Approach to Detection of Community's Consensus and Interest

Xijin Tang

Institute of Systems Science, Academy of Mathematics and Systems Science
Chinese Academy of Sciences, Beijing 100190 P.R. China
xjtang@amss.ac.cn

Abstract. Nowadays as Internet enables to find, publish and then share information among unfamiliar people and then enable virtual community emerges, it is natural to detect the consensus or interests from those on-line opinions or surveys, especially for those business people to acquire feedback and get senses which are beneficial for new prototypes design and products improvements. In this paper, several ways to approach community's consensus and interest are addressed. Those ways mainly denote three kind of technologies, augmented information support (AIS), CorMap and iView, which mainly support different kinds of work during an unstructured problem solving process where creative ideas are barely required.

Keywords: AIS, CorMap, iView, qualitative meta-synthesis.

1 Introduction

Internet creates a giant knowledge system. Currently if we want to know something, a search engine, e.g. *google* can pull many relevant or irrelevant web pages. We can also browse *wikipedia* to get more detailed information. E-commerce and e-business changes our traditional life style. Before buying something, we may go to search news about what we are concerned and may get many know-how replies from communities at BBS or some on-line shopping sites. Even we find partners to buy favorite things under a group purchase price, much lower than that at retail stores. Before traveling, Internet searching even becomes a necessary step and may even play important role to make a trip schedule. Business organizations also make use of the textual information to get some information about the feedbacks which are beneficial for new prototypes design and products improvements. That is one of driving forces of tide of business intelligence and data mining technologies.

As companies issue new products or services, customer survey is a usual way to get assessment. However people are not always patient with questionnaires, even during a so-called 5-minute phone-call investigation. They may scratch a few lines at the blank area at the answer sheet or post their ideas at a familiar on-line forum or BBS, instead of comparing those options directly. People may not show their attitude exactly during direct investigation. That is why to adopt new ideas toward finding customers' interest and opinions. In this paper, we address several ways to approach

Y. Ishikawa et al. (Eds.): APWeb 2008 Workshops, LNCS 4977, pp. 17–29, 2008.

community's consensus and interest. Those ways could be a supplement to those traditional approaches to potential new product designs or trends of customers' interests. The prediction of customers' preferences is usually an unstructured problem since always changing customers' appetites lead to many uncertainties. The following addressed technologies, augmented information support (AIS), CorMap and iView, mainly support different kinds of work in community opinion processing, are helpful to acquire a knowledge vision of unstructured problems, a result of qualitative meta-synthesis of community intelligence.

2 Knowledge Vision by Qualitative Meta-synthesis

During the unstructured problem solving process, we need to depict the problem in structured way so as to deal with it using known methods or their integrative ways. How to get some structures towards those problems is of more difficulties. It is necessary to get to know problem structuring methods so as to develop appropriate information technologies to help human information processing and decision making along the unstructured problems solving process.

2.1 Problem Structuring Approaches and Computerized Support

Analytical decision methods explain how to make choices among a set of alternatives. Oriented to substantive rationality, those computerized methods help to fulfill the third phase, i.e. *choice* within the Simon's intelligence-design-choice model of decision making. However, alternatives should be available at first. More attentions are required to be paid to the *intelligence* and *design* phases, where relevant tasks are undertaken through a problem structuring process. Lots of approaches to problem structuring are proposed mainly in Europe, especially in UK [1-5]. The *Wisdom* approach proposed by soft OR group at Lancaster University aims to procedural decision support [6]. A *Wisdom* process refers to facilitated session includes brainstorming, cognitive mapping and dialogue mapping. The cognitive mapping phase provides a macro view of the problem discussed by the group and the dialog mapping phase helps the group to develop consistent micro views. In parallel to many western schools in approaches and methodologies for unstructured problem solving, a Chinese system scientist Qian Xuesen (Tsien HsueShen) and his colleagues proposed meta-synthesis system approach (MSA) to tackle with open complex giant system (OCGS) problems from the view of systems in 1990 [7]. OCGS problems are usually regarded as unstructured problems. The essential idea of MSA can be simplified as from confident qualitative hypothesis to rigorous quantitative validation, i.e. quantitative knowledge arises from qualitative understanding, which reflects a general process of knowing and doing in epistemology. OCGS problem solving process goes through three types of meta-synthesis, (i) qualitative meta-synthesis; (ii) qualitative-quantitative meta-synthesis; and (iii) meta-synthesis from qualitative knowledge (hypotheses) to quantitative validation based on systems engineering practice [8]. The 1st type, qualitative meta-synthesis, aims to produce assumptions or hypotheses about the unstructured problems, i.e. to expose some qualitative relations or structures of the concerned problems. Computerized tools, such as group support systems (GSS),

