



# ROBOT SHAPING

AN EXPERIMENT IN BEHAVIOR ENGINEERING

MARCO DORIGO AND MARCO COLOMBETTI

# Robot Shaping An Experiment In Behavior Engineering

**Hussein A. Abbass, Robert A. Hunjet**



## **Robot Shaping An Experiment In Behavior Engineering:**

*Robot Shaping* Marco Dorigo, Marco Colombetti, 1998 foreword by Lashon Booker To program an autonomous robot to act reliably in a dynamic environment is a complex task The dynamics of the environment are unpredictable and the robots sensors provide noisy input A learning autonomous robot one that can acquire knowledge through interaction with its environment and then adapt its behavior greatly simplifies the designer's work A learning robot need not be given all of the details of its environment and its sensors and actuators need not be finely tuned Robot Shaping is about designing and building learning autonomous robots The term shaping comes from experimental psychology where it describes the incremental training of animals The authors propose a new engineering discipline behavior engineering to provide the methodologies and tools for creating autonomous robots Their techniques are based on classifier systems a reinforcement learning architecture originated by John Holland to which they have added several new ideas such as mutesspec classifier system energy and dynamic population size In the book they present Behavior Analysis and Training BAT as an example of a behavior engineering methodology **The Developmental Organization of Robot Behavior** Roderic A.

Grupen, 2023-03-14 A comprehensive introduction to the mathematical foundations of movement and actuation that apply equally to animals and machines This textbook offers a computational framework for the sensorimotor stage of development as applied to robotics Much work in developmental robotics is based on ad hoc examples without a full computational basis This book's comprehensive and complete treatment fills the gap drawing on the principal mechanisms of development in the first year of life to introduce what is essentially an operating system for developing robots The goal is to apply principles of development to robot systems that not only achieve new levels of performance but also provide evidence for scientific theories of human development RoboCup 2003: Robot Soccer World Cup VII Daniel Polani, Brett Browning, Andrea

Bonarini, Kazuo Yoshida, 2004-09-02 This book constitutes the seventh official archival publication devoted to RoboCup It documents the achievements presented at the 7th Robot World Cup Soccer and Rescue Competition and Conferences held in Padua Italy in July 2003 The 39 revised full papers and 35 revised poster papers presented together with an overview and roadmap for the RoboCup initiative and 3 invited papers were carefully reviewed and selected from 125 symposium paper submissions This book is mandatory reading for the rapidly growing RoboCup community as well as a valuable source of reference and inspiration for R D professionals interested in robotics distributed artificial intelligence and multi agent systems *Shepherding UxVs for Human-Swarm Teaming* Hussein A. Abbass, Robert A. Hunjet, 2021-03-19 This book draws

inspiration from natural shepherding whereby a farmer utilizes sheepdogs to herd sheep to inspire a scalable and inherently human friendly approach to swarm control The book discusses advanced artificial intelligence AI approaches needed to design smart robotic shepherding agents capable of controlling biological swarms or robotic swarms of unmanned vehicles These smart shepherding agents are described with the techniques applicable to the control of Unmanned X Vehicles UxVs

including air unmanned aerial vehicles or UAVs ground unmanned ground vehicles or UGVs underwater unmanned underwater vehicles or UUVs and on the surface of water unmanned surface vehicles or USVs This book proposes how smart shepherds could be designed and used to guide a swarm of UxVs to achieve a goal while ameliorating typical communication bandwidth issues that arise in the control of multi agent systems The book covers a wide range of topics ranging from the design of deep reinforcement learning models for shepherding a swarm transparency in swarm guidance and ontology guided learning to the design of smart swarm guidance methods for shepherding with UGVs and UAVs The book extends the discussion to human swarm teaming by looking into the real time analysis of human data during human swarm interaction the concept of trust for human swarm teaming and the design of activity recognition systems for shepherding Presents a comprehensive look at human swarm teaming Tackles artificial intelligence techniques for swarm guidance Provides artificial intelligence techniques for real time human performance analysis

