

The Philosophy of Time

Lecture Seven

Presentism and Special Relativity

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Presentism and Special Relativity

Simultaneity and the Present

The Special Theory of Relativity: Two Postulates

The Addition of Velocities

The Relativity of Simultaneity

The Problem for Presentism

Presentist Solutions

When is the Present?

- **Presentism** = Only the present exists
- But when is “the present”?
- Which events count as present events?
- Answer: an event is present iff it is **simultaneous** with my speaking right now
 - Of course, we have to keep re-applying this definition at every moment, since the present is always changing!

The Problem...

- The problem with this definition of the present is that it does not seem to fit very well with modern physics
- In particular, it does not fit well with Einstein's **Special Theory of Relativity** (SR)
- According to SR, simultaneity is **relative** to different frames of reference
 - There are pairs of events which are simultaneous according to one frame of reference, but not according to another
- So there is no such thing as **the** present: we get different “presents” depending on which frame of reference we are using
- But in that case, how can we say that only **the present** exists?

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The Two Postulates of Special Relativity

(1) **The Relativity Postulate**

The laws of nature are the same in all inertial frames of reference

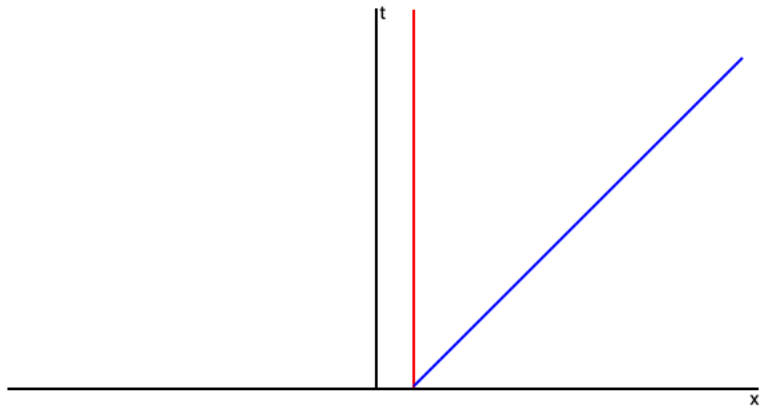
(2) **The Light Postulate**

The speed of light (in a vacuum) is a constant: c

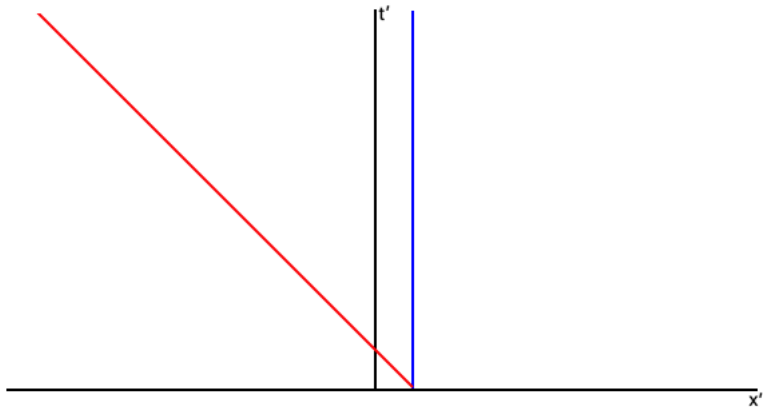
Frames of Reference

- A frame of reference is a system of co-ordinates we can use to describe where everything is in time and space
- There are lots of different frames of reference, i.e. there are lots of different ways of assigning co-ordinates to things
- Some frames of reference are “moving” relative to other frames
 - All this means is that some of the bodies that are at rest according to one frame of reference are moving according to another

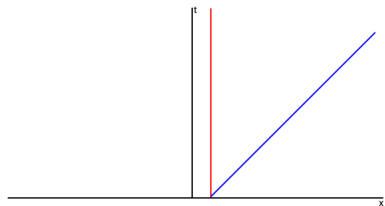
Frames of Reference



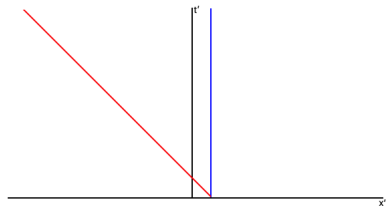
Frames of Reference



Frames of Reference



Frame A



Frame B

- Relative to A, B is moving to the right on the x -axis
- Relative to B, A is moving to the left on the x -axis

