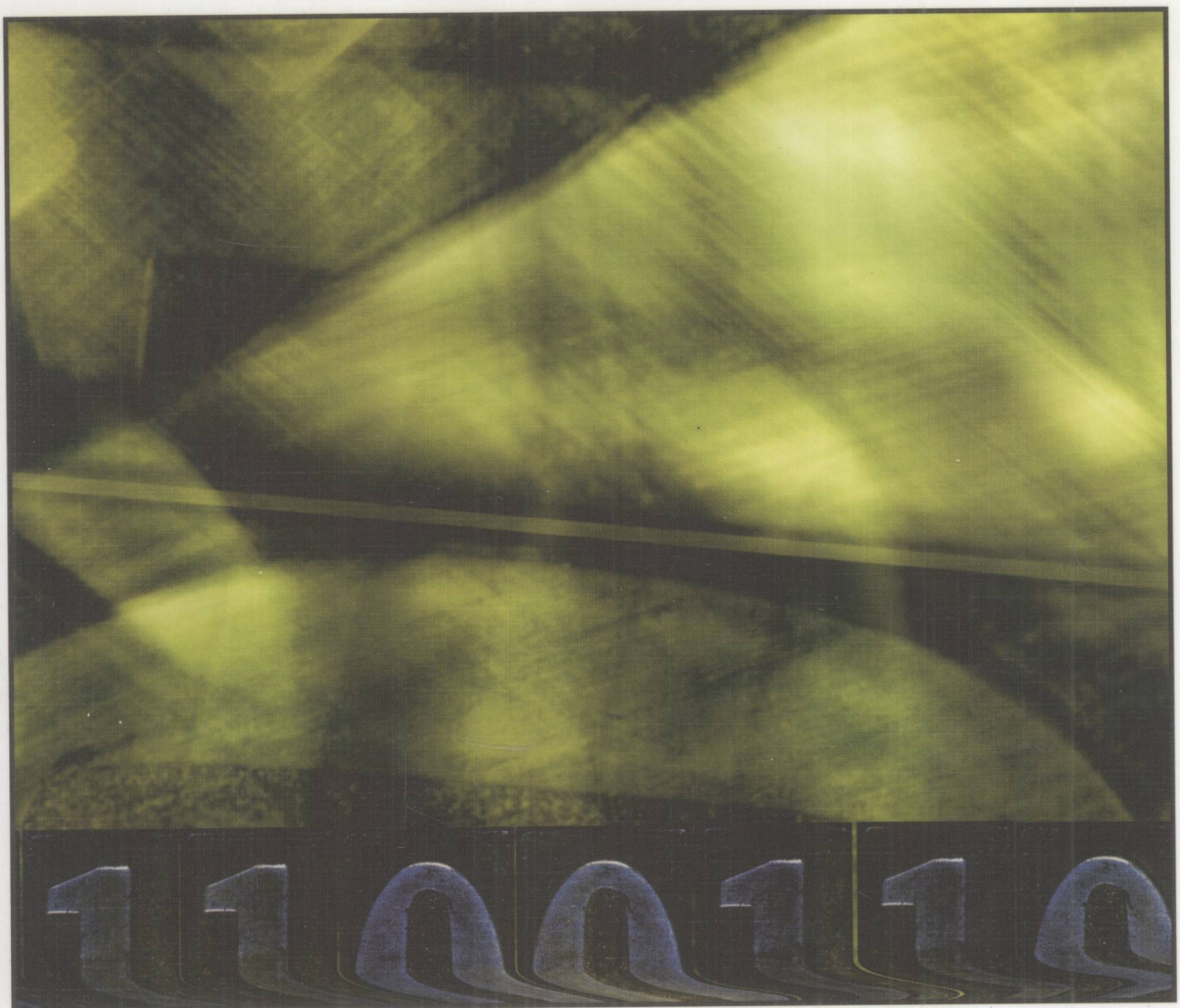


HANDBOOK OF RESEARCH ON

# **MULTI-AGENT SYSTEMS**

Semantics and Dynamics of Organizational Models



TP18  
H236

# Handbook of Research on Multi-Agent Systems: Semantics and Dynamics of Organizational Models

Virginia Dignum  
*Utrecht University, The Netherlands*



E2010000975

Information Science  
**REFERENCE**

**INFORMATION SCIENCE REFERENCE**

Hershey • New York

Director of Editorial Content: Kristin Klinger  
Director of Production: Jennifer Neidig  
Managing Editor: Jamie Snaveley  
Assistant Managing Editor: Carole Coulson  
Typesetter: Jeff Ash  
Cover Design: Lisa Tosheff  
Printed at: Yurchak Printing Inc.

