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REVIEWS

The Association for Symbolic Logic publishes analytical reviews of selected books and articles in the field of symbolic logic. The reviews were published in ***The Journal of Symbolic Logic*** from the founding of the JOURNAL in 1936 until the end of 1999. The Association moved the reviews to this BULLETIN, beginning in 2000.

The Reviews Section is edited by Steve Awodey (Managing Editor), John Baldwin, John Burgess, Mark Colyvan, Anuj Dawar, Marcelo Fiore, Noam Greenberg, Hannes Leitgeb, Roger Maddux, Ernest Schimmerling, Carsten Schürmann, Kai Wehmeier, and Matthias Wille. Authors and publishers are requested to send, for review, copies of books to *ASL, Box 742, Vassar College, 124 Raymond Avenue, Poughkeepsie, NY 12604, USA.*

In a review, a reference "JSL XLIII 148," for example, refers either to the publication reviewed on page 148 of volume 43 of the JOURNAL, or to the review itself (which contains full bibliographical information for the reviewed publication). Analogously, a reference "BSL VII 376" refers to the review beginning on page 376 in volume 7 of this BULLETIN, or to the publication there reviewed. "JSL LV 347" refers to one of the reviews or one of the publications reviewed or listed on page 347 of volume 55 of the JOURNAL, with reliance on the context to show which one is meant. The reference "JSL LIII 318(3)" is to the third item on page 318 of volume 53 of the JOURNAL, that is, to van Heijenoort's *Frege and vagueness*, and "JSL LX 684(8)" refers to the eighth item on page 684 of volume 60 of the JOURNAL, that is, to Tarski's *Truth and proof*.

References such as 49***5*** or 280***1*** are to entries so numbered in *A bibliography of symbolic logic* (the JOURNAL, vol. 1, pp. 121–218).

ANDRÉ NIES. ***Computability and randomness.*** Oxford Logic Guides, vol. 51. Oxford University Press, Oxford, 2009, xv + 433 pp.

Algorithmic randomness from a mathematical standpoint has become a popular and fruitful area of research, particularly over the last decade, though until now no systematic treatment of the topic has appeared. André Nies's ***Computability and Randomness***, from Oxford University Press this year, is the first of two new computability-theoretic books to address the topic of algorithmic randomness and in particular its interactions with classical computability theory. The other, ***Algorithmic Randomness and Complexity*** by Rod Downey and Denis Hirschfeldt, is expected to be a little more comprehensive (and correspondingly less readable) and more aimed at the theoretical computer scientist, and will appear in the new CiE book series from Springer in mid-2010. Nies's book covers a range of work, mainly from the last fifteen years, regarding randomness notions such as Martin-Löf randomness and in particular the connections with computability-theoretic notions such as diagonally-non-computable degrees and traceability. Nies has been very active in this field of research and has contributed to many of the topics treated in the book. The book does not attempt to cover all aspects of randomness and related topics; the author has concentrated on certain topics that display interesting and fruitful interactions with computability theory and to which the author has made a particularly significant contribution. In particular, K-trivials and lowness properties are treated in depth, including low for Martin-Löf randomness, low for Ω and traceability properties. Also of note is the final chapter on randomness via

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descriptive set theory, which develops an analogue of algorithmic randomness based on higher computability concepts such as Π^1_1 sets instead of c.e. sets. A notable omission is the considerable recent work on effective dimension, of particular interest to computer scientists; however this will be covered in Downey and Hirschfeldt's upcoming book.

The book serves two roles, both as a reference on recent research in computability and randomness, and as a textbook for students interested in randomness. The earlier chapters are particularly suited for self-study or for use in conjunction with a graduate course on randomness. The author provides a diagram of dependencies between chapters, and the many exercises range from straightforward lemmas to challenging proofs taken from recent research papers. The later chapters are primarily a reference for some significant bodies of recent work, covering several topics in detail and not shying from difficult or sophisticated constructions.

