THE CONCEPT OF FAIRNESS IN THE GROUP DECISION SUPPORT SYSTEMS – A SOCIO-PSYCHOLOGICAL APPROACH

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Abstract

In this paper we present ae general concept of the consensus reaching process supporting by the group decision support systems. We proposed the idea which combines the mathematical direction based on "soft" consensus developed by Kacprzyk and Zadrożny [6] and relevant socio-psychological factor concerning fairness component. Essentially, we divide fairness approach in consensus reaching process on two possible directions: a fair distribution (fair resource allocation) and a fair final decision. We stress the benefits resulting from the implementation of proposed concept in the group decision support systems and point the direction of further model formalization.

Key words: decision support systems, consensus reaching process, fairness, fair distribution, soft consensus, fair decision, fair resource allocation

1 Introduction

It is well-known that decision theory is an absolutely interdisciplinary domain which combines researches from many disciplines, i.e. psychology, sociology, economics, philosophy, political science, etc. The formal direction can not be the only course of decision making problems, since all the classical methods had a very limited capacity for explaining empirical choices.

Regardless of its origin, the essence is always the same: there are some options to choose between and only one has to be chosen. In fact, many different models of decision making process occurred, enriched at analysis of human behavior, social interactions and other socio-economic descriptions depending

on the respective purpose. All of these novel agent-based computational models appeared in order to make the process more human-consistent and believable. That is the reason, why we decided to apply psychological and sociological theories to investigating and designing systems in this research topic.

We agree with the statement that the group of individuals is known to be an effective organ in decision making process. In spite of several dysfunctions of groupwork, there are more crucial benefits (process gains). Namely, groups are better that individuals at understanding problems, at catching errors, so they provide learning. Moreover, a group has more information than any one member and can combine this knowledge to derive better solutions and stimulate the creativity of the participants and the process. Hence, the *group decision making process* will be the groundwork of our further consideration. Considering different natures of group decision making problem, we took into account *interpersonal orientation group*. It means, that where the final solution of the problem is only a minor goal. Here, the priority is to ensure a good relation within the group members during decision making process and to achieve consensus in the sense of some satisfactory agreement as to the chosen option.

We want to guarantee an equal participations of all decision members during the consensus reaching process. In most cases, there is also a small group of outsiders who are isolated in their opinions as to the rest of the group and omitted. Finally, outsiders do not sense the satisfaction of the discussion what affects on the effectiveness of entire group. Of course, it does not exclude the final decision achievement, but decreases the opportunity of many, further activities, i.e. practical implementation of the final decision, survival of the group in the long time period, etc. Therefore, all of these socio-psychological aspects forced us to seek for a novel approach of consensus degree which will consider the satisfaction of every individual throughout the consensus reaching process. Furthermore, we attend to reduce the complexity of proposed system with detailed description of only relevant aspects. According to the fact, that most human behaviors have not been formalized mathematically yet, our purpose is to get a better understanding of how social mechanism in group decision support systems works.

2 Group Decision Support Systems

Since the development of modern technology, computerized support in making decision have enormously progressed. Today's tools are flexible, efficient, easy in use and allow to create an interactive user-friendly interface to view data, configure models, etc. This class of computer-based information systems including knowledge based systems that support decision making activities has a common terminology *decision support systems.* They combine

the intellectual resources of individuals with the capabilities of the computer to improve the quality of final decision.

Similarly, *group decision support systems* mean interactive, computer-based systems that facilitate solution of unstructured problems by a set of decision-makers working together as a group. Unstructured problems are fuzzy, complex processes for which there are no cut-and-dried solution methods and where human intuition is often a basis for decision making. Software products provide collaborative support to groups, i.e. supply a mechanism for teams to share opinions, data, information, knowledge, and other resources. What matters here is that group decision support system is an adjunct to decision makers to facilitate their decision making process but not to replace their judgments. Moreover, it is a dynamic system which adaptive over time, therefore the decision makers should be reactive and able to change their opinions quickly. Group decision support systems attempt to improve the effectiveness of decision making (accuracy, quality) rather than its efficiency (the cost of making decisions)[7].

