

Rigid Body Simulation in 2 Dimensions

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The Simulation Problem

Simulation of interacting bodies is very important in developing and testing new models in physics, from jamming transitions in granular systems to the formation of galaxies. There exist many different kinematic models and computational techniques to simulate rigid bodies, each with their own trade offs. However, there are few resources available that describe the strengths and weaknesses of these different approaches, so it is difficult to tell a priori which approaches are most viable and appropriate for a particular physical problem.

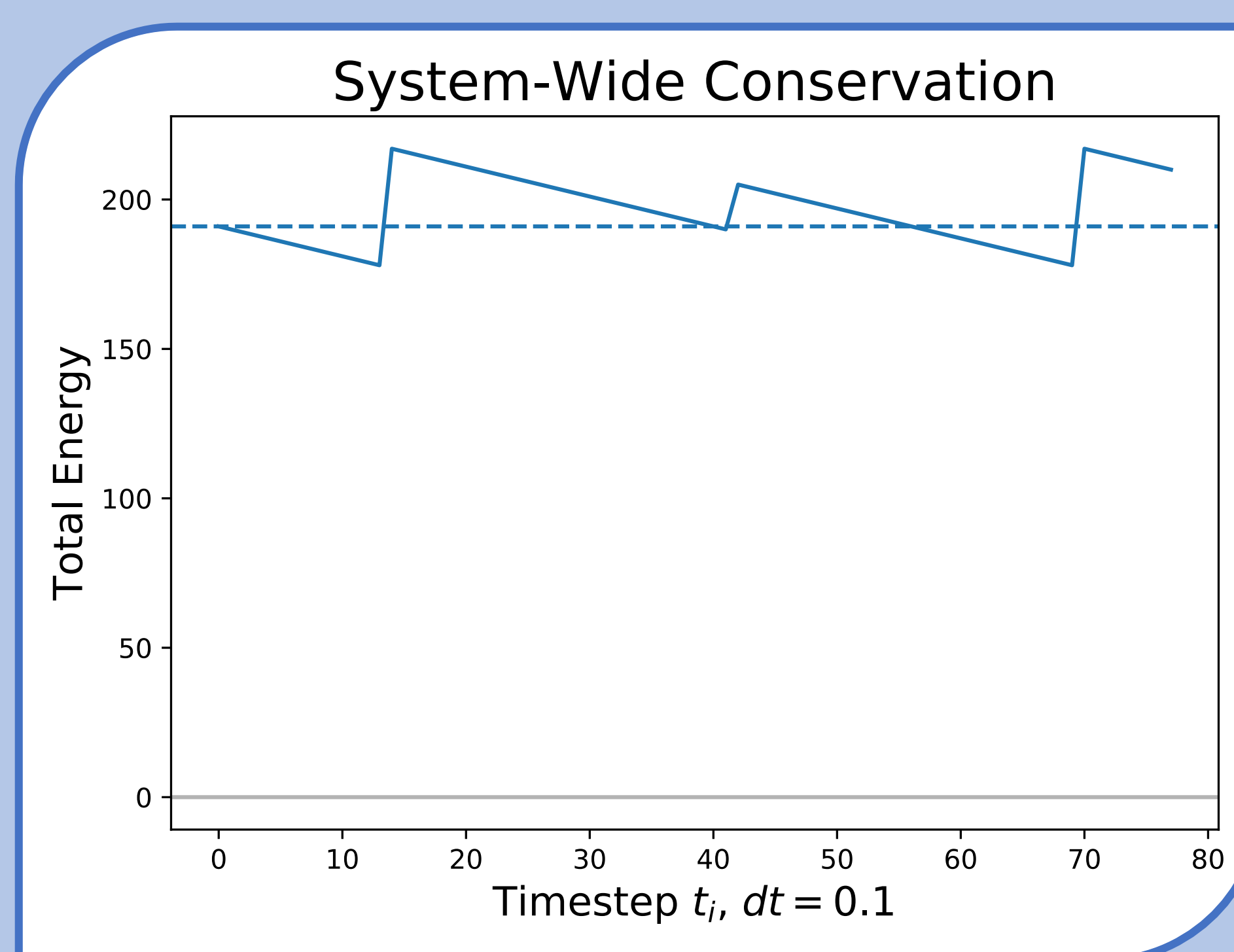
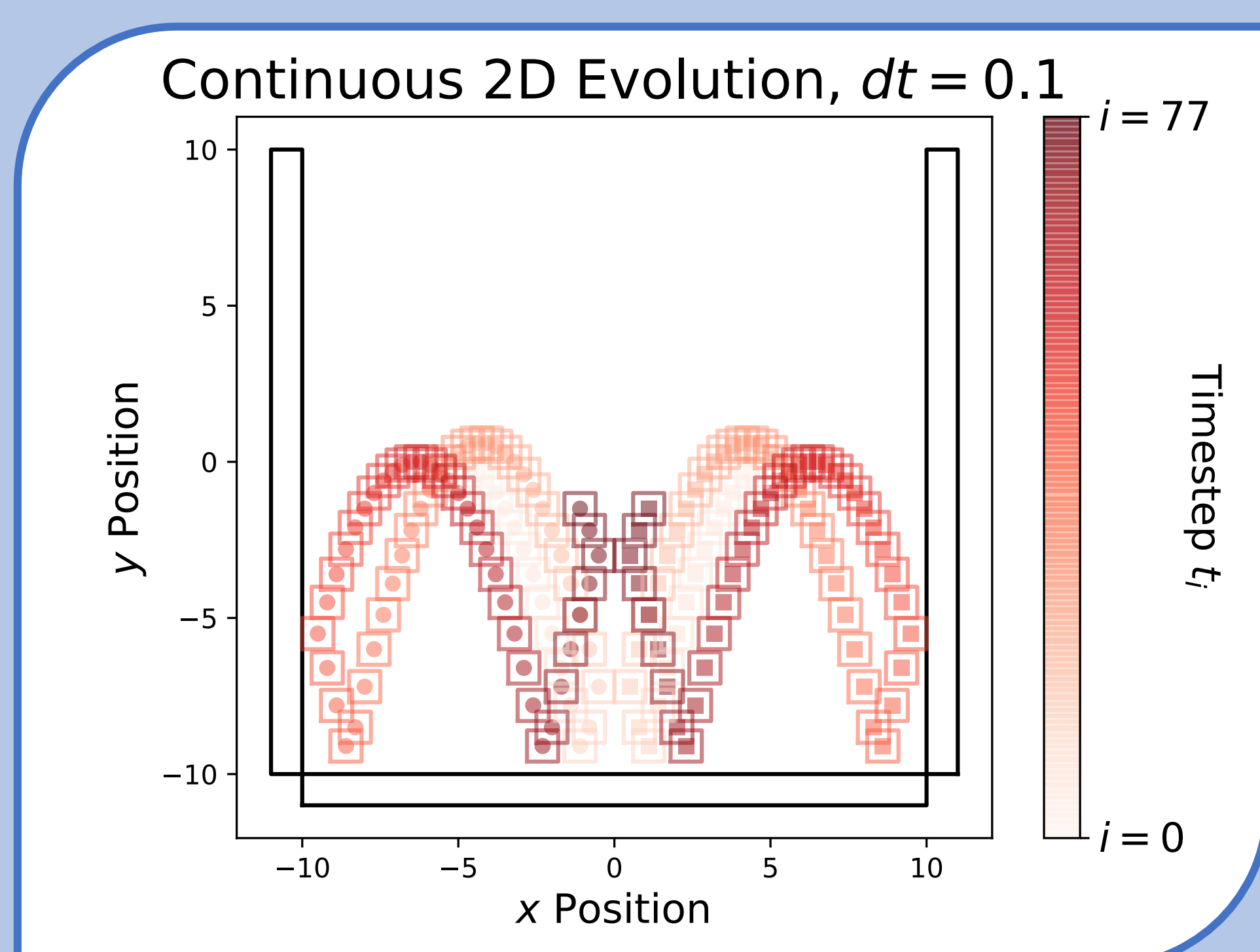
Methods and Goals

We implemented two rigid body simulation models, each of which was developed with different strengths in mind, in order to compare their qualitative and quantitative properties.

