

# A WEB-BASED PROBLEM SOLVING TOOL FOR INTRODUCTORY COMPUTER SCIENCE

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## ABSTRACT

We present a “Problem Solving Tutor” ([tutor.fi.muni.cz](http://tutor.fi.muni.cz)) – a web-based educational tool for learning through problem solving. The tool contains more than 1 400 problems, mainly introductory programming problems, math and logic puzzles. All problems are interactive and the system gives students immediate feedback on their performance. The tool makes individual predictions of problem solving times and therefore is able to recommend each student a problem of suitable difficulty.

## Categories and Subject Descriptors

K.3.2 [Computing Milieux]: Computers and Education—*Computer and Information Science Education, Computer science education*

## General Terms

Human Factors

## Keywords

Problem solving, intelligent tutoring systems, computer science education

## 1. MAIN APPROACH

For efficient learning it is important to respect individual learning pace. Difficult problems may be frustrating, easy problems boring. Our Tutor makes learning individualized. It uses machine learning algorithms to predict solving times for every student (see [1]). Based on these predictions, the Tutor recommends problems for further solving.

When students finish a solving task the Tutor displays an immediate feedback – their solving time and comparison with others. Moreover for each problem set students gather “learning points”, which reflects number and difficulty of successfully finished problems.

Compared to usual intelligent tutoring systems, our system is easy to extend with new problems. Problem ordering

and recommendations are done automatically by machine learning techniques and thus it is not necessary to use human experts.

## 2. PROBLEMS

The Tutor is an online application, therefore all problems run in a web browser and do not require any installation. To make learning topics more attractive, all problems are interactive. This means, that students do not only fill in a multiple choice test, but they usually have to widely interact with a learning environment to solve a presented task. We believe that a good problem solving formulation can make even less interesting topics (like learning binary numbers) quite entertaining.

Currently, the Tutor contains 20 different problem sets (more than 1 400 individual problems). Eight problem sets are directly oriented on computer science education. Particularly popular are robot programming problems, where students have to program a robot to perform a particular task. These problems have very simple syntax and semantics, yet can provide challenging problems which illustrate important concepts (particularly recursion). Other computer science problems include “programming by selection” in C and Python, data filtering by regular expressions, and binary numbers crosswords.

## 3. APPLICATION

The Tutor provides two modes. In an individual mode, students may pass through all problem sets and compete with other students for the best results. In a class mode, teachers can create a virtual class for their students. Students then solve problem sets chosen by their teacher and teachers can see detailed statistics of their students. Based on these statistics, teachers can suitably target their behavior in a real class – focusing on problems with which students struggled the most or helping specific students.

The Tutor was launched in March 2011 and is already used by more than 5 500 users who have spent more than 8 200 hours by problem solving and solved more than 260 000 problem instances. The Tutor is used both at introductory university courses and at more than 20 high schools in information technology lessons.

## 4. REFERENCES

- [1] P. Jarušek and R. Pelánek. Analysis of a Simple Model of Problem Solving Times. In *11th International Conference on Intelligent Tutoring Systems*, 2012. To appear.

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