ELECTRONIC NEWSLETTER ON
REASONING ABOUT ACTIONS AND CHANGE

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Today

Today, we advertise the acceptance of an additional contribution: the article by Antonis Kakas and Rob Miller has been accepted to the ETAI following our tough discussion and refereeing procedure. As the readers recognize, we have had an extensive open discussion about the paper, which has now been followed by confidential refereeing by three referees. All three referees recommended unconditional acceptance of the article. Two of them also made additional suggestions for further improvement of the article. These suggestions have been added to the open discussion about the article, only the identity of the reviewers being kept confidential. We congratulate the authors to having passed this test!

Also today, Jixin Ma and Sergio Brandano pursue the discussion about standard vs. non-standard ontologies of time.

ETAI Publications

Discussion about received articles

Reasoning about Actions, Narratives and Ramification

by Antonis Kakas and Rob Miller

Comment from: **Anonymous Reviewer 2**

The paper by Baral, Gelfond and Provetti published recently in JLP describes an $\mathcal{A}$-like language, $\mathcal{L}$, which, like $\mathcal{E}$, attempts to combine ontologies of situation and event calculus. It is done in a manner substantially different from that in $\mathcal{E}$ and so a reference to this paper may be appropriate.

Comment from: **Anonymous Reviewer 3**

Your paper makes the following contributions:

1. Extending the declarative temporal language $\mathcal{E}$ to deal with ramifications
2. Furnishing a translation between $\mathcal{E}$ and logic programs

Both these contributions are welcome. The ramification problem is an important problem in temporal reasoning which is still not well understood. Studying the problem in the context of a unified temporal language has the potential to shed light on the connection between the ramification problem and other problems in temporal reasoning, though see below for further comments. The translation between $\mathcal{E}$ and logic programs is very welcome as well, as it grounds theoretical and formal results on theories of action to implementable programs.

Although the paper is in general well written and well organized, and I consider it acceptable for publication as it is, I also suggest that it could be improved in the following ways.

1. First, and most saliently, the paper does not explain *why* your approach solves the ramification problem. (Indeed, you don't explain why the approach solves the frame problem either, though that presumably was the job of the 1997 JLP paper.) It would be helpful to give some intuition of why this central problem in temporal reasoning arises, what other approaches have been suggested, how these approaches succeed and fail, what this approach provides, intuitively, in the way of a solution to the ramification problem, and how this approach compares to other approaches.

You do the last (comparing your approach to other approaches) briefly, in the beginning of section 5, but this treatment is too cursory and raises almost more questions than it answers. For example, in comparing your approach to those of Thielscher, McCain and Turner, and Lin, you aruge that their approach is essentially a causal-based approach, because the effect of action occurrences cannot be propagated backward through r(amification)-propositions. To this reviewer, this fact hardly seems to be the characteristic fact of causal theories. A deeper analysis of what makes a causal theory, whether sets of axioms in E can be considered causal theories, and how causal approaches can be used to solve the ramification problem, would be helpful here.

Also very desirable would be a discussion of how solutions to the ramification problem interact with solutions to the frame problem. In particular, there is often a duality between the two problems, in that the frame problem is often seen as a mainly representational problem, whose solutions may worsen things from the computational point of view, and the ramification problem is often seen as mainly a computational problem, whose solutions may worsen things from the representational point of view. How do your two solutions interact? A discussion would be useful.

2. The examples in the paper would be more helpful if they were expanded more. Examples:

- On p. 6, you state:

  > *In a domain description with no h-propositions or t-propositions at all, it would be possible to construct a model where ... WindowClosed and VentClosed were true at all time-points, but Stuffy was false.*

  It would be useful to see that model explicitly.

- On p. 8, you state:

  > *In particular, if we replace (sr9) with "CloseVent happens at 3" our semantics does not give rise to the type of anomalous model is problematic for some other approaches .... in which a change at 3 from not Stuff to Stuff is avoided by incorporating an unjustified change from WindowClosed to not WindowClosed.*

  Here is where it would be really good to discuss other approaches, how they run into problems, and how your approach avoids these problems.

- In the same vein, it's not clear why Thielscher's approach has trouble with the last variation of the switch example that you discuss in section 3. A more detailed discussion would help.

3. The unique contributions of this paper over the JLP paper are not so explicitly stated, namely, the introduction for the "whenever" construct into $\mathcal{E}$, and the resulting modifications in the definitions of the language, the translation into logic programs, etc. It would be helpful to be more explicit about them.

4. The writing is in general clear, understandable, and straightforward, but there are several places which were unclear, or in which an additional English gloss would be helpful. Specifically:

- p. 4: It it not clear what the partial order is supposed to range over. In the 10th line from the bottom on this page, is the relation on points (1rst, 2nd, and 4th items in that line) or on sequences (3rd item in the line)?
- p. 7, clause 2 of Def. 14, and p. 12, clause 2 of Proposition 2: In both cases, an English gloss would be helpful. (That is, an intuitive explanation of when a ramification statement is true. This is, after all, the heart of the paper, and extra effort and space to make this well understood would be well worth it.)

