BOOK REVIEWS AND ABSTRACTS

BOOK REVIEWS

UNDERSTANDING SYSTEMS: Conversations on Epistemology and Ethics, by Heinz von Foerster and Bernhard Poerksen. Kluwer, New York, 2002, 161 pages, ISBN 3-89670-467-5.

For two idyllic weeks in June of 1997, Heinz von Foerster and journalist Bernhard Poerksen sat on Professor von Foerster's patio in Pescadero, California, engaged in a delightful and insightful discussion on epistemology and ethics. Professor von Foerster needs little introduction to the readers of this journal. His career in the systems and cybernetics movement has spanned more than half a century. He has worked side by side with the likes of Norbert Weiner, John von Neumann, Gregory Bateson, Margaret Mead, Anatol Rapoport, Ross Ashby, Francisco Varela, Humberto Maturana and Ludwig von Bertalanffy. His pioneering Biological Computer Laboratory, established in 1957 at the University of Illinois, was a trailblazing institution of cross-disciplinary collaboration. Readers of this journal are less likely to be familiar with journalist Bernhard Poerksen but to him we are indebted for his penetrating and intelligent querying of Professor von Foerster. The result is this wonderful little book that is rich with thought provoking insights and leaves you feeling as though you can smell the very coffee over which these discussions took place. Do not be deceived, however, by the book's informal and inviting nature. Professor von Foerster is masterful at challenging basic assumptions about the nature of reality and inquiry.

Von Foerster's and Poerksen's conversations are organized into five chapters. The first chapter covers von Foerster's basic views on epistemology. Here, von Foerster establishes his thesis that knowledge is not an internal representation of an objective world that is "out there." Arguing that the veracity of sensations is impossible to confirm, von Foerster understands knowledge to be a system of relationships between sensations residing entirely in the central nervous system. He remains neutral as to the question of whether or not a "real" world exists, deeming this question undecidable. While one might be inclined at this point to say, "Oh, constructivism," it would be doing oneself a disservice to quickly conclude that one understands von Foerster's views. He does a wonderful job of illuminating many of the subtleties of this epistemological position and views the label of "constructivism" as being a disaster for the collection of ideas that it represents. To quote him directly, "Constructivism should remain a pure and skeptical attitude that casts doubt on the self-evidence of realism" (pp. 45–46). Poerksen plays the role of the naïve realist in questioning von Foerster with respect to his radical epistemological views. As we follow the two of them along in their discussions, Poerksen asks von Foerster the questions that common sense wants answered,
protesting that “there must be some connection between the real world and the perceived world.” Poerksen, however, is no common journalist. Having studied German language and literature, journalism and biology at the University of Hamburg and Pennsylvania State University he is well equipped to query von Foerster on his views. The following extended excerpt will best communicate the flavor of their discussions.

B.P. Doesn’t this criticism of the concept of truth neglect a basic need that we have? People can’t survive without yearning for something that is finite and without any questions. They need the certainty that there is something absolute.

H.F. For me, this certainty of the absolute that is supposed to render stability is a dangerous thing. It robs human beings of their responsibility for their perspective on things. My goal, however, is to place a greater emphasis on each person’s own responsibility and individuality. I would like to see people learning to stand on their own two feet and to trust their own personal perspectives. It would be my desire to help other people to develop their own ideas, their own thoughts, and their own language; to help them to refine their gift of observation and to use their own eyes and ears. Of course, there are people who don’t want to know anything about this and believe that they cannot survive without having a dogma that tells them how they have to see, hear, and speak. I call them “monodancers”. They are people who are impossible to dance with and with whom it is impossible to start up a dialogue. They turn down the invitation to talk about these things, because they already know everything. They know the results. But it’s not my problem if other people run away into blindness towards the huge number of possibilities. They have to manage to deal with this themselves. I would never attempt to convince them otherwise.

These initial discussions on epistemology constitute about half of the book. The second chapter of the book deals with the application of von Foerster’s ideas to various fields including teaching, psychotherapy, management and communication. This chapter contains many provocative ideas with respect to each field. Of particular interest to this reviewer was von Foerster’s view that “The majority of our institutionalized teaching efforts have the object of trivializing our children.” Here he uses “trivializing” in the sense of insisting upon predictable behaviours. Chapter 3, is a nice layman’s introduction to cybernetics. Chapter 4, covers von Foerster’s biographical background, which in and of itself represents a small history lesson on the systems and cybernetics movement. Chapter 5, entitled “Knowledge and Ethics”, concludes the book with a summary discussion of von Foerster’s epistemological views and their ethical consequences. Von Foerster’s insistence that ethics is not a topic to be debated in easy chairs, but rather it is a subject to be lived out in one’s life, is refreshing.

In the end Heinz—and yes, by the end of the book you do feel familiar enough to address him so—invites his readers to let go of static notions of causality, truth, objectivity and definitions and to enter into a dynamic world where the mind is not so quick to grasp at definitions and where the unexpected is to be expected. In the end, this reader is left with the hope of bumping into Heinz von Foerster someday so that the conversation might continue.

