Application of Learner Style Modeling to Determine Preferable Form of Learner Assessment

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Abstract: One of the main theories in pedagogical environments is that different learners have different learning styles. Within this respect, regarding the individualized assessment, it is important for the tutoring system to adapt its form of assessment based on individual learner model parameters to improve assessment outcomes. Here, the tutor can use learner style model to predict which form of assessment will be effective for the learner. In this paper, we propose a decision support system (DSS), which uses the parameters of learner model for personalizing his preferable form of assessment in a certain field. The learner style model that has been used is based on Dunn and Dunn, Kolb, and Myers-Briggs theories which comprises of eight distinct parameters. We trained a MLP with collected data sets and then used it in the decision making process of the assessment system for selecting the most suitable form of assessment for the learner.

Key Words: Different forms of assessments, Intelligent Tutoring System, user model, learner style, Multi Layer Perceptron.

1. Introduction

Assessment is an important but difficult task in the whole teaching and learning process. It has a strong influence on student approaches to learning and their learning outcomes. Recent development in education has shifted its emphasis from teacher-centered learning to student-centered learning [2]. With the latter, students are exposed to involve in the assessment cycle. They are often the best referees for judging their performances. In this regard, estimation of student abilities is not only based on tutor's estimations but self and peers' judgments are also taken into account.

In the current student centered learning environments, the lectures in charge are solely responsible for determining form of assessment and its criteria. This may reduce the students' autonomy in the whole learning process and lower their learning quality. In order to encourage students to participate in the whole learning process, this paper proposes adaptation of selected form of assessment to learner preferences. It allows lecturer to generate the most suitable form of assessment regarding student model parameters.

The structure of this paper is as follows. In the second section, selected learner style model and its parameters are discussed. Possible forms of assessment in a collaborative learning environment are introduced in section 3. Section 4 is dedicated to explaining the inference mechanism of the system for determining suitable form of learner assessment. Experimental results and final remarks are also given in section 4.

2. Learner Style Model Parameters

In providing individualized forms of assessment, it is important to diagnose the preferable form of assessment based on learner identifications. Identification of the learner often involves analysis of learner's intentions, desires, background knowledge (or belief) and style which is the duty of the learner model component of an Intelligent Tutoring System (ITS). Thus a learner model is an approximate representation of the learner.

The learner style model that has been used in our system is based on Kolb, Dunn and Dunn, and Myers-Briggs theories [1]. According to Kolb, “Processing Continuum” of learner is bound to his/her two extremes of “Active” and “Reflective” attitudes. Therefore, based upon the status of learners’ tendency toward these two extremes, the very features for their learning object can be determined. Recognition of the above learner’s attitude has been done via some questionnaires. The same discussion is valid for the two extreme attitudes of “Abstract” and “Concrete” which have been considered for “Perception continuum”[1].

Table 1 The attributes and values of the learning style modeling in our sample system

Attribut	Value
Perception	(**Sen**sitive/**Int**uitive)
Input	(**Vis**ual/**Ver**bal)
Organization	(**Ind**uctive/**Ded**uctive)
Understanding	(**Seq**uential/**Glo**bal)
Processing	(**Act**ive/**Ref**lective)
Decision Making	(**Thi**nking/**Fee**ling)
Attitude to Outside World	(**Jud**gment/**Per**ception)
Orientation to Life	(**Ext**rovert/**Int**rovert)

As far as it concerns Dunn and Dunn theory, in providing questionnaires for learning style modeling, different types of stimuli (to be given to the learner) are to be considered. Finally, with respect to Myers-Briggs theory, the four dimensions elaborated by him regarding learning style, i.e. Extroversion vs. Introversion, Sensing vs. Intuition, Thinking vs. Feeling, and Judging vs. Perceiving, have been observed in the process of questionnaire preparation. Considering the above discussion, the total features of learner style, used in our proposed system, are illustrated in Table 1[1].

3. Possible Forms of Assessment in a Collaborative Learning Environment

As traditional testing methods do not fit goals such as lifelong learning, reflective thinking, being critical, evaluates oneself, problem solving, and autonomous learning, Assessment is now represented as a tool for learning and present contributions of assessment focus at one new dimension of assessment innovation, namely the changing place and function of assessor. Therefore alternatives in assessment have received many attentions in the last decade and several forms of more authentic assessment such as skills of self-, peer- and co-assessment are introduced [3].

The current ranges of approaches to assessment are explained shortly: Traditional form of assessment is the standard form of assessment, in which just the tutor is responsible for the assessment process. Self-assessment is an innovative form of assessment that refers to the involvement of learners in making judgments about their own learning [4]. Another widely used form of assessment called peer-assessment is the process whereby groups of individuals rate their peers. The form of assessment often called collaborative assessment is the process where groups of tutors evaluate one examinee. This process is often used in summative assessments. A form of collaborative assessment which is called, negotiated collaborative assessment stresses the shared activity typically undertaken by a classroom teacher and the student being assessed, to produce an agreed assessment [4].

