

Jaime S. Sichman
Luis Antunes (Eds.)

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Multi-Agent-Based Simulation VI

International Workshop, MABS 2005
Utrecht, The Netherlands, July 2005
Revised and Invited Papers



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Preface

This volume groups together the papers accepted for the 6th International Workshop on Multi-Agent-Based Simulation (MABS 2005), co-located with the 4th International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS 2005), which occurred in Utrecht, The Netherlands, on July 25, 2005.

MABS 2005 is the sixth workshop of a series that began at ICMAS 1998 (Paris, France), and continued successively with ICMAS 2000 (Boston, USA), AAMAS 2002 (Bologna, Italia), AAMAS 2003 (Melbourne, Australia) and AAMAS 2004 (New York, USA). The revised version of the papers of these workshops appeared in Springer's *Lecture Notes in Artificial Intelligence*, in volumes 1534, 1979, 2581, 2927 and 3415. All information about the MABS Workshop Series can be found at <http://www.pcs.usp.br/~mabs>.

After some hesitations about the numbering of the volumes, we decided to set the pace right between the workshop edition and the volume name. So, this volume is called *Multi-Agent-Based Simulation VI*, and subsequent editions of the book series will correspond to the ordinal number of the workshop.

The scientific focus of MABS lies in the confluence of social sciences and multi-agent systems, with a strong applicational/empirical vein, and its emphasis is on (i) exploratory agent-based simulation as a principled way of undertaking scientific research in the social sciences and (ii) using social theories as an inspiration to new frameworks and developments in multi-agent systems.

As the area of agent-based simulation is quickly auto-organizing, MABS has proposed itself as a forum for social scientists, agent researchers and developers and simulation researchers to assess the current state of the art in the modeling and simulation of social systems and multi-agent systems, identify where existing approaches can be successfully applied, learn about new approaches and explore future research challenges.

MABS 2005 attracted a total of 28 submissions from 14 different countries (Belgium, Brazil, Canada, France, Germany, Hungary, India, Japan, Portugal, Spain, The Netherlands, Tunisia, UK, USA). Every paper was reviewed by three anonymous referees, and in the end 12 papers were accepted for presentation in the workshop. Every paper was later reviewed again by a Program Committee member for this volume.

We are very grateful to every author who submitted a paper, as well as to all the members of the Program Committee and the additional reviewers for their hard work. The high quality of the papers included in this volume would not be possible without their participation and diligence. We would also like to thank Scott Moss and Emma Norling, who gave a very wholehearted invited talk.

Thanks are also due to Rino Falcone (AAMAS 2005 Workshop Chair), to Sarit Kraus and Munindar Singh (AAMAS 2005 General Chairs), to Sven Koenig and Michael Wooldridge (AAMAS 2005 Program Chairs) and to Frank and

Virginia Dignum (AAMAS 2005 Organization Chairs). Finally, we would like to thank Springer staff, especially Alfred Hofmann and Christine Günther, for their support of MABS and their help in the making of this book.

Social simulation is a terrifically exciting scientific endeavor, and MABS contributes to the significant role of bridging this multidisciplinary area with computer science and especially multi-agent systems.

January 2006

Jaime Simão Sichman
Luis Antunes

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Multi-Agent-Based Simulation: Why Bother?

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Abstract. This year's MABS workshop was the sixth in a series which is intended to look at "using multi-agent models and technology in social simulation," according to the the workshop series homepage [1]. We feel that this is an appropriate time to ask the participants and the wider community what it is that they hope to gain from this application of the technology, and more importantly, are the tools and techniques being used appropriate for achieving these aims? We are concerned that in many cases they are *not*, and consequently, false or misleading conclusions are being drawn from simulation results. In this paper, we focus on one particular example of this failing: the consequences of the inappropriate use of numbers. The translation of qualitative data into quantitative measures may enable the application of precise analysis, but unless the translation is done with extreme care, the analysis may simply be more precisely *wrong*. We conclude that as a community we need to pay careful attention to the tools and techniques that we are using, particularly when borrowing from other disciplines, to make sure that we avoid similar pitfalls in the future.

1 Introduction

The Multi-Agent-Based Simulation workshop series began in 1998, with the stated aim of developing "stronger links between those working in the social sciences, for whom agent-based simulation has the potential to be a valuable research tool, and those involved with multi-agent simulation, for whom the social sciences can provide useful theories and exemplars" [2]. Over the years, the community has developed and expanded, with participants from all corners of the globe, and applications in a wide range of areas. How strong are the links though, between those working in social sciences and those working in multi-agent simulation? Recent workshops have been dominated by researchers with backgrounds in agent-based simulation, with little input from the social scientists. Is that simply because of the workshop's association with the AAMAS conference series (which contains little else of interest to social scientists), or is it a symptom of a more serious problem: that the work of those in the MABS community is seen as largely irrelevant to those in the social science community? We do not believe that we have quite reached this critical situation, but fear that we have identified some disturbing trends that are leading us as a community down this path.

