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The co-occurrence test for non-monotonic inference

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ABSTRACT

According to the co-occurrence test, q is (non-monotonically) inferrible from p if and only if q holds in all the reasonably plausible belief change outcomes in which p holds. A formal model is introduced that contains representations of both the co-occurrence test (for non-monotonic inference) and the Ramsey test (for conditionals). In this model, (non-nested) conditionals and non-monotonic inference satisfy the same logical principles. However, in spite of this similarity the two notions do not coincide. They should be carefully distinguished from each other.

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1. Introduction

It is often assumed that the logic of non-monotonic inference coincides with that of "the flat (i.e. nonnested) fragment of a conditional logic" [17, p. 171]. Under the equally common assumption that conditionals are related to belief revision via the Ramsey test this means that the Ramsey test will be applicable to non-monotonic inference as well. This was also suggested by Makinson and Gärdenfors [19], according to whom "q follows non-monotonically from p" means that q holds if an "arbitrary but fixed background theory" (p. 189) is revised by p. Denoting that theory by K, belief revision by $*$, and non-monotonic consequence by $|\sim$ we obtain:

The Ramsey test for non-monotonic inference
$p \mid\sim q$ holds if and only if $q \in K * p$.

This proposal has been further investigated by Gärdenfors and Makinson [7], Wobcke [24], del Val [4], Rott [23, pp. 111–119], and many others. However conditionality and inferribility are distinct albeit related concepts. Even if both of them are connected with belief revision they need not be connected in the same way. It is the purpose of the present contribution to investigate what happens if we replace

Ramsey's criterion
If the agent revises her beliefs by p, then she will believe that q.

by the following alternative criterion:

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The co-occurrence criterion
If the agent comes to believe that p, then she will believe that q.

The two criteria differ since an agent can come to believe in p not only as the result of revising her beliefs by p but also as the result of revising them by some other input. According to the co-occurrence criterion q has to be an element not only of $K * p$ but also of other belief sets containing p. The criterion concerns whether we will *in general* (given our present epistemic commitments) believe in q if we come to believe in p, not only whether we will do so in one singular case. This seems to make it better aligned with the notion of inferribility (in contradistinction to conditionality) than what Ramsey's criterion is.

The co-occurrence test needs to be specified with respect to which of the belief sets containing p we should include in the analysis. A simple answer would be to include all potential belief change outcomes that contain p, i.e. all belief sets $K * r$ such that $p \in K * r$. However, such an approach would be inadequate since it does not reflect the essential feature of non-monotonic reasoning that comparatively remote possibilities are left out of consideration. When you conclude from "Tweety is a bird" that "Tweety can fly" that is precisely because you do not take remote possibilities into account. The degree of remoteness referred to here is relative to the antecedent. Some of the possibilities that are too remote to be taken into account when considering "Tweety is a bird" would be quite close at hand when considering "Tweety is a bird who was born in Antarctica".

To sum this up, when evaluating non-monotonic inferences with p as the antecedent we have to consider not only $K * p$ but also other, reasonably plausible, p-containing belief sets. This amounts to the following test of inferribility:

The co-occurrence test for non-monotonic inference
$p \mid\sim q$ holds if and only if q holds in all the p-satisfying belief change outcomes that are reasonably plausible as compared to other p-satisfying belief change outcomes.

It should be noted that this criterion does not exclude the existence of some belief change outcome in which $p\&\neg q$ holds. There can be some sentence r, less plausible than p, such that $p\&\neg q$ holds in some or all of the r-satisfying belief change outcomes. (For an example, let p denote that Bitsy is a female mammal, q that Bitsy gives birth to live young, and r that Bitsy is a platypus.)

One immediate difference between the Ramsey test and the co-occurrence test concerns the following property of conditionals: (The symbol $\rightarrowtail$ will be used to denote "standard" Ramsey test conditionals.)

Property CS
If p and q both hold then so does $p \rightarrowtail q$.

It is usually assumed that if $p \in K$, then $K * p = K$. From this it follows directly that a relation $\rightarrowtail$ that is based on $*$ via the Ramsey test will satisfy CS. However, an operation $\mid\sim$ based on the co-occurrence test will not in general do so. Even if $K * p = K$ and $q \in K$ there may be other reasonably plausible p-containing belief sets that do not contain q, and then $p \mid\sim q$ will not hold.

This difference between the two tests seems to correspond fairly well to a difference between conditionality and inferribility. To see that, let p denote that it rains in London today and q that Real Madrid wins the match they are playing tonight in Berlin. If I become convinced that both p and q are true, then I may arguably conclude that "if p then q".[1] However, it would be absurd to also conclude that "from p it can be inferred that q".[2] More generally speaking, inferribility seems to imply conditionality, but not the other way around.

In Section 2 a framework for belief revision will be presented that is useful for our present purposes since it contains a straightforward representation of the differences in plausibility between belief sets. In Section 3, representations of conditionality ($\rightarrowtail$) according to the Ramsey test and non-monotonic inference ($\mid\sim$) according to the co-occurrence test will be introduced into that framework. In Section 4 a theorem is presented, showing that they have (nearly) the same logic. Finally, in Section 5 the interpretation of that theorem is discussed and it is argued that the two concepts should nevertheless be distinguished from each other.

2. The formal framework

The analysis will be based on descriptor revision, a model of belief change that was introduced in [11]. Like most other formal models of belief change it employs a selection mechanism, but that mechanism does not operate on possible worlds

[1] CS holds in many systems of conditional logic, see for instance [18, pp. 26–31], [22, p. 249], and [21]. However, it has also been criticized, for instance by Bennett [2, pp. 386–388], and Nozick [20, p. 176].

[2] One way to explain the difference is that when determining whether or not q can be inferred from p we consider whether we would believe in q after some revision that made us believe in p, whereas when determining whether "if p then q" holds we only consider whether revision by p would have that effect.

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