Providing Supplemental Teaching Materials in Order based on the Rough Set Theory

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Abstract

Nowadays, Problem-Based Learning (PBL for short) is a popular teaching strategy for teachers. In the PBL environment students can learn how to solve the real life problems by discussing with their teammates and developing their brainstorm map. How a teacher decides what kinds of teaching materials are appropriate to students according to their learning performance is an important issue. Therefore, this paper proposes a sequencing mechanism to provide the teacher recommendatory sequence of remedial teaching for each group. In this paper the Rough Set theory is used to discover the hidden data pattern in the tree-like concept map which is transformed from the brainstorm map constructed by the students.

Introduction & Research Backgrounds

Teacher always want to know what a student had already learned. In PBL environment, teachers can understand the mental model of a small group of students through the brainstorm map. Moreover, teacher is a facilitator to students in PBL teaching process.

This paper proposes a mechanism to provide the teaching suggestion to the teacher. The brainstorm map will be transformed to a tree-liked concept map suchlike the Figure 1 shown below in order to simplify the analysis process.

However, finding the hidden information inside the concept map is somehow a little of difficult. Since the Rough set theory is usually used to discover the hidden data patterns, therefore, this paper proposes a mechanism for analyzing the sequence of supplemental teaching materials based on the rough set theory.

Via the rough set theory the data will be divided into three sets, including the Positive Set (POS), the Negative Set (NEG), and the Boundary Set (BND). For example, data belongs to the POS means the data is consistent with what the researcher expected. On the contrary, data belongs to the NEG means the data is inconsistent with their expectation. The Boundary Set (BND) is a set in which all of the data can not be classified yet belong to.

The POS and BND sets will be taken into consideration while develops a mechanism to sequence the lacks of concepts of the student for teachers in this paper.

Relations between Tree-Like Concept Map and Rough Set

Students can discuss with their teammates and draw their own brainstorm map based on PBL instructional theory. In PBL environment the teacher is a facilitator

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during the teaching process and will also draw his/her concept map in the brainstorm time. At this moment, the student's brainstorm map could be transformed to a tree-liked concept map just as the student part at the top-right corner in Figure 1.

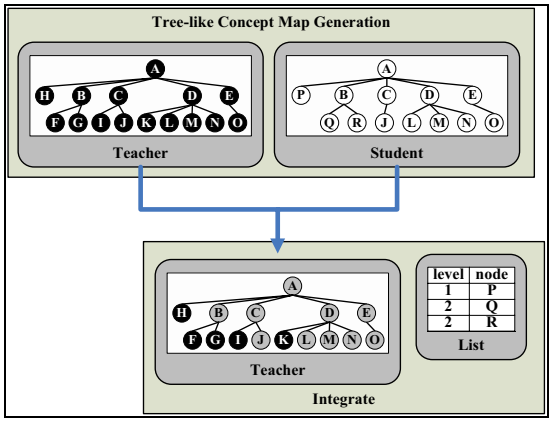

Figure 1. The Integrated Map

In order to compare the differences between the tree-liked concept maps of the student and the teacher, an integrated map then merge the maps of both student and teacher as the Integrate part in Figure 1 shown above. After an integrated map is constructed, the rough set theory can be used to analyze the differences between the student and the teacher. However, before designing the sequencing mechanism, the three sets in the rough set theory have to be defined at first.

Take an integrated map in Figure 2 as example, the gray circle indicates the concept exists in both student's and teacher's mind; the black circle represents the concept is missing in the student's mind. Moreover, the POS, the NEG, and the BND sets in each level can be defined as Table 1 lists in the following. Obviously, the elements of the POS and the NEG sets in each level will be the gray circles and black circles. Regarding the BND set, this paper takes the parent nodes of the elements of the POS and NEG sets as the elements of the BND set.

According to Figure 2 there are many concepts that belong to the lack of concepts and will be necessary to provide the correspondent materials to the student by the teacher. However, how does the teacher decide the teaching order for each missing concepts? This paper designs a sequencing algorithm for each missing concepts based on the rough set theory.

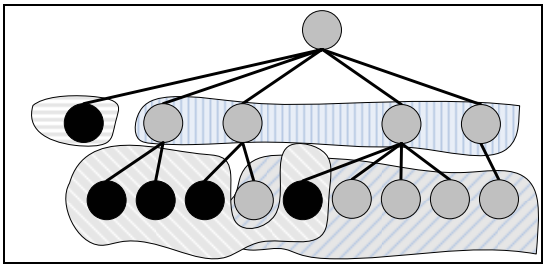

Figure 2. Integrate map with rough sets

Table 1. Rough sets and its elements

$POS_2(\mathbf{C})$	J, L, M, N, O
$NEG_2(\mathbf{C})$	F, G, I, K,
$BND_2(\mathbf{C})$	B, C, D, E
$POS_1(\mathbf{C})$	B, C, D, E
$NEG_1(\mathbf{C})$	H
$BND_1(\mathbf{C})$	A
$POS_0(\mathbf{C})$	A

Each of the lacks of concepts will be assigned a value with the sequencing algorithm. After that, the order of providing supplemental teaching materials could be generated to teacher as a teaching recommendation.

Sequencing Algorithm for missing concepts

In this section the calculation process is revealed. The sequencing algorithm proposed by this paper will calculate bottom-up the important degree of each concept except the leave concepts in the integrated map. Take the integrated map in Figure 2 as example.

