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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 Burgess, Mark Colyvan, Anuj Dawar, Noam Greenberg, Rahim Moosa, Ernest Schimmerling, Alex Simpson, 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).

The development of modern logic, edited by Leila Haaparanta, Oxford University Press, 2009. x + 994 pp. — therein:

LEILA HAAPARANTA. *Introduction*. Pp. 3–10.

TUOMO AHO and MIKKO YRJÖNSUURI. *Late medieval logic*. Pp. 11–77.

MIRELLA CAPOZZI and GINO RONCAGLIA. *Logic and philosophy of logic from humanism to Kant*. Pp. 78–158.

VOLKER PECKHAUS. *The mathematical origins of nineteenth-century algebra of logic*. Pp. 159–195.

CHRISTIAN THIEL. *Gottlob Frege and the interplay between logic and mathematics*. Pp. 196–202.

RISTO VILKKO. *The logic question during the first half of the nineteenth century*. Pp. 203–221.

LEILA HAAPARANTA. *The Relations between logic and philosophy, 1874–1931*. Pp. 222–262.

GÖRAN SUNDHOLM. *A century of judgment and inference, 1837–1936: Some strands in the development of logic*. Pp. 263–317.

PAOLO MANCOSU, RICHARD ZACH, and CALIXTO BADESA. *The development of mathematical logic from Russell to Tarski, 1900–1935*. Pp. 318–470.

WILFRID HODGES. *Set theory, model theory, and computability theory*. Pp. 471–498.

JAN VON PLATO. *Proof theory of classical and intuitionistic logic*. Pp. 499–515.

TAPIO KORTE, ARI MAUNU, and TUOMO AHO. *Modal logic from Kant to possible worlds semantics*. Pp. 516–550.

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RISTO HILPINEN. *Appendix to chapter 12. Conditionals and possible worlds: On C. S. Peirce's conception of conditionals and modalities*. Pp. 551–561.

GABRIEL SANDU and TUOMO AHO. *Logic and semantics in the twentieth century*. Pp. 562–612.

ANDREW ABERDEIN and STEPHEN READ. *The philosophy of alternative logics*. Pp. 613–723.

SANDY ZABELL. *Philosophy of inductive logic: The Bayesian perspective*. Pp. 724–774.

ALESSANDRO LENCI and GABRIEL SANDU. *Logic and linguistics in the twentieth century*. Pp. 775–847.

RICHMOND H. THOMASON. *Logic and artificial intelligence*. Pp. 848–902.

J. N. MOHANTY, S. R. SAHA, AMITA CHATTERJEE, TUSHAR KANTI SARKAR, and SIBAJIBAN BHATTACHARYYA. *Indian logic*. Pp. 903–961.

This collection of articles was largely written by philosophers for a philosophical audience, as appears from the list of contributors, of whom twenty-five belong to philosophy or humanities departments, two to departments of mathematics, and one to a department of linguistics. Philosophical interests dominate in the choice of topics, as shown by the coverage of developments in logic in the period after 1935. The excellent short article by Hodges takes only twenty-eight pages to describe the numerous advances in technical classical mathematical logic during this time, whereas several hundred pages are devoted to developments in inductive logic, linguistics, and modal and other nonclassical logics, all areas of special interest to philosophers.

The title itself reflects philosophical usage, since the word "modern" is used in the same way as in the phrase "modern philosophy," that is, post-Cartesian philosophy. Even so, two somewhat anomalous chapters are included on late medieval logic and Indian logic; since the latter chapter is largely confined to work in logic from the first millennium A.D., it is hard to see why it was included.

The chapter by Capozzi and Roncaglia begins with the humanist revolt against medieval logic, continuing to the late eighteenth century and Immanuel Kant, including discussions of Leibniz and Lambert. An interesting feature of the chapter is the inclusion of lesser known figures such as Johann Segner, who gave an axiomatic formulation of syllogistic logic.

Peckhaus's fine article outlines the beginnings of the era of mathematical logic proper, from Boole to Schröder and Peirce. Although the work of Boole was inspired by the controversy between De Morgan and Sir William Hamilton about the quantification of the predicate in the theory of the syllogism, Peckhaus makes it clear that the mathematical reform movement of Babbage, Peacock and Herschel was of greater importance for Boole.

