The virtual rocky shore — linking A-life with ecological and pedagogical research

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The design and analysis of manipulative experiments is a key skill for undergraduate ecologists to learn. Despite this, students rarely conduct a true manipulative experiment with appropriate control treatments in the field, because of practical constraints such as time. Meaningful ecological experiments typically require months to obtain results, as well as constant maintenance and attention; and often require the use of large areas of undisturbed habitat. One solution to this problem is to allow students access to a virtual ecosystem in which they can conduct a possibly unlimited range of experiments which will quickly provide realistic data for subsequent statistical analysis and interpretation.

Currently, virtual ecosystems fall into two basic categories: those that are vast oversimplifications of real ecosystems, displaying simplistic and pre-programmed behaviours; and those that bear little resemblance to real ecosystems, made entirely of interacting digital organisms. While the latter are of more interest to the A-Life community, they are not user-friendly to biology students who are generally not computer literate beyond the basics of word processing, spreadsheets and internet technologies.

"The Virtual Rocky Shore", is grounded in a variety of A-life techniques, including agent-based modelling, self-organisation, evolutionary algorithms and cellular automata. The present version of The Virtual Rocky Shore is based on the high intertidal region, a simple consumer / resource ecosystem consisting of grazing snails and a photosynthetic mat or biofilm of lichens, diatoms and bacteria. Although the system is simple, research underpinning the system's models has demonstrated that these intertidal snails show many similar behavioural rules to those displayed by classic A-Life inspirations such as ants. The intertidal snails, for example, exhibit self-organisation as a result of trail following. The dynamics of the photosynthetic components of the virtual shore are also suitable to being modelled in space and time by use of cellular automata and computer-based optimisation processes including evolutionary algorithms.

Current development of The Virtual Rocky Shore using a user-friendly interface has already provided novel insights into the functioning and evolution of intertidal communities; with many of these insights backed up by empirically derived data from real shores and published in peer reviewed journals.

The first implementation of the Virtual Rocky Shore allows experiments to be designed and analysed in a matter of minutes, rather than the many months traditionally required, facilitating the active and potentially deep experiential learning of experimental design by students. The results obtained from the simulation are also similar, and result in comparable statistical analysis, to those obtained from experiments on real shores.

The full potential of The Virtual Rocky Shore, however, lies in its expansion to cover the mid and lower shore systems. The complexity found at these shore levels will allow many opportunities for further research at the interface of ecology and computer science, as well as the development of a wide range of potential experiments beyond simple grazer / biofilm interactions.