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Assessment Study For E-Learning Using Bayesian Network

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Abstract*—E-Learning for educational institutions has created a challenging situation due to the COVID-19 pandemic. The universities and institutions can impart knowledge. However, evaluation of the learner's learning and outcomes remained a challenge for them. The article aims to add its dimension towards the evaluation of outcomes especially for the learners of E-learning platforms. E-Learning delivers the training using the online mode of knowledge dissemination. E-learning has a wide range of resources that may improve the learning assessment. Stil,l assessment in education remains a challenge. E-Learning for learner's knowledge is extremely significant because the beginner does not realize learning assessment properly. To improve the learner performance of an evaluation system for classified learners, the Bayesian Network (BN) for a random process is used. A BN is a graphical representation of the probabilistic relationships of a complex system. BN is the most challenging task in the e-learning framework. The goal of this work is achieved by constructing a BN to make causal analysis and then provide personalized interventions for different learners to improve learning. This network was effectively implemented with the accuracy of 45% of a slow learner, 15% of the average learner, and 40% of excellent learners from the required quantitative data set. Further the results of the experiments are promising.

***Keywords*— Assessment, Bayesian Network, E-Learning, Learner.**

I. INTRODUCTION

E-Learning information is delivered to the learner which should be personalized based on the profile of the learner so that learning can be effective. The start of the e-learning information and related technology, e-learning study is connected to the personalization of contented release and learner's knowledge to measure the evolution of learner. However, a lot of notice has been generated in adaptive contented delivery based on the outline of the learner [1]. Hence, the aim of e-learning is not given much concentration to the assessment of the learning content. Assessment of a learner's knowledge objective is normally done by posing a set of level of questions without documenting the learner's capabilities [2]. Assessment of a learner's knowledge is a challenge in the e-learning system.

As e-learning is used, the collection of questions in the question bank is increasing. The question bank is one of the main parts of e-learning to store questions. The questions that have been uploaded to the e-learning system can certainly be used repeatedly. However, the large number of questions makes the search difficult.

The purpose of this work is to find out the right method to form a network model for an e-learning system in the process of level of questions appropriately. So, the questions used in the e-learning system can be found easily and quickly to improve the learner performance of an evaluation system.

The goal of this work is to study whether or not the learner assessment can be improved by using BN for e-learning. The BN paradigm was chosen because it has proven to be a sound methodology for learner assessment modelling [3]. It has been explained that a BN allows for a sound and detailed evaluation of each learner, according to the level of questions defined by the lecturer. Instead of having only final marks to improve learner's performance, the BN will be able to provide a more detailed model of learner knowledge, which contains information about which level of questions the learner is struggling with and which domain he/she has already mastered. This information is essential to provide feedback, remediation, and personalized instruction.

Bayesian network (BN) has been a self-learning network that has been used to support sightless persons, climate forecast, scrap e-mail strain, picture investigation intended for strategic supercomputer help choice, client support inside software utilize, scam finding, and so on. A Bayesian network is graphically represented by a directed acyclic graph (DAG), such element indicate casual states and each link of the DAG signify the straight influence of single element towards the last. Bayesian network is a special type of figure together with a related set of probability tables [4]. Bayesian network is the visual representation of a graph that is vertices and edges have meaning. The vertices that represent variables, each with an associated conditional probability table, and edges that model the dependences between variables. The network structure itself gives you valuable information about conditional dependence between the variables.

A. Problem Statement

To compress a dynamic e-learning content a dynamic assessment has to implement using BN. A complex assessment for BN, i.e., one that has on the order of hundreds of variables and parameters is induced from a large learner's dataset. It is an extremely challenging task since it requires a

major course of action of resources and domain knowledge. Learner's Knowledge in the e-learning framework is balanced to offer a certain rank/grade. E-Learning can hold for rules in a learner dataset to assess the learner assessment like skills, performance, etc, from which the BN model is induced. BN could help to improve the current systems and current self-learning models.

