

# Time Travel between Physics and Philosophy

Physics and the philosophy of the future, July 11, 2019, INFN, Frascati

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# The history of Time Travel

- Since Wells, **science fiction** writers have explored the idea in different fashions:
  - Historical tourism (unproblematic)
  - Incoherent / multiplicity of time-lines / hyper-time
  - Coherent (R. Heinlein)
- Since GR (Gödel?), **physicists and philosophers** have begun considering the idea seriously
  - metaphysical/physical possibility, even if not as a technically feasible one

# The present of Time Travel

- In **physics**:
  - No-go theorems (chronology protection conjecture)
  - Novikov consistency; K. Thorne's billiard
  - Multiverse (Lockwood, Green): five-dim manifold
- In **philosophy**:
  - Grandfather "paradox" and consistency (changing the past)
  - Information/knowledge from nowhere

# Time Travel

- Traveling in space: being in different places at different times
- Traveling in time: being in different times at different times
- Time travel requires in some sense **two times**

# The times of time travel

- **External time** (coordinate time):
  - Ordered as “time itself”: (roughly) the global causal order
- **Personal time** (proper time):
  - Ordered as (roughly) traveler’s causal path

# A visitor from the past

- Anna walks in the *INFN* in Frascati, at 15:30, July 11th 2019, and convinces you that she is a positivist scientist (born in 1845), who left her present, ca. 1880 on a time machine to visit the future... *her future*, namely *our present* (2019)...

# A visitor from the past

- Although at first she is pleased by many things she finds in 2019 (medical and technological advances, universal suffrage...), she quickly realises that *something went wrong* at a certain point along the way.
- Too many things are so disappointing, so many dangers: fake news and alternative facts, anti-scientism, AI “singularity”, climate change...
- “*This* future,” she tells you, “is certainly not the best possible one.”

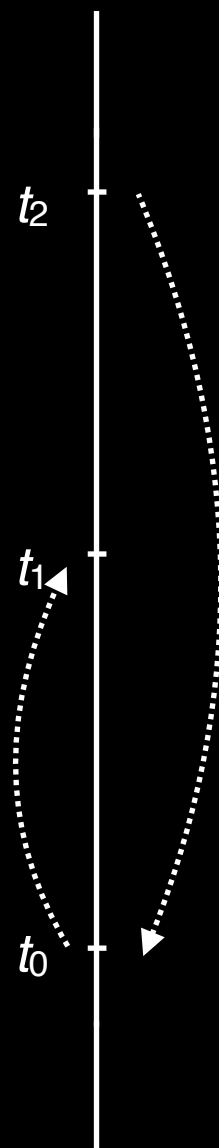
# A visitor from the past

- One day she tells *you* that she knows how to fix things. She will come back to the present (her present, that is our past), and make it the case that the future takes on *a new course, a better course...*
- “Believe me,” she says, “the future generations will be thankful”.
- *What should you do?* Let her go, or try to stop her, destroy the machine?



# Linear time

- No way to change the past, no way to change the future
  - *Monday*, I am in Milan, I buy a ticket to go to Venice on Sunday
  - *Thursday*, I change the ticket for a ticket to Rome
  - *Sunday*, I am in Rome



# The question

- If time is linear, no matter what Anna will<sub>P</sub> do, she has already done<sub>E</sub>, no reason to destroy the machine
  - She cannot realise her intentions, because the hypothesis that she does so it is **incoherent** (no “second time around”)
- “Banana peel” scenario, viz. **something** will prevent her to realise her intentions: maybe the time machine will malfunction and she died in her way back, maybe her memories of the future will be altered or erased, maybe she changes her mind.

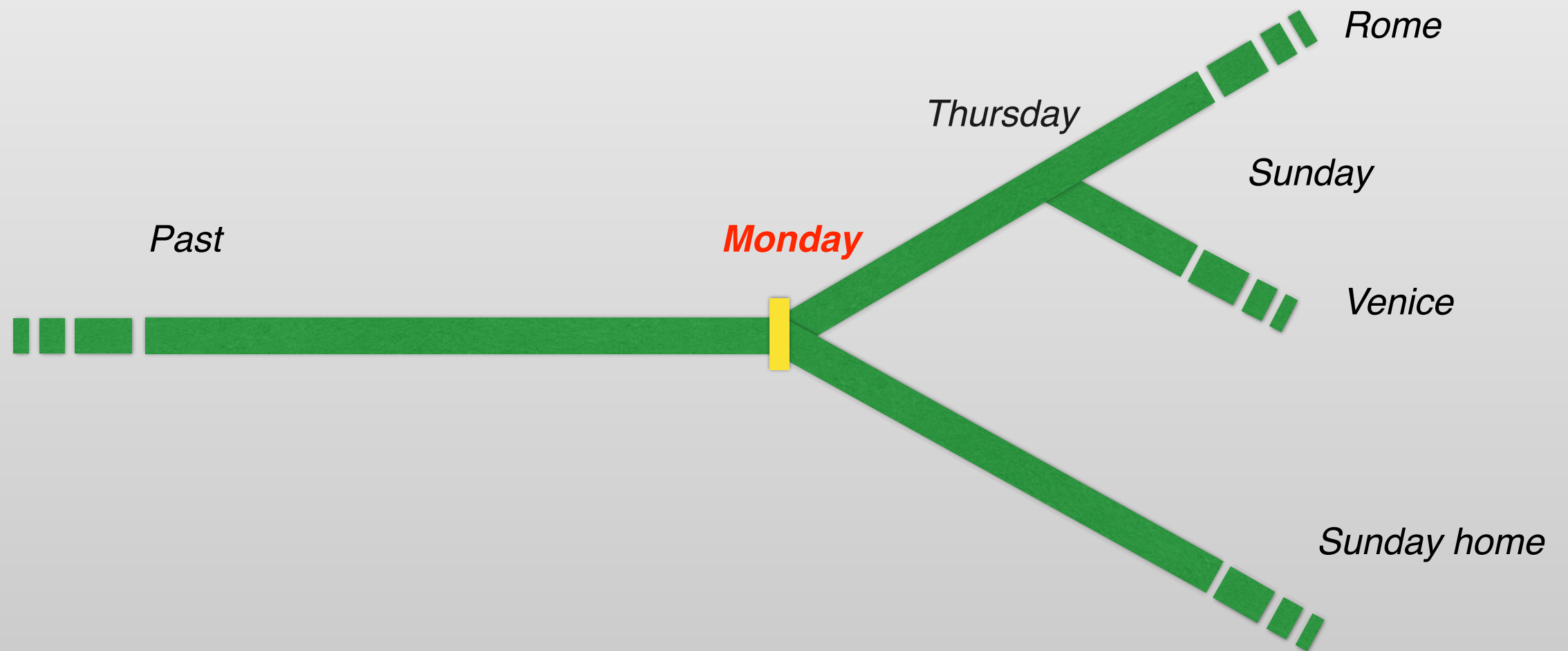
# Inexplicability?