Chapter 1 provides a background of computability theory and basic measure theory. This includes Turing reducibility, the arithmetical hierarchy, basic finite injury constructions and a survey of other useful theorems such as the low basis theorem. Turing machines are described informally, but most other notions are defined precisely and full proofs are usually given. Nevertheless an understanding of basic computability is required, of the level of an introductory text such as Cooper's ***Computability Theory*** or Cutland's ***Computability***, as Nies's exposition is intended as a review and not a complete treatment of classical computability.

Chapter 2 treats Kolmogorov complexity of finite strings, both plain and prefix-free, including basic properties of Kolmogorov complexity and tools such as the Kraft-Chaitin Theorem (or 'Machine Existence Theorem' in the author's terminology). Chapter 3 introduces the key notions of randomness, including Martin-Löf tests, Martin-Löf randomness and variants. Martin-Löf randomness is defined first in terms of Martin-Löf tests, but followed almost immediately by Schnorr's characterisation in terms of Kolmogorov complexity. Indeed, throughout the book, the measure-theoretical approach to randomness via (Martin-Löf) tests and the initial segment complexity approach via Kolmogorov complexity are given roughly equal attention, with the author using techniques or intuition from either approach as each situation requires. Weaker and stronger variants of Martin-Löf randomness are also discussed, though a more comprehensive treatment of computable randomness is postponed until chapter 7.

Chapter 4 deals with the class of diagonally noncomputable (DNC) degrees and their interaction with randomness. This includes the result of Stephan that sets which are both DNC and Martin-Löf random must compute the halting problem $\emptyset'$. This chapter includes a very readable presentation of Kučera's injury-free solution to Post's problem (namely, to construct c.e. Turing degrees strictly between $\mathbf{0}$ and $\mathbf{0}'$), including some variations and simplifications obtained from randomness-theoretic notions.

Chapter 5 is one of the most substantial and valuable chapters of the book, treating the topic of K-triviality and lowness properties. This has been one of the most successful research topics in the field over recent years, and an area in which the author has made considerable contributions, culminating in the celebrated equivalence of several (conceptually distinct) classes[1] of sets with the class of K-trivials. This chapter presents the various classes and the proofs of their equivalence, including the elaborate decanter method. It also addresses the well-known cost function method, presenting it in an abstract and general setting, with the previous applications of the method presented as models of the general theory. Although a unified treatment of the various cost function constructions is appealing, and it does shed light on certain aspects of the K-trivials, Nies's abstract approach here sometimes feels overly formal and suffers somewhat from the additional terminology and abstract notation. This chapter also contains a wealth of other assorted results about the K-trivials and equivalent classes, including many significant results which are left as exercises.

[1] *Class* in the sense of complexity class, not the set-theoretical sense.

Chapter 6 covers some advanced computability-theoretic techniques in preparation for the later chapters, including prompt simplicity and pseudojump inversion. Chapter 7 turns to the third major paradigm of randomness, martingales. The characterisation of Martin-Löf randomness in terms of c.e. martingales is covered briefly, before turning to computable and Schnorr randomness, which is the main topic of the chapter. Most of the chapter is devoted to separating Schnorr, computable and Martin-Löf randomness, utilising results and techniques from earlier chapters. The chapter ends with a brief section on Kolmogorov-Loveland randomness and non-monotonic betting strategies.

Chapter 8 continues the work on lowness properties, presenting a comprehensive study of a wide range of classes of computational complexity including low for Ω, low for Schnorr randomness, strongly jump traceable and others. It contains many results, as well as numerous unsolved problems, and along with chapters 5 and 7 forms the heart of the book (in its role as a reference for researchers).

The final chapter starts to develop a theory of randomness via effective descriptive set theory. Using Π^1_1 sets as a 'higher computability' analogue of c.e. sets, Nies develops Π^1_1 analogues of concepts such as Martin-Löf tests, Martin-Löf randomness, prefix-free machines, Kolmogorov complexity and K-triviality. The material in this chapter is an introduction to the study of randomness via higher computability notions, but it is not a full treatment of the topic. Some important results are omitted (notably, the analogue of Schnorr's theorem) or claimed to hold without giving details. The approach taken in this book, via Π^1_1 machines, is somewhat technical, and familiarity with the techniques and concepts from earlier in the book is assumed. Readers from a descriptive set theory background hoping to find a self-contained account of this topic may therefore be disappointed; however those having covered the required earlier chapters should find this new topic quite accessible.

