

Programming Proverbs

- 1. “Define the problem completely.”
- Henry F. Ledgard, “Programming Proverbs: Principles of Good Programming with Numerous Examples to Improve Programming Style and Proficiency”, (Hayden Computer Programming Series), Hayden Book Company, 1st edition, ISBN-13: 978-0810455221, December 1975.

Recommended Reading

- Ian Millington, "Game Physics Engine Development", 2nd Edition, Morgan Kaufmann, 2010
- read chapter 1
- read chapter 3

What is a Game Physics?

- it could include the way light travels and bounces around a simulated world to make better looking graphics
- generally however it does not include the above, but refers to classical mechanics
- mass, inertia, elasticity, density, friction, velocity, acceleration of objects

What is a Game Physics?

- might include objects which can be stacked, destroyed, crumpled
 - ragdoll effects
 - fluid flow
 - flags in wind
 - rope
 - springs

What is a Physics Engine?

- in early games, physics was coded up ad-hoc, per game
 - usually consisting of crude hacks
 - memory was extremely tight, many machines did not have floating point units

- as machines become faster and had more memory developers started to use high level languages for games
 - thus the push for reusable code
 - reusable generic code
 - became natural to attempt and isolate game physics in a module or set of modules

Advantages of a Physics Engine

- development time saving
 - a couple of thousand lines of code should solve many of the common effects required

- quality of game physics
 - reliability of code behaviour
 - accuracy of physics

- separating the physics engine from the game should allow more realistic scenarios
 - as the developer does not need to enumerate each combination

Weakness of a physics engine

- speed
 - a physics engine can become a simulation
 - feature creep, more realism, more computation required
- may be fine on a desktop
 - but will be unusable on a mobile device
- development time, if you build a physics engine, be mindful that the game might be improved easily by devoting time elsewhere
- one size fits all, rarely

Approaches to Physics Engines

- first distinction is between "rigid body" and "mass aggregate" systems
- consider a crate

Rigid body systems

- our crate is a single object, simulated as a whole

Mass aggregate systems

- our crate could be considered as eight boxes
 - one per corner, connected by rods
- these systems are easier to program
 - for example rotation can be considered at the center of our crate

Contact resolution

- game engines treat contact differently
 - what happens when an object comes to rest touching another?
- consider a game engine simulating jenga

Contact resolution

- three kinds of contact resolution
 - iterative (fast, but one object might effect another)
 - jacobian based (physically realistic)
 - reduced coordinate (for a specific scenareo we are simulating)

Impulses and forces

- how does the physics engine resolve contacts?
- consider a box on a table
- a game engine using forces treats gravity as a force pulling the box down, equally the table pushing up by the same amount
- a game engine using impulses consider both table and box to be having many, many, micro collisions or impulses occurring
 - this is easier to code than the forces approach

Collision detection or prediction

- finally there are different approaches on how collisions are caught
 - most common is frame based collision detection
 - after each frame each object is tested to see if it has intersected with another
 - in which case a collision has occurred and a re-action is calculated

- alternatively the game engine can predict when a collision will occur
 - waits until this time and then calculates the re-action

- the code for reaction will be the same

Collision detection or prediction

- the implementation for frame based collision is much easier than collision prediction
- collision prediction game engines, might be more efficient, more pixel accurate
 - very complex, so much so that normally objects are very restricted
- collision prediction, works well for simulating bagatelle, or snooker
- frame based collision works well for Rage etc