CS130 : Computer Graphics

Lecture 19: Animation

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Types of animation

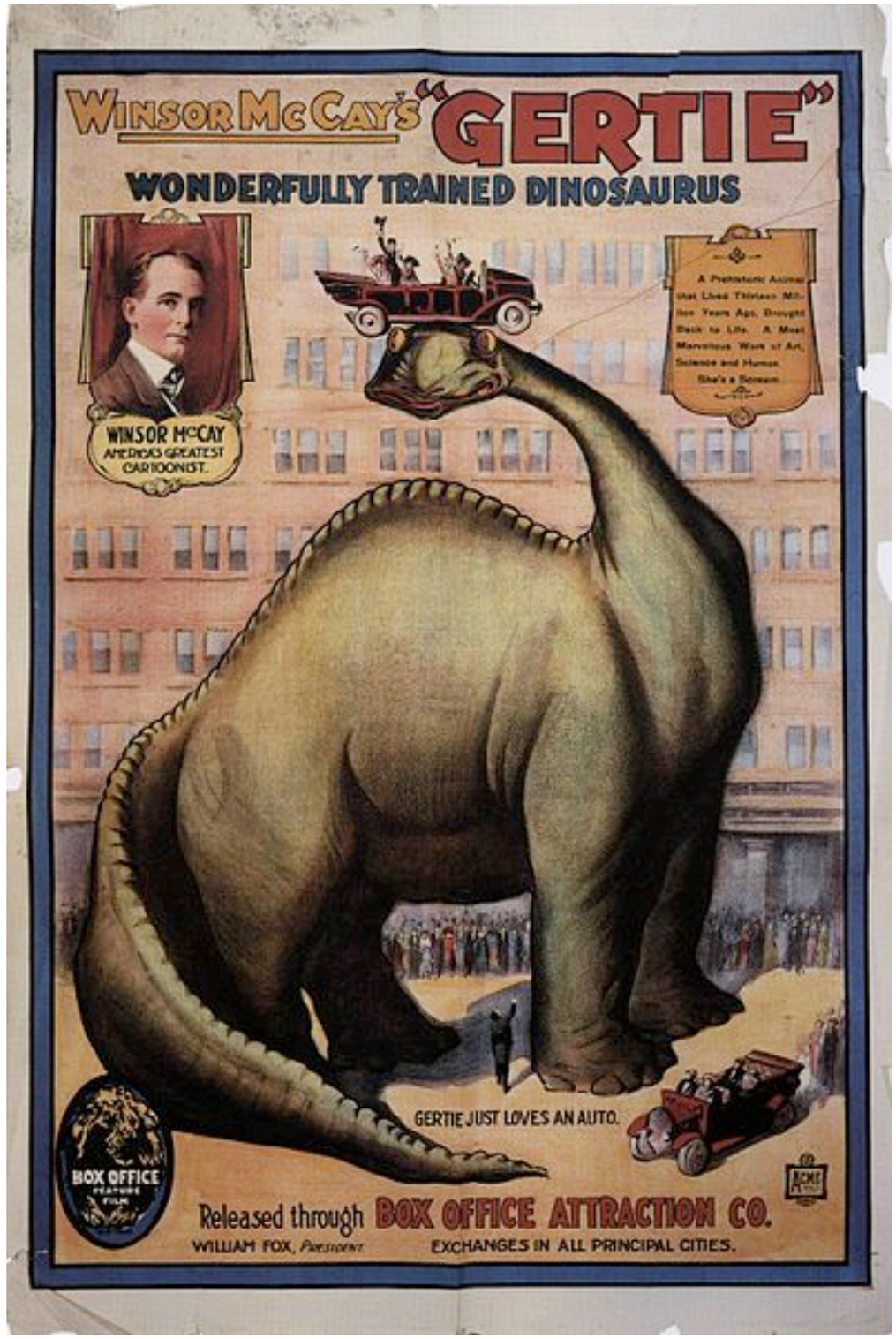
- keyframing
- rotoscoping
- stop motion
- procedural
- simulation
- motion capture

history

Gertie the Dinosaur

1914
12 minutes
hand drawn
keyframe animation
registration
cycling

link

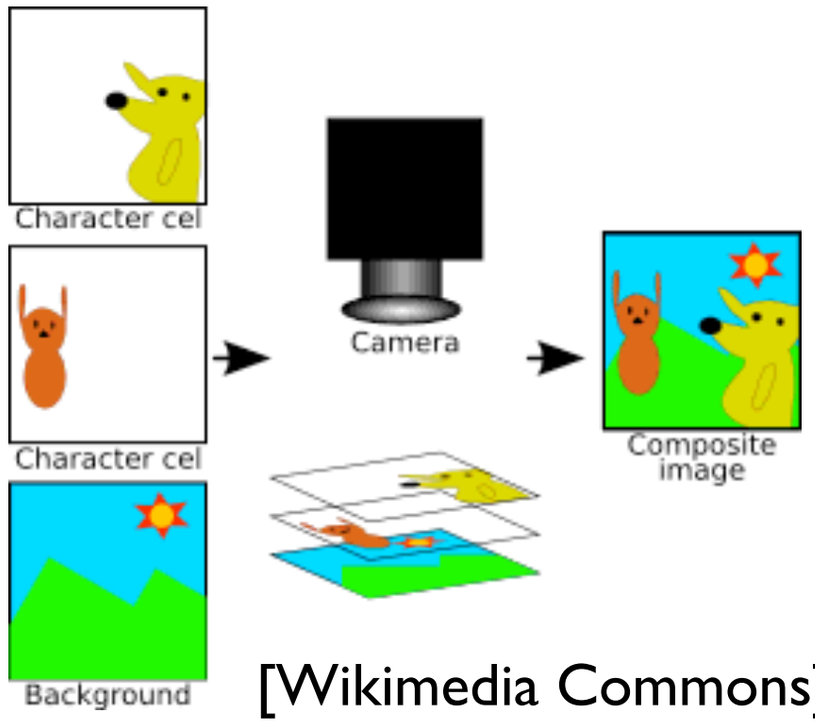


Traditional animation

Cels

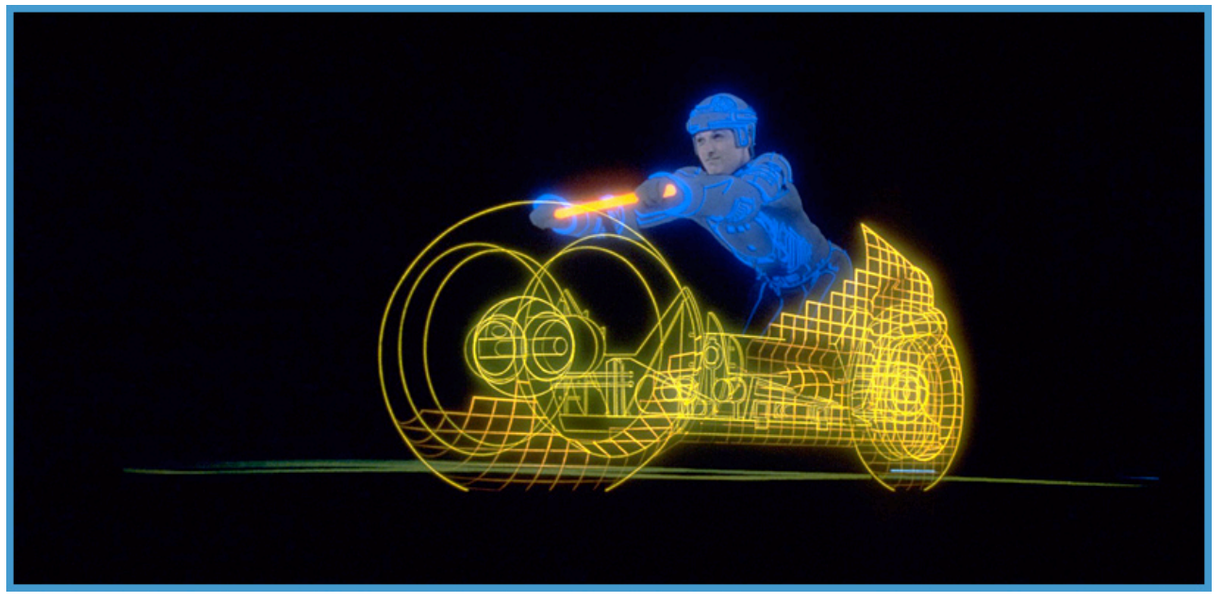
Multiplane camera

Sleeping Beauty, Disney, 1959

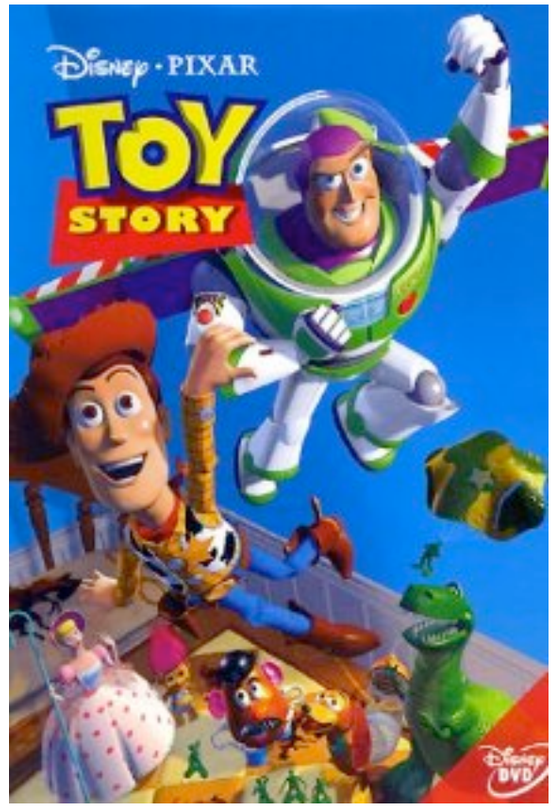


[Wikimedia Commons]