creativity support systems (CSS) etc. may support qualitative meta-synthesis. The working process of the qualitative meta-synthesis may be achieved by those problem structuring methods, such as the *Wisdom* approach, which may also support the third type of meta-synthesis to achieve final validated knowledge via facilitated collective intelligence. Different meta-synthesis needs different supports, which are of comprehensive discussions in correspondence with knowledge creating process in [9].

2.2 Qualitative Meta-synthesis to Knowledge Vision

MSA expects to take the advantages of both human beings in qualitative intelligence and machine system in quantitative intelligence to generate more new validated knowledge which may be stored into a conceptual knowledge system. The attention to the qualitative intelligence reflects the emphasis of human's dominant role at problem structuring and solving process, where resolutions about unstructured problems are captured through a series of structured approximation. For unknown or new issues, new ideas are often needed. Those new ideas may come from human's imaginary thinking, intuition and insight. Supported by creativity software, sparkling ideas may drop into one's mind. Creative solutions are often related with wisdom. Then, the practice of MSA is expected to enable knowledge creation and wisdom emergence.

At this point, we can sense that Internet is such a giant knowledge system, whose knowledge comes from contributions of Internet users facilitated by those various computer technologies enabled by the Web. A seraching engine can provide many *url*s. However people still need many efforts to acquire a rough vision of the concerned matter even with specialized supporting tools. If the interesting topic is across multiple disciplines, more efforts have to be taken to investigate those searching results. How to gain some senses about the concerned issue both efficiently and effectively is a problem. If got some hints or senses from those information, scenarios would then be drawn for further validating process, which may finally lead to a comprehensive knowledge vision of the issue. Thus a rough knowledge vision is required at first.

Then creative ideas are barely required than analytical or logical thinking. Creative thinking methods, such as brainstorming, KJ method, etc. are practical ways to acquire creative ideas, especially undertaken at group working level. Even complaints never fade toward low efficiency of group meeting, whatever is both feasible and effective for communication and information sharing, opinion collection and acquisition of expert knowledge. The Internet provides ideal context for active interactions, especially those empathic feedbacks and critical comments, and inevitably becomes a natural *ba* to harness the collective knowledge and creativity of a diverse community during collective problem solving process. The problem is how to faciliate such a process of acquiring knowledge vision from on-line community opinions, where augmented information technologies are being developed to provide somewhat helps.

3 Augmented Information Technologies toward Community's Consensus and Interests

Shneiderman abstracted four activities, collect, relate, create and donate for a framework of creativity based on creativity models [10]. The augmented information

technologies are mainly developed to facilitate those four basic activities to acquire basic threads or constructs from those on-line community opinions, such as customers' preferences.

3.1 AIS – Augmented Information Support

The AIS technology actually refers to a large category of those widely studied Web and text mining technologies. Web text mining technology focuses the Web pages which contain not only pure texts but also the hyperlinks between Web pages and more preprocess should be counducted on Web texts than pure texts. Figure 1 shows a basic Chinese Web text mining process [11].

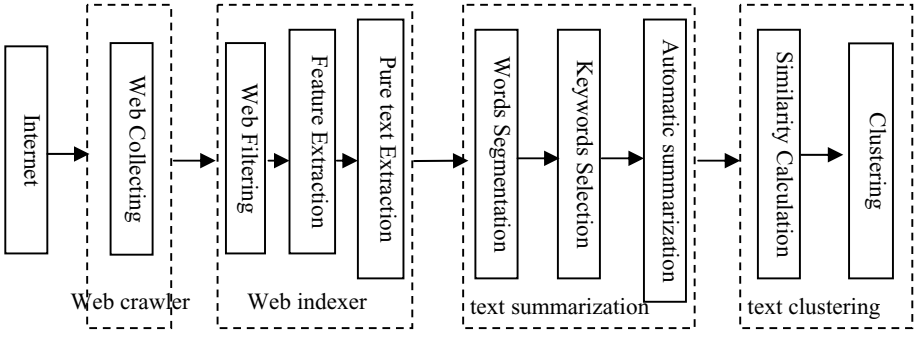

Fig. 1. A basic Chinese Web Text mining process [11]

All those technologies referred at Fig.1 are oriented to information collection, the 1st basic activity at the problem solving process or *intelligence* phase.

