Commonsense Entailment: A Modal Theory of Nonmonotonic Reasoning

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Abstract

In this paper, we use the Stalnaker-Lewis semantics for conditional logic to construct a truth conditional semantics for generic sentences. The resulting notion of logical entailment captures intuitively valid argument forms involving generics. A dynamic semantics is built on top of the truth conditional one, and the resulting inference notion captures nonmonotonic argument patterns familiar from the artificial intelligence literature. The theory developed here extends that of Asher and Morreau (1991). That theory enables specific information to prevail over more general information by using techniques familiar from prioritized circumscription; this theory uses a constraint on modal frames to achieve the same effect.

1. Introduction

*Potatoes contain vitamin C, amino acid, protein and thiamin* expresses a true generalization about potatoes. *John smokes a cigar after dinner*, understood in its generic sense as expressing a regularity in John’s behaviour after dinner, can be true, and it can be false. This realist conviction inspires the theory of generic propositions which it is the purpose of this paper to explain. Given that these things can at all be true, their truth should depend on the nutritional value of particular potatoes and John’s behaviour on particular occasions after dinner, but this is the puzzling thing about generic propositions: they are only very loosely connected with particular facts. Potatoes contain vitamin C even though large numbers of them are boiled for so long that it is lost. Potatoes would contain vitamin C even if all of them were to be boiled for so long that it is lost. If John happens to run out of cigars sometimes, or even if he regularly runs out, it does not thereby become untrue that he smokes a cigar after dinner.

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This tolerance of exceptions has for a decade or more frustrated efforts in artificial intelligence, linguistics, and philosophy to provide generic sentences with a rigorous semantics. We offer such a semantics here, and to this extent our undertaking is an ambitious one. From a linguistic point of view it is much less ambitious; in concentrating on a few kinds of sentences, we do little justice to the great variety of genericity in language which has been documented in the linguistics literature. Nor do we have anything to say about how genericity is actually expressed in natural language, or about translation procedures which associate formal representations with natural language expressions. We assume generic sentences somehow to have been recognized and represented as such in a formal language to be made precise below, and concentrate on providing this formal language with a semantics.

Along which dimensions are different candidate semantic theories for generics to be compared? Three answers to this question that we now discuss will motivate our theory. A first requirement is that any theory of genericity should explain the ways in which we reason with generic sentences. Logical entailment, the relation which holds between the premises and conclusion of an argument whenever truth is invariably passed from the former to the latter, is one form of reasoning. Some forms of argument involving generic sentences seem clearly to be cases of logical entailment. There is, for example, what we call the DUDLEY DOORITE:

\[
\text{Quakers are politically motivated} \\
\text{Republicans are politically motivated} \\
\text{Quakers and Republicans are politically motivated}
\]

Another convincing pattern is

WEAKENING OF THE CONSEQUENT:¹

\[
\text{Lions have manes} \\
\text{Lions have manes or wings}
\]

We do not claim that whenever it makes sense to assert the premise of this argument it also makes sense to assert the conclusion-- only that whenever the former is true the latter is true too. Among the intuitively valid generic sentences, those which are entailed by everything, we count Lions are lions, and the nested generic sentence People who don't like to eat out don't like to eat out. The reason we take this last sentence to be nested is that it says that people possessing a characteristic property -- namely the property of typically not liking to eat out-- typically have this property.

There are a few other valid sentences and argument patterns involving generics besides these, but the logic of generic sentences seems to support few valid argument forms. Moreover, the few we have found relate the truth of generics only to that of other generics, at least when we consider only a fragment formalizable in the language with

¹The rationale for this name will become clear subsequently.