Inertial Frames of Reference

- An **inertial** frame is a frame which is not accelerating (i.e. is moving at a constant speed in a straight line)
- In other words: no accelerating body is represented as either being at rest or having a constant velocity by an inertial frame
- In other words again: accelerating bodies are always represented as accelerating by inertial frames

The Relativity Postulate

- **The Relativity Postulate:**

The laws of nature are the same in all inertial frames of reference

- This postulate tells us that the laws of nature will be exactly the same, no matter what inertial frame of reference we are using
- An important consequence: no experiment would ever reveal if we are stationary, or moving with a constant velocity in a straight line

The Relativity Postulate

Shut yourself up with some friend in the main cabin below decks on some large ship, and have with you there some flies, butterflies and other small flying animals. Have a large bowl of water with some fish in it; hang up a bottle that empties, drop by drop into a wide vessel beneath it. With the ship standing still, observe carefully how the little animals fly with equal speed to all sides of the cabin. The fish swim indifferently in all directions; the drops fall into the vessel beneath; and, in throwing something to your friend, you need throw it no more strongly in one direction than another, the distances being equal; jumping with your feet together, you pass equal spaces in every direction. When you observe all these things carefully (though there is no doubt that when the ship is standing still everything must happen in this way), have the ship proceed with any speed that you like, so long as the motion is uniform and not fluctuating this way and that.

The Relativity Postulate

You will discover not the least change in all the effects named, nor could you tell from any of them whether the ship was moving or standing still. In jumping, you will pass on the floor the same spaces as before, nor will you make larger jumps toward the stern than toward the prow even though the ship is moving quite rapidly, despite the fact that during the time that you are in the air the floor under you will be going in the direction opposite to your jump [...] The droplets will fall as before into the vessel beneath without dropping toward the stern [...] The fish in the water will swim towards the front of their bowl with no more effort than toward the back [...] the butterflies and flies will continue their flight indifferently toward every side. (Galileo, reprinted in Dainton 2010 pp. 169–70)

The Speed of Light

- **The Light Postulate**

The speed of light (in a vacuum) is a constant: c

- I am sure that this law of physics is familiar to you
- The law is a consequence of the fact that the speed of light has nothing to do with the speed of the **source** of the light
- Rather, the speed of light depends entirely on the properties of the medium it is travelling through
- So no matter what, light is guaranteed to travel at a constant speed (approx $3 \times 10^8 m/s$) in a vacuum

The Two Postulates Back Together Again

(1) The Relativity Postulate

The laws of nature are the same in all inertial frames of reference

(2) The Light Postulate

The speed of light (in a vacuum) is a constant: c

- The Relativity Postulate and the Light Postulate are both well confirmed, and by themselves seem pretty straightforward
- **BUT:** when we put them both together, we get some surprising results!
- The result we care about: simultaneity is always relative to a frame of reference

Presentism and Special Relativity

Simultaneity and the Present

The Special Theory of Relativity: Two Postulates

The Addition of Velocities

The Relativity of Simultaneity

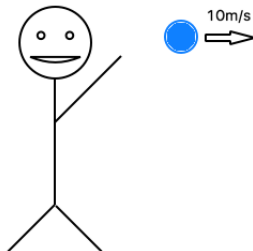
The Problem for Presentism

Presentist Solutions

A Necessary Prerequisite...

