First CABM/HEMA Workshop

"Agent-Based Modelling of Social, Economic and Biophysical Systems"

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SET OF ABSTRACTS

BizSim:
The World of Business in a Box

John CASTI

This talk addresses the question of why computer simulations are useful in understanding problems arising in the business world. The general points are illustrated with a case study of the world's catastrophe insurance industry, as well as brief examples from the worlds of finance and retail marketing (i.e. supermarkets).

Multi Agent Systems and Ecosystem Management in France:
Some Reflections on the Past, Present and Future

Francois BOUSQUET

If a history of multi-agent systems in France were to be written over the coming years, its authors would certainly locate its birth and formative years in the rich breeding ground of the interdisciplinary movement. Originally, multi-agent systems emerged from the field of artificial intelligence (AI). For example, MAS was introduced in France by computer scientists such as Jacques Ferber and Yves Demazeau. In parallel, researchers from physics – such as G. Weisbuch and E. Bonabeau – were interacting with the Santa Fe Institute's school of complexity. This proved to be a fertile ground for the emergence of a modelling community who developed several case studies in the early 1990s. During the second part of the presentation, the focus will be on a companion modelling approach that is shared by a network of researchers. Emphasis is put on the collective learning approaches with MAS. Concrete examples will be presented and future directions in both the computer sciences and the social sciences will be discussed.

Laboratory Experiments and Agent-Based Modeling

Marco JANSSEN

Laboratory experiments are common in the social sciences, and show that subjects do not behave like selfish rational agents outside competitive market situations. A new field in economics – behavioral game theory – tests alternative learning models on relatively simple games. In more complex social dilemmas like public good and common-pool resources, multiple subjects have more complex interactions, and we use agent-based models to test alternative behavioral models. Often agent-based models are based on rather ad hoc rules using armchair social science. A better connection between tools and data is desirable. The use of experimental data might provide an opportunity to develop more rigorously agent-based models that are well grounded in behavioral theories and empirical. There are multiple methodological challenges in order to make this happen. How to distinguish the performance of alternative models in complex situations, how to calibrate agent-based models, and how to translate observations of laboratory experiments into the larger scales in space and time of the application areas of agent-based modeling? Some results with public good experiments will be discussed.

Electricity Markets as Complex Adaptive Systems:
Some Behavioural Observations from our National Electricity Market

David BATTEN, George GROZEV and Xinmin HU

Abstract: Electricity industries have undergone reform worldwide. There are various (even contradictory) conclusions about the performance of these restructured electricity markets. Market outcomes depend largely on market design – including market rules, operational procedures, information revelation, and how each participant responds to the market design. In this paper, we identify and examine strategies adopted by generators in Australia's National Electricity Market – based on publicly available data for the period from May 1, 2002 to May 31, 2003. We try to understand and answer basic questions like how generators respond to changing market conditions (e.g. load changes) and why they behave in these ways. Statistics computed from the data show: that wide variations in the frequency of strategic rebidding exist; that generators more frequently use capacity offers as a strategic tool than price offers; that larger generating units are more likely to use the capacity strategy to control market prices; and that generators are capable of adapting to changing market conditions. These and other empirical observations help us to encode the representative behaviours of generator agents in NEMSIM.

Collecting, Interpreting and Encapsulating Local Knowledge into Multi-Agent Based Simulations: Lessons from two water management projects

Pascal PEREZ and Nicolas BECU

MABS have proven highly useful in simulating agents with different viewpoints that represent somehow the different representations of the environment given to the real actors. The link between simulated viewpoints and actual representations relies on our ability to understand, elicit and encapsulate the later into formal computer procedures. Unfortunately, the concept of representation itself is subject to several contrasted theories. Two recent projects dealing with water management in northern Thailand and west Timor have given us the opportunity to elaborate and test field survey methodologies.

In the northern Thailand case study, we consider individual representations as an assemblage of cultural references, beliefs and knowledge. The main assumption behind our constructivist stand is that actors involved in a participatory modelling are given information that may interactively change their own socially constructed representations. Semi-conducted interviews are held in relevant locations in order to facilitate the actor's expression and to help the interviewer in his understanding. In our methodology the analysis of the transcript and the modelling are merged. Hence, we build the elements of the model during the course of the transcript analysis. When a missing element is identified and cannot be retrieved from the transcript, a usual solution is to perform complementary surveys and interviews. We propose here to involve the actors in the formalization process. The missing elements are replaced by a temporary formal expression that is submitted to the judgement of the relevant actors. Successive feedback interactions are used to finalize the formal expression.

