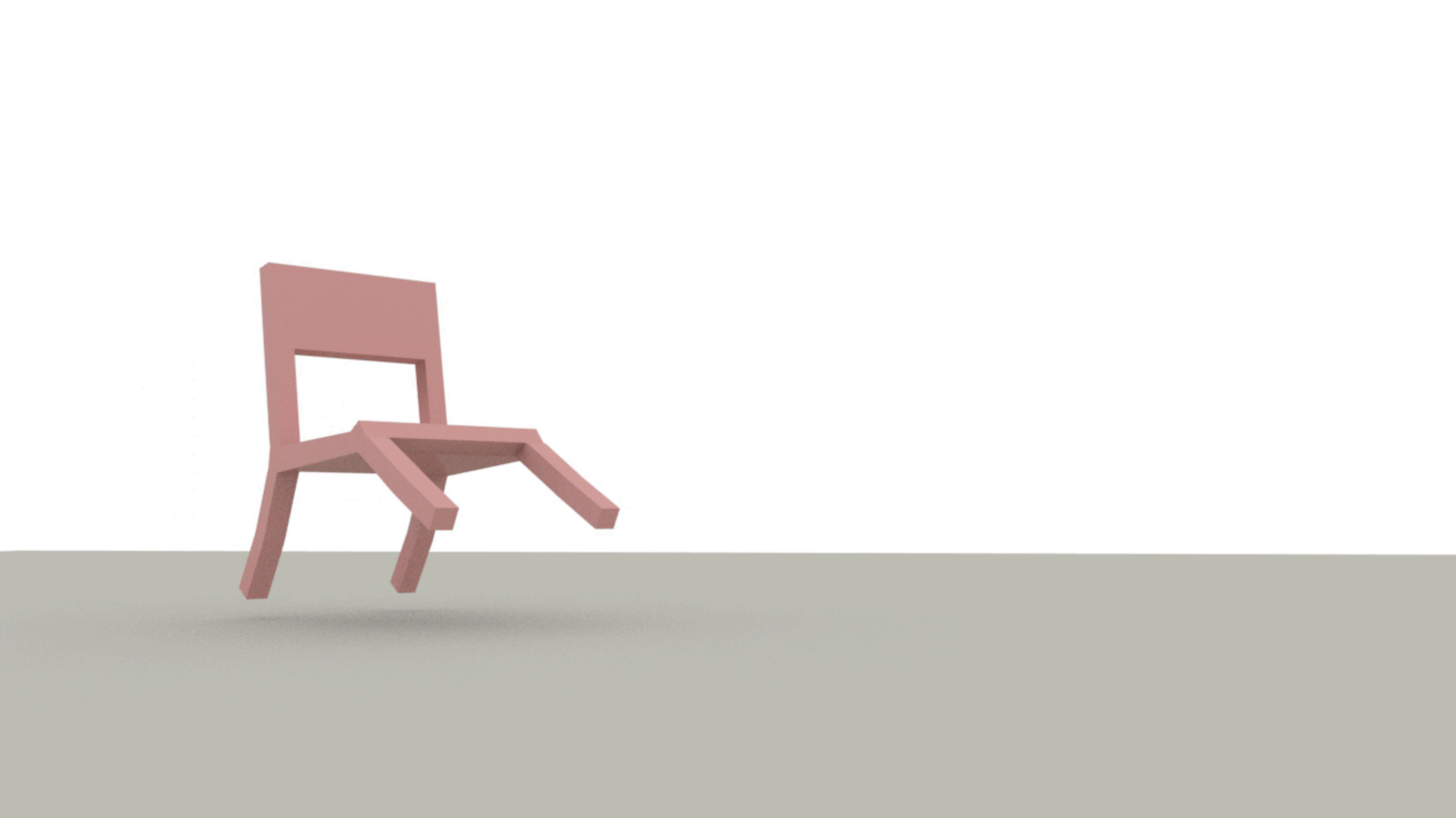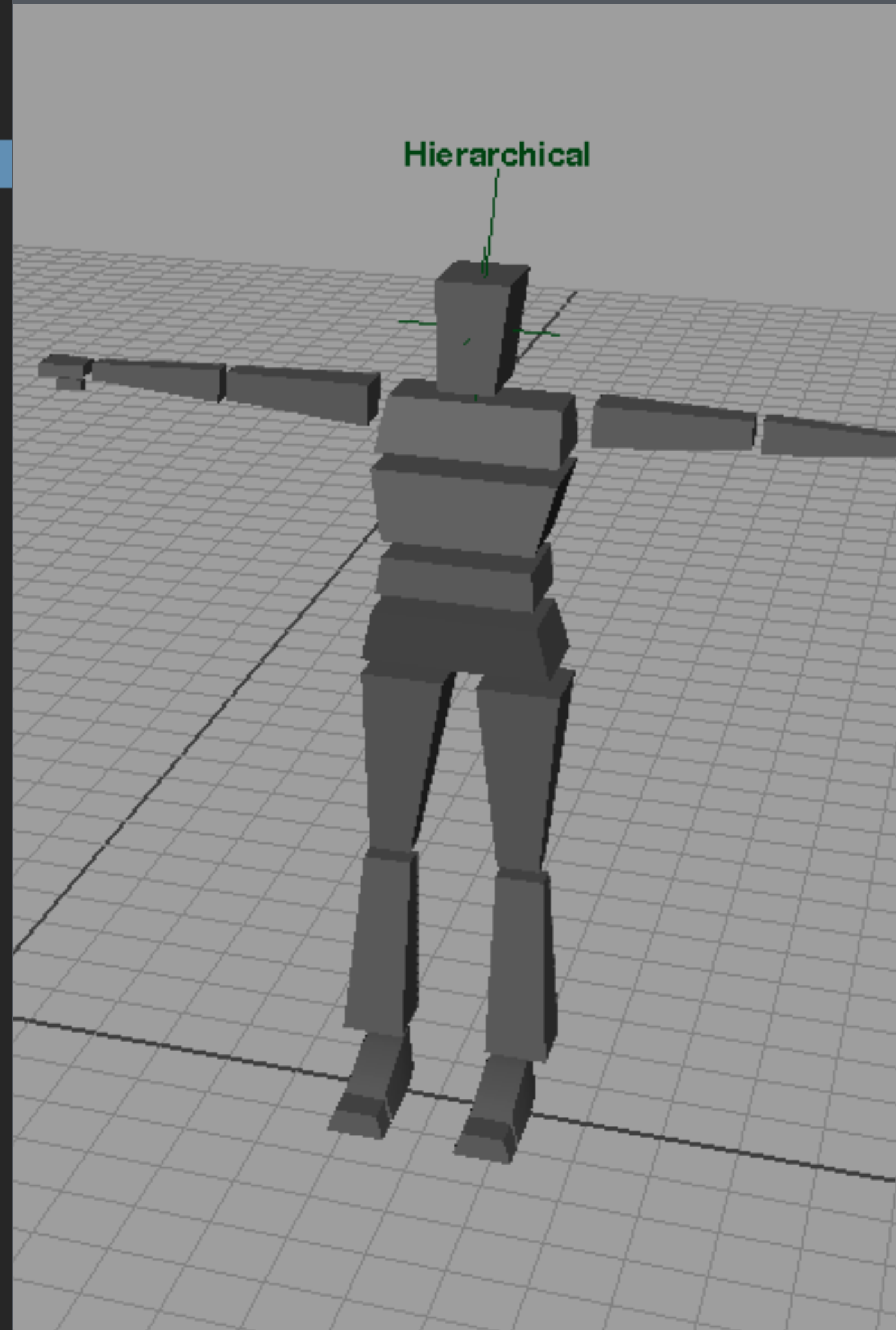# SM2231 :: 3D Animation I :: Basic
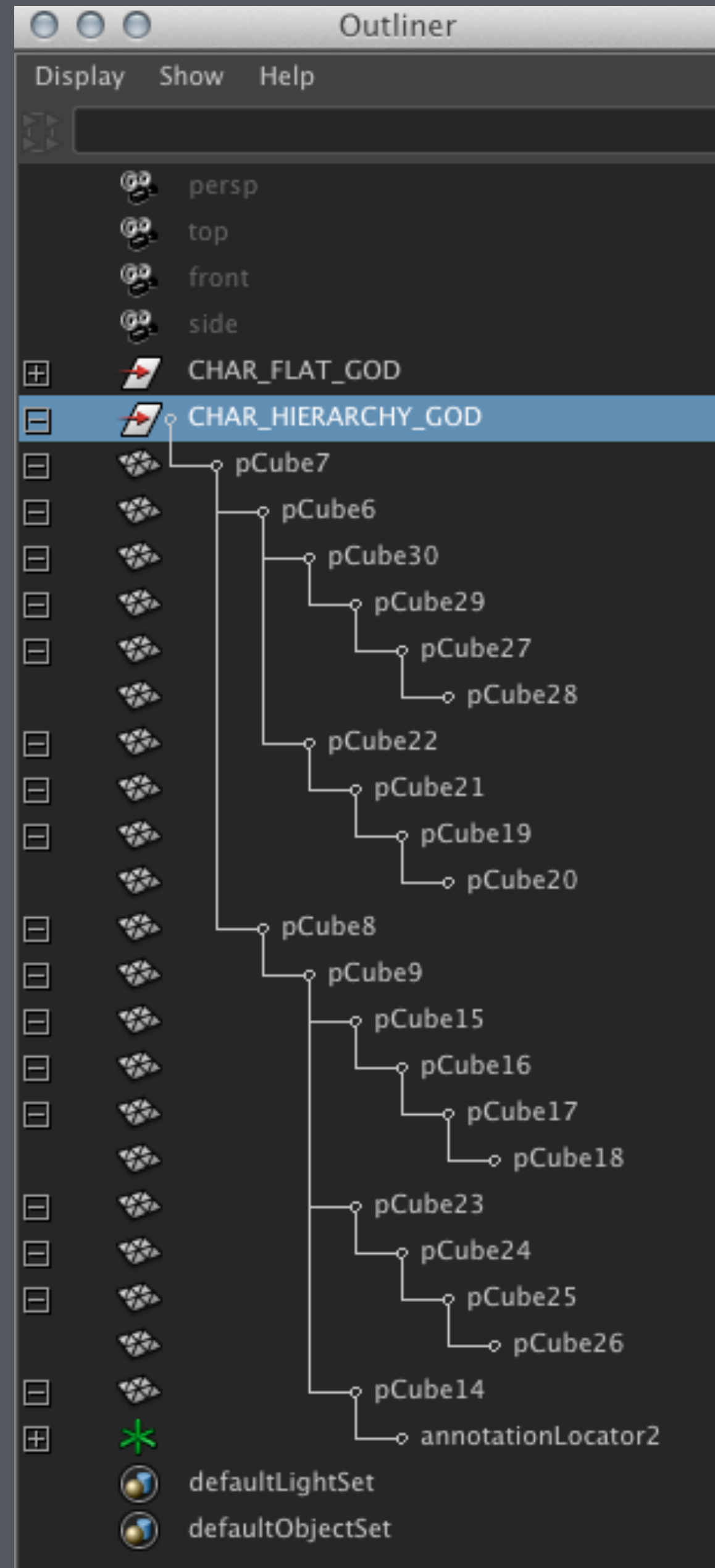
Rigging
