Endurantism and Perdurantism: An Ongoing Debate

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Introduction

The following is a dialog about how to model entities and change with respect to time. These issues have practical application in temporal reasoning, natural language understanding and robot world modeling. This discussion assumes a context of the need to formalize these models in logic, either first order logic (FOL), or possibly FOL with some extensions.

The two broad positions explored in this debate are a model in which entities that are situated in space and time are modeled as persisting over time and undergoing change without losing their identity. This position has been termed *endurantism* or "3-D" modeling. The opposing position advocates a model in which entities do not change. Unchanging entities are situated in space and time and are related to their different manifestations at different points in time. These temporal slices of an entity, when taken together, form a history of the existence of an object. This position has been termed *perdurantism* or "4-D" modeling. This summary does not do full justice to either position but should serve to orient the reader to the issues explored below. Further helpful background may be found in (Loux, 1998).

Editorial notes below are contained in [].

The Debate

Fritz Lehmann: My view that the "temporally qualified 3-D versus 4-D spacetime" distinction has nothing whatever to do with the "continuant versus occurrent" distinction. To me, the former is a mere modeling (and logic) choice. The latter is an important (though tricky) classification of actual content.

Pat Hayes: That, I think, is characteristic of the perdurantist, often misdescribed as 4-D, view of things (which I myself find congenial, as you know.) To an endurantist, however, the continuant/occurrent distinction is much more fundamental and basic, on a par with the abstract/physical distinction.

FL: The important thing for occurrents is change. The important thing for continuants is that which gets changed (or not). (The usual "identity criteria" dirge applies to both.)

FL: An "event" most primitively is just some change in something. A change is any difference in something at different times.

PH: Ah, there indeed speaks a true perdurantist. But Fritz, ask yourself: what kind of thing is that 'something' that has differences at different times?

FL: Identity criteria (by convention) settle this.

PH: Yes, I agree that is the most useful way to encode this discussion within a perdurantist viewpoint. But I also recognize that this point of view isn't really acceptable to a confirmed dyed-in-the-wool endurantist, who would regard this entire framework of putting together fake (as it would seem to them) 'continuants' by using identity criteria to assemble the right collection of 'slices' (which they would not even recognize as meaningful entities) as bogus and confused, and as approaching the entire discussion backwards. And since the occurrent/continuant distinction is one that is made primarily by endurantists, so that this is in a sense their technical vocabulary.

FL: If some authority requires endurantism (3-D) to define them, I'll use different words. I say that 3-D vs. 4-D modeling should be irrelevant to distinguishing events from objects (where a sneeze is an event and a nose is an object). Events involve, or are, changes in objects. Whether we use 3-D or 4-D, we still need this distinction.

PH: Please don't identify endurantism with '3-D modelling'. (Maybe you didn't intend to.)

PH: Look, *everyone* agrees that there are (intuitive) objects that typically last for a while and which undergo changes in which their properties change, and things that are

intuitively events. Nobody disagrees with that. The issue is how to describe all this properly in some ontological framework.

PH: Actually I'm not sure I fully agree with your last claim, however. Maybe I'm a more thoroughgoing perdurantist than some others, but I would rather like to get rid of the sharp object/event distinction. I think it is less useful than it seems to be. Many entities seem to be neither object nor event, but to have aspects of both; or maybe, can be looked at in either way, while being the same thing (flames, waves, weather phenomena, etc.);

FL: Agreed; that's what I meant by event-constellations. These are not single or primitive changes, but large, spatially extended, temporally extended complexes of interrelated sub-events, participants, etc.

PH: Well, I wouldn't normally think of a flame as large, having many parts, etc.; or indeed of an ocean wave, for that matter. Seems to me that very small things indeed can often be thought of as both object-like and event-like (e.g., photons)

FL: At a gross enough level of granularity they can be deemed simple events (localized changes) or moving objects.

PH: The essential descriptive apparatus for talking about physical relationships between spatiotemporal entities applies equally well to anything with a spatiotemporal boundary, i.e. to objects and events together. So while the distinction is often useful, I wouldn't say it was fundamental or absolute.

FL: Yes. For event-constellations it must be a matter of some convention.

PH: But I recognize that endurantists would disagree: they think of it as one of the most basic distinctions possible in describing the temporal physical world.

FL: For simple changes (as opposed to the thing changed) I think the distinction is fundamental, in 3-D and in 4-D.

PH: I disagree. I don't think it is fundamental anywhere, but it is often pragmatically useful in medium-sized everyday life.

FL: By "change" in 4-D I mean only a difference in properties of two parts of a timeworm at different positions in the temporal dimension, not that timeworms move.

Chris Welty: Note that an event can be something that causes properties to *stop* changing.

PH: True. Or to alter their rate of changing, etc. (Sound of whip cracking.)

FL: Ok, since we've agreed what "change" means in a 4-D model, no future protests "There's no change in 4-D!" will be instructive.

PH: Since we are here discussing two different perspectives, I'm not sure if you are using the terms (like 'change') intuitively, or with the technical meaning from one of those perspectives.

FL: A timeworm that is a perfect, uniform, straight, endless cylinder aligned along the temporal dimension has no such "change".

CW: But the shape of the worm is just an artifact of its 3-D position and shape over time. Such a cylinder could easily have changing properties over time.

PH: That is true, and Fritz and I have been careless. Think of the worm as having many colors, for example.

FL: Indeed a 4-D cylindrification (in the Cylindric Algebra sense (Feldman, 1990)) of any 3-D shape along the time dimension has no such "change".

CW: Right - but that's only the shape. What about the color, age, etc. These could be properties of different sections.

PH: Right. In fact, age is a *necessary* property of different sections, right? (I thought you might like to see me using a modality for a change.)

CW: You got it!

PH: So a "change" here is a kind of kink, or maybe an alteration in cross-section, of the timeworm. But that isn't what an endurantist would think of as a change.

PH: I think that to *assume* that these terms have the relatively weak meanings that they acquire when mapped into a different ontological framework (that an endurantist would reject out of hand) is really not doing the terms justice. It is a bit like an atheist wiping his nose on an altar cloth, and then professing to be puzzled at the rage expressed by one of the faithful, on the grounds that altar cloths are only cloths. I would agree in a purely intellectual sense; but I would also recognize that the rage might well be justified.

CW: I don't think any strong argument against having an event/object distinction in a 4-D view was made. Pat seems to be arguing against it as a distinction at all. Part of the basis of his argument, of course, is that no self-respecting perdurantist would view the distinction as meaningful.

CW: Since event is my distinction, I don't expect you to believe that the mapping into a "different ontological framework" is relatively strong. I want the distinction, so I'll worry about making it carry the right meaning.

CW: It seems to me we're actually swapping our usual positions: Pat arguing that the philosophical "perdurantism" and "endurantism" are labels for a bag of things that *should* be kept together, and I'm arguing to throw away the philosophy in this case and see if the parts can be interchanged.

CW: I get it, though I'm not clear whom you are casting as the religious ones here. But to continue your story, there are also agnostics who (to use the modern meaning) aren't sure if they're religious or not, that wouldn't be offended by the nose wiping, but probably wouldn't wipe their noses on the cloth either (just in case).

CW: I believe I am in that boat, that is, not really strictly endurantist, but don't buy into the perdurantist story either, because it just seems like the same darn thing!

PH: I am genuinely unable to follow what your position is, then. I can understand taking one view over the other here, but I cannot see how you can possibly think they are the same.

CW: I'm certainly not a "dyed in the wool" endurantist, by your definition, because identity criteria seem just fine as a way to settle the issue. But I don't want to be limited to your identity criteria. I want to use mine. You shouldn't care - identity criteria are an independent notion from perduring/enduring.

PH: Maybe you could say what you mean by 'identity criteria'. This phrase gets bandied about a lot, but I suspect that we don't all agree what it means. What I mean by 'identity' is strict logical identity: being the very same thing. What that means, of course, depends on what you count as 'things', but then so does everything else we say.

FL: Yes exactly! The set-mavens of the world (the Great Unwashed - which includes model-theorists) –

PH: This from a man who makes his living writing first-order axioms? Shame on you!

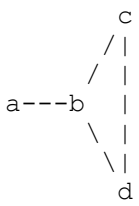
FL: - *start* with a nice set (the domain "D") in which all the individuation work has already been attended to (leaving aside "pure sets" made of the empty set). Members of a *set* are, by *definition*, pairwise nonidentical. The whole identity-criteria decision has been made *prior* to accepting D as given. Ask them about exact cardinality. A finite set always has one. Some El Setto declaims: "Let us take the set of the world's mountain ranges, and ..." - Hold it, what's the *exact* cardinality of "the set"?

PH: There are many sets, each with an exact cardinality. The problem (if there is one) isn't with "set" in that "Let us take....", but with "mountain ranges". If that is supposed to *define* a *particular* set, then indeed whoever makes that stipulation had better be prepared to give us a clear criterion for what counts as a mountain range. However, a perfectly reasonable response could be: "I'm not sure exactly what counts as a mountain range, but whatever you choose, let S be the set of those....", and now S is not precisely defined. That is ok, of course: one can make imprecise assertions about precise entities by being imprecise about which entity one is talking about; its like saying 'let P be a person...' without saying exactly who.

FL: To decide this requires deciding what is one mountain range versus two (or zero: Sutter Buttes, California, is declared by locals, with pride, to be "the world's smallest mountain range"). John Sowa mentioned something similar with trees connected at the roots: one tree or many? For abstract things a different problem arises, where isomorphism is identity.

PH: You seem to have been hung up about this for years, Fritz, and I have no idea why. This really isn't a serious issue. If there is one thing that set theory *can* describe well, it is mathematical abstractions. There is no 'problem' with isomorphism being identity.

FL: How many graphs of the form



FL: are there?

PH: It depends on what you mean by 'graph'. You can play the same trick with all kinds of things. Consider the following line of text:

PH: foodle foodle foodle faddle

PH: and ask how many words there are in it. If you mean word tokens there are 4, if you mean words in a more abstract sense there are 2. So, you have to say what you mean; tough luck.

FL: Is it the "same graph" if a and b are switched?

PH: With the usual definition of 'graph', yes.

FL: What about switching (the categorically indistinguishable) c and d?

PH: Yes, same graph. Also if you draw it with c on the left and d on the right, same graph.

FL: What if all the labels are removed?

PH: Then it's a different kind of graph.

FL: Or if you add arrows, etc. Are there zillions because of every graph-drawing or constellation or coat hanger that has this form?

PH: No.

FL: To count these "things" requires a prior decision about what constitutes one distinct thing.

PH: True. We all agree on that point, it seems.

FL: Only then does x=x, etc. work fine. Equality is a mere naming (or, with functions or "the", describing) issue. Another issue: Did the abstract character string "ABC" exist before the invention of the alphabet?

PH: Does it matter? I would say the question is ill formed and has no answer. (It asks a temporal question about an atemporal entity.)

FL: If so, did the work Moby Dick exist in 1 million B.C.?

PH: No. But then the *work* is not an abstract character string, e.g. it has an author, was composed at a particular time, etc.

FL: Is the italic version of "ABC" the "same" string? How about "abc"? Etc.

PH: All these questions force us into making more distinctions than we might want to make (tough), but none of them are unanswerable or mysterious. The real moral of all this rhetoric is that the conceptual world is more complicated than it seems to be to the naive listener. Do you find that surprising? Common sense is not common-sensically obvious. This is like thinking that one can do linguistics just by talking.

