Book Reviews

SATISFICING GAMES AND DECISION MAKING: WITH APPLICATIONS TO ENGINEERING AND COMPUTER SCIENCE, by Wynn C. Stirling, University Press, Cambridge, 2003, hardback, xvii + 249 pp., ISBN 0-521-81724-2 (£55.00).

The term "satisficing" is attributed to Herbert Simon and is usually understood to mean much the same as optimisation except that the search is terminated once a "good enough" solution has been found. The effort required to find a better solution may not be justified by the further improvement. In this book, however, it is argued that "satisficing" should not be seen merely as truncated optimisation, but that it offers the key to a fresh and useful approach to many problems of decision-making. For one thing, it may be possible where the data do not allow optimisation.

In the theory of games and economic behaviour as developed notably by von Neumann and Morgenstern it is assumed that players act purely in self-interest and that for each there is a payoff to be maximised. With more than two players there are complications that have led to the introduction of principles such as Pareto optimality and Nash equilibrium. A shortcoming of these is that they may indicate a solution (or a set of solutions) that is in some sense optimal, but not how it might have been reached by the interacting players. Also, there are situations that do not lend themselves to such analysis, one such arising when the preferences of one player depend on a choice made by another. A final and crucial shortcoming is that for many situations the results of the analysis do not correspond well with the observed behaviour of actual players.

Reference is made to the "prisoner's dilemma" situation often postulated as a model of international conflict, and to the studies by Axelrod and Rapoport suggesting how altruism might arise in evolution and how situations of the "prisoner's dilemma" kind need not produce deadlock. Altruism is a feature of human nature, and groups of people form a group identity even when all decisions are made individually. One of the advantages of the approach based on satisficing is that it can readily embody multiple objectives, and so can deal with the case where each player is responds in accordance with group, as well as individual, preferences.

Obviously, there are many unanswered questions since for instance the means by which group identity arises is little understood. Consequently, the approach based on satisficing requires many rather arbitrary choices by the analyst. It is argued, however, that this is inevitable when a little-understood process is modelled and that other approaches such as that based on standard games theory are no better in this respect.

The approach and viewpoint based on satisficing is cogently defended and will prompt studies by psychologists and sociologists. Such studies are needed to fill in some of its details, particularly where group identity is involved. My own feeling is that a good case has been made, and that, faced with a meta-decision about which version of decision theory to employ in a social or economic study, I would be inclined to opt for this one.

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GUIDE TO BIOMETRICS, by Ruud M. Bolle, Jonathan H. Connell, Sharath Pankanti, Nalini K. Ratha and Andrew W. Senior Springer, New York, 2004, hardback, xxix + 364 pp., ISBN 0-387-40089-3 (£38.50).

PRACTICAL BIOMETRICS: FROM ASPIRATION TO IMPLEMENTATION, by Julian Ashbourn Springer, London, 2004, hardback, xiv + 159 pp., with CD-ROM, ISBN 1-85233-774-5 (£38.50).

Both books belong to Springer Professional Computing series.

The emphasis of each of these is on overall systems rather than detailed description of specific biometric techniques, though the first of them reviews the main features of the various possibilities. The most useful techniques include recognition of fingerprints, faces, voices, iris patterns, hand geometry and signatures. Others that are described briefly in the first book include DNA matching (which however has not been implemented in any convenient device giving a quick response, and has the additional disadvantage that identical twins are not distinguished), retina recognition (less convenient for the subject than iris pattern recognition), thermograms (essentially recognition of a face or other body part from its infrared image, which is less easily disguised and less dependent on incident lighting than the visual one) and recognition of gait. Some of the methods, such as the use of gait, allow recognition at some distance.

The types of error associated with the schemes are discussed in detail. There is usually a threshold that can be set to strike a balance between false rejections and false acceptances. In manned installations there is likely to be a way of referring some cases for manual attention, but the number of these should be small. Many considerations affecting choice of a biometric are discussed, including cost, convenience of use, and size and robustness of the sensors, the latter being specially important for unmanned operation.

A comparison of methods suggests that fingerprint and iris recognition are strong candidates for large-scale low-error applications. An interesting point is that in some applications a less powerful

technique may be preferable simply because it is felt to be less of an invasion of privacy. In a scheme to record the attendance times of employees, for example, a method based on hand geometry would be more acceptable than one using fingerprints or iris patterns, as well as being much less costly.

