An Interactive Method for Group Decision Making

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Introduction

Decision making problems are unformalized or weakly-formalized problems that require a decision maker (DM) in order to be solved. The resulting solutions are subjective, depending on the DM's preferences. The decision making problems are divided into three major classes: multicriteria problems, decision making problems in risk conditions and decision making problems in uncertainty conditions. Different tasks ranging from planning, management, analysis and control, transport, education to ecology, etc. can be formulated as multicriteria problems. Multicriteria problems are divided in two major classes depending on formal formulation. Multicriteria optimization problems are defined by a finite number of explicitly given functions, which describe an infinite number of alternatives. Multicriteria analysis gives a finite number of alternatives in table form.

In multicriteria analysis problems, a set of criteria are optimized simultaneously in an admissible set of alternatives. Generally, there is no alternative, optimal by all criteria (in this case the solution of the problem is trivial). For practical purposes, it is necessary to select only one alternative – with the help of additional information, extracted from the DM. According to the types of information given by the DM the methods are divided into: weighting methods, outranking methods and interactive methods.

With the development of information technologies, Internet and electronic communications more attention is paid to group decision making problems (GDMP). They are an extension to existing problems. However, in GDMPs the decision is not made by a single DM but a group of DMs, often referred to as experts. There are two different approaches, the apriori and the aposterior approach, to aggregating the information provided by the decision makers in GDMP. The methods implementing the apriori approach aggregate the DM's preferences. It is assumed that the group is

working as one entity with one hierarchy. Different decision makers lose their identity and they are very consistent. The methods implementing the aposterior methods focuses the final result, final personal ranking of the alternatives of each decision maker where the rankings have to be aggregated in one final ranking. These methods are the crosspoint of multicriteria analysis and voting methods. In voting there are multiple decision makers and multiple alternatives/candidates and the task is to sort them in a priority list. Multicriteria analysis methods provide the personal rankings of the decision makers and voting methods provide the aggregation of the rankings in one final ranking.

Borda score

This is one of the first methods, published by the French mathematician and navigator of the same name in 1784. It is described in [1]. With m alternatives in A, assign marks $m-1, m-2,...,1, 0$ to the first ranked, second ranked, ..., last ranked alternative for each individual, then determine the Borda score for each alternative as the sum of the individual marks for that alternative. The Borda socre of a alternative x is equivalent to the sum of the number of individuals, that have x preferred to y for all y belonging to A, excluding x. The alternative with the highest Borda score is declared the winner.

Interactive method for group decision support GCBIM

The GCBIM method is designed for supporting group decision making in the individual consultative style [2]. In this style the leader defines the problem and shares his vision with the members of the group. The leader solicits ideas regarding causes of problems and their potential solutions. The leader may also use these individuals' expertise in evaluating alternative solutions. Once this information is obtained, the leader makes a choice of the individual alternative solution which is to be implemented.

In the GCBIM method all decision makers are working in one and the same space of alternatives. In GCBIM it is the rankings, not the preferences that are aggregated and because of that the criteria by which the alternatives are evaluated can be different. The whole process of decision making is iterative. In the first iteration every DM starts with a given alternative and gives aspiration levels, directions and intervals of change and finally gets the ranking of the currently admissable alternatives.

All rankings are sent to the leader. He has solved the problem by himself and has a ranking of his own. When all decision makers send their rankings to the server, the aggregated ranking is calculated with the help of borda score. The leader determines „the chosen" ranking for this iteration by evaluating the rankings, which are closest to the aggregated ranking or to his/her ranking. If he is satisfied with the solution the process is terminated and the first alternative in the chosen ranking is the winner . If the current iteration does not give a solution which satisfies the leader, the process goes on with the next iteration where the best (first in the ranking) alternative in preferred ranking is taken as a reference alternative for the next iteration.

Finding the closest ranking to a given ranking is calculated by minimizing the maximal Tchebyshev distance between the positions.

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If a_{ij} is the position of the alternative i in the ranking of expert j; a_{ic} is the position of the alternative i in the aggregated ranking and λ_i – the difference between the maximal and the minimal position on which alternative i is placed, then we are seeking $\min(\max(a_{ij} - a_{ic})/\lambda_i)$, which gives us the ranking closer to the aggregated ranking.

GCBIM-bee method

This method is inspired by the decision making process bees use when searching, evaluating and choosing a new hive, as described in [3].

This method is different from the previous one because it assumes that group goals are the same for all members of the group and they differ only in their vision of achieving this goals. In this method no leader is required, so it is suitable for leaderless team style. The process is iterative and the group work in turns, but instead of sending every ranking for aggregating, the experts can move trough several points in the alternatives space with the help of the CBIM method [4] before choosing an alternative to vote for in this turn. Every alternative already voted for is added to the list of "discovered" alternatives. If a DM votes for an alternative more then once, every time after first the weight of his vote is dropped by 15%. This stimulates the DM to search for other possible solutions (alternatives) and gives chance to later found alternatives. The DM can keep voting for one and the same alternative at every turn, but he/she can also choose other alternatives to vote for from the list of "discovered" alternatives.

A system implementing this method should offer a communication between decision makers and using this feature they should be able to "advertise" their currently preferred alternatives at every turn, so that other decision makers will eventually be able to choose an alternative to vote for.

