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Topic of Ph.D.: Adaptive Intelligent Tutoring Systems

Key Research Findings

Empirical studies have shown that success of an Intelligent Tutoring System (ITS) depends largely on its student modeling approach. There exists a strong interaction between cognitive and affective processes in the context of learning. Thus, modeling learner's affective behavior helps in better personalized adaptation and improves learning performances. However, understanding the complex correlation between cognition and affect is always a challenging task. Numerous affect modeling techniques which employ various physical sensors like camera, pressure sensitive chair and mouse, devices to measure heartbeat, skin conductance, etc. have shown promising results. But their deployment in real world situations at a large scale is limited due to concern about their cost, privacy, intrusiveness, etc.

On the other hand, modeling affective factors from cognitive behavioral patterns like amount of time spent, frequency of help seeking, types of response given, browsing pattern, etc., have shown encouraging results too. Such approaches are based on the assumption that cognition is the predominant factor of modeling motivation as well as emotion. The advantages with these kinds of soft student modeling techniques are that they are less intrusive, cost-effective and easily applicable to any ITS.

The goal of this research was to develop a framework for designing adaptive ITSs which model a learner's cognitive as well as affective states to guide the learning process. Among various Artificial Intelligence (AI) techniques available, production rule based approach has been followed since such rules allow to capture a detailed conditional matching of different parameters to fire the consequent action. For each learner, the framework maintains a student model containing problem solving patterns, performance history, affective tendency, as well as current level of domain knowledge. The student modeling is based on eight different interaction parameters like - current learning activity status, total time spent, amount of help sought, number of attempts made, correctness of an answer, conceptual knowledge, pre-requisite concepts mastery status and past performance history. A total of 936 rules have been generated by using these eight parameters to carry out the instructional process, while maintaining the learner in an affective state of mind suitable for learning. This process is accomplished through system controlled navigation of domain knowledge concepts along with feedback messages.

The validation of the developed framework was done in three phases. In the first phase, the framework was validated by a group of selected experts of the field. Based on their suggestions in terms of feasibility and usefulness of the approach, the framework went through minor modifications. In the second phase, a prototype ITS on eight concepts of Set Theory was developed and tries out with a group of 129 learners. Performances during pre-test, post-test as well as retention-test were compared to see the effectiveness of the framework. The test scores have shown encouraging results and significant learning gain have been recorded for majority of the test subjects. The third and the last phase of evaluation was done through a user validation of the framework. Learners were asked to give their views about ten statements on a five-point likert scale. These statements were bout user satisfaction in terms of ease of use, satisfaction about pedagogical decisions, effectiveness of the framework, etc. Satisfactory responses were received for each of the indicators. Evaluation of the framework through this questionnaire has also yielded satisfactory results. Overall, the results have validated our approach in the development of the framework and thus described it to be effective in one-to-one instructional settings.