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SUPPORT SYSTEMS FOR DECISION AND NEGOTIATION PROCESSES

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GENERATION OF ALTERNATIVES IN GROUP DECISION SUPPORT

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Abstract:

In many practical group decision problems, alternatives are not well defined a priori, but have to be constructed as combinations of actions introduced by different group members. Both the generation of such "Composite alternatives" in the presence of global constraints and their aggregate evaluation can lead to specific problems. The combinatorial nature of the generation process also requires techniques for reducing the total number of composite alternatives generated.

Keywords:

Alternatives, group decision support, program planning, aggregation of data, filtering

1. Introduction

Many group decision support systems presented in the literature are based on the assumption that the group decision problem consists of choosing among a predefined, fixed number of alternatives (e.g. SCDAS: Lewandowski et al., 1987; Co-oP: Bui, 1987). An example, which is often used for this kind of problem, is the selection of one candidate out of several applicants for a given position. In many other problems, however, the definition of alternatives is not as clear, a priori, as in this example.

Often, each group member controls different aspects of the final group choice. When we view a group decision problem basically as a decision problem with several criteria, this control can have two kinds of effect: it might concern only criteria in which only that group member is interested, or criteria which are relevant for other members too. In the first case, the member might simply apply whatever changes he finds appropriate to the choice made by the group. For a group decision problem, only the second case is relevant.

In this case, we can formally structure the decision problem as a choice among alternatives, which are themselves combinations of different individual actions by group members. We will call such alternatives "composite alternatives" in order to distinguish them from the a priori defined alternatives which are usually considered.

Composite alternatives can arise in both cooperative and non-cooperative group decision problems. Examples for cooperative settings are joint programs of actions, which consist of different measures undertaken by different group members. In non-cooperative settings, composite alternatives can be seen as "packages" of concessions, which the different parties will jointly undertake (c.f. Saaty 1987).

The class of composite alternatives raises two closely connected problems: the first problem is that of the aggregation of individual components to actual decision alternatives, which the group as a whole faces. Since this aggregation is essentially a combinatorial problem, a second problem arises as the potential number of alternatives becomes very large and techniques for the reduction of the set of alternatives have to be developed. In the following section, we will successively discuss approaches to handle these two problems.

Problems, in which different aspects are based on different actions, might also be treated not as a decision problem with discrete alternatives but as a problem in which alternatives are only implicitly defined through constraints. However, especially for group decision problems, a representation based on explicitly formulated, discrete alternatives offers several advantages over implicit definition. For many decision problems, only ordinal rankings of alternatives or merely the selection of a single "best" alternative are required. On the other hand, individual evaluations can more easily involve a cardinal evaluation of alternatives. This makes it possible to exploit the span between ordinal and cardinal evaluations for the support of achieving consensus (Vetschera, 1991).

2. Composite Alternatives

2.1. Generation of Composite Alternatives

As an example for composite alternatives, we will use the problem of program planning, in which a program consists of several distinct projects which are undertaken by different group members. For example, the investment program of a company consists of several distinct investment projects, which are undertaken in different divisions of the company. Each project has consequences, which also might affect other group members (divisions). For example, investing in new production technology in one manufacturing branch might increase the quality of parts delivered to other branches and also affect the possibilities for marketing the final products. This leads to the problem of determining aggregate consequences of programs. On the other hand, projects also draw on common resources, e.g. the total funds available for investment in that company. Therefore, certain restrictions concerning the possible combinations of projects have to be formulated.

The generation of composite alternatives (programs) can thus be divided into three distinct phases: the selection of projects belonging to the program, the aggregate evaluation of consequences for the program and checking its feasibility.

The problem of generating programs from various projects is essentially a combinatorial one. It can be represented by a binary search tree, in which each branch corresponds to the decision of whether to include a certain project or not. The search tree can be significantly reduced when the three phases outlined above are not performed in sequence (i.e. first generating all possible combinations and checking for feasibility afterwards) but when restrictions on the programs are taken into account during their generation.

Whether this is possible depends on the aggregation mechanism used to determine the outcome of an entire program. For some attributes, the outcome of the program is simply the sum of individual outcomes of its projects. For example, in investment planning, the total funds required for an investment program are the sum of all funds required for the individual projects contained in the program. For other criteria, different forms of aggregation might be necessary. Especially in more qualitative criteria, extreme values of the projects can determine the total outcome ("A chain is as strong as it weakest link").

As long as the aggregation mechanism used is monotonous, in the sense that inclusion of another project will always increase (or always decrease) the total outcome, it is possible to reduce the search tree by branch-and-bound techniques, in which the tree is not further expanded once a branch has exceeded a constraint. For example, no further projects need to be considered in a branch, if all the funds available are already used by the projects included.

This approach can be conveniently implemented for many possible types of aggregation techniques and constraints using the search mechanism of fifth generation programming languages, especially Prolog.

2.2. Reduction of Complexity

Even if the constraints used in the generation process greatly reduce the number of programs generated, the resulting number of alternatives may still be too large for the problem to be treated as a standard discrete-alternatives decision problem. In this case, reduction strategies have to be applied to further reduce the number of decision alternatives.

One obvious reduction is the exclusion of dominated alternatives. Here a problem arises when not all group members consider the same set of attributes in evaluating alternatives. In this case, dominance could either be defined with respect to the entire set of criteria considered by any group member or with respect to each individual member's set of criteria. If individual sets of criteria are used, alternatives will appear to some members as dominated and to others as not dominated; thus a uniform reduction is not possible. If the entire set of criteria is used, only a small set of alternatives will be eliminated, but that set is the same for all members.

Since dominance, especially with respect to a large set of criteria, will eliminate only a small subset of alternatives, a further reduction in the set of alternatives might be necessary. Such a reduction can be based on two approaches:

1. Alternatives which are a priori bad choices (e.g. because they do not meet certain aspiration levels) are eliminated.
2. Only a representative sample of alternatives is generated and used in the decision process.

The first approach introduces a certain a priori element into the decision process. Especially if one takes into account the possibility of preference changes during the group process, this a priori influence is undesirable. The second approach, on the other hand, allows for a multi-step approach: after the group has reached consensus about one alternative in the sample originally considered, a second phase might be started, in which several alternatives close to that solution are introduced for more detailed evaluation.

3. References

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