MICHAEL A. ARBIB

Brains, Machines, and Mathematics

Second Edition.
Springer-Verlag, New York—Berlin—Heidelberg—London—Paris—Tokyo 1987.
xiii + 202 pages; 63 figs.; DM 55,—.

"This is a book whose time has come — again." This first sentence of the introduction expresses very aptly the reasons for a new edition of 23 years old Arbib's book [1], and also, indirectly, hints at the revolution which has recently occurred in one of the areas of cybernetics. Indeed, this book can be used in a twofold way. First, as a rather quick, yet by no means superficious introduction to some of the most interesting themes of cybernetics from neuronal modelling to Gödel's theorem, and second, as a convenient source for observing the lengthy and peripethic romance of the brain theory with the main and prevailing stream of computer science and technology.

As for the first purpose I cannot but suggest the reader to read the book itself: it is hard to imagine a more informed and informative survey of the most important ideas, methods, and results making the core of cybernetics (and, moreover, using the mathematical formalism only to the necessary extent to make the subject clearer and more accessible).

Let us use, therefore, the book for the second purpose — as a guide indicating what has happened in cybernetics in the last quarter of century. The new edition is, of course, completely rewritten and extended to cover the contemporary state so that it is enough for us to notice the main differences from the original edition from 1964 (that I found in a Russian translation). Above I have used the word "of course" since I cannot imagine the author so productive as Arbib (I counted 17 monographs written or co-authored by him) to let his older book be published without having it first completely rewritten.

Already the first chapter (A Historical Perspective) is new and enables us to understand better the meaning of the above mentioned first sentence of the introduction. The year of birth for cybernetics as a science is 1943 — the year when three important works appeared simultaneously: the first contribution to Wiener's theory, the well-known paper by McCulloch and Pitts on neural networks (which later originated the switching and automata theoretical orientation in cybernetics) and a relatively forgotten book by Craik [2], in which the process of forming an internal model of world was suggested as the basic feature of thought and explanation — an idea anticipating the main paradigma of contemporary AI. But the actual development of computer technology (based on von Neumann architecture with digital hardware, algorithmic software and sequential processing) and subsequently also symbolic and task-oriented AI gradually suppressed the cybernetical approach (in the Anglo-American sense, emphasizing biological connections).

After a temporary revival around 1960 due to (somewhat overoptimistic) interest in perceptron models a new great rapproachement has occurred according to Arbib only quite recently, in eighties — more about that in the connection with the fifth chapter.

The second chapter (Neural Nets and Finite Automata) brings the traditional material (part of Chapter I in [1]: basic schema of a single neuron, its formal model as a McCulloch-Pitts' threshold unit, and a formal definition of an automaton — more or less all themes which are part of general education in this area. New is here just a remark in the sense that an abstract model is one thing and the modelled biological object — or a technical realization of the model — another thing (this distinction would according to me deserve a more explicit elaboration than offered by the author).

The third chapter (Feedback and Realization) preserves from the original edition (Chapter 4) only introductory treatment of positive and negative feedback; the rest of the chapter is devoted to a formalization of the control and identification problems as well as to an introduction to system theory in the shape more thoroughly elaborated elsewhere [3].

The fourth chapter (Pattern Recognition Networks) is organized in a completely different way — apparently in response to the rise and fall of the perceptron theory in the sixties. It is a result of reshuffling the text of part of the original Chapter 4 and especially Chapter 2 (frog's vision, the concept of perceptron) and of adding some new material: a proof of the perceptron convergence theorem, some models of visual memory (Spinelli, Malsburg) emphasizing some more recent neurophysiological research (Hubel and Wiesel, Kandel), Minsky-Papert's theory (including the limitation results) and finally the theory of complexity of multilayer logical circuits (to which Arbib himself contributed). These are mostly themes from late sixties and early seventies that subsequently disappeared from the research projects. The reason they are included is not only that they were not present in the first edition but also and mainly for their natural relevance to the research of neural computing in its present form — a topic of the following chapter. (It is worth noting in this respect that Minsky's and Papert's monography on perceptrons from 1969 appears again, in extended form [4].)

This chapter has its thematical follower in the fifth chapter (Learning Networks) which is entirely new and, by my opinion, the most important in the new edition of Arbib's book. It is concerned with the new and rapidly expanding direction in cybernetics, known under different names: parallel distributed processing (PDP), neural network models, neural computers, and, with emphasis on the basic principle, connectionism. We can characterize a connectionistic model in the following way:

(a) Let us assume a large network of mutually connected active units (modules or formal neurons).

(b) the units are functionally simple and uniform; they are akin more to threshold units (McCulloch-Pitts' neurons).

(c) Interconnections between units are modifiable by changing their weights.

(d) The behaviour of the network is based on the principle of massive parallelism with no central control and it depends only on the topology and distribution of the connection weights.

(e) Basic elements with semantical meaning are dynamically represented either by single units (local representation) or by patterns of activity over a large number of units (global representation).

(f) These representations (memory traces) and the processes operating on them are usually not expressed by means of an explicit prescription but they are emergent collective phenomena that occur due to modifications of connections weights according to specific learning rule.

The connectionist approach unifies in a specific way brain science, cognitive psychology, new generation computer architectures and artificial intelligence.

Arbib attempts in this chapter to give a brief introduction into some of the newest research directions in this area (synaptic matrices, recurrent nets, Hopfield nets, Boltzmann machines) and presents several general learning principles (reinforcement learning, back-propagation). The main emphasis is given to disclosing mutual relationships between various approaches and especially to the relation between contemporary connectionism on the one side and classical cybernetical modelling and perceptron theory on the other side. This historical continuity is often neglected in the literature — due partly to the "generation gap" and partly to the current style of scientific endeavor that values the new always more than to the old. Especially in this respect it is worth mentioning that Arbib was one of the few who has permanently emphasized parallel and biologically motivated approaches in AI as an alternative to the dominating trend on sequential algorithms and symbolic representations.

The remaining part of the book covers more or less the standard material from automata and computability theory. The sixth chapter (Turing Machines and Effective Computations) deals with the sequential machines, Turing machines and with the theory or recursive and recursively enumerable sets. The presentation differs from the previous edition only by organization.

The seventh chapter (Automata that Construct as well as Compute) is a new version of par. 1.9 of [1]. It contains the theory of self-reproducing cellular automata — more or less in the shape of late fifties — and is supplemented only by a section on biological models reviewing one of the author's paper from that time.

Unfortutately the new revival of interest in cellular automata in the eighties is mentioned only by one sentence and one reference (to a paper in Scientific American). It is a pity since this research (for instance the works by Wolfram and others — cf., e.g., [5]) is by its nature relevant to the theme and standpoint of the book, and in a certain aspect it can be considered as an alternative to the connectionistic approach.

Finally the last, eighth chapter (Gödel's Incompleteness Theorem) is an adapted — rather by its form than contents — introduction to metamathematics from the first edition. It culminates in a proof of Gödel's incompleteness theorem and Ehrenfeucht's speed-up theorem. The closing section is concerned with some philosophical consequences of both theorems to the general mind-body problem. (Philosophy is a recent addition to the great number of various Arbib's interests [6].)

Let us close by mentioning some of the topics from the first edition that do not appear in the second: the theory of regular events including Kleene's theorem, a whole chapter on error correcting codes (including classical information theory) and the material on resonance frequencies in neuronal networks (Green's theory).

