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Guest Editorial

Spatial agent-based modelling

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The convergence of object-oriented approaches to data modelling within geographic information science together with increasingly fine-scale data collection approaches and discrete-event simulations has created new opportunities to build dynamic representations of geographical systems (Gimblett 2002, Brown *et al*. 2005). In particular, agent-based modelling has become an important representational paradigm within both the biological (DeAngelis and Gross 1992) and social (Epstein and Axtell 1996) sciences. A software agent can be constructed as a self-directed object, i.e. it has the ability to satisfy internal goals or objectives through actions and decisions based on a set of internal rules or strategies (Iglesias *et al*. 1999) and can be used in one of two primary modes: instrumental and representational. In the *instrumental* mode, agents are created for the primary purpose of performing a computing task to reduce reliance on the attention and cognition of a human operator, i.e. the agents stand in for the computer user. A good example is the system described by Sengupta and Bennett (2003) that uses agents to assist new users of geographic information systems in their application for decision support. In *representational* mode, the agent is designed for the primary purpose of behaving in a manner that is consistent with that of a third party, i.e. another person, group, institution, animal, or other animate object. Although this distinction is somewhat arbitrary and, in practice, not always clear, it highlights the range of purposes to which agent-based modeling is put within the articles presented here.

This special issue draws together six papers that were presented at the GeoComputation 2005 conference, held on 1–3 August 2005 in Ann Arbor, Michigan and jointly hosted by the School of Natural Resources and Environment at the University of Michigan and the Institute for Geospatial Research and Education at Eastern Michigan University. As we surveyed the themes of papers presented at the conference, agent-based modelling was clearly a dominant one. Though the papers here tended to focus on issues associated with using agent-based modelling in representational mode, a couple of papers hinted at instrumental uses. For example, Parunak *et al*. discuss how agents can be used to solve the problems of navigation in heterogeneous landscapes, largely an instrumental application in which the agents perform computations collectively to solve complex spatial problems. Graniero and Robinson present a framework for building coupled agent-landscape models and illustrate the framework with representational agent-based

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models, some of which are designed towards instrumental ends (e.g. testing and designing environmental sampling schemes).

The other papers focus primarily on issues of representation in agent-based models. A substantial sub-theme within the papers is the appropriate representation of cognitive and decision-making processes of agents (i.e. humans, households, or elk). Manson proposes and tests the use of genetic programming as a tool for representing human cognition in land-use decision-making, and the representational links to bounded rationality. In order to empirically ground decision-making strategies in a similar land-use context, Evans *et al*. propose the use of experimental methods, in which subjects are asked to make stylized decisions through interaction with a simulated landscape and with other subjects, and compare spatial patterns of land use that emerge from experiments with those of perfectly rational agents. Bennett and Tang, like Manson, focus on representing learning and adaptation though the use of genetic programs, but present an approach to representing spatial learning in an elk herd. Their model essentially uses two types of representations of the space through which elk move: first are the spatial data representations traditionally used within geographic information systems, and the other is a network model that represents the mental map possessed by the elk as they learn and remember how to move through the landscape. Finally, Jepsen *et al*. present an applied agent model of farmers in Vietnam, in which they provide a simulation-based test of a hypothesis for the observed pattern of farm-field sizes.

Collectively, these papers provide a valuable vignette into the emerging area of spatial agent-based modelling. In the course of these efforts, the researchers have risen to the challenge of developing new model design approaches, designing software linkages between different types of representations (e.g. physical and cognitive spaces), and creating new tests for validating the representational fidelity of their models. Many of these papers represent results from ongoing projects, and work remains to be done on these specific projects, and in developing agent-based models that both effectively perform computational tasks in geographical information science and efficiently represent the animate geographical objects. The papers in this issue demonstrate the substantial promise offered by these approaches.

We wish to thank the editors of the *International Journal of Geographical Information Science* for providing this forum for these papers, the reviewers who helped the authors produce the highest-quality papers, and the authors themselves for their timely production of the papers and their subsequent revisions.

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