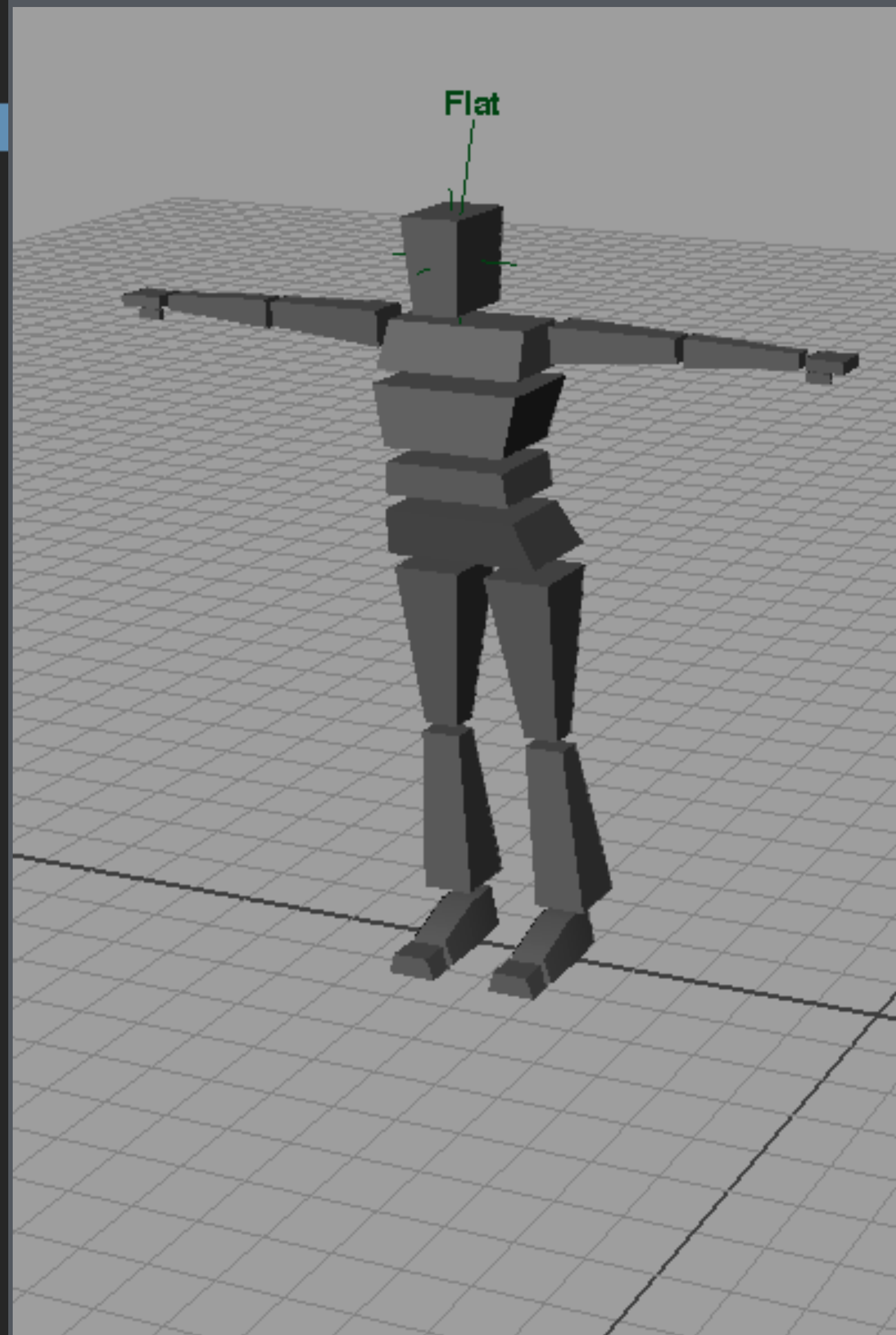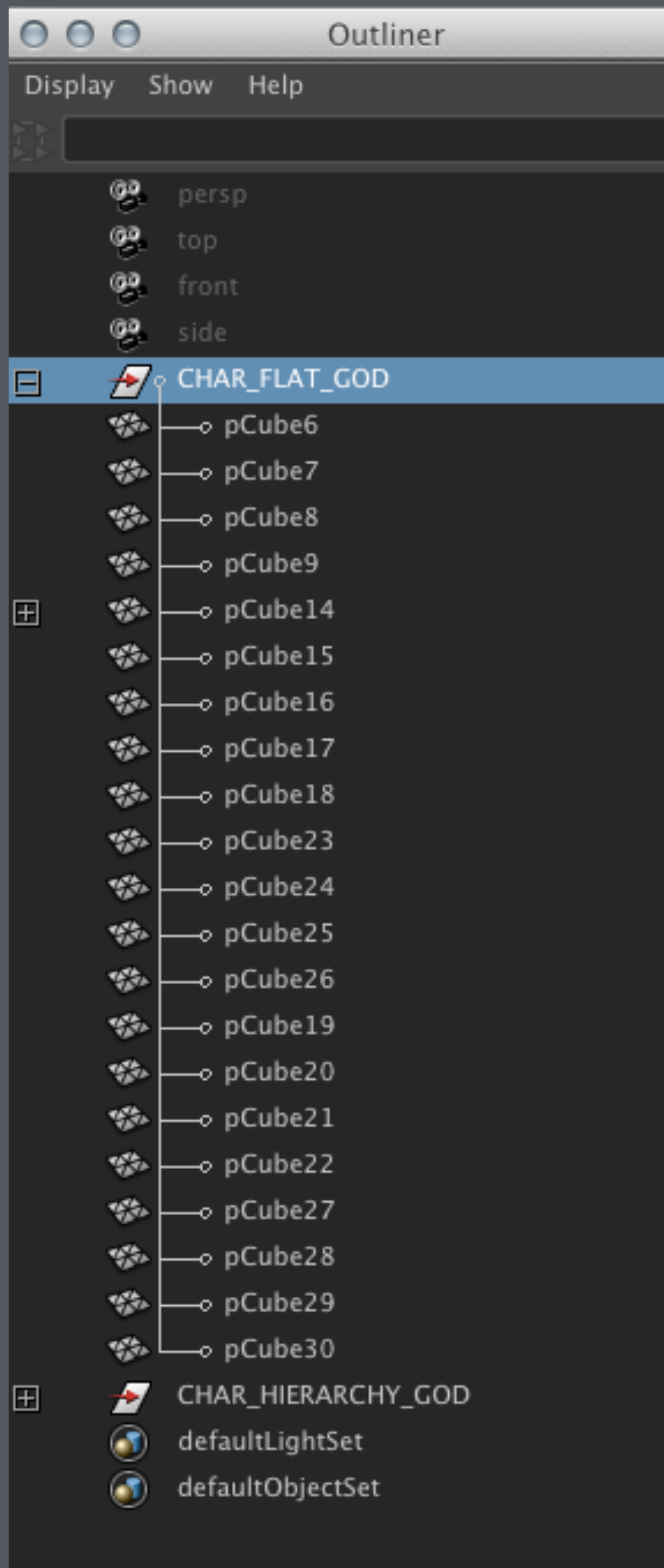