book of choice for theoretical computer scientists. AI students and researchers, on the other hand, may prefer the book under review and will appreciate the thorough treatment of logics modeling knowledge, belief, action, and time, as well as the emphasis on relations with non-monotonic logics. Philosophers will probably find both books interesting for the technical results but infuriatingly short on philosophical argument. They may like to complement their reading of either book with W. Lenzen's paper mentioned above.

RINEKE VERBRUGGE

HENRY PRAKKEN. ***Logical tools for modelling legal argument. A study of defeasible reasoning in law.*** Law and philosophy library, vol. 32. Kluwer Academic Publishers, Dordrecht, Boston, and London, 1997, xiii + 314 pp.

Mathematical models of defeasible reasoning and mathematical models of argument tend to puzzle classical logicians. Is a calculus of argument a logic? Is there no place left for an indefeasible, material conditional? Are procedural semantics really unavoidable?

Logics of argument and defeasible reasoning do seem to push farther from the classical core than the usual non-standard logics. Their models invariably include non-monotonicity, resource limitation (non-ideality), weak negation, dialogical and metalogical relations, and semantic ascent. The mathematics is usually veiled in intellectual historical invective, perhaps matching the acerbic tone of argument's detractors.

In the present book, Henry Prakken takes care to avoid controversy and to explain why models of argument deviate so much from standard logics. He is content to survey the technical issues surrounding the contemporary logical work on argument in and around artificial intelligence. Prakken's title refers to "logical tools" as opposed to "logics," refers to "models" rather than "foundations," and restricts its scope to "reasoning in law" rather than the whole of "commonsense reasoning." In being so careful, Prakken has produced a resource for those who want a quick, current, and authoritative introduction to this body of work. While the discussion does in fact focus on the issues specifically raised in the modeling of legal argument, no special interest in law is needed or assumed. Meanwhile, Prakken would not be the first in the history of logic to find patterns of legal argument logically fertile.

Mathematical defeasible reasoning in AI is of course the culmination of work that had been known as "non-monotonic reasoning," beginning with inheritance hierarchies, closed-world databases, and the semantics of negation-as-failure and logic programming. Defeasibility is the main competitor of belief revision for those who want to systematize qualitative ampliative inference; it is the main competitor of deontic logic in the ethical and policy fields. It is a topic that makes paraconsistent logic, dialogue logic, and belief revision each look like one piece of a much larger puzzle.

The tradition of using a defeasible conditional (if p then q, defeasibly, non-demonstratively, *ceteris paribus*, or *prima facie*) is as old as any logical tradition. What is new in this decade is (i) the attempt to mathematize the subject, to understand its procedural suppositions, to understand why it cannot be reduced to non-procedural descriptive sentences; and (ii) the construction of reasoning patterns on top of defeasible conditionals: defeasible decision-making, defeasible statistical inference, defeasible analogy, defeasible deontic reasoning, and adversarial argument that employs defeasible conditionals. Defeasible reasoning has shown itself to be widely applicable, or more accurately, applications of logic in the "representation of knowledge" have frequently rewarded the use of defeasible conditionals.

To begin to appreciate the body of work that Prakken is studying, the mathematical logician must first stipulate two assumptions that distinguish defeasible reasoning.

First, the rule "if p then defeasibly q" might have procedural content: it need not simply constrain co-occurrence of p-states of affairs and q-states of affairs (not even in preferred possible worlds). It could instead say that an argument for p can be extended into an argument for q (much as the PROLOG rule would say that one way to derive q is to derive p). Prakken has it matter-of-factly: "knowledge representation formalisms have both procedural and declarative aspects, and the importance of logic lies in its ability to analyze the declarative aspects" (p. 10 f).

Secondly, classical logic is to be used for its descriptive regularities, not for its patterns of reasoning. Logics are better at defining useful representations than in restricting the scope of rational reasoning. Prakken repeatedly says, on this point, that logic is a tool for modeling often embedded within a greater framework (such as dialogue or belief revision): "using logic does not commit to the 'axiomatic' or even to the 'naive deductivist' view on reasoning. ... it leaves room for other reasoning activities, like induction, analogical reasoning and ways of arguing against a rule" (p. 277).