The key to success is to create more 'human consistent' and 'human centered' tools and techniques to grasp and deal with difficult (decision making type) problems. These systems should provide computational tools, cognitive aspects and social dimension. In the GDSS consideration it means that the computer asks a group to solve a problem, then collects, interprets and integrates the solutions obtained by the humans.

3 A schematic view of the proposed system

The general overview of the proposed system is presented in figure 1. The participants will be referred to as individuals, and the interaction of them takes place during the discussion of two or more agents. Its core is composed of preference structure (pairwise comparison) and consensus measurement modules, but the discussion and external information sources are also treated as significant part of the scheme.

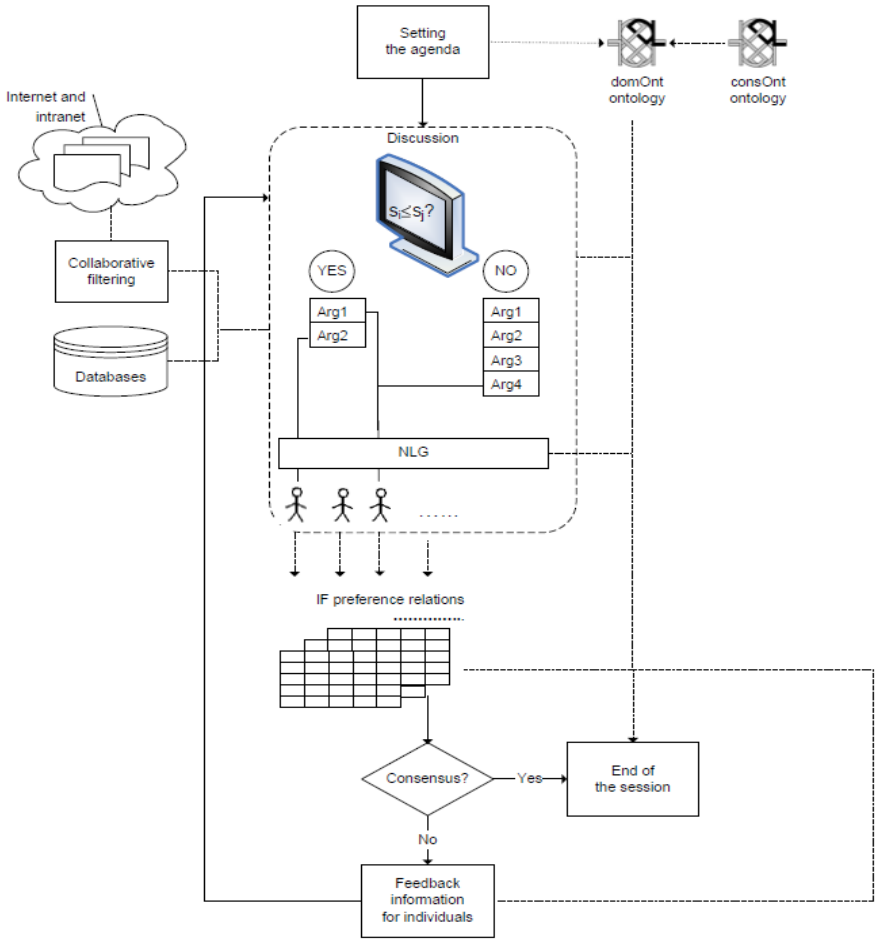

Figure 1. The structure of proposed system [5]

Setting the agenda is the first stage which concerns defining and planning the decision making problem. The representation of options is denoted as *domain ontology* (*dom-ont*) while the *consensus ontology* (*cons-ont*) defines main concepts of the consensus reaching process.