Other exiting forms of assessment are a two by two combination of self, peer and collaborative assessment. Self- and peer- assessment are combined when students are assessing peers but the self is also included as a member of the group and must be assessed [3].Co-assessment, is a kind of assessment process which stands for the participation of students with staff in the assessment process; it provides an opportunity for students to assess themselves while allowing the staff to maintain the necessary control over the final assessments [3].

4. The proposed decision support system for selecting the best form of assessment

The proposed DSS is a multi-agent system composes of three distinct agents. It uses a quantity model comprises of four parameters related to the current situation and one for previous evaluated forms of assessment. These parameters are as follows:

-Number of students and tutors involving in the assessment

-Aim of assessment (diagnosis, formative, summative)

- Expenditure
- Affects of student learner style on preferable form of assessment

For deciding on the value of the first three parameters, a fuzzy inference engine with predefined rules is used in the decision maker agent. As focus of this paper is on the fourth parameter, we trained a MLP with a set of collected data to be used in the system for that special purpose.

The student modeling agent of the proposed system consists of three stages respectively related to registration, learning style and learner's Belief, Desire, Intension (BDI).The learner modeling process is started by identifying the current learner. Before filling out the registration form, learner is first authenticated, and based upon this authentication, the registration and learning style phases for those whose corresponding information exits in learner history, are by passed. The learning style phase is based on some of the principles already discussed in section 2, with respect to Dunn and Dunn, Kolb, and Myer-Briggs theories. In our approach, based upon our recognition of the above learner's attitude via their responses to some questionnaires, we determine the preferences of the current examinee on the basis of these features. Then the results are sent to the decision maker

agent to decide on the suitable form of assessment for the current examinee.

The decision maker agent senses the environment for the current available resources and using a fuzzy inference mechanism [2] assigns a credit to each form of assessment. It also asks the preferences of the test administrator on selected decision making parameters. The final decision making process of the system is based on linear combination of these parameters and their preferences. The evaluation of previous similar assessment experiments [5] are also taken into account as a factor in the final decision making process, according to the following formula:

$$F_i = \sum_{j=1}^{N} \alpha_j (parameter\_new\_req_j) + \gamma \sum_{k=1}^{M} \beta_k (parameter\_previous\_\exp_k) \quad (1)$$

where coefficients α_j, β_k are the preferences of test administrator (tutor) on each sets of parameters and γ_l determines how much the $l-th$ previous experiments should affect the final decision. The formulas will be calculated separately for each method of assessment and the maximum value of the quantity models determines the most suitable method [5]. The general architecture of the proposed decision support system is shown in figure 1.

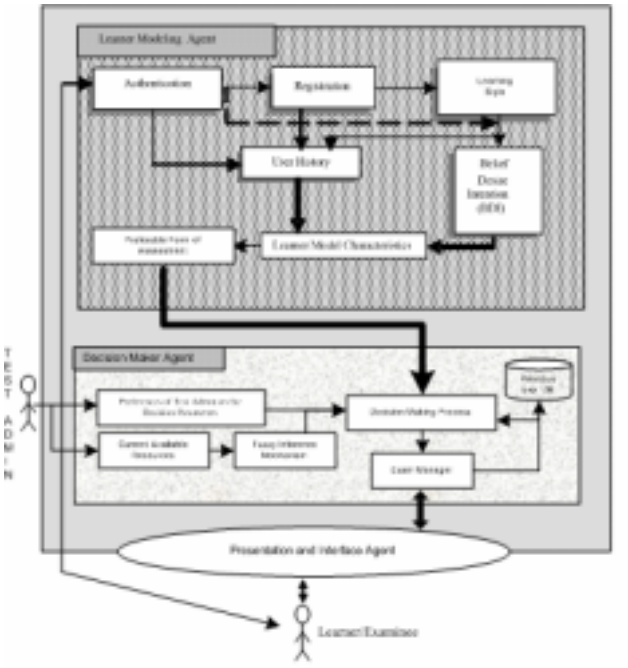

Figure 1- General Architecture of the Proposed Decision Support System

4. A Multilayer Neural Network for Obtaining Preferable Form of Assessment

As shown in figure 1 while deciding on the suitable form of assessment, the preferences of learner are considered. To do so, learner modeling agent is now responsible for determining preferences of learners on different forms of assessment based on their learning style. For this purpose a trained multilayer neural network was used. Its inputs are the learner model characteristics. The network maps them to the preferences of the learner on different forms of assessment.

