Combining intelligent tutoring systems and automatic story generation for personalized tutoring with mobile robots

Type: Master Thesis
Supervisors: Dr. Stéphane Magnenat (stephane@magnenat.net)  
 Fabio Zünd (fzuend@inf.ethz.ch)
External supervisors: Dr. Pierre-Yves Oudeyer, Inria Bordeaux, France  
 Dr. Didier Roy, Inria Bordeaux, France
Professor: Prof. Dr. Robert W. Sumner

Goal

In the last years, we have been teaching programming to children using the Thymio mobile robot (bottom, left) and a visual programming environment (bottom, right). This action has proven successful in schools where children are supported by professional educators. However, at home, children are likely to be left alone facing programming exercises, feel lost, and give up. Recent research results, in learning technologies and video games, provide evidence that artificial intelligence techniques can be used to improve this situation.

The practical goal of this project is to build a tutoring app that provides an engaging experience for children learning programming with the Thymio robot. The scientific goal is to assemble an intelligent tutoring engine that combines a probabilistic approach and adaptive algorithms for automatically generating the story and the levels.

The app should propose a sequence of challenges to the user, in which each challenge trains a certain programming knowledge. To maintain the user in a feeling of flow, the content of the challenges should be adapted in function of her/his progress. At every step, a method called ZPDES can select the knowledge that the learning progress of the user. Then, methods from procedural content creation in video games should build an interesting challenge and integrate it into a consistent story. The result should form a tutorial that provides an engaging and non-repetitive adventure game.

This project will be implemented in Qt-QML and C++, with some minor contributions to the script of the robot. The student should combine recent methods from the state of the art in novel ways and adapt them to the context of the project.
Context

In the last 10 years, EPFL, ETH Zurich, and écal (an art school in Lausanne) have teamed up to develop the Thymio educational robot and related software tools. The Thymio robot (http://thymio.org) is an open source mobile robot, which is employed to teach programming and computer science concepts, both in schools and at home. The Thymio project is successful and 15 000 units have been distributed so far; half of them in schools around the world.

Recent work has focused on developing a mobile version and a gamified adventure based on augmented-reality, called Thymio Programming Adventure (see below). The work of the student will build on the prototype of this mobile version, and will be integrated into a future version of Thymio Programming Adventure, should the developed system prove to be of educational value.

Tasks

1. Structure existing programming exercises into knowledge units w.r.t. concepts to teach.
2. Implement the ZPDES algorithm in the mobile visual programming environment.
3. Deploy a procedural content-creation algorithm to generate on the fly a programming exercise for a given knowledge unit.
4. Integrate this algorithm with a story generation engine such that, for any student, her/his particular sequence of exercises forms a consistent and motivating story.
5. Develop and run, in collaboration with the staff of the Game Technology Center, a user study evaluating the resulting system.

Outcome for the student

At the end of the project, the student will have strengthen her/his knowledge in intelligent tutoring systems, artificial intelligence algorithms, Qt-QML, and C++.

This project is a collaboration with the Flowers Laboratory (http://flowers.inria.fr/) at Inria, Bordeaux, France. This group is a world-leading expert in lifelong learning and development in robots and humans. The student will therefore have the opportunity of experiencing research at an international level during her/his project.

In addition, her/his contribution will be integrated to future Thymio products that will be used by thousands of children worldwide who will, thanks to that contribution, have a higher chance to both have fun and learn programming efficiently.