# Foreword

I would like to first congratulate the editors on the publication of this book and thank them for the invitation to write a foreword. I am a keen student of both soft computing and nature-inspired computing. Both of these paradigms help us push the boundaries of traditional mathematics in real-world applications. The domain of each of the two paradigms is not well-defined and the boundary between the two is fuzzy (pun intended).

Some researchers use the term soft computing when the solutions are imprecise, uncertain, imperfect, and – in many cases – unpredictable. Imprecision is almost inevitable in most practical applications. For real-world applications, we are only looking for an acceptable level of precision. For example, we only need to be precise to the closest half-inch when specifying the size of a shirt. Students of fuzzy logic tell us that when we use words such as "hot", "warm", "cool" and "cold", it is impossible to be precise. Instead, in most cases, we assign a degree of membership to describe our imprecision. Uncertainty needs to be taken into account in our knowledge of the existing state of the system or our prediction of the future. The theory of probability provides one of the earliest formalization of uncertainty. A number of alternative methodologies have been used to represent uncertainty when the probability axioms make the computing cumbersome. Lack of sufficient information is another joy of working in the real world. Rough set theory is a popular methodology for dealing with insufficient or uncertain information.

This book brings together soft computing and nature-inspired computing. Imperfection is an issue generally shared by soft computing and nature-inspired computing. While it is theoretically possible to come up with the perfect solution in a number of problems, it is not realistic to reach the optimal solution in practice. Therefore, we have to settle for an imperfect but a reasonably good solution. We see this principle used in a number of nature-inspired techniques, such as genetic algorithms, particle swarm, ant colony, and bee colony optimizations.

Unpredictability is another aspect seen in both soft computing and nature-inspired computing. In many nature-inspired and soft computing attempts, the optimization is the initial solution that is used as a starting point in the search for the optimal solution. Depending on where we begin in the search space, we may end up with a different quasi-optimal solution. Therefore, unlike traditional computing algorithms, the soft and nature-inspired computing solutions are unpredictable, i.e. they may change from one execution to the next. Most nature-inspired algorithms safeguard against spiraling into some local minima. One example is the use of the mutation operation in genetic algorithms. Despite such safeguards, our experience suggests that these optimizations tend to produce variable solutions. We typically run the optimization a number of times and cluster the resulting solutions. The medoids of these clusters are then analyzed in greater detail for practical implementation.

In addition to the bio-inspired techniques such as genetic algorithms, particle swarm, ant colony, and bee colony optimizations, simulated annealing is another nature-inspired optimization technique discussed in this book. I have often wondered whether simulated annealing can be called a nature-inspired computing technique. In addition to being nature-inspired, the former four techniques correspond to biological processes. While simulated annealing is analogous to an industrial/engineering process that is initiated by humans, annealing is still a natural process, albeit not bio-inspired. I believe that simulated annealing may be especially appropriate for some engineering applications. In fact, this book uses simulated annealing in an engineering application. Overall, I notice a strong emphasis on engineering applications in this book. It is interesting to consider the strengths and weaknesses of these intriguing nature-inspired techniques in different real-world situations.

Other nature-inspired techniques that have been investigated in this book are various extensions of neural networks. Neurocomputing has come a long way over the previous half-century since the rise and fall of the perceptron algorithm. Despite initial criticism of the perceptron's inability to accommodate a non-linear real-world system, researchers have been coming up with variations that are pushing the boundaries of computational intelligence. While the modeling of artificial neural networks is an over-simplification of extremely complex biological neural networks, the models have shown a remarkable ability to solve complex problems. Deep learning that is being explored by giants in both academia and industry may help enhance human intelligence and spare us from more mundane mental activities. The two neurocomputing techniques that appear in this book represent two different directions in which the perceptron was refined. The Hopfield networks represent more complex interconnections of neurons, including recurrent feedback. Support vector machines (SVM), on the other hand, derive their ability to address non-linearity through non-linear transformations using kernel functions, which are further supported by operations research.

In summary, I would like to say that this book presents a diversity of nature-inspired techniques with soft-computing refinements for real-world applications. I believe engineering practitioners will especially enjoy reading this work.

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