Exploratory Activity Support Based on a Semantic Feature Map

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Abstract. In this paper, we propose a framework based on a sub-symbolic approach for the support of exploratory activities in a hyperspace. By using it, it is possible to express the semantic features of the whole hyperspace and the states of exploratory activities in topological order. This approach is applied to generate the navigation information for the exploratory activity. The space explored is changed automatically by using the semantic similarities of the nodes which constitute that space. An extended self-organizing feature map is used as the semantic feature map of the hyperspace. This map is applied to express the user model and generate the navigation strategy for the user. The exploratory history of the user is mapped on it. Then, the semantic relations between nodes are shown on the map. The result reflects the exploratory state of the user, interpreted with the help of a user model.

1 Introduction

Hypermedia provides an effective activity environment, where users can acquire knowledge by exploring the hyperspace in their own way. Still, users often tend to *"get lost"* in the hyperspace [5]. To improve such undesirable effects on users, many researchers have been working to construct hypermedia systems which can identify the user's interests, preferences and needs, and give some appropriate advice to the students during the exploring activity process [1,2].

We have developed an adaptive navigation system for exploratory activity by using a sub-symbolic approach [3]. This system generates an advice message for a user who is in impasse, and also provides a list of recommended nodes which the system proposes to the user to refer as the next step of exploratory activity. The system shows advice to the user to give the student a chance to escape from undesirable exploratory states. To increase support effect for the learner, the system's navigation function is being improved, to attach semantic knowledge to whole elements in hyperspace. In this study, we use the relations between the concepts, which each node in the hyperspace represents, as the preliminary knowledge, for the process of navigation information generation. By using this knowledge, the system develops a model of the user's exploring activity on a semantic feature map of the hyperspace. The system generates navigation information which ensures that the exploring activity becomes reasonable and continual.

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2 Research Goal

The purpose of this study is to propose a framework to support exploratory learning, based on a-priori knowledge embedded in a semantic feature map of the hyperspace and a user model of the learner's exploratory activity. To support the exploratory learning, our navigation system realizes the following three exploratory learnng sub-goals: to escape from stagnation and deadlock, to clarify the learner's purpose and to guarantee the validity of the result.

3 Semantic Feature Map of the Hyperspace: Hy-SOM

Two extensions of the original SOM [4] (*self-organizing feature map*) are proposed. Firstly, for improving the accuracy of the ability to classify, a new learning function is proposed. With this extension, the features of the input pattern reflect the structure of the output layer more exactly. Concretely, improvements based on the theory of probability are made on the composition of the input pattern and the initial phase of the learning (training) process. Categories for distinguishing each trained pattern (node) are created in the trained network. The configuration of the nodes is based on their semantic topological similarity. Secondly, for improving the robustness of the ability to classify, a method of reconstructing all weights in the trained network is proposed. In this way, some regions are defined on the map. Each region shows distinct topics (semantic cluster). Concretely, in order to represent visually the appearance probability of the value of each element in the input pattern (forming a vector), the trained weights are reconstructed into binary values. The topic configuration, similar to the node configuration, is based on semantic topological similarity. As a result of this structure, semantic similarities between topics, of which the course designers or instructors may not be aware, can appear clearly expressed on the map automatically.

By using our approach, the space explored is reorganized automatically according to the semantic similarities of the nodes which constitute that space. The resulting shape is a kind of map. We call this map the semantic feature map of the hyper-space, in short Hy-SOM. The Hy-SOM is applied to express the user model and navigation strategy for user. The exploratory history of the user is mapped on the Hy-SOM. Then, the semantic relations between nodes are given on the map. The result shows the exploratory state of the user. This is interpreted as a user model.

4 Hy-SOM Based Navigation for Exploratory Activities

The user model assembles information of two kinds. The first type of information is extracted from the exploratory history of the Hy-SOM. The second type of information is gathered from the interpretation of the exploratory history on the semantic network built from the attributes of the nodes and links. From these two types of information, our navigation system creates the user's exploratory activity model. The user exploratory model has three states: reference state, exploratory state and cognition state. The exploratory tendencies of the user are inferred from the above user's exploratory model. Based on the deduction about the user's exploratory tendencies and on the expert knowledge embedded in the navigation system, navigation guidance trying to correct the undesirable patterns is developed. The navigation strategy parameters are instantiated by using the Hy-SOM, the hypermedia node hierarchy and the semantic attributes of both nodes and links.

