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Semantic Enhanced Argumentation Based Group Decision Making for Complex Problems

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Chapter 8 Conclusion and Future Work

Abstract: In this chapter, an overall conclusion of this research is given. The gaps in the traditional GDSS are presented; the outcome and contribution of the proposed research are concluded. The significant contribution of this research is to propose a formal conceptual framework of group argumentation based decision making support system, in which semantic support approach is applied to enable fully integrating argumentative information into the decision making process.

This research is only a beginning in the use of semantic enhanced group argumentation approach to group decision making support. The future researches along this trend have been recommended. They include investigation into the semantic integration between the argumentation model and knowledge systems, research on the social web enhanced large scale argumentation modelling , mapping , evaluation and decision making process based on them, and also the study of the relation between proof standards and decision task .

Keywords: conclusion, research recommendation.

8.1 Conclusion

The traditional GDSS greatly depends upon the assumption of classical decision theory. There the decision problem is assumed to be well defined, the actions and outcomes are assumed to be fixed to start with, and criteria for evaluation also can be pre-defined. However, in reality we often face some wicked problems or emergent complex problems. This kind of problem lack clear pre-definition of problem situation and evaluation criteria, and often needs to be decided by group members with different ranges of expertise. Moreover, the changing requirement is difficult to recognise and the effort to solve one aspect of the problem may reveal or create another problem. On the other hand, in most cases the traditional GDSS only can offer passive support for the user and lack of the mechanism to capture and analyse the group members' decision rationale behind the decision which are claimed to be very useful for decision evaluation, decision task evolution and even decision process reuse.

The group argumentation approach has been regarded as a powerful way of discovering the structure and identifying various aspects of ill structured problem. On the one hand the argumentation as a manifestation of reasoning process can establish the connection between the premise and conclusion to assist decision making; on the other hand the argumentation as a communication approach can stimulate the participants to propose ideas from different views and discover the perspectives of the problem. Much group argumentation based research has been conducted in GDSS for consensus making, collaborative negotiation, decision making and collective brain storming etc. These approaches either concern the ontological structure of argumentation model and computational decision function based on the semantics of different elements and the underlying rules or concern the semantic topic of argumentative contents for concept sharing or expansion.

In this research, the main elements of group argumentation and decision making are identified. A new conceptual framework is designed to glue those two sets of elements together to support decision making fully using argumentation approach. The argumentation schema is the core of this conceptual

framework, which is not only required for supporting an iterative process but also for supporting decision making and evaluation. Taking these requirements into account, the combination of IBIS model, Toulmin's model and Amgoud's abstract argument-based framework is proposed as a comprehensive argumentation model. In this, IBIS elements provide the basic discussion and group interaction capability; Toulmin model provides the notion of strength of the claim and pro/cons argument; and Amgoud's framework distinguishes different argument types from practical view and epistemic view, and different analysis and evaluation approaches are provided for these two different types of argument. This argumentation model is formally described by a semantic representation including class, relation, and constraint. The application of this semantic argumentative model representation has been tested in a small scale group argumentation using the developed prototype system.

In this research, the semantic support is not only constrained in the structure of the argumentation but also in the topic of argumentation content. This will facilitate the intelligent agent to discover, retrieve and map related information. The result of experiment in chapter 6 has shown that the semantic topic annotation for the utterance can better present the perspectives of the decision problem and identify the criteria for evaluating the solution. On the other hand, the credibility of the expert modelled and updated based on the unified topic terms can more precisely and consistently reflect the expertise of the participant. It conversely will affect the trustworthiness of the participants' utterance and has been exploited in the design of decision labelling function. It has shown that linguistic analysis based automatic semantic annotation is too complex, however fully manual semantic annotation is too time-consuming. A middle way solution in this research is proposed which allows the user to manually label the content with a simple keyword and then automatically conceptualize the keyword using formal ontological term querying from the cross domain ontology knowledge base –DBpedia. The approach has been proved to be viable in the prototype system.

A multi-agent based design approach is exploited to model the process and interaction protocol of the decision making in the group argumentation context. The roles of the agents are identified and their functionalities are specified in detail; the agents' states and behaviours are modelled using an agent activity diagram. Within each agent the argumentation data model and the operation on it are formally represented, which can handle incoming and outgoing messages encoded by the semantic argumentation schema. Based on this design, an agent based distributed group argumentation for the decision making prototype system is developed. This prototype system acted as a test bed in the group argumentation environment to test the proposed hypothesis.