In the first of the two books these considerations are explored in detail, and attention is given to overall system requirements, including the means of setting up and maintaining the database. Security is an important issue, and difficult to maintain where the database is held centrally and accessed from many sensor points. Several kinds of attack that could be made on systems are analysed. The considerations are treated very fully in the first of the books, with a fair amount of statistical and other mathematics. There are also copious references to the literature and to commercially-available systems.

The second book is written from an operational rather than an academic perspective, and has distinctly polemic character. The widespread use of biometrics for personal identification has already been mandated by the US government and others are likely to follow. The book's author believes that use of biometrics offers many advantages but will only take off if the right decisions are made. As it is expressed in the Foreword to the book: "Failure of design or execution in huge open-ended systems could cripple wide sectors of our society and economy. If the first mass deployment of biometrics founders, the public and therefore leaders of government might just call it quits. The technology will take the rap, deserved or not."

Stimulated by this the author deals perceptively with numerous issues of implementation, taking a wide view and paying attention to user psychology. In a "conclusions" section he asserts that the new era of personal identity verification is "not just a matter of technological development but a fundamental re-think in societal trust and how we interact with each other". He goes on to ask his readers to try to ensure that developments are not rushed into blindly, but are "properly considered and implemented in an ethical and responsible manner".

The main contents of the CD are two program packages called *Pentakis* and *Bantam*. *Pentakis* contains five "Wizards" that can be used to assess biometric schemes according to data requested from the user. They are the User Psychology Wizard, the Transactions Wizard, which allows analysis of the interaction and particularly the time required, the Scalability Wizard, Population Profile Wizard and Cost Analysis Wizard. The *Bantam* package supports project management, with particular applicability to biometrics projects.

Also on the CD are various references to commercial systems, including an enthusiastic description of a system used in the Ben Gurion airport in Tel Aviv. This has been highly successful in providing airport workers and regular travellers with biometric identification, which saves them time and trouble and also greatly reduces the load on the security staff who are free to check the other passengers. Rather surprisingly, the system allowing all this is based on what would seem to be the relatively crude biometric of hand geometry.

These books are undoubtedly extremely valuable guides to their topic.

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ROUGH-NEURAL COMPUTING: TECHNIQUES FOR COMPUTING WITH WORDS, edited by Sankar Kumar Pal, Lech Polkowski and Andrzej Skowron, Springer, Berlin, 2004, hardback, xxv + 734 pp., ISBN 3-540-43059-8, Cognitive Technologies Series, ISSN 1611-2482 (£61.50).

MODELLING WITH WORDS: LEARNING, FUSION, AND REASONING WITHIN A FORMAL LINGUISTIC REPRESENTATION FRAMEWORK, edited by Jonathan Lawry, Jimi Shanahan and Anca Ralescu, Springer, Berlin, 2003, paperback, xi + 228 pp., ISBN 3-540-20487-3, Lecture Notes in Artificial Intelligence Series no. 2873, ISSN 0302-9743 (£27.50).

Both of these introduce very new ideas in Artificial Intelligence, mainly inspired by an initiative of Lotfi Zadeh, the originator of fuzzy set theory and hence of the revolution sparked by it. The second book starts with a foreword by Zadeh in which he defends the new viewpoint, arguing that the traditional emphasis on numerical data in science is unwarranted and that modelling and computing with words offer valuable new possibilities in which the primacy of numerical information is challenged.

Zadeh quotes Lord Kelvin as defending the primacy of numerical information, as a focus for his defence of the alternative. This is, I think, a little unfair since Kelvin was certainly enthusiastic about principles that could only be expressed verbally, but claimed that a test of their soundness was the possibility of numerical data. The same test is accepted today and even these new theories are judged by their performance in applications that either use numerical data or whose output is evaluated using numerical statistical criteria.

Since the time of Kelvin, digital computation has developed in ways that even he could not have visualised. It is now possible to consider automated modelling and computing with words rather than numbers, and these new methods appear to substitute words for numbers in established procedures including adaptation in neural nets. The basic elements are information granules rather than neurons.

