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An Intelligent Agent to Provide Advice to a Self-Instructional Learner under E-Learning Environment

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[1]**Abstract.** This paper presents an intelligent agent that plays the role of an advisor for an e-learner to facilitate the learner to achieve his learning objective. It provides advices to assist an e-learner while solving problems that are normally provided by human experts A Bayesian network is employed to collect data on learner's mistakes and the way in which one learner may commit a mistake during the problem solving process. On the basis of the statistical data on the learner's behavior, especially with respect to his tendency to commit an error, the agent anticipates the point of difficulty during a problem solving session and accordingly guides the learners to solve the given problem free of errors. The Bayesian network is trained with training data, prior information (e.g., expert knowledge, casual relationships, and estimated graph topology or network structure) and the parameters of the joint probability distribution.

Keywords: ITS, Intelligent Advisory System (IAS), Intelligent Agent, Bayesian Network.

1. Introduction

Development in the field of information and communication technology has opened up immense possibilities in the contemporary education and training arena. The traditional classroom based teaching learning systems are augmented by various kinds of e-learning systems e.g. Intelligent Tutoring Systems (ITS), Learning Management Systems (LMS), and Virtual Laboratory etc. However student advising is an important issue that is not given enough attention in Intelligent Tutoring Systems (ITS)[1][2][3].

In basic ITS one student is evaluated by some multiple choice questions. Here the main drawback is, when one student makes some wrong answer, there is no chance of understanding the proper step, where the student has committed the mistake while solving the problem. Usually, solution of a problem consists of a sequence of steps. A learner may commit a mistake at any point during the solution process.

So, in ITS, user knowledge management is necessary. The basic underlying perspective is to consider every student as being unique and advice him according their knowledge, understanding and types of mistake while solving a problem. This paradigm can be built by creation of a user or student model [4]. The main objective of student model is to understand the knowledge level of individual student, how they learn and what their problems are while they learn [5]. Assessing the user state of knowledge and profile requires uncertainty reasoning. Artificial Intelligence has addressed this problem in various ways such as fuzzy logic, Bayesian Networks [6] etc. So, using student model ITS can build an advisory system to advice a student at appropriate time and help him solve a problem correctly.

Advisory systems provide the advices and assist for solving problems that are normally provided by human experts. They can be classified as a type of expert systems [7][8]. Advisory system has the power to make recommendations but not to enforce a decision maker and it does not make decisions but rather help guide the decision maker in the decision-making process. While the system is leaving the final decision, it makes authority up to the human user [9]. The decision maker works in collaboration with advisory system

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to solve a problem. The three main processes in advisory systems are knowledge acquisition, cognition, and interface [10].

In this paper, we propose an Intelligent Advisory System (IAS) using Bayesian network and intelligent agent to help a student in problem solving. The Advisor agent will act on behalf of the human advisor and advice the learner at appropriate time. There is another intelligent agent, which is named Expert agent. The Expert agent determines the user module and selects the problem according to learner's level of understanding.

Rest of the paper is organized as follows. Section 2 presents an overview of Bayesian network and Intelligent Agent. Section 3 discusses the proposed system as a combination of two intelligent agents. These two intelligent agents are named as Advisor agent and Expert agent. This section also discusses how the Bayesian network is learning. Section 4 presents the architecture of the developed system as well as the user interface of the developed system. The last section concludes the paper.

2. Preliminaries

An advisory system has the power to make recommendations but not to enforce them. In the e-learning environment an advisory system is used to advice a learner to assist him attains his learning objectives. Using artificial intelligence techniques it is possible for the advisory system to trace a learner's steps to solve a problem, his skill, motive and so on. The proposed system is based on Bayesian network [11][12] as its structural framework to build an intelligent agent whose goal is to provide useful advices to the e-learner.

2.1. Bayesian Network

A Bayesian network (BN) is a directed acyclic graph (DAG) [13], where, every child node depends on its parent node. Each node represents some state with some variable. Each variable A with parent $B_1, B_2 \ldots B_n$ has a conditional probability $p(A|B_1, B_2 \ldots, B_n)$ associated with it. If the variable A has no parents then the probability is unconditional $p(A)$. Fig. 1 presents an example of a Bayesian networks.

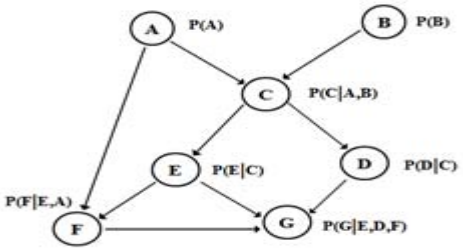

Fig. 1. Bayesian Network

2.2. Intelligent Agent

An agent is an entity that perceives the environment and takes actions to change the environment to reach the desired environmental state [14]. Smith *et al.* (1994) defines software agent as "a persistent software entity dedicated to a specific purpose"; Janca (1995) defines software agent as "a software entity to which tasks can be delegated". A Software Agent is a computational software system which has goals, sensors, and effectors, and decides autonomously which actions to take, and also when to take.