We discuss a consensus reaching process in a group of individuals. To simplify, we attempt to make preferences of the individuals more similar and, in fact, get the decision makers closer to the consensus in the sense of agreement. Basically, there is a finite set of $N \geq 2$ alternatives, $S = \{s_1, s_2, ..., s_N\}$, and a finite set of $M \geq 2$ individuals $E = \{e_1, e_2, ..., e_M\}$. Each individual $e_M \in E$ expresses his/her preferences as to the particular pairs of options in the form of individual *fuzzy preference relation* R_m in $S \times S$, and its member-

ship function $\mu_{R_m} : S \times S \to [0,1]$. Namely, $\mu_{R_m}(s_i, s_j) > 0.5$ indicates the preference degree of an alternative s_i over an alternative s_j, and $\mu_{R_m}(s_i, s_j) < 0.5$ indicates, properly, the preference degree of an alternative s_j over an alternative s_i. The third possible relation represented by $\mu_{R_m}(s_i, s_j) = 0.5$ is also acceptable and denotes the indifference between two considering alternatives s_i and s_j.

The *discussion* is meant as a way to clarify the preferences of the decision makers as to the every pairs of alternatives, exchange of the knowledge and advocate different opinions. During this part, moderator monitors the decision making process, identifies problems (opportunities), filters and tracks relevant data and information and provides suggestions and hints which helps to obtain a final decision. If the satisfactory consensus has been received the session ends, otherwise another round of discussion is set up and some other clues are made by the system in order to help guide the process to the final agreement.

By the *feedback information generation* we understand the fact that the system confronts the individual preferences relations and the list of options submitted by the decision makers during the discussion. Furthermore, *external information sources* and *collaborative filtering* support the discussion by any additional available information and make the flow of information more efficient [5].

It seems that such a combination of tools and modern knowledge will help to develop an innovative human-consistent systems for supporting consensus reaching process. In these systems human perception or valuation becomes essential, thus we can not ignore human characteristics like variability of opinions, imprecise preferences, etc [3].

4 Notion of fairness in group decision support systems

One of the definition of *fairness* says that "fairness means the satisfaction of justified expectations of agents that participate in the system, according to rules that apply in a specific context based on reason and precedent" [10]. Fairness is an intricate idea that depends on many factors, i.e. cultural values, context of the problem. It combines many different research areas such as mathematics, philosophy, economics and other social sciences, especially social psychology. The last research area is crucial because it gives a response to a question: how people understand fair behavior.

The explanations can be given by the definition of the *cooperative game theory* which virtually is a game where players can enforce fair behavior. Cooperative game theory is connected with the distribution of benefits that a group of agents achieves from cooperation. The model assumes that the group

of individuals wishes to solve a common problem and by cooperating they could solve the problem more efficiently [9]. In fact, several research in psychology has shown that in group situations, the decisions of individuals are influenced by motives such as group performance, sense of responsibility for others, or social concern.

Furthermore, many psychological studies have revealed that, in real life, decision makers are not as selfish as the solutions received using mechanisms of rational choice approaches, in the sense of maximization of some utility function. Experiments showed that individuals tend to cooperate and give priority to fairness over greedy behavior [3].

Trust game will transparently perform this activity. In the *trust game*, A has an initial amount of money he or she could either keep or transfer to B. If A transfers it, the sum is tripled. B could keep this amount, or transfer it (partially or totally) to A. Traditional game theory suggests that A should keep everything, or if A transfers any amount to B, then B should keep all. Experimental studies have revealed that agents tend to transfer about 50% of their money and this fairness and cooperation is related to all cultures, sexes, etc [1].

With reference to our assumption that fairness means the satisfaction of expectations of agents, group decision support system should provide the sense of satisfaction among the group members during the discussion and after process completion. According to the psychological research, satisfaction of decision makers has a direct influence on higher quality of final decision and several further activities, i.e. practical implementation of the final decision or survival of the group in the long time period.