In the west Timor case study, not only do we acknowledge the socially constructed representations, but also we assume that individuals share holistic representations of their environment within acquaintance groups. According to this assumption, we first focus on leaders and key-players representing different or nested social groups in order to elaborate a first sketch of the system (Targeted Global Assessment). Then, we validate the model by interviewing farmers about their usual or anticipated behaviour (Individual Farm Survey). According to this view, individual agents update their motivations and behaviour while the social body conducts the representation changes.

Modelling Fisher Interactions in an Agent-Based Model of Fishing Behaviour

Rich LITTLE and David McDONALD

Reaction of fishers is an essential source of uncertainty in implementing fishery management decisions. Provided they realistically capture fisher behaviour, models of fishing vessel dynamics provide the basis for simulating the impact of proposed management strategies that are not yet implemented. Vessel interactions have not been a major focus of such models however, although they might play an essential role in the adaptation of a fleet to change. In order to address these issues we have developed an agent-based model of vessel fishing behaviour. We use Bayesian networks as a novel way of simulating social interactions and information flow among fishing vessel agents. We seek to produce various patterns with the model, like alliances and animosities, and wish to determine the effect that such properties have on the status of the exploited population. For example, because humans can adopt different risk-averse or risk-seeking strategies, with costs and benefits associated with each, by modelling strategy-switching behaviour we seek the conditions that lead to evolutionary stable strategies (ESS) of behaviours, as suggested by evolutionary game theory. Second, we seek the emergence and characteristics of alliances and animosities among agents by having them transmit either truthful or deceptive information. Third, we are interested in how fisher success and resource exploitation are affected by network connectivity, or different degrees of information sharing. The goal is to determine what degree of information sharing results in optimal resource exploitation, and whether a critical threshold exists, beyond which the exploitation rate changes catastrophically, irrespective of resource availability.

Possible Links between Experimental Economics and Simulations with Multi-Agent Systems.

Juliette ROUCHIER

In this presentation, I will explain what experimental economics is and why it is a very interesting discipline for simulators who want to study economic theory. Then I will describe two ways for experimental economists to use multi-agent simulations. Three types of experimental settings will be briefly described to illustrate the relation in both directions. One is a market with a double-auction setting, the second is a common good experiment and the third is an economy with constraints that are supposed to induce speculative attitudes among individuals. In conclusion, I will describe the problems that simulators with an “artificial life approach” face to accept experimental proofs and the changes that could occur if the two groups were to collaborate and draw a common framework of model descriptions and validation protocols.

GremLab: Taming Gremlins

Geoff POULTON and Philip VALENCIA

GREMLab's key aim is to solve the general problem of design of the global response characteristics of multi-agent systems (global response engineering) by optimising the properties and capabilities of the individual autonomous agents, and the interactions between them. This collaborative virtual laboratory combines CTIP and CMIS expertise in machine learning and agent-based modelling with the aim of achieving the directed design and control of emergent behaviour in multi-agent systems, on the macro-, meso- and nano-scales. Initial work, which started in November 2002, is concentrating on developing the necessary tools for design and control for a large scale system known as the Ageless Aerospace Vehicle concept demonstrator. In addition to this, recent work has begun on understanding meso-scale self assembly with the desire that this research can be extended into the nano-scale. The ambitious goals of GREMLab and it's related projects are receiving ever increasing interest and support, such as that from the CSS and ICT Emerging Science Areas which directly support this activity.

Simulating Ecological and Economic Dynamics using MABS: ReedSim

R. MATHEVET, R. LIFRAN, A. MAUCHAMP, G. LEVEFBVRE and B. POULIN

Designing complex adaptive policies for sustainable ecosystems management involves both modelling and stakeholders participation. In this presentation, we will first present the current state and initial results of the ReedSim model, then we will give some insight into further research involving the joint use of MABS and Choice Modelling approach. We will address the case study of large Mediterranean reedbeds. These habitats are subject to different human uses (reed harvesting, grazing, hunting, fishing and recreational activities), each associated with a particular water and reed management. Here we present the general structure of ReedSim, a multiagent model that integrates system dynamics, scale and cross-scale interactions in both human and natural systems. Using the CORMAS software, we built a model based on a hydro-ecological submodel (reedbed, water level and bird populations), and a socio-economic submodel (reed market and management). The model integrates data from a GIS to create a virtual reedbed similar to the studied wetland. As water management involves processes of collective decision-making, we put emphasis on the coalitional dimension of the users' interactions, including public agencies. The model is designed to be used in environmental planning, and to support collective decision-making, especially when involving negotiations between users or stakeholders and public agencies.