Christian Thiel's short article on Frege forms a contrast with the lengthy chapters elsewhere in the volume. Nevertheless, it gives a concise and clear picture of the outline of Frege's logic, as well as pointers to the very voluminous secondary literature.

The chapter by Risto Vilkko is devoted to debates among nineteenth century German philosophers about the nature of logic, in particular the opposition between the school of Hegel and that of Herbart.

The chapter by Haaparanta surveys various topics in the philosophy of logic; the main figures in the discussion are Frege, Husserl and Peirce. The topics include the relations between logic and ontology, psychologism and logic, and the role of intuition.

The interesting contribution by Sundholm serves to tie together some of the material on traditional logic with more contemporary work. He traces the replacement of the notions of judgment and inference with those of proposition and logical consequence. In his picture, the key figure in the transition to modern logic is Bernard Bolzano, whose *Wissenschaftslehre*, 171, appeared in 1837. Sundholm traces the development of the new ideas through Frege, Russell, Wittgenstein and Gentzen.

The chapter by Mancosu, Zach and Badesa amounts to a small monograph outlining the history of mathematical logic in the period of the title. A good deal of the material included should be familiar to logicians acquainted with the developments of that time, but there are some places where the coverage augments and supplements the standard histories. The discussion of Löwenheim's paper 1719 of 1915 is unusually detailed, and the work of the Hilbert school is outlined in considerable detail, including new information on the relation between Hilbert and Russell that is not to be found in the usual sources.

The article by Hodges is a small miracle of compression. In only a few pages, he manages to survey the major results and trends in mathematical logic after 1930, as well as relating them to earlier developments.

Jan von Plato gives a short but efficient introduction to proof theory in the style of Gentzen. The emphasis is on the study of structure of proofs in themselves, as opposed to proof theory as a tool used in Hilbert's consistency program.

The chapter on modal logic by Korte, Maunu and Aho covers a lot of territory, beginning with Kant's theory of judgment-forms and proceeding to an overview of possible worlds semantics, concluding with Quine's strictures and David Lewis's modal realism. The brief appendix by Risto Hilpinen discusses the frequently insightful remarks of C. S. Peirce on modality and conditionals, some of which prefigure contemporary themes in logic.

The central part of the chapter by Sandu and Aho is devoted to Tarski's theory of truth, as well as the work of Kripke, Herzberger and Gupta on languages containing their own truth predicate. However, the earlier part concerns itself with aspects of the theory of meaning as conceived by Frege, Russell and Ramsey. The last part discusses a variety of topics, including situation semantics and Quine's critique of semantical notions.

The long chapter by Aberdein and Read is in two parts. The first part is devoted to a discussion of what it means to propose a logic as an alternative to classical logic; the various possibilities are discussed in terms of political metaphors such as various forms of revolution and 'radical left' and 'radical right.' The second part discusses four non-classical logics: intuitionistic logic, quantum logic, relevance logic and paraconsistent logic.

The chapter by Sandy Zabell is a first-rate historical introduction to the modern theory of subjective probability. Starting from Thomas Bayes, and proceeding to the work of Carnap and his successors, Zabell gives a clear account of the mathematical details of the theory, together with a sensitive account of the historical background.

A principal theme in the chapter by Lenci and Sandu is the quest for the universal logical structure of natural languages. They begin with Frege and Russell, proceeding to the work of the Polish school and Bar-Hillel on categorial grammars, then to the early work of Chomsky on transformational grammar. After a detailed discussion of Montague grammar and model-theoretic semantics, they conclude with Chomsky's newer theory of government and binding.

Richmond Thomason's chapter explains the common ground between philosophical logic and artificial intelligence by a shared interest in extending logical formalism to nonscientific reasoning. The topics of the chapter include: nonmonotonic reasoning, logics of action and change, and epistemic logic.

In the preface to the volume, the editor expresses her intention of producing a volume that was "meant to be written by a number of scholars *almost as if* it had been written by one scholar only." The book, however, consists of a series of often loosely connected essays on a wide variety of topics ranging from Hegelian metaphysics to artificial intelligence. Nevertheless, it can be recommended to logicians as an introduction to a large selection of topics that go beyond the usual limits of a history of logic.