It turns out that perhaps everything in this book (the fifth chapter is an exception) is taken — usually in a simplified form — from one or another Arbib's book. Nevertheless a possible objection that it is just "an eleventh out of ten books" is not quite valid for two reasons: first, it is, in fact, an eighteenth out of seventeen books, and second, the main value of this book is that it can be taken as a concise, clear and logically interconnected presentation of a science that could be called the "Cybernetics of Eighties". As for its future one cannot but wait with curiosity for a possible third edition of the same Arbib's book.

REFERENCES

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[3] L. Padulo and M. A. Arbib: System Theory: A Unified State-Space Approach. Saunders-Hemisphere Books, 1974.

[4] M. L. Minsky and S. A. Papert: Perceptrons. Expanded Edition. MIT Press, Cambridge, Mass. 1987.

[5] Theory and Applications of Cellular Automata (S. Wolfram, ed.). World Scientific Publishing Co., Singapore 1986.

[6] M. A. Arbib and M. B. Hesse: The Construction of Reality. Cambridge University Press, 1986.

Ivan M. Havel

CRISTIAN CALUDE

Theories of Computational Complexity

Annals of Discrete Mathematics 35.
North-Holland, Amsterdam—New York—Oxford—Tokyo 1988.
xii + 488 pages; Dfl. 200,—.

Since Euclid times to thirtieths of this century the notion of algorithm had been used in mathematics at an informal level and the common sense of each mathematician, or at least the common sense of mathematical community as a whole was believed to be a good enough tool to separate the effectively computable functions or effectively executable procedures from the other ones. The effort to solve the crisis in mathematics through the well-known Hilbert program involved the necessity to formalize the notion of effective computability within the frameworks of mathematics, and several models occurring almost simultaneously were proved to be equivalent in the sense that they defined the same class of effectively computable functions. With the occurrence and rapidly increasing role of computers the theoretical effort has been focused on a more detailed quantitative classification of time, space and other demands connected with implementation and computation of various classes of functions and algorithms. The theory of effective computability and computational complexity has been developed into an integral part of modern theoretical mathematics, also with its own monographical tradition, let us recall, e.g., the Davis' and Rogers' books.

Calude's monography can be seen as a "non-traditional continuation of this tradition". The author emphasizes the notion of computational complexity, but only after having read all the book the reader is able to understand that and in which sense the central position of this notion is legitimate. In every case, the first two chapters of Calude's book may well serve as a traditional textbook of the theory of recursive functions, or of effective computability in general, on the other hand, the reader should be warned not to look for results dealing with computational complexities of particular functions or algorithms in the sense common in computer science (o- and O-classes, polynomial vs. exponential algorithms, P-NP problem, etc.).

The book is divided into five chapters. Chapter one deals with primitive recursive functions. The class of these functions is not defined in the usual sense "at once", i.e. through the fixpoint of a mapping taking sets of functions into other sets of functions, but rather as the limit point of an increasing sequences of hierarchy of particular primitive recursive functions. Hence, each primitive recursive function enters the hierarchy at a certain level which can be taken as a degree of complexity of this function. Namely, Ackermann's (or Ackermann-Peter's) and Sudan's hierarchies are studied in details with many interesting results (including some Calude's original ones) presented.

Chapter two covers, roughly speaking, partial recursive functions, recursive and recursively enumerable sets, arithmetization of computation, Gödel undecidability results in the extent comparable with former monographies. Partial recursive functions are defined through their equational characterizations and this approach enables, again, to classify computational complexities of particular partial recursive functions by the complexity of their corresponding definitions within the framework of equational calculus.

As one of Calude's great merits should be considered his systematic explanation of Blum's abstract computational complexity theory in Chapter three. This theory formalizes and investigates the most general conditions which a measure of complexity is to satisfy to be able to play the role of computer-independent computational complexity measure for effectively computable functions and procedures. Blum's spaces and complexity classes definable through them, including hard recursive functions are investigated in more details. The central role in this chapter plays the speed-up phenomenon and union theorem with a number of related notions and results.

In spite of many papers dealing with Blum's ideas and enriching his results, Calude's presentation is, as far as the reviewer knows, the first one when Blum's theory forms an integral and legitimate part of a monography on computational complexity.

Also Chapter four, explaining Kolmogorov and Martin-Löf's complexity theory, must be considered as an original Calude's enrichment of the tradition of monographies of this kind, in spite of the fact that this area has been already covered by some books (let us remember Schnorr or Fine among the already classical ones). Calude's attention is concentrated toward the relations between Kolmogorov algorithmic complexity and Martin-Löf's tests of randomness in order to prove the high degree of identity between the sequences of high algorithmic complexity and those which pass successfully the universal test of randomness. However, the chapter contains also many other results, including the very important Chaitin's one on undecidability of certain assertions dealing with algorithmic complexities, which offer a deeper insight into the nature of randomness and its mathematical description and treatment.

Finally, Chapter five deals with Loop-programs and Loop-languages which can serve as an alternative tool to define the classes of functions investigated in Chapters 1 and 2. Loop-programs can be easily and intuitively interpreted as basic stones of more complicated programs in the usual sense, so that Loop-programs may serve as a bridge between an informal idea of computing device and the notion of effective computability in the formalized sense, just like the notion of Turing machine in some classical monographies on effective computability (e.g. in Davis). Moreover, the conception of Loop-language is close to the basic ideas of dynamic logic with its successes in the field of automated program verification.

When considering the reviewed book as a whole, first of all the high pedagogical qualities of Calude's explanation should be appreciated. In spite of a very high level of mathematical formalization, almost all the argumentation and proofs can be understood by a reader with no preliminary knowledge in this domain, just with a certain level of common mathematical culture. Each chapter is closed with an interesting historical survey of the domain in question and with a great number of exercises ranging from relatively simple consequences and generalizations of the presented results till some yet open problems. The book meets the traditional high level of North Holland mathematical monographies and can be recommended to post-graduate students beginning their studies in the domain of theoretical computer science and theory of recursive functions, as well as to specialists from other fields of pure and applied mathematics.

Ivan Kramosil

ANDRZEJ BLIKLE

MetaSoft Primer

Towards a Metalanguage for Applied Denotational Semantics

Lecture Notes in Computer Science 288.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1987.
XIII + 140 pages; DM 31,50.

The book Metasoft Primer deals with a simplified version of denotational semantics which is known as naive denotational semantics (NDS). Methods of denotational semantics have been developed during the last twenty years, and their development has been evoked by the requirement of a mathematically exact and implementation-independent specification of a software product. Such a specification can serve as a base for realization of the software product and as a point which the correctness of an implementation can be referred to. First attempts at a formal mathematical specification dealt with the semantics of programming languages. Since one of the broadly used languages — ALGOL 60 — provides such mathematically unnatural features as the self-applicability of procedures and jumps nested in structured programs,

a powerful definitional method known today as standard denotational semantics (SDS) was developed. Formal mathematical apparatus underlying this method was described by D. Scott — the model of reflexive domains and C. Strachy — the technique of continuations, the former being evoked by the problem of a procedure taking itself as a parameter, the latter leading to the solution of the "jump problem". SDS, though being an adequate mathematical model for a compositional semantics of complex programming languages, has not been broadly applied by software engineers and has been used only at the academic level. Two main causes of the SDS non-applicability can be characterized as follows:

— the lack of a convenient metalanguage
— the complexity of reflexive domains and of continuations.

