A Prototype System for Exploring Disagreement in Group Decision

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***Abstract*—The knowledge of the positions of the different members in a group decision situation is used in a prototype of a group decision support tool that explicitly computes and presents the differences between the individual positions held by each group member to help the group describe and define the parameters of the decision problem.**

A collaboration model based on two stages, one of group structuring (communication), and one of individual discrimination (appropriation) is proposed. These stages alternate as each individual learns about other group members preferences, to accommodate other inputs and preferences, or to explore the problem. Information regarding the sources of disagreement between group members' positions and the changes that would be needed to achieve equal results are provided by the system, to help achieve a common solution (if possible).

I. Introduction

The process of group decision making may be thought of as being one of interactive (and frequently iterative) decision and comparison between group members. In [13] its proposed that it includes three iterative levels of information processing:

Individual
: Group members process information individually, concentrating on their own decision processes.

Interpersonal
: They learn about the thoughts and opinions of other members, and incorporate them in their own decision processes to arrive at an individual decision.

Collective
: The group exchanges and processes information as a collective entity in order to arrive at a joint decision.

Even though these levels are intertwined in any collaborative situation, it is important to draw a conceptual distinction among them because each level supposes distinct modes of interaction and requires different levels of support. Most notably, there seems to be a marked distinction between the first stage of individual information processing and the following two, of group interaction and contrasting of positions.

The prototype described here tries chiefly to help group members in the interpersonal stage of group decision, trying to help them achieve individual positions that are acceptable to other group members, as a point of departure from which to eventually achieve consensus, or at least to strive to elaborate a collective decision. However, as the individual decision stage influences the subsequent, and may be responsible for the success or failure of the others, the system must also concern itself with it.

In fact, if this individual stage is not addressed, it is quite likely that the differences on outcomes (disagreement) present at later stages will be bigger than required. This can happen as the result of choices made by each group member which could easily be changed to equivalent (or almost equivalent) decisions that would give the same (or similar) individual results, while respecting the preferences of the user. In such a situation, the disagreement between group members stem not from known individual preferences, but are an "artifact" of the decision method used.

Although there are plenty of systems that intend to help groups in their decision tasks (e.g. [1], [5], [7], [14]) most of those focus mostly on qualitative help. The fewer that try to provide quantitative support, usually don't care explicitly about the differences between the positions of group members (the actual sources of disagreement), considering them just a tool to be used while striving for the common solution. We present another approach, in which those sources of disagreement between the group members' preferences are the explicit focus of the system, rather than something unpleasant to be dealt with. Although the main focus will also be (if group consensus is desired) to minimize this disagreement, it is assumed that there will be some occasions where the disagreement will not be overcome. However, we hope that even in this situation, the explicit knowledge gained by a system like the one presented here can be useful (for instance – if that is permitted by the group decision process – to form the basis of alliances on "shared" preferences, or "near" preferences).

To support the approach a mathematical representation of the decision process of each group member, allowing the explicit representation of the differences among the preferences of all group members is used (defined in [10]). From this base a disagreement description stemming from the pair wise comparisons of each member's individual decision making process is computed. This provides support for the interpersonal level of information processing.

To test this approach, a prototype of a Group Decision Support System (GDSS) that includes support for explicit disagreement between group members was developed. This prototype tries to guide group members to a common characterization of the problem, supporting group communication and generic problem description, but also allowing for individual incorporation of problem characteristics in personal models (problem appropriation). During both communication and appropriation stages, the group tries to minimize the disagreement sources that are harmful to group consensus by depicting the effect of individual choices on pair wise consensus between group members.

Although the approach presented is generic, the prototype was created assuming a decision problem requiring the classification of discrete alternatives. These alternatives ("actions") are characterized according to several criteria, and classified according to different classes with boundaries provided by "reference actions", as defined in the ELECTRE TRI method (presented in [19]). The objectives of the work described included validating the capability of implementing a framework to compute and evaluate disagreement within this setting, for this problem.