FL: Is there a "set" consisting of the world's web-pages?

PH: Without the scare quotes, and if you say precisely when you are asking, yes.

FL: Are two mirrored web-pages "the same page"?

PH: No, by decree of the W3C. [ed. note: see http://www.w3c.org/]

FL: Are two utterly different URLs that happen to point to a single physical disk file "the same web page"?

PH: The web pages are the same, the URIs are different.

FL: If it's updated tomorrow, is that "the same" web page or "a different" web page?

PH: Also by decree, it is the same "resource". But this is widely acknowledged to be something of a fantasy. All these are interesting questions about web pages, but they haven't got anything to do with sets.

FL: What if a URL returns a different document on each access? What if a web page is physically copied to a new place and URL? I don't want answers here. There are various known answers. I just want to show non-obvious cases.

PH: What I don't understand is a kind of let-it-all-hang-out ontological agnosticism, which says that identity is kind of arbitrary and flexible. If identity has no sharp meaning, then neither does quantification or predication, and all our logical machinery is confused and meaningless. So I'm presuming that we have the notion of individual thing settled before we even start talking about 'identity'.

FL: Yes. That's the rub.

PH: If you think that is a 'rub', then you shouldn't be using logic at all. That is like complaining that cars use oil.

PH: One of the basic incompatibilities between the endurantists and the perdurantists is that they start out with different notions of identity. I'm not saying that either is right (though I prefer the perdurantist approach myself for doing ontology), but I do insist that they are different and incompatible.

FL: Ok, you're agreeing that they are different notions of identity.

PH: I'm not 'agreeing', I've been saying that loud and clear at every opportunity for several years.

FL: The 3-D (endurantist) statement: Pat happy (today) and Pat not happy (yesterday), is contradictory in first order logic (FOL) unless times are arguments of happy.

PH: Right; but notice, this is so because Pat is the *same* (3-D) Pat at two different times. Contrast the 4-D way of talking.

FL: (If, instead, FOL just treats is-happy and was-happy as two different predicates, then immediately the question is how they're related.) It makes sense in temporal logic because you get was-true versus is-true, where "Pat" is deemed to be somehow the "same" Pat even though the happiness is different. Or, rather, is-true(was-true(happy (Pat))) and is-true(not(happy(Pat))) are not contradictory in temporal logic.

FL: With criteria such that "Pat at time X" has no identity with any Pat before or after, then fine, you've got a 3-D Pat.

PH: No, you have a 3-D Pat-slice. But that is a different thing from the slice of Pat a few minutes later. The endurantist position is that Pat is *exactly the same thing* at all times throughout Pats life. That is what 'endure' means: a continuant *retains* its identity. Pat-at-3pm is *identical* to Pat-at-5pm. Really, really identical.

FL: Alas, identity criteria are crucial to this, since Pat changes while doing this enduring but is still the same Pat.

PH: The only 'identity criterion' that is relevant is actual identity, the relationship which holds between a thing and itself. Logical identity, if you want to call it that.

CW: Well now - they are the *same entity*, however the real problem is coming up with a way of accounting for identity while still allowing for change.

PH: That is one way to think about it. Another is to find a framework that simply has no change (the perdurantist one).

CW: Some seem to think if Liebnitz Rule doesn't hold *on the entity*, then they're different, period. But of course this doesn't account for common sense.

PH: Well, it shows that common sense needs to be encoded into a logically coherent framework with a little finesse. It doesn't show that there is a unique way to do that, however.

CW: Pat, by the normal understanding, is the same Pat as we saw before, even though he's lost some hairs or whatever. Of course, if we choose to define identity criteria that make Pat at two times different entities, then we would have to live with that.

PH: Right, that is perdurantism, and people have learned to live with it. It seems to me that you do this yourself, in fact, though you don't want to admit it.

CW: My point is that choosing our identity criteria let us have it either way.

PH: No, it does *not*. They are *logically* incompatible.

CW: In the perdurantist view, it does not seem like you ever have that choice.

PH: On the contrary, the perdurantist view probably gives you most flexibility in this regard. Too much, in fact, for an endurantist. For example, here's a perfectly well-defined perdurantist entity. Take a group of people p1 p2 p3....pn standing in a circle, and think of the history which has the spatial envelope of p1 during the interval [ti, t2), then of p2 during [t2, t3), and so on around the circle to pn during [tn, tn+1), then back to p1 during [tn+1, tn+2), etc. . (This space-time 'worm' has some disconnections in it, but so do plenty of others that make intuitive sense, and in any case with a bit more work we could have made it spatiotemporally continuous by putting in 'morphing'.) Now, that thing certainly isn't any kind of continuant or any rational kind of occurrent, I suspect, but its there in 4-D space-time. You have *complete* freedom of choice to stitch together 'slices' in any way you like.

CW: Since Pat is one worm from womb to tomb, we can not choose to say he is a different entity at any point in time.

PH: I have no idea what you are talking about here. Why would I ever want to say I am something different from what I in fact am?

PH: Bear in mind that these 'worms' are just like 'locations' in 3-space or 'intervals' in 1-D time; they are only pieces of spacetime. They might contain anything. So of course Pat's history (to be exact) is one worm, but that in itself doesn't say anything other than that Pat is Pat.

CW: Note, also, that the non-perdurantist has the advantage of not having to live with people calling them worms.

PH: Not my term. I personally am a man of History.

PH: And, moreover, Pat is really, really, 3-D (not 4-D; only occurrents are 4-D) Continuants are always 3-D (or lower, e.g. surfaces) and always retain their identity through time. This is impossible in the perdurantist framework, if taken literally, which may be why you seem to have such trouble with it. But it is the way that we speak and seem to think, when we aren't being ontologists: this thing I'm typing on is the same machine that it was yesterday, for example, and its all here, in front of me; there isn't anything missing. If someone says that it's yesterday-part is missing, so it's incomplete, I will just laugh at them.

CW: Ok, well if this is the criterion you want to use, then try responding that "it's the same spatiotemporal worm!" Yeah, that's real natural.

PH: Yes, I agree (presuming that you are being sarcastic, right?). I was speaking earlier as an endurantist would argue, trying to get Fritz to see what that position's rationale is.

CW: It has always seemed to me that, in fact, the way we think and speak is *not* what the perdurantists want to account for at all.

PH: Be careful. That isn't the way we *speak*, I agree. But we do often think that way, I think one can show. We express ourselves using endurantist talk, but we easily make mental distinctions that seem to be possibly only in a perdurantist framework.

FL: Agreed, but my experience (Cyc (Lenat, 1995) had 4-D "subabstractions" as well as 3-D "holdsIn") taught me that people have a much easier time with "was-true" or "true-in-1988" than with "Pat-throughout-1988" even though the *logic* of the latter is much simpler. Maybe it's because all declarative English is tensed.

PH: Yes, I suspect that a lot of our ways of using *language* have evolved in the setting of a surrounding context of a communicative act, so there is always a 'now' and a 'here' and an ‘I’ and so on.

PH: For example, try to define something like a moving weather front, which by coming south will bring rain to Wisconsin within 24 hours, in endurantist terms.

CW: I've always thought of it as a revisionist theory, that uses physics or quantum physics (whatever the latest is) as the basis of their justifications. Isn't this what you were trying to say?

PH: No, the opposite. The 4-D space we are all talking about here is not the 4-D space used in special relativity - Minkowski space (Thompson, 1996) - which is altogether more peculiar and quite unintuitive.

FL: There is no "change" within the slice, whereas 4-D Pat with identity across times includes "change". (In Maine lots of breath was wasted on the meaning of "change" in the 4-D approach --- on the one hand the 4-D model includes "change" within it, e.g. as a bend along the time dimension, while the whole 4-D world does not itself "change".) Simons' (Simons, 1987) "all parts wholly present" confines Pat to the 3-D slice, excluding past or future Pats from the "something".

PH: No, that is a perdurantist misunderstanding. Those 'past or future Pats' are the *same* Pat as the one that is here now. They aren't excluded (how could they be, if they are the

same?) And they aren't part of Pat, either. Pat 'extends' through time (though that is a misleading way of putting it), but is wholly present at every single time.

FL: That just means that this 'extends' does not involve the notion of part-whole used in Peter Simons' "wholly present".

PH: *No*. That is the perdurantist reading, but that is *not* what the endurantist means. He really does mean *logical* identity. Pat at one time and Pat at another time are *exactly* the same thing; they are identically the same thing. There is only one thing, and they are both it.

PH: Is Pat all here now? Yes. Wait a minute. Is Pat all here *now*? Yes. All of Pat is all here at both times. Same Pat, always all there.

FL: This does not preclude there being relations between things at different times that amount to the same notion, but then they are not the relations of identity or parthood. Like almost all arguments about identity criteria, this can be handled either way, by agreed-upon convention.

PH: It's not that simple. They can be handled in this way *provided* that one rejects the endurantist ontology and accepts a perdurantist one. However, I think you want to have it both ways, and you can't.

CW: What? That's clever. I think the misunderstanding is going around in heaps. Why can't the endurantist say this?

PH: Because the endurantist 'convention' of identity between times for continuants is not a mere convention, and admits of no degrees or ambiguity; it is logical identity: being the same thing.

FL: Yes there are no degrees, but calling it "logical identity" doesn't mean you haven't followed some convention on what is "the same thing".

PH: It means that whatever those 'conventions' are, they are presupposed by the logical language in use. As you point out above, there have to be some conventions in use, in a sense; but calling it 'logical identity' means that it is determined by these conventions that are *outside* the ontology, and cannot be discussed or modified from within it.

FL: If Pat and Claudia Schiffer have a brain transplant, is that really a body transplant? Will the Claudia-bodied one then be former president of the AAAI? Will the Pat-bodied one be the Supermodel? Which is "the same Pat" under endurantism? Again, I don't really want an answer –

PH: Good, because you aren't going to get one. (In a former life I actually used to have serious conversations with rational adults on topics like this. What a total waste of time.)

FL: - but there is an issue here to decide before saying Pat then is the identical person to Pat now.

PH: Tell this to an endurantist. They take identity-across-times as absolutely fundamental, not admitting of degrees. All you are saying here, in endurantist terms, is that one has to decide whether or not something is a continuant. True, of course. However, once it is a continuant, there is no further room for discussion about identity.

CW: I just don't get why you see making properties temporally indexed is any different than making entities worms with "slices" that can have properties.

PH: Well, I don't know if I can possibly explain it better than I have already. Temporal indexing of properties does not imply that the things that the properties are true of have temporal extents, for example, or have temporal slices, or indeed have any temporal 'structure' at all.

PH: I didn't used to think it was different, but Peter Simons (and others since) convinced me otherwise. I now see that I have been a perdurantist most of my life (certainly since being a teenager) and had not fully appreciated the force of the endurantist position. I really do think of things as histories, and I don't think of myself as being the same person now as I was when I was, say, 21. (I'm a different person with memories of that other person.). My own private ontological view - my common-sense view - is more like a universe of Whiteheadian (Whitehead, 1929) processes than one filled with continuants. But I also acknowledge that I may be unusual in this regard.

FL: I want a choice between the two, without either choice mucking up the event-object distinction.

PH: Each choice will muck up that distinction in the other choice. Sorry, no way around this. From a perdurantist perspective, endurantism is logically incoherent, and vice versa. The perdurantist can translate the endurantist ontology into perdurantist terms, but not in a way that an endurantist would find acceptable.