5. The online ETAI discussions highlighted a number of interesting points, including the issue of using a special purpose language $\mathcal{E}$ instead of standard first-order logic, whether truth conditions can really be given for all the predicates in $\mathcal{E}$, as well as more basic philosophical (ontological) questions on how you divide changes into causations and ramifications. It would be nice to see the paper deal with these to some extent. You can't, of course, give a whole dissertation defending the use of action-type languages, but integrating short versions of your statements on these positions into the paper would be useful.

Tony and Rob

Debates

Ontologies for time

From: Jixin Ma

To Sergio,

> First of all, what do you mean "the classical one"? (the classical continuous time structure)? Does it refer to the classical physical model of time, where the structure is a set of points which is isomorphic to the real line?

I can just quote myself ...

> Here in Pisa, we write "continuity" and we read "axiom of completeness", which is what everyone commonly means when speaking about (the founding notion of) continuity...

> *Concerning the core theory that you and Jixin are willing to obtain, I already developed a Basic Time Structure which may be of interest. It is as simple as I managed to design it, without un-useful complications. The structure works well in my case. you are welcome to read and comment my contribution, which may be found in my ETAI's reference.*

So, you didn't refer "the classical one" to "the Basic Time Structure" you developed, did you? If No, why **did** you develop it? What is **your** convincing argument(s) on the need of such a structure? Is it also an alternative to the classical one? (Sorry, I am here using the similar question raised by youself to ask you, though I don't have to, see below). If Yes, I shouldn't ask this question.

> > At the ontological level, the notion of continuous time vs. discrete time is closely related to questions "Is the set of time elements dense or not?", and " Are there really time atoms?".

> *The word "continuity", even at the ontological level, can not be read as "continuous with some exception".*

What I actually said is very clear as you quoted above. Does it imply that "the word continuity can be read as continuous with some exception"? In fact, even when Pat talked about "continuous with some exception", he didn't really mean that it is as same as the word "continuity". What he means, as I understand, is just that, with the exception of time moments, each time interval can be decomposed into (at least two) sub-intervals.

> *The axiom of completeness states:*
>
> *Let be A and B non empty subsets of S such that $a \leq b$ for all $a \in A$ and $b \in B$. Then exists $\xi \in S$ such that $a \leq \xi \leq b$ for all $a \in A$ and $b \in B$.*
>
> *Now, the set S, that is your domain, may consists as well either of time-points or time-intervals; S holds real numbers on the former case, intervals from the real line on the latter case.*

Firstly, you said here, "the former case" and "the latter case". Can these two cases be mixed together? In other words, can the domain contain both time-points and time-intervals. I suppose it should. Otherwise, you will meet some problem in satisfying the so-called completeness axiom (see below).

Secondly, you take time-points as real numbers, and intervals "from" the real line. Are your intervals sets of real numbers limited by their end-points (real numbers)? If no, what are they? If yes, have you considered the dividing instant problem? This problem would be more obvious with your time structure when you try to impose the axiom of completeness (see below).

Thirdly, if the domain S consists of time-intervals, you need to re-define (or revise, or, at least, explain) the relation $\leq$ between elements of the domain S. After you have done this properly (You didn't show how to do it, you just claimed that the domain "may" contain either time-points or time-intervals), you have to show, for the case that interval a in A is immediately before interval b in B (that is, there is no other time elements between a and

b) what is the required ξ such that $a \leq \xi \leq b$. Obviously, ξ cannot be an interval (non-pointlike), otherwise, it will overlap with a and b. Therefore, if you can define what it is, it has to be a point (This is why I said earlier in the above that if your domain contains intervals, it needs to contain points as well). Now, you meet the dividing instant problem, as I expected.

By the way, may I take this as one of the "un-useful" complications with your time structure?

> As for general treatments, the Basic Time Structure **does not** have to impose the axiom of density or discreteness (Similar arquements apply to issues such as linear/non-linear, bounded/un-bounded). Therefore, the time structure as a whole may be continuous or discrete, or neither continuous nor discrete.

I agree with your premise: the Basic Time Structure does not have to impose the choice, in fact it leaves you free in that sense. As soon as you make the choice, then you obtain either a continuous structure or a discrete structure, just depending on this choice. I do not agree, instead, with your conclusion. If I leave you the freedom to choose, it does not mean the Structure is neither continuous nor discrete; it simply means you still have to make the choice.

If you don't impose the continuous axiom (!!! as argued by Pat, it does *not* have to be the so-called axiom of completeness !!!) or discrete axiom, the structure **can** be neither continuous nor discrete. I think it is very easy to form a structure which satifies the basic axiomatisation, but does not satisfy the continuous requirement, and does not satisfy the discrete requirement. In fact, you can write down any extra constraint as long as it is consistent with the basic theory.

