AN ADAPTIVE CONSENSUS SUPPORT SYSTEM FOR GDM PROBLEMS WITH HETEROGENEOUS INFORMATION

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The goal of this contribution is to present a computer-based application of an Adaptive Consensus Support System that deals with heterogeneous information. This application may be used to carry out consensus processes in Group Decision Making Problems defined in heterogeneous contexts. It allows experts to express their opinions using multiple expression domains in order to bring decision situation closer to real-word problems. In addition, the implemented consensus process is adaptive, i.e, it can adjust its behavior depending on the level of agreement reached in each consensus round, suggesting a greater number of changes when the agreement is far, and decreasing it when the consensus becomes nearly.

1. Introduction

Group decision-making (GDM) problems may be defined as decision situations where given as set of feasible alternatives, two or more experts try to achieve a common solution taking into account their opinions or preferences.

In the literature we can find many proposals to solve decision problems where experts use the same information domain to express their preferences [**1, 2**]. However, it may happen that in decision problems experts could prefer to provide their preferences in several expression domains, because they have different degree of knowledge about alternatives. In such situations, we consider the decision problem is defined in a heterogeneous context [**3**].

Usually GDM problems have been solved carrying out Selection Processes where experts obtain the best solution set of alternatives from their preferences [**1, 4**]. However some experts could consider that their preferences have not been considered in order to obtain the solution, and therefore they do not agree with this solution. To avoid this situation, it is suitable to carry out a consensus process consists of several rounds (see Figure 1) where experts discuss and change their preferences in order to reach a sufficient agreement before making a decision [**5, 6, 7, 8**].

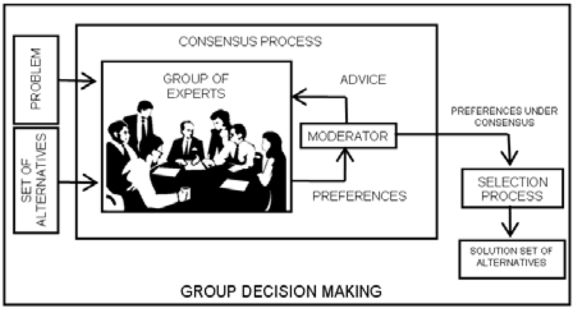

Figure 1. Resolution process of a GDM problem.

Consensus has usually been coordinated by a moderator who helps experts to make their preferences closer to each other and so improve the level of agreement. However, the moderator may not be objective and may have problems to understand the different domains and scales used by experts in heterogeneous contexts.

The aim of this contribution is to present an adaptive consensus support system to carry out consensus processes in GDM problems with heterogeneous information. This application uses the model proposed in [**9**] but applied to GDM problems in a heterogeneous context. The application is characterized by: i) experts can provide their preferences by means of numerical, linguistic or interval-valued preference relations, and ii) the changes suggested to experts are adapted to the level of agreement achieved in each round of consensus.

The rest of the paper is set out as follows. GDM problems in heterogeneous contexts are briefly reviewed in Section 2. In the Section 3 the adaptive consensus support system model is introduced. In Section 4 we present the application. Finally some conclusions are drawn in Section 5.

2. GDM Problems defined in heterogeneous contexts

GDM problems are classically defined as decision situations in which a set of individuals (also called experts) $E = \{e_1, e_2, \ldots, e_m\}$ ($m \geq 2$) express their preferences on a set of alternatives $X = \{x_1, x_2, \ldots, x_n\}$ $(n \geq 2)$, to derive a solution. Depending on the nature of the alternatives or on the degree of knowledge over them, experts may give their preferences by using different approaches. Usually experts provide their preferences by means of preference relations [**2**] defined as $n \times n$ matrixes, where each element of the matrixes

$P_i(x_l, x_k) = p_i^{lk}$ represents the degree of preference of alternative x_l over x_k given by expert e_i.