FL: If any one thing experiences change at all, it must have some identity across times.

PH: What does 'some identity' mean? That is like 'slightly pregnant'.

FL: In 4-D it mean the same worm (the whole timeworm is identical with itself) whereas I put the "some" in for the 3-D case in which some identity criterion distinguishes

essential from accidental properties that may change and yet preserve the object's identity as time passes.

PH: It is clear that for you, being the 4-D worm is not the same as being any of its 3-D cross-sections. Clearly, you are a perdurantist. The endurantist does not need any scare quotes around 'identical' when he says that a continuant is identical as time passes; he does not need to appeal to 'identity criteria' to reconstruct the enduring continuant from some collection of slices. To the endurantist, the continuant simply is the same - literally the same - thing, at all times during its lifetime. There is only one thing there; it is 3-Dimensional, and it endures. The only 'criterion of identity' is, simply, identity.

PH: Identity means being the *same* thing.

FL: (Incidentally, all this emphasis of *identical* and *same*, and "really, really identical", suggests to me that the confusing ambiguity of "identical" and of "same" in English isn't irrelevant to discussions like this.)

PH: Think otherwise. I am only trying to emphasize to you that I am using 'identical' in the strictest sense possible, i.e. as logical identity; not in some derivative sense from some vaguely defined 'criterion of identity'. The relationship I have in mind is the relationship whose extension is the set of pairs of the form <x,x>, and no others.

PH: That isn't a relationship that admits of degrees: if there is any difference, then identity is false.

FL: Difference in what?

PH: In any property describable in the formal language in current use.

FL: Essential properties - under some identity criterion - then yes you're right. Anything else - no.

PH: I have no idea what 'essential' means; and since we are only talking about a single world here, I don't see that it can possibly be relevant. In any case, nothing I have said in this thread has anything to do with any notion of 'essential'.

FL: Note that I agree that no two things are identical; if identical, "they" are one.

PH: Right, exactly.

CW: I am slightly different than before, but I'm the same entity. Identity does *not* mean "identical", it means I have the same identity.

PH: Wrong. That is *exactly* what it means. It is the relation of equality, the relation whose extension is all and only the pairs <x,x>, the relation that things have with themselves and with no other thing. Period. If you mean something else, don't call it 'identity' (just like if you want to say that 2+3 both =5 and =/=5, don't call it 'addition') For the record, that is the only sense I can make of 'same entity'.

PH: However, this is only a matter of terminology. I would be interested to know more about this relationship that you call 'identity'. Apparently it does not mean 'identical to' in the logical sense. So what does it mean, then? If Pat-today is w-identical to Pat-yesterday, but not actually identical to him (it?), what does this relation between the (two different) Pat-things amount to, exactly? And what *kinds* of thing are those two different Pat-things? (They are apparently not the same continuant, for example, or they really would be identical. Are they two slices of something, maybe? Or two things that have the same identity-hood, or the same Secret Name, or something like that?)

PH: Having the same identity means being the same thing, as far as I can see. If it means something else for you, please explain what you mean, and how we can put it into an ontology written in KIF (Genesereth, 1991).

PH: Maybe you mean that there is Pat, for example, on the one hand, and Pat's identity, on the other; and that there is a relationship of 'having' between them? That would make a kind of eerie sense; then the identity-things themselves could persist, enduring like continuants, but would not need to be spatiotemporal in nature; and the slices of the space-time worms could also exist: embodying, as it were, the identity in the crass, mundane, world of spatiotemporality, by 'having' the same identity, rather in the way that two pieces of carpet can 'have' the same color. This gives a kind of dualistic picture with a perdurantist physical world but an endurantist world of abstract identity. It raises the issue, however, of where the identities go after death, which might take a few days to get sorted out to everyone's satisfaction.

FL: This isn't preposterous.

PH: I'm afraid I think it is.

FL: The "stuff" of 4-D spacetime is a miasma before we agree on the useful boundaries of the worms.

PH: I think I agree with what you intend to say here, but not with your words. Apply it to 3-D; there are locations - patches of space - containing matter, and also ones that do not, and all kinds of things in between. That is called having a theory of spatial location, not a "miasma".

FL: The worms "exist" (as values of bound variables [joke]) for convenience. I believe in the cookie-cutter theory of individuals and categories, but with lumpy dough.

PH: I cannot follow that metaphor, sorry. If you mean, there is stuff occupying space, and some histories have stuff in them (and that this is a significant fact about them that needs to be described properly), then of course I agree. But that kind of distinction arises in both 3-D and 4-D, so has nothing particularly to do with the (original) topic of this thread (except that there are more kinds of 4-D stuff than there are of 3-D stuff, e.g. melting icecream and freezing water (i.e. water becoming ice, not freezing-cold) are both kinds of 'dynamic' stuff in 4-D. In general, 4-D ontologies tend to be richer in kinds of entities than the 3-D one.)

FL: Pro-abortionists assume shorter person-worms than anti-abortionists.

PH: They assume that people occupy shorter histories, but they can still both talk about the same sets of histories, just as they use the same spatial geometry and the same calendar.

FL: If a French company dissolves and the same people re-form for the same purpose with the same owners a year later, it's a new company under French law, whereas in Germany it's the same company (longer, but non-connected corporate worms).

PH: The histories are the same; a German lawyer can *reason* about French law, after all. They differ about the spatiotemporal shapes of 'companies', is all; that is the kind of disagreement that can be discussed within a single ontology, however. It's like disagreeing over whether saucepans are round or oval.

CW: Some subset of my properties persists and must persist.

PH: Must? That seems a little presumptuous to me. I personally wouldn't go so far as to insist that any of my properties *must* persist. God alone knows what could happen to me tomorrow. (By the way, had you ever noticed that phrases like 'God knows', when applied to the future, embody a kind of divine perdurantism?)

FL: By the way, I don't *like* talking about identity criteria. They come up all the time. But, a) they're sometimes needed, and b) they're mainly a matter of convention.

PH: How can something in one place be *identical* with something at a different place? It can't.

CW: Sure it can. I just read the *same* story to my kids that someone else did.

PH: The story is not *in* the place that it is read. The event of the story-telling is, maybe; but then that event is not the same as another event of reading the same story.

CW: Of course it's hard to pin down place for a story.

FL: It's hard to pin down identity criteria for a story, since a story is in no physical place at all, any more than an algorithm is. Identity criteria for algorithms are hard to devise too.

PH: Right. For sure, however, they are not spatiotemporal.

CW: What about the color of my carpet? If I rip a piece off, it has the same color as the rest of the carpet.

PH: Right, no problem with that. Different piece, same color. Color in this sense is a property of spatiotemporal things, though, not a spatiotemporal thing itself.

CW: So maybe you don't admit to instances of colors.

PH: Actually I can take it either way. If we are talking about color tropes [ed. note, from (Zalta, 2002) "A trope is an instance or bit (not an exemplification) of a property or a relation; e.g. Clinton's eloquence, Sydney's beauty"], then the carpet and the ripped-off piece have *different* color-tropes, so no problem. If we are talking about colors, see above.

CW: There are other examples, if you want to allow for non-concrete entities. What about sets? Numbers?

FL: Slight digression: Suppose, in a knowledge base like Cyc or the like, you define a set S in list form: S = {Moe, Curly, Larry, Scott, AuthorOfWaverly} –

PH: What do you mean? A set is not a list, so this sounds to me like saying you are defining a dog in cat form. What exactly are you saying here? The answers to your subsequent questions depend on your answer to this. (Is S a set, and those are its members? I will assume that is correct.)

FL: - and, later on, the identity Scott=AuthorOfWaverly is deduced from the rest of the knowledge base. Does the cardinality of S change?

PH: No.

FL: Was S not well-formed?

PH: It was well-formed. It had (at most) 4 members, but you didn't know that then, apparently.

FL: Was it merely the set of stooges plus one (like {a, b, b}={a,b})?

PH: Right, exactly.

FL: Was S not really a set at all, but rather a multiset/bag?

PH: You *said* it was a set. Were you lying?

FL: Or was the S definition "false" by falsely claiming non-identity of Scott and AuthorOfWaverly?

PH: Well, that again depends on what *you* meant. If that list was supposed to indicate that its elements were distinct, then you already had a contradiction when you inferred Scott=AuthorOfWaverly

FL: This isn't a deep question, just a practical implementation issue for {,,,,} set notation -- it doesn't arise for {x|P(x)} "such that" notation.

PH: Neither of them spatiotemporal, so irrelevant to the present discussion

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PH: In the perdurantist view, time is just like space. How can something located at one time - one Pat-slice- be *identical* with something located at a different time? It can't. They can both be *part* of something else, of course; but then that other thing - the 4-D Pat-salami - cannot be all present at any time. So whatever that thing is, it's not *me*, buddy, because I am *all here now*.

PH: (By the way, if you are going to say, but when *is* 'now'? The response is, whenever you like; but it doesn't matter, since whenever now is, I'm all here then as well.)

PH: In the 4-D view of things, aren't the slices of the salami just as much first-class citizens as the salami itself? So why do we have words for things like apples, but no words for, say, apple-slices five seconds apart? If the apple changes color between t1 and t2, and yet it is the same apple, what *kind* of thing is an apple, that it can be the same but also be different?

FL: "Same but different" arises normally in all issues of identity criteria.

PH: You are just tossing words around here. Identity has a strict, firm meaning. If you mean something else, don't say "identity".

CW: Of course it does, but it refers to something more fundamental than matter - which is what you seem to be hung up on.

PH: Nothing to do with matter at all. I haven't mentioned matter once; I've been talking about space-time, time, identity and logic.

CW: Matter is not all there is. Nor energy.

PH: Well, just for the record, matter IS energy.

CW: I am me, I am not a worm, and I am the same person I was a few minutes ago, yet not everything is the same about me.

PH: Ok, try writing that down in logic and see how long it takes to get a contradiction (two steps in most ND systems: 1. a=b; 2. P(a); 3. not P(b); 4. P(b) [1,2: subst] ; false [3,4: not-elim.] .)

FL: The 3-D endurantist, to talk about time, can either use real temporal logic, add times as arguments of P in FOL, or use distinct predicates is-P and was-P in FOL.

PH: Yes, I know, but Chris was *not* doing that, which was my point. I have never argued that endurantism is incoherent or unformalizable.

PH: Look, it's *easy* to write English sentences like the above and feel one has solved the problem. But that is an illusion, like a politician making a speech and feeling that he has put the economy in order. The problems we are talking about here haven't even had their surfaces scratched until one gets down to a logical description. You seem to have the intuitions of an endurantist, and seem unable to appreciate perdurantism: the exact opposite of Fritz; yet you seem to think you agree with him. I suspect that it because you only talk to one another in intuitive English prose, which allows each way of thinking to go along by itself without apparently contradicting the other, by an elegant process of mutual misunderstanding. Try swapping axioms and see how long you agree.

CW: Why do you see this as a problem for non-perdurantists?

PH: See above. Now, you can get around it by saying that you are not the same person you were a few minutes ago, which is a perdurantist position, at bottom. Or, you can get around it by insisting that you are the same person, but by saying that predications have to be made relative to a time, so that apparent contradiction between P(a) and notP(b) is an error and should instead be written P(a, t1) and notP(a, t2). That would be more an endurantist's strategy. Both of them work, but they give different notions of 'object'. What you can't do, consistently, is have it both ways.

