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# Poster: Arguing the validity of Models and Simulations for Scientific Exploration

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**Abstract** As a tool for researching complex systems in life sciences, computer simulation must be demonstrably suited to the scientific purpose. Using approaches from traditional computer simulation and critical systems engineering, we propose argumentation techniques to present fitness for purpose arguments. The illustration is a basic argument used to establish and express a basis for understanding between modellers and scientists. The purpose was to establish agreement that an agent-based computer simulation on an extensible platform is adequately equivalent to an earlier, less-efficient, computer simulation used in a trait-based study of ecological abundance.

**Keywords** computer simulation · agent-based simulation · validation · argumentation · systems engineering

## Poster Introduction

As part of the CoSMoS project (www.cosmos-research.org: Complex Systems Modelling and Simulation Infrastructure), we are developing support for scientific research through agent-based computer simulation. We are working to extend studies in trait-based plant ecology (with SIMBIOS, Abertay University, UK), and with immunologists studying variously granuloma formation, lymphocyte migration to lymphnodes (with Centre for Immunology and Infection, University of York, UK), and aspects of T-regulatory networks of relevance to autoimmune diseases (with Torrey Pines Institute for Molecular Studies, US) Read et al (see, for example 2009); Andrews et al (see, for example 2008); Polack et al (see, for example 2009); Ghetiu et al (see, for example 2009).

Traditional scientific experimentation is hampered by the need to understand the dynamic behaviour of complex systems, which may entail very large numbers of components or long time-scales. If the scale and variability can be captured, computer simulations can provide a useful complement to experimentation. However, we need to overcome prevalent scepticism about the ability of computer simulations to contribute to scientific research (summarised in Polack et al, 2008).

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As computer simulators and modellers, we work closely with the collaborating scientists. The shared understanding built up by systematic collection and exposure of assumptions and documented rationale for simulation and experimental designs has allowed scientists to use even basic agent-based models to test their understanding and guide their experiments.

To support this approach, we turn to traditional simulation validation (for example Sargent, 2005) and to techniques from critical systems engineering (for example Wu and Kelly, 2007), systematising the use of *arguments* to demonstrate the extent to which a simulation can be thought of as equivalent to a scientist's understanding of reality or to another simulation or model of that reality. Such arguments not only document the basis of confidence in a simulation; their development also forms the basis for discussion between the simulators and the scientists (see Polack et al, 2009; Ghetiu et al, 2009, for further discussion).

A simple example of such an argument establishes agreement that an agent-based computer simulation on an extensible platform is adequately equivalent to an earlier, less efficient, computer simulation, used in the trait-based study of ecological abundance (Bown et al, 2007). The agreed basis for adequate equivalence is that the simulations represent the same science, that, at an abstract level, they use sufficiently-similar implementational structures and algorithms, and that, for an existing corpus of experiments, the data generated over many runs of the simulations are equivalent within the usual statistical confidence limits. This is the basis from which the ecological abundance research will be extended to look at numerically and characteristically realistic populations of plants[1].

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[1] The argument is summarised in a forthcoming Workshop paper (Ghetiu et al, 2009) and technical report