Published in the United States of America by  
Information Science Reference (an imprint of IGI Global)  
701 E. Chocolate Avenue, Suite 200  
Hershey PA 17033  
Tel: 717-533-8845  
Fax: 717-533-8661  
E-mail: [cust@igi-global.com](mailto:cust@igi-global.com)  
Web site: <http://www.igi-global.com>

and in the United Kingdom by  
Information Science Reference (an imprint of IGI Global)  
3 Henrietta Street  
Covent Garden  
London WC2E 8LU  
Tel: 44 20 7240 0856  
Fax: 44 20 7379 0609  
Web site: <http://www.eurospanbookstore.com>

Copyright © 2009 by IGI Global. All rights reserved. No part of this publication may be reproduced, stored or distributed in any form or by any means, electronic or mechanical, including photocopying, without written permission from the publisher.

Product or company names used in this set are for identification purposes only. Inclusion of the names of the products or companies does not indicate a claim of ownership by IGI Global of the trademark or registered trademark.

Library of Congress Cataloging-in-Publication Data

Handbook of research on multi-agent systems : semantics and dynamics of organizational models / Virginia Dignum, editor.  
p. cm.

Includes bibliographical references and index.

Summary: "This book provide a comprehensive view of current developments in agent organizations as a paradigm for both the modeling of human organizations, and for designing effective artificial organizations"--Provided by publisher.

ISBN 978-1-60566-256-5 (hardcover) -- ISBN 978-1-60566-257-2 (ebook)

1. Intelligent agents (Computer software)--Handbooks, manuals, etc. 2. Self-organizing systems--Handbooks, manuals, etc. I. Dignum, Virginia.

QA76.76.I58H335 2009  
006.3--dc22

2008033935

British Cataloguing in Publication Data

A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book set is original material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

# Editorial Advisory Board

Alexander Artikis, *National Centre for Scientific Research "Demokritos", Greece*  
Olivier Boissier, *ENS Mines Saint-Etienne, France*  
Rafael Bordini, *Durham University, UK*  
Cristiano Castelfranchi, *University of Siena & National Research Council, Italy*  
Rosaria Conte, *National Research Council, Italy*  
Ulisses Cortés, *Technical University of Catalonia, Spain*  
Mehdi Dastani, *Utrecht University, The Netherlands*  
Frank Dignum, *Utrecht University, The Netherlands*  
Shaheen Fatima, *Loughborough University, UK*  
Nicoletta Fornara, *Università della Svizzera Italiana, Switzerland*  
Christian Lemaitre, *Universidad Autónoma Metropolitana, Mexico*  
Victor Lesser, *University of Massachusetts, USA*  
Fabiola López y López, *Benemérita Universidad Autónoma de Puebla, Mexico*  
Michael Luck, *King's College London, UK*  
Eric Matson, *Wright State University, USA*  
Pablo Noriega, *Artificial Intelligence Research Institute, Spain*  
James Odell, *James Odell Associates, USA*  
Eugénio Oliveira, *University of Porto, Portugal*  
Andrea Omicini, *Bologna University, Italy*  
Sascha Ossowski, *University Rey Juan Carlos, Spain*  
Anna Perini, *Fondazione Bruno Kessler, Italy*  
Paolo Renna, *University of Basilicata, Italy*  
Antônio Carlos da Rocha Costa, *Universidade Católica de Pelotas, Brazil*  
Juan A. Rodríguez-Aguilar, *Artificial Intelligence Research Institute, Spain*  
Paul Scerri, *Carnegie Mellon University, USA*  
Jaime S. Sichman, *University of São Paulo, Brazil*  
Maarten Sierhuis, *RIACS/NASA Ames Research Center, USA*  
Katia Sycara, *Carnegie Mellon University, USA*  
Liz Sonenberg, *University of Melbourne, Australia*  
Wamberto Vasconcelos, *University of Aberdeen, UK*  
Javier Vazquez-Salceda, *Technical University of Catalonia, Spain*  
Mario Verdicchio, *University of Bergamo, Italy*



## Foreword

Fifty years after the publication of the influential book on human organizations by March and Simon (1958) this new publication presents an overview of current work in agent organizations. Researchers have been attempting to use our understanding of human organizations to inform our appreciation of artificial organizations for over 50 years and this volume clearly illustrates a maturing of those investigations. It is also of note that the varied perspectives presented by the internationally diverse author panel demonstrates that the field is still at a formative stage.