Besides the efficiency enhancement of searching, it is expected to acquire a set of records based on AIS technology with the structure as

<topic, userID, text, keywords, time>

Such metadata indicates the corresponding *userID* drops one *text* (e.g. one comment, one blog, a title of a paper, a reply to one question) with a set of *keywords* under the *topic* at the point of *time*. By word segmentation and filtered feature keywords used in text summarization, or even manual selection, a variety of human ideas and opinions can be transferred into one piece record of this form. The keywords for a blog may denote the tags. The keywords are articulated as attributes of the *userID* or the *text*. The next addressing technologies are based on such metadata.

3.2 Knowledge Vision by CorMap Analysis

CorMap analysis denotes a technology of exploratory analysis of textual data. Two major tasks will be carried out when CorMap analysis is applied.

3.2.1 Correspondence Analysis of Textual Data and Visualization of Correspondence Results

This technology mainly adopts correspondence analysis which provides a method of factoring categorical variables and displaying them in a property space where to map their association in 2 or more dimensions. This method has been widely used in many disciplines [12]. The singular value decomposition (SVD) is the principal mathematics of CorMap analysis. Given an *m-by-n* matrix *Z,* SVD is defined as $Z = U\Sigma V^T$ where *U* is an *m-by-m* unitary matrix contains a set of orthonormal vectors called row singular vectors, Σ is *m-by-n* matrix where the diagnoal elements are nonnegative singular values sorted in descending order, and V^T denotes the conjugate transpose of *V*, an *n-by-n* unitary matrix contains a set of orthonormal vectors called column singular vectors.

By AIS technology, a dataset of community opinions with the quintuplet about one topic can be acquired and two contingency tables are formulated. Each table refers to a frequency matrix. The element of one matrix denotes the frequency of keyword *i* referred by the participant *j* relevant to the topic. The element of another matrix denotes the frequency of keyword *i* referred by the text $j, i = 1, 2, \ldots, m$, $j = 1, 2, \ldots, n$. Then correspondence analysis is applied to both matrices and brings out two visual maps. By performing a series of transformations and SVD towards the transformed matrix, a set of row vectors and column vectors are achieved and then rescaled with the original total frequencies to obtain optimal scores. These optimal scores are weighted by the square root of the singular values and become the coordinates of the points. Given the coordinates, both participants and keywords can be mapped into 2-dimensional space. As a result, a pair of participants with more shared keywords may locate closer in the 2D space.

Such kind of analysis can be applied to any combination of available participants, and may help to "drill down" into those community thoughts to detect some existing or emerging micro community. If applied to an individual participant, CorMap analysis may unravel personal thinking structure.

Fig. 2 shows a CorMap of an investigation of working definition of knowledge science contributed by 20 faculty members and researchers of School of Knowledge Science at Japan Advanced Institute of Science and Technology (JAIST) taken in the end of 2006. Those respondents only wrote their understandings about what knowledge science research and education should be. Obviously differences existed among their understandings. If more than 2 sentences exist in one reply, more records for each reply are generated for better understanding. Then the whole data set includes 33 comments with a total of 74 filtered keywords.

CorMap aims to show a global thinking structure contributed by comments contributors, while different foci toward the topic could be easily seen. The respondent who locates close to the bottom of the visual map (Fig.2) obviously holds opinions far away from the majority.

Moreover three indicators, dominance, agreement and discrepancy, are provided to measure the contributions or roles of those participants relevant to the discussion of the topic. Who is active in posting comments? Who always follows others' ideas?