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INFORMATION-GAP DECISION THEORY: Decisions Under Severe Uncertainty. by Yakov Ben-Haim. Academic Press, San Diego, 2001, X + 330 pages, ISBN 0-12-088251-5.

Decision-makers in business, finance, public policy and engineering seldom have enough information to realistically frame their problems in normative decision-theoretic terms—as utility functions and probability distributions over state of nature. Sometimes even gamblers struggle to do so. In Information Gap Decision Theory Professor Yakov Ben-Haim proposes an alternative approach, based on the belief that “a little information can go a long way,
especially when it is not corrupted by unwarranted or unjustifiable assumptions.” His info-gap theory aims to deal with open-ended and unstructured decision problems that are accompanied by a severe scarcity of information, situations in which conventional probability theory is most challenged.

Info-gap theory has its origins in the early 1980s in convex modelling of materials, mechanical and dynamical problems. A system model is parameterized so that system response to loading is represented by nested convex sets containing excursions of system behaviour. Of particular interest is the level at which system behaviour exceeds some failure criterion. In work with Isaac Elishakoff, Ben-Haim demonstrated how diligently applied probabilistic methods can result in disturbingly inaccurate estimates of the probability of failure of safety-critical system, whilst convex analysis identified more reliable bounds on system behaviour. This work was cultivated into a theory of non-probabilistic robust reliability, working through the potential of convex models in a variety of engineering problems and systems. The last chapter of Ben-Haim’s book Robust Reliability in the Mechanical Science (Springer, 1996) was titled “Last but not final”, tentatively looking towards the problem of how convex models could be employed in a theory of decision. Up to that point an engineer or manager would have struggled to compare the insights from alternative convex models or to use them in a formal way to justify preference for one option over another. Ben-Haim has now surpassed the challenge he set at the end of Robust Reliability, having written a book that is much more ambitious in its aim, broad in its scope and profound in its philosophical grounding.

The engineering origins of info-gap theory are evident perhaps most significantly in the sense that it is a theory of reflective action. It seeks to address the process by which practical decision-makers acquire information, learn, make decisions and modify their decisions. It is not dogmatic in being derived from axioms of “rationality” and leading to prescribed behaviour, though it certainly has a rationale that is justifiable as far as available information will allow. Knowledge is seen as being mutable, contingent and relativistic. The emphasis upon exploring and reflecting upon references and attitudes to uncertainty may be unpalatable to those accustomed to firm prescription. It will be much more attractive to those who have found the conventional axiomatization of normative decision theory unsatisfying. Yet this is not a psychological work—the analyst in a room full of experts will find very little guidance on how to elicit expert knowledge or stakeholder preferences in the format required to construct an info-gap model whilst guarding against hidden biases. Guidance on elicitation took some time to follow the emergence of the theory of subjective probability, so we cannot be impatient for its counterpart in info-gap theory.

An info-gap analysis has three components: a system model, an info-gap uncertainty model and performance requirements. The system model describes the structure and behaviour of the system in question, using as much information as is reasonably available. The system model may, for example, be in the form of a set of partial differential equations, a network model of a project or process, or indeed a probabilistic model such as a Poisson process. The uncertainty in the system model is parameterized with an uncertainty parameter \( \alpha \) (a positive real number), which defines a family of nested sets that bound regions or clusters of system behaviour. When \( \alpha = 0 \) the prediction from the system model converges to a point, which is the anticipated system behaviour, given current available information. However, it is recognised that the system model is incomplete so there will be a range of variation around the nominal behaviour. Uncertainty, as defined by the parameter \( \alpha \), is therefore a range of variation of the actual around the nominal. No further commitment is made to the structure of uncertainty. The \( \alpha \) is not normalized and has no betting interpretation, so is clearly distinct from a probability. Ben-Haim is also dismissive
about the links with possibility theory, though the distinction is not as pronounced. $\alpha$ is distinct from a fuzzy membership in the sense that it is not normalized, yet if a system model is helpful at all, the magnitude of $\alpha$ must be related to the potential surprise associated with excursions from the norm, which is not at all far from some interpretations of possibility.

Next, two contrasting consequences of uncertainty are introduced: “catastrophic failure” and “windfall success” (the choice of vivid terminology should help to popularize the theory). Two immunity functions, a robustness function and an opportunity function describe the variation of $\alpha$ with the magnitude of the unfavourable and favourable consequences. Info-gap theory therefore seeks to gain from favourable excursions in uncertain system behaviour as well as developing robust strategies that guard against the effects of unfavourable excursions. It is illustrated how excessive emphasis on failure can result in a loss of opportunity, but that the two are not always mutually exclusive.