A desirable situation in a GDM problem is that all experts have a precise knowledge about the alternatives and provide their preferences in a numerical precise scale [**2, 10**]. However, in some cases, experts may have different degrees of knowledge about the alternatives and then they may use different domains to provide their opinions, such as numeric values, interval-valued [**11**] and linguistic labels [**12**].

In this contribution we deal with GDM problems defined in heterogeneous contexts because experts use three different information domains: numerical, interval-value and linguistic to assess their preferences.

3. The Adaptive Consensus Support System Model

Here we briefly describe the adaptive consensus support system model implemented in this application. The preliminary ideas of this model were proposed in [**9**]. The model is able to carry out a consensus reaching process in GDM problems defined on heterogeneous contexts and to adapt its performance to the consensus degree reached in each consensus round. The model is composed of the following phases:

1. *Making the information uniform*. Taking into account that it works in heterogeneous contexts, the heterogeneous information should be unify into a common domain in order to deal with it.
2. *Computing of consensus degree and control of the consensus process*. The consensus degree among experts' preferences is calculated. If the consensus degree is high enough, the consensus process is over and the selection process will start. Otherwise, the consensus process keeps going.
3. *Adaptive search for preferences.* The model adapts the search for preferences in disagreement according to the level of agreement reached in each round. To do so, the model distinguishes three levels of agreement (very low, low and medium). Each level entails a different preferences search procedure in order to identify the preferences to be changed.
4. *Production of advice*. The system suggests how to change the preferences in disagreement to increase the consensus degree.

4. Adaptive Consensus Support Application description

The application implements the above model. It has been developed using web technologies (HTML, Java, MySQL) under a client-server architecture.

Two kinds of users may be defined in the system: Administrators and Experts.

a) Administrators: Users are in charge of defining the problem features and maintaining the database system.

b) Experts: They provider their opinions about a problem by means of preference relations assessed in: numeric, interval-valued or linguistic domains.

4.1. *GDM problem definition*

Obviously, the first task in the process is to define the GDM problem, task done by the administrator. The required data to define a GDM problem is shown in the form of the Figure 2. Among other features, it includes a brief description of the problem, the maximum number of consensus rounds to carry out, consensus thresholds and the list of feasible alternatives. In addition, participant experts and their respective expression domains are added at definition time.

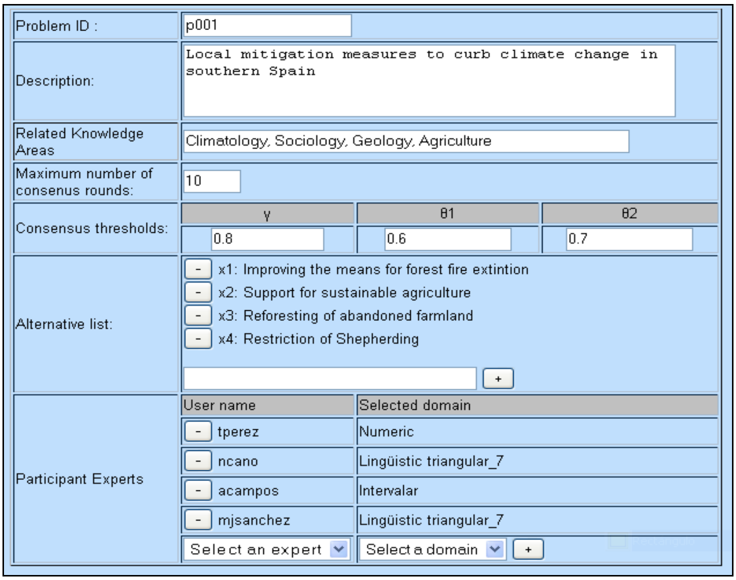

Figure 2. GDM problem definition form.

4.2. *Preference expression*

Experts use preference relations to provide their preferences for the application. The preference relations [**2**] are shown as $n \times n$ matrixes, where each element is the preference degree of the alternative x_l over x_k.

4.3. *Consensus degree evaluation and advice generation*

Once all experts have expressed their preferences, the system computes the consensus degree reached in the current round. If it is big enough, the process is over and shows a summary of the consensus process, including the global consensus and the number of suggested changes, for each round (Figure 3).