It is assumed that disagreement among the group members may be present either on preferential information or in the actual model of the problem. Some kinds of sources of disagreement are easier to accommodate than others, and as such the prototype tries to lead the group members into create descriptions with less "disruption potential". While each group member has a model of the decision problem, it cannot be said that the group as a whole has such a model (or rather, it possesses a description that may incorporate many such models). The task of the system is therefore to allow each group member to create such a description and (later) to use it to create individual operational decision models that can be used as a step to an eventual group model (if such a model is agreed).

In this article, we start by referring the sources of the disagreement that may arise in a decision situation and (very shortly) how they can be handled. We then present the distributed collaboration model we are following, based in two stages, one of communication and another of appropriation. Finally, after a presentation of related work, the basic components and usage of the prototype are described in section V, followed by a discussion of the approach and future work directions.

II. Disagreement in Decision Making

At the lowest level, the process of reaching a decision on a group decision task may be thought as including at least a stage during which the group members try to reconcile their positions by comparing and contrasting them (as in [3]). In these stages, the differences between those positions (sources of disagreement) are very important, and as such they should be computed and (if possible) minimized, as a stepping stone to reach a decision. Moreover, care must be taken that the disagreement between group members reflect actual differences in preferences, and are more than just artifacts created by the structuring or the decision processes. A framework (presented in [10]) within which those differences may be computed, and compared, was implemented in this work.

A. Handling Disagreement and its sources

If we focus on the interpersonal interaction between group members, it is easy to conclude that disagreement may stem from differences existing in several of their approaches to the decision problem. If we assume that the group task ranges from the problem structuring up to the final decision, that there is a set of alternatives each to be evaluated according to a set of criteria (each alternative is assumed to be characterized quantitatively on these criteria). It is further assumed that each group member reaches a conclusion by giving to each criteria an individual valuation (individual parameters, usually related to weights). According to this model, we can see that individuals may disagree on the:

individual parameters
: which each group member assigns, representing their individual valuations (usually of decision criteria);

criteria used
: which may be seen as an extension of the ones previously used, or may be independently handled (may even allow the usage of criteria to represent and thus quantify "other people opinions");

alternatives evaluation
: though more usually considered as "given" ([3]), these may also be considered during the structuring stage;

processing method
: a necessary extension if we assume that group members create their evaluations individually, though it may make the process of achieving consensus (or even measuring their disagreement in a meaningful way) quite difficult.

These sources of disagreement are sorted roughly by the "disruption potential" - the difficulty of other group members to incorporate changes on these items inside their own decision mechanisms. It can be predicted, however, that allowing unrestricted structuring by group members may lead to precisely the emergence of "harder" kinds of disagreement.

A framework that tries to handle the first two kinds of disagreement sources was applied to the ELECTRE TRI method (see [10], [19]). Incorporating this work, the prototype presented here tries to provide support for this task in a distributed collaboration environment, and to lower the "disruption potential" of the differences encountered.

III. Distributed Collaboration

The task of supporting group decision is a hard one, not only because of difficulties inherent to any kind of decision support, but also because it must face the problems that are present in any distributed cooperative-work system (see, for instance [1], [12], [17]).

The prototype acts as a distributed, asynchronous system, allowing its usage both when all group members are "on-line", and connected to the central system (synchronous usage) as well as when the group member is working alone, or without connection to the central repository (asynchronous usage). In the following section we will focus instead on the system usage, and how it proposes to achieve some of the goals stated in section II-A.

A. Communication and Appropriation

If the task of group problem solving is to incorporate structuring, support must be provided for two stages (see Table I): a communication stage, during which the group members try to describe the shared information about the problem, and an appropriation stage, where each group member tries to recover from the common information a structured problem description that fits its preferences. The rationale for this approach is to allow incorporating into the problem description the different components required by each group member but at the same time to manage the incorporation of those elements in the individual problem description, so that the differences among those descriptions don't unduly contribute to final disagreement among group members.

During the first, communication stage, as seen in Figure 1a, the group members cooperate in adding to (structured) group memory record the details about what they think is the problem. This is at heart a structuring problem, which could be seen as somewhat independent of the subsequent problem resolution. However, as we are concerned with the disagreement that the subsequent process will elicit, we may already try, in this stage, to guide the group members to structures that lower the "disruption potential". This may be done either by presenting to the group members either components judged adequate to the problem domain or even what the other group members have already chosen (thereby trying to frame the problem within common elements).