Rather than pointing directly to examples of these trends in MABS research, we illustrate our point here with examples from a related field, management

research, that is already regarded with scepticism by many management practitioners. We believe that there are strong parallels between the examples from this field and the research presented in MABS. Not only are there commonalities in the topics studied (for example, self-managing groups [3, 4] and innovation [5, 6]), but similar techniques are used to interpret and analyse data. The claim has been made that management education is irrelevant – or even downright harmful – by Pfeffer and Fong [7] and the late Sumantra Ghoshal [8], both writing in the Academy of Management's *Learning & Education* as well as, in the practitioner press, Bennis and O'Toole [9] in the *Harvard Business Review*. While the tag line for these articles claims a crisis in business education, they have in common a critique of academic research and scholarship in the area of management. In this paper, we aim to show firstly that practicing managers are right to doubt the relevance of leading management research as represented by articles published in recent issues of the most influential journals in the field.

The critique of current management research follows from the following dictum: formalism confers precision but neither descriptive nor predictive accuracy. The desire for precision amongst management researchers is evidenced by the practice of summarising notions and concepts from secondary evidence as propositions or hypotheses. Frequently, these propositions or hypotheses are then tested by some statistical means or restated as algebraic formulations. There is a question as to whether particular formal or pseudo-formal formulations produce any descriptively or predictively accurate statements and also whether statistical tests devised for these statements are able to distinguish what is accurate from what is simply precise.

In addition, precision itself has a cost even where precise formulations are also accurate. The cost is in terms of expressiveness. An algebraic expression or a regression model denote only what can be expressed precisely by numbers. Formal logics can use mnemonic terms in the drawing of inferences from axioms and rules of inference. The mnemonic terms are more expressive than number and, in general, are more expressive the more closely they resemble natural language. Natural language, of course, is rich in connotation but much less precise than formal logics.

As a community, we should be asking ourselves “*What is it that we hope to achieve with our simulations, and are the tools and techniques that we are using appropriate for achieving these aims?*” The second part of this question cannot be answered without answering the first, and so in the next section of this paper we consider why we do simulation. We also need to understand the intrinsic characteristics of our simulations (Sect. 3), as well as the limitations and bounds of the tools and techniques that we choose to use. In this paper, we do not intend to analyse all the tools and techniques that are used in our field. Rather, we show how one technique – the translation of qualitative data into quantitative data – is often mis-used (Sect. 4). We draw our examples from management research rather than the MABS community, but the techniques used in the cited examples are also used in social simulation, and the same pitfalls must be avoided. We present a discussion of how we believe agent-based simulation

can contribute to these particular types of problems (Sect. 5), and in summation urge all researchers to reconsider their tools and techniques, particularly when ‘borrowing’ from other disciplines, to ensure that they are being applied in an appropriate way. If not, we run the risk of presenting irrelevant, if not invalid, conclusions and having little impact with our research.

2 Why Do We Do Simulation?

Good science enables us to understand what we observe. Different sciences have different criteria of what it means to do this. In physics, the depth of understanding is judged on the prediction of specific events and phenomena or distributions of numerical measures. Evolutionary biologists do not predict the emergence of previously described species but they do provide an explanation of speciation that was developed by Darwin to cohere with the fossil record and has subsequently cohered with statistical and molecular genetics. We assume that researchers in our field also wish to contribute to the advancement of science; the question then becomes, how do we see our simulations to be doing this?

For social simulation, the main area of interest in this workshop series, the processes of interest are social processes: the way that people interact, and the effect that this has upon society (or a sub-group of society) as a whole. The predictive powers of our simulations depend upon the explanatory powers of earlier simulations: until we have satisfactorily produced explanations of behaviour, we can have little confidence in predicting future behaviour. For this reason, many of the simulations that we develop are intended to test theories, implementing the theories to see if the expected results are produced. In this year’s workshop, an example of this use of simulation that of Antunes et al. [10] who are seeking to understand tax compliance. Other simulations are intended to be used predictively, particularly for evaluating how proposed new policies or systems will affect a system’s behaviour. Melo et al’s police patrol route simulation (also in this year’s workshop) gives an example of this [11].

