Returning finally to the substance of the book, after the introduction the real numbers are defined. They are defined, essentially, as numbers that are given by our standard, base ten, decimal representation. No explanation for this choice is given. As a mathematician, I find binary, or signed binary (whereby -1 is also allowed as a digit—much more sensible constructively), or arbitrary Cauchy sequences of rationals, natural, and base ten not. A reason for this unnatural choice should have been given. As for the rest of the chapter, it is quite in order that the mathematics is not advanced, given the intended audience. The downside is that the reader is presented with page after page of tedious verification of statements that look like trivialities, and little else. The theorems are the basic properties of $>$ and $\geq$ (transitivity, irreflexivity in the former case, and such like), absolute value, the triangle inequality (in three versions no less), equality and apartness, convergence, and so on. Perhaps the most frustrating part of this is that the differences with the classical theory, just the thing that might intrigue a reader, are nowhere brought out.

I could go into comparable detail about the remaining two chapters, but the upshot will be the same. With the essence of the constructivism hidden, the text reads like unnecessarily difficult proofs of things you would find in any standard, classical text, often just left to the reader there, except for those notions, inherently constructive, that, in this context, just make no sense at all.

If one wanted an introduction to constructive analysis, there are any of a number of other texts that stand up well against the current one. Some of the best known are Michael Beeson's ***Foundations of Constructive Mathematics*** (Springer, Berlin-Heidelberg-New York, 1985), Errett Bishop's ***Foundations of Constructive Analysis*** (McGraw-Hill, New York, 1967), Errett Bishop's and Douglas Bridges's ***Constructive Analysis*** (Springer, BerlinHeidelbergNew York, 1985), Douglas Bridges's and Fred Richman's ***Varieties of Constructive Mathemataics*** (Cambridge University Press, Cambridge, 1987), and Anne Troelstra's and Dirk van Dalen's ***Constructivism in Mathematics***, vol. 1 (North Holland, Amsterdam-New York-Oxford-Tokyo, 1988). Perhaps the most apt comparison can be made with Douglas Bridges's and Luminiţa Vîţa's ***Techniques of Constructive Analysis*** (Springer, Berlin-Heidelberg-New York, 2006), being dedicated solely to the same subject and having appeared just about a year after the text under review. Authored by arguably the current leading constructive analyst and a student of his, it does in 47 pages what ***The Continuum*** does in 128, plus a lot more: exercises, a section on constructive logic, a fuller history, more notions defined and principles identified. To say nothing of the remaining 153 pages. Admittedly parts of this book would be rough going for the audience in question of introductory students. But I'd rather have my students struggle with advanced, inherently difficult material than with tedium.

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Nathan Salmon. ***Metaphysics, mathematics, and meaning.*** Collected papers, vol. 1. Oxford University Press, Oxford, 2005, xiv + 419 pp.

Volume 1 of Nathan Salmon's collected papers contains nineteen papers written from 1984 to 2005, two of which are previously unpublished. The chief topics are the metaphysics of modality and semantics. Many of the papers are required reading for those with either interest.

The previously unpublished *Modal logic Kalish-and-Montague style* presents natural deduction systems for $S5$, $S4$, B, and T. Chapter 6 reprints Salmon's substantially negative review of David Lewis's ***The plurality of worlds***. *The limits of human mathematics* discusses the philosophical significance of Gödel's Incompleteness Theorems.

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Tense and intension presents a four-layered semantic theory (akin to David Kaplan's three-layered account) with the fourth layer designed to accommodate the double temporal relativity that occurs in contexts such as in 'Sometimes the present President is a Republican' and thus allow propositions to be taken as eternal. *Pronouns as variables* defends Peter Geach's claim that anaphoric pronouns (excepting pronouns of laziness) are bound variables.

The three papers *Existence*, *Nonexistence*, and *Mythical objects* are closely related. The first argues against Quine's slogan "to be is to be the value of a variable." Salmon argues *contra* Kant, that existence is a property and that we need to allow variables to range over non-actual and even impossible objects in order for the semantics of natural language to work out. *Nonexistence* takes up the problem of nonreferring proper names. Denials that the referent of such names exist are argued to be ambiguous, with a reading on which they are true, and one on which they lack truth value. An account of discourse about fictional entities is developed and 'accidental fiction' is introduced to cover cases of inadvertent failure of reference. In both of the first two papers an account of propositions is developed on which sentences that contain names referring to impossible objects express possible propositions that do not themselves exist, yet some of them are true. *Mythical objects* exploits the notion of accidental fiction to address Peter Geach's problem of how to make sense of Hob and Nob having thoughts about the same witch, given that there are no witches.