In the vision of this research, supporting group decision making is not only to help choosing optimised solution and revealing the rationale behind the decision, but also providing the mechanism to iterate the process of discovering all the perspectives of the problem and decompose the proposed solutions. So after a group argumentation session, the decision maker should know what the best solution is, the reason behind that, how to implement this solution in certain detailed steps, the possible problems under the solution, how to solve these problems, and what any unsolved issue under the solution is. Particularly the result of experiment has shown that unsolved issue is an explicit indicator for the decision maker to iterate the group argumentation to the next session. Due to the connection between the experts' expertise semantics and the topic semantics of the unsolved issue, any further decision task can be intentionally assigned to a group of experts with higher expertise in related domains. Theoretically the mechanism of expertise based task assignment could make the iteration process of problem solving more efficient and effective, though it needs to be further evaluated in future work.

In order to evaluate the proposed research assumption, a group argumentation based decision making experiment was designed and carried out, in which the developed prototype software system was used by the participants. In the experiment a questionnaire was designed to capture the participants' experience towards the prototype system. The performance of the system was measured based on the analysis of the result of experiment and questionnaire. The result indicates that this semantically enhanced group argumentation based decision making approach not only can advise the solution route for decision task with high satisfaction but also can present more perspectives of the decision problems which can enable an iterative process of problem solving. In addition, the

prototype system also demonstrates that the expert's credibility in different domains can be dynamically updated along with the process of argumentation, which could benefit team formation for new decision tasks or next round group argumentation.

In this research, a metric based qualitative evaluation is also carried out. Based on the analysed requirement of group argumentation and decision making support, a feature metric is identified which is regarded as a guidance to compare the related approaches from different aspects regarding group argumentation based decision making support. The comparison has shown that our approach shares some common features with others such as tree-like information visualization, labelling decision function, formal argumentation model etc. However, our approach also has many unique characteristics enhanced by the comprehensive argumentation model and semantic support. Among these, the iteration mechanism, solution & problem decomposition mechanism and rationale level reuse capability are the most prominent features of our approach. In some sense, these features are essential for the new decision support paradigm.

8.2 Contribution

It is considered that the expectations as given in the initial aims have been achieved and that the findings from this study may make a contribution to the issues affecting the group argumentation based decision making support for the complex problem.

The basic results from the literature survey revealed there is lack of formal description about the conceptual framework of group argumentation based decision making support system. Group argumentation and decision making are often regarded as two separate stages so that argumentative information cannot be fully integrated into the decision making process. In this research, firstly the main elements in the group argumentation and decision making process and the interaction among them are identified and further analysed; secondly a conceptual framework is proposed to combine these two different domains together; thirdly a prototype system based on this framework is developed and tested in the small scale group argumentation environment; lastly a comparison based evaluation is conducted to identify the position of our framework in related works. This conceptual framework is independent on any application domain, which can be referred by the related systems development.

The research has shown various group argumentation based approaches have been employed in the decision making context and argumentation schema is core to develop this kind of system. However, the present methods either focus on the reasoning capability of the argumentation or focus on the communicative capability of the argumentation. In practice, the semantic support is constrained to either argumentation structure level or argumentation content level. In our approach, comprehensive argumentation ontology for argumentation structure and a semantic annotation mechanism to conceptualize the argumentative content are designed so that the semantic support can cover both argumentation structure level and content level. In the argumentation model, different categories of argumentative elements have indicated the different intention of the participants' utterance in the group argumentation. It has been proved that those defined argumentation categories and their attributes have been intelligently utilized by the system to support the decision making process. For example, issue category is often used for the iteration of decision process; solution category is often used for constructing solution space to clarify the detail route of solution; support/challenge category is used for evaluating proposed solution to give a recommendation. Content level semantics introduced by semantic annotation can better facilitate the system to categorize, analyse, integrate and evaluate information to automate the process of decision making. On the other hand, there is a risk that incorrect semantic annotation in the content level will cause system to produce an unreliable decision. In our experiment, participants claim that some identified criteria by system are not appropriate. It shows the limitation of the DBpedia based annotation approach. So how to improve the quality of semantic annotation is still a very challenging task and open research issue.

