First lecture: Time in philosophy

There is some sense – easier to feel than to state – in which time is an unimportant and superficial characteristic of reality. Past and future must be acknowledged to be as real as the present, and a certain emancipation from the slavery of time is essential to philosophic thought. (Bertrand Russell)

Philosophical problems about time (in random order)

- is time real, and in what sense?
- what is primary, time or events?
- does time 'flow'? is there temporal transition? is there becoming or only being?
- what, if anything, does the mind contribute to time?
- would there be time in the absence of any *material* body?
- is time one-dimensional? i.e. are the events in the world linearly ordered by 'before–after'?
- can there be an infinite past?

From (philosophy of) time to (semantics of) tense

- naive idea: 'there is nothing problematic about verb tenses, one talks about the past, the present and the future; that's all' – but it is not as simple as that:
- verb tenses are much more complicated (e.g. French has two past tenses, English has at least four future tenses), and tense cannot be separated from *aspect* (cf. the English progressive)
- a typical question in analytic philosophy is: 'what must the world be like for tensed talk to make sense?'
- in particular, what do sentences in the past tense or future tense refer to if Saint Augustine is right in his implied answer to the question

  > Of these three divisions of time, then, how can two, the past and the future, *be*, when the past no longer is and the future is not yet? (*Confessions*, Book XI, Ch. 14)

- Augustine then goes on to question even the existence of the present

From (philosophy of) time to (semantics of) tense

- if Augustine is right, the semantics of tense cannot be *extensional*, but must be *intensional* (i.e. referring to concepts, not to the real world)
- if Augustine is not right on the level of ontology, and past, present and future exist somehow, it must be explained why psychological reality is different (or is it?)
- is ontology (or physics) relevant to semantics of tense?
- there is a presupposition in the question: 'what must the world be like for tensed talk to make sense?: that language is used for talking about the world!
- 'tensed talk' may equally well provide a window on how the world is represented cognitively

Aspects of time

- time as order: before – after, earlier – later (B-series); is the ordering linear?
- time as past – present – future (A-series)
- time as anisotropic: 'time's arrow' (some processes *de facto* go only one way) or as symmetric
- time as continuous or discrete
- time as duration, perhaps with a metric: clock time

Logical question: how are these related?

Time and space

- we can move around freely in space and return to point of origin
- we have no freedom to move in time (except in the Gödel solutions to the Einstein equations)
- therefore trend toward elimination/spatialization of time, to eliminate perspective

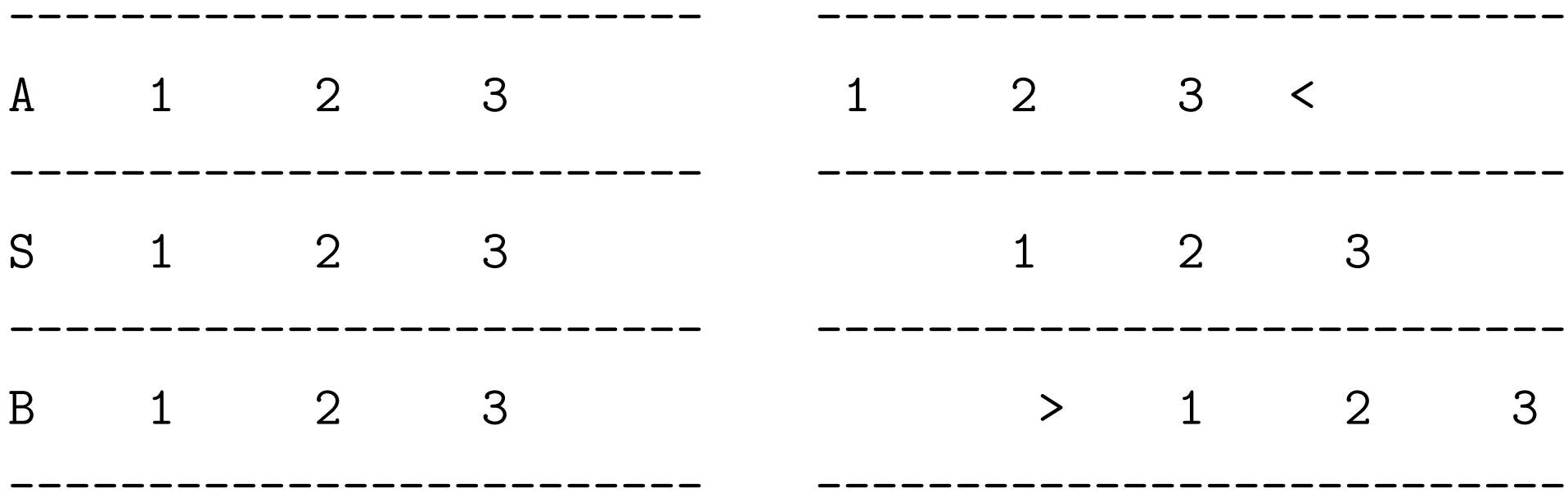
Zeno's four paradoxes of time and motion

