Belief Revision in a Deductively Open Belief Space

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I am researching the traditional belief revision integrity constraints and postulates, which are designed for deductively closed belief spaces, and revising them so that they are applicable to implemented knowledge representation and reasoning systems with deductively open belief spaces (DOBS).

A knowledge representation and reasoning system must be able to deal with contradictions and revise beliefs. This is especially important to data fusion, where information is combined from multiple sources, which might contradict each other. Most theoretical postulates for belief revision and belief contraction assume a deductively closed belief space (DCBS), where all beliefs derivable *from* a belief space are *in* that belief space. This is hard (or impossible) to produce in an implemented belief revision system, which has real-world limitations on computation time and database size. This makes it difficult to evaluate such a system using the theoretical postulates; yet evaluating system adherence to these postulates is a pressing issue for those doing belief revision research in computer science.

Unlike a DCBS, a DOBS uses a base set of assertions (hypotheses), but only deduces beliefs from that base gradually over time – i.e. some implicit beliefs may not yet be explicit (or part of the belief space). Thus, it can grow even if the base remains static, and it can never be referred to as consistent – only either inconsistent or "not known to be inconsistent." My research begins with a formalism that describes a DOBS and its integrity constraints (ICs) and postulates, which will guide belief revision techniques for implemented systems. This formalism can then be used to better enable system/postulate comparisons.

I plan to offer a DOBS version of the AGM postulates (Alchourron, Gärdenfors, and Makinson 1985), Hansson's base contraction postulates (Hansson 1993), and postulates proposed for ranked beliefs, and to provide brief comments regarding postulate adherence for paraconsistent logics and incomplete systems. Using these postulates, I hope to develop a theory for comparing systems, so that implementers will be able to (a) evaluate how well their systems meet the standards of the postulates and (b) compare their systems to other systems.

Of the four ICs listed by (Gärdenfors & Rott 1995), there remains an open discussion on how to properly weight and combine constraints IC3 (minimizing damage to the belief space) and IC4 (removing the least important or entrenched beliefs over those more entrenched) during contraction or revision. For example: How do you choose between retracting many weak beliefs vs. one strong belief?

As I develop my theories, I will continue revising my enhancement of our implemented belief revision system, SNeBR (Martins and Shapiro 1988), to adhere to the DOBS postulates and to improve its method of weighting and combining IC3 and IC4. Also, although many systems require quantitative measures of entrenchment (or belief strength), our system will use qualitative, partial orderings – thus allowing the inclusion of information whose credibility is only known relative to that of another belief. This ordering information is stored as beliefs and can also be reasoned about and revised.

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