

Computerized Support for Idea Generation During Knowledge Creating Process*

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Abstract. In daily life, people spend a lot of time in group activities, such as communication, debate, collaboration and consensus achieving for problem solving where creative ideas are expected to be generated by active interaction and stimulation between participants. In this paper, we focus on exploring effective computerized support for group argumentation, mainly on group brainstorming for idea generation. Versatile aids are explored, such as visualization of expert opinion structure, text-mining of external information, clustering of contributed opinions and various analysis about participation, etc. and integrated into a group argumentation environment (GAE), to support the emergence of a *ba* for knowledge creation. We apply such an environment to top-level small-scale academic conferences (Xiangshan Science Conference) on frontiers of science and technology in China.

Keywords: Idea generation, knowledge creation, meta-synthesis, *ba*, Xiangshan Science Conference

1 Introduction

In daily life, people spend a lot of time in group activities, such as communication, debate, negotiation, collaboration and consensus building. Group argumentation, especially held in most expert meetings, academic seminars, etc, is regarded as a convenient way to acquire ideas or knowledge from experts for new options or solutions towards complex problems. To facilitate group argumentation for idea generation, heavy endeavors have been engaged in computerized support with social cognitive perception of human creativity and tremendous advances of information technologies. Research on human creativity provides conceptual models for creativity support systems (CSS) or similar tools. Famous models about creativity proposed by western scholars are 4-stage model by G. Wallas in 1926 [1] and 2-space transformation model by M. Boden [2]. Continual refinements or extensions of both models have been applied and brought out many CSS or idea processors [3, 4]. On the other hand, by deep thinking over oriental epistemology creativity while absorbing western thoughts, eastern people also proposed conceptual framework of creativity or knowledge creation. Japanese scholar I. Nonaka proposed SECI model about organizational

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knowledge creating process based on Polanyi's distinction between tacit knowledge and explicit knowledge and related 4 distinguished kinds of *ba* for different phases of SECI process [5, 6]. *Ba* can be viewed as a platform where knowledge is created, shared, and exploited. So how to develop a right *ba* for exploiting and creating knowledge effectively and efficiently is a major concern. Most computerized support tools for group work can provide help for effective interaction between participants under different levels or facets during knowledge creating process, such as communication, information sharing, argumentation or even sense making, such as AIDE [7], and many other lab or business products.

In early 1990s, Chinese system scientist X. S. Qian proposed meta-synthesis approach (MSA) and the concept of Hall of Workshop for Meta-Synthetic Engineering (HWMSE) which serves as a test bed of meta-synthetic support for unstructured problem solving by utilization of breaking advances in information technologies [8, 9]. The essential idea of MSA can be simplified as "confident hypothesizing, rigorous validating", i.e. quantitative knowledge arises from qualitative understanding. MSA accepts Chinese philosopher's distinction of qualitative facet and quantitative facet of human intelligent capability and calls for man-machine collaboration during problem solving process, and emphasizes the active roles of human beings during human-machine collaboration, which is beyond traditional decision support systems (DSS) where machine plays active roles during human-machine interaction. For unknown or new issues, new knowledge is often needed for a creative and practical solution. Creative solutions may refer to wisdom. Then HWMSE is expected to enable knowledge creation and wisdom emergence. Moreover HWMSE could be treated as a *ba* for knowledge creating [10, 11].

In this paper, we concentrate on computerized support for group argumentation for idea generation during problem solving process, which is supposed as a knowledge creating process. The basis of our work is MSA and HWMSE in consideration of both western and eastern models in creativity and rich achievements in CSS. Versatile computerized aids have been developed, such as visualization of expert opinion structure, text-mining of external information, clustering of contributed opinions and evaluation of subjective participation, etc. and integrated into a group argumentation environment (GAE), to support the emergence of a *ba* for knowledge creation. An application of GAE to top-level small-scale academic conferences (Xiangshan Science Conference) on frontiers of science and technology in China is given and future works are indicated.

2 Computerized Support for Meta-synthetic Support for Idea Generation

For hypothesis (scenarios or multiple perspectives) towards unknown issues during problem solving process, creative ideas are always desired especially for different perspectives development. Idea generation is always applied during divergent thinking process and usually starts with a topic, which is the anchor for creative thinking and insights of the topic are expected to be acquired or for further investigation from a variety of expanding aspects. In this section, the framework of our developing versatile aids for group working process is given.

2.1 Framework of Computerized for Group Argumentation

Fig. 1 shows the three layers (interfacing, function and data services) of the functional structure of the integrated group argumentation environment (GAE) which is based on client/server framework and mainly includes an online electronic brainstorming argumentation room (BAR).