During the second, appropriation stage, seen in Figure 1b, each group member is free to choose among common information those bits that better reflect its preferences. However, the system should again try to help the group to achieve descriptions that are less "disruptive". Therefore, it is proposed that the choice may be guided. The actual form of guidance can be dependent on the problem to be solved (that is, the guidance may use expert knowledge, associated to the problem domain, to suggest "common" complex structures or even more or less complete problem descriptions) or can be achieved simply by "blind" association mechanisms (that try to suggest problem descriptions based only on knowledge of previous choices taken by other group members).

IV. Related Work

Measuring disagreement and its sources among members in a decision task is not a common approach to the process of group decision. In [18] an approach is presented which relies on measuring agreement although related to limited information exchange situations. The subject of consensus however is one of long discussion on group support systems, though the extent of the contribution of such systems to achieve such consensus may be debated. Though a rough agreement may point to the hypotheses that GSS decrease consensus [9], or at best have no discernible effect [8], some studies present opposite views [11].

Further, the concept of consensus is frequently ill defined, encompassing both unanimity and simple majority of views. To give operational meaning to the definition, several measures have been proposed and used. Frequently used measures include rank correlation measures (Spearman-ρ, Kendall-τ-b, either directly or through a fuzzy measure [15]) which however have the problem of frequently equating preference relations to order relations. In [18] an alternative measure is proposed based on pair-wise comparison of alternatives, however limited to binary choices. More recently, [4] presents a consensus measure with similarities to the one proposed (although more geared to the outcomes and not to the inputs of the process) based on Dempster-Shafer probabilities.

Although the concept of two stages (Communication and Appropriation) may evoke the obvious parallels to the divergent and convergent phases of group problem solving, a remark must be made that the divergence of the communication stage may be limited by efforts to prevent it (through the convergent approaches presented). The more directly convergent appropriation stage may stop short of achieving actual convergence, but that result, either by design or failure to achieve consensus, is common in several approaches that allow actual divergence in a group ([2], [6]).

V. The ELECTRE-TRI-G-DIST Prototype

To provide the support defined in section III, a prototype of a GDSS has been developed by the authors. This prototype provides specific support for the two stages described before, in the context of a classification problem.

This tool intends to support some group structuring and provide information regarding the evaluation of differences between group members' preferences. It uses a simplified ELECTRE TRI method (described in [10]) as the group decision / processing method.

A. The Prototype Functional Components

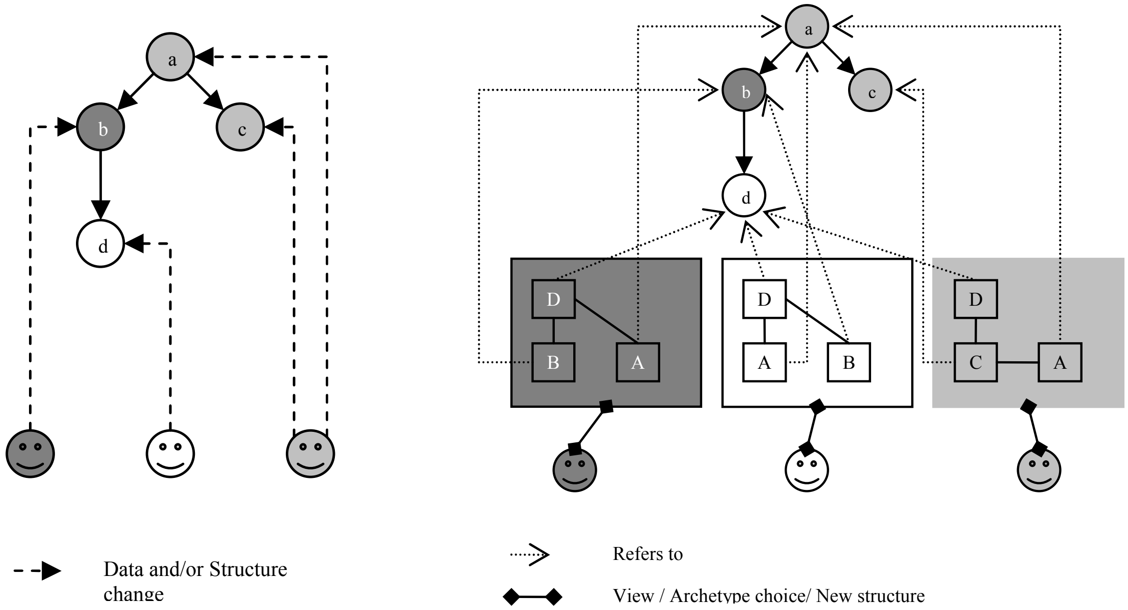
The communication stage makes use of all the usual mechanisms present in group collaboration tools, including threaded messages and optional attachments, in an environment that allows both synchronous and asynchronous message exchange (see Figure 2).