Starting with this fairly simple apparatus, ingenious and subtle models and examples are constructed, and necessary features of a theory of decision are worked through: value of information, multi-criteria decision, risk sensitivity, group decisions, portfolio investment and so on. Two chapters of the book have been written with the non-technical decision-maker in mind and contain no notation, being illustrated with practical examples. I hope that Professor Ben-Haim is successful in attracting public policy analysts, environmental regulators and industrial risk assessors as well as the financiers who may make his fortune! His prose is engaging and his breadth of learning admirable, stretching from elegant mathematics to thoughtful and well-researched epistemology. The technical chapters close with problem questions that readers can use to test their learning.

An attraction of info-gap theory is that it concentrates on consequences rather than antecedents. Clustering of events is a central organizing concept. Too much probabilistic system modelling in engineering and other domains dwells upon constructing probability distributions for parameters describing the system and then “turning the handle” to project those distributions through a system model. Info-gap theory concentrates on clusters of events in the output of the system model and the effect they have upon decisions. It may be easier to bring domain experts’ experience to bear upon information in the form of an info-gap model (“Is this the sort of envelope of system behaviour you would expect to see?”) rather than seeking to elicit parameter distributions about which they have less intuition. However, operating in the range of a function makes an info-gap model function-dependent. How is the decision-maker to proceed if he has several alternative system models of different complexity that are more or less suitable for the problem in hand? Some suggestions are presented for calibration of info-gap models and comparing information content making use of the robustness function, but for the time being these are far from being a common currency for evidence-based comparison of models. Yet, this is the price to be paid for a theory that refuses to use more, or at least not much more, information than the decision-maker can reliably supply. The onus is placed back on decision maker to explore their preferences and attitudes to uncertainty iteratively with the construction of options and models. Tackling a problem with info-gap theory will take intelligence, ingenuity and honesty. Yakov Ben-Haim’s impressive book convinces that investment of these precious resources in an info-gap model will yield valuable insights and improved decisions.

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This is intended as a teaching text and its contents have been the basis of a course in the University of Veszpréms, Hungary, over 5 years, taken by more than 100 students. It will also be useful for self-study by practising engineers. The topic is interdisciplinary since it combines artificial intelligence with computer control and this is claimed to be the first comprehensive textbook. Two classes of reader are visualized, one of them existing or intending knowledge engineers or developers who would design and implement systems, and the other the users who would interact with systems in permitted ways, in what might be termed fine-tuning and can include extending the knowledge bases.

The treatment begins with a discussion of knowledge representation, especially in databases and rule sets, and then of reasoning and search in rule-based systems. A chapter is then devoted to verification and validation of rule-bases, where the properties to be checked are freedom from contradiction, and completeness, the latter in the sense that the system gives an answer to any possible query.

There is then a chapter that treats the AI languages LISP and PROLOG pretty thoroughly, as well as expert system shells. The following chapter is on the special requirements of expert systems to operate in real-time, where it is clear, for example, that lock-out must be avoided. As well as this, undue processing delays have to be avoided by assigning levels of priority to the respective queries, with operation such that processing of a lower-priority query may be interrupted to allow an urgent one to be dealt with.

The remaining four chapters treat other specific topics related to the main theme. One is on Qualitative Reasoning and introduces imprecise methods under the headings of sign and interval calculi. These are applied to qualitative simulation and qualitative physics and signed directed graph (SDG) models. These methods appear to correspond to human “rough and ready” but effective ways of thinking about control problems, though they lose accuracy if continued through several stages.

The next two chapters treat, respectively, Petri Nets and Fuzzy Control Systems, both with commendable clarity. The final chapter is on the implementation of a real-time expert system using a commercial shell called G2, from Gensym Corporation. This is shown to be extremely comprehensive and to allow interaction with the developer, and subsequent user, through a graphical representation of the process that has been produced in response to appropriate text and numerical inputs. It also interacts in a language whose syntax is specified, and provides connections to the process to be controlled, as well as to other software whose facilities it may use, including the possibility of another G2 implementation on another computer. It also embodies the means of running a process simulation, either to check the effectiveness of a control policy before going online, or to run high-speed simulations as a part of control decision-making.

The topics are introduced and treated very clearly and this is certainly a valuable text. As a poor linguist myself I am impressed by writers who can produce such a work in a language not their own. There are occasional constructions that are not exactly what a native speaker would probably have used but they do not detract from clarity or flow.

A defect of the book, presumably remedied in the taught courses, is that it fails to fill in a wider picture. For instance, it is not made clear just how the topics under the headings of Qualitative Reasoning and Petri Nets fit in. They are clearly potentially valuable in connection with complex control schemes, and their exposition is a valuable feature of
the book, but there is, for example, no indication whether the versatile G2 shell makes
explicit provision for their inclusion. It is not made clear whether these topics (a) have
already been embodied in working systems, or (b) are included in the book to bring them to
the notice of students and readers who might achieve this in future, or (c) are included purely
as an aid to manual analysis.

A related complaint is that there is no indication of the range of practical applications
visualized. It is easy to imagine that the techniques would be applicable in, say, oil refineries
or car assembly lines, but the only hints to where applications have been made are in the
titles of a few items in the References. It would be nice to have some indication of what
the 100+ students went on to do.