Realistic 3D animation



- Disney's Tron, 1981
- Pixar's Toy Story, 1995, first 3D feature



Performance capture

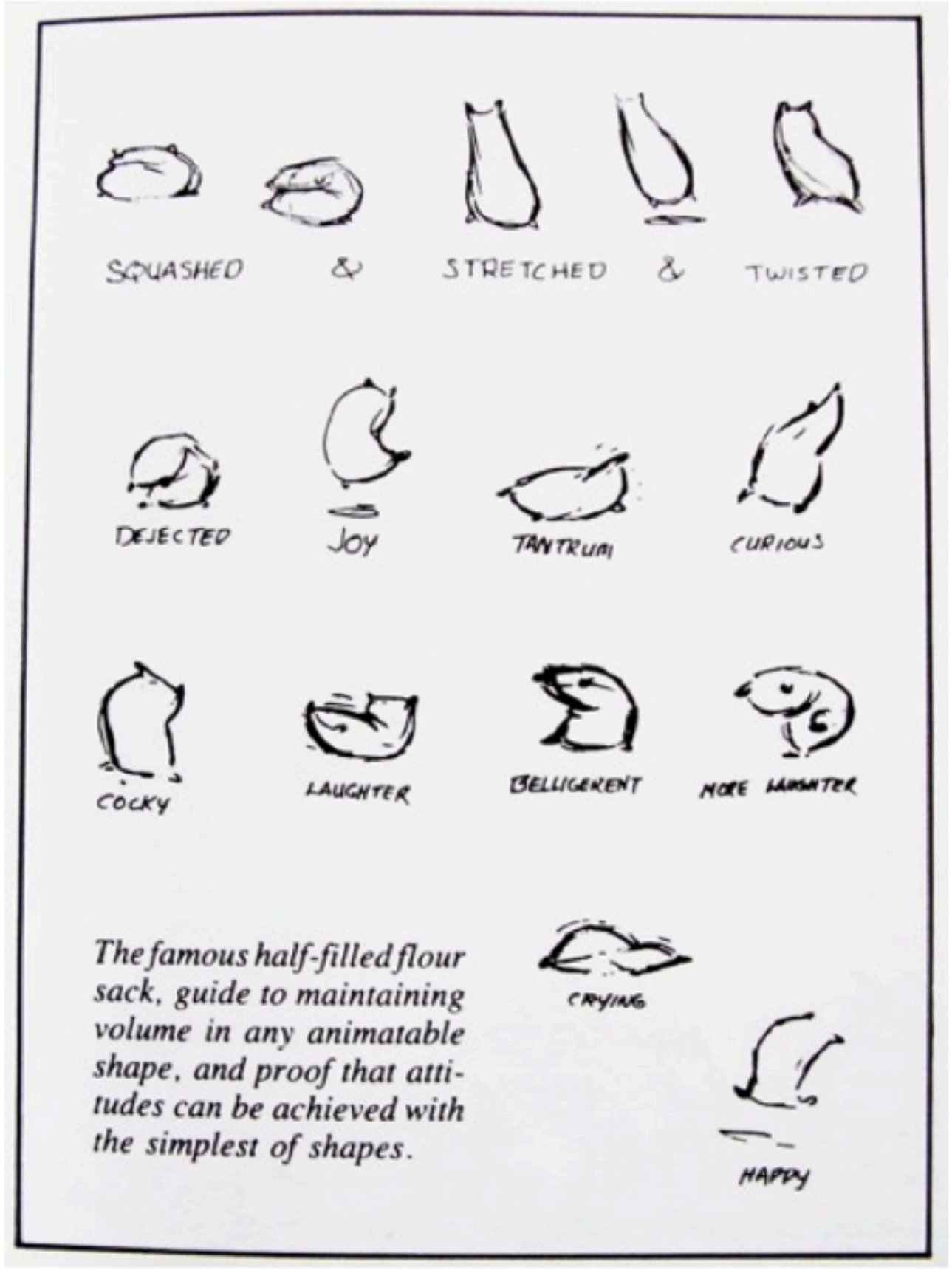
Rise of the Planet of the Apes, 2011

Lord of the Rings, 2001

Avatar, 2009

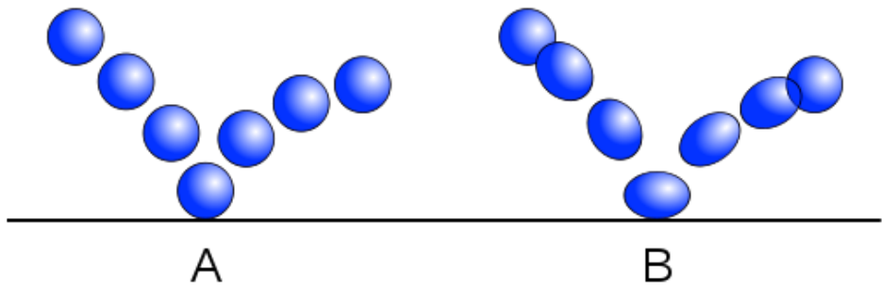
Andy Serkis – Gollum, Lord of the Rings
challenges – resolution, occlusion,

animation principles



- animation can bring even a flour sack to life
- animations principles common to any type of animation

12 principles of animation



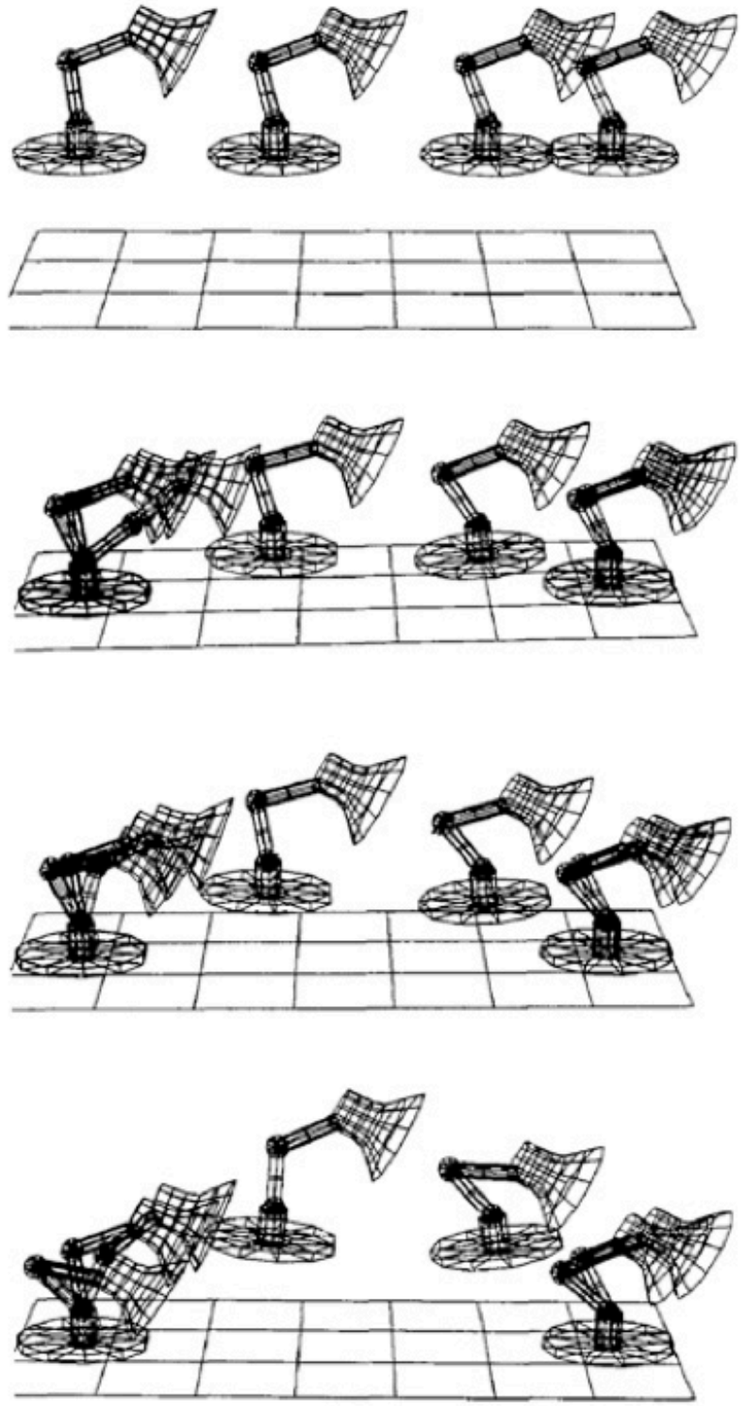
1. Squash and stretch
2. Anticipation
3. Staging
4. Straight ahead action and pose to pose
5. Follow through and overlapping action
6. Slow in and slow out
7. Arcs
8. Secondary action
9. Timing
10. Exaggeration
11. Solid drawing
12. Appeal

[Lasseter 87]

principles are related to the underlying physics of motion
timing: important information. ease in/ease out

Physics-based animation

- Many animation principles follow from underlying physics
  - anticipation, follow through, secondary action, squash and stretch, ...
- *Spacetime Constraints*, Witkin and Kass 1988



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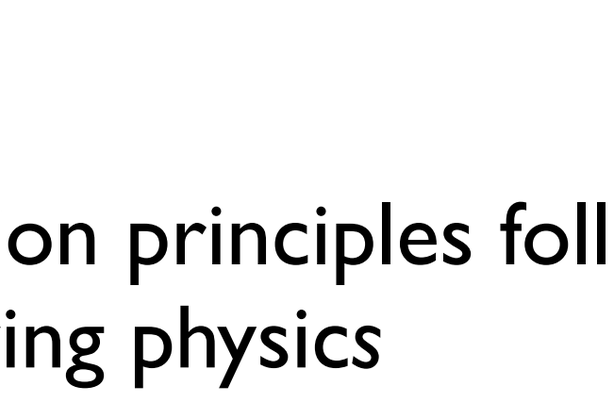
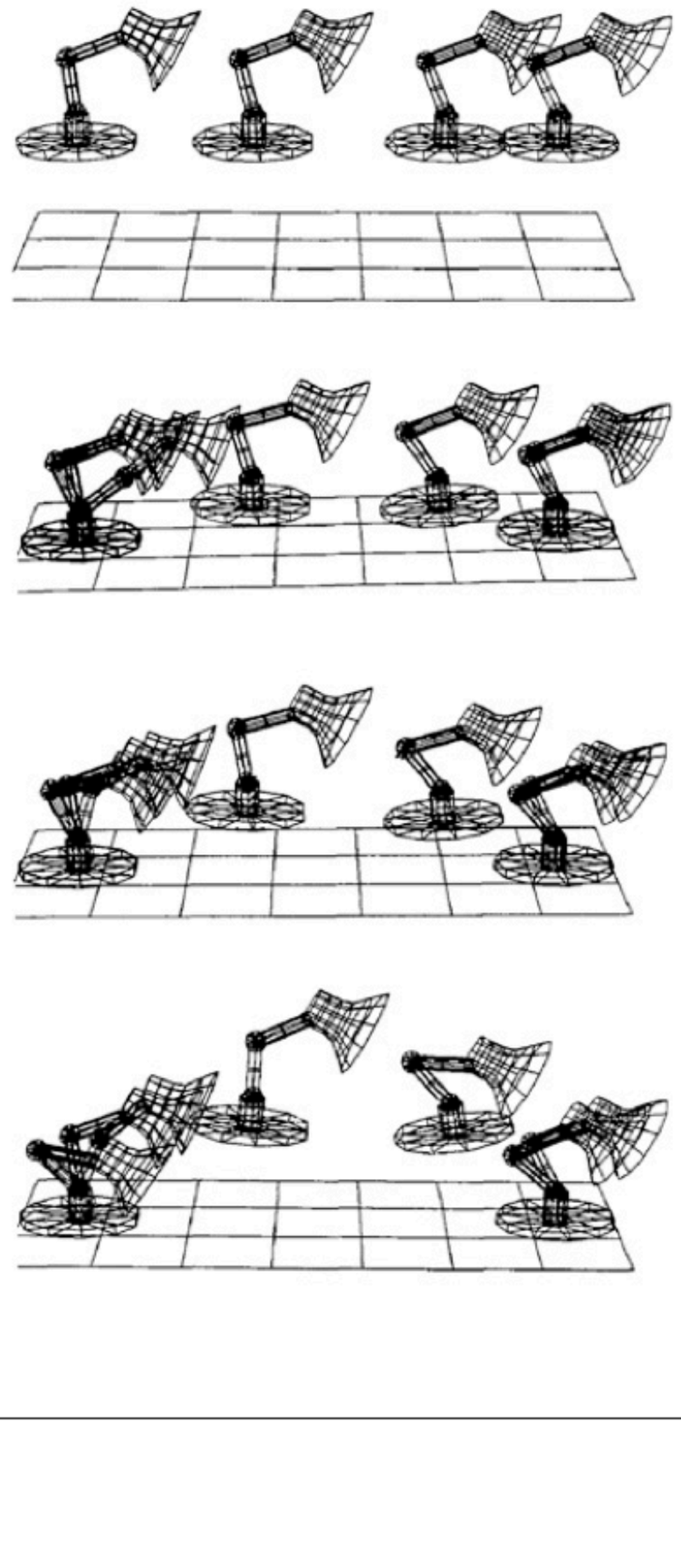
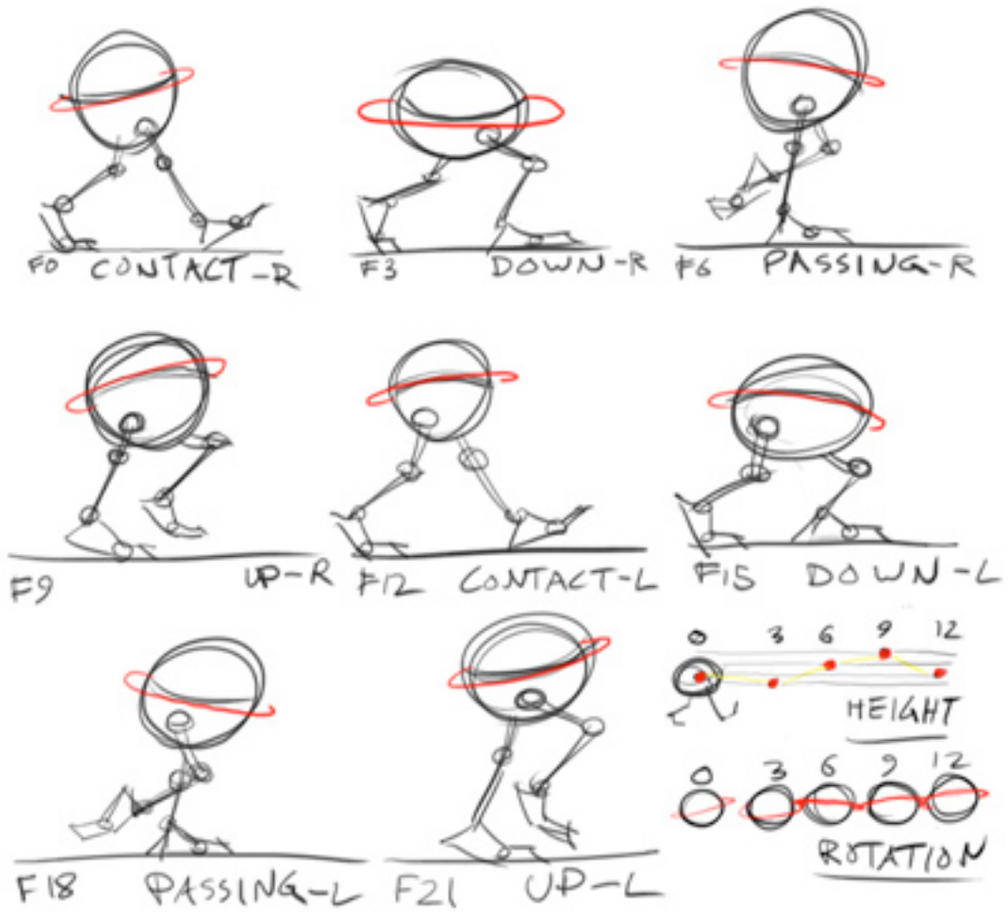




