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Efficiency of Probabilistic Network Model for Assessment in E-Learning System

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Abstract*— The knowledge acquirement by the learner is a major assignment of an E-Learning framework. Evaluation is required in order to adapt knowledge resources and task to learner ability. Assessment provides learner's an approach to evaluate the skills gained through the e-learning domain they are accessing. A dissimilar method can be used to assess the information acquirement, such as probabilistic Bayesian Network model. A Bayesian Network is a graphical representation of the probabilistic relationships of a complex system. This network can be used for reasoning with uncertainty. Bayesian Network is the most challenging task in e-learning system as learner evaluation model are an element of uncertainty. In this paper the current proposed scheme is constructed on Bayesian Network to deduce the stage of knowledge possessed by the learner. It also proposes type of assessment to identify the knowledge whatever the learner identifies. Throughout the assessment, it can be performed by two approaches namely Sequential and Random. In Sequential approach, questions can be displayed on the learner machine in sequential order. In Random approach, questions can be displayed on the learner machine in random order. However, both have their inherent limitations. Questions that are considered to be answered easily by the learner may also be presented to the learner who is not desirable. This system determined on the illustration of Bayesian Network model and algorithm for inference about learner's knowledge. The Bayesian Network model was efficiently implemented for three levels of learner called Higher Learners (HL), Regular Learners (RL) and Irregular Learners (IL) for learner's assessment and was successfully implemented with 81.1% of probabilities for learner's assessment.

Keywords*— Assessment, Knowledge design, Bayesian Network (BN), Evaluation, E-Learning, Intelligent Tutoring System (ITS)

I. INTRODUCTION

As the technology is improving teaching learning methodologies are also changing by making Electronic Learning (E-Learning) as one of the leading trends in education. During this change the complexity of the educational paradigm are emerging. Due to which improvement of knowledge delivery and evaluation is necessary in future dynamics of learning. The outcome of learner's personal experience in e-learning can be defined as internal processes of change or adding new which involves any modifications or variations that are attained earlier.

Professors guide the learners during the knowledge and must observe the learners requests in bid to the progress education. One-on-one instance decreases the commitment of professors for each learner in group tutoring environments. So according to the authors of [1][2] to satisfy these needs software systems can be used and later these software systems modified to the learners needs. Adaptability is defined as the software adaptation to individual user characteristics according to user aims. The challenges for the software engineers are to emphasis on the essentials of student's adaptability. The authors [3] have explained about different types of software adaption and also discussed about the content of adaption where the information is presented to the users according to user characteristics and software interaction. Artificial Intelligence strategies can also be implemented on learning environment for carrying out intelligence by assuming user needs for adaptability.

Intelligent Tutoring System (ITS) is distinct kind of software that meets all the characteristics of student adaptability as mentioned earlier. This software also involves artificial intelligence techniques for teaching the same way as a teacher teaches the students by interacting with students [4][2]. ITS generalized architecture was proposed by Carbonell [5][1] learner, tutoring and domain model are considered as three basic modules [2] with user interface.

A significant crisis in ITS expansion is the valuation or assessment of learner knowledge. Intelligent Tutoring System should be able to decide an exactly and rapidly for learner cognitive stage, which is the vital role to tutor [2]. For handling the uncertainty in implementing the learner knowledge various authors have planned and used probability theory. Bayesian Network graph is planned, for modeling the techniques on how an intelligence system should infer causality within the structure of artificial intelligence and probability. The study depicts the fundamental relationship which refers to nodes that represent ideas/concepts which are associated with nodes to achieve the area of information design [6]. This article proposes an ITS for knowledge assessment model to establish the learner e-learning desires evidently, in bid to strengthen the topics. This work is describes BN graph allowing for uncertainty organization, knowledge design, and wide use in analytical and model identification [2][7][8].

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The research work is divided into various sections where section 1 illustrated about introduction of the work. Section 2 defines literature work. Section 3 followed by executing the model of the proposal knowledge design for the assessment. It also explained how BN is applied for knowledge design and its e-learning assessment.

This section also explained the working algorithm in model. Section 4 defines the experimented of knowledge evaluation system. Section 5 shows the experimental results and discussions followed by the conclusion and references of the work.

