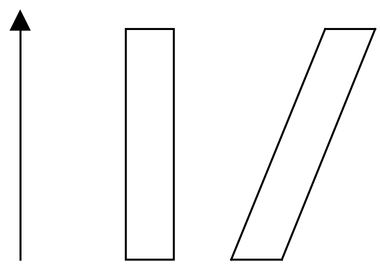
The scientific argument against presentism

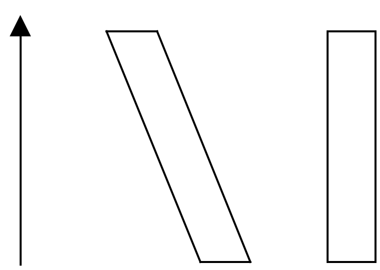
November 6th, 2001

1. Newtonian spacetime

When we originally explained the conventions for drawing spacetime diagrams, we said that vertical lines represented (the boundaries of) static objects, while slanted lines represented (the boundaries of) moving objects. Thus, in this diagram, the object on the left is static and the one on the right is moving:



But does it really make sense to ask whether an object is *really* moving, and how fast it is moving—not with respect to some other object, but absolutely? Newton thought it did. But this view seems hard to accept. For—and ironically, it was Newton himself who did more than anyone (except maybe Galileo) to establish this—the laws of standard physics entail that there is absolutely nothing we could do to decide the question. Everything would *look* just the same to us whether we were in the world depicted above, or the following world:



The facts about *relative* motion are the only facts that matter from the point of view of standard Newtonian physics. So if you agree with Newton, you will have to admit that all of the following mutually hypotheses are left open by our evidence—and it is hard to see what principled basis we might give for choosing some over others:

We are (right now) at absolute rest
We are moving at 10 ms^{-1} towards Alpha Centauri
We are moving at 10,000 ms^{--1} towards the sun
etc.

2. Neo-Newtonian spacetime

You might reply: what's so bad about that? Just because we can't know something doesn't mean that there's no fact of the matter!

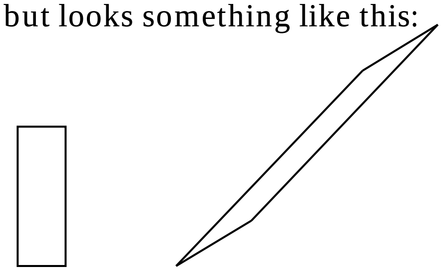
Good point. But still, the facts I've just described seem like a good reason to see if we really need to agree that questions about absolute velocity make sense.

Certainly we should not be misled into thinking that they make sense just because there are two different *diagrams* on the preceding page. Not all facts about a spacetime diagram correspond to objective facts about the bit of the world that is represented by your diagram. Some choices are arbitrary, or made simply for the sake of convenience. The choice of scale for time and space are like this. Stretching your diagram in space or time doesn't affect what it represents the world as being like. So if we like, we can declare that the two diagrams on the preceding page are two equally good diagrams of the same objective situation.

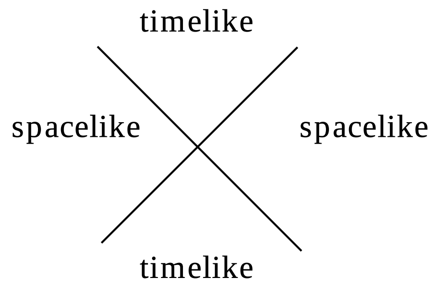
Neo-Newtonian spacetime is a type of geometrical structure with the property that when you draw diagrams of it, there is no objective sense to be made of the distinction between diagrams which differ only by a *Galilean transformation*: a 'shear' perpendicular to the time axis.

3. Minkowski spacetime

Minkowski spacetime is a much stranger geometrical structure. In Minkowski spacetime, two diagrams which differ only by a *Lorentz transformation* are equally good representations of the same situation. A Lorentz transformation is hard to draw, but looks something like this:



Note that a line which used to be horizontal is transformed into one that isn't horizontal. This tells us that there is no objective sense to be made of the notion of *simultaneity* in Minkowski spacetime. All that's objective is the 'light cone structure': the distinction between points that are space-like, time-like and light-like separated from a given point:



We *can* make sense of the notion of simultaneity *relative to a frame of reference*. That is, if we choose some straight timelike line through a point and decide to draw that line as a vertical line in our diagram—in other words, we treat that line as the trajectory of an object *at rest*—this will determine which plane—or more properly, which 3d hyperplane—we should draw as horizontal, i.e. treating it as the set of all points simultaneous with the given point. The converse is true: if we fix on a certain hyperplane and decide to treat points on that hyperplane as simultaneous, we will uniquely determine a notion of rest, relative to that hyperplane. ***

Einstein's special theory of relativity, as it is normally interpreted, proposes that our spacetime—*real* spacetime—is a Minkowski spacetime.

4. Presentism and spacetime diagrams

A presentist can explain what goes on when we draw a spacetime diagram in terms of the operators 'It was the case *n* units of time ago that…' and 'It will be the case *n* units of time hence that…'.

A presentist will think that to make a diagram fully explicit, you should say which [hyper]plane in the diagram corresponds to the present. The other bits of the diagram represent facts about what was and will be the case.

5. Presentism and special relativity

In Newtonian or Neo-Newtonian spacetime, it's objective which hyperplanes count as *times*, so you know what sort of thing you should pick out. But in Minkowski spacetime, the presentist, in picking out a distinguished hyperplane, must also pick out a distinguished frame of reference. Given this, we're back to the Newtonian picture: the presentist has to agree that the question 'are we at absolute rest or in absolute motion, and if the latter, in which direction and velocity?' makes good sense, despite the fact that physics doesn't give us any clue how to answer it.

(Prior seems happy to embrace this consequence.)

6. "Hybrid" views considered by Sider