keyframe animation

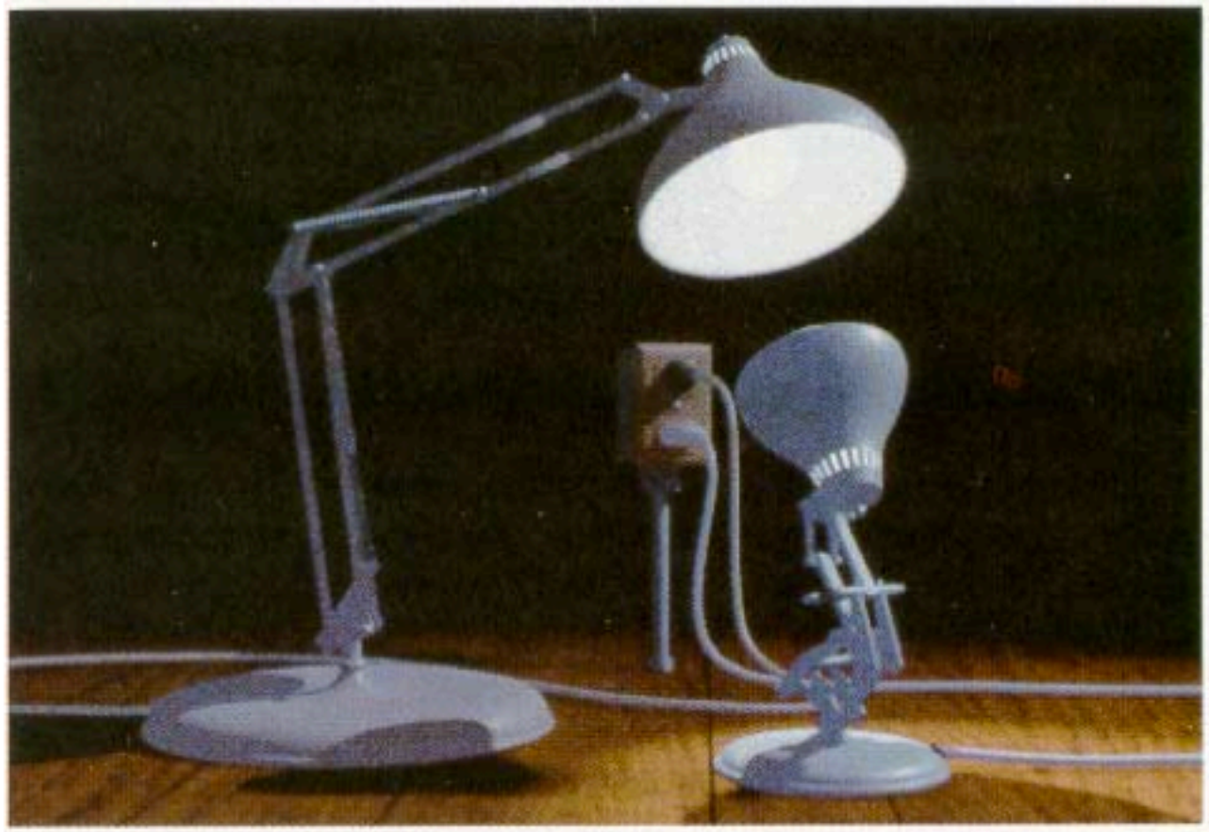
Keyframe animation

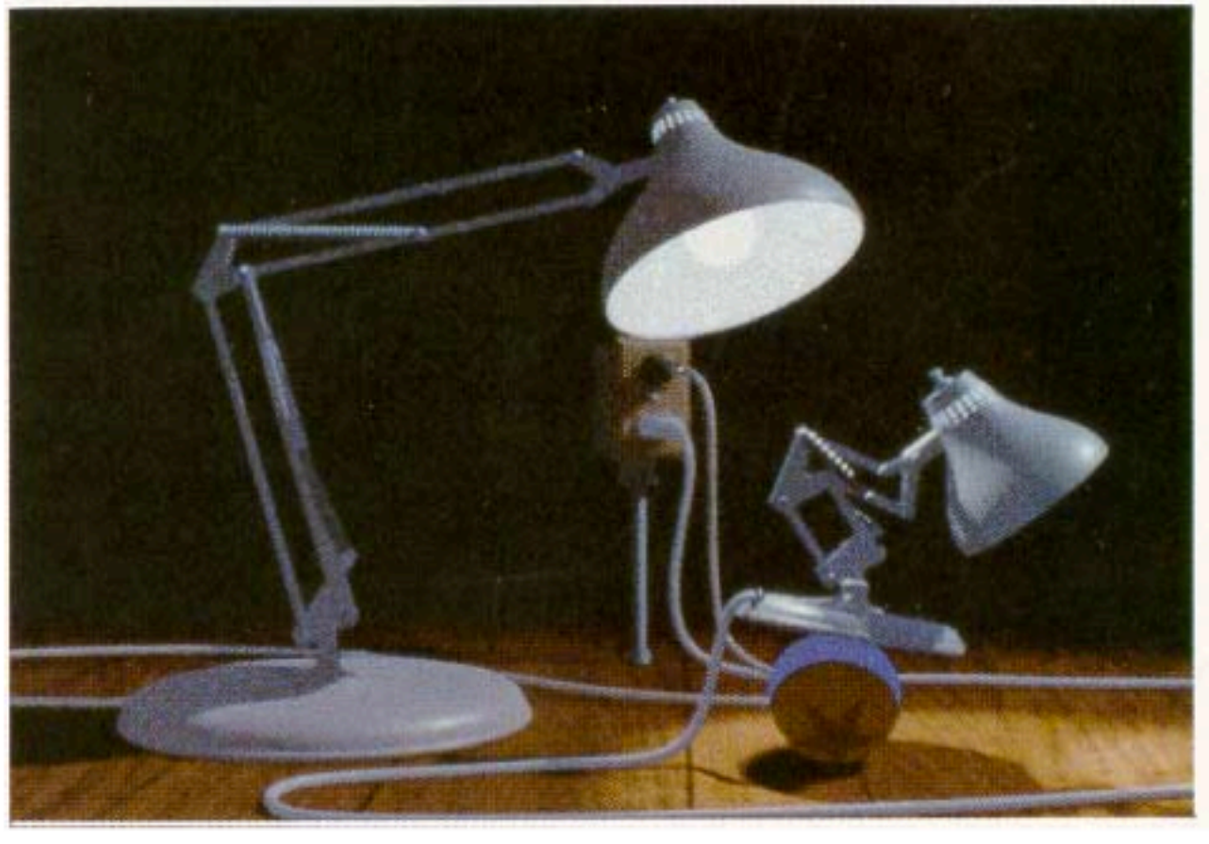
- draw a series of poses
- fill in the frames in between ("inbetweening")
  - computer animation uses interpolation