The promise of “with examples” in the book’s title is misleading since the treatment is
entirely with reference to a single rather simple system, namely a coffee-making machine.
This serves very well for expository purposes but obviously cannot by itself give a feeling for
the power of the methods.

This is, however, a welcome addition to the literature that will be in much demand, both for
study in its entirety and for relatively painless introductions to the separate topics.

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A TREATISE ON MANY-VALUED LOGICS, by Siegfried Gottwald. Research Studies
Press Ltd., Baldock, Hertfordshire, England, 2001, 604 pages, ISBN 0-86380-262-1.

This is an amazing book which can serve as an exhaustive reference manual on many-valued
logic and should never be missing from the table of any logician, computer scientist, or
simply of anybody who is interested in many-valued logic (MVL). Let us emphasize that
Professor S. Gottwald is one of the leading specialists in this area of logic and this book
increases still the author’s high credit.

The book consists of 24 chapters divided into four parts. It starts with Basic Notions (Part I)
consisting of 4 chapters. The general assumption on the readers of this book is that they are
acquainted with classical logic, at least on the level of a computer science course of logic. Of
course, the book is not reading for beginners in logic. After informal discussion on classical
and many-valued logic one is briefly reminded of a few basic notions on functions, operations
and group theory. Then, immediately, the second chapter follows where the proper logical
staff has begun to be explained.

Let us remark that the reader should not omit reading of Chapter 1, at least to learn the
notation. The latter is one of the places of discussion—the notation in the book is fairly
complicated. This burdens falls on all those who study and/or write a book on logic. The
author must always choose between a more precise notation which is thus more
complicated, or vice versa: a less complicated but also less precise one. S. Gottwald’s
decision lies a little more towards a more precise notation, which forces the reader to be
careful since small variations in symbols (but important in meaning) may be easily
overlooked. The proper balance is a matter of taste and can never be solved to satisfy
everybody.

Chapters 2 and 3 discuss syntax, semantics and model theory of MVL in general.
In Chapter 4, a brief presentation of the history of MVL can be found.
Part II focuses on general theory of MVL which is further elaborated in Part III. Let us stress that logic discussed in this book is predominantly truth functional, i.e. the interpretation of the connectives is assigned a function on the truth values set. Hence, Chapter 5 is devoted to discussion about various kinds of functions which are suitable candidates for this role. One finds here, besides others, briefly discussed essential concepts of the extensive theory of $t$-norms. The following chapter raises questions on axiomatizability of propositional and propositional many-valued logical systems. A general core set of axioms is discussed in detail. In this chapter, especially finitely valued systems are of concern. The rest of Part II is devoted to sequent and tableau calculi and functional completeness of $m$-valued systems.

The most extensive is Part III (Chapters 9–16) devoted to particular systems of MVL. One finds here Łukasiewicz, Gödel, product and Post systems. The first three systems have been intensively investigated in the past 10 years by many researchers with a full picture starting from logic based on residuated lattices (monoidal logic initiated by U. Höhle) to the logic base on continuous $t$-norms. All these logics have been proved to be complete.

Part IV called “Applications of Many-Valued Logic” contains discussion of some possible application aspects. A new realm of applications and also strong support even for ontological arguments towards MVL comes from fuzzy set theory, which is a general mathematical tool for modeling vagueness phenomenon in its various aspects. Since the latter is omnipresent in our thinking and in the way of capturing the world around us (this is reflected in natural language semantics), especially fuzzy logic provides (ontological) justification for the use of more than two truth values. Though not underlined, this point of view has been accepted by the author and so, two main chapters of this part, namely 18 and 19, are devoted to fuzzy set theory and fuzzy logic. S. Gottwald is also one of the long term proponents of fuzzy set theory and so, one finds in Chapter 18 most essential concepts and propositions of fuzzy sets and fuzzy relations. Chapter 19 is mainly devoted to fuzzy logic with evaluated syntax. However, the presentation is too brief and does not mention a lot of notable results in the field.

Interesting, though very succinct is Chapter 20 on “Presentation and its treatment using MVL”. This problem is largely discussed in linguistics and I doubt whether it indeed can and should be treated in logic. The rest of Part IV is devoted to some additional topics-modalities, approximating intuitionistic and other logics, and especially the use of MVL for the independence proofs and consistency considerations for set theory.

All in all, the book is a splendid source of information about all essential systems of MVL and results in them. I appreciate highly the unified way of explanation which, after adaptation on the notation, is transparent and consistent. I can only praise the book and recommend it to everybody interested in the topic.

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DATA MINING: Concepts, Models, Methods, and Algorithms, by Mehmed Kantardzic. IEEE Press, Piscataway, NJ, and John Wiley, New York, 2003, XII + 345 pages, ISBN 0-471-22852-4.

In my opinion, this book on data mining should be of interest to many readers of this journal for at least three reasons: (i) data mining is viewed in this book as an activity by
which we construct a system from large data sets, i.e. as a data-driven systems modeling; (ii) the book covers a broader spectrum of systems methods than other books on data mining; and (iii) the way in which the book is written is excellent from the pedagogical point of view.