> Now, "why an alternative notion of continuous structure is needed at all"? It has been noted that temporal knowledge in the domain of artifical intelligence, including "temporal reasoning about actions and change", is usually imcomplete, and using time intervals in many cases is more convenient and more in-keeping with common sense of temporal concepts than to use the classical abstraction of points. In fact, the notion of time intervals (or periods) has been introduced for a long time in the literature. In addition, in order to overcome/bypass the annoying question of if intervals are open or closed, various approaches have been proposed. An example is Allen's interval-based time theory. As for these time theories, the old (classical?) notion of continuity no longer simply applies.

My question referred to what is needed *rather than* convenient. *I understand it may be convenient, in some cases, to use intervals, but this is not pertinent with my criticism, which still holds.*

So, you think intervals are *not needed*? Anyway, our arguements about the convenience of using intervals are based on the belief of the need of them.

Let me ask you a more stringent question.

Premise: It is evident that if you assume the axiom of completeness, the domain S can just be continuous, while if you do not assume the axiom of completeness then S is necessarily discrete.

Wrong! Even if you do not asssume the axiom of completeness, it is still not necessarily discrete.

> *Question: Suppose that you define your neither continuous nor discrete Temporal Structure. What is your domain S? What is your replacement for the axiom of completeness? Does this structure (provably) solve for at least one problem what can not be (provably) solved via the axiom of completeness? Can you give an example?*

The domain is just a collection of time elements each of which is either an interval (in a particular case, a moment) or a point.

The basic core theory doesn't commit itself to whether the time structure is continuous or discrete. So, if you would like one which is neither continuous nor discrete, you don't need the axiom of completeness. Why do I need a replacement for it, anyway, if it is not supposed?

Extra axioms regarding dense/discrete, linear/non-linear, bounded/non-bounded time structure, etc. can be given (e.g., see Ma and Knight's 1994 paper [j-cj-37-114]). Specially, the characterisation of continuity does not have to be in the form of axiom of completeness. In addition, as shown above, in the case where time intervals are addressed, it becomes very complicated (if not impossible) to simply apply such an axiom.

As for example you would like to see, the DIP is a typical one, as I have shown in the above.

Also, in your reply to Pat you wrote:

> *What properly formalizes the notion of continuity is the axiom of completeness. Alternative notions are equivalent, until we speak about continuous domains. The point was whether one can have a continuous domain (that is the S I stated above) ... with exceptions.*
>
> *If another axiom exists, which* does as well*, then it is surely equivalent to the axiom of completeness, just because* it does as well*. Alternative notions are clearly equivalent, until we speak about continuous domains. The point here, instead, was whether one can have a continuous domain with exceptions, that is the claim I originally criticized.*

First, as shown in the above, the axiom of completeness doesn't simply apply to the case when time intervals are involved. Therefore, your claim that "alternative notions of continuity are clearly equivalent" is unjustified, at least it is not **clear**!

Second, the question of "whether one can have a continuous domain with exceptions" depends on how you understand the real meaning. It is important to note that neither Pat nor myself claims that one can have such a structure as you understood and hence described by "a continuous domain with exceptions". Of course, if you have already assumed that the domain as a whole is continuous, then it must be continuous - no exception! This is just like if you impose that "The traffic light was green throughout last week", then, of course, it was green any time during last week, no exception. Similarly, if you impose that "The traffic light was red throughout last week", then it was red any time during last week. Again, no exception. However, if you don't have either of them, why can't one have the case that over the last week, the traffic light was sometimes red, and sometimes green, and even sometimes yellow?

As I said earlier, when Pat talked about "continuous with exceptions", he actually meant that "except at those time moments, the time is continuous", or more specially, "except for time moments, each time interval is decomposable". I don't think he would actually assume, in the first place, the continuity of the *whole domain*, then expect there are some exceptions. Do I understand your meaning rightly, Pat?

Jixin

References:

[j-cj-37-114] Jixin Ma and Brian Knight. *A General Temporal Theory.* Computer Journal, vol. 37 (1994), pp. 114-123.

From: Sergio Brandano

Pat Hayes wrote (ENRAC 21.4.1998):

> *Why cannot time be continuous in some places but discontinuous at others? There is no mathematical objection to such a structure, and it has been argued that a continuum punctuated by a sparse collection of points of discontinuity might be a plausible mathematical picture of time which seems to 'flow smoothly' except when things happen suddenly. (Similar arguments can be made for describing spatial boundaries, by the way; and elementary physics makes similar assumptions, where velocity is supposed to change smoothly except when 'impact' occurs.)*

If a given temporal structure includes the solution to the problem of representing "perceived smooth" flux and "perceived fast" flux of time, then that temporal structure is necessarily agent-centric, since different agents may have a different perception of the world. In being agent-centric, this structure can not aim at generality. In fact, if we design an agent-centric temporal structure and the world is inhabited by more than one agent, then we must design a more general structure that reconciles the different views from the different agents. I say "must" because, otherwise, we pre-destine agents to never interact with each other, which would be a major restriction.

Sergio

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