The system includes support for structured information to be input by group members in the messages in a way which allows automatic access by other components of the system. To do so, however, the information structures that comprise a problem must have been defined beforehand. This limits somehow the freedom of group members in describing the problem in their own terms, but at the same time it may also provide some guidance that may help limit disruptions.

The information that describes the problem is thus introduced in a discussion as a set of (standard) attachments to messages. These attachments include "criteria", "actions",

Stage	Kind	Activity
Communication	Pre-Structuring	Collective, on Shared Information
Appropriation	Post-Structuring	Individual, "Views" on the common information

TABLE I
THE TWO STAGES OF INFORMATION STRUCTURING



(a) Communication (b) Appropriation

Fig. 1. Two Stages of Information Structuring

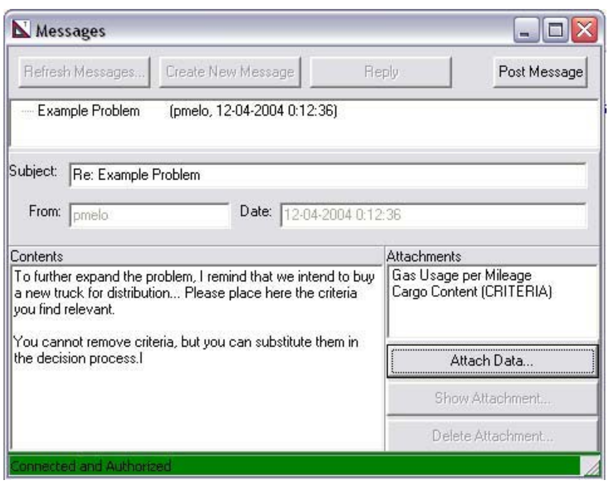


Fig. 2. ELECTRE-TRI-G-Dist Messages

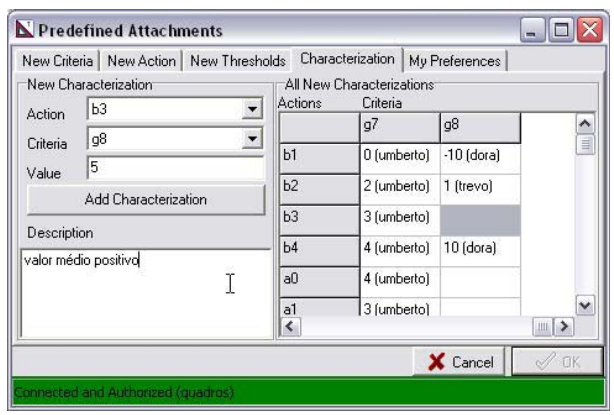


Fig. 3. Standard Attachments

"thresholds" and "characterizations", as can be seen in Figure 3. This was achieved by creating distributed objects that describe those structuring components. The definitions of "actions" (alternatives) and "criteria" are those of standard Multi Criteria Decision Making theory, while "characterizations" and "thresholds" are numerical values that relate them. This mechanism can be extended to incorporate alternative problem descriptions.

