Lesson 5 - Exercise

Logical Computational Thinking

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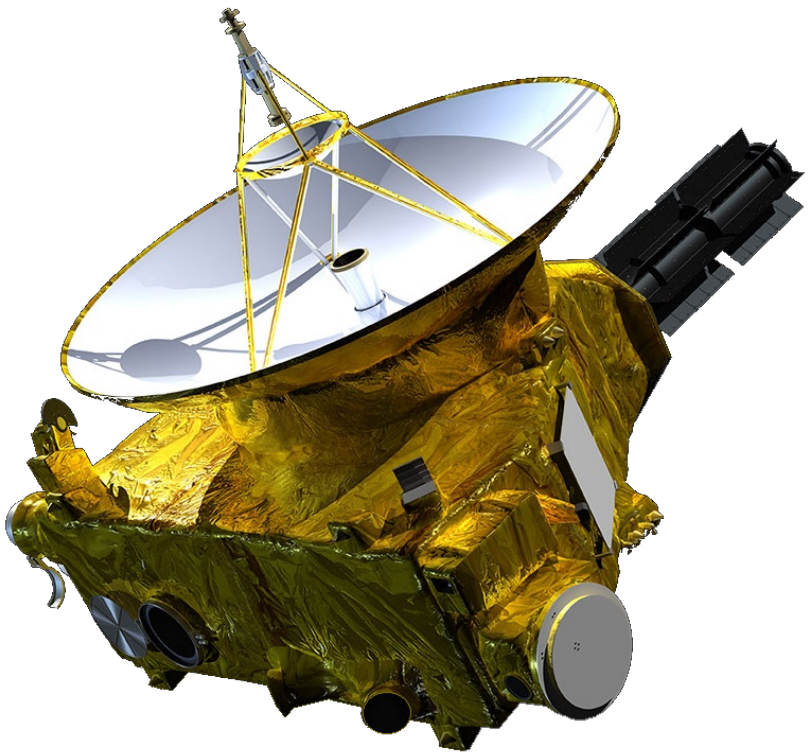
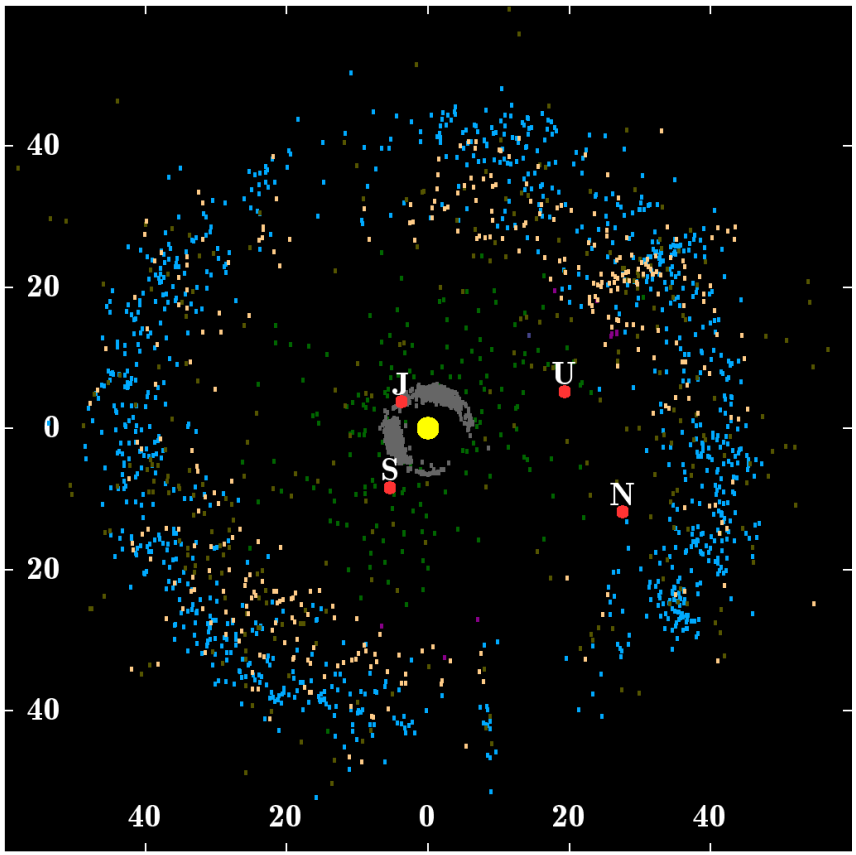
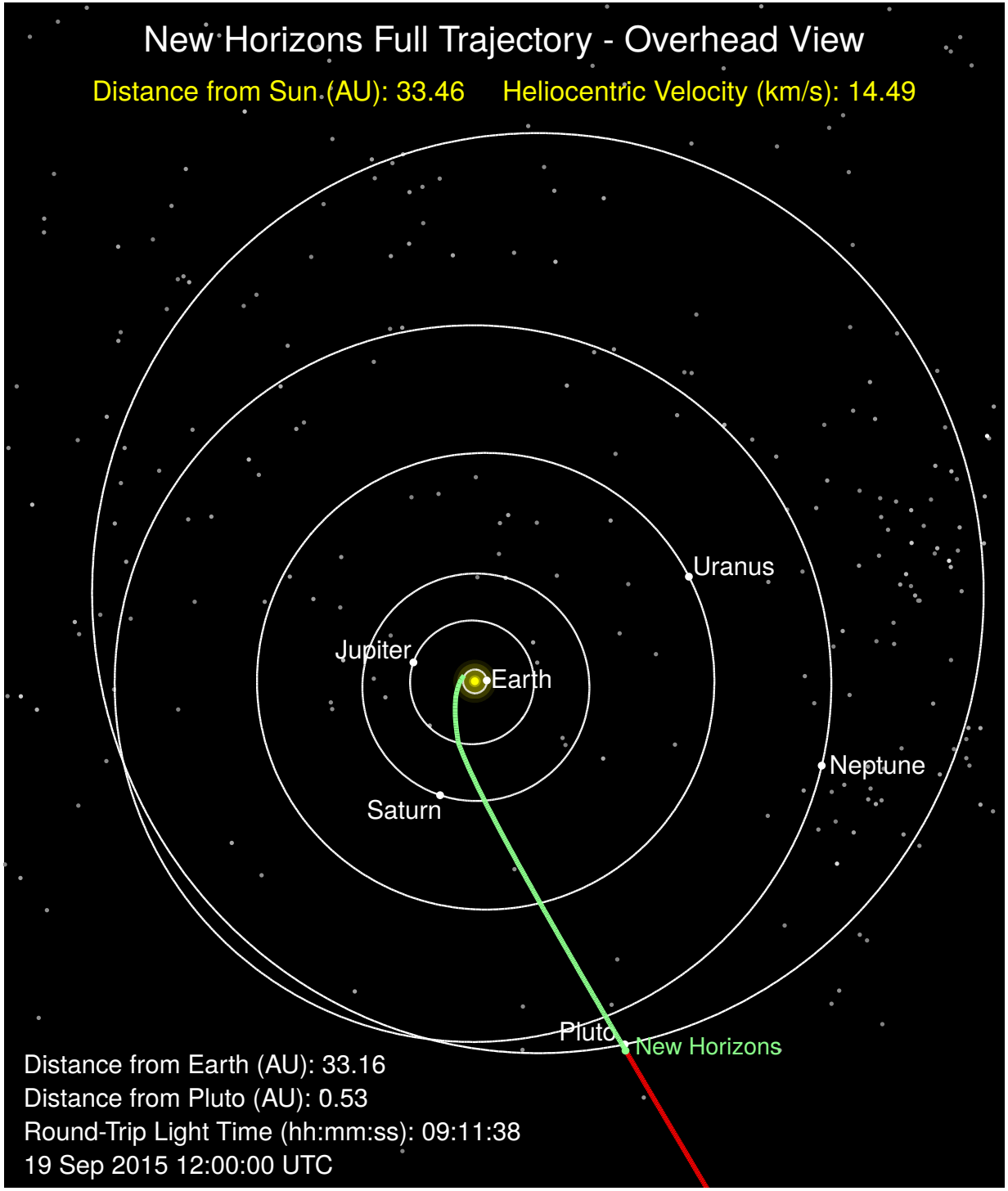
Problem