CW: If I'm looking for a common sense account of things

PH: That remark deserves a book-length comment. Do you think that "common-sense" means "so stupidly simple that any jerk can do it with his eyes shut"? Formalizing common sense is *hard*. We shouldn't expect it to seem, or to be, easy; any more than having a brain should make one into a brain surgeon, or being able to speak makes one into a linguist. I don't expect it to be done properly in any of our lifetimes.

FL: I'd like us to accomplish a big part, semi-properly at least, in my short expected lifetime.

CW: Anyway, even if you take that for identity, when I'm out of your sight and return again your identity criteria don't help me, because I lost track of your worm, yet still we're able to do it. I don't identify you as Pat because of your worm.

PH: Please, try to think about the ideas, not the words. If I *am* my worm, then *obviously* you are going to do that. You identify me as me because I am me, right?

PH: In fact, it's the endurantists who make the distinction. They would allow the Pat-worm as well as Pat. It's an occurrent: Pat's life; the sum total of events that make up my most intimate biography. Unlike a thoroughgoing perdurantist, however, they cannot identify that with Pat, since one is an occurrent and the other is a continuant, so for them (and for you, I think) the question arises which of these two different things has ontological priority. To a perdurantist like me, that is like asking whether 2 is better than 2; it just seems to be a silly question.

PH: Identity, in the sense I am using it, admits of no degrees.

FL: Identity and nonidentity presuppose identity criteria. (So do sets and hence models.)

PH: That sounds neat but doesn't stand up to scrutiny –

FL: I tried to explain that earlier.

PH: - and the fact of the matter is exactly the opposite; without a basic notion of logical identity, "identity criteria" don't even make sense, and could not possibly be stated. How are you going to state an 'identity criterion'? Its conclusion will have the form (.... then x=y), right? Whatever you mean by '=' here is what I mean by 'identity', OK? Being the same thing in the universe of discourse. Being the same value of a bound variable. Being the same thing. What could be simpler, or more fundamental, than that?

FL: Leibniz's "strict" Identity of Indiscernibles (Loemker, 1969) begs the question because the identity criteria determine what can be "discerned" as distinct. (By the way, I don't really believe in the Identity of Indiscernibles –

PH: Me neither, but that's irrelevant to this discussion.

FL: - in a symmetric universe -- but I do believe in the Indiscernibility of Identicals.) Your own example of being the *same* Pat tomorrow but different in properties from Pat today illustrates my point.

PH: I fail to see how. Seems to me that it just illustrates that you think like a perdurantist.

FL: As I was saying earlier, "Same but different" arises normally in all issues of identity criteria. equivalence-classes, isomorphisms, homomorphisms, "kernels" of relations, fluents, etc. The apple is the "same apple" but "different" at different times.

PH: Now you are talking like an endurantist. That is nonsensical in the perdurantist framework. You can't have it both ways; say what you mean, and don't use scare quotes.

FL: The scare quotes are needed for ambiguous "same" and "different".

PH: I didn't use those words in a sense that could admit ambiguity. "Same" means literally, logically, the same entity. "Different" means not the same. x is the same as y iff (x=y) is true. End of story.

FL: Endurantism allows fluents, and changes (differences) in the properties (fluents) of a (the same) thing. Perdurantism allows differences between the properties of the different temporal (as well as spatial) parts of the same thing.

PH: Yes, but those two notions of 'thing' are *different*. Surely you can see this? It's as obvious as it can get. The 'thing' the endurantist is talking about is 3-D, but it has no temporal location; it is the same - no scare-quotes, logically the same - thing at different times. (Think of it as in a 3-D universe, which is the domain of quantification of an essentialist Kripkean (Kripke, 1971) model of a temporal logic.) The perdurantist 'thing' that has temporal parts is *not* 3-D, but 4-D; it is *not* the same thing at different times, because it doesn't even make sense to speak of it being 'at' a time; and its not the same as any of its temporal parts.

PH: The perdurantist (4-D) position is that there are three things; the apple extended through time (the apple-history) and two parts of it, two temporal slices of the apple at two different times. Call these A, B and C. The endurantist position is that there is one, single, 3-D apple, which endures through time. Call that D. Now, D is not identical to any of A, B or C. It isn't identical to A because (among other things) C is 3-D and A is 4-D. It

is more like B and C, but it can't be identical to them, because if we used that criterion of identity is would have to be identical to them both, and they are not identical. In fact, there isn't *anything* in the 4-D world corresponding exactly to D, since anything that did would have to be extended in time, and D is not extended in time; it endures through time, but is itself 3-D, not 4-D. It has no temporal extent, but it endures. It doesn't really belong in the 4-D world at all.

FL: Agreed. No 3-D entity is identical to any 4-D (or 42-D) entity, though it could be a projection of it.

PH: The 3-D things in the perdurantist world - the slices or projections of the 4-D worms - are not the same as the 3-D things the endurantist is talking about. For a start, they don't endure. Pat-yesterday isn't around today *at all*. In fact, Pat-when his finger-hits-the-'p'-key isn't around when Pat's finger is hitting the 'a' key.

FL: What "we have words for" is not fundamental, but English suggests temporal qualification (and temporal logic) with identity across times, as the easiest to map to English simply. (English fails to distinguish similarity from identity -

PH: True, but irrelevant to the current discussion.

FL: We say "they're the same" or "they're identical" to mean only that they are very similar, or are "the same up to equivalence as to P". "All men are equal" doesn't mean that there's only one man!)

PH: Such things apparently do not have colors as such. Do they have any properties as such, *in re*, in themselves, or are all properties only applicable at times? (What about the property of a thing being identical to itself?)

FL: With (3-D-based) temporal qualification, some predicates vary with time and some don't. "Fritz is fat (now)." varies; "1 plus 1 equals 2 (now).", "1984 ends before 2001 begins (now)." and "x equals x (now)." don't vary since they are timelessly true.

PH: I don't mean to imply by this rhetorical outburst that these questions have no answer, but only to try to shake your confidence that the answers are obvious, and unique.

FL: I believe that the answers are fairly obvious and fairly obviously not unique, since you can adopt either convention (4-D or 3-D) at will.

PH: A perdurantist can do that, but an endurantist will vehemently reject the 4-D view as incoherent, fallacious, nonsensical, violently unintuitive, etc.

FL: The last two are ok just to allege, but the first two should be proved. I don't know that either 3-D space+time or 4-D spacetime is internally incoherent or fallacious.

PH: Well, endurantists can be just as blinkered in their outlook as perdurantists can be.

PH: Moreover, they are right to get so feshed, since the 4-D view is radically incompatible with their way of thinking; any change produces an immediate logical contradiction. If Pat-now is wearing a hat and Pat-then isn't, and Pat-now is the identically same thing as Pat-then, then there is a contradiction. The endurantist response is to refuse to talk about things like Pat-then and Pat-now.

FL: Yeah; the endurantist talks about True-then and True-now instead.

FL: This was a main point of mine. Instead of a stack of Pats, a stack of worlds.

PH: The perdurantist response is to reject the identity of Pat-now and Pat-then. You seem to want to have the logical security of the latter while also pretending to have the identity criteria of the former, but that isn't logically possible. If A is *identical* to B then if P(A), then P(B) follows *logically*. There isn't any room for 'partial identity' to have it both ways; partial identity is just non-identity.

FL: Agreed, or rather: there is no partial identity. But there are identity-up-to-isomorphism, identity-up-to-equivalence-wrt-P, etc. Identity-up-to-Leibniz is the extreme.

PH: There is only what you are calling the 'extreme'. Even to talk about 'up-to-ismorphism' is to admit that there is a set of *different* things that are isomorphic, but not identical, to each other. Mathematicians are very careless about identity (they can afford to be, since they are usually based in pure set theory) but we aren't doing mathematics here.

FL: An "event" less primitively is a constellation of changes and participants therein.

PH: But what distinguishes events from their participants? Aren't they all just (the contents of) variously-shaped pieces of spacetime, all on a par with each other? After all, Germany existed both before and after WW II, so in what sense were, say, Germany-during-1914 or Germany-during-1999 "part" of WW II? Or did you mean to say that German-during-WWII was a 'part' of WW II? Ok, then, but what does just plain "Germany" refer to? Was it the same Germany in 1914 as it is now? Was it the same Germany five seconds ago?

FL: The "pure" events are just changes.

PH: There are no changes in the 4-D world.

PH: I know we spent a lot of time talking about this, but you don't seem to have fully understood what this means.

FL: See my tentative definition, above, of "change" in a 4-D spacetime model.

PH: If you want to classify some 4-D regions as 'change-like' as opposed to 'thing-like' then of course we can try to do that, but you need to come up with some criteria for making the distinction.

FL: Yes, I will, but it will turn out to be not quite regions, I think, but certain Husserlian "moments" (as opposed to parts) of regions. (Note: My scare-quotes on "moment" are to stop anyone from thinking that this very technical term has *anything* to do with normal English moments which are short time periods.)

PH: Saying they 'are just changes' doesn't say anything, and there is no prior notion of 'pure event' to fall back on. The basic 4-D spatiotemporal geometry has no way to make this distinction; it can't tell the difference between things and events.

FL: I think that's wrong, if you mean we can't, in 4-D, distinguish a change from the object that changes.

PH: I mean that there is no basis in the geometry or topology of 4-D spacetime itself for making this distinction, even qualitatively, so it has to be made on some external criteria. The distinction is axiomatic and fundamental to the endurantist, but poses a problem in definition for the perdurantist. (If you see it as a problem, that is. For myself I'd be happy to treat it as an arbitrary pragmatic distinction of no basic importance.)

PH: (In fact, this is one of its strengths, seems to me, since many entities are a kind of thing/event hybrid, and being forced to distinguish them just gets in the way.)

FL: This deals with event-constellations.

PH: I don't know what that means either. Is a flame or an ocean wave an event-constellation? How about a green tomato slowly ripening to red in the sunshine?

FL: Yes. Most common-sense notions of event are in fact about compound event-constellations.

PH: But these examples seem to me to be quite un-constellation-like. Maybe I still don't follow what you mean by this term.

FL: I believe that various workable schemes can be defined (classifying regions of 4-D spacetime as event-constellations) once the change/thing-changed distinction is clear.

PH: I'm puzzled as to why you want to get it clear. I think it is almost more trouble than it is worth. Suppose for example that we (both 4-D perdurantists for now) know that some thing, A, is an object as opposed to an event. What follows from this? If we say, that means that its properties don't change unless something makes them change, then (a) this is false, e.g. consider the tomato, and (b) we have just created the frame problem where there was no problem before. If we say that this means that it will endure, the same is true for many events, and false of many short-lived objects (such things are rife inside machinery, cellular chemistry, etc.); wouldn't it be better just to talk about its temporal dimensions directly?

FL: The "constellation" events and their participants are as you suggest -

PH: I wasn't suggesting anything, only asking you what you meant.

FL: - The colloquial meaning in English of "event" (and "Germany") is not precise.

PH: I am not relying on colloquial ambiguities. I am asking you what *you* mean by this example, and I want to you get more exact about the structures of events and participants that you are assuming. Seems to me that you are in a tar-pit here, and I won't let you escape by retreating into vagueness.

FL: (in this meaning, Germany is a sort-of "part" of the "event" World War II). The former, purer, meaning shouldn't be confused with the latter, colloquial, meaning.