Those attachments create a (probably redundant) description of the problem, which will be then "trimmed" by each group member according to its preferences. Notice that additional preferential information will also be shared, as a result of this appropriation stage. Each group member thus faces a choice of which information from the shared description should be incorporated in their personal structure. In the current version, the prototype tries to help on this task by supplying

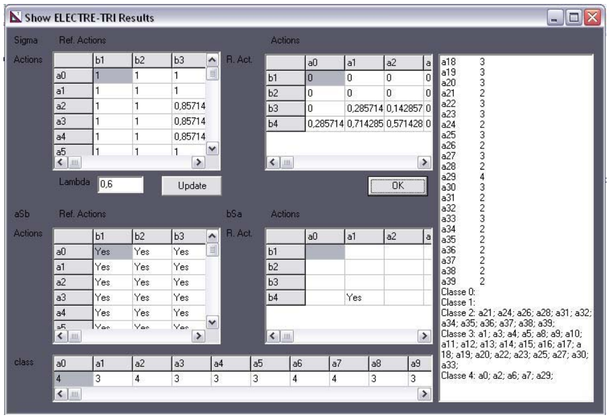


Fig. 4. ELECTRE TRI calculation

the structures chosen by other group members (if they are available) - "context blind" guidance. The prototype will then be able to perform the ELECTRE TRI method calculations using the preferences of that (or of any other) group member (see Figure 4), and therefore to present a classification using currently chosen actions and criteria.

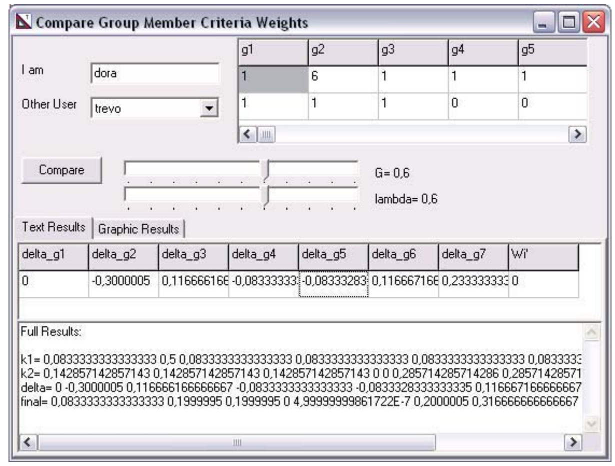
A rough disagreement measure between group members can be computed at any time (see Figure 5). The disagreement is presented in the form of the changes that are needed in the preference structure of one individual to achieve the same results of the other. That group member is then able to change (or not) his preference structure to accommodate the other.

Notice that this "disagreement sources" exploration process is not "the final stage", as at any time the problem structure can be enriched, possibly as a direct result of this exploration. Support for automatic inclusion of other group members' preferences in the individual preference structure has been considered, but in order not to deny freedom to the decision makers, it was decided that such action should always be made explicitly by them, upon looking at the other members preferences.

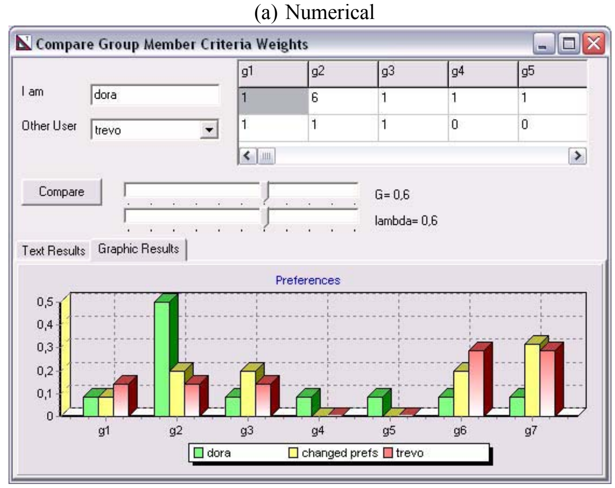
B. Prototype Usage - an outline

To clarify the previous description, we will provide an outline of the prototype usage. In the beginning, the raw data regarding the problem must be input into the central repository, where it will be available to all group members. That will generally be made using message attachments, like the ones presented in Figure 2 and 3. There is also support for automatic loading of full problems previously analyzed, to allow either to create a more advanced starting point or to further analyze previous problems.

Even before the full problem information is entered into the system, group members may begin integrating the parts they considered important into their own problem descriptions (appropriation stage). They can then discover the ELECTRE TRI result of this problem. In Figure 4 we assume that the group has already introduced a problem constituted by 40 actions (a0 to a39) and 4 reference actions (b1 to b4). According to the preferences of the group member chosen,



(a) Numerical



(b) Graphical

Fig. 5. Disagreement between Group Members

these actions are placed into 5 classes by ELECTRE TRI, as shown.