Based on this argumentation model and semantic support, the system can better interpret and manage the information generated in the process of group argumentation to capture expert's

preference model and authority of argumentation which are the important factors for automatic decision making. Also the system provides more semantic services such as argumentation process iteration, decision rationale reuse, decision problem discovery etc. These semantic services could be the essential part of the new decision making paradigm.

8.3 Future Work

Different proof standards are used to evaluate arguments and solutions. In this research, we simply choose Preponderance of Evidence (PoE) as the proof standard, aiming to better aggregate the group's expertise, based on which the decision labelling functions are designed. However in reality, Scintilla of Evidence (SoE) and Beyond Reasonable Doubt (BRD) have their own uses regarding different decision tasks and contexts. Though it is a very challenging task for the system to identify the suitable proof standard, the system should have some flexibility to allow users to configure proof standard and correspondently update the decision labelling function.

Due to the time and resource limitation of this research, only one session experiment of the small scale group argumentation was undertaken. The experiment has demonstrated that the system can decompose the problem and solution into different levels and also have the capability to iterate the argumentation to next session. However, more experiments based on multiple successive sessions could make an opportunity to evaluate the quality of raised issues in the previous session and better test the knowledge reusability across the different sessions and task assignments based on experts' credibility.

In recent years, large scale argumentation on the web has been given much attention. (Rahwan, 2007) Social network systems have increased in popularity, and a large amount of conversations often occur in 'web 2.0' media. Various semantic web models, notably FOAF[1] and SIOC (Semantically-Interlinked Online Communities) (Breslin, 2005), have become popular for interlinking, exporting and exchanging information about online communities and their conversation. Some research initiatives (Passant, 2009) have attempted to align the domain discourse representation and social semantics in order to navigate the argumentative information across different online platforms such as blogs, wikis, online forums etc. The research in this thesis does not concern the web as group argumentation platform, however the various methods employed in this research such as semantic argumentation representation, decision labelling function and experts' credibility update could be extended to the social web environment to support large scale argumentation based decision making. In this case, the argumentation about a decision task could be retrieved from different sites by the agent to construct a global argumentation map to support the decision making process.

Current research focus on the semantic argumentation structure and content modelling, and the decision making process solely relies on analysis and computation of the participants' wisdom. How to integrate the argumentation with the large range of distributed and heterogeneous resources or knowledge system and collaboratively work to solve a wicked problem is still an open issue. Semantic Web technologies, that focus on interoperability between applications by relying on common data formats (RDF) and models or ontologies (RDFS/OWL), could play an important role in this. The Semantic Grid as a new computational paradigm is an intersection of Grid computing, semantic web and software agents for better describing all shared resources to implement seamless automation and global collaboration. This paradigm could be utilized to develop a networked group argumentation support platform to semantically fuse all the resource to support decision making process.

Although much survey, theoretical analysis, prototype development and experimental work was undertaken in this research, and some useful findings were obtained from the experiment result and comparison based evaluation, it is still only a beginning in the use of semantic enhanced group argumentation approach to the decision making support. It is recommended that future investigation could be carried out in the following areas:

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[1] http://www.foaf-project.org/

(i) The relation between proof standards and decision task or problem should be investigated. The labelling decision function should be adapted to different circumstances.
(ii) The scale of group argumentation based experiment in this research is not nearly enough to obtain more applicable data and finding. Therefore, in the any future work more subjects should be enrolled and more successive argumentation sessions should be organised.
(iii) In this research, only group members' wisdom is utilised for decision making purpose rather than distributed and heterogeneous knowledge systems including authorized evidence, experiment or simulation result, and case-based experience etc. Further the investigation into the semantic integration between the argumentation model and knowledge systems is a very promising direction.
(iv) Extending this research to the social web level could connect more useful argumentative material across different sites for decision making purposes. Some research initiatives have attempted to align the domain discourse representation and social semantic, semantic web technology plays crucial role in this field. The research in this field will raise new challenges in the issues of large scale argumentation modelling and mapping, argumentation comparison and evaluation, and decision making processes based on them.