- The only “explanation” we can provide of why Anna won’t make is that make it would be incoherent
  - Is that enough? No local explanation?
- A different question: does the local explanation requires a “conspiracy” on the initial conditions?
  - **NO**: the explanation can be entirely within the achronal area. **Circular explanation**?!?! Yez! It’s time travel, baby!

# ...still...

- OK, **sometimes** the explanation is entirely within the achronal area...but can we rule out conspiracy cases?
  - Wheeler & Feynman: if it is a continuous process, it is easy to find coherent evolutions within the achronal area, so probably yes (assuming physical processes are continuous)
- The problem is that it is too easy: there is often an **infinity** of solution, and no way to pick up one or another (Thorne's billiard)
  - Failure of determinism, even at the level of Newtonian laws. This is not **so** surprising, since we already know that without limiting conditions Newtonian physics is not deterministic

# Non-linear time



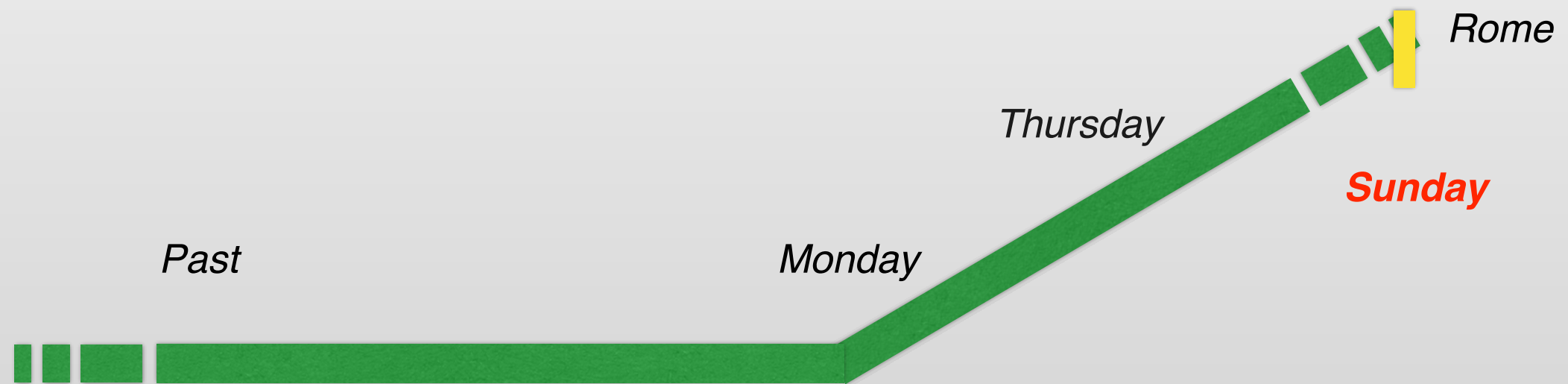
*Monday: I buy a ticket to Venice*

# Future changes from indet. to det.



*Thursday: I change it to a ticket to Rome*

# Future changes from indet. to det.



*Sunday: I am in Rome*



# Can the past change<sub>1/2</sub>?

- According to a long (Western) tradition: **No**, the future can change, the past is immutable.
- *Nicomachean Ethics*, Aristotle (attributed to the poet Agathon): “This only is denied even to God, the power to make what has been done undone”.

# Few underdogs...

- Petrus Damiani (*Letter on Divine Omnipotence*, 1067)
- Lorenzo Valla
- “It has been said that though God cannot alter the past, **historians can**; it is perhaps because they can be useful to Him in this respect that He tolerates their existence.” (Samuel Butler, *Erewhon Revisited*, ch. XIV [1872 / 1901])

# Ways of changing

- Two ways something can change
  1. The leave changes from green to brown —> *same* entity has different properties at different times
    - Intrinsic (getting fatter, happier ...)
    - Extrinsic (getting married, changing city...)
  2. The president has changed —> different entities at different times plays the *same* role

# Ways of extrinsic change<sub>1</sub>

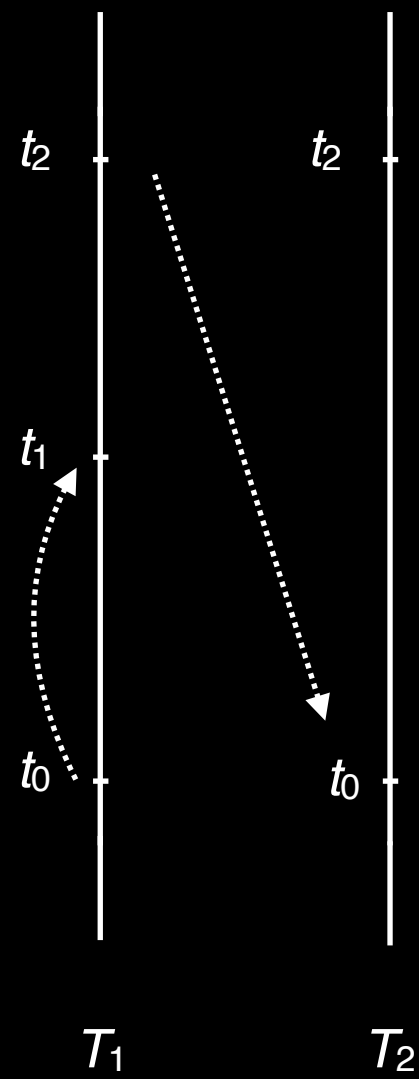
- Boring change: past events get more and more past
- Descriptive change: the birth of a woman in 1915, Billie Holiday, becomes the birth of the famous singer
- Institutional change: “Lance Armstrong is no longer the winner of the Tour de France from 1999-2005”
- Perception: D. Dennett on “Orwellian” and “Stalinesque” cognitive processes

# Meaningful extrinsic change<sub>1</sub>

- Change of historical perspective. Is it changing the past or *better knowledge* (when successful, e.g. debunk)?
- Narrative change: damnatio memoriae, tradition creation (Swiss fondue, Palio di Siena...), propaganda, re-writing the history...
  - Danger of being mistaken for *intrinsic*
- Effects of Uchronic narratives: criticisms of an historical figure, institution, tradition, government...