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ALEXIS G. BURGESS and JOHN P. BURGESS. ***Truth.*** Princeton Foundations of Contemporary Philosophy. Princeton University Press, Princeton, 2011, xiv + 158 pp.

Philosophy students occasionally complain that it is difficult to grasp the philosophical motivations and a grand picture in certain discussions in analytic philosophy. In fact, not only students can easily get bogged down in details and lose sight of the original motivations to look at specific problems, say, in philosophy of language or logic.

In their introductory textbook of only 172 pages the father and son duo John P. and Alexis Burgess on truth do a remarkably good job of painting a larger landscape and developing a greater picture, which is not confined to the discussion about truth narrowly understood. The authors bring out the relations of the discussions on truth, realism, and the like with topics such as vagueness or the reference of proper names and natural kind terms; and unlike some of its competitors, the authors do not flinch from also looking at the more formal work on truth and the paradoxes. Of course neither the formal theories nor the 'philosophical' doctrines—such as deflationism or the various substantial theories—are covered in great detail. But exactly the brevity of the presentation helps the reader to grasp the grand picture and the main strands in the debate.

The Burgesses concentrate on three major standpoints concerning the 'nature of truth': deflationism, realism, and antirealism (with Tarski's theory as a kind of prologue to the modern discussion). Their main aim is to introduce the reader to the present state of the debate, but they trace back various strands in the contemporary discussion at least to Tarski and in some cases even slightly further. The classical literature in the analytic tradition such as Russell, Ramsey, or Strawson is skimmed only in as far as it is relevant for this purpose. The authors put a stronger emphasis on nowadays fashionable topics such as dialetheism, relativism about truth, and truth maker theory, although these developments are not always treated in a favourable way. The two concluding chapters are devoted to the semantic paradoxes and proposed solutions.

As the book mirrors the present state of the discussion, it also shares its shortcomings to some extent. In particular, the question of the nature of truth is treated more or less separately from the problem of the semantic paradoxes. But when they consider such drastic measures as various alternatives to classical logic or contextualist solutions, which involve a rejection of one single truth predicate, and when they finally advance their preferred view, the 'defeatist' or inconsistency view of truth (plus possibly a fictionalist stance on truth), then it will be plain to the reader that the 'philosophical' discussion about truth cannot be cordoned off from the effects of the paradoxes. The authors are aware of this and admit 'that the topics are inseparable' (p. xii) in the end. Their separation may be inevitable in an introductory textbook, because the links between the theory of the paradoxes on the one hand and the traditional discussion on the 'nature' of truth on the other hand still have to be fathomed. But at least the relevance of the formal research on the paradoxes for the philosophical analysis of truth is made evident to the reader.

It may be added that in the book the formal work of truth, except for Tarski's, makes it appearance mainly on the form of the theory of the paradoxes, while such topics as groundedness, the complexity of truth, and the logical analysis of the reduction of truth to other notions are not seriously addressed in the book. For their treatment the reader can resort to the papers of the second author and probably an assessment of the impact of these formal investigations on the philosophical discussion belongs to the agenda of future work on truth and again not into a textbook.

Given the merits and the concise and lucid writing style, I recommend the book not only as a textbook in a course on truth for undergraduates and graduate students alike but also as a background reading in a general course on philosophy of language. Overall the book makes for a highly stimulating reading not only for the novice in the area but also for the advanced reader and expert for whom the text contains numerous quips and insightful observations and hints for directions in future research.

Years ago reviews occasionally concluded with a comment on how a book was produced. I hope they are still permissible: Generally the book is nicely produced, but the mix of an almost type-writer style slab-serif typeface for headings and a traditional old-style typeface for body text (used also for other books in the series) doesn't match the elegance of the content.

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ALLEN L. MANN, GABRIEL SANDU AND MERLIJN SEVENSTER. ***Independence-friendly logic: A game-theoretic approach.*** LMS Lecture Notes, vol. 386. Cambridge University Press, Cambridge, England, 2011, vi + 208 pp.

