

# Design of Bulletin Board System for Online Chance Discovery Process

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## Abstract

A bulletin board system (BBS) equipped with KeyGraph is proposed for supporting online chance discovery process. While conventional meeting for chance discovery with KeyGraph requires participants to meet in a meeting room, the paper aims to expand the discussion space over the Internet. In order to support online chance discovery process, the BBS has functions for assisting a user in writing scenarios with visual annotation on the KeyGraph. The system also has a function for retrieving similar scenarios. The experimental result with test subjects shows the effectiveness of the BBS for online chance discovery process.

**Keywords:** Chance discovery, bulletin board system (BBS), online discussion, and data annotation.

## 1. Introduction

A bulletin board system (BBS) equipped with KeyGraph is proposed for supporting online chance discovery process. When we have a discussion about something with KeyGraph, which is one of major visualization tools for chance discovery, each participant makes his / her own scenario from displayed KeyGraph. As a scenario represents the interpretation of the KeyGraph by a participant, the comparison or combination of different scenarios would discover new viewpoints / interpretations about the matter, which would lead to chance discovery. That means a group discussion is very effective for chance discovery. While conventional meeting for chance discovery with KeyGraph requires participants to meet in a meeting room, the paper aims to expand the discussion space over the Internet.

As the BBS proposed in this paper is equipped with KeyGraph, we can hold an online discussion with KeyGraph. One of the merits of online discussion is that participants do not have to come to the same place all together. Therefore, the number of participants can be much more than conventional meeting, which will

contribute to the discussion from various viewpoints.

In order to make an online discussion with KeyGraph efficient, the proposed BBS has two important facilities. One is for assisting a user in writing scenarios with visual annotation on the KeyGraph. Another is for retrieving scenarios which relate to the scenario written by a user.

The prototype system is developed as a Web application, based on which experiments with test subjects are performed. The experimental results show the effectiveness of the proposed BBS for online chance discovery process. It is also found that presenting users scenarios that relate to their own scenarios but contain different viewpoints is effective for them to notice a new viewpoint / interpretation.

Section 2 discusses an online chance discovery process with KeyGraph, followed by the proposal of KeyGraph-based BBS in Sec. 3. Experimental results are shown in Sec. 4.

## 2. Online Chance Discovery

### 2.1. KeyGraph

Concerning the important role of information visualization, a variety of information visualization systems have been designed for chance discovery process [1,2], among which one of the most famous systems is KeyGraph [1,3]. This section briefly describes the graph generated by KeyGraph. The detailed description such as how the KeyGraph processes the original data is found in [3].

Fig. 1 shows the example graph generated by KeyGraph, which consists of the following objects.

- **Black nodes** indicate the items frequently occurred in a data set (the word arranged close to a node refers to its content.).
- **White nodes** indicate the items not occurred so frequently in a data set.
- **Double-circled nodes** indicate the items that can be considered as keywords.

- **Links** indicate that the connected item pair co-occurs frequently in a data set. A solid line is used for forming an *island*, while a dotted line is used for connecting islands.

There are also composite objects that are very important for grasping what a graph shows. An **island** is defined as the connected component of the black nodes with solid lines. In Fig. 1, the sets of keywords, {"Fruit", "Meat", "Milk", "Vegetable", "Fish"}, {"Instant-food", "Snack", "Toy"}, and {"Cigarette", "Magazine", "Beer", "Baby-diaper", "Lighter"}, respectively. A **bridge** is defined as the dotted line that connects one island to the node that does not belong to the island.

The islands can be viewed as the underlying common contexts, because they are formed by the set of items co-occurred frequently in the data set. For example, the island in the left part in Fig. 1 refers to daily food. On the other hand, bridges are important in the sense that they connect two common contexts with new context, which is brought by the items that are not frequently occurred. While the common context represented by islands are widely known, the context represented by bridges are not so popular at this moment, which will lead to a chance.

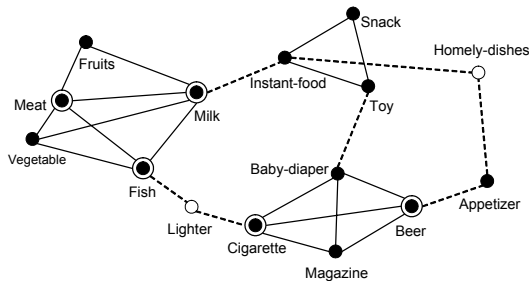


Fig. 1: Example of KeyGraph

## 2.2. Online Discussion for Chance Discovery Process

It is known group discussion and the introduction of other persons' viewpoints is effective for creating new ideas as well as for cooperative problem solving. In divergent thinking process, group discussions such as brainstorming are encouraged for collecting as many ideas / opinions as possible. In convergent thinking process, group discussion can introduce various viewpoints from participants for evaluating ideas as well as for making decisions. These advantages of group discussion are also applied to chance discovery process.