# Change<sub>2</sub>: universe hopping

- Various (quasi-)*parallel universes*
  - *Changing the past is like changing your house by moving (or one's surroundings by traveling)*
    - Counterfactual version (Ucronia)
    - Time travel version (Multiverse stories)



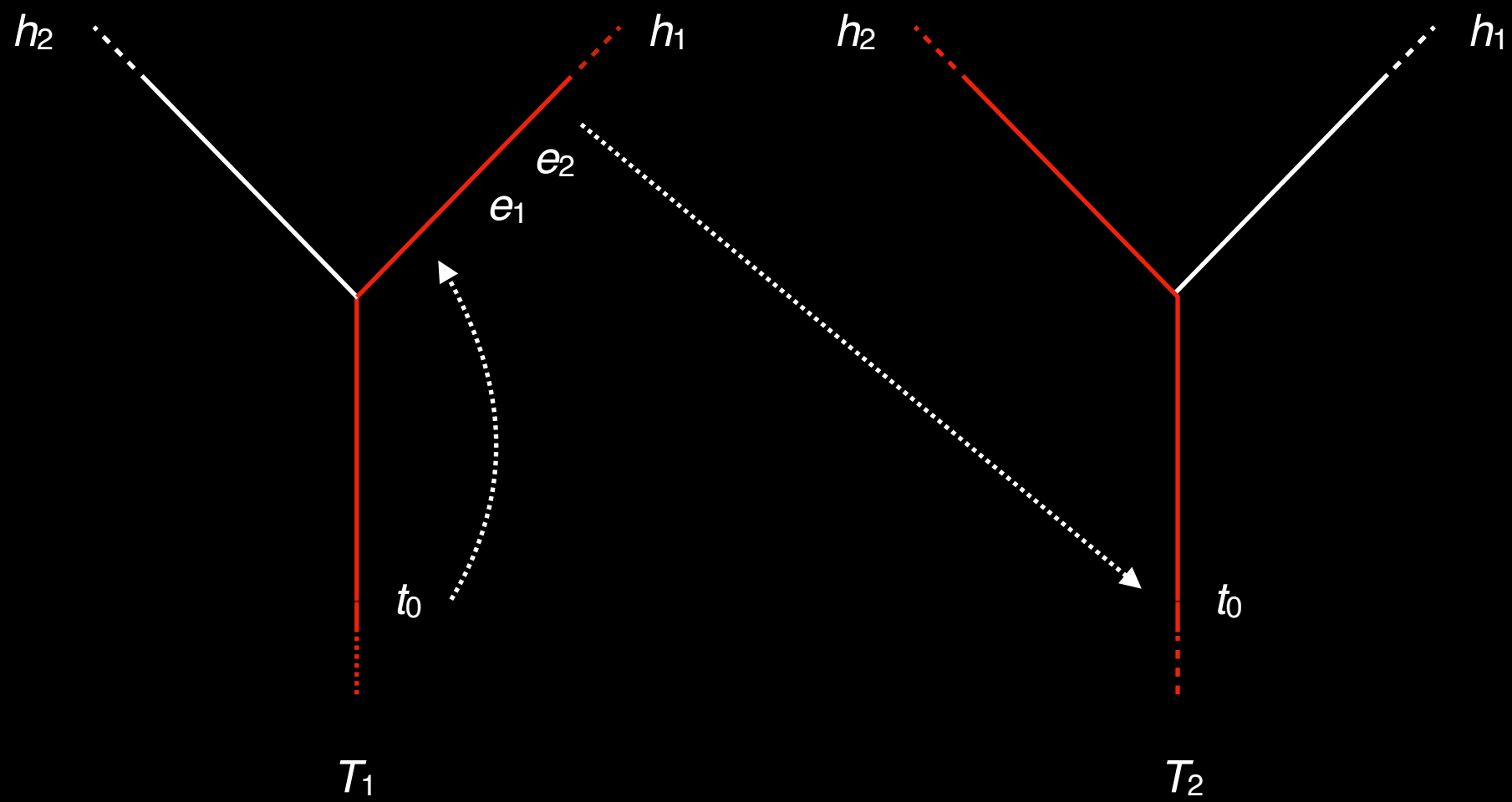
# The question

- If there are many time lines arranged as quasi-parallel universes, nothing she can do in the past will affect **your** present.
- You can “change” your present only by *moving* to another universe



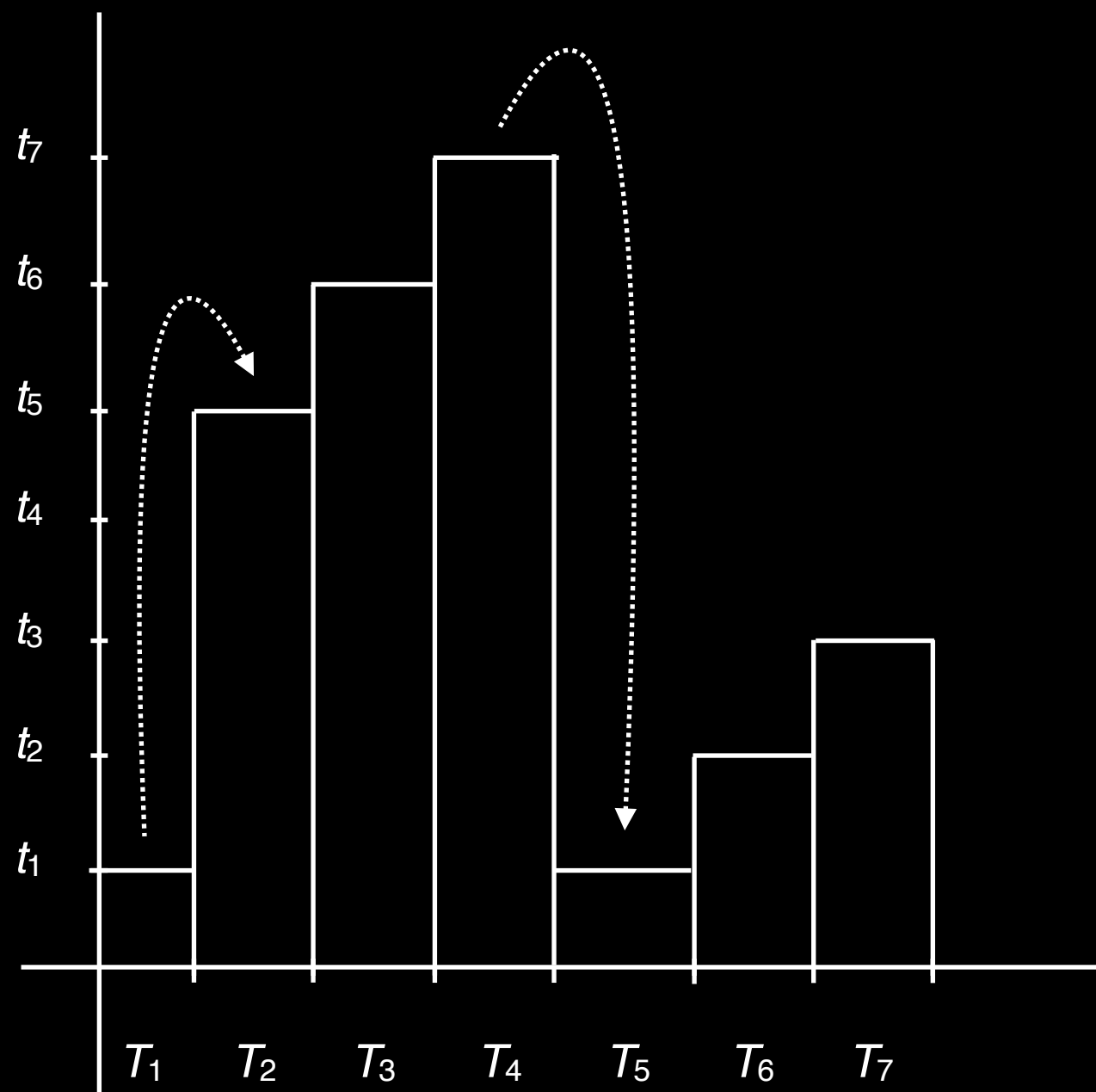
# Change<sub>2</sub>: hypertime

- Various competing *time lines*
- *Changing the past is like changing your house by refurbishing (substituting all furniture, etc. )*
  - Visions of the future versions
  - Time travel versions



# The question

- One thought: if there are alternate futures and only one will become present, her action in the past can lead to a new future, and thus potentially (almost certainly, actually) wipe out us all...
- But when will we be wiped out? “After” her jump, but what she will<sub>P</sub> do has already happened<sub>E</sub>, hence why haven’t we already been wiped out<sub>E</sub>?



