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PERSONALIZING E-LEARNING SYSTEM FOR COURSES USING PREFIX SPAN ALGORITHM

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ABSTRACT

With a great variation of topics and titles in a particular course and users' reading or learning behaviors, the arrangement of the topics in the E-Learning system is more beneficiary than the sequential pattern which are normally used. It has been proved that by mounting a model with the help of Prefix Span Algorithm. The algorithm is used to mine the users learning style and guiding the learners about the sequence of the topics on the order mined learning patterns. The experimentation is performed by comparing the satisfaction levels of users using the normal sequential pattern and the patterns mined by using the Prefix Span algorithm.

Keywords: -*Learning System, Personalization, learner profile, Sequential pattern mining, Prefix Span Algorithm, Sequential mining*

1. INTRODUCTION

E-Learning is defined as "Pedagogy authorized by digital library [21]. It refers to the learning method that is empowered or made able to the learner via electronic technology. With the rapid evolution of the internet technology, E-Learning systems have been widely used. Learning is a cognitive activity which differs from student to student[22]. Most of the E- Learning systems are engineered for generalized users//learners not considering their individual requirements. To make them adapting to the requirements of the learner, the system can be personalized. Personalization in E-learning system is a widely used method of making adjustments in the existing learning system like course delivery to make it more suited to various learners.

Due to the latest development and the competition in the educational field, Educationists devising E-Learning systems are striving hard to improve their usability. To improve the usability of E-Learning systems for a particular subject, various analyses are carried out to conclude how different topics in the subject should be in-order environment for sequential mining on the historic learning behavior. Modern learning research has implied that in-placement stimuli such as navigating the learning path of the topics for a subject have a great motivation upon the learner learning the subject. The placement of the topics in a subject plays a crucial role for improving the usefulness of the learning management system. To know this, we use the information about the topics that are learnt together. This type of learning process is known as market basket analysis. It is a distinguished application in data mining technology. The set of topics which are frequently accessed in an order are called as frequent item sets and their orders are known as sequences. In recent times, the researchers (Masseglia et al 2003 , Zhao and Bhowmick 2003, Antunes and Oliveria 2003) have accepted that a frequent sequential pattern is the preeminent method that can be applied to decide the systematize of placing the topics. The objective of the proposed approach is to personalize the e-learning system for a particular course to make it more beneficiary than the conventional e-learning system. The conclusion of this approach is evaluated by comparing the satisfaction level of the learners of using the LMS(learning management system) with the normal sequential pattern using the frequent sequential pattern.

2. REVIEW OF RELATED WORKS

There are lots of experiments performed for the personalization. In [1], Ibrahim E. Mowad et al presented a detailed knowledge-based system design for personalizing the e-learning material learning resources i.e An ordered list of material learning resources based on the learning styles ranking.. In [2] Yusminar Yunus et al demonstrated the pedagogical perspective and

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specified more emphasis with eleven evaluation criteria such as motivation, attitudes, learning styles outcomes, structured design etc. In [3], Marie Stanislas et al established how the learning process is enhanced by providing personalized learning context to the learner in an efficient and dynamic intelligent way. In [4], Na Liu et al analyzed the instructor's role for developing the course content with multiple case studies. In [5], Chen Mu-Chn et al proposed a model to demonstrate how mining changes (purchasing the goods) in customer behavior in retail marketing . In [6], Vivekamoorthy et al. confirmed how the traditional / conventional learning method limitations can be overcome by evolving a feedback system and implementing corrective actions. In [7], Xiachui Tao et al proposed a personalized Ontology model for Knowledge representation and reasoning over user profiles rather than utilizing only knowledge from either a global knowledge base or user local information. In [8],Wai tak Noong et al developed a teaching or learning tool / model for teaching or learning for introductory C Programming . In [9], George Aloysius et al have proposed an approach to product optimization policy in supermarkets using the Prefix Span Algorithm. In [10], Paulo Gomes proposed an integrated model with an ontology, enabling the personalization system to guide the student's learning process and the developed model monitors the student's progress, so that it can update the concepts known by the student and decides which concept s/he should learn next.