FL: This has nothing to do with time-slices and time-worms.

PH: Of course it does. See above comments on temporal sections of Germany, for example.

FL: I still disagree. The colloquial ambiguities in "event", "Germany" "part", etc. are still there regardless of whether 3-D or 4-D formal modeling is used.

FL: I don't see that Peter Simons' "all parts wholly present now" helps (it merely says that a slice excludes the rest of the salami - so what?) since that is just about 3-D vs 4-D objects.

PH: No, it says much more than that. It says - you may find this crazy, but it does say this - that the slice *is* the *entirety* of the thing. There are no 'salamis' to be sliced; the 'slices' are what are real - except that the it is the *same* thing, not a series of distinct slices - and the 4-D salami is a fiction; and a pernicious fiction, at that, according to Simons (at least,

the Simons of a certain while ago who wrote a famous book) and for example Barry Smith. Things that you call true 'of the slice' are true at a certain time, of course; but *all* things are true at a time in this world-view. In fact, all things that are true, are true now, because there is only one world, and it is all present now. In this view, time is not a dimension, to be laid out like a ribbon and viewed from 'nowhen', but more like a kind of enclosing dynamic property of the instantaneous world, and that world is *all* that is real.

FL: That's fine; it's one of the two models, either of which is fine. I find neither model pernicious.

PH: But you do agree that they are incompatible, right? If not, please explain how you would make A B C and D all fit together into one framework.

FL: The two models are distinct but can be linked by projection of 4 dimensions into 3 dimensions and translation between classical logic (with timeless truth) and temporally-qualified (technically, modal) logic (with truth at time t). Various books explain the latter translation.

PH: Yes, I know about that stuff. But that doesn't do the endurantist perspective justice. Endurantist entities are translated, in these mappings, into collections of distinct entities that are event-like (because momentary) and hence not thing-like from the endurantist viewpoint.

FL: There are two different issues mixed here. First is: 4-D time versus temporal qualification of (and outside of) a 3-D world. Second, given temporal qualification, is: "God's eye" ("P true at the turn of the 20th Century") versus "situated relative to the context", i.e. "tensed" ("P was true") relative to the "now" of the context. The latter distinction is McTaggart's (McTaggart, 1908) A-Series versus B-Series [ed note: from http://www.bun.kyoto-u.ac.jp/~suchii/mctaggart.html "'past, present, and future' is the A series, and that in the 'earlier than' relation is the B series"]. All this has been analyzed plenty in works on temporal logic.

PH: Yes, I know all that stuff. But that distinction alone does not do justice to the radical ontological differences between the perdurantist/endurantist viewpoints.

PH: We can speak of the past and the future, of course, but we always do so from the present, and in the present.

FL: Yeah, that's A-Series talk.

PH: Right. But one could be an A-series-talking perdurantist.

FL: I think that makes sense (A-Series being really an indexicality choice) but it's rare. As far as I know, I've never met one.

PH: Well, I used to be one. As a perdurantist, you should have no trouble thinking about being introduced to one of my past slices. Fritz, Past-Pat; Past-Pat, Fritz. Good day to you, Sir.

PH: Things - continuants - endure; and while they do of course change, they retain their identity - that is real identity, the logically-equals kind. They are *not* made up of unchanging slices arranged in time like a series of movie stills, all distinct and separated from each other: two such 'slices' cannot both exist; for if they could, they would be the same thing. On this view, there are no 4-D objects; the idea is nonsensical. Events happen, of course, but events - occurrents - are completely different kinds of things altogether, The occurrents are what constitute time, in a sense: they are the enclosing dynamical entities that constitute changes in the continuants; but all the structure in the world, the fabric, as it were, that makes our world more than simply chaos, is comprised of the continuants that serve as the basis for our sense of identity through the plenum of change created by the occurrents. Occurrents (literally) do not exist in the sense that continuants do; they *happen*.

FL: I agree with the last sentence, but the "made up of" "exist" "enclosing" "plenum of change", etc. are the places in that paragraph where a choice between 3-D and 4-D may be made.

PH: I obviously did not express myself well enough. The point I was trying to convey by this rather poetic language was exactly the opposite; that the endurantist perspective allows no such choices; it insists on a very strict adherence to a binary classification, in which one kind of entity is *essentially* 3-D (or less) but *endures* through time, and the other kind of entity is *essentially* temporally extended but has no enduring. In this framework, the rather casual 'spatial' sense of temporal occupancy which comes naturally to you and me, where pieces of the world can both occupy time and be located in time, is completely and rigorously suppressed. A thing either is purely spatial, with no temporal extent, and endures; or it is temporally extended, and happens. Nothing is both; that is as impossible, in this world-view, as a solid integer.

FL: Isn't that classification just the distinction between 3-D and 4-D -

PH: Nope. It has to be 3-D with a particular relationship to time; neither embedded or projected.

FL: - extending is not enduring, this occupying is not locating-in, etc.? "Happening" being "temporally extended but not enduring" is one proposed answer to the event-object distinction.

PH: But in 4-D that is meaningless, right? To endure *is* to be extended in time. There isn't any other way to be 'at' two times than to be extended in time. The idea of something enduring but having no temporal parts is incoherent in 4-D.

FL: (It is a 3-D answer that reminds me a little of my earlier proposed 4-D answer, now abandoned, that objects are long skinny timeworms in the time dimension whereas events are spacetime regions that are short in the time dimension.)

PH: That notion of 'enduring' is very odd indeed to a perdurantist, and deserves careful thought. It is the key to the endurantist position, as the name suggests. It does NOT mean having a temporal extent; on the contrary, it means having no temporal extent, but nevertheless continuing to be 'present' as time passes.

FL: Even in a 4-D model, a bend (an occurrent) in a time-worm is not a piece or part of it, rather it's a foundationally-dependent "moment" in the Husserl/Barry Smith/Peter Simons sense.

PH: Maybe this is the first place we genuinely disagree. I cannot see any way to justify this claim. What, in the 4-D perdurantist framework, can possibly justify one spacetime part having a different ontological status than another?

FL: A Husserlian "moment" is not a part, strictly speaking.

CW: I was under the impression that 4-Dism doesn't exclude moments, though I'm not sure how they would be treated and I'm not enough of an expert in 4-D to think of how.

PH: Well, I have no idea what these 'moments' are, so maybe we could try some mutual education. (I gather that this does not mean 'moment' in the vulgar sense of very short time period, as in "Hang on, I'll just be a moment", right? Does it have any relationship to the sense of 'moment' from mechanics, as in 'moment of inertia'?)

CW: A moment in this sense is I think supposed to be the spatial equivalent of a temporal moment. They cannot exist without the object they are part of (yes, they are parts).

PH: Ok, you and Fritz please settle that one; he says they are not parts.

CW: You can't have an edge without the knife, you can't have a bend without a road - this is what we meant by dependence.

PH: Well, you can't have an edge by itself, or a surface; but you can have a bend. I bet that bends have been built on movie sets without any surrounding road leading to them or from them.

CW: In addition, the boundaries of the part are difficult to pin down.

PH: Speaking now as a perdurantist, the bend in the road seems obviously just as much a part of the road as any other part of the road.

CW: I strongly agree with Fritz's position here.

PH: So you think the bend is *not* part of the road?

CW: No, of course not. What we were disagreeing with was the "just as much" - they are not "just as much parts" as the rest. They are special kinds of parts - dependent parts - they cannot be separated from the whole. They cannot be cut out. They can only exist as parts of the whole.

PH: I know bends in roads that have skid marks on them; am I hallucinating? Road signs often warn of dangerous bends ahead; are they lying? Are those curved pieces of road not just as real, solid, pieces of road as the straight sections? (Do you guys think that roads are essentially straight, so that bends do not count as road, or something?)

CW: I love it when you say, "essentially".

PH: Well, I was being sarcastic, you understand.

CW: Anyway, there *are* bends in roads - not all roads are straight. *Make sure you understand this before you drive home!*

PH: Ok, then you can isolate the bend; you can have the bend without the (rest of the) road. Maybe we are at cross-purposes about the meaning of 'bend'?

CW: Maybe, but this could get lengthy - a Hollywood set of a bend makes sense only because it is implied that there is a road. Anyway, we're talking about a bend in something, like a bend in a branch, etc.

CW: I don't see how you can deny that edges and bends exist, and have special properties such as dependence, but again I'm not sure the 4-D view excludes them. Does it, or is it just the Pat view that does?

PH: Of course I don't deny that edges and bends exist. In fact, I drive around bends all the time, and sometimes touch edges, and I don't feel like the road ceases to exist. However, I have no idea what it means to have a *property* of dependence.

PH: As far as I know, nothing (including me) excludes them in 4-D either. (I'm not sure what led you to suppose anyone was saying that.)

CW: The problem with moments is unity - how do you identify what is, e.g. the edge, and what isn't?

PH: I have no idea what you mean. I have no trouble identifying edges in real life; being a sometime carpenter, I often spend a lot of time attending to edges, in fact, and I usually know exactly where they are. (It is dangerous not to, I find.) There are special ways to carry chisels and saws in order to protect their edges from damage, for example. So you surely do not mean 'identify' in the ordinary everyday sense, of being able to locate them in space/time. I wonder what sense you can have in mind that could possibly make this into a sensible question?

CW: I was careless in using the word “identify”. I meant "isolate". One property of moments is that they are tough to isolate (this is not unique to moments, of course).

PH: Fair enough. Seems a bit weak, though, if that is all that can be said about them.

CW: A *lot* can be said about them, hence a book edited by Barry on them, among others. They are dependent, in that they cannot exist without the thing they are a moment of. They typically have special geometric properties. I'm not an expert on it.

CW: For example, say you have a sword. The edge is sharp. Another sword has a dull edge. How do you represent that in a 4-D view?

PH: The same as you would in a 3-D view, it being a purely 3-D matter. The difference is that the 4-D view would also contain some other dependent things, e.g. the history of the edge becoming sharp - the sharpening - would have the same kind of relationship to the knife-history that the edge does to the knife.

CW: How do you say, "The edge is sharp". Use your where and when (and whatever else) notation below.

PH: Well, the thing that would be sharp would presumably be a temporal section of the history of the edge (unless this was an unusual knife) so this would be something like Sharp(edge(knife)@I) which would be equivalent to Sharp(edge(knife@I)) precisely because of the dependency relationship that you note, which in this case would be described extensionally as a rule saying that any history of the edge is the (spatial) edge of a contemporary history of the knife:

PH: edge(x)@I = edge(x@I)

CW: Fine, of course I could just say this in a 3d view the same way: sharp(edge (knife),t1)

PH: Right, sharpness is a basically 3-D phenomenon. Becoming sharp is more of an essentially 4-D kind of thing. There are essentially 4-D kinds of 'sharpness', however, and they would be things like a cutting, i.e. the exact event (or if you prefer, the spatiotemporal envelope of the event) of a sharp edge cutting a surface; that would be a temporal boundary which is in all other respects exactly like the spatial boundary defining the sharp edge (and which coincides with that spatial boundary at the exact time of the cut, by the way.)

CW: But now that I'm getting it I see that there is no particular difficulty in defining moments - no more than in 3-D, which is what I suspected in the beginning.

CW: Good, so I believe Fritz's point is that many of these moments in your 4-D world represent what we intuitively call "change", as you say.