To start with, the notion of “organization” in artificial intelligence is anything but crisp, and several of the early chapters discuss models and dimensions that can be seen as complementary attempts to capture the essence of the concept. Just as one can choose to describe a light switch as an “agent,” but it is generally not fruitful to do so (Shoam, 1993), the study of organizations is indeed intended to capture more than just the presence of multiple, interacting entities. The contributions in Sections I, IV, and VI provide the reader with a selection of analyses that point to the richness of organizations as a way of capturing complex “macro” phenomena in an integrated model. In contrast, the chapters in Section III adopt a “micro” perspective where interactions between agents are the focus of attention. Bridging these views, the material presented in Section II, can be seen as an attempt to ensure that the theory is supported by semantics, or, as McDermott (1978) puts it, “No notation without denotation”. The chapters in Section VI, by providing a trio of practical applications, can then be viewed as a response to the exhortation “No notation without exploitation” (Shoam, 1993).

This book presents a journey through a complex landscape. The editor, Virginia Dignum, has built on the tradition of contributions from the Utrecht group to the agent research community by bringing together a panel of highly credentialed authors. These researchers, who have already made individually significant contributions to the study of agent organizations, are well placed to influence the direction of the field. While the route taken in the book is shaped by the choice of authors, not simply by navigating to agreed signposts of the field, readers can be sure that they will have been taken to some of the most interesting landmarks, and are then well prepared to appreciate the opportunities for future research on agent organizations.

*Liz Sonenberg  
University of Melbourne  
July 2008*

## REFERENCES

March, J. G., & Simon, H. A. (1958). *Organizations*. Wiley.

Mc Dermott, D. V. (1978). Tarskian Semantics, or no notation without denotation! *Cognitive Science* 2(3), 277-282.

Shoam, Y. (1993). Agent-oriented programming. *Artificial Intelligence*, 60, 51-92.

**Liz Sonenberg** is professor of Information Systems and currently Dean of the Faculty of Science at the University of Melbourne, Australia. Her research expertise includes reasoning machinery as may be useful for the design of systems that exhibit complex collaborative behaviours and she has received funding from government and industry sources. Liz Sonenberg was a member of the Board of the International Foundation for Autonomous Agents and Multiagent Systems from 2002 to 2008, and in 2004 was program co-chair of the Third International Joint Conference on Agents and Multi Agent Systems hosted in New York.

# Preface

The main topic of this book is agent organization. Organizations in Multi-Agent Systems (MAS) can be understood as complex entities where a multitude of agents interact, within a structured environment aiming at some global purpose. Agent organizations are often associated with the idea of openness and heterogeneity in MAS. Open and heterogeneous environments pose new demands on MAS design and implementation including the integration of global and individual perspectives and the dynamic adaptation of systems to environmental changes. As systems grow to include hundreds or thousands of agents, there is a need to move from an agent-centric view of coordination and control to an organization-centric one to cope with the complexity of interaction in an environment. The view of coordination and control central to MAS needs to be expanded to enable a societal-centric focus. MAS design languages provide structures for developing organizational models, but can also enable the analysis of how natural organizations may be augmented or enhanced. That is, the tools needed for modeling, simulating agent organizations will provide new insights into organization theory.

The term agent organization, of multi-agent organization, has become common-place within the Multi-Agent Systems (MAS) community, but is used to mean different, often incompatible, issues. On the one side, organization is taken as the process of organizing a set of individuals, whereas the other side sees organization as an entity in itself, with its own requirements and objectives. As it is often the case in such situations, this leads to a fragile sense of understanding causing interpretation and integration problems when trying to compare, merge, or analyze different models and frameworks. Practical applications of agent organizations and of agent principles for organizational modeling are being widely developed; however, formal theories are needed to describe interaction and organizational structure. Furthermore, it is necessary to understand the relation between organizational roles and the agents that fulfill them. Without attempting to merge different views into one general whole, this book presents a comprehensive overview of the different perspectives, such that the reader will be able to better understand and judge the differences.

