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Today

This mailing contains the answer by Marc Denecker, Daniele Theseider Dupré, and Kristof Van Belleghem to the Michael Thielscher's question for their ETAI submitted article. This item was missing when yesterday's newsletter was sent out.

ETAI Publications

Discussion about received articles

An Inductive Definition Approach to Ramifications

by Marc Denecker, Daniele Theseider Dupré, and Kristof Van Belleghem

Comment from: authors

To:**Michael Thielscher**

Michael,

Here is an answer to your comments.

First of all, we agree with you that it is unnatural to have just the absence of an effect as a cause for anything. in fact as you can see in the paper, our high-level effect rules (which syntactically look a lot like Lin's) contain only the presence of an effect (on a complex formula) as possible trigger for further changes. But at a low level, we need to introduce negative cause literals to define initiation of complex formulas.

For example, when is the formula $sw1 \wedge sw2$ initiated? Is it initated when $sw1$ is true in the initial state and is made false and $sw2$ is made true simultaneously? No: it is initiated when both are made true, or when one of them is made true and the other is already true and is not made false. To represent this, a negative causal literal is needed. Observe however that any syntactically correct high-level rule corresponds to a set of low-level rules in which each rule contains at least one positive cause literal. There is always one actual effect at the basis of any propagation, but the propagation can be prevented by other effects - hence the negative cause literals.

One could argue that one should define that $sw1 \wedge sw2$ is initiated by comparing two successive states (and so there would be no need for resorting to low-level rules), which is what you do in your approach. However, our approach is constructive in that the next state is computed using the previous one and the computed causal literals. This definition of the next state is of course only mathematically sound if we can compute the caused literals without knowing the next state already.

In Lin's approach (the IJCAI95 paper), absence of causation is not present because the formalisation is entirely based on the values of fluents, not on their changes. One might say that all (present or absent) causations are implicit because it is the resulting state that is considered rather than the transition, as apparent in the rule

$$up(L1, s) \wedge up(L2, s) \rightarrow Caused(open, true, s)$$

Wrt our approach, things are somewhat mixed since no concurrent actions are considered in that paper, but it's true that the approach would also work for the concurrent flipping of the two switches. The fluent-triggered causal statements are similar to our complex initiation formulae. One difference is of course that Lin's rules necessarily imply the corresponding state constraint. Related to this is the fact that a number of "useless" (even if correct) instances of "Caused" can be derived for any situation where $L1 \wedge L2$ is true but not initiated. "Useless" here just means that it does not give rise to any changes, but just maintains a reason for *open* being true. For cases where the causal rules have a corresponding state constraint, it is probably a matter of taste if our formalisation or Lin's one is preferable. In our version

$$\textsf{initiating } L1open \wedge L2open \textsf{ causes } open$$

it is the change of $L1open \wedge L2open$ that causes a change in *open*. In Lin's view, it is the state of $L1open \wedge L2open$ that causes the state of *open*.

This different view allows our approach to be more general: in cases where causal rules do not correspond to state constraints, such as example 1 in our paper (with the electronic counter), the relation is inherently dependent on the value change: it's the change of "out" from true to false that makes "count" change. This is not a case where absence of initiation is needed, since the dependency is on the single fluent "out" but how would this be modeled in Lin's causal rules?

We had another example (in our NAIC'97 paper and in Kristof's PhD thesis): an alarm system that detects if somehow people enter a building. While the system is active, anyone entering the building triggers the alarm: if *in* (someone in the building) becomes true when *active* is already true, *ring* becomes true. Under one interpretation of that example, the alarm does not ring if it is deactivated at the same time where someone enters. Then we would have the rule:

$$caus(ring) \leftarrow init(in) comma holds(active) comma \neg init(\neg active)$$

Could the same be achieved in Lin's causal rules? A rule

$$in(s) \wedge active(s) \rightarrow Caused(ring, true, s)$$

is not correct precisely because the state constraint

$$in \wedge active \rightarrow ring$$

is not true: we suppose in fact that the bell does not ring if the system is activated where someone is already in.

Regarding your interpretation of

$$caus(p) \leftarrow \neg caus(q)$$
$$caus(q) \leftarrow \neg caus(p)$$

as a representation of $caus(p)$ xor $caus(q)$.

As indicated above, we agree that having only "not caus" literal as the body of a causal rule is counterintuitive, precisely because such rules are not constructive. However negative cycles can also occur if there are positive caus literals present (just add $caus(r)$ to both rules).

We wanted the constructive principle of inductive definition to model the propagation of effects. It is hard to interpret the above two rules as a well-defined inductive definition. As you say, it could be interpreted as a cause for p or for q, but it seems (as you also say) to be a very peculiar way of modeling this. We prefer to model that there is either a cause for p or for q explicitly by using a nondeterministic effect rule (something like $toss$ causes $headsxortails$). This may be a matter of taste, but we do not want unintended nondeterministic effects, therefore, we force the expert to make nondeterministic effects explicit.

It is true that in stable semantics the above clauses do represent the exclusive disjunction p xor q. But we do not regard stable semantics as the right sort of semantics for modeling definitions. For more discussion on this, see the paper by Marc which appeared at NM-98. In Kristof's PhD thesis a version of our approach is presented in a narrative-based (i.e. Event-Calculus-like) temporal structure, also including actions with alternative effects like tossing a coin. Only a more restricted form of nondeterminism is in the ETAI paper, but the idea in the semantics is the same.

As regards your "Steady vs stabilizing state constraints". There, you say that mixing the two types of ramifications is responsible for the unintended conclusion in the example. From our point of view, the problem in the specific example would be that the causal rules are not correct: in our formalisation we would say that $up(lhs)$ causes $stain$ if $notup(rhs)$ is *and remains* true, i.e. $\neg caus(up(rhs))$. Again, absence of causation solves the problem, but it again appears in combination with a positive causation, due to an interaction of causes. So on the basis of this example we can not give a definite answer.

Nevertheless, the issue of delays is intriguing, and your distinction between zero and non-zero delays is an interesting contribution, even if there could be a more general view on it. First, it could be possible that even what you consider zero delays (steady constraints and ramifications) are an abstraction wrt reality. Maybe in quantum physics it is not true that an object (a sub-atomic particle, in particular) cannot be in two locations at the same time? (is any expert of quantum physics reading ETAI?)

More importantly, you argue that the important distinction in qualitative reasoning is between zero and non-zero delays, but still small enough to be considered virtually instantaneous by common sense, so to be distinguished by actually "delayed" effects. That makes sense, even if one could also view a continuum between zero delays (or delays that are too small for classical physics), non-zero but "commonsense" instantaneous delays, and delayed effects. Knowledge about different delays could be still qualitative or imprecise, but still allow to conclude that a delay is smaller than another and then it is not correct to apply the (non-zero-delay) causal rules in any order.

Marc, Daniele and Kristof

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