PH: Yes, of course they do, that has never been at issue. Although why one singles out these particular parts of the 4-D world as 'moments' is rather beyond me. (I am in general averse to making categorizations that have no functional or pragmatic basis; it is the worst fault of mediocre philosophy to become a kind of abstract botanizing, a process of classifying nothing in particular on no particular observational basis.)

CW: Are you seriously trying to claim that events are not observed?

PH: Of course not. The issue is not whether there really are things we intuitively call 'events' or 'objects'. As I've said many times, we all agree about that. The issue is how we design the *formal* frameworks to describe this world, which we all inhabit and know pretty well. Endurantism is a strategy for doing that which elevates this intuitive distinction into a basic - perhaps *the* basic - foundational distinction on which the entire framework rests. To an endurantist, things and events are as different as chalk from cheese, and to even dream of confusing them would be a basic category error. What I am talking about is this elevation of the distinction into something ontologically basic. It seems to me that the closer and more carefully I look at the actual world, the *less* basic the distinction becomes. Some objects can be seen as events, some things can be seen either way, some things can only be adequately described by using notions from both categories in a kind of blend (e.g. a falling water droplet that is changing its shape and also evaporating as it falls). Sometimes, the reasoning that we seem to need can only be done by switching between the 'object' and 'event' ways of thinking (e.g. explaining how slanting waves make the sand on a beach move sideways, or doing weather forecasting, or explaining why one should not drink out of a cup that has been in a sewer) In fact, the more closely one looks, the more the distinction seems to become inadequate as a basis of any kind of formal classification.

PH: And in fact, what I was talking about above was 'moments'. I haven't seen the need for this classification yet in any part of the observational world. There are edges and corners and holes and curves (etc), of course; but like most other everyday classifications, these things all seem to demand their own axiomatic treatments, and they seem to have little to do with one another. Moreover, I feel like I pretty much understand edges, corners, surfaces and bends (and even things like linear movements of cutting edges, spatiotemporal locations of point impacts, and things like that), but I wouldn't know what to say about a moment, so introducing them doesn't seem to be helpful. I don't see any need for the general category.

CW: That change is not observed? That a great part of our language supports the capability of describing change and events?

PH: Yes, in fact I think that the distinction is more linguistic than physical. But you know my opinion about using linguistic data in ontology, right?

PH: "Edge" here would be defined topologically, probably as the 2-D history of the line where two 3-D surface-histories (parts of the surface of the history of the knife) intersect. (This is a slight idealization, in treating a physical edge as though it were a mathematical edge. A better theory would distinguish them and have a notion of approximation relative to a granularity. However, I have no idea how to do this adequately, so I won't claim to be able to.) Exactly how to define 'Sharp' I don't know off-hand, but it might involve geometry, although I suspect that my own experience with tools just treats 'sharpness' as a predicate of physical edges, without going into geometrical details, and connects it to properties like the ability to cut fine shavings, make smooth mortises in cross-grain wood, etc.

FL: I think this is wrong, which is key to my current view. A curve in a road, like a corner, a boundary, a smile, a hole, an angle, a line-end, a difference, or a change, is not a part in the ordinary sense (in the way that a brain is part of a head).

PH: I see what you mean. However the key point is that you said 'curve' and I said 'bend'. Let us stick to purely spatial terminology for the moment. The bend is part of the road; one can drive along it, it can be surfaced with concrete as opposed to tarmac, it has a weight, and so on. The curve is more like an abstraction of come kind; it is the 'shape' of the bend considered in isolation from any of the stuff that is used to realize this shape in the actual road. The bend is the part of the road that is curved, we might say, or perhaps that realizes or instantiates the curve, though I am not sure what this way of talking really means.

PH: However, there is something odd about talking of these shape-abstractions as separate from the parts of the shaped thing, in any sense other than as properties of them.

I see what you mean, and agree, that a corner of a brick, say, is not a part of the brick in quite the sense that my liver is part of me, since it could not be removed and exhibited in isolation. (If it is part of anything, it is perhaps part of the *surface* of the brick, which similarly cannot be removed from the brick; but even this isn't quite right, since even if we allow surfaces to be real, one feels, a corner in isolation would simply be a point; what makes it a corner is the spatial dispositions of the other parts of the brick, rather than the corner itself - whatever that could possibly mean). But the key point, seems to me, is that there has to be some real thing there, and that these words - curve, corner, surface, boundary, angle, whatever - refer to *properties* of those things, usually properties that can be referred to (locations of) parts of the things. We often use the same word for the property and the (location of the?) part, e.g. when speaking of damage to a corner of a piece of furniture, or of repairing a hole in something, or smoothing a metal angle by filing. I suspect that we can get a long way by continuing to be careless about this distinction, and thinking of these things as being parts. For example, I am quite happy to think of the surface of a brick as being part of the brick. It is a very peculiar and special kind of part, and it cannot be separated from the brick, but so what? It certainly has things like location and size, and can be touched (and when we do, we say we have touched the brick). A corner of a brick is the place (on the surface) where the property of cornerness is manifested. If you take away the brick, that location has no such property, of course; that is the (rather crude) sense in which the corner is not a part. But in every other useful sense it is a part of the brick.

FL: These are Husserlian "moments". Barry Smith and Kevin Mulligan co-edited a whole book (Smith, 1982) on this distinction, called "Parts and Moments". Among other things, an individual "moment" is existentially-founded upon whatever individual it's a moment of (unlike a part).

PH: That seems too simple, though, as a basis for making the distinction. Many things we call parts are 'existentially founded' in the sense that they wouldn't be what they are when considered purely in isolation.

FL: Right - that's why I said "among other things" - mere dependence isn't enough but now I forget what the other requirements for the "foundation" of a Husserlian "moment" are besides dependence (individual existential dependence). I think maybe Peter Simons threw in an extra requirement for foundation that the dependent thing is not "founded" on its own parts, because that would make almost everything trivially "founded", since almost no thing can exist without its parts existing.

PH: They are 'contextual' in a sense, e.g. the largest lake in Finland, or a basal-cell carcinoma (the point being here that this refers to the whole carcinoma, not part of it.)

FL: Being functionally-defined based on features of X is distinct from being existentially "founded on" X. The largest internal organ of Pat (thus functionally-defined) is Pat's

liver, and "it" could possibly exist without Pat existing. Being functionally-defined is a matter of description rather than individual existence.

PH: Thanks, I get that now. But you know, this entire game of arguing about what counts as a 'moment', what is or isn't 'existentally founded' and so on strikes me as tiresome and pointless. Does *any* of this matter, Fritz? Isn't it like having a debate on some point of theology? Suppose I were to say: Ok, Husserlian moments exist, fine. I would then completely ignore them when writing axioms about anything I would ever want to talk or reason about, and I suspect that you would, also.

FL: An individual brain can exist without the head existing that it is the brain of, but an individual corner necessarily cannot exist without the box existing that it is the corner of. Similarly, an individual curve in a road necessarily cannot exist unless the individual road exists (for the curve to be a curve in).

PH: In the sense I used 'bend' that is not true. One could have an isolated 'bend' (perhaps on a film set somewhere) all by itself, and it would be quite existentially secure all by itself. What you cannot have is a curve in a road with no road to be curved, of course.

FL: Similarly, an individual "change" (as I define it for 4-D above, as an instance of certain sort of difference) in an object necessarily cannot exist unless the individual object exists.

PH: But now, consider these individual objects that exist, in your account. Are they 3-D things that endure, or 4-D things with a temporal extension? I am guessing the latter, right? If so, then I suspect that you and Simons were at cross-purposes.

FL: [Nicola] Guarino, Simons and I have pushed for necessary existential dependence (a main feature of Husserlian "foundation") as a top distinction ([John] Sowa has a different reason).

FL: On this view, a universe could have perpetual objects with no events, but it could not have events (changes) with no changed things. Thus this proposal doesn't have quite the symmetric duality of the 3-D-based view.

PH: Not sure what you mean by this last point. Endurantism does not have this symmetric duality you refer to, e.g. occurrents can have continuant parts but not vice versa. (Which, by the way, strikes me as a bug rather than a feature.)

PH: And obviously, that part exists, just as much as any other part exists.

FL: That's slightly controversial. I think that Husserlian moments exist "as much as" parts exist, but not quite in the same way. This to me is still formal ontology (as Husserl

urged), i.e. a matter of theories and not a matter of pure logic (except for necessity). I'd prefer not to mess up backwards E, in 4-D or in 3-D.

PH: I am not really following you here. When I say 'exists', I mean backwards E. If you mean something else, please explain.

PH: By the way, you have continuant/occurrent backwards here. It's the occurrents that have a temporal extent.

FL: So even in 4-D I'd agree that "Occurrents (literally) do not exist in the sense that continuants do".

PH: Then maybe you could say in what sense they do exist, and how that differs from any other sense of existence. (I presume you are not going to say that the 4-D 'bend' does not exist *at all*, right?)

FL: Right. I've mentioned the main sense, and that I don't think it's mainly a matter of logic (in 4-D at least - 3-D needs temporal logic to allow change). I'm not competent to give you the full story on the mode of existence of "moments"; Peter Simons could.

PH: Well, I do know that Peter's view is resoundingly endurantist; he is the one who referred to the 4-D perspective as a 'fallacy'. So maybe you and he aren't using words like 'object' in quite the same way.

FL: (This is related, but not quite identical, I believe, to Peirce's (Peirce, 1931) Secondness, and to Sowa's (Sowa, 2000) Role-Types.)

FL: I only say "Husserlian moments" just to make sure that it's understood in the very technical sense; I think "moment" is a terrible choice of word, in English as well as in German, since it has the normal meaning so strongly. And I'm probably wrong to call them "Husserlian" anyway; they might come from Bolzano (Berg, 1962) or the scholastics (Bishop Uhrplek?) or somebody else pre-Husserl, or maybe it should be "Simonsian" because of Peter Simons' aforementioned exclusion of one's own parts.

PH: I will leave the historical scholarship to the historians.

PH: That is endurantism; it has deep roots in Hegel and is very consistent with Heideggerian (Heidegger, 1927) phenomenology, in contrast with the 'objective' view of the world that is embodied in most of our physical science, from Newton to Minkowski, and which notoriously has no place for subjectivity or experience. Again, don't shoot the messenger. I'm not advocating endurantism as a useful ontological perspective; on the contrary, in fact; but I do think that we need to respect its internal coherence and wide appeal (and for example its deep ties to natural language and to much of intuitive

psychology), and to not simply ignore it, try to legislate it out of existence, or pretend that it is something else.

FL: Agreed, if this means only 3-D space+time. I just doubt that 3-D is needed to distinguish objects from events usefully.

FL: Yes it's a perfectly fine model (as is 4-D) and it better fits English. My claim is (still) that it has nothing to do with occurrent versus continuant. Occurrents and continuants are fundamentally different both in 3-D and in 4-D. Since an occurrent can't fit in a slice, 3-D needs relations across time to define occurrents.

FL: So here are the distinctions I say not to mix up:

1. Occurrents versus Continuants.
2. 4-D spacetime model versus temporally-qualified 3-D space model.
3. God's-eye time versus contextually-situated (tensed) time.
4. Events as pure changes versus events as constellations consisting of changes and the participants changed.
5. Identity criteria decisions.

PH: To the first point, maybe it would help if you were to state what you take this distinction to mean. You seem to use these terms in a way that differs from their use by the people who introduced the terminology.

