Computer Graphics

by Ruen-Rone Lee
ICL/ITRI

Wrap up from last week

- **Non-Photorealistic Rendering**
  - **Stroke based rendering**
  - **Watercolor**
  - **Oil-painting**
  - **Pen-and-Ink**
  - **Hatching**
  - **Chinese painting**

Animation, Visual Effects, and Simulation

Animation Process

Special Effects

Physical-based Simulation

Behind the Scene – Algorithms and Techniques

Computer Animation

- The process for generating animated images

Computer Animation

- The process for generating animated images

Computer Animation

- The process for generating animated images

Computer Animation

- The process for generating animated images

Pixar: Monster University

Computer Animation

- The process for generating animated images

"MONSTERS UNIVERSITY" Progression Image 1 of 6: STORY

Pixar: Monster University

Computer Animation

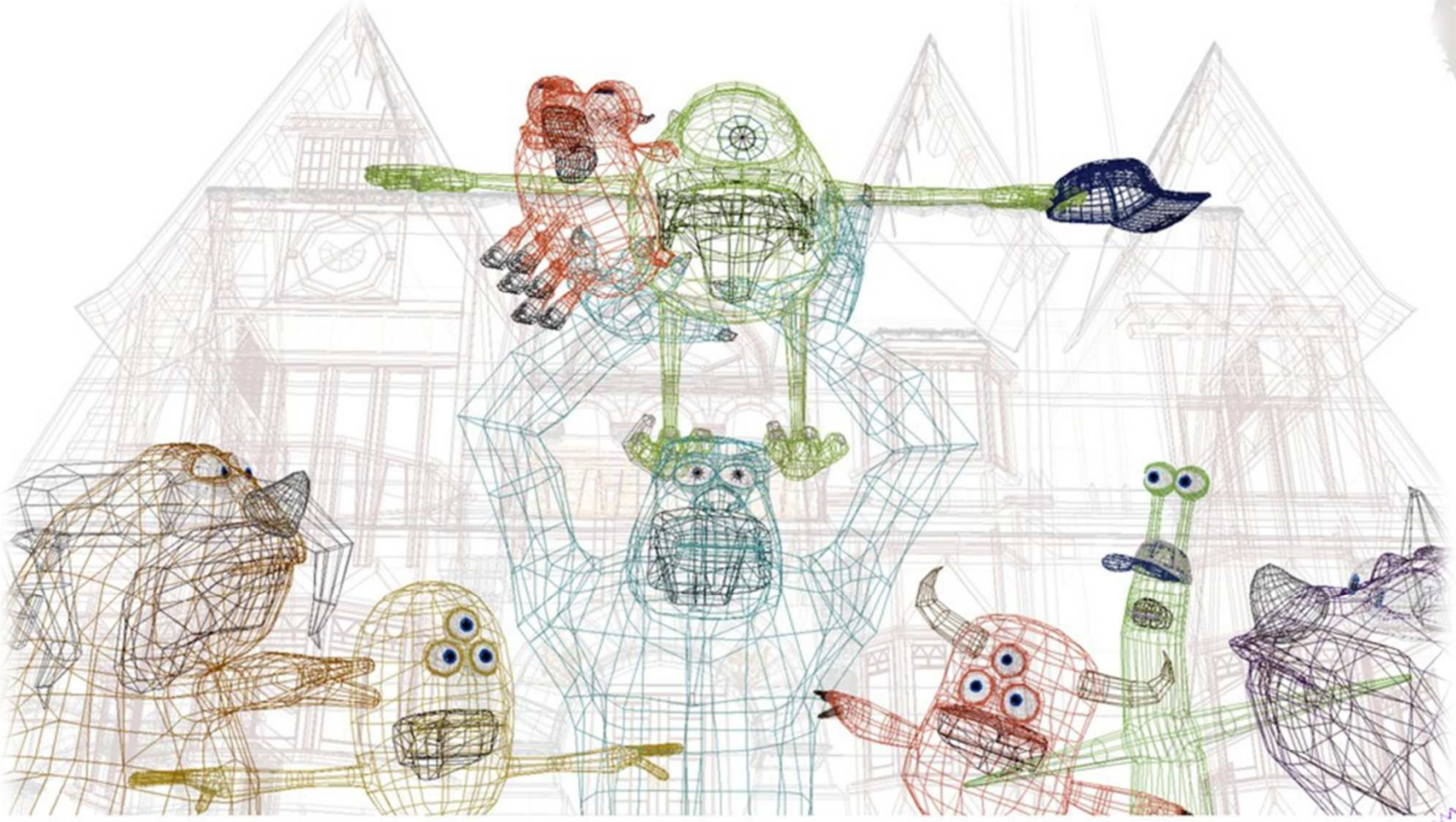
- The process for generating animated images

"MONSTERS UNIVERSITY" Progression Image 2 of 6: ART

Pixar: Monster University

Computer Animation

- The process for generating animated images



"MONSTERS UNIVERSITY" Progression Image 3 of 6: MODELING

Pixar: Monster University

Computer Animation

- The process for generating animated images

"MONSTERS UNIVERSITY" Progression Image 4 of 6: LAYOUT

Pixar: Monster University

Computer Animation

- The process for generating animated images

"MONSTERS UNIVERSITY" Progression Image 5 of 6: ANIMATION and SIMULATION

Pixar: Monster University

Computer Animation

- The process for generating animated images

"MONSTERS UNIVERSITY" Progression Image 6 of 6: LIGHTING and FINAL IMAGE

Pixar: Monster University

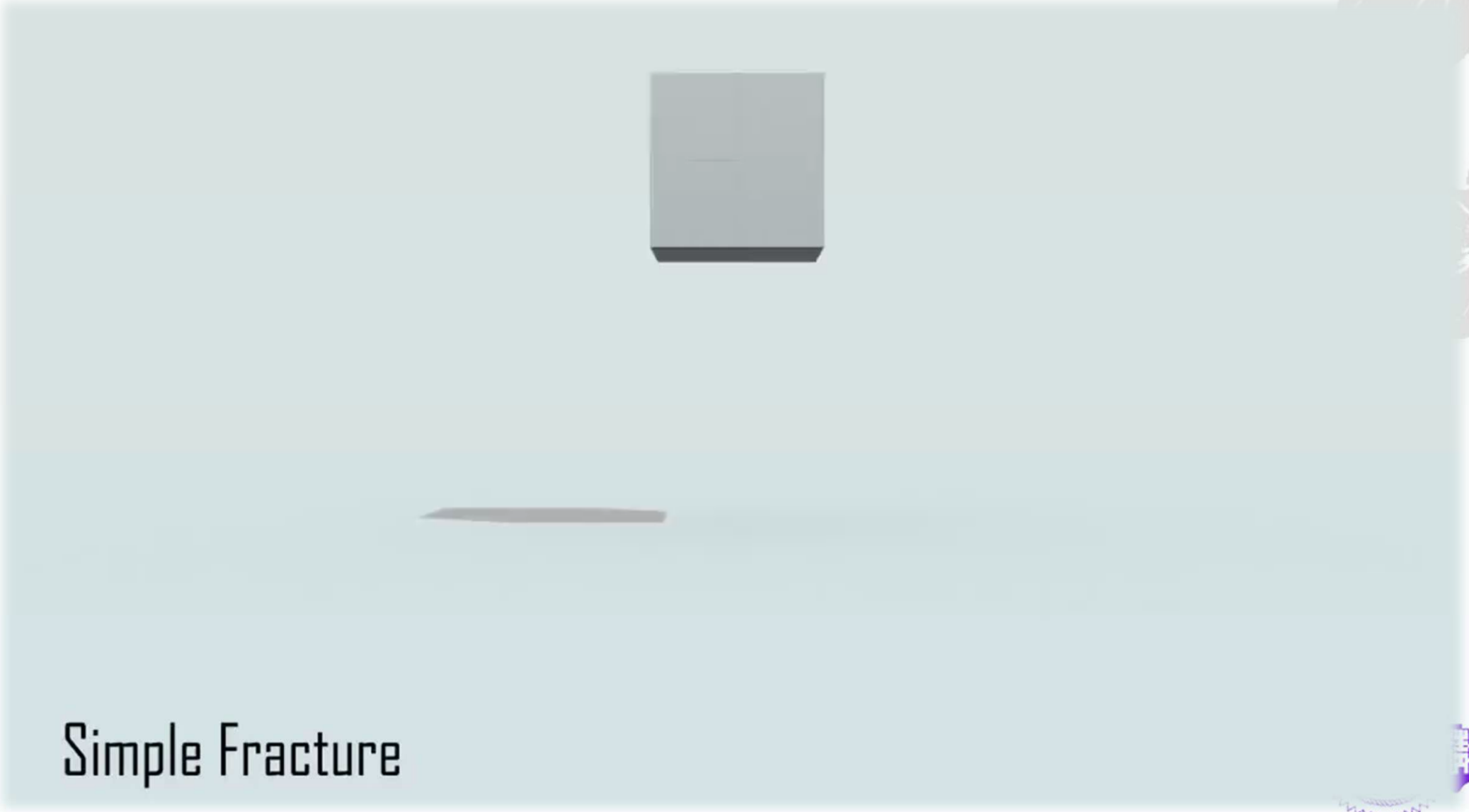
Visual Effects (VFX)