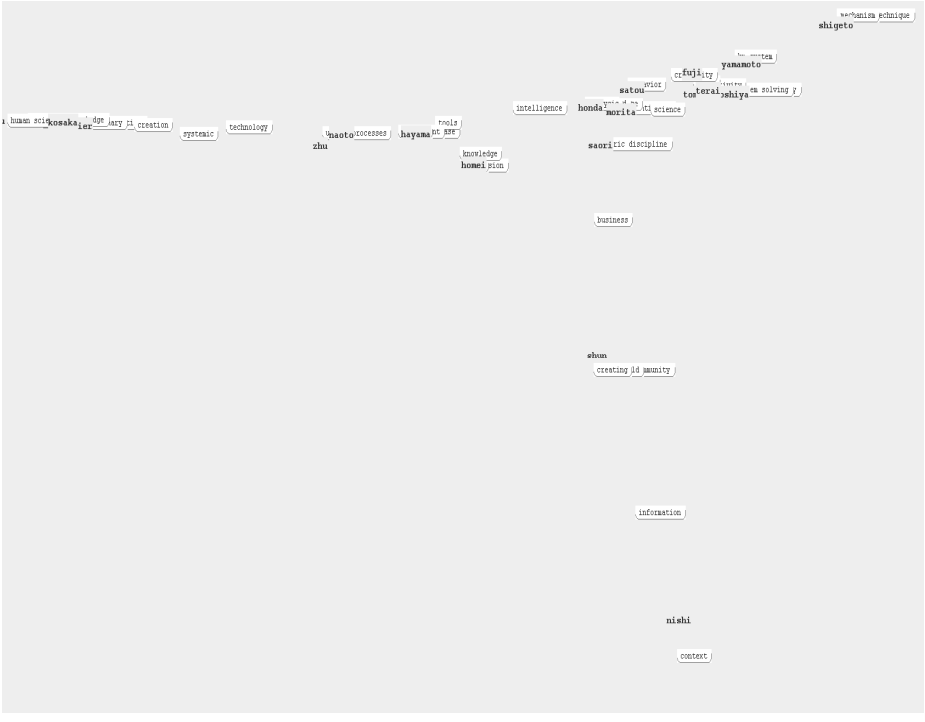

Fig. 2. CorMap visualization of a community towards working definition of Knowledge Science (20 People with 33 comments, 74 filtered keywords)

Who is of so peculiar thinking in this topic? Some of indicators were proposed in 2004 [13] and an improvement was taken in 2006 [14]. Such kind of work may also be helpful to select appropriate people for further study later.

3.2.2 Clustering of Ideas Based on Spatial Relations

Given the spatial relations acquired by correspondence analysis, a variety of clustering methods such as *k*-means clustering can then be applied to ideas clustering and concept extraction for qualitative meta-synthesis.

As shown in Fig.3, those 74-keyword spread across the 2D map is clustered into 6 clusters by *k*-means method. The keyword (whose label is of bigger size of fonts) which is closest to the centroid of the affiliated cluster could be regarded as the label of the cluster. The pop-up window lists all keywords and their frequencies in the Cluster labeled as “interdisciplinary” close to the left border of the map.

Furthermore instead of traditional human’s judgment of clustering numbers by trial-and-error, CorMap analysis applies a method to determine the true number of clusters. This method is based on distortion, a measure of within cluster dispersion, which is from the field of rate distortion theory in the information theory [15].