On the whole, the book is well-written, readable and concise. Every chapter begins with a discussion of the motivations and intuitions of the upcoming mathematics. Many of the more elaborate proofs are preceeded with a discussion of the ideas of the proof or a proof sketch, which greatly aids the understanding of the (sometimes quite involved) constructions. Indeed, the proof sketches alone are often enough for an experienced reader to grasp the proof without reading the formal details. Nies uses some idiosyncratic or uncommon notation and terminology, such as '$\#S$' for the cardinality of a set S, and Knuth-style summation notation, which readers may at first find awkward. Fortunately an index of notation is provided and will be particularly helpful to those using the book for occasional reference. The list of references is comprehensive, however it is not always clear to whom specific theorems are attributable or where the original version of a result may be found; in some cases, the attribution for an entire chapter is limited to a comment along the lines of "Most of the material in the following chapter is due to ... ". There are many cross-references within the book, particularly in the introductory and background chapters. Many interesting and notable results are left as exercises in the later chapters, most of which have hints or sketch proofs provided in an appendix; the serious reader will certainly not want to overlook the exercises. The book has been thoroughly proofread, and contains very few errors. ***Computability and Randomness*** will be a valuable resource for students and invaluable for researchers working in computability and related areas.

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LOTHAR KREISER. ***Logik und Logiker in der DDR. Eine Wissenschaft im Aufbruch.*** Leipziger Universitaetsverlag, Leipzig, 2009, 479 pp.

20 years ago the German Democratic Republic (GDR) became history. The GDR was a small country with easily comprehensible university network. Of course, the logic tradition

in East Germany was modest but noble, beginning as it did in 1948 with the appointment of the well known Scholz-pupil Karl Schroeter to the chair at the Humboldt University (Berlin).

The book under review contains the first fully-fledged account of the history and academic life of logic in the GDR. The book informs extensively and in detail about exciting themes such as the quarrels of the scientists with the ideology in general, the ministerial overlords, the epistemological relation to dialectic logic and so on. The author obviously undertook a very long journey through numerous university archives and federal institutions, for the book contains far more than merely personal memories and well-prepared presentations of the scientific work done during those decades. As a basis, Kreiser used many hitherto unknown documents: minutes, decrees, letters, instructions, statutes, party resolutions. On more than 450 pages the author develops a multidimensional picture of the many facets of logic in the GDR. Kreiser presents the long path the logicians had to pursue before they and their subject were deemed harmless for political questions. This book contains an account of individual biographies and fates as well as the history of the process of emancipation from ideological doctrines and political scrutiny, of the successful integration of logic as a mature and recognized discipline into philosophical studies and general education, counter to all reservations.

The monograph is organized into six chapters and three appendices. Chapter one (pp. 16–46) can be considered as a general introduction to the subject. It contains a short résumé of the general discussion of the claims of formal logic beginning with the 1951 logic conference at Jena (see below) and including a presentation of the three different directions taken by logic in the GDR: the semantic, the pragmatic and the syntactic conceptions. This threefold distinction should not be understood as a categorical difference, but rather as a consequence of personal emphasis by the leading logicians.

More than 200 pages long, the second chapter is by far the longest and for most readers probably the heart of the book. It is especially dedicated to the presentation of the major schools and the specific characteristics of various universities. In this chapter, what was already the subject of the first one can be found in detail: a specification of the three different conceptions of logic embedded in their systematical, historical and biographical contexts. A small section of the chapter informs about the development and organization of logic at Rostock University, the University of Halle and the Technical University of Dresden (pp. 235–266). But particularly exciting are the detailed reports about the rise and alignment of the Berlin group in logic (pp. 63–118) and its counterpart at Leipzig (pp. 118–168) as well as the history of logic at Greifswald University (pp. 206–235) and the University of Jena (pp. 168–205). To make the presentations of the content more readable, this chapter and the three following contain in all over 40 individual portraits, mostly under the heading of "protagonists." They are written in the first or third person perspective and besides CVs and subjective points of view frequently document personal reminiscences and private episodes. In addition, most of the cursory notes on the scientific achievements of East German logic are to be found here. The portraits do not follow a common scheme—they differ in extent as well as in presentation, for instance, the reader is informed via the biographical sketches of the two leading and influential figures Schroeter and Georg Klaus of the odd relationship between them (pp. 69ff. and pp. 86ff.).

