Book Reviews

PERL PROGRAMMING FOR BIOLOGISTS, by D. Curtis Jamison, Wiley, Hoboken, 2003, ISBN 0-471-43059-5, ix + 191 pp. (Pbk, £27.95).

This is a comprehensive guide to the use of this useful and interesting programming language. It is written in a pleasant chatty style with obvious enthusiasm for the topic. No previous knowledge of programming by the reader is assumed.

Perl is a general-purpose programming language but with many unusual features. It has special facilities for text manipulation that readily allow the parsing and transformation of data files to new formats, and that can be applied to manipulation of DNA sequences and the search for matching segments. The name originated as an acronym for: "Practical Extraction and Reporting Language".

Other useful features of *Perl* include means of interfacing to a wide range of database formats, and to standard systems used in storing and searching databases of DNA sequences. In an Appendix to the book the main such systems are listed and described. The tools denoted by the acronyms BLAST (Basic Local Alignment Search Tool) and FASTA are explained. They are features of, for example, the human genome site at: *http://www.ncbi.nlm.nih.gov/genome/guide/human*. *Perl* has also become the principal language used in programming interactive websites.

The book has three parts, labelled respectively as The Basics, Intermediate *Perl* and Advanced *Perl*. The first part, and the initial chapters of the second, introduce the reader very gently to principles of general-purpose programming in *Perl*, which at this stage has much in common with other languages, and is said to be very easy to learn. However, Chapter 7, in the "Intermediate" part, on Input and Output, treats very complex and unfamiliar aspects, since *Perl* not only accepts input and provides output through the usual channels but when running on a multi-thread machine can even be made to interact with other programs running simultaneously.

In the "Advanced" part of the book the reader is introduced to the use of pointers, as in *PASCAL*, and also to Object-Oriented Programming. *Perl* appears to have the nice feature that it can be used with or without OOP and this seems to imply a smoother transition for learners than in, say, going from *C* to *C++*. One deficiency, shared also by the much more primitive *Javascript*, is that there seems to be no facility for any kind of graphics. However, the fact that *Perl* can interface readily with a range of database formats (and even, as has been seen, with other programs) should mean that data can readily be passed to a separate graph-drawing facility.

Another nice feature is that everything needed to use the language can be downloaded free from the website: *http://www.perl.org*. Some operating systems have it built in from the start. A large amount of documentation is included in the download and with diligence it would probably be possible to learn to use the language without the help of the present book, but the book is well worthwhile to give orientation and to make learning much easier and to get encouragement from the author's obvious enthusiasm.

Alex M. Andrew
95 Finch Road
Earley
Reading RG6 7JX (UK)

HANDBOOK OF FINGERPRINT RECOGNITION, by Davide Maltoni, Dario Maio, Anil K. Jain and Salil Probhakar, Springer, New York, 2003, hardback, xii + 348 pp., with DVD-ROM, ISBN 0-387-95431-7 (£46.00).

This is a comprehensive review of its topic, whose importance in crime investigation has been recognised for many years. There is now reason for interest from another viewpoint since fingerprint recognition is one of the biometric techniques coming into use for personal identification in many areas (welfare disbursement, entry to secure premises, automatic teller machines, driving licences, and so on). Various possibilities for such biometric methods are compared and those most commonly used are listed as fingerprints, face, iris, speech and hand geometry.

The thoroughness of the treatment of biometric methods is not obvious from the title. This feature will make the book particularly valuable in some robotics contexts.

It is acknowledged that fingerprint recognition is a complex problem, and despite a great deal of attention to it over nearly fifty years as a forensic tool it is by no means a fully-solved problem, despite a popular misconception that it is. It is still a challenging and important recognition problem, especially where poor-quality images must be processed.

The authors give their aims in writing the book as being to:

- introduce the readers to automatic techniques for fingerprint recognition. Introductory material is provided on all components/modules of a fingerprint recognition system;
- provide an in-depth survey of the state-of-the-art in fingerprint recognition;
- present in detail recent advances in fingerprint recognition, including sensing, feature extraction, matching and classification techniques, synthetic fingerprint generation, multimodal biometric systems, fingerprint individuality, and design of secure fingerprint systems.

- Serve as the first complete reference book on fingerprint recognition, including an exhaustive bibliography.

All of these aims are well met in the nine chapters and 40-page bibliography. The intended audience includes researchers, practising engineers, and students who wish to understand and/or develop fingerprint-based recognition systems. The book is suggested as a reference book for a graduate course on biometrics. The material is clearly presented, with only a light sprinkling of mathematics, but with a great deal of detail in the illustrations, graphs and tables. This will certainly be a standard reference work in its field.

The included DVD contains four fingerprint databases used in a 2002 Fingerprint Verification Competition, and another four that were used in a similar event in 2000. It also includes a demonstration version of software that can be used to generate synthetic fingerprint images. The DVD has to be used with a suitably-equipped computer, and it is perhaps hardly necessary to mention that I have verified that nothing of its content can be viewed on a DVD player attached to a television set.