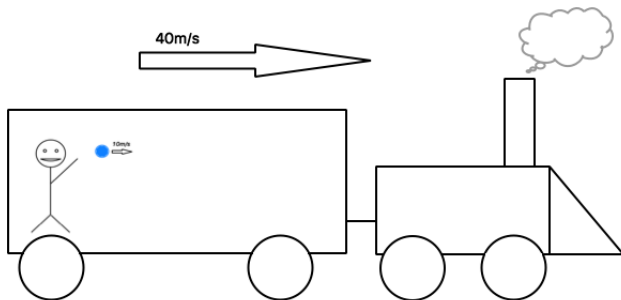
- Before we can see why SR makes simultaneity relative to frames of reference, we need to look at how to add velocities
- The first strange thing that happens in SR is this doesn't work in the way that you would expect

The Addition of Velocities



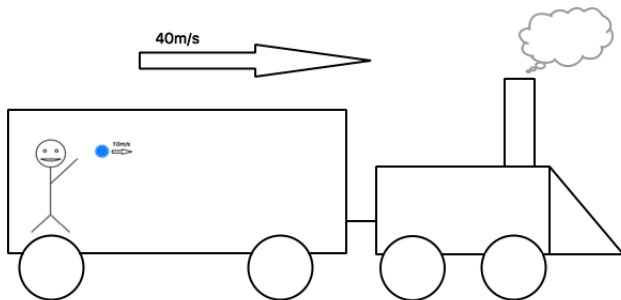
- Imagine you throw a ball at 10m/s

The Addition of Velocities



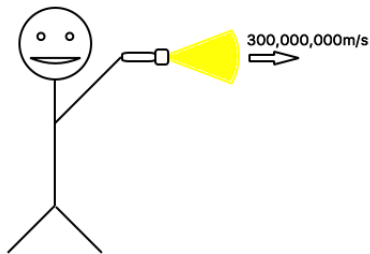
- And now imagine that you are on a train, moving past a station at 40m/s

The Addition of Velocities



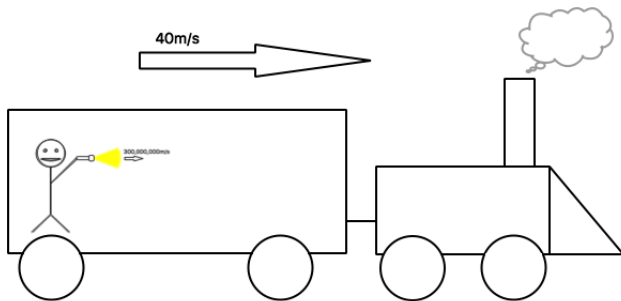
- Clearly, from the position of the station, we measure the speed of the ball as being $10\text{m/s} + 40\text{m/s} = 50\text{m/s}$

The Addition of Velocities Fails



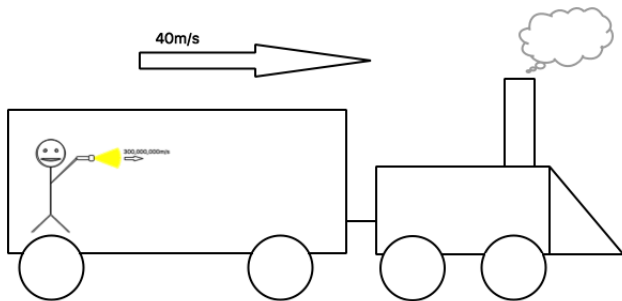
- Now imagine you are shining a torch; the light comes out at $3 \times 10^8 m/s$

The Addition of Velocities Fails



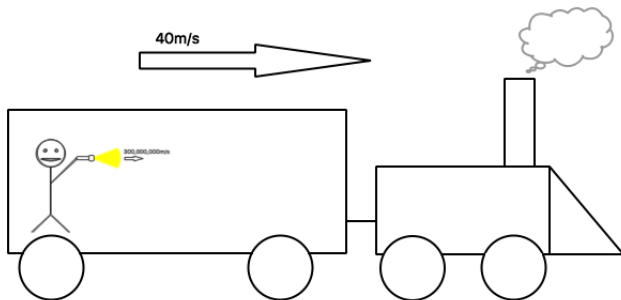
- And now imagine that you are on a train, moving past a station at 40m/s

