MAS $\cup$ ABSS $\supseteq$ MABS

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The purpose of the Second International Workshop in Multi Agent Based Simulation is to investigate and develop the synergy between software engineering for multi agent systems and agent based social simulation. Some computer scientists see little overlap.

Edmonds (1998), for example, quotes Wooldridge and Jennings (1998) to the effect that "[i]f a system contains many agents…, then the dynamics can become too complex to manage effectively. There are several techniques that one can use to try to manage a system in which there are many agents. First, one can place it under central control... Another way... is to severely restrict the way in which agents can interact... one can ensure that there are few channels of communication... [or] by restricting the way in which agents interact. Thus very simple cooperation protocols are preferable…." Edmonds goes on to say that "these are sensible warnings for the software engineer, but they are not necessarily relevant for social simulation, since the unforeseen behaviour that the engineer is trying to prevent is what the social simulator is interested in. For the social simulator, the issue of how society can impact upon individual behaviour is at least as important as how individuals impact on society."

More recently, we have observed the growing articulation of an alternative view stemming from the growing importance of large scale, complex, distributed software systems such as the Internet and large, federated databases. While the importance of agents in software engineering research is hardly in doubt, there have been some rumblings of disquiet about the scalability and breadth of applicability of the agents paradigm. The classic paper by Nwana and Ndumu (1999) points out a range of problems that the agents community has largely ceased to address – much less to resolve and concludes that

> A new field is *only* defined by its *problems*, not its *methods/techniques*. We argue strongly that MAS has to some degree been falling into the trap that has befell AI

– that of deluding itself that its methods and techniques (e.g. cooperation, rationality theories, agent languages, conceptual and theoretical foundations, multi-agent planning, negotiation) are the real important issues. No! They are not! It is the problems that they are meant to solve….[1]

The papers included in the MABS2000 workshop were selected either because they explore how agent *interaction* can be used to build multi agent systems or they offer examples of problem-oriented (rather than technique-oriented) systems. No paper was selected if it specified a model or an issue to make it fit a previously chosen technique.

There is a longstanding tradition in the agents research literature of formalising concepts taken from sociology. Major contributors to this tradition are Castelfranchi, Conte and their collaborators from IP-CNR in Rome. Classic examples are Conte and Castelfranchi (1996) and Castelfranchi and Falcone (1998) which use formal logic to investigate the meaning of such concepts as social structure or trust and how these emerge from and influence agent interaction. Three papers that draw explicitly and directly on sociological theory are included in the present collection. Two (Sawyer and Schillo *et al.*) are position papers addressing key issues in the development of multi agent systems and the third (Pedone and Conte) formalises the Simmel hypothesis on social differentiation within a grid-based simulation model.

Together with Axtell's investigation of the effects of spatial representations of relationships among agents and the sequencing of their actions, these four papers address interaction issues from a more abstract perspective than any of the other papers. It may be useful to offer a framework within which to relate these papers for the workshop.

Writers as diverse as the sociologist Mark Granovetter (1985) and philosopher/modeller Bruce Edmonds (1998) have independently developed the concept of social embeddedness. An individual is socially embedded if his decisions and actions cannot be understood except in a social context. Wooldridge and Jennings argued in the passage quoted above that, in effect, socially embedded software agents are less reliable

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[1] MAS is by no means the only research field where technique sometimes seems to prevail over problems and applications. Moss (1999) documented that specific core techniques in economic theory are so important that formal demonstrations of their invalidity are repeatedly and systematically ignored. *Cf.* Moss and Pahl-Worstl (1998) or Moss, Pahl-Worstl and Downing (in press).

in an engineering sense than are socially unembedded agents. Granovetter pointed out that all agents in economic theory are not in any way socially embedded since their decisions and behaviour are determined entirely by their utility functions. He also pointed out that in some approaches to sociology, behaviour is so determined by social forces that there is little or no freedom of action for the individual. In his terminology, economic agents are “undersocialized” while individuals in Parsonian sociological theory are “oversocialized”.

The general point here is that the degree of socialization or, perhaps more clearly, the form and extent of social embeddedness ought to be chosen on the basis of experience and experiment. The point seems to have some force *a priori* whether we are concerned with agents to represent human actors or software agents to act independently in large, complex social environments.

Three of the papers in the workshop collection address precisely this issue. Sawyer offers an extended example of observed and documented social embeddedness in order to discuss the phenomenon of emergence. In his example, emergent behaviour is observed in an improvisational theatre performance. His paper is intended to clear the ground for the development of multi agent systems with properties that emerge clearly as consequences of social interaction among agents. While I did not understand Sawyer to be concerned explicitly with the determination of an appropriate form of social embeddedness, the importance of the form (as distinct from some abstract *degree*) of social embeddedness is central to his discussion. Schillo *et al.* do address the issue of the degree of embeddedness, again from a sociological and abstract perspective. Axtell, though not concerned with the more abstract sociological issues deals with the representation of social interaction. He demonstrates in particular that the results from models implementing different representations of social interaction yield qualitatively different individual and social behaviours. Taking these papers together, we have the implication that the choice of the form and representation of social embeddedness is highly non-trivial. These results give further force to the argument that multi agent systems – whether as software engineering or as social simulation – should be designed with the problem in mind, recognising the potential importance of the form of social embeddedness for the validity of the system.

