exhaustive that the unhappy undergraduate soon gets lost in the maths addressed to more experienced readers. And, due to the rapid development of the discipline, any such textbook must face the gloomy prospect of becoming outdated before long. However, lecturers value good sources so much that they usually do not feel like forsaking them just because of slight information ageing. Rather, they want to recommend supplementary reading. But this, again, is far from being easy because journal papers are written for scientists, and students can find them discouragingly difficult to read.

Wasserman's book is aimed at those who have already acquired some initial knowledge about artificial neural networks and want to learn what is new in the domain without having to delve into oceans of theories. Vividly written and accompanied by copious illustrations, the text leads you through cutting-edge science without becoming excessively theoretical or superficial, and, importantly, without boring you. Moreover, you do not need any special background knowledge to understand the explanations. If you search for an easy overview, grab the book.

The volume is conceived as a loose collection of chapters presenting novel ideas in neural networks and their close neighbourhood. Apart from field theory methods, probabilistic neural networks, radial basis functions and sparse distributed memory, separate chapters are devoted to genetic algorithms and fuzzy logic as well as to questions pertaining to the application of neural networks in control. The author does not hesitate to venture into even such controversial issues as, for example, the relation of neural networks to chaos theory. Due space is devoted to second-derivative variations of the backpropagation algorithm and, incredibly, all these topics are squeezed into hardly more than 250 pages—an ideal size for quick information.

Obviously, there is a price to be paid for such diversity. Any book of this kind has to face the danger of becoming inconsistent and, in a way, this is a weak spot of Wasserman's book as well. Some chapters address topics that are easy to visualize with pictures, diagrams and graphs while others necessitate more abstract treatment. For instance, the introductions to sparse distributed memory and to fuzzy logic are spirited and elegant and the same goes for the explanation of the essence of chaos. But then, all of a sudden, the lulled reader is abruptly thrown into a complicated neural network based model of the olfactory system—definitely not material that can be understood at first sight. Similarly, the cobweb of mathematical formulae relating to advanced approaches to the backpropagation algorithm sharply contrasts with the "softer" presentation of other chapters.

However, these objections should not be considered as principal and are certainly outweighed by more positive aspects. As for the selection of topics, this will always depend upon each author's experience and personal preferences. But even though the reviewer might be tempted to complain that some of his favoured themes are missing while others are improperly overemphasized, Wasserman's choice certainly covers the mainstream of today's research in artificial neural networks.

To summarize, the book provides a good source of knowledge for interested students and, as artificial neural networks emerge from research labs into real world applications, to any scientifically trained practitioner that seeks an overview of some new perspectives of this technology.

Reviewed by Miroslav Kubat, Institute of Systems Science, Johannes Kepler University of Linz, Austria

Model theory by Wilfred Hodges, Encyclopedia of Mathematics and its Applications, Vol. 42, Cambridge University Press, 1994, pp 772, £65.00, ISBN 0-521-30442-3.

Mathematics works at various levels of abstraction. Geometry, as learnt at an early stage at school, is an example of a formal mathematical theory which is an abstraction from observations made about the real world. It became clear to mathematicians in the nineteenth century that a theory may have more than one "model" when Bolyai and Lobachevski, and Reimann, constructed alternative non-euclidean geometries. These provided two different, yet self-consistent, models of a theory defined by all of Euclid's axioms bar the parallel postulate (that there exists one and only one line parallel to a given line, which passes through a point not on that line).

During the twentieth century, certain mathematicians turned their view inwards to look at foundational aspects of their own subject. In addressing the internal consistency and completeness of mathematics and how theorems related to properties of the real world, they began to look at the relationship between theories expressed as mathematical symbols and the properties of models of those theories. During the 1950s, the phrase "theory of models" was coined (by Tarski) to refer to a field which began to address properties of those models in the abstraction; abstract properties of abstract models of the real world.

Esoteric as it may seem, this does have application to computer science. One can, for example, view a formal specification as a theory; an abstract statement of the properties of an intended system. An implementation then becomes a model of that theory. A process of stepwise refinement whereby a specification is gradually refined into an implementation may be viewed as stepping through a sequence of equivalent models.

Of course, there is also the importance of Herbrand models in studying the semantics of logic programs. Indeed semantic issues in general, for which model theory is an appropriate tool of exploration, are an important part of the agenda of computer science. That is by way of a, rather extended, apology for reviewing this book in this journal. What does it offer?

Comparison must be made with Chang and Keisler (1973). That book begins by setting up a formal language; first order logic. The sentences of the formal language are then used to "say things about the models". Thus far is familiar territory for a software engineer. The bulk of the book then continues with descriptions of methods of constructing models, with example applications of those methods.

Wilfred Hodges' book generally works at a slightly more abstract level. He begins with a discussion of structures; the stuff of which models are made. Concrete examples of such structures might include graphs or groups. Following that, the language for talking about structures is developed. This reflects a slight broadening of outlook over Change and Keisler. The latter focused more on the aspects of formal languages that are of interest to the computer scientist. Hodges' book in contrast is motivated more by a desire to study *all* the classes of structures that are of interest to the mathematician (not just those specifiable in first order logic). As with the earlier book, though, most of the content is focused on model-theoretic methods of construction, although in a more up to date and slightly more comprehensive exposition.

So, as might be expected, that makes the present book more of a mathematician's book than a computer scientist's. Nevertheless, for quality of writing, Hodges' dry and at times almost surrealistic sense of humour, and clarity of presentation, this book makes an extremely valuable source of insight and information. Chapters open with an informal motivating/scene-setting section, and conclude with historical notes and a bibliography. Exercises are provided after each section of each chapter.

Model Theory would perhaps have most interest to those who have mathematics to degree level. But given that, it is a pleasure to read and Hodges' joy at the beauty of, and enthusiasm for, his subject comes across clearly.

References

Chang, CC and Keisler, HJ, 1973. *Model Theory*. North-Holland.

Reviewed by Paul J. Krause, Advanced Computation Laboratory, Imperial Cancer Research Fund, 61 Lincoln's Inn Fields, London WC2A 3PX, UK

Artificial intelligence through search by Chris Thornton and Benedict du Boulay, Intellect, 1992, pp 363, ISBN 1-871516-24-2.

The engineering of knowledge-based systems—theory and practice by Avelino J. Gonzalez and Douglas D. Dankel, Prentice Hall International, 1993, pp 523, ISBN 0-13-334293-X.

Here are two more textbooks aimed at introductory courses on aspects of artificial intelligence, both of them based upon interesting ideas, and both of them ultimately let down by a lack of attention to detail.