The first handy tool for real-life applications has been provided by the well-known Vienna Development Method (VDM) which avoided the above disadvantages — treating reflexive domains as sets, defining jumps without continuations and providing a metalanguage called META-IV. This method was developed by two main protagonists of formal specification methods, namely D. Björner and C. B. Jones. Author's interest in applied denotational semantics originated in a visit in the Technical University of Denmark in Lyngby where discussions with D. Björner's group about VDM inspired the author to the research of a VDM-like denotational semantics. This research led into a five-year project MetaSoft developed in the Institute of Computer Science of the Polish Academy of Science in Warsaw; the main goal of this project can be characterized as the development of a set-theory based denotational semantic method with a purely functional metalanguage. The semantic kernel of this metalanguage is described in the presented book. When reading the book no special knowledge is required (just a common knowledge of mathematics and logic and the ability of reading Pascal programs is needed); nevertheless, works on the Vienna Development Method and its applications can be highly recommended for a deeper understanding of author's motivations. Czech readers may also appreciate the possibility of studying D. Björner's lectures published in the proceedings of the SOFSEM seminar (ÚVT UJEP Brno, 1981, 1986).

Two kinds of exposition can be found in the book: Part One provides a general mathematical/logical framework for the recursive definitions of denotations and introduces a corresponding notation. Part Two contains a denotational definition of a subset of the programming language Pascal. Even those who feel to be rather practitioners than theoreticians will find the part One to be extremely interesting. Not neglecting informal explanations and motivations, the author at the same time gives an exact and precise definition of the used mathematical apparatus making thus the exposition comprehensive. We would like to point out explications of the fixed-point techniques, binary relations, three-valued predicates and input-output correctness statements which (except the fixed-point techniques) form the major extension of the proposed metalanguage with respect to META - IV. Only slight notational inaccuracies disturbing the formal fairness of this part can be criticized here, such as, e.g.:

— in the definition of a minimal element of A (p. 3) there should be stated that $a' \neq a$. In the following example there should be noted that the family A of sets is ordered by the set theoretical inclusion;
— the example of a fixed-point definition (p. 2) of Expression seems to be inadequate. For, what is the semantics of "concatenation"? Is concatenation really defined for *sets* of characters?
— the least upper bound (p. 4) is usually called the supremum of A *in* D and, therefore, denoted by "$\sup_D A$"; it is, therefore, not proper to denote it by "$\bigsqcup A$" omitting thus the reference to D, which could lead to ambiguities; an analogic objection concerns the limit of a chain;
— a cpo of subsets (p. 4) — the well-known fact that the family of all subsets of A ordered by the set-theoretical inclusion creates a complete lattice (not only a cpo) would be worth citing;
— the notation $A \mid B$ is introduced (p. 2) as denoting the set union, but the same symbol "|" is also used throughout the book in the definitions of sets where the semicolon would be more

suitable (cf., e.g., pp. 12, 13:

$$\text{Rel.}\langle \text{A, B}\rangle = \{R \mid R \subseteq A \times \text{B}\}$$

$$\text{P}(R \mid \text{Q}) = \text{PR} \mid \text{PQ})\,;$$

— p. 26: defining mapping as a partial function with a finite domain does not fit the common mathematical terminology.

Part Two provides an example definition of a subset of Pascal containing the standard types integers and booleans, structured types records without variables, and a restricted class of expressions and commands (omitting procedures, blocks and goto's). The goal of this part can be characterized as a precise definition of Pascal types and of mechanisms of records and pointers. Two main interesting results can be pointed out. First, giving an abstract definition of Pascal types, the author shows how an inadequate definition or description of this important concept is given in the original report on Pascal as well as in the ISO standard of Pascal. Second, analyzing the mechanisms of records and pointers, the author is forced to define records as mappings from identifiers to locations rather than to values. This mathematical model of records is not in accordance with the common Pascal-users' intuition. The author comes to the result that records cannot be treated as pure data types, which is the consequence of using reference parameters (rather than value parameters) in procedures. Thus it is clarified here that Pascal is much more machine- and implementation-oriented than it is commonly believed.

Marie Duží

ROBERT CORI, MARTIN WIRSING, Eds.

STACS 88

5th Annual Symposium on Theoretical Aspects of Computer Science held in Bordeaux, France, February 11—13, 1988, Proceedings

Lecture Notes in Computer Science 294.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1988.
IX + 404 pages; DM 55,—.

The volume contains the invited address by C. P. Schnorr, 34 contributions divided into nine groups and eight short descriptions of software systems, all the contributions and systems were presented at the occassion of the 5th Annual Symposium on Theoretical Aspects of Computer Science held in Bordeaux, France, on February 11—13, 1988. Because of a great thematical variety of the presented papers we shall preserve the partition defined by the editors and we shall mention all the contribution in their sequential order.

C. P. Schnorr's invited address is of the form of a short summary mentioning some latest results in the field of geometry of numbers and integer programming. The first group of contributions is headed as "algorithms" and is introduced by G. Gambosi, G. F. Italiano and M. Talamo's paper considering the set-union problem with possible backtracking over the union operations. B. Becker and R. Kolla suggest an algorithm to construct optimal time address. The next contribution by B. Just, M. Meyer auf der Heide and A. Wigderson deals with computations with integer division. M. H. Overmars and M. H. M. Smid investigate, how to maintain range trees in secondary memory. The paper by D. Fernandez-Baca and G. Slutzki describes how to solve parametric problems on trees. W. Unger deals with the problem of k-colouring of circle graphs. The last contribution of this group shows how to characterize tree-like data structures by functional equations and is presented by F. Bergeron, G. Labelle and P. Leroux.

"Complexity" is the next group of contributions containing five items and introduced by the

Ch. Meinel's paper on the power of polynomial size Ω-branching programs. It is followed by the U. Schöning and K. W. Wagner's contribution on collapsing oracle hierarchies, census functions and logarithmically many queries. E. Grädel deals with domino games used as a tool to investigate the complexity of Boolean algebras with bounded quantifier alternations. Automatic speed-up of random access machines with powerful arithmetic instructions is investigated by I. Wald, and the last paper of this group is that by B. Jenner and B. Kirsig characterizing the polynomial hierarchy by alternating auxiliary pushdown automata.

The third group of papers is devoted to formal languages (six contributions). W. Dickert and A. Möbus present Hotz-isomorphism theorems in formal language theory, and U. Heuter investigates first-order properties of trees, star-free expressions and aperiodicity. Relationships between polynomially bounded rational transductions, cyclic rational transductions of finite image and polynomials of rational functions are studied by A. Terlutte. C. de Felice proposes a construction of a family of finite maximal codes. The paper by J. P. Allouche B. Rande and L. Thimonier deals with generating transcendent functions the coefficients of which are generated by 2-automata (written in French). The relation of two patterns with comparable languages is investigated by G. File.

Each of the two following chapters "Rewriting Systems and Abstract Data Types" and "Graph Grammars" contain two items. W. Bousdira and J. - L. Remy deal with hierarchical contextual rewriting with several levels, some results on generalized bisimulation in relational specifications are presented by E. Astesiano, A. Giovini and G. Reggio. The contribution by F. - J. Brandenburg is devoted to polynomial time graph grammar and B. Courcelle offers an axiomatic definition of context-free rewriting applied to NLC grammars.

The three following contributions are covered under the headline "Distributed Algorithms". P. Spirakis and B. Tampakas examine the effect of limited asynchrony on three fundamental problems of distributed computation: the problem of symmetry breaking in a logical rings, that of mutual exclusion and the problem of readers and writers. A simple protocol for secure circuit evaluation is presented by M. Abadi and J. Feigenbaum. Finally, G. I. Chen and T. H. Lai consider the problem of scheduling independent jobs on hypercubes. The next chapter deals with geometrical algorithms and contains five items. R. Klein and D. Wood present new results concerning Voronoi diagrams based on general metrices in the plane. Geometric containments, common roots of polynomials and partial orders are examined by N. Santoro, J. B. Sidney, S. J. Sidney and J. Urrutia, P. Lienhardt deals with an extension of the notion of map and subdivisions of a three-dimensional space. An optimal algorithm for detecting weak visibility of a polygon is suggested by J. R. Sack and S. Suri. The last paper of this group is that by F. Avnaim and J. - D. Boissonnat dealing with polygon placement under translation and rotation.