II. LITERATURE WORK

In this work literature work underlines the utilization of BN for better education and learning. Captivating into this account the BN are used to evaluate the performance of learning knowledge. In [9] the student assessment might be look from the perspective of assess the beginner capability by pretension questions that the beginner is deem not to answer without difficulty. In artificial (or computational) intelligence techniques such as Case-Based Reasoning, Stochastic Process Model and Bayesian Networks be able to make available for functioning of additional efficient e-learning within the outline of contented release & beginner evaluation.

Student modelling process was proposed with BN in Liu et al. [8]. In this work was just implemented a model to calculate the conditional probability distribution using 3 parameters for logistic model to test the items. They have focused on Binary-tree structure for the course called DS subject. Evaluation and design of a BN process was presented in misconceptions of domain of decimals in Goguadze et al. [10] for modelling the student approach. In student approach the predictions of results are reached high level, also they have not defined how precisely was built using BN. Torabi et al. [11] had projected BN model for inference method. In this work, courses score for predicting the student's educational history. The primary effects on quality of student learning results were shown in this method and it was used as helpful tool for this method. In [11] there is a significant move towards learning BN as of information use of score task to calculate the condition of an applicant system and utilize a investigate process to discover the position of applicant system. Within this an optimization base scheme for knowledge BN has been deliberate. Mahbobe et al. [12] where the cuckoo search algorithm is introduced a metaheuristic which has been effectively functioning to resolve optimization problems based on selection.

A Bayesian student model is evaluated and integrated in Millan et al [6]. In this work focus was given on mathematics area for solving first-degree equations. Total 12 concepts were used to evaluate the learning knowledge. Every concept is computed in group of 4 question stating that require response 4 questions as single. Bloom's taxonomy [13] was implemented categorized questions into 5 stages of complexity to adapt questions according to the Learner's knowledge stage. Finally, own an algorithm was used to change stages and select appropriate question to the learner.

III. EXECUTING THE MODEL FOR KNOWLEDGE DESIGN

The section describes the efficiency of fundamentals of the BN model for knowledge design. This is organized in four different stages. Stage 1 defines framing of questions. Stage 2 explains the structure of BN followed by stage 3 about the process for knowledge design of evaluation system for learners. Finally stage 4 analyzes the learner using Bayesian Network (BN).

A. Framing Questions

In this work set of 100 questions were created and divided into various stages. The questions were selected based on the random process and provided to the learners. If the learner fails in the present stage, he/she will be in the same stage based on the previous questions, whereas if the learner succeeds the present stage, he/she will be in the next stage based on the previous questions. Each question will be given the probabilities [14]. But questions are dissimilar based on the stages what we have asked to the learner.

As mentioned initially, weights are allocated based on specialist scheme when he/she creates the exam. There is likelihood that specialist will allocate different weights to questions; rely on who frame the questions. In order to confirm the right act of the questions theses are reviewed with teachers of the different domains.

The study was carried with teacher who teaches the courses of different domains, the observation helped the research work to progress with the following aspects:

a. Some of the concepts were not covered in the classroom.

b. Since some concepts were not covered some questions lead to the ambiguity.

c. Some questions were located in a wrong category

Organized to this comment, set of questions were enhanced to increase the reliability of the work carried.

The questions were ordered based on Blooms Taxonomy [13]. The first five levels of this work are represented in Table 1 which illustrates the organization of the questions.

TABLE 1. Stages of convolution

Bloom's Taxonomy	Name of Stages	Number of Questions
Knowledge	Basic (B)	20
Comprehension	Intermediate A (IA)	30
Application	Intermediate B (IB)	20
Analysis	Advanced A (AA)	18
Synthesis	Advanced B (AB)	12
Total		100

From the above Table 1, the stage one of basic knowledge identifies and recovers appropriate information from extended-term memory to practice in the little-term memory. The second stage comprehension includes questions that require the structure of significance from learning [5] [10].

The third stage called application applies the questions of learning procedure.

The next analysis stage separates information in elements and applying the logic is required. Finally synthesis stage connects elements to form an entry. Learner's logic is extended; questions are slightly more complex than difficult stage. The model targets the learners to reach their maximum possibilities to use at this stage.

B. Structure of Bayesian Network

Structuring of the network plays vital role in model building. The structuring process is separated into 6 segments [11] which are as follows:

a. Describing domain knowledge in important for selecting the work area.
b. Establishing a hierarchical level of knowledge which categories knowledge in different levels.
c. Build Bayesian Network model and structure the nodes by creating dependence relations between them.
d. Framing the Conditional Probability Tables (CPT) and assigning probabilities to nodes.
e. Framing the questions to evaluate knowledge generating random set of questions.
f. Generating the CPT for the questions and allocate probabilities to question nodes.

