New Books

Kybernetika, Vol. 27 (1991), No. 1, 72--74

Persistent URL: http://dml.cz/dmlcz/125655

LADISLAV KOHOUT

A Perspective on Intelligent Systems

A framework for analysis an design

Chapman and Hall, London—New York—Tokyo—Melbourne—Madras 1990.
xiv + 255 pages.

The intelligent systems, their ability to analyze the given situation, to process information and to make reasonable decisions under complex circumstances, that all represents a very actual and extremally urgent object of contemporary scientific research. The development of informatics and various branches of the artificial intelligence means also a strict demand for general model of intelligent behaviour applicable also in design of computers. However, it is not easy at all to compose a representative survey of different attempts to the research of intelligent systems and to cover different aspects of intelligence in a unitary style of presentation.

The author had to respect two contradictorical conditions. It was desirable to keep the unity of the considered model, and to show the natutral diversity of objects generally considered for intelligent systems as well as the diversity of their descriptions. It is necessary to note that the author suceeded to fulfill both of these complicated tasks. He found a common general core of intelligent systems applicable across numerous research disciplines, and he gathered a variety of branches in which the concept of intelligent behaviour was used. The book touches such areas like brain sciences, information technology, medicine, psychology, linguistic, logic, knowledge engineering and others. The common core of the mentioned concepts of intelligence was extracted by a careful detailed and enlightened analysis of concepts and techniques developed in the branches mentioned above.

The proper style of the book is purely mathematical. The author uses methods and tools of modern higher mathematics but he does it in a very lucid way well acceptable also for mathematically oriented specialists from other sciences. The mathematical and formal apparatus of logic allows him to avoid ineffective verbal analyses and to concentrate the explanations to the essential points of interest. One of important methodological tools is the concept of fuzzy set and generally fuzziness consequently used for modelling the uncertainty, vagueness and subjectivity in real systems.

To unify the view at different aspects and cases of intelligent behaviour, the author uses a few general abstract concepts. The first of them is the concept of activity structure which helps him to capture the diverse features of adaptive activities in natural and technical systems. The second one is the notion of protection structure as special type of activity structure including some a priori given limitations and constraints. In certain sense also the notion of constraint, general in its nature, helps to unify the contents of the book.

The book is divided into twelve chapters completed by preface, two appendices, very rich list of references and subject index. They can be grouped according to their subjects in a few, generally not disjoint, sets.

In the first group we can include, in accordance with the author, chapters oriented to the formalization of the environment models and belief structures. Namely Chapters 2 (Abstract structures for modelling action), 3 (An organism in its environment), 5 (Protection structures and their relevance to a theory of action) and 9 (Multicentre control of movement and protection structures). They contain, among others, also sections subjected to general topologies and abstract logic, influence of the structure of an organism on internal models of environment, inner structure of the environment models, problem of protection in computer systems and in cooperative systems, theories of movement and its analyses with respect to the design and control of robots,

etc. This group is closely connected also with Appendix 1 (A survey of generalized topologies) containing formal mathematical apparatus for models used in these chapters.

The second group can be composed of chapters concerned with several practical questions of analysis and synthesis. They are discussed in Chapters 6 (One formal model of protection), 7 (Analysis of dynamic protection models), 8 (Many-valued logics in protection), 10 (Activity structures for the systems processing knowledge), and also some parts of Chapters 3 and 9, mentioned above, can be included into this group. They deal with algebraic models, object-oriented protection systems, composition of actions, hierarchical structure of protection models, complexity of large protection models, different aspects of information processing in activity structures, evaluation of knowledge systems, knowledge identification by communication, conversation and agreement, and other related topics.

Some information about the brain sciences and a few concepts from them relevant to the subject of the book can be found in Chapter 4 (Behaviour and structure) and in some notes included in Chapter 9. Especially the neuroscientific description of behaviour, system view of functional structures, and brain control of natural movements are explained there. Together with some parts of Chapter 5 subjected to hardware and software engineering of computing systems and to the construction of control systems of robots, this group contains examples of concrete intelligent systems and their structure. Also Appendix 2 (Representation of knowledge in the brain) can be attached to these parts of the book.

Chapter 1, not being mentioned yet, contains introductory sections about the methodology of actions, relevant areas of study, structure of the book and brief synopsis of particular chapters.

The complex problems and methods forming the contents of the book are treated and explained in a clear systematic way. The mathematical models applied for the description and investigation of the proper structure of intelligent systems are accompanied by heuristic introductions and discussions, and they are presented in the style acceptable not only for mathematicians but also for mathematically instructed readers interested in other relevant branches. The unified description of the subject enables the reader to get a global view of very different aspects and examples of intelligent systems and intelligent behaviour. Also in this sense the author succeeded to accomplish a respectable piece of work.

