Space-Based Approach

3-22-2005

Opening Discussion

- What did we talk about last class?
- Exam results. There is an 11 point curve to bring the median to 80. (2 As, 3 Bs, 2 Cs, 2 Ds)
- Card game simulation.
- Canceling assignment #5.

Entity-Based Approach

- In space-based we care about the nature of the space or some generalized value associated with the space. Sometimes we care about the entities in the space and only consider the space itself to optimize things.
- In this situation we care about the spatial layout of the entities, but not so much the space itself. Most physical systems that aren't connected fit under this category, but other simulations with disjoint entities that interact with neighbors also fit.

L-Systems

- The concept of an L-system (short for Lindenmeyer system) was developed to help with the modeling of plant growth. They are based on the concept of grammars similar to the Chompsky hierarchy. Unlike Chompsky grammars, L-systems have productions applied in parallel.
- An L-system is defined by a start state and a number of productions. If a character has no production from it, it stays unchanged.

Uses and Why L-Systems Count

- There are two questions that you might ask about L-systems, what all can you use them for, and why are they considered spatial models.
- L-systems not only model plant growth, they are very good at modeling many types of fractals because they naturally produce self-similar features.
- We call them spatial models for two reasons. Naturally they can be 1-D spatial models. Turtle style graphics also work.

Examples of L-Systems

- To really understand an L-system we should look at some simple examples.
- For turtle graphics in 2-D we can use + and – for turning left and right. We can also use brackets for push and pop of positions.
- Some simple examples include a Koch snowflake or basic branching trees. Let's look at grammars for those.

More Complex L-Systems

- L-systems can be made more complex in numerous ways.
- Probabilistic L-systems can have multiple productions for a character with probabilities for each one.
- Context sensitive L-systems allow us to put requirements so productions only happen if the character has a given character on the left or right.
- Parametric systems have us attach values/parameters to characters.

Gas Dynamics

- A very simple type of physical spatial model is that of an ideal gas. This consists of particle that move along straight lines and don't interact with one another. They only bounce off the walls of their container.
- This type of system might not seem interesting, but it helps us to illustrate some nice properties of spatial simulations.

Gas Dynamics with Time Slicing

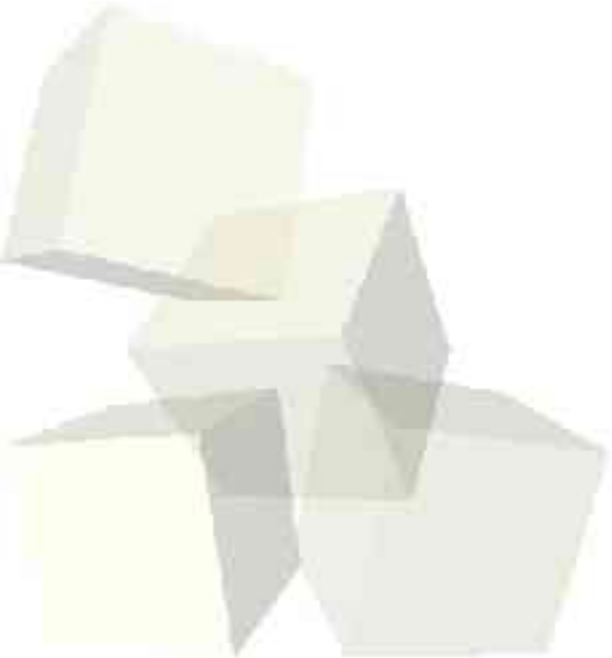
- One was of doing the gas dynamic model is with time slicing. With this approach we advance each particle a small amount along the line it is traveling until we get to a wall and then we bounce off in the proper direction.
- In this approach we update all of the particles every slice. For a model as simple as we are discussing here, this is rather inefficient because most of the time nothing interesting is happening to the particles.

Gas Dynamics with Event Scheduling

- We can fix the efficiency issue in this type of simulation by moving to event scheduling. The only time anything interesting happens is when a particle hits a wall so we can make those the events. At any instant our queue contains the times at which each particle will hit a wall. When we pull an event off, the particle is moved to the wall, it's velocity is changed, and we find the next time it will hit a wall and enqueue that event.

Code

- Let's write some code for doing gas dynamics. We can show some simple properties of ideal gases using this.
- We will do a time slicing model because that will work better for next class.



Minute Essay

- What are you thinking of doing for your project? Remember that your project ideas are due next class.