

## Preface

The discipline of pattern recognition has seen enormous progress since its beginnings more than four decades ago. Over the years various approaches have emerged, based on statistical decision theory, structural matching and parsing, neural networks, fuzzy logic, artificial intelligence, evolutionary computing, and others. Obviously, these approaches are characterized by a high degree of diversity. In order to combine their strengths and avoid their weaknesses, hybrid pattern recognition schemes have been proposed, combining several techniques into a single pattern recognition system. Hybrid methods have been known about for a long time, but they have gained new interest only recently. An example is the area of classifier combination, which has attracted enormous attention over the past few years.

The contributions included in this volume cover recent advances in hybrid pattern recognition. In the first chapter by H. Ishibuchi and M. Nii, a novel type of neural network architecture is introduced, which can process fuzzy input data. This type of neural net is quite powerful because it can simultaneously deal with different data formats, such as real or fuzzy numbers and intervals, as well as linguistic variables.

The following two chapters deal with hybrid systems that aim at the application of neural networks in the domain of structural pattern recognition. In the second chapter by G. Adorni *et al.*, an extension of the classical back-propagation algorithm that can be applied in the graph domain is proposed. This extension allows us to apply multilayer perceptron neural networks not only to feature vectors, but also to patterns represented by means of graphs. A generalization of self-organizing maps from  $n$ -dimensional real space to the domain of graphs is proposed in Chap. 3, by S. Günter and H. Bunke. In particular, the problem of finding the optimal number of clusters in a graph clustering task is addressed.

In Chap. 4, A. Bargiela and W. Pedrycz introduce a general framework for clustering through identification of information granules. It is argued that the clusters, or granules, produced by this method are particularly suitable for hybrid systems. The next two chapters describe combinations of neural networks and hidden Markov models. First, in Chap. 5, G. Rigoll reviews a number of possible combination schemes. Most of them originated in the context of speech and handwriting recognition; however, they are applicable to a much wider spectrum of applications. In Chap. 6, by T. Artieres *et al.*, a system for on-line recognition of handwritten words and sentences is investigated. The main building blocks of this system are a hidden Markov model and a neural net.

The following three chapters address the emerging field of multiple classifier systems. First, in Chap. 7, T. K. Ho provides a critical survey of the field. She identifies the lessons learned from previous work, points out the remaining problems, and suggests ways to advance the state-of-the-art. Then, in Chap. 8, F. Roli and G. Giacinto describe procedures for the systematic generation of multiple classifiers and their combination. Finally, in Chap. 9, A. Verikas *et al.* propose an approach to the integration of multiple neural networks into an ensemble. Both the generation of the individual nets and the combination of their outputs is described.

In the final three chapters of the book applications of hybrid methods are presented. In Chap. 10, A. Klose and R. Kruse describe a system for the interpretation of remotely sensed images. This system integrates methods from the fields of neural nets, fuzzy logic, and evolutionary computation. In Chap. 11, D.-W. Jung and R.-H. Park address the problem of fingerprint identification. The authors use a combination of various methods to achieve robust recognition at a high speed. Last but not least, M. Junker *et al.* describe a system for automatic text categorization. Their system integrates symbolic rule-based learning with subsymbolic learning using support vector machines.

Although it is not possible to cover all current activities in hybrid pattern recognition in one book, we believe that the papers included in this volume are a valuable and representative sample of up-to-date work in this emerging and important branch of pattern recognition. We hope that the contributions are valuable and will be useful to many of our colleagues working in the field.

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