

Closed Time and Local Time: A Reply to Dowe

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ABSTRACT

In his contribution to this issue, “A and B Theories of Closed Time”, Phil Dowe argues that A- and B-theories of time are equally compatible with closed time, though it is commonly supposed that only B-theories are compatible with it. With some reservations to be noted below I agree with Dowe’s general conclusion, but in the course of his argument there are a number of false statements and misrepresentations of detail that require comment. I will not be able to deal with all of them in this brief note.

Kurt Gödel, quite famously, found a solution to the field equations of the general theory of relativity (GTR) that had odd and perhaps even disquieting properties. In his 1949 paper introducing what we now call *Gödel spacetime*, *G*, he listed nine of its properties, and I will highlight four as of particular relevance to the discussion here:

- (4) The totality of time-like and null vectors can be divided into +

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- and — -vectors in such a way that: (a) if ξ is a + - vector, $-\xi$ is a — -vector, (b) a limit of + - (or — -) vectors, if $\neq 0$, is again a + - (or — -) vector. That is, a positive direction of time can consistently be introduced in the whole solution.

(4) says, in more contemporary terms, that G is temporally orientable, that a past/future distinction can be made consistently throughout the spacetime.

(5) It is not possible to assign a time coordinate t to each space-time point in such a way that t always increases, if one moves in a positive time-like direction; and this holds both for an open and a closed time coordinate.

(5) says, basically, that G lacks a global time function. A relativistic spacetime (M, g_{ab}) admits a *global time function* if there is a smooth function

$t: M \rightarrow \mathbb{R}$ such that, for any distinct points $e, e' \in M$, if $e' \in J^+(e)$, then $t(e') > t(e)$.¹ The set $J^+(e)$ is the set of points that can be reached from e by either future-directed timelike curves or future-directed lightlike curves. (Notice that definition of a global time function makes sense only in temporally oriented spacetimes.)

(6) [I]f P, Q are any two points on a world line of matter, and P precedes Q on this line, there exists a time-like line connecting P and Q on which Q precedes P ; i.e., it is theoretically possible in these worlds to travel into the past, or otherwise influence the past.

(6) says that Gödel spacetime contains closed timelike curves (CTCs).

(7) There exist no three-spaces which are everywhere space-like

¹ Except when quoting I will follow the notation and terminology of Manchak (2016).

and intersect each world line of matter in one point.

(7) says that there are no global time slices (or just slices) in Gödel spacetime. Stein (1970) also mentioned this fact in his first footnote: “It is a simple consequence of the facts to be discussed that there exist *no* complete spatial cross-section of the Gödel spacetime...” (p. 590)

Dowe wrote: “Of course, as for any world, it is possible to partition the Gödel world into mutually exclusive jointly exhaustive hypersurfaces...” (p. 186) Unfortunately, property (7) tells us that this is not so, assuming that the hypersurfaces are intended to be achronal sets. And this mistake is philosophically critical, because it is precisely the successive occurrence of hypersurfaces (or slices) that, in Gödel’s view, constitutes the objective lapsing or passing of time. “The existence of an objective lapse of time... means (or, at least, is equivalent to the fact) that reality consists of an infinity of layers of ‘now’ which come into existence successively.” (Gödel, 1949b, 558)

If one accepts Gödel’s characterization of the objective lapsing of time, then it seems at first blush that one has no choice but to think that there is at least one physically or nomically possible spacetime in which it is demonstrable that there is no objective lapsing of time. This, in turn, might make one feel quite uncomfortable with the notion of an objectively lapsing time in *any* spacetime.²

But one can agree (reasonably, I hope) that Gödel’s characterization of the objective lapsing of time captures succinctly our *pre-relativistic* notion of passage³ but then wonder whether there is some viable relativistic analog of this notion, even if there is no duplicate. Of course the notion of an analog is vague and somewhat open-ended. The idea that I had when writing Savitt (2005) was that some sort of local succession might be found in all relativistic spacetimes, even if global succession (the successive occurrence of slices) might sometimes be absent or superabundant. I have an ally in this focus on succession, I

² The precise nature of this discomfort has been extensively examined. See Manchak (2016) and the references therein.

³ As I argued in Savitt (2002).

think, in Arthur Prior, who wrote (1998, 104): “I believe that what we see as a progress of events *is* a progress of events, a *coming to pass* of one thing after another...”

If succession is the core of passage but there is no succession of slices, then just what is it that succession is succession of? That is, what is the (or, perhaps, a) relativistic analog of the present? It seemed clear to me that this structure would have to be local rather than global, and the one local structure that I found compelling was a causal diamond.⁴

Choose two points, p and q , with p (say) earlier than q , on a timelike line in a relativistic spacetime M . Then the interior of the intersection of the future light cone of p with the past light cone of q is a *causal diamond*.⁵ This is a bounded structure. If, for example, q occurs one second of proper time later than p , then the structure at its widest spatially is one light-second across. One light-second is roughly 300,000 km.