The Addition of Velocities Fails



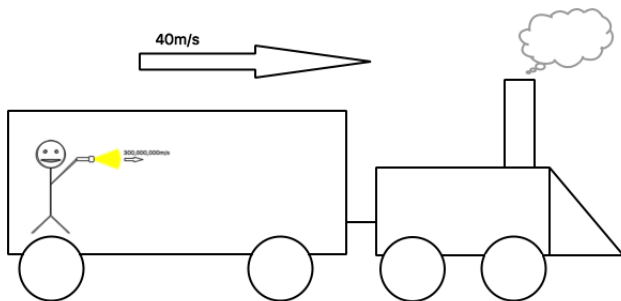
- From the position of the station, we would expect to measure the light on the train as being $c + 40\text{m/s}$

The Addition of Velocities Fails



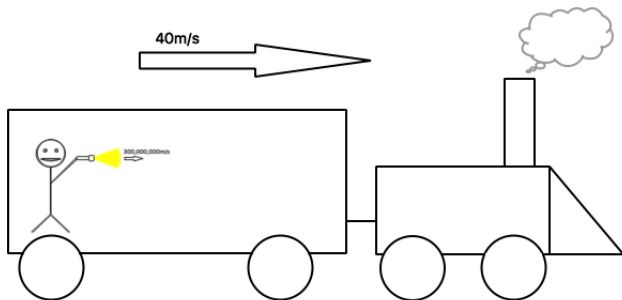
- But the Light Postulate is a law of physics saying that the speed of light is always c

The Addition of Velocities Fails



- And the Relativity Postulate tells us that the laws of physics are the same in **all** inertial frames of reference

The Addition of Velocities Fails

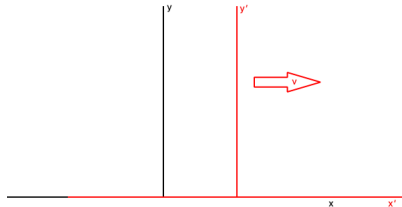


- So from the position of the station, we measure the speed of the light on the train as c , not $c + 40\text{m/s}$!

Galilean Transformations

- This looks contradictory, but that is only because we have a background assumption about how to add velocities

- $t' = t$
- $y' = y$
- $z' = z$
- $x' = x - vt$



- These equations are known as **Galilean Transformations**

Lorentz Transformations

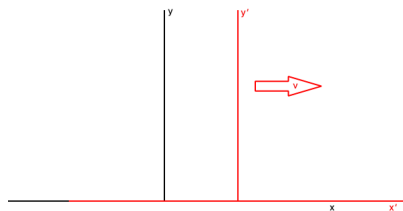
- We need to replace these Galilean transformations with the following equations:

- $$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

- $$y' = y$$

- $$z' = z$$

- $$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}$$



- These equations are known as **Lorentz Transformations**

Don't Worry Too Much!!!!

- We do not need to know anything about these Lorentz Transformations
- **This is all you need to remember:**
 - The speed of light is **always** c , no matter what inertial frame you are measuring it in!
- This is the key thing you need to bear in mind in our discussion of simultaneity

Presentism and Special Relativity

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The Special Theory of Relativity: Two Postulates

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The Problem for Presentism

Presentist Solutions

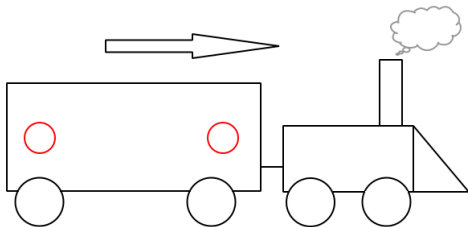
Defining Simultaneity

- In SR, we use light to define what it is for two events to be simultaneous:
 - Events A and B are simultaneous iff: light rays sent off from A and B would meet at a point exactly midway between A and B at the same moment
- Given the Light Postulate, we know that this definition works

Justifying the Definition of Simultaneity

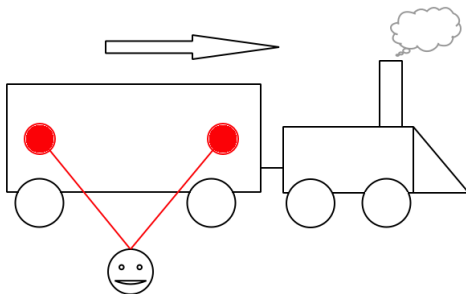
- Imagine that M is a point midway between events A and B , and light beams sent off from A and B meet at M at the same moment
- Since M is midway between A and B , the path $A \rightarrow M$ is exactly as long as the path $B \rightarrow M$
- Since the speed of light is constant, light travels along $A \rightarrow M$ and $B \rightarrow M$ at exactly the same speeds
- So if a ray of light from A reaches M at exactly the same moment as a ray of light from B reaches M , then they must have been sent off at the same time
- So A and B must be simultaneous

