Framework for distributed special needs education using an agent-based learning environment

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Motivation. Special needs education provides a special challenge to computer science since every user can be radically different from others. Disabilities range from slight to severe, and impairments can be related to sight, hearing, cognition or motor coordination.

It can be impossible for children with severe disabilities to communicate without a computer. For them a computer is essential to convey, transfer and reproduce information and knowledge. As stated in [1], the need for high quality educational software becomes obvious, since sophisticated solutions to special needs education does not exist.

Like the trend in traditional computer-aided education, we are trying to move from a passive teaching machine to an activating learning environment, which provides novel ways to enhance the learning process.

The structure of the framework. The concept *learning environment* can be viewed as a physical space where learning occurs. In this framework, the learning environment consists of networked computers and their users. Users can be students, teachers, occupational therapists, neuropsychologists etc.

The basic idea is to tailor an *agent* for each participant in the learning environment. Here, an agent can be defined as a part of a program that acts on the behalf of the user or, as Russell and Norvig state it [3, p. 33], "an agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors."

This framework is to be used in a normal classroom with one or more teachers and several learners. The environment can be distributed over a local-area network. The framework is designed to support the learning and teaching processes of each individual learner and teacher. One of the goals is to divide the responsibility of the teaching between a computer and a human teacher.

There are customized agents for each learning environment participant. The agents belong to various classes according to environment users. Every learner has his/her own *learner agent*, teacher has his/her *teacher agent* etc. The agents communicate with other agents and modify the teaching and learning processes. Learner agents can, for example, provide exercises and additional material to learners when needed. Other agents, e.g. *neuropsychologist agent* and *therapist agent*, can gather information for corresponding authorities.

The environment is planned to be open so that various topics can be taught and learned by adding a proper module containing exercises and additional materials.

Prototype implementation. The first prototype implementation of the learning environment is for one user, and is used in teaching fundamental mathematics to learners who have difficulties in starting and concentrating on a task. To be more precise, the intended users are persons with *mental programming disorders*. See [4] for more details.

The exercises in the prototype are in a "cube". The cube provides the adaptability in the implementation. Each user are likely to travel a different trail through the cube during the learning session. The trail is dependent on the decisions made in a *decision tree*. The decisions have neuropsychological and pedagogical basis. For example, if the user cannot maintain the motivation to solve a multi-part problem, the decision is to partition the problem and help the learner to achieve a final solution step-by-step. Or, if the learner cannot solve a problem 1+5, the decision could be to present the problem 5+1.

The cube can contain various exercises, i.e. addition, subtraction, multiplication. The cube can easily be replaced by another set of exercises, since the cube is an ASCII-text file. Also the decision tree is replaceable.

The exercises must be hand-code into the cube. The reason for this procedure is that pedagogically sound exercises are almost impossible to create by a computer. Creating exercises manually forces to think the educational basis thoroughly and transfers the responsibility to the pedagogue.

The user interface is designed to be usable with a variety of input devices with accompanying software. The design is done in collaboration with a neuropsychologist and a special pedagogue.

Future research. Admittedly, the framework described above is a demanding scenario and the work is in its early stages. However, the initial prototype is shown to be functional, and the first bridges between different disciplines have been built. The preliminary results from the users of the first implementation are expected to be available within next months.

There are several topics of research in the near future: more sophisticated decision making, shift from a static decision tree to dynamic, adaptivity in the user interface, networking etc. Before the learning environment is of any value, many questions need to be answered. The level of reasonable usability can be achieved by boldly tackling the interdisciplinary challenges.

References

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