

Lecture Notes in Artificial Intelligence

1871

Subseries of Lecture Notes in Computer Science

Edited by J. G. Carbonell and J. Siekmann

Lecture Notes in Computer Science

Edited by G. Goos, J. Hartmanis, and J. van Leeuwen

Springer

Berlin

Heidelberg

New York

Barcelona

Hong Kong

London

Milan

Paris

Tokyo

James L. Rash Christopher A. Rouff
Walt Truszkowski Diana Gordon
Michael G. Hinchey (Eds.)

Formal Approaches to Agent-Based Systems

First International Workshop, FAABS 2000
Greenbelt, MD, USA, April 5-7, 2000
Revised Papers



Springer

Series Editors

Jaime G. Carbonell, Carnegie Mellon University, Pittsburgh, PA, USA

Jörg Siekmann, University of Saarland, Saarbrücken, Germany

Volume Editors

James L. Rash

Walt Truszkowski

Michael G. Hinchey

NASA Goddard Space Flight Center

Greenbelt, Maryland 20771, USA

E-mail: {james.rash/walt.truszkowski/mike.hinchey}@gsfc.nasa.gov

Christopher A. Rouff

Science Applications International Corporation

4001 Fairfax Drive, Suite 300, Arlington, VA 22203, USA

E-mail: rouffc@saic.com

Diana Gordon

Naval Research Laboratory

4555 Overlook Avenue, S.W., Washington, D.C., USA

E-mail: gordon@aic.nrl.navy.mil or dspears@cs.uwo.edu

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Formal approaches to agent based systems : first international workshop ; revised papers / FAABS 2000, Greenbelt, MD, USA, April 5 - 7, 2000. James L. Rash ... (ed.). - Berlin ; Heidelberg ; New York ; Barcelona ; Hong Kong ; London ; Milan ; Paris ; Tokyo : Springer, 2001

(Lecture notes in computer science ; Vol. 1871 : Lecture notes in artificial intelligence)

ISBN 3-540-42716-3

CR Subject Classification (1998): I.2.11, I.2, C.2.4, F.3, F.4.1, D.2.4

ISBN 3-540-42716-3 Springer-Verlag Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer-Verlag Berlin Heidelberg New York

a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2001

Printed in Germany

Typesetting: Camera-ready by author, data conversion by PTP-Berlin, Stefan Sossna

Printed on acid-free paper SPIN: 10722329 06/3142 5 4 3 2 1 0

Preface

The FAABS Workshop was conceived at NASA Goddard Space Flight Center while the Agent Technology Development Group in the Advanced Architectures and Automation Branch (Code 588) was developing a prototype agent community to automate satellite ground operations. During the development of this system, several race conditions arose within and between agents. Due to the complexity of the agents and the communications between them, it was decided that a formal approach was needed to specify the agents and the communications between them, so that the system could be checked for additional errors.

A formal model of the inter-agent communications was developed, with the expectation that this would enable us to find more errors. Success on this convinced us of the importance of using formal methods to model agent-based systems. To share our own experiences and to learn how others were approaching these issues, we decided to hold a workshop on formal methods and agent-based systems.

The response was overwhelming. We intentionally limited numbers to encourage discussion and interaction. Invitations were issued on the basis of either a paper abstract, or a position statement explaining the author's interests and experience. The response was so great that we had to increase the number of invitations dramatically, and limit participation to one author per paper.

The workshop was a successful gathering of people from all over the world to discuss formal approaches to agent-based systems. The wide range of approaches and many interesting interactions of the participants made the workshop a rewarding experience. Posters, paper presentations, panels, and the invited talk by J Moore stimulated much discussion.

The proceedings contains both papers and write-ups of the poster presentations and panel discussions. It also includes author contact information to help further information sharing.

We would like to express our sincere thanks to all those who attended the workshop, presented papers or posters, and participated in panel sessions and both formal and informal discussions. Our thanks go to the NASA Goddard Code 588 for financing the workshop. Additionally, thanks go to the Naval Research Laboratory and to DARPA for their active support of the workshop.

Our thanks also go to Springer-Verlag for their assistance and interest in publishing the proceedings of this first Workshop on Formal Approaches to Agent-Based Systems.

