

An Intelligent Tutor for Teaching Basic Computer Science and Java Programming to Medical Informatics Students

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ABSTRACT

Teach Me Java is an intelligent tutor for the teaching-learning of basic computer science principles and the Java programming language. It offers a new kind of teaching-learning environment for distance learning that is adaptive to the personal needs of each student. With the proliferation of the Internet and access to inexpensive computers, we can explore a new kind of personalized teaching machine based on the seamless integration of incremental instruction with practice and provide this instruction to medical informatics students throughout the world. The tutor is virtually unique in its attempt to ensure mastery of the material. No human instructor is needed and students get individualized instruction.

Intended for medical informatics students with little or no previous programming background, the tutor introduces computers as problem solvers using the Java programming language. Students learn to decompose problems into algorithms and data structures and then code, debug, analyze, maintain and document programs using techniques of good programming style. Related topics include the basic aspects of abstraction, recursion, parameter passing, file I/O and classes. Examples are drawn from within medical informatics with particular emphasis on data mining, artificial intelligence, parallel computing, distributed computing and cryptography. Students explore different ways to think about problem solving including top-down decomposition, object-oriented programming, client/server networking and event-driven programming (such as that used in graphical user interfaces). Students construct Java stand-alone applications as well as applets that run within web pages. Knowledge of the concepts and material presented will give students better problem-solving skills and insight into today's computational medical environment.

Prototypes were constructed and two experiments conducted with students at Harvard University. Students learned part of their computer

programming material using the traditional lecture, book and assignments, while others had the additional benefit of a computer tutorial that was responsible for teaching a small segment of the course material. The first study identified student attitudes towards an adaptive, intelligent computerized tutor. The computer was responsible for teaching and seamlessly incorporating practice into the session. For students using the intelligent tutor, the computer constantly engaged students in reinforcing and interactive activities. Each student worked at their own pace, and at a time that best suited them. The intelligent tutor spent more time on the subject matter than could be afforded during class time, and gave each student individualized attention. All students were then given an aggressive problem to solve based on their newly acquired knowledge. Students reported learning 78% more of the material, had twice the fun of a textbook and found the intelligent tutor 30% less difficult than lecture or section. In the second study, student performance was measured. Among many other outstanding results, the median test score was 20% higher for students that used the intelligent tutor than for students that did not.

A tightly-structured teaching-learning environment with integrated incremental instruction and practice can be used effectively in the teaching-learning of any skill, technique or facts that can be succinctly itemized. Further, adding a psychological model of the student along with data mining techniques over the database of stored results provides a new kind of powerful tutor that can be used with many other medical topics as well. Medical informatics is best viewed as a multi-disciplinary pursuit. Empowering physicians with computer science knowledge and integrating medical informatics examples into such instruction can lead to better and more insightful applications of computational technology in medicine.