- **Integration of still photography and computer generated imagery which look realistic**

Visual Effects (VFX)

Simulation

- **Rigid Body Simulation**



Simulation

- **Fluid Simulation**

Flood scene

Up to 29M foam particles

Avg. foam rendering time per frame: 235 ms

Simulation

Simulation

- Cloth Simulation

Animation Process

Animation Process

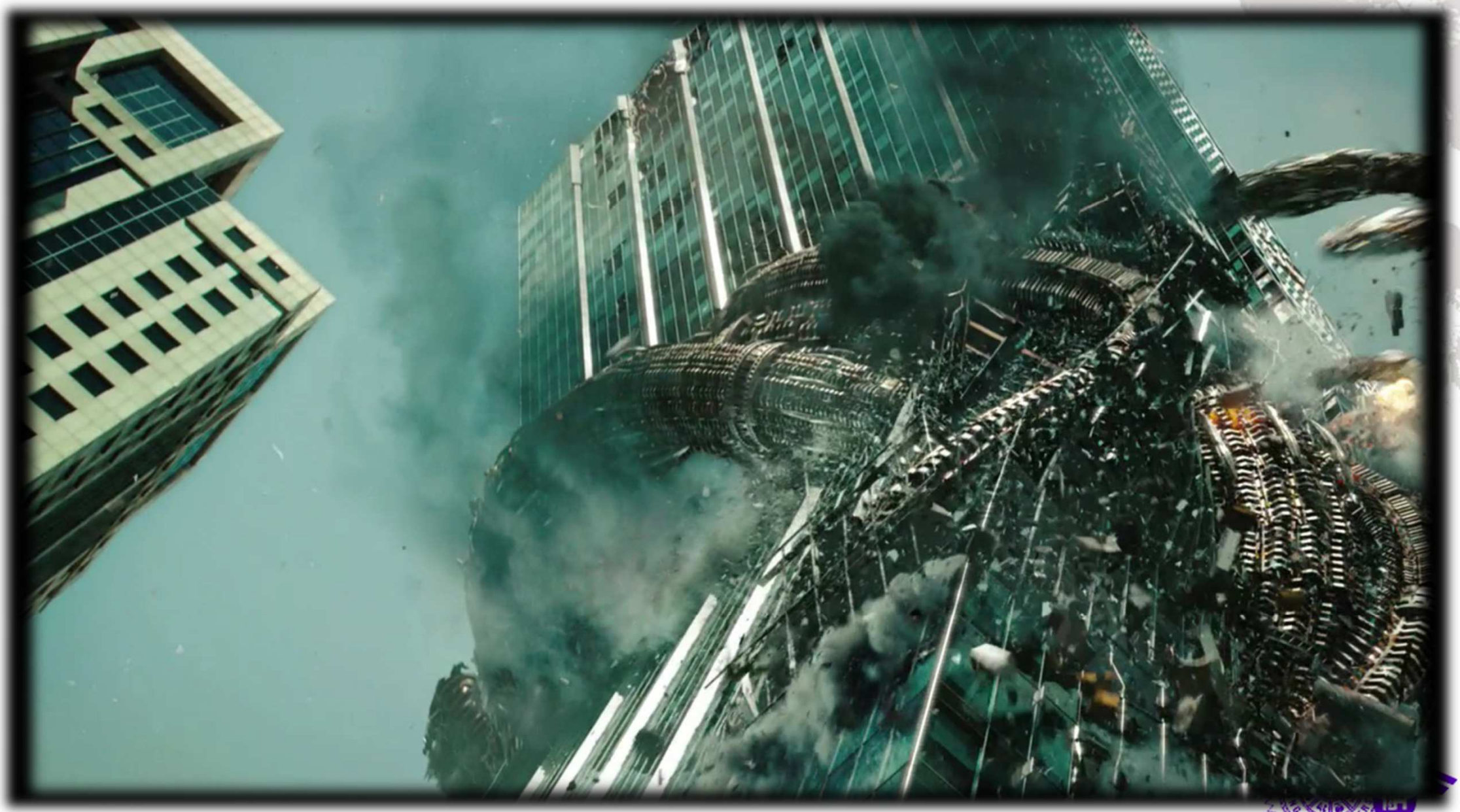
Animation Process

Behind the Scene (Avator)

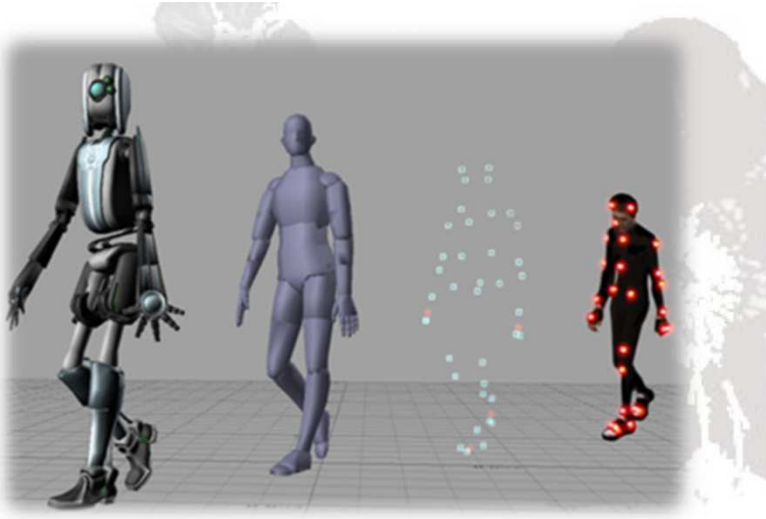
Behind the Scene (2012)

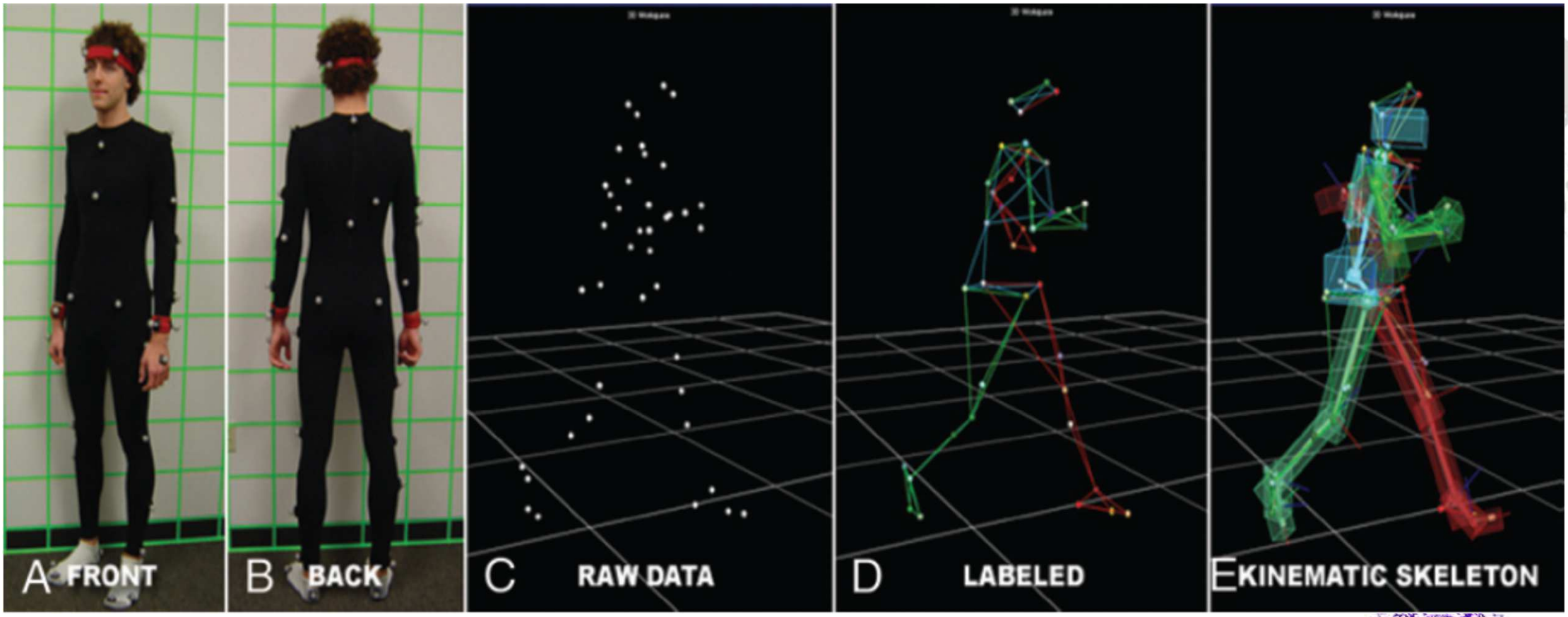
Behind the Scene (Transformer)

