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Procedia Engineering 15 (2011) 3366 – 3370

Procedia Engineering

www.elsevier.com/locate/procedia

Advanced in Control Engineering and Information Science

Study of Personalized E-Learning System Based on Knowledge Structural Graph

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Abstract

It is necessary for different learners demand for personalized learning contents in e-leaning environment. In this paper, the personalized learning system was constructed based on personalized knowledge structural graph (KSG) by the artificial intelligence, the data mining and the database technology. The system can dynamically assess the learning process to come out personalized KSG based on different learners. The optimal learning path (OLP) generator was designed and implemented based on personalized KSG through the topological sort algorithm, in order to provide learners personalized learning content and teaching methods. In addition, the system can also dig for the learning history data and gain the knowledge to improve personalized service decision-making rules and student model of the system. The experiments show that it greatly increases the efficiency of e-learning.

Selection and/or peer-review under responsibility of [CEIS 2011]

Keywords: knowledge structural graph (KSG); optimal learning path (OLP); personalized e-learning

1. Introduction

In the online learning environment based on network and computer technology, autonomous learning for many students is main learning mode. Students' learning process in network shown alone, helpless and facing mass network learning resources has been overwhelming situation of computer, network and education etc researchers paid more attention to. And according to the students' learning goals and

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doi:10.1016/j.proeng.2011.08.631

knowledge level, the curriculum repository from huge extract different learning content, as the goal of building an effective learning crowd, realize the guiding model for autonomous learning mode "teachers' scientific guidance" in recent years, has become e-learning the researchers focused research topic. For above problems, the personalized learning system was constructed based on personalized KSG by the artificial intelligence, the data mining and the database technology. The system can dynamically assess the learning process to come out personalized KSG based on different learners. The OLP generator was designed and implemented based on personalized KSG through the topological sort algorithm, in order to provide learners personalized learning content and teaching methods. In addition, the system can also dig for the learning history data and gain the knowledge to improve personalized service decision-making rules and student model. The experiments show that it greatly increases the efficiency of e-learning.

2. System Structure

The design target of the system is that the students' model and the personalized decision rules should be updated at any time by the tracking students' learning status. According to the knowledge that the students have got and the personalized decision rules, the personalized teaching contents have been generated dynamically. Fig. 1 shows the system structure.

The working process of the system is that: Firstly, the students hand in the basic information by the registry services, and the static information are input in the students' information base. When the student login in, controller can get identifications of the student and his course taken. By identifications got, matching the knowledge that the student had got with KSG of the course so as to construct the student' KSG. Then it should be sent to the OLP Generator, which produces OLP by KSG of the student and choice the suitable teaching method to guide in the instructional strategy base. At the time of following the OLP, the student also can use the learning tools, exercising tools, answering tools, communicating tools and text tools to assist himself achieve the every task which are contain in the OLP. When the act is going, controller tracks, collects and stores the information of study performance. For increasing historical data in the students' information base, the data mining module can be called. And using the knowledge acquired from the excavation to improve personalized service and the student model. Such as revising and consummating teaching method and knowledge structure of course.

3. Design of Main Functional Modules

This paper focuses on designing the representation of the course knowledge structure, the establishment and modulation of personalized KSG and the generation of the OLP.

3.1. Knowledge structure of courses

We will divide the course knowledge into three levels: unit layer, conceptual layer and the physical layer. The knowledge of unit layer is defined for teaching unit(TP), gathering together knowledge of a chapter; The knowledge of conceptual layer is the abstraction of teaching knowledge, called knowledge points(KP); The knowledge of the physical layer is the description in detail of conceptual layers, called pages(P). As fig. 2 shows.

(1) Composition of knowledge points

In order to automatically increase and delete knowledge points, we use an existence degree to present an important degree of the knowledge point. In personalized learning system it is required that the knowledge point can describe the information such as the difficulty and threshold, so we expressed each knowledge point as a seven part group: (I, A, ED, LA, AA, LT, SC), where:

I: identifier of knowledge point; A: pointer of knowledge point, because the specific content of teaching knowledge is not included in knowledge points, and the specific content is described in the physical layer, therefore, knowledge point pointer points to the corresponding page set in the physical layer; ED: exist degrees, means the important degree of knowledge point; LA: through threshold, when the score of the knowledge point is no less than the threshold, it is allowed to leave this knowledge point, into the next knowledge point learning; AA: skip threshold, when the score of the knowledge point is more than the threshold, it can skip this knowledge point, into the next knowledge learning directly; LT: reach difficulty, difficulty threshold which system requires students to achieve in learning the knowledge point; SC: choose difficulty, difficulty threshold which the students choose by themselves.