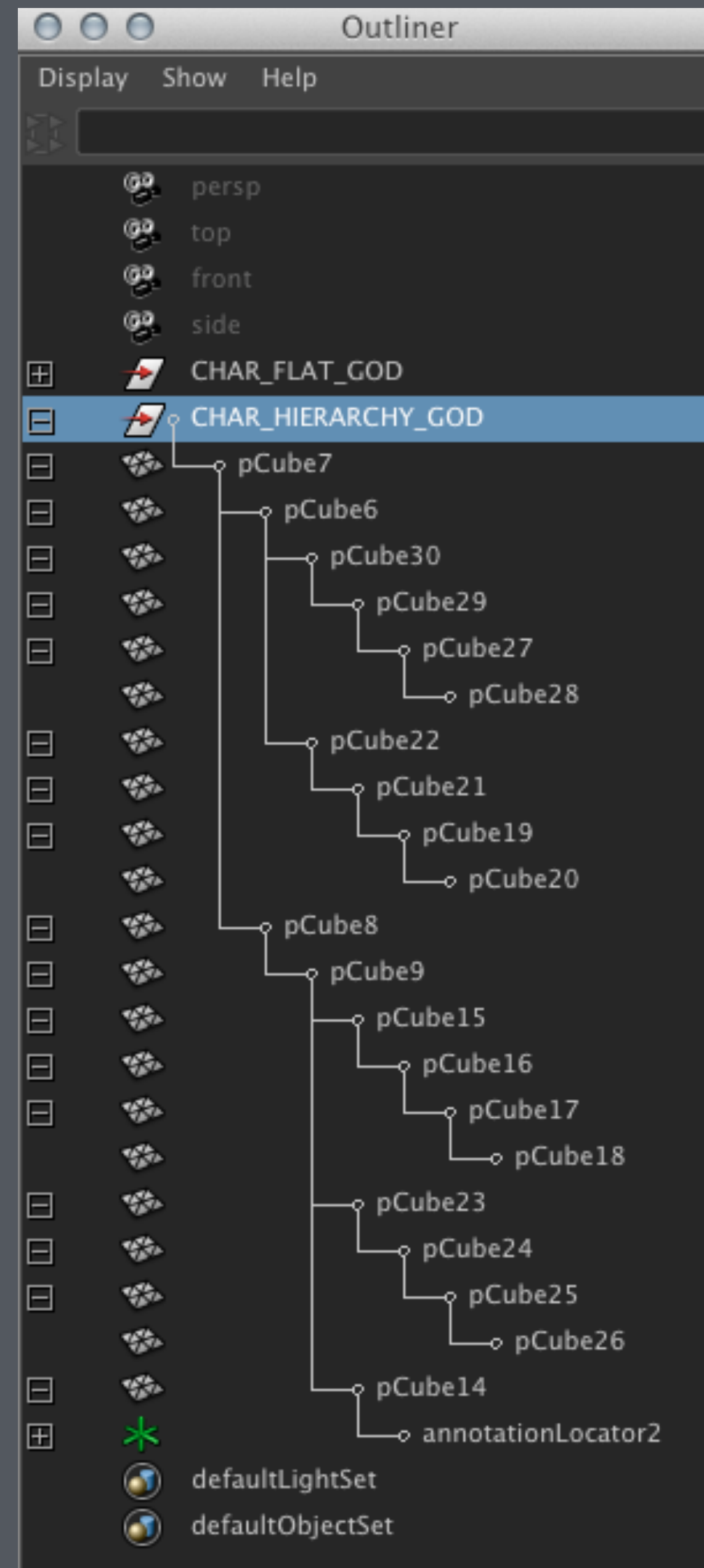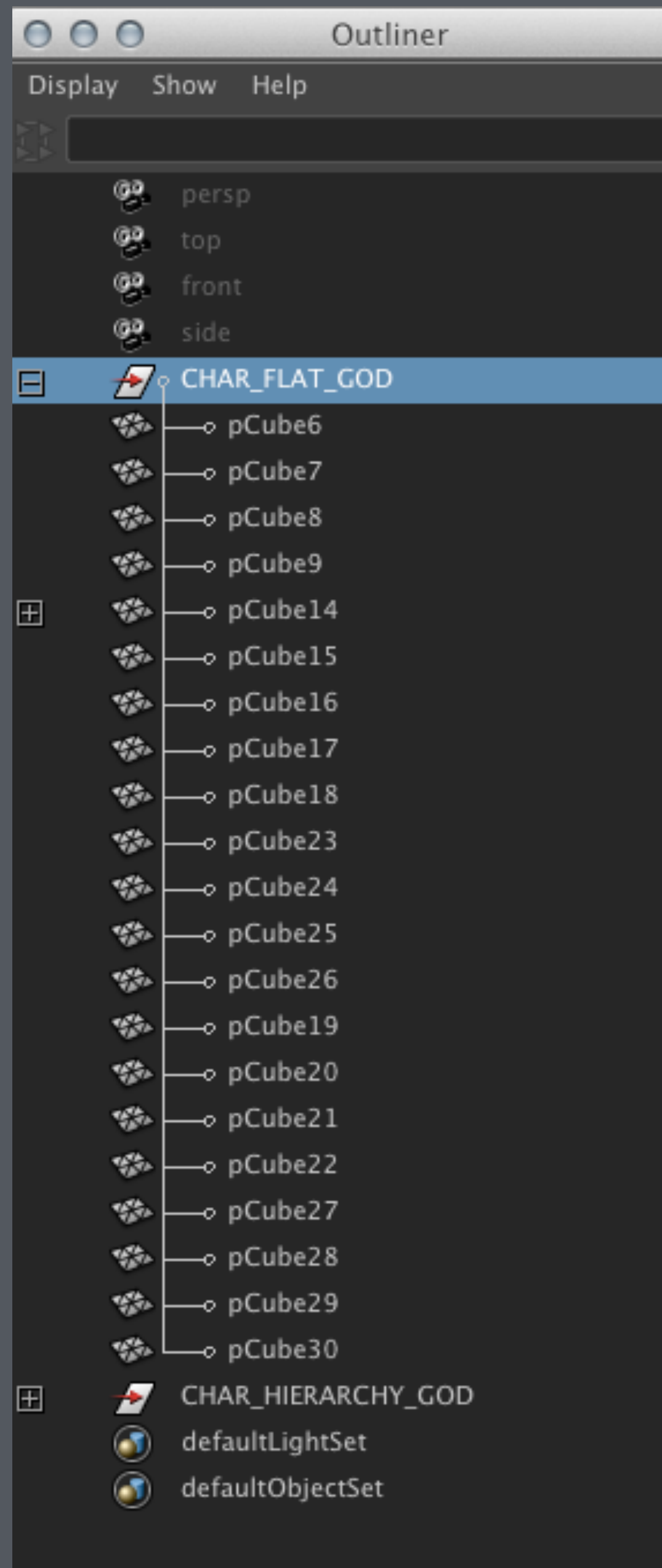
Object arrangements