Behind the Scene (Transformer)



Motion Capture (Mocap)





Motion Capture (Mocap)

- With markers

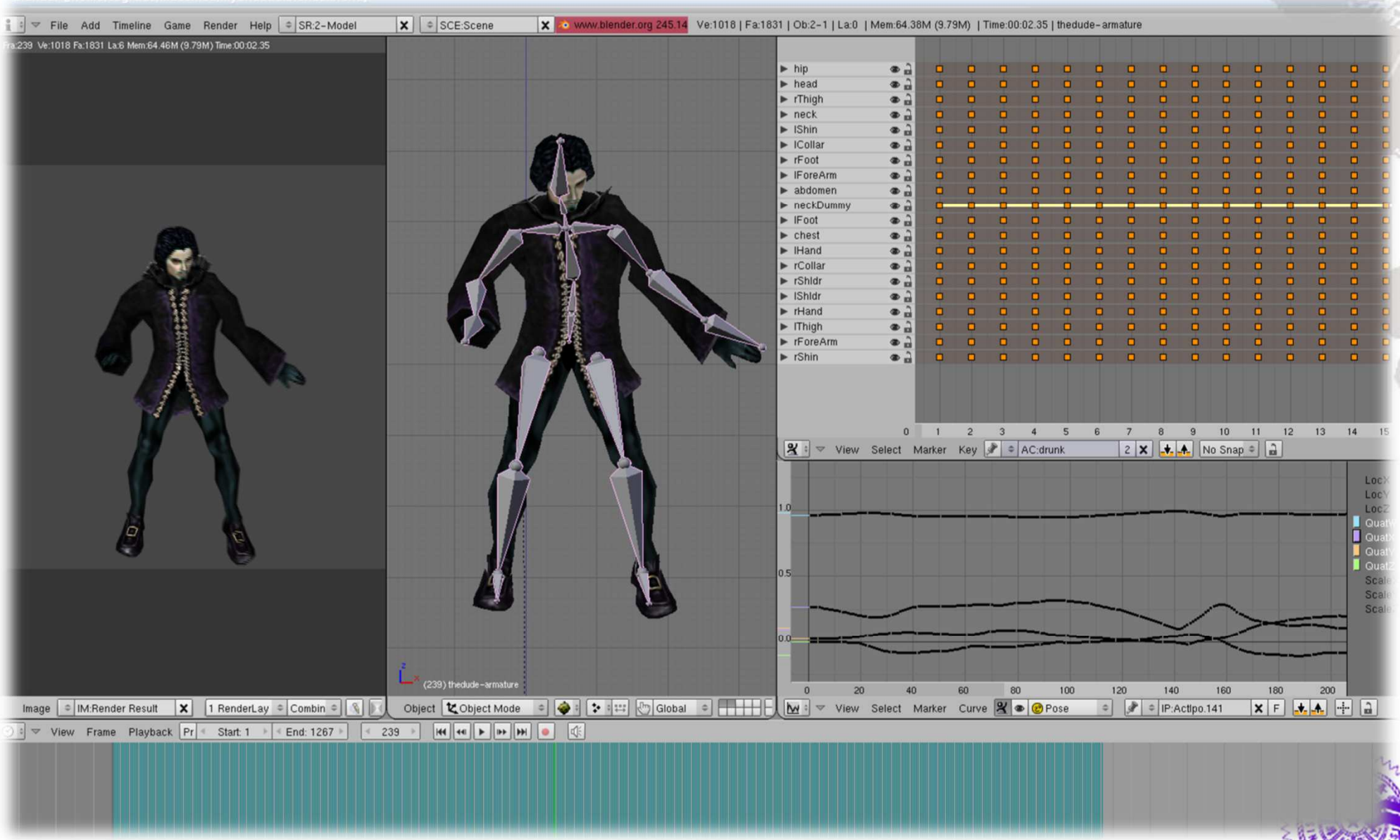
Motion Capture (Mocap)

- Without markers

Skeletal Animation

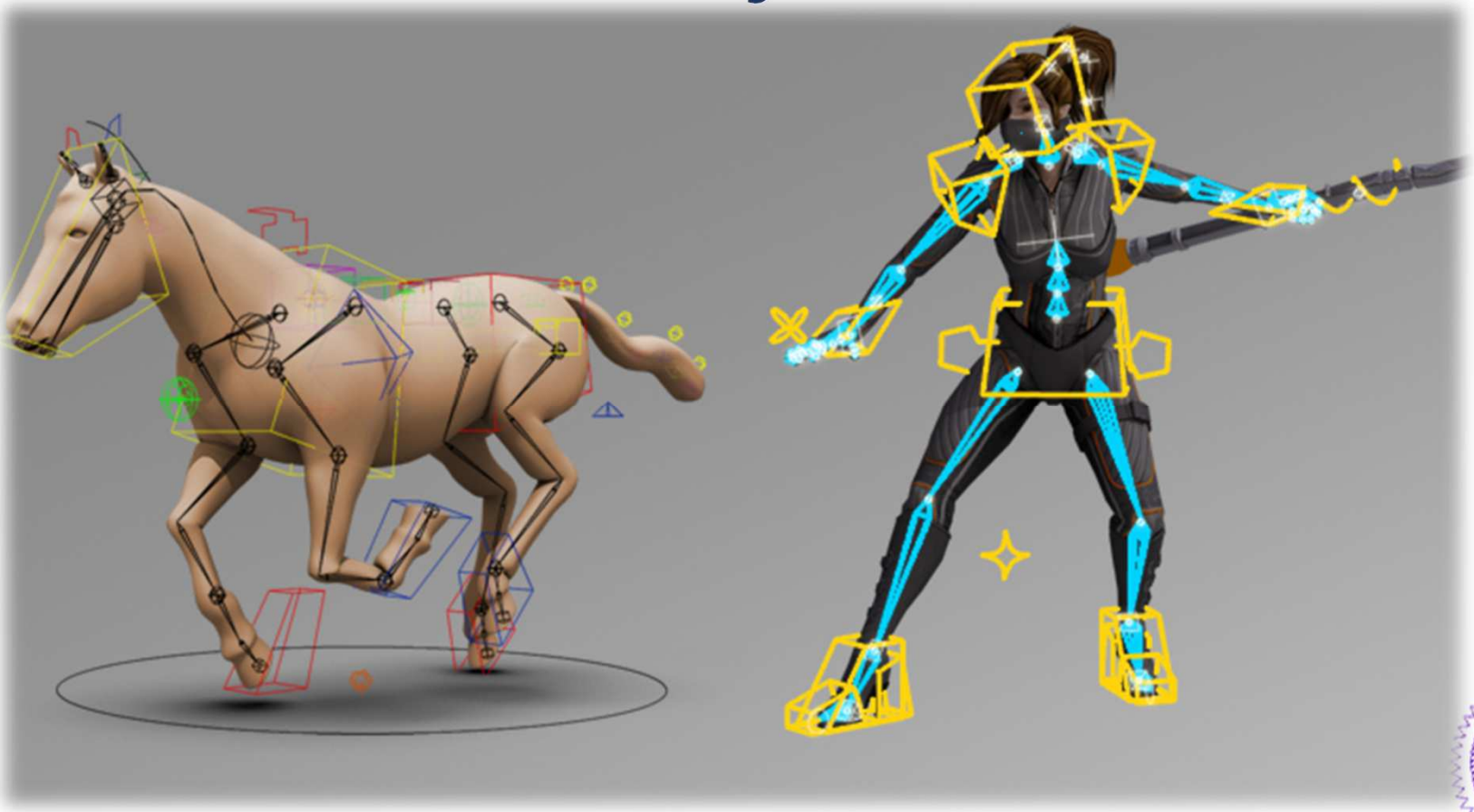
- A technique in computer animation in which a character is represented in two parts
  - A surface representation used to draw the character (called skin or mesh)
  - A hierarchical set of interconnected bones (called the skeleton or rig) used to animate (pose and keyframe) the mesh
- The skeleton serves as a handle for the animation process

