Lecture Notes in Computer Science

Edited by G. Goos and J. Hartmanis

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P. Gorny M.J. Tauber (Eds.)

Visualization in Human-Computer Interaction

7th Interdisciplinary Workshop on
Informatics and Psychology
Schärding, Austria, May 24–27, 1988
Selected Contributions

Springer-Verlag
Berlin Heidelberg New York London
Paris Tokyo Hong Kong Barcelona

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CR Subject Classification (1987): B.4.2, H.1.2, D.2.2, J.4

ISBN 3-540-52698-6 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-52698-6 Springer-Verlag New York Berlin Heidelberg

Printing and binding: Druckhaus Beltz, Hemsbach/Bergstr.
2145/3140-543210 – Printed on acid-free paper

Preface

This volume presents a selection of the contributions to the Seventh Workshop on Informatics and Psychology at Schärding, Austria, May 1988. The theme of the workshop was Visualization in Human-Computer Interaction. The workshop was organized by the Austrian Computer Society (OCG) in cooperation with the German Chapter of the ACM.

Visualization is nowaday recognized as an important aspect of user-oriented human-computer interfaces. Both informatics and psychology are concerned with this topic. Informatics on one side is working on the technology which makes visualization and interaction based on visual concepts feasible. However, there is another important trend in informatics: the development of prototypical solutions. Visual programming, visual languages, graphical interfaces, visual representations and many other keywords characterize the current efforts in this field. Psychology on the other side is working on the question of how people represent knowledge visually and how they can take advantage of visual representations when solving tasks.

The contributions to the book address the problem of visualization from different point of views. Brandenburg discusses the computational problem of constructing nice graphs from a theoretical viewpoint. The paper of Mahling et al. demonstrates the value of visualization for expressing semantics of the problem domain in a powerful way. Fehrle et al. show how visual representations of knowledge can be generated in the context of an advice-giving system. The following papers (Riekert, Möbus/Schröder, Polak/Guest, Schneider-Hufschmidt) give examples of how visualization supports a better understanding of complex structures and processes. The example systems visualize the complex structure of an object-oriented representation of knowledge (Riekert), a functional language (Möbus/Schröder), how PROLOG works (Polak/Guest), and processes like tracing and stepping in an object-oriented programming environment (Schneider-Hufschmidt). The next two papers present application systems which are centered around a visual representation of the application domain (Anghern et al., Pejtersen/Goodstein). Psychological aspects are discussed by Kunkel/Strothotte, van der Veer/Wijk, and Preece. Gimnich presents a data model for a direct manipulation interface to databases. Harrison/Dix discuss a formal model that expresses the relation between conceptual states and display states and allows the definition of concepts like visibility, observability, and direct manipulation in a strong way. Viereck's paper is concerned with a software engineering approach to the development of human-computer interfaces.

The workshop was the tenth in the series of workshops on informatics and psychology. In the course of a celebration of this event, Milos Lansky, who was one of the initiators of these workshops, was invited to give a talk on his current work on doing intrinsic geometry with a turtle graphic language like LOGO. His paper is the last in this volume.

The editors have refrained from giving a survey of a very important part of the Schärding workshop: the discussions which traditionally occupy about half of the program. We would like to thank all participants who have contributed to these discussions with their ideas and experiences.

Finally, we express our gratitude to two institutions on either side of the Austrian/German border: to the University of Passau for the support of the workshop and to the town of Schärding for being an excellent host for the conference.

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Nice Drawings of Graphs are Computationally Hard

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Abstract

How to draw a graph? And more importantly, how to draw it nicely? As a formal approach to this problem we propose graph embeddings. A graph embedding is a mapping from a guest graph into a host graph. Graph embeddings are very rich in their descriptive capabilities. These should suffice to capture all instances from real applications in an appropriate way. Graph embeddings offer various parameters for optimizations, which are used to describe aesthetics in a formal and uniform way. Thus, we measure the niceness of a drawing by the values of its aesthetic parameters, such as area, width, expansion, maximal and total edge length, or non-planarity. However, in this general framework and from an algorithmic point of view optimal embeddings or equivalently nice drawings of graphs are intractable. In general, they are NP-complete, which means that one must pay for nice drawings with a high computational effort. This fact holds even for trees. To the contrary, there are drawings of trees which satisfy the upper and lower bounds up to some constant factor and are computable in polynomial time.

1. Introduction

Abstraction is an important human capability, and by the process of abstraction one can model complex real world situations and get a simplified view. There are many levels of abstraction depending on the complexity of the real world situations, on the intellectual capabilities of the individual observer and on his tools for an abstract description. Let us restrict our view to situations in computer science and engineering and to a very high level of abstraction, where we model a piece of reality by diagrammatic representations consisting only of points and curves. All other features are ignored or, if necessary, they can be added to our model in terms of labels attached to the points and the curves. For example, on a plan showing existing and non-existing flight connections, cities become points which are pairwise connected by straight lines iff there is a direct connection between