The Relativity of Simultaneity



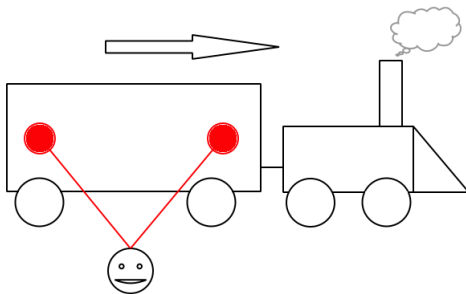
- There are two flash bulbs on a moving train

The Relativity of Simultaneity



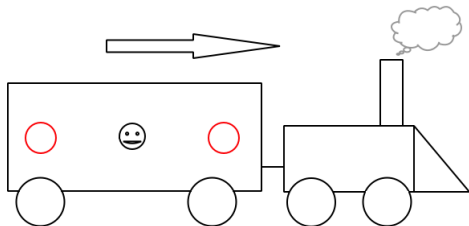
- They go off, and the rays reach an observer on the platform at the same time

The Relativity of Simultaneity



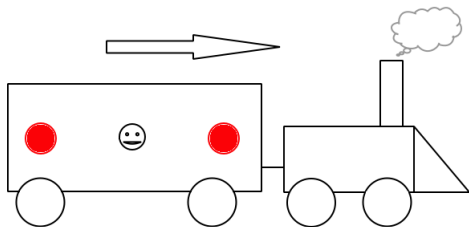
- The observer is equidistant between the two bulbs, and so from their perspective, they flashed at the same time

The Relativity of Simultaneity



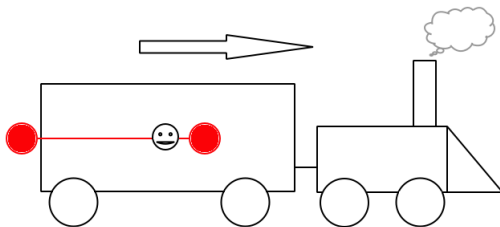
- But now imagine that there is someone inside the train

The Relativity of Simultaneity



- The bulbs go off, but the person in the train is moving towards the bulb on the right

The Relativity of Simultaneity



- The light from the bulb on the right will therefore reach the person in the train before the light from the bulb on the left

The Relativity of Simultaneity



- But now consider what the person on the train will see

The Relativity of Simultaneity



- Relative to this person's frame of reference, they remain stationary and equidistant between the two bulbs

The Relativity of Simultaneity



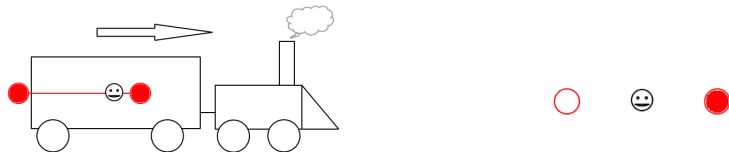
- So they will say that the right bulb goes off **first**...

The Relativity of Simultaneity



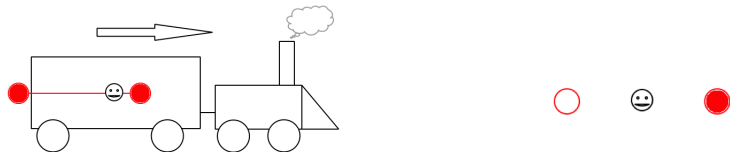
- ...and the left bulb goes off **second**

The Relativity of Simultaneity



- It might have been tempting to say that this is just because from the perspective of the person on the train, the light coming from the right bulb is moving faster than the light coming from the second bulb
- But the Light Postulate and the Relativity Postulate together tell us that the speed of light is constant **on every inertial frame of reference**

The Relativity of Simultaneity



- So the person on the train will agree that the speed of the light coming from the right bulb is **exactly the same** as the speed of the light coming from the left bulb
- The only conclusion which the person on the train can reach is therefore that the right bulb went off first, and then the left bulb went off second!