# A visitor from the future

- We know behind any reasonable doubt that time is linear
- Someone who looks like Massimo Ferrario, just a couple of years older, pops out as of thin air at the INFN, *now*
- *If* Massimo<sub>o</sub> is Massimo<sub>y</sub>, then Massimo<sub>o</sub> cannot kill Massimo<sub>y</sub>... indeed, **nobody** can!

# Identity facts

(1) Massimo *this morning* = Massimo *this afternoon*

(2) This afternoon, Massimo<sub>O</sub> = Massimo<sub>Y</sub>

- What makes claims such as (1) and (2) true (when true)?
  - Is it only what we find at the time(s) they are about, or we have to look at other times too?

# Persistence

... ..  $t_n$ : Massimo<sub>Y</sub> ... ..  $t_m$ : Massimo<sub>O</sub> ... ..

(E) Numerical identity of Massimo<sub>Y</sub> and Massimo<sub>O</sub>: the same entity is located both at  $t_n$  and  $t_m$

(P) Numerical identity of the **whole** “fourdimensional salami” Massimo of which Massimo<sub>at- $t_n$</sub>  and Massimo<sub>at- $t_n$</sub>  are (temporal) parts

# Persistence in time travel

(2\*) This afternoon, Massimo<sub>o</sub> = Massimo<sub>y</sub>

If (E), then (2) is trivial (something weird is happening with respect to location, not with respect to identity)

If (P), it is doubtful whether there are at  $t$ =this afternoon facts about the identity of the whole “fourdimensional salami” Massimo, after all even if Massimo<sub>o</sub> = Massimo<sub>y</sub> the two parts of the salami are *numerically distinct*



# Just an epistemic worry?

- **Yes.** If eternalism is true, especially in its B-theoretic version (block universe)
  - The facts about other times are there at *any* time, they may just not be accessible to us
- **No.** If A-theory, especially in its “no future” variety (presentist and grow block) is true.
  - Depending on how things evolve, it may turn out that  $\text{Massimo}_O = \text{Massimo}_Y$  or that  $\text{Massimo}_O \neq \text{Massimo}_Y$

**Grazie!**

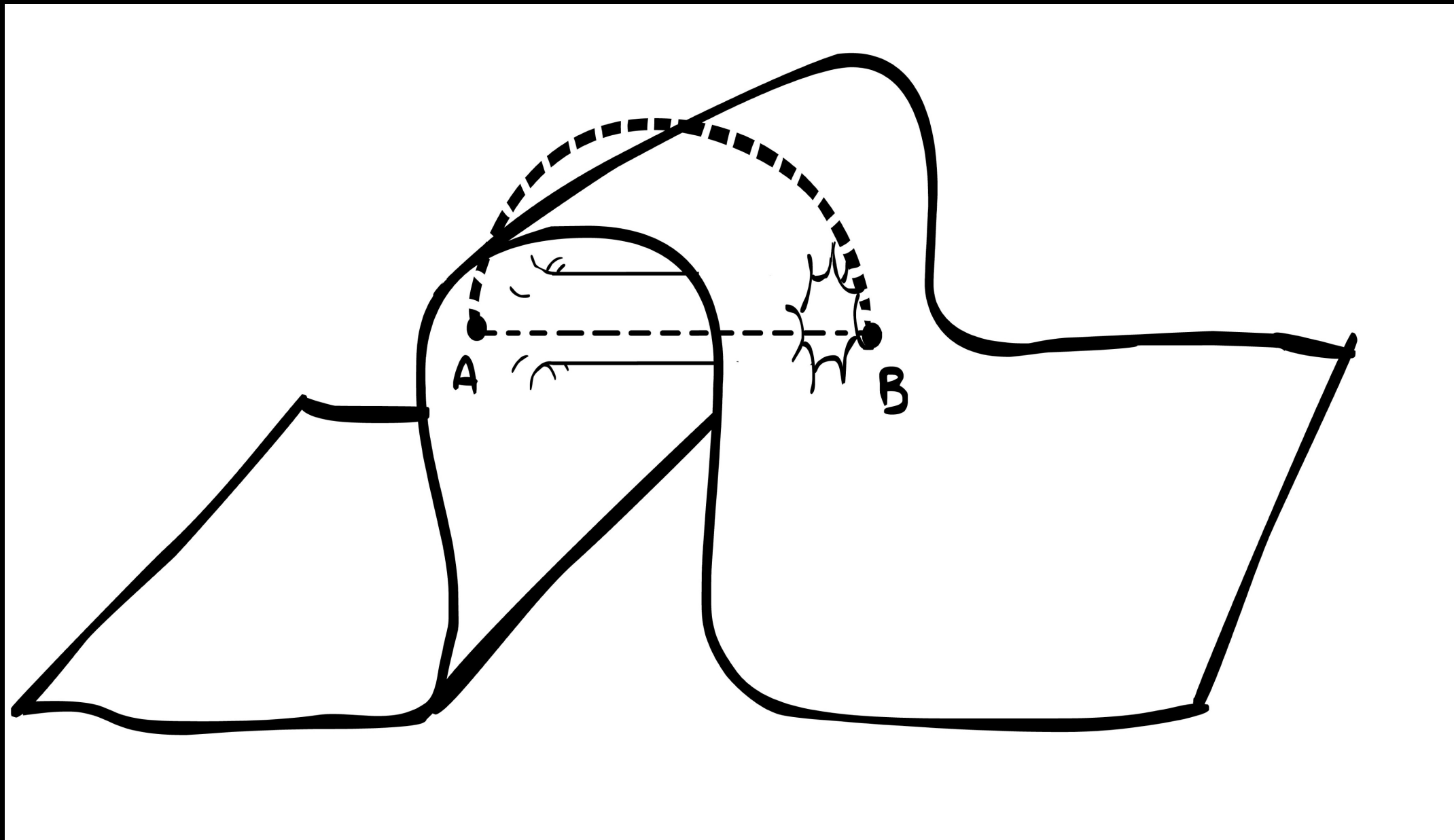
# Swiss Fondue

- “The recipe of fondue can be traced back in cooking books to the middle of the 19th century, but it’s probably older. It was common for cheese-makers working on the alps during summer to melt some cheese as a kind of party dish at the end of the summer.. But it certainly wasn’t a traditional dish in the sense of a popular one before the 20th century. The reason is simple: Switzerland was a poor country and they simply couldn’t afford melting important quantifies of an expensive product like cheese.”
- “However, at some point in the 20’s or 30’s, a surproduction of cheese occurred, probably related to emergent new agricultural techniques, and the cheese industry didn’t know what to do with this surplus. Apparently, they had the genius idea to popularise the fondue as a national dish through the army[...] As a result, in a very short period of time, fondue was spread as a national dish.”

