

# EVOLUTIONARY DESIGN BY COMPUTERS

EDITED BY PETER J. BENTLEY



"DARWIN WOULD LOVE THIS BOOK"

RICHARD DAWKINS





# Evolutionary Design By Computers

**Nadia Nedjah, Luiza de Macedo  
Mourelle**





## **Evolutionary Design By Computers:**

**Evolutionary Design by Computers** Peter Bentley, 1999-05-28 Evolutionary Design By Computers offers an enticing preview of the future of computer aided design Design by Darwin Lawrence J Fogel President Natural Selection Inc Evolutionary design by computers is the major revolution in design thinking of the 20th century and this book is the best introduction available Professor John Frazer Swire Chair and Head of School of Design the Hong Kong Polytechnic University Author of An Evolutionary Architecture Peter Bentley has assembled and edited an important collection of papers that demonstrate convincingly the utility of evolutionary computation for engineering solutions to complex problems in design David B Fogel Editor in Chief IEEE Transactions on Evolutionary Computation Some of the most startling achievements in the use of computers to automate design are being accomplished by the use of evolutionary search algorithms to evolve designs Evolutionary Design By Computers provides a showcase of the best and most original work of the leading international experts in Evolutionary Computation Engineering Design Computer Art and Artificial Life By bringing together the highest achievers in these fields for the first time including a foreword by Richard Dawkins this book provides the definitive coverage of significant developments in Evolutionary Design This book explores related sub areas of Evolutionary Design including design optimization creative design the creation of art artificial life It shows for the first time how techniques in each area overlap and promotes the cross fertilization of ideas and methods Design by Evolution Philip F. Hingston, Luigi C. Barone, Zbigniew Michalewicz, 2008-09-30 Evolution is Nature s design process The natural world is full of wonderful examples of its successes from engineering design feats such as powered flight to the design of complex optical systems such as the mammalian eye to the merely stunningly beautiful designs of orchids or birds of paradise With increasing computational power we are now able to simulate this process with greater fidelity combining complex simulations with high performance evolutionary algorithms to tackle problems that used to be impractical This book showcases the state of the art in evolutionary algorithms for design The chapters are organized by experts in the following fields evolutionary design and intelligent design in biology art computational embryogeny and engineering The book will be of interest to researchers practitioners and graduate students in natural computing engineering design biology and the creative arts Creative Evolutionary Systems Peter Bentley, David W. Corne, 2002 Written for computer scientists and students and computer literate artists designers and specialists in evolutionary computation this text brings together the most advanced work in the use of evolutionary computation for creative results **Evolutionary Design and Manufacture** I.C. Parmee, 2012-12-06 The fourth evolutionary adaptive computing conference at the University of Plymouth again explores the utility of various evolutionary adaptive search algorithms and complementary computational intelligence techniques within design and manufacturing The content of the following chapters represents a selection of the diverse set of papers presented at the conference that relate to both engineering design and also to more general design areas This expansion has



been the result of a conscious effort to recognise generic problem areas and complementary research across a wide range of design and manufacture activity There has been a major increase in both research into and utilisation of evolutionary and adaptive systems within the last two years This is reflected in the establishment of major annual joint US genetic and evolutionary computing conferences and the introduction of a large number of events relating to the application of these technologies in specific fields The Plymouth conference remains a long standing event both as ACDM and as the earlier ACEDC series The conference maintains its policy of single stream presentation and associated poster and demonstrator sessions The event retains the support of several UK Engineering Institutions and is now recognised by the International Society for Genetic and Evolutionary Computation as a mainstream event It continues to attract an international audience of leading researchers and practitioners in the field

*Introduction to Evolutionary Computing* Agoston E. Eiben, J.E. Smith, 2013-03-14 Evolutionary Computing is the collective name for a range of problem solving techniques based on principles of biological evolution such as natural selection and genetic inheritance These techniques are being increasingly widely applied to a variety of problems ranging from practical applications in industry and commerce to leading edge scientific research This book presents the first complete overview of this exciting field aimed directly at lecturers and graduate and undergraduate students It is also meant for those who wish to apply evolutionary computing to a particular problem or within a given application area To this group the book is valuable because it presents EC as something to be used rather than just studied Last but not least this book contains quick reference information on the current state of the art in a wide range of related topics so it is of interest not just to evolutionary computing specialists but to researchers working in other fields

