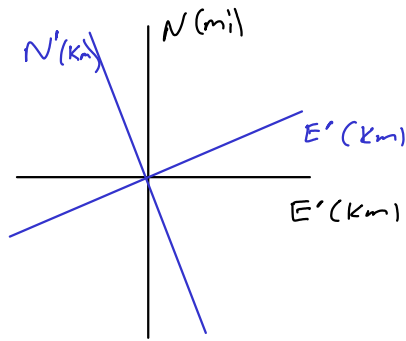


# The surveyors



Daytime: use North Pole

Nighttime: use compass

Both:  
• north  $\perp$  east  
• north in miles  
• east in Kilometers

## Moral

- Use the same units
- (squared) distance is invariant
- frames related by rotation

---

## Us!

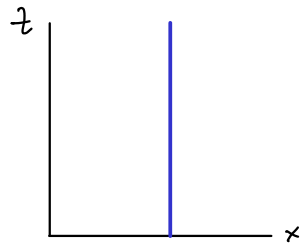
At rest: use stationary watch

moving: use moving watch

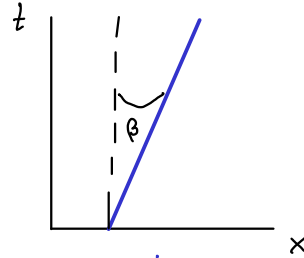
Both:  
• measure length  
at constant time  
• length in meters  
time in seconds

# Spacetime

(show: train sched. pdf)



standing still  
(getting older)



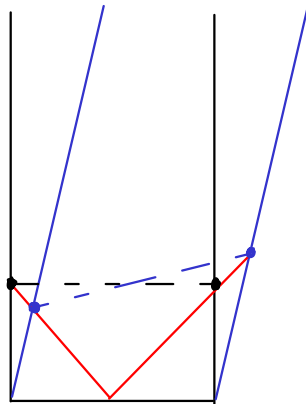
moving

How fast?

$$\left( \frac{v}{c} = \frac{\Delta x}{c \Delta t} = \tanh \beta \right)$$

Fact: speed of light is the same for all observers

This is weird!  
Compare to ball thrown on train.



Both observers  
must see light  
reach both ends  
of train car  
simultaneously!

∴ different notions of time!

# Dot Product

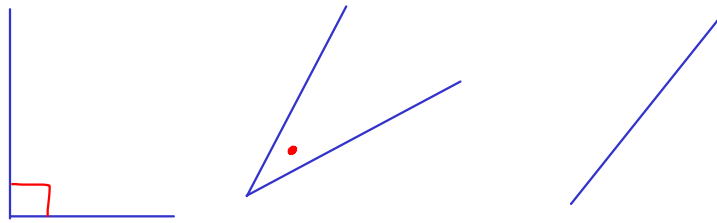
$\hat{x}, \hat{y}, \hat{z}, \hat{t}$  orthonormal

but  $\vec{t} \cdot \vec{t} = -1$

$$\vec{v} = \bar{v} + v^t \hat{t}$$

$$\bar{v} = v^x \hat{x} + v^y \hat{y} + v^z \hat{z}$$

swBQ: Find 2 orthogonal vectors



right angles are not angles!