3. PROBLEM STATEMENT

For mining sequential patterns, there are many algorithms such as Apriori algorithm, Prefix Span Algorithm, etc. Prefix span algorithm is the latest data mining algorithm having a lot of advantages. This algorithm is used for personalizing the E-learning system to make it suitable for learners.

The algorithm is executed as follows:

Step 1: The algorithm scans the sequential data base of finding the frequent items with respect of minimum support

Step 2: Partition the data base into multiple subsets of sequential patterns

Step 3: Mine the subsets of sequential patterns

Step 4: Generate the projected database to mine the (K+1) sequence for every frequent k-sequences

Read (Input): A sequence data base S_d and the minimum threshold m_t

Method: Call PrefixSpanAlgorithm(< > , 0, S_d)

Subroutine: PrefixSpanAlgorithm (Ω , l, $S_d | l_\Omega$)

Parameters: Ω : A sequential pattern ; l be the length of Ω; $S_d | l_\Omega$: the Ω - projected data base if $\Omega = < >$; Otherwise the sequence database S_d.

Result(Output) : Complete set of sequential patterns

Algorithm

1. Scan $S_d | l_\Omega$ once, find the set of frequent pattern F_i such that

   F_i is assembled to the last statement of Ω to form a sequential pattern Or

   $F_i>$ is appended to Ω informing the sequential pattern.
2. With each frequent item append it to Ω to form sequential pattern Ω' and output Ω'
3. For each Ω', construct Ω' – projected data base $S_d | l_\Omega$ and call PrefixSpanAlgoithm(Ω' , l + 1 , $S_d | l_\Omega$)

4. AN OVERVIEW LAYOUT OF TOPICS IN OOPS WITH C++

The layout for the subject "Object oriented Programming with C++" in any learning system and in the prescribed books has the sequence of the topics Specified in the Figure.1.

The satisfaction level of the learner who has an average knowledge in the subject "Programming in C" is declined when the normal sequence is followed. To increase the satisfaction level of them, there should be some alterations in the layout. The alterations in the topics sequence of layout is justified by the application of the Prefix Span Algorithm. The algorithm is executed as follows to find the referred layout for the learner. There are two stages for the process.

Stage I : Do the mining to find sequential patterns among various classifications

The prefix algorithm is used in this stage to mine the sequence of topic classification and the resultant classifications are placed in the layout. This stage performs the following steps.

Step 1 : Create the classification data base for the topics available for the course

Example: Assume that there are five transactions (learner doing the learning) with titles and the classification table has five classifications having different titles. The following table (Table.1) represent the classifications.

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Table 1. Transaction Database

Transaction Id	Titles
1	Features of OOPS, Classes, Polymorphism
2	Features of OOPS, Classes, function Overloading , inheritance
3	Classes, Structures, Polymorphism
4	Classes, Polymorphism, Run time polymorphism
5	Function overloading, Pointers, Templates Polymorphism types

The topics which are put in the classifications are grouped in the Classification table (Table 2)

Table 2. Classification Table

Cid	Titles
CL1	Features of OOPS, Classes, Polymorphism
CL2	Control Statements, Loops, Arrays and functions
CL3	Structures, Classes, Operator and function overloading Inheritance
CL4	Run time polymorphism, Files and Streams, Pointers
CL5	Exception Handling, templates, STL

The titles in the transaction database are to be replaced by respective classification for building classification database.

