A Tutoring System for Red Black Trees

SIGCSE Special Project Grant
End-of-Project Report
Chun Wai Liew
Department of Computer Science
Lafayette College
Easton, PA 18042
liewc@lafayette.edu

Introduction

The goal of the project is to develop a web based tutoring system to teach the construction/insertion and deletion algorithms for red black trees. Specifically, we wish to teach the top-down insertion and deletion algorithms. We found that current textbooks, online resources including animations of tree algorithms are insufficient and in the case of online tutorials provide incorrect information for the students to effectively learn the algorithms. The online resources primarily focus on the mechanics of the tree transformations (e.g., single rotation, double rotation) but our studies have shown that students most frequently have troubles with determining when the transformations are to be applied, i.e., recognizing the appropriate preconditions.

Funding

The grant from SIGCSE was used to fund a student for one year. Lafayette College provided additional funding for a second student.

Results

The project was very successful. We designed and implemented a web based tutoring system for red black trees. The tutoring system has been used by three instructors over four semesters. We have also extended the system to administer online tests and automatically grade the student answers. The student performance has been analyzed with a Bayesian student model that we developed.

The results have been reported at various conferences:

1. *Using Student Logs to Build Bayesian Models of Student Knowledge and Skills* H. Nguyen and C.W. Liew. Proceedings of the International Conference on Educational Data Mining (July 2018)

2. *Determining What The Student Understands - Assessment In An Unscaffolded Environment* C.W. Liew and H. Nguyen. Proceedings of the International Conference on Intelligent Tutoring Systems (June 2018)

3. *Building Student Models in a Non-Scaffolded Testing Environment* H. Nguyen and C.W. Liew. Proceedings of the International Conference on Intelligent Tutoring Systems (June 2018)

4. *Assessing Student Answers to Balanced Tree Problems* C. W. Liew, Huy Nguyen and Darren Norton. Proceedings of International Conference on Artificial Intelligence in Education (June 2017)

The software is available for general use. Interested parties should contact *liewc@lafayette.edu* to create student accounts and materials (questions) tailored for their particular needs.