SOME REMARKS ON THE CONCEPT OF FAIRNESS IN THE SUPPORTING
OF CONSSENSUS REACHING PROCESSES

DOMINIKA GOŁUŃSKA, JANUSZ KACPRZYK

Summary

We briefly present the idea of a new approach to a more effective and human
consistent supporting of consensus reaching based on the concept of fairness. Our
approach combines a formal, fuzzy logic based direction to the derivation of the con-
cept of a (degree of) "soft" consensus proposed by Kacprzyk and Fedrizzi [10,11],
with roots in Kacprzyk's [6, 7] concept of a fuzzy majority, and then further devel-
oped and implementd by Kacprzyk and Zadrożny [15–17] and some new directions in
multiperson decision theory and decision analysis that are based on some results of
social, cognitive economic, psychological, etc. sciences that advocate the inclusion of
some sort of fairness. In our case, we propose the idea of a fairness based consensus
reaching process, and its support, taking into account two aspects: a fair distribution
(fair resource allocation) and a fair final decision. We emphsize benefits resulting
from the implementation of proposed concept in group decision support systems, no-
tably those related to consensus reaching, and indicate some fruitful directions of
a further model development.

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

Introduction

Decision making is a mental process of choosing a best option from among those options that
are available or feasible, and it is clear that a full fledge analyses of decision making processes
should be interdisciplinary and involve results from many disciplines, for instance, psychology, so-
ciology, economics, philosophy, political science, etc. Of course, our interest is in formal,
mathematical approaches but – by their very nature – they cannot by themselves only capture intri-
cacies of human behavior and choice.

Basically, in all the above mentioned directions, the essence of decision making is always the
same: there are some options to choose from and some of them has to be chosen. In fact, many
different models of decision making process are known, with many of them enhanced by the analysis
of human behavior, social interactions and other socio-economic descriptions depending on a par-
ticular need and purpose. All of these novel agent-based computational models appeared in order to
make the process more human-consistent and hence easier implementable. That is the reason, why
we decided to apply psychological and sociological theories to investigating and designing systems
in this research area, in our case in group decision making and consensus reaching.
Some remarks on the concept of fairness in the supporting of consensus reaching processes

As it is well known, a group of individuals is very often, if not always, the most effective (though often not the most efficient) body of decision makers in decision making processes. In spite of several dysfunctions of the functioning of groups, there are some crucial benefits. Namely, groups are usually than individuals at understanding the very essence of the problems, at discovering errors, at learning how to proceed, etc. Moreover, a group has more information than any single member and can combine this knowledge to derive better solutions and stimulate the creativity of the participants in the process. Hence, the group decision making process will be the main focus of our further consideration. Considering different natures of the group decision making problem, we basically take into account interpersonal orientation groups. It means that the final solution of the problem is only a minor goal and the priority is to ensure a good relation within the group members during the decision making process and to achieve consensus in the sense of some satisfactory agreement as to an option.

In our setting, we want to guarantee an equal participation 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 are therefore omitted. Finally, outsiders do not feel the satisfaction of the discussion what affects the effectiveness of decisions by the group as a whole. Of course, it does not exclude the reaching of a final decision but decreases the opportunity, for instance, a 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 a consensus degree which will consider the satisfaction of every individual throughout the consensus reaching process. According to the fact that most of the human behaviors have not yet been fully formalized mathematically, our purpose is to get a better understanding of how social mechanism in group decision support systems works, and how they can be described in a more formal way. Furthermore, we should reduce the complexity of proposed system with a detailed description of only relevant aspects.

Group Decision Support Systems

Since the development of modern technology, computerized support in decision making has received much attention in both the research community and among practitioners. Today, tools and techniques employed in systems developed are flexible, effective and efficient, easy in use and allow to design and implement 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 is usually termed decision support systems. They combine the intellectual resources of individuals with the capabilities of the computer to improve the quality of a final decision.

Similarly, group decision support systems (GDSSs) mean interactive, computer-based systems that facilitate the solution of nontrivial, unstructured problems by a group of decision-makers working together in some sort of a synergistic way. Unstructured problems are usually fuzzy, and occur in complex processes for which there are no clear cut solution methods and where human intuition is often a basis for decision making. Software products provide a more and more effective and efficient collaborative support to such groups of individuals (agents, actors, . . .), 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 just a support for decision makers to facilitate their decision.
making processes but not to replace them; the underlying assumption is that the decision makers are autonomous. Moreover, it is a dynamic system which is 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) cf. Fedrizzi, Kacprzyk, Owsiński, Zadrożny [2], fedizzi, Kacprzyk, Zadrożyń [3], Kacprzyk J., and Zadrożny S. (1988) Kacprzyk and Zadrożny [16,17], Turban, Aronson, Liang [24], etc.