The five papers grouped under the applications heading are all examples of problem-driven multi agent simulation models. Davidsson extends the work of Parunak *et al.*, reported in the first MABS workshop, on the differences in the results obtained from multi agent simulations and those obtained from system dynamics and other more mathematical simulation models. The discussion is problem-centred in that the example used to develop the argument and render it more concrete is an actual problem of designing intelligent building systems. McGeary and Decker are working on mechanism and agent design for the scalable control and coordination of systems where "agents must interact in complex, changing ways." They report work on a simulation system for investigating the mechanism and agent designs to support such interactions where necessary for the effective performance of software systems. While McGerary and Decker are working within relatively abstract, general systems, El hadouaj *et al.* take a similar problem-centred approach to a highly specific, empirical issue. They consider the psychological evidence on driver behaviour in road traffic, how well such behaviour supports observed traffic patterns and then assess and develop their agent representations to conform to both observed patterns in traffic systems and the evidence on individual behaviour. While they do not claim complete success, they do report improvements based on validation procedures involving domain experts. A third discussion of alternative simulation approaches to address a problem issue is offered by Breton *et al.* who argue explicitly for the advantages of multi agent simulations over previous approaches to the analysis of the dynamic properties of piles of granular material such as sandpiles, grain in storage elevators and the like. In this paper, uniquely for the present collection, the agents are representing inanimate objects (grains of sand) rather than animate (usually human) creatures. The paper by Kafeza and Karlapalem investigates and extends the work flow management system framework to speed up activities in multi agent environments, using simulations to assess the effectiveness of their innovation. While this paper is the least clearly focused on agents, it is also the clearest in raising implementation issues that affect agent and mechanism design.

Three papers address issues of actual social interaction in order to develop clear hypotheses for empirical validation. Hemelrijk's paper on sexual attraction and dominance, builds on her own and others' earlier work to develop new hypotheses about the effects of aggressiveness, social cohesion and sexual attracttion – several of these hypotheses emerging unexpectedly from the simulations. Rouchier *et al*. report and compare three models developed in the French research institute CIRAD that generate hypotheses concerning the use of common renewable resources. The issues addressed in all of the models reported in both of these papers were selected because of their empirical importance and lack of obvious resolution in the literatures. The implementation of each model was also guided and informed by empirical observation of relevant populations of primates, butterflies and human communities in western Africa. The third paper in this vein, by Downing *et al.*, reports no models (though some have been implemented) but does outline a strategy for modelling large scale, complex environments. The particular application is the development of integrated physical-biological-social simulation models to inform the policy process concerning the mitigation and effects of climate change. The reliance on agent based social simulation models in such integrated policy assessment applications is novel and uses an agent based software engineering approach dramatically to push back the trade-off between the scale of the system to be simulated and the detail of the representation.

We turn finally to the triad of papers dealing with the role of formal logics in agent based simulation. Teran *et al.* use the elements of SDML that make it consistent with a fragment of strongly grounded autoepistemic logic as a theorem prover for a model implemented in SDML. This is a different approach from that used in (say) Concurrent MetaTem (*e.g.*, Fisher, 1997) where the program is written in an executable logic. The point of the Teran *et al.* paper is to prove that all runs of a simulation model will yield outputs conforming to the theorem. This is an efficient alternative to Monte Carlo studies and is more convincing than reports of outputs from a few runs of a given simulation model. The David *et al.* paper reports an integrated model with utility-oriented parameters (but not utility maximisation) and a Newell-Simon approach to the representation of cognition to simulate coalition formation based on mutual dependence as an alternative to trust. The dynamics of the model are investigated by means of simulation experiments. An important feature of the paper is its authors' explicit recognition of the limitations of the model and the specification of further issues to be investigated. This is an alternative to some literatures where the problem is simply respecified to avoid the effect of the limitations of the analysis.

Less directly formal, but dealing with extensions to the use of BDI formalisms, is the paper by Norling *et al.* Their purpose is to extend BDI-inspired languages by augmenting the representation of agent cognition to give the agents more human-like decision making strategies. These strategies are derived form the natural decision making (NDM) literature which is specifically geared to agent decision making in messy, uncertain environments with significant agent interaction. This is, of course, very different from the environment – the mechanism and agent designs – recommended by Wooldridge and Jennings for, *inter alia*, BDI agents of the Rao-Georgeff type.

In conclusion, papers were selected for MABS2000 only if they made some clear contribution to the development of agent based simulation as a means of analysing large scale, complex systems involving substantial interaction among agents. Many, though by no means all, such systems are social systems populated by humans. Software systems populated by software agents are increasingly important and modelling those systems to inform mechanism and agent design is an important application of the modelling methodology and technology being developed for agent based *social* simulation. Included papers that do not incorporate demonstrator models were accepted because of the clarity with which they identified either new areas of research or new means of addressing existing areas of research.

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