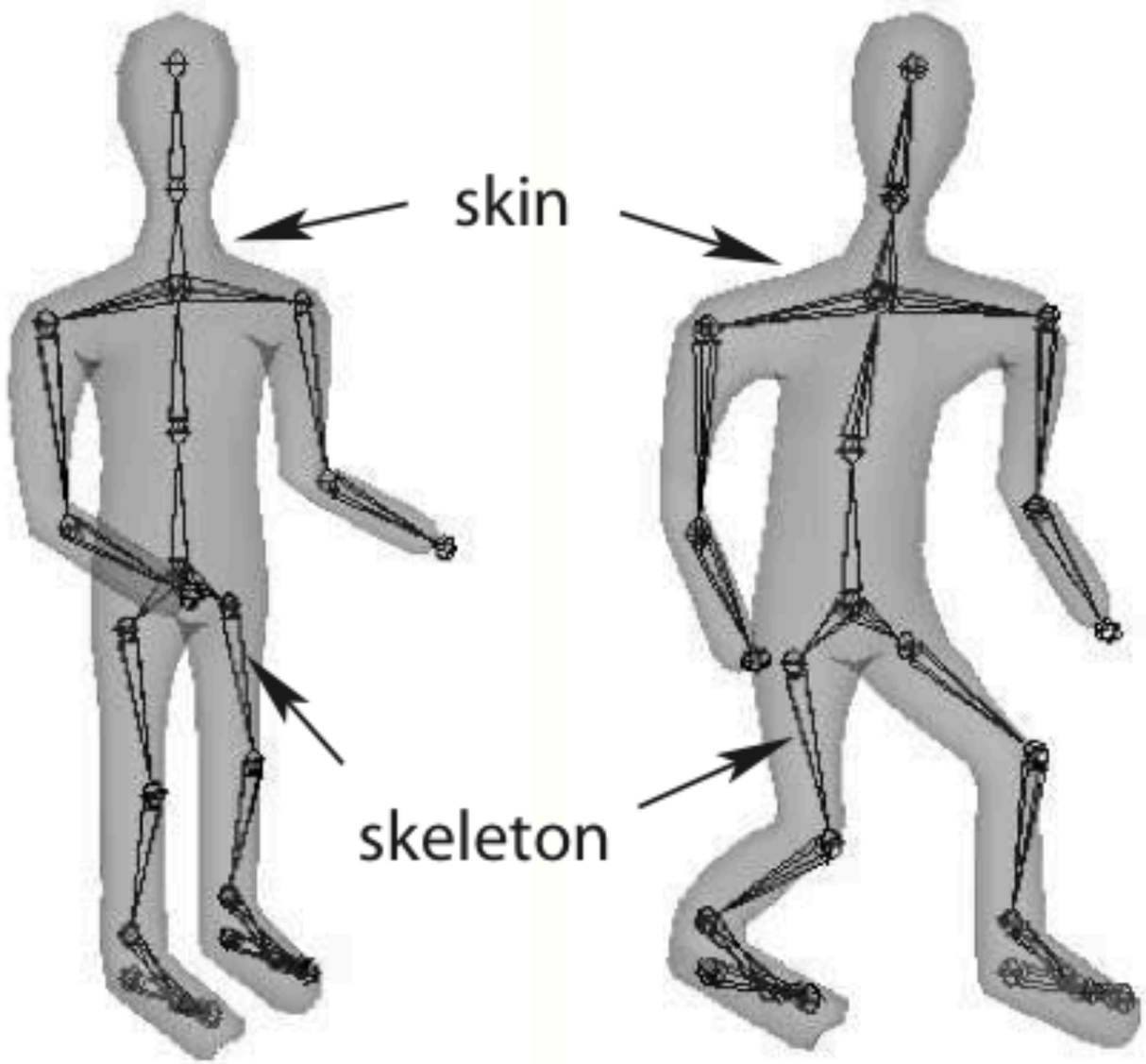


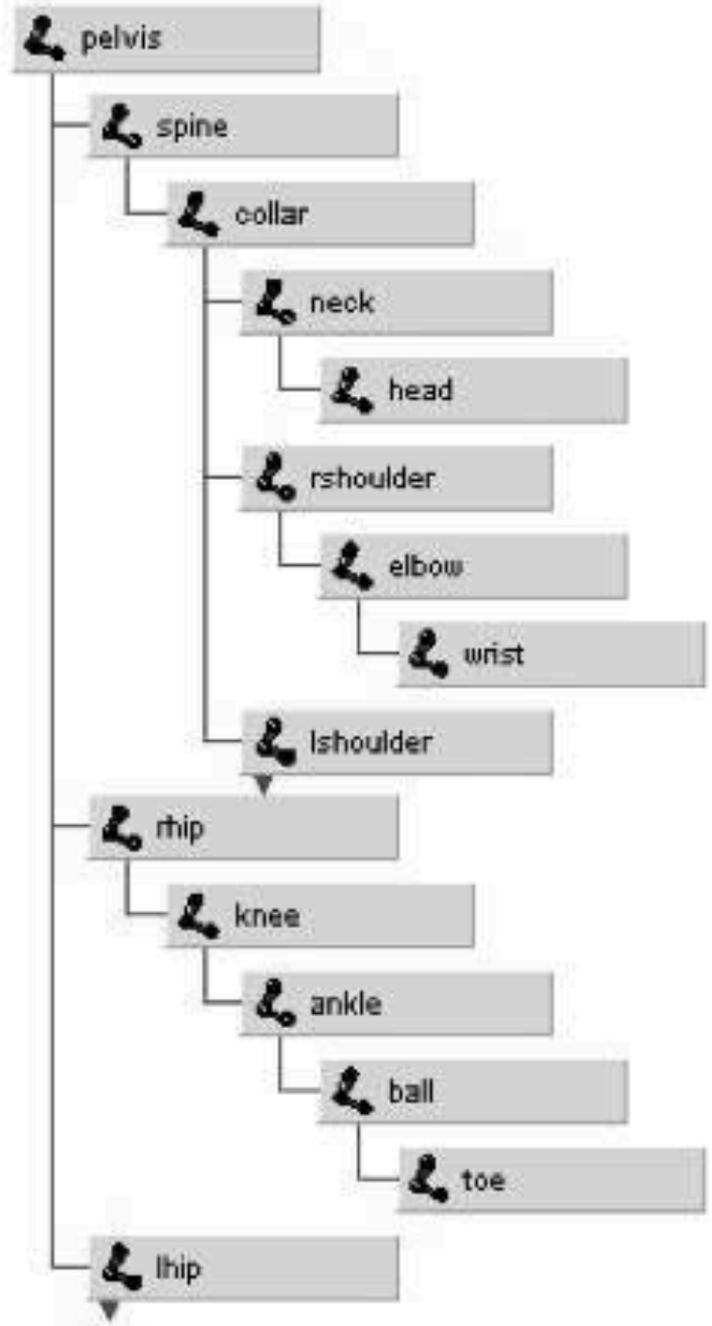
http://anim.tmog.net

Luxo Jr.



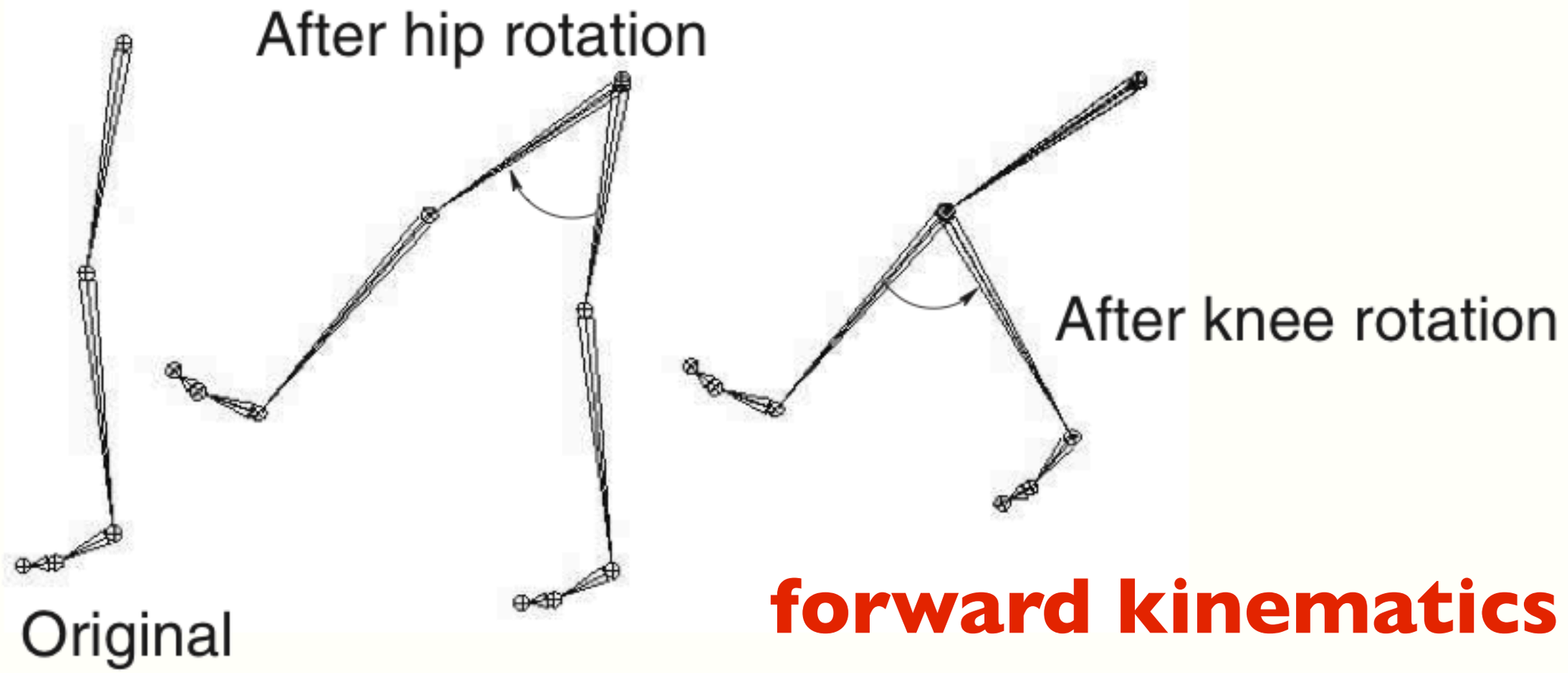




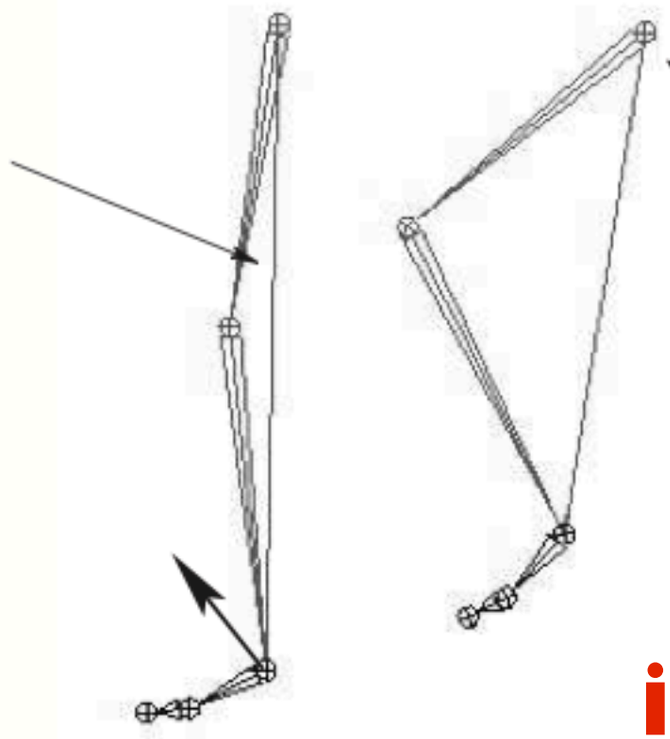


[Shirley and Marschner]

- forward kinematics – set joint angles starting at a root and working down the tree
- inverse kinematics – set end effector (e.g., hand) and solve for state of dofs up to root

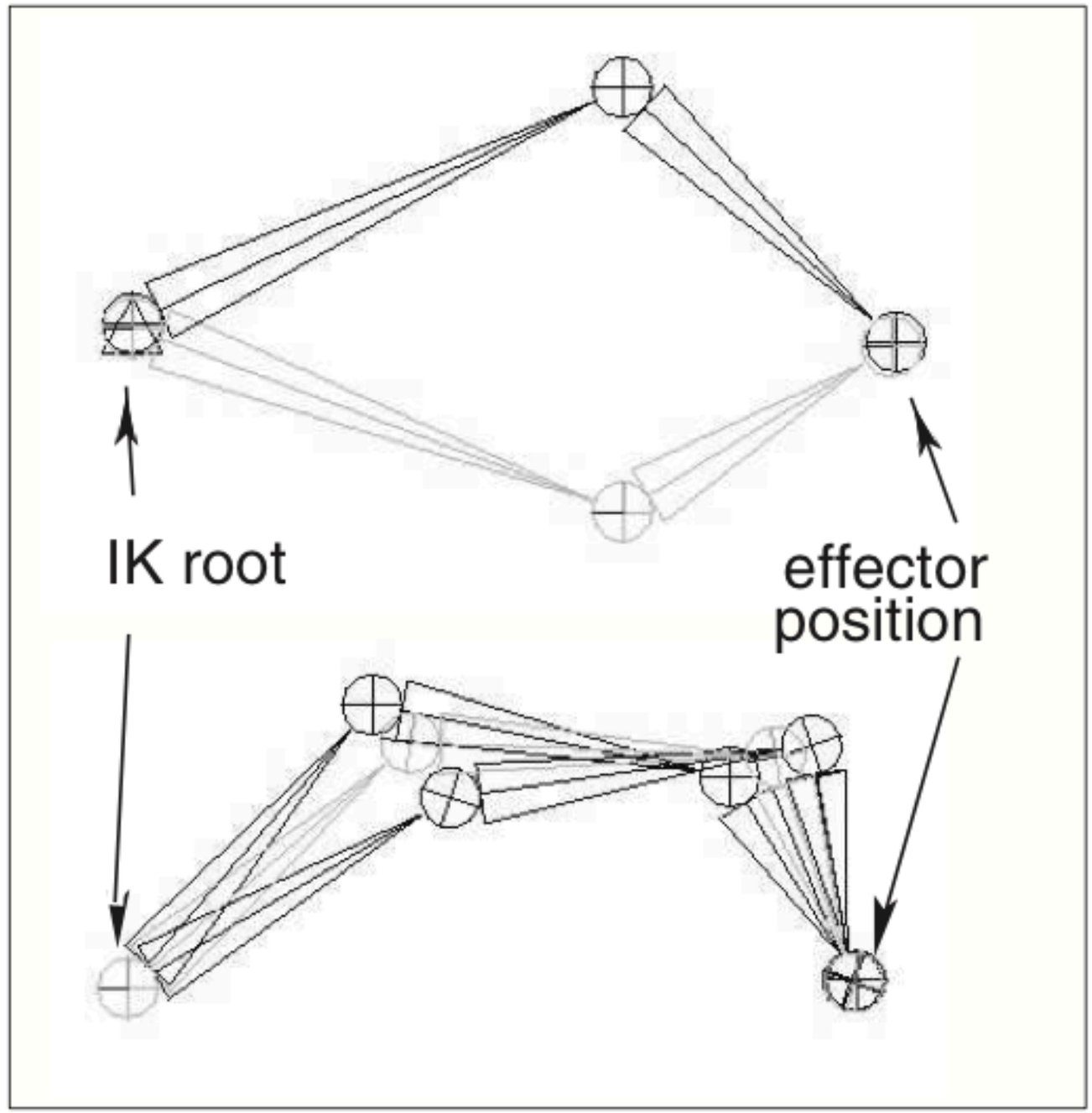


forward kinematics



inverse kinematics

[Shirley and Marschner]