The segments 'a', 'b', 'c' and 'e' are used for designing structure of the network and the segments 'd' and 'f' to compute assess probability values for every node. The segments'd' and 'f' are been divided into segments but these two can also be combined in single step.

The subjects of skills like C, C++ and so were considered for the learners. The above methodology was followed to create the BN of learner assessment, which contains the questions framework in the next section.

C. Knowledge Design for Evaluation System

The BN system model is based on different processes in order to adapt to the learner. It is based on stage process the following information mentioned in detailed.

a. Stage process

The questions were selected randomly and given to the learners from basic stage. The learner can move through the stages accordingly depending on the knowledge of the domain. The algorithm 1 shifts the learners through the stages of questions. Relational database was designed and used to store the answered questions (correct or wrong) in every stage. Documentation of questions named QuestionsDocumentation is maintained by storing results of all stages. The loop is repeated until BN system decides to finish learning test. The learner can end-up with three causes: 1) high knowledge, 2) low knowledge, 3) intermediate knowledge.

The QuestionsDisplay( ) procedure from the algorithm 1 was not defined until this section because it fits in to the questions display section and needs another algorithm to be called. Hence the below section is dedicated to that. The QuestionsCompute( ) procedure explains identification if the question is correct or wrong. The PushQuestions( ) procedure allows to store questions, answers, and level within the defined structure (QuestionsDocumentation( )).

The PresentStage( ) and NextStage( ) procedure allows the learners to move through stages, either present or next depending on the learner stage. The EndTest( ) procedure is called to end the assessment for one of the aforementioned reasons. The ReachStage( ) procedure helps students to make decisions based on the question number and return to the previous level if needed.

Process (Steps)

1. QuestionsDocumentation=Framework used to control the questions by stage
2. while not EndTest() do
3. ReachStage();
4. QuestionsDisplay();
5. QuestionsCompute();
6. PushQuestions();
7. if node of the question=correct then
8. NextStage();
9. end if
10. if node of the question=incorrect then
11. PresentStage();
12. end if
13. if learner ends the question
14. EndTest();
15. end while

D. Structuring and analyzing the learner using Bayesian Network (BN)

BN supported to determine the learner's cognitive degree; these resources were assessed in the areas of better in development and knowledge. Initially, name the fundamental elements of BN for analysing learner's efforts. The elements are nodes, parameters and edges between nodes. The determination of the work is based on the process by the authors [15][3] were they considered the below mentioned aspects:

Nodes for measuring learner's attained knowledge: This is used three stages of granularity. The concepts were found in the subordinate stage. Smallest unit of dividing the knowledge are represented using these cluster concepts in the next domain stage. Finally, units that involve domains is represented in the last stage.

Nodes for gathering evidence: This aspect specifies the random questions which can be wrong or right Edges between nodes to measure the knowledge: These aspects represent dominating knowledge which has influence on knowing them early. The immediate stages represent related granularity hierarchy. Knowledge has a causal influence on correctly answering the questions when considered edges between the nodes and the questions [16].

The parameters indicate dependency on probability values of the child variables on parent variables.

IV. EXPERIMENTED OF KNOWLEDGE EVALUATION SYSTEM

The demonstration considered three investigations to confirm model study, each detail has under:

• Domain inference: determines in which the questions of BN model deduce as known or unknown, according learner data.

• Examine node of the question inference: confirm the BN exactness in inference.

After the process: once learner finishes the test, those questions of BN model infers as correct or incorrect are selected, in order to make a paper examination. The identical learner responses the BN model examination also response the paper examination; the learner response was evaluated (compared) to decide the inference usefulness. We expect this assessment is inferred questions as right or wrong will have the equivalent outcome in the paper examination.

• Deciding the learner knowledge: attaining this, the BN model does the study of probability values of the learning. Based on the probability values we can know the low or high exactness in which the level of learner he/she is.

A different learner of sample is collected because we needed to cluster learners according to their marks to evaluate grades of learners with similar probability values of questions to keep a fair concept.

