A GROUP DECISION SUPPORT SYSTEM
A description on models and modules in GDSS based on cooperative MAS

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Abstract: GDSS is a popular and attractive topic in decision field. It is reasonable to introduce multi-Agent technology and methodology into GDSS because they are both distributed systems and support interaction in group members. We look at the development of GDSS as being a process of putting together a coordinated workflow of collaborating Agents that is able to support a problem-solving process. We propose models to describe character of Agents and issue in GDSS, define the modules of group-decision as cognitive, group organizing, decision-making by cooperation, feedback and adjust decision, conduce consensus decision by negotiation, knowledge management and repository evolution, and explain the process of every part.

1 INTRODUCTION

In most organizations, decisions are made by group members who usually consider a set of attributes. Group decision-making is considered to be a process for deriving a single group preference from a number of individual preferences regarding a set of criteria and alternatives (L. Mikhailov, 2004). But it is sometimes difficult to achieve a consensus among group members. Therefore, a group decision-supporting tool is needed to help group members to reach a consensus for the group decision-making under multiple attributes.

2 GDSS AND MULTI-AGENT

Group decision support system (GDSS) is an interactive computer-based system and it combines communication, computing, and decision support technologies. It facilitates the solving of unstructured or semi-structured problems by a group of decision-makers (DeSanctis G, Gallupe RB, 1987), assists managerial decision-making by presenting information and interpretations for various alternatives and facilitates communication among team members, regardless of the geographical limitations and group decision obstruction, so such system can help the decision-makers to make more effective and efficient decisions (Radermacher, F. J., 1994).

Group decision is a dynamic and continuous process under conflict restraint. Problems in these fields are usually semi-structured, and concern complex, uncertain, incorrect, changing, and large amounts of information. The critical and distinctive feature of a group decision support system is to use mathematical models, especial optimization models, for decision-making and pose consensus decision.

As researchers began GDSS experimental studies, a good decision generally cannot be defined by a single criterion. It is not always the one with the highest profit or the lowest risk. Generally it is some combination of these two with other criteria such as prestige, power, and ethical concerns. Equal opportunity for participation appeared as a major consideration in settings where groups were required to reach a consensus (Watson et al., 1988; Chidambaram et al., 1990; Easton et al., 1990; Miranda and Bostrom, 1993).

The most charming advantage of GDSS is the interaction and cooperation mechanism comparing with traditional systems in which the individual parts are designed independently with little interaction, due to the lack of a unified representation, simulation, and synthesis framework. A number of typical characteristics of an intelligent Agent include: autonomy, proactiveness, purposefulness, competence, reasoning capability and interaction with environment or other Agents.

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An intelligent Agent is a software object capable of communicating with other intelligent Agents, as well as with humans, with a view to achieving a given task. It monitors the world, anticipates the consequences of its actions and the actions of other Agents, and determines the action plan. An intelligent Agent offers many advantages in the situations that the GDSS cannot cover the entire decision process. These features make intelligent Agents an attractive tool for building active GDSS (Franklin & Graesser, 1997; Luck, Griffiths, & D'Inverno, 1997; Maes, 1995; Wooldridge & Jennings, 1995).

There have been several attempts to combine GDSS and Agent technology. A lot of researches focus on combining GDSS and Agent technology to improve decision quality.

Some researchers (Kuhlmann T, Lamping R, Massow C, 1998) propose Agentified DSS software to support decision-making. Bui et al. (Bui T, Lee J., 1999) advocated an Agent based DSS framework to facilitate decision-making in large-scale enterprises and among scattered organization units. Paulson and Kim at Stanford University conducted a study of Agent-based project scheduling and control to develop a software Agent-based system to support decentralized decision-making. Some commercial Agent-based GDSS have been presented, such as Agnetis Business Systems in Australia, and Scientia in British, which use distributed intelligence technology for scheduling. Salo (Salo AA, 1995) developed an interactive approach for the aggregation of group members' preference judgments in the context of an evolving value representation. He suggests strict dominance (SD) or weak dominance (WD) relations and in the case of WD, the results are presented to the group members and additional preferences are elicited for further.

Both GDSS and multi-Agent are distributed systems and are good at deal with complex issue. Normally, complex decision making tasks cannot be done by a single Agent. Rather, they are typically achieved through a coordinated effort of many Agents with different sets of expertise and assignment. We view GDSS based on multi-Agent intelligent system as typically a network with decision-making unites as nodes and communication channels as links.

3 MODELS

As the feature of the system mentioned above, we suggest the models of the GDSS based on multi-Agent. We define the group decision models based on Agent as:

Agent<S, D, A, G, C, P>

S: state of Agent, busy or idle. Idle Agent, not the busy one, is chosen when facing with new issue. It is useful in balance the system load, mentioned in 4.2.

D: domain of Agent. It is helpful in chosen the right Agent to cooperation.

A: ability of Agent, input/out constraint, quality, duration or cost. Only match ability of Agent with goal of the issue can guarantee the veracity of the decision.

G: goal of Agent. We can find the credit of Agent by compare goal of Agent with the decision outcome.

C: credit of Agent, expressed history record. Agent with good credit can result in re-cooperation by other Agents.

P: protocol of Agent accepted. Protocol of Agent is the precondition of cooperation.

Issue<P, T, G, C, M >

P: priority of issue, important, urgency, or both. The system pursues the important and urgent issue in time.

T: deadline of the issue. The settlement fails if the time is out.

G: goal of issue. The organized form of group member determinates by goal of issue.

C: output constraint of issue. That is the constraint on the group-decision outcome.

