Proceedings of the 13th Annual Conference of JSAI, 1999
A Probabilistic Approach for Student Modeling Task

Anete Hiromi Hashimoto  Hassan Hajji  B. H. Far
アネテ 弘美 橋本  ハサン ハジ  B.H. ファー

Graduate School of Science and Engineering, Saitama University
埼玉大学大学院理工学研究科

Abstract: Student modeling is the task of gathering information about the target student in order to offer tailored instruction. To achieve this purpose, the formalism chosen to represent the student module should be able to draw estimations based on a set of restricted and uncertain information as well evolving aspects as a learning process implies. The approach we propose is the dynamic probabilistic network which is a formalism suitable for representing evolving information in an uncertain environment. The probabilistic student module will depict the student’s cognitive states in a domain independent manner which will be used as the source of information to prepare a general instructional plan. This plan, combined with the student’s response diagnose, is refined to a more specific instructional action. In this article, the basics of dynamic probabilistic student module will be presented.

1 Introduction

There are systems that consider the student’s answer to the unique piece of information in order to provide a personalized guidance. We think that the answer should be the key to give specific remedy action, however, it can be enriched considering information about the student’s performance monitored while studying the lessons. In this article we emphasize the domain independent aspects of the student’s cognitive states such as the student’s interest level or the challenge factor, which will be inferred in the probabilistic network and later used as the cues to determine the best tailored action.

2 Probabilistic Student Module

The probabilistic student module can be thought of as a coarse granular diagnose designed to infer “how” to proceed the tutoring while the student’s answers diagnose gives the “what” to present. Suppose that a student who has been demonstrating a high interest in the tutoring does not know how to begin an exercise classified as medium difficulty level. Rather than judging that the student does not know the rule and suggesting him/her to review the lesson, it would be better to present a similar example. It is more likely that a good student suffers from the inability to recall a studied knowledge rather than missing knowledge. On the contrary, a student with a poor performance probably needs to re-study the lesson before trying to solve exercises. In the following sections, we formalize our proposal.

2.1 The Student Modeling Task

The dynamic probabilistic student module depicts the student’s temporal and evolving cognitive states and will be represented by a probabilistic network. To build the network, we go through the following steps:

1. Define tutoring contexts in which the student will be engaged: The tutoring context concerns the student’s focus of attention at each interaction. Namely, we have defined three: (a) lesson presentation context, where the student studies a lesson, (b) exercise solving context, where the student solves exercises, and (c) remediation context, where student is presented tailored instructions.

2. Elicit relevant information at each tutoring context: While retention and acquisition factors are relevant to deduce how well the student studies a lesson, the confidence and challenge factors are relevant to the exercises selection in the problem solving context.

3. Describe the dependence among the elicited information: Finally, to build the network, links should be added to depict the dependence among information not only for each context but for the transition of contexts. The result is the network shown in Fig. 1 and 2.

2.2 Elements of the Student Model

The elements of the probabilistic student model is one of the following types: (a) evolve over interaction (bold
line box), (b) exist in only one interaction (dashed line box), and (c) continue over interaction (normal line box). (One interaction corresponds to one time slice, as suggested in [Reye, 1998])

![Figure 1: Lesson Presentation Context](image)

![Figure 2: Problem Solving Context](image)

2.3 How the Approach Works

In an ideal situation, the student studies one lesson, solves selected exercises and advances to new lessons. Since this is almost impossible with novice students, who probably will need more assistance, the system should be able to change the natural course of instruction and facilitate the learning process. Specifically, the student module will be used to:

1. **Predict the appropriateness of the selected problem**: The problem will be classified before hand according to the difficulty level, but the ability to solve it depends on the student’s expertise and how well the student studied related lesson.

2. **Infer a suitable type of hint**: We deduce from the student’s response (whether correct, incorrect, or no response) and from the problem appropriateness the type of hint most likely to help the student’s level.

3. **Select the difficulty degree of the next exercise**: To keep student’s motivation, the exercise is selected based on the challenge factor.

4. **Suggest remediation**: Based on the student’s history (the accumulated interaction), the system recommends alternative views of the lesson.

3 Related Works

There are two closely related work based on dynamic probabilistic networks. In [Reye, 1998], it is proposed a two-phase approach to update the student model. In phase 1, the updating incorporates the evidence (if any) about the student’s knowledge before the first interaction in any topic, while in phase 2, the updating is concerned with the expected changes in the student’s knowledge due to the tutoring. Another related work applied the dynamic probabilistic network for the user modeling task in an interactive assistant system [Jameson et al., 1999]. The network is used to assess the user’s resource limitation over time and to adapt the assistance accordingly.

4 Conclusion and Future Work

One of the shortcomings of the probabilistic network approach concerns the difficulty in providing the probabilistic values. Since in tutoring applications usually exact numbers are neither available nor necessary, as a future work, we are studying the possibility of replacing the quantitative values by qualitative probabilistic intervals. A central issue is to depict how one information affects another rather than what the resultant information value is. This formalism, called qualitative probabilistic network, although less powerful than the numerical approach, may be a solution for application like tutoring, that presents low risk and new information is constantly available.

References