II. LITERATURE SURVEY

In [1] the student assessment might be observing from the perspective of assessing the beginner capability by pretension questions that the beginner is considered 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.

In [2] the student computes the values of reflections in favor of forecast for the knowledge presentation through a blended education subject and deterioration replica is evaluated using a replica of strength. Causal states are examined using a stepwise process that employs an element choice method and the force of replica is comparing using R2 and AIC indices. It challenges, several indication indices be choosing support for the failure replica by an element choice technique. Therefore, a proposition that the evaluation of reflections contributes to the knowledge presentation is been established.

Learner information is concerned with the idea of learning content in e-learning organizations. It has been conceded in 3 mechanisms: 1- information break finding of a beginner in understood technique concerning any idea of learning contented. 2- The shock of idea complexity, student field & level field the information breach invention. 3- Modeled beginner information of idea based on information breach with Bayesian network [3].

In [4] there is a significant move towards learning Bayesian networks 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-based scheme for knowledge Bayesian networks has been deliberate. Where the cuckoo search algorithm has introduced a metaheuristic in which has been effectively functional to resolve a selection of optimization problems.

It is observed that in [5] the factors used in the learner educational system can be used as a few high-quality forecasters. It depends on top of the entire aim and goals, several predictors work superior used for assured effect predictions. It seems to earlier educational performance is the main major factoring in establish a student's outlook performance.

The aim is to build a Bayesian Network (BN) mock-up in the direction of study to the casual relationship among standards of socio-economic and final educational thing with student's educational performance at an advanced minor stage. It is observed that the superior Bayesian Classifier models through dissimilar class standards are accomplished on behalf of forecasting learner performance. Through an analytical accuracy, a BN model gives a vigorous scheme to forecast the educational performance of advanced minor stage for students [6].

The common presentation of the learner in [7] belong to the diverse country is analyzed based on top of unlike attribute such as planned actions, chapter academic and amount of time they interact through the subject. The attribute is compared with the standard marks of the learner in a particular country and it has been done that, the marks are not simple responsibilities to signify the appropriate patient of the subject. The examination can be widespread to obtain into deliberation for the last characteristic such as 'certified', 'explored' etc.

Student modeling in [8] the training systems aim is to provide students through interactive assist, it desires to be familiar with what information the learners have and what goal the learner is presently annoying to accomplish it. So has to do jointly evaluation and plan the gratitude. These modeling responsibilities are engaging a far above the ground point of improbability at what time the learner is authorized to track a range of logic queues & not necessary to demonstrate all their analysis.

III. E-LEARNING

E-Learning is defining the use of PC and information technology in the direction of a wide array of answers to facilitate better knowledge and get better act.

A. Why extend E-Learning?

Several institutes and organizations are using e-learning since it can be as efficient as conventional education at a minor price.

Just beginning e-learning is further costly than preparing to the lecture hall resources and coaching the guide, particularly if multimedia or extremely interactive technique is used. Though, release expenses for e-learning (contain the price of network servers & scientific support) be significantly lighter than those for lecture hall facilities, instructor time, participant journey, and work period missing to be present at lecture hall assembly.

Besides, e-learning appears on a wider goal for students by charming the learners who contain complexity presence conservative lecture hall tuition because they are:

a) Geographically spread through some degree of time and/or resources to journey;
b) Full of activity using effort or relations assurance which do not permit them to be present at subjects on exact time with a set agenda;
c) Situated in disagreement and post disagreement part & secret inside their mobility since of safety reasons;
d) Some degree of contribution in lecture hall session as of educational or spiritual beliefs; in front of problems

through concurrent statement (e.g. overseas speech student or incredibly introverted student).

E-learning container proposes efficient instructional process, such as experience using a related comment, join teamwork performance through self-paced learning, personalizing knowledge course base on top of learners' requirements & use replication and sports event. Moreover, every learner accepts the similar excellence of training since there is no confidence in a precise tutor.