The intent of this book is simple – to provide an overview of current work in agent organizations, from several perspectives, and focus on different aspects of the organizational spectrum. It is the hope that the work presented here will provoke additional thought, research attention and concern, for the concept of organization in and for multi-agent systems.

The book is divided in 6 sections, each focusing on a different aspect of multi-agent organizations. The first section “*Methodologies and Frameworks for Agent Organizations*” sets the tone of the book by presenting state-of-the-art developments on integrated models for MAS where the notion of organization is central.

**Chapter I**, “*The Role of Organization in Agent Systems*” provides an introduction to the volume, focusing on the use of organization concepts in MAS and discusses the differences between organizing MAS and MAS for organizations.

**Chapter II**, “*Modelling Dimensions for Agent Organizations*” by Coutinho, Sichman, and Boissier, discusses how to classify diverse aspects, or modelling dimensions, of agent organizations currently captured by different organizational models. Four basic dimensions are proposed: the structural dimension, mainly composed of roles and groups; the interactive dimension, characterized by dialogical interaction structures; the functional dimension, formed by goal/task decomposition; and, the normative dimension, defining norms, rights, rules, and so forth. Apart from the basic dimensions, four complementary dimensions are discussed: environment, evaluation, evolution, and ontology. These are related to the aspects of situatedness, measurement, adaptation, and domain specific semantics of agent organizations.

**Chapter III**, “*Towards an Integral Approach of Organizations in Multi-Agent Systems*” by Ferber, Stratulat, and Tranier, posit that a genuine organizational approach has to take into account both the environment and the institutional part of MAS societies. As in Chapter I, they also stress the importance of integrating different dimensions (agents, environment, interactions, organizations, and institutions) into an integral vision. A meta-model, MASQ (Multi-Agent System based on Quadrants), is proposed and constitutes an abstraction of the various aspects of an organization centred MAS, extending the well known AGR (Agent/Group/Role) model.

**Chapter IV**, “*OMACS: A Framework for Adaptive, Complex Systems*”, DeLoach introduces a suite of technologies for building complex, adaptive systems that includes a set of methodologies, techniques, and architectures that allow it to be implemented effectively on a wide variety of systems. It uses the organization model for adaptive computational systems (OMACS) to define the knowledge needed about a system’s structure and capabilities to allow it to reorganize at runtime in the face of a changing environment and its agent’s capabilities.

Another concrete example of an organization-oriented methodology for MAS is given in **Chapter V**, “*Hermes: Designing Flexible and Robust Agent Interactions*” by Cheong and Winikoff. Hermes is a goal-oriented design methodology for agent interactions which is aimed at being pragmatic for practicing software engineers. Hermes focuses on interaction goals, such as goals of the interaction which the agents are attempting to achieve, and results in interactions that are more flexible and robust than message-centric approaches.

**Section II** is about formalisms for agent organizations. In **Chapter VI**, “*A Formal Framework for Organization Modeling and Analysis*” by Popova and Sharpanskykh is a formal framework for modeling and analyzing organizations is proposed and allows representing and reasoning about all important aspects of artificial and human organizations structured in a number of views, including performance-oriented, process-oriented, power- and interaction-related aspects.

**Chapter VII**, “*Describing Agent Societies: A Declarative Semantics*” by Tsvetovat, proposes a declarative language designed specifically for describing in an expressive way a variety of social interactions.

**Chapter VIII**, “*Structural Aspects of Organizations*” by Grossi and F. Dignum, investigates how organizations can be represented as graphs endowed with formal semantics. They distinguish different dimensions of organizations leading to different graph structures. By giving the graphs a formal semantics using Description Logic, the chapter shows that it is possible to formalize the effect of the organization on the activities of the agents playing the roles of the organization.

**Chapter IX**, “*A Logic for Agent Organizations*” by Virginia and Frank Dignum, posits that in order to develop a theory on the relation between organizational structures, organizational actions, and actions of agents performing roles in the organization, a theoretical framework to describe and reason about organizations is needed. The Language for Agent Organization (LAO) proposed in this chapter is sufficiently generic to enable the comparison of different existing organizational approaches to Multi-Agent Systems (MAS), while having enough descriptive power to describe realistic organizations.