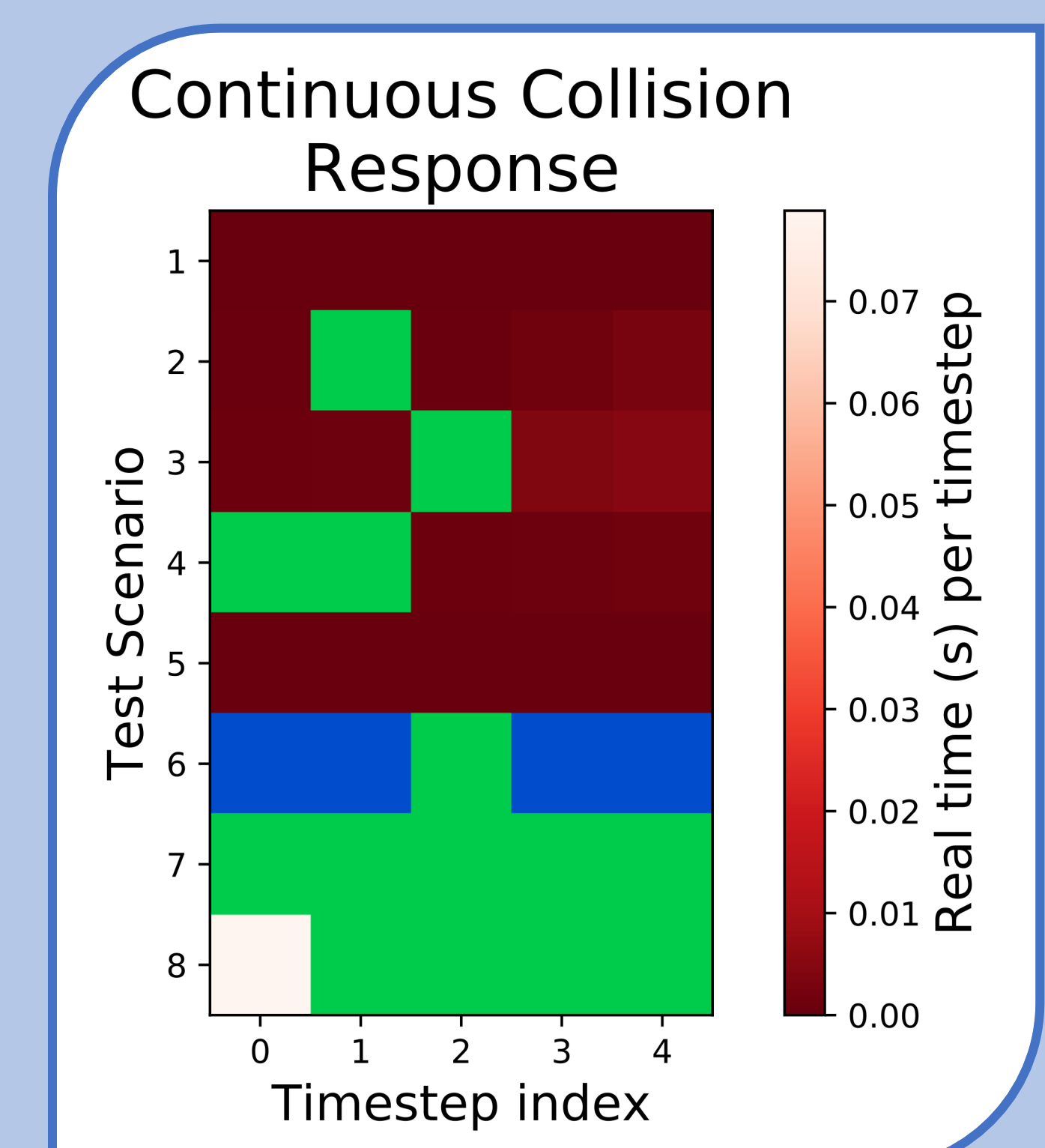
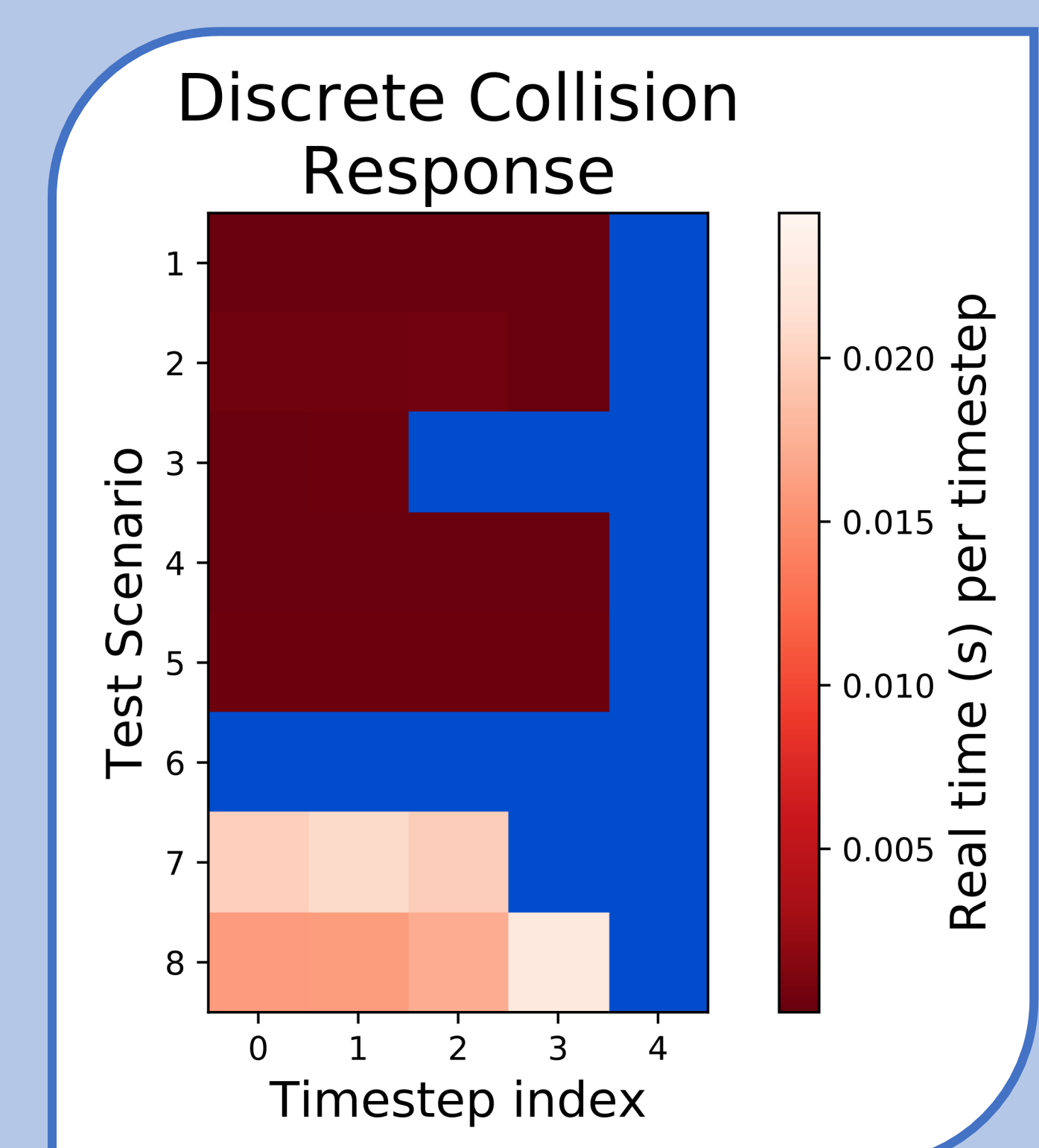
1. Discrete-time collision detection; penetration resolved using non-physical translation; no angular interactions (200 lines of C++ code)
2. Continuous-time collision detection based upon root finding; penetration prevented proactively; collision response based upon linear and angular impulse (1000 lines of C++ code)

