

# Computer Simulation of Statistics and Educational Measurement

## StatSim: An Intelligent Tutoring System for Statistics

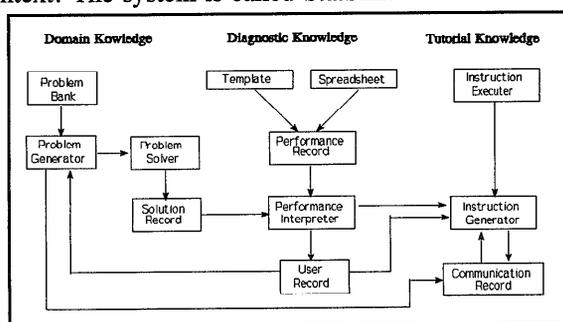
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The purpose of this research is to develop an adaptive tutoring system which uses AI techniques to explore how to diagnose student's misconceptions in problem solving and generate relevant instructions from the context. The system is called StatSim.



StatSim is an expert system for teaching basic concepts of statistics such as standard deviation, normal distribution and standard scores. It simulates three types of knowledge: statistics domain knowledge, diagnostic knowledge and tutorial knowledge to guide students in problem solving. At the beginning of the tutorial, the student is given a case as a statistics problem to solve, produced by the problem generator based on the student's record. The consultation program (domain expert) solves the problem first and saves the results and reasoning process in working memory. The diagnosis program (diagnosis expert) interprets the student's behavior by comparing the student's behavior in solving the same problem with the expert's behavior. The tutoring program (teaching expert) responds to the student's behavior on the basis of what the student knows and his goals for the tutorial session. It can take the initiative by offering orientation when a new concept is introduced or by interrupting a student when it finds some explanation is necessary. The purpose of this tutorial is to use the context of an actual problem to make the student aware of gaps and inconsistency in his knowledge and to correct these deficiencies.

The whole tutoring process consists of two

sessions: a consultation session and a tutorial session. During the consultation session, the Problem Solver program applies domain knowledge production rules to derive a solution. It reads in a problem text, converts it into a set of keywords in the form of attribute-value pairs and saves them in working memory. The rule interpreter fires all the rules whose conditions are satisfied and saves the results as a text file.

During the tutorial session, the Tutor program maintains and updates a student model and a record of the communication between the tutor and student. A set of tutorial rules are used to control what to teach and how to teach on the basis of what the student knows. A template-based user interface is designed to keep track of the student's mental activity. It serves both as an external memory and a source of input to the system. The student's problem-solving behavior is recorded in performance history.

A special module (performance interpreter) which simulates the diagnostic expertise of a teacher is developed to reconstruct the student's model of domain knowledge on the basis of the student's performance history. The input to the performance interpreter comes from the generic template and working spreadsheet. Each move in the student's behavior on the screen is recorded whenever an input textbox is out of focus. The interpreter keeps its observations until it collects enough information to update the student model. Interpretation rules are employed to decide when to intervene and how to intervene, one of the major issues in ITS. The system is sensitive to every step in the student's problem solving process but at the same time lets him explore the solution to the problem.

StatSim has four major features: 1) it uses multiple faulty diagnosis techniques to locate student's misconceptions; 2) it employs graphics, animation, menus, windows and other interactive techniques in instruction delivery to enhance understanding and motivation; 3) it uses production rules to control the intervention so that the user has enough control of the system; 4) it uses planning to refine the explanations and instructional acts to maximize the teaching effects.