**Computer-Aided Architectural Design Futures (CAADFutures) 2007** Andy Dong, Andrew Vande Moere, Asko Riitahuhta, 2007-11-07 CAAD Futures is a biennial conference that aims to promote the advancement of computer aided architectural design research and teaching The conferences are organised under the auspices of the CAAD Futures Foundation The conference series started in 1985 in Delft and has since traveled to major cities in Europe Asia and USA This volume is the proceedings of the 12th International Conference of CAAD Futures which took place in Sydney Australia The internationally refereed papers in this book present the state of the art in computer aided architectural design research The papers in this year's conference theme Integrating Technologies for Computer Aided Design provide the technological foundation for new ways of thinking about using computers in designing and the use of computers in design itself as well as in the education of designers Information about the 2007 Conference and this book is available at <http://www.arch.usyd.edu.au/kcdc/conferences/cf07>

**Applications of Evolutionary Computing** Günther Raidl, 2004-03-25 This book constitutes the joint refereed proceedings of six workshops on evolutionary computing EvoWorkshops 2004 held together with EuroGP 2004 and EvoCOP 2004 in Coimbra Portugal in April 2004 The 55 revised full papers presented were carefully reviewed and selected from a total of 123 submissions In accordance with the six workshops covered the papers are



organized in topical sections on evolutionary bioinformatics evolutionary computing in communications networks and connected systems hardware optimization techniques evolutionary computing in image analysis and signal processing evolutionary music and art and evolutionary algorithms in stochastic and dynamic environments

**Advances in Soft Computing** Rajkumar Roy, Takeshi Furuhashi, Pravir K. Chawdhry, 2012-12-06 Advances in Soft Computing contains the most recent developments in the field of soft computing in engineering design and manufacture The book comprises a selection of papers that were first presented in June 1998 at the 3rd On line World Conference on Soft Computing in Engineering Design and Manufacturing Amongst these are four invited papers by World renowned researchers in the field Soft computing is a collection of methodologies which aim to exploit tolerance for imprecision uncertainty and partial truth to achieve tractability robustness and low solution cost The area of applications of soft computing is extensive Principally the constituents of soft computing are fuzzy computing neuro computing genetic computing and probabilistic computing The topics in this book are well focused on engineering design and manufacturing This broad collection of 43 research papers has been arranged into nine parts by the editors These include Design Support Systems Intelligent Control Data Mining and New Topics in EA basics The papers on evolutionary design and optimisation are of particular interest Innovative techniques are explored and the reader is introduced to new highly advanced research results The editors present a unique collection of papers that provide a comprehensive overview of current developments in soft computing research around the world

**Design Computing and Cognition '06** Asko Riitahuhta, 2007-05-16 This is the second volume of the new conference series Design Computing and Cognition DCC successor to the successful series Artificial Intelligence in Design AID The conference theme of design computing and cognition recognizes not only the essential relationship between human cognitive processes as models of computation but also how models of computation inspire conceptual realizations of human cognition

**Advances in Evolutionary Computing** Ashish Ghosh, Shigeyoshi Tsutsui, 2012-12-06 The term evolutionary computing refers to the study of the foundations and applications of certain heuristic techniques based on the principles of natural evolution thus the aim of designing evolutionary algorithms EAs is to mimic some of the processes taking place in natural evolution These algorithms are classified into three main categories depending more on historical development than on major functional techniques In fact their biological basis is essentially the same Hence EC GA uGP uES uEP EC Evolutionary Computing GA Genetic Algorithms GP Genetic Programming ES Evolution Strategies EP Evolutionary Programming Although the details of biological evolution are not completely understood even nowadays there is some strong experimental evidence to support the following points Evolution is a process operating on chromosomes rather than on organisms Natural selection is the mechanism that selects organisms which are well adapted to the environment to reproduce more often than those which are not The evolutionary process takes place during the reproduction stage that includes mutation which causes the chromosomes of offspring to be different from those of the parents and recombination which combines the chromosomes of



the parents to produce the offspring Based upon these features the previously mentioned three models of evolutionary computing were independently and almost simultaneously developed An evolutionary algorithm EA is an iterative and stochastic process that operates on a set of individuals called a population Evolutionary Machine Design Nadia Nedjah, Luiza de Macedo Mourelle, 2005 In recent years genetic programming has attracted many researchers' attention and so became a consolidated methodology to automatically create new competitive computer programs Concise and efficient synthesis of a variety of systems has been generated by evolutionary computations Evolvable hardware is a growing discipline It allows one to evolve creative and novel hardware architectures given the expected input/output behaviour There are two kinds of evolvable hardware extrinsic and intrinsic The former relies on a simulated evolutionary process to evaluate the characteristics of the evolved designs while the latter uses hardware itself to do so Usually reconfigurable hardware such as FPGA and FPAAs are exploited One of the main problems that still faces researchers in the field of evolutionary machine design is scalability This book is devoted to reporting innovative and significant progress in automatic machine design Theoretical as well as practical chapters are contemplated The scalability problem in evolutionary machine designs is addressed The content of this book is divided into two main parts: evolvable hardware and genetic programming and evolutionary designs In the following we give a brief description of the main contribution of each of the included chapters