I thought (and still do think) that the passage of time in relativistic spacetimes can be thought of as the succession of causal diamonds along a timelike line. I thought (but no longer think) that this view of passage would suffice to extend the notion of passage straightforwardly to causally anomalous spacetimes like Gödel spacetime. It is not hard to see that in any spacetime in which property (6) of Gödel spacetime holds, both the past light cone and the future light of any point is the whole spacetime. The proposal that I made in Savitt (2005) to accommodate passage in Gödel spacetime fails there, as Dowe notes.

There are two points to make in regard to this failure. First, it may be that a revised version of essentially the same strategy can succeed even in Gödel spacetime. What I have in mind is suggested by a remark in Wald (1984, p. 263) that for every spacetime $(M, g_{\mu\nu})$ and for every point p in M , one can find a neighborhood O of p such that $(O, g_{\mu\nu})$ is a globally hyperbolic spacetime. Since $(O, g_{\mu\nu})$ is globally hyperbolic, (1) it admits a global (global, that is, for $(O, g_{\mu\nu})$) time function and (2) it admits the Alexandroff topology, the topology consisting of causal diamonds, since

⁴ I try to give some reasons for this choice in Savitt (2009). This paper was criticized in Dorato (2011), and I respond in Savitt (2015).

⁵ More formally, in this case a causal diamond is the set $I^+(p) \cap I^-(q)$.

it must be strongly causal.

From the standpoint of cosmology, a galaxy can be represented as a point in a general relativistic spacetime. (See Schutz, 2009, p. 336.) On quite a large scale compared to us, then, the objective lapsing of time can straightforwardly be represented by the succession of causal diamonds along timelike lines.⁶ And this can be done at every point in the spacetime, so one could patch together, say, a trip around a CTC.

The second point is that, as the discussion above indicates, my motivation to propose causal diamonds as presents in relativistic spacetimes was to find a way to account for passage, for a dynamic element, in those spacetimes. I had no intent to defend any thesis regarding “temporal ontology”. In fact, I have long (since about 2001) believed and that there is no genuine content to the supposed ontological dispute between presentism and eternalism. I argued this at length in Savitt (2006), where I claimed that both views are (trivially) true, insofar as they are views.⁷

Dowe tries, however, to cram my view into the Procrustean categories beloved of contemporary analytic metaphysics. He discusses my view in a section called “Local Presentism in Closed Time” (p. 6) He says there that Savitt

...defines ‘real and present for space-time points p , q ’ as the region containing p , an earlier event q , and the overlap between p ’s backward and q ’s forward light cones, where the distance between q and p is the measure of a minimum time of conscious

⁶ Since each (O, g_{ab}) is globally hyperbolic, the passage of time in each such spacetime could be represented by a succession of “global” hyperplanes as well.

⁷ I suggested in that paper that it would be more philosophically illuminating to view them as complementary, equally valuable perspectives on the temporal world rather than as would-be rival substantive theses. In a recent correspondence Natalja Deng has led me to see that this view might be pushed further—that the supposed opposition between presentism and eternalism might reflect the sorts of ethical or practical trade-offs that time bound creatures like us must inevitably make in regard to the values or the utilization of resources in the present versus other times.

experience (Savitt 2005, fn 17, p. 421, see also Arthur 2006).

Let me now quote in its entirety my footnote 17:

Formally, the set defined is usually indicated by $I^+(p) \cap I^-(q)$. This set is the intersection of the interior of the future light cone of p with the interior of the past light cone of q . In the language of Naber (1988: 29), this set is the intersection of the future time cone of p with the past time cone of q . The existence of this set of events is not dependent upon any sort of mind or sensibility “experiencing” the events p and q , although the length of proper time chosen to separate the beginning and end of each present is fixed with an eye towards human psychology.

The reader should notice that the words ‘real and,’ though they appear within quotation marks in Dowe’s paper and so look as if they were my words, are entirely absent in footnote 17 and its context. These gratuitously added words make it seem as if I am espousing a sort of metaphysical view that I eschew.

I do attempt in footnote 17 to forestall what I take to be an entirely different (but persistent) misunderstanding (as I see it) of my view—the view that causal diamond presents are somehow mind-dependent entities. It is true that the scale of the diamonds I think of as presents is set by the human specious present (modulo the well-known fact that ‘now’, like ‘here’, has an accordion-like sensitivity to context when it comes to extent)—roughly .5 to 3 seconds of proper time along the given world line. Whether readers agree with me regarding the mind-independence of causal diamonds or not, I hope they will recognize that this view is entirely distinct from one that might be called (local) presentism.