Modelling Rangelands as Complex Adaptive Social-Ecological Systems

Ryan McALLISTER, John GROSS, Nick ABEL,
Yiheyis MARU and Mark STAFFORD-SMITH

In rangeland systems, adaptive links between ecological, economic, and social processes combine to generate complexity. We seek to build models that can guide policy in Australian rangelands. Accordingly we model rangelands as complex adaptive systems. Our work has progressed in three areas. First, we developed a parsimonious conceptual model of rangeland systems, including biophysical processes central to the functioning of rangelands, commercial enterprises, and institutions. Second, we used an agent-based modelling approach to implement parts of the conceptual model. Monthly precipitation drove a bio-physical model of rangeland grass growth and degradation. Pastoral enterprises stocked patches of land with cattle that were sold and bought using simple rules. Less financially successful pastoral enterprises also learnt (imperfectly) from more successful ones, and adjusted stocking rates accordingly. When precipitation data from Dalrymple Shirewere used, resulting biophysical responses were broadly consistent with those observed in the region. The results also illustrated the consequences of interactions between environmental heterogeneity and learning. Third, we explored an agent-based modelling approach for exploring social capital in regional Australia. Results suggested that stronger social ties can be developed in a system with strong inter-regional links compared to a system with strong links to a central bureaucracy. Social capital is important because ultimately the range of adaptation drivers used in our models will include social aspects. As our models are refined, we will use them to address questions about relationships between institutions, learning, and ecosystem dynamics.

The North West Shelf *"in vitro"*: Agents in Glass

Randall GRAY, Beth FULTON, Brian HATFIELD, Rich LITLLE,
Vincent LYNE, David McDONALD, Keith SAINSBURY and Roger SCOTT

The NWS-InVitro model is a spatially explicit agent-based biophysical simulation model. Developed as the basis of the NWS-JEMS management strategy evaluation study, it is a multi-sector, multi-part model. The model is described here in the context of the spatially explicit, temporally adaptive framework in which it has been developed.

The World Bank Coral Reef Modelling Project

Roger BRADBURY

The World Bank is creating a major international research program – the Targeted Coral Reef Research Project – under the auspices of the Global Environment Facility. The program will investigate impacts of localized stress and compounding effects of climate change on the sustainability of coral reef ecosystems, and implications for management. The 15-year program will have a total budget of US$ 22 million and will include scientists from both developed and developing countries. One of the six workgroups is tasked with developing modelling and decision support systems. It will use agent-based modelling to integrate our understanding of the natural science of coral reef ecosystems and the social sciences of coral reef communities. It will deliver results to policy makers and communities in ways that empower them to manage their resources sustainably. This paper summarizes the state of play of the project as it moves towards full mobilization.

Walking with the Wagyl:
Network Approaches to Managing Complex Urban River Systems

Lorraine BATES, Geoff SYME and Paul WALKER

The threats to the Swan River both in terms of water quality and human demands are multiplying. This is in the face of a lack of a cohesive vision for the river and a confused and complex process of planning and governance. Such problems are ubiquitous to urbanized rivers. In this proposal we plan to build on the European FIRMA project and to examine the potential for network analysis to describe and explain the outcomes of current governance of the river. In a participatory stakeholder based program we will also examine alternative modes of governance to ensure that agreed futures are most likely to be met. Further, the application of both the process and the tools will build the capacity of governance structures to work together. In addition to the practical outcome of the project, a significant contribution to organizational complexity theory will develop.

Participatory, Agent-Based Modelling and Processes of Social Learning.

Claudia PAHL-WOSTL

Transformation processes towards more sustainable resource management regimes have to take the complexity of human behaviour and of human-environment interactions into account. "Decision making" is more appropriately characterized as search processes in an open possibility space than as optimal choice among a well defined set of alternatives in a closed action space. Models may serve as communication tools in processes of social learning – triggering institutional change, innovation and collective decision making. This talk will report on ongoing research being pursued in a number of projects funded within the 5th Framework Programme of the European Union.