The third chapter (pp. 268–349) considers the role of logic in a wider educational context, especially as a subject at pedagogical and technical colleges. The content of this chapter is, maybe more than any other, characteristic for one crucial topic in East German sciences, namely the constant intellectual supervision of science by the party and the tensions between scientific content and ideology. In the actual case the ministry for national education was responsible for the partially disappointing endeavors to implement logical content into the curricula of pedagogical colleges and high schools. This changed in the late 1960s (cf. e.g., pp. 280ff.) as among other things the officials recognized the need for scientific progress especially in cybernetics and computational technologies. As basic knowledge for automation and computer centers, logic was eventually recognized as an analytical skill and became a serious subject at some pedagogical colleges.

Whereas chapter four (pp. 352–393) is dedicated to the role of logic at several academies in East Germany, the fifth chapter (pp. 396–427) deals with the developments of logical methods within philosophy, e.g., for analyzing the language games of question and answer and the general methodology of science in the tradition of Carnap, Hempel and Stegmueller. This chapter also contains four portraits of foreign protagonists, for example the vividly written memoirs by Christian Thiel. The last chapter and the first appendix (pp. 430–465, they belong together) is dedicated to the logicians' 1986 report of the results and further developments of the subject at universities and colleges. It is worth mentioning that this report (as presented by Kreiser) contains a fair and critical examination, free from ideology. It becomes obvious that in the closing years of East Germany, logic was finally recognized by the leading politicians not only as a distinguished discipline but also as politically harmless.

With respect to the huge number of sources the author had to consider and the extended presentation of the many faces of logic, it would be unfair to criticize Kreiser for aspects that were disregarded. But the most important of them should at least be mentioned: the fundamental role of the 1951 logic conference at Jena. I am myself not able to judge the importance of this conference for any further developments taking place in East Germany. But Kreiser's mention of this event on only few pages (pp. 35–39, plus some additional minor remarks in the following chapters) marginalizes its pioneering role, especially the decisive engagement of Schroeter and others against an ideological occupation. At the beginning of the 1950s they were sometimes confronted with the objection that modern formal logic is an enemy of the working class and peasants since it is the specific formal language of the bourgeois. But in the run up to the Jena conference, where the logicians got into conflict with the beliefs of some party bigwigs, Stalin declared in his letters on linguistics that language and grammar are not class-dependent phenomena. Thus, if the variant grammars of natural languages have to be counted as class-independent, then very same must hold for the rules and axioms of modern formal logic. This reference to Stalin was curiously a great advantage for the logicians. It is worth mentioning that the Jena conference was dominated by hard and honest statements presented without ideological flourish. And it is surely a tribute to the character of this conference that in the following years the logic conceptions of Schroeter and Klaus became dominant, whereas the influence of those who wanted formal logic to be subservient to dialectical materialism dwindled. In footnote 10 on page 35 Kreiser remarks that he will treat the theme of the Jena conference differently from the way Carl Friedrich Gethmann already had in his marvelous essay "Formale Logik und Dialektik. Die Logikdiskussion in der DDR 1951 bis 1958" (in ***Ein kurzer Frühling der Philosophie***, edited by C. Burrichter). I am not sure what that means since Gethmann's kind of treatment seems to me the appropriate way to achieve an adequate understanding of the early setting in the discussion and its pioneering role for many future developments in East German logic.

Kreiser's book is an important contribution to the history of logic and the history of science in the German Democratic Republic and it is especially recommended to anybody who is interested in these fields.

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