Chapter 3

Neuroeconomics: A Viewpoint from Agent-Based Computational Economics

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ABSTRACT

Recently, the relation between neuroeconomics and agent-based computational economics (ACE) has become an issue concerning the agent-based economics community. Neuroeconomics can interest agent-based economists when they are inquiring for the foundation or the principle of the software-agent design, normally known as agent engineering. It has been shown in many studies that the design of software agents is non-trivial and can determine what will emerge from the bottom. Therefore, it has been quested for rather a period regarding whether we can sensibly design these software agents, including both the choice of software agent models, such as reinforcement learning, and the parameter setting associated with the chosen model, such as risk attitude. In this chapter, we shall start a formal inquiry by focusing on examining the models and parameters used to build software agents.

NEUROECONOMICS: AN ACE VIEWPOINT

From the perspective of agent-based computational economics (ACE), our interest in neuroeconomics is different from that of general psychologists and neural scientists. Agent-based computational economics advocates a bottom-up research paradigm for economics. This paradigm does not treat micro and macro as two separate entities and work with each of them separately; instead, it studies the relationship between the two in a coherent framework. Therefore, given the bottom-up manner, we pay more attention to the micro details, and always start the modeling at the level of agents. This methodological individualism drives us to incorporate the psychological, cognitive, and neural attributes of human beings into the study of economics. What causes ACE to differ from these behavioral sciences is the scope of the research questions; therefore, while ACE cares about the fundamental cause (the
neural cause) of the cognitive biases, it is more concerned with the implications of these cognitive biases for any possible emergent mesoscopic or macroscopic phenomena. Furthermore, ACE researchers do not regard the behavioral factors as given (exogenous); they also study the feedback from the aggregate level (social outcome) to the bottom level (individual behavior).  

Given what has been said above, we believe that unless neuroeconomics can provide some important lessons for agent-based computational economists, its significance may hardly go far beyond neural science, and would not draw much attention from economists. This, therefore, motivates us to ask: Does neuroeconomics provide some important lessons for agent-based economic modeling? It is this question that this chapter would like to address.

In the following, we will review the recent progresses in neuroeconomics in light of its contributions to different aspects of agent engineering. We start from the most fundamental part of agents, i.e., preferences (Section 2), which points to two foundational issues in economics, namely, the measurement or representation of preference and the formation of preference. Some recent advances in the study of these two issues may lead to new insights in the future of agent engineering with regard to preference development. We then move to the immediate issue after preferences, i.e., choices, or, more precisely, value-based choices (Section 3), and further specify the intertemporal choice (Section 3.1), where we can see how the discount rate should be more carefully designed. We then focus more on two behavioral aspects pertaining to the design of financial agents, namely, risk perception (Section 3.2.1) and risk preference (Section 3.2.2). The neural mechanism regarding learning or adaptation is given in Section 4. Finally, the chapter ends with a final remark that connects the relationships among behavioral economics, neural economics and agent-based economics, which is a continuation of the points made earlier (Chen, 2008).

PREFERENCE

“The nature of wealth and value is explained by the consideration of an infinitely small amount of pleasure and pain, just as the theory of statics is made to rest upon the equality of indefinitely small amounts of energy. (Jevons, 1879, p. 44; Italics, added)”

Standard economic theory takes individual preferences as given and fixed over the course of the individual’s lifetime. It would be hard to imagine how economic models can stand still by giving up preferences or utility functions. They serve as the very foundation of economics just as we quoted above from William Stanley Jevons (1835-1882). Without preference or utility, it will no longer be clear what we mean by welfare, and hence we make welfare-enhancing policy ill-defined. Nevertheless, preference is now in a troubling moment in the development of economics. Even though its existence has been questioned, the development of neuroeconomics may further deepen this turbulent situation.

The Brain as a Multi-Agent System

The recent progress in neural science provides economists with some foundational issues of economic theory. Some of its findings may lend support to many heated discussions which are unfortunately neglected by mainstream economics. The most important series of questions is that pertaining to preference. While its existence, formalization (construction), measurement, consistency and stability has long been discussed outside mainstream economics, particularly in the realm of behavioral economics, neuroeconomics provides us with solid ground to tackle these issues.  

To see how neuroscience can inform economists, it is important to perceive that the brain is a multi-agent system. For example, consider the Triune Brain Model proposed by Maclean (1990).
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