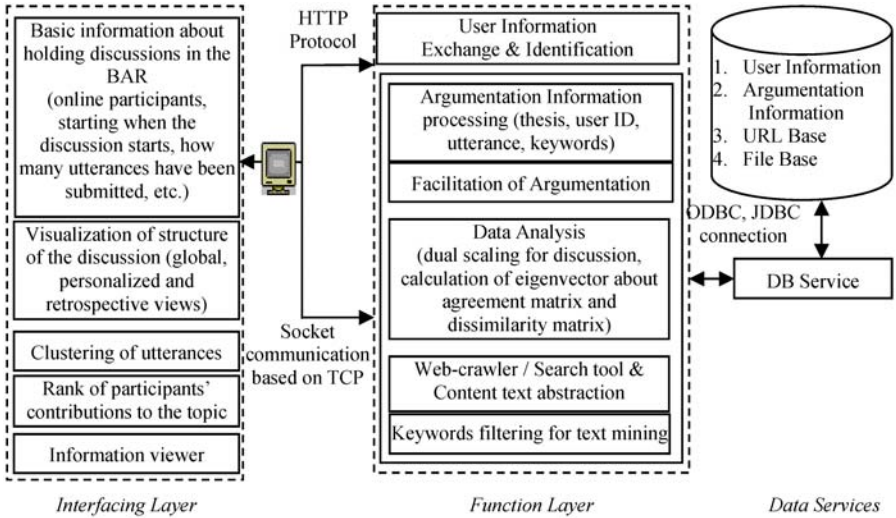


Fig. 1. Functional Framework of Group Argumentation Environment

Interfacing layer shows what can be achieved at client window of BAR, and function layer is services provided at server side. Firstly, GAE can be regarded as a group support system. Furthermore, by providing visualized thinking structure during the group working process together with a variety of analytical mechanism about the process and participants, it aims to support emergence of a dynamic originating *ba* and evaluation of its effectiveness which is one of core issues in providing meta-synthetic support for unstructured problem solving [12]. Follows introduce some salient functions.

2.2 Visualized Shared Memory for Group Argumentation

As shown in Fig 2(a), the main client window for visualized shared memory (as depicted at the interfacing layer in Fig. 1) is consisted of event record area, dialoguing area and visualizing area.

Both common viewer and personal viewer provide timely updated visualized global structure about relationships between participants and their keywords/utterances in the session at the shared visualized area and help to acquire a whole perspective about the discussed topic which may expose some structured elements of an unstructured issue.

Fig. 2(b) shows retrospective analysis which applies same mechanism as both viewers and provides participants to “drill down” the discussing process for visualized

partial perspectives. Further analysis of pieces of discussion such as selected intervals of discussion or combination of any selected participants may be helpful to detect the existence or formulating process of a micro community and acquire further understanding about participants' thinking structure.

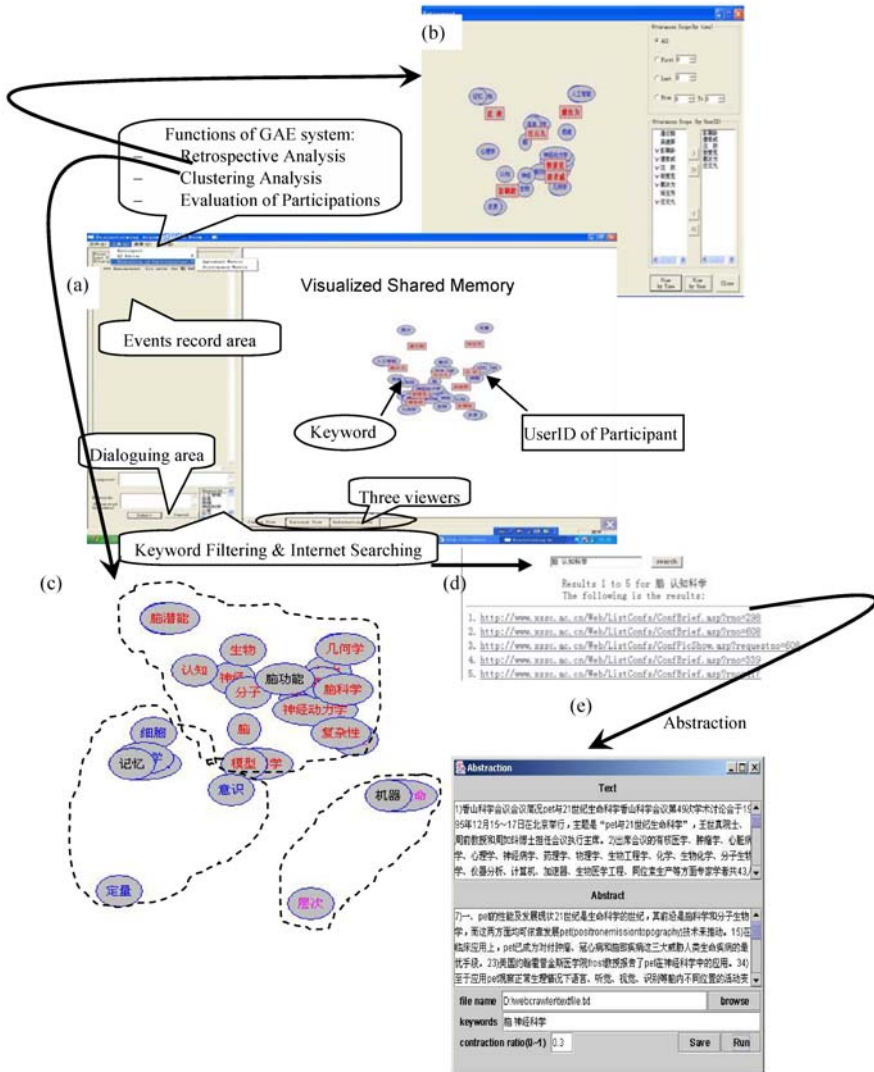


Fig. 2. Client Window of BAR (a) Main client window, (b) Retrospective viewer, (c) Clustering analysis (K=3), (d) Selected keyword searching, (e) Text abstraction

