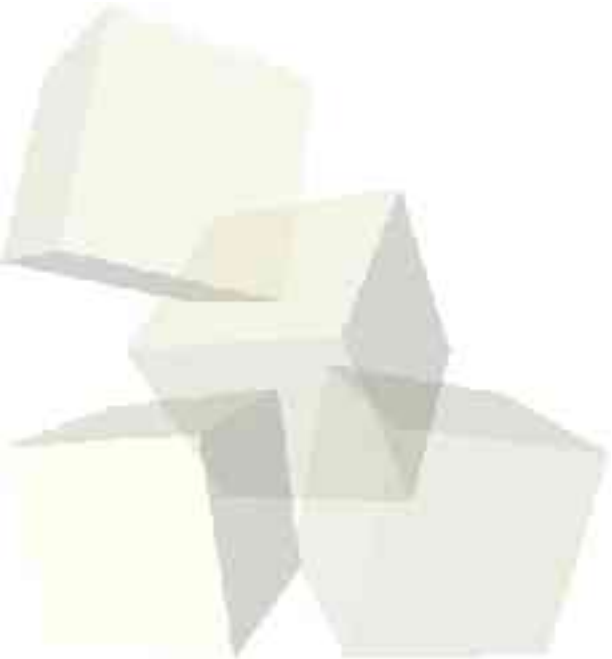
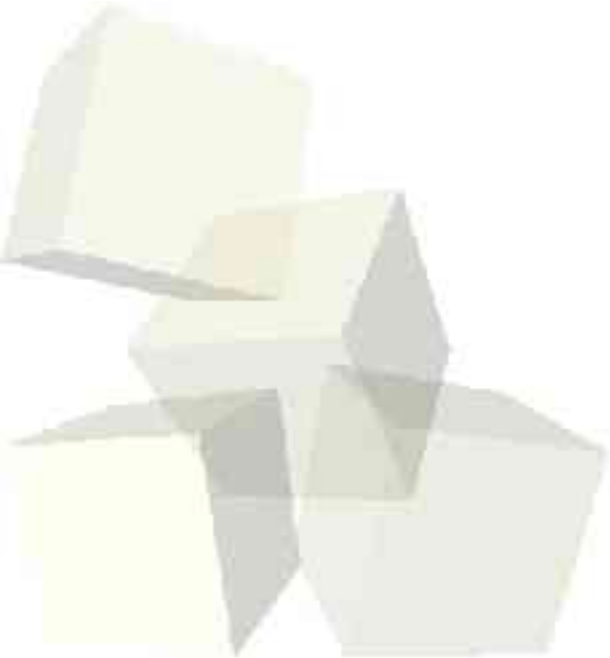
Spatial Modeling

3-11-2005



Opening Discussion

- What did we talk about in the class before the exam?
- Do you have any questions about the assignment?



Spatial Modeling

- So far the models we have created didn't really care that much about where things where, at least not with significant accuracy. The closest to that was constraint models of physical systems with x and y.
- Sometimes you want accurate simulations with many pieces and you care about their physical positions. For this you use spatial modeling.
- These models can be space based or entity based.

Space-Based Models

- In a space-based model, the space itself is what we care about, or can be assigned some value that we care about. This is opposed to the situation where we care about things that are in the space specifically.
- Examples of this would be flows of fluid or the population density in regions as opposed to the actual molecules or individuals in the population.

Cellular Automata

- Perhaps the most general form of space-based model is the cellular automata. Like FSAs, these have their roots in theoretical computer science.
- The idea is that we break a space up into a regular grid of cells and each cell has values associated with it.
- The system advances by having each cell change state based on a set of rules regarding the cells that are near it.

Game of Life

- The CA that most people know of is Conway's Game of Life, which was intended to do a simple spatial model of populations.
- Cells can be either on or off (have population or don't).
- Cells that are on will die if there are too many (more than 3) or too few adjacent cells on (less than 2).
- Cells that are off will turn on if there are exactly 3 occupied adjacent cells.
- Simple changes make different systems.

Margolus Neighborhood

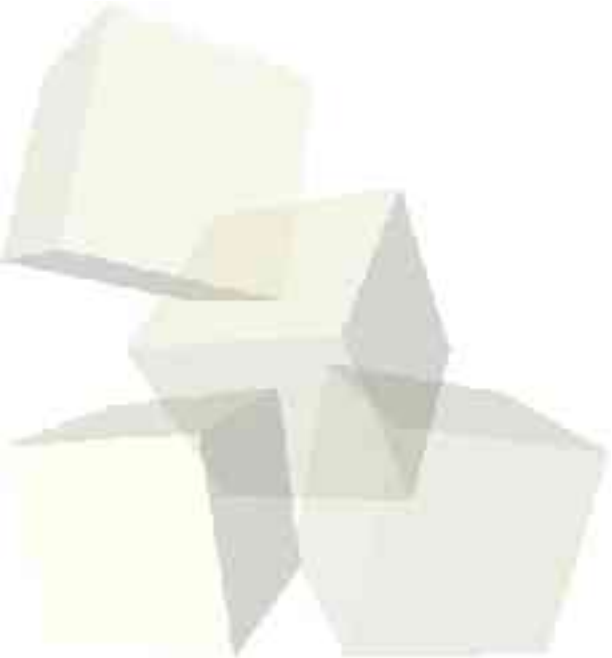
- One problem with the simple model of a CA that only depends on neighbors is that it is very hard to conserve values in that model.
- An alternate approach is to do updates for a whole block at a time where a block contains multiple cells. The rules take a block configuration and change it.
- Blocks do not overlap, but for each iteration we adjust the block locations slightly so that there is continuity.

Diffusion

- We could model diffusion by randomly moving the block configuration randomly. This can control total count while allowing a form of randomness.
- By using other sets of rules we can create gas dynamic like behavior as well.
- Latices can be made that aren't based on squares as well to allow simply rules that give alternate types of motion.

CAs for General PDEs

- By giving cells more than just an on or off, we can also model partial differential equations with techniques that are very similar to cellular automata.



Minute Essay

- What do you plan to do over spring break?