Background

You work for the *New Horizons* mission. Few months ago the probe flew near *Pluto*, but it is still in the *Kuiper belt* and the mission is not yet concluded.
The astrophysicists wants you to build a program for calculating when the probe will reach the end of the belt, or more in general when it will reach a certain distance from the sun.







Astronomical Units (AU)

1 *AU* is approximately the average distance from the Sun to Earth, and the exact value is:

$$1\ AU = 149597870700\ m$$
$$= 149597870,700\ km$$

- ✓ http://pluto.jhuapl.edu/
- ✓ https://www.nasa.gov/mission_pages/newhorizons/main/index.html
- ✓ https://it.wikipedia.org/wiki/New_Horizons
- ✓ https://en.wikipedia.org/wiki/Kuiper_belt

Model

Input

- ✓ Current distance from the Sun (in AU)
- ✓ Current velocity respect the Sun in radial direction (in km/sec)
- ✓ Target distance from the Sun (in AU)

Output

- ✓ The necessary time from now to reach the target (in sec)

Approximations

- ✓ New Horizons probe is not going in radial direction respect the sun, but for now we can assume a radial direction and ignore the error
  - An improvement to the program can be the possibility to specify the angular deviation from the radial direction

Physics

After the acceleration phases (https://en.wikipedia.org/wiki/Gravity_assist), probes are moving in uniform linear motion, the law that govern it is:

$$\Delta x = v \cdot \Delta t$$

where Δx is the distance covered in Δt time by a body that is moving at a constant velocity v in a linear direction.