	Round	Global Consensus		Number of suggested changes
Summary of the consensus process	1st	0.55	Low	23
	2nd	0.66	Medium	15
	3st	0.73	High	11
	4th	0.76	High	8
	5th	0.81	Enough	

Figure 3: Result of consensus process.

Otherwise, if it is not enough, the application generates a set of advices for each expert. In Figure 4 we can see an advice set generated by the system after second consensus round for the expert called *tperez*.

	Round	Global consensus	Number of suggested changes
Summary of the consensus process	1st	0.55 (low)	23
	2nd	0.66 (Medium)	15

		x1	x2	x3	x4	
Suggested changes for expert **tperez**	x1	-	0.80	0.20	0.20	You should increase your degree of preference.
	x2	0.2	-	0.80	0.30	You should decrease your degree of preference.
	x3	0.70	0.2	-	0.5	You do not have to change your degree of preference.
	x4	0.8	0.8	0.7	-	

Figure 4: A preference relation with suggested changes for a particular expert.

These recommendations should be taken into account by experts before given their new preferences in the next consensus round. This process is repeated until the consensus threshold is reached or the maximum number of consensus rounds is exceeded.

5. Conclusions

In this contribution we have shown a system to carry out a consensus reaching process in GDM problems defined in heterogeneous context, i.e., experts use numerical, interval-valued or linguistic assessments to express their preferences. Additionally this system provides suggestions to the experts in order to make opinions closer based on the consensus degree achieved in each round.

Acknowledgements

This contribution has been supported by the Research Project TIN 2006-02121

References

1. J. Fodor and M. Roubens, *Fuzzy preference modelling and multicriteria decision support*, Kluwer Academic Publishers, Dordrecht, 1994.
2. J. Kacprzyk, *Group decision making with a fuzzy linguistic majority*, Fuzzy Sets and Systems **18** (1986), 105-118.
3. F. Herrera, L. Martínez and P. J. Sánchez, *Managing non-homogeneous information in group decision making*, European Journal of Operational Research **166** (2005), no. 1, 115-132.
4. M. Roubens, *Fuzzy sets and decision analysis*, Fuzzy Sets and Systems **90** (1997), 199-206.
5. C. Carlsson, D. Ehrenberg, P. Eklund, M. Fedrizzi, P. Gustafsson, P. Lindholm, G. Merkuryeva, T. Riissanen and A. G. S. Ventre, *Consensus in distributed soft environments.*, European Journal of Operational Research **61** (1992), 168-185.
6. F. Herrera, E. Herrera-Viedma and J. L. Verdegay, *A model of consensus in group decision making under linguistic assessments*, Fuzzy Sets and Systems **79** (1996), 73-87.
7. E. Herrera-Viedma, F. Herrera and F. Chiclana, *A consensus model for multiperson decision making with different preference structures*, IEEE Transactions on Systems, Man and Cybernetics-A **32** (2002), no. 3, 394-402.
8. J. Kacprzyk, H. Nurmi and M. Fedrizzi, *Consensus under fuzziness*, Kluwer Academic Publishers, 1997.
9. E. Herrera-Viedma, L. Martínez, F. Mata and L. G. Pérez, *An adaptive module for the consensus reaching process in group decision making problems*, Modeling Decisions for Artificial Intelligence, 2005, 89-98.
10. R. R. Yager, *On ordered weighted averaging aggregation operators in multicriteria decision making*, IEEE Trans. on Systems, Man, and Cybernetics **18** (1988), 183-190.
11. J. F. L. Téno and B. Mareschal, *An interval version of promethee for the comparison of building products' design with ill-defined data on environmental quality*, European Journal of Operational Research **109** (1998), 522-529.
12. F. Herrera and E. Herrera-Viedma, *Linguistic decision analysis: Steps for solving decision problems under linguistic information*, Fuzzy Sets and Systems **115** (2000), 67-82.