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What is it for the world to be temporal? (abstract)

Our world is a temporal one: time passes; the acorn grows into the mighty oak; entire solar systems are born and decay. But what is it for the world to be temporal? The property of being a temporal world supervenes on other features of the world; but what other features?

One might think that the property of being a temporal world supervenes on the geometrical spatiotemporal structure of the world. In more detail: talk of the geometrical spatiotemporal structure of the world is talk of the geometrical structure of spacetime; one might think that there are some possible geometrical structures such that a possible world is temporal just in case its spacetime has one or another of these structures. But there are counterexamples to this claim: pairs of worlds, one temporal and the other not, in which the structure of spacetime is the same. There are purely temporal worlds, with no space but only (perhaps) non-spatial minds with ever-changing experiences, in which time is one-dimensional and Euclidean; and purely spatial worlds, in which nothing ever happens, in which space is one-dimensional and Euclidean.

To see what else, or what in addition to, the structure of spacetime is relevant to whether a world is temporal, we should ask a slightly different question: what makes time different from space? Or, to ensure that the question makes sense when considering spacetimes other than Newtonian spacetime: what makes timelike directions different from spacelike directions?

One might claim that here, in possible worlds that are both spatial and temporal, it is the geometry of spacetime that makes the difference between timelike and spacelike directions. This seems to be the tacit assumption of textbooks on spacetime theories. In particular, in the standard four-dimensional spacetimes, there is a clear sense in which time is one-dimensional and space three-dimensional.

Still, I think there are counterexamples to this claim as well. In two-dimensional Minkowski spacetime, both time and space are one-dimensional. If geometry alone makes the difference between time and space, then in possible worlds with two-dimensional Minkowski spacetime there is no fact of the matter about which directions are timelike and which spacelike. But when I consider worlds with such spacetimes in which the laws of nature look

a certain way, it seems to me that there *is* a fact of the matter about which directions are timelike.

It is the laws, I claim, that breaks the symmetry between space and time in such worlds. We normally think that the laws 'govern the temporal evolution of the world'; but this way of speaking makes it sound like the distinction between time and space is more fundamental than the laws. In my view, this is not so: instead, the temporal dimension gets to be the temporal dimension in part by playing a certain role in the laws: it is that dimension along which the laws govern the evolution of the world.

Timelike directions, then, are those that play a certain role in the geometry and the laws. This allows us to answer the question with which we began: what is it for the world to be temporal? A temporal world is one in which there is a timelike direction in spacetime.

There is a challenge for my view: what about possible worlds in which the laws and the geometry disagree about which directions are timelike? Are no directions temporal, or is there no fact of the matter about which directions are temporal, in such worlds? Neither answer is attractive. I argue that there are no such worlds: it is necessary that the laws and the geometry of spacetime agree on which directions are temporal. This picture of the relationship between the geometry of spacetime and the laws is independently attractive, and is kin to the common demand that the symmetries of spacetime and the symmetries of the laws are the same.