

Designing a Data-Driven Tutor Authoring Tool for CS Educators

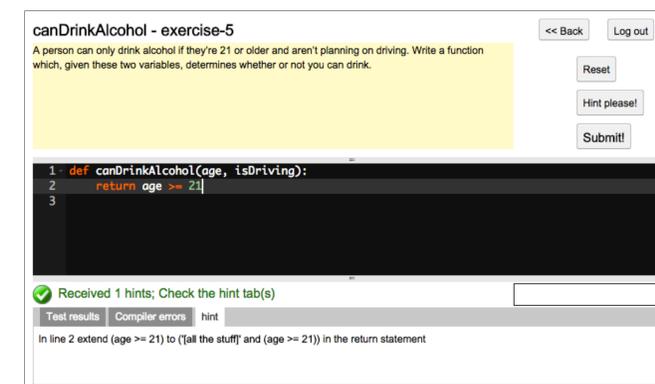
Kelly Rivers

Human-Computer Interaction Institute, Carnegie Mellon University

This work was supported in part by Graduate Training Grant awarded to Carnegie Mellon University by the Department of Education (# R305B090023).

SUMMARY

Intelligent Tutoring Systems are highly effective at helping students learn, but have required intensive amounts of development time in the past, keeping teachers from making their own. Data-driven tutoring has made it possible to build these tutors more efficiently. For my thesis work, I intend to extend my work on ITAP, the Intelligent Teaching Assistant for Programming, to build an authoring tool for data-driven tutors, designed for computer science teachers. I plan to design this system based on data gathered in interviews with CS educators and evaluate it on its usability and the effectiveness of the tutors it generates.



A screenshot of the current state of ITAP, demonstrating the hint provided for a given programming state.

CONTEXT & RESEARCH QUESTIONS

Code-writing is one of the essential skills that student programmers need to learn in CS1, and students often get the chance to practice this skill by completing practice problems. However, support for these practice problems tends to be minimal; students can get test-case feedback to show them what they're doing wrong, but if they need help figuring out what to do next, they need to reach out to their teacher. Teachers may be interested in using and developing technology which can provide help to students when they do not have enough time to reach out to the whole class. Therefore, my main research question is: **will CS teachers use more adaptive practice problems in their classes if they have the ability to create the content themselves?** In addition to this, I also plan to investigate what kinds of practice code-writing problems teachers want to make, how these relate to CSED best practices, and what usability concerns need to be addressed in an authoring tool for programming tutors.

PROGRAM CONTEXT

I am beginning my 5th year as a PhD student studying Human Computer Interaction (with a focus in learning science) at Carnegie Mellon University. I have spent the past four years meeting program requirements and developing ITAP (the Intelligent Teaching Assistant for Programming) alongside my advisor, Ken Koedinger. I plan to propose my thesis in late 2015 and defend sometime in 2016/2017.

PREVIOUS WORK

I have designed a tool to automatically generate data-driven programming tutors using naturally occurring data. This system creates a solution space that any given student can be placed. Then it creates a path from the student's state to the nearest correct solution using the differences between the states. These differences become the components of the constructed hint message.

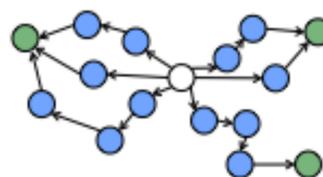
EXPECTED CONTRIBUTIONS

At the conclusion of my thesis, I plan to have developed an online authoring tool which teachers can use to create their own data-driven Python programming tutors. I hope to use my findings from my primary research questions to determine how much personalization should be available within such a system, and how much should be pre-created problems and curricula.

RESEARCH PHASES

For my thesis, I plan to pursue three primary research phases:

- 1) Needs-finding:** Determine what the needs of CS teachers currently are (for finding & creating practice problems).
- 2) Development:** Extend ITAP to create an authoring tool for data-driven programming tutors in an online environment.
- 3) Evaluation:** Perform a usability evaluation with CS educators to test the authoring tool and the resulting tutors.



This shows an example solution space used to find paths from start state (white) to end state (green)

RESEARCH METHODOLOGY

For the first research phase, I plan to use interviews and surveys to find the teacher's needs, and to survey the literature to establish the context that code-writing problems are used in. In the second phase I'll use iterative design to test the authoring tool with CS teachers throughout development. In the final phase I'll conduct traditional usability evaluations and will also collect data from tutor use in classrooms to determine the educational effectiveness of the tool.