PH: A continuant is something that has no temporal parts, is wholly present when present, and endures through time, retaining its (logical) identity: so Pat is identically the same Pat at all times, even though his properties may change. An occurrent happens, rather than endures; it occupies time and may have temporal parts, which differ from one another. The relationship to time is fundamentally different for continuants and occurrents. Continuants occupy no time; they endure through time, but they have no temporal dimensions or extents. Occurrents, in contrast, do occupy time, but do not endure. A temporal part of an occurrent has only a momentary existence, and once past, is wholly past. The only temporal residue, as it were, that an occurrent can pass into the future, is by virtue of the changes it produces in continuants, since only continuants endure, to provide any kind of connection between temporal parts of occurrents. (Think of the continuant players in a soccer match occurrent, for an example.)

PH: Pat is a continuant; Pat's lifetime (lifespan?) is an occurrent, which is ontologically a completely different kind of thing from Pat, even though it has the same spatiotemporal envelope when mapped into 4-D. You can see and talk to Pat, but you cannot see or talk to his lifetime. Pat has a liver, but his lifetime does not. His lifetime has a childhood, but Pat does not (any more).

PH: To an endurantist, the perdurantist view seems to be an attempt to assimilate continuants to occurrents. Indeed, it does make sense to speak of 'timeslices' of an occurrent, and one could argue that there is no more to an occurrent than the sum of its slices. But, the endurantist would protest, that provides no way to account for the rather persuasive intuition that some things - most notably, perhaps, we conscious beings - seem to be the *same* things as time passes; we are the same people we were yesterday. There seems to be something very basic missing from the 4-D picture, which is the very 'things' that provide the thread to weave those slices together into coherent wholes; they are all slices of one thing. And, an endurantist would claim, if you take this 'one thing' seriously, it has to be something more than a mere occurrent, defined by a spatiotemporal envelope, like a ball game or a thunderstorm; it has to *retain* its identity as time passes; it has to *endure*. Without the these enduring threads, there are no principled ways to state temporal 'identity criteria', whatever that is supposed to mean exactly. But there is nothing in the 4-D picture that can perform this essential ontological service; all there are are occurrents, sliced however thick or thin. That is like trying to make a necklace with beads but no string.

PH: I agree about distinguishing points two through four, and not getting them mixed up. However, they are related, in that if one takes talks about 4-D spacetime then one is obliged to take the gods-eye view, for example; and the continuant/occurrent distinction, if treated with the respect intended by its inventors, is *incoherent* in the gods-eye view.

PH: As to point five, I continue to be slightly mystified by what exactly this is supposed to mean, to be honest.

CW: I've been thinking about this a bit more, I wonder if it might not be clearer if Pat would just give us a simple example of how to represent one of his 4d worms in logic. How do you represent the 4-D Pat?

PH: Well, there are any number of ways to do it. How would *you* represent 3-D things? Generalize from there. For example, all the 'standard' part/whole theories, mereologies, etc., all apply directly to 4-D entities just as well as they do to 3-D ones, or for that matter to 75-d ones.

CW: So, then, what's the difference? Why is object/event different in a 4-D view and a 3-D view?

PH: I can't answer a nonsequiteur. What do you mean? The fact that a single theory applies to two cases does not imply that the cases are indistinguishable, only that the theories are weak.

CW: One claim is that logic is insufficient for represent a 4-D world, due to its ontological promiscuity. Only sets can handle it. All there is are objects and sets, that's the ontological commitment you need.

PH: I think this is completely confused. Logic has quite literally got nothing to do with dimensionality: of course 4-D can be described in logic. One can describe Hausdorff spaces (Porter, 1987) in logic, for God's sake, and they are infinite-dimensional.

PH: In fact, most axiomatic theories of 'space' are not tied to any particular dimensionality, and can be interpreted directly as 4-D theories. A 4-D hole parallel to the time-axis, for example, is a 3-D hole maybe changing in size or properties.

CW: You said "change!" Fritz, he said "change!"

PH: I was using the term intuitively here. Right, we are all talking about intuitive change.

CW: So why can't these little moments be occurents (oh, call them what you like).

PH: To an endurantist they would indeed be occurrents. The chief issue is that there is nothing in the perdurantist framework that corresponds to continuants.

PH: A 4-D hole perpendicular to the time-axis might be for example a dent appearing in a surface, enlarging, then contracting back to nothing.

CW: I don't have any problem "visualizing" (or understanding, or whatever) 4-D worms and what they correspond to. I simply have trouble seeing that there is any difference at all. What you call "slices" I call time variables.

PH: You can translate back and forth, of course. But the fact that you can translate between English and French doesn't make them *identical*.

PH: In the “Naïve Physics manifesto” (Hayes, 1985:1, 1985:2) I used quantification over 4-D 'histories' (what Fritz calls worms or salami) and functions called 'where' and 'when' (from an old English political protest song), so that when(h) is the time-interval got by projecting h onto the time-axis, and where(h) the spatial region got by projecting perpendicular to time, and the basic function (written as an infix) @ which takes a timeslice of a history with regards to an interval, so h@t is the t-section of h. To talk about a movement, for example, you would say that where(h@t1) =/= where(h@t2). Then for example where(h@[t1,t2]) is the spatial envelope of h as it moves during the interval [t1, t2] (eg the path of the storm). There were other functions for things like spatiotemporal boundaries (the histories of the spatial boundaries) and how they were related to the histories themselves, and obvious things like being connected across such boundaries (e.g. if you put a block on a table then take it off again, then one part of the

spatiotemporal boundary of the block is shared with a part of the spatiotemporal boundary of the table, and the when of that part is the interval), and so on.

PH: Almost all the work in qualitative physics has been done in some variant of this framework, for example.

PH: One cute thing about thinking in 4-D is that, after a while, one simply stops worrying about things like change, temporal modalities, and so on. Its all just shape and topology; from the ontological point of view, 4-D space is very much like 3-D space. What a relief!

CW: I don't see that this is such a relief - you still have to deal with it if you want to explain the world to people. *We* see change. "Hey Pat, you've changed!" You still need to map this into your morphology.

PH: Oh, I can, no problem. In fact, I can reason about all kinds of things, such as the track left in the surface of a plank left by a nick in the edge of the blade of the plane, or the guttering of a flame being caused by pressure instabilities resulting from feedback in the gas pressure control system, or the process by which liquid flows from one container into another, which I would be very hard pressed to even describe, let alone account for, in a rigidly stratified endurantist framework.

CW: You still need an endless catalog of things like "a 4-D hole perpendicular to the time-axis might be for example a dent appearing in a surface, enlarging, then contracting back to nothing."

PH: No, you don't. The reasoning itself does not even mention terms like 'dent' . It just reasons about the processes and their geometry and their relationships. English words and concepts only come up on input and output, and maybe not even then in all cases. Much of what one is thinking about cannot even be properly said in English. I don't think I could articulate in English more than a tiny fraction of all the things that constitute my own 'common sense' knowledge of the world. (Have you ever made up a double bed, and opened a sheet by flicking it across the bed so that it settles slowly onto the bed, spread evenly? You know *how* to do that, but you could not possibly tell someone how to do it. Now think of breaking an egg into a bowl, of walking, of taking a shower, of lifting a cup to your lips, of holding and opening a book, etc.)

CW: So have you gained anything?

PH: What you gain is precisely that it isn't a catalog any more: one has the power to describe the *dynamic geometry* and to reason about the causal and other relationships that are present; the temporal aspects are just as geometric as the spatial ones, and there are all

kinds of other 'mixed' relationships that cut across the rigid object/event classification. In the 'liquids' paper (Hayes, 1985:1) I used some of them.

CW: And back to the original point, what is preventing someone from defining continuants and occurrents (other than the sanctity of the altar cloth) in both?

PH: The notion of continuant is logically incoherent in the 4-D ontology. The nearest thing to it is its corresponding occurrent, the 'worm' or 'history' or 'salami' of the continuant. Pats lifetime, rather than Pat. But speaking as a perdurantist, I don't *want* to define continuants. I don't even believe in continuants, myself. And I certainly do not want to be obliged to make a rigid high-level classification of everything into one of two equally useless categories, just to keep the ghost of Husserl happy.

CW: I see your point regarding the terminology - everything is an occurrent for you, right?

PH: Well, no; for me, speaking now as a perdurantist, the distinction has no particular meaning or utility. If someone wants to say that is the same as saying that everything is an occurrent, then fine, as long as I am free to ignore this as meaningless.

CW: Fine, fine. But there is still a distinction between special parts of a worm that represent "intuitive change" and the worms themselves.

PH: That is what Fritz says, and what I still have trouble following. Actually I have trouble following what it means. Stick to 3-D for a moment and think of curved roads. You two seem to want to say that if a road goes around a corner, then there are two things; the road, which it itself is merely a kind of undifferentiated road-thing; and the curve, which is something *else*, which when in some sense 'added' to the road, produces a road with a curve in it. I find this incomprehensible. Roads, like many fairly rigid 3-D solid things, have a shape, and being curved at a certain place is one aspect of the shape of something. But the shape isn't *part* of the thing, or a component of it in some sense; it is a *property* of it. So if someone were to get puzzled about how to distinguish the road from the curve, I would be puzzled by their puzzlement. What *kind* of distinction can you possibly be seeking? This is either trivial or meaningless, seems to me.

CW: Well, here I give you the same medicine you gave me. There is plenty written about these "moments" (Smith, 1982):

CW: They are neither trivial nor meaningless. People talk about "the edge" and "the bend" (lets use bend instead of curve, I think curve has several subtle meanings that are confusing the point). They are talking about parts of an object that, as you observe, are identified by their shape, mainly. But they are special.

PH: But are they special *as a category*, i.e. is there anything useful to be said about them as a whole, that wouldn't be better stated as being about edges, bends, etc.? Maybe there is, but I would like to see that *emerge* from the particular axiomatizations, rather than being assumed on a priori philosophical grounds.

CW: The blade of a knife has a shape, too, it is usually roughly triangular (pointed knives). But we don't talk about it as "the triangle" of the knife.

PH: What it does it matter what we *talk* about it as? There are all kinds of words for parts of knives: blade, tang, rivet, handle, back, point, edge, serration, guard, and pommel. Seems more use to see if we can say what these *mean* rather than catalog them or try to draw conclusions from the particular lexical forms being used.

CW: And, in fact, in your 4-D view some of them correspond to something that, at least from a common sense and from a linguistic standpoint, is very important: events.

PH: Right, but those events are not like the events described in the situation calculus. or other 'state-based' event descriptions They are spatially located, for example.

PH: Exactly the same seems to apply in 4-D. Histories have shapes, just as 3-D solids do; more complicated kinds of shape are possible, of course, in higher dimensions, but the basic ideas seem to survive the move from 3 to 4.

CW: Isn't that our point?

PH: It may be *your* point, but it’s not the endurantist's point. The whole idea of 4-D shape or 4-D parts would be anathema to an endurantist. I'm not sure what position you are arguing in this debate, to be honest, or what your point actually is.

PH: So for example the history of a ball bouncing on a solid surface has a characteristic 4-D shape, and many other kinds of events or processes have characteristic 4-D 'shape' features by which they may be recognized, in fact. Some of these aspects of 4-D shape are surface- or line- or point-like, and therefore hard to 'isolate', but there is nothing odder about that in 4-D than in 3-D or even 2-d for that matter. (They are often locations of surface discontinuities, for example, which are in fact rather easy to describe geometrically)

CW: This sounds exactly like the point we're trying to make. Are you capitulating, or do you think you are saying something different?