Autonomous Bidding Agents Michael P. Wellman, Amy Greenwald, Peter Stone, 2007 E commerce increasingly provides opportunities for autonomous bidding agents computer programs that bid in electronic markets without direct human intervention Automated bidding strategies for an auction of a single good with a known valuation are fairly straightforward designing strategies for simultaneous auctions with interdependent valuations is a more complex undertaking This book presents algorithmic advances and strategy ideas within an integrated bidding agent architecture that have emerged from recent work in this fast growing area of research in academia and industry The authors analyze several novel bidding approaches that developed from the Trading Agent Competition TAC held annually since 2000 The benchmark challenge for competing agents to buy and sell multiple goods with interdependent valuations in simultaneous auctions of different types encourages competitors to apply innovative techniques to a common task The book traces the evolution of TAC and follows selected agents from conception through several competitions presenting and analyzing detailed algorithms developed for autonomous bidding Autonomous Bidding Agents provides the first integrated treatment of methods in this rapidly developing domain of AI The authors who introduced TAC and created some of its most successful agents offer both an overview of current research and new results Michael P Wellman is Professor of Computer Science and Engineering and member of the Artificial Intelligence Laboratory at the University of Michigan Ann Arbor Amy Greenwald is Assistant Professor of Computer Science at Brown University Peter Stone is Assistant Professor of Computer Sciences Alfred P Sloan Research Fellow and Director of the Learning Agents Group at the University of Texas Austin He is the recipient of the International Joint Conference on Artificial Intelligence IJCAI 2007 Computers and Thought Award

Encyclopedia of Artificial Intelligence Rabuñal Dopico, Juan Ramón, Dorado, Julian, Pazos, Alejandro, 2008-07-31 This book is a comprehensive and in depth reference to the most recent developments in the field covering theoretical developments techniques technologies among others Provided by publisher

**Mechanics of Robotic Manipulation** Matthew T. Mason, 2001-06-08 The science and engineering of robotic manipulation Manipulation

refers to a variety of physical changes made to the world around us Mechanics of Robotic Manipulation addresses one form of robotic manipulation moving objects and the various processes involved grasping carrying pushing dropping throwing and so on Unlike most books on the subject it focuses on manipulation rather than manipulators This attention to processes rather than devices allows a more fundamental approach leading to results that apply to a broad range of devices not just robotic arms The book draws both on classical mechanics and on classical planning which introduces the element of imperfect information The book does not propose a specific solution to the problem of manipulation but rather outlines a path of inquiry

**Autonomous Robots** George A. Bekey, 2005 An introduction to the science and practice of autonomous robots that reviews over 300 current systems and examines the underlying technology *Artificial Intelligence, Evolutionary Computing and Metaheuristics* Xin-She Yang, 2012-07-27 Alan Turing pioneered many research areas such as artificial intelligence computability heuristics and pattern formation Nowadays at the information age it is hard to imagine how the world would be without computers and the Internet Without Turing's work especially the core concept of Turing Machine at the heart of every computer mobile phone and microchip today so many things on which we are so dependent would be impossible 2012 is the Alan Turing year a centenary celebration of the life and work of Alan Turing To celebrate Turing's legacy and follow the footsteps of this brilliant mind we take this golden opportunity to review the latest developments in areas of artificial intelligence evolutionary computation and metaheuristics and all these areas can be traced back to Turing's pioneer work Topics include Turing test Turing machine artificial intelligence cryptography software testing image processing neural networks nature inspired algorithms such as bat algorithm and cuckoo search and multiobjective optimization and many applications These reviews and chapters not only provide a timely snapshot of the state of art developments but also provide inspiration for young researchers to carry out potentially ground breaking research in the active diverse research areas in artificial intelligence cryptography machine learning evolutionary computation and nature inspired metaheuristics This edited book can serve as a timely reference for graduates researchers and engineers in artificial intelligence computer sciences computational intelligence soft computing optimization and applied sciences

**Layered Learning in Multiagent Systems** Peter Stone, 2000-03-03 This book looks at multiagent systems that consist of teams of autonomous agents acting in real time noisy collaborative and adversarial environments This book looks at multiagent systems that consist of teams of autonomous agents acting in real time noisy collaborative and adversarial environments The book makes four main contributions to the fields of machine learning and multiagent systems First it describes an architecture within which a flexible team structure allows member agents to decompose a task into flexible roles and to switch roles while acting Second it presents layered learning a general purpose machine learning method for complex domains in which learning a mapping directly from agents sensors to their actuators is intractable with existing machine learning methods Third the book introduces a new multiagent reinforcement learning algorithm team partitioned opaque

transition reinforcement learning TPOT RL designed for domains in which agents cannot necessarily observe the state changes caused by other agents actions The final contribution is a fully functioning multiagent system that incorporates learning in a real time noisy domain with teammates and adversaries a computer simulated robotic soccer team Peter Stone s work is the basis for the CMUnited Robotic Soccer Team which has dominated recent RoboCup competitions RoboCup not only helps roboticists to prove their theories in a realistic situation but has drawn considerable public and professional attention to the field of intelligent robotics The CMUnited team won the 1999 Stockholm simulator competition outscoring its opponents by the rather impressive cumulative score of 110 0