Learner classrooms and agenda were identified and chosen learners to be inspected. This process consists of creation an outlook list and selects them arbitrarily. Learners were separated into cluster according to their marks, as Higher Learners (HL) with average greater than or equal to 8.5. (HL >= 8.5), Regular Learners (RL) with average greater than or equal to 7.0 and less to 8.5. (7.0 <= RL < 8.5), and Irregular Learners (IL) with average less to 7.0 (IL < 7).

At last, the further sets have 25 learners, the regular sets have 26 learners and the irregular sets have 10 learners. Learners were arbitrarily selected using a simple source code that sort learner names alphabetically coherent to the categorization. Every learner has a mark of 0 to 25 for advanced group, 0 to 20 for regular group, and 0 to 13 for irregular group. Eight arbitrary learners were choosed per sets. A total of 24 learners were chosen of 58 learners can be done, corresponding to 29.8% of learner population.

V. RESULTS AND DISCUSSION

The work highlights the large sum of inferred questions with little responses questions. Captivating into description of 24 evaluated learners, an average of 2.1 inferred questions were obtained for every learner responses question. Standard deviation of 0.85 and median of 2.28 is obtained. Extra knowledge can be computed with smaller amount of questions.

In this work it was also examined the ideas of inferences with written assessment of questions inferred by the BN model. This assessment was applied to the same equivalent learner. Coherent to the outcome, the BN model obtained success of 81.1% of occurrences. In other words, the model inferred a question as known or unknown, this strike nearly in 4 to 6 instances when compared with written assessment. Standard deviation of 10.3 and a median of 69.1 was used.

An ‘n’ number of times the learners responses the assessment in BN model are lesser than the learners in written assessment. Learners answered equivalent questions in fewer seconds of time and make top use of the methods to reach the equal grades. Hence it has been well organized to use 41.04% seconds of time normally to make use of in a conventional assessment. The below figure 1 illustrates results of selected learner (hard line) and all learners (scattered line). The graph is evaluated depending concepts of X-axis. Y-axis is values of every concept (range between 0 and 1). From graph it’s been analyzed that the learners have high probability of knowing most concepts. This part is interpreted by the learner. The professors can analyze the results of their own ranges. We considered for this case has previously a defined rule has known, unknown, and indeterminate questions.

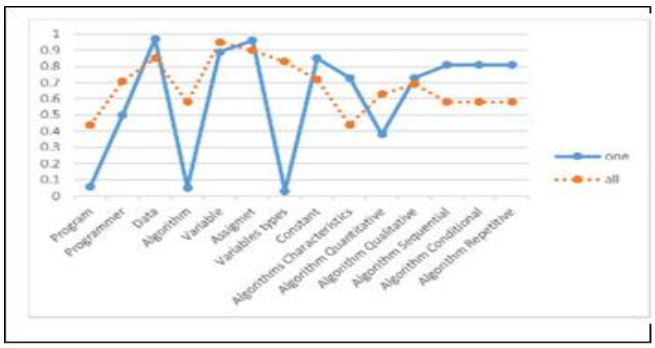

Fig 1. Learner Position and Prediction of different Concepts.

From figure 1 show that the learner performed badly are mainly significant part of the theories; those theories required extraordinary concentration. Figure 1 shows that, learner was unable to think clearly of questions about Algorithm, Variables Types and Program. From figure 1 indicated with scattered lines, we can assess the knowledge possessed by a number of learners computing the average of theories. Instead of serving only a learner, we might focus on different theories for a learner’s batch with connected problems and assist additional learners. Through this method we can identify the theories in smaller acquired and then strengthen these weak points.

VI. CONCLUSION

This work explained about new approach for implementing of learner assessment using BN model to evaluate the e-learning system. The learner assessment was performed by two approaches namely Sequential and Random. Though both approaches had their inherent limitations they were effective and efficient than the personal computer assessment and a conventional paper and pen assessment. It was also found that the learners can response assessment three times quicker than the conventional assessment or personal computer assessment without knowing cleverness. The BN model was successfully implemented for learner levels are Higher Learners (HL), Regular Learners (RL) and Irregular Learners (IL) for learner’s assessment. In average, BN model can deduce 3.1 unknown or known concepts for each learner response. Also, this learning confirmed that 81.1% of probabilities had been correct for those concepts has determined unknown or known.

By knowing existing learner’s knowledge concepts, e-learning questions can be personalized. Considering this BN model, the work implemented showed that BN model has reflected learner shortage of concepts and knowledge. From this work the conclusion can be provided that for assessing the learner cognitive levels a Bayesian Network model are best suitable.

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