"...immeasurably subtle and profound..." (Bertrand Russell)

"...silly little catches..." (C.S. Peirce)

- time consists of indivisible units
  - Stadium
  - Arrow
- time is infinitely divisible
  - Dichotomy
  - Achilles

The Stadium



A and B move in opposite directions, velocity one point per instant.

First B1 is in line with A1, and *at the next instant* with A3.

Zeno thinks this is absurd: there should be intermediate instant in which B1 lines up with A2.

The Arrow (as reformulated by C.S. Peirce)

Major premise No body in a place no larger than itself is moving.
Minor premise Every body is a body in a place no larger than itself.
Conclusion No body is moving.

Peirce: minor premise is only true in the sense of mathematical limit; hence *during no time a body* moves *no distance*. Russell/Whitrow: major premise is false. Motion should be *defined* as a body is in different positions at different times'.
Motion is a *relation*, not a property!

The Dichotomy

In order to traverse a distance [0,1], first half of that distance, i.e. $[0,\frac{1}{2}]$ must be traversed; but this implies first traversing $[0,\frac{1}{4}]$. Etc. Hence infinitely many acts must be accomplished in finite time, which is impossible.

The Achilles, according to Aristotle

"The slowest runner [tortoise] will never be overtaken by the swiftest [Achilles], since the pursuer must first reach the point from which the pursued started, and so the slower will always be ahead."

Superficial solution (Cantor, Russell,...): suppose Achilles runs $10\times$ faster than the tortoise. Then Achilles catches up with the tortoise at the point

$$10 + 1 + \frac{1}{10} + \frac{1}{100} + \ldots = 11\frac{1}{9},$$

in time

$$1 + \frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \ldots = 1\frac{1}{9}.$$

But what does the mathematical solution have to do with the physical world? Achilles and the tortoise will not meet at any of the $10 + 1 + \frac{1}{10} + \ldots + \frac{1}{10^n}$; how do we know that they meet at the limit?

Whitrow's version of the Achilles

- imagine ball projected vertically upwards from horizontal floor
- initial velocity v_0 against uniform gravity, downward acceleration is g
- bounce on the floor has restitution ('elasticity') coefficient e
- assume bounce is instantaneous
- time t until first bounce is $\frac{2v_0}{g}$ (NB upward velocity $v = v_0 - gt$)
- time elapsed when ball comes to rest on the floor

$$t = \frac{2v_0}{g}(1 + e + e^2 + e^3 + \dots) = \frac{2v_0}{g}(\frac{1}{1-e}).$$

E.g. if $e = \frac{3}{4}$, and $v_0 = \frac{1}{2}g$, then $t = 4s$: but if time is infinitely divisible, infinitely many bounces!

Whitrow's analysis

- let $A_0,\ A_2,\ A_4, \ldots$ denote the sequence of bounce events
- let $A_1,\ A_3,\ A_5, \ldots$ denote the sequence of reverse-direction events
- the ball traces the infinite sequence of up and down paths $A_0,\ A_1,\ A_1,\ A_2, \ldots, A_{2n},\ A_{2n+1}, A_{2n+1},\ A_{2n+2} \ldots$
- each time the ball touches the ground it has described an even number of paths, except when it finally comes to rest on the floor.
- if we think of time as flow, as temporal *transition*, the whole sequence of paths cannot be traversed
- transition interpreted here as: from one event to *the next* event.

Sample comments

The disavowal of becoming as an attribute of elementary physical events is a necessary condition for the meaningful affirmation of the denseness of physical time (A. Grünbaum).

There is no nature apart from transition, and there is no transition apart from temporal duration. This is why an instant of time, conceived as a primary simple fact, is nonsense (A.N. Whitehead).

St. Augustine: first psychologist of time

- two times: physical and mental
- physical time viewed relationally, came into being when objects and their motions were created: 'time is the movement of bodies', but not of any single body
- it makes no sense to ask what the eternal God did before he created the world
- time itself is not eternal

Augustine on mental time

- past and future exist only by virtue of being present
- present exists as attention; past exists as memory; future as anticipation or planning
- 'I must not allow my mind to insist that time is something objective': extensiveness of time exists in the mind only
- but how (if at all) are the two times related?