The book can be recommended to everyone who wishes to find a good and fundamental survey of the recent mathematical research of intelligent systems, their nature and general structure. The knowledge of this book means a significant contribution for specialists interested in artificial intelligence, computer science, robotics and related topics of contemporary interdisciplinary man-machine research.

Milan Mareš

T. S. PARKER, L. O. CHUA

Practical Numerical Algorithms for Chaotic Systems

Springer-Verlag, New York—Berlin—Heidelberg—London—Paris—Tokyo—Hong Kong 1989.

xiv + 354 pages; 152 illustrations; DM 98,—.

The interest in chaotic systems bursted with one decade delay after the publication of Lorenz's 1962 seminal paper. Rather similarly, only after 2 years after construction of Chua's 3rd order nonlinear electrical circuit in 1982, it was observed by Matsumoto that the Chua's circuit exhibits (for some parametrization and wild nonlinearity) may be chaotic behaviour, and only in 1986 it was proved by Chua-Komuro-Matsumoto that the behavior (even for a slight nonlinearity) is really chaotic. According the three authors this was the first rigorously proved chaotic behaviour for a real system. And only very recently the new paradigm of healthy behavior

was set by Goldberger: the healthy behavior is chaotic, the behavior at illness is periodic, and the point attractor is attracting to death. So the chaotic systems are definitely here and we should enjoy them and of course study them. The reviewed book presents tools for analysis of chaos, the tools being supported even by a software package (—available by INSITE Software, POB 9662, Berkeley, CA 94709-9662).

Chap. 1: *Steady-State Solutions and Limit Sets.* (29 pp.) Systems to start with are the dynamical systems $dx/dt = f(x)$ where x is n-dimensional state. After formal definition of limit sets, the chaotic attractor is introduced only informally, say as a limit set of chaotic system — the system with bounded behavior which, being sensitive on initial conditions, acts as an information source. As an example of discrete-time chaotic system, the Smale horseshoe is given. The chapter, as each of the other chapters is closed by very finely itemized Summary.

Chap. 2: *Poincaré Maps.* (26 pp.) Both first-order and higher-order Poincaré maps are introduced. For the former the algorithns and pseudo-codes are given. The Cantor set or fractal nature of chaotic attractors of Poincaré map are depicted. More is covered by Appendices D *Results on the Poincaré Map.* (5 pp.) and F *Cantor Sets.* (5 pp.)

Chap. 3: *Stability of Limits Sets.* (16 pp.) The algorithm and pseudo-code for computation of Lyapunov exponents of chaotic attractors are given.

Chap. 4: *Integration of Trajectories.* (32 pp.) Mainly standard results contain the valuable discussion of a special problem of integration of a chaotic system.

Chap. 5 *Locating Limit Sets.* (24 pp.) The spectrum of methods for the locating of limit set is unfortunately reduced to single one in the most interesting case. "There is currently no method except brute force for locating chaotic solutions".

Chap. 6: *Stable and Unstable Manifolds.* (28 pp.) For deeper understanding of the chapter, a fine Appendix C: *Differential Topology and Structural Stability* (8 pp.) in enclosed. Unfortunately nowhere in the book the fundamental Center Manifold Theorem of Kelly is mentioned. Šilnikov's Theorem and Smale-Birkhoff Homoclinic Theorem are presented and discussed. The algorithms and pseudo-codes for computation of half-manifolds are given. In fact these compute the continuation of initial parts of real eigenvectors of second order hyperbolic systems, nevertheless this approach was used lately by the reviewer even for higher order systems with both real and complex conjugate eigenvectors of linearized systems near each equilibrium point.

Chap. 7: *Dimension.* (23pp.) The non-integer, fractal dimensions: capacity, information dimension, correlation dimension, kth nearest-neighbor dimension, and Lyapunov dimension are introduced with the application to the dimension of chaotic attractor. The pseudo-codes are given for the correlation dimension, kth nearest-neighbor dimension, for the Lyapunov dimension see Chap. 3. The Taken's way to reconstruct the chaotic attractor from a sampled waveform on just one component of the state is given.

Chap. 8: *Bifurcation Diagrams.* (35 pp.) The basic model is the Dynamical System with a real parameter α: $dx/dt = f(x, \alpha)$ which for a bifurcation value of α changes qualitatively its solution. Algorithms and pseudo-codes for computation of bifurcation diagrams are given. It is noted: "There is no robust way to distinguish chaotic from quasi-periodic solutions on the basis of the bifurcation diagram alone".

Chap. 9: *Programming.* (31 pp.) This chapter is rather out of scope of this journal.

Chap. 10: *Phase Portraits.* (32 pp). This chapter concerned with the state plane does not cover the chaotic systems which occurs in the state space only.

The highly recommendable book is finely typesetted and bound keeping the high standards of Springer-Verlag. The color photograph on the book cover shows the Double Scroll chaotic attractor of Chua.

Antonín Vaněček