Engineering, University of Granada, Granada 18071, Spain*

Abstract

Group decision making situations are part of today's organizations. It is a type of decision making involving many decision makers which act collectively to choose the best alternative (or alternatives) from a set of feasible alternatives. Usually, numerical values have been used by the decision makers to express their opinions on the possible alternatives. However, as the standard representation of the concepts that humans use for communication is the natural language, words or linguistic terms instead of numerical values should be used by the decision makers to provide their preferences. In such a situation, the linguistic information has to be made operational in order to be fully utilized. In this contribution, assuming that decision makers express their opinions by using linguistic terms, we present an information granulation of such a type of information, which is formulated as an optimization problem in which consistency is maximized by a suitable mapping of the linguistic terms on information granules.

Peer-review under responsibility of the Organizing Committee of ITQM 2016
Keywords: Group decision making, linguistic information, information granulation, consistency.

1. Introduction

One of the most crucial human activities is decision making, whose essence is to find the best opinion, alternative, and so on, from a set of feasible ones. In particular, most of decision making situations in real world usually involve multiple decision makers to make the decision [1]. In such a case, it is called a multiperson decision making situation, being group decision making (GDM) an important class among multiperson decision making settings [2].

GDM is defined as a situation in which there is a set of alternatives and a set of decision makers who provide their preferences concerning the alternatives. The problem here is to find a solution (an alternative or set of alternatives) which is best acceptable by the group of decision makers as a whole. The ideal situation would be one where all the decision makers could convey their preferences on the alternatives in a precise way by means of numerical values.

* Corresponding author. Tel.: +34 958244258 ; fax: +34 958243317 .
E-mail address: cabrerizo@decsai.ugr.es

Peer-review under responsibility of the Organizing Committee of ITQM 2016
doi:10.1016/j.procs.2016.07.062

Unfortunately, in many cases, decision makers deal with imprecise information or have to verbalize their preferences on qualitative aspects which cannot be evaluated by means of quantitative values. In addition, as decision making is an inherent human ability that is not necessarily rationally guided, it can be based on tacit or explicit assumptions and it does not need complete and precise measurements about the alternatives [3]. This fact has led to researchers to apply the fuzzy sets theory, introduced by Zadeh in 1965 [4], to model the vagueness and uncertainty in GDM situations [5–7].

In recent years, linguistic information have been used to represent the preferences expressed by the decision makers about the alternatives [3,8–11]. The main purpose of using words or sentences in natural language, i.e. linguistic values, instead of numerical ones is that linguistic values are, in general, less specific than numbers, but much more closer to the way that humans verbalize and use their knowledge [3,12]. For instance, if we say "the man is tall" is less specific than "the man measures 2 m". Here, "tall" can be seen as a linguistic value which is less precise and informative than the numerical value "2". Despite its less informative nature, the value "tall" allows humans to naturally convey and deal with information that may be uncertain or incomplete (the speaker may not know the exact man height). As these situations where information is not precise are very common in real world, linguistic variables are a powerful tool to model human knowledge [3].

In GDM situations in which linguistic values are used to represent the opinions given by the decision makers, a mechanism to made operational the linguistic information is required. To do so, linguistic computational models have been presented by researchers [3]:

- The linguistic computational model based on membership functions [13].
- The linguistic computational model based on type-2 fuzzy sets [14].
- The linguistic symbolic computational models based on ordinal scales [15–17].
- The 2-tuple linguistic computational model [18], which is a symbolic computational model that extends the use of indexes.
- The linguistic computational model based on discrete fuzzy numbers [19].

In this contribution, we present an information granulation of the linguistic information in order to made it operational. To do so, granular computing representing and processing information in form of information granules is used [20]. Information granules are complex information entities arising in the process, which is called information granulation, of abstraction of data and derivation of knowledge from information [21]. Here, due to the process of information granulation and the nature of information granules, the definition of a formalism well-suited to represent the problem at hand is required. The resulting information granules are then effectively processed within the computing setting pertinent to the assumed framework of information granulation. In the literature, we can find several formal frameworks in which information granules can be defined, as for example:

- Sets (interval mathematics) [22].
- Fuzzy sets [4,23–25].
- Rough sets [26].
- Shadowed sets [27].
- Probabilities (probability density functions) [28].

Two important questions about information granulation in order to make operational the linguistic information are the following:

- How the linguistic values have to be translated into the entities?
- What optimization criterion can be envisioned when arriving at the formalization of the linguistic values through information granules?

Here, we formulate the information granulation as an optimization problem in which a consistency index is optimized by a suitable mapping of the linguistic values on information granules. To do so, the particle swarm optimization (PSO) [29] is used as the optimization framework, which supports the formation of the information granules. In