Algorithmic and Experimental Design

God does not care about our mathematical difficulties. He integrates empirically.

Albert Einstein (1879 - 1955) –Physicist

The main hypothesis in this book is that we can create better algorithms by relying to cellular concepts in GAs. To this end, we have followed the usual scientific way of analyzing, proving, and modelling concepts. Now we arrive to the point of depicting how the rest of hypothesis support is going to be developed: simulation and experimentation. In the big picture, a little bit of all this has been used in the previous chapters, but it is in this chapter where the whole abstract approach is sketched.

After the introduction to the cEAs field and the study of the state of the art in this domain performed in previous chapters (Chaps. 4 and 2, respectively), we present here some of the most important improvements to the proposed canonical cEA existing in the literature. These new models aim to improve the efficiency, accuracy and/or efficacy of the canonical cEA by modifying the exploration/exploitation tradeoff performed by the algorithm on the search space in some way.

We describe in Sect. 5.1 the new approaches for improving the behavior of the canonical cGA that are addressed in this book. In Sect. 5.2, it is shown the way in which we proceed in our studies for obtaining the reported results, and how they are analyzed in order to obtain statistical relevance in our conclusions when comparing the different models. Finally, we present in Sect. 5.3 our main conclusions.

5.1 Proposal of New Efficient Models

Nowadays, there exists a huge interest for finding more efficient optimization techniques without losing their capacity for being applied to new problems. As it was already said, we focus on cellular genetic algorithms (cGAs) in this book, a kind of very efficient GA with structured population which has been explored by the scientific community in lesser extent than other GAs as panmictic or distributed ones. Despite of that, cGAs are techniques which have demonstrated to be very efficient when solving really complex problems.
and, as it was probed in Chap. 3, the use of cGAs leads us many times to obtain a better efficiency according to the equivalent structured in islands and panmictic GAs.

This book mainly focuses on the search of new models of cGAs which improve the behavior of an equivalent canonical cGA, and on the adaptation of the cellular model to other domains where they have not been exported until the moment, in order to improve the existing proposals in these domains. There are too many ways for achieving this goal. For example, in the recent literature of cGAs we can find some examples which try to improve the efficacy of these algorithms investigating new genetic operators [229], using different population topologies [101, 203], adjusting the tradeoff between the exploration and the exploitation performed by the algorithm in the search space [26, 192], etc.

In this book, we pay special attention to those algorithms of innovative design (see Fig. 5.1) which improve the tradeoff between exploration and exploitation performed on the search space (e.g., hierarchial cGAs, adaptive cGAs, or cellular memetic algorithms), on the adaptation of some of the developed models to new domains where cGAs have not been applied, and on the search of efficient parallel models.

We think that a really appropriate methodology for improving the behavior of an heuristic is working on its principles of functioning. For that, it is necessary to study and characterize theoretically the algorithm, although many researchers do not consider this important step. However, we performed this study in our investigations (see Chap. 4). Maybe, the most influential feature