Hierarchical

- Separate parts arranged in a hierarchy can be animated without a skeleton

Flat
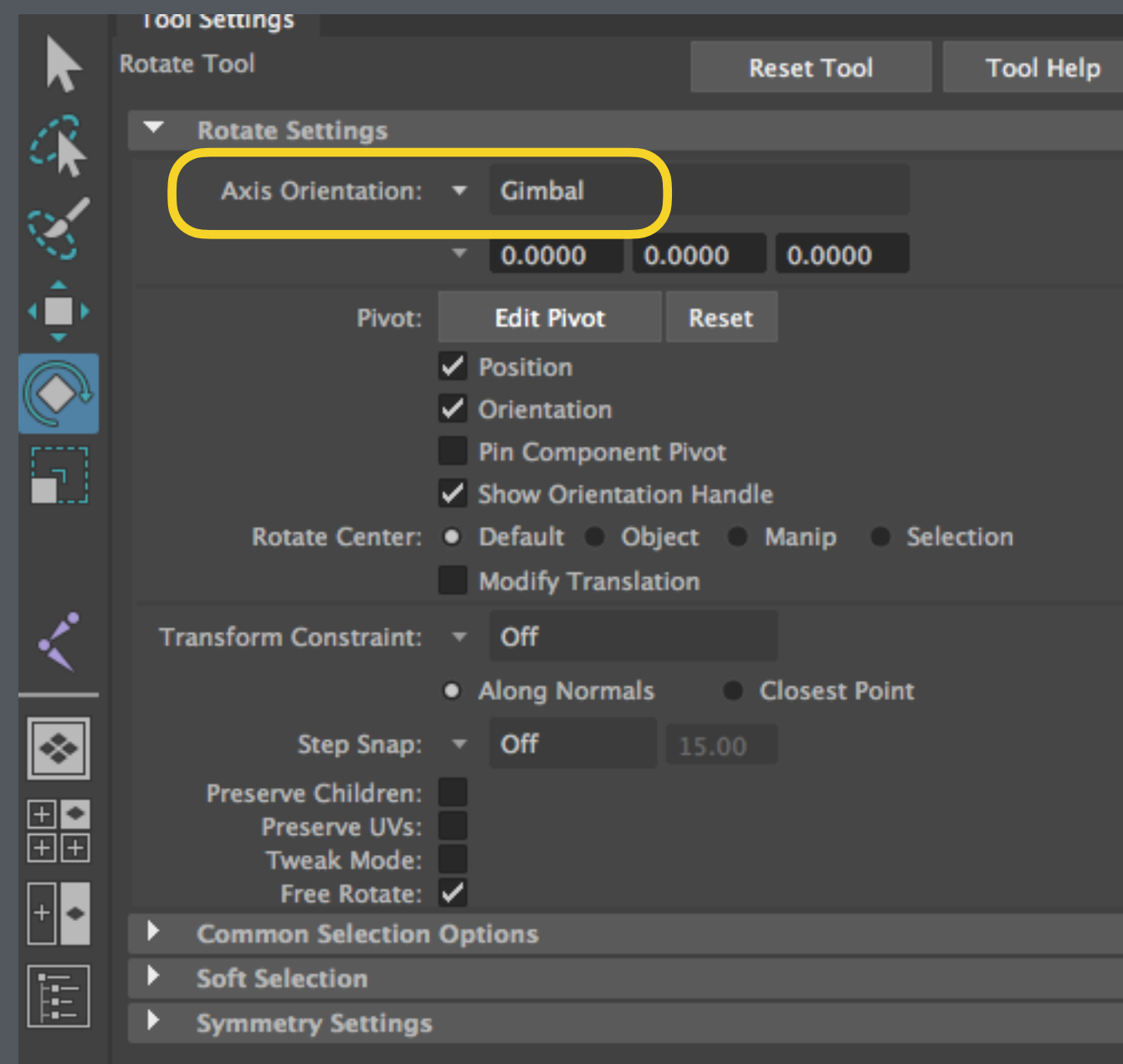
- Flat hierarchy is usually preferred, if using a skeleton to animate.

The GOD node

A GOD node is a group node at the top of a hierarchy
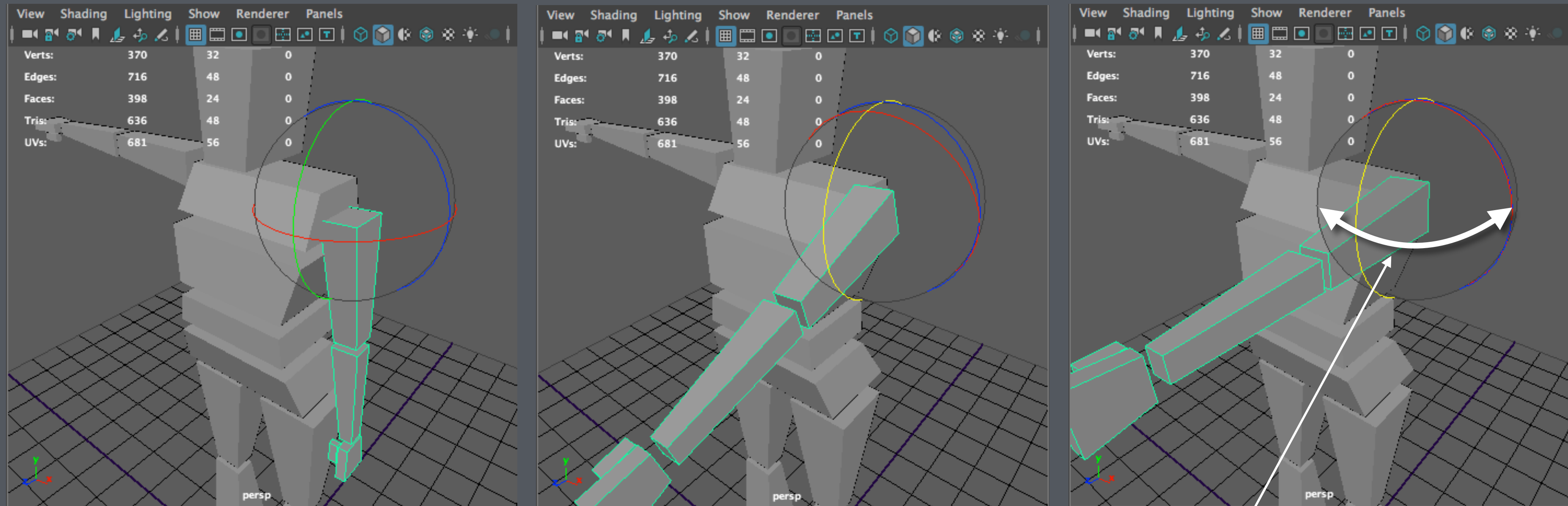
Gimbal Rotation