With these two assumptions, the student of defeasible reasoning is invariably constructivist and conventionalist: unlike intuitionists, the important division is between smaller and larger finite constructions, not between countably and uncountably infinite constructions. As a conventionalist, believing that the appraisal of the logic is rooted in the usefulness of its conventions, the student of defeasible reasoning is also resigned to a plethora of logical systems much as database managers admit a plethora of database languages.

Prakken begins by considering patterns of legal reasoning, where exceptions to rules, priority among conflicting rules, and "open texture" are fundamental phenomena that drive logical innovation. An exception to "if p then q" is "unless r." A priority might be from "*lex specialis*" (the more specific rule dominates), "if p then q; but if p and r, then not q." Open texture is the idea that "$P(x)$" might be a predication such as "x is a reasonable person" which is subject to defeasible patterns of reasoning and analogical argument.

Prakken then considers existing non-monotonic approaches and the unusual features that such non-monotonic logics have: their weak negation, failure of antecedent-strengthening, contraposition, and cumulativity; their fixed-point entailments and preferential semantics. Prakken surveys those approaches that permit a preference between rules or an ordering of arguments. This leads to a metatheory of non-deductive entailment, and one finds definitions such as the following (which can be found in any contemporary theory of argument) on page 162:

Definition 6.4.17 (specificity defeat) Let A_1 and A_2 be two arguments. A_1 *defeats* A_2 iff

1. A_1 attacks A_2; and
2. A_2 is defeasible; and
   (a) A_1 is strict; or
   (b) for some conflict pair (C_1, C_2) of (A_1, A_2) it holds that C_2 is not strictly more specific than C_1.

The main novel technical contribution of the author is the extension of existing argument systems to permit reasoning about the priorities among rules. In a PROLOG program, there is an implicit priority based on the ordering of rules. A more theoretically interesting implicit priority is based on relative logical strength of each rule's protasis (as in the above definition of "specificity"). Prakken's novelty permits a dialogical move such as (p. 209)

O_2 : $[d_6 : \Rightarrow r,\ d_7 : r \Rightarrow d_1 \prec d_2]$

wherein argument O_2 consists of rules d_6 and d_7 saying "by presumption, r; and given r, the rule d_2 defeats the rule d_1."

The final overarching contribution of this book is Prakken's "four-layered view" of argumentation (p. 271 ff): "Firstly, procedural models contain a *logic layer*. For example, ... a party may not contradict himself. ... In addition [they contain] a *dialectical layer*, at which such notions as 'counterargument', 'attack', 'rebuttal' and 'defeat' are defined. ... Finally, there is the *procedural layer*, which regulates how an actual dispute can be conducted. ... we can even identify a fourth level of what may perhaps be called *strategy*, at which ... tactics for playing the game are identified."

There is emerging consensus in the field that this multi-layered view of argumentation is right. It helps explain why logics of argument venture so far from the usual logical picture.

In the end, Prakken has written the best current text with which the interested logician can quickly study the main, surviving, applicable ideas of non-monotonic reasoning and can glimpse the themes that are shaping current research in defeasible reasoning. R. P. LOUI

LAMBÈR M. M. ROYAKKERS. ***Extending deontic logic for the formalisation of legal rules.*** Law and philosophy library, vol. 36. Kluwer Academic Publishers, Dordrecht, Boston, and London, 1998, ix + 191 pp.

The *Introduction* (Chapter 1) presents some relatively complicated puzzle situations about traffic regulations (mainly from the Dutch regulation) which have to be analyzed by deontic logic. Classical or standard systems are not sufficient for this purpose, so the method of the book consists in extending two well-known deontic logics, the standard deontic logic (SDL) and the dynamic deontic logic (DDL).

Chapter 2 presents SDL in a more or less orthodox manner, using Kripke semantics and the Beth tableau method. The presentation takes considerable space to describe first an informal deontic logic and then a formal one, but this can be considered as an advantage for readers with no special knowledge of deontic logic. Distinction between logical and normative consistency is recalled, as are some classical