Time Travel

Time Travel

Question: What is it to travel in time?

Personal Duration: The journey's duration in personal time: Δ_p.

External Time: The time for Earth's frame of reference: t_i.

External Duration: The difference in the external start and end times: $\Delta_w := t_e - t_b$.

Trival Time Travel: Occurs when $\Delta_w \neq 0$.

Non-Trival Time Travel: Occurs when $\Delta_p \neq \Delta_w$ (e.g., $0 < \Delta_p < \Delta_w$).

- If Bob travels close to the speed of light.

Extraordinary Time Travel: Occurs when Δ_w is negative or much greater than Δ_p.

Example: t_b is 10am EST, April 1st, 2024 and t_e is 10am EST, April 1st, 1924.

- Then $\Delta_w = -100$ years (i.e., 100 years in the past).

Metaphysical Possibility

Question: Is it possible to travel in time (in an extraordinary way)?

Practical Possibility: Is it possible for me to do a double backflip (on Earth's surface)?

Nomological Possibility: Is it nomologically possible for me to do a double backflip?

Metaphysically Possibility: Is it metaphysically possible to travel faster than the speed of light?

Objective Modality: Each modality concerns a range of objective *ways for things to be*.

- Metaphysical modality is the maximal objective modality.

Epistemic Modality: Is it possible that $a^n + b^n = c^n$ for some $a, b, c \in \mathbb{N}^+$ and $n > 2$?

- Fermat's last theorem was proven to be true (1995).
- Moreover, it is not possible for Fermat's last theorem to be false.
- Nevertheless, it may be epistemically possible for the uniformed.
- Or consider the epistemic possibility that $2,641 \times 31 \neq 81,971$.

The Possibility of Time Travel

Assume: It is practically impossible to travel back in time.

Agnostic: It is nomologically possible to travel back in time.

Question: Is it metaphysically possible to travel back in time?

World Travel

Actuality: Suppose that nobody has ever arrived from a future time.

- Deep in an MIT laboratory, Michele finishes her time machine.
- She gets in, eager to zip off into the distant past.
- Is it possible to travel into the past?

Branching Worlds: Is it possible to change the past?

- Instead of traveling to the actual past, one has traveled to another past.
- In what sense is traveling to a branching world count as time travel?

Take Two: Assume we restrict attention to time travel within one time-line.

- Michele can't travel back in time if she hasn't already arrived.
- If she has already arrived, she must travel back to those times.

Open Future: Is the future open if time travelers have already arrived?

- At least it is not as open as it might otherwise be assumed to be.
- But traveling back in time may be assumed to be entirely fixed.

Possibility: We don't just want to ask if our open future includes any time travel.

- We are asking if there are any worlds at all that include time travel.

Grandfather Paradox

Paradox: Tim travels to a time before his grandfather and grandmother met.

Question Can Tim kill his grandfather?

- If so, then neither Tim's father, nor Tim would have been born.
- So Tim wouldn't have traveled back in time, nor killed his grandfather.
- But how could Tim fail if appropriately poised to kill his grandfather?
- It would seem that Tim both can and cannot kill his grandfather.
- Perhaps this shows that time travel is not possible after all.

Equivocation: Or perhaps Tim can time travel, but only do exactly what he did.

- Considering everything, Tim cannot kill his grandfather.
- But 'can' is context sensitive, only taking some things into account.
- There are contexts which do not take everything into account where Tim *can* kill his grandfather.
- Tim has the necessary skills, position, timing, etc., he just doesn't do it.

Determined: Perhaps Tim can kill his grandfather even though it is impossible.

- Time travel has been defined in such a way that the future is closed.
- But as we will see next time, nothing forces this choice.