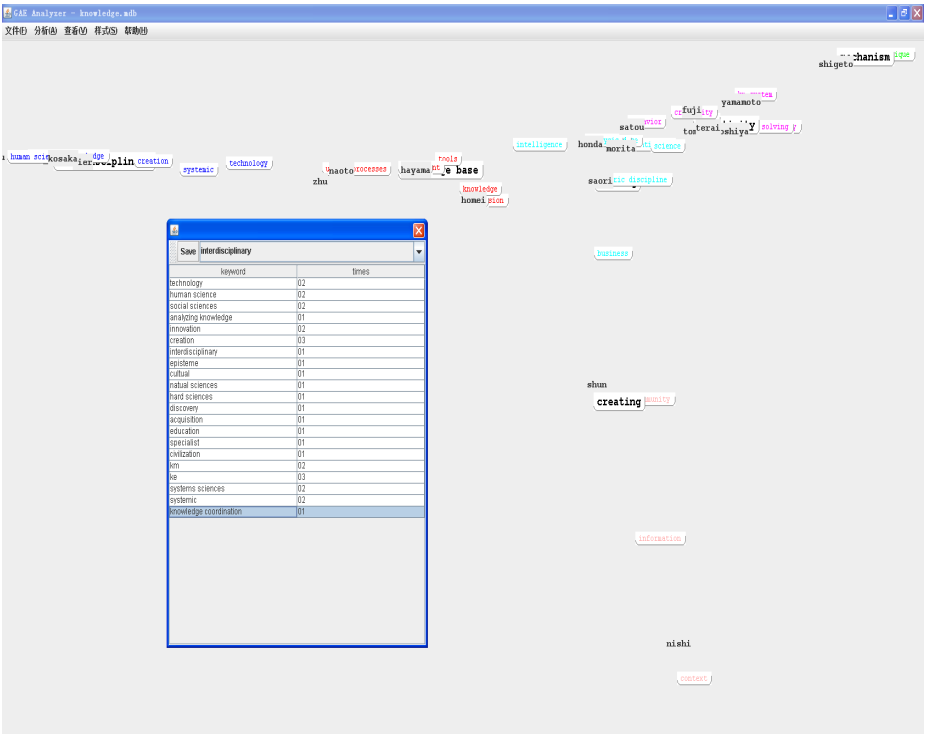

Fig. 3. Clustering of keywords (6 Clusters) and one pop-up box showing the keywords belonging to the left cluster labeled as *interdisciplinary*)

The motive to apply correspondence mapping about participants' opinions is to provide a basic or possible association between participants and their thoughts represented by keywords. As correspondence analysis is a method for exploratory analysis, significance testing is not supported. Then the visualized association is not confirmatory, even two dimensions may not visualize more than 75% of the association between humans and keywords. Therefore it is necessary to do further analysis instead of drawing conclusions directly from the visualized relevance. During the community opinion aggregating process, the dynamic mapping is to stimulate active association and feedback as a catalyst for shared understanding and wider thinking. A spontaneous and free-flowing divergent thinking mode is expected and possible helps are pushed for participants' awareness, even those hints are not confirmatory. Wild ideas toward the dynamic relevance, especially those isolated ideas far away from the majority may lead to some in-depth investigation for curiosity.

3.3 Knowledge Vision by iView Analysis

Given the same dataset used by CorMap analysis, iView analysis mainly applies network analysis methods to depict the scenario of the topic. The first step of iView

analysis is to construct a pair of networks, one is keyword network (or text network), the other is human network. Here keyword network is addressed for illustration.

3.3.1 Keyword Network: A Collective Idea Map

In a keyword network $G=(K,E)$, the vertex refers to a keyword. If keyword k_i and keyword k_j simultaneously belong to the keyword set of one *text*, then an edge exists between two vertices $e_{ij}=(k_i,k_j), i\neq j$, $e_{ij}\in E$ (E is the edge set). Then each keyword set of one *text* constructs a complete keyword graph, a somewhat structure of the text which reflect personal opinions. A keyword network denotes the aggregation of all keyword graphs based on all texts relevant to the concerned topic. If $G_l=(K_l,E_l)$ indicates the keyword graph of the lth text where $K_l=\{k_1^l,k_2^l,\cdots,k_n^l\}$ is the keyword set, E_l is the edge set, then $G=(K,E)$ where $K=\cup K_l=\cup\{k_1^l,k_2^l,\cdots,k_n^l\}$, $E=\cup E_l=\cup\{e_{ij}\}$, $i,j=1,2,\ldots,m,\ i\neq j$. This topological network is a weighted undirected network where the weight of edge denotes the frequency of co-occurrence of keywords among all texts. Such a network is referred as an *idea map* contributed by all participants.

Given such a network, more senses may be obtained via a variety of network analysis by detecting some of its features, such as cutpoints, centrality of keywords, keyword clustering, etc. which may expose different perspectives of a collective vision of all the participants. The underlying mathematics applied is mainly from graph theory social network analysis (SNA) [16]. For example, a cutpoint (articulation point) of a graph is a vertex whose removal increases the number of connected component [17]; then the cutpoint keyword may unravel the real key ideas. So does the centrality analysis of the keyword vertex. With use of community structure detection methods, clustering of keywords may help to understand the major points from those keyword clusters easier instead only by frequencies of individual keywords.