The Relativity of Simultaneity

- So simultaneity is always **relative** to a frame of reference
- There are events which count as simultaneous according to **one** frame of reference, but not according to **another** frame
- This causes **big problems** for presentism!

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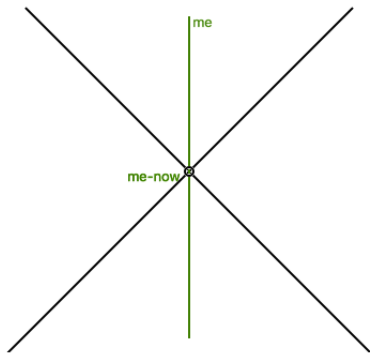
The Problem for Presentism

Presentist Solutions

The Problem in a Nutshell

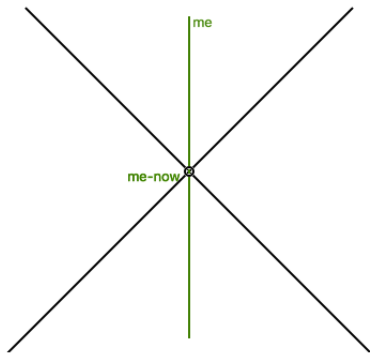
- According to presentism, only present events exist
- But whether an event counts as being “present” will depend on the frame of reference we are working with
- And in that case, we will get different answers to the question ‘What exists?’ depending on which frame of reference we are working with
- Presentism converts the relativity of **simultaneity** into a relativity of **existence**
- Here is Putnam’s way of developing this point in his 1967 article ‘Time and Physical Geometry’

Putnam's Argument



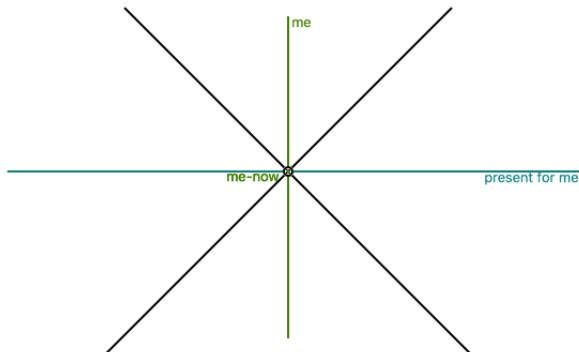
- Here is a “spacetime diagram” showing me as being stationary

Putnam's Argument



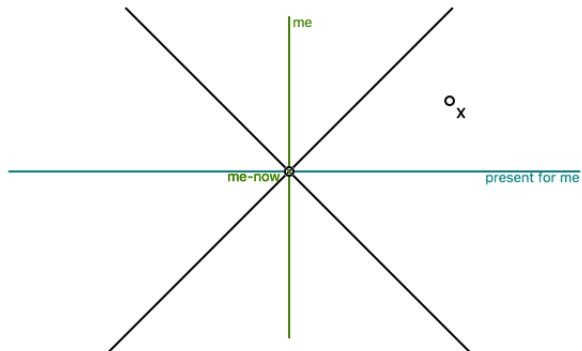
- (I am the green line; the black lines represent the “lightcone” of the point marked “me-now”)

Putnam's Argument



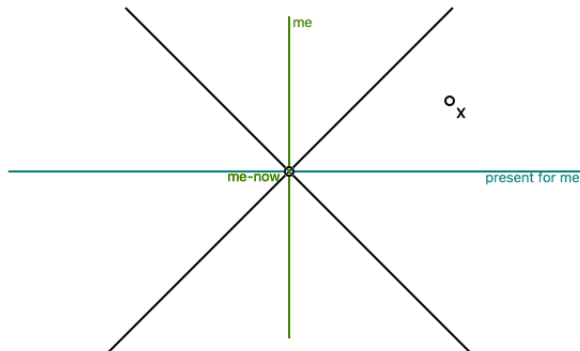
- This line represents “the present” from my frame of reference; every event on this line is simultaneous with me-now

