Chapter 13
A Zoo of Self–Replicators

INTRODUCTION

Our basic metaphor: in this chapter, we present a taxonomy of self-replicators - as if they were animals in a zoo. In the zoo, we play the role of an external observer (a zoologist) whose role is to describe the animals (artificial organisms) and their behavior. Different species reproduce in different ways - some sexually, some asexually. We observe differences in their developmental dynamics and differences in the way they adapt to their environment. In each case, what we see are life-like self-replicators, each adapted to a specific habitat.

In Chapters 7 and 8, we have seen how evolutionary techniques can create a broad variety of self-replicators. The complex ways in which these self-replicators grow, reproduce and become extinct bring to mind the behavior of biological systems. In Chapter 11, we examined their genetics. Here we examine their behavior at the individual and the species level, applying a range of observational and experimental methods and using the results as the basis for a taxonomy.

Like eukaryotic cells, artificial organisms can divide, creating offspring similar to themselves and transmitting their genetic heritage to the next generation. In our artificial world, we can identify several different models of mitosis. As in biology, it is these models that underlie the growth of individual organisms and of popula-
tions of genetically similar organisms. We also observe meiosis: the basis for sexual reproduction in diploid cells. Meiosis allows recombination of the different elements in a population’s gene pool as well as mutations giving rise to novel behaviors and patterns. In the natural world, the combination of mitosis and meiosis allows species to adapt to unfavorable environmental conditions. At times, different species, that normally reproduce asexually, hybridize, in a simulation of sexual reproduction. Artificial organisms and species behave in the same way. We can thus consider our simulation environments as artificial eco-systems with an equilibrium that depends on the sizes of populations belonging to different species. In some species, populations are relatively constant; in other they undergo short or medium-term fluctuations that may include exponential growth and collapse. Sometimes, these fluctuations are due to internal factors (the traits characterizing the species), sometimes to external causes (expanding populations of competing species, resource availability, disease etc.). When we observe fluctuating populations of artificial organisms, we are observing a behavior also found in plants, micro-organisms, funguses and the majority of animals. These species, which typically have very high rates of mortality, use the energy available to them to produce the highest possible number of offspring. Both in artificial organisms, and in animal populations, this reproductive strategy typically produces temporary spurts and collapses in population. In the opposite strategy, similar to the reproductive strategies of birds and mammals, energy is invested in the development of individual organisms and birth and death rates are relatively low. In these conditions, the artificial eco-system is relatively stable.

As zoologists studying artificial worlds, we use two distinct methods.

a. We can observe artificial ecosystems and classify the species they contain;
b. We can engineer new species, with their own ad hoc developmental dynamics. This way of proceeding allows us introduce novel processes of “sexual” reproduction leading to changes in the characteristics of the species. This is one of the tasks of the artificial laboratory described in Chapter 1.

Applying this method we have detected forms of asexual reproduction similar to those we observe in plants, micro-organisms, funguses, corals etc. When organisms reproduce asexually there is no exchange of genes and no genetic recombination. Offspring are clones, identical to the parent organism, which can thus be considered as the founder of a colony. Like their biological counterparts, artificial organisms display different kinds of asexual reproduction:

a. Fragmentation: A part of the artificial organisms breaks off to form a new individual, or a group of highly active cells that give rise to a new individual.
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