Fig.4 shows the keyword network of the above-mentioned investigation of knowledge science. Three components and nine cutpoints, *business, human, information, knowledge, KM* (knowledge management*), processes, science, systemic* and *tools*, are detected. Table 1 lists the top 15 keywords in measure of degree centrality and betweenness centrality, respectively. Obviously, different methods lead to different results. All cutpoints are among the top 15 keywords of centrality of betweenness, but only 6 appear within the high rank list of centrality of degree. Whatever, those central keywords may reveal how the community understand the concept of knowledge science, and may represent their interests in research and education. Based on Newman-Girvan algorithm for community clustering [18], 4 clusters are founded (the maximum value of the modularity measure Q = 0.6482) at the largest component with 62 keywords. The community structure analysis of a keyword network may provide some further senses than centrality of keywords about the consensus of the KS community.

Fig. 4. Community idea map of working definition of knowledge science (Cutpoint: vertex in square; modularity measure $Q = 0.6482$)

Table 1. The top 15 keywords in measure of centrality of both degree and betweenness

Rank	Keyword	Degree	Keyword	Betweenness
1	*knowledge*	38	*knowledge*	1337.17
2	*human*	21	*human*	470.83
3	*processes*	14	*systemic*	228.00
4	*science*	14	*processes*	186.00
5	creation	11	*science*	160.83
6	technology	11	*business*	118.00
7	innovation	10	*information*	60.00
8	creativity	9	creativity	54.67
9	discovery	9	intelligence	45.00
10	acquisition	9	creation	35.50
11	education	9	*km*	29.50
12	specialist	9	ke	29.50
13	civilization	9	innovation	29.00
14	*business*	8	technology	12.00
15	*information*	7	*tools*	5.00

3.3.2 Human Net Via Keyword-Sharing between Humans

In iView analysis, keywords-sharing between participants is considered and a human network where the vertex denotes a participant is constructed. If two participants share one keyword, a link between exists. The strength between two participants indicates the number of the different keywords or the total frequencies of all the keywords they share. From such a human net, social network analysis (SNA) is then applied to find the powerful people by centrality analysis and to detect the interest group by community structure detection, etc.

As shown in Fig.5, the keyword-sharing network of KS investigation has 1 component, which is split into 3 clusters. 2 cutpoints (*Wier* and *Shun*) are detected. The top 4 keywords in centrality of degree are *Saori* (15), *Morita* (14), *Honda* (13) and *Wier* (10). There are 6 vertices with a degree value of 6, *Shun* is among them. The top 5 keywords in centrality of betweenness are *Saori* (26.65), *Wier* (26.00), *Honda* (25.75), *Morita* (20.65) and *Shun*(18.00). All other humans' betweenness values are below 10.00. The pop-up window shows one respondent's reply (text, keyword and its frequency).