Another type of simulation that is discussed in this workshop series is that which draws upon social science for inspiration in the algorithms used for distributed systems. These simulations are typically used to evaluate the algorithms, comparing them against alternatives. Examples of this type of simulation that appeared in this year’s workshop are those of Rodrigues and Luck [12] and Sultanik et al. [13]. This paper is more relevant to those who are interested in social simulation than this ‘socially-inspired’ simulation, because we are particularly focusing on how human knowledge is represented. However the general lesson – that researchers should take care in the application of tools and techniques, and understand their limitations – applies equally here.

3 The Nature of Social Simulation

In social simulation, much of the data that we are capturing is human knowledge: how people make decisions, relate to others, etc. In some cases, this knowledge is

naturally quantitative (for example M has 5 children) but more often than not, it is qualitative (for example, X has a business relationship with Y , or A is more thrifty than B). The problem that we face is that more often than not, the formalisms (that is, programming languages) that we use more naturally represent quantitative data than qualitative data, and so we have a tendency to transform from latter to the former. While there is nothing inherently wrong with translating qualitative data into quantitative, this process can introduce serious errors into the data and its analysis, as will be seen in the examples in Sect. 4.

By using declarative languages (or languages with declarative features) in our simulations, we can avoid the need to translate qualitative data into numerical data. However this alone will not free us from troubles with numbers: almost certainly there will be some numerical – probably statistical – analysis of the simulation results, and it is equally important then to understand the assumptions underlying and limitations of the techniques being used. We are not the first to have made this point – our colleague Bruce Edmonds is one who has repeatedly argued for care in numerical representation and analysis [14, 15]. We stress again that although our examples focus on one particular type of problem, this problem is intended to be representative, rather than comprehensive. There are other examples of assumptions or limitations that are ignored, and these too lead to questionable inferences and conclusions.

4 A Case in Point: Management Research

As previously mentioned, we take our examples from management research rather than pointing directly at examples in the MABS literature. As academics in a business school, our research enters into both social science and management research, using agent-based-simulation as a tool. Here we identify some of the weaknesses in management research; in the following section we consider the implications of this for our research community.

It should be noted that although strong arguments against theoretical management research have been presented, as discussed in Sect. 1, the management research community as a whole do not acknowledge this gap between theory and practice. The establishment view on the principled relationship between theory and evidence is taken from the mission statements of leading, elite, world class journals of management research: *The Academy of Management Review*, *The Academy of Management Journal*, *The Strategic Management Journal* and *Administrative Science Quarterly*. These journals represent four of the top five journals¹ in the field of management ranked by their impact index in the ISI Journal Citation Reports. The journal *Management Science* is also considered to give us the top five journals in the field ranked by number of citations to their articles and because it is far and away the most frequently cited journal.

¹ *MIS Quarterly* was not included because it is more specialised than the others and therefore does not necessarily reflect the most general conventions in management research.

Table 1. Mission statements of five top management research journals

Academy of Management Review	[E]ach manuscript published in AMR must advance theory or the theory development process in the area of management and organizations. [16]
Academy of Management Journal	The mission of the Academy of Management Journal is to publish empirical research that tests, extends, or builds management theory and contributes to management practice. [17]
Strategic Management Journal	It is devoted to the improvement and further development of the theory and practice of strategic management and it is designed to appeal to both practising managers and academics.[18]
Administrative Science Quarterly	The ASQ logo reads, “Dedicated to advancing the understanding of administration through empirical investigation and theoretical analysis.” ... Theory is how we move to further research and improved practice. If manuscripts contain no theory, their value is suspect. Ungrounded theory, however, is no more helpful than are atheoretical data. [19]
Management Science	Management Science seeks to publish articles that identify, extend, or unify scientific knowledge pertaining to management. [T]he unifying thread ... is a fundamental focus on improving our understanding of the practice of management. Within this scope, theoretical, empirical, prescriptive and descriptive contributions are welcome. [20]

While one of these mission statements – that of the *Academy of Management Review* – does not mention empirical work, even in that case arguments are based on secondary evidence. In general, it seems clear that there is an establishment view that in practice evidence is an essential aspect of good management research. This view is very different from (say) that of the economics establishment where the most highly prized articles are frequently those that build some new theoretical insight on top of some previous theoretical basis that itself could hardly be more divorced from any reality we have ever observed. In other words, management research ideal is closer to the best of the natural sciences in its regard for evidence that is the norm in the social sciences. Of course, this leaves open the question of how the ideal translates into practice – a question to which we now turn.

From the journals mentioned in Tab. 1, we present a detailed analysis of two articles from issues in early 2005. These two articles have been selected not because they are in any way special, merely that they are two typical articles from the leading journals at this particular point in time. Analysis of other articles from the same pool reveals many similar features; there is simply not sufficient space to report this analysis here.

4.1 A First Example

The standard procedure in management research is to present a discursive verbal account of published literature and observational (as distinct from statistical)