The fundamental steps of the gene expression algorithm (GEA) are schematically represented in Figure 3.1. The process begins with the random generation of the chromosomes of a certain number of individuals (the initial population). Then these chromosomes are expressed and the fitness of each individual is evaluated against a set of fitness cases (also called selection environment which, in fact, is the input to a problem). The individuals are then selected according to their fitness (their performance in that particular environment) to reproduce with modification, leaving progeny with new traits. These new individuals are, in their turn, subjected to the same developmental process: expression of the genomes, confrontation of the selection environment, selection, and reproduction with modification. The process is repeated for a certain number of generations or until a good solution has been found.

In this chapter, we will analyze with great detail all the fundamental steps of this evolutionary algorithm, starting with the random generation of the chromosomes of all the individuals of the initial population and finishing with their selection and reproduction with modification, which obviously leads to the creation of the new individuals of the next generation. The goal consists not only in studying the logistics of the gene expression algorithm but also in understanding why and how populations of computer programs evolve from generation to generation, becoming better and better solutions to the problem at hand.

We have already seen that populations of entities, be they organisms or computer programs, evolve because individuals are reproduced with modification, giving rise to genetic diversity, which is the raw material of evolution. This genetic diversity is the basis for a differential selection and, therefore, plays a central role in evolution. Thus, we are going to analyze thoroughly the mechanisms and effects of all the agents of genetic diversity – the genetic operators. Each genetic operator is going to be used to solve the
Figure 3.1. The flowchart of a gene expression algorithm.