July 2001

James L. Rash
Christopher A. Rouff
Walter Truszkowski
Diana F. Gordon

Table of Contents

Verifying Agent's Mental States	
Model Checking-Based Analysis of Multiagent Systems	1
<i>M. Benerecetti and F. Giunchiglia</i>	
Towards Formal Specification and Verification in Cyberspace	16
<i>S. Ambroszkiewicz, W. Penczek, and T. Nowak</i>	
Verification within the KARO Agent Theory	33
<i>U. Hustadt, C. Dixon, R.A. Schmidt, M. Fisher, J.-J.C. Meyer, and W. van der Hoek</i>	
Synthesizing Agents Initially	
On Formal Modeling of Agent Computations	48
<i>T. Araragi, P. Attie, I. Keidar, K. Kogure, V. Luchangco, N. Lynch, and K. Mano</i>	
Modeling and Programming Devices and Web Agents	63
<i>S.A. McIlraith</i>	
A Programming Logic for Part of the Agent Language 3APL	78
<i>K.V. Hindriks, F.S. de Boer, W. van der Hoek, and J.-J.C. Meyer</i>	
The Nepi ² Programming System: A π -Calculus-Based Approach to Agent-Based Programming	90
<i>Y. Kawabe, K. Mano, and K. Kogure</i>	
Frameworks and Formalization	
From Livingstone to SMV (Formal Verification for Autonomous Spacecrafts)	103
<i>C. Pecheur and R. Simmons</i>	
Verification of Plan Models Using UPPAAL	114
<i>L. Khatib, N. Muscettola, and K. Havelund</i>	
Formalization of a Spatialized Multiagent Model Using Coloured Petri Nets for the Study of an Hunting Management System	123
<i>I. Bakam, F. Kordon, C. Le Page, and F. Bousquet</i>	
Formal Agent Development: Framework to System	133
<i>M. d'Inverno and M. Luck</i>	

Modeling and Execution	
Automatic Synthesis of Agent Designs in UML	148
<i>J. Schumann and J. Whittle</i>	
Direct Execution of Agent Specifications	163
<i>M. Fisher</i>	
Using the π -Calculus to Model Multiagent Systems	164
<i>A.C. Esterline and T. Rorie</i>	
Specifying and Checking Fault-Tolerant Agent-Based Protocols Using Maude	180
<i>J. Van Baalen, J.L. Caldwell, and S. Mishra</i>	
Inter-agent Communication	
Agents Talking Faster	194
<i>T. Menzies, B. Cukic, and H. Singh</i>	
Refining Interactions in a Distributed System	209
<i>N. Soundarajan</i>	
Design and Mathematical Analysis of Agent-Based Systems	222
<i>K. Lerman</i>	
Modeling Task and Teams through Game Theoretical Agents	235
<i>M. Rudnianski and H. Bestougeff</i>	
Web Agents Cooperating Deductively	250
<i>R. Waldinger</i>	
Adaptive Agents	
Formal Specification of Agent Behaviour through Environment Scenarios ..	263
<i>H. Zhu</i>	
APT Agents: Agents That Are Adaptive, Predictable, and Timely	278
<i>D.F. Gordon</i>	
Posters	
Ontology Negotiation in a Community of Agents	294
<i>S.C. Bailin</i>	
Analysis of Agent-Based Systems Using Decision Procedures	298
<i>R. Bharadwaj</i>	
A Formal Approach to Belief-Goal-Role Agents	300
<i>W. Chainbi</i>	

Model Checking of Autonomy Models for an In-Situ Propellant Production System	302
<i>P. Engrand and C. Pecheur</i>	
Adaptive Supervisory Control of Multi-agent Systems	304
<i>K. Kiriakidis and D.F. Gordon</i>	
Machine-Learning for Logic-Based Multi-agent Systems	306
<i>E. Alonso and D. Kudenko</i>	
Using a Formal Framework for Agent System Design	308
<i>V. Carchiolo, M. Malgeri, and G. Mangioni</i>	
Modeling Agent-Based Systems	318
<i>S. Mandutianu</i>	
Modeling Agent Systems by Bayesian Belief Networks	321
<i>Y. Peng</i>	
The Anthropomorphizing of Intelligent Agents	323
<i>T. Riley</i>	
Controlling Multiple Satellite Constellations Using the TEAMAgent System	335
<i>D.M. Surka, M.E. Campbell, and T.P. Schetter</i>	
Operations Assistants for Johnson Space Center's Mission Control Center .	337
<i>S.E. Torney</i>	
A Real Time Object-Oriented Rational Agent Development System	339
<i>L.P. Wesley</i>	
Panel Sessions	
Empirical versus Formal Methods	345
<i>Moderator: D.F. Gordon</i>	
<i>Participants: H. Hermoor, R. Artell, and N. Ivezic</i>	
Future Directions	354
<i>Moderator: M. Hinchey</i>	
<i>Participants: J. Hendler, C. Pecheur, C. Heitmeyer, D.F. Gordon,</i>	
<i>M. Luck, and W. Truszkowski</i>	
Author Index	369