Putnam's Argument



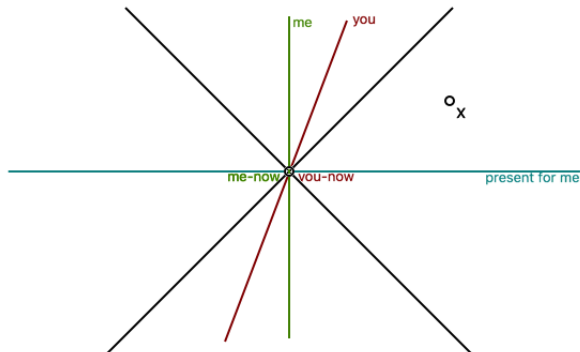
- Now consider event X

Putnam's Argument



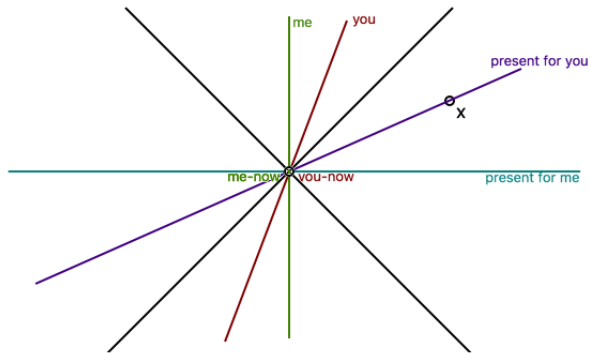
- If I am a presentist, I will say that this event does not exist, because it is in the future

Putnam's Argument



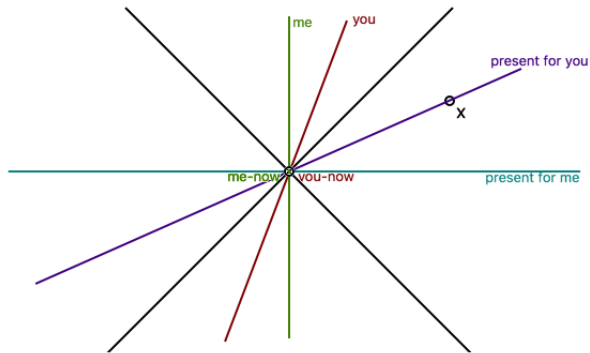
- Now imagine that you are moving very fast relative to me, but cross my path now

Putnam's Argument



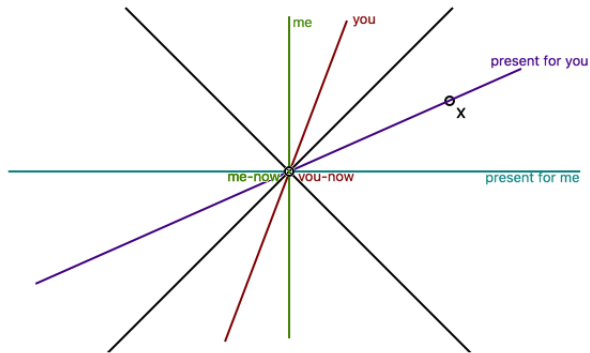
- Because you are working with a different frame of reference, you will have a different present

Putnam's Argument



- For you, event X will exist, because it is in the present

Putnam's Argument



- So according to my frame, X does not exist, and according to yours, it does!

Putnam's Argument

- So in the context of SR, presentism entails that existence is relative: different events exist on different frames of reference
- This seems absurd: surely existence isn't "relative" to anything?
 - There exist the things that exist, and that's that!
- Moreover, even if we could get our heads around the idea that existence is relative to **something**, surely it isn't relative to a frame of reference?
- Remember: a frame of reference is just a way of assigning co-ordinates to things!

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The Premises in the Argument Against Presentism

- There were three premises in the argument against presentism:
 - (1) An event is present iff it is **simultaneous** with right now
 - (2) Existence isn't relative to frames of reference
 - (3) The Special Theory of Relativity is true
- These three premises together are enough to refute presentism
- But all that a presentist needs to do is reject one of these premises
- Presentists could (and actually have) reject any one of these premises, but we are going to focus on (3)

Rejecting Physics for Philosophy?