PH: I am certainly not capitulating. I'm not sure who "we" are, or what their point is, but this isn't what an endurantist would say, since he or she would deny the validity of the 4-D framework.

PH: (You never thought that a 4-D space didn't contain 3-D spaces, did you?)

CW: You acknowledge that bends, edges, etc. exist, and that 4-D worms have them. You acknowledge that they are parts.

PH: No, I don't acknowledge that. Some of them seem to be parts, some of them do not. They do not seem to form a coherent class, in fact, given the examples I've seen so far (for example, things like edges, bends and corners seem to obviously go together (and are maybe best not called parts, though they could be parts of surfaces) but I wouldn't put holes or colors into the same category).

CW: Nor would I. That's fine.

PH: Nobody has yet come up with a definition or even an explanation of what 'moments' are supposed to be that would enable me to tell whether any given thing was or was not one of them with any degree of confidence.

CW: Maybe Fritz can, it's been a while for me. But they are things "like" edges, corners, surfaces, etc.

PH: Already I can form no sensible category to include all these. I don't know what that "like" could possibly mean.

PH: (This is a common problem I have with this kind of philosophy, by the way. We start with the common-sense world, most of the entities in which I feel that I have a pretty good intuitive grasp of: I can recognize and describe tables, chairs, carpets, chisels, etc. etc. Then someone comes along and, by way of providing an *analysis* of these everyday terms, asks me to use terms that I have absolutely no idea how to define or characterize: sortals, moments, tropes, necessities, God knows what. Is this supposed to be progress, in some obscure way? It sure doesn't feel like progress.)

FL: The reason for making good distinctions near the top is to get a few, reliable inferences that apply to huge classes of things. For example, Pat said that a work like Moby Dick is not a character string; nor is it a physical object; nor is a a straightforward event. (See (Reicher, 1998)) If we say chapter 6 is a "part" of it, what should an automatic reasoner conclude? That it comes "after" chapter 5? Yes. But temporally? Well, yes if read aloud in the conventional order. We speak loosely about these things because the context tells us what's meant - say, by "Moby Dick is a lot bigger than Anna Karenina." - but a computer needs to get it right for mundane reasoning purposes. This and lots of other things ("Repealing a statue." in natural language) depend on near-top-level distinctions.

PH: Sure, I have no gripe with top-level distinctions. But I want them to arise from actual use, not be imposed by someone's philosophical agenda. Moby Dick is indeed a good example to worry about, but I don't see 'moments' being much use there. My rhetorical point in the above paragraph is that 'moments vs nonmoments' is in fact, as far as I can tell, a rather bad top-level distinction.

CW: The top-level utility of moments is probably also a separate and tangential argument. I believe "moments" were thrown in by Fritz as a way of accounting for change in the 4-D view. At one point in the past, Pat said something that both Fritz and I took to mean, "there is no change in 4d". Fritz countered that, for example, a "bend" in a worm would correspond to a change, and that you could isolate these bends using moments. Some of these moments would be events, or at least caused by them.

FL: I think Pat is mistaken to suggest that these top-level distinctions lack practical value.

PH: Let me suggest a pragmatic guide. Any high-seeming distinction should only even be contemplated if the person suggesting it can give about 10 things that need to be said that involve making the distinction, ie that cannot readily be said without it. That immediately would suggest a concrete(physical, spatiotemporal)/abstract distinction, for example, and might also justify an animate/inanimate one, and would suggest introducing surface/edge/solid kinds of distinctions, and thing/stuff distinctions, and with a little thought would also justify type/token distinctions in textual abstractions. But I don't see it providing a basis for choosing among mereologies, or for introducing moments or tropes as classifications, or for wanting to distinguish sortals from nonsortals.

CW: This is a fine upper level. Note that sortal/nonsortal is a meta-level distinction, in that "being a sortal" is a property of a property.

CW: But anyway, the point is that my upper level includes events. This seems not only reasonable, but very common-sensical. I'm not asking you to *put* them in your upper level, even that debate is a separate one. I just want events. Can you give any reason why someone who wants events can't use 4-D?

FL: They should not occupy us endlessly (except for fun) - we should decide and move on. I agree that, by far, most of the inferential power comes from axioms at middle levels, not those at the top.

CW: Oh come on, surely Philosophy is not the only field guilty of that. Look at us. Look at "ontology" - this was only ever intended as a fancy new word for something old so that people wouldn't associate it with expert systems. In every single "real-world" "ontology" project I've ever worked on, we always found ourselves foundering when it came to assigning terms to the highest level categories we identified. Usually we resorted to the

dictionary or some philosophy textbook, just to find a suitable term, and usually it wasn't a term most people were familiar with.

PH: I wasn't meaning to complain about the vocabulary being used, but about the actual concepts involved. The notions of moment, trope and logical necessity seem to have no utility in the world I inhabit. I live my life surrounded by very complicated stuff that I would love to be able to describe axiomatically, but I swear on a pile of Bibles that I have never, in all my born days, once laid eyes on, or even thought about, a trope or a moment, until I met a philosopher.

CW: The suggestion is that these special parts be called events (that's not strictly correct, but I think is ok for now).

PH: My suggestion is that classifications like 'event', 'object', and so on are largely useless, and often in fact actively confusing, since many things can be categorized either way. What is the point of calling these things, whatever they are, "events"? Suppose I were to agree to this: how would that move us forward one iota towards the goal of forming a useful, coherent, description of the world? What insight or utility would it provide? What useful axioms would it enable me to write, or what errors help me to avoid? Why is it worth spending even a centime's worth of mental effort arguing over? I don't want to waste time discussing how to decide how to classify something into some pre-defined categories that do not give any insight into the phenomena being described; it is a complete waste of time. It has a medieval flavor about it, like making catalogs of all the things in the universe before any actual science has been done.

CW: Well, take the large number of people who do want classifications like event and object.

PH: I would respond: justify your choice of classification. We are talking here about formal ontological classifications, not intuitive, loose, everyday ones. So it’s not enough to say 'it feels right to me' or 'my old granny talks that way'. One wants to see how this classification is going to enable one to write better axiomatic descriptions.

CW: The simple point we're trying to make is that, for such people, the 3-D vs. 4-D views do not prevent you from having them.

PH: Maybe you can say exactly what those 'views' are. If you mean the endurantist/ perdurantist contrast, then they each, in their own way, can make the informal distinction (of course); but for the endurantist, it has been made into a basic, rigid partitioning of the entire physical universe into two exclusive categories; while for the perdurantist, it has kind of dissolved into an incidental matter, a distinction that can be made if you wish, but also can be ignored or even flaunted with impunity. Those are not compatible ontological strategies.

CW: Let me see if I can cast this right: how do you decide what makes a worm?

PH: Everything in the spatiotemporal - physical, if you like - universe ihas a worm as its extent. These worms - I prefer the term 'history' - are the spatiotemporal extents of physical things. Think of the 3-D idea of a spatial extent. Worms are 4-D extents.

PH: If you like, you could say that continuants were the occupants of certain histories. That wouldn't sit well with an endurantist, however. However, I'll let you in on a dirty little secret: there is in fact no need to distinguish between a thing and its extent, for almost all purposes. We can identify things with the space-time regions they occupy. Its philosophically most unsatisfactory, but it works. Tough luck for philosophical satisfaction.

CW: How is a book a worm?

PH: It takes up some space and lasts for a time, so it occupies a history.

CW: How do you decide what collections of matter to assign worm-ness to?

PH: You do not need to. Histories need not contain any matter. One does not 'assign' anything. Existing is not something that needs to be assigned (except possibly by God?)

[ed note: At this point, we end the dialog. While neither side has prevailed, it is hoped that the wealth of references, examples, and explanations given has helped the reader to understand the issues, and the positions of the people in the dialog, more fully.]

References

Berg, J., (1962) *Bolzano's Logic*. Stockholm.

Feldman, N., (1990) Cylindric algebra with terms. The Journal of Symbolic Logic, 55(2): 854-866.

Genesereth, M. (1991). "Knowledge Interchange Format," *Proceedings of the Second International Conference on the Principles of Knowledge Representation and Reasoning* (KR-91), J. Allen et al., (eds), Morgan Kaufman Publishers, 1991, 238-249. See also http://logic.stanford.edu/kif/kif.html.

Hayes, P., (1985:1). Naive Physics I: Liquids, in J.R. Hobbs and R.C. Moore (Eds.) *Formal Theories of the Common Sense World* (Vol. 1). Norwood, NJ: Ablex Publishing Company, 1985.[Reprinted in: *Readings in Cognitive Science*, ed. Collins and Smith, 1988.also in: *Readings in Qualitative Reasoning about Physical Systems*, ed. Weld and deKleer, 1989.]

Hayes, P., (1985:2) The Second Naive Physics Manifesto, in J.R. Hobbs and R.C. Moore (Eds.) *Formal Theories of the Common Sense World* (Vol. 1). Norwood, NJ: Ablex Publishing Company.[Reprinted in: *Readings in Knowledge Representation*, ed. Brachman and Levesque, 1986.also in: *Readings in Qualitative Reasoning about Physical Systems*, ed. Weld and deKleer, 1989.also (abbreviated) in: *Computation and Intelligence: Collected readings*, ed. G.Luger, MIT Press 1995]

Heidegger, M., (1927). *Sein und Zeit*. English Translation of *Being and Time* by Joan Stambaugh (1996) SUNY press.

Kripke, S.A. 1971. Identity and necessity. In (M. Munitz, ed) *Identity and Individuation*.

Lenat, D. (1995). "Cyc: A Large-Scale Investment in Knowledge Infrastructure." Communications of the ACM 38, no. 11 (November).

Loemker, L., (ed. and trans.) (1969), Leibniz, G. W., Philosophical Papers and Letters, 2nd ed., Dordrecht: D. Reidel.

Loux, M., (1998). *Metaphysics: A Contemporary Introduction*, Routledge pub.

McTaggart, J., (1908). The Unreality of Time, Mind, pp. 457-474.

Peirce, C. S. (1931-1958) Collected Papers of C. S. Peirce, ed. by C. Hartshorne, P. Weiss, & A. Burks, 8 vols., Harvard University Press, Cambridge, MA.

Porter, J., (1987).. *Extensions and Absolutes of Hausdorff Spaces*. New York: Springer-Verlag..

Reicher, M., (1998). Works and Realizations, in: N. Guarino (ed.), Formal Ontology in Information Systems. Proceedings of the First International Conference (FOIS'98), Trento, Italy (June 6-8 1998), Amsterdam 1998 (Frontiers in Artificial Intelligence and Applications 46), 121-132.

Simons, P. (1987). *Parts: A Study in Ontology,* Oxford: Oxford University Press.

Smith, B. (ed), (1982). *Parts and Moments Studies in Logic and Formal Ontology* Philosophia Verlag.

Sowa, J. (2000) Knowledge Representation, Brooks/Cole, Pacific Grove, CA.

Thompson, A. C. (1996). *Minkowski Geometry*. New York: Cambridge University Press.

Whitehead, A., (1929) *Process and Reality*, New York: Macmillan.

Zalta, E. (ed.), (2002) The Stanford Encyclopedia of Philosophy, http://plato.stanford.edu/, The Metaphysics Research Lab at the Center for the Study of Language and Information, Stanford University, Stanford, CA, International Standard Serial Number: ISSN 1095-5054