The systemic orientation of the book is perhaps best captured in the following quote from Chapter 1:

The two primary goals of data mining tend to be prediction and description. Prediction involves using some variables or fields in the data set to predict unknown or future values of other variables of interest. Description, on the other hand, focuses on finding patterns describing the data that can be interpreted by humans. ... On the predictive end of the spectrum, the goal of data mining is to produce a model, expressed as an executable code, which can be used to perform classification, prediction, estimation, or other similar tasks. On the other, descriptive end of the spectrum, the goal is to gain an understanding of the analyzed system by uncovering patterns and relationships in large data sets.

In Chapters 1–4, basic concepts of data mining are introduced, the various issues of data preprocessing are discussed, and some general ideas regarding learning from data are presented. In Chapters 5–12, the principal classes of data-mining methods are introduced. They are well captured by the titles of the individual chapters: Statistical Methods; Cluster Analysis; Decision Trees and Decision Rules; Association Rules; Artificial Neural Networks; Genetic Algorithms; Fuzzy Sets and Fuzzy Logic; and Visualization Methods.

In addition to the twelve chapters, the book contains an excellent list of references and two valuable appendices. One of them contains a list of commercially available data-mining tools and relevant web sites, each with a brief description. In the second appendix, five application domains are examined (financial data analysis, telecommunications industry, retail industry, health care and biomedical research, and science and engineering) and illustrated by specific results of data-mining systems that have been implemented.

The book is clearly written and virtually self contained. Each chapter contains review questions and problems, as well as carefully chosen and annotated references for further study. These features of the book make it eminently suitable for a textbook in upper-division undergraduate or first-year graduate courses. However, it is also an excellent resource for self-study.

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FUZZY LOGIC: Mathematical Tools for Approximate Reasoning, by Giangiacomo Gerla. Kluwer Academic Publishers (Trends in Logic, Studia Logica Library, Vol. 11), Dordrecht, 2001, 288 pages, ISBN 0-7923-6941-6.

The present book is another book from the Kluwer’s series Trends in Logic which is devoted to fuzzy logic. The book deals with several general aspects of fuzzy logic in a narrow sense and foundational aspects of fuzzy reasoning. The book is based on the author’s contributions that have been published during the last 20 years. The book is quite unique in that unlike other books on fuzzy logic in a narrow sense, this one deals with an abstract approach to fuzzy logic. By abstract approach we mean here that rather than particular logical calculi (like Łukasiewicz logic, BL-logic, etc), one studies the various structures and problems related to logical calculi like inference rules, closure and consequence operators, axiomatizability, effectiveness, etc. The book is much in the spirit of the approach due to Tarski by which a logic is a set of formulas and a suitable deduction operator. This point
of view is elaborated in detail for the case of fuzzy logic, i.e. logic that deals with reasoning in the presence of vagueness. In the following, I will go through the book chapter by chapter.

Chapter 1 introduces basic notions (lattices, closure operators and systems in lattices, abstract logic, and related notions). Under the abstract approach, an abstract logic consists of a complete lattice, a closure operator on this lattice and an abstract semantics which is a subset of the lattice not containing the largest element. A prototypical example of an abstract logic has the power set of a set of all logical formulas of a particular logical calculus as its complete lattice, the naturally induced deduction operator as the closure operator, and the set of all complete theories as the abstract semantics.

Fundamental concepts of abstract fuzzy logic are introduced in Chapter 2. One should point out that the author uses the real interval [0,1] as the standard structure of truth values with min and max as the standard conjunction and disjunction operations, and 1 − x as negation operation. Since these operations have relatively strong properties (for example, both min and max are idempotent and 1 − x is involutive), one cannot expect that the results can be easily generalized to other structures of truth values where one uses other logical operations. Thus, while considering arbitrary fuzzy logics fitting the definitions of an abstract fuzzy logic makes the approach very general, the particular choice of the structure of truth values makes it in a sense specific. Note, however, that additional operations on [0,1] are considered in later chapters. Chapter 2 starts with basic notions of fuzzy sets and cuts (alpha cuts) of fuzzy sets (cuts of fuzzy sets are heavily used in the book as a means for extending crisp notions to fuzzy ones). Then, fuzzy abstract logic is introduced by a natural generalization of the crisp approach. Other issues treated are the ultraproduct construction, nonmonotonicity of normalized deduction operator, abstract similarity logic (a particular example of abstract fuzzy logic), and a result showing that, in principle, every abstract fuzzy logic is equivalent to an abstract (crisp) logic.

Chapter 3 deals with extensions of an abstract logic to an abstract fuzzy logic. The basic idea is that of extending a closure operator to a fuzzy closure operator in a cut-like manner: one takes a fuzzy set, decomposes it into cuts, applies the original closure operator to the cuts and the resulting system of sets represents the closure of the fuzzy set under the fuzzy closure operator. Several results are obtained for this straightforward construction and its application to extending crisp logic to fuzzy logic.

