boek. Samenvattend: een goed leesbaar boek. Men moet wel voor lief nemen, dat de schrijver vaak 'gezellig' wil overkomen. Het woord 'nice' is niet van de lucht en de opmerking op blz. 45 over het Ferrero-paar is wel erg zouteloos.

A.H. Boers.

C. REUTENAUER, *Free Lie algebras*. Oxford: Clarendon Press, 1993. 269 p., prijs £ 55,- (London Mathematical Society monographs, new series; 7).
ISBN 0-19-853679-8.

Gegeven een alfabet $A := \{a_1, a_2, ..., a_n\}$, dan heet de kleinste deelruimte van de lineaire ruimte van A–woorden, die de woorden van lengte 1 bevat en gesloten is onder de haakoperatie $[f, g] := fg - gf$, gewoonlijk *de vrije Lie–algebra over A*. Dit boek is waarschijnlijk het enige boek dat uitsluitend vrije Lie-algebra's behandelt. De klassieke thema's met de laatste stand van zaken komen allemaal aan de orde: Een deelalgebra van een vrije Lie-algebra is vrij (stelling van Shirshov en Witt, bewezen via de *weak algorithm* van P. M. Cohn), formules van Campbell-Baker-Hausdorff en Dynkin, Hall-basis van de vrije Lie-algebra en de corresponderende Poincaré-Birkhoff-Witt-basis van de vrije associatieve algebra, Lyndon-basis, schuffelalgebra met Lyndon-woorden als vrije voortbrengers, Hall-woorden en halssnoeren, representaties van de symmetrische groep op een vrije Lie-algebra en de zgn. *Solomon descent algebra*. Te vermelden zijn nog de volgende correcties: Op p. 200 moet in de definitie van de Klyachko q-idempotent, $r_n(q)$ worden vervangen door $r_m(q)$ met $m = maj(\sigma)$ en in §8.6.5 op p. 209 is de Specht-idempotent van p. 195 bijna overal met n vermenigvuldigd, zodat enige aanpassing noodzakelijk lijkt. Nu nog iets over de stijl van het boek. Bij het lezen van de inleiding, waar de Lie-algebra's met zes bladzijden commutatieve diagrammen worden ingevoerd (en dat bij een in essentie combinatorisch onderwerp), merkt men al dat het geen boek is om al bladerend snel een overzicht te krijgen. Bij de belangrijke hoofdstukken over Hall-bases en toepassingen van Hall-verzamelingen was ik blij de artikelen van Marshall Hall, A. I. Shirshov en P. M. Cohn dertig jaar te hebben bewaard, terwijl ook de recente overzichtsartikelen van A. M. Garcia uitkomst boden. Deze en andere artikelen staan vermeld in de bijzonder waardevolle historische aantekeningen aan het einde van ieder hoofdstuk. Samengevat: Een onmisbaar en zorgvuldig geschreven boek voor onderzoekers, echter geen boek om dit mooie onderwerp aan de man te brengen, maar misschien mag men dat van zo'n prominent onderzoeker als de auteur ook wel niet verlangen.

T.H.M. Smits.

Handbook of logic in computer science, vol. 1,2; ed. by S. ABRAMSKY et al. Oxford: Oxford University Press, 1992. 827 p. + 571 p., prijs £ 145,- (Oxford Science Publications). ISBN 0-19-853735-2.

Contents. Vol. 1: *Valuation systems and consequence relations*, M. RYAN and M. SADLER; *Recursion theory*, I. C. C. PHILLIPS; *Universal algebra*, K. MEINKE and J. V. TUCKER; *Basic category theory*, A. POIGNÉ; *Topology*, M. B. SMYTH; *Model theory and computer science: An appetizer*, J. A. MAKOWSKY. Vol. 2: *Term rewriting*

systems, J. W. KLOP; *Lambda calculi with types*, H. P. BARENDREGT; *Elements of algorithmic proof*, D. M. GABBAY; *Designing a theorem prover*, L. C. PAULSON; *Modal and temporal logics*, COLIN STIRLING.

