New Books

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Identification of Continuous Systems

North-Holland Systems and Control Series, Vol. 10.
North-Holland, Amsterdam—New York—Oxford—Tokyo 1987.
xvi + 378 pages; 117 figures, 28 tables; Dfl. 240,—.

The high quality of control requires to take advantage of the mathematical model of the controlled process in order to design an optimum controller. It is well known that this model may be achieved either by mathematical modelling, when for the description of all elementary events of the process physical and other laws and relations are used, or by evaluation of input, output, disturbing and auxiliary variables measured on the real process. The first approach used nearly exclusively up to the sixties follows historical traditions. Of course, due to certain technical reasons, it is applied till the present days. The second approach represents the identification procedures designed since the very beginning of the control theory development. The original methods evaluated the simple characteristics like step response and others. Now, statistical and probabilistic methods are preferred.

The book by Unbehauen and Rao represents a monography of identification procedures yielding continuous form of models for continuous processes.

The book is divided into seven chapters. The first one is devoted to a brief overview of the field and to the scope of the book covering the essential approaches enabling to identify models of continuously working processes.

The second chapter presents nonparametric, parametric, stochastic and distributed parameter continuous-time models of dynamical systems including time-varying and nonlinear processes. Some basic properties and transformations of models are outlined.

The third chapter deals with characterization of input-output relationships of process models and their signals handling the information. It concerns Laplace transform, z-transform, fast Fourier transform, orthogonal functions, block-pulse functions and Rademacher, Walsh and Haar functions. Attention is paid also to time- and frequency-domain descriptions of stochastic signals, to correlation functions, power density spectra and Poisson moment functionals.

Chapter fourth contains the most important identification approaches of nonparametric linear time-invariant models using deterministic and random input signals. Authors draw attention to impulse and frequency response determination or estimation in the case of random signals as well as to methods for obtaining transfer functions from nonparametric models. Transformations between time- and frequency-domains are discussed in a special section.

In chapter fifth identification of parametric linear models is presented. The main procedures concern Poisson moment functionals, orthogonal functions, method of linear filters, direct and recursive application of least squares, instrumental variable method and maximum likelihood method. The forgetting factor and its significance is introduced in connection with regression model and Kalman filtering modified for parameter estimation of linear processes.

Chapter sixth outlines the application of adaptive models. Four sections of this chapter are devoted to model adaptation via gradient method, to model adaptation in frequency-domain, to approaches using stability theory and finally using linear filters including Liapunov stability theory and hyperstability theory.

The seventh chapter is denoted as Identification of multi-input multi-output systems, distributed parameter systems and systems with unknown delays and with nonlinear elements. Several special procedures and processes are discussed like multi-input single-output processes, decom-

position of this kind of systems and time-varying parameter systems. Last section of this chapter concerns determination of system structure.

The book is completed by Notation and Symbols, Authors Index and Subject Index.

All chapters are presented in a comprehensive but clear form. In many sections the text is accompanied by illustrative examples.

In conclusion it is possible to stress that in spite of the overwhelming activity with discrete model identification the authors preferred, as it is expressed already in the preface, to retain the models of actually time-continuous dynamical systems in continuous time-domain. This is actually the main difference in comparison with other publications dedicated to problems of parameter estimation of continuously acting dynamical systems. The reader may object that there are general and effective approaches for estimation of nonparametric as well as parametric time-discrete models in the presence of uncertainties caused for example by noise and that there are also effective methods for converting the time-discrete models to the continuous ones. Obviously, these approaches are out of the scope of this book. Consequently, the reader cannot find in the book by Unbehauen and Rao numerical procedures like square-root filtering, Cholesky and LD- or UD-factorization, directional forgetting and other statistical and probabilistic tools belonging explicitly to the category of time-discrete approaches. In this sense the reviewed book represents an entirely different stand-point and concept by recommending methods and procedures for direct identification of time-continuous models of continuously working processes. It is praiseworthy that the authors draw attention to methods which are in the professional literature often omitted and which have not been presented so far comprehensively in the book form. It is possible to say that the book by Unbehauen and Rao extends the field of identification by supplementary areas which are for the first time summarized and discussed in an adequate way.

Vladimír Strejc

GERALD W. EVANS, WALDEMAR KARWOWSKI, MICKEY R. WILHELM, Eds.

Application of Fuzzy Set Methodologies in Industrial Engineering

Advances in Industrial Engineering. 8.
Elsevier Publishing Company, Amsterdam—Oxford—New York—Tokyo 1989.
330 pages.

During the nearly a quarter of century of its existence (the Zadeh's seminal paper was published in 1965) the fuzzy set theory grew up to a significant and widely applicable mathematical theory. The variety of its applications necessarily leads to the publication of specialized works devoted to specific fields of interest. One of them, subjected to fuzzy set theoretical methods of industrial engineering, is also the referred book.

It contains 24 papers dealing applications of fuzzy sets to different industrial engineering problems ranging from human factors to quality control. Those papers are grouped into seven groups respecting the diversity of sub-disciplines concerned in the compiled contributions.

The first part contains two introductory articles briefly reviewing the basic concepts of the fuzzy set theory. The remaining six parts are subjected to the control of industrial processes (two papers), traditional industrial engineering functions (six papers), human factors (three papers) organizational design and financial management (three papers), operations research and decision making (four papers), and miscellanous applications (metallurgical grade assignment, specialized expert system, industry-environment conflict, location problem).

