

## Chapter 14

# Simulating an Incentive Framework for Scientific Production by Means of Adaptive Agents

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### **ABSTRACT**

*This chapter describes an agent-based simulation of an incentive mechanism for scientific production. In the proposed framework, a central agency is responsible for devising and enforcing a policy consisting of performance-based incentives in an attempt to induce a global positive behavior of a group of researchers, in terms of number and type of scientific publications. The macro-level incentive mechanism triggers micro-level actions that, once intensified by social interactions, lead to certain patterns of behavior from individual agents (researchers). Positive reinforcement from receiving incentives (as well as negative reinforcement from not receiving them) shape the behavior of agents in the course of the simulation. The authors show, by means of computational experiments, that a policy devised to act at the individual level might induce a single global behavior that can, depending on the values of certain parameters, be distinct from the original target and have an overall negative effect. The agent-based simulation provides an objective way of assessing the quantitative effect that different policies might induce on the behavior of individual researchers when it comes to their preferences regarding scientific publications.*

## INTRODUCTION

*The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom.*  
(Isaac Asimov)

It can be argued that one of the main differences between social and natural sciences lies in the methods used to assess their results. While natural sciences can rely on empirical procedures for evaluating their hypotheses, social sciences are seldom in a position to use such an approach, mostly due to ethical questions and to the absence of instrumental conditions for allowing the construction of a reasonable experimental environment.

Agent-based models for social simulation provide an alternative to overcome those difficulties. They both rule out the ethical concerns – after all, no human subjects are involved in the experiments – and accomplish the necessary instrumental conditions, by means of proper computational modeling of the simulated environment.

A generally accepted statement is that our organizations (whether we are talking about government agencies or private companies) fairly regulate the distribution of rewards/recognition to high-performance individuals by means of incentive mechanisms. In most aspects of life, one is encouraged to pursue ever higher standards of performance, which are often arbitrarily set by a central agency, such as the government or the upper management of an organization. In order to reach this goal, one is typically “led by example,” in such a way as to replicate (or, at least, approximate) the behaviors of a few examples of successful individuals, or prototypical models of success.

In this chapter we model an incentive framework for scientific production, in which agents are individual researchers that take decisions regarding what type of scientific journals they should target as potential vehicles for publicizing their work. A central agency is responsible for evaluating the performance of each researcher (in terms of published work) and providing an incentive that temporarily increases the researcher’s productivity. The framework’s policies regarding how to evaluate scientific publications and how to define rules for providing incentives are parameters of the simulation. Agents interact in a non-deterministic way, adjusting their preferences for scientific journals as they see fit, in light of the observed successes of their peers, as well as their own.

While decision-makers responsible for defining the framework’s policies might have the best collective interests of the scientific community in mind, it is possible that certain choices of parameters of the framework lead to undesirable results. Specifically, it is possible that the aggregate numbers obtained at the macro level reflect a scenario of increased productivity that is not accompanied by an effort from individual researchers to engage in high-quality scientific investigation. Different policies might induce different behaviors from researchers and journals, some of which can be negative, as recently reported by Van Noorden and Tollefson (2013). Therefore, using agent-based models to simulate certain aspects of research incentive policies might be a useful way to assess potential risks.

The remainder of this chapter is organized as follows. First, we present the operant behavior theory (Skinner, 1965) and its presence in the institutions’ (governmental or private) praxes. In addition, we discuss some recent studies about aspects of human behavior dynamics in academia. Next, we present the details of our social simulation model, specifying its parameters and the rules that control and induce agent behavior. Finally, we discuss the results obtained via simulation of different scenarios, tracing a parallel between B. F. Skinner’s operant conditioning (Skinner, 1965) and Thomas Schelling’s micromo-

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