The result of the instantiation is an ordered list of nodes recommended by the system for reference in the next step of the user's exploration. The system presents this ordered list to the user as navigation guidance information.

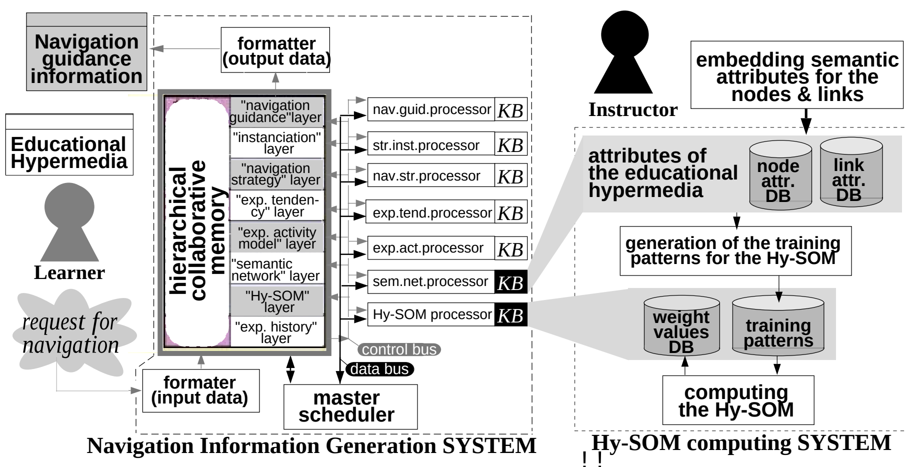

Fig. 1. The architecture of the navigation system.

5 System Architecture and the Interfaces

The entire process, starting from the logging of the exploratory search history, till the navigation guidance information generation, is based on the collaborative problem solving model. This model contains a collaborative memory based on a hierarchic structure, and implements the collaborative-problem-solving's result sharing mechanism.

In Figure 1, the architecture of our navigation system is shown. This system consists of two sub-systems. One is the Hy-SOM computing system. The user of this system is the designers of the educational hypermedia. They have to embed the semantic attributes of whole nodes and links in the hypermedia. Our system also offers an attributes editor. The other sub-system is the navigation

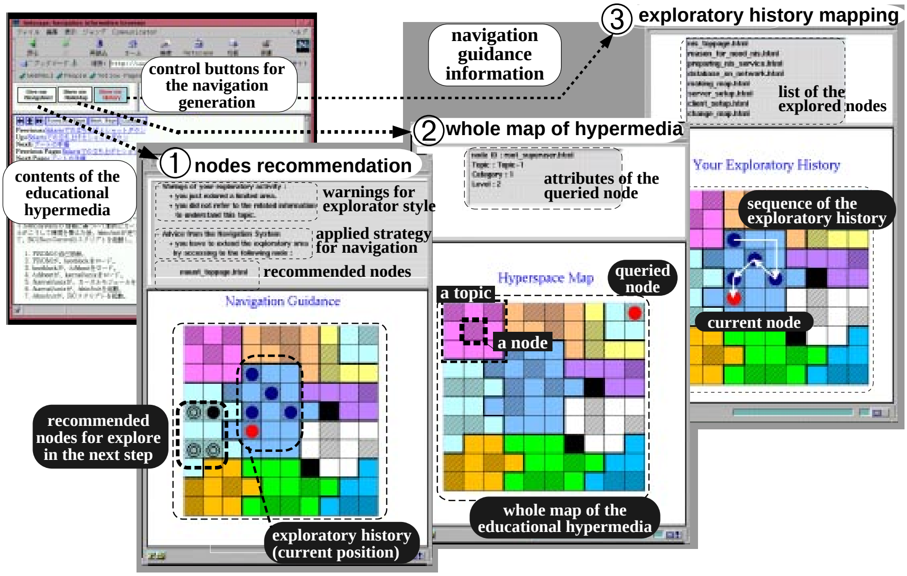

Fig. 2. The interface of the navigation system.

information generation system. The interfaces of this system are shown in Figure 2. Three types of navigation guidance information (recommendation of the appropriate nodes to explore in the next step, the whole map of the educational hypermedia and the learner's exploratory history) are given.

6 Conclusion

In this paper, we have presented an overview of our semantic feature map-based system for exploratory activity support. We have focused especially on the two extensions we proposed for our Hy-SOM, for improving both classification accuracy and robustness. Moreover, we have shown the information types that we use for our user model. Finally, the system architecture was described.

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