A. Know how to E-Learning live use in the direction of extends some kind of talent?

Tuition course could plan at immediately diverse kind of talents such as:

a) Cognitive talents, which be able to engage information and understanding (e.g. accepting technical idea), subsequent directions (technical talent), while affect process in original circumstances in the direction of resolve effort (philosophy or psychological talents);
b) Interpersonal talents (e.g. talents concerned in lively pay attention, bargain, etc.);
c) Psychomotor talents, connecting the attainment of objective awareness & activities (e.g. creating games/ riding a four-wheeler).

IV. BAYESIAN NETWORK

Before our research, the use of Bayesian networks in learner knowledge is characterizing such arrangement of nodes and deal with the significance of inference in this circumstance.

Learners Performance can ease educational systems to get better quality and help learners to perform improved in their studies and therefore have a superior future!! Bayesian networks (BNs) can represent the causal interactions and statistical relationships of a system's states with a graphical revelation that is easy to understand. Using such models and having proof about single or numerous of performance indicators of learner, it is possible to examine the status of other indicators in the model. It is also possible to compute the effect an intervention on single or more indicators on the other parts of the network.

Despite, obtain a topology of vertex enthused by Conati [8], and originate in altered conditions in the literature.

A. Definition

Various representations are formed during the illustration of information. Probabilistic graphical representations, & particularly BNs begin by Pearl [9] in the 1980s, contain confirmed in the direction of live valuable tools for demonstrating undecided information & analysis as of partial in order.

A Bayesian network, a Bayesian belief network, or just a belief network is a probabilistic graphical illustration to permit towards signify in addition to cause regarding the unsure region. A Bayesian graph is a directed acyclic diagram within a vertex that communicates in the direction of the states (client assets); along with the connections signify probabilistic associations in control. Each state can fit into the ground of information, bottom information and/or the cognitive form. Every vertex symbolizes the system's belief about achievable principles (stage, state) of the element. Therefore, the conditional probability allocation has got to be exactly meant in support of every vertex. But the state is distinct; they know how to be reachable a panel.

The diagram calls the "formation" of the representation, and the probability tables are its "factors". Be capable of making available by experts, or compute from statistics; generally speaking, the formation is defined by experts and the calculated factors are from experimental in sequence.

Where a BN B= (A, Z) definite is.

A=(W, Y), an acyclic directed diagram through a multiplicity of vertex connected through a position of arbitrary states W =(W,..., Wn) ; Z = {P(Wi | Pa(Wi))} every the probability of all vertex Wi are conditional towards the state of its parents Pa(Wi) in A.

According to Mayo [10] [11], a BN permits dense illustration of the joint probability distribution above the place in states:

$$P(W1, W2, \cdots, Wn)=\prod P(Wi \mid Pa(Wi)) \quad (1)$$

Equation 1, these techniques utilize the idea of conditional probability, i.e., what is the probability of Wi communicative to observed Wj ; other than they also make use of Bayes theorem, which compute, equally, the probability of Wj expressive Wi, when P(Wi | Wj) is familiar.

A pattern of a straight-forward Bayesian network has given away in Fig 4.1. Similar joint probability distribution in support of Fig 4.1 can be printed within the outline as shown below in Equation 2 using the joint probability distribution of Equation 1:

$$P(I,J,K) = P(I|J,K)\ P(J|K)\ P(K) \quad (2)$$

In a Bayesian network, every state is a move in a similar method and some single can be regarded as the class state arrangement. A Bayesian network classifier engages the stage probabilistic inference on the Bayesian network with single alive probabilistic inference algorithms [12] [13].

