Summary. In recent years, the use of hybrid Soft Computing methods has shown that in various applications the synergism of several techniques is superior to a single technique. For example, the use of a neural fuzzy system and an evolutionary fuzzy system hybridises the approximate reasoning mechanism of fuzzy systems with the learning capabilities of neural networks and evolutionary algorithms. Evolutionary neural systems hybridise the neurocomputing approach with the solution-searching ability of evolutionary computing. Such hybrid methodologies retain limitations that can be overcome with full integration of the three basic Soft Computing paradigms, and this leads to evolutionary neural fuzzy systems. The objective of this chapter is to provide an account of hybrid Soft Computing systems, with special attention to the combined use of evolutionary algorithms and neural networks in order to endow fuzzy systems with learning and adaptive capabilities. After an introduction to basic Soft Computing paradigms, the various forms of hybridisation are considered, which results in evolutionary neural fuzzy systems. The chapter also describes a particular approach that jointly uses neural learning and genetic optimisation to learn a fuzzy model from the given data and to optimise it for accuracy and interpretability.
problem to be solved are available, rather than a solution algorithm for the problem. In general, neural networks can learn from examples. The way in which a knowledge base is extracted through a learning process is not easy for humans to understand. Evolutionary strategies, despite the learning speed being slower than neural networks, are able to use much more general functions than differentiable ones. This is because they do not require the computation of the gradient of the functions. Finally, as evolutionary algorithms explore in several directions the search space, they are less affected than neural learning by the problem of finding local minima.

A hybrid technique which makes use of a combination of the three Soft Computing paradigms is an interesting prospect. When these constituents are combined, they operate synergistically rather than competitively. Their mutual dependence may produce unexpected performance improvement.

In the last decade, several Soft Computing frameworks have been developed for a wide range of domains. Many of them solve a computational task by using a combination of different methodologies. The aim is to overcome the limitations and weakness of the several techniques.

This chapter gives an overview of different viewpoints of hybridisation among Soft Computing paradigms. The main features of principal Soft Computing paradigms are introduced. The attention is focused on all the possible ways of integrating the characteristics of two paradigms. This results in neural fuzzy systems, which is a hybrid of approximate reasoning method of fuzzy systems with the learning capabilities of neural networks, evolutionary fuzzy systems that use evolutionary algorithms to adapt fuzzy systems, and evolutionary neural systems, integrating the solution-searching ability of evolutionary computing with the neurocomputing approach. In conclusion, full hybridisation of the three paradigms is addressed. We summarise the research done on evolutionary neuro-fuzzy systems that integrate the solution-searching feature of evolutionary computing and the learning ability of neurocomputing with the explicit knowledge representation provided by fuzzy computing.

An example of full integration between Soft Computing paradigms is presented that makes use of neural learning and genetic algorithms to learn fuzzy models from data. This improves the accuracy and the ease of interpretation.

The chapter is organised as follows. Section 2.2 gives the fundamentals on the three main Soft Computing paradigms. That is, neural networks, fuzzy inference systems and evolutionary algorithms. Sections 2.3 to 2.5 provide a review of all possible forms of combination among the paradigms. In section 2.6 different examples of evolutionary-neuro-fuzzy hybridisation are considered, and some applications are reported. Section 2.7 presents a hybrid approach for the optimisation of neuro-fuzzy models based on an evolutionary algorithm. An example of the application is included in this section. Section 2.8 concludes the chapter.