

UNDERSTANDING
COMPLEX SYSTEMS

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COMPLEXITY

Rolf P. Würtz
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Organic Computing



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Organic Computing Understanding Complex Systems

Octavian Iordache



Organic Computing Understanding Complex Systems:

Organic Computing — A Paradigm Shift for Complex Systems Christian Müller-Schloer, Hartmut Schmeck, Theo Ungerer, 2011-04-29 Organic Computing has emerged as a challenging vision for future information processing systems Its basis is the insight that we will increasingly be surrounded by and depend on large collections of autonomous systems which are equipped with sensors and actuators aware of their environment communicating freely and organising themselves in order to perform actions and services required by the users These networks of intelligent systems surrounding us open fascinating application areas and at the same time bear the problem of their controllability Hence we have to construct such systems as robust safe flexible and trustworthy as possible In particular a strong orientation towards human needs as opposed to a pure implementation of the technically possible seems absolutely central The technical systems which can achieve these goals will have to exhibit life like or organic properties Organic Computing Systems adapt dynamically to their current environmental conditions In order to cope with unexpected or undesired events they are self organising self configuring self optimising self healing self protecting self explaining and context aware while offering complementary interfaces for higher level directives with respect to the desired behaviour First steps towards adaptive and self organising computer systems are being undertaken Adaptivity reconfigurability emergence of new properties and self organisation are hot topics in a variety of research groups worldwide This book summarises the results of a 6 year priority research program SPP of the German Research Foundation DFG addressing these fundamental challenges in the design of Organic Computing systems It presents and discusses the theoretical foundations of Organic Computing basic methods and tools learning techniques used in this context architectural patterns and many applications The final outlook shows that in the mean time Organic Computing ideas have spawned a variety of promising new projects Organic Computing Rolf P.

Würtz, 2008-10-21 In this book the major ideas behind Organic Computing are delineated together with a sparse sample of computational projects undertaken in this new field Biological metaphors include evolution neural networks gene regulatory networks networks of brain modules hormone system insect swarms and ant colonies Applications are as diverse as system design optimization artificial growth task allocation clustering routing face recognition and sign language understanding

Morphogenetic Engineering René Doursat, Hiroki Sayama, Olivier Michel, 2012-12-13 Generally spontaneous pattern formation phenomena are random and repetitive whereas elaborate devices are the deterministic product of human design Yet biological organisms and collective insect constructions are exceptional examples of complex systems that are both self organized and architectural This book is the first initiative of its kind toward establishing a new field of research Morphogenetic Engineering to explore the modeling and implementation of self architecting systems Particular emphasis is placed on the programmability and computational abilities of self organization properties that are often underappreciated in complex systems science while conversely the benefits of self organization are often underappreciated in engineering

methodologies Altogether the aim of this work is to provide a framework for and examples of a larger class of self architecturing systems while addressing fundamental questions such as br How do biological organisms carry out morphogenetic tasks so reliably br Can we extrapolate their self formation capabilities to engineered systems br Can physical systems be endowed with information or informational systems be embedded in physics so as to create autonomous morphologies and functions br What are the core principles and best practices for the design and engineering of such morphogenetic systems

Complex Behavior in Evolutionary Robotics Lukas König,2015-03-30 Today autonomous robots are used in a rather limited range of applications such as exploration of inaccessible locations cleaning floors mowing lawns etc However ongoing hardware improvements and human fantasy steadily reveal new robotic applications of significantly higher sophistication For such applications the crucial bottleneck in the engineering process tends to shift from physical boundaries to controller generation As an attempt to automatize this process Evolutionary Robotics has successfully been used to generate robotic controllers of various types However a major challenge of the field remains the evolution of truly complex behavior Furthermore automatically created controllers often lack analyzability which makes them useless for safety critical applications In this book a simple controller model based on Finite State Machines is proposed which allows a straightforward analysis of evolved behaviors To increase the model s evolvability a procedure is introduced which by adapting the genotype phenotype mapping at runtime efficiently traverses both the behavioral search space as well as recursively the search space of genotype phenotype mappings Furthermore a data driven mathematical framework is proposed which can be used to calculate the expected success of evolution in complex environments

