Computational Physics for Physics Educators

Unity as a Modeling Environment - Lennard Jones 3D Box example

Physics Modeling in Unity

- Pros
  - Integrated C# editing
  - Vector3 classes for easy vector math
  - High quality 3D rendering
  - Wide platform range
  - Free for personal use, education license grants readily available
- Cons
  - Native math is floating point
    - (but you can use System.Math, or there are rewrites of the Unity Math libraries in double precision)
  - Unity game is a single threaded process
    - (but C# has strong embedded support for threads)
  - No built in higher level Math libraries
    - (but options are available for C#)

Unity Modeling Toolkit

https://github.com/joinerda/unity-modeling-toolkit

Adds a threaded update routine to MonoBehaviour, includes an integrator class with Euler, RK4, and ABM routines, and a double precision copy of the standard Unity Math libraries, including Vector3

https://joinerda.github.io/LennardJones/

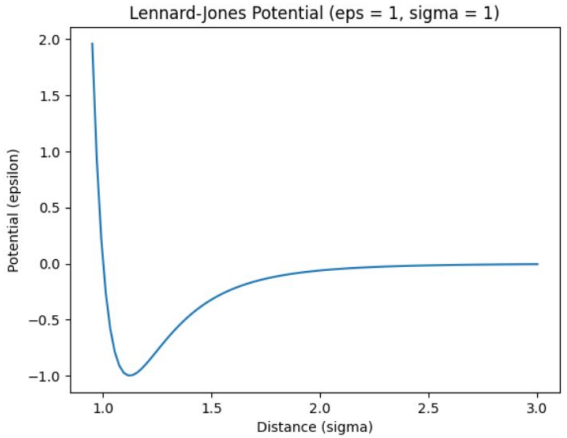
Lennard Jones Unity Model

The Unity model here is of a Lennard Jones potential applied to particles in a periodic box.

This was inspired by the 2D example in Landau et. al.'s A Survey of Computational Physics.

The Lennard-Jones potential is given by

$$u(r) = 4\epsilon \left[\left(\frac{\sigma}{r}\right)^{12} - \left(\frac{\sigma}{r}\right)^{6} \right]$$



and is used to model long range attraction and short term repulsion in atomic and molecular interactions.

DEMOs

- Unity Modeling Toolkit
- Lennard Jones model in 3D