Agent-Based Simulation: Social Simulation and Beyond

Bruce Edmonds (bruce@cfpm.org)
Emma Norling (norling@acm.org)
Centre for Policy Modelling
Manchester Metropolitan University
Aytoun Building, Aytoun St, Manchester, M1 3GH, United Kingdom

Abstract

Our interest in agent-based simulation is for *social simulation*, where the society-level outcomes emerge from the interaction of individuals. In this tutorial, we aim to introduce the core concepts of agent-based social simulation, illustrated by a range of examples, before walking through a specific example with the participants so that they can experience these issues at first hand.

Keywords: social simulation, social theory, agent-based modelling

What is Agent-Based Simulation?

Agent-based simulation (ABS) represents each individual with a separate encapsulated object in a simulation. Beyond this, the definition of an "agent" varies quite widely, but in general they are seen to be autonomous, pro-active entities. Simulation outcomes emerge from the interactions between these entities, and often even quite simple interactions can give rise to complex system dynamics.

The individuals that agents represent in a simulation need not be humans, and could be social actors of any type. Examples of entities that have been represented by agents in simulations range from individual cells and bacteria through to multi-national corporations. Typically though in social simulation we are interested in modelling each individual person with a single agent. At the same time, we are often interested in modelling the interactions of large numbers of individuals, and this forces a trade off between the detail of the individual models and the number of entities that can be modelled.

Thus, while it is desirable for the agents to include models of various aspects of cognition (such as decision making, learning, belief representation, autonomous goals), it is necessary to pare them down to the bare minimum required to model the social interactions of interest. By the standards of cognitive models many of the programs internal to each agent might be fairly simple, although some researchers in this area are investigating ways of including more detailed models of individuals within this type of simulation.

Simulating Societies

Our interest in ABS is to simulate how humans (or other social entities) might interact: for example, how complex coordination might be achieved through the interaction of essentially selfish agents (Edmonds, 2006). Some of these models can be very detailed, including many different aspects of a particular observed social situation. In this case the result is more like a dynamic description within a simulation – a distributed representation that may incorporate many different kinds of evidence.

Emergent Behaviour

At the same time, complexity science has repeatedly shown how the interaction of fairly simple agents can result in complex ("emergent") outcomes. Thus, one stream of research in ABS is looking at how social systems might be understood in this way. These tend to be quite abstract simulations with very simple agents, which are intended to encapsulate a general social theory, rather than to represent any particular observed social phenomena.

Applying Social "Rules" to Other Networks

One outcome of the study of emergent behaviour in human societies has been to transfer these principles to other social systems. For example, when systems of independently programmed computers interact in a network, many of the same issues (trust, reputation, coordination etc.) that occur in human societies are found to be important. The previously mentioned work on cooperation between self-interested individuals, for example, has been used to develop algorithms for peer-to-peer computing systems that are robust against "cheaters" (Hales, 2006).

Outline of the Tutorial

This tutorial introduces the main ideas of ABS, highlighting the difficulties as well as the strength of these issues, drawing on many examples of ABS, from complex specific simulations, up to highly abstract simulations that encapsulate social theories. In the second half of the tutorial, these ideas will be illustrated through the use of a concrete example. Depending on the existing skills of the participants, there will be opportunities to implement their own realisation of this example.

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References

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