If a group member considers at any time the problem description incomplete, he/she can add to it, again by using messages and attachments. The other group members can then decide whether or not to incorporate that new information in their problem description.

The theme of disagreement is raised by the system, both during appropriation, by showing what the other group members have chosen, and during / after the ELECTRE TRI calculation, by showing the actual differences between two group members positions, and what each would need to change to arrive at the others position. In Figure 5 it can be seen the changes needed for 2 group members that have preferences that differ in the 7 criteria (g1 to g7) to achieve the same ELECTRE TRI classification, using either a numerical (Fig. 5a) or graphical (Fig. 5b) interface.

The changes needed are depicted as variations needed on individual criterion preferences and/or explicitly give a certain degree of "trust" to the others decision (to the aggregate preferences depicted). Those amounts can be traded off (that is, a lower "trust" level on the other's decision will usually lead to higher changes on direct preferences).

Notice that information considered to achieve the results must obviously include the full information agreed upon by both group members. Although it does not allow true alternative characterization of a problem, and as such it is best that a common description can be found, if required the prototype can accommodate differences on characterizations by using "pseudo-actions", with similar semantics but differing characterizations. Likewise "pseudo-criteria" similarly constructed can be used to allow variation in the characterization according to a particular criterion.

If there is divergence between selected criteria, the system assumes a null weight on the "discarded" criteria, while differences between selected actions are handled by including on the results the union of all actions considered by the pair of group members (it is however assumed that all the reference actions and their characterization must be shared).

Based on the differences found between group members, they can either alter positions, convince others to change theirs, or simply "agree on the disagreement". In a group comprising (for instance) three members, two may share similar positions while a third is distant from them. This kind of system will allow the first two to reach a "partial consensus" position, by showing what (and by how much) each of them must change to achieve perfect consensus on outcomes (which does not need to imply full consensus on preferences). If the third member is so "far" that the changes needed on preference structure to achieve his results would be unacceptable for the first two, the group may use some other method (e.g. voting) to arrive to the final decision (in this situation, presumably, the first two members could ally themselves, since they share common preferences).

The prototype, as all of those systems that allow/require individual group member input, can be subject to strategic manipulation ([16]). As this possibility is intrinsic to the approach, the only response in the prototype to such behavior by group members is to record full logs of preference changes.

VI. Discussion and Future Work

We presented a prototype, now in field testing, that purposes to help group members to structure a classification problem, while taking into account (and trying to minimize) the differences existing between their preferences (sources of disagreement). In the current prototype, this "disagreement minimization" occurs mostly by explicit actions from the group members, in choosing compatible structures, and eventually incorporating in their preference structures the preference of others. The authors are considering incorporating into the prototype more automatic mechanisms, to help the group member in this task.

The work presented encompassed two main objectives: to create a prototype that implemented the adaptation of an approach based on computing the sources of disagreement in classification situations to using the ELECTRE TRI method, and to provide a group information structuring approach based on favoring the emergence of sources of disagreement with lower disruption potential over those of higher disruption potential. At the moment it is possible to validate the first component (since the artifact has been built, and functional testing allow us to confirm its working as designed), but the validity of the second component and of this approach must still be subject to further testing. While mathematical exploration of the problem does indeed point to certain sources of disagreement being harder to handle than others (both harder on a mathematical level and harder to understand by group members) further research is needed to check whether groups using this approach achieve higher consensus than those using alternative (or unguided) approaches.

When full group consensus is not forthcoming, subgrouping can be a strategy, assuming other means of conflict resolution can be used. Support for automatic clustering by statistical analysis of the individual differences, as well as other clustering solutions, is being studied for further incorporation in the prototype. As seen, choice methods could be supported by the prototype to handle situations where sub-groups can be identified. It is nevertheless not guaranteed that such an arrangement may be found in the general case. Since differences among individual positions are not symmetrical (that is, group element A may be "closer" to B than vice-versa) it is possible to hypothesize situations where no definite clustering of group members is viable. In this case, further research is required to decide the best subsequent course of action.

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