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Attending to Temporal Assumptions May Enrich Autonomous Agent Computer Simulations

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ABSTRACT

Agent-based computer simulations use agents on landscapes to investigate epidemics, social phenomena, decision making, supply networks, the behavior of biological systems, and physical and chemical processes, among other things. This essay examines how agents and landscapes are oriented in time and this orientation's relevance to observing and interpreting findings. I argue that the proposed temporal deepening of how simulations are constructed involving interaction of multiple temporalities (itself a kind of temporality) could lead to the unexpected triggering of cascades of secondary emergences. Such cascades may already be there but going unobserved. Buddhist cosmology is briefly used as a contrast with current simulation temporal orientations to illuminate key points. Katherine Hayles's work on media, my theoretical work on time-ecologies and heterochrony, and J. T. Fraser's theory of the nested hierarchy of time and associated causalities are used to explore these issues.

Keywords: *autonomous agents; emergence; simulation; time; time-ecologies*

INTRODUCTION

In an earlier paper, "Computer Simulation as Hidden Time-Ecologies," NetLogo is used to show how a limited concept of temporality affects NetLogo's simulations (Koehler, in press). Here we will look more closely at how a limited temporal perspective of the programmer/experimenter raises problems with understanding exactly what the simulation is showing. As noted by Wilensky (1999):

[NetLogo] is a programmable modeling environment for simulating natural and social phenomena. NetLogo claims to be particularly well suited for modeling complex systems developing over time. Modelers can give instructions to hundreds or thousands of independent "agents" all operating concurrently. This makes it possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from the interaction of many individuals.

NetLogo is used to simulate emergent phenomena involved in AIDS epidemics, altruistic acts, ethnocentrism, chemical and physical processes, earth sciences, segregation, art, mathematical problems, and ant activity without any variations in temporal concepts.

Rehearsing the general theoretical argument, I start with the point that in a digital computer, the simulation creation instructions are "in the form of COMMAND (ADDRESS) where the address is an exact (either absolute or relative) memory location, a process that translates informally into "DO THIS with what you find HERE and go THERE with the result." Everything depends not only on precise instructions, but on HERE, THERE, and WHEN being exactly defined." (Dyson, 2005). With these instructions, a simulation as ones and zeroes in a machine is established without a one-on-one referent in the real world. There are no actors playing out ethnic community relations for example, only digits. The instantiation of these temporal relationships in computer based media—hardware, program, computer processing, and visualization—suggests that analysis of each is necessary to understand the temporal assumptions of a simulation as it is constructed, how temporality is incorporated and limited by its operation, and how media shapes interpretations of the results by the temporally instantiated experimenter. For example, artistic control for interactive evolution of images and animation is important for 2D images seen in a simulation. Attractive and expressive mutation types and genotype transforms are sometime introduced as a way to make genotypes more receptive to mutation. For evolving animation, tree alignments of evolutionary sequences may be introduced. The result is an intervention that provides greater control and expressive power over space-time as governed by the artistic eye of the programmer and experimenter.

I will hold that simulation representations and the technologies producing them are inextricably intertwined. (This discussion draws heavily from Hayles, 1999, 2002, and 2005). Further, the form of the representational artifact always affects what the semiotic components mean, be they "turtles" or "landscapes" on a computer screen. For example, much current analysis of simulations does not account for the signifying components that reveal the simulation process, its manipulation and interpretation such as sound, animation, motion, visualization, and software functionality, among other factors. Efforts are underway to design avatars—a more sophisticated turtle—to appear more trustworthy and to interact more gracefully, suggesting that the information conveyed is more reliable, which isn't necessarily so (Donath, 2007). Such design considerations are also relevant to simulation control panels and data visualization methods (Chen, 2004). These become significant issues as agent simulations and virtual worlds are used for scientific social research (Bainbridge, 2007).

The NetLogo world is constructed by programming interactions among three interrelated types of agents, all controlled by a computer "timer"—the when—with a resolution in milliseconds or so depending on the underlying Java Virtual Machine. The first, an "agent"—one semiotic component—appears to move (actually different pixels light up) according to programmed rules over the second called "patches" or a landscape, another semiotic component. Agents can be designated as "breeds" of agents such as foxes, chickens, and grass that interact in set ways. The third agent—a third and complex semiotic component—is an "observer" which "hovers" over the unfolding agent-landscape and uses the clock to demark agent and landscape activities. "[All three] are beings that can follow instructions. Each . . . can carry out its own activity, all simultaneously." (Dyson, 2005). Agents execute commands asynchronously but are programmed to "wait" for the others to complete their commands before going on. Groups of agents (foxes and chickens for example) are started randomly every time the program is initiated so as not to favor one agent or segment of the landscape over another. Landscapes may have a preferential point such as a pile of grass for a chicken agent, but its constituent patches may be set or evolve according to some rule.