Polystochastic Models for Complexity Octavian Iordache,2010-04-19 This book is devoted to complexity understanding and management considered as the main source of efficiency and prosperity for the next decades Divided into six chapters the book begins with a presentation of basic concepts as complexity emergence and closure The second chapter looks to methods and introduces polystochastic models the wave equation possibilities and entropy The third chapter focusing on physical and chemical systems analyzes flow sheet synthesis cyclic operations of separation drug delivery systems and entropy production Biomimetic systems represent the main objective of the fourth chapter Case studies refer to bio inspired calculation methods to the role of artificial genetic codes neural networks and neural codes for evolutionary calculus and for evolvable circuits as biomimetic devices The fifth chapter taking its inspiration from systems sciences and cognitive sciences looks to engineering design case base reasoning methods failure analysis and multi agent manufacturing systems Perspectives and integrative points of view are discussed in the sixth chapter with reference to the classification of sciences cybernetics and its extensions and to transdisciplinarity and categorification Written for engineers researchers and students in chemical biochemical computing and systems science engineering in neuroscience psychology philosophy and mathematics

Bio-Inspired Self-Organizing Robotic Systems Yan Meng,Yaochu Jin,2011-05-08 Self organizing approaches inspired from biological

systems such as social insects genetic molecular and cellular systems under morphogenesis and human mental development has enjoyed great success in advanced robotic systems that need to work in dynamic and changing environments Compared with classical control methods for robotic systems the major advantages of bio inspired self organizing robotic systems include robustness self repair and self healing in the presence of system failures and or malfunctions high adaptability to environmental changes and autonomous self organization and self reconfiguration without a centralized control Bio inspired Self organizing Robotic Systems provides a valuable reference for scientists practitioners and research students working on developing control algorithms for self organizing engineered collective systems such as swarm robotic systems self reconfigurable modular robots smart material based robotic devices unmanned aerial vehicles and satellite constellations

Distributed, Parallel and Biologically Inspired Systems Mike Hinchey, Bernd Kleinjohann, Lisa Kleinjohann, Peter Lindsay, Franz J. Rammig, Jon Timmis, Marilyn Wolf, 2010-08-06 This volume contains the proceedings of two conferences held as part of the 21 IFIP World Computer Congress in Brisbane Australia 20-23 September 2010 The first part of the book presents the proceedings of DIPES 2010 the 7 IFIP Conference on Distributed and Parallel Embedded Systems The conference introduced in a separate preface by the Chairs covers a range of topics from specification and design of embedded systems through to dependability and fault tolerance The second part of the book contains the proceedings of BICC 2010 the 3 IFIP Conference on Biologically Inspired Collaborative Computing The conference is concerned with emerging techniques from research areas such as organic computing autonomic computing and self adaptive systems where inspiration for techniques comes from exhibited behaviour in nature and biology Such techniques require the use of research developed by the DIPES community in supporting collaboration over multiple systems We hope that the combination of the two proceedings will add value for the reader and advance our related work

Organic Computing Tomforde, Sven, Sick, Bernhard, 2017-01-01 Key Terms Autonomic Computing ProActive Computing Complex Adaptive System Self Organisation

Self-Aware Computing Systems Samuel Kounev, Jeffrey O. Kephart, Aleksandar Milenkoski, Xiaoyun Zhu, 2017-01-23 This book provides formal and informal definitions and taxonomies for self aware computing systems and explains how self aware computing relates to many existing subfields of computer science especially software engineering It describes architectures and algorithms for self aware systems as well as the benefits and pitfalls of self awareness and reviews much of the latest relevant research across a wide array of disciplines including open research challenges The chapters of this book are organized into five parts Introduction System Architectures Methods and Algorithms Applications and Case Studies and Outlook Part I offers an introduction that defines self aware computing systems from multiple perspectives and establishes a formal definition a taxonomy and a set of reference scenarios that help to unify the remaining chapters Next Part II explores architectures for self aware computing systems such as generic concepts and notations that allow a wide range of self aware system architectures to be described and compared with both isolated and interacting systems It also reviews the current

state of reference architectures architectural frameworks and languages for self aware systems Part III focuses on methods and algorithms for self aware computing systems by addressing issues pertaining to system design like modeling synthesis and verification It also examines topics such as adaptation benchmarks and metrics Part IV then presents applications and case studies in various domains including cloud computing data centers cyber physical systems and the degree to which self aware computing approaches have been adopted within those domains Lastly Part V surveys open challenges and future research directions for self aware computing systems It can be used as a handbook for professionals and researchers working in areas related to self aware computing and can also serve as an advanced textbook for lecturers and postgraduate students studying subjects like advanced software engineering autonomic computing self adaptive systems and data center resource management Each chapter is largely self contained and offers plenty of references for anyone wishing to pursue the topic more deeply