Impossible worlds, *The logic of what might have been*, and *This side of paradox* all discuss an argument of Salmon's (derived from earlier work of Hugh Chandler and Roderick Chisholm) for the conclusion that the S4 axiom $\Box\phi \rightarrow \Box\Box\phi$ has false instances. The argument proceeds as follows: let t be a table, made from some particular hunk of matter h_1. On non-essentialist views regarding material composition there will be other hunks of matter sufficiently similar to h_1 such that t could have been constructed out of them. But not any hunk will do. So, let h_3 be a hunk that overlaps with h_1 but is just slightly too different from h_1 for it to be possible that t was constructed from h_3. It is thus necessarily true that t was not made from h_3. Now, let h_2 be a hunk of matter intermediate between h_1 and h_3. It is, by hypothesis, possible that t had been constructed from h_2. But had it, it would have been possible that the table had been formed from h_3. So, while it is necessary that the table was not formed from h_3, it is not necessarily necessary that it was not.

Salmon draws a number of morals from this argument. First, in *Impossible worlds*, he concludes there are possible worlds that are impossible relative to the actual world. Second, in *This side of paradox* (itself devoted to a discussion of a related argument of Timothy Williamson's) Salmon rejects the principle (W) that the differences between two artifacts constructed in two possible worlds from sufficiently similar hunks of matter (such as h_1 and h_2) are small enough that they stand in the relationship of trans-world identity. He prefers principle (A′) to the effect that given an artifact fashioned from one hunk of matter, there could not have been a distinct artifact fashioned from a sufficiently overlapping hunk. The reason Salmon denies (W) is clear—if we accept it and the transitivity of identity, we would have to say that the possible table formed from h_3 is trans-world identical to the actual table t formed from h_1 as t could have been formed from h_2, and any table formed from h_2 could, it its turn, have been formed from h_3. On the other hand, if we deny that the possible table formed from h_2 stands in a relation of trans-world identity to t, it is no longer clear that the existence of a table manufactured from h_2 in some possible world shows that t could have been formed from h_2. Furthermore, it is unclear to me how the denial that the possible table fashioned from h_2 is distinct from t differs from the claim that t and that possible table are trans-world identical. Third, *The logic of what might have been* deploys the anti-$S4$ argument coupled with a conception of possible worlds as maximal scenarios to argue that some worlds are absolutely impossible worlds (rather than merely impossible relative to the actual world). An example such world is one in which Nathan Salmon is a Visa credit card. Worlds reflecting violations of logical consistency are another class of such impossible worlds.

The paper defends these views by insisting on a distinction between a way for things *to be* and a way things *might have been*. Thus, the impossible world with a Visa card that is also a well-know philosopher is counted as merely a way for things to be. While the distinction seems fruitful—it is necessarily true that there is no largest prime, but it seems coherent to say that there is a way that things would have been were there, even though that way is not possible—it is open to question whether 'Salmon is a Visa card' is sufficiently coherent so as to count as a specification of a way for things to be at all.

The short *The fact that* $x = y$ provides a proof that if x and y are possible individuals in two different possible worlds, then if $x = y$ there is no qualitative fact about x and y that makes this so. The argument is simple: there is no qualitative fact about x in virtue of which $x = x$. Thus, if $x = y$, then by the indiscernability of identicals, there is no such fact about y in virtue of which $x = y$, either. *Identity facts* deploys a similar argument for the conclusion that there are no objects that are indeterminately identical. The core idea (Salmon discusses several variants) is easily stated. Let $\langle x, y\rangle$ be a pair of objects that are indeterminately identical. It is determinate that the members of the pair $\langle x, x\rangle$ are identical. But then the pairs $\langle x, x\rangle$ and $\langle x, y\rangle$ are distinct. Thus, $x \neq y$ and there is a determinate identity fact after all. This proof is a *reductio* and that allows the indeterminate identity theorist to complain that the appeal to bivalence is illicit. Much of the paper consists of Salmon's discussion of such a response by Terence Parsons.

The previously unpublished *Personal identity: What's the problem?* starts from a case of brain transplantation from a Woody Allen joke. Salmon exploits this and related cases to make a number of distinctions in modal metaphysics such as ones between different grades of Haecceitism. Ultimately, he argues for a brain essentialism solution to the problem of personal identity.

