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Preface

The term "Embodied Artificial Intelligence" designates a rapidly growing, highly interdisciplinary field, uniting researchers from areas as diverse as engineering, philosophy, psychology, computer science, biology, neuroscience, biomechanics, material science, and linguistics. What motivates these researchers to cooperate is the common interest in intelligence, in particular the development of intelligent machines. Another unifying characteristic of the field is the conviction that intelligence must be embodied, must be conceived of in terms of physical agents – biological or artificial – behaving in a real physical and social world. Given this perspective, most of the work involves the design and construction of robots or other kinds of artifacts.

The reason for the very strong transdisciplinary nature of "Embodied Artificial Intelligence" is that intelligence, especially embodied intelligence, is to do with behavior, with real-world interaction, and because we are dealing with physical agents there are many aspects and components involved: materials, morphology, sensors, actuators, energy supply, control, planning, cognition, and perhaps even consciousness. This makes the study of embodied intelligence truly challenging but it is precisely what makes the subject area so unique and fascinating.

In this book we provide a representative collection of papers written by the leading researchers in the field who attended a seminar on "Embodied Artificial Intelligence", held at Schloss Dagstuhl, Germany, July 7–11, 2003. The contributions are all interdisciplinary in nature and are targeted at an interdisciplinary audience. As far as possible, they avoid scientific jargon and do not contain unnecessary technical detail. The authors were all asked to critically review the state-of-the-art in their particular domain, to elaborate the basic principles, and to describe what they consider to be research challenges for the coming years. This gives the book also a certain tutorial flavor so that it can be used for classes as additional reading material.

The first part of the book, "Philosophical and Conceptual Issues", tries to uncover the basic characteristics of "Embodied Artificial Intelligence", and discusses a number of deep issues related to high-level cognition, abstract thinking, and consciousness in an embodied system. How the contributions to this volume are situated within the field is discussed in the overview article on "Embodied Artificial Intelligence – Trends and Challenges". The papers in the second part, "Information, Dynamics, Morphology", deal with one of the basic principles of embodiment, namely the trade-offs and task distributions between morphology, materials, control (computation), and system-environment interaction, or, in other words, with the information theoretic aspects of embodiment. This contrasts with the more standard way of conceptualizing, embodiment, i.e., in physical terms (inertia, forces, torques, control, energy dissipation), thereby largely ignoring the information theoretic implications. The section on "Principles

of Embodiment for Real-World Applications" explores how neural systems can be embodied to enable interactions with the real world, and describes a number of cutting-edge applications to the design of robotic arms, hands, and robots moving in the real world. The collection of papers under the heading "Developmental Approaches" all share the vision of mimicking, one way or another, developmental processes of biological systems, and/or they attempt to achieve technological solutions by imitating aspects of development typically using humanoid robots. Finally, "Artificial Evolution and Self-reconfiguration" deals with "population thinking" and discusses on the one hand automated design methods by drawing inspiration from nature, where, in contrast to the usual evolutionary approaches, developmental processes are taken into account; on the other hand, principles of self-reconfiguration are discussed not only in simulation but in the real world.

We would like to thank all of the participants of the seminar, the authors, and the reviewers for their excellent contributions to this volume. We would also like to express our thanks to Prof. Reinhard Wilhelm, the scientific director of the International Conference and Research Center for Computer Science in Schloss Dagstuhl, who suggested that we organize a workshop on "Embodied Artificial Intelligence", and to the organizers of this center for their continuous and professional support of the seminar. Credit also goes to the Executive Editor of the Springer series LNCS/LNAI, Alfred Hofmann, for his helpful comments and support of this publication project.

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