In **Section III** the individual agent and their interactions in organizations are central. In **Chapter X**, “*Grounding Organizations in the Minds of the Agents*”, by Castelfranchi, presents organizations as a macro-micro notion and device. Organizations presuppose autonomous proactive entities (agents) playing the organizational roles. However, agents may have their own powers, goals, and relationships (of dependence, trust, etc.), which opens up important issues to be discussed. In order to model human organizations, and designing effective artificial organizations, models that exhibit a high degree of flexibility, exploiting autonomy and pro-activity, intelligence, and decentralized knowledge of role-players are needed; allowing for functional violations of requests and even of rules.

**Chapter XI**, “*Modelling Interactions via Commitments and Expectations*” by Torroni, Yolum, Singh, Alberti, Chesani, Gavanelli, Lamma, and Mello, presents and discusses two declarative, social semantic approaches for modeling interaction. The first one takes a state-oriented perspective, and models interaction in terms of commitments. The second one adopts a rule-oriented perspective, and models interaction in terms of logical formulae, expressing expectations about agent interaction.

**Chapter XII**, “*Communications for Agent-Based Human Team Support*”, by Sukthankar, Sycara, Giampapa, and Burnett, discusses the problem of agent aiding of ad-hoc, decentralized human teams so as to improve team performance on time-stressed group tasks. To see how human teams rise to the challenge, communication patterns of teams performing a collaborative search task are analyzed using empirical experiments.

The focus of **Chapter XIII**, “*Autonomous Agents Adopting Organizational Rules*”, by Van der Vecht, F. Dignum, and Meyer is agent autonomy. In particular, it discusses the adoption of organizational rules into the reasoning process of autonomous agents. It proposes a modular reasoning model that explicitly includes organizational rules and shows that this stimulates bottom-up dynamics in organization models.

**Section IV** presents the institutional view on organizations in which they are taken as highly regulated environments governed by norms. In **Chapter XIV**, “*Specifying Artificial Institutions in the Event Calculus*”, by Fornara and Colombetti, communication in open interaction systems is central. An approach to the standardization of communication is formally defined in the Event Calculus, which consists in modeling open interaction systems as a set of artificial institutions.

**Chapter XV**, “*Verifying Organizations Regulated by Institutions*”, by Viganò and Colombetti, proposes institutions to explicitly represent norms in open multi-agent systems, where agents may not follow them and which therefore require mechanisms to detect violations. A framework to verify organizations regulated by institutions is presented, which is characterized by a precise formalization of institutional concepts, a language to describe institutions, and a tool to model-check them.

In **Chapter XVI**, “*A Programming Language for Normative Multi-Agent Systems*”, by Dastani, Tinnemeier, and Meyer, views MAS as consisting of individual agents whose behaviors are regulated by an organizational artifact. The chapter presents a programming language that aims at facilitating the implementation of norm-based organizational artifacts for MAS.

**Section V** introduces several approaches to organizational dynamics and adaptation. In **Chapter XVII**, “*A Minimal Dynamical MAS Organization Model*”, by Rocha Costa and Pereira Dimuro, the Population-Organization model is presented as formal tool for studying the organization of open multi-agent systems and its functional and structural dynamics. The model is minimal in two senses: it comprises a minimal set of extensional concepts capable of adequately accounting for the notion of dynamic organization; and, it is a core organization model upon which a certain kind of dynamical rules can be defined to account for the action of intensional organizational elements like prestige, power, morality, and so forth.

**Chapter XVIII**, “*A Framework for Dynamic Agent Organizations*”, by Fatima and Wooldridge, presents an adaptive organizational policy for multi-agent systems called TRACE. TRACE allows a

collection of multi-agent organizations to dynamically allocate tasks and resources between themselves in order to efficiently process an incoming stream of tasks.

**Chapter XIX**, “*Dynamic Specifications for Norm-Governed Systems*”, by Artikis, Kaponis, and Pitt, a framework for executable specification of norm-governed multi-agent systems, is extended to allow for “dynamic specifications”, that is, specifications that may be modified at run-time by the members of a system. The framework extension is motivated by Brewka’s “dynamic argument systems”—an argument systems in which the rules of order may become the topic of the debate.

**Chapter XX**, “*Interactions Between Formal and Informal Organizational Networks*”, by Lamieri and Mangalagiu, presents a model of organization aimed to understand the effect of formal and informal structures on the organization’s performance. The model considers the interplay between the formal hierarchical structure and the social network connecting informally the agents emerging while the organization performs a task-set.