Table 3. Classification Database

Transaction Id	Classification Database
1	CL1 CL3 CL3
2	CL1 CL3 CL3
3	CL3 CL3 CL3 CL3
4	CL3 CL3 CL4
5	CL3 CL4 CL5 CL3

Table 4. Projection Database

Prefix	Projected Database
<CL1>	<CL3,CL3> <CL3,CL3,CL3>
<CL2>	---
<CL3>	<CL3><CL3 CL3> <CL3 CL3 CL3 > <CL3 CL4 > <CL4 CL5 >
<CL4>	<CL5 CL3 >
<CL5>	<CL3>

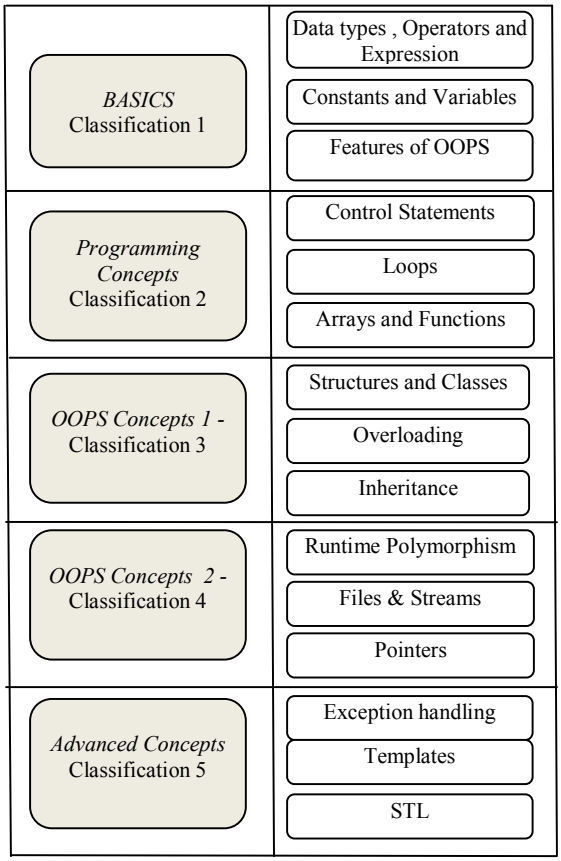

Fig.1. Conventional Layout for C++ Subject

Step 3: Determining the subsets of sequential patterns produces the transaction database

Table 5. Transaction Database

Prefix	Projected Database
<CL1>	<CL3,CL3> <CL3,CL3,CL3> <CL1><CL1 CL3> <CL1 CL3 CL3> <CL1 CL3 CL3 CL3 >
<CL2>	---
<CL3>	<CL3><CL3 CL3><CL3 CL3 CL3> <CL3> < CL3 CL3 > < CL3 CL4> <CL3 CL4 > <CL4 CL5 > < CL3 CL3 CL3>
<CL4>	<CL5 CL3 > <CL3 CL3 CL4 > <CL3 CL4 CL5 > <CL3 CL3 CL4 > <CL3 CL4 CL5 > <CL3 CL4 CL5 CL3 >
<CL5>	<CL3> <CL5><CL5 CL3>

Stage II : Finding the optimal placement of classification

The following steps are performed for arranging the classifications according to the requirement of the learners.

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Step1: Construct the classification transaction database for all classifications as

Table 6. Classification – Transaction Database for CL1

Transaction Id	Classification Database
1	Features of OOPs
2	Features of OOPs
3	--
4	--
5	--

Table 7. Classification – Transaction Database for CL2

Transaction Id	Classification Database
1	--
2	--
3	--
4	--
5	--

Table 8. Classification – Transaction Database for CL3

Transaction Id	Classification Database
1	Classes, Polymorphism
2	Classes, overloading , inheritance
3	Classes, Structure, Polymorphism
4	Classes, Polymorphism
5	Operator Overloading

Table 9. Classification – Transaction Database for CL4

Transaction Id	Classification Database
1	--
2	--
3	--
4	Run time Polymorphism
5	Virtual function

Table 10. Classification – Transaction Database for CL5

Transaction Id	Classification Database
1	--
2	--
3	--
4	--
5	STL

Step 2: Do mining of patterns from each classification – transaction database. It is for placing the topics in the Expected sequence in each classification.