Leibniz against Newton

- Newton assumed 'absolute time': 'Absolute, true and mathematical time, in and of itself, in its own nature flows equably and without relation to anything external ...'
- seen as necessary to account for 'truer time': it makes a difference whether a day runs from sunrise to sunset or from 6am to 6pm
- Leibniz' criticism based on principle of identity of indiscernibles:
- if there is absolute time, God could have created the world later or sooner than he actually did
- these worlds would have indiscernible event-orderings, hence they are identical
- therefore there must exist a unique instant of creation, which is also the beginning of time
- this leads to the *relational theory of time*: time is relative to (periodic) motion of objects

Kant and the first antinomy of the Kritik der reinen Vernunft: time

Concept 'time' is not applicable to the universe, only part of mental apparatus, as shown by paradox:

- suppose the world did not have a beginning in time, then an actual infinity of events must have occurred (which K. considered impossible)
- suppose the world did have a beginning in time, then it must have been preceded by 'empty' time, but (assuming causality) no coming-to-be is possible in empty time
- conclusion: application of time leads to contradiction
- but recall St. Augustine's solution: time began with the universe.

McTaggart's proof of the unreality of time (1908)

- time as order: before – after, earlier – later (B-series)
- time as past – present – future (A series)
- no change in B-series, only in A-series
- B-series is like space, can be described without egocentric perspective
- the B-series cannot exist without the A-series: time is change, and this provides the ground for ('generates') the B-facts
- the A-series is contradictory, and therefore the B-series is groundless

Why the A-series is contradictory

- McT: any event E has the incompatible properties future, present, past
- opponent: but, E *was* future, *is* present, *will be* past; no contradiction?!
- McT: reformulate as 'E is present at a moment of the present, past at a moment of the future, future at a moment of the past'
- McT: this *moment*, the event of E's happening, itself has the three incompatible properties of past, present and future!
- opponent: but the event of E's happening is identical to E's happening; *time is not a process in time*!

Dummett on McTaggart (in *Truth and other enigmas*)

- 'E *is* present, *was* future, *will be* past' to be formalized as
- 1. $Happens(E, now)$; 2. $\exists t < now \exists s > t\ Happens(E, s)$; 3. $\exists t > now \exists s < t\ Happens(E, s)$
- 2,3 follow from 1, hence no contradiction
- now used essentially; no analogue for space
- real time, *time as change* involves egocentric reference point *now*
- but how is *complete*, *viewpoint-independent* description of reality compatible with time as change?
- does this leave us with a relational concept of change as in the B-series?
- is *now* really egocentric only, or a property of the world?

Time in physics

- variable t in physical theories, which can take values in $\mathbb{R}$ (but cf. the bouncing ball ...)
- Newton: 'Absolute, true and mathematical time, in and of itself, in its own nature flows equably and without relation to anything external ...'
- Newton: objects in space *evolve* in time
- Einstein/Minkowski/Weyl: four-dimensional space-time continuum with no distinguished time coordinate
- in STR, separation relative to an observer by means of clock and measuring rod
- in STR, 'before – after' absolute for events which are potentially causally connected; observer-dependent for other events
- in GTR, time may have different properties at different scales
- 'block universe' (W. James): the world is like a film strip

Weyl 1922 on the 'block universe'

The scene of action of reality is not a three-dimensional Euclidean space, but rather a *four-dimensional world, in which space and time are linked together indissolubly.* However deep the chasm may be that separates the intuitive nature of space from that of time in our experience, nothing of this qualitative difference enters into the objective world which physics endeavors to crystallize out of direct experience. It is a four-dimensional continuum, which is neither 'time' nor 'space'. Only the consciousness that passes on in one portion of this world experiences the detached piece which comes to meet it and passes behind it, as *history*, that is, as a process that is going forward in time and takes place in space.

If we assume the block universe . . .

'Whence the becoming in the case of *mental* events that become and are causally dependent on physical events, given that physical events themselves do not become independently of being perceived, but occur tenselessly?'

- Whitrow: in the absence of a convincing answer, best assume there is becoming, and that are minds are evolutionary adapted to this
- Grünbaum: why is mental dependence of becoming more puzzling than mind dependence of, say, colours?

Philosophical problems about time: have they been solved?

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Summary and outlook

- philosophical questions about time are wide open
- it is interesting to investigate to what extent thinking about time has influenced representation of temporal notions in natural language
- semantics of tense leads to deep questions about the nature of linguistic meaning, in particular about the role of cognition as an intermediary between language and world
- it will turn out that logical techniques are extremely useful in investigating these problems