Approaches to Reasoning About Actions: A Position Statement

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1. Explicit time vs. the situation calculus. The following situation calculus formula seems to have no counterpart in languages with explicit time:

value(f,result(a1,s)) = value(f,result(a2,s)). (1)

It says that the value of *f* at the next instant of time does not depend on which of the actions *a1, a2* is going to be executed. For instance, if I now send an e-mail message to Erik Sandewall, the total number of messages sent by me since this morning will be the same as if I send a message to Ray Reiter instead. This is an argument in favor of the situation calculus.

But there is a little problem here. What is the meaning of (1) if the effects of *a1* and *a2* on *f* are nondeterministic? I have a few coins in my pockets; let *a1* stand for getting a coin from my left pocket, let *a2* stand for getting a coin from my right pocket, and let *f* stand for the value of the coin that I have in my hand. We can interpret (1) as a counterfactual, but this seems less interesting than assertions involving some kind of quantification over the outcomes of *a1* and *a2*, for instance:

(i) there exist an outcome of *a1* and an outcome of *a2* such that (1) holds,

(ii) for any outcome of *a1* and any outcome of *a2*, (1) holds,

(iii) for any outcome of *a1* there exists an outcome of *a2* such that (1) holds.

The situation calculus has no mechanism for expressing these distinctions.

2. Filtering. I understand it as applying a nonmonotonic logic to a subset of the given facts and then using the remaining facts–"constraints"–to discard some of the models of this nonmonotonic theory. This is a powerful idea, and "nested abnormality theories" are merely a syntactic device that can be used to describe filtering. In reasoning about action, treating initial conditions as constraints makes the formalization problem easier. The reduction of domain circumscription to predicate circumscription in John McCarthy's 1980 paper is an early example of filtering.

3. Occlusion. I undertand it as restricting inertia so that it would not apply to some fluents at some instants of time. This is a special case of the more general idea of restricting a default so that it would not apply to some objects. According to an axiom from John McCarthy's 1986 paper on applications of circumscription, unless an object is abnormal in aspect 1, it can't fly; then birds are declared to be "possible exceptions" to this default by postulating that they are abnormal in aspect 1. This is similar to occlusion.

4. Why are there so many action languages? An action language is a formal model of the part of natural language that is used for describing the effects of actions. Whenever we improve our understanding of that part of natural language, this improved understanding may be expressed by defining a new dialect of "script-A." I expect that we will see many such dialects in the future.

And I hope that this will bring us simplicity and elegance, rather than the multiplication of independent language constructs. In the first action language that was capable of representing ramifications, there were "causes" propositions for representing dynamic causal laws, and "always" propositions for representing static causal laws. But recent research on the logic of causality shows that causal laws of both kinds have similar properies; we can expect that in future action languages "causes" and "always" will be subsumed by a more general construct.

5. Explicit information about causal directions. Causality differs from material implication in that it is not contrapositive. The crucial role of this difference for the study of action and change is among the most important things that we have learned in this area over the last years. Several recent theories of causality grasp this distinction, but they do not seem to be mathematically reducible to each other. This is very much like what happened around 1980, when several mathematically non-equivalent nonmonotonic formalisms were proposed. Attempts to relate these formalisms to each other have led to interesting research in logic.