Skeletal Animation

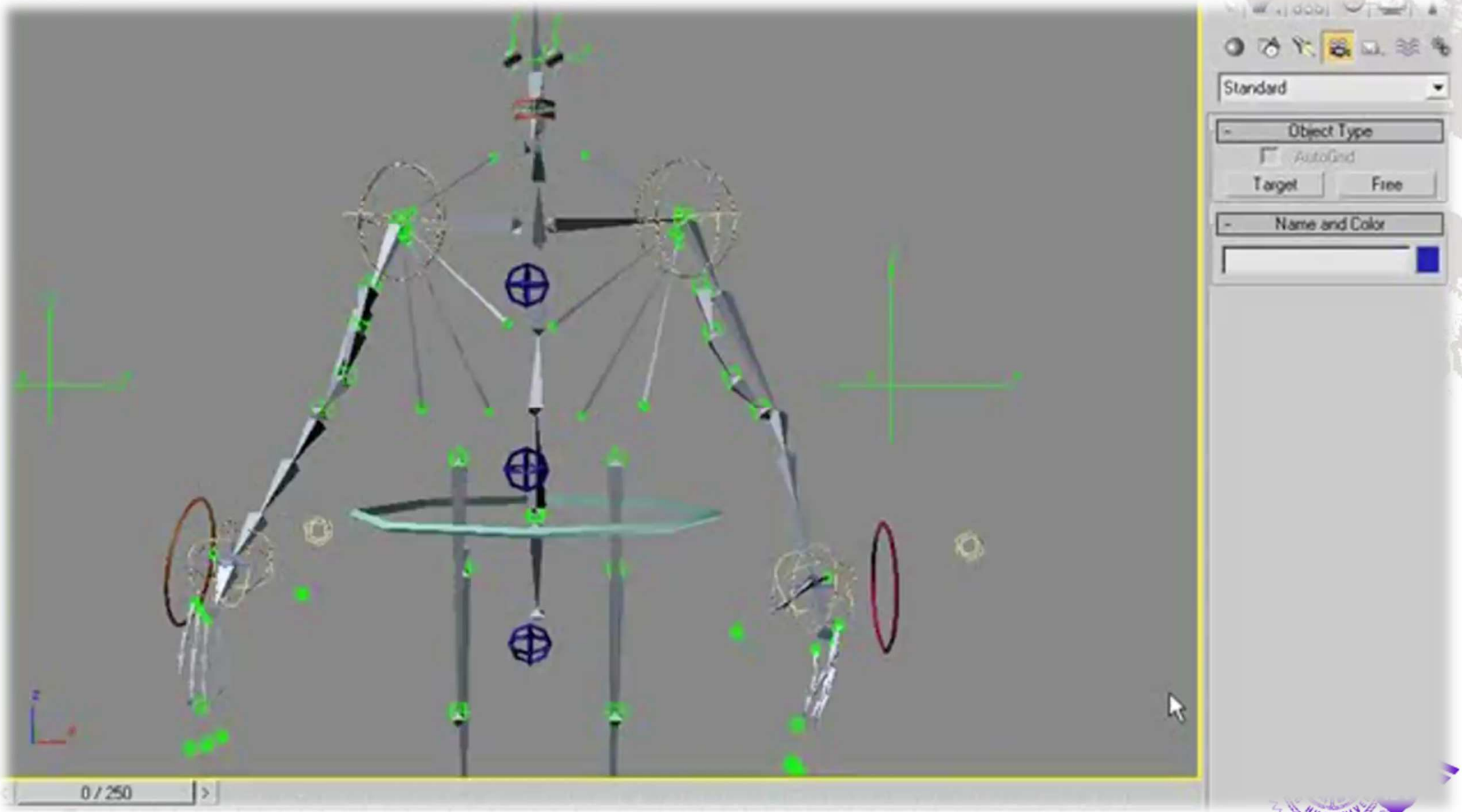


Rigging

- Define the underlying skeleton structure that bound to the 3D model with means to control the bones and joints



Rigging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Target
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Name and Color
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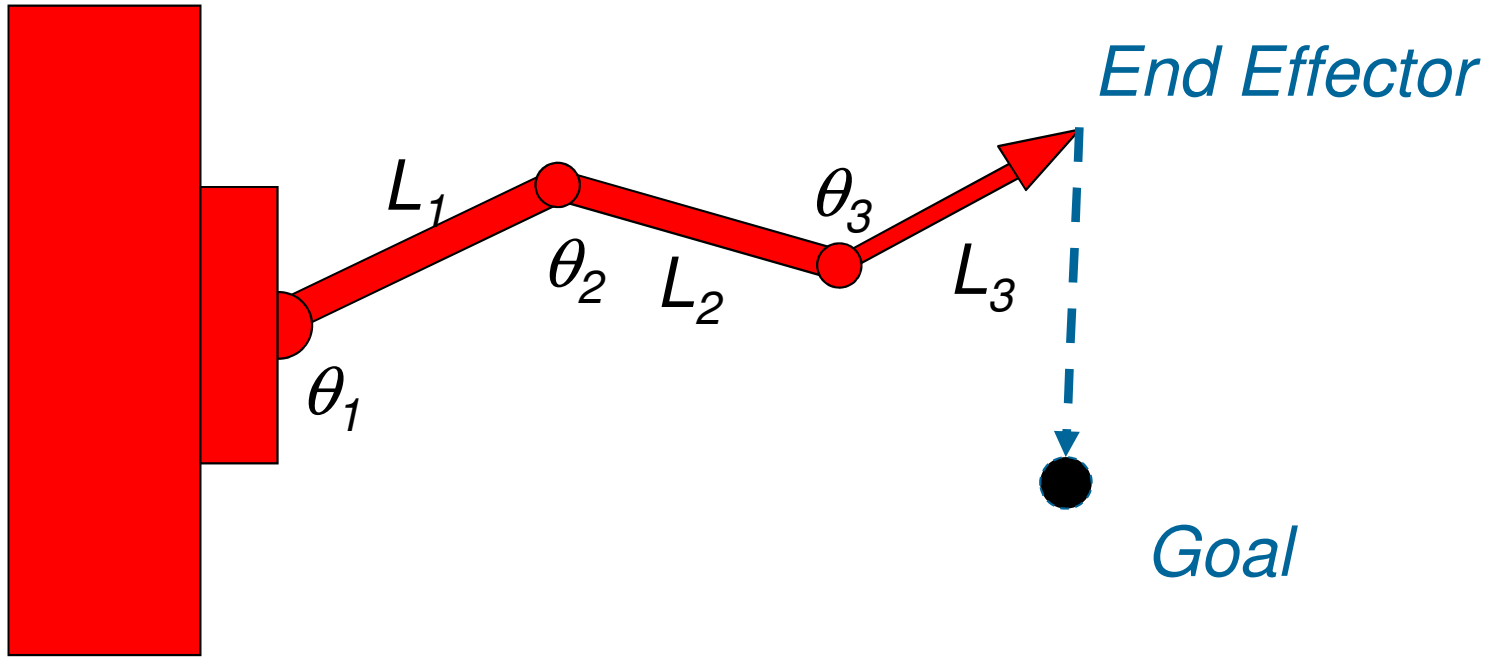
Inverse Kinematics (IK)