**Evolutionary Computer Music** Eduardo Reck Miranda, John Al Biles, 2007-04-26 This book discusses the applications of evolutionary computation to music and the tools needed to create and study such systems These tools can be combined to create surrogate artificial worlds populated by interacting simulated organisms in which complex musical experiments can be performed The book demonstrates that evolutionary systems can be used to create and to study musical compositions and cultures in ways that have never before been achieved *Evolutionary and Adaptive Computing in Engineering Design* Ian C. Parmee, 2012-12-06 Prior to the early 1990s the term evolutionary computing EC would have meant little to most practising engineers unless they had a particular interest in emerging computing technologies or were part of an organisation with significant in-house research activities It was around this time that the first tentative utilisation of relatively simple evolutionary algorithms within engineering design began to emerge in the UK The potential was rapidly recognised especially within the aerospace sector with both Rolls Royce and British Aerospace taking a serious interest while in the USA General Electric had already developed a suite of optimisation software which included evolutionary and adaptive search algorithms Considering that the technologies were already twenty-plus years old at this point the long gestation period is perhaps indicative of the problems associated with their real-world implementation Engineering application was evident as early as the mid-sixties when the founders of the various techniques achieved some success with computing resources that had difficulty coping with the population-based search characteristics of the evolutionary algorithms Unlike more conventional deterministic optimisation procedures evolutionary algorithms search from a population of possible



solutions which evolve over many generations This largely stochastic process demands serious computing capability especially where objective functions involve complex iterative mathematical procedures *Computer Supported Cooperative Work in Design II* Weiming Shen,Kuo-Ming Chao,Zongkai Lin,Jean-Paul A. Barthès,Anne James,2006-02-26 This book constitutes the thoroughly refereed post proceedings of the 9th International Conference on Computer Supported Cooperative Work in Design CSCWD 2005 held in Coventry UK in May 2005 The 65 revised full papers presented were carefully reviewed and selected from numerous submissions during at least two rounds of reviewing and improvement

Applications of Evolutionary Computing Franz Rothlauf,Jürgen Branke,Stefano Cagnoni,Ernesto Costa,Carlos Cotta,Rolf Drechsler,Evelyne Lutton,Penousal Machado,Jason H. Moore,Juan Romero,George D. Smith,Giovanni Squillero,Hideyuki Takagi,2006-03-04 This book presents the refereed joint proceedings of seven workshops on evolutionary computing EvoWorkshops 2006 held in Budapest in April 2006 65 revised full papers and 13 revised short papers presented were carefully reviewed and selected from a total of 149 submissions The book is organized in topical sections including evolutionary bioinformatics evolutionary computation in communications networks and connected systems and more

**Computational Design Thinking** Achim Menges,Sean Ahlquist,2011-10-24 The current transition from Computer Aided Design CAD to Computational Design in architecture represents a profound shift in design thinking and methods Representation is being replaced by simulation and the crafting of objects is moving towards the generation of integrated systems through designer authored computational processes While there is a particular history of such an approach in architecture its relative newness requires the continued progression of novel modes of design thinking for the architect of the 21st century This AD Reader establishes a foundation for such thinking It includes multifaceted reflections and speculations on the profound influence of computational paradigms on architecture It presents relevant principles from the domains of mathematics and computer science developmental and evolutionary biology system science and philosophy establishing a discourse for computational design thinking in architecture Rather than a merely technical approach the book will discuss essential intellectual concepts that are fundamental not only for a discourse on computational design but also for its practice This anthology provides a unique collection of seminal texts by authors who have either provided a significant starting point through which a computational approach to design has been pursued or have played a considerable role in shaping the field An important aspect of this book is the manner in which adjacent fields and historical texts are connected Both the source of original inspiration and scientific thought are presented alongside contemporary writings on the continually evolving computational design discourse Emerging from the field of science principally the subjects of morphogenesis evolution and mathematics selected texts provide a historical basis for a reconfigured mindset of processes that generate arrange and describe form Juxtaposed against more contemporary statements regarding the influence of computation on design thinking the book offers advancements of fundamental texts to the particular purpose of establishing



