Chapter I
Artificiality in Social Sciences

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ABSTRACT

This chapter provides an introduction to the modern approach of artificiality and simulation in social sciences. It presents the relationship between complexity and artificiality, before introducing the field of artificial societies which greatly benefited from the fast increase of computer power, gifting social sciences with formalization and experimentation tools previously owned by the "hard" sciences alone. It shows that as "a new way of doing social sciences," artificial societies should undoubtedly contribute to a renewed approach in the study of sociality and should play a significant part in the elaboration of original theories of social phenomena.

INTRODUCTION

The "sciences of the artificial" deal with synthesized things which may imitate natural things, which have functions and goals and which are usually discussed in terms of imperatives as well as descriptives. Imitation with computer is now usually termed simulation and is used to understand the imitated system (Simon, 1996).

Artificiality has invaded science over the last thirty years, and physicists, chemists, or biologists now daily use widespread computing tools for simulations. Social sciences did not set this trend aside (Halpin, 1999). This chapter will first introduce the essential link between complexity and artificiality before presenting the highly promising field of artificial societies.

Complexity and Artificiality

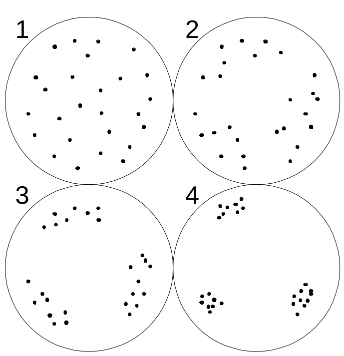
Since the seminal book of Herbert Simon in 1969 (Simon, 1996), the sciences of the artificial knew a jerky evolution. In the field of artificial intelligence, the excessive ambitions of the sixties were considerably lowered in the seventies, before knowing a new wave of optimism in the mid-eighties. The renewed interest toward artificiality originates in new approaches of artificial intelligence and in the success of the highly innovative related fields of *artificial life* (Langton, 1989) and *artificial societies* (Gilbert & Conte, 1995; Epstein & Axtell, 1996). Artificial life is at the crossroad of the rebirth of artificiality and offers many nice examples illustrating this revival, like this one:

Many ant species tend to form piles of corpses (cemetery) in order to clean their nest. Experiments with different species showed that if corpses are randomly distributed, ants tend to gather them in some clusters within a few hours.

Deneubourg et al. (1991) proposed a simple model of corpses gathering (see also Bonabeau, Dorigo, & Théraulaz, 1999). They designed virtual ants having the following behaviors:

- The probability for an ant to pick up a corpse is $p_p=(k_1/(k_1+f))^2$ with k_1 a threshold constant and f the fraction of perceived corpses in the neighborhood.
- The probability for an ant to deposit a corpse is: $p_d=(f/(k_2+f))^2$ with k_2 a threshold constant. Deneubourg et al. (1991) computed f as the number of items perceived during the last t periods divided by the largest number of items that can be encountered during the last t periods.

Figure 1. Virtual ant cemetery



To put it simply, virtual ants tend to pick up isolated corpses to drop them in dense zones. The result (see Figure 1) is close to the real phenomenon.

Highly simple virtual individuals (“agents”) without any knowledge of the global process manage to carry out cemetery building. Furthermore, it “suffices” to define different types of objects to obtain sorting capabilities, like for example larval sorting observed in anthills. The gathering or the sorting process *emerges* from the interactions of simple agents.

Emergence

Emergence can be defined as the qualities or properties of a system which are new compared with the qualities or properties of the components isolated or differently organized (Morin, 1977). According to Gilbert (1995b):

Emergence occurs when interactions among objects at one level give rise to different types of objects at another level. More precisely, a phenomenon is emergent if it requires new categories to describe it that are not required to describe the behavior of the underlying components. For example, temperature is an emergent property of the motion of atoms. An individual atom has no temperature, but a collection of them does.

Most authors consider that emergence relies on three conditions:

1. The global process is distributed, there is no central control, and the result depends on the interactions between components.
2. The process is autonomous, there is no external controller.