

Open Lecture

Genetic Programming in Agent-Based Modeling of Artificial Stock Markets

Lecturer: Shu-Heng Chen

(Professor, Department of Economics, National Chengchi University)

Date: March 24, 2000 (13:00-14:00)

Place: ERB-347

This lecture starts with a paper by Lucas (1986), the 1995 Nobel Prize Winner in Economics, published in *Journal of Business*. In this paper, Lucas proposed a notion of an *adaptive economic agent* which is described as the evolution of a *collection* of decision rules. Lucas did not articulate how this evolutionary process should be implemented. Nevertheless, one should not be surprised by this disappointment because, back to the 1980s, the technique to evolve a population is simply not in economists' toolkit. In fact, the earliest proposal to impose Lucasian adaptive economic agents in economic models is the *multi-population genetic algorithm (PGA)* made by Holland and Miller (1991). Arthur (1992) gave a first application of the PGA to build an artificial financial market, which started the research area currently known as the *agent-based computational finance*.

While the genetic algorithm can effectively encode a certain class of decision rules, it can, at its best, only effectively handle the *parametric* decision rules, not the non-parametric ones. Moreover, decision rules in their general forms are *mathematical functions* and *computer programs*. Therefore, the real challenging issue for economists is how to *evolve a population of computer programs* rather than a population of parameters. At this point, the relevance of genetic programming (GP) to economics

seems clear. In a sense, **GP** pioneered by Koza (1992) can be considered as a methodological innovation to economics because it shows exactly how to evolve a population of programs. A series of *snapshots* of the evolving population of bargaining strategies in a double auction market is shown via a brief review of Andrews and Prager (1994), the earliest application of GP to economics.

Finally, we introduce the artificial stock market built by the AI-ECON Research Center, **AIE-ASM**. We started from a standard asset pricing model, and then provided an agent-based computational version of it. In this sense, AIE-ASM is very similar to the Santa Fe artificial stock market. Nonetheless, the former allows for both social and individual learning, whereas the latter only allows for individual learning. Moreover, the use of genetic programming gives AIE-ASM the potential to feature more interesting dynamics of traders' behaviour. We demonstrate AIE-ASM with a few typical finance examples, such price discovery, effects of herd behaviour and the price-volume relation.