Data Structures and Algorithms in Pen-based Computing Environmentsr

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Abstract

Data structure visualization (or animation) has been studied for more than twenty years, though existing systems have not gained wide acceptance in the classroom by students and their instructors. The main reason is that animation preparation is too time consuming. A more technical reason is that when a particular data structure is encoded into an animation, it does not have the flexibility often needed in a classroom setting. There is also a pedagogical reason: a number of prior studies have found that using algorithm visualization in a classroom had no significant effect on student's performance. We believe that the Tablet PC, empowered by digital ink, will challenge the current boundaries imposed upon algorithm animation. One of the potential advantages of this new technology is that it allows the expression and exchange of ideas in an interactive environment using sketch based interfaces. In this paper we discuss teaching and learning Tablet PC based environment in which students using a stylus would draw a particular instance of a data structure and then invoke an algorithm to animate over this data structure. A completely natural way of drawing using a digital pen will generate a data structure model, which (once it is checked for correctness) will serve as a basis for execution of various computational algorithms.

1 Introduction

We are entering a new era of teaching, learning and computing. With an abundance of useful information available on any subject, anywhere, anytime, and on any device, the challenge (faced by all us, the educators) is to create a teaching/learning environment that is mobile, smart, personable, and easy to use. Next generation's learning tools will require that we receive only the information we need at the right time. Future applications will also require natural interfaces that allow students (as well as instructors) to interact with any computing device with ease. The time for having "problem solving environments" in the classroom has emerged. A problem solving environment is an integrated computational system for solving problems in a specific application domain [1]. Such environments, in general, should enable the user to input and work on problems in a manner that is natural to the problem domain. The animation data structures and algorithms integrated with a natural pen-based interface is one of the most valuable environments in the classroom setting. Intuitively we, the computer science educators, believe that algorithm animation is helpful in teaching advanced computer science concepts. Students often study in either of the following two distinct modes according to their cognitive learning style. The first study mode is the initial learning of an algorithm and the associated data structure. In this mode students simply step through an algorithm to attain a preliminary grasp of the algorithm. This process of learning can be supported either by textual algorithm description or graphical algorithm animation. Some studies [2] have shown little improvement in student performance (mostly on analytical questions) due to the use of animations in teaching data structures and algorithms. Another study [3] has shown that simply viewing animation in a classroom setting did not significantly improve students' understanding. The second study mode is when students are active participants of the learning process. An example of this study mode is when students test themselves in preparation for an exam. In this mode a data structure visualization system must provide a high level of interactivity. It would be most helpful for students to have a system that will automatically verify the correctness of the student's manual algorithm execution. Although algorithm animation has been studied for more than twenty years, the systems that have been proposed have not gained

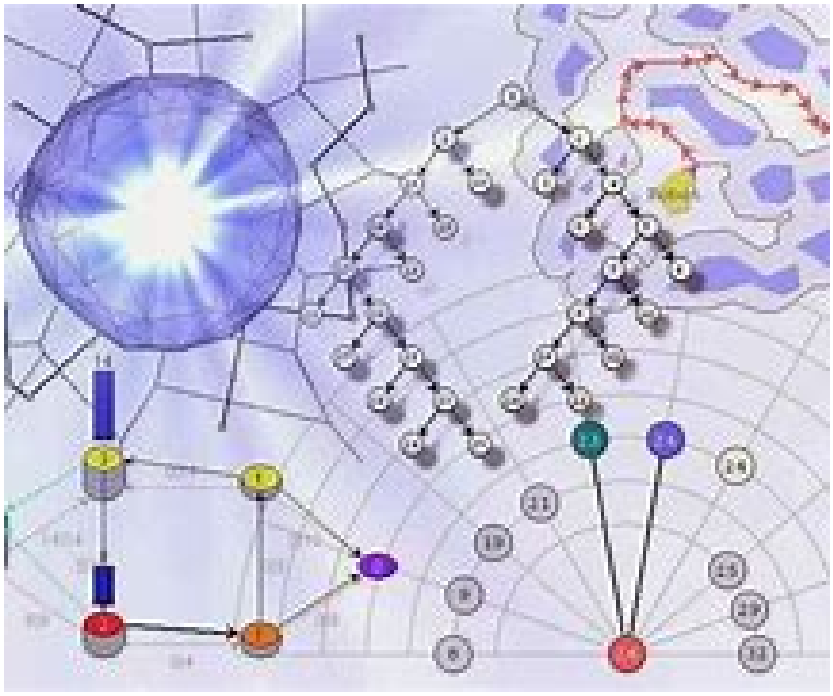

Figure 1: Data Structure and Algorithm

a wide acceptance in the classroom by students and their instructors. The reason is that most of the evaluations indicate that algorithm animation has no significant effect when students are just observers. We all know that students must be mentally engaged in order to learn. Therefore, we strongly believe that any new electronic educational technology integrated with a Tablet PC environment will have a fundamental influence on education in general. One of the principal aims of our study is to investigate the suitability of a Tablet PC environment in teaching data structures and algorithms. In this environment sketching is an integral part of computer science exploration. It allows the expression and exchange of ideas in a highly interactive atmosphere. Using the pen-based gesture interface, we will promote students' intuition for problem solving and algorithmic thinking. .

2 Categories and Subject Descriptors

H.5.3 [Group and Organization Interfaces]: User Group and Organization Interfaces – collaborative computing. K.3.1 [Computers and Education]: Computer Uses in Education – collaborative learning, computer-assisted instruction. General Terms Algorithms, Visualization, Design, Human Factors, Keywords Programming education, natural interfaces

sub	roll
DS	82
OOP	80
Eelectronics	87
English	90
EEE	90
ICT	90
Physics	90
Chemistry	90
Biology	90

3 Mathematics

$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3 \tag{1}$$

4 References List

[1] From "Computer as Thinker/Doer: Problem-Solving Environments for Computational Science" by S. Gallopoulos, E. Houstis and J. Rice (IEEE Computational Science and Engineering, Summer 1994).

[2] J. Stasko, A. Badre, C. Lewis, Do Algorithm Animations Assist Learning? An Empirical Study and Analysis, Proceedings of the ITERCHI Conference

[1] From "Computer as Thinker/Doer: Problem-Solving Environments for Computational Science" by S. Gallopoulos, E. Houstis and J. Rice (IEEE Computational Science and Engineering, Summer 1994).

[2] J. Stasko, A. Badre, C. Lewis, Do Algorithm Animations Assist Learning? An Empirical Study and Analysis, Proceedings of the ITERCHI Conference.