Each of the last two groups, entitled "Trace Languages" and "Semantics of Parallelism" contains two contributions. D. Bruschi, G. Pighizzini and N. Sabadini characterize concurrent alphabets for which every recognizable trace language admits a minimum finite state asynchronous automaton. They also consider the equivalence problem for unambiguous regular trace language, proving this problem to be decidable even in some cases with non-transitive concurrency relation. E. Ochmanski investigates morphisms of trace monoids. Various kinds of fairness for finite state SCCS processes by providing an automaton-theoretic characterization of the class of fair languages are described by I. Guessarian and W. Niar-Dinedane. J. - N. Kok proposes a compositional semantics for concurrent Prolog.

The volume is closed by short reports (two page each) on various software systems under construction or already in service, which were presented during the symposium. The contributions briefly mentioned above contain 10—12 pages in average, some are presented as extended abstracts (about one half of them), the rest being conceived as full texts with more detailed proofs or argumentations. Even when preserving the traditional wide scale of subjects of STACS Symposia ranging from philosophical and purely mathematical papers to technical applications, the

reviewed volume seems to prove a non-negligible shift toward more practical software and hardware problems of computer engineering. The volume keeps the traditional form and level of LNCS series and can be recommended to specialists interested in the topics of contemporary computer science.

Ivan Kramosil

TUNG X. BUI

Co-oP

A Group Decision Support System for Cooperative Multiple Criteria Group Decision Making

Lecture Notes in Computer Science 290.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1987.
XIII + 250 pages; DM 40,50.

The referred book presents an interesting contribution to the existing decision support systems (DSS) implementable on personal computers.

The decision support systems used in practice are individual, non-cooperative, respecting only one system of preferences. In this sense they offer a useful tool for rational decision making in many practical situations in which no conflict of interests appears. Nevertheless, there exist many decision-making problems connected with a confrontation of more preference scales or more criteria, in which a rational and balanced compromise is to be found. It is desirable to support such group decision-making by software tools which would be able to provide the mechanical steps connected with the decision- and compromise-finding procedure. The methodological fundaments and technical structure of such group decision support system are presented in the book.

The DSS suggested by the author possesses three principal properties guaranteeing its cooperativity and objectivity.

— The decision setting, even if connected with negotiations, is not intentional in the sense of eventual misinterpretation of data or preferences.
— The decisions are made in democratic and distributed fashion; each participant is individual, no group leader is supposed.
— The system forms a basis for wider exchange of information and supports further development and continuation of other related forms of cooperation among participants.

Each decision-maker participating in the group is supposed to have his own personal computer connected to the others via a network. The arbitration among preferences, aggregation of criteria and negotiation should be mostly provided by the system. The system should also enforce and coordinate other components of the decision-making procedure realized and agreed upon by the group participants.

The book is divided into twelve sections devoted to the definition, description and discussion of different components of the system, their architecture and design. The sections are written in a systematic and lucid way, even if certain degree of proficiency in the DSS theory is desirable for the reader. Tables, schemes and graphs complete the text of the sections.

After the explanatory Introduction the other sections are subjected to the Definition of terms and context, Review of prior related research, Functions and roles of DSS in group decision making, Design issues for the model components, Design for the dialogue component, Communications design, System architecture and software components, Evaluation issues, Empirical evidence on relations between some group DSS, Non-cooperation in group DSS, Design for

organizational making, and a few Conclusive remarks. The book is completed by an ample Bibliography and Index.

The referred book brings a new and interesting approach to the decision support systems and their development. The possibility of cooperation among the group decision-makers and the computer-based finding of compromise enlarge the area of real applications of the suggested system.

The book and methods included in it can be useful namely for readers having already certain experience with the development and applications of the DSS and skilled in their practical handling. It can enrich their knowledge and turn their attention to an interesting direction of further development of the DSS theory and procedures.

Milan Mareš

CARLOS DELGADO KLOOS

Semantics of Digital Circuits

Lecture Notes in Computer Science 285.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1987.
IX + 124 pages; DM 27,—.

The book introduces a formal language for description of behaviour of electronic circuits. The author distinguishes the following levels of description of hardware

- the register transfer level, characterized by words of binary values of fixed length and registers, modules and transfers;
- the gate level, characterized by the laws of Boolean algebra and additional mechanisms;
- the switch level, in which one deals with a simplified model for power sources, transistors, resistors and capacitors and may employ a multivalued logic.

The language called STREAM is presented as a common skeleton for the different levels of hardware description allowing simple equivalent transformations to be performed formally.

In Chapter 2 the syntax and semantics of the STREAM language is defined. The language is based on streams. A stream is a finite or infinite succession of basic values of a given set *D*. *D* should include at least Boolean values. The functions processing streams are called agents. The language contains a set of predefined primitive agents and a variety of tools for composing agents into nets, called STREAM nets, which can simulate circuits.

Chapter 3 describes a relatively straightforward way of translating a program in "a simple procedural language" to an equivalent circuit.

The rest of the book is based on examples of representation of circuits on different levels of description in the STREAM language. Chapter 4 contains description of some commonly used circuits (demultiplexor, multiplexor, and flip-flop circuits D, RS, and JK). The main idea presented in Chapter 5 is that the method of modelling real circuits on gate level by ternary logic (discussed e.g. in J. Brzozovski, M. Yoeli: On a Ternary Model of Gate Networks, IEEE Transactions on Computers *C-28* (1979), No. 3, 178—183), can be formulated using streams. Chapter 6 suggests the STREAM language description of the behaviour of the switch level elements (resistors, capacitors, transistors, ...).

There is about sixty items of bibliography. The book can be of some interest to those who develop general software for manipulating circuits.

Petr Savický

J. T. SCHWARZ, R. B. K. DEWAR, E. DUBINSKI, E. SCHÖNBERG

Programming with Sets — An Introduction to SETL

Text and Monographs in Computer Science.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1986.
XV + 493 pages; 31 illustrations, included index; DM 108,—.

The SETL language summarizes many years of programming and pedagogical experience. The book to be introduced here contains a complete and fresh description of this "very high" programming language.

At first look the language (and the book as well) is based on a simple trick — on the extensive use of the mathematical concept of a "set". Sets are fine tools for structuring and exact description of real world problems, but they are rather clumsily tracted by programming languages we mostly, use. At second more detailed look it gets clearer than the language covers also a long queue of methodical approaches formed in last two decades — but now altogether in executable form (refinements, packages, control structures for backtracking etc.).

What are features of the SETL language which allow authors to claim it to be a "very high level"? The SETL introduces abstract and composite objects — namely general sets, "tuples" and maps over arbitrary domains. It introduces powerful operations over them as well and direct availability of these objects and operations enhances compact and readable from of program text, which sometimes resembles the specification of a problem more then the solution of it.

Three ways of data objects structuring were mentioned above. Sets are composite objects, which allow efficient tests for memberships, cycles over elements of the sets and selection of an element with properties specified. The general and flexible syntactic category of a "set former" is the basic tool creating and manipulating sets in SETL. Tuples are another composite objects, from mathematical point of view finite sequences of elements. Maybe the characteristic of tuples as sets, but with elements being ordered and repeating of elements being possible, gives a good picture of this concept as well. This is a probably the most useful concept of the language, which integrates flexibility of tuple and subtuple manipulation and construction — close to that of sets — with implementation efficiency near as good as that of arrays. Maps are designed as sets of pairs addressable by "domain" elements.