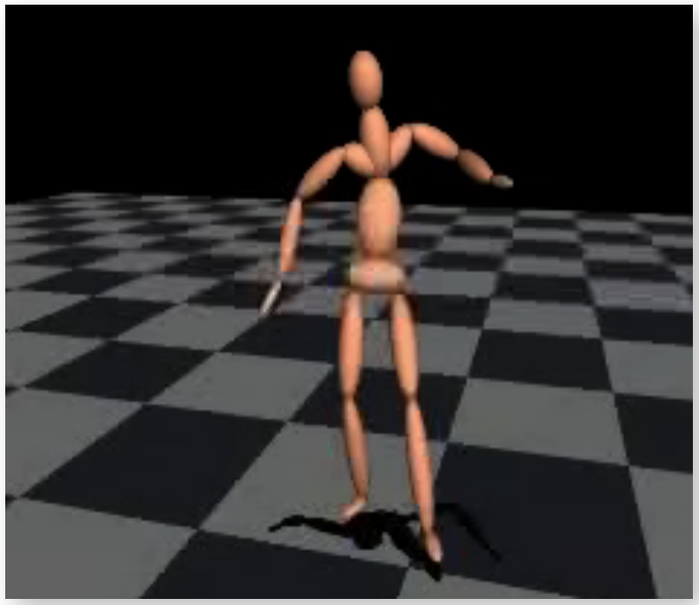


multiple possible states of joints

inverse kinematics

[Shirley and Marschner]

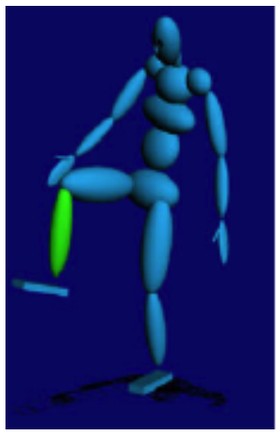
Keyframe character DOFs

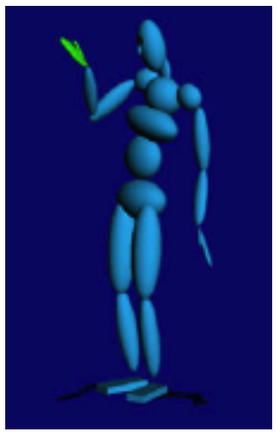


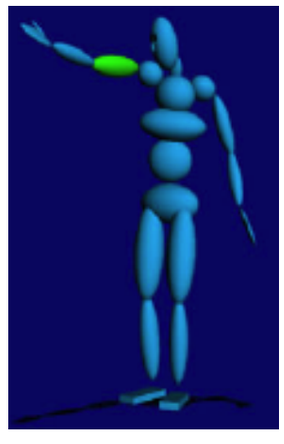
3 translational DOFs

48 rotational DOFs

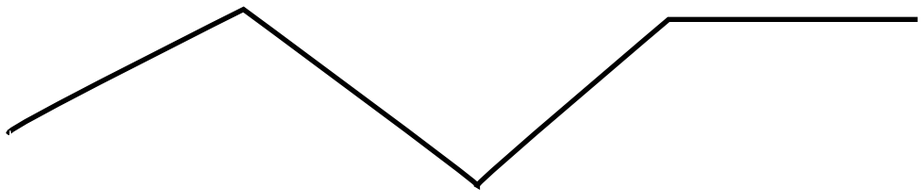
Each joint can have up to 3 DOFs



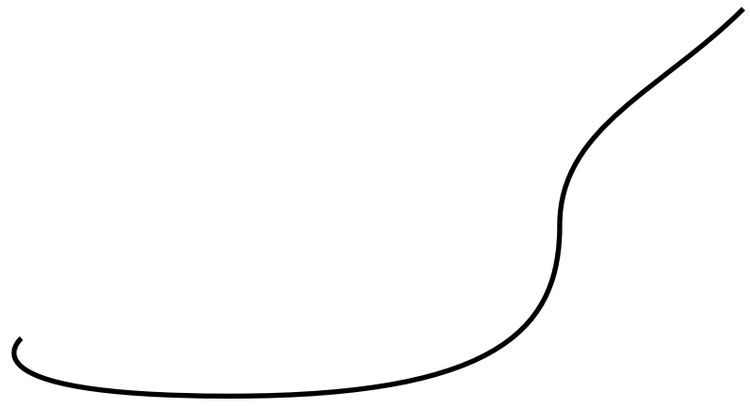




Interpolation of keyframes

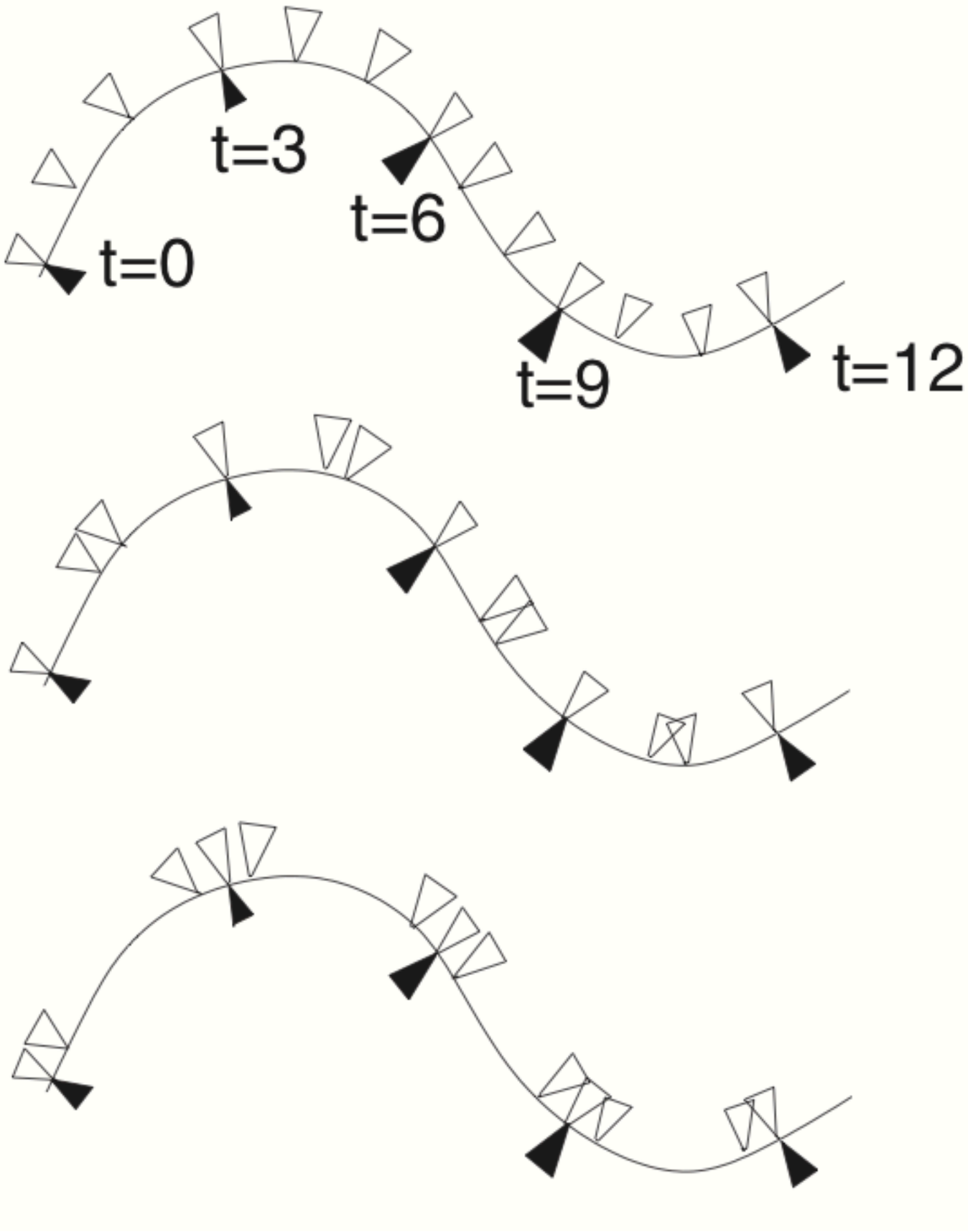


linear interpolation



spline interpolation

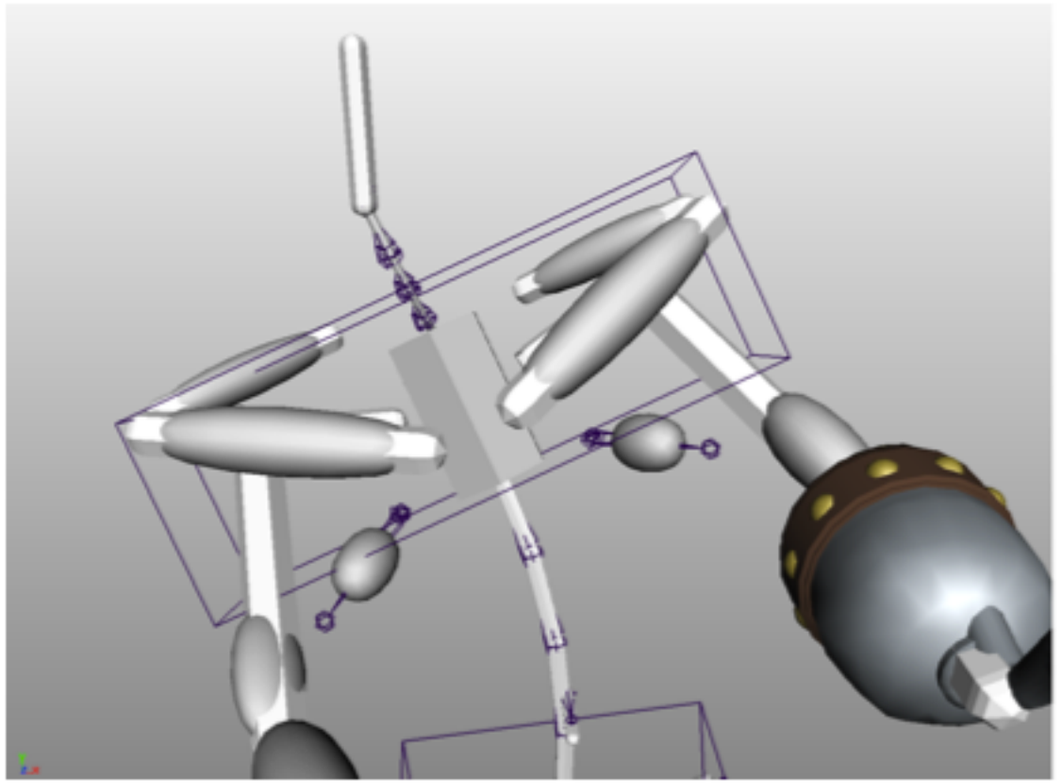
Straightforward to interpolate position but what about orientation?