Furthermore, in the text of the paper, following just after the occurrence of footnote 17, I try to make clear my indifference with respect to the eternalism/presentism distinction without wandering too far off the topic of that paper. There is a picture of a series of causal diamonds along a timelike curve, trying to illustrate the sort of passage I was hoping to defend, and then I say:

Is this picture coherent when the curve in question is a CTC? Now that we have dissociated ourselves from the suspect metaphysics of the universal now, what reason is there to suspect that it is not? All points on the curve equally exist in the detensed sense, which means only that they are points or events in the spacetime. Any point on the curve, were one located there, has associated with it a well-defined present. One might feel that only that point and its associated present exist (in the tensed sense). Others at other places and times moving on other timelike trajectories will disagree, but we are used to such disagreements in relativity theory. And for those who are nearby and moving slowly with respect to one another, the amount of overlap of their presents will be so great that it will be easy to understand how we developed the idea of frame-dependent universe-wide layers of “now”.

I suggest that no fair-minded reader would see in these remarks an espousal of any sort of non-trivial presentism.

I said at the beginning of this note that I was in broad agreement with Dove’s contention that closed timelike curves were equally compatible with A-theories and B-theories. My reservations with his conclusion begin with the invocation of the A-theory/B-theory distinction. These terms are used in different ways by different authors. They do represent common syndromes of views, but I do not think the use of these terms conduces to clarity or precision in discussion.

Dowe does tell his readers what he means by these terms. The B-theory denies that there is becoming, and becoming is “the change from future to present to past.” (ibid) On the other hand, “[F]or A-theories time is the change from future to present to past in events so ordered.” (p. 187) I will assume that the A-theory is the denial of the B-theory as I stated it, though that is not quite what Dowe says.⁸

I will further assume that what “the change from future to present to past” means is spelled out in a famous passage of C. D. Broad’s (1938, pp. 266-67) in which he describes what he calls *the transitory aspect of*

⁸ There is an ontological component to his characterization of these “theories”, and I have noted above that I find the contrast that he is trying to get at empty.

temporal facts:

The third, and much the most puzzling, set of temporal characteristics are those which are involved in facts of the following kind. An experience is at one time wholly in the future, as when one says "I am going to have a painful experience at the dentist's tomorrow." It keeps on becoming less and less remotely future. Eventually the earliest phase of it becomes present; as when the dentist begins drilling one's tooth, and one thinks or says "The painful experience I have been anticipating has now begun." Each phase ceases to be present, slips into the immediate past, and then keeps becoming more and more remotely past. But it is followed by phases which were future and have become present. Eventually the latest phase of this particular experience becomes present and then slips into the immediate past. There is the fact which one records by saying "Thank God (on the theistic hypothesis) that's over now!" After that the experience as a whole retreats continually into the more and more remote past.

It seems to me as certain as anything in experience that temporal facts do have this transitory aspect. Accordingly, I deny the B-theory and so embrace the A-theory (as characterized here).⁹ Since, as I explained above, much of my work has been motivated to find a way to model passage (or becoming) in relativistic spacetimes, It should not be surprising that I agree with Dowe's conclusion that the A-theory is compatible with the existence of closed timelike curves in a spacetime.¹⁰

Moreover, it may well be time to think more about closed time. At the end of my discussion of Kit Fine's views about time in my essay in the first half of this special issue (Savitt, 2016), I cited a recent result of John Manchak's:

⁹ But since I have no qualms about insisting that the entire spacetime manifold exists in the detensed sense, by some accounts I would be reckoned a B-theorist as well. So be it.

¹⁰ I add that of course it is one thing to affirm the existence of the transitory aspect of temporal facts but quite another matter to provide a satisfactory philosophical account of it. I tried to do this in Savitt (2002).

Proposition 1. Every space-time (M, g_{ab}) is weakly observationally indistinguishable from a space-time (M', g'_{ab}) that fails to have a global time function. (2016, p. 1053)

On the basis of this result I claimed that no matter how much evidence we may acquire at any time, there is always a weakly observationally indistinguishable spacetime (an “evil twin”) that cannot be foliated—divided into mutually exclusive and exhaustive slices. If the passage of time requires such foliation, then, as I have already claimed, we cannot know that time passes here, in our world. Since I think we do know that time passes, I concluded that the requirement of global slices is too strong.

But in writing this note, I came to see that Proposition 1 has another implication. A global time function imposes a linear ordering on time. If our evil twin lacks a global time function, then it may well have some other temporal ordering, like a circular ordering. It looks as if no amount of evidence available to us can rule out the (nomic) possibility of circular time (assuming GTR, of course). There may well be much more to say about the import of Proposition 1, but it does seem to imply that discussions of time that presuppose its linearity are overly narrow.

Dowe contrasts two ways of doing philosophy of time. The first is bending your understanding of spacetime theories to the metaphysical views you bring to them. The second is deriving your metaphysical views from the science (while recognizing that no scientific theory is likely to settle by itself all relevant philosophical questions). He characterizes the latter method as “trivial”, but I think that my observations above show that this view of the second way results from his failure to understand the depth of the relevant scientific theories.¹¹

¹¹ I wish to express my gratitude to the editor of this special issue for affording me the opportunity to reply to Dove’s paper.

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