2.3 Information Support

Currently there are two ways to provide external information for participants in the course. One is to search Internet directly via any searching engines. Another is sup-

ported by text mining techniques. Here three tools are provided, web-crawler, search tool and content text abstraction. The web-crawler is tailored to collect the web pages automatically from WWW which are relevant with concerned topic; search tool provide access to relevant information (web) pages collected via web-crawler according to selected keywords; and content text abstraction extracts the information page into an outline by Luhn method [13].

2.4 Outcome of Argumentation and Evaluation of Participation

Besides basic functions of visualization of expert opinion structure during argumentation process for expanding both individual and group thinking spaces, some work has also been undertaking by synthesizing practical requirements, psychological models and algorithms when more concerns go to procedural rationality of group working process. Currently, two kinds of supports are available in evaluation of a session. 1) Automatic summarizing of experts ideas, which is mainly based on KJ method. There are two ways based on visualized spacial relations. One is to map the 2-dimension structure into 16×16 grids. Those utterances which fall into same cell is regarded as one cluster. Another uses K-means clustering method to get k centroids, where k is an assumed number of clusters. The closest keyword to the centroid could be regarded as cluster label. 2) Evaluation of participation by calculation of eigenvectors about agreement matrix and dissimilarity matrix. Both matrixes are constructed by the number of keywords shared or different between all participants.

Next we apply our tool to analyze Xiangshan Science Conference (XSSC, www.xssc.ac.cn), which is initiated in 1993 in similar to Gordon Research Conferences and denotes as the general designation of a series of small-scale academic meetings which bring together a group of scientists working at the frontier of research of a particular area and enable them to discuss in depth all aspects of the most recent advances in the field and to stimulate new directions for research in China.

3 GAE Practice in Xiangshan Science Conference




In this experiment, all those conferences whose main theme is about ‘brain & mind’ are selected from over 200 conferences. The chairpersons and people who give plenary speeches are participants and the titles of their talks are utterance. Then we have 9 participants. Fig. 2 shows basic analysis taken in this test. Fig. 2(a) is a whole perspective of all concerned scientists’ contributions among those concerned conferences. It shows participants who share more common keywords locate closer in the 2-dimension space. Fig. 2(c) shows 3 clusters by K-means clustering method, where keywords ,  and  are acquired as the label (centroid) of each cluster.


Table 1 lists the evaluation of participation based on agreement and discrepancy matrixes. It is shown that user  holds highest rank based on both eigenvectors, which may be justified by his active role as one of chairpersons or plenary speech contributors among those conferences, which furthermore exposes his big influence in neuroscience field in China.

Table 1. Evaluation of 9 Participants

Maximum eigenvector of agreement matrix:	(0.3761, 1.0914, 0.3082, 0.6179, 0.2522, 0.3618, 0.3125, 0.1937, 0.1092)
Rank of the top five participants: Meaning of the indicator:	郭爱克 > 汪云九 > 唐孝威 > 彭聃龄 > 戴汝为 which expert holds more common concerns during the brainstorming session
Maximum eigenvector of discrepancy matrix:	(0.3438, 0.2799, 0.3437, 0.4088, 0.3482, 0.3274, 0.3628, 0.2839, 0.2783)
Rank of the top five participants: Meaning of the indicator:	郭爱克 > 彭聃龄 > 沈政 > 汪云九 > 戴汝为 which expert's perspectives are more diverse than those of other people during the brainstorming session

It is expected such kind of further analysis about users' participation could provide more information about the performance assessment of group argumentation, and for further testing of some assumptions about individual impacts towards group behaviors.

4 Concluding Remarks

In this paper, we focus on computerized support for group argumentation for idea generation. Research on creativity and knowledge creation together with computerized supports provides basis for our research, which is mainly on man-machine collaborative meta-synthetic support for complex problem solving. What we are exploring is not only a computerized support tool for idea generation, but also expecting to support the emergence of originating *ba* during group interacting process. Our developed group argumentation environment exhibits our ideas in combining SECI model and concept of HWMSE.

Our current work is still at very initial stage from both research and practice [11, 14, 15]. From the research perspective, currently we mainly concentrate on divergent thinking process supporting for confident hypothesis formulation, a basic step of meta-synthesis approach [8]. The aim of GAE is to support dynamic emergence of a knowledge creation environment (*ba*). Lots of further work are under exploration, such as better human-machine interaction, opinion synthesis in consideration of expert's background, and evolving process of keyword network to detect the pathway of knowledge creation, etc. More experiments will also be undertaken for verification and validation of GAE in practice. XSSC is a rich land for such kind of tests.

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