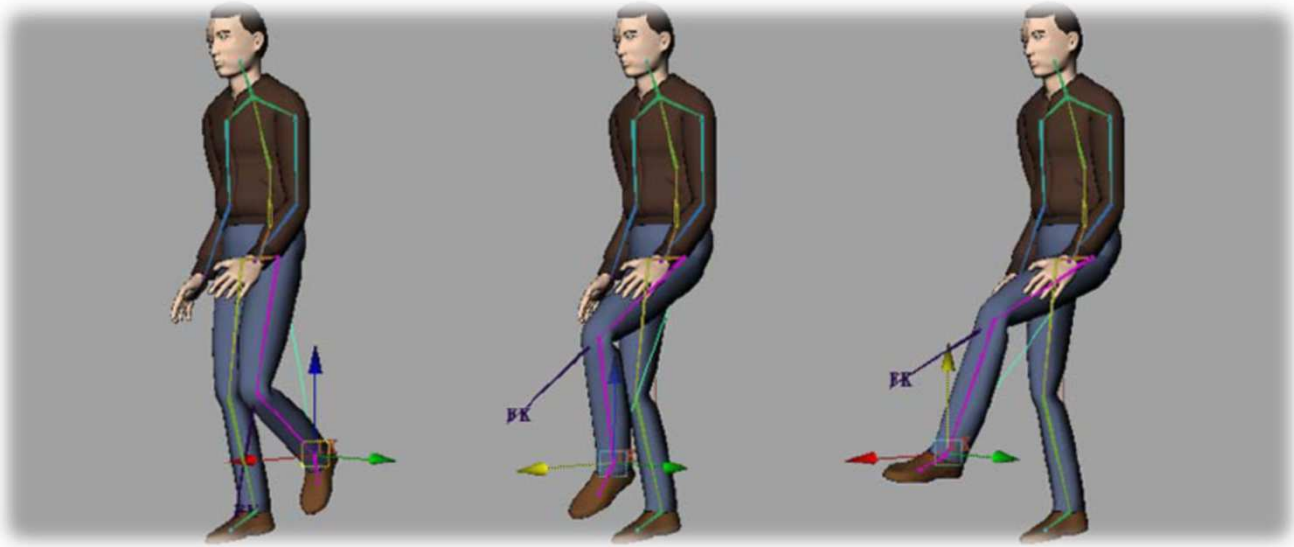
- Set goal configuration of end effector
- calculate interior joint angles



Inverse Kinematics (IK)

- **Forward Kinematics vs. Inverse Kinematics**

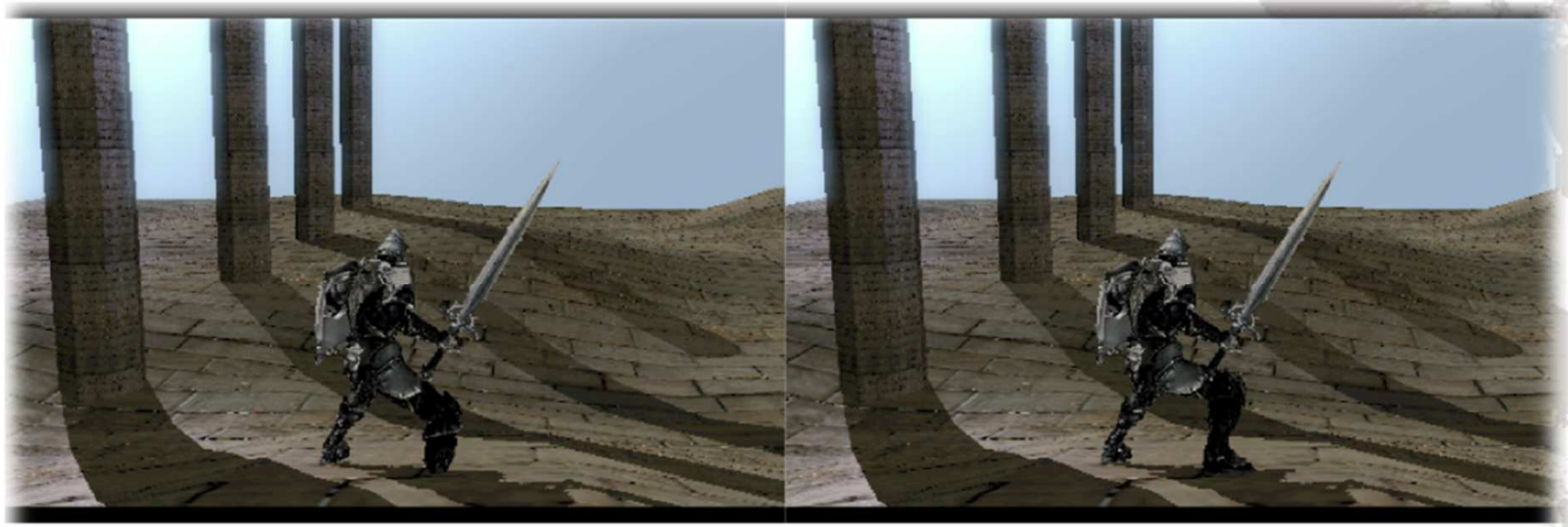
Forward Kinematics

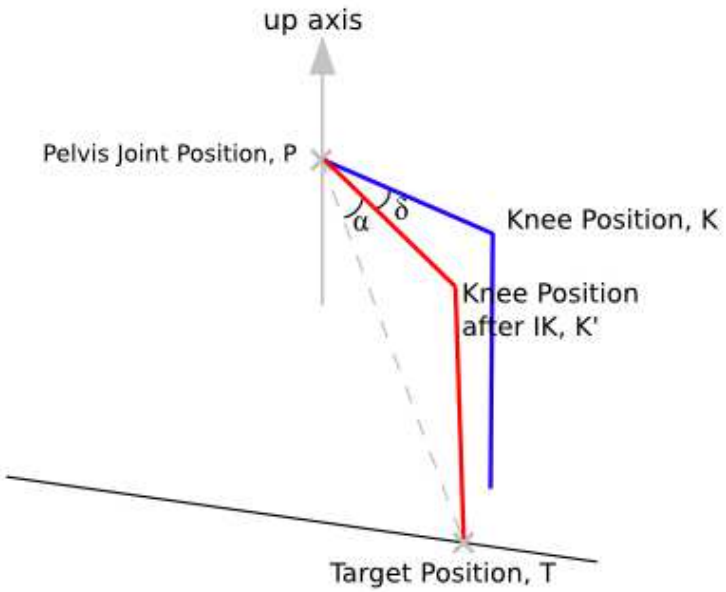


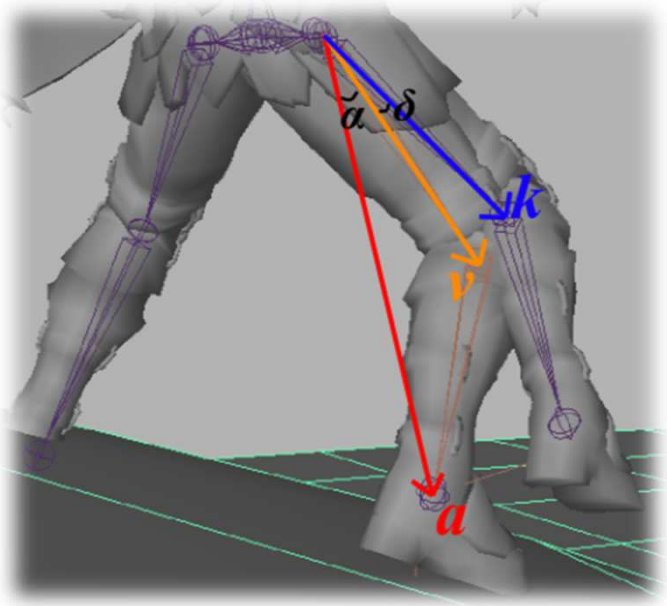
Inverse Kinematics

Inverse Kinematics (IK)