As a scenario by a person is his / her interpretation of the data visualized with KeyGraph, collecting as many scenarios as possible would contribute to discover a chance.

When a group discussion is to be held, participants have to come to the same place all together. However, the number of participants is limited by the capacity of a meeting room. Furthermore, time constraint for many participants to meet together is also serious.

Online discussion can conceptually solve these problems. There is no theoretical limitation on the number of participants, who can virtually meet together via the Internet. Also, the synchronicity of attending discussion is not necessarily required. As a result, the number of participants can be much more than conventional meeting, which will contribute to the discussion from various viewpoints.

## 2.3. Functions for Chance Discovery Support

There exist various tools for online meetings, such as video teleconference, chat, instant message and BBS. Among them, this paper employs BBS for supporting online chance discovery process. In particular, we propose the BBS on which participants can write and post scenarios while looking at the same KeyGraph. In the proposed BBS, a thread is generated for each KeyGraph, to which participants post their scenarios drawn up from the KeyGraph. A scenario corresponds to a comment.

In order to support chance discovery process on the BBS, this paper also proposes the following functions:

- Functions to annotate visually on displayed KeyGraph.
- Functions to retrieve similar scenarios.

As noted in Sec. 2.1, a KeyGraph is characterized by islands and bridges, which are clues for users to interpret the data. As a result, a scenario usually refers to islands and bridges. This paper proposes annotation functions, which let users mark islands and bridges visually on the KeyGraph. This function is expected to be useful for supporting user's scenario generation process.

When many scenarios are posted to the proposed BBS, it would be difficult for participants to find the relationship among scenarios. As noted in Sec. 2.2, the comparison / integration of scenarios is important for chance discovery. Therefore, this paper also proposes to equip the BBS with functions to retrieve similar scenarios.

### 3. KeyGraph-based BBS

#### 3.1. Scenario Generation Support

This section describes the BBS designed for KeyGraph-based online chance discovery process. The system employs client-server system, and a server is implemented as CGI with Ruby (<http://www.ruby-lang.org/>). The server stores both logs of BBS (such as thread and scenarios) and the graph data of KeyGraph. A client is implemented with Flash™, and can be accessed with an ordinary Web browser. The displayed data is transmitted from the server to the client with XML format.

Fig. 2 shows a screenshot of the BBS, which is displayed with a Web browser. As the BBS is currently designed for Japanese users, subsequent figures contain Japanese. The screen is divided into 3 areas: a KeyGraph area (upper left), a posting form area (lower left), and a thread area (right). A KeyGraph area displays a KeyGraph to be discussed in a thread. It is displayed as a clickable map, with which users can define islands and bridges that are going to be referred to in their scenarios. Users write a scenario in a posting form, and post it to the server. Posted scenarios are displayed in a thread area in arrival sequence, as displayed in ordinary BBS.

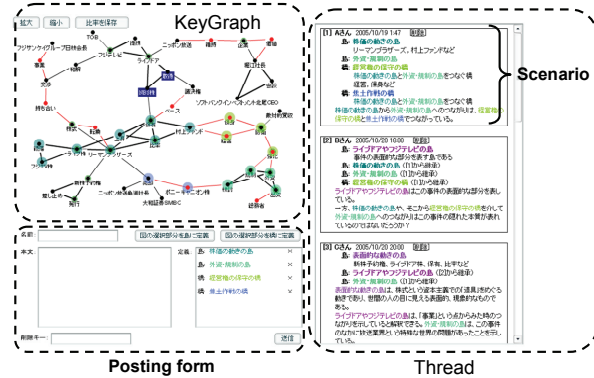


Fig. 2: Screenshot of KeyGraph-based BBS

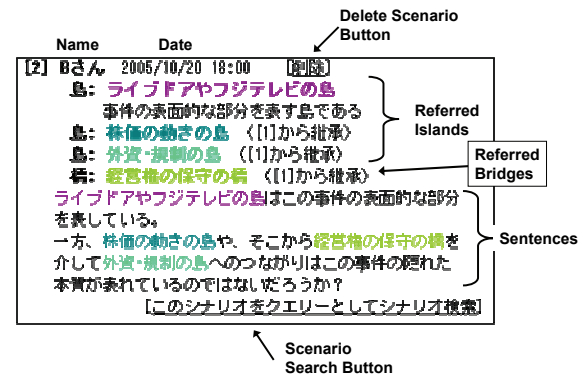


Fig. 3: Example of scenario description

Fig. 3 shows a description of a scenario, which is displayed in the thread area. The first line of a scenario describes the id, the author name and posted date of a scenario, along with a button to remove the scenario from a thread. From the second line, islands and bridges that are referred to in the scenario are described, and then followed by the sentences of the scenario. Each island and bridge is highlighted with different color in sentences. Furthermore, when a mouse pointer is being over a scenario in the thread area, the referred islands and bridges are also highlighted on the KeyGraph area.