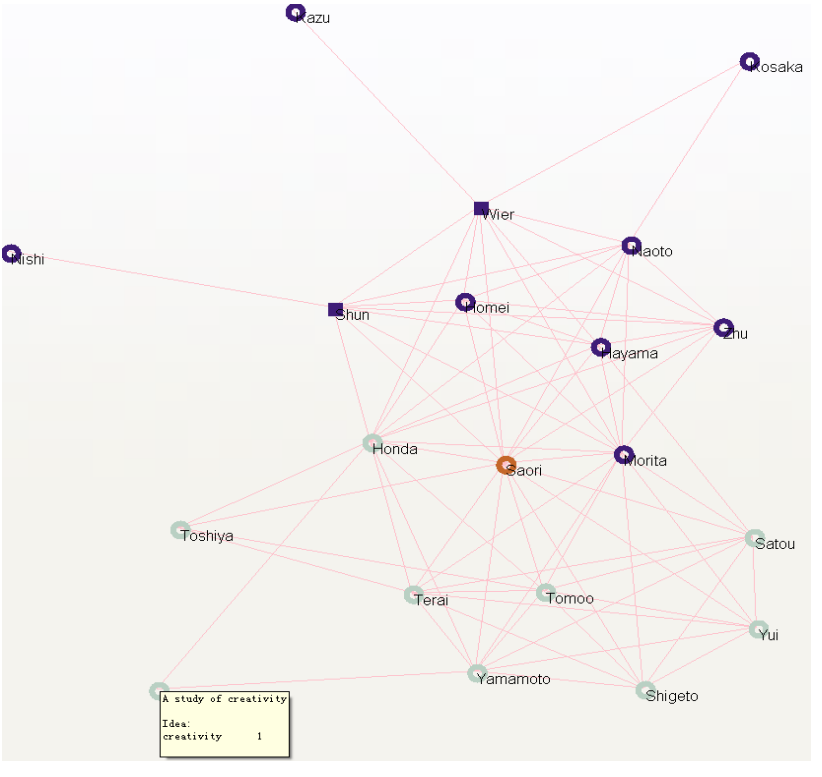

Fig. 5. Human net of KS investigation (3 Clusters, $Q = 0.3245$)

Small scale discussion always brings out human net with one giant component. If the topic scope expands, more components may emerge.

The pair of idea map and human net could be regarded as one kind of structure about the dedicated topic. The exploited network analysis aims to detect basic concepts and main themes, influential people and the potential micro communities emerged during the discussion. Those information could be regarded as the constructs of the concerned topic and may be helpful to those latecomers or entrants to quickly get a rough understanding of the interesting topic, a consensus of the existing community.

We can also take iView analysis to text network according to the keyword reference. Obviously, the text network is a directed network. This network may help to show how the ideas grow and spread during the discussion. Due to space limitation, detailed discussions are omitted.

4 Concluding Remarks

In this paper, we address three kinds of augmented information technologies, AIS, CorMap and iView, which are oriented to detect community's consensus and interest from those opinions contributed at BBS or various on-line forums. AIS technology aims to collect more useful textual information from the Web. The goal of both CorMap and iView analysis is to depict the collective vision toward the concerned issue by different ways to explore relevance between the texts and their contributors, support awareness and insights for potential hints, ideas, or senses of problems from which to undertake quantitative modeling for alternatives during problem solving process. The information detected by those data-driven, textual computing based visual exploration technologies could be pushed to the people to stimulate active participation, to show a map of human or community thinking process and then to construct a holistic vision by community opinions.

It is easier for people to show real attitude due to the decentered subjectivity encouraged by the Internet which also enables the on-line community creation. Nowadays, emerging technologies are being explored and exploited to improve the effectiveness of information retrieval and understanding. The tag cloud shows a visual depiction of user-generated tags used typically to describe the content of Web pages/sites. The cloud model lists the feature words alphabetically and the importance of a word is shown with font size or color. At this point, both CorMap and iView analytical technologies expose further relevance of those words and have it visualized. Web 2.0 technologies enable human participation and provide context to apply CorMap and iView technologies to quickly get a rough understanding of the interesting topic. For new comers or bystanders, it is easier to know some points from the visualized maps of community thinking, find fancy ideas which may lead to some in-depth investigation for curiosity.

The three technologies had already been applied to a famous science forum in China [11, 19, 20]. Both CorMap and iView technologies had integrated into different kind of tools for different uses, such as TCM Master Miner which exhibits a special way of TCM master thoughts' mining [21]. The iView analysis is of more application in conference mining to show the collective knowledge vision of one discipline [22]. Others' ideas are worth adopting or comparing, such as chance discovery using KeyGraph [23] and skillMap [24] for further explorations of current technologies.

Acknowledgement

This work is supported by Natural Sciences Foundation of China under Grant No. 70571078 & 70221001. The author is grateful to Mr. Kun NIE, a doctoral student at JAIST, who provided the original investigation data which was then processed and transferred to be as illustrations in this paper.