Example 1: Given an integrated map in Figure 2

a. the concept set is $\mathbf{C} = \{c_i\}=\{c_A,c_B,\ldots,c_O\}$
b. the children concept set of c_i is *Children*(c_i)
c. the POS, NEG, BND sets for each level will be denoted as $POS_{level}(\mathbf{C})$, $NEG_{level}(\mathbf{C})$, $BND_{level}(\mathbf{C})$
d. the elements of the POS, NEG, BND sets for each level are listed in Table 1. □

First, in order to bypass the leave nodes of the integrated map, those leave nodes, F, G, I, J, K, L, M, N, and O, are identified. Since the deepest level of the integrated map in Figure 2 is 2, the BND set of level 2, $BND_2(\mathbf{C})$, then will be processed. Second, the important degree of each concept which belongs to $BND_2(\mathbf{C})$ for sequencing can be calculated by Eq.(1).

Therefore, the important degree of each concept in the $BND_2(\mathbf{C})$ is listed in Table 2.

$$\alpha_{level}(c_i) = \frac{|Children(c_i) \cap POS_{level}|}{|Children(c_i)|} \quad (1)$$

Table 2. Important degrees of $BND_2(\mathbf{C})$

	$BND_2(c_B)$	$BND_2(c_C)$	$BND_2(c_D)$	$BND_2(c_E)$
$\alpha_{level}(c_i)$	0	0.5	0.75	1

Hence, the teacher can decide how to provide either a student or a group (6-8 students for each group) the supplemental teaching materials in sequence by the important degree of each concept. He/She can decide the order from either small to large (0.00 to 0.99) or large to small (0.99 to 0.00). If the important degree of a concept node is 1.00, then the whole branch from the concept node is known clearly by the student.

Experiment and Discussion

In this paper, some data was collected by our previous researches is used to verify the sequencing mechanism. These data came from the PBIALS which is a web-based application and running with the PBL-based teaching environment in the Information Program of the Chih-Ping Senior High School.

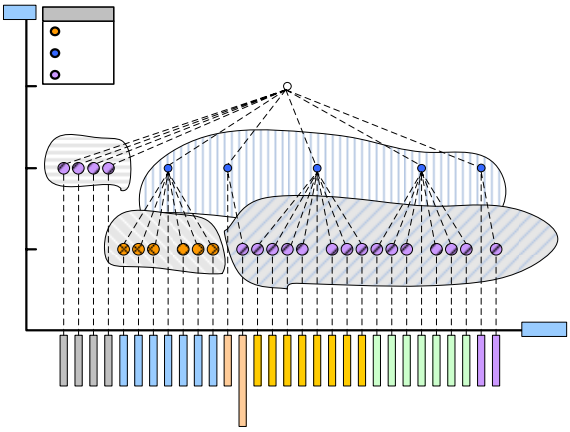

Figure 3. Integrated Map of Team 8 and the teacher

The experiment lecture is the Dream Computer. There are 53 participants whom are the first year students of the Information Program in the school (most of them are male and divided into 8 small groups). After the lecture a self-designed questionnaire is sent to teachers in order to know their feelings about using the feedback system.

According to the Figure 3 we can find the Integrated Map of Team 8 and the teacher. Table 3 lists the rough sets retrieved from the Integrated Map in Figure 3.

Table 3. Rough sets of the Integrated Map in Figure 3

$POS_2(\mathbf{C})$	{Cordless Optional Mouse, ABIT, IWill, Soyo, MSI, GIGA, ECS, ASUS, WD, Maxtor, IBM, Seagate, Quantum, IBM40G, Intel}
$NEG_2(\mathbf{C})$	{EDORAM, SRAM, SGRAM, RAMBUS, DDR, SDRAM}
$BND_2(\mathbf{C})$	{Memory, Mouse, Mainboard, Hard Disk, CPU}
$POS_1(\mathbf{C})$	{Memory, Mouse, Mainboard, Hard Disk, CPU }
$NEG_1(\mathbf{C})$	{CD-ROM}
$BND_1(\mathbf{C})$	{Dream Computer}
$POS_0(\mathbf{C})$	{Dream Computer}
$NEG_0(\mathbf{C})$	{Ø}
$BND_0(\mathbf{C})$	{Ø}

With the Table 3 the important degree of each node from the BND_2 to BND_0 is able to calculate based on Eq.(1) as the Table 4 shown below.

Table 4. Important degrees of Table 3

	Memory	Mouse	Mainboard	Hard Disk	CPU
$\alpha_2(c_i)$	0	1	1	1	1
	Dream Computer				
$\alpha_1(c_i)$	0.56				

In this case, the system will suggest a teaching order to the teacher, such as EDORAM, SRAM, SGRAM, RAMBUS, DDR, and SDRAM in the [Memory] branch. Because only the important degree of the [Memory] branch is 0, which means, the students in Team 8 are not familiar with any children concepts of the [Memory].

Conclusions

A teacher can discover the learning effect of his/her student according to the transformation of the Brainstorm Map in PBL teaching environment. Moreover, it is easily for him/her to realize the lacks of concepts of students and provide the necessary supplemental teaching materials of the missing concepts to the students with the sequencing mechanism developed in the paper.