- **Example**

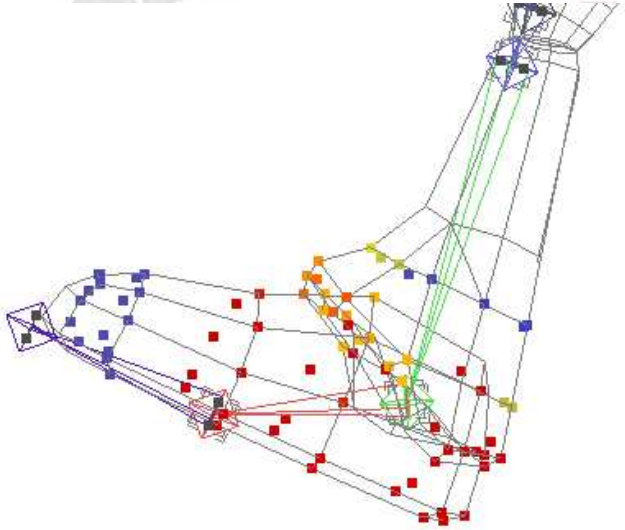


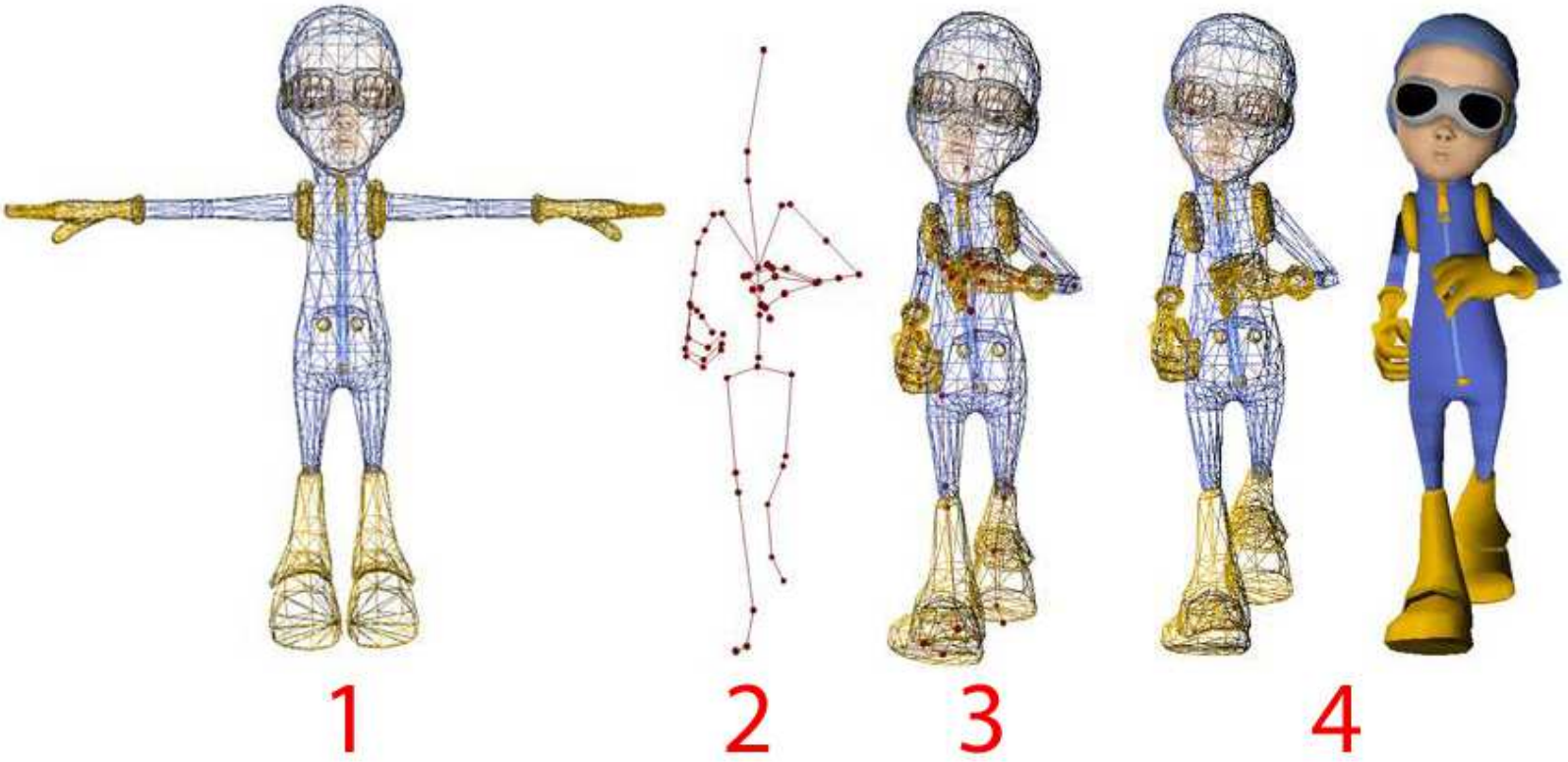


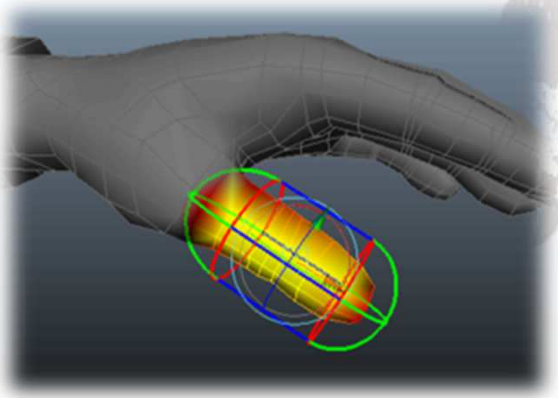


Skinning

- **Attaching a renderable skin to an underlying articulated skeleton**

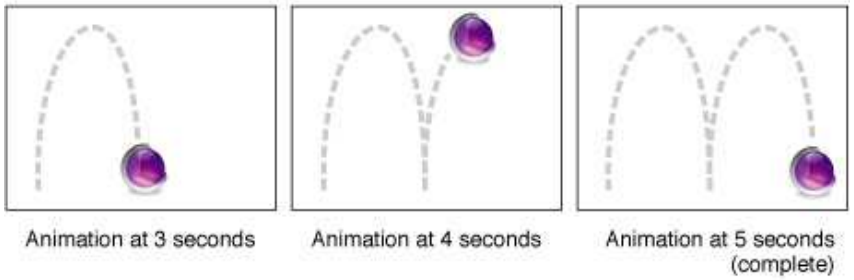


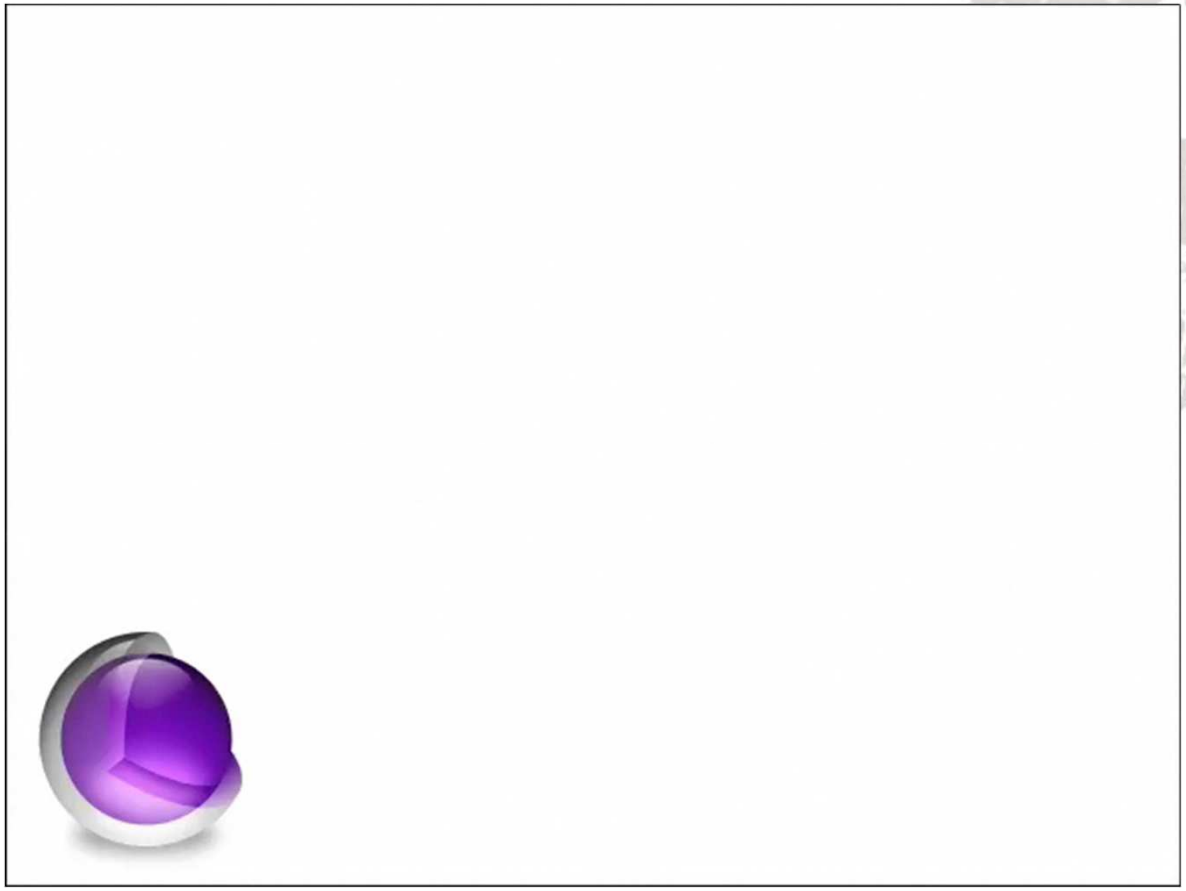




Interactive binding for Smooth skinning

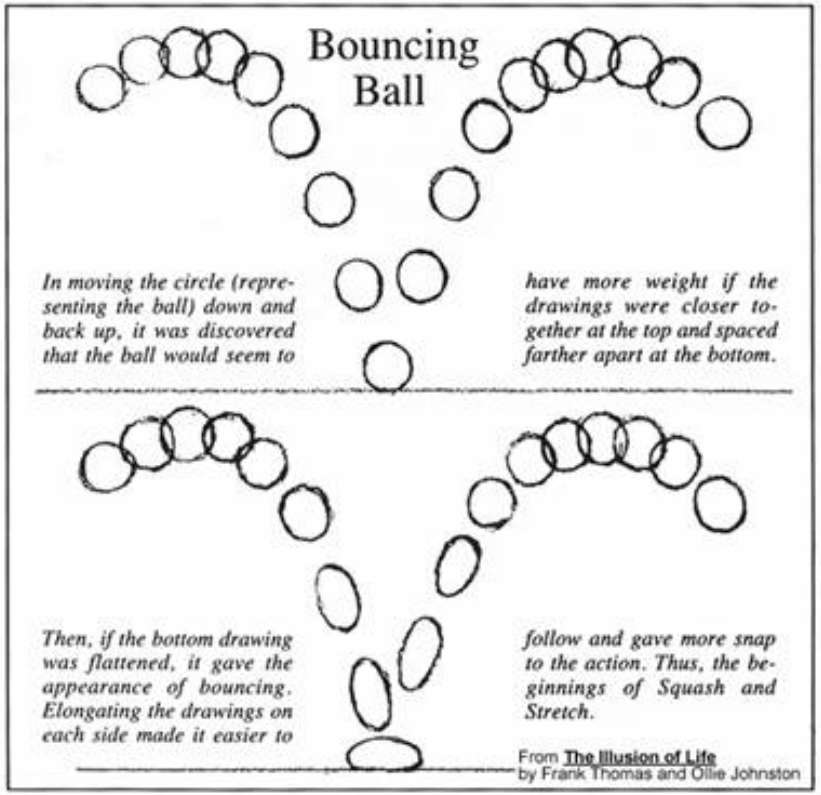
Keyframe Animation

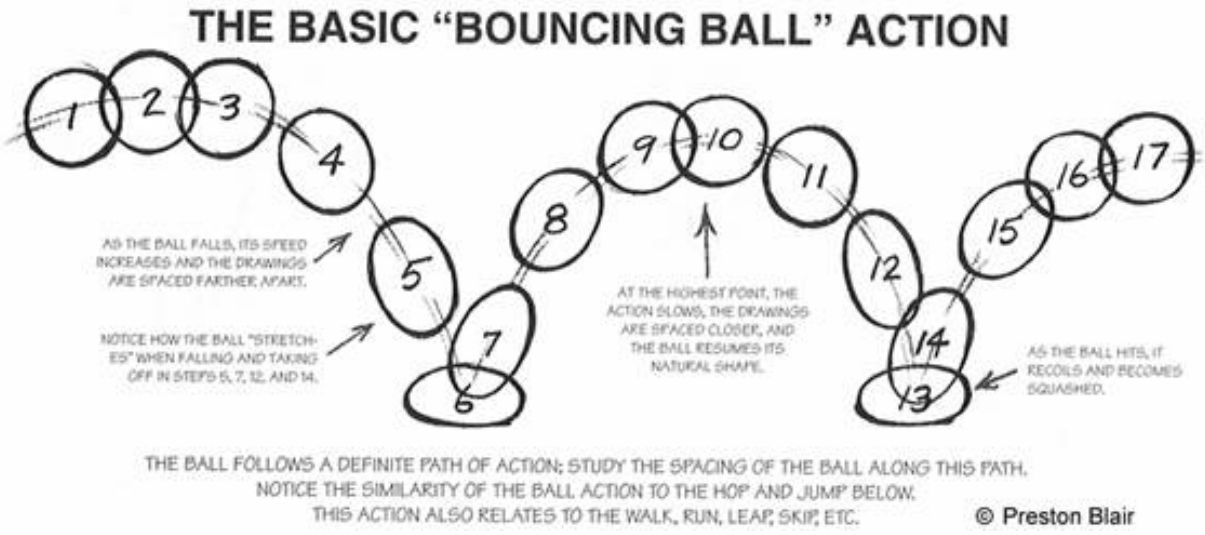