There is a problem of efficiency, which is generally able to discredit any finely thought-out concept in programming practice, but this seems not to be the very problem of SETL. The authors force reader to be aware of efficiency problems, and to distinguish between "one-shot" programs, where the efficiency is of a little concern, and programs, where execution times may be critical. The more, SETL also presents a powerful mechanism for stepwise refinement of efficiency — so called data representation sublanguage. It enables to concern on the algorithm design first and only then, if needed, it is possible for (more experienced) programmer by demanding more intricated or more relevant storing of data to speed up a program, which works right, but appears to be too slow.

The book is self-contained and should be accessible to beginners too, but a non-programmer may expect an uneasy task of getting familiar with many details and variant constructions possible. On the other hand, the first chapter dedicated to unexperienced reader contains some interesting views and remarks and it would be amiss to skip it even for professional. Chapter 2 to 5 introduce major data objects and variant control structures of the language. Chapter 6 gives useful and interesting remarks on program testing and debugging and contains the efficiency analysis review. These chapters are followed by more advanced topics and notions, namely backtracking feature, mechanism for large program structuring and data representation sub-

language. The book is closed with 11th "language in action" chapter, syntactic graphs and detailed index. Many exercises are appenend to corresponding chapters.

It is no worth to discuss whether the SETL language is good for today's programming practice and/or why not. The book is no doubt worth close reading. It contains some new and stimulating concepts and notions, which may do help in daily programming, and which we sometimes can expect to be taken for granted in our programming tools to be.

Vladimír Hora

R. CONRADI, T. M. DIDRIKSEN, D. H. WANVIK, Eds.

Advanced Programming Environments

Proceedings of an International Workshop, Trondheim, Norway, June 16—18, 1986

Lecture Notes in Computer Science 244.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1986.
Stran VII + 604; cena DM 88,—.

Sborník z mezinárodní konference pořádané pracovní skupinou IFIP 2.4 (systémové programovací jazyky). Toto pracovní setkání bylo věnováno vytváření perspektivních programovacích prostředí. Sborník obsahuje text asi 30 vyžádaných referátů, dále řadu drobnějších příspěvků a záznamy diskusních vystoupení. Příspěvky jsou tematicky rozděleny do 7 hlavních okruhů, které se značně překrývají a doplňují.

Referáty mají většinou značně popisný charakter, obsahují řadu drobných postřehů a někdy i pokusů o analytické vyhodnocování charakteristik softwarových prostředí. Rysy moderních prostředí jsou vesměs dokumentovány na konkrétních programových systémech, u nás málo známých. Po přečtení sborníku si čtenář odnese velmi dobrou představu o tom, jak by moderní a perspektivní softwarová prostředí měla vypadat, ale neubrání se myšlence, že koncepčně se stále ještě na cosi čeká.

První sekce, nazvaná "Programování v malém" je zaměřena na moderní prvky softwarové podpory — textové editory, syntaktické editory, na rozvoj prostředků pro ladění programů ve zdrojovém tvaru. Zdůrazňuje se potřeba přejít na grafické metody a přiblížit softwarové prostředky co nejvíce lidskému uvažování. Opouští se strohá rigoroznost softwaru předchozích generací a přechází se na globální způsob uvažování a softwarové podpory.

Navazující problematika se diskutuje v sekci "Programování ve velkém", věnované architektuře softwaru velkého rozsahu (např. softwarový celek pro řízení kosmické lodi). Zatímco u softwaru malého rozsahu se zájem soustřeďuje na efektivnost a rychlost ladění, u velkých celků vystupuje do popředí především celková architektura a strategie návrhu a ladění. Připomíná se Vídeňská metoda návrhu, ale i editory založené na přirozené řeči, inkrementální kompilátory, analyzátory toku dat, návrh softwaru na základě báze znalostí apod. Mezi zásady návrhu softwarového prostředí pro velké programovací práce patří otevřenost celého systému, snadnost provádění změn, zabezpečení toku dat z jednoho softwarového prostředku do jiného včetně přístupu do databází a znalostních bází.

U velkých integrovaných softwarových celků vystupují problémy se závislostí softwaru na konfiguraci a existencí programových celků v řadě variant a verzí. Těmto otázkám je věnována další sekce sborníku. Pojem verzí a závislosti na konfiguraci se zavádí i do programovacích jazyků. Mnoho prostoru se věnuje i kooperaci a ochraně softwarových modulů.

V sekci „Integrace prostředků" je věnována pozornost diskusi monolitického návrhu proti stavebnicovému návrhu a způsobu budování napojení softwaru, zvláště na databázové systémy. Těm je věnován i následující oddíl.

Rozvojem programování velkého rozsahu vystupují do popředí otázky návrhu programu pro vícenásobné použití a metody transformace programů. Ukazuje se, že možnost vícenásobného užití programu je limitována silou abstrakce užitého programovacího jazyka a hledají se prostředky, jak problém řešit — slibnou cestou se jeví rozvoj abstraktních typů dat a algebraické přístupy k programování.

V závěru se diskutuje budoucnost počítačů a programování. Počítá se s rozvojem všech dříve zmíněných přístupů, ale na kvalitativně vyšší úrovni. Tuto kvalitativní změnu lze charakterizovat tak, že jak složitost, tak i objem programovacích prací porostou a je proto třeba hledat další metody softwarové podpory vývoje softwaru. Dále, a to je pravděpodobně důležitější, je třeba k softwaru přistupovat jako k integrální složce rozsáhlých heterogenních systémů.

Petr Nedoma

HANS LOEPER, HANS-JÖRG JÄKEL, WOLFGANG OTTER

Compiler und Interpreter für höhere Programmiersprachen

Informatik — Kybernetik — Rechentechnik 17.
Akademie-Verlag, Berlin 1987.
Stran 390; cena 50,— M.

Recensovaná kniha je velmi solidní učebnicí technologii informatiky v oblasti překladu a interpretace programovacích jazyků, zahrnující i potřebné teoretické zázemí. Tvorba překladačů a interpretačních systémů pro vyšší programovací jazyky již překonala stadium, kdy byla uměleckým řemeslem, řízeným zkušenostmi a invencí autorů. Nestala se však ještě rutinní činností, již by bylo možno svěřit středně technickým kádrům a z větší části ji provádět počítačem. Učebnice, kterou máme před sebou, soustavě a přitom srozumitelně vykládá teorie, jež byly kolem programovacích jazyků vytvořeny. Seznamuje čtenáře se všemi v současné době důležitými pojmy, myšlenkami a zásadami implementace jazyků a podrobně probírá algoritmy a datové struktury, jež se v soudobých implementačních technikách používají.

Názvy jednotlivých kapitol poskytnou podrobnější představu o obsahu knihy: Matematické základy definice programovacích jazyků, Struktura programovacího systému, Elementy teorie bezkontextových jazyků, Syntaktická hierarchie a popis syntaktických struktur pomocí stromů, Akceptory, Syntaktická analýza, Sémantika programovacích jazyků, Struktura a organizace seznamů, Struktura a generování cílového kódu, Optimalizace.

Výklad je dobře uspořádaný a promyšlený, s mnoha podrobnými příklady, diagramy a schématy. Jsou tu cvičení (jejichž řešení autoři slibují vydat později), seznam literatury (80 položek) a věcný rejstřík. Škoda, že kniha je napsána německy; tím je okruh jejích čtenářů u nás omezen.