Table 11. Revised Sequential pattern for Classification and Transaction

Classification – transaction database	Revised sequential pattern
CL3	Classes, Structures, Operator and function overloading inheritance
CL1	Features of OOPs , Constants, Variables, data types, operators, expression
CL4	Pointers, run time polymorphism, files and streams
CL5	Templates, STL, Exception Handling
CL2	Control statements, Loops, Arrays and functions (no alteration for the classification 2)

5. RESULTS AND DISCUSSION

Both the layouts (Traditional and personalized) are stored in two different data bases. The learning management system which helps the learner to learn the subject "Object oriented programming with C++" in the sequence found after determining the knowledge level of the learner in the subject "Programming in C" by conducting a test. If the knowledge level is below the threshold level, the learner is given by the traditional approach in which conventional sequence pattern is followed to learn the subject. Otherwise the learner is given by the personalized approach in which LMS is sequenced on the navigation path recommended. This experiment has been implemented in J2EE software. The experimentation was performed with the sample of 96 learners. The 96 learners were divided into two groups, and each group consists of 46 persons. After they use the approaches, they were asked to give their satisfaction level in the

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form of feedback. The Feedback obtained from the learners are tabulated in the table 12.

According to the feedback collected from the learners, the percentages for different levels of satisfactions are measured with the formula mentioned below.

Average weight for each classification (C_j, j=1 to k) for an attribute A_i

$$\Psi\ (C_j, A_i) = \sum_{j=1}^{nqai} w(i, C_i) / \lambda$$

where $w(i,C_j)$ is the weight for the classification C_j in the Attribute Ai, λ = no. of classification * no.of samples * nqai, nqai is the number of questionnaires for the attribute a_i

The cumulative data are used for measuring the averages of the different types of the learners (See the table 13). The following table shows the comparison data of the different types of users for the conventional and personalizes approaches. (See the table 13)

The following chart represents the comparison of both the models (Traditional and Personalized Learning System) on the basis of satisfaction level of the learners

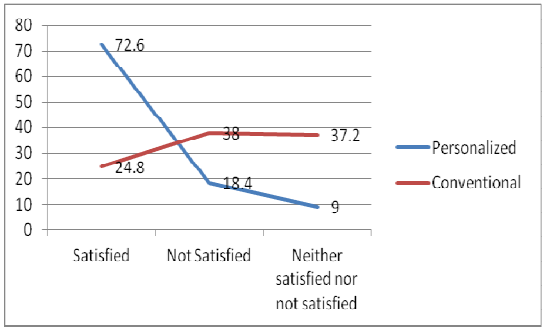

Fig. 2. Comparison Chart For The Approaches

6. CONCLUSION AND FUTURE WORK

The personalized E-leaning system for the course "Object oriented programming with C++" in which the classification of topics using the prefix span algorithm is more suited to the learners having minimum knowledge (threshold) than the traditional sequence of topics. It has been proved in this paper with the experimentation. It may be applied to other courses also. The data analysis in this paper is performed with only 96 learners and it can be extended to more also.