Chapter 4 is devoted to abstract fuzzy logics with deduction operator obtained using elementary fuzzy inference rules. Such logics are called Hilbert logics. The idea of a fuzzy inference rule goes back to Pavelka and is elaborated on the abstract level here. Note that, in addition to a syntactic part, which is the only one constituting a crisp inference rule, a fuzzy interference rule has its semantic part which, given the truth degrees of formulas that input the inference, gives the lower estimation of the truth degree of the inferred formula. This is a very general approach to making inferences under various types of indeterminacy, not only vagueness (as shown in Chapter 9).

A natural extension of fuzzy inference rules are rules that allow for reasoning over statements like “truth degree of a formula is between 0.3 and 0.5”. This problem is addressed in Chapter 5.

In Chapter 6, an extension of crisp Hilbert logics to Hilbert fuzzy logics is studied. After presenting the general case, several interesting examples are presented. These include necessity logic which is related to the so-called possibility logic, and furthermore, various connections to important notions of fuzzy set theory (like necessity measures and fuzzy subalgebras).

Chapter 7 considers graded consequence relations. The principle enabling us to extend a closure operator to a fuzzy closure operator (formulated in Chapter 3) is generalized
here so that one can start from a family of closure operators indexed by \([0,1]\) and obtain a fuzzy closure operator. Such fuzzy closure operators are called stratified. This construction is studied in detail. After that, consequence relations are generalized into fuzzy setting and their connection to stratified fuzzy closure operators is investigated.

Truth-functional fuzzy semantics is studied in the context of previous investigations in Chapter 8. Truth-functionality means that the truth value of a compound preposition (logical formula) is determined by the truth values of the constitutive proposition (subformulas). One of the main problems investigated in this chapter is the axiomatizability of a fuzzy semantics: given a truth-functional fuzzy semantics, is it axiomatizable by some deduction operator? Following the fundamental discovery of Pavelka, it is shown that this question is strongly related to continuity of operations on \([0,1]\) that interpret logical connectives (it is shown that any continuous truth-functional fuzzy semantics is, indeed, axiomatizable and vice versa).

Chapter 9 shows that the interpretability of the calculi with fuzzy inference rules described in the book goes far beyond the idea that degrees from \([0,1]\) are truth degrees. In Chapter 10, these degrees are interpreted in a probabilistic manner. This shows a surprising application of the approach developed: presented are logics for inferences over probabilities of statements and their completeness results.

Chapter 10 presents a logical approach to fuzzy control. Fuzzy control is the most commercially successful area of fuzzy modeling and this chapter contributes to logical investigation of this area. In particular, fuzzy control is approached via fuzzy logic programming.

The last chapter, Chapter 11, deals with selected computability aspects of fuzzy logic. The central theme is the search for proper generalization of concepts like enumerable set to the framework of fuzzy sets. This chapter, like all the previous, is based on author’s active research in the field.

The book contains a representative list of references which is heavily used in the book (there are many citations which keep the reader well-informed about the development of the presented ideas), an index (I did not, for example, find the term fuzzy closure operator in the index, but this seems to be an exception), and a list of symbols (which is very useful because the notation is not commonly known).

Gerla’s book is written in a lucid style. Except for some very minor points (e.g. I find the term fuzzy class a bit misleading: I would expect that a fuzzy class is a fuzzified notion of a class but this is not so and a fuzzy class as introduced in the book is a crisp subset of the set of all fuzzy sets). I cannot imagine objections with respect to the presentation and arguments motivating the study of topics covered. The book shows an enormously rich world of fuzzy logic from a perspective that has not been presented so far. Systematic treatment of fuzzy approach to metalogical notions makes the book unique. The book provides a coherent view on several important problems connected to the abstract approach to fuzzy logic. On the other hand, taking into account the recent investigations of various particular fuzzy logical calculi given by selecting a \(t\)-norm (or \(t\)-norms) as pursued, e.g. by P. Hajek, it is fairly obvious that a lot of interesting research is still needed to advance our understanding of reasoning under vagueness. The book by Professor Gerla provides us with both deep and broad fundamentals for future research. The book is a research monograph and will probably be used mainly by researchers in the field and in graduate courses on fuzzy logic in a narrow sense.
KALMAN FILTERING AND NEURAL NETWORKS, edited by Simon S. Haykin. John Wiley, New York, 2001, 314 pages, ISBN 0-471-36998-5.

Kuhn in *The Structure of Scientific Revolutions* (1962) says that the publication of the first textbook is an indication that a scientific theory has become an accepted paradigm. Simon Haykin was one of the pioneers in ensuring the establishment of this change with his very important book on neural networks (Haykin, 1999). Indeed before that and to a certain extent after the publication of this work, neural networks had been relegated with other techniques of unproven consistency. This new book, edited by Haykin, again leads the way in developing the science behind neural networks, and provides a good base from which many post-graduates or practitioners can start their work.