Ivan Havel, Petr Liebl

J. L. C. SANZ, E. B. HINKLE A. K. JAIN

Radon and Projection Transform-Based Computer Vision

Algorithms, A Pipeline Architecture, and Industrial Applications

Springer Series in Information Sciences 16.
Springer-Verlag, Berlin — Heidelberg — New York — London — Paris — Tokyo 1988.
VIII + 123 pages; 39 figures; DM 59,—.

As far as parallel computing have been penetrating application areas new thinking in algorithm theory appears: together with formulation of algorithms computer architectures for their processing are suggested. When the FFT for numerical counterparts of the Fourier transform was found twenty years ago, its algorithm consists of step-after-step set of instructions. But $P^3E =$

= PPPE = *Parallel Pipeline Projection Engine*, the subject of the book in question, is proposed all at once beginning from a proper hardware components through their architecture and control to a wide variety of possible applications.

Machine vision systems require great demands on image processing and the manipulation of such an extraordinary amount of data at video-rate speed must be supported also by different representations for pictures. The *Radon transform*[1] is one of available tools. Projection [2] space representations and manipulations offer, when an efficient engine for changing representations from the image space to the projection space and back again is at hand, not only direct applications like computer-aided tomography but also impact on various machine vision problems. The reviewed book, the 16th volume of Springer Series in Information Sciences, brings the mentioned novel pipeline[3] architecture PPPE for numerical counterparts of the Radon transform, its inversion and other projections.

This tender book is divided into nine chapters. Rather large introduction mentions in the first part all topics concerning machine vision systems with respect to their organization and gives a great number of references. The second part surveys projection-based algorithms and architectures for machine vision and compares them with classical ones.

To reach for proper pipelining of the Radon transform a special model and computation of digital lines are presented in the second chapter; the lines are arranged to cover and disjointly resolve the image. One projection is then computed on one stage of the pipeline by histogramming the image over all resolution classes with a global weighting. If the number of stages equals the number od chosen projections the discrete version of the Radon transform is in this way obtained by one pass through the pipeline. This relatively crude approximative method gives to arise a noise that is showed to be not important for many image analysis applications.

The third, key chapter describes P^3E. First, the local stage consisting of three parts (the contour image generator for the resolution of the image, the projection data collector and a one-dimensional signal processing hardware for the inversion) and then the pipeline configuration are discussed. Implementations in commercially available short-pipeline image processors were successfully performed and close the chapter. Also other sophisticated image resolutions may be computed by P^3E effectively and are presented in chapter four, e.g. for the covariance computation hyperbolical contours are needed.

Chapter five and six introduce P^3E-based algorithms and techniques for image analysis and image processing, respectively.

The developed image analysis algorithms include computing classical statistical (e.g. principal components) and geometrical (e.g. convex hulls, diameters, enclosing boxes) features, line and curve detection based on the Hough transform, and generating multi-color polygonals masks. The explanation is intelligible and many experimental results are attached for illustration.

Reducing the dimensionality of certain image processing operations via the Radon transform is the main motivation of the projection-based image processing algorithms (e.g. two-dimensional convolution, rotation and translation, polar Fourier transform), but they would be supported, when performed on P^3E, also by a P^3E-based inverse Radon transform. The model is shown to be complete, i.e. filtered/convolution backprojection techniques for the numerical inversion are well realizable by P^3E and have reasonable numerical properties. Nice figures accompanying this part of the book prove practical tractability of all considerations.

[1] The Radon transform of an integrable function f on Euclidean plane is the function $\hat{f}$ on the set of all lines with values equal to the line integrals along these lines.

[2] Projection of f is its Radon transform $\hat{f}$ restricted on a set of all parallel lines. Also another families of curves are considered.

[3] Pipeline is the parallel computer architecture of type MISD (multiple instruction, single data stream).

The *Radon transform theory for random fields* has been expected with great attention during the last decade. First results appeared in 1984 by Jain and Ansari[4] and are (without essential changes) repeated in the seventh chapter. This rather theoretical part without outlining experimental point of view contrasts with all other chapters. Also explanation is too formal and concise. Nevertheless, the excellent idea to filter random field in a special manner before taking projections, which lies in the theory foundations, may have great influence on the future development in this area.

One but last chapter deals with a special real-world industrial application: P^3E architecture is implemented in the machine vision system oriented to automated visual inspection of thin-film-disk-heads.

As stated in the conclusion the PPPE architecture proposed in the book does indeed unleash the power of Radon transform theory for digital images and will encourage more widespread use of projection-based computer vision.

We hope all specialists in computer vision and image processing will sincerely wellcome these new and challenging ideas. This book will undoubtedly stimulate a number of potential yet unresolved vision applications. Maybe, the abbreviation P^3E will become as popular as FFT.

František Matúš

PIERRE A. DEVIJVER, JOSEF KITTLER, Eds.

Pattern Recognition Theory and Applications

NATO ASI Series — Series F: Computer and Systems Series, Vol. 30.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1987.
XI + 543 pages; DM 178,—.

This book, dedicated to the memory of Prof. K. S. Fu, represents the outcome of a NATO Advanced Study Institute on Pattern Recognition and Applications held in Belgium, in June 1986. It is an up-to-date account of the state of the art in pattern recognition, covering in eight chapters all the major areas of contemporary theoretical research and applications. The editors arranged the book to have a consistent form. Each chapter is introduced by at least one tutorial paper, providing an excellent introduction to the topic and a survey of recent results. This tutorial paper is followed by more specialized contributions, including applications.

The first three chapters cover the "classical" probabilistic domain of pattern recognition. Chapter 1 is devoted to statistical methods and clustering techniques. The introductory paper by A. K. Jain provides not only a brief but excellent discussion of all the main directions including the assessment of various approaches, but presents as well the most recent developments in pattern recognition. It includes the discussion of error estimation, feature selection versus extraction, bootstrap techniques, computational complexity and geometry, as well as extensive bibliography. Other contributions are devoted to texture subspaces, linear models in spatial discriminant analysis, and automatic selection of a discrimination rule based upon minimization of the empirical risk.

Chapter 2 is devoted to probabilistic relaxation techniques which offer an important tool for exploiting contextual information in image interpretation. These techniques represent a class of parallel iterative algorithms for the cases when data concerning the system are either uncertain or corrupted. They are aimed at iterative improving of global consistency of data. J. Kittler develops in his paper a theoretical basis for the probabilistic relaxation technique, followed by J. Illingworth's review of optimization algorithms in probabilistic relaxation labelling.

[4] A. Jain, S. Ansari: "Radon transform theory for random fields and optimum image reconstruction from noisy projections", Proc. ICASSP'84, San Diego.

Chapter 3 covers the theory and usage of Markovian and connectionist models, introduced by P. Devijver's paper on learning the parameters of a hidden Markov random field image model. Other contributions in this chapter are devoted to locating texture and object boundaries, the detection of geological fault lines in radar images and finally to speech recognition, namely the experiment with a large dictionary and adaptive networks in speech pattern processing.

Chapter 4 is devoted to graph theory and geometry in pattern recognition. Three contributions deal with problems and possible solutions in the analysis of sparse images, stochastic geometry and perception and a survey paper by Toussaint on recent results in computational geometry relevant to the problem of shape decription and recognition by machines. Chapter 5 concerns another major area of pattern recognition — theory and usage of structural methods. M. G. Thomason presents a valuable survey and discussion of structural methods in pattern analysis, including formal relational approaches and syntactic/semantic methods. It is followed by contributions on a random graph approach, inexact graph matching used in machine vision and development of an incremental graph matching device.

Chapter 6 is devoted to very important topic — hybrid methods in pattern recognition. These methods combine both traditional pattern recognition approaches, namely statistical and structural methods with those utilized recently in the field of artificial intelligence. In the introductory paper by H. Bunke the particular emphasis is given to the discussion how different methods are related with each other and how they can be combined into a single hybrid approach. The other contributions in this chapter deals with the exploitation of fuzzy sets in pattern recognition.