# Swiss Fondue

- “It’s probably a picture of Lady Helvetia beating up the rest of the world represented under the traits of a clueless newborn. It’s a fitting metaphor of the Swiss self-understanding of their democracy and its place in the universe.” Patrick Engisch (personal communication 23/05/19)

# “Wormhole”



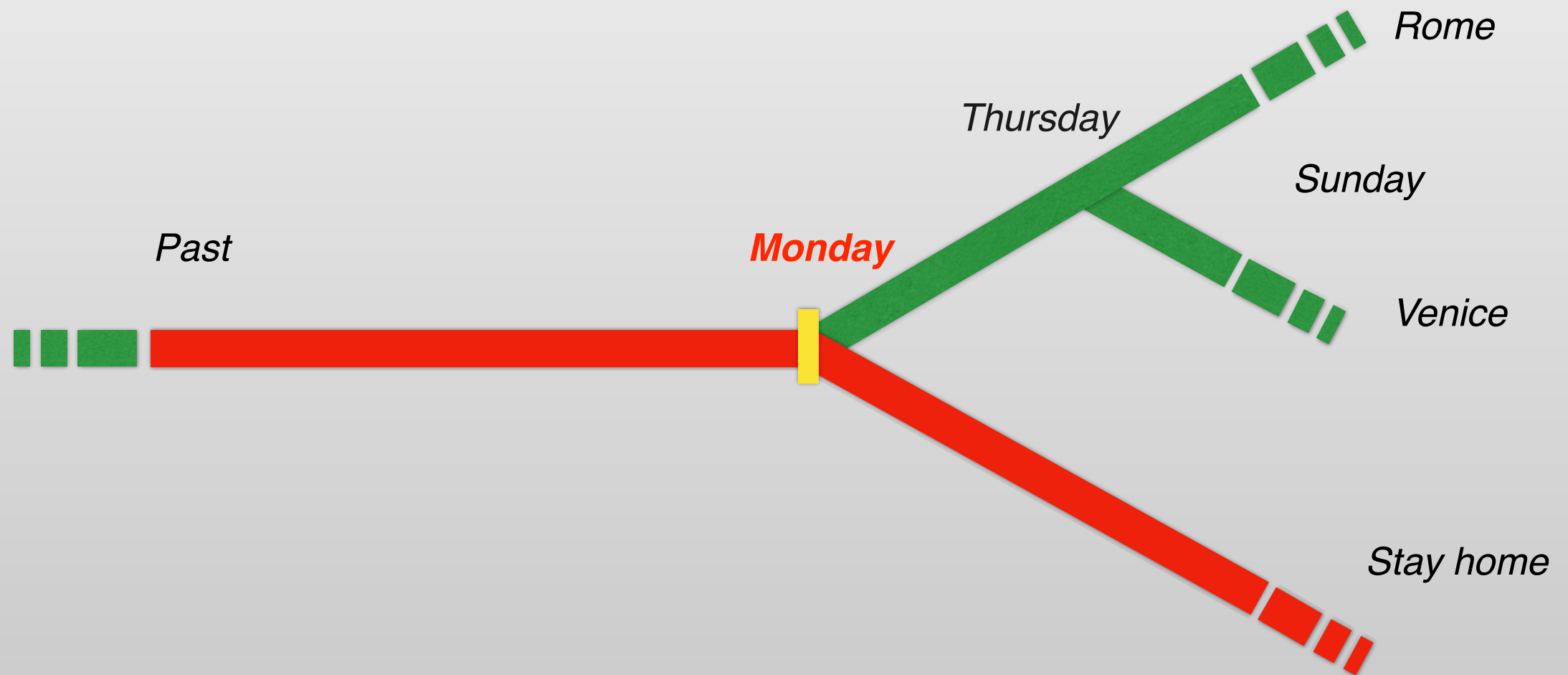
# Conoscenza e cambiamento

- Stime affidabili possono aiutarci a cambiare l'andamento degli eventi rispetto al passato...
- ...e quindi realizzare un “nuovo” futuro.
- Nostra responsabilità nei confronti del futuro non dipende dal poterlo cambiare, ma dal fatto che le nostre scelte contribuiranno a realizzarlo.