The editors succeeded to compile a relatively representative survey (44 authors of articles are from 10 countries) of methods and ideas convincingly illustrating the possibilities of the fuzzy set theory applications in an important field of human endeavour.

Milan Mareš

WENDY B. RAUCH-HINDIN

Artificial Intelligence in Business, Science, and Industry. Volume 1: Fundamentals, Volume 2: Applications

Prentice-Hall, Englewood Cliffs, New Jersey 1985, 1986.
Volume I.: xviii + 332 pages, $ 56·60.
Volume II: xii + 348 pages; $ 57·95.

Aimed at the nonexperts in Artificial Intelligence, the book is intended to bridge the technology gap between potential AI users and AI experts. It has two goals: to provide a general overview and some technical knowledge of Artificial Intelligence as well as to give additional technical information about what to do with the new technology and how to do it. The book tries to give a balanced survey of the benefits of AI, as well as its problems and difficulties of getting started with AI.

The two volumes of the book make a practical compendium of AI for a broad scope of readers. The text is well organized to reach this goal. First, no prior knowledge of AI is assumed. All sections of the book are independent. Each section starts with general interest information and gradually gets into more technical detail. There is no need to read the book sequentially. Every reader may start with the topic of his interest and follow it to the depth that correspond to his technical background.

Volume I presents a survey of fundamentals of AI. The first two chapters start with basic concepts of AI and explain what AI is and what it is not. There are described three main branches of AI, namely that of expert systems, natural language systems and perception systems for vision, speech and touch. The commercial future of AI is evaluated with its limitits and caution. Getting started in AI is the subject of Chapter 3. It is discussed from several angles: AI technology, learning AI, graphics, technology transfer and managerial problems.

Various aspects of expert systems are treated in Chapters 4 through 9, namely, choosing an application of expert systems, knowledge system reasoning strategies, knowledge representation by frames, rules, processes, logical formulas, semantic networks and object oriented programming. This part of the book culminates by describing how knowledge is acquired from a human expert, how it is translated and coded to the computer.

Chapters 10 and 11 serve as guides to building Expert/Knowledge Systems with microcomputer-based AI tools and with large-scale application development tools. The way an AI development tool works is show by examples of four different knowledge systems: M. 1, Personal Consultant, Expert-Ease and Rulemaster. Large-scale knowledge systems often need integrated development and special AI capabilities that are accessible only by large-scale tools that run mostly on large-scale conventional computers, and specialized Lisp machines. These large-scale tools can access the integrated, interactive graphics in Lisp environment. By this way, it is possible to show visually the different structures of the knowledge system which makes it easier to understand the developing knowledge system. From the managerial point of view, it is important to note that these AI tools also help to satisfy the company's need for confidentiality — the expert system can be made by the company's software engineers without help of some other AI specialists.

Chapters 12 through 15 discuss the problems of communication in natural language. They explain various systems of natural language understanding showing their basic principles. These systems are grouped according to their possible use in simple conversation systems or in interfacing a database in such a way that users can query the database in their native language. Examples of various types of commercial natural language systems illustrate these chapters and the reader is advised what to look for, and beware of, when choosing a natutral language system.

Volume II focus on applications of Artificial Intelligence techniques in various fields. It is explained cautiously what exactly these applications do an how they do it in order to distinguish

the benefits they provide that cannot be obtained from conventional programs. It includes as well some more in-depth technical material.

Manufacturing applications of knowledge-based systems are the main topic of Chapters 1 to 4. These include scheduling, planning, project management, monitoring, distribution and diagnosis. AI in business and financial industry is discussed in Chapters 5 to 7. Application examples deal with interest-rate swaps, exchange trading, portfolio management, banking services advice, insurance advice and office automation. Applications of AI to scientific research are discussed in Chapter 8. Their target fields range from mechanical engineering, knowledge-based interfaces to scientific instruments and complex software, real-time knowledge systems, statistical analysis and designing experiments.

Chapter 9 treats AI applications in medicine. Several expert systems e.g. PUFF, CARE, MYCIN and HELP are discussed, some of them written by AI specialists and some by physicians. Chapter 10 is devoted to AI applications in engineering. The field of VLSI-based chip design is among those fields that were penetrated by artificial intelligence recently. It thus serves as a model application. Chapter 11 written by Harvey J. Hindin is on computer vision. It starts with a quick overview, estimates how much of AI this field contains, describes its present state and future perspectives.

The rest of Volume II consisting of Chapters 12 to 16 gives more place to advanced AI tools and techniques and future directions for research and development of AI. Chapter 12 gives a thorough survey of AI programming languages. It describes in some detail the LISP language and compares its merits to those of its main competitor PROLOG. Other languages e.g. OPS 5 and Smalltalk are also explained. Chapters 13 and 14 are about AI hardware and cope with AI hardware and systems development that are both important supporters of good programing environment. Chapter 15 describes the present state and yet unsolved problems of Automated Programming. It discusses what must be done to develop AI programming systems that help the programmer to write programs or write programs for a given specification. Chapter 16 touches one of the most interesting goals for AI to construct programs that learn by experience or by analogy. These types of programs are still in the research stages.

The book under review is recommendable to anyone interested in AI and in particular in AI commercial application. It is aimed at an interested layman. It begins from scratch and gives information about all branches of AI sometimes with surprisingly deep technical insight.

Petr Štěpánek