Alex M. Andrew
95 Finch Road
Earley
Reading RG6 7JX (UK)

LOGIC FOR LEARNING: LEARNING COMPREHENSIBLE THEORIES FROM STRUCTURED DATA,

by J. W. Lloyd, Springer, Berlin, 2003, ISBN 3-540-42027-4, x + 256 pp. Cognitive Technologies series, ISSN 1611-2482 (Hbk, £29.50).

As the author says at the start of his Preface, this book is concerned with the rich and fruitful interplay between the fields of computational logic and machine learning, and the intended audience is senior undergraduates, graduate students, and researchers in either of these fields. He goes on to say that the treatment is meant to be self-contained, and therefore accessible to specialists in computational logic without previous knowledge of machine learning, and similarly to specialists in machine learning with no previous knowledge of computational logic.

The description is slightly misleading since only one kind of machine learning is treated in any detail, namely that based on logic. Some other kinds are mentioned in the first chapter, including reinforcement learning, neural nets and genetic algorithms, but apart from a brief reference at one point to use of a genetic algorithm in conjunction with a logic approach, none of them is mentioned again. The approach of the book is essentially that treated in the *AI* literature as Inductive Logic Programming.

I think it is also a fair comment, though I may be excusing my own ineptitude, to say that the author has underestimated the difficulty of his specialty and that the book is not readily accessible to someone meeting computational logic for the first time. It introduces a higher-order version which allows functions to have other functions as arguments. The coverage of the logic theory is not claimed to be exhaustive, but to focus on what is applicable to machine learning, and within this a "shortest path" is offered for readers who want to focus even more strongly on applications. The presentation is dauntingly formal, with definitions and propositions to be digested well before their relevance becomes apparent. Though again the observation must be relative to my own comprehension, I think more could have been done to smooth the path of the reader with interspersed plain-text guidance, supplementing the useful and chatty sections he provides at intervals.

However, for the reader who perseveres or who has previous acquaintance with advanced formal logic, there is clearly a great deal of valuable material here. As the second part of the title indicates, the aim is to derive theories from structured data, with particular though not exclusive interest in formulations that are comprehensible to a user. The data constitutes a training set that may contain hundreds or thousands of examples, or even, when the term "data mining" is used, some millions. The interest is in "supervised learning" where each example is accompanied by an indication of a value. For a classification task the value would normally be Boolean, and for tasks having the nature of regression it would be numerical. Methods are developed depending on metrics between the individuals in a training set, and on the related idea of kernels, and the procedure of predicate rewriting features largely.

The methods developed are the basis of a learning system called Alkemy that can be downloaded free, as a *C++* program, from a website associated with the book, and a graphical user interface is also available for free download. The author recommends that readers obtain the Alkemy system and use it to get first-hand experience.

There are finally examples of the use of Alkemy, and although the author says these have been kept simple for purposes of demonstration, three of them are certainly very impressive. The treatment places great emphasis throughout on data types, and the specifications in training sets acceptable to Alkemy can contain data in many forms, including details of links in structural chemical formulas, and numerical magnitudes as "real" numbers. There is an important field of application to biology and medicine, where the training set can be a list of drugs or other substances of known composition, with an indication for each of whether or not it produces some specific effect. In one example the effect is mutagenesis and the system produces the comprehensible answer: "A molecule is mutagenic if and only if it does not have an atom of type 1 and charge greater than or equal to 0.290, nor an atom of type 50."

In two other examples referring to molecules the results are a good deal more complex and it is difficult to imagine that they would ever have been derived by purely manual inspection. One example refers to the conditions under which a substance has the smell of musk, and for this physical distances within the molecule have to be taken into consideration.

The book undoubtedly introduces and develops a very powerful technique.

Alex M. Andrew
95 Finch Road
Earley
Reading RG6 7JX (UK)

ANALYSIS AND DESIGN OF VERTICAL CAVITY SURFACE EMITTING LASERS, by Siu Fung Yu, Wiley, Hoboken, 2003, hardback, xviii + 445 pp., ISBN 0-471-39124-7, Wiley Series in Lasers and Applications (£58.50).

This is an extremely thorough treatment of its somewhat specialised but important topic. VCSELs are generators of light that can be modulated as required in fibre-optic communication and opto-electronic devices generally. A variety of applications is mentioned, including barcode scanners and digital displays. Special mention is made of "smart pixel" devices in which each VCSEL is combined with a phototransistor to produce a component that is useful in optical information processing, and of circular or pie-like arrays of VCSELs each producing light of a different wavelength and so allowing multiplexed use of a single optical fibre. (Though not mentioned specifically in the book, there is current interest in optical fibre links within aircraft, so that "fly by wire" becomes "fly by fibre", and presumably such links will find many applications in robotics.)

A number of advantages are claimed for VCSELs compared to the earlier possibility of facet-emitting lasers. VCSELs can be produced at lower cost and are smaller, and also have narrow beam divergence, low power consumption, high modulation bandwidth, and easy polarisation control. The amount of wafer space required for one unit is typically a square of side $400\,\mu m$. The use of these devices is also compared to that of light-emitting diodes (LEDs) as sources for fibre optic communications and it is shown that VCSELs, of similar cost to LEDs, can achieve higher transmission speeds with better noise immunity, to such a degree that systems can be upgraded by replacing LEDs with VCSELs.