Gimbal Rotation

A Gimbal is a 3-axes rotation mechanism

Gimbal Rotation

- To rotate an object using the 3 axes

- Rotate one axis at a time E.g. X, Y, then Z

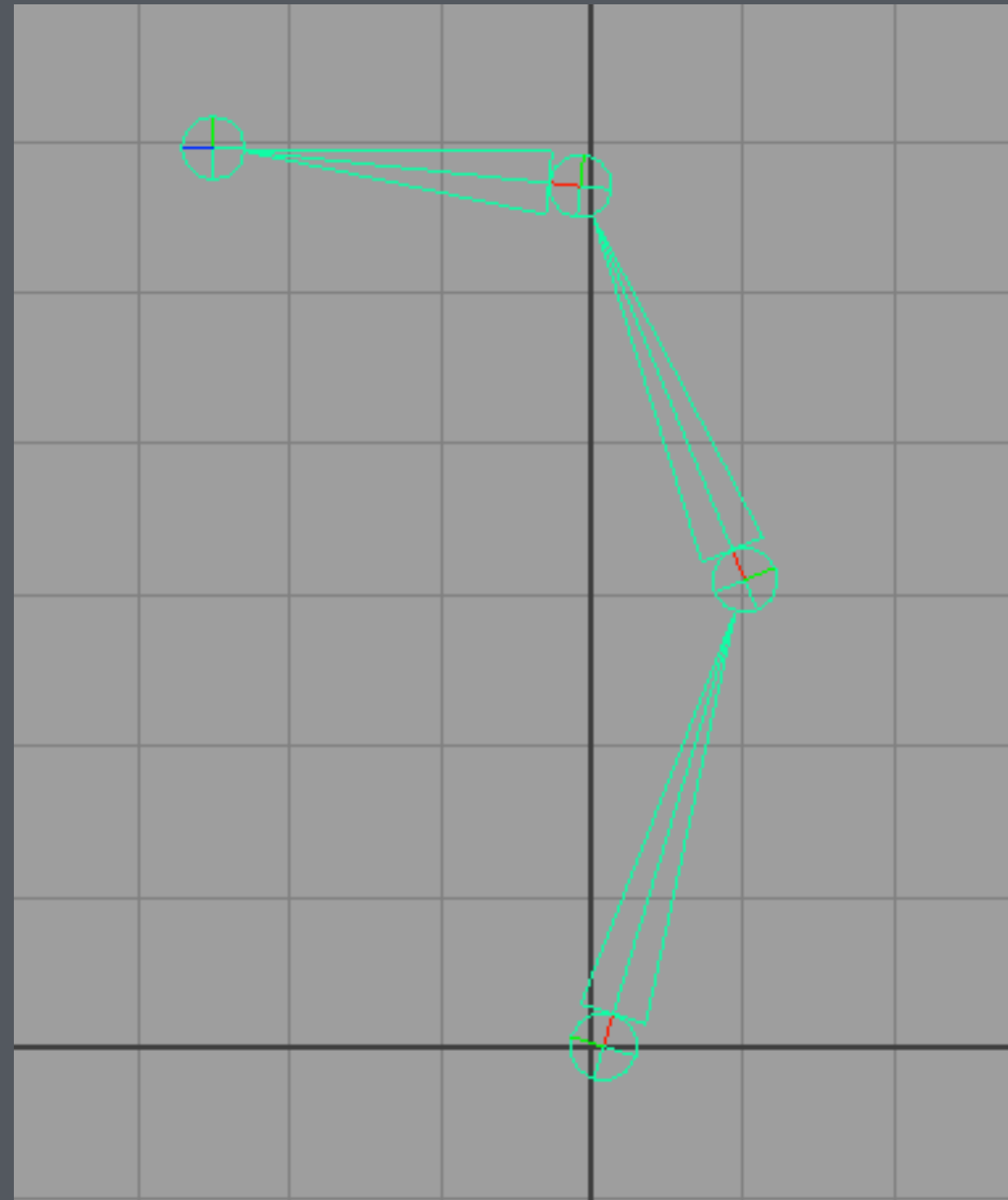- Most 3D applications handle rotation using Gimbal Rotation