It is not an easy task to review two volumes spanning almost 1400 pages and ranging over several areas of mathematics and theoretical computer science. The book under review is supposed to provide a necessary background to those interested in the use of logic and neighbouring disciplines like category theory and topology in theoretical computer science. The idea of the editors was to divide the handbook into several volumes. So far two have appeared. The first volume entitled *Mathematical structures* puts emphasis on the necessary background knowledge, and the second, *Computational structures*, puts emphasis on various computational paradigms. In presenting such a wealth of material some obvious choices had to be made. In this review, I shall devote more attention to the selection of topics made by the authors. The first chapter of the first volume, written by M. Ryan and M. Sadler, is an introduction to the basic notions of interpretation, consequence relation, proofs and proof systems. In particular, Hilbert style, natural deduction and sequent style formalizations of proof theory are given, with some reference to cut elimination and its uses. However, the tableau method and the resolution method are not discussed. Modal logic is also briefly mentioned, but only the S4 system is introduced. The second chapter, written by I. C. C. Phillips, provides a very readable introduction to recursion theory. The computer science perspective is visible throughout the presentation. In the first section various computing paradigms, including Turing machines, flowcharts, while programs and simple functional programs are thoroughly discussed. Then the basic results on (un)decidability are developed followed by an overview of the use of the least fixed points and, a nice novelty, of greatest fixed points. By way of example the denotational and operation semantics of the functional language are presented and their equivalence proved. The chapter ends by presenting various versions of the fixed point theorems. The next chapter, written by K. Meinke and J. V. Tucker, provides a 200 pages plus systematic introduction to universal algebras. Semantics is now presented in an algebraic way and three notions of compositionality are introduced. The basic constructions, including congruences, quotient algebras, products and ultraproducts are systematically explained. The final part deals with three fragments of first-order logic: equational logic, conditional equations and equational Horn formulas. In contrast to other chapters much emphasis was put here on examples. For further discussion of this chapter see the chapter on model theory below. The next chapter, written by A. Poigné, is a 230 pages long systematic introduction to basic concepts of category theory and its use in theoretical computer science. Several issues like the relation between Cartesian closed categories and lambda calculus, and the categorical abstract machine, a basis for implementation of functional languages, are thoroughly presented there. The subsequent chapter, written by M. B. Smyth, deals with topology. It provides a systematic introduction of basic concepts and constructions of topology with emphasis on its applications in theoretical computer science. Already at the very beginning Scott topology on cpo's is introduced and its connection with the idea of finitary testing is explained. Dijkstra's weakest precondition semantics of nondeterminisitic programs is explained in topological terms. An extensive discussion on the effectiveness and representation provides interesting and useful insights into the rela-

tion between computability and topology. Lot of attention is devoted to metric spaces, including Banach fixed point theorem, and their use in theoretical computer science – the examples include synchronization trees, semantics of buffers and context-free grammars, and processes in relation to non-well-founded sets. The last chapter in the first volume, written by J. A. Makowsky, deals with the "model theory and computer science". The discrepancy in length between this chapter and the previous ones is quite amazing – it is barely 50 pages long. With such a length it is obvious that several important topics were barely touched upon and that no proofs were included. Even worse, some concepts are discussed but not defined. For example, less than half a page is devoted to ultraproducts. They were defined earlier in the chapter on universal algebras for the case of algebras but their role in the first-order model theory was ignored there (though good references were mentioned). Now they are referred to in the context of first-order logic but without providing any formal definition and without pointing interesting applications of it within computer-science. The discussion of the 0-1 laws also takes less than one page (sic). In contrast, the important relation between computability over finite structures and definability in various logics is duly explained. The chapter ends with a ... recepy for a Tuscany cake.
The second volume is much different in nature, so I shall be much more brief. It consists of the state of the art survey articles of various domains of theoretical computer science dealing with computational mechanisms. The contributions of J. W. Klop, H. P. Barendregt and C. Stirling are the best introductions I have seen to the areas of , respectively, term rewriting systems, typed lambda calculi and the use of modal and temporal logics in theoretical computer science. Especially the chapter on lambda calculi with types is very complete (and almost 200 pages long) and deals with several extensions of lambda calculus. The chapter written by D. Gabbay seems to me somewhat more specialised. It presents various logic from the theorem prover point of view. It is not a well-known topic and – as its bibliography shows – mostly developed by the author himself. Finally, the chapter by L. Paulson is a very readable introduction to the design of a theorem prover. In the chapter various known theorem provers are discussed and the listing of a toy theorem prover written in ML is included.

K.R. Apt.

R. HORST and H. TUY, *Global optimization, deterministic approaches*. 2nd ed.. Berlin, etc.: Springer-Verlag, 1993. 698 p., prijs DM 220,- (hc). ISBN 3-540-56094-7.

Eerst zal de plaats van het boek binnen de literatuur over globale optimalisering en de vorm worden besproken. Vervolgens wordt de inhoud besproken. Grofweg zijn er binnen de globale optimalisering twee stromingen te onderscheiden. De eerste school, waar ook Horst en Tuy deel van uitmaken, richt zich op optimaliseringsproblemen met een specifieke structuur. De oplosmethoden willen zo goed mogelijk gebruik maken van deze structuur en worden deterministisch genoemd. De tweede school bestudeert methoden die door het random zoeken in het toegelaten gebied de kans proberen te vergroten dat het globale optimum wordt gevonden; de zogenaamde probabilistische of stochastische methoden. In Nederland is hier met name in de jaren tachtig veel aandacht aan besteed o.a. aan de Erasmus Universiteit. Van de eerste school bestaat