Finally, in **Section VI**, practical applications of MAS organizations are presented. **Chapter XXI**, “*Personal Assistants for Human Organizations*” by Okamoto, Sycara, and Scerri, focus on intelligent software personal assistants. The chapter describes the development of a computational model of organization to evaluate the impact that different proposed assistant abilities have on the behavior and performance of the organization. By varying the organizational structures under consideration, is possible to identify which abilities are most beneficial, as well as explore how organizations may adapt to best leverage the new technology.

**Chapter XXII**, “*Organizational Self-Design in Worth-Oriented Domains*”, by Kamboj and Decker, presents an approach to Organizational-Self Design (OSD), a method of designing organizations at run-time in which the agents are responsible for generating their own organizational structures. OSD is applied to worth-oriented domains – that is, domains in which problems are represented using TÆMS-based task structures.

**Chapter XXIII**, the final chapter, “*A Formal Petri Net-Based Model for Team Monitoring*” by Bonnet-Torrès, and Tessier, focuses on a Petri Net-based model for team organization and monitoring. The applications considered are missions performed by several robots that cooperate in different ways according to the goals to be achieved. The model allows several failure propagation ways within the team to be highlighted and local plan repair to be considered.

We have attempted to provide a comprehensive view of current developments in agent organizations as a paradigm for both the modeling of human organizations, and for designing effective artificial organizations. This book is intended to inspire and stimulate further research in the topic.

*Virginia Dignum*  
*Utrecht University, The Netherlands*  
*July 2008*

## Acknowledgment

It is appropriate to conclude by acknowledging all the *agents* that together made this book possible. First, I want to thank all authors for their excellent work. Without their contributions, representative of the high standard of the research in the field, this volume would not have been possible. Thanks are also due to the members of the editorial advisory board for their excellent reviewing work and their detailed suggestions to the authors that have directly contributed to the high quality final result presented here. Special thanks to Liz Sonenberg for her kind foreword to this book, for her contribution to the idea of this volume, born during my sabbatical at the University of Melbourne in 2006, and for the continued interchange of ideas, students, and projects. Hopefully, it will continue for many years. Thanks also to Heather Probst at IGI Global for her never failing efficiency on answering all mine and the author's questions and for her management of the editing process. Thanks to Laura Dignum for the organization and verification of all camera ready materials.

This work was made possible by the support of The Netherlands Organization for Scientific Research (NWO), through the Veni-fellowship project "Supporting Knowledge Sharing in Organizations".

Finally, I dedicate this book to Frank, Martyn, and Laura, my home *organization*.