Variant 1

At every iteration/turn alternatives with lowest borda score (the borda score is accumulated trough iterations) are dropped. The number of dropped alternatives may depend on the number of iterations already made, but this may not be necessary as this would mean to compensate for the initial "wandering" of the decision makers. However, this issue is resolved due to the fact that decision makers can make more than one step before finding an alternative to vote for.

Variant 2

After the number of "discovered" alternatives reaches a certain threshold the procedure goes on with the final iteration and experts choosing only among alternatives in the list of "discovered" alternatives. The final solution of the problem is the alternative, chosen at this iteration.

The GCBIM, GCBIM-bee1 and GCBIM-bee2 methods are intended for implementation in the Group Multichoice system, which already implements four methods for solving multicriteria analysis problems – one weighting method, two outranking and one interactive. The group decision support features are provided by the interactive GCBIM, GCBIM-bee1 and GCBIM-bee2 methods and one aposterior method, based on borda score powered aggregated ranking.

The aposterior method

A system, implementing this method (or any other group decision support method) should provide some kind of communication between decision makers as a channel for exchanging information in an informal way is needed for solving such problems. After defining the problem and entering the values of the alternatives for all criteria, every DM chooses for himself a method for solving the problem. He/she enters the method-specific information and gets a ranking in the final step. This final result/ ranking is then sent to the server, where all others rankings from other decision makers are received as well. After all rankings are received on the server, the borda-score aggregating method is applied to the data and the final aggregated ranking is send back to every decision maker.

The a posteriori method works independently of the method used for obtaining the ranking. The a posteriori method only aggregates all rankings of the decision makers in one final ranking. The advantages of this approach is that no additional knowledge on group decision support methods is required on behalf of the decision makers. They can use their preferred GDS method for obtaining the final ranking.

Classification of group decision support systems

Decision support systems are divided in two major classes – universal systems and problem-oriented systems. Depending on the number of the decision makers, the systems can be local, intranet and Internet-based. Local systems are installed on one computer and are used either by one DM, or (in group decision making) by a number of decision makers using the computer in turns. Intranet based systems are deployed in LAN environment, where every decision maker uses his/her own computer. Depending on the software architecture there can be a central server. The time for decision making/using the system is limited due to the use of telecommunication technologies for providing communication between the group participants. The minimum is a text chat, but audio or video conference lines are also recommended.

Internet based systems allow the team to be spread over a large geographic area. This systems has a central server used not only for relaying information but also for storing it, and that is what provides the opportunity for a decision making process extended over a longer periods of time. Every GDSS should provide two functions: communication and decision support. Depending on the period of time for one decision making process and the geographic area different types of systems are most suitable for different situations, as shown in Table 1.

Table 1

Type	limited time	long-term
dispersed	internet-based	internet-based
close	local, intranet	local

Description of the *Group Multichoice* system

The decision making process supported by the system goes through the following stages:

    1. Definition of the criteria and alternatives (Each participant can add criteria and alternatives. Text communication is active.)

    2. Entering the values of the alternatives regarding criteria, performed by the group facilitator. If needed text chat is used for consulting with other members of the group.

A posteriori method
    3. MCA method is chosen. (performed by every expert for himself)

    4. Entering method-specific information (performed by every expert for himself)

    5. Obtaining final local result and sending it to the server.

GCBIM-bee1 method
    3. Every participant selects an alternative to vote for

    4. The selected alternative is sent to the server

    5. The alternatives with the lowest borda-score are removed

The process continues until the number of remaining alternatives drops under a given threshold and then the alternative with the highest borda-score is declared the winner.

GCBIM-bee 2 method
    3. Every participant selects an alternative to vote for.

    4. The selected alternative is sent tothe server. If the number of the "discovered" alternatives reaches a given threshold the process continues till its final iteration.

    5. In the final iteration decision makers choose only among the "discovered" alternatives.

GCBIM method
    3. The final local result are obtained and sent to the server

    4. The group leader selects a reference alternative for the next iteration

    5. The process goes on with the next iteration.

    6. The process stops when an alternative satisfying the leader is reached

The system interface is designed as a wizard – a sequence of steps where each step is a logical operation. Every stage of the work with the system corresponds to one or more windows in the wizard. The DM is able to go forward or to go back in order to make some changes or to try another option.

Group Multichoice system operates in client or server mode. Every decision making session has only one server and all clients are connected to this server. The leader/group facilitator works with the server. *Group Multichoice* offers dynamic context help. The user can get information for every element of the interface just by moving the mouse over it. The system operates in two languages – Bulgarian and English. All interface is translated and language can be switched at every stage of working with the system. The translation module is designed in a way that makes adding new languages easy. The system performs automatic software updates if Internet connection is available when it is started.

Conclusion

GCBIM, GCBIM-bee1 and GCBIM-bee2 are interactive method for solving group decision making problems of multicriteria analysis. Their application covers large part of the specter of different decision making styles. Group Multichoice is an experimental software system, supporting group decision making and solving multicriteria analysis problems. The system implements four methods for this class of problems and four methods for supporting group decision making. The group decision can be taken in autocratic style with advisors or in democratic style, when all participants are equal. The systems allows network communication, provides user-friendly interface and rich help information. Every decision maker is able to reach a final result using HIS/HER preferred method.

R e f e r e n c e s

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Интерактивный метод группового принятия решений

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В статье представлены два новые методы группового принятия решений, учитывающие разные стилья принятия решений. Описаны также подробности реализации методов в системе *Group Multichoice*, разработанной в Институте информационных технологий – БАН.