# Can the past change?

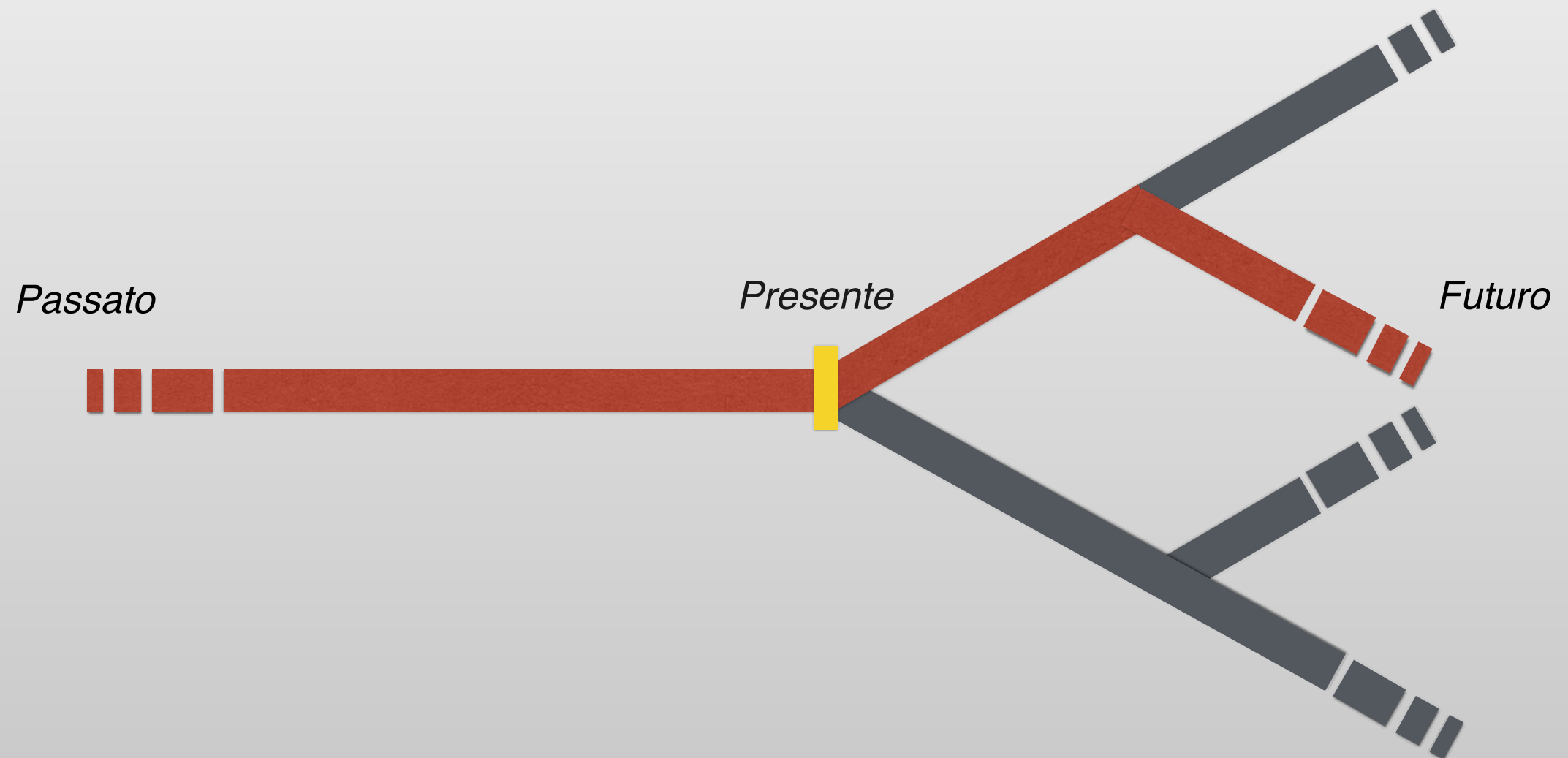
- You are in a position to destroy the time machine for good, *if you want*, so that she cannot come back and change the past (your past, her present and close future)
- 2 meanings of change
  - A. The leave has changed from green to brown —> Different properties at different times
  - B. The president has changed —> at different times, different people play *the same role*
- Can the past change, and in which sense?

# Thin red line change

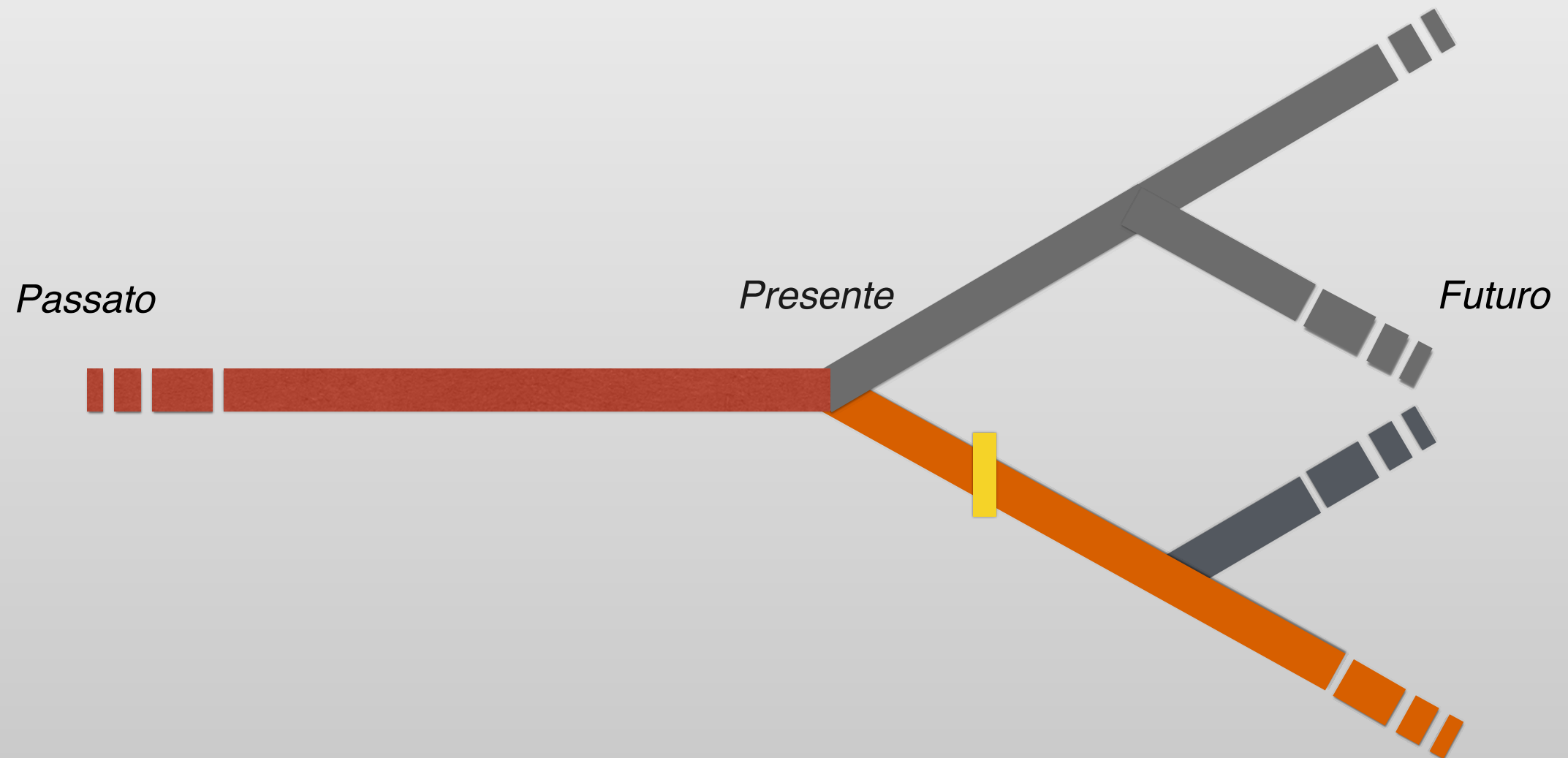




# Thin red line



# Thin red line



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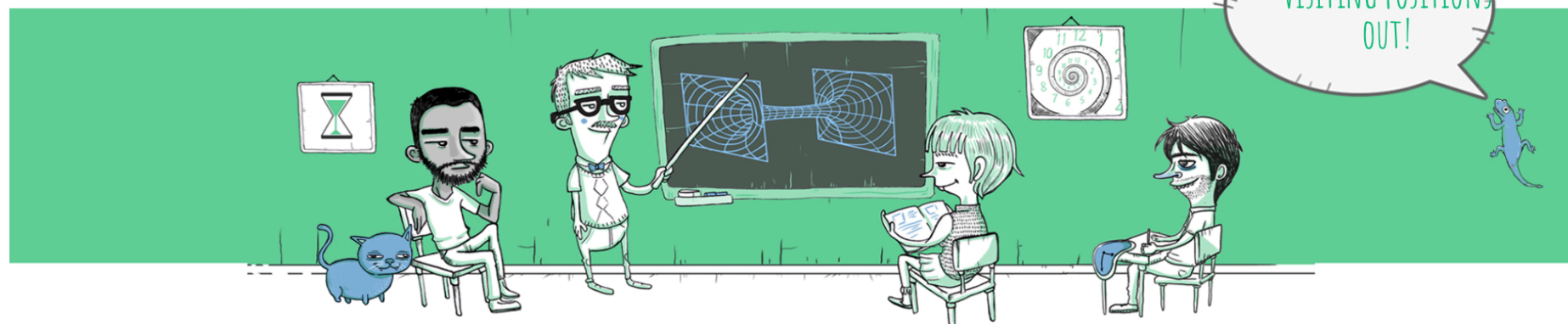
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# CENTRE FOR PHILOSOPHY OF TIME