A distinction is drawn between modelling with words and computing with words, though Zadeh believes the gap will narrow. The combination of rough sets and neural networks, denoted by rough-neural computing, fits the computing requirement, and the first of the books has a foreword and an introductory chapter by Professor Zdzislaw Pawlak, the founder of rough set theory. The book has 28 chapters by different authors, including a final part devoted to case studies.

One paper is by Witold Pedrycz, the authority on fuzzy system theory, and describes the use of the methods to allow operation of a distributed system of collaborative databases. Other papers refer to aspects of audio and visual perception, including handwritten digit recognition, and to biomedical inference. Two others refer to aspects of audio perception, one of them to the acquisition of audio signals and one to the influence of visual clues on surround sound perception. Others deal with signal classification, and with rule discovery in data. The robustness of the methods in the face of uncertainty and noise is emphasised throughout.

The topics of the eleven papers in the second book are on the whole rather more abstract but the general thrust is the same, and it is asserted that these new techniques allow the integration of

information from different and diverse sources, one of the advantages being the emergence of simpler learning algorithms because of better utilisation of past experience. An illustration on the cover shows a face with describable features picked out, implying an application to face recognition based on automatic linguistic description.

Both books are intended to be introductory, and the second is described by Zadeh as reader-friendly. Nevertheless, the material is not accessible in any depth without some background. Even so it is impossible not to be impressed by the enthusiasm of the authors and to feel that this may be the beginning of something very big.

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FAULT DIAGNOSIS: MODELS, ARTIFICIAL INTELLIGENCE, APPLICATIONS, edited by J. Korbicz, J. M. Kościelny, Z. Kowalczuk and W. Cholewa, Springer, Berlin, 2004, hardback, xxix + 920 pp., ISBN 3-540-40767-7, Engineering Online Library series (£154.00).

This is an extremely full treatment of its topic, with a total of 23 chapters by different groups of authors, all of them including one or more of the editors. It is in three Parts, of which the first, with seven chapters, has the heading Methodology, the second, with ten chapters, is on Artificial Intelligence, and the third, with six chapters, is on Applications.

In a Foreword, Professor P. M. Frank (Duisburg University) confirms the current importance of fault diagnosis and observes that modern methods are model-based. However, analytic or parametric modelling presents difficulties in setting suitable levels of deviation to indicate faults. The system must obviously be sufficiently sensitive to respond when needed, but will be useless if it gives numerous false alarms. Solutions are to be found among techniques coming under the heading of Artificial Intelligence and these are thoroughly treated in the large Part II of the book. At the same time, approaches coming from established methods in control theory are also included and there is mention of Kalman filtering and the Luenberger observer, and alternative methods due to Wiener and Hammerstein for modelling nonlinear systems. The book is intended as a reference for industrial control engineers and as a textbook for undergraduate and postgraduate students.

As Professor Frank goes on to say: "The book on hand is one of the few comprehensive works on the market covering the fundamentals of model-based fault diagnosis, which has become an emerging discipline of modern control engineering, in a very wide context including both analytical and non-analytical (fuzzy and neural) models as well as approaches based on artificial and computational intelligence. It is a multiauthored book, where the editors are well acknowledged experts in the field, not only in the theoretical domain but also with respect to industrial applications. The latter finds expression in the fact that a substantial part of the text is dedicated to practical applications".

The importance attached to the topic is reflected in the fact that an earlier comprehensive work has appeared in the same series (*Diagnosis and Fault-Tolerant Control*, by Blanke, Kinnaert, Lunze and Staroswiecki, reviewed in *Robotica*, vol. **22**, pp. 347–348 (2004). The emphasis in the new work is somewhat different, especially in its attention to methods based on Artificial Intelligence. The earlier work is produced by workers directly sponsored by the European Science Foundation and taking part in its COSY and DAMADICS projects. The new work also contains acknowledgement, at several points, of support from the DAMADICS project. The range of topics coming under the general heading of Artificial Intelligence is quite wide and includes evolutionary algorithms, artificial neural nets, fuzzy logic, genetic algorithms, pattern recognition and expert systems.

Part 3 of the book is on Applications, and a number of specific cases are described, but there is also general discussion of how diagnostic and remedial measures should operate in a complex system. It will often be possible to isolate a faulty part, temporarily, without closing everything down and a built-in strategy has to be carefully devised and is again model-based. Allowance must be made for multiple simultaneous faults. Specific application areas mentioned include detecting and locating leaks in transmission pipelines, and faults in processes in a sugar factory, as well as others within a steam power generator and a pneumatic actuator.

