Spatial Cognition

An Interdisciplinary Approach to Representing and Processing Spatial Knowledge
Preface

Research on spatial cognition is a rapidly evolving interdisciplinary enterprise for the study of spatial representations and cognitive spatial processes, be they real or abstract, human or machine. Spatial cognition brings together a variety of research methodologies: empirical investigations on human and animal orientation and navigation; studies of communicating spatial knowledge using language and graphical or other pictorial means; the development of formal models for representing and processing spatial knowledge; and computer implementations to solve spatial problems, to simulate human or animal orientation and navigation behavior, or to reproduce spatial communication patterns.

These approaches can interact in interesting and useful ways: Results from empirical studies call for formal explanations both of the underlying memory structures and of the processes operating upon them; we can develop and implement operational computer models obeying the relationships between objects and events described by the formal models; we can empirically test the computer models under a variety of conditions, and we can compare the results to the results from the human or animal experiments. A disagreement between these results can provide useful indications towards the refinement of the models.

The insight we gain in doing basic research on spatial cognition has a potential towards a great variety of applications. Without understanding human spatial cognition we will not be able to develop appropriate technology and interfaces for spatial information systems that communicate with humans by language and graphics in natural and efficient ways. Autonomous robots finding their ways in an unknown environment require abilities to infer locations of objects from incomplete and qualitative information from various sources and to follow imprecise instructions much like human beings. To use maps and other diagrams for the communication with computers we must understand how people generate and interpret them. To fully exploit the potential of virtual reality technology we must adapt its capabilities to human conceptions of space. To develop computers programmed by spatial structures rather than by sequential instructions we must more fully understand the relevant aspects of space.

In 1996, the Deutsche Forschungsgemeinschaft (DFG) established a priority program on spatial cognition to promote interdisciplinary research in this field. Fifteen research projects at thirteen research institutions across Germany cooperate in this program. In Fall 1997, a colloquium was held at the University of Trier. Fifteen projects from the priority program, two thematically related projects from other DFG programs, and five invited experts from other countries presented and discussed their work. After the discussions at the colloquium, the contributions were revised and underwent an anonymous reviewing and revision procedure. The resulting papers are collected in this volume.

The volume consists of 22 contributions and is structured into three sections: Spatial knowledge acquisition and spatial memory, Formal and linguistic models, and Navigation in real and virtual worlds. The first section consists of contribu-
tions describing empirical investigations and representations derived from such
investigations; knowledge acquisition, memory organization, and spatial refer-
ence systems are addressed. The second section presents formal approaches to
structuring spatial knowledge; the connection between language and spatial con-
cepts and the formal organization of spatial concepts are addressed in this sec-
tion. The third section brings together empirical and application-oriented views
of navigation; the connections to robotics on one hand and to virtual reality on
the other hand are addressed here.

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