Whole, parts, and numbers considers the problem of how many oranges there are on a table which had three oranges until one was cut in half and eaten. Considerations are adduced against all of the answers 2, 2.5, and 3. Salmon himself tentatively endorses 2.5, seeing it as a property of the plurality of oranges and thus suggests that we might adopt plural quantification to accommodate this. A further consequence that Salmon claims to find is that numerical quantifiers such as '2' are then nonextensional. This is supposed to be so since 'There are exactly 2 whole oranges' is true, yet 'There are exactly 2 oranges' is false, as there are exactly 2.5. This, however, only counts against the extensionality of '2' if we take, as Salmon does, the phrases 'whole orange' and 'orange' to be extensionally equivalent. It seems more natural to me to take the difference in truth value between the two sentences not as a sign that the quantifier is nonextensional, but as a sign that 'orange' and 'whole orange' are not extensionally equivalent.

'On Designating' takes up the interpretive challenges posed by the 'Gray's *Elegy*' passage of Russell's *On denoting*. At nearly 50 pages it is a formidable paper. Much of it consists of a close reading of the passage, together with a 'translation' aimed at resolving the notorious ambiguity in Russell's use of quotation marks. Salmon rejects the interpretive positions that Russell in that passage was attacking Frege or his own earlier view in the ***The principles of mathematics***. Instead, he suggests that the specific target of the passage was the view that a definite description has a semantic content that determines what the description designates. He further maintains that the ultimate aim of the attack was to show that such descriptions are not singular terms. Thus, Salmon sees the argument of the passage as having a much broader scope than many other interpreters would accord to it.

A problem in the Frege–Church theory of sense and denotation argues that Church's solution to the Paradox of Analysis whereby an analysis is informative because the analysandum and analysans, while referring to the same things, differ in customary sense is in conflict with two other claims: (1) the Fregean claim that terms that occur in propositional attitude ascriptions refer to their usual sense, and (2) the claim from Church's Translation Argument that expressions like 'brother' and 'male sibling' may be translated into the same expression of another language that has only one phrase for the concept while preserving sense. Salmon proposses to resolve the conflict by abandoning Church's solution to the paradox, noting that doing so appears to undermine the original impetus behind Frege's distinction between *Sinn* and *Bedeutung*. *The very possibility of language* also discusses Church's Translation Argument, arguing that the moral of that argument shows that Dummett's account of language collapses into the absurd position that it is impossible for us to know a language.

The volume contain a helpful bibliography of Salmon's writings from 1979–2005. Unfortunately, there is no bibliography of the works cited; the details are included only in footnotes. There is a good deal of cross-referencing amongst the included papers; regrettably, these references refer to other papers that appear in the collection by their original pagination. Furthermore, cross-references to footnotes internal to an individual paper seem not always to have been updated when changes to the text affected the numbering of the notes. The text is well bound, attractively if densely type-set, and relatively free from typographical errors. Happily, those that exist are easily rectified.

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Ian Chiswell and Wilfrid Hodges. ***Mathematical logic.*** Oxford Texts in Logic, vol. 3. Oxford University Press, Oxford, England, 2007, 250 pp.

This is an introductory textbook to mathematical logic on the undergraduate level. As such, it is comparable to many other books, such as the well-known ones by Enderton and Mendelson. Not surprisingly, it is at the same time unique in several ways, and so might be the text of choice, depending on the instructor's and institution's preferences and abilities.

Regarding the content, the goal of Chiswell–Hodges is to prove the Completeness Theorem for first-order logic. This is done by proving it for ever larger fragments: first for propositional logic, then for the quantifier-free predicate calculus, and finally for the full first-order theory. This can be contrasted with Enderton in two ways. For one, after the chapter in Enderton culminating in completeness, there is another chapter almost as long which highlights the various incompleteness and undecidability theorems, the climax of that text. (In Chiswell–Hodges, those latter theorems are mentioned only in the four-page postlude.) Another contrast is that Enderton develops the propositional calculus without proving completeness, and then immediately moves to full quantifier logic. Similarly, Mendelson has a full chapter on incompleteness, followed by one on set theory and another on computability. Apparently the goal of that work is to be a well-rounded introduction to all of logic and foundations. Even though it's intended for a two-semester course, the author recommends that a one-semester version go through incompleteness. The lead-up to completeness is structured similarly to Enderton's, with the sentential calculus introduced first and completeness proved only for the full first-order language, only Mendelson introduces equality as a dedicated symbol only after the proof of completeness (whereas Enderton does it before). So the goals of the book at hand are more modest than those of these other two.

Personally, I find it unfortunate that incompleteness gets such short shrift in Chiswell–Hodges. Incompleteness is exactly what's most powerful and interesting behind introductory logic (when studied for its own sake: this does not apply if the goal is applications, such as in CS or linguistics). In fact, the completeness theorem becomes significant only in the context of the search for a decision procedure for provability or such like. While a thorough proof of any of the incompleteness theorems might well be unnecessary, or even inadvisable, depending on the audience involved, some discussion as well as some indication of the proof is necessary in order to show something of the excitement and depth that logic can offer.