Computational intelligence in economics and finance: Carrying on the legacy of Herbert Simon

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Abstract

This is an editorial guide for the special issue on computational intelligence (CI) in economics and finance. A historical introduction to the background is given. This research paradigm is traced back to Herbert Simon, who, as a founder of artificial intelligence, pioneered the applications of AI to economics. The move from the classical AI to CI indicates a continuation of the legacy of Herbert Simon. Computational intelligence has proved to be a constructive foundation for economics. In responding to what Herbert Simon referred as procedural rationality, our study of bounded rationality has been enriched by bringing autonomous agents into the economic analysis.
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Keywords: Computational intelligence; Artificial intelligence; Agent-based computational economics; Autonomous agents; Stock price-volume relation; Micro-macro relation

1. Computational intelligence in economics and finance

The incessant interaction between the development of real-world issues and the progress in science has continuously moved the frontier of economics

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forward. Herbert Simon, as the only person to win the *Nobel Memorial Prize in Economics, the Turing Award* by the ACM and the ORSA/TIMS von Neumann Prize, is a perfect illustration of this advancement in economics. Being a life-long scholar of *human decision-making*, Simon believed that economic research should start from the study of actual behavior rather than be based on con-venient but unrealistic assumptions. He acted upon his belief by drawing materials from his own contributions to *computer science* and *cognitive psy-chology* so as to enrich the study of economics and management science. His inventions in economics, *satisfying behavior* and *bounded rationality*, were substantiated by making extensive use of the computer to simulate human thinking and to augment it with *artificial intelligence*.

The development of economics over the last two decades has been largely in line with the legacy of Herbert Simon. Artificial intelligence, of which Simon was one of the founders, is now widely applied to modeling the adaptive and learning behavior of boundedly-rational agents. With the advent of the high-performance computing era, computer simulations of human behavior, on which Simon spent more than 40 years, seem to have become a promising direction for empirically grounded economic reason. The significance of psy-chological and behavioral approaches to economics, of which Simon was a pioneer, was well acknowledged by the Nobel Prize Committee. [1]

Simon's main contribution to AI is what is known as the *symbol-processing approach*, a kind of classical AI. There is a severe limitation of this approach. Where do the symbolic concepts come from? How do they evolve and grow? How are they modled by feedback from the environment? Symbol-processing computers (agents) cannot come up with useful ideas of their own to make sense of new situations. Since the economic system is doubtlessly a complex adaptive system, in which surprises, innovations, novelties, and sudden chan-ges are ubiquitous, it is hard to satisfy modeling agents living in such a system with just a manually-driven device. Over the last decade, an interdisciplinary research area, known as *autonomous agents*, has opened a new avenue to economists who are longing for the *life* of economic agents in their models. [2]

The implementation of autonomous agents in economic models was made feasible or easier by a series of toolkits from the development of modern AI. Collectively, they are known as *computational intelligence* (CI). It has been shown in many different contexts how CI has effectively extended Simon's boundedly-rational agents into autonomous agents. Little by little, CI has been

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[1] Mentioning this is particularly appropriate when the 2002 Nobel Laureates in economics just happen to be pioneers of these two fields of research: Daniel Kahneman and Vernon Smith.

[2] The idea that agents possess *artificial life* was first introduced to economists in [30]. Also see [8] for a historical development of the idea of *adaptive economic agents* in the light of genetic algorithms and genetic programming.