The key to the 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 by taking into account cognitive aspects and social dimension. In the GDSSs context this means that the computer asks a group to solve a problem, then collects, interprets and integrates the partial solutions obtained by the humans, and possibly suggests a solution that would be preferable to the entire group.

1. A schematic view of the proposed system

The general scheme 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 between two or more agents. Its core is composed of a preference structure (obtained via pairwise comparisons of options) and consensus measurement modules, but the discussion and external information sources are also treated as a significant part of the scheme.

Setting the agenda is the first stage which concerns the definition of the decision making problem considered and a plan for its analysis and solution. The representation of options is denoted as domain ontology (domont) while the consensus ontology (consont) defines main concepts of the consensus reaching process – cf. Kacprzyk and Zadrożny [17].

We discuss a consensus reaching process in a (small, that is, not – for instance – within a nation) group of individuals. To simplify, we basically attempt to make preferences of the individuals more similar and, in fact, get the decision makers closer to the consensus in the sense of an agreement as to their preferences.

Basically (cf. Kacprzyk and Fedrizzi [10,11], suppose that 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 membership 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 $s_j$. 
Some remarks on the concept of fairness in the supporting of consensus reaching processes

The discussion is meant as a way to clarify the preferences of the decision makers as to each pair of alternatives, exchange of knowledge and opinions, and suggest some possible changes in the preferences of individuals to attain a greater consensus degree. During this part, a special individual who is commissioned and responsible for an effective and efficient running of the consensus reaching process, called a moderator, monitors the decision making process, identifies problems (opportunities), filters and tracks relevant data and information and provides suggestions and hints which can help obtain a final decision (a high degree of consensus). If a satisfactory degree of consensus is obtained, the session ends, otherwise another round of discussion is set up and some other clues are made by the system or the moderator in order to help guide the process to a better 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 process. Furthermore, **external information sources** and **collaborative filtering** support the discussion by any additional available information and make the flow of information more efficient – cf. Kacprzyk and Zadrożyń [17].

It seems that such a combination of tools and modern knowledge will help develop an innovative human-consistent system for supporting consensus reaching process. In such a system human perception or valuation becomes essential, thus we cannot ignore human characteristics like the variability of opinions, imprecise preferences, etc – cf. Tyler and Smith [25], Young [27].

### 2. The concept of fairness in group decision support systems

One of better known definitions 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” – cf. Wierzbicki [26], Young [27]. Fairness is an intricate idea that depends on many factors exemplified by cultural values, individual perception, social, economic, etc. context, etc. The analysis of fairness 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 can obtain from cooperation. The model assumes that the group of individuals is meant to solve a common problem and by cooperating they could solve the problem more effectively and efficiently. In fact, many results in psychology have clearly indicated that in group decision type situations, the decisions of individuals are influenced by motives such as group performance, sense of responsibility for others, or some social concern.

Furthermore, many psychological studies have revealed that, in real life, decision makers are not as selfish as it may be expected looking at traditional decision making approaches based on mechanisms of rational choice in the sense of maximization of some utility function. Experiments showed that individuals tend to cooperate and give priority to a fair over greedy behavior – cf. Camerer [1], Kacprzyk [8].

**Trust game** is a good example in this respect. In the trust game, agent A has an initial amount of money he or she could either keep or transfer to agent B. If A transfers it, the sum is tripled. B can keep this amount of money or transfer it (partially or totally) to A. The traditional game theory suggests that A should keep everything, or if A transfers any amount to B, then B should keep everything obtained. Experimental studies have shown that agents tend to transfer about 50% of their money and this fairness and cooperation is related to all cultures, sexes, etc. – cf. Kacprzyk [8].

What concerns our context, fairness means the satisfaction of expectations of all agents, that is, that the tools developed and the group decision support system should provide the sense of satisfaction among the group members during the discussion and decision making phases, and even after the process completion, for instance, while the decision or solution reached is being implemented. According to the results of psychological research, the satisfaction of decision makers has a direct
influence on a higher quality of the final decision, and hence a higher chance of its implementability, and even the survival of the group in the long time period.

**Fair share of distributed resources**

In our research we are mainly concerned with the fairness of judgments identified by social psychology, namely the so called *distributive fairness* – cf. Tyler and Smith [25]. 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 a best general result. Of course, in our case this is under the condition of a fair treatment of all the participants or agents. 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 main field of interest, the decision support systems, we consider what might be called *system fairness*. It could be meant as the ability of a system to determine and propose a fair distribution of resources, goods or costs, to all participating individuals.

