CLASS 10
SCENE GRAPHS
BASIC ANIMATION
A scene Graph

- A data structure to hold components of a scene
- Usually a Tree of a Directed Acyclic Graph
- Contains
  - Objects and parts of objects
  - Transformations (rotates, translates, scales)
  - Support for grouping
  - Support for cameras
  - Support for lighting
  - Support for behaviors
  - Support for collision detection
- A standard depth first traversal
Tree and DAG Examples

The actual shape of the scene graph
Animation 1 Key frame

- Key-frame
- Master animator draws key frames on acetate
- “in-betweeners” draw the in-between frames on acetate cells
- Inkers fill in color
- Now cheap animation is like this with computer assistance
- + a library of effects, e.g. repetitive walking.
Key frame animation Disney style
Components of the process

- Sketches showing key events (storyboards)
- Maquettes of main characters may be drawn
- Liveliness is achieved by means of stylistic techniques – squash and elongation.
Squash and stretch

In moving the circle (representing the ball) down and back up, it was discovered that the ball would seem to have more weight if the drawings were closer together at the top and spaced farther apart at the bottom.

Then, if the bottom drawing was flattened, it gave the appearance of bouncing. Elongating the drawings on each side made it easier to follow and gave more to the action. Thus, the beginnings of Squash Stretch.
Computer assistance for traditional animation

- Use digitizing table to draw.
- Automatic in betweens — use splines, or simple physics.
- Color fills

Figure 10.10  Inbetweening with nonlinear interpolation and easing. The ball changes speed as it approaches and leaves keyframes, so the dots indicating calculations made at equal time intervals are no longer equidistant along the path.
3D animation

- Behavioral
- Kinematics
- Inverse kinematics
- Dynamics
- Motion-capture
Behavioral animation

- Objects move according to rules.
- They sense adjacent objects in simple ways.
- Background characters.

Flocks, herds and schools:  
A distributed behavioral model, Proceedings ACM SIGGRAPH, 25-34
Boids (herds, flocks, schools)

- **Global behavior – scripted by animator**
  - Add a tendency to follow a path to all actors

- **Individual behavior – “flight, swimming”**
  - Move forward, limit on acceleration, rate of turn
  - Obstacle avoidance
  - Tendency to a certain fixes speed (slow-down, speed-up)
  - Banked turns – for birds
  - Locomotion movements (walking, flying, swimming);

- **Rules with respect to neighbors**
  - Avoidance: avoid collisions with nearby flockmates
  - Velocity Matching: attempt to match velocity with nearby flockmates
  - Flock Centering: attempt to stay close to nearby flockmates
Kinematics

- Animator controls all joint angles on a 3D model.
- In-betweening is done by computer
Inverse kinematics

- Animator sets body positions.
- Computer determines joint angles.
- Can be undetermined (many combinations of joint angles lead to same result)

IK solver connection

Effector motion

hip and knee joint angles computed automatically
Dynamics

- Mass, and kinetic energy taken into account.
- In the most advanced systems algorithms can cause characters to “walk” though simulations of muscle actions.
Motion capture

- The actions of an actor are used to control the motions of a character.