novel thought processes for architecture theoretically and practically The first reader to provide an effective framework for computational thinking in design Includes classic texts by Johan W von Goethe D Arcy Thompson Ernst Mayr Ludwig von Bertalanffy Gordan Pask Christopher Alexander John H Holland Nicholas Negroponte William Mitchell Peter J Bentley David W Corne Sanford Kwinter John Frazer Kostis Terzidis Michael Weinstock and Achim Menges Features new writing by Mark Burry Jane Burry Manuel DeLanda and Peter Trummer      Introduction to Evolutionary Computing A.E. Eiben,J.E. Smith,2015-07-01 The overall structure of this new edition is three tier Part I presents the basics Part II is concerned with methodological issues and Part III discusses advanced topics In the second edition the authors have reorganized the material to focus on problems how to represent them and then how to choose and design algorithms for different representations They also added a chapter on problems reflecting the overall book focus on problem solvers a chapter on parameter tuning which they combined with the parameter control and how to chapters into a methodological part and finally a chapter on evolutionary robotics with an outlook on possible exciting developments in this field The book is suitable for undergraduate and graduate courses in artificial intelligence and computational intelligence and for self study by practitioners and researchers engaged with all aspects of bioinspired design and optimization      **Applications of Evolutionary Computing** Mario Giacobini,Anthony Brabazon,Stefano Cagnoni,Gianni A. Di Caro,Rolf Drechsler,Aniko Ekart,Anna I. Esparcia-Alcazar,Muddassar Farooq,Andreas Fink,Jon McCormack,Michael O'Neill,Juan Romero,Franz Rothlauf,Giovanni Squillero,Sima Uyar,Shengxiang Yang,2008-04-03 Evolutionary computation EC techniques are efficient nature inspired planning and optimization methods based on the principles of natural evolution and genetics Due to their efficiency and simple underlying principles these methods can be used in the context of problem solving optimization and machine learning A large and continuously increasing number of researchers and professionals make use of EC techniques in various application domains This volume presents a careful selection of relevant EC examples combined with a thorough examination of the techniques used in EC The papers in the volume illustrate the current state of the art in the application of EC and should help and inspire researchers and professionals to develop efficient EC methods for design and problem solving All papers in this book were presented during EvoWorkshops 2008 which consisted of a range of workshops on application oriented aspects of EC Since 1998 EvoWorkshops has provided a unique opportunity for EC researchers to meet and discuss application aspects of EC and has served as an important link between EC research and its application in a variety of domains During these ten years new workshops have arisen some have disappeared while others have matured to become conferences of their own such as EuroGP in 2000 EvoCOP in 2004 and EvoBIO last year      *Computer-Aided Innovation (CAI)* Gaetano Cascini,2008-07-17 Computer Aided Innovation CAI is emerging as a strategic domain of research and application to support enterprises throughout the overall innovation process The 54 Working Group of IFIP aims at defining the scientific foundation of Computer Aided Innovation systems and at identifying state of the art and trends of CAI tools and methods



These Proceedings derive from the second Topical Session on Computer Aided Innovation organized within the 20th World Computer Congress of IFIP. The goal of the Topical Session is to provide a survey of existing technologies and research activities in the field and to identify opportunities of integration of CAI with other PLM systems. According to the heterogeneous needs of innovation related activities, the papers published in this volume are characterized by multidisciplinary contents and complementary perspectives and scopes. Such a richness of topics and disciplines will certainly contribute to the promotion of fruitful new collaborations and synergies within the IFIP community.

Gaetano Cascini, th  
Florence, April 30, 2008. CAI Topical Session Organization. The IFIP Topical Session on Computer Aided Innovation (CAI) is a co-located conference organized under the auspices of the IFIP World Computer Congress WCC 2008 in Milano, Italy. Gaetano Cascini, CAI Program Committee Chair, gaetano.cascini@unifi.it. *Artificial Intelligence in Design '02*, Asko  
Riitahuhta, 2013-04-17. One of the foundations for change in our society comes from designing. Its genesis is the notion that the world around us either is unsuited to our needs or can be improved. The need for designing is driven by a society's view that it can improve or add value to human existence well beyond simple subsistence. As a consequence of designing the world which we inhabit is increasingly a designed rather than a naturally occurring one. In that sense, it is an artificial world. Designing is a fundamental precursor to manufacturing, fabrication, construction, or implementation. Design research aims to develop an understanding of designing and to produce models of designing that can be used to aid designing. Artificial intelligence has provided an environmental paradigm within which design research based on computational constructions can be carried out. Design research can be carried out in a variety of ways. It can be viewed as largely an empirical endeavour in which experiments are designed and executed in order to test some hypothesis about some design phenomenon or design behaviour. This is the approach adopted in cognitive science. It often manifests itself through the use of protocol studies of designers. The results of such research form the basis of a computational model. A second view is that design research can be carried out by positing axioms and then deriving consequences from them.



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