The knowledge-based recognition techniques, closely connected with the results from quickly expanding knowledge-based or expert systems are discussed in Chapter 6. The tutorial paper by Chandrasekaran and Keuneke discusses hierarchical classification from the point of view of artificial intelligence approach. It decribes a medical diagnosis system that performs knowledge-based hierarchical classification, together with a high-level language, especially designed for this purpose. L. Kanaal in his paper on the structure of parallel adaptive search discusses an adaptive dynamic algorithm especially designed in order to exploit full paralelism in a multiprocessor environment as well as utility of parallel accumulated information. Other papers discuss three dimensional organ recognition by tomographic image analysis and knowledge-based computer recognition of speech.

The last Chapter 8 is devoted to problems of application, concerning machine vision and image processing. In this chapter there are contributions from so different fields as CAD systems, electron microscopy, recognition of blood cells with the aim to detect leukemia, tissue image segmentation and other problems.

From the presented outline it is obvious that the book, containing the contributions of many leading experts in the field of pattern recognition, provides not only the state of the art in pattern recognition but suggests as well directions for future research, including the interconnecting pattern recognition with artificial intelligence. It can be, therefore, strongly recommended to all who are interested in pattern recognition theory and its application, as well as a reference book for those engaged in artificial intelligence.

Pavel Pudil

RUTH F. CURTAIN, Ed.

Modelling, Robustness and Sensitivity Reduction in Control Systems

Proceedings of the NATO Advanced Research Workshop on Modelling, Robustness and Sensitivity Reduction in Control Systems held in Groningen, The Netherlands, December 1—5, 1986

NATO ASI Series — Series F: Computer and Systems Sciences, Vol. 34.
Springer-Verlag, Berlin—Heidelberg—New York—London—Paris—Tokyo 1987.
IX + 492 pages; DM 148,—.

The main theme of the workshop was a new research area in Systems and Control Theory known as H^∞-Control. We shall concentrate — with a single exception — on selected papers on this theme.

Francis: A guide to H^∞-control theory. The standard problem is: find a real-rational proper K to minimize the H_∞-norm of the transfer matrix from exogenous input to the controlled output under the stability constraint. (H stands for the Hardy space.) The standard problem is then transfered to equivalent model matching problem.

Safonov: Imaginary-axes zeros in multivariable H^∞-optimal control. The author's abstract: When a plant has $j\omega$-axis zeros or $j\omega$-axis poles, algorithms for computing H^∞-optimal control laws fail. Closely related problems arise with strictly proper plants; these plants may be interpreted as having $j\omega$-axis zeros at $\omega = \infty$. These intrinsic problems with H^∞ arise because the optimal control system has an irrational transfer function with point discontinuities on the $j\omega$-axis at the offending $j\omega$-axis poles of the plant. The difficulties with $j\omega$-axis poles and zeros are discussed and the methods for perturbing the H^∞-problem to produce near-optimal rational control laws are proposed."

Kwakernaak: A polynomial approach to H_∞-optimization of control systems. The author concentrates on two-degree-of-freedom SISO control system for which he solved the numerical example. To obtain a particular optimal compensator $k_1 = -3{\cdot}0$, $k_2 = 3{\cdot}1(s + 1)(s + 4)$ the author had performed "several" — in fact 8, resp. 7 cancellations.

Doyle, Lenz, Packard: Design examples using μ-synthesis: Space shuttle lateral axis FCS during reentry. Let us remind the distinguished pioneer work of Doyle in the area of robustness (or loss of it) analysis. In 1978 he published in IEEE Trans. AC-23 (1978), 756—7 a correspondence "Guaranteed margins for LQG regulators" with the abstract: "There are none". The paper studies the application of structured singular values for analysis and synthesis of the Space shuttle lateral axis flight control system during reentry. The theorems on robust stability and on robust performance are presented. The 4-state rigid body aircraft is the point of departure. From the authors' comment: "High controller state order is a potentially annoying problem associated with H_∞ and μ-synthesis. H_∞ optimal controllers are usually at least the order (and often twice) of the interconnection structure, which includes not only the plant but also all the weights used to set up the interconnection structure. With the rigid body aircraft model, actuator models, delay approximation, ideal model response, and weights on sensor noise, performance errors, gust, and command, the nominal interconnection structure used in this paper for the H_∞ design has 23 states." The Doyle-Lenz-Packard paper is likely the most important paper of the book.

Grübel, Joos: Performance-robust design via multi-criteria/multi-model approach — a flight control case study. The main problem was a robust stabilization of an aircraft, JAS 39, whose center of gravity is behind the aerodynamic centre. For this problem, a third order analog robust control law was constructed. No mention to H^∞-optimization was given, the eigenvalues placement was of some use.

Poistlethwaite, Gu, O'Young, Tombs: An application of H^∞-design and some computational improvements. From the author's abstract: "We present the results of a case study in which a recently developed H^∞-design package is used to design a full authority flight control system for a high performance helicopter."

Jonckheere, Juang: Hankel and Toeplitz operators in linear quadratic and H^∞-design. It is suggested to alleviate the computational burden of the H^∞-synthesis by the linear quadratic approximation.

Saeki, Grimble, Kornegoor, Johnson: H_∞-optimal control, LQG polynomial systems techniques and numerical solution procedures. The authors are concerned with SISO discrete time systems, for the H_∞-optimization they develop some Diophantine polynomial equations.

Pearson, Dahleh: Control system design to minimize maximum errors. The objective is to stabilize a given system and minimize the effect of a class of persistent disturbances both for SISO and MIMO control systems.

It is remarkable for the reviewer to see how the classical concept of the M-circles of Brown, Hall: Trans. ASME *68* (1946), 503—524, which the reviewer had learned during his school years from Trnka: Servomechanisms (1958, in Czech) has still impetus for modern control design. Nevertheless, in the whole book, there is no mention about the M-circles and H_∞-control.

Antonín Vaněček

JENS G. BALCHEN, KENNETH I. MUMMÉ

Process Control Structures and Applications

Van Nostrand Reinhold Company, New York 1988.
540 pages; price not indicated.

The gap between the theory and applications of automatic control is a problem discussed frequently at conferences in the introductory or plenary papers. On the one hand there is the enormous amount of theoretical approaches proposing the design of automatic control systems and on the other hands, in practice, the real design relies mostly on experience, intuition or on elementary rules verified by experiments.

The present book by J. G. Balchen and K. I. Mummé is a significant attempt to bridge this gap by introducing first in Chapter 2 the short overview of the principles of automatic control theory. Attention is paid not only to basic single variable feedback and feedforward control but to specific process controls such as ratio control, cascade and parallel control, multivariable control including decoupling and state estimation. Possibilities of system parameter estimation are briefly discussed as well as adaptive and predictive control. The last paragraphs of this Chapter are devoted to steady-state and dynamic optimization of continuous production processes and to the practical design of process control systems. For details concerning the theoretical procedures the reader is referred to the professional extensive literature.

All next Chapters deal with continuous industrial processes. The main aim of the book is to provide typical examples which can be useful to the practicing engineer.

Chapter 3 describes systematically important types of unit operations and unit processes with respect to their properties. It concerns e.g. transport of liquids, solids and gases, mixing and separation processes, heat generation and heat exchange, evaporators and others.

Chapter 4 is concerned with process control of basic functions like level control, pressure control, control of volume flow and mass flow, energy, temperature and enthalpy control etc.

