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Nicholas J.J. Smith. *Logic: The Laws of Truth*. Princeton University Press 2012.

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Nicholas J.J. Smith. *Logic: The Laws of Truth*. Princeton University Press 2012. 544 pp. $55.00 USD (Hardcover ISBN 9780691151632).

Logic: The Laws of Truth is a thorough introduction to first-order classical logic with identity and is an excellent textbook for an undergraduate course on this topic. The real strength of this work is the skillful balance struck throughout between a focus on the mechanics and methodology of first-order logic and a focus on establishing a deep understanding of the purpose of this methodology; or, as Smith puts it in the opening sentence of the book, 'the how and the why of logic'. In striking this balance, the book not only provides an introduction to logic suitable for students interested in computer science or the foundations of mathematics (and similarly-minded philosophers), but also provides an introduction to the philosophy of logic or, at the very least, a guide to where in the philosophical terrain a study of logic might and can lead, particularly the basic connections between logic and natural language (Ch. 6), and theories of truth (Ch. 11).

The book introduces first-order logic using the truth tree methodology and is set out in three parts. The first part treats basic propositional logic, culminating in an introduction to the tree method; the second part treats predicate logic; and the third part addresses foundational issues, like the soundness and completeness of the tree method, and other methods of proof, like natural deduction. The book is on the lengthy side compared to other similar introductory texts on logic, but its modularity alleviates any worry one might have about fitting it into a 12 week undergraduate course; the obvious candidate – though not necessarily the only candidate – for material to eschew would be Part III. This is indicative of the work having pedagogical utility beyond a basic introduction to logic. (However, this is not to suggest that it has diminished utility as such an introductory text; on the contrary, the clarity and pace of the work are significantly suited to the first-year classroom as well as to the incipient autodidact.)

The development in Parts I and II of propositional logic (PL) and both monadic and general predicate logic (MPL and GPL, respectively), as well as general predicate logic with identity (GPLI), follows a systematic pattern: syntax, semantics, testing. Smith initially moves reasonably slowly through the development of PL, introducing the basic symbols before representing the truth-functionality of the connectives in the form of truth tables. As Smith emphasizes, truth tables play a dual role in PL: they provide a precise definition of the central logical notions, such as validity, and they provide a method for testing logical formulas for such properties. By teasing apart the dual role that truth tables play in semantics and testing in this manner, the way is paved to conclude Part I with the introduction of truth trees – a method of testing, but not an endower of semantics – and introducing models in Part II to define the central logical notions.

Part II traverses the syntax-semantics-testing pattern with greater urgency: MPL commands a chapter for each of the three elements (Ch. 8-10), while both GPL and GPLI are dealt with in a single chapter each (Ch. 12 and 13, respectively). By this stage, the pattern is well entrenched, with the focus shifting squarely to the greater generality of the enhanced languages. The systematicity of the treatment greatly facilitates ease of understanding and ensures that the interesting philosophical extensions do not get lost in the logical mechanics.

From the outset, Smith outlines his task in such a way as to provide a guiding principle with which to underpin and unify the work. This task is to provide a 'foolproof' and general method of determining whether some given argument is valid; that is, 'a method that establishes beyond doubt

whether the given argument is valid and that can be followed in a straightforward, routine way, without recourse to intuition or imagination' (19). Smith characterizes validity as necessary truth preservation by virtue of form and the 'foolproof' methodology he presents is the truth tree method.

By framing the goal of the work in this way, Smith portends an explicit underscoring of logical form (Ch. 5). While it is certainly possible to imagine a course on first-order logic foregoing an explicit treatment of the relationship between form and content (and dealing with only instances as exemplars of the relevant forms), by walking the reader through the mechanics of the reciprocal processes of (i) abstracting from content and (ii) obtaining instances, Smith promotes a deeper understanding of the nature of the logical language. That is, the reader is encouraged to think about the 'why' of logic, not just the 'how'.

There is a second notable, and indeed laudable, feature of the 'slow and steady' approach to the understanding of logic in the first half-dozen chapters. Chapter 6 explicitly concerns a common hurdle that students in the early stages of learning logic face: namely, the imprecise nature of the logical structure of natural language and its translation to the precise specification of the logical connectives of first-order logic. The concern goes something like this. First-order logic specifies that such-and-such natural language expression has so-and-so logical translation. However, by such-and-such natural language expression, I can mean a range of different things that do not necessarily accord with so-and-so logical translation. Thus, the argument would go, first-order logic is dysfunctional as a representative logical language.

Smith tackles this issue head on by recourse to a Gricean analysis of assertibility. While there may be many technically synonymous terms that could be interchanged in any particular proposition, not all of these will result in a statement that is assertible given a particular context of utterance. Following Grice, Smith outlines three categories of information conveyed by an utterance in context. The first category – *what is said* – defines the content relevant for logic; '[the logical formula] we write down as the translation of an English utterance is supposed to be a perspicuous representation of the proposition expressed by that utterance' (100). The second category is what is *implied*, which consists of information concerning the logical consequences of the proposition expressed. And the third category is what is *implicated*. The *implicatures* of an utterance 'are those things that follow from the assumption that the utterance is correct' (100) (according to the Gricean analysis of assertibility).

This Gricean analysis becomes a powerful tool for Smith. The ability to bracket particular translational issues as pragmatic concerns rather than logical concerns works twofold: it demonstrates to the reader that the relationship between logic and natural language is not black and white (and this helps to suggest to the interested student that there is further philosophy to be explored); and it ensures that confidence in the adequacy of first-order logic is not undermined by doubt concerning the superficially imprecise nature of translation. Thus, for the case of some purported errant translation of some natural language expression, Smith is able to employ the services of Grice's notion of implicature to point out that the translation of what is said comes apart from what is implicated, and it is the former that we wish to capture in the logical language, and the latter that contributes to the seeming error in translation.

These more pragmatic considerations naturally lead Smith in the final section of Chapter 6 to consider the notion of functional completeness for a logical language. The idea here is that there

is a certain arbitrariness associated with the particular set of connectives we decide to utilize as the basis for logic. When we choose a basis set of logical connectives that is functionally complete, then we have – by definition – a set that has sufficient resources to construct all possible truth functions. Considering that we have limited ability to tweak such sets of connectives according to the subtleties of natural language (as there is only a finite number of possible functionally complete sets of, say, one- and two-place connectives), we should not expect to find a set with an exact correspondence to the structure of our language. This is a skillful and convincing move for alleviating any worries the student of logic may have concerning the nature of translation.

As a final point, the importance of logic exercises cannot be overstated. This book contains a plethora of exercises on each of the topics covered that would more than placate even the most ravenous appetite for logic problems. Furthermore, and especially important as universities move perpetually towards web-based learning tools, solutions to these problems can be accessed online (the website is provided in the book). While it may be argued that there could be more worked examples incorporated into the text – the relative economy of which may slightly increase the effort required from the self-learner – there are certainly sufficient resources (or perhaps with the additional accompaniment of a competent teacher) to facilitate the reader to become master of the mechanics of first-order logic, with a deeper understanding of the associated philosophical terrain.

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