*Virginia Dignum*

# Introduction



# List of Contributors

<b>Alberti, Marco</b> / <i>University of Ferrara, Italy</i> .....	263
<b>Artikis, Alexander</b> / <i>National Centre for Scientific Research “Demokritos”, Greece</i> .....	460
<b>Boissier, Olivier</b> / <i>ENS Mines Saint-Etienne, France</i> .....	18
<b>Bonnet-Torrès, Olivier</b> / <i>Beorn Technologies, France</i> .....	568
<b>Burnett, Christopher</b> / <i>University of Aberdeen, Scotland</i> .....	285
<b>Castelfranchi, Cristiano</b> / <i>ISTC-CNR, Italy</i> .....	242
<b>Ch. Meyer, John-Jules</b> / <i>Utrecht University, The Netherlands</i> .....	314, 397
<b>Cheong, Christopher</b> / <i>RMIT University, Melbourne, Australia</i> .....	105
<b>Chesani, Federico</b> / <i>University of Bologna, Italy</i> .....	263
<b>Colombetti, Marco</b> / <i>Università della Svizzera italiana, Switzerland &amp; Politecnico di Milano, Italy</i> .....	335, 367
<b>Coutinho, Luciano R.</b> / <i>University of São Paulo, Brazil</i> .....	18
<b>da Rocha Costa, Antônio Carlos</b> / <i>Universidade Católica de Pelotas, Brazil</i> .....	419
<b>Dastani, Mehdi</b> / <i>Utrecht University, The Netherlands</i> .....	397
<b>Decker, Keith S.</b> / <i>University of Delaware, USA</i> .....	541
<b>DeLoach, Scott A.</b> / <i>Kansas State University, USA</i> .....	76
<b>Dignum, Frank</b> / <i>Utrecht University, The Netherlands</i> .....	190, 220, 314
<b>Dignum, Virginia</b> / <i>Utrecht University, The Netherlands</i> .....	1, 220
<b>Fatima, Shaheen</b> / <i>Loughborough University, UK</i> .....	446
<b>Ferber, Jacques</b> / <i>LIRMM – University of Montpellier II, France</i> .....	51
<b>Fornara, Nicoletta</b> / <i>Università della Svizzera italiana, Switzerland</i> .....	335
<b>Gavanelli, Marco</b> / <i>University of Ferrara, Italy</i> .....	263
<b>Giampapa, Joseph A.</b> / <i>Carnegie Mellon University, USA</i> .....	285
<b>Grossi, David</b> / <i>Utrecht University, The Netherlands</i> .....	190
<b>Kamboj, Sachin</b> / <i>University of Delaware, USA</i> .....	541
<b>Kaponis, Dimosthenis</b> / <i>Imperial College London, UK</i> .....	460
<b>Lamieri, Marco</b> / <i>Institute for Scientific Interchange Foundation, Italy</i> .....	480
<b>Lamma, Evelina</b> / <i>University of Ferrara, Italy</i> .....	263
<b>Mangalagiu, Diana</b> / <i>Management and Strategy Department, Reims Management School, France, &amp; Institute for Scientific Interchange Foundation, Italy</i> .....	480
<b>Mello, Paola</b> / <i>University of Bologna, Italy</i> .....	263
<b>Okamoto, Steven</b> / <i>Carnegie Mellon University, USA</i> .....	514
<b>Pereira Dimuro, Graçaliz</b> / <i>Universidade Católica de Pelotas, Brazil</i> .....	419
<b>Pitt, Jeremy</b> / <i>Imperial College London, UK</i> .....	460
<b>Popova, Viara</b> / <i>De Montfort University, UK</i> .....	141

<b>Scerri, Paul</b> / <i>Carnegie Mellon University, USA</i> .....	514
<b>Sharpanskykh, Alexei</b> , <i>Vrije Universiteit Amsterdam, The Netherlands</i> .....	141
<b>Sichman, Jaime S.</b> / <i>University of São Paulo, Brazil</i> .....	18
<b>Singh, Munindar P.</b> / <i>North Carolina State University, USA</i> .....	263
<b>Stratulat, Tiberiu</b> / <i>LIRMM – University of Montpellier II, France</i> .....	51
<b>Sukthankar, Gita</b> / <i>University of Central Florida, USA</i> .....	285
<b>Sycara, Katia</b> / <i>Carnegie Mellon University, USA</i> .....	285, 514
<b>Tessier, Catherine</b> / <i>Onera-DCSD, France</i> .....	568
<b>Tinnemeier, Nick A.M.</b> / <i>Utrecht University, The Netherlands</i> .....	397
<b>Torroni, Paolo</b> / <i>University of Bologna, Italy</i> .....	263
<b>Tranier, John</b> / <i>LIRMM – University of Montpellier II, France</i> .....	51
<b>Tsvetovat, Maksim</b> / <i>George Mason University, USA</i> .....	172
<b>van der Vecht, Bob</b> / <i>Utrecht University, The Netherlands &amp; TNO Defense, Security and Safety, The Netherlands</i> .....	314
<b>Viganò, Francesco</b> / <i>Università della Svizzera italiana, Switzerland</i> .....	367
<b>Winikoff, Michael</b> / <i>RMIT University, Melbourne, Australia &amp; University of Otago, Dunedin, New Zealand</i> .....	105
<b>Wooldridge, Michael</b> / <i>University of Liverpool, UK</i> .....	446
<b>Yolum, Pinar</b> / <i>Boğaziçi University, Turkey</i> .....	263

# Table of Contents

<b>Foreword</b> .....	xx
<b>Preface</b> .....	xxii
<b>Acknowledgment</b> .....	xxvi

## Introduction

### Chapter I

The Role of Organization in Agent Systems.....	1
--	---

*Virginia Dignum, Utrecht University, The Netherlands*

## Section I Methodologies and Frameworks for Agent Organizations

### Chapter II

Modelling Dimensions for Agent Organizations .....	18
--	----

*Luciano R. Coutinho, University of São Paulo, Brazil*  
*Jaime S. Sichman, University of São Paulo, Brazil*  
*Olivier Boissier, ENS Mines Saint-Etienne, France*