Keyframe Animation

- **Rigid body animation or deform animation**

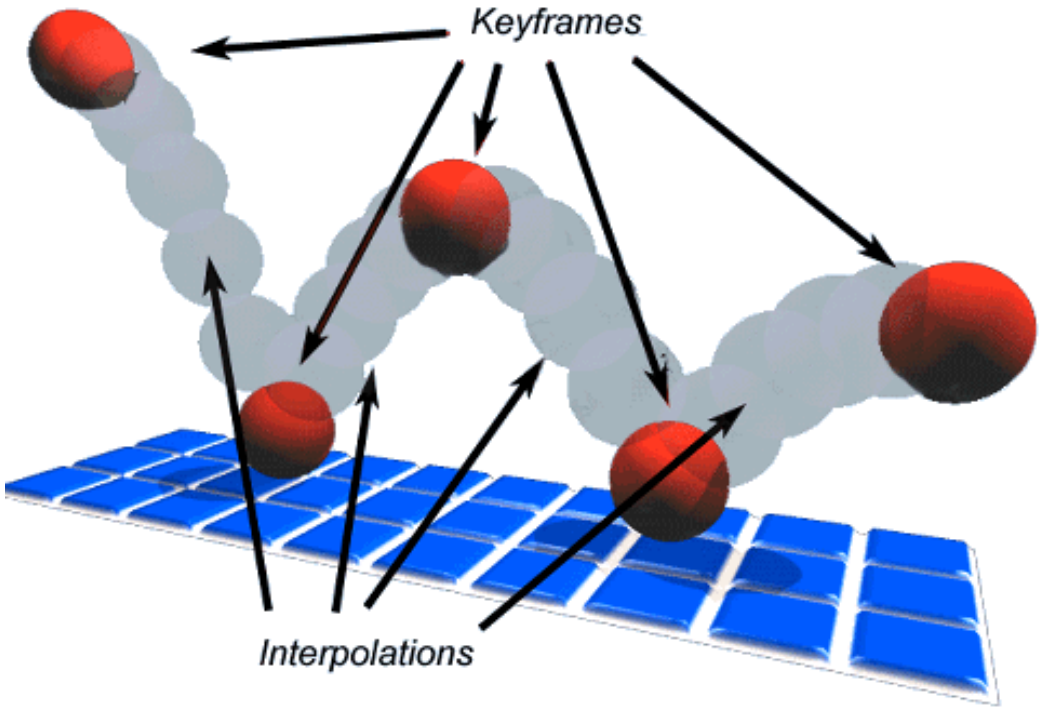


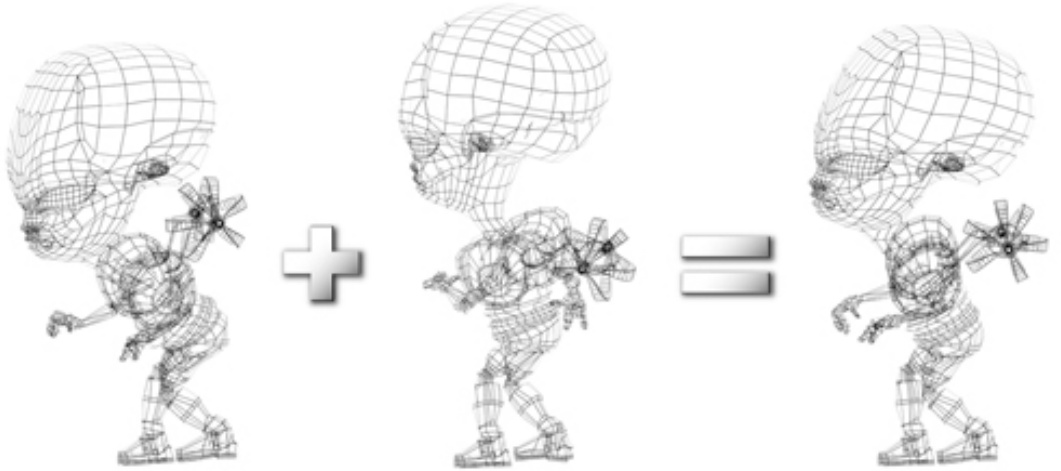


Keyframe Animation

By Masahiro Ushiyama

Keyframe Interpolation



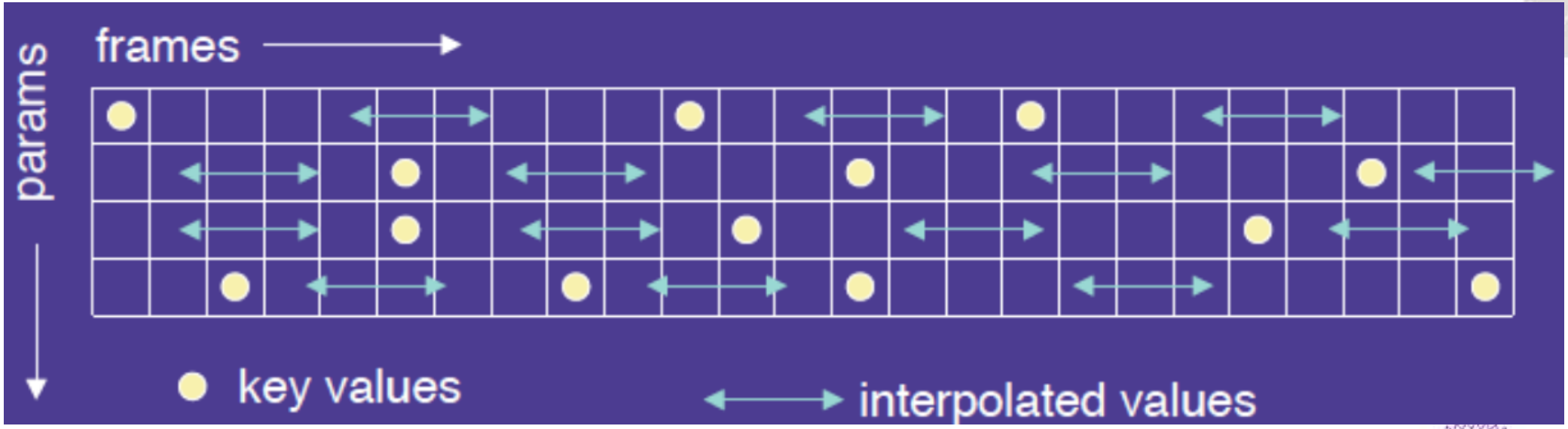


Keyframe Interpolation

- Lead animators create important keyframes
- Computers draw the in-betweens through interpolation
- Need to avoid or solve
  - Invalid configurations (pass through objects)
