Current Research on Reasoning about Actions and Change: Topics for a Debate

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Several approaches to reasoning about actions and change co-exist at present in the literature. The major divide seems to be between the situation calculus on one hand, and approaches using explicit time on the other hand. It may not be easy for the readers of this literature to see how the different approaches relate, and what are their respective weaknesses and strengths. Sometimes, it is even difficult for the researchers in the area to make this analysis. For example, in this recent KR paper, Ray Reiter writes:

There have been a few earlier papers on formalizing natural actions and continuous time. Shanahan's approach [30] is embedded in the **event calculus** *(Kowalski and Sergot [11]); Sandewall [27] relies on a temporal logic. Accordingly, these proposals are difficult to compare with ours, based as it is on the situation calculus.*

After a suggestion by Ray, ECSTER invites researches in this area to an on-line colloquium exchange of views on **different approaches to reasoning about actions and change**. The basic idea is to have a mailgroup which is combined with a lasting on-line presentation of the accumulated contributions, and with a permanent publication of the entire debate.

The purpose of the debate is *to clarify what are the major alternative approaches to reasoning about actions and change* in contemporary research, and also *to identify and compare the capabilities and the limitations of those approaches.*

Some distinctions will be made already at this point in order to further define the topic. We propose a distinction on ontological grounds between *situation calculus approaches* and *narrative timeline approaches*, which are defined as follows: In narrative timeline approaches, one uses a multisorted logic where "time" is one of the sorts, and actions are *attached to* the timeline using a construct such as *Do(s,t,a)*, saying that the action a is performed during the interval starting at s and ending at t. In situation calculus approaches, on the other hand, one uses an equally multisorted logic where "situations", as one of the sorts, form a tree-structured domain where each situation *contains* a sequence or other structure of actions. Thus, to express that the property p holds when the action a is concluded, a situation-calculus approach would write something of the form *Holds(p, Result(a,s))*, and a narrative timeline approach would write something along the lines of *Do(s,t) and Holds(p,t)*. In both cases, there are of course many variants to the theme. One topic for the present debate is what are the advantages and disadvantages of these two approaches.

Within each of those approaches, and possibly independently of the distinction, there are various *entailment methods* which define how to obtain the intended conclusions for a given scenario description. Some of these entailment methods are defined in terms of preference relations or other selection mechanisms on models, others are defined in terms of syntactic transformations on the initially given set of axioms. Chronological minimization of change is an example of a semantically defined method; explanation closure is an exampleof a method defined through syntactic transformations. One topic for the present debate is what are the presently available entailment methods (including both those that are defined semantically and those defined syntactically) and what is known about their properties.

A number of techniques which have been proposed in recent years have been adopted by several researchers. These techniques include the use of *occlusion*, *filtering*, *nested circumscription*, the *release predicate*, and *composition of actions*, but the list can probably be extended. One topic for the present debate is what are these generally used techniques, and to identify cases where a previously known technique reappears in new guise or disguise.

The concepts of *intended models*, and of an *underlying semantics* defining the set of intended models, have developed as a way of characterizing what one expects from a logic of actions and change. This raises a number of topics for the present debate: what are appropriate ways of defining intended models; in what sense are intended models truly "intended"; are there alternative definitions of intended models and how do they relate to each other.

One noticable phenomenon in recent years has been the appearance of *action description languages*, in particular the different variants of the script-A language. Some questions of debate are: in what ways are action description languages different from logics (or are they?); why are there so many action description languages; and how do action description languages relate to underlying semantics.

When *ramification* is addressed, there is an issue between those methods using minimization of change and those methods that make use of explicit information about causal directions. What is true about the capabilities and limitations of these alternatives?

This is already a number of non-trivial questions, but that should not preclude anyone from also addressing other questions of a similar character with respect to reasoning about actions and change.