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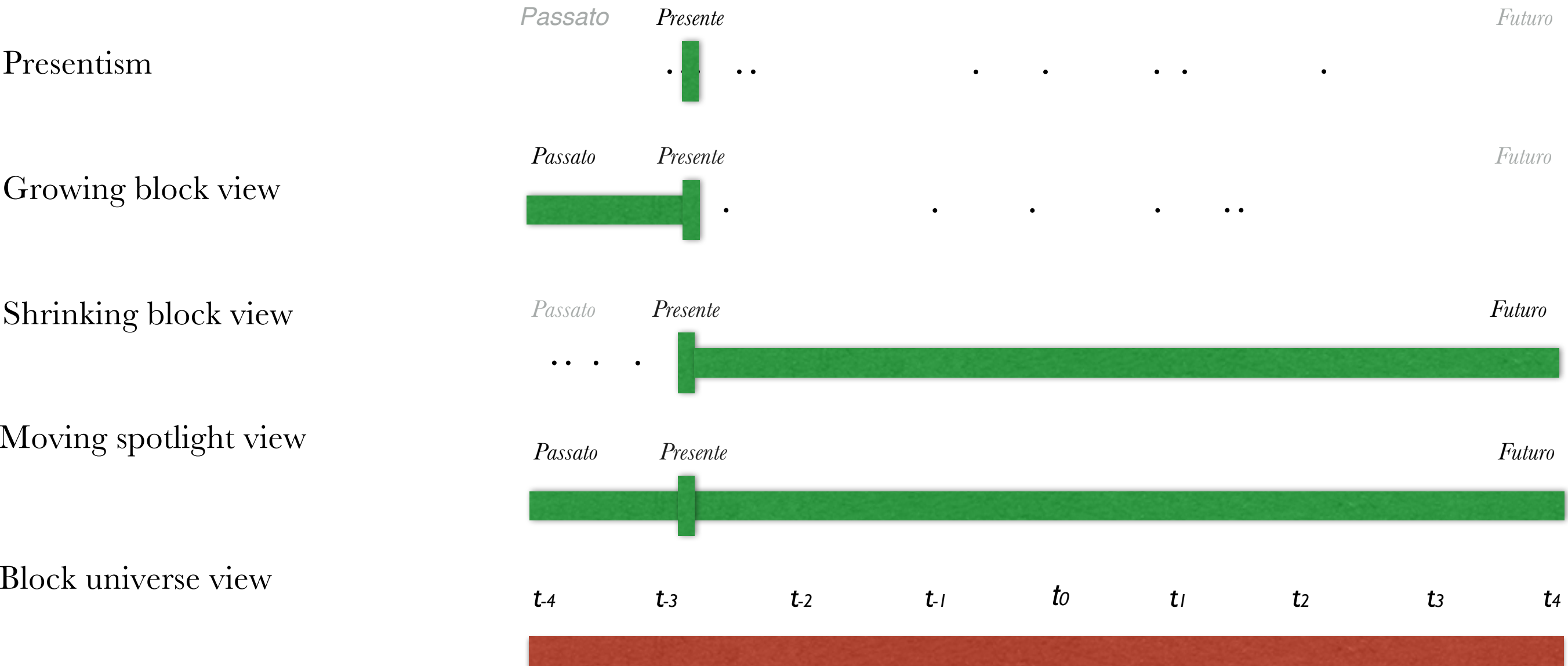
**20 May – Francesca Vidotto (University of Western Ontario)** – “Relational Observables and Relational



