Structured Hypermedia Algorithm Explanation System

Dr. Tomasz Müldner :: Dr. Elhadi Shakshuki :: Dr. Hassouna Moussa
Mr. Tuan Vu :: Mr. Sun Yibo

ACADIA UNIVERSITY

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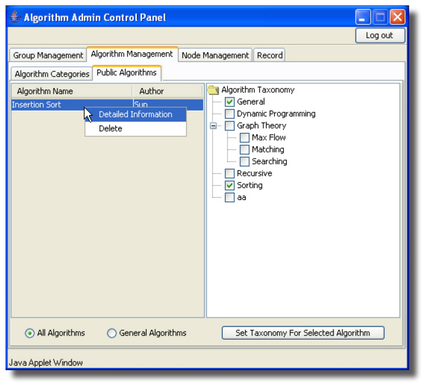
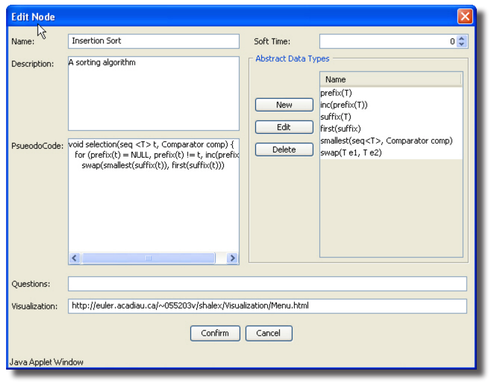
Introduction

Algorithm visualization aims to facilitate the understanding of algorithms by using graphics and animation to reify the execution of an algorithm on selected input data. However, the pedagogical potential of visualization is lessened if irrelevant objects are included in the visualization, or if essential properties of the algorithm, such as invariants, are left out. In addition, many current visualization techniques tend to present the algorithm at a single level of abstraction, which has been shown to be less effective than if the visualization occurs at various levels of generality.

This project shows a novel approach to explaining algorithms using multi-level abstractions. Each abstraction explains a single operation and provides the textual and graphical representation of this operation. Visual representation is used by students to help them understand the basic properties of this abstraction; for example, invariants of the selection sort. Textual representation uses operations explained at lower levels of abstraction. This way the learner can focus on understanding of just one operation at a time.



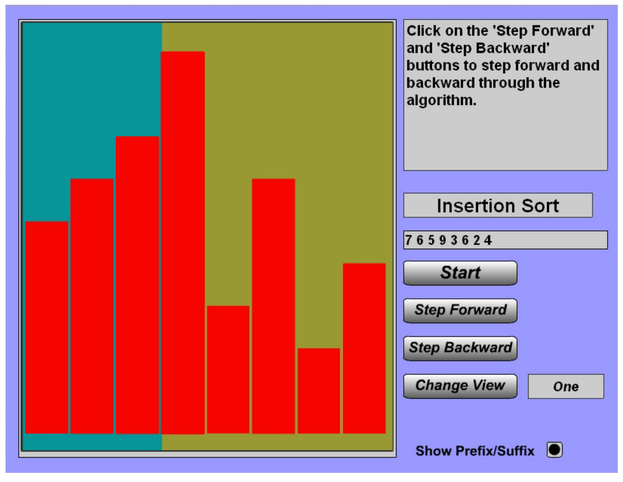


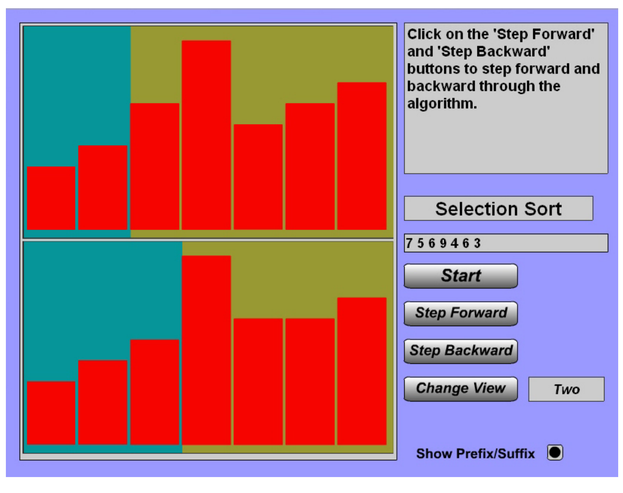
Methods

The main objectives of our approach are achieved by representing the algorithm as a hierarchy of abstractions. Each abstraction within the hierarchy focuses on explaining a single operation, and contains two types of explanations: a textual representation using the Abstract Data Type associated with this abstraction, and a graphical visualization of the operation represented by this abstraction. Some operations are left as primitives. Rather than attempting to explain primitives, the proposed system provides an abstract implementation of these operations that allow users to easily map these abstractions to various programming languages.

SHALEX supports active learning through interactions with users, for example by posing various questions about the algorithm to the user, along with a "do-it-yourself" mode which provides the user with means of testing their understanding of the given algorithm by having them attempt to explain it. In addition, SHALEX provides various tools to help the user gain an understanding of the time complexity.

In this project we developed a Structured Hypermedia Algorithm Explanation System called SHALEX. The system is based on a novel approach to explaining algorithms, using a structured, adaptive, web-based system available through any browser. Instructors can create explanations of algorithms, and students can study algorithms that have been assigned to them.

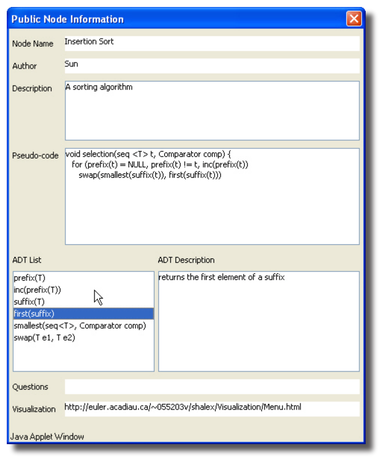


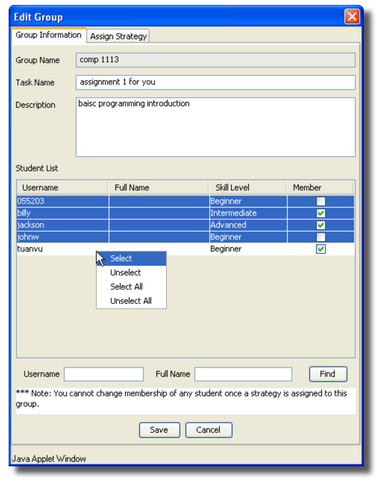


Finished Project

SHALEX has been implemented as a distributed application based on client/server architecture. A user can use any browser to open the SHALEX applet that communicates with servlets on Apache Tomcat server using http request protocol. All information is persistent, i.e. it is saved in a database on the server in a native XML, Extensible Markup Language format, database (e.g. eXist). The system is implemented with four main roles, including administrator, algorithm administrator, author and student.

Our future work will concentrates on adding hypertext links, providing adaptability using a student model, software agents, and finally testing this system at Acadia University and University of Kaiserslautern, Germany.





Analysis

The study of algorithms is an important component of undergraduate education in computer science. However, it proves to be one of the most difficult areas for students to master, in large part due to the abstract nature of the subject matter. Our project should prove to be an effective algorithm explanation tool that would assist students to gain an understanding of the working of algorithms. Some specific benefits are:

- ☐ Creation of an easy to use tool for learning algorithms.
- ☐ Creation of a test bed for research into educational environments.
- ☐ Providing the students with the opportunity to interact with other users and learn about the development process of algorithm explanations.