Gimbal Lock

However, because of the nature of Gimbal Rotation, it is very often to come to a scenario like the pictures above - The arm cannot be rotated sideway because there is no rotational axis available.
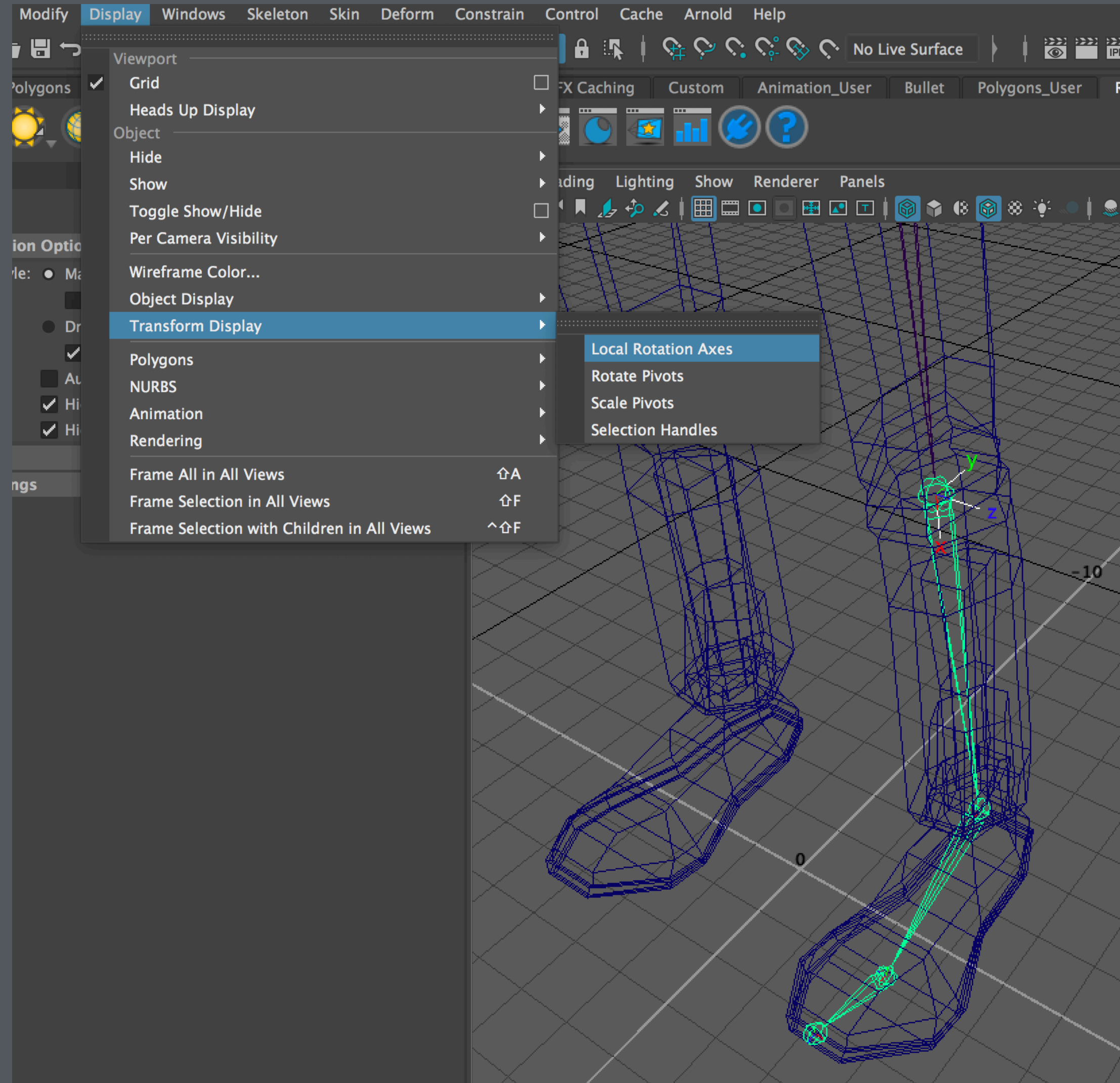
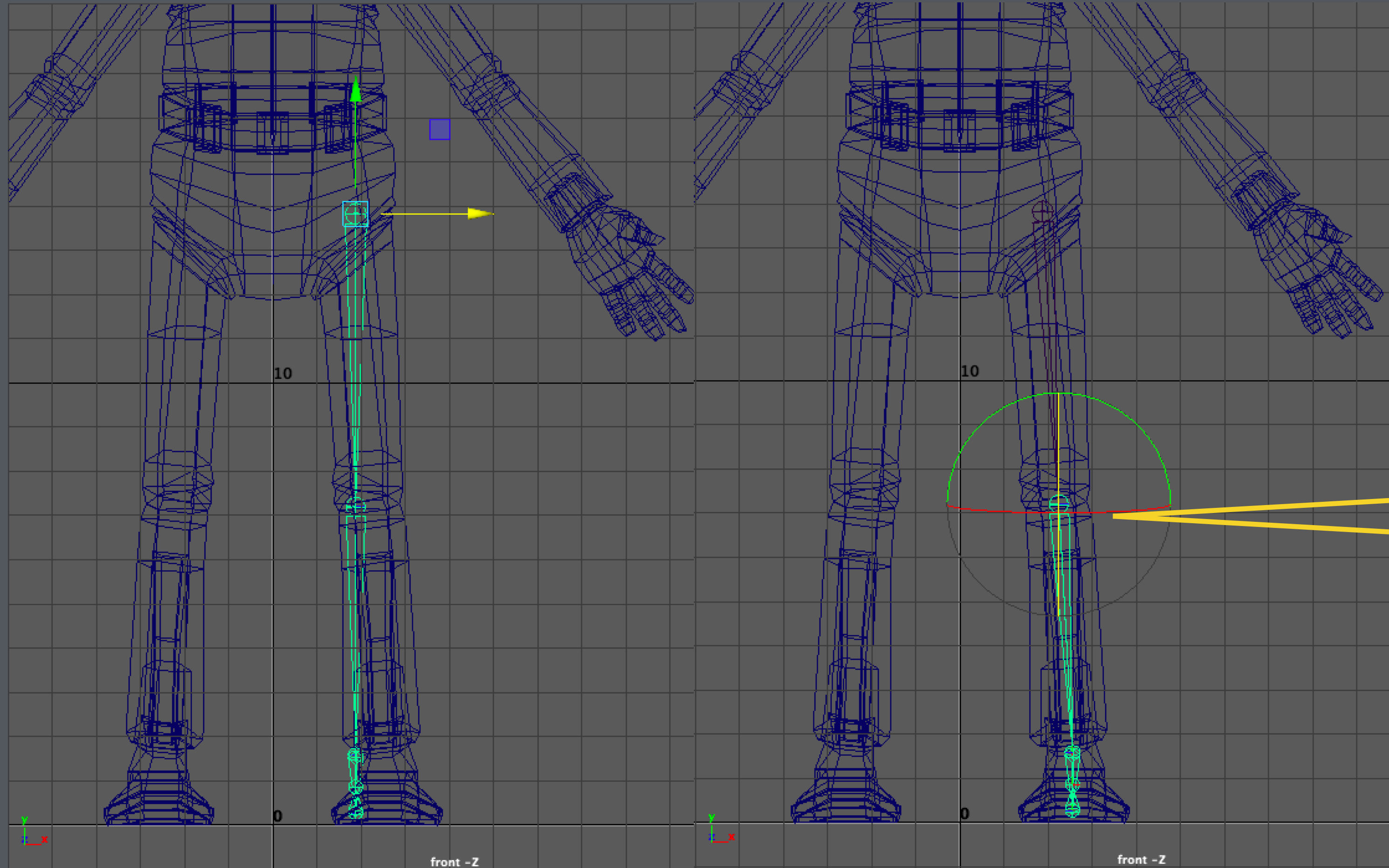This problem is known as the *Gimbal Lock*
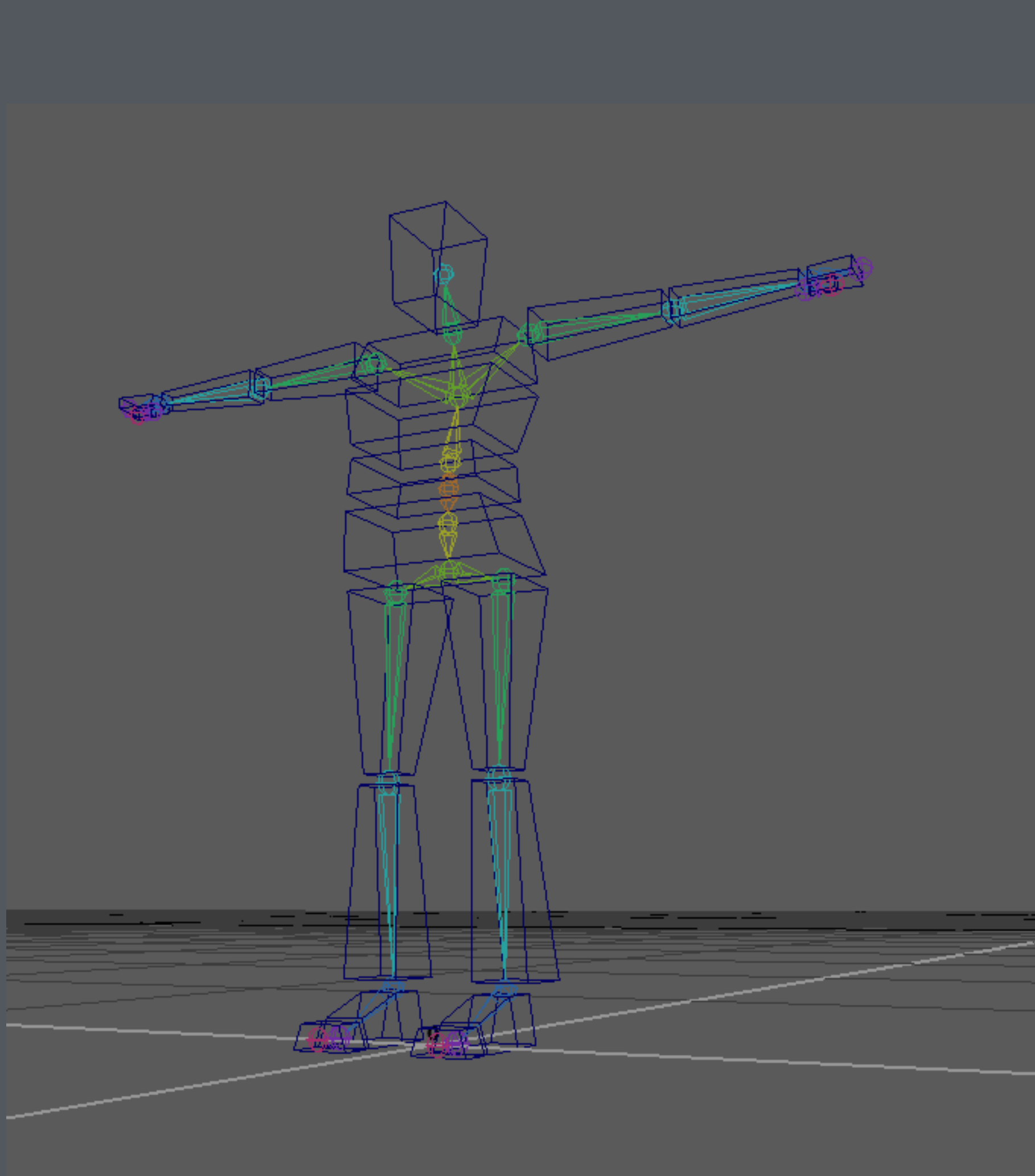
Skeleton