- Could a presentist save their presentism by denying SR?
- On the face of it, the suggestion seems absolutely absurd
- SR is a **hugely** successful physical theory, and presentism is a dodgy bit of philosophy
- Who would ever give up on physics for philosophy?!?!

A Methodological Question

- These days, many philosophers call themselves **naturalists**
- It is not entirely clear what this means, but it seems to involve a certain deferential attitude towards the sciences
 - If there is ever a conflict between philosophers and scientists, always side with the scientists!
- No naturalist would dream of rejecting SR just to save presentism
- But as ever, things are not quite so simple
- Very often, distinctively **philosophical** assumptions are smuggled in to the way that scientists formulate their theories
- SR seems to be a case of this

Special Relativity's Hidden Verificationism

(1) The Relativity Postulate

The laws of nature are the same in all inertial frames of reference

(2) The Light Postulate

The speed of light (in a vacuum) is a constant: c

- Let's focus on (1): what is the evidence for this postulate?
- Really, just this: no **experiment** will ever show that the laws of physics differ from one inertial frame to another
 - If an experiment has a certain outcome in one inertial frame, then it will have exactly the same outcome in any other inertial frame

Special Relativity's Hidden Verificationism

- There is clearly a certain kind of verificationism at play here: if **we cannot detect a difference** in the laws of physics in different inertial frames, then **there is no difference**

(Einstein himself most definitely had verificationist leanings)

- But if we reject that verificationism, we can insist that although no **experiment** could ever show that the laws of physics change, they do still undetectably change

Saving Presentism

- In particular, we could say: the speed of light is only c in certain special, **privileged** frames of reference; in other frames, it has other velocities
- Admittedly, we could never perform an experiment to show which frames are privileged
- But without verificationism, that does not entail that no frames are privileged!

Saving Presentism

- If we did decide to privilege certain frames of reference in this way, then we could give an absolute definition of the present:
 - An event is present iff **according to one of the privileged frames of reference**, it is simultaneous with my speaking right now
- This would be enough to save presentism

The Cost of Saving Presentism

- Still, even if this is something we **could** do to save presentism, that doesn't automatically mean it is something we **should** do
- Why should we bother introducing an undetectably privileged frames of reference, rather than just rejecting presentism?
- In order to decide whether the price of saving presentism is too high, you will need to compare the costs to the benefits of presentism
 - If you were convinced by the arguments for presentism last week, then you **might** find it worth while
- But before you make your decision, it is important for you to realise one drawback for this way of saving presentism

The Drawback

- Suppose that you and I are moving relative to one another at a constant velocity
- This tells us straight away that we have different frames of reference
- More importantly, it tells us that we cannot both be working with one of the “privileged” frames of reference
- As a result, at least one of us will be wrong about what is present
 - **Either** the events which are “present” according to your frame of reference aren’t **really present**...
 - ...**or** the events which are “present” according to my frame of reference aren’t **really present**

The Drawback

- Worse than that, there are infinitely many different frames of reference, and so in all likelihood **neither** of us are working with privileged frames
- At this point presentism begins to look a lot less attractive, and a lot less intuitive!
- I for one do not think it would be worth trying to save this bizarre version of presentism: we should just stick with SR, and accept eternalism
- And for what it is worth, this was Einstein's view too

Einstein's Eternalism

- Einstein sent this letter to the family of his friend Michele Besso after Besso died:

now he has preceded me a little by parting from this strange world. This means nothing. To us believing physicists the distinction between past, present and future has only the significance of a stubborn illusion.

Quoted in Foslin, Albert Einstein, A Biography, p. 741

Next Week

- Next week we will be looking at a different kind of problem for presentism: the triviality argument
- I recommend that you read the following articles:
 - Ludlow (2004) 'Presentism, Triviality and Varieties of Tensism'; item 24 in the reading pack
 - Stoneham (2009) 'Time and Truth: The Presentism-Eternalism Debate'; item 25 in the reading pack
 - Meyer (2005) 'The Presentist's Dilemma'; item 26 in the reading pack