In Chapter 5 the authors solve the automatic control of unit processes described in Chapter 3. According to the complexity of the system to be controlled attention is paid to all important aspects. E.g. the boiler control in the paragraph dealing with heat exchangers is considered with respect to decoupling, state estimation and state feedback. Interesting is the comparison of tran-

sient responses of drum pressure and drum water level controlled by conventional linear controllers and noninteracting controllers respectively.

Chapter 6 deals with process control in large industrial complexes. The authors selected control processes in the pulp and paper industry, in oil extraction and refining, in the petrochemical industry and in ammonia-based industry. All control problems are carefully interpreted not omitting the possible positive feedback in certain configurations making automatic control more difficult.

Finally, it is necessary to mention 15 appendices representing an important part of the book. The reader can find in appendices A through E more details relating to control theory e.g. application of the modified w-transformation, evaluation of a particular model-based estimator, derivation of interaction and pairing of variables in multivariable systems, algorithms for adaptive control of monovariable processes and robustness of multivariable control systems.

The last appendices F through L describe exemplary mathematical models of selected systems, i.e. dynamics in gas systems, velocity profile characteristics in pipes, mathematical models of heat exchangers, of a boiler, evaporators, crystallization processes and of a rotary drum dryer.

The book is in certain sense unique combining the fundamental control theory with the art of control of typical industrial continuous processes. The readers, students and practicing engineers can find in the book professional hints and strategies for the design of control systems respecting the properties of these systems. The knowledge of the dynamics and control of basic processes provide the building blocks enabling or at least facilitating the design of similar control systems consisting of the basic process units, and enabling to transfer the gained knowledge from one process or industry to another.

The authors are experienced experts in the field of industrial control. The book is presented in a comprehensive but clear form accompanied by a great number of drawings and reproductions of measured control processes. A substantial number of references and a large subject index help the reader to find areas of his particular interest.

Vladimír Strejc

B. JAKUBCZYK, W. RESPONDEK, K. TCHOŃ, Eds.

Geometric Theory of Nonlinear Control Systems

International Conference, Bierutowice, Poland, 18—21 IX 1984

Wydawnictwo Politechniki Wroclawskiej, Wroclaw 1985.
Stran 278; cena 300,— zł.

Sborník je věnován v posledních 15 letech bouřlivě se rozvíjejícím diferenciálně geometrickým přístupům v oblasti hladkých nelineárních řízených systémů, tj. využití aparátu hladkých variet, Lieových grup a Lieových algeber k analýze nejrůznějších otázek, spojených s teorií nelineárních řízených systémů.

První část sborníku obsahuje předem vyžádané přednášky autorů, široce známých svou prací v oblasti diferenciálně geometrických metod, namátkou jmenujme např. M. Fliesse, P. E. Crouche, B. Jakubzyka a W. Respondeka. Je možné říci, že tato první část představuje určitý přehled nejtypičtějších postupů v oblasti diferenciálně geometrických metod jakož i nejtypičtějších problémů, které řeší (např. realizace, linearizace a reprezentace hladkých nelineárních systémů apod.).

Druhá část obsahuje zaslané přednášky účastníků konference. V této části je patrný větší rozptyl tématiky a určitá nahodilost výběru příspěvků, hlavně co se týče řešených problémů teorie řízení, některé příspěvky ani nepoužívají diferenciálně geometrické metody. Vcelku však lze říci, že i v druhé části je použití diferenciálně geometrických přístupů jednotícím prvkem.

Na závěr je možné doporučit sborník zájemcům o problematiku využití diferenciálně geometrických metod v teorii řízení spíše jako určitý reprezentativní vzorek jak používaných metod, tak i jimi řešených problémů, protože v současné době již existuje řada podrobných přehledových článků, shrnujících danou problematiku mnohem úplněji (viz např. S. A. Vachramejev, A. V. Saryčev: Geometričeskaja těorija upravlenija, Itogi nauki i techniki, tom *23* — Algebra. Topologija. Geometrija, VINITI — Moskva 1985, str. 197—280).

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Metoda okrajových prvků v inženýrské praxi

Teoretická knižnice inženýra.
SNTL — Nakladatelství technické literatury, Praha 1987.
Stran 192; 57 obr., 5 tab.; cena 30,— Kčs.

Předložená kniha je první monografií v českém jazyce zabývající se numerickým řešením širokého okruhu okrajových úloh pro parciální diferenciální rovnice metodou okrajových prvků (dále MOP). Na rozdíl od populárnější metody konečných prvků (dále MKP) má MOP poněkud užší pole aplikací (v základní variantě dokonce pouze homogenní izotropní lineární úlohy), ale v případě, že může být aplikována, má řadu výhod ve srovnání s MKP: snižuje dimenzi úlohy (což přináší podstatnou redukci zadávaných dat i řešených rovnic), má velkou přesnost aproximace i numerickou stabilitu, splňuje apriori současně podmínky rovnováhy i kompatibility. Nevýhodou MOP je to, že matice řešených soustav lineárních rovnic nejsou řídké ani symetrické jako v MKP. Pole aplikací MOP se dá vhodnými obraty rozšířit na úlohy, které jsou pouze po částech homogenní (včetně kontaktních úloh), na některé nelineární úlohy, na úlohy na neomezených oblastech, na evoluční úlohy, nebo se dá i vhodně kombinovat s MKP (tím vším se zabývá odstavec 3.6 a kapitola 5). Věnujme se nyní jednotlivým kapitolám knihy.

Po úvodu (kap. 1) následuje kapitola 2 shrnující základní užívané pojmy: některé prostory funkcí, lineární diferenciální operátory s konstantními koeficienty, fundamentální řešení rovnic s těmito operátory a Greenovy funkce příslušných okrajových úloh.

Kapitola 3 se zabývá sestavením rovnic pro přibližné řešení MOP pro okrajové úlohy pro Laplaceovu rovnici, Poissonovu rovnici, dvourozměrný Lamého systém, biharmonickou rovnici a nakonec trojrozměrný Lamého systém. Používá se převážně polygonální aproximace hranice a po částech konstantní aproximace funkcí na elementech aproximované hranice (v případě hladké hranice), což umožňuje výhodně vypočítat potřebné integrály analyticky. Použití po částech lineární aproximace funkcí v případě Lipschitzovské hranice je popsáno v odstavci 3.5.

V kapitole 4 je proveden odhad chyby přibližného řešení získaného MOP od přesného řešení ve vnitřních bodech uvažované oblasti pro případ Laplaceovy rovnice a biharmonické rovnice.

V kapitole 5 jsou základní přístupy MOP použity k řešení různých fyzikálních úloh: úloh pružnosti a difrakce vlnění v polorovině, úloh s pružně plastickým materiálem, kontaktních úloh, a evolučních úloh (difúzní a vlnová rovnice). Po popisu každé úlohy následuje odvození hraniční integrální rovnice s využitím fundamentálního řešení nebo případně Greenovy funkce, nalezené metodou obrazů. Pro nelineární úlohy je navržen vhodný iterační algoritmus.

V kapitole 6 jsou uvedeny ukázky numerického řešení některých úloh z kapitoly 3 a 5.

Závěrečná kapitola obsahuje stručný popis algoritmu a program v jazyku Basic pro řešení Poissonovy rovnice MOP na dvourozměrné jednoduše souvislé oblasti.

Knihu jistě ocení široká technická veřejnost zabývající se numerickým řešením praktických úloh popsaných parciálními diferenciálními rovnicemi, zejména mnohorozměrnými. Lze jen litovat, že kniha obsahuje na některých místech značné matematické nepřesnosti (nepřesné definice nebo ne zcela jasné formulace), což může čtenářům místy ztížit porozumění textu.

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