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Book Reviews

David Makinson, **Bridges from Classical to Nonmonotonic Logic**, King's College Publications, London, 2005, pp. 216, ISBN 1-904987-00-1.

Nonmonotonic logic is a part of logic which covers a family of formal frameworks devised to capture and describe so called defeasible inferences. By defeasible inferences we usually mean a kind of inference of everyday life in which reasoners draw conclusions and reserve the right to change them in the light of further information. They are called nonmonotonic, because they do not satisfy the Horn condition of monotony. This failure reflects a mechanism which is present in natural reasonings: for some set of premisses A and a proposition x we may think that x is the best conclusion on the base of A we could draw, but if our set of premisses is extended to B, a proper superset of A, we may find unreasonable to hold x still as a good conclusion, since for example B contains a negation of x. This property is in contrast to classical logic, whose inferences, being valid, can never be "undone" by new information.

There are lots of frameworks for nonmonotonic reasonings. At the first glance they seem to be unordered and there is no consensus which are more basic and in some sense better to be applied. The book of David Makinson in an exhaustive way provides a general view on this multitude. But its main feature is an order which every reader obtains. On the one hand we see how nonmonotonic inferences arise from classical logic, on the other they are bounded by logical systems called by the author bridges. They are bridges from classical consequence to nonmonotonic consequences.

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All logical systems presented in the book are defined on propositional, boolean language. It is worth to say that the book is written in a Polish tradition of logic. The basic tools used by the author are consequence operations (respectively, relations). It enables to compare inference strength of the considered systems. They are divided into three groups, which moving ideas are to use additional background assumptions, exclude certain classical valuations or to add extra rules of inference alongside the premisses. Thanks to those mechanisms these systems are stronger than classical logic. Hence, each correct from classical perspective inference is also correct on the ground of the systems. How is it possible that the systems are stronger than classical logic, but simultaneously they differ from the trivial consequence, i.e. the consequence which associates with every premisses set any individual formula? The answer is simple. They are not logics in a usual sense. These systems include classical logic, but are not closed under substitution rule in their properly supraclassical parts. Consequently, on the ground of a certain system and some premisses we can infer more than using only classical logic, but still less than on the base of trivial consequence.

The mile stone between classical logic and nonmonotonic systems are consequence operations called by David Makinson bridges. Like classical consequence, they are closure operations, so perfectly monotonic. As we said, they are generated by one of three ways[1]. The author called them *pivotal systems*.

The first idea is to add a constant set of *additional background assumptions* K. For any nonempty set of formulas K we obtain a new supraclassical consequence Cn_K, one of the *pivotal-assumption consequences*. Another class of consequences is defined by *restricting the set of valuations*. Given some subset W of the set of all boolean valuations V we define a new paraclassical consequence in the following way: $Cn_W(A) = \{x \in \mathsf{For} : \neg\exists_{v \in W} v(A) = 1, \text{ whilst } v(x) = 0\}$, for any $A \subseteq \mathsf{For}$, where For is obviously the set of all Boolean formulas. For every $W \subseteq V$ we obtain a consequence stronger than classical, a *pivotal-valuation consequence*. The last way to generate paraclassical consequence is similar to the way based on additional background assumptions. This time instead of assumptions we allow to use *additional rules* of inference R. The operation consequences Cn_R we obtain, for some sets of rules R, are called *pivotal-rules consequences*. The initial small difference between assumptions and rules makes a big difference in results.

[1] See chapters 2-4.

How to pass from bridges to corresponding nonmonotonic systems? In the first case, ie. pivotal-assumptions operations, the nonmonotonicity is created, if a set K is allowed to vary with premisses. This is done by a consistency condition, and diminishing this part of K, which collides with the premisses. In other cases the similar strategy is applied, but with some nuances, like, for example, imposing order on the set of valuations or restricting applications of rules. The systems generated in these ways are called default operations (respectively, *default assumption consequences*, *default valuations consequences* and *default rules consequences*).

In the all cases nonmonotonic operations are weaker then corresponding pivotal systems, but still stronger then classical logic. For example, let $K \subseteq \mathsf{For}$, then we have the inclusion sequence $Cn \leq C_K \leq Cn_K$, where classical sequence Cn can be treated as a lower bound, while pivotal consequence Cn_K as an upper bound on C_K. This pattern occurs in the context of all ways of generating nonmonotonic consequences shown in the book.

During presentation particular ways of passing to nonmonotonic operations, we meet various variants, particularizations or generalizations of some methods. The differences and possible variants are results of many strategies of passing from pivotal to nonmonotonic systems.

Among others, a reader can find in the book three more issues. One of them concerns representation theorems. Each of discussed operations have some syntactical properties, which are extensively presented and proved. But the question is which are sufficient to define certain operations? We meet representation theorems for pivotal and default systems with proofs, and comments on a history where there are theorems only for finite parts, so operations limited to finite sets of premisses.

One of the chapter is completely devoted to connections between nonmonotonic and probabilistic inferences[2]. We see there how to bring them together closer along with accompanying differences and similarities.

In the last chapter we can read about relations that connect nonmonotonic inferences with other kinds of logic. Individual sections describe links with logic of belief change and logics of updating, counterfactuals and conditional directives. Although at the surface they have different motivations, at the deeper level they are characterized by very similar semantic structures. Again, thanks to clear narration and comments a reader gains a very good view on the issue. After these comparisons the author summarizes all considerations on representation theorems.

[2]See chapter 5.

Each chapter of the book ends with some amount of exercises, for some of them in one of the appendixes we find answers. With many examples, comments and fluent narrations it makes the book self-explanatory as well as very instructive for anybody who wants to enter into the realm of nonmonotonic inferences.

At the end, we cite words of the author: "From the outside, nonmonotonic logic is often seen as a rather mysterious affair. [...] Our main purpose is to take some of the mystery out of the subject and show that it is not as unfamiliar as may at first sight seem" (p. ix). The book absolutely accomplishes this aim.

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