M: group members deal with the issue. It expresses the group members that cooperate in the issue decision-making.

4 MODULES OF THE GDSS BASED ON AGENT

4.1 Cognitive Module

Cognitive behaviours play an important role in-group decision process. Information and dataflow with different forms exchange in several portions of GDSS including input part, output part, feedback part, even decision-environment and users. The information and dataflow expressing change in decision-environment or concession of the users can't identify by functional Agent. Real-time responses take place when the change in environmental is cognized. The group decision-making will be interrupted or terminated without cognitive behaviors.

4.2 Group organizing Module

The frames in GDSS we propose is not fixedly organize Agent to execute. The system forms the decision-group flexibly according to the two principles: balance the system load and match the capability of Agent with issue mission. On the one hand, the Agent with different function distribute in the GDSS, some Agents are overloaded while others are idle all the time. Search the matched group member from the idle Agents at first; turn to the busy Agents if no Agent can be matched. All the Agents in GDSS have the equal opportunity to participate in the item. On the other hand, the capability of Agent chosen must match with the object of the issue, the perfect decision depend on the correct match mechanism greatly.

4.3 Decision-making Module

Facing with the complexity of the issue, the localization of computational capacity, no Agent can fulfil the decision by itself. Due to the limitation of information and resource availability, the cooperation among group member is indispensable. We view the procedure of model resolved and decision come into being as cooperation among all the Agents in the decision-group. Cooperative systems are typically designed to perform complex processes. In such systems, the effectiveness of a GDSS to support them depends on the interaction capacity and computational capacity of the individual Agents.

4.4 Feedback Module

Traditional decision models in GDSS focus on the methods of making group decisions, forming a group decision through synthesizing group members' preferences while not paying much attention to the problems of the environmental change during the decision making period and continual decision making under conflict restraint (P.Lehner et al., 1997).

Feedback from the group points of view and to the representations of the individual's points of view is required. Feedback means that a group member changes his or her preferences so that they converge to the other group members' preferences, as perceived by that member, or the decision-environment changed (Pinson SD, Louca JA, Moraitis P, 1997).

The group member changes the structure of his/ her evaluation system (e.g. changing the attention paid to the criteria); and/or

The group member alters his/her own set of criteria, adding or deleting some criteria (it is also possible to create a criterion named group's opinion); and/or

The group member adjusts his/her assumptions and predictions (subjective or not) according to some extra information provided by the other group's elements; and/or

The group member uses another method or process of aggregating the criteria that he or she considers relevant; and/or

The decision-environment parameters changed with the change in time, resource and so on.

Continuous decision is usually adjusted to reach a better outcome through properly responding to and managing the feedback.

4.5 Conduce consensus decision Module

Conflict happen when system is short in source, disagreement appears in target or alternatives produced in group decision. A lot of research focuses on the individual preference into group preference. The compromised decision produces, and so many group members is unsatisfied with the result. The procedure of preference aggregation violates the procedure of concede in group members in nature.

Negotiation in GDSS takes place when the requirements cannot be satisfied and an alternative solution is to be provided. On the one hand, each member in group would like to reach some agreement rather than disagree and not reach any agreement. But, on the other hand, each group member would like to reach an agreement that is as favourable to it as possible (Shaheen S. Fatima, Michael Wooldridge, Nicholas R. Jennings, 2004) Negotiation in our framework is a method of Agent-oriented interactive problem solving. It is clear that group decision support systems with the negotiation support facility will be a key issue in the next decade (M. Norita, 2000). The research on negotiation focus on the four aspects: the negotiation protocol; the negotiation strategies; the information state of Agents; the negotiation equilibrium.

The newly emerging constraint Agent technology provides a promising solution for such negotiation Agents. Constraint Agent technology has emerged as a promising research field. Constraint languages are powerful tools to support the development of constraint Agent systems. They provide necessary facilities of representation, reasoning and maintenance of constraint-based knowledge bases. Although some difficult tasks need sophisticated negotiation methods, interactive constraint

satisfaction is sufficient for most of GDSS tasks. Sophisticated negotiation strategies can be programmed with no great effort with flexible constraint programming. For example, requirements can be naturally represented as constraints and objective functions of a set of variables. In addition to the constraints about the user's requirements, an answer to the user may also have to satisfy the constraints from the GDSS system, such as constraints on the resources of the systems, and the constraints about the relations among the Agents.

In one words, negotiation is necessary to balance the satisfaction among different group members and conduce the consensus decision to fulfil the requirement of users.

4.6 Knowledge management Module

Knowledge used in decision-making is a valuable asset of an organization, and accumulating such knowledge is an important task (Kung-Jeng Wang, Chen-Fu Chien, 2003). It is necessary to provide a mechanism to store decision-related knowledge. In this context, background decision-related knowledge can be summarized as business rules and facts in repository of every Agent to improve the quality of a decision.

The decision-making process itself results in improved understanding of the problem and the process, and generates new knowledge. In other words, the decision-making and knowledge creation processes are interdependent. Because of such interdependence, the research in the fields of group decision support systems (GDSS) should integrate the knowledge management systems (KMS) and evolution in knowledge repository adequately.

5 CONCLUSION

The rationality to combine multi-Agent technology and GDSS has been proved by the references mentioned. We propose the models of Agent and issue; suggest the function of the modules in GDSS. The variables in the models are concise and simple. The cognitive on the decision environment change; procedure of group member organized; the decision-making by cooperation; environmental information by feedback; the procedure of consensus decision conduce by negotiation and the procedure of knowledge management can be expressed by the models. Hence, the proposed method is a promising and attractive alternative to construct GDSS based on multi-Agent.

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