*Strategic Negotiation in Multiagent Environments* Sarit Kraus,2001 A model for strategic negotiation for intelligent agents *Reasoning about Rational Agents* Michael Wooldridge,2003-01-01 This book focuses on the belief desire intention BDI model of rational agents which recognizes the primacy of beliefs desires and intentions in rational action One goal of modern computer science is to engineer computer programs that can act as autonomous rational agents software that can independently make good decisions about what actions to perform on our behalf and execute those actions Applications range from small programs that intelligently search the Web buying and selling goods via electronic commerce to autonomous space probes This book focuses on the belief desire intention BDI model of rational agents which recognizes the primacy of beliefs desires and intentions in rational action The BDI model has three distinct strengths an underlying philosophy based on practical reasoning in humans a software architecture that is implementable in real systems and a family of logics that support a formal theory of rational agency The book introduces a BDI logic called LORA Logic of Rational Agents In addition to the BDI component LORA contains a temporal component which allows one to represent the dynamics of how agents and their environments change over time and an action component which allows one to represent the actions that agents perform and the effects of the actions The book shows how LORA can be used to capture many components of a theory of rational agency including such notions as communication and cooperation

**Reinforcement Learning** Marco Wiering,Martijn van Otterlo,2012-03-05 Reinforcement learning encompasses both a science of adaptive behavior of rational beings in uncertain environments and a computational methodology for finding optimal behaviors for challenging problems in control optimization and adaptive behavior of intelligent agents As a field reinforcement learning has progressed tremendously in the past decade The main goal of this book is to present an up to date series of survey articles on the main contemporary sub fields of reinforcement learning This includes surveys on partially observable environments hierarchical task decompositions relational knowledge representation and predictive state representations Furthermore topics such as transfer evolutionary methods and continuous spaces in reinforcement learning are surveyed In addition several chapters review reinforcement learning methods in robotics in games and in computational neuroscience In total seventeen different subfields are presented by mostly young experts in those areas and together they truly represent a state of the art of current reinforcement learning

research Marco Wiering works at the artificial intelligence department of the University of Groningen in the Netherlands He has published extensively on various reinforcement learning topics Martijn van Otterlo works in the cognitive artificial intelligence group at the Radboud University Nijmegen in The Netherlands He has mainly focused on expressive knowledge representation in reinforcement learning settings

Genetic and Evolutionary Computation — GECCO 2003 Erick Cantú-Paz,James A. Foster,Kalyanmoy Deb,Lawrence David Davis,Rajkumar Roy,Una-May O'Reilly,Hans-Georg Beyer,Russel Standish,Graham Kendall,Stewart Wilson,Joachim Wegener,Dipankar Dasgupta,Mitchell A. Potter,Alan C. Schultz,2003-08-03 The set LNCS 2723 and LNCS 2724 constitutes the refereed proceedings of the Genetic and Evolutionary Computation Conference GECCO 2003 held in Chicago IL USA in July 2003 The 193 revised full papers and 93 poster papers presented were carefully reviewed and selected from a total of 417 submissions The papers are organized in topical sections on a life adaptive behavior agents and ant colony optimization artificial immune systems coevolution DNA molecular and quantum computing evolvable hardware evolutionary robotics evolution strategies and evolutionary programming evolutionary scheduling routing genetic algorithms genetic programming learning classifier systems real world applications and search based software engineering

*Developmental Robotics* Angelo Cangelosi,Matthew Schlesinger,2015-01-09 A comprehensive overview of an interdisciplinary approach to robotics that takes direct inspiration from the developmental and learning phenomena observed in children s cognitive development Developmental robotics is a collaborative and interdisciplinary approach to robotics that is directly inspired by the developmental principles and mechanisms observed in children s cognitive development It builds on the idea that the robot using a set of intrinsic developmental principles regulating the real time interaction of its body brain and environment can autonomously acquire an increasingly complex set of sensorimotor and mental capabilities This volume drawing on insights from psychology computer science linguistics neuroscience and robotics offers the first comprehensive overview of a rapidly growing field After providing some essential background information on robotics and developmental psychology the book looks in detail at how developmental robotics models and experiments have attempted to realize a range of behavioral and cognitive capabilities The examples in these chapters were chosen because of their direct correspondence with specific issues in child psychology research each chapter begins with a concise and accessible overview of relevant empirical and theoretical findings in developmental psychology The chapters cover intrinsic motivation and curiosity motor development examining both manipulation and locomotion perceptual development including face recognition and perception of space social learning emphasizing such phenomena as joint attention and cooperation language from phonetic babbling to syntactic processing and abstract knowledge including models of number learning and reasoning strategies Boxed text offers technical and methodological details for both psychology and robotics experiments