The main goal of the system considered here is to take into account preferences of each individuals and get the entire group closer to the consensus with a fair treatment of all the participants. We neglect the situation when though the moderator gets decision makers closer to the consensus by argumentation and persuasion, some individuals who are isolated in their opinion are omitted. In our approach it is assumed that the moderator cannot ignore the individuals who are isolated in their opinions in comparison to the rest of the group members. To the contrary, he or she has to convince them to change their previous preferences. This attitude undoubtedly carries out one of our assumption, namely, an active participation of each individual during the entire consensus reaching process.

As we assume here, our research follows the 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 of the entire group, then, 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.

2. Fair solution to decision making problem

As we have already mentioned, the basic idea of fairness in our context of consensus reaching is divided into two possible aspects. The first one, presented in the previous section, concerns a fair distribution of resources, while the second is directly related to a fair outcome of the decision making process, namely a *fair final decision*.

Fair solution to decision making problem has again its origin in the voting process and concerns two main aspects: each vote counts and the majority of agents rule decide. We simply define a *fair decision* as the one that is obtained as a result of reaching a (sufficiently high degree of) final consensus during a series of discussions. However, the majority here refers directly to the outcomes and can be defined in terms of the concept of *soft consensus*, a conceptual human-consistent framework proposed by Kacprzyk and Fedrizzi [10, 11], and further developed by Kacprzyk and Zadrozny [15–17], etc.. The developed idea is meant basically as an agreement of a considerable majority of individuals with respect 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 employed. The computations of this relative type of linguistic quantity can be also handled via the classic Zadeh’s [28] calculus of linguistically quantified propositions. 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 is that in this traditional approaches, which are clearly efficiency oriented, we only take into account what a majority thinks (the so called “tyranny of majority”) so that a minority must obey a majority and change their opinions accordingly. In the proposed system, first of all, the use of Kacprzyk and Fedrizzi’s [10, 11] degree of consensus based on Kacprzyk’s [x] concept of a soft (fuzzy) majority, does provide by itself some mechanisms and tools to take into account opinions of a minority, as we are concerned with what, for instance, “most” thinks. This can lead to some formal models which have been proposed in our next papers (e.g. Kacprzyk and Goluńska [9, 12]).

Concluding remarks

In this article we proposed a new concept of supporting group consensus reaching process. We operated within the context of kacprzyk and Fedrizzi’s [10, 11] soft degree of consensus implemented following the idea of Kacprzyk an Zadrożyń’s [13] consensus reaching decision support system. We have indicated that those traditional approaches do not fully take into account relevant results obtained in the areas of sociology, cognitive sciences, psychology, etc. which clearly indicate that fairness in the accounting of opinions of of the majority and minority should be accounted for. We proposed a conceptual framework to include fairness in such consensus reaching and its computer based support systems.

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Some remarks on the concept of fairness in the supporting of consensus reaching processes

Bibliography


Dominika Gołuńska, Janusz Kacprzyk

Some remarks on the concept of fairness in the supporting of consensus reaching processes

UWAGI O POJĘCIU SPROWIEDLIWOŚCI W PROCESACH WSPOMAGANIA KONSENSUSU

Słowa kluczowe: konsensus, osiąganie konsensusu, komputerowe wspomaganie decyzji, logika rozmyta, strategie sprawiedliwe

Streszczenie

Przedstawiono nowe podejście do wspomagania procesu osiągania konsensusu w grupie agentów (ekspertów) oparte na koncepcji sprawiedliwości. Zaproponowane podejście łączy w sobie formalne podejście do osiągania konsensusu oparte na koncepcji “miękkiego” stopnia konsensusu wprowadzonej przez Kacprzyka i Fedrizziego [10,11], wywodzącego się z koncepcji większości rozmytej Kacprzyka [6,7], rozwiniętego w pracach Kacprzyka i Zadrożnego [15–17]. W pracy korzysta się z nowych koncepcji i wyników naukowych uzyskanych w teorii i analizie decyzji wieloosebowych, opartych o wyniki badań w dziedzinie psychologii, nauk społecznych, kognitywistyki itp., w których akcentuje się potrzebę uwzględnienia sprawiedliwości w uwzględnianiu opinii, rozdzielce zasobów itp. W pracy proponuje się nowa koncepcję wspomagania osiągania konsensusu i jego wspomagania z uwzględnieniem sprawiedliwości w alokacji zasobów informacyjnych i sprawiedliwej decyzji finalnej. Pokazano zalety takiego podejścia, głównie związane z możliwym przyspieszeniem osiągania konsensusu i osiągnięciem lepszego jego stopnia w grupie. Ponadto, wskażano na dalsze kierunki badań.

Dominika Gołuńska
Department of Physics and Applied Computer Science
AGH University of Science and Technology
Aleja Adama Mickiewicza 30, 30-059 Kraków

Janusz Kacprzyk
Systems Research Institute, Polish Academy of Sciences
ul. Newelska 6, 01-447, Warsaw
e-mail: kacprzyk@ibspan.waw.pl