Joints

Local Rotation Axis

One very important component of a joint is the *Local Rotation Axis*.

It determines how the joint rotate and behave.

Local Rotation Axis

Whenever a joint's position is adjusted, its *Local Rotation Axis* is no longer oriented correctly.
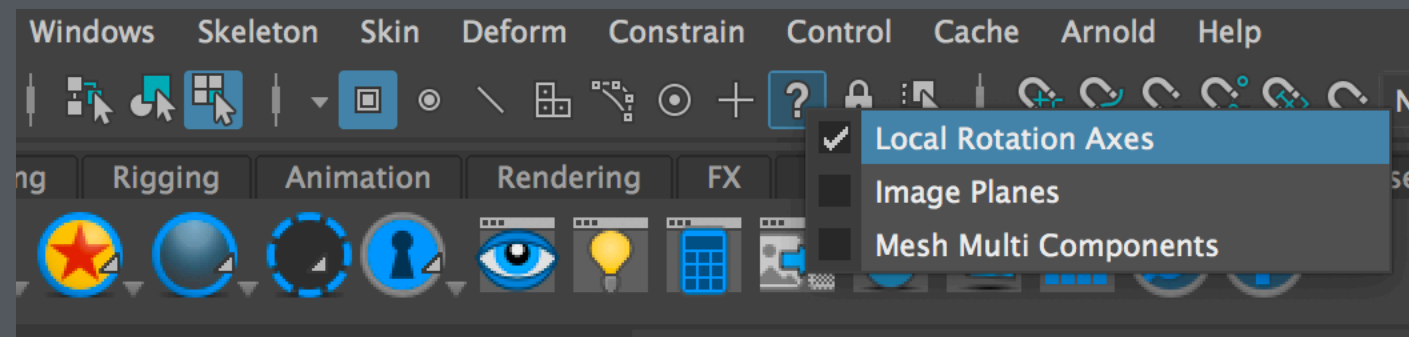
The knee joint in this example here needs to have its Local Rotation Axis re-oriented.

