

Zeno

Analyzing the argument

Zeno Race Course

Zeno's Argument

- In order to get from *starting point* to *end point*, the runner must make infinitely many runs.

Zeno Race Course

Zeno's Argument

1. It is impossible for the runner to make infinitely many runs (to the various “halfway points” and “*halfway* halfway” points).
2. Therefore, it is impossible for runner to reach *the end*.

Zeno

- **Assessing the argument**
 - It is **valid** because the conclusion follows from the premises.
 - But is the argument **sound**? Does the argument have genuinely **true premises**?

Zeno - Arrow

- If, Zeno says, everything is at rest when it is in a space equal to itself, and the moving body is always in the present moment in a space equal to itself, then the moving arrow is still. Therefore the arrow in flight is stationary.
(Aristotle, *Physics* 239b5)

Zeno

Here's Aristotle's take on Zeno's argument:

1. When the arrow is in a place just its own size, it's at rest.
2. At every moment of its flight, the arrow is in a place just its own size.
3. Therefore, at every moment of its flight, the arrow is at rest.

Zeno - Arrow

Comments about Aristotle's solution

- Zeno's argument falsely assumes that time is composed of "nows" (i.e., a continuous series of indivisible instants).
- Aristotle seems to think that there is no such thing as motion (or for that matter, rest) "in the now".

Zeno - Arrow

- Are there problems with Aristotle's view?
- Aristotle seems to deny the possibility of motion or rest "at an instant", something which modern physics allows.

Zeno - Arrow

- **Velocity** refers to “the rate at which an object changes its position.”
- Imagine a person moving rapidly - one step forward and one step back -always returning to the original starting position. While this might result in a frenzy of activity, it would also result in a zero velocity. Because the person always returns to the original position, the motion would never result in a change in position. Since velocity is defined as the rate at which the position changes, this motion results in zero velocity.

Zeno - Arrow

- If a person in motion wishes to maximize his/her velocity, then that person must make every effort to maximize the amount that he/she is displaced from his/her original position. Every step must go into moving that person further from where he/she started. For certain, the person should never change directions and begin to return to where he/she started.

From: <http://www.physicsclassroom.com/Class/1DKin/U1L1d.html>

Zeno - Arrow

But in modern physics, the following holds:

Instantaneous speed is the speed of an object at a precise instant in time.

Instantaneous velocity is the instantaneous speed in a specified direction.

<http://www.sasked.gov.sk.ca/docs/physics/u1d3phy.html>

<http://www.sparknotes.com/testprep/books/sat2/physics/chapter5section2.rhtml>

Zeno's Greatest Hits

The paradoxes:

The Dichotomy: There is no motion, because that which is moved must arrive at the middle before it arrives at the end, and so on ad infinitum.

The Achilles: The slower will never be overtaken by the quicker, for that which is pursuing must first reach the point from which that which is fleeing started, so that the slower must always be some distance ahead.

Zeno's Greatest Hits

- *The Arrow*: If everything is either at rest or moving when it occupies a space equal to itself, while the object moved is always in the instant, a moving arrow is unmoved.

Zeno's Greatest Hits

- *The Stadium*: Consider two rows of bodies, each composed of an equal number of bodies of equal size. They pass each other as they travel with equal velocity in opposite directions. Thus, half a time is equal to the whole time.