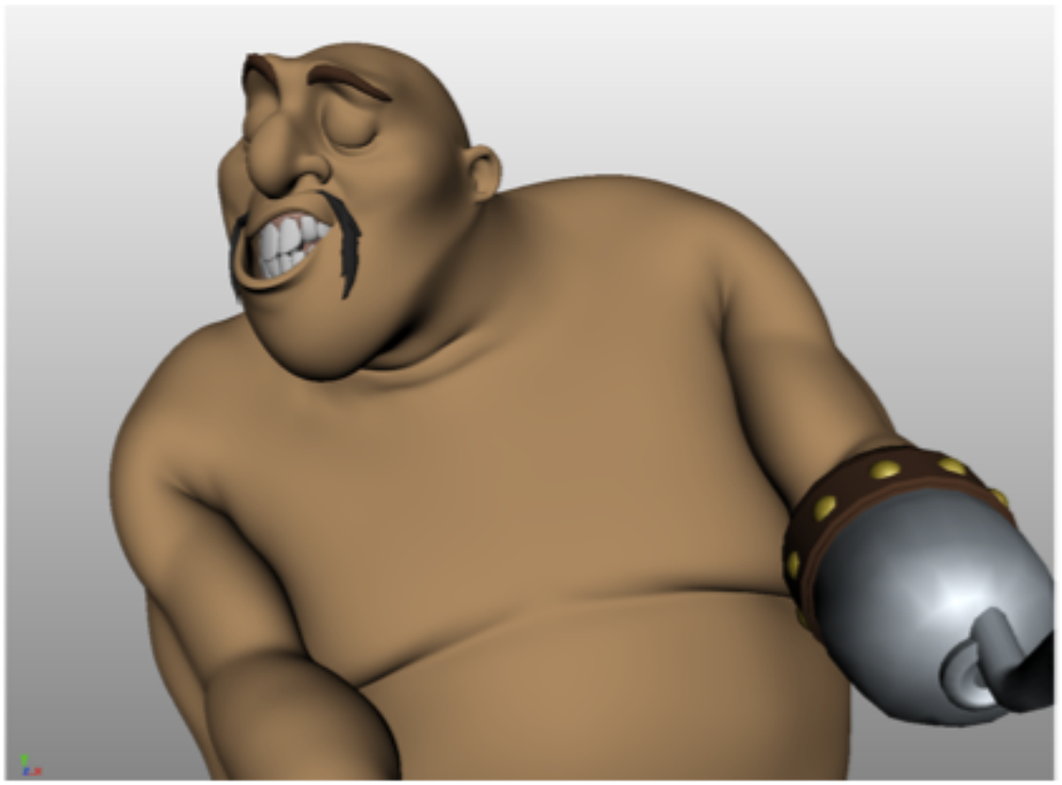


need to consider
both
shape of motion
and
speed of motion

[Shirley and Marschner]