References

1. Tomlinson, R., Kiss, I. (eds.): Rethinking the Process of Operational Research and System Analysis. Pergamon, Oxford (1984)
2. Flood, R.L., Jackson, M.C.: Creative Problem Solving: Total Systems Intervention. John Wiley & Sons, Chichester (1991)
3. Rosenhead, I., Mingers, J. (eds.): Rational Analysis for a Problematic World Revisited, 2nd edn. John Wiley & Sons, Chichester (2001)
4. Detombe, D.J. (ed.): Handling complex societal problems (special issue). European Journal of Operational Research 128(2), 227–458 (2001)
5. Slotte, S., Hämäläinen, R.P.: Decision Structuring Dialogue, Systems Analysis Laboratory, Helsinki University of Technology, Electronic Reports (2003), http://www.e-reports.sal.tkk.fi/pdf/E13.pdf
6. Mackenzie, A., et al.: Wisdom, decision support and paradigms of decision making. European Journal of Operational Research 170(1), 156–171 (2006)
7. Qian, X.S., Yu, J.Y., Dai, R.W.: A new discipline of science - the study of open complex giant systems and its methodology. Nature Magazine 13(1), 3–10 (1990); (in Chinese, an English translation is published in Journal of Systems Engineering & Electronics 4(2), 2–12(1993))
8. Yu, J.Y., Tu, Y.J.: Meta-Synthesis - Study of Case. Systems Engineering - Theory and Practice 22(5), 1–7 (2002) (in Chinese)
9. Tang, X.J.: Towards Meta-synthetic Support to Unstructured Problem Solving. International Journal of Information Technology & Decision Making 6(3), 491–508 (2007)
10. Shneiderman, B.: Creativity Support Tools. Communications of the ACM 45(10), 116–120 (2002)
11. Zhang, W., Tang, X.J., Yoshida, T.: Web Text Mining on a Scientific Forum. International Journal of Knowledge and Systems Sciences 3(4), 51–59 (2006)
12. Beh, E.J.: Simple Correspondence Analysis: a Bibliographic Review. International Statistical Review 72(2), 257–284 (2004)
13. Tang, X.J., Liu, Y.J.: Exploring Computerized Support for Group Argumentation for Idea Generation. In: Nakamori, Y., et al. (eds.) Proceedings of the 5th International Conference on Knowledge and Systems Sciences (KSS 2004), pp. 296–302. JAIST Press, Japan (2004)
14. Tang, X.J. (ed.): Meta-synthesis and Complex Systems (2006 -2007). Research Report No. MSKS-2007-05, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, pp. 47-50 (2007) (in Chinese)
15. Sugar, C.A., James, G.M.: Finding the number of clusters in a dataset: an information-theoretic approach. Journal of the American Statistical Association 98(463), 750–763 (2003)
16. Hanneman, R.A., Riddle, M.: Introduction to Social Network Methods, University of California, Riverside (2005), http://faculty.ucr.edu/hanneman/nettext/

17. Harary, F.: Graph Theory, ch. 3. Addison-Wesley, Reading (1969)
18. Newman, M.E.J., Girvan, M.: Finding and Evaluating Community Structure in Networks. Physical Review E 69, 026113 (2004)
19. Tang, X.J., Liu, Y.J., Zhang, W.: Augmented Analytical Exploitation of a Scientific Forum. In: Iwata, S., et al. (eds.) Communications and Discoveries from Multidisciplinary Data. Studies in Computational Intelligence, vol. 123. Springer, Heidelberg (2008) (the first paper in chapter 3)
20. Zhang, W., Tang, X.J.: A Study on Web Clustering with respect to XiangShan Science Conference. In: Iwata, S., et al. (eds.) Communications and Discoveries from Multidisciplinary Data. Studies in Computational Intelligence, vol. 123. Springer, Heidelberg (2008) (the first paper in chapter 7)
21. Tang, X.J., Zhang, N., Wang, Z.: Exploration of TCM Masters Knowledge Mining. Journal of Systems Science and Complexity 21(1), 34–45 (2008)
22. Tang, X.J., Zhang, Z.W.: How Knowledge Science is Studied - a Vision from Conference Mining of the Relevant Knowledge Science Symposia. International Journal of Knowledge and Systems Sciences 4(4), 51–60 (2007)
23. Matsuo, Y., Ohsawa, Y., Ishizuka, M.: KeyWorld: Extracting Keywords from a Document as a Small World. In: Jantke, K.P., Shinohara, A. (eds.) DS 2001. LNCS (LNAI), vol. 2226, pp. 271–281. Springer, Heidelberg (2001)
24. Meyer, B., Spiekermann, S., Hertlein, M.: skillMap: Identification of parallel developments and of Communities of Practice in distributed organizations. In: Gu, J.F., Chroust, G. (eds.) Proceedings of the First World Congress of the International Federation for Systems Research (IFSR 2005), Kobe, Japan, November 14-17. JAIST Press (2005) No. 20053