The book *Kalman Filtering and Neural Networks* has seven chapters, each written by an experienced practitioner in their field. The first chapter is an introduction to Kalman filters, and provides a very good overview of this particular area. It also provides a very good basis for what follows in the later chapters. The later chapters bring together the two areas of neural networks and Kalman filters. In chapter two, decoupled extended Kalman filters provide a basis for the development of training algorithms for neural networks. This is then taken forward in the next two chapters to provide the readers with an insight into the working of the neural networks in two different domains of the study of image sequences and the construction of chaotic sequences. Chapter 6 deals with the ability of neural networks to learn stochastic nonlinear dynamics. This is done by bringing together two algorithms, one from statistics and the other from systems engineering. The result is a powerful algorithm capable of learning dynamical data and bringing out the underlying functionality.

This book is a must-read for researchers wanting to understand the workings of neural networks, and the ability of these networks to represent functions.

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HARMONIC ANALYSIS AND TONE SYSTEMS, edited by Ján Haluška. Special Issue of *Tatra Mountains Mathematical Publications*, Vol. 23, 2001, Mathematical Institute of Slovak Academy of Sciences, Bratislava, 178 pages, ISBN 1210-3195.

The editor of this Special Issue, Ján Haluška, is known to readers of this journal by his recent paper (Haluška, 2002), in which he investigates uncertainty associated with well-tempered tone systems. This Special Issue, which also deals with tone systems, demonstrates that music is strongly connected with mathematics and systems thinking. This connection was suggested in this journal many years ago by Goguen (1977), and more recently by Rhodes (1997). For anyone interested in this fascinating connection, *Harmonic Analysis and Tone*
Systems is an important resource. To help interested readers to assess the content of this publication, let me list titles of the individual articles contained in it:

- On some properties of periodic sequences in Anatol Vieru’s modal theory
- Reciprocity between presence and content functions on a gestalt composition space
- Enumeration of non-isomorphic canons
- Algebraic varieties of musical performances
- Classifying algebraic schemes for musical manifolds
- Inner metric analysis
- Algebraic language in the theory of harmony
- Repetition and pseudo-periodicity
- Automatic learning composition based on polyphonic wave signals and musical histograms
- Survey of some topics of harmonic analysis

As the titles suggest, all these articles deal with mathematical issues. They are written for readers with a fairly strong mathematical background.

The overall spirit of this interesting collection of articles is perhaps best captured by the following quote from the Foreword written by Ján Haluška:

At present, we understand the couple “mathematics and music” as a special spiritual duality. Mathematics being a special science studying quantities and spacial forms, reflexes the inner, i.e. subjective and spiritual world of music. This relation can be useful in music: there are composition, musical instruments, interpretations and medial technologies based on the recent mathematical research. The vice versa reflection and usefulness of music for mathematics was never argued on the general level. On the contrary, this opinion is commonly appreciated and accepted. But only the opinion! At the present state of science, “mathematics and music” is understood rather as a curiosity and mathematicians avoid silently this area not risking their good name among colleagues and professional career based on scientometric quantitative indexes. This issue shows that the above mentioned duality mathematics → music (quantity → quality, material → spiritual, outer → inner, etc) should be understood not only in the direction mathematics → music, but also in the direction music → mathematics. It is worth for mathematics to turn again to music as to a fruitful spring of pure water.

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ABSTRACTS

INTELLIGENT SYSTEMS AND INTERFACES, edited by Horia-Nicolai Teodorescu, Daniel Mlynek, Abraham Kandel, and Hans-J. Zimmermann. Kluwer, Boston, 2000, XXXI + 452 pages, ISBN 0-7923-7763-X.

The field of “intelligent interfaces and systems” has witnessed a rapid growth during the last decade. An impressive number of papers, conference tutorials, and volumes have
been devoted to the topic. Ten years ago, intelligent systems constituted a rather exotic topic and many were skeptical as to whether such systems would amount to more than a nice name. Nowadays, intelligent systems represent a powerful tool in many applications, in all industrial fields. Their development evolved on both the horizontal dimension, with a constantly increasing number of applications, and on the vertical dimension, by including more capabilities going from sensoric to neurofuzzy systems, intelligent agents, speech and image understanding, and decision making in complex environments.

*Intelligent Systems and Interfaces* represents a comprehensive coverage of the field, including fundamental aspects, software-, sensors-, and hardware-related issues. Moreover, the contributors to this volume offer, beyond a systematic overview of intelligent interfaces and interfaces and systems, deep, practical knowledge in building and using intelligent systems in various applications. Special emphasis is placed on specific aspects and requirements in applications.

*Intelligent Systems and Interfaces* is intended to be an essential tool for the scientific community in all areas of applied intelligent technologies. The chapters are written by a selected pool of experts in the field of intelligent systems. The contributors thoroughly review the state of the art, explain the problems to be addressed and show how these problems can be solved. Extensive references are included, offering the reader a perspective on the currently available literature and trends.

