Editorial

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The development of methods for decision support has been studied in different research communities from different perspectives. On the one hand, *multiple criteria decision aid* (MCDA) research is mainly done in the area of operational research, so that the first approaches were devoted to use optimisation techniques to assist management and decision problems. MCDA methods include planning techniques, simulation, and statistical and mathematical methods for analysing a set of options from several conflicting points of view.

On the other hand, the field of *artificial intelligence* (AI is part of computer science) aims at allowing the machines to think (or behave) like humans. In AI decision support systems have been studied to provide computer-assisted software tools that are able to make decisions or, at least, to assist the decision makers. Expert Systems are well known in this field (Davis, 1986; Giarratano and Riley, 2004), as systems based on a set of knowledge-based logical rules that can be used in prediction, diagnosis or classification, for instance. AI techniques usually take a symbolic approach to the management of data, rather than a numerical one. In this sense, we can highlight the works on linguistic operators applied to aggregation and group decision making, such as Herrera et al. (2009), De Baets and Fodor (2010), Martínez et al. (2010), Isern et al. (2010) and Rodríguez and Martínez (2013). Recently, the semantics of the linguistic terms has also

been incorporated through the exploitation of the knowledge represented in ontologies (Valls et al., 2013). Moreover, in computational intelligence we may find bio-inspired methods, like genetic algorithms (i.e., evolutionary computation) or neural networks (Fogel, 1995; Haykin, 1999; Engelbrecht, 2007). Those models have also been successfully applied to solve decision making problems.

Those two fields have developed their research during the last decades with scarce interaction between them. However, they have a common interest and, therefore, they can benefit from sharing and integrating their respective techniques. This fact has been recognised in the last years by many authors (Perny and Pomerol, 1999; Doumpos and Zopounidis, 2011; Torra et al., 2012; Doumpos and Grigoroudis, 2013) as illustrated, for example, by the commonalities between MCDA and the data mining discipline, focused on the exploratory analysis of large datasets to extract rules of classification or patterns that may help decision makers (Meisel and Mattfeld, 2010; Corne et al., 2012). Another goal pursued by the two disciplines is the modelling of the user preferences, which has been studied in machine learning (or preference learning), mainly through techniques that construct a model from a large set of examples, versus MCDA where this issue is tackled with interactive methods, disaggregation analysis or ordinal regression (Doumpos and Zopounidis, 2011; Greco et al., 2010). Some recent works have started to define online automatic preference learning in web-based systems (Marin et al., 2013).

Some initiatives to promote hybrid techniques that come from both areas can be found, such as the organisation of workshops devoted to this topic (e.g., MCDA75 or DA2PL), special sessions (e.g., at MCDM-2009, IPMU-2012, EURO-2012) or even some specific conferences like Modelling Decisions for Artificial Intelligence (MDAI) (Torra et al., 2012). We believe that the integration of the two approaches is a promising research line that may bring relevant results.

The papers in this special issue have been collected from the contributions to the 75th meeting of the European Working Group on Multiple Criteria Decision Aid, which took place in Tarragona (Catalonia, Spain) in April 2012. The main topic of that meeting was ‘MCDA and AI: connections and challenges’. Additional contributions were also accepted and all papers have been thoroughly peer-reviewed before acceptance. The papers illustrate how the models and techniques of both disciplines can be fruitfully combined to enhance the quality of the decision aid in complex problems.

Two papers address the issue of modelling uncertainty in multi-criteria decision making proposing different approaches and solving some complex real problems. First, the paper by Kabir shows how some tools for uncertainty management, like fuzzy sets, can be integrated in well-known MCDA methods. This combination facilitates the consideration of situations with low-precision data. This paper describes a linguistic version of the VIKOR method, which is based on finding a compromise solution with conflicting criteria, by measuring the closeness to the ideal solution. The use a linguistic approach with labels represented by fuzzy sets permits to approach the decision making process from a qualitative perspective rather that requiring a hardly achievable level of precision by using numerical scores. A real application is studied in this paper to show the practical use of this qualitative approach. The paper addresses the problem of one of the largest automotive battery manufacturing plants in Bangladesh. The company needs to identify the best total quality management (TQM) programme, for which it has to select the best TQM consultant company. The selection is based on five criteria which are evaluated by a group of decision makers using linguistic preference scores.

Second, the paper of Lehikoinen et al. shows the application of a technique originated in the AI field that has later been used for MCDA: Bayesian networks (BN). In fact, when using BN in decision making under uncertainty they are called Bayesian influence diagrams. The BN model is particularly interesting for its way of dealing with uncertainty in a probabilistic network of actions-decisions. This work focuses on the evaluation of the expected utility of different decisions concerning the nutrient abatement measures implemented in coastal countries of the Gulf of Finland. The utility is defined with respect to the achievement of the objectives of the European Water Framework Directive for 2015. A complex structure of criteria is considered, which includes ecological, physical, chemical and biological indicators in the three different countries on the border of this gulf. The proposed system is able to integrate data provided by different simulation models for those indicators, which are difficult to interpret separately. Moreover, the system permits the user to introduce 'what if' questions, which may be helpful for the decision maker.

The following two papers focus on the pre-processing stage (i.e., the problem structuring) and the post-processing stage (i.e., interpreting the results to give explanations to the decision maker) by developing conceptual models.

Norese and Novello study the problem structuring process, prior to the use of any MCDA method. This initial step consists on organising the knowledge and information elements in order to understand the decision context, in complex and uncertain situations. They propose to integrate an actor analysis method with cognitive mapping techniques. The former is used to analyse the actors and their roles, whilst the latter helps to model their different points of view. Those two techniques can be used in a learning cycle that finally generates a map of logically connected concepts. This map synthesises the essential elements of the system, like the actors' preferences in relation to specific goals and constraints, risks that cannot be accepted, aspiration levels, etc. This method has been successfully applied in an industrial project with the aim of identifying the needs to achieve an effective land monitoring with unmanned aerial vehicles.

On the other hand, Gibert's paper addresses the problem of post-processing, or explaining to the decision maker the results obtained from an analysis of the data. This point is especially relevant in the multiple-criteria decision aid view, because it aims at defining the process of decision making as an integral one in which the involvement of the decision maker (and stakeholders) is a key part of the process. In this paper, this idea is brought to the field of data mining methods, in this case to hierarchical unsupervised clustering. Usually the result given to the decision maker is a partition of a set of objects into clusters, without providing any help for a high-level interpretation of these clusters. This work proposes a methodology to identify distinctive concepts to be associated to each cluster, taking advantage of the hierarchical structure discovered in the clustering process. This characterisation of the classes can be of great support to the decision maker.

Finally, the fifth paper tackles another new area of research that has attracted the attention of both the AI and MCDA communities: personalised recommender systems. Especially in the web, users are faced with a large amount of information and, consequently, finding the relevant items is difficult and time-consuming. Search engines try to help in the selection of the appropriate items. However, two users may enter the same query but have different personal needs. The paper of Baazaoui et al. presents a new personalised search engine that constructs a preference model for each user, which is exploited using utility-based decision tools to make a selection of the documents found in

the web. The authors propose a method to build models of the users and also to connect these models by forming a user's models network. The individual user model is constructed by means of analysing the interaction of the user with the search engine (i.e., in an implicit way). Then, the network of users is based on finding semantic similarities between the user's models. The proposal also pays special attention to include spatial considerations in the search, by evaluating the location's relevancy and accessibility. The paper is illustrated with a case study focused on finding the appropriate hotels for tourists with different needs.

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