5 Fair share of distributed resources

In our research we mainly reflected on one of fairness judgments identified by social psychology, namely *distributive fairness* [8]. It is usually related to the distribution of resources, goods or costs, thus to *fair resource allocation problems*. Resource allocation problems are concerned with the distribution of constrained resources within competing activities so as to achieve the best general implementation of the system with respect to fair management of all the participants. Briefly speaking, the aim is to take a *fair share* of the distributed goods, thus to find such a distribution that is perceived as fair by all individuals.

According to our background – decision support systems – we considered *system fairness*. It could be meant as the ability of a system to enforce the distributional fairness of all individuals participation in goods or costs [9].

The main goal of considering system is to take into account preferences of every individuals and get the entire group closer to the consensus with fair

treatment of all the participants. We neglect the situation when the moderator gets decision makers closer to the consensus by argumentation and persuasion as to the most promising directions, individuals which are isolated in their opinion are omitted. Moderator can not ignore the individuals who are isolated in their opinions as to the rest of the group members, quite the contrary it has to convince them to change their previous preferences. This attitude undoubtedly carries out one of our assumption, namely, active participation of every individual during the entire consensus reaching process.

As we assumed, our research should be done with respect to fair distribution. The theory of distributive fairness can be applied whenever it is possible to precisely define a fair distribution problem and to find a solution that is accepted by the participants (or proposed by the moderator). If we consider the distances of the individuals' opinion to the final opinion, naturally, the final opinion should be fair in the sense that the distances of the individuals' opinions to the final opinion should be fairly distributed.

6 Fair solution to decision making problem

The basic idea of fairness has been divided on two possible directions. The first one, presented in the previous section concerns a fair distribution of resources, while the second is directly connected with the outcome of decision making process, namely a *fair final decision*.

Fair solution to decision making problem has its origin in a voting process and concerns two main aspects: every vote counts and the majority rules. We simply define a *fair decision* as to reach a final consensus during a series of discussions. However, the majority here refers directly to the outcome and can be defined as the *soft consensus,* a conceptual human-consistent framework proposed by Kacprzyk and Fedrizzi [4,5], and Zadrożny [2]. The developed idea is meant basically as an agreement of a considerable majority of individuals with regards to a considerable majority of alternatives. This operational definition of consensus can be, for instance, expressed by a linguistically quantified preposition: *„most of the individuals agree in their preferences to almost all of the options"*, and the consensus degree (in the range [0,1]) is computed. It means that, except none or total agreement between agents as to the chosen solution, this approach allows to some partial, acceptable consistency.

Notice, that to define a fuzzy majority for measuring a degree of consensus the application of *fuzzy linguistic quantifiers* (most, almost all etc.) has been performed. The computations of this relative type of linguistic quantity can be also handled via, i.e. Zadeh's classic calculus. Regardless of the way of implementation, the main condition of this novel approach is that it definitely overcomes the conventional concept in which full consensus occurs only

when „all the individuals agree as to the all the alternatives", what is unrealistic in practice.

What matters here, is that we neglect the majority related to the discussion when it was defined by the opinion holding by more agents in a encounter. Hence, the situation when minority must obey majority and change their opinions accordingly is in a proposed system ignored.

7 Conclusions

In this article we proposed a new concept of supporting group consensus reaching process. We considered the approach of soft consensus model proposed and successfully implemented by Kacprzyk an Zadrożny [6] enriched by the novel fairness component. This notion is strongly connected with psychology, economics, game theory, etc. and, as a result, takes into account more socio-psychological aspects of group behavior. In fact, it helps us to understand typical human behavior within a group of individuals and to extend more intelligent, human-centric and human-consistent systems for supporting consensus reaching in the future development.

Our research determined us to formulate conclusion that degree of consensus obtained by including aspect of fairness would be higher than the previous approach based solely on soft consensus with the use of fuzzy logic. Hence, we take liberty of defining a hypothesis that the concept of novel approach affects directly on effectiveness of decision making process and the quality of the final decision, which becomes highly justified. The ultimate goal of our further research is the mathematical formalization of the fair group consensus reaching process (building a model with regard to the real events and psychological facts) in order to confirm or to reject our assumptions.

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