3. Proposed System

Fig. 2 shows the behavior of the proposed intelligent agent as a state instruction diagram. When one learner is going to solve a problem he/she will go through some steps. When a learner is in **initial state**, then system has a model of next steps and also statistics of previous learners, who had done some wrong steps or right steps. So, system has the information regarding probabilities of committing a mistake at various steps. According to this information, system can advice the learner at appropriate time and prevent him from committing a mistake.

When the system is used very first time then system has not nay information about previous learners. So, in this case we will impose some information, which are taken by some practical experiment.

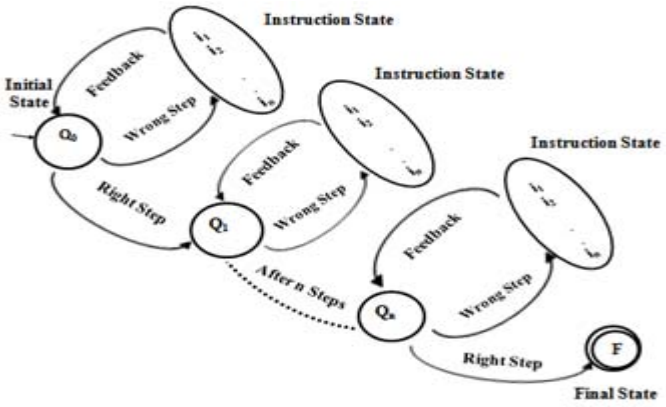

Fig. 2. State wise model for solving a problem

After every problem solving step a learner may move along with either the wrong step or the right step. If a learner takes right step then he/she will reach to the next state and after few right step learner will reach to **final state,** which means the problem is solved. If the learner commits any mistake then learner will reach **instruction state** (Fig .3). An instruction state contains few instructions according to corresponding possible mistakes. Here intelligent agent has the statistics of previous mistakes, which were committed by other learners. The intelligent agent can advice according to higher frequency of mistakes has been done previously.

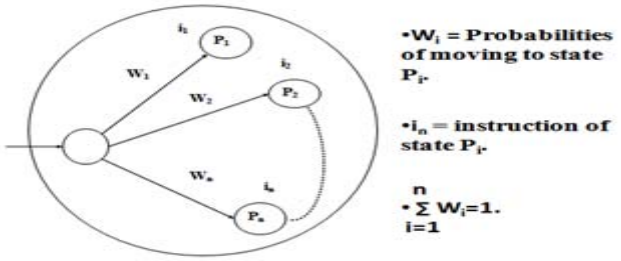

Fig. 3. The model of Instruction State

3.1. The Advisor Agent

This agent advice the learners according to their response in a particular problem. Performance of the system depends heavily upon its feedback in proper time and the way how it advices. Here, proper time refers to when the learner is giving a response to the solution, when the feedback is presented to the learner should be governed by what the learner has done. Tutors are better than teachers in this respect they can provide a learner with timely feedback better than most teachers.

The advisor agent will collect information from Bayesian network about previous learner's mistakes and the way in which one learner can commits some mistakes. As this network is updating according to the use of this system and the way a learner can solve the problem and commit mistakes.

However the initial practical settings the Bayesian network is unknown and one needs to learn it from the data. This problem is known as the *Bayesian network (BN) learning problem* [15]. We can solve this problem by given practical training data and prior information (e.g., expert knowledge, casual relationships, estimated graph topology or network structure) and the parameters of the joint probability distribution in the Bayesian network.

3.2. The Expert Agent

This agent determines the learner's performance, learner's level of understanding and learner knowledge of concept from the given problem statement, the problem specification and learner's feedback. When the learner reaches a certain score above the current level of difficulty, for example 80 percent or more, the expert agent increase the level of difficulty of the problem to be given for the learner.

4. The System Developed

We keep track of learner's knowledge of concept using the number of mistakes they are doing to solve a problem. When they commit a few mistakes then expert agent increases the level of difficulty of the problem for the learner. The expert agent can take information from student model (Fig. 4.) and BN to increase the difficulty level of the problem.

Fig. 4 presents the architecture of the proposed system. In the developed system, when one new learner login, his record is stored in student module. The main focus of this module is to consider every student as being unique and takes record of individual student, how they learn and what their problems are while they learn. While the learner solving the problem, the Bayesian network learns concurrent with the solving process. When the learner commit any mistake while solve the problem, the advisor agent advices the learner according to their mistake. The Bayesian network has the information regarding probabilities of committing a mistake at various steps. According to this information, system can advice the learner at appropriate time and prevent him from committing a mistake.

