reinforcement over a series of future actions, as opposed to merely over the next action. Such systems can learn actions for which the reward is delayed. Existing techniques are reviewed and extended using the interval estimation method and the algorithms are compared experimentally. Again, Kaelbling deems the interval estimation method as having only limited value and the problem as needing further work. Finally, some of the algorithms developed are applied to an actual mobile robot with mixed but overall very encouraging results.

This is an important and impressive work. It is scholarly, richly detailed, and presents systematically a number of new algorithms in reinforcement learning. it should be studied by anyone with an interest in learning; it will influence the development of reinforcement learning methods for some time.

Reviewed by Richard Wyatt, Department of Mathematics and Computer Science, West Chester University, USA

Information systems development: A database approach (2nd ed) by D. E. Avison, Blackwell Scientific, 1992, £16.99, pp 329, ISBN 0-632-03028-3.

Information systems, according to the foreword in this book, is a larger view of information technology, including the technology but considering its development, use and social or business consequences. Blackwell Scientific provides a series on Information Systems for this obviously interdisciplinary area, and this particular text is intended for students of computer science and business. It provides a readable, readily comprehensible overview of the subject, from a user's perspective. The reader could easily come from a business background or be a technically minded manager involved with information systems, or a student in applications of computer science.

The reader is given an easy and broad introduction to database technology and system implementation, using what is termed a "data-oriented methodology". The book's content is based around database concepts but focuses on this particular methodology and its implementation. At a general level it provides the essentials of entity-relation or conceptual modelling, explaining the conceptual schema, data analysis and the relational model. A sketch is provided, for the intended wide readership, of relational algebra and calculus and logical schema. Similarly, the basics of relational, hierarchical, network and object-oriented databases are explained clearly and comparatively.

This book is well structured with extensive internal cross-referencing, and it makes good use of bold type and emphases. It is well illustrated with figures, and features simple but often real examples. For the more interested reader there are references for further reading at the end of each chapter.

The author is realistic in describing the book's content. He is not over ambitious in its claims to depth but admits readily to simplification and brevity. The explanations are very clear and the subject matter is treated to a systematic overview. Avison explains and describes the many database terms and concepts clearly and well, but cannot avoid including the acronyms that plague this discipline.

Notions such as the software engineering lifecycle are described in applications development and database implementation. Points of theory and practice in information systems are made concrete with examples, criticisms and implementation details. The information systems requirement for databases is described in so far as it is met by current and old technology, which is appropriate for the applied approach of the book. Similarly, the shortness of the section on object-oriented (OO) databases reflects the publication date (1992), and is an honest comment on the lack of widespread usage of OO in business.

Since this is not a solely technical book it mixes discussion of business objectives and management structures with design issues of modelling and hardware aspects of file access. This

creates the desired, realistic impression that these are not to be separated in business environment. The analysis of business is shown to be necessary before implementation of information systems and application development can take place.

At times this seems a strongly business oriented book for those unfamiliar with that world. The problems of implementing applications are highlighted and research solutions are offered from published analyses of strategies and corporate structures. An important distinction is made for the data-oriented reader between the issues and the tasks involved in implementing a database system; the task is computing but the issues are frequently people and their jobs.

The business analysis chapter (Chapter 2) deals sensitively with the people and politics of business, balancing people and technology. It stresses that this is essential to smooth and efficient implementation of information systems. The principles of business beyond the profit motive are explained for computer scientists and the role of well-managed data as a company resource explained for top and middle management as well as operational staff. Both the information system and the quality of database administration are vital to good performance in implementation and usage, in areas such as security, privacy and integrity of data, and there is a need to recognize this in appointment of associated personnel.

Building on the basics of earlier sections on databases and database environments, newer technologies are described. These include distributed databases along with their requirements, principles and design, and fourth generation tools, workbenches and data dictionaries. Sound advice is offered to business people on evaluating tools, with descriptions, explanations and cost benefit analyses, and including criticism of inflated claims of suppliers and writers. The book finishes positively with two examples of successfully implemented systems, which it calls "the approach in action". These bring together the principles and pragmatism described so far, to complete a useful introduction and summary of a rapidly developing, interdisciplinary subject.

Reviewed by Catherine Hearne, Advanced Computation Laboratory, Imperial Cancer Research Fund, London, UK

Rough sets—theoretical aspects of reasoning about data by Zdzisław Pawlak, Kluwer Academic, The Netherlands, 1991, pp 229, £56.00, ISBN 0-792-31472-7.

When a well-established author, especially one who has been working in a single field for as long as Professor Pawlak has, sets out to write a monograph on the subject that he invented, the resulting book is usually well worth reading. Books such as Judea Pearl's *Probabilistic reasoning in intelligent systems* and Bob Kowalski's *Logic for problem solving*, to take two examples which I can find directly to hand, are cases in point. Ideas which were previously spread around a number of papers are brought together in a single volume, and together are greater than the sum of the parts, giving a view of the author's area of expertise which is both broad and deep, and which suggests both applications and related avenues of research. Since I am a strong believer in the usefulness of rough sets I was greatly disappointed to find that this volume is not such a book. Indeed, the collection of all the ideas that Professor Pawlak has previously published on rough sets has almost exactly the opposite effect to that which I expected. Having read the book I found myself wondering quite where all the ideas and insights that I had previously found in the various papers on rough sets had gone to, and I am still not quite sure. However, I think I can, to some extent, explain what has happened.

The first thing to understand about rough sets is that the idea behind them is extremely simple. This is in no way intended as a criticism of them, since I firmly believe that ideas do not have to be complex to be good. The idea is the following. Consider a set of old-fashioned children's building blocks, made of wood and painted bright colours—red cubes, red pyramids and yellow pyramids, blue spheres and yellow spheres. Now, consider dividing the blocks into groups by their colours alone. The set of red blocks will contain cubes and pyramids, that is cubes and pyramids cannot be distinguished by colour alone. Alternatively, one can consider describing the colour of the blocks in