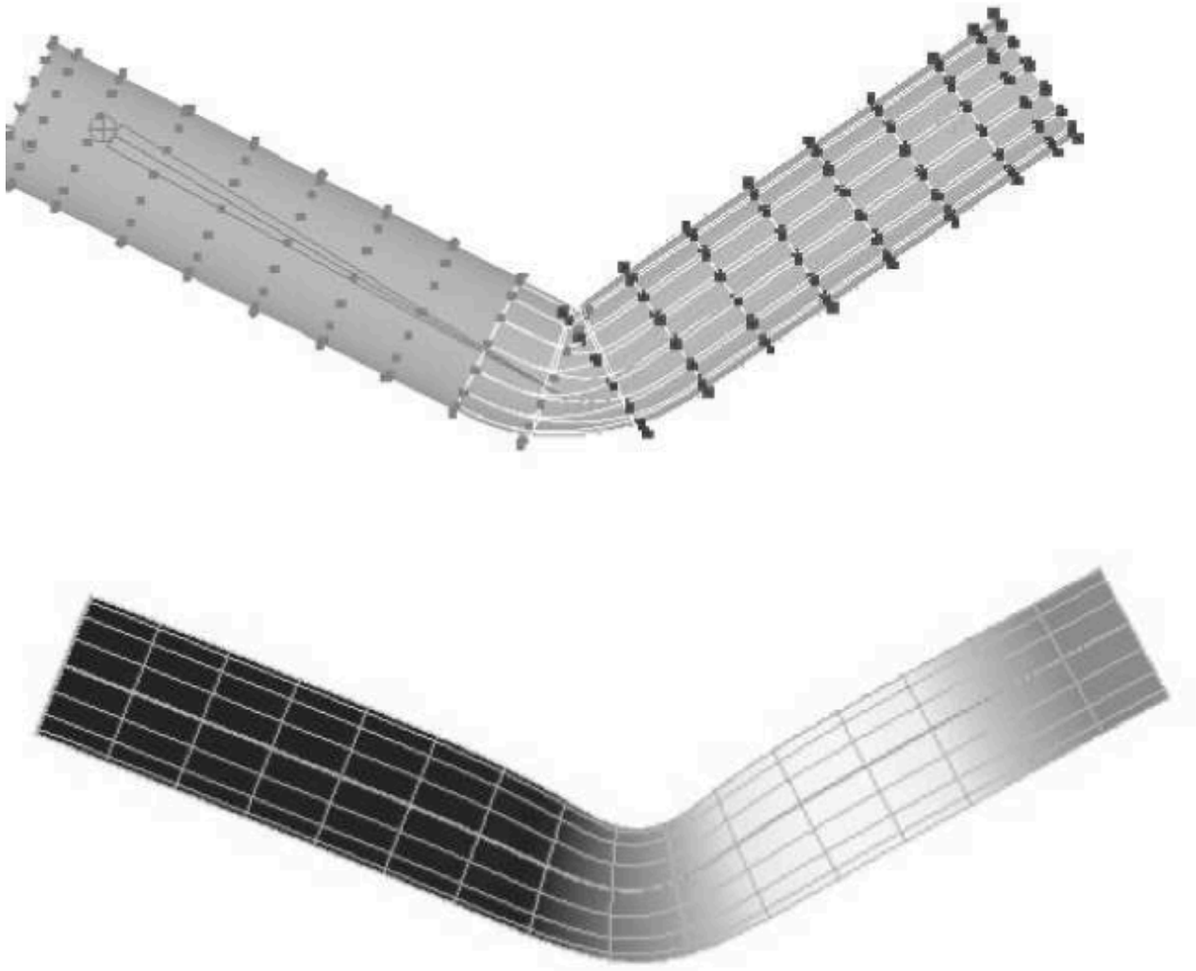
Character Skinning

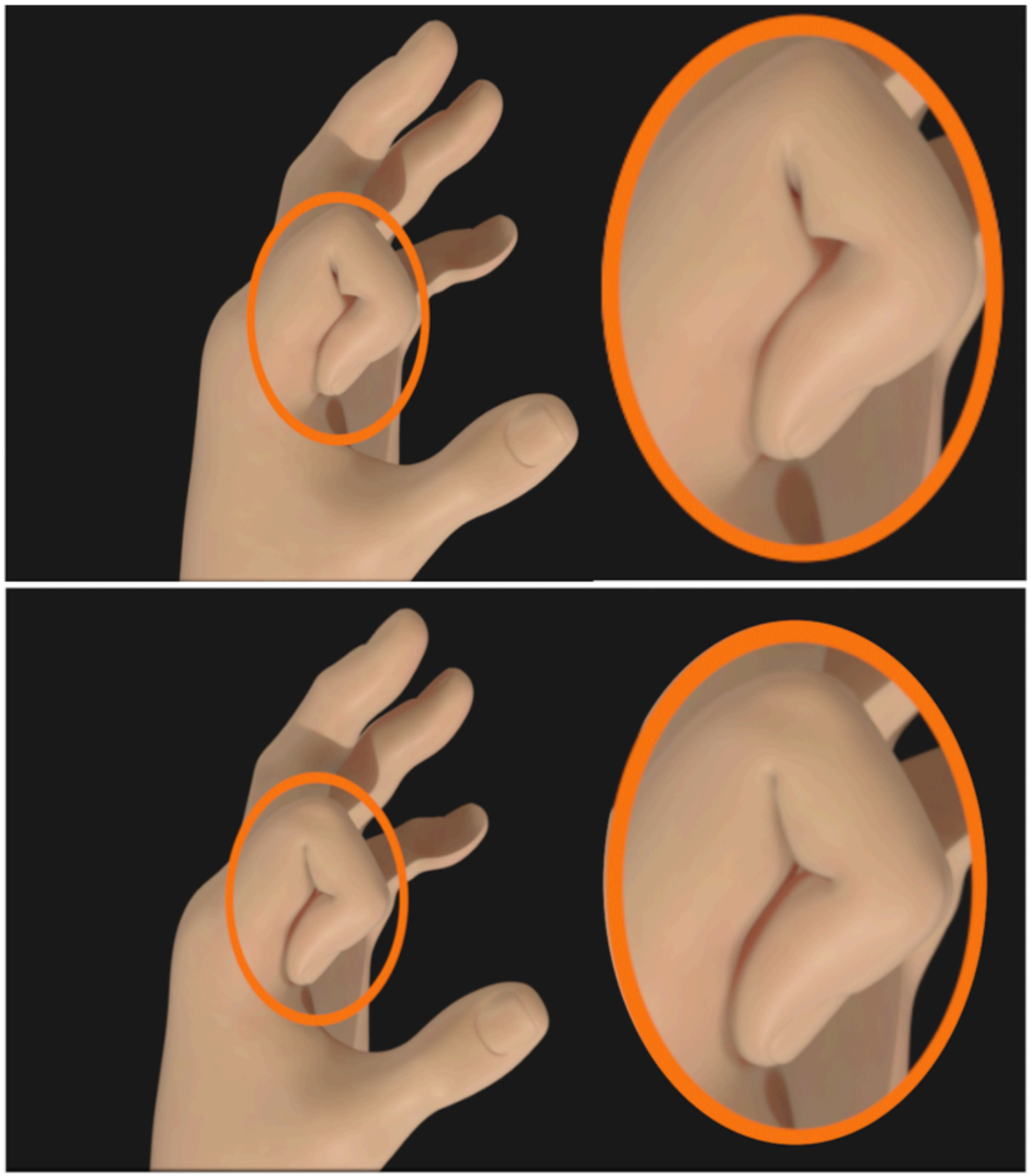




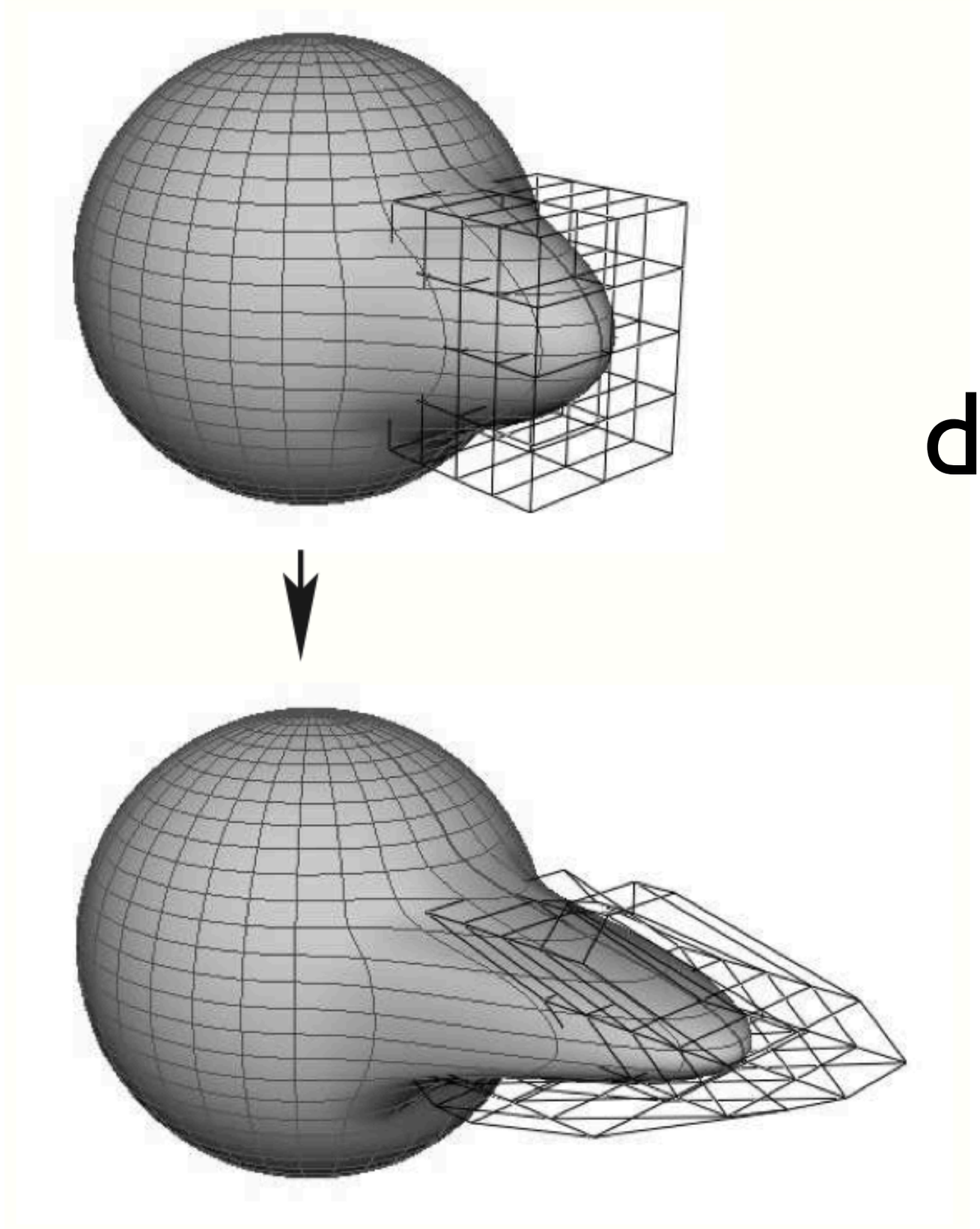
[McAdams et al. 2011]

Character Skinning





[McAdams et al. 2011]



free form deformation

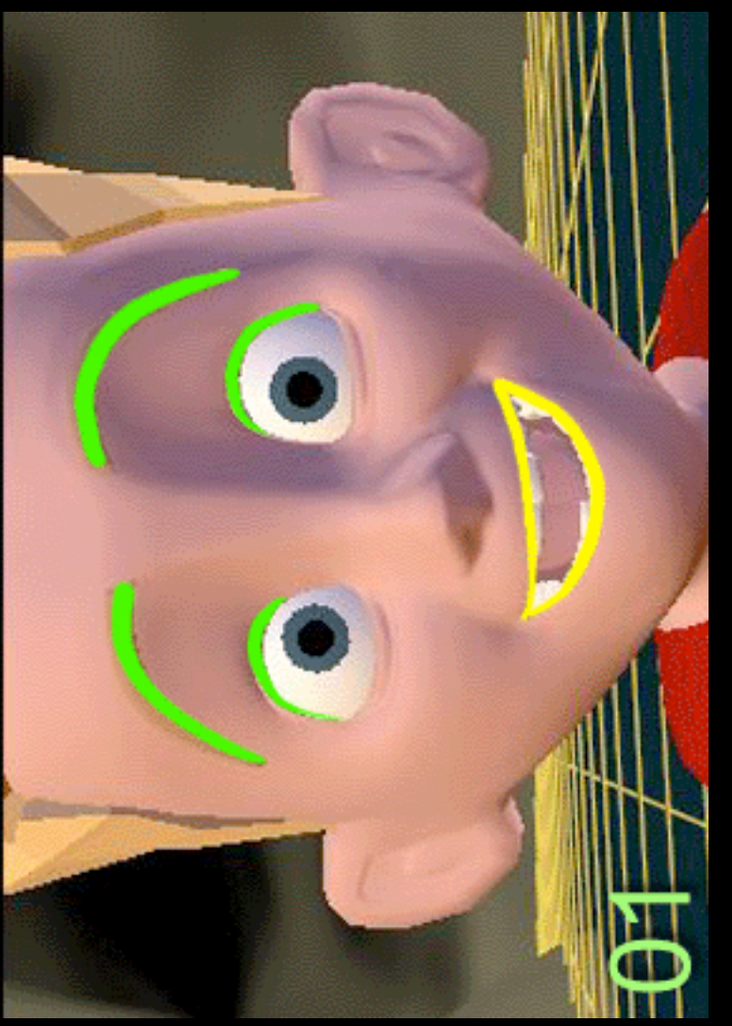
[Sederberg 1986]

[Shirley and Marschner]

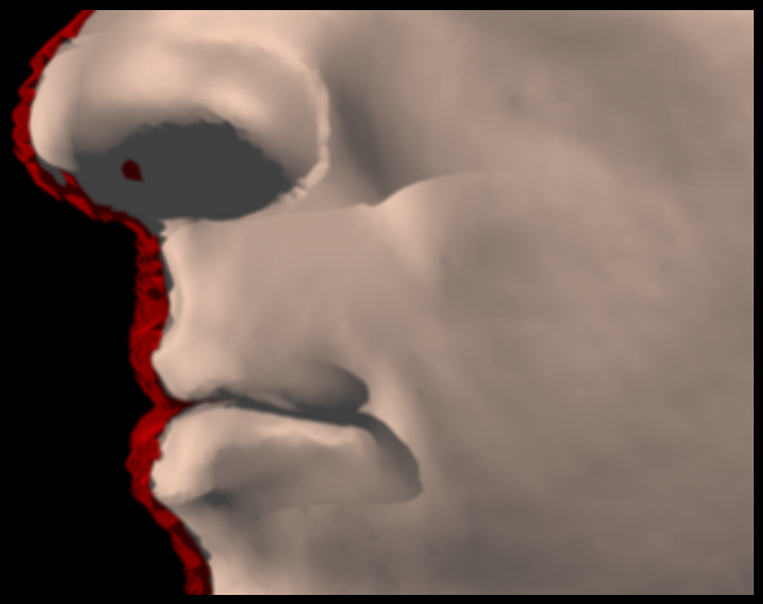
facial animation

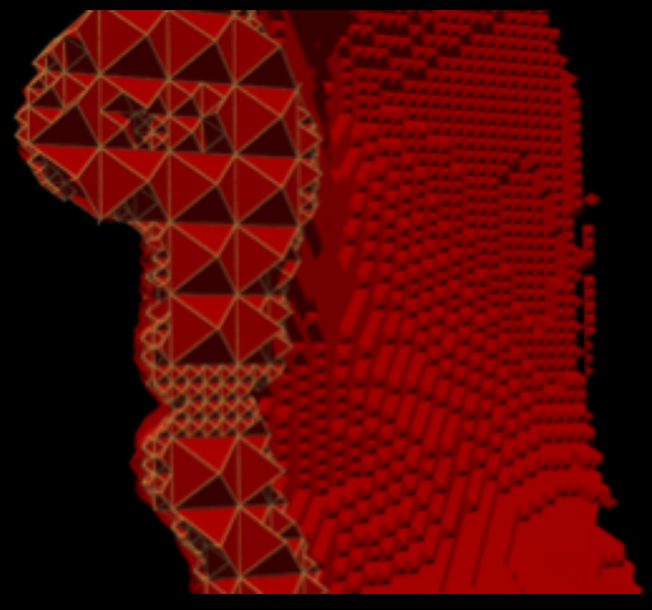
http://www.navone.org/HTML/Tutorial_DashTake.htm

