Chapter XVII
Agent–Based Modeling with Boundedly Rational Agents

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ABSTRACT

This chapter introduces an agent-based modeling framework for reproducing micro behavior in economic experiments. It gives an overview of the theoretical concept which forms the foundation of the framework as well as short descriptions of two exemplary models based on experimental data. The heterogeneous agents are endowed with a number of attributes like cooperativeness and employ more or less complex heuristics during their decision-making processes. The attributes help to distinguish between agents, and the heuristics distinguish between behavioral classes. Through this design, agents can be modeled to behave like real humans and their decision making is observable and traceable, features that are important when agent-based models are to be used in collaborative planning or participatory model-building processes.

INTRODUCTION

Modeling human behavior is challenging. Modelers of agent-based models face a choice and a trade-off: how simple and traceable or realistic and psychologically plausible should agent behavior be modeled. Theory does not provide much guidance in this respect since numerous and sometimes contradictory theories on human behavior exist. We chose to model agents as boundedly rational. We base their behavior on observation, both from experimental economics and field studies.

The agents in our models are characterized by a set of attributes, which have been derived from experimental data and theoretical ap-

proaches. They have expectations about their environment and the other agents. In this way, agent diversity is introduced. They exhibit boundedly rational behavior through aspiration levels and the use of simple heuristics.

This chapter introduces our modeling approach and the tool developed for our purposes which provides an environment for creating agent-based models with boundedly rational decision making. The focus lies on developing models based on economic experiments, but the tool is expandable to include field studies as well. Experimental economics provides us with a rich database of human behavior in simple, well-defined settings. The experimental results can be compared and reproduced. This allows extracting behavioral regularities from the data and using these to define micro behavior in the model. This is important because different micro behavior can lead to similar aggregate results. This chapter includes two exemplary models of economic experiments.

The software tool provides the agents with attributes and a set of heuristics that can be expanded to include new heuristics that fit better to problems which have not yet been modeled. The modeler can set parameters, like which kind of agents use which kind of heuristics. He or she can include new heuristics and learning processes, as well as new decision environments. With this tool it is possible to compare different micro behavior as well as reactions on different model framings. We expect this modeling approach to make it possible for stakeholders to identify with agent behavior and thus facilitate group model building and collaborative planning.

The remainder of this chapter is organized as follows. The section "Bounded Rationality" is a brief introduction to this theory of human behavior and its advantages for our purposes. In the section "Attributes and Heuristics," our modeling approach is described. In the section "Exemplary Models," two different models are described that reproduce data from economic experiments. These are the voluntary contribution mechanism with and without punishment, and appropriation games with and without communication. Some concluding remarks are made about the relevance of the modeling approach presented in this chapter. The appendix provides some technical details for modelers who want to use the tool.

BOUNDED RATIONALITY

The decision environments considered here are explicitly those in which the classical economic model of decision making fails to make correct predictions of actual human behavior. With classical model we refer to subjectively expected utility maximization of perfectly rational actors. The situations we are interested in include social dilemmas in which individual rationality differs from group rationality, and gift exchange situations in which gift giving seems to follow norms of reciprocity or fairness. At least in these situations the classical economic model of perfect rationality has to be enriched or complemented by theories that explain instances of cooperation and reciprocity.

Bounded rationality was introduced as an alternative to perfect rationality as the principle of human decision making (Selten, 1990). Instead of grounding a behavioral theory in optimization processes with a number of rather unrealistic assumptions on the capabilities and preferences of humans, bounded rationality is psychologically plausible (Gigerenzer & Todd, 1999; Gigerenzer & Selten, 2001).

The main idea is that learned heuristics are the basis of human behavior instead of permanent optimization. Heuristics are simple behavioral patterns that are triggered by the decision