The chapters contain meaty explanations of the history, application and direction of the techniques used to study DNA sequences, protein structure and to model complex biological systems. As this field is in its infancy, Hunter has carefully balanced the book to present the reader with a number of possible approaches to the problems faced.

Newcomers to biology are introduced to the subject of biological molecules in an outstanding overview by the Nobelist Joshua Lederberg. His discussion of molecular biology in this book must rank as one of the clearest pieces of popular scientific writing ever. The most stimulating discovery for me in this book was the emerging application of computational linguistics to DNA sequence analysis and protein structure prediction. The introductory chapter by Searls on this topic deserves special praise.

Artificial intelligence approaches discussed here include neural net learning and knowledge based simulation which can detect patterns or model complex systems of biological molecules. The role of these models is discussed by Lederberg in his concluding chapter. He emphasizes that any model or interpretation of a system is only as reliable as the rules we use to define it, and lists no less than 13 major biological dogmas which have proven to be partly or wholly incomplete. The constant watchword is "vigilance" against inductive reasoning and incorrect rules which are incorporated into the algorithms used in these calculations. Nevertheless, the potential for discovery in this field is immense. For example, over 90% of the DNA in the genome does not support the formation of proteins. There is much speculation about a possible regulatory role for this "junk" DNA. Perhaps through deductive approaches using linguistics and neural net pattern recognition, patterns may be detected in the organization of the genome itself. Biologists cannot yet do experiments on the regulatory role of large scale DNA organization, although there is clear evidence that it occurs.

The only criticisms of the book are minor. Given the range of difficult subject matter covered, it would have been useful if there was a glossary or, at least, an indication in the index of the most descriptive entry of a term. Hunter makes one minor exaggeration in ascribing a role for quantum mechanics in protein structure, where it (fortunately) has no role to play. One omission on DNA regulatory regions are chromosome attachment sites—points where DNA strands are attached to the chromosome skeleton and which can drastically influence DNA function.

I found this book a stimulating and balanced introduction to a subject which will be the computational and biological equivalent of the Apollo Program in the 1960s and 1970s. Everyone with an interest in artificial intelligence or information theory—or even a curious mind—should skim a copy and savour the wealth of ideas described. Anyone working in this field will find it an excellent source of reference and definitive reviews. By examining the very nature of life, computational approaches to biology will potentially deliver more than a biro which can write upside down. This excellent book has started the countdown.

Reviewed by B.R. Clark

Case-based reasoning by Janet Kolodner, Morgan-Kaufmann, CA, USA, 1993, pp 668, £45.95, ISBN 1-55860-237-2.

Does case-based reasoning deserve to be considered as a radical new idea, or does it simply reconstitute a number of traditional approaches in a new guise? Janet Kolodner has contributed to research in this area from its early days in the late 1970s, and has produced a wide ranging account of the field. Unlike earlier texts (such as Riesbeck and Schank's *Inside Case-Based Reasoning*, she has attempted to provide more than a collection of examples of systems—much of her effort has been devoted to providing a rationalized summary of the methodology. This should provide us with a window onto this area of activity, and allow us to place it in the wider context of KBS research.

To provide a balanced account of case-based reasoning, it is necessary to accommodate both the "cognitive modelling" view, in which psychological plausibility is a dominant theme, and the

"engineering" view, which tends to concentrate on what is technically possible. Kolodner attempts to satisfy both communities by providing a core of practical detail, interspersed with references to cognitive modelling. This works well—making it possible to navigate through the chapters according to taste. Given this subtheme, the main structure of the book is based around the architectural components of case-based systems. An early chapter takes us through some of the representational decisions which must be made in structuring a case library. This is followed by a discussion of the choice of vocabulary for indexing cases. The narrative then moves to considering how features may be organized to make retrieval of cases easier, then introduces heuristic algorithms for assigning "best" matches on the basis of strength of similarity. Having chosen a best matching case, the next step is usually to adapt it to match the current problem, so we find chapters on common adaptation strategies and on using explanations of failed cases to guide the repair process. The sequence of chapters on representation, indexing, matching and adaptation are bolstered by introductory chapters which set the general context for case-based reasoning, and a penultimate chapter on the practicalities of making the various components work effectively when combined.

Looking at the list of computational mechanisms used in the book (frames, discrimination networks, causal models, semantic networks, model-based reasoning, and so on), one is struck by the diversity of implementational techniques, and also that most of them are familiar from other KBS areas. Thus, if we simply look at the implementational components of many case-based systems we will find little of novelty. However, this is to miss the point. The contribution of case-based reasoning is not in the implementation methods themselves, but in the way in which these are employed to tackle problems in difficult domains. The reuse of previous examples for problem solving can often be achieved, in appropriate domains, using comparatively standard techniques. The trick, which Kolodner attempts to teach us, is to approach domain problems in a way which makes this form of attack successful. In her concluding chapter, Kolodner cites "scaleup" (by which she means increasing the size of case libraries) as the major technological issue for future research. However, of at least equal importance is the need to understand more fully the formal basis on which case matching is undertaken, and to develop a body of experience which permits us to judge reliably when a given problem warrants a case-based approach. These problems are not purely technical but, as Kolodner points out, the production of improved tools and design methodologies can help. What also helps is a thorough understanding of the extent to which case-based reasoning actually works in realistic domains; the book provides a detailed summary of over 40 case studies but (since each is tightly limited in application), it would be instructive to know what the limiting factors were in each domain.

Kolodner's book is invaluable as a guide to the variety of case-based reasoners which have been built. It contains a wealth of practical advice on how to approach the design of such systems, and tempers the obvious enthusiasm of the author for her subject with warnings of potential pitfalls. As the foundation for a teaching course, its only failing may be that it contains no demonstration programs—but perhaps these will appear in a second edition. As it stands, this is the most comprehensive and best written survey of case-based reasoning which I have seen. I recommend it as an addition to any KBS library.

Reviewed by Dave Robertson, University of Edinburgh, UK

Decentralized A.I. 3 edited by E. Werner and Y. Demazeau, North-Holland, Amsterdam, 1993, pp 356, hardback, ISBN 0 444 89661 9, Dfl 250.00.

There has been an increasing amount of research in multi-agent systems (MAS), including human, automated and hybrid systems. These systems may cooperate or compete with each other, or they may simply be indifferent about each other's activities. However, if agents have inter-related individual goals, which may contribute to or contradict each other, or if they have joint goals, issues