Creativity Support System for Idea Creation, Integration and Evaluation
(アイデアの創造、統合および評価のための創造支援システム)

氏　　　名　　　王　　浩

Name of Author　　　WANG　　Hao

In this research, we focus on computational support for collective creativity with artificial intelligence (AI). Unlike traditional text-based discovery methods, such as such as literature-based discovery and patent based discovery, Idea Discovery as an evolution and extension of Chance Discovery initiated by my supervisor Prof. Ohsawa, mainly depends on potential and important information (events and their relations) and their dynamic changes for driving idea creation, integration and evaluation during sustainable creativity process. The process of Idea Discovery is in accordance with a dynamic model shown in Figure 1 where includes two key components : (1) *IdeaGraph,* a novel algorithm to turn data into a scenario map for eliciting human insights; (2) 4W-IMG and Market Innovation Storming (MIS), two scenario-based creativity support techniques towards more actionable ideas generation.
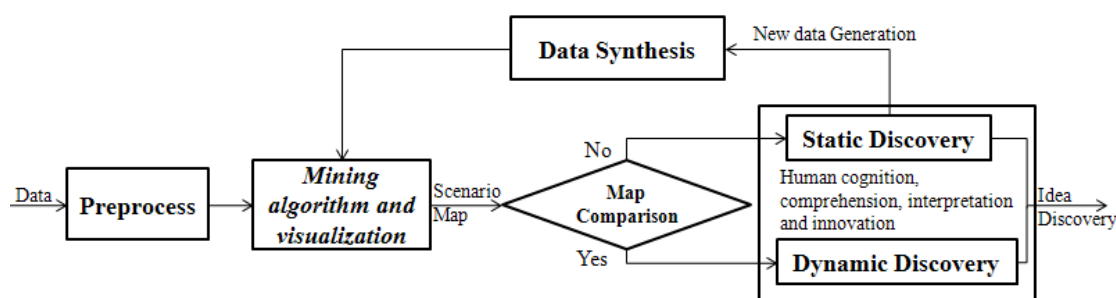

**Figure 1** A Dynamic Model of Idea Discovery Process

Idea Discovery process and the details are presented as below:

Step 1: Data gathering and preprocessing. Determine the objective of task and select relevant data. And then data is preprocessed into a group of basket data sets denoted by D, each row of which is a basket data set. For example, $P\,1$, $P\,2$, $P\,3$ and $P\,4$, four items constitute a basket data set.

$$D \quad = \quad \begin{matrix} P\,1, P\,2, P\,3, P\,4 \\ P\,2, P\,7, P\,5 \\ P\,3, P\,10, P\,6, P\,9, P\,5 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \end{matrix}$$

Step 2: Scenario map visualization. Preprocessed data D is mined by a mining algorithm and the result is finally visualized into a scenario map. Here, we apply *IdeaGraph* introduced in Chapter 3, which is a novel algorithm to generate a rich scenario map

for human cognition, comprehension, interpretation and innovation. *IdeaGraph* not only works on discovering more rare and significant events, but also focuses on uncovering latent relationship among events. Figure 2 shows a scenario map generation process by *IdeaGraph* algorithm.
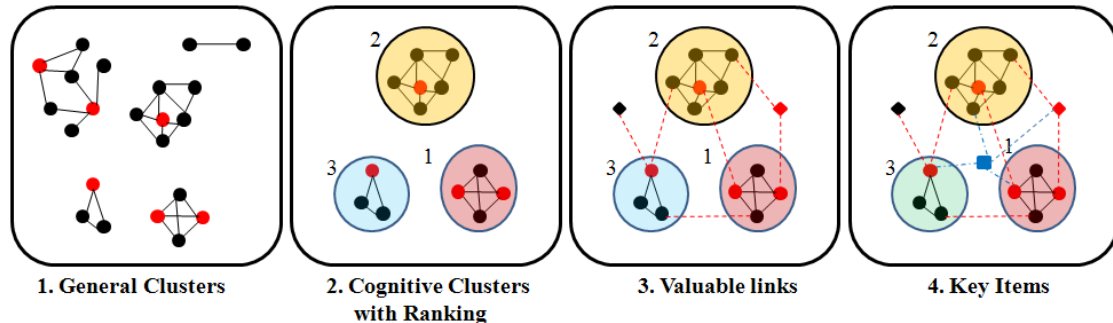
Figure 2 The generation process of a scenario map using *IdeaGraph* algorithm

Step 3: Scenario Maps Comparison. This step refers to a choice of discovery pattern, static discovery and dynamic discovery. If a dynamic discovery is needed and choosing 'Yes', current and previous scenario map will be compared for observing dynamic changes of latent information. As mentioned previously, dynamic changes refer to an event point or an event relationship changing from nonexistence to low frequency to high frequency, and vise verse. If choosing "No", scenario map is directly provided to Step 4 for a static discovery process.

Step 4: Static and dynamic discovery. Table 1 illustrates there are two kinds of discovery pattern in Idea Discovery.

One pattern is static discovery that user groups obtain value cognition from scenario map and come up with new ideas by combinational, analogical and reasoning thinking. Reasoning thinking needs directed scenario map, so *IdeaGraph* algorithm is also used to generate direct scenario map as well as undirected scenario map.

The other is dynamic discovery that human conceives new ideas through dynamic observation. Here, a tool is needed to track dynamic changes of each event point and their relationship by comparing before and after scenario maps. In static discovery, MIS and *iChance* are used to supply user groups with table-based and Web-based creativity support and eventually high-quality ideas will be obtained. In the meanwhile, new basket data sets *D'* are output. Each basket set in *D'* indicates how a designer creates a new idea. For instance, a designer created an *Idea 1* with consideration of Product *P1, P5* and customer demand *Demand 1*.