Table 12. Feedback Obtained From The Learners

Sl. No	Attribute	Questionnaire	Traditional					Personalized				
			SA	A	N	D	SD	SA	A	N	D	SD
1	Attribute 1	The instructor has clearly presented the skills to be learned	2	12	10	17	7	14	21	7	5	1
2	*Presentation & Clarity*	The instructor has effectively presented the concepts and techniques	2	7	19	11	9	12	23	9	4	0
3		The instructor has presented in an organized manner	5	7	21	13	2	19	19	7	3	0
4		The instructor has explained the concepts clearly	6	9	12	12	9	17	22	7	1	1
5		The instructor has increased by understanding of course material (helpfulness / availability)	2	11	6	19	10	16	20	11	0	1
6		The instructor has helped me to identify the resource I needed	1	8	19	14	6	17	19	9	2	1
7		The instructor has helped me achieve my goals	2	12	10	17	7	19	19	7	2	1
8		The instructor was helpful to me individually	2	6	9	22	9	18	19	8	2	1
1	Attribute 2	The instructor encourages initial engagement with the material	3	7	30	7	1	18	21	9	0	0
2	*Scope & Usage*	The aim and objectives of the course were made clear	3	7	10	19	9	9	32	5	2	0
3		I have no difficulty reading what is on the system	4	5	19	19	1	12	22	11	3	0
4		Some topics in the course were too difficult	2	7	15	19	5	16	26	3	1	2
5		The subject matter is more difficult to understand than other modules available on the net	2	9	20	17	0	19	21	1	4	3
6		The subject matter is interesting	3	10	15	18	2	20	15	9	3	1
7		There is correct quality of material	2	11	26	8	1	16	19	10	1	2
1	Attribute 3	The course stimulated my intent in the subject and I would like to learn more	4	9	24	10	1	19	22	5	1	1
2	Organization	The course presented skills in helpful sequence	0	5	16	27	0	19	22	6	1	0
3		The course was organized in a way that helped me to learn	4	10	20	13	1	17	27	2	2	0
4		The course provided balance between instruction and practice	2	3	25	15	3	16	22	7	3	0
5		The sections was effectively organized	1	7	14	19	7	15	19	12	1	1

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Sl. No	Attribute	Questionnaire	Traditional					Personalized				
			SA	A	N	D	SD	SA	A	N	D	SD
6		The course developed my ability to read and think critically	3	12	10	17	7	14	21	7	2	1
1	Attribute 4	The course helped me conceptualize and present my ideas in my artistic medium	10	10	18	5	5	12	25	3	4	4
2	*Skill Development*	The course helped me to understand ethical issues involved	5	7	17	10	9	8	24	12	0	4
3		The course displayed my communication / presentation skills	4	0	39	4	1	9	24	12	1	2
4		The course gave me a deeper insight into the topic	3	8	28	7	3	17	17	11	1	2
5		In this course , I learned a great deal	1	9	15	19	4	17	18	9	3	1
6		The course improved my problem solving skills	0	12	23	12	1	9	31	4	4	0
1	Attribute 5	How satisfied were you with this course	3	7	9	27	2	11	13	20	4	0
2	*General Questionnaire*	How would you rate the effectiveness of the instructor's teaching	4	1	30	12	1	12	19	10	6	1
3		Could you continue after an interruption	3	9	15	17	5	12	17	15	2	2
4		How satisfied were you with effort put on this course	6	13	20	9	0	12	13	12	8	3
5		Whether the course content requires any modification in the sequence	11	8	5	20	4	11	16	17	2	2
6		Do we put some content (rarely used) at the end of the course structure	9	12	8	13	6	9	20	6	9	4
7		There is the correct quantity of material	8	9	7	21	3	10	10	13	9	6
8		It required some modification in the sequence	7	9	8	16	8	13	11	14	5	5

Table 13. Cumulative Data Of The Approaches

Attribute	Traditional					Personalized				
	SA	A	N	DA	SD	SA	A	N	DA	SD
Attribute 1 *Presentation & Clarity*	6%	19%	27%	33%	15%	34%	42%	18%	5%	1%
Attribute 2 *Scope & Usage*	5%	17%	41%	31%	6%	33%	47%	14%	4%	2%
Attribute 3 Organization	5%	16%	37%	35%	7%	35%	46%	14%	3%	2%
Attribute 4 *Skill Development*	9%	16%	48%	18%	9%	25%	47%	18%	5%	5%
Attribute 5 *General Questionnaire*	13%	18%	27%	35%	7%	23%	31%	28%	12%	6%

Table.14. Comparison Data Of Various Users In The Approaches.

Approach	Satisfied %	Not satisfied	Neither satisfied nor not satisfied
Conventional Approach	24.8%	38.0%	37.2%
Personalized Approach	72.6%	18.4%	9.0%

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