Independence-friendly logic (IFL), introduced by Hintikka and Sandu, extends first-order logic (FOL) with explicit notations for expressing the independence of quantifiers—so subsuming the branching quantifiers of Henkin. Thus one obtains a logic with existential second-order expressivity, and with many intriguing and sometimes disturbing properties. Over the last two decades, there has been a small but enthusiastic group of researchers (mostly in Helsinki and Amsterdam) developing the theory of IFL, with a wider fringe of occasional contributors and users.

This book serves two purposes. Firstly, it proselytizes for the game-theoretic understanding of logic developed by Hintikka, which was originally the only way in which IFL was to be understood. As such, it starts with a self-contained game-theoretic introduction to FOL, before going on to imperfect information games and the development of IFL. Secondly, it serves as a survey of the current state of IFL, and a collection of the available facts and theorems about it. This is especially useful for IFL, as the afore-mentioned 'disturbing' properties misled a number of early researchers.

Following an introductory overview, the book moves in Chapter 2 into a brief but comprehensive summary of the notions required from game theory, namely finite extensive and strategic games. Chapter 3 then develops FOL in detail via game-theoretic semantics. It is assumed that the reader already knows FOL, so this section cannot quite serve as an introductory course, but few, if any, assumptions are made beyond the level of a first logic course. The game-theoretic approach is well motivated and explained. The approach is semantic and model-theoretic, and traditional proof theory is ignored (it has never played much of a role in IFL, as IFL is too powerful to have an effective proof theory). However, the usual laws of logic are stated and proved in terms of semantic equivalence, and again the game-theoretic approach is well motivated. The traditional Tarskian semantics is then discussed, not least for later use—the existence of compositional semantics for IFL was an early controversy.

Chapter 4 gets into the real topic of the book. IFL is introduced in its original slashed syntax, e.g., $\forall x\, \exists y/\{x\}.x = y$ means for all x, there is a y independent of x such that $x = y$. This traditional example also demonstrates one of the oddities of IFL, as although it's clearly not true on a domain of more than one element, it's also not fully false, as we see when the game-theoretic semantics is introduced. The semantics is familiar to anybody who has looked at IFL: the verification game now has imperfect information, and a formula is true if Player I (traditionally called Eloise in IFL, following Hodges) has a winning strategy, false if Player II (Abelard) has a winning strategy, and undetermined otherwise. Following this, the semantics via Skolemization (as with Henkin quantifiers) is given, and then the compositional 'trump semantics' due to Hodges, which is the best that can be done towards a Tarskian truth definition for IFL.

Chapter 5 is entitled 'Properties of IF logic'. IFL does not obey many of the laws of FOL that we use without thinking—for example, vacuous quantifiers are not harmless in IFL—and so this chapter both warns of the many traps for the unwary, and gives a concise but comprehensive list of valid properties, such as useful logical equivalences. It also discusses a couple of extensions, independent junctions (slashed $\vee$ and $\wedge$), and negation. I find the discussion of negation a little lacking—only the easy game-theoretic duality negation is discussed, whereas for somebody trying to use IFL in applications, or to extend it, classical negation, and indeed the whole question of when and how to collapse the IFL truth domain to booleans, is interesting. At least a reference to Hodges' discussion would be useful for the newcomer. The chapter closes with a brief discussion of model-theoretic theorems.

Chapter 6 is a short chapter describing the well known results on the expressive power of IFL, namely its equivalence (via unskolemization) to existential second-order logic.

Chapter 7 concentrates on a project of the second and third authors, which is the application of probabilistic and stochastic game-theoretic definitions to IFL. In short, the idea is that undetermined games can be given a more refined semantics by considering the probability of Eloise winning, assuming the non-deterministic choices become probabilistic. I have not been entirely convinced—it's not clear that the numbers in the examples are actually very meaningful—but the project has some interest, and would make for a good discussion in a course.

Finally, in chapter 8 there is a little more on compositionality—and a proof of the lack of a 'simple' compositional semantics—, and a survey of Tulenheimo's version of an independence-friendly modal logic.

To sum up, this book satisfies admirably its placement in a Lecture Note Series. It provides a concise but full, self-contained introduction to the main work on IFL. As one already familiar with all the material, I cannot really judge how it would look to a newcomer; but for me it is very well written, with excellent intuitive exposition combined with detailed proofs. It would make an excellent text for an advanced undergraduate or graduate course. Unfortunately, the book's placement with a commercial publisher has made it rather expensive to use as a compulsory class text for a non-core course, and definitely too expensive to recommend to a casually interested student; with a non-commercial publisher it could have been priced low enough for both markets.