©2004 Disney/Pixar

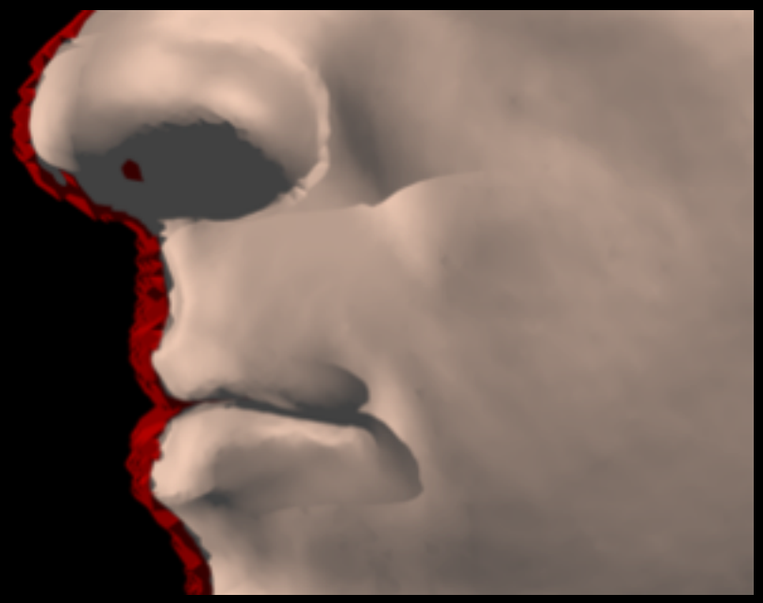


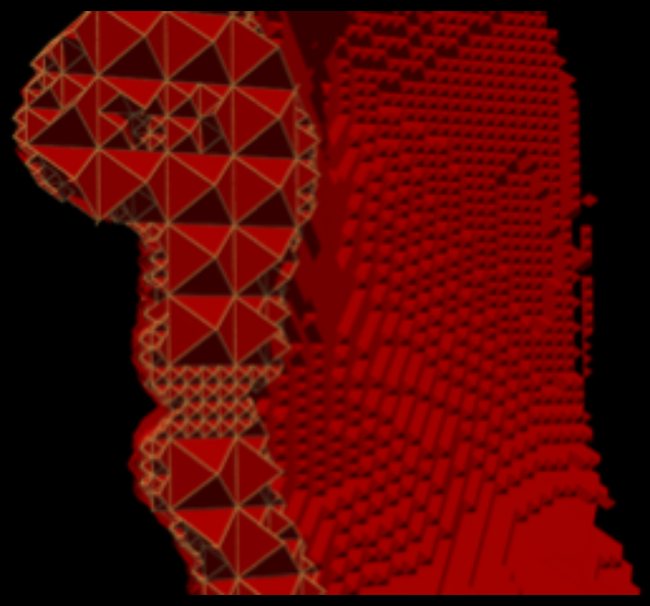
Facial animation





Facial animation

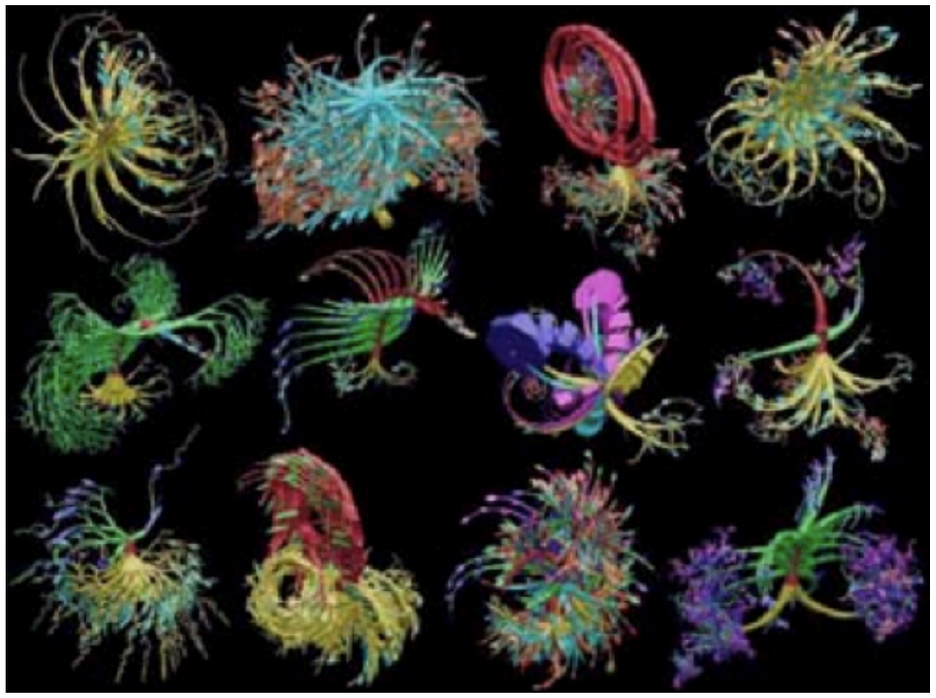




procedural animation

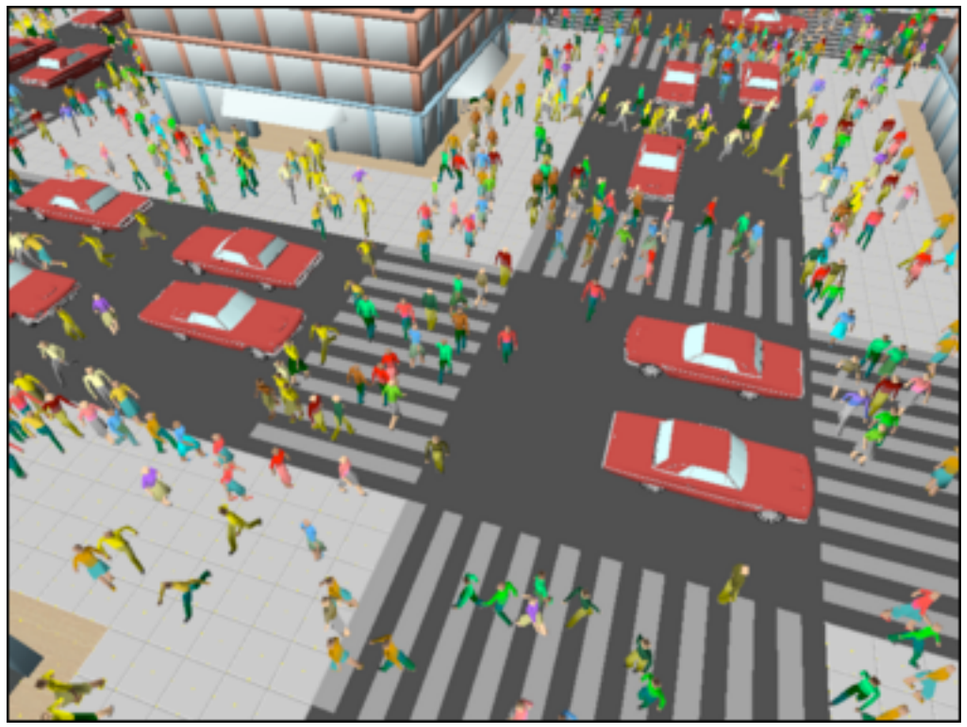
Artificial life

- plants - movement and growth
- evolving artificial life



virtual worlds, special effects, games

Crowd simulation



[Treuille et al. 2006]

- agent-based, model behavior
- also, “global effects” - e.g., incompressibility
- emergent phenomena

physics-based animation

Rigid body simulation

[Weinstein et al 2006]

Deformable object simulation

[Molino et al. 2004]

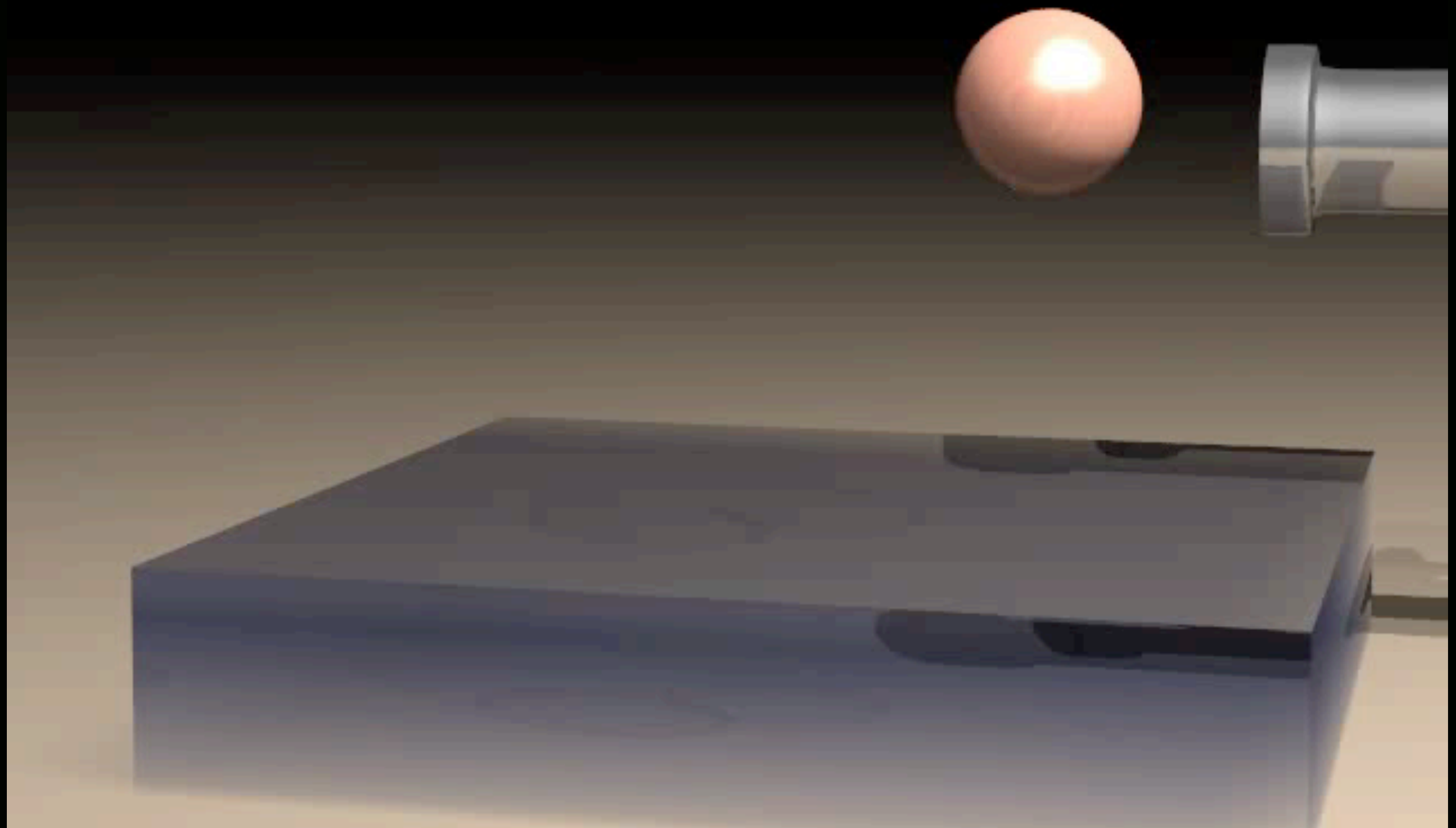
[Selle et al. 2008]

Fluid simulation

[Losasso et al. 2006]

Fluid simulation

[Losasso et al. 2006]



Control of virtual character

[Shinar et al. 2008]

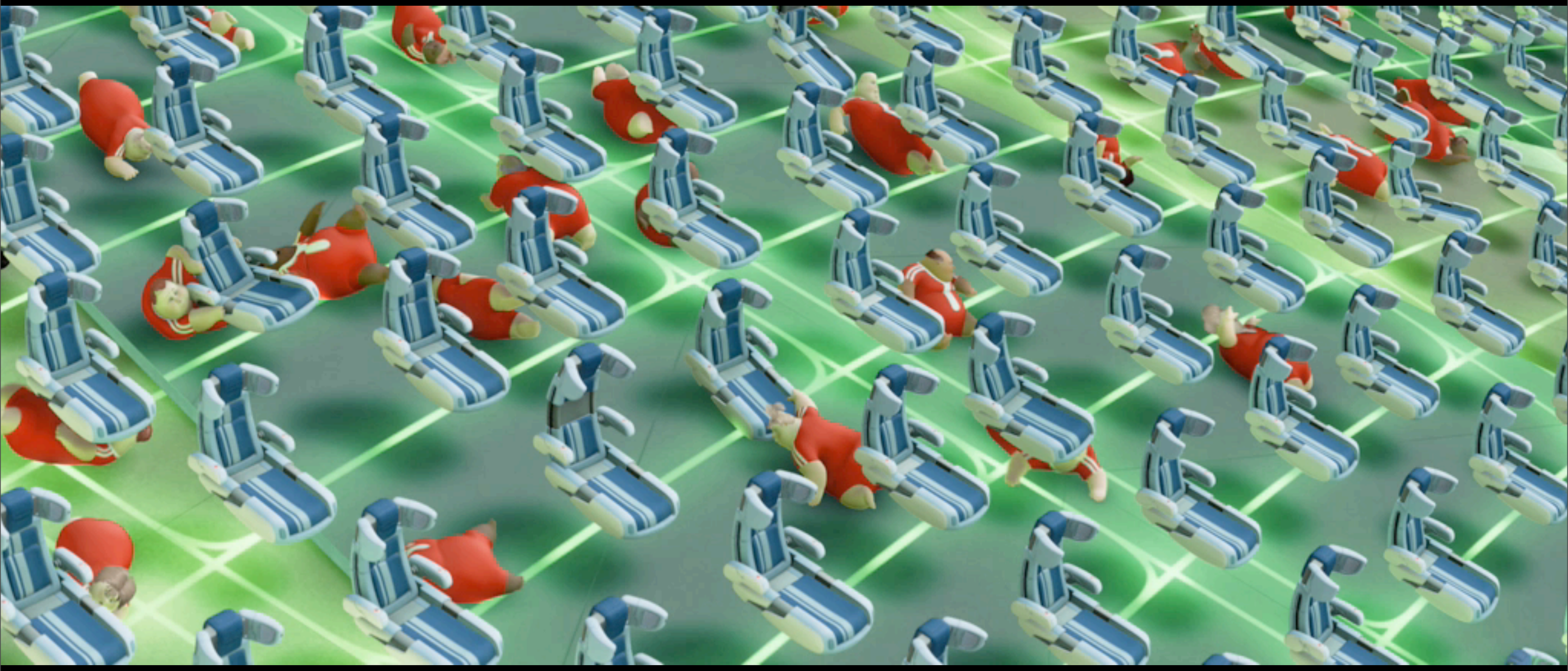
issues: control algorithms, interaction with environment

Control of virtual character

[Shinar et al. 2008]

issues: control algorithms, interaction with environment

rigid/deformable simulator in Pixar's *WALL-E*



rigid/deformable simulator in Pixar's *WALL-E*