Next Events

**11-12 April – Symposium on ‘Thinking in and about time’**

# A- vs. B-theories



# A- vs. B-theories

Presentism



Growing block view



Shrinking block view



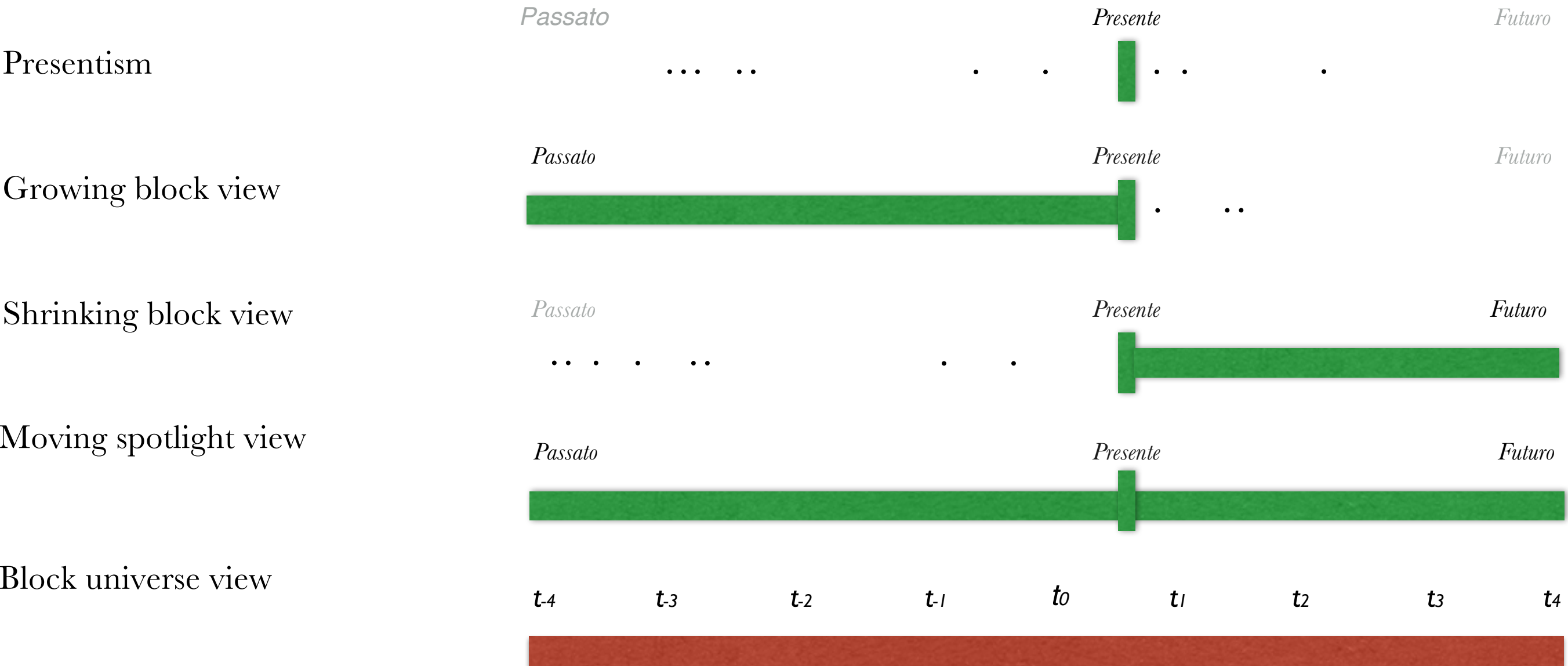
Moving spotlight view



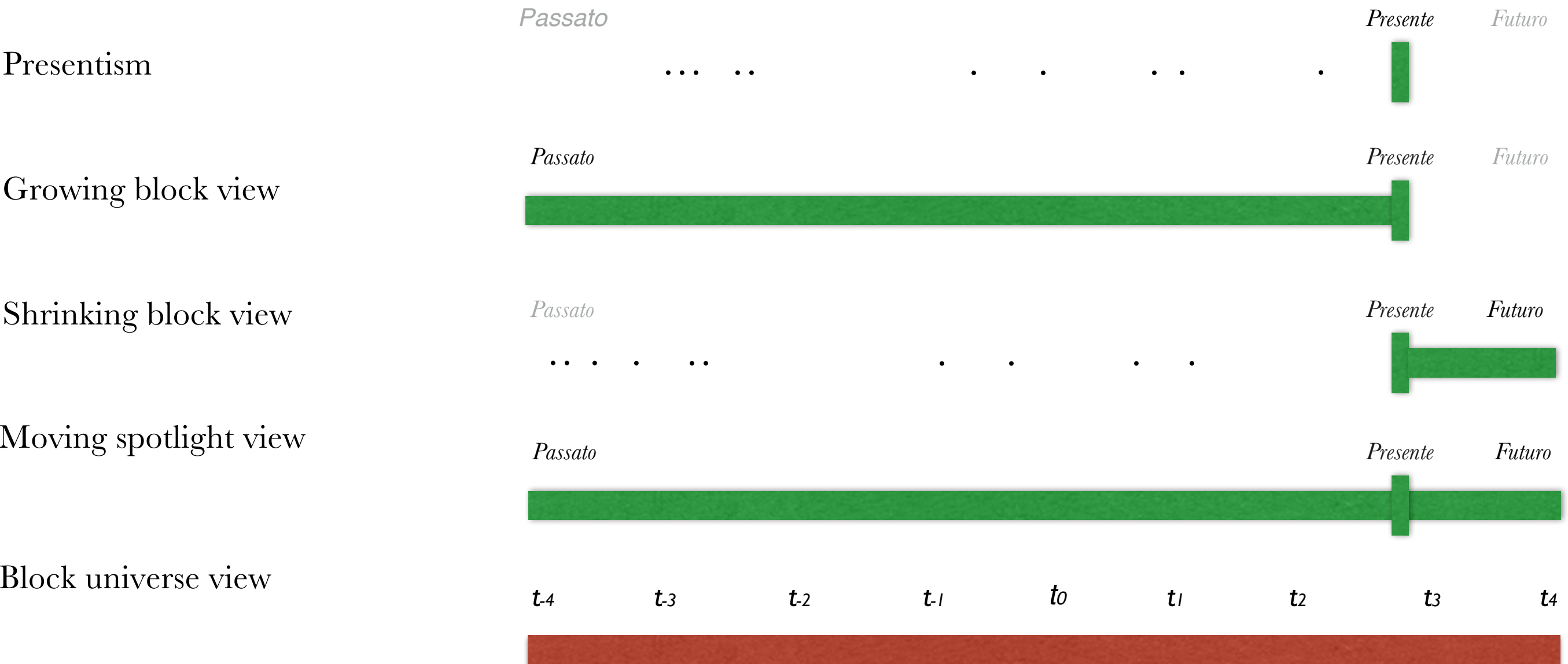
Block universe view



# A- vs. B-theories



# A- vs. B-theories



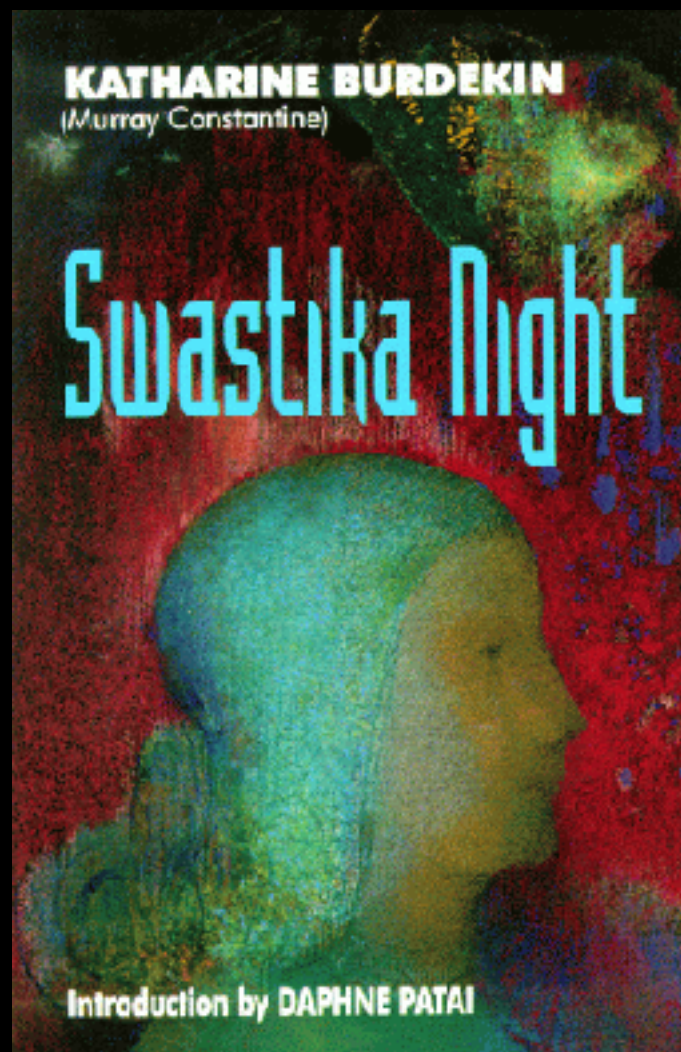
# A moral puzzle

- We owe it to the future generations to leave a habitable planet with resources
- *Who* are the future generations?
- Suppose we now act for the good: the ones who would be born if we do not nothing are *not* the ones who will be born





# her futures, our pasts



- 1937
- Speculation about the future
- Ucronia