### Chapter III

Towards an Integral Approach of Organizations in Multi-Agent Systems.....	51
---	----

*Jacques Ferber, LIRMM – University of Montpellier II, France*  
*Tiberiu Stratulat, LIRMM – University of Montpellier II, France*  
*John Tranier, LIRMM – University of Montpellier II, France*

### Chapter IV

OMACS: A Framework for Adaptive, Complex Systems .....	76
--	----

*Scott A. DeLoach, Kansas State University, USA*

## **Chapter V**

Hermes: Designing Flexible and Robust Agent Interactions.....	105
---	-----

*Christopher Cheong, RMIT University, Melbourne, Australia*

*Michael Winikoff, RMIT University, Melbourne, Australia & University of Otago,  
Dunedin, New Zealand*

## **Section II**

### **Formal Approaches for Agent Organizations**

## **Chapter VI**

A Formal Framework for Organization Modeling and Analysis .....	141
---	-----

*Viara Popova, De Montfort University, UK*

*Alexei Sharpanskykh, Vrije Universiteit Amsterdam, The Netherlands*

## **Chapter VII**

Describing Agent Societies: A Declarative Semantics.....	172
--	-----

*Maksim Tsvetovat, George Mason University, USA*

## **Chapter VIII**

Structural Aspects of Organizations.....	190
--	-----

*David Grossi, Utrecht University, The Netherlands*

*Frank Dignum, Utrecht University, The Netherlands*

## **Chapter IX**

A Logic for Agent Organizations .....	220
---------------------------------------	-----

*Virginia Dignum, Utrecht University, The Netherlands*

*Frank Dignum, Utrecht University, The Netherlands*

## **Section III**

### **Interactions in Organizations**

## **Chapter X**

Grounding Organizations in the Minds of the Agents .....	242
--	-----

*Cristiano Castelfranchi, ISTC-CNR, Italy*

## **Chapter XI**

Modelling Interactions via Commitments and Expectations .....	263
---	-----

*Paolo Torroni, University of Bologna, Italy*

*Pinar Yolum, Boğaziçi University, Turkey*

*Munindar P. Singh, North Carolina State University, USA*

*Marco Alberti, University of Ferrara, Italy*

*Federico Chesani, University of Bologna, Italy*

*Marco Gavanelli, University of Ferrara, Italy*

*Evelina Lamma, University of Ferrara, Italy*

*Paola Mello, University of Bologna, Italy*



## **Chapter XII**

Communications for Agent-Based Human Team Support.....	285
--	-----

*Gita Sukthankar, University of Central Florida, USA*

*Katia Sycara, Carnegie Mellon University, USA*

*Joseph A. Giampapa, Carnegie Mellon University, USA*

*Christopher Burnett, University of Aberdeen, Scotland*

## **Chapter XIII**

Autonomous Agents Adopting Organizational Rules.....	314
--	-----

*Bob van der Vecht, Utrecht University, The Netherlands & TNO Defense,  
Security and Safety, The Netherlands*

*Frank Dignum, Utrecht University, The Netherlands*

*John-Jules Ch. Meyer, Utrecht University, The Netherlands*

## **Section IV Norms and Institutions**

## **Chapter XIV**

Specifying Artificial Institutions in the Event Calculus.....	335
---	-----

*Nicoletta Fornara, Università della Svizzera italiana, Switzerland*

*Marco Colombetti, Università della Svizzera italiana, Switzerland & Politecnico di Milano,  
Italy*

## **Chapter XV**

Verifying Organizations Regulated by Institutions.....	367
--	-----

*Francesco Viganò, Università della Svizzera italiana, Switzerland*

*Marco Colombetti, Università della Svizzera italiana, Switzerland & Politecnico di Milano,  
Italy*

## **Chapter XVI**

A Programming Language for Normative Multi-Agent Systems.....	397
---	-----

*Mehdi Dastani, Utrecht University, The Netherlands*

*Nick A.M. Tinnemeier, Utrecht University, The Netherlands*

*John-Jules Ch. Meyer, Utrecht University, The Netherlands*

## **Section V Organizational Dynamics**

## **Chapter XVII**

A Minimal Dynamical MAS Organization Model.....	419
---	-----

*Antônio Carlos da Rocha Costa, Universidade Católica de Pelotas, Brazil*

*Graçaliz Pereira Dimuro, Universidade Católica de Pelotas, Brazil*