Organic Computing - Technical Systems for Survival in the Real World Christian Müller-Schloer, Sven Tomforde, 2017-12-28 This book is a comprehensive introduction into Organic Computing OC presenting systematically the current state of the art in OC It starts with motivating examples of self organising self adaptive and emergent systems derives their common characteristics and explains the fundamental ideas for a formal characterisation of such systems Special emphasis is given to a quantitative treatment of concepts like self organisation emergence autonomy robustness and adaptivity The book shows practical examples of architectures for OC systems and their applications in traffic control grid computing sensor networks robotics and smart camera systems The extension of single OC systems into collective systems consisting of social agents based on concepts like trust and reputation is explained OC makes heavy use of learning and optimisation technologies a compact overview of these technologies and related approaches to self organising systems is provided So far OC literature has been published with the researcher in mind Although the existing books have tried to follow a didactical concept they remain basically collections of scientific papers A comprehensive and systematic account of the OC ideas methods and achievements in the form of a textbook which lends itself to the newcomer in this field has been missing so far The targeted reader of this book is the master student in Computer Science Computer Engineering or Electrical Engineering or any other newcomer to the field of Organic Computing with some technical or Computer Science background Readers can seek access to OC ideas from different perspectives OC can be viewed 1 as a philosophy of adaptive and self organising life like technical systems 2 as an approach to a more quantitative and formal understanding of such systems and finally 3 a construction method for the practitioner who wants to build such systems In this book we first try to convey to the reader a feeling of the special character of natural and technical self organising and adaptive systems through a large number of illustrative examples Then we discuss quantitative aspects of such forms of organisation and finally we turn to methods of how to build such systems for practical applications

Systemdienstleistungserbringung durch intelligente Gebäude Kochannek, Sebastian, 2020-02-14 **Verhaltensgarantien in Selbst-Organisierenden**

Systemen Florian Nafz, 2012 Zukünftige Systeme erfordern ein hohes Mass an Flexibilität um den wachsenden Anforderungen gerecht zu werden Gleichzeitig werden technische Systeme in mehr und mehr Bereichen eingesetzt und sollen dabei vielfältigste Aufgaben übernehmen Selbst Organisation ist ein Ansatz um robuste und anpassungsfähige Systeme zu entwickeln welche auch bei unerwarteten Störungen ihren Anforderungen gerecht werden indem sie Entscheidungen von der Designzeit in die Laufzeit verlagern Um auch in sicherheitskritischen Anwendungen von den Vorteilen der Selbst Organisation profitieren zu können werden Techniken benötigt die es erlauben trotz der Selbst Organisation Verhaltensgarantien abzugeben Dieses Buch stellt einen Spezifikations und Verifikationsansatz für selbst organisierende Systeme vor Mit dem Restore Invariant Ansatz wird eine Technik vorgestellt die es erlaubt einen Verhaltenskorridor für ein System zu spezifizieren Dabei wird das Verhalten des Systems auf das gewünschte Verhalten eingeschränkt ohne dabei das System in seiner Flexibilität und seinen Entscheidungsmöglichkeiten zu beeinträchtigen Der vorgestellte Ansatz ermöglicht die Abgabe von Verhaltensgarantien in selbst organisierenden Systemen und sorgt damit dafür dass auch sicherheitskritische Systeme von den Vorteilen der Selbst Organisation profitieren können

Biologically Inspired Networking and Sensing: Algorithms and Architectures Lio, Pietro, Verma, Dinesh, 2011-08-31 Biologically Inspired Networking and Sensing Algorithms and Architectures offers current perspectives and trends in biologically inspired networking exploring various approaches aimed at improving network paradigms Research contained within this compendium of research papers and surveys introduces researches in the fields of communication networks performance modeling and distributed computing to new advances in networking

