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Daniel Hernández

Qualitative Representation of Spatial Knowledge

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Preface

Cognitive spatial concepts are *qualitative* in nature, i.e., they are based not so much on exact quantities but on comparisons between perceived magnitudes. We develop a qualitative model for the representation of spatial knowledge (in particular, of positional information about 2-dimensional projections) that is based only on locative relations between the objects involved, does not need a global scale, and takes different kinds of reference frames into consideration. The resulting model is both cognitively plausible and computationally efficient.

The core of the book is the study of qualitative inference methods. We extend constraint reasoning mechanisms to take the rich structure of physical space into consideration, and describe methods to transform among reference frames and for the composition of relations. We also sketch extensions of the qualitative approach to represent positional information in 3-D scenes, as well as other spatial concepts such as size, shape, and distance.

Qualitative representations make only as many distinctions as necessary to identify objects, events, situations, etc. in a given context (recognition task) as opposed to those needed to fully reconstruct a situation (reconstruction task). Thus, they can be used in many application areas from everyday life in which spatial knowledge plays a role, particularly in those that are characterized by uncertain and incomplete knowledge, such as computer aided systems for architectural design, geographical information systems, but also robot control or natural language information systems to give directions.

This book is a revised version of a dissertation submitted to the *Institut für Informatik* (Department of Computer Science) of the *Technische Universität München* (Munich, Germany) in December of 1992. In the meantime, interest in qualitative models of space has multiplied as reflected by several recent workshops and conference sections on the subject (QUARDET 93, COSIT 93, IJCAI 93, KI-93).¹ Taking all of these new developments fully into account is impossible within the time allotted for revision, and without a complete rewrite of several parts of the text. However, I have tried to compile the references to newer published work in the bibliography, and to point to them in the appropriate sections.

I am indebted to Wilfried Brauer and Christopher Habel for their guidance

¹Proceedings edited by Piera Carreté and Singh (1993), Frank and Campari (1993), Anger, Guesgen, and van Benthem (1993), and Hernández (1993c) respectively.

and support. Christian Freksa's insights inspired much of this work. The former and present members of the AI/Cognition Group provided the academic and computing environment that made this book possible. My colleagues Martin Eldracher, Margit Kinder, and Gerhard Weiß took much of the administrative burden from my shoulders during the final phase of this work. I had many fruitful discussions with Stephan Högg, Irmgard Schwarzer, and Kai Zimmermann. Daniel Kobler contributed through his own research work, through detailed proofreading of draft versions, and with clever $\text{\TeX}$ -macros to draw the icons of many tables. Viola Krings made an excellent job drawing some of the figures and tables. I want to thank Christopher Habel's group at the Universität Hamburg, particularly Simone Pribbenow, Ralf Röhrig, Rolf Sander, and Christoph Schlieder, and Josef Schneeberger (TH Darmstadt) for their critical interest in my work. Finally, I would like to express my appreciation for the hints provided by the anonymous reviewers, the help and patience of the editorial staff at Springer, and the many other people who contributed in various forms to the completion of this book.

February 1994

Daniel Hernández

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