
The name “intelligent control” was coined by K.S. Fu in 1971 when he was asked to define an area that goes beyond adaptive and learning control. Saridis has defined intelligent control as the process of autonomous decision-making in structured or unstructured environments based on the interaction of the disciplines of artificial intelligence, operations research, and automatic controls. Key notions in these ideas are those of “going beyond” and “interaction.” Intelligent control implies, at least in the systems and controls community, a rising above or beyond currently accepted practice.

This book is a compendium of 16 essays by different authors. It is remarkable in several aspects, not the least of which is the bringing together, under one book cover, work by some of the best-known researchers in several different fields. The breadth of coverage alone makes this volume unique.

The book is divided into three parts. Part I: Theory and Architectures, describes foundations for intelligent control structures and design. Several different paradigms are covered, but the chapters are more remarkable in their similarities than their differences. A basic multi-level (often three-level) hierarchy based on the principle of increasing precision with decreasing intelligence appears in many of the approaches. The decomposition of each level into sensors, processor/world model, and actuators is another ubiquitous theme.

Part II presents Design Approaches and Techniques and includes work by well-known control engineers, computer scientists, and industrial engineers. The multi-faceted perspective that emerges provides the reader with a panoramic intuitive feel for intelligent control. Discussed are expert systems, fuzzy logic and neural nets, learning control, and AI planning systems.

Part II deals with Applications of intelligent control in robotics, failure diagnosis, flight control, and diagnosis in process operations.

The chapters are self-contained essays by different authors, so that the work of developing a coherent point of view for intelligent control is placed squarely on the shoulders of the reader. In this endeavor, fortunately, he is considerably aided by the preliminary overview, which helps bring the ideas in the chapters together.

The similarities in the ideas of these authors from disparate disciplines, areas of research, and industrial vs. academic backgrounds make for an overall point of view that is in some measure reassuringly unified. This can only indicate one thing—at long last there is emerging a paradigm for intelligent control in the sense of Thomas Kuhn. There has been a long period of years of disagreement, argument over definitions, and individualistic investigation by independent researchers using their own theories. That long fruitful period of innovative pioneering research is beginning to coalesce into a unified point of view of intelligent control that is now producing rigorous stability proofs and repeatable design algorithms at the level of neural network control and fuzzy logic control in the real-time loops, as well as at the hybrid system level and the rule-based sequencing/routing control level.

It is due to books such as this one that the development of a unifying paradigm in an enigmatic and contested field of human endeavor is finally possible.


This clear and concise overview of learning automata contains a wealth of useful references and several interesting examples within 225 pages organized into six chapters. The last chapter, Applications of Learning Automata, is almost a third of the length of the entire book. It covers seven examples, three of learning control: of a drying furnace, an absorption column, and an evaporator. The first case illustrates multilevel learning control leading to an explicit and effective control algorithm. The second, hierarchical learning control, is too complex for the explicit control method, yet a probabilistic result also improves operations. The other three examples range over communication system cyclic code choice, multimodal function optimization, constrained optimization, and neural network synthesis. Occasionally the authors err on the side of too-concise an exposition, as in the introduction to the application chapter, where the second sentence includes "...implementation of the classical PID control algorithm..." with no explanation of the acronym. Since PID is cited in the index, but nowhere explained, the authors have chosen to write for an audience of specialists on automatic control, while only slight expansion of their book could have made it accessible to a wider group.

This review begins with the applications because the authors state that the book can be read in a nonlinear mode, and the examples convey a great deal more of the flavor of this field than do the initial theoretical chapters. Stating the theory re-
quires using a large number of notational conveniences. Thus, multiple indices abound, as do sub- and super-scripting and many other familiar mathematical devices used to convey subtleties. The exposition in these initial chapters is heavily weighted toward the mathematical as well, although the approach is less axiomatic and more classificatory.

The book is technically accurate and physically useful. There are eight pages of references, an index that can be consulted for rapidly locating concepts, and separate pages on the nomenclature (symbols).


Fuzzy control theory was originally expected to be applicable only in the soft sciences, i.e., those fields in which the conventional mathematical techniques are of limited effectiveness. Since in most real-world settings precision is illusory, it is now clear that even in those fields in which the dependencies between the variables are well-defined (hard sciences), it may be necessary or advantageous to employ fuzzy algorithms. In fact, we are now witnessing a paradigm shift from traditional hard computing to soft computing. Soft computing deals with various modes of computation that are approximate rather than exact.

Presently, the principal components of soft computing are fuzzy logic (FL), neural network theory (NN), and probabilistic reasoning (PR), with the latter subsuming belief networks (BN), genetic algorithms (GA), and the theory of chaotic systems (CT). While there is a substantial overlap among FL, NN, and PR, in general, FL, NN, and PR are complementary. Within soft computing, FL is concerned in the main with imprecision and approximate reasoning; NN with learning and curve-fitting; and PR with uncertainty and propagation of belief. This paradigm shift is very amply reflected in the orientation and contents of this volume.

This edited book, with a foreword by Lotfi A. Zadeh, is divided into three parts. Part A is devoted to the general theory of fuzzy control systems. Part B deals with a multitude of methodologies and algorithms used in the analysis and design of fuzzy control systems. The various paradigms considered include fuzzy reasoning models, fuzzy neural networks, fuzzy expert systems, and genetic algorithms. Part C consists of some current implementation of fuzzy controllers, and control of chaotic systems, superconducting actuators, phase-locked loops, and hard-disk drives.

Part A is mainly theoretical in nature and consists of eight chapters. Chapter 1 is devoted to learning algorithms for neuro-fuzzy networks. Neuro-fuzzy networks result from the fusion of neural networks and fuzzy logic. The neural techniques bring supervised learning capabilities for extracting fuzzy rules from numerical data. However, the learning algorithms, which are mostly inspired by back-propagation algorithm, do not entirely take into account all the specifics of neuro-fuzzy networks. This chapter proposes different learning algorithms without back-propagation which make use of several of the advantages of neuro-fuzzy networks. In Chapter 2, the authors argue the point that to make a significant inroad into the field of intelligent autonomous control requires an integrated approach in exploring the advances of the disciplines relevant to this topic. Therefore, this chapter attempts to provide foundations for a descriptive and computational approach that puts on equal footing the mathematical control-theoretical part and the AI-based symbolic part needed for such a unification.

Chapter 3 deals with reasoning by analogy in fuzzy controllers. This can be viewed as a mechanism for providing conclusions about fuzzy control based upon a level of similarity achieved between facts available in the collection of if-then rules, and a new piece of data for which an appropriate control action has to be determined. Chapter 4 analyzes the complexity of extracting information from fuzzy data. The chapter mainly studies the complexity of element identification through binary search, based on progressively more complex fuzzy domains.

Chapter 5 looks at the fuzzy logic controller and describes the basic assumptions inherent in the Mamdani model. A new structure for the representation of rules in fuzzy systems is introduced. Called the hierarchical prioritized structure, this new structure allows for a natural framework for learning rules in addition for providing a useful structure for representing knowledge.

Part B deals with a variety of methodologies and algorithms used in the analy-