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IVAN WELTY. *Frege on indirect proof*. ***History and Philosophy of Logic***, vol. 32 (2011), pp. 283–290.

Frege's treatment of indirect proofs has sometimes to be judged as problematic, since this treatment seems to presuppose a notion of logical consequence Frege did not have. Ivan Welty defends Frege's approach of indirect proof as being as useful as our current interpretation of indirect proof by exemplary demonstrating that nowhere Frege's approach does suppose a hypothetical deduction using counterfactual assumptions. Apart from a short "Introduction" (p. 283) and a short "Conclusion" (p. 290) the paper consists of three parts. In the paper's major part, "2. The supposed problem" (pp. 283–287), Welty, while starting out from a critical analysis by Jamie Tappenden, who evaluated Frege's account as resting on "treacherous ground" (p. 283), but already presents his solution. Welty starts with a reformulation of Tarski-style indirect proof and shows that Tarski's criterion of logical consequence can be formalized in second-order logic and therefore has a second-order counterpart. His strategy of analysis used a 'would be' Fregean reading of Tarski, since this is "the easiest way to make it clear how Frege understood indirect proof" (p. 284). With respect to Tarski's account, the implication rational-($\sqrt{2}$), $A_1, \ldots, A_n \models \perp$ ($A_1, \ldots, A_n$

are the relevant axioms) is valid (meaning: $\perp$ is a logical consequence of rational-($\sqrt{2}$), $A_1, \ldots,$ and A_n), since there is no interpretation on which all formulas left from implication-sign prove to be true, whereas the formula on the right side ("falsum") proves to be wrong. By means of Frege's logic this can be formalized as a universally quantified material conditional (cf. p. 285), and by pure logic it can be proven as a logical truth (cf. pp. 285f.). From there this follows the instantiation rational-($\sqrt{2}$) $\wedge A_1 \wedge \cdots \wedge A_n \rightarrow \perp$, which is equivalent to $\neg$rational-($\sqrt{2}$) $\vee \neg A_1 \vee \cdots \vee \neg A_n$. And since $A_1, \ldots, A_n$ are known to be true (they are axioms) there results that $\neg$rational-($\sqrt{2}$) has to be true: "Note that nowhere have we supposed that rational-($\sqrt{2}$) is true" (p. 286). Whereas according to the common standard procedure hypothetical deductive reasoning starting out from a counterfactual assumption in order to give indirect proof/proof by contradiction ('*Assume* A to be true, then we can prove an inconsistency. Therefore A is false.'), Welty shows "that Frege *could* accept hypothetical deduction as a syntactic expedient whose justification lay elsewhere—in short, as an eliminable technical device" (p. 287).

Whereas section two showed how to derive Frege's account from our predominant understanding today, section "3. Logic and Inference" (pp. 287–289) deals with the question of where the obvious differences between the accounts rest. Welty argues in support of the thesis that the "real difference there is can be boiled down to a difference in conception of logic" (p. 290), and obviously this differs from several philosophical implications (cf. p. 289). The last section "4. Counterfactual assumptions" (pp. 289–290) underlines the already established interpretation by showing through some other observations that Frege's account "is actually closer to common sense than even the preceding might make it seem" (p. 289).

Welty's 'would-be-Fregean-reading-of-Tarski' is a pleasant defense of Frege's account. There is only one thing I want to question: Welty's use of the phrase "indirect proof" throughout the whole paper. I do not really understand this dominant use, since especially his foremost example "only" represents a proof by contradiction and Frege would accept Welty's interpretation—presupposed Frege would accept the interpretation already for the case of indirect proof—also for the wider class of proof by contradiction. As far as I can see, nowhere Welty's arguments make essential use of the law of double negation, which would be necessary to speak significantly of indirect proof. At least it is the crucial adoption of the law of double negation which motivates us to differentiate between indirect proof and proof by contradiction, without necessity of the law of double negation. With respect to this conceptual difference, Welty defends already Frege's account of proof by contradiction.

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