Computer Animation Algorithms and Techniques

Behavioral Animation: Crowds

Crowd Applications

For evaluation

- **Building evacuation, e.g. virtual fire drill**
- **Architecture evaluation, e.g. signage**

For training

- **Military scenarios, e.g. sniper training**
- **Emergency response, e.g. disaster response**

For entertainment: e.g., background crowds

- **games**
- **films, e.g., Titanic, Saving Private Ryan, Lord of the Ringss**

Qualities of crowd

Emergent behavior - similar to flocking, flocking system
Uniform – sameness of members
Quantity & density - average distance between members
Viewing distance – aggregate behavior, inspect individuals
Function – simple traversal, background activity, main actions

Individual processing – amount of computation per member
Physics – simulated reaction to environment
Intelligence - reasoning capability - agents

Uniformity, granularity

Background noise:

Activity without intention

Statistical behavior:

On average, intentional activity

Individuality:

Believable activity at level of individual

Execution environment

Real-time v. Off-line computation

simple computations

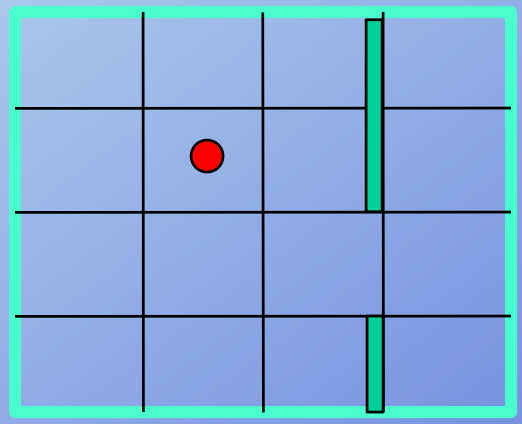
avoid n-squared algorithms

size limited

Spatial organization

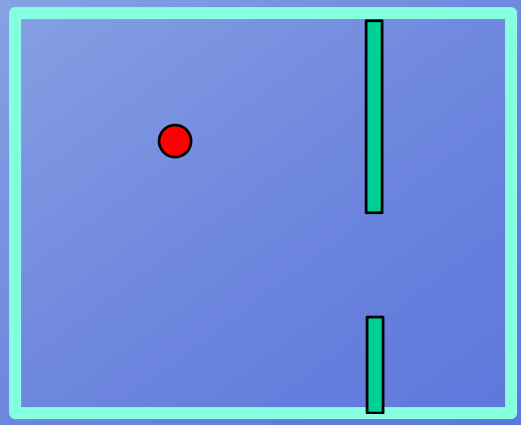
Cellular decomposition:

- **Regular 2D grid**
- **Adjacency accessible**
- **Density limited**
- **Cells define obstructions**



Continuous space:

- **Step in any direction**
- **Need to decipher obstructions**
- **Perception needed**



Perception Modeling

Vision

Memory

Knowledge of environment

Navigation

Fluid flow:

density fields, potential functions

Particle systems:

Individual navigation

Flocking systems:

individual perception, navigation

Rule-based

Cognitive modeling

Cellular automata

Panic & Congestion handling

Personal space

Packing people during evacuation

Stairwell traversal

Exit awareness

Motion & Navigation

Path planning

Roadmaps

Passing on pathways

Potential fields

Forming & maintaining subgroups

Structure in crowds

Homogenous – no individuality

Subgroups

- **Group by belief systems**

A collection of Individuals – personality modeling

Penn Station

See animations

Other topics

Heterogeneous – pedestrians and cars

Data driven crowds – image processing

Comparison to real-world situations

Massive

http://www.massivesoftware.com/

Commercial de facto standard

See animation