Organic Computing Sick, Bernhard, Tomforde, Sven, 2014-01-01 This book consists of twelve different contributions that reflect several aspects of OC research Therefore we introduced four major categories summarizing the contents of the contributions as well as describing the different aspects of OC research in general 1 design and architectures 2 trustworthiness 3 self learning and 4 self x properties

Models of Brain and Mind Rahul

Banerjee, Bikas K. Chakrabarti, 2008-02-14 The phenomenon of consciousness has always been a central question for philosophers and scientists Emerging in the past decade are new approaches to the understanding of consciousness in a scientific light This book presents a series of essays by leading thinkers giving an account of the current ideas prevalent in the scientific study of consciousness The value of the book lies in the discussion of this interesting though complex subject from different points of view ranging from physics and computer science to the cognitive sciences Reviews of controversial ideas related to the philosophy of mind from western and eastern sources including classical Indian first person methodologies provide a breadth of coverage that has seldom been attempted in a book before Additionally chapters relating to the new approaches in computational modeling of higher order cognitive function and consciousness are included The book is of great value for established as well as young researchers from a wide cross section of interdisciplinary scientific backgrounds aiming to pursue research in this field as well as an informed public Presents the latest developments in the

scientific study of consciousness Critically reviews different theoretical and philosophical explanations related to the subject An important book for both students and researchers in designing research projects on consciousness *Computational Linguistics / Computerlinguistik* Istvan S. Bátori, Winfried Lenders, Wolfgang Putschke, 2008-07-14 It was the late co editor of the series Handb cher zur Sprach und Kommunikationswissenschaft Gerold Ungeheuer who was first to recognize the need for this handbook and who committed himself to the all important inclusion in the series The editors dedicate this volume to his memory

Natural Computing for Simulation and Knowledge Discovery Nunes de Castro, Leandro, 2013-07-31 Nature has long provided the inspiration for a variety of scientific discoveries in engineering biomedicine and computing though only recently have these elements of nature been used directly in computational systems Natural Computing for Simulation and Knowledge Discovery investigates the latest developments in nature influenced technologies Within its pages readers will find an in depth analysis of such advances as cryptographic solutions based on cell division the creation and manipulation of biological computers and particle swarm optimization techniques Scientists practitioners and students in fields such as computing mathematics and molecular science will make use of this essential reference to explore current trends in natural computation and advance nature inspired technologies to the next generation

Dynamically Reconfigurable Systems Marco Platzner, Norbert Wehn, 2010-03-10 Dynamically Reconfigurable Systems is the first ever to focus on the emerging field of Dynamically Reconfigurable Computing Systems While programmable logic and design time configurability are well elaborated and covered by various texts this book presents a unique overview over the state of the art and recent results for dynamic and run time reconfigurable computing systems Reconfigurable hardware is not only of utmost importance for large manufacturers and vendors of microelectronic devices and systems but also a very attractive technology for smaller and medium sized companies Hence Dynamically Reconfigurable Systems also addresses researchers and engineers actively working in the field and provides them with information on the newest developments and trends in dynamic and run time reconfigurable systems

Symmetry and Complexity Klaus Mainzer, 2005 Cosmic evolution leads from symmetry to complexity by symmetry breaking and phase transitions The emergence of new order and structure in nature and society is explained by physical chemical biological social and economic self organization according to the laws of nonlinear dynamics All these dynamical systems are considered computational systems processing information and entropy Are symmetry and complexity only useful models of science or are they universals of reality Symmetry and Complexity discusses the fascinating insights gained from natural social and computer sciences philosophy and the arts With many diagrams and pictures this book illustrates the spirit and beauty of nonlinear science In the complex world of globalization it strongly argues for unity in diversity

Securing Cyber-Physical Systems Al-Sakib Khan Pathan, 2015-10-06 Think about someone taking control of your car while you re driving Or someone hacking into a drone and taking control Both of these things have been done and both are attacks against cyber physical systems CPS Securing Cyber Physical Systems explores

the cybersecurity needed for CPS with a focus on results of research and real world deploy

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