Users cannot only define new islands and bridges, but also “inherit” those that have been already defined in other scenarios. Users can also reuse already defined islands / bridges with modifications (i.e., addition / removal of nodes). Using those definition / inheritance facilities make it possible to grasp the topics of a scenario, because readers can confirm the story of a scenario on the KeyGraph with the help of the visual annotation.

#### 3.2. Scenario Retrieval Engines

The last line in Fig. 3 contains a button to retrieve similar scenarios from a thread. In order to retrieve similar scenarios, this paper employs two retrieval methods; a method based on vector space model (VSM) and that based on data annotation [4, 5]. The VSM-based method uses keywords that correspond to nodes in a KeyGraph as index terms, based on which a scenario is represented as a vector. The similarity between scenarios is calculated based on cosine value of the corresponding vectors.

The method based on data annotation (called DA-method hereinafter) calculates the similarity between scenarios in terms of overlap of corresponding data in an original data file. As explained in Sec. 2.1, islands and bridges on a displayed KeyGraph are extracted based on the co-occurrence of keywords (nodes) in the data file. Therefore, it is possible to find the baskets in the data file that correspond to an island / a bridge. When a scenario is posted, the corresponding baskets in an original data file are extracted and annotated. The similarity between scenarios is calculated based on Jaccard coefficient, which calculates the overlap of the corresponding baskets between the scenarios.

Compared with VSM-based method that calculates the similarity based on keywords appeared in the scenarios, DA-method calculates the similarity based on the factors hidden behind scenarios. Therefore, DA-method is expected to retrieve scenarios referring to related topics. As a result, DA-method would provide users with related but different viewpoints.

## 4. Experimental Results

The implemented BBS is evaluated with test subjects. Thirteen subjects used the BBS for discussing economic topic: the M&A issue between Livedoor Co., Ltd. and Fuji Television Network, Inc. The headlines relating with the topic were collected from Nikkei News (12 Jan. 2005 to 26 Jun. 2005). Total 214 headlines were collected, from which a KeyGraph is generated by considering each headline as a basket.

First, subjects are asked to write scenarios regarding the above-mentioned topic with using the proposed BBS. After the experiments, they are asked to answer the questionnaires, in which they evaluate the functions for defining and inheriting islands / bridge with 5-point scale (1: poor, 5: good). The evaluations are summarized in Table 1, in which the column "Freq." shows the number of times a subject used the function. It is seen from the table that both functions are given high scores. It is also observed that all subject except subject 2 used the function for defining islands / bridges. Although the frequency of using inheritance function is lower than that of definition function, we can see that all subjects used at least either of the functions.

Table 1: Evaluations of scenario generation support

SubjectID	Definition Fn.		Inheritance Fn.	
	Score	Freq.	Score	Freq.
1	4	5	3	0
2	4	0	5	1
3	4	1	3	2
4	4	2	3	0
5	4	3	4	0
6	4	4	5	1
7	5	2	3	0
8	5	5	4	2
9	3	4	2	0
10	5	2	4	0
11	5	1	5	2
12	4	3	5	2
13	5	5	2	0
Average	4.3	2.8	3.7	0.8

Table 2: Experimental results of retrieval method

Retrieval method	Score	Rank of reference scenario
VSM-method	3.8	2.7
DA-method	3.7	3.8

After generating a scenario, each subject is asked to retrieve similar scenarios with both VSM-based method and DA-method, and to generate a new sce-

nario based on the retrieved result. In the questionnaires, they are asked to evaluate each of retrieval method with 5-point scale, as well as to answer the rank of the scenario that is used as a reference to generate the new scenario.

Table 2 summarizes the evaluation. Although the score given to both methods are almost similar, the rank of reference scenario is different. When VSM-method is used, subjects tend to refer to highly-ranked scenarios, whereas reference scenarios tend to be ranked lower when DA-method is used. For the reason of the difference, some test subjects gave comments about VSM-based method that only a few top scenarios were similar to query scenario, but subsequent ones seemed to be less related with query. On the other hand, the scenarios retrieved by DA-method were said to be related with query, even in lower ranks.

## 5. Conclusion

A BBS equipped with KeyGraph is proposed for supporting online chance discovery process. In order to support online chance discovery process, the BBS has functions for assisting a user in writing scenarios with visual annotation on the KeyGraph. The system also has functions for retrieving similar scenarios. The experimental result with test subjects shows the effectiveness of the BBS for online chance discovery process. Future works include the application of the BBS to online discussions about various topics, as well as its comparison with face-to-face discussion.

## 6. References

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