  - Unnatural motions (painful twists/bends)
  - Jerky motion

Keyframe Interpolation

- Keyframe is defined by a bunch of parameters (state values)
- Interpolate the state values for in-betweens
  - Usually a spline interpolation is adopted

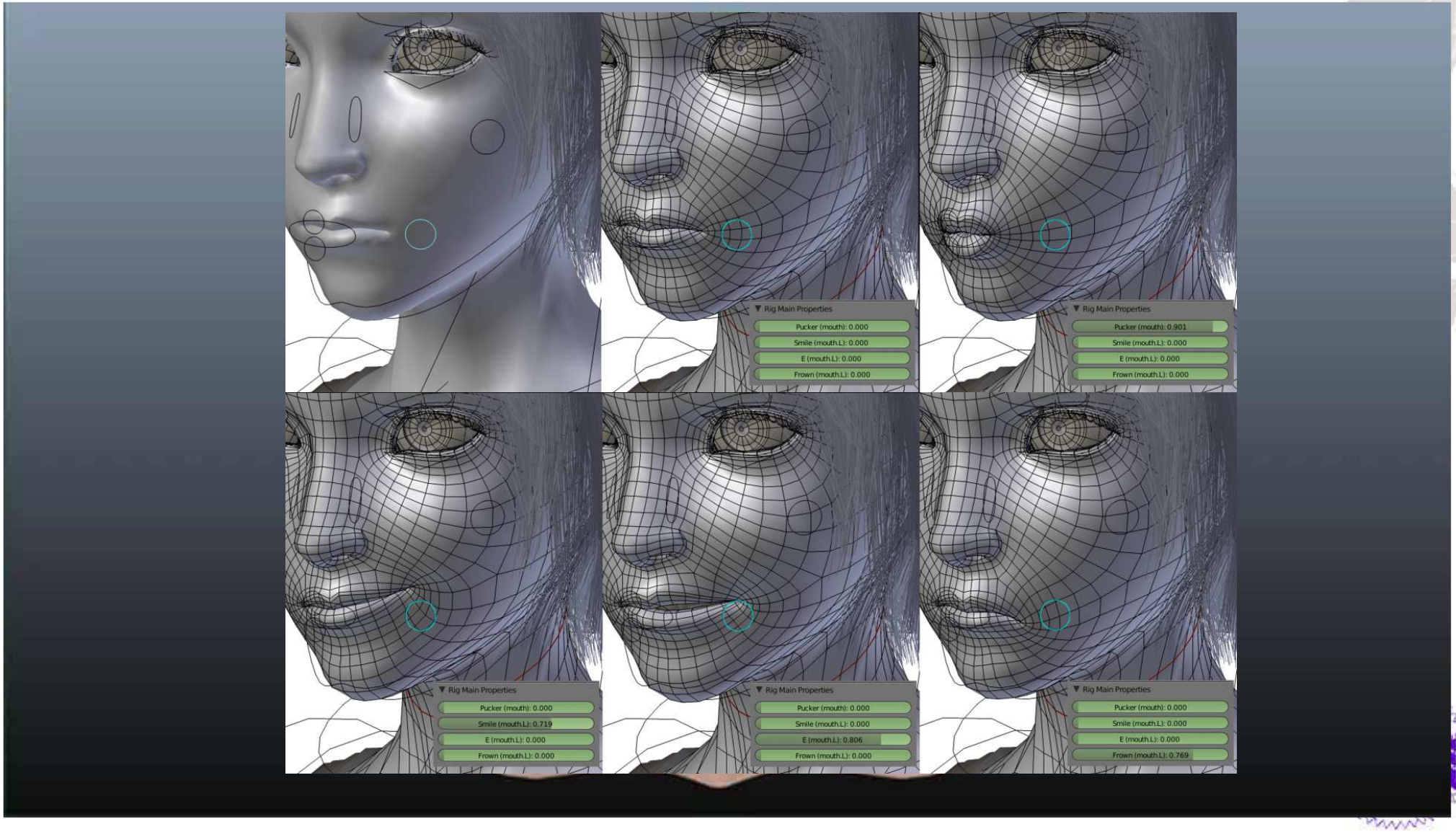


Facial Animation

Facial Animation

Facial Animation

- Blend Shapes



Blue Screens (or Green Screens)

Blue Screens (or Green Screens)

Q&A