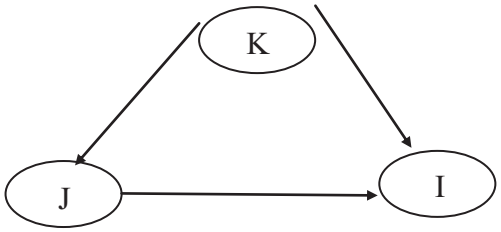


Figure 4.1: A Simple Bayesian Network

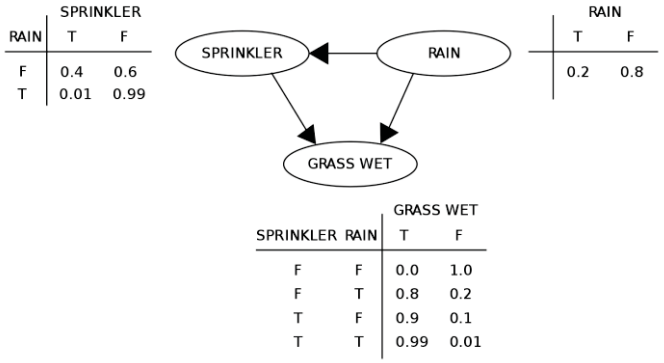
Example

As in Fig 4.2, the two actions can root grass to be wet: a lively sprinkler or rain. The rain has a straight result on top of

the utilized sprinkler (specifically with the aim of when it rains, the sprinkler usually is not lively). These circumstances can model with a Bayesian network. Each state has 2 likely elements, T (for correct) and F (for wrong).

The joint probability function is:

$$\Pr(G,S,R) = \Pr(G|S,R)\Pr(S|R)\Pr(R) \tag{3}$$



RAIN	SPRINKLER T	SPRINKLER F
F	0.4	0.6
T	0.01	0.99

RAIN T	RAIN F
0.2	0.8

SPRINKLER	RAIN	GRASS WET T	GRASS WET F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

Figure 4.2: BN with Conditional Probability Tables (CPTs)

Equation 3, where G = Grass wet (correct / wrong), S = Sprinkler turned on (correct / wrong), and R = Raining (correct / wrong).

The representation can respond to difficulties regarding the occurrence of a root known the incidence of an outcome (supposed inverse probability) similar to "What is the probability to it is raining, known the grass is wet?" with using conditional probability formula and summing over all nuisances:

$$\Pr(R=T|G=T) = \frac{\Pr(G=T,R=T)}{\Pr(G=T)} = \frac{\sum_{S\in\{T,F\}}\Pr(G=T,S,R=T)}{\sum_{S,R\in\{T,F\}}\Pr(G=T,S,R)} \tag{4}$$

Equation 4, the extension for the joint probability function Pr (G, S, R) and the conditional probabilities as of the conditional probability tables (CPTs) known in Fig 4.2, single container estimate both period of the amount in the numerator and denominator. For example using equation (4), calculating the joint probability distribution for Pr (G, S, R)

$$\begin{aligned}\Pr(G=T,S=T,R=T) &= \Pr(G=T|S=T,R=T)\Pr(S=T|R=T)\Pr(R=T)\\ &= 0.99\times 0.01\times 0.2\\ &= 0.00198.\end{aligned}$$

After that the mathematical mark (subscripted with the associated state values) is:

$$\Pr(R=T|G=T) = \frac{0.00198_{TTT}+0.1584_{TFT}}{0.00198_{TTT}+0.288_{TTF}+0.1584_{TFT}+0.0_{TFF}} = \frac{891}{2491} \approx 35.77\%.$$

V. IMPLEMENTATION

The beginner knowledge assessment keen was included on an e-learning structure to execute customized contented delivery using BBN [14]. The assessment part is executed based on track: Measured a place of stage questions for a subject individual accessible by the e-learning framework. The position of questions is alienated into three groups such as Satisfactory, More Satisfactory, and Most Satisfactory. Under every position of questions, there is division. For example in the satisfactory category, built-up questions that E= {Much Satisfactory, More Satisfactory, Most Satisfactory}. Likewise, questions are built-up for the last two categories such as More Satisfactory and Most Satisfactory [15].

A. Satisfactory Stage Questions

E1, E2, E3,…….E27, and E30 are set of Satisfactory stage questions.

E1, E2, E3,…..E9, and E30 are much satisfactory questions, E10, E11, E12.....E18 are more satisfactory questions and E19, E20,.....E22, E24,… E27 are most satisfactory questions.

B. More Satisfactory Stage Questions

D1, D2,……D18 and D20 are set of More Satisfactory stage questions.