4.1 Simulations

As neural networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities, input vectors and the corresponding target vectors are used to train the network until it can approximate a function, associated input vectors with specific output vectors [6]. The architecture of the network is shown in figure 2. In this figure, an input vector consists of learner style model parameters and the output vector is a vector with the length of nine for nine different possible forms of assessment. The architecture is a multilayer feed forward network, used with the back propagation learning algorithm. The back propagation algorithm updates the network weights and biases in the direction in which the performance function decreases most rapidly- the negative of the gradient. One iteration of this algorithm can be written

$$x_{k+1} = x_k - \alpha_k g_k \quad (2)$$

where x_k is a vector of current weights and biases, g_k is the current gradient, and α_k is the learning rate(0.05).

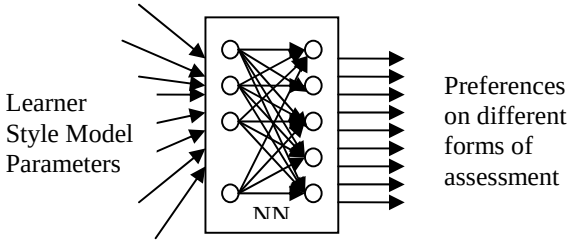

Figure 2- Architecture of the applied feed forward neural net

4.2 Experimental Results

The multilayer neural network was trained using 40 data sets collected from different people with known

learner style models. The proposed system was tested with another 20 collected data sets. For gathering different learner style parameters and their preferences on the forms of assessment, we used the benefits of the above mentioned learner style modeling system. Figure 3 and 4 show the result of training and testing the network with the gathered data sets. Although the training data sets are small, and in a real situation one must gather more data for training the network, the underlying theory is applicable.

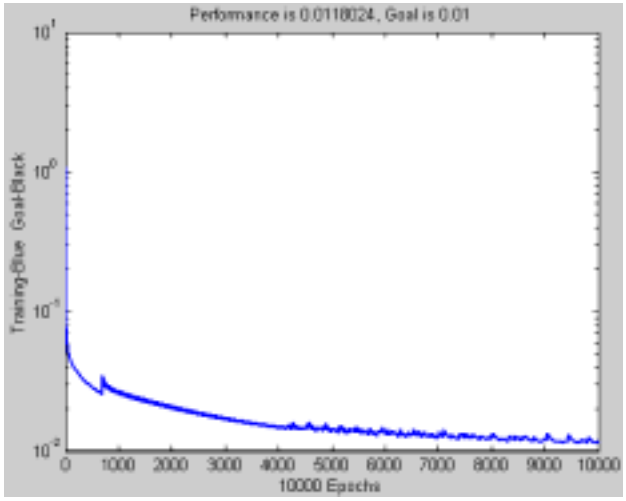

Figure 3- Training phase of the MLP with 40 data sets

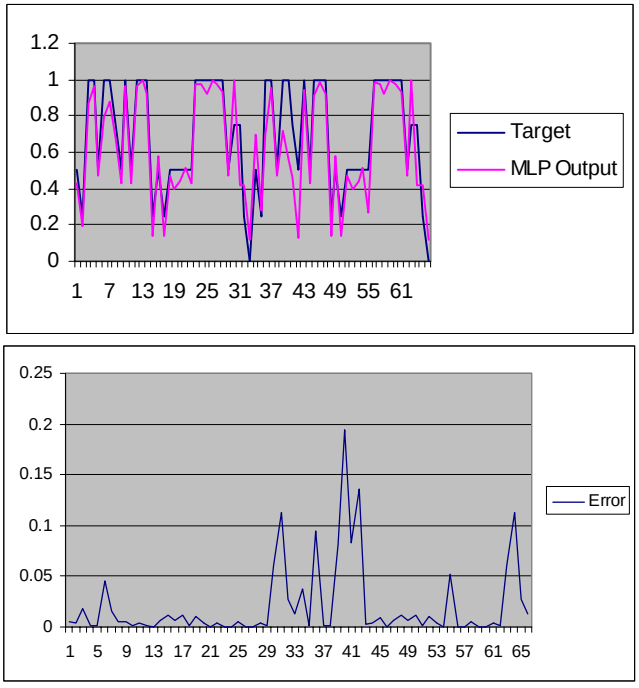

Figure 4- Output of the network and its error in test phase

5. Conclusion

To improve learning and assessment process of Intelligent Tutoring Systems, adaptation of form of assessment based on individual learner model parameters is an important task. In this paper, a decision support tool for determining the best form of learner assessment with regards to his/her learner style model was proposed that can be effective in determining the suitable form of assessment for each individual separately. The learner style model that has been used is based on Dunn and Dunn, Kolb, and Myers-Briggs theories which comprises of eight distinct parameters. We trained a MLP with collected data sets and then used it in the decision making process of the assessment system for selecting the most suitable form of assessment. The simulation results show that a multi-layer perceptron trained with an acceptable number of training data sets among different learning styles can be a good solution for the current problem.

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