
Preface

In a nutshell, Organic Computing is a research field emerging around the conviction that problems of organization in complex systems in computer science, telecommunications, neurobiology, molecular biology, ethology, and possibly even sociology can be tackled scientifically in a unified way, by means of which progress in understanding aspects of organization in either field can be fruitful in the others. From the computer science point of view, the apparent ease with which living systems solve computationally difficult problems makes it inevitable to adopt strategies observed in nature for creating information processing machinery.

As an idea whose time simply has come, Organic Computing is growing from multiple roots. In November 2001, a Symposium “Organic Computing – Towards Structured Design of Processes” was held at the Heinz Nixdorf Museum in Paderborn, Germany, bringing together computer scientists and biologists to pursue the idea. Independently, the Technical Informatics Branch of the German Computer Science Society (GI) developed the concept in a series of workshops in 2002. The scope was broadened by the Organic Computing Initiative of GI at a workshop in Hannover in 2003, which outlined the scope of today’s Organic Computing research. As a third root on the industrial side, Forrester Research presented a study in 2002, which proposed Organic IT as a strategy for information systems infrastructure.

In the meantime, Organic Computing is a powerful driving force for a whole spectrum of research. Most visibly in terms of academic funding, in fall 2004, the DFG issued a call for proposals for a priority program on Organic Computing, which started with 18 projects in August 2005 and is currently in its second phase. In January 2006, there was a first Dagstuhl seminar, which also attracted participants from overseas, a second one is scheduled for the spring of 2008.

In this book the major ideas behind Organic Computing are delineated, together with a sparse sample of computational projects undertaken in this new field. Many more can be found at the homepage of the Deutsche Forschungsgemeinschaft (DFG) priority research program 1183 “Organic Computing” at

<http://www.organic-computing.de/spp> and the rapidly growing literature list at <http://kbs.cs.tu-berlin.de/~parzy/oclc/>.

To set the stage for the chapters to come I give an incomplete list of biological metaphors used in Organic Computing and show for each chapter which ones are applied and what applications are tackled. These metaphors include *evolution*, *neural networks*, *gene-regulatory networks*, *networks of brain modules*, *hormone system*, *insect swarms*, and *ant colonies*.

Chapter 1 is an introduction to goals and ideas, chapters 2 through 5 lay the theoretical foundations of Organic Computing. Chapter 6 describes the importance of the evolutionary metaphor together with modern developments in evolutionary optimization. Chapter 7 combines evolutionary approaches with neural network learning. Chapters 8 and 9 build on ontogenesis for system construction, with cross-references to neural networks. Chapters 10 and 11 use metaphors of insect swarms for applications in networking. Chapters 12 and 13 use procedures gleaned from the workings of the hormone system for networking applications. Finally, chapters 14 and 15 look at neural networks and interaction of modules in the mammalian brain for applications in computer vision.

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