Preface

This thesis describes a new approach to the generation of algorithmic animations for computer science education. Two different rendering platforms are used for the animations: the first is an electronic chalkboard in which the user enters data and starts computations by using handwritten symbols and letters; the second is a de-facto standard high quality animation engine for the Web, i.e. Macromedia's Flash.

The animations described in this thesis are produced by generating commands in a special script language which I have called *Flashdance*. The commands are interpreted by one of my animation engines: *Chalk Animator* is the animation engine I wrote for the electronic chalk system (E-Chalk); Flashdance is the name of the animation interpreter I wrote for Macromedia Flash (the interpreter and the script language share the same name). Animation files can be played on any of these two platforms.

E-Chalk Animator is the first algorithmic animation system able to process handwritten and sketched input. An instructor can explain an algorithm using an electronic blackboard, sketch a graph or write numbers, which are then consumed as input for the algorithm. The algorithm is animated directly on the E-Chalk board. In this thesis, I explain how to adapt a handwriting recognizer to the recognition of computer code, so that an instructor can execute the code he or she just wrote in the electronic blackboard. In the future, pseudocode will be also recognizable and will be executed on the fly.

Flashdance is the first algorithmic animation system based on a standard animation engine. By adopting Flash, the interpreter of the script language can be reduced to its essential algorithmic features, the animations are portable, and they can be viewed on the Web. The graphic rendering is of high quality. This thesis introduces also the concept of overlays in algorithmic animations, providing additional information layers for the viewer.

The thesis contains some other secondary contributions such as a new visualization method for heaps, examples of high-quality hand-crafted algorithmic animations of sorting algorithms, and an example of a full Web production about linked data structures. All features of the animation system were extensively tested by producing animations of algorithms for sorting, hashing, combinatory, graphs, and many other topics.

The animations described in this thesis have been successfully used in the classroom, both at the Freie Universität Berlin, and at two Technical Colleges (Berlin and Kiel), and even in a seminar at Princeton University. The interpreter for Flash animations was used by students learning to program in C during the winter term of 2003 in Kiel. They could produce their own animations with minimal overhead.

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Prof. Dr. Klaus-Dieter Graf kindly adopted me as one of his assistants after my first contract expired. I could then continue my research on algorithmic animation in his computer science education group which allowed me to finish this thesis.

I am greatly indebted to the E-Chalk team for having developed the tools and interfaces needed for my animation system. Lars Knipping extended E-Chalk with a macro execution capability and defined the API needed for coupling external applications to E-Chalk. Gerald Friedland provided help, advice, and information regarding the E-Chalk internals. Ernesto Tapia wrote the handwriting recognizer used as front-end for my small BASIC interpreter. Prof. Dr. Raul Rojas, leader of the E-Chalk team, provided the original impulse behind the E-Chalk project and its interface for external applications.

Fachhochschule Kiel supported me during the last period of my work with a scholarship for development of women faculty. I am grateful to this institution for its support.

The thesis was written in Berlin, at the Free University, which has been the center of my activity for several years. With this thesis I expect to give something back to the Computer Science Department and to my colleagues. I hope they enjoy my animations.