Coexistence in Minkowski Spacetime

Yuri Balashov
University of Georgia
yuri@uga.edu
http://yuri.myweb.uga.edu

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Extended Abstract

For the eternalist (i.e., non-presentist) about time, there is a basic sense in which all the inhabitants of spacetime—those which we call (in our unreflective moments) past, present and future—coexist with each other, simply because all such entities—dinosaurs, Nebuchadnezzar, Jacques Chirac, future outposts on Mars and Gorbachev's great great grandson—*exist* at their respective spacetime locations. But even the eternalist must admit that there is another and non-trivial sense of the coexistence relation such that she bears this relation to Chirac but not to Nebuchadnezzar. Chirac, in his turn, bears this relation to the eternalist, but there was a time when he did not. Chirac never coexisted, in the interesting sense, with Napoleon. Chirac no longer coexists with Ronald Reagan, but there was a time when he still did.

This sense of coexistence is familiar and important and its application is not limited to sentient beings. The Great Wall of China coexists, in this interesting sense, with the Taj Mahal, but there was a time when it did not. The Milky Way has similarly coexisted (and still does—as far as we know) with the Magellanic Clouds.

It is relatively easy to characterize the interesting notion of coexistence in classical terms: roughly, things coexist, in this sense, just in case they are located at the same moment of absolute time. Can the interesting notion of coexistence be extrapolated to Minkowski spacetime? To the extent that this is possible it requires certain adjustments in the notion. (Everyone must be prepared to make adjustments in making a transition to something as full of surprises as Minkowski spacetime.) The need to make the adjustments reveals two distinct strands in the "intuitive lore" of the coexistence relation. They work together in the classical setting but come apart in the relativistic context, thus giving rise to two different sets of rules associated with the use of the interesting concept of coexistence. Which of them, if any, can claim the title? I consider the alternatives and defend my preferences.

In a bit more detail, I defend the concept of Coexistence As Spacelike Separation (CASS) against a rival account recently developed by Gibson and Pooley (2006). In both cases it is convenient to start with a four-place relation CO involving two idealized pointlike objects o_1 and o_2, and their spatiotemporal locations p_1 and p_2:

(CO) $CO(o_1,o_2,p_1,p_2) =_{df} o_1$ is located at $p_1 \wedge o_2$ is located at $p_2 \wedge R(p_1,p_2)$.

CO obtains just in case o_1 and o_2 are located at spacetime points p_1 and p_2, respectively, and the relevant two-place relation R holds between p_1 and p_2. The nature of R is determined by a particular spacetime theory. CO defines the basic notion of coexistence, which, in turn, gives rise to a family of derivative notions, some familiar some new.

I argue that the best candidate to ground (the interesting notion of) coexistence in Minkowski spacetime (ST^M) is the invariant relation of spacelike separation between momentary locations of persisting objects:

(CASS) $\quad R^M(p_1,p_2) =_{df} I(p_1,p_2)<0,$

The rival account builds on the notion of an object's "Alexandrov-Stein Present" (AS-Present), which comprises the location of the entities with which the object can *interact* (i.e., affect and be affected by) during a short but finite interval of its intrinsic "specious present" Δt^{NOW}. The AS-Present of Δt^{NOW} — $\text{Present}_{AS}(\Delta t^{NOW})$ — is a discus-shaped region, typically with a huge spatial extent and a very short temporal extent.

"Alexandrov-Stein Coexistence" (AS-Coexistence) can then be defined as follows. Suppose two objects o_1 and o_2 are located at p_1 and p_2, respectively. Assuming that one can associate with o_1 and o_2 the corresponding finite intervals of their extended NOWs, $\Delta t^{NOW}{}_1$ and $\Delta t^{NOW}{}_2$, let us say that they *Alexandrov-Stein-coexist* (*AS-coexist*) iff they are located in each other's AS-Presents:

(AS-Coexistence) $\quad R^M(p_1,p_2) =_{df} p_1 \in \text{Present}_{AS}(\Delta t^{NOW}{}_2) \wedge p_2 \in \text{Present}_{AS}(\Delta t^{NOW}{}_1).$

The basic idea is that objects coexist (in an interesting sense) provided their presents "substantially overlap" and, hence, "there is a reasonable sense in which they share a common present" (Gibson and Pooley 2006, 170).

Initially AS-Coexistence may have much to recommend it. But in my view, it suffers from many defects and must, in the end, be rejected in favor of CASS. One way to show it is to see how both accounts fare vis-à-vis certain natural requirements that may be imposed on an interesting notion of coexistence in spacetime. I introduce and motivate four such requirements: Symmetry, Objectivity, Multigrade and Relevance. I then argue that, while CASS passes all of them with flying colors, AS-Coexistence barely passes Multigrade, seriously stumbles on Objectivity and completely fails Relevance.

The whole situation throws some interesting light on how to extend metaphysically important ordinary concepts beyond their original domains of applicability.

A rough draft (work in progress) of the whole paper is available at:
http://yuri.myweb.uga.edu/Working/coexistence_in_minkowski_spacetime.pdf