Time Travel

Summary Sheet – 24.118, Spring 2021

1 Defining Time Travel

Our working definition: to travel in time is for there to be a discrepancy between:

1. the start-time and end-time of one's journey, and
2. the duration of the journey from the perspective of one's own perspective.

2 Inconsistent Time Travel Stories

For a time travel story to be consistent is for it to never make conflicting statements about what the world of the story is like at a given time.

- For instance, *Back to the Future* is an inconsistent time travel story:

What we're told	**When we're told**
In 1985, George is unhappy	beginning of film
In 1985, George is happy	end of film

2.1 Caveat: No "Changing Timeline" Stories

"Changing Timeline" stories rely on two different senses of time:

1. an ordinary notion of time, which is used to describes changes *within* a given timeline;
2. a non-ordinary sense of time, which is used to describe "changes" in the timeline itself.

But: is the second sense really intelligible?

2.2 Caveat: No World Travel Stories

One can make some inconsistent time travel stories consistent by interpreting them as world travel stories.

But: that just means that we've changed the subject.

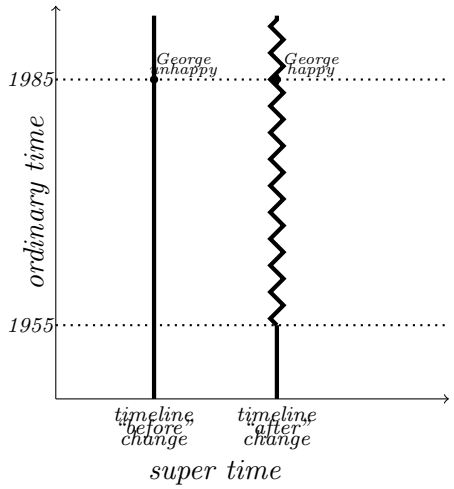


Figure 1: A change in George's timeline. The straight lines represent events as they "originally" occurred. The jagged line represents events as they occur "after" the change.

3 The Grandfather Paradox

You travel back in time to kill your grandfather, who is yet to have any children. You have a loaded gun at point-blank range.

- If you succeed, Grandfather will never have any children. So you'll never be born, which contradicts the setup of the story.
- If you don't succeed, what stops you?

Some reasons you might think the Grandfather Paradox is interesting:

1. It shows that the concept of time travel is incoherent.
2. It raises questions about whether the laws of physics could rule out paradoxical time travel in a principled way, without banning it altogether.
3. It shows that time travel is incompatible with free will.

(For what it's worth: I think these reasons are all mistaken.)

4 A Toy Model*

The particles of our world live on two dimensions and obey the following laws:

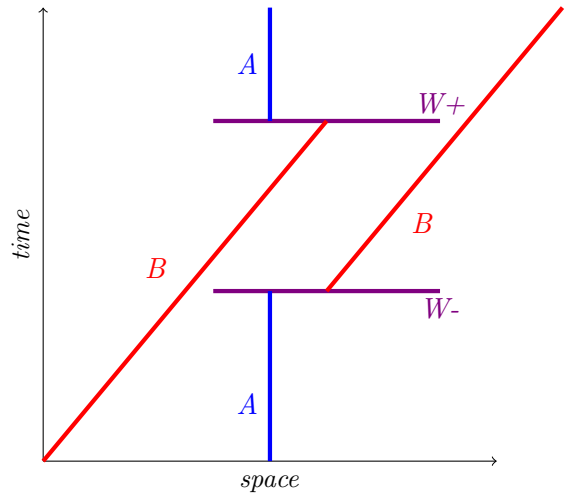
Law 1 In the absence of collisions, a particle's velocity remains constant.

Law 2 When two particles collide, they exchange velocities. (There are no collisions involving more than two particles.)

*The model is due to philosophers Frank Arntzenius and Tim Maudlin.

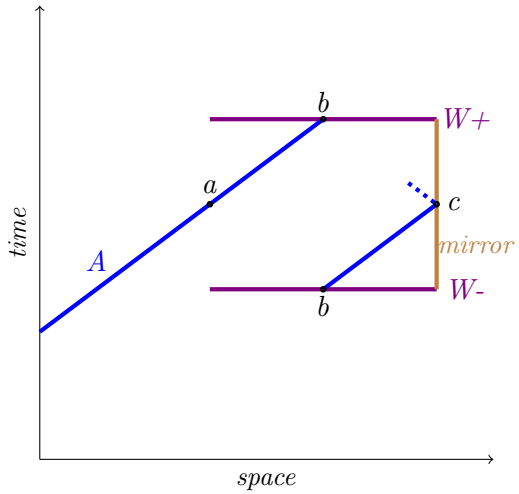
4.1 Wormholes

Our laws are consistent with wormholes. For instance:



In this diagram, the points represented by W- are identified with the points represented by $W+$. A jumps to the future when its spacetime trajectory reaches a point at which the wormhole is active; B jumps to the past when its spacetime trajectory reaches a spacetime point at which the wormhole is active.

