

Time and Change

PARADOX AND INFINITY

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Real Change

Grid: Consider a universe consisting of three pieces on a 3×3 grid.

- Consider three successive configurations of the grid in time.
- Compare this to three configurations of the grid separated in space.
- How does change across time differ from change across space?

Identity: The spatially separated grids are not identical.

- By contrast, the temporally separated grids are one.
- The properties of one and the same grid differ at different times.
- Call a complete configuration a *world state*.

Properties: What properties are to be included in a world state?

- A piece x is *shrew* at t iff either: (1) x is shaded at t and t is before 11am; or (2) x not shaded at t and t is after 11am.
- Suppose a shaded piece goes on being shaded at 11am.
- Does that piece change from being shrew to not being shrew at 11am?

Things: Consider the object which consists of the grid at different times.

- This object does not change in time, but goes on just as it is.
- Suppose we exclude temporally defined properties and things.
- We can ask what real properties every real thing has at a time.

Existence: World states determines which properties everything has.

- But suppose one grid ends and another begins at each change.
- Can still say that each grid is thus and so at each time.
- Do the things and properties that exist also change?

Change: A difference between the real properties real things have.

- Do two times differ only if there is a change between them?
- Something is some way at time t , and not that way at time t' .
- Could there be two times where the same things are all the same ways?

Real Possibility

Logical Possibility: “What is in question here is not whether it is physically possible for there to be time without change but whether this is logically or conceptually possible.” — Shoemaker (p. 368, 1969)

- Important to distinguish logical possibility in the sense of consistency.
- It is consistent for the atom to be gold and to have only 6 protons.
- There is no *way for things to be* where the gold atom has only 6 protons.

Metaphysical Possibility: Broadest range of objective possibilities (ways for things to be).

- Fixing the interpretation, how must things be for the claim to be true?
- Is there any way whatsoever for things to be where the claim is true?
- Interpretational possibility concerns truth on any interpretation.

Total Freezes

Universe: Suppose there is a possible world with A, B, and C regions.

- Local freezes occur every 3rd year in region A.
- Local freezes occur every 4th year in region B.
- Local freezes occur every 5th year in region C.

Total: On certain years, the freezes in different regions align.

- A and B freeze together every 12th year.
- A and C freeze together every 15th year.
- B and C freeze together every 20th year.
- A, B, and C all freeze every 60th year.

No Change: On that 60th year, does time pass without change?

- More dramatically, could there be permanently frozen worlds?
- What about worlds that occupy the same world states more than once?

Possible Worlds: Let W be the set of *world states* and T a strict total order of *times*.

- A *world evolution* is any function from $\tau : T \rightarrow W$.
- Which world evolutions are possible worlds?
- Are constant functions permitted? What about loops?

Convention: Is it a matter of convention whether there are total freezes or not?

- Which of two bodies is rotating around each other?
- The year is exactly 365 days long with a one day freeze every 4th year.
- Compare the continuum hypothesis or axiom of choice for sets.