D1, D2,….D6, and D20 are much satisfactory questions, D7, D8,….D12 are more satisfactory questions and D13, D14,….D18 are most satisfactory questions.

C. Most Satisfactory Stage Questions

MD1, MD2,…MD15 are set of Most Satisfactory stage questions.

MD1,MD2,…MD5 are much satisfactory questions, MD6,MD7,…MD10 are more satisfactory questions and MD11,MD12,…MD15 are most satisfactory questions.

a) If E1 is False there is slightly much satisfactory question E4 than satisfactory question E1 in Satisfactory stage questions as shown in Fig 5.1, and if E1 is True then more satisfactory question E10 in satisfactory level questions as shown in Fig 5.1.
b) If E10 is False there are slightly much satisfactory question E11 than more satisfactory question E10 in satisfactory stage questions as shown in Fig 5.1, and if E10 is true then more satisfactory question E19 in satisfactory stage questions as shown in Fig 5.1.

There are nine-stage values

Where,

1) E1, E2, E3, E4, E5, E6, E7, E8, E9 and E30 are 1st stage.
2) E10, E11, E12, E13, E14, E15, E16, E17 and E18 are 2nd stage.
3) E19, E20, E21, E22, E24, E25, E26 and E27 are 3rd stage.
4) D1, D2, D3, D4, D5, D6, and D20 are 4th stage.
5) D7, D8, D9, D10, D11, and D12 are 5th stage.
6) D13, D14, D15, D16, D17, and D18 are 6th stage.
7) MD1, MD2, MD3, MD4, and MD5 are 7th stage.
8) MD6, MD7, MD8, MD9, and MD10 are 8th stage.
9) MD11, MD12, MD13, MD14, and MD15 are 9th stage [16].

If the learner answers the 1st stage of the set of questions true then only he will be going to the next stage i.e., 2nd stage of the level of questions in the same level of satisfactory stage questions as shown in Fig 5.1. If the learner answers true in all the stages in satisfactory stage questions, then he will be going to the next level of more

satisfactory stage questions. If the learner answers the 1st stage of the set of questions false then he will be in the same stage i.e., 1st stage of the level of questions in the same level of satisfactory stage questions as shown in Fig 5.1, so on for the next of the stages.

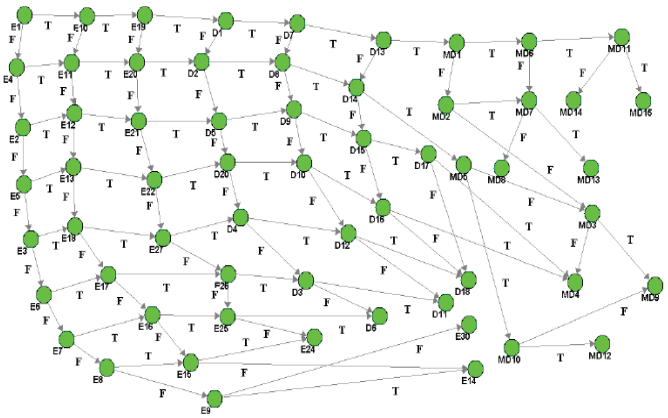


Figure 5.1: Learner Bayesian Network Level Questions

Table I depicts the Questions contain two potential standards Probability Correct (PC for true) and Probability Incorrect (PI for false).

Table I. Conditional Probabilities

Questions	PC (True)	PI (False)
E1	0.5	0.5
E2	0.52	0.48
E3	0.54	0.46
E4	0.51	0.49
E5	0.53	0.47

VI. RESULTS AND DISCUSSIONS

Fig 6.1 and 6.2 shows the learner performance of learner whose outline is capture through the e-learning framework. The content was delivered based on the learner's outline. It can observe that conventional performance is efficient compare with the e-learning framework. In Fig 6.1 the learner has answered the different categories of levels like E1 to MD15, whereas in Fig 6.2 the learner also answered the different categories of levels like E1 to MD13. But in Fig 6.2 the learner has answered incorrect level in MD1, and then he/she will be at the same level as shown in Fig 5.1 shows in the learner network.