Results

Example System

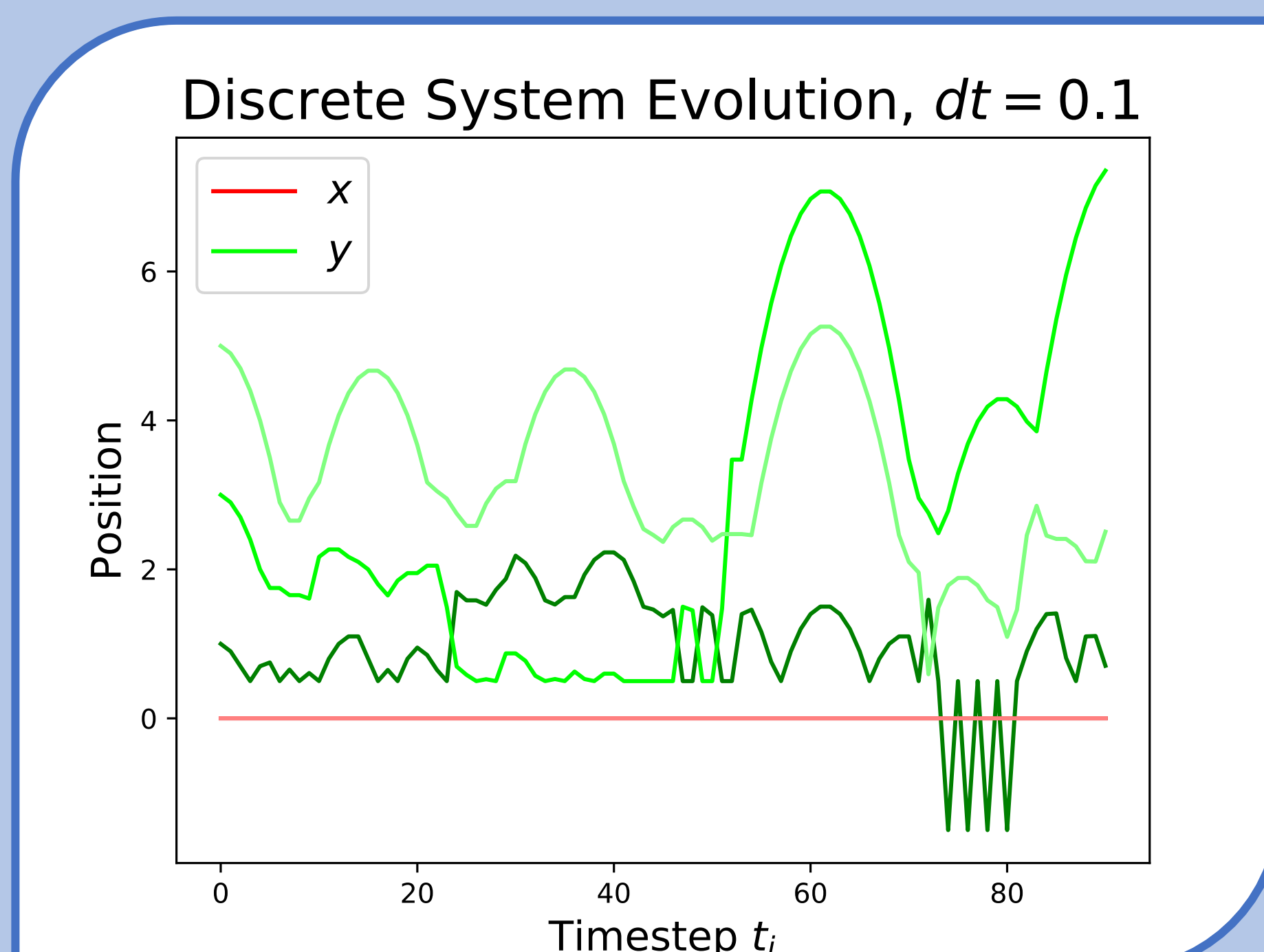


Speed, Accuracy, Convergence



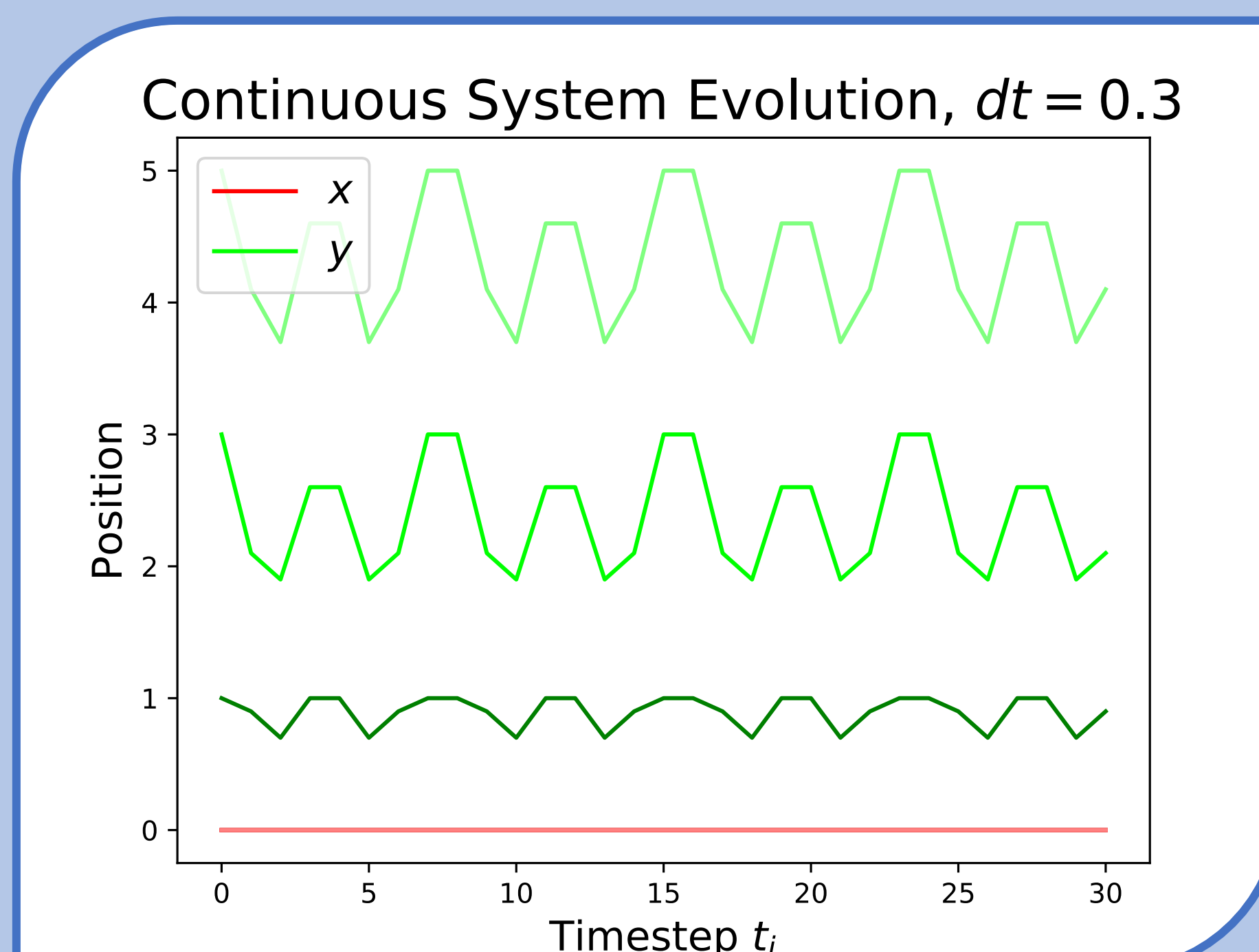
1. Discrete

A fast and unyielding solution for distinct collision events. Frequent tunneling and physical instability.



2. Continuous

Complex and fragile, with many vulnerabilities. Remains stable even as timestep is increased substantially.



Acknowledgements:

1. Erin Catto, Game Developers Conference 2010, GDC 2013, GDC 2014
2. Nilson Souto, *Collision Detection for Solid Objects*, Toptal.com
3. William Bittle, *Separating Axis Theorem*, dyn4j.org

Source Code:

<https://github.com/lfdelta/RbodySim>