VCSELs, most of them operating at wavelengths in the region of 850 nm, are produced commercially by a number of companies. The book's author sees the future as lying with longer-wavelength devices still to be developed. As he puts it (p. 21):

"It is believed that the future industrial standard of VCSELs is an even higher modulation rate ($>$10 Gbits/s), longer link lengths ($>$60 km), and lower power consumption ($<$10 mW) and the further development of 1300/1550-nm VCSEL technology in mass production is the key to the success of a billion-dollar business."

A great deal of relevant mathematical theory is given, not only of the basic laser operation but of such associated aspects as the occurrence of spontaneous emission and the distribution of heat throughout the laser and its effect on performance. The author has chosen the method of treatment of each topic, from the choice offered in the current literature, to be that which he believes to be most valuable. Some of the results can only be applied using finite-element computing methods, and recommendations are made for suitable software packages. The book will certainly be a standard reference wherever development work on VCSELs and related devices is going on. It is highly mathematical and much of its content must be of rather specialist interest, but the author's assessment of the opportunities gives a strong incentive to develop such interest.

Alex M. Andrew
95 Finch Road
Earley
Reading RG6 7JX (UK)

WORLD ROBOTICS 2003, United Nations Publication-coauthored by International Federation of Robotics, New York, Geneva, 2003, xiv + 370 pp., ISBN: 92-1-101059-4, ISSN: 11020-1076 (Price on application)[*]

World Robotics 2003 is the latest of a series published yearly, and compiled by the United Nations Economic Commission for Europe (ECE) and the International Federation of Robotics (IFR). The UN Economic Commission's Mr Jan Karlsson, who is the Team Leader ECE Statistical Division, with the assistance of the IFR secretariat, wrote this publication and also the previous yearbooks. The text covers Statistics, Market Analysis, Forecasts, Case Studies and Profitability of Robot Investment. It provides a time-series data up to 2002 and forecasts 2003–6 which are invaluable to researchers, market developers and industrialists. Indeed, it is so well written that anyone with an interest in robotics or automation can read its contents.

The UN and the IFR announce that it is the world's only publication which presents comprehensive global statistics on industrial robots as well as on service robots, in uniform tables which allow for consistent country comparison. It contains detailed statistical data for some 20-countries, which has been broken down by application areas, industrial branches, types of robots and by other techno-economic variables. The data on production exports and imports are presented for a selection of countries and also includes a section on 'Trends in robot densities', e.g the number of robots per 10,000 employed. Neither 2002 nor the years to 2006 are left out with analyses for the former, and forecasts for the latter, presented. Other section cover a number of case studies, and what is described by the authors, as 'hands-on' information has been compiled.

The editorial, written by Massimo Mattucci (Strategic Planning and Advanced Engineering, Comau S. p. A) and Arturo Baroncelli (Comau Robotics and Final Assembly) highlights production system evolution in the automative industry. They briefly consider productivity and flexibility and list six body production systems which are called 'best practices'. *Open Robogate*, patented by Comau, provides an illustration. In describing production systems that consist of modular, standardized sets of components two examples: the *SMART H4* robot and the *SMART X1* robot are compared with conventional robots and the practical advantages outlined. Readers really would want more detail and an in-depth

analysis before accepting the conclusions that were given. Indeed, this section could well have been included in the main text which had been divided, logically into 7 readable sections: Introduction; Worldwide diffusion of industrial robots; Prices and wages; The structure of the diffusion of industrial robots in individual countries; Forecasts of worldwide investment in industrial robots (2003–6); Profitability of industrial robots with case studies; and some 53 pages that provide a most comprehensive summary of the result of the 2003 market survey of service robots.

Annex A provides details of the sources and methods used by the national robot associations in their submissions of robot statistics. *Annex B* contains 6 tables which detailed a time series of accumulated sales, operational stock and shipments of multipurpose industrial robots. Any reader who intends to use these statistics needs to examine these in detail.

Annex C contains 6 more tables that gave information about employment in the manufacturing industry (food, beverages, tobacco and motor industry) in selected countries: A short note in *Annex D* outlines the assumptions made in the calculation of the quality adjusted price index for industrial robots. Some of these notes are of more interest to statisticians, but anyone who intends to use the presented statistical data needs to be assured not only that the data received from worldwide sources has been obtained according to precise definitions of robot devices and systems, but also that the statistical analysis and presentation are reliable and accountable.

The attraction of this book to readers of *Robotica* is that it provides an excellent reference to the statistics of 2002 and forecasts for 2003 and beyond. For many it will join the previous volumes which have served them so well. Whilst it is an obvious choice as a 'book shelf' reference book, its text is clear and readable and forms a worthwhile introduction and study of the remarkable evolution of industrial robots since their first introduction in the 1960s. Most of us, however, will be well satisfied with the information provided in the 10-page Executive Summary which is, in effect, an excellent précis of the salient trends and data contained in the main text.

B. H. Rudall
Norbert Wiener Institute and University of Wales (UK)