Figure 3 shows a Web-based collaborative creativity support system called *iChance* has been developed to supply designers and technical experts in enterprises with an online platform to make collaborative creativity with their customers.

$$D' = \begin{array}{l} P\ 2,\ P\ 5,\ Demand\ 1,\ Idea\ 1 \\ P2,\ P3,\ P\ 4,\ Idea\ 2 \\ P10,\ P\ 6,\ P\ 9,\ Complaint\ 1,\ Idea\ 3 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \end{array}$$

Table 1 Static and dynamic discovery in Idea Discovery

|	Static discovery	Dynamic discovery
Scenario Map	Single	Multiple
Thinking Mode	Combination/ Analogy/ Reasoning	Dynamic Observation
Observed objects	Event points & relationship (Nodes and links in map)	Changes of event points & relationship (Status changes of nodes and links in map)

Figure 3 A screen shot of *iChance* system

Step 5: Data Synthesis. The synthesized data *Syn_D'* is obtained by adding *D'* to the end of *D*.

$$Syn\_D' = \begin{array}{l} P\ 1,\ P\ 2,\ P\ 3,\ P\ 4 \\ P\ 2,\ P\ 7,\ P\ 5 \\ P\ 3,\ P\ 10,\ P\ 6,\ P\ 9,\ P\ 5 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ P\ 2,\ P\ 5,\ Demand\ 1,\ Idea\ 1 \\ P2,\ P3,\ P\ 4,\ Idea\ 2 \\ P10,\ P\ 6,\ P\ 9,\ Complaint\ 1,\ ,\ Idea\ 3 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \end{array}$$

Step 6: Idea discovery process iteration. Return to Step 2 for a new round of idea discovery. *IdeaGraph* is applied again to generate a new scenario map. Dynamic discovery may be carried out by comparing current new scenario map with previous map.

An intelligence system named *Galaxy* shown in Figure 4 has implemented *IdeaGraph* algorithm to analyze data and visualize data into an undirected or directed scenario map for eliciting human insights. In addition, *Galaxy* is also utilized to support the dynamic process of Idea Discovery.
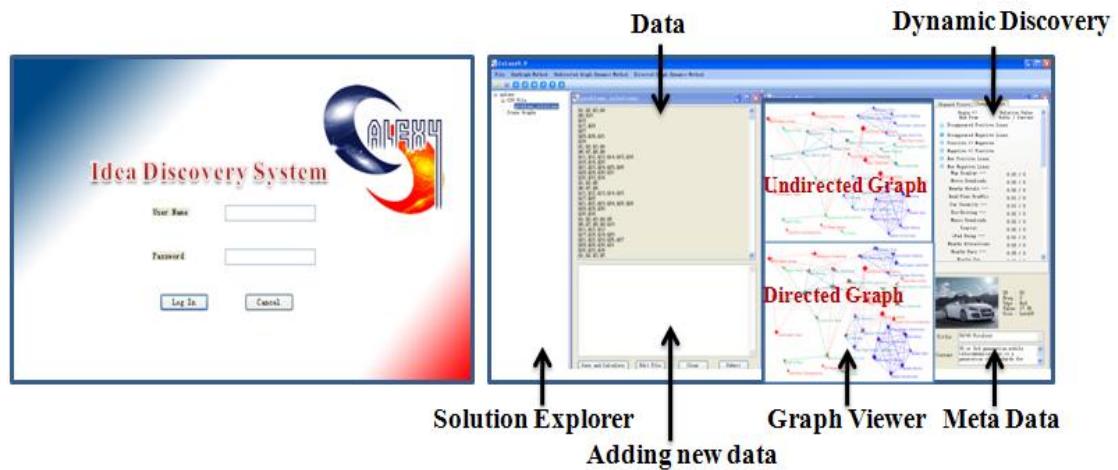
Figure 4 A screen shot of *Galaxy*

Case studies have verified the effectiveness of proposed methods and systems. More to the point, we have successfully carried out an innovation project in an automobile industry. The objective of the project is to explore Chinese users' preference on HMI system for further product development. As Figure 5 shows, comparing with group brainstorming, our approach helps the enterprise obtain more than twice actionable ideas and achieve high acceptance rate by nearly 90 percent so that it accelerates the efficiency of product development as high as approximately 50%. Moreover, dynamic discovery makes the enterprise discovering additional creative ideas regarded as potential business opportunities in the future and timely develop their new strategies to respond ever-changing customer demands and market opportunities.
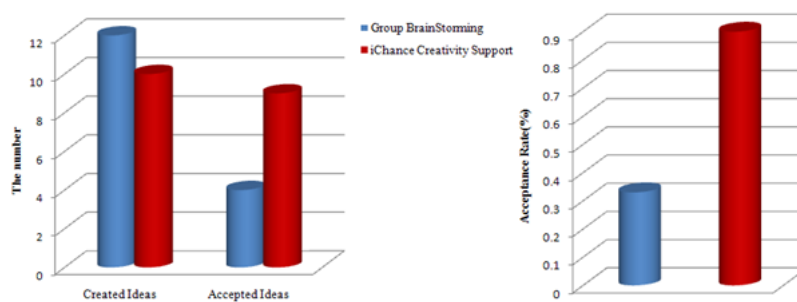
Figure 5 The comparison of group brainstorming and *iChance* creativity support