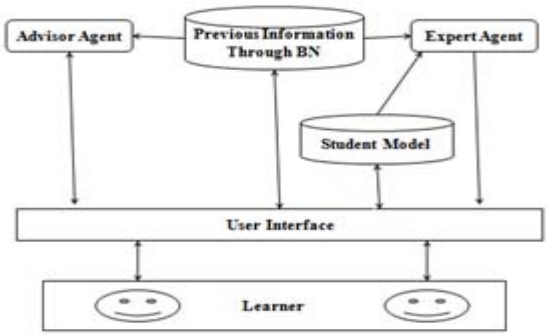

Fig. 4. System Architecture

4.1. User Interface

The user interface of ITS have a very important roll and we gave it a careful consideration during the design of the Tutor. The user interface is implemented by popular integrated development environment kits as JAVA. When a learner connects to the Tutor website, the student's browser displays the studying environment for the Tutor. In this environment there is an option for learner to study the tutoring materials. In evaluation environment an appropriate skill-level problem is selected by the expert agent module or the problem that last attempted is presented to the learner.

The student solves the problem in the Solution window, where there will be some step by step options to solve the problem. After answering a step, student presses Check button. Then advisor agent determines the appropriate response based on the diagnosis of the student's answer. The feedback of the advisor agent is sent to the output window. The student, at any time, may explicitly request to the tutor to view the solution, Exit from then current problem and ask for a new one; furthermore, the student can view his performance based on statistics including problems attempted, problems solved, number of attempts on a problem and problem difficulty. A typical conversation is cited below:

Test Result for Learner 1: Name: Suman Dey; ID: IAS012.

Problem: A car is moving at 30m/s. It has acceleration $2m/s^2$. What will be its velocity after 20 sec.?

System: Select the appropriate formula.

Learner: $s = ut + ½ ft^2$.

System: "You have been given u, f, t, and you need to find out v. Is this your right formula? ".

Learner: No.

System: Then what should be the correct formula?

Learner: $v = u + ft$.

System: Good**.** Now put the values for the variables.

Learner: u=30

f=2

t=20.

System: Good. Now calculate v.

Learner: v=70m/s.

System: Good. Well done.

5. Conclusions

An architecture of intelligent advisor in agent based intelligent tutoring systems has been presented in this paper. The system is expected to enhance the learner knowledge, performance in the problem domain of Newton's Laws of motion. The system presented in this paper has the potential to build estimated Bayesian network structure or graph topology relevant for any other problem domain. The capacity of the system can farther be enhanced by a little modification of the structure of the system by which the system can easily move from instruction state to next state while a learner unable to understand the problem and unable to choose the right steps in a problem solving process.

6. References

[1] Hyacinth S. Nwana ,"Intelligent Tutoring Systems: An overview", Department of computer science, University of Liverpool, Liverpool L69 3BX UK.

[2] S. S. Abu Naser, "Intelligent Tutoring System (ITS) for Teaching Database to Sophomore Students in Gaza and its Effect on their Performance", Information Technology Journal, Vol.5 (5), 2006, pp. 916-922.

[3] S. S. Abu Naser, "A comparative study between Animated Intelligent Tutoring Systems (AITS) and Video-based Intelligent Tutoring Systems (VITS)", Al- Aqsa University Journal, Vol. 5 No. 1 Part (1). 2001, pp. 72-96.

[4] VanLehn, K. 1988. Student Modeling. In Polson, M. C., and Richardson, J. J., eds., *Foundations of Intelligent Tutoring Systems*. Lawrence Erlbaum Associates. chapter 3, 55–78.

[5] Maria Virvou, Konstantinos Manos and George Katsionis. *"An evaluation agent that simulates atudents' behaviour in Intelligent Tutoring Systems"*. 2003, IEEE.

[6] Pearl, J. 1998. *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*. Morgan Kaufmann.

[7] Forslund, G., "Toward Cooperative Advice-Giving Systems: A Case Study in Knowledge Based Decision Support," *IEEE Expert*, pp. 56-62,1995.

[8] Vanguard Software Corporation, Decision Script, 2006. Accessed via www.vanguardsw.com/decisionscript/jgeneral.ht

[9] Aronson, J. and E. Turban, *Decision Support Systems and Intelligent Systems*. Upper Saddle River, NJ: Prentice-Hall, 2001.

[10] A. E. E. ElAlfi, M. E. ElAlami, "Intelligent Advisory System for Supporting University Managers in Law". (IJCSIS) International Journal of Computer Science and Information Security, Vol. 3, No. 1, 2009.

[11] F. Sahin and J.S. Bay "Learning from Experience using a decision-theoretic intelligent agent in multiagent system" in SMCCia/01 Mountain Workshop on Soft Computing in Industrial applications, Verginia Tech, Blacksburg, Virginia, June25-27, 2001

[12] D. Heckerman, D. Gieger and M.Chickering, "Learning Bayesian network: The combination of knowledge and statistical data." Technical Report MSR-TR-94-09, Microsoft Research, Redmond, WA, 1994.

[13] Narshing Deo, "Graph Theory: with applications to engineering and computer science.", Prentice- Hall of India Private Limited, 2003.

[14] S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, PHI Learning Private Ltd., 2008.

[15] Ben-Gal I., Bayesian Networks, in Ruggeri F., Faltin F. & Kenett R., Encyclopedia of Statistics in Quality & Reliability, Wiley & Sons (2007).