"Nonmonotonic" does not mean "probabilistic"

Stenning, K.; van Lambalgen, M.

DOI
10.1017/S0140525X0900048X

Publication date
2009

Document Version
Final published version

Published in
Behavioral and Brain Sciences

Citation for published version (APA):
“Nonmonotonic” does not mean “probabilistic”

doi:10.1017/S014050525X0900048X

Keith Stenninga and Michiel van Lambalgenb

Abstract: Oaksford & Chater (O&C) advocate Bayesian probability as a way to deal formally with the pervasive nonmonotonicity of common sense reasoning. We show that some forms of nonmonotonicity cannot be treated by Bayesian methods.

Figure 1.

where the last equality follows under the plausible assumption that $p$ and $r$ are independent. O&C assume that the subject assigns a lower probability to $P(q|p)$ in the enlarged representation $P(q|p & r)/P(r)$, suggesting that this is because the subject lowers $P(r)$ from 1 to a value smaller than 1 when becoming aware of possible exceptions. In probability theory, $P(q|p & r)$ $P(r)$ would simply be a different representation of $P(q|p)$, and the values of these expressions must be the same. There are no rationality principles governing changes in probabilities when enlarging the probability space, or rather there is one such
principle, that $P(q|p)$ remains the same when computed on an enlarged space. This is the only way in which one can guarantee that enlargements of the probability space in the limit lead to a coherent probability distribution – the starting point of Bayesian rationality.

(2) An orthodox Bayesian alternative would be a construction in which the probability spaces remain the same (namely, the universal space based on all possible propositions), but the probability distributions change. In our toy world, the probability space is in both cases $\{p, q, r\}$, but one could assume that the probability distribution first assigns probability 0 to not-$r$, and, upon becoming aware of the second conditional “if $r$ then $q$,” a nonzero probability. The trouble with such a suggestion is that from a Bayesian point of view, the transition from the a priori probability $P(\text{not}-r)=0$ to the a posteriori $P(\text{not}-r) > 0$ is not allowed, because this cannot be achieved via (BaCo): conditiona-lizing on more evidence cannot make a null probability positive. One thus needs an additional rationality principle (beyond [BaCo]) governing such transitions. In the absence of such a principle, one has to assume that the probabilities of all non-salient exceptions (such as $\text{not}-r$) are initially very small but nonzero. This increases the computational complexity of probabilistic reasoning enormously: One requires massive storage and intricate computations to maintain consistency of the probability assignment.

These considerations show that in order to account for the data on the suppression task any probabilistic model needs to be supplemented with a theory about nonmonotonic and non-Bayesian, but still somehow rational, changes in degrees of belief. One may then question whether a probabilistic model is necessary at all: Stenning and van Lambalgen (2005; 2008a) provide a model cast entirely in terms of nonmonotonic logic.