Who's the expert? Alternative Viewpoints in Multi Agent-Based Systems for Participatory Water Management

Nils FERRAND

We reconsider the position of experts and naive users in the design and use of Multi Agent-Based Simulations (MABS) for participatory water management. To do this, we compare the different roles of designer, experts, model players and participants in the following situations: exploratory research models, realistic "what-if" simulations, qualitative aspects, problem solving, co-modelling, role-playing, and protracted MABS supported negotiations. We show how underlying assumptions about the decision process and individual or group responsibilities can affect our views. "ViewPoints" are taken as a basis for an open and constructive participation of the public in the path towards viable management. Formulating, comparing and applying ViewPoints is the real challenge. Finally, we show multi-agent systems have specific properties and drawbacks related to the latter. A practical and prospective research agenda is proposed.

Agent-Based Modelling at Charles Sturt University

Terry BOSSOMAIER

The Research Group for Complex Systems supports a number of cellular automata and agent-based modelling projects that we shall outline in this talk. First, we consider some fundamental issues surrounding cellular automata rules and the search for rules with specific functionality. Then we look at projects related to agent-based spatial information modelling – for map registration, house price modelling, load-balance in online computer games, and telecommunications. Finally, we look at some new projects on agent trading models and how these might apply to modelling of the human brain.

Changes in Landscape Structure and Ecosystem Function: Using Agent-Based Modelling to Predict Global Change Impacts on Rainforest Seed Dispersal Processes

David WESTCOTT

Seed dispersal is a fundamental ecosystem process in tropical rainforests. It often directly involves the majority of rainforest vascular plant and vertebrate species and determines the recruitment surface for subsequent plant generations. Consequently, seed-dispersal has a significant influence on the evolution and maintenance of rainforest communities. While seed dispersal has been the focus of several decades of research, a spatially-explicit and community level description of the process which could be incorporated into a modelling framework is still lacking. This limits our ability to understand and predict the impacts of global change on rainforest seed-dispersal processes and the long-term consequences of these for rainforest communities. In this talk, I outline a project which quantitatively describes the ecological functioning of, and the seed-shadows produced by, seed dispersal processes in Australia's tropical rainforests. The project describes the functional groups of fruits and dispersers and their patterns of interaction across the landscape. It also describes how the behaviour of dispersers, particularly an individual's movement, is influenced by landscape structure and the influence of this on seed-shadows (frequency distributions of seed dispersal distances from parental plants). From the project's outset, we have used an agent-based simulation approach to guide the work. Agent-based simulation has the potential to provide simulation tools that can be used to address a variety of theoretical and applied questions: i) predicting the long term consequences of the loss of key dispersers from the system, ii) documenting the effects of landscape structure on disperser movement and seed shadows and (through these) on plant community dynamics, and, iii) predicting and controlling the spread of invasive species.

Memes in Complex Social Systems – a Piggy-Back Proposal

Roger BRADBURY

A key issue for modelling human social systems is how to capture the complexity of human ideas – key, but highly malleable, drivers of such systems. Usually we encode ideas as if they were properties or descriptors of individuals or groups. At the present time, social scientists tell us our models are clumsy and crude. But the advent of CAS thinking allows us to use a richer, more realistic and potentially more useful paradigm – the Darwinian concept of the meme. The instantiation of CAS through ABM frees us from the need to only have physical entities as agents in our models. Just as we can let economic agents dealing in money interact with fish dealing with carbon atoms and photons, and social agents dealing with human laws, we can construct agents that themselves are not physical entities and which interact happily with those that are. Indeed this is the way the world actually works. But this is frontier territory. Traditional funding agencies have not been willing to have a go at this, even though the benefits would be great. I call here for a new strategy to get this issue off the ground, by drawing on the resources, experience and momentum of the CABM group. Perhaps as an interaction task, my suggestion is that we seek to extend some projects that have strong socio-economic aspects by adding a meme component to them. This would involve adding ideas as memes to work in areas like fisheries, rangelands, catchments and infrastructure, and developing a common toolbox and approach on how to encode and manipulate such agents. This would be a 'no-regrets' approach, because its failure would not impede the progress of the projects on which it piggy-backs. But it would have the potential to extend and enhance their results if it was successful.