So if you know the position x_p and the velocity v_p of the probe, and the position x_t of the target in the radial rectilinear direction you can calculate:

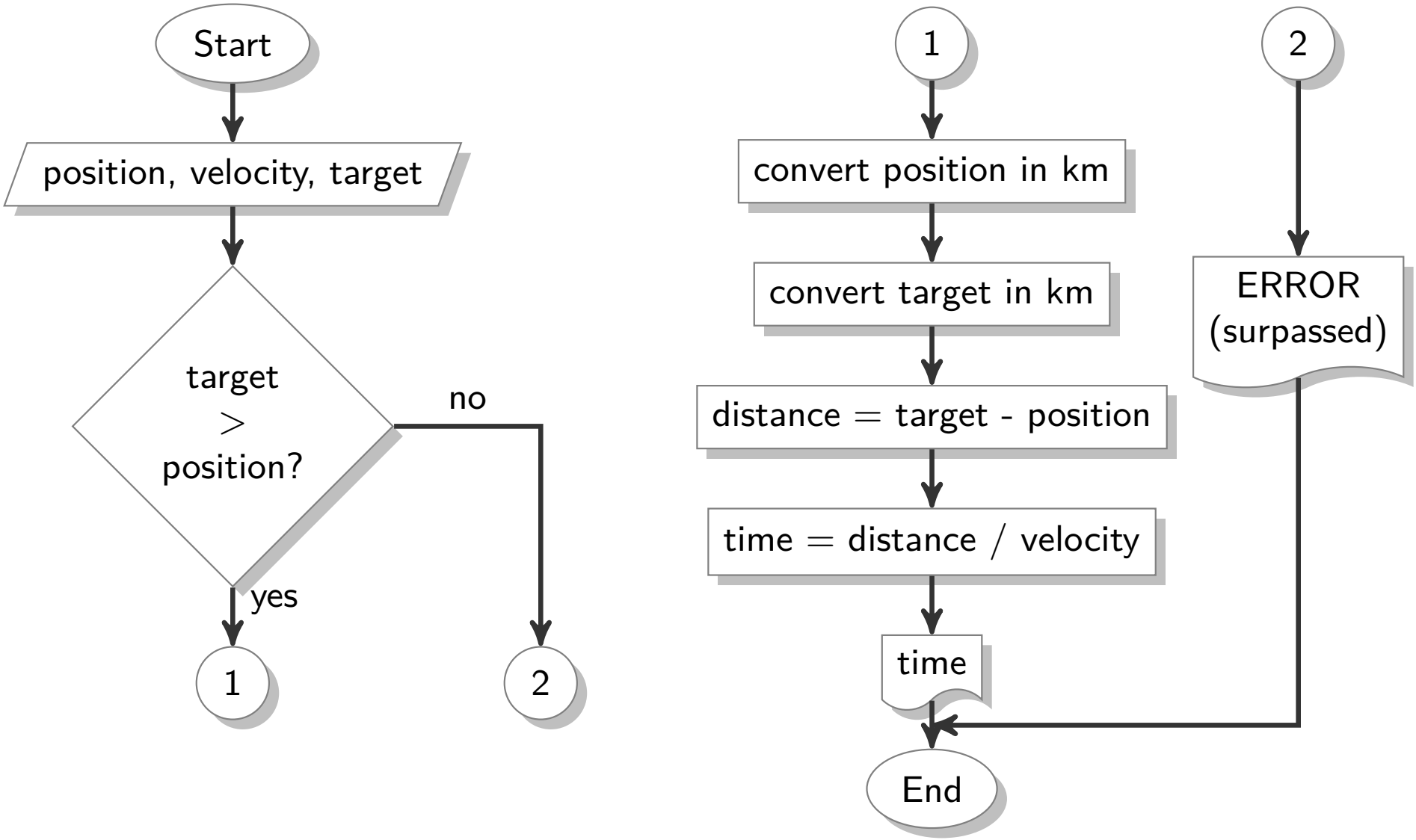
$$\begin{aligned} \Delta x &= x_t - x_p \\ \Delta t &= \frac{\Delta x}{v_p} = \frac{x_t - x_p}{v_p} \end{aligned}$$

Unit of measures

For doing the calculations you need coherent unit of measures, so if x_p and x_t are expressed in AU and v_p is in km/s, first is necessary to convert x_p and x_t in km using:

$$\begin{aligned} 1\ AU &= 149\,597\,870\,700\ m \\ &= 149\,597\,870,700\ km \end{aligned}$$

Algorithm


Start
position, velocity, target
target
>
position?
no
yes
1
2
1
convert position in km
convert target in km
distance = target - position
time = distance / velocity
time
End
2
ERROR
(surpassed)