EPFL Fall 2018
Doctoral School
Civil and Environmental Engineering

Scientific Programming
for Engineers

Week 9 — *Unit Tests*
Particle's Code

The goal of the present exercise is to setup series of unit tests for the particle's code and to ensure that various classes/routines are implemented correctly.

Exercise 1: ***Unit Test : for reading/writing of CSV files***

- Create an unit test which creates a planet from a CSV file. Implement a routine which checks whether the planet created has the same attributes (position, velocity, force, radius, name) as provided in the input CSV file.
- Within the same unit test, implement another routine which writes the created planet to a CSV file. Also, check whether the attributes are written correctly to the CSV file.

Exercise 2: ***Unit Test : for computation of forces***

- Create an unit test to check whether the class *computeGravity* is computing the gravitational forces correctly.
- Use the following initial conditions for two particles of mass $m_1 = 1.$ and $m_2 = 1.$.
  - $p_1 = (0, 0, 0)$ and $v_1 = (0, 0, 0)$
  - $p_2 = (1, 0, 0)$ and $v_2 = (0, 1.2, 0)$

  where the gravitational constant is 1, timestep dt is 5.10^{-3} and the first particle is fixed (sun). Check the computed forces.

Exercise 3: ***Unit Test : for an ellipsoid trajectory***

- Create an unit test to check whether the class *computeVerletIntegration* is performing the integration correctly. We will check this by computing the trajectory for a planet revolving around the sun.
- A planet should yield an ellipsoid trajectory for the given initial condition.
  - $p_1 = (0, 0, 0)$, $f_1 = (0, 1e^{-4}, 0)$, $m_1 = 1$ and $v_1 = (0, 0, 0)$
  - $p_2 = (1, 0, 0)$, $f_2 = (0, -1e^{-4}, 0)$, $m_2 = 1e^{-4}$ and $v_2 = (0, 0.5, 0)$

  with a gravitational constant of 1, timestep dt is 5.10^{-3} and p_1 is fixed.
- Compare the computed trajectory with the trajectory given by the analytical solution. The eccentricity for an ellipsoid path should be $0 < e < 1$

Exercise 4: ***Unit Test : for a circular trajectory***

- Create an unit test to check whether a planet yields a circular trajectory for the given initial condition.
  - $p_1 = (0, 0, 0)$, $p_1 = (0, 1e^{-4}, 0)$, $m_1 = 1$ and $v_1 = (0, 0, 0)$
  - $p_2 = (1, 0, 0)$, $p_2 = (0, -1e^{-4}, 0)$, $m_2 = 1e^{-4}$ and $v_2 = (0, 1, 0)$

with a gravitational constant of 1, timestep dt is 5.10^{-3} and p_1 is fixed.

- Compare the computed trajectory with the trajectory given by the analytical solution. The eccentricity for a circular trajectory should be $e = 0$