(2) Links between knowledge points

It defines three links among knowledge-points: order chain, supply chain and the OLP chain. Their implications are described below.

1) Order chain: it presents the basic order relation among knowledge points in the conceptual layers, which is similar to a book structure composed of chapter, the section, small matter. It enables the information presented hierarchical structure in overall.

2) Support chain: it presents the learn first relationship related of the knowledge-points. They connect knowledge points into network structure. In order to balance the importance of learning first between knowledge, we add the connection intensity on the chain, says the close connection degree between knowledge-points. The connection intensity can be the number of 0 ~ 9.

3) OLP chain: make sure the best teaching sequence and guide student's study, generated dynamically by OLP Generator according to student model.

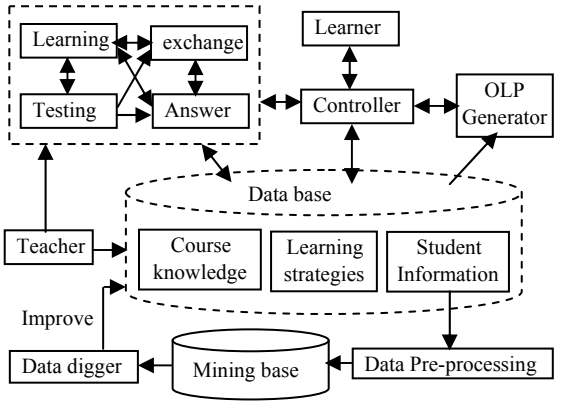

Fig.1. system architecture

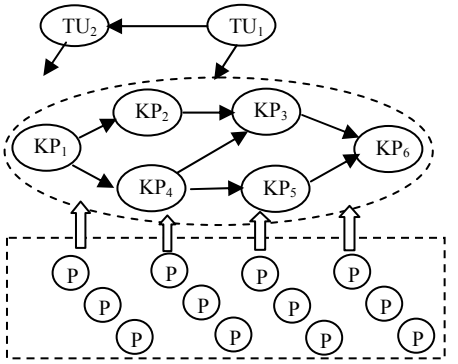

Fig.2. hierarchy of the knowledge for course

3.2. Establish and adjust the individualized knowledge state chart

Knowledge level of student is recorded in the student knowledge structure information. In general, the student knowledge is a part of the course knowledge. So the student knowledge state diagram is organized according to the course knowledge structure. The curriculum knowledge is divided into a number of the teaching units which is consisted of a number of knowledge points, therefore, each teaching unit must corresponds with a student knowledge state diagram for recording the mastery of the chapter.

Based on the characteristics of the course, the teacher should define the assessment methods for the different class of the students to get the initial knowledge state diagram. The learning outcomes of the

related knowledge points are assessed by the after-school tests. Data mining to question-answering, knowledge exchanged and other learning activities gives a score and applies it to the state and relationship of knowledge points.

The scoring principle of the test: if answers for the knowledge point i was correct, then the its score would be added one; if answers for the knowledge point i was error, then the its score would be subtracted one; if the knowledge point i had not been tested, the result is zero.

In general, when students took part in test of a unit, the system would automatically adjust the student knowledge state diagram according to student scores. As there are many parameters in the student knowledge state diagram, such as existing degree(ED) and connection intensity(CI) which can be a number between 0 and 9. Therefore we can achieve the purpose of adjusting the knowledge structure by adjusting the value of these parameters. Parameter adjustment rules are as follows: DE = DE-score of a last test; CI = CI + score of a last test.