*Intelligent Systems and Interfaces* is an important reference on intelligent systems, intended for a large audience. Graduate and postgraduate students in computer science, electronics, micro-technology, robotics, and control theory will benefit from this comprehensive, in-depth study of the topic. Engineers from high-tech industries and researchers involved in the design, manufacturing, and use of intelligent interfaces and systems and of related technologies will find many solution to research and design problems.

**EMERGENCE IN COMPLEX COGNITIVE, SOCIAL AND BIOLOGICAL SYSTEMS**, edited by Gianfranco Minati and Eliano Pessa. Kluwer/Plenum, New York, 2002, XVI + 394 pages, ISBN 0-306-47358-5.

The systems movement is made up of many systems societies as well as of disciplinary researchers and researchers, explicitly or implicitly focusing on the subject of systemics, officially introduced in the scientific community fifty years ago. Many researchers in different fields have been and continue to be sources of new ideas and challenges for the systems community. In this regard, a very important topic is the one of EMERGENCE. Between the goals for the actual and future systems scientists there is certainly the definition of a general model of it. The goal of this book is to recall to the systems community an important challenge to be dealt with in the immediate future: the study and characterization of general features of what is commonly qualified as “emergence”, chiefly in complex systems such as biological and cognitive ones. Such a topic was a fundamental one at the very beginning of the systemic movement, and to it the founding fathers, such as Von Bertalanffy, Ashby and von Foerster, devoted most effort. In more recent times, however, the interests shifted towards an empirical study of systemic properties characterizing human organizations, and the subject of emergence was partly abandoned. Notwithstanding, the understanding of what is emergence, and of the circumstances which allow for its occurrence
within a complex system, is of crucial importance for systemics. Namely all systemic properties—the ones which allow a system to behave as a whole and not as an aggregate of constituents—are just emergent properties.

**SYSTEMS ENGINEERING PRINCIPLES AND PRACTICE**, by Alexander Kossiakoff and William N. Sweet. John Wiley, New York, 2003, XX + 463 pages, ISBN 0-471-23443-5.

*Systems Engineering Principles and Practice* is designed to help readers learn to think like life systems engineers to integrate user needs, technological opportunities, financial and schedule constraints, and the capabilities and ambitions of the engineering specialists who have to build the system. The book devotes particular attention to knowledge, skills, mindset, and leadership qualities needed for successful professionals in the field.

This book is an outgrowth of the John Hopkins University Master of Science Program in Engineering, developed to meet an urgent and expanding need for skilled systems engineers in industry and government. The authors, who have sixty years of collective experience in this field, were part of the curriculum design team as well as members of the initial faculty. The book is used to support four core courses in the curriculum, and has been exhaustively classroom tested.

**LINEAR TIME-INVARIANT SYSTEMS**, by Martin Schetzen. IEEE Press, Piscataway, NJ, and John Wiley, New York, 2003, XI + 372 pages, ISBN 0-471-23145-2.

The modern development of engineering and science requires a deep understanding of the basic concepts of system theory. Approaching the subject from a system, rather than an application-oriented perspective, world-renowned system expert Martin Schetzen provides practising engineers and scientists, as well as students, with a solid, clearly explained foundation in the fundamentals of linear time-variant (continuous) system theory.

Developing linear systems from a functional viewpoint, the book is noteworthy for its presentation of:

- The time-domain theory of continuous time linear time-invariant (LTI) systems
- System transfer function, gain, and phase-shift
- An original development of the Fourier transform, the unilateral and bilateral Laplace transform, and their inverses from a system theory viewpoint
- Basic filter analysis and design techniques from the s-plane viewpoint
- Feedback systems and their stability, interconnected systems, and block diagram reduction
- The state-variable approach to system analysis and its advantages for certain problems

Taking an original, highly useful approach to system theory, *Linear Time-Invariant Systems* lays a solid foundation for further study of system modeling, control theory, filter theory, discrete system theory, state-variable theory, and other subjects requiring a system viewpoint.
This book presents a collection of twenty-three timely contributions that cover a well-selected repertory of topics within the autonomous systems field. Intelligent autonomous systems (IAS) are finding new applications in industrial production, health-care-service and other sectors of modern life. The book is divided into the following three parts: Part 1—General Concepts, Architecture and Technologies, Part 2—Mobile, Walking and Snake-like Robots, and Part 3—Applications. Part 1 contains seven chapters dealing with the requirements, architectures and implementation(s) of intelligent/sensor-based autonomous systems and robots. Part 2 represents eleven contributions covering the design, path-planning, navigation, and motion-planning and control of mobile robots including legged robots and snake-like robots. Finally, Part 3 involves five important applications, namely: cellular manufacturing, robotic wheelchairs, robotic excavators, robotic wheelchairs, robotic explorers and autonomously controlled vehicles on the highway.

The book can serve as a reference for the young and senior researcher and practitioner in the field. A wide repertory of IAS design, construction, control and operation problems can be found along with a multiplicity of well-established and novel solutions.