This is an impressively comprehensive and well-prepared work. Each chapter begins with an introduction and ends with a summary, and is followed by an extensive list of references. There is no subject index, but in the initial contents list all section and subsection (and sometimes subsubsection) headings are shown and navigation for reference should not be difficult.

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IPA: CONCEPTS AND APPLICATIONS IN ENGINEERING, by Jerzy Pokojski, Springer, London, 2004, hardback, viii + 171 pp., ISBN 1-85233-741-9, Decision Engineering Series, ISSN 1619-5736 (£45.00).

This is an extremely comprehensive and thoughtful survey of the possibilities of computer assistance to a design engineer, and their realisation in an "Intelligent Personal Assistant". The undertaking of an engineering project is considered in detail, from initial jottings through successive refinement requiring reference to data and catalogues, and employment of software facilities for computer aided design (CAD) and computer aided engineering (CAE), as well as consultation with colleagues.

It is acknowledged that details of the procedure are highly individual, and are not normally recorded fully in formal reports. Neither are details of the experience gained. One function of an IPA is to provide a personal record, tailored to individual needs and idiosyncrasies.

Another function is to provide ready access to data sources and to relevant software, including facilities for CAD and CAE. As an

adjunct to this, the IPA can keep a record of what sources were used in each collaborative session of the engineers, and can arrange that these are readily available next time.

Surprisingly, there is no indication of a way of purchasing or downloading a complete system, and the author merely mentions that he used a database environment and Visual Basic. His reticence about offering a system may be an expression of his insistence that an IPA should be tailored to individual needs. At any rate, the requirements are analysed in impressive detail and it would certainly be a strong recommendation for a complete IPA to be able to say it was fully compliant with the recommendations here. The treatment is influenced by the author's experience in giving lectures and conducting seminars over twelve years in the Warsaw University of Technology, with participants coming from a wide range of industrial engineering backgrounds.

The chapter on optimisation is particularly impressive and multi-objective operation is treated very fully, with reference to Pareto optimality and the possibility of ordering the priority of objectives, and comparison of alternative strategies. It is mentioned that the author's implementation can interact with databases to explore alternative solutions to subproblems.

There is a very great deal of valuable material here, though not an actual IPA available "off the shelf".

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AUTOMATIC FINGERPRINT RECOGNITION SYSTEMS,
edited by Nalini Rotha and Ruud Bolle, Springer, New York, 2004, hardback, xvii + 458 pp., ISBN 0-387-95593-3 (£54.00).

The 21 chapters are from different leading workers in the field, apparently selected by the editors and not associated with a conference. Almost all of them have affiliations in USA, though Canada, Italy and Japan are also represented. The topic is of current interest not only because of its forensic significance but also because it contributes to the "hot topic" of biometric techniques for identity checking to protect against terrorism and fraud.

The editors review the contents in their Preface, from which the following is abstracted:

Chapter 1 summarises the history of fingerprint recognition and its social significance. In Chapter 2, new developments in inkless sensing are presented with specific emphasis on radio frequency imaging. Images may require enhancement and correction of distortion and the next two chapters describe ways of assessing image quality and hence the need for improvement. Then Chapters 4–6 describe means of automatic enhancement using statistical methods and Fourier and Gabor filters.

In Chapter 8 the adaptation of established manual methods to automatic recognition is considered, including the recognition of minutiae and broad classification by ridge patterns. In Chapters 9 and 10 other approaches are described depending on the Karhunen-Loève transform and on hidden Markov models.

Subsequent chapters deal with fingerprint authentication and matching, with reference to distortion-tolerant filters and eigen-features, and higher-level issues including recognition reliability and methods to be applied when images from two or more fingers of a subject are available.

Forensic aspects arise again in two chapters dealing with treatment of latent images, with comparison of automatic and manual methods. A means of generating synthetic fingerprints for testing schemes is described, as well as means of storing and transmitting fingerprint data, the latter with attention to security as well as fidelity.

This is an admirable review of the state of the art in this important field, and many of the principles described will find application to other forms of biometry and pattern recognition. Each chapter has a substantial bibliography and there is an overall subject index.

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