4.2 A Toy Version of Grandfather's Paradox



Particle A is on a "paradoxical path". It travels rightward, passes through spacetime point a and enters the wormhole at spacetime point b, jumping to the past. It exits the wormhole and continues its rightward trajectory until it reaches the mirror at spacetime point c. But what happens next?

4.3 An answer to the toy paradox

- One does not characterize a world by *first* deciding how many particles the world is to contain (and assigning them each a position and velocity at a time), and *then* using the dynamical laws to calculate the spacetime trajectories of these particles.
- Instead, one characterizes a world by *first* drawing a family of spacetime trajectories that conform to the dynamical laws and *then* using the laws to determine how many particles the resulting world must contain.
- So: it is a mistake to think that one can characterize a world by stipulating that it is to contain a single particle traveling as in figure **??** and then ask what happens when the dynamical laws are used to calculate the particle's spacetime trajectory.

5 The Grandfather Paradox

Bruno travels back in time to kill Grandfather, who is yet to have any children. He has a loaded gun at point-blank range.

- If Bruno succeeds, Grandfather will never have any children. So Bruno will never be born, which contradicts the setup of the story.
- If Bruno doesn't succeed, what stops him?

6 What Does the Paradox Show?

Some possible answers:

1. It shows that the concept of time travel is incoherent.
2. It raises questions about whether the laws of physics could rule out paradoxical time travel in a principled way, without banning it altogether.
3. It shows that time travel is incompatible with free will.

I think these answers are all mistaken!

7 What is Free Will

The following hypothesis is meant to capture the idea that someone who acts freely has *control* over the action she performs:

Control Hypothesis An agent acts freely in doing X if and only if: (1) she does X by making a certain decision, and (2) she is in a position to do something other than X by making a different decision.

- The Control Hypothesis is actually incorrect. But it is a good starting point for elucidating the connection between time travel and free will, so we'll treat it as our working hypothesis for now.
- We'll assume the Control Hypothesis, and consider a couple of arguments purporting to show that Bruno fails to act freely because he was not in a position to make a different decision about how to take his shot.

8 First Argument

Argument: We know that, on pain of contradiction, Bruno's assassination attempt will fail. So Bruno isn't free to pull the trigger.

Reply: It is important to make the following distinction—

- Whether we—who live in the present day—have information about Grandfather's future that entails Bruno's assassination attempt will fail.
- Whether Bruno was in a position to kill Grandfather, regardless of whether we—who live in the present day—happen to know that things won't actually turn out that way.

9 Second Argument

Argument: If Bruno were ever on track to kill Grandfather, the laws of physics would intervene to derail him.

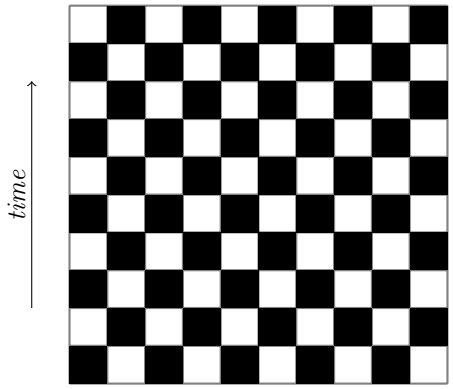
9.1 Determinism

For a system of laws to be **determinisitic** is for it to entail, on the basis of a full specification of the state of the world at any given time, a full specification of the state of the world at any later time.

- *Note:* Possessing free will is not simply a matter of having a decision-making process that is not subject to deterministic laws.

- *Note:* There are two different conceptions of physical law,

  1. The laws tell us what *will* happen, on the basis of what has happened.
  2. The laws tell us what *must* happen, on the basis of what has happened.



9.2 Back to the Argument

- On the second conception of physical law—a law tells us what *must* happen, on the basis of what has happened—it is indeed the case that the laws make it impossible for Bruno to act otherwise.
- On the first conception of physical law—a law tells us what *will* happen, on the basis of what has happened—the laws are silent on whether Bruno could have acted otherwise.

  (They are simply descriptions of the patterns that, as a matter of fact, characterize our world's mosaic.)

But, what *would* have happened if Bruno acted differently?

- Don't say that some additional defeater would have appeared and saved Grandfather.

  (That assumes that aiming just right would have *caused* the additional defeater to come about and we have been given no reason to think that such a causal structure is in place.)
- If Bruno had managed to aim just right, we would would have ended up in a situation that cannot be accounted for while keeping the rest of the story fixed.

10 Why the Control Hypothesis is Incorrect

- Suppose Susan freely decides to stay in New York. But had she attempted to leave she would have been prevented from doing so. (Perhaps she would have even been prevented from *deciding* to leave.)
- Then Susan acts freely. But the Control Hypothesis entails (incorrectly) that she does not.