Chapter 18
Building ABMs to Control the Emergence of Crisis Analyzing Agents' Behavior

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ABSTRACT

Agent-based models (ABMs) are quite new in the modeling landscape; they emerged on the scene in the 1990s. ABMs have a clear advantage over other approaches: they create the capacity to manage learning processes in agents and discover novelties in their behavior. In addition to bounded rationality assumptions, ABMs share a number of peculiar characteristics: first of all, a bottom-up perspective is assumed where the properties of macro-dynamics are emergent properties of micro-dynamics involving individuals as heterogeneous agents who live in complex systems that evolve through time. To apply this framework to financial crisis analysis, a simplified implementation of the SWARM protocol (www.swarm.org), based on Python, is introduced. The result is the Swarm-Like Agent Protocol in Python (SLAPP). Using SLAPP, it is possible to focus on natural phenomena and social behavior. In the case of this chapter, the authors focus on the banking system, recreating the interactions of a community of financial institutions that act in the payment system and in the interbank market for short-term liquidity.

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INTRODUCTION: LITERATURE REVIEW[1]

... there is no general principle that prevents the creation of an economic theory based on other hypotheses than that of rationality (K. J. Arrow, 1987)

The *raison d'être* of Agent-based models (ABMs) lies in a vision of the world that is completely different from the conventional view of rational choice theory, which prevails in economics.

Beginning with Adam Smith's idea of the "invisible hand," the (minor) history of economic science may be represented in a stylized fashion as a progressive refinement of the rational agent hypothesis, which first materialized in profit (utility)-maximizing agents and, later, in the Lucas and Sargent rational expectation theory.

In the game theoretical strand of economic science, the rational agent paradigm translates into infinitely forward- and backward-looking agents that are usually endowed with common knowledge about their opponent's rational behavior.

Although infinitely rational, strategies elaborated by these agents may be proven as less successful than simpler strategies based on heuristics and shortcuts, as witnessed by the famous Axelrod tournament reported in Schellenberg (1996). Axelrod invited game theorists and behavioral economists to play an iterated prisoner's dilemma by submitting computer programs translating the strategies that they thought a player should follow during the game. A number of scholars joined the tournament: some of them presented complex software replicating forward- and backward-looking agents, and others submitted simple programs mimicking agents' behaviors with simpler rules, heuristics and shortcuts. The simplest of these programs was the one named "Tit for Tat," built by Anatol Rapoport, a famous psychologist. The artificial agent embedded in the Rapoport "Tit for Tat" program acted on a minimal decision tree (represented in four instructions), which led the agent to cooperate at the first iteration and then to match the opponents' strategy: cooperate if the other cooperates, and defect if the opponent defects. Against every forecast, the Rapoport program won the tournament. Surprisingly, "Tit for Tat" emerged the winner in a second tournament in which the artificial agents embedded in the competing programs had been built to challenge "Tit for Tat" on the basis of complex decision trees. It was not the surprise effect that enabled "Tit for Tat" to overcome its opponents in the first tournament; Rapoport's artificial agent emerged as the most effective program, even though other artificial agents had been aware of its behavior.

The Rapoport "Tit for Tat" software history unavoidably recalls the concept of "bounded rationality," originally introduced by Nobel Laureate H. Simon in the 1950s as a "rational choice under computational constraints," whose specific ingredients are (1) the limited, sometimes fuzzy, information regarding possible alternatives to a specific problem and the related consequences at the agents' disposal; (2) the limited ability of the agents to elaborate the available pieces of information; and (3) the limited amount of time agents can spend deciding. Given these constraints, agents tend to adopt "satisficing" rather than optimizing behavior by relying on rules of thumb, heuristics and shortcuts to deliberately save resources (Simon, 1955).

The plausibility of the bounded rationality paradigm has been confirmed by a great deal of additional experimental evidence rooted in the seminal works of Daniel Kahneman, Amos Tversky, and their collaborators (who laid the foundation of an enormous body of literature on the topic). Among their main contributions (such as Tversky and Kahneman (1992)) was the discovery of the framing effects governing the decision processes of the agents whose choices do not depend on the contents of the choice but rather on the way that the decision problem is framed, i.e., the way the alternatives are presented.

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