From the above that the more skilled a student is, the more small existing degree of this knowledge point becomes. It shows that this knowledge point is the less important for the student in the whole teaching process. When this parameter is less than some threshold by constantly adjusted the parameters, it indicates that the knowledge point is deleted. Whereas, the more awkward a student is, the more large existing degree of this knowledge point becomes. It shows that this knowledge point is the more important for the student. When this parameter is greater than some threshold by constantly adjusted the parameters, it indicates that the knowledge point is added. Adjusting automatically of students knowledge structure makes the system generate the optimum teaching array by the current knowledge state diagram for achieving the purpose of individualized instruction.

3.3. Generation of the optimal learning path based on knowledge structural graph

To enable students to learn according to the order of knowledge in self-learning process, a OLP generator was designed and implemented based on the individual KSG through the topological sort algorithm.

Personalized knowledge structure is a directional weight graph. The optimal learning sequences based on a direction graph can be obtained by means of topological sorting. The topological sorting can usually give out many kinds of topological sequences, but which one in them is optimal? It is represented with sum of weigh values between nodes in the topological sequence, and the topological sequence with max total weigh value is optimal, and is regarded as the optimal learning sequences.

3.4. Design of instruction rules

Some important instruction parameters follow: Si: student's master degrees to node i, are distributed by student model; ADE: the average existence degree of all nodes; DEi, LA, AA: same as before.

Some relatively important instruction rules follow:

The rule 1: if (DEi >=ADE) and (Si <LA) then <repeatedly studying >;

The rule 2: if (Si >=LA) then < turning into next a node to study >;

The rule 3: if (DEi <ADE) and (Si>AA) then <allow skipping the node and turn to next a node>.

4. Analysis of Application Example

On the basis of the above, combined the "data structure", we developed a personalized learning system based on knowledge structures.

Firstly, the knowledge base of data structure course is created, that the relationship between knowledge points are defined by the expert and KSG are built. Secondly, a large number of learning resources are constructed, including video learning courseware, kinds of tests and problems of the operation and demonstration, and evaluated each type of the learning object. Finally, when students select a unit in the self-learning process, the system will generate the optimum teaching array according to the current knowledge structure of the unit, and give students the best guidance based on the teaching rules.

For example, the past threshold was set by LA = 60, the skip threshold was set by AA = 100. Current student model and knowledge structure of a unit are shown in Tab.1 and Fig.3, where the data in the square represents the existence degree of the knowledge points, the data in the circle represents the number of the knowledge points. When the students enter this unit learning, the system produces the optimal node sequence (KP1)(KP4)(KP5)(KP2)(KP3)(KP6) based on current KSG. We can see from Fig.3, DE(KP1)=7, AED=5.5, S(KP1)=55. According the teaching rule 1: if (ED(N)>AED) and (S(N)<LA) then <repeating learning >, when the student finishes knowledge point 1, clicks the button of OLP button, the system will show the guide information “repeat learning this knowledge point again”. When click OK, then turn to knowledge point 1 and produce node sequence (KP1) (KP1)(KP4)(KP5).....

Through the analysis above, we can see that in concept layer structure of the unit, there is no mutual support relationship between knowledge point 2 and knowledge point 3, if has a good hold on knowledge point 2, the system will arrange learning first knowledge point 2; Conversely, the learning first knowledge point 3. In addition, in the learning process, if students have a poor hold on the knowledge point, the system arranges them repeating learning; If students has a very good hold on the knowledge point, then system allows them skipping this knowledge point, entering into the next knowledge point learning directly. Therefore, it can be said that the OLP is the best teaching sequences which is generated according to the gradual rule. The results show that t it greatly increases the efficiency of student learning in network.

Tab.1 student model

	KP_1	KP_2	KP_3	KP_4	KP_5	KP_6
DE_i	7	6	8	4	5	3
S_i	55	36	38	50	45	46

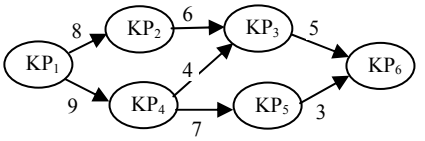

Fig.3. knowledge structure

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5. Conclusion

Individual learning content demand for different learners is necessary in e-leaning environment for independent learning, so an Individual learning system was constructed in this paper. The experiments show that it greatly increases the efficiency of e-learning.

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