*Robot Behaviour* Ulrich Nehmzow,2008-12-18 Robots have evolved impressively since the 3 D manipulator built by C W K ward 1957 the two little electromechanical turtles Elmer and Elsie Walter 1950 Walter 1951 and

the first mobile robots controlled by computers Shakey Nilsson 1984 CART Moravec 1979 Moravec 1983 and Iqbal et al 1979 Since then we have seen industrial robot manipulators working in car factories automatic guided vehicles moving heavy loads along predefined routes human remotely operated robots neutralising bombs and even semi autonomous robots like Sojourner going to Mars and moving from one position to another commanded from Earth Robots will go further and further in our society However there is still a kind of robot that has not completely taken off so far autonomous robots Autonomy depends upon working without human supervision for a considerable amount of time taking independent decisions adapting to new challenges in dynamic environments interacting with other systems and humans and so on Research on autonomy is highly motivated by the expectations of having robots that can work with us and for us in everyday environments assisting us at home or work acting as servants and companions to help us in the execution of different tasks so that we can have more spare time and a better quality of life

Genetic Programming III John R. Koza, 1999 Genetic programming GP is a method for getting a computer to solve a problem by telling it what needs to be done instead of how to do it Koza Bennett Andre and Keane present genetically evolved solutions to dozens of problems of design control classification system identification and computational molecular biology Among the solutions are 14 results competitive with human produced results including 10 rediscoveries of previously patented inventions

**The Handbook of Brain Theory and Neural Networks** Michael A. Arbib, 2003 This second edition presents the enormous progress made in recent years in the many subfields related to the two great questions how does the brain work and How can we build intelligent machines This second edition greatly increases the coverage of models of fundamental neurobiology cognitive neuroscience and neural network approaches to language

Midwest **Design of Intelligent Multi-Agent Systems** Rajiv Khosla, Nikhil Ichalkaranje, 2013-07-25 There is a tremendous interest in the design and applications of agents in virtually every area including avionics business internet engineering health sciences and management There is no agreed one definition of an agent but we can define an agent as a computer program that autonomously or semi autonomously acts on behalf of the user In the last five years transition of intelligent systems research in general and agent based research in particular from a laboratory environment into the real world has resulted in the emergence of several phenomena These trends can be placed in three categories namely humanization architectures and learning and adaptation These phenomena are distinct from the traditional logic centered approach associated with the agent paradigm Humanization of agents can be understood among other aspects in terms of the semantics quality of design of agents The need to humanize agents is to allow practitioners and users to make more effective use of this technology It relates to the semantic quality of the agent design Further context awareness is another aspect which has assumed importance in the light of ubiquitous computing and ambient intelligence The widespread and varied use of agents on the other hand has created a need for agent based software development frameworks and design patterns as well architectures for situated interaction negotiation e commerce e business and informational retrieval



Preface nally traditional agent designs did not incorporate human like abilities of learning and adaptation      Advances in Learning Classifier Systems Pier L. Lanzi, Wolfgang Stolzmann, Stewart W. Wilson, 2003-07-31 Learning classifier systems are rule based systems that exploit evolutionary computation and reinforcement learning to solve difficult problems They were introduced in 1978 by John H Holland the father of genetic algorithms and since then they have been applied to domains as diverse as autonomous robotics trading agents and data mining At the Second International Workshop on Learning Classifier Systems IWLCS 99 held July 13 1999 in Orlando Florida active researchers reported on the then current state of learning classifier system research and highlighted some of the most promising research directions The most interesting contributions to the meeting are included in the book Learning Classifier Systems From Foundations to Applications published as LNAI 1813 by Springer Verlag The following year the Third International Workshop on Learning Classifier Systems IWLCS 2000 held September 15 16 in Paris gave participants the opportunity to discuss further advances in learning classifier systems We have included in this volume revised and extended versions of thirteen of the papers presented at the workshop

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## Robot Shaping An Experiment In Behavior Engineering Introduction

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