If the learner answers only the satisfactory stage of questions, then the learner called has slow learners, whereas the learner answers satisfactory stage and more satisfactory stage of questions, then the learner called has average learners and the learner answers satisfactory stage, more satisfactory stage and most satisfactory stage of questions, then the learner called has excellent learner as shown in Fig 6.3 based on the learner BN level of questions.

It was observed that from Fig 6.1 and 6.2 that the learner performance of different levels of questions has compared between the two sets of learners to meet the learning objectives. Last but not least Fig 6.3 shows the performance analysis based on classified learners that include slow learner, average learner, and excellent learner. By using the Learner Bayesian Network framework the result shows 45% of a slow learner, 15% of the average learner, and 40% of excellent learners from the required quantitative data set.

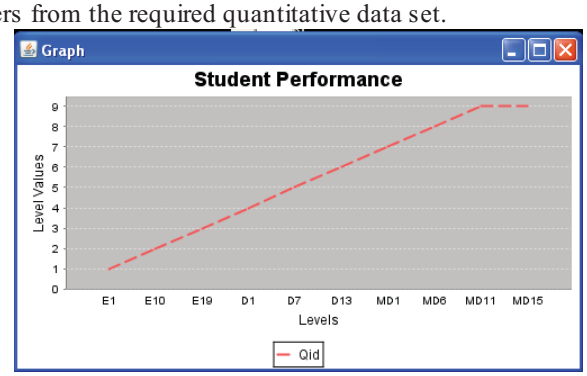


Figure 6.1: Learner1 Level of questions

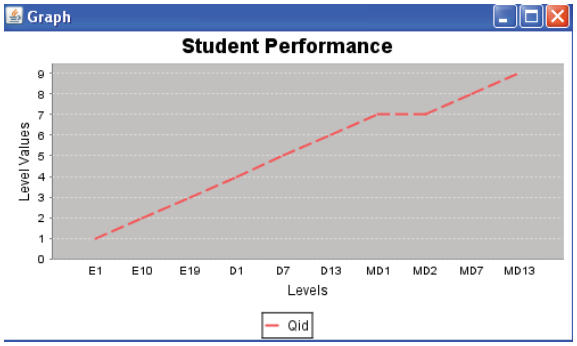


Figure 6.2: Learner2 Level of questions

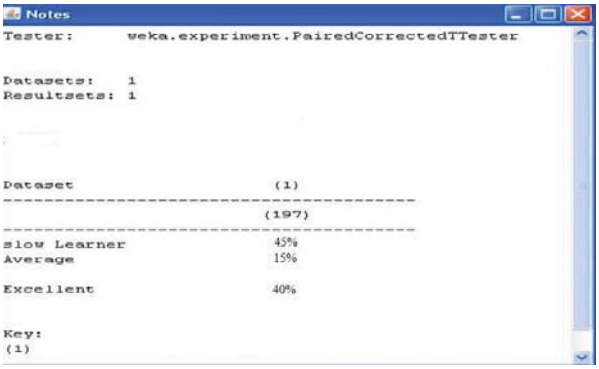


Figure 6.3: Learner's Performance analysis based on BN

VII. CONCLUSION

In this work, it has been implemented an assessment study for e-learning using Bayesian Network (BN) to improve learner's performance of an evaluation system for classified learners that include slow learner, average learner, and excellent learner. Besides, the beginner measurement may be observing from the perspective of assessing the learner's knowledge potential by pretentiousness

questions that the learner does not realize learning contented properly in the direction of e-learning. This learning is extremely helpful to recognize the percentage of a slow learner in the learners' knowledge domain. This work is resolved the learner failures for a necessary act to upgrade the weaker learner in a complete method. Bayesian Network can provide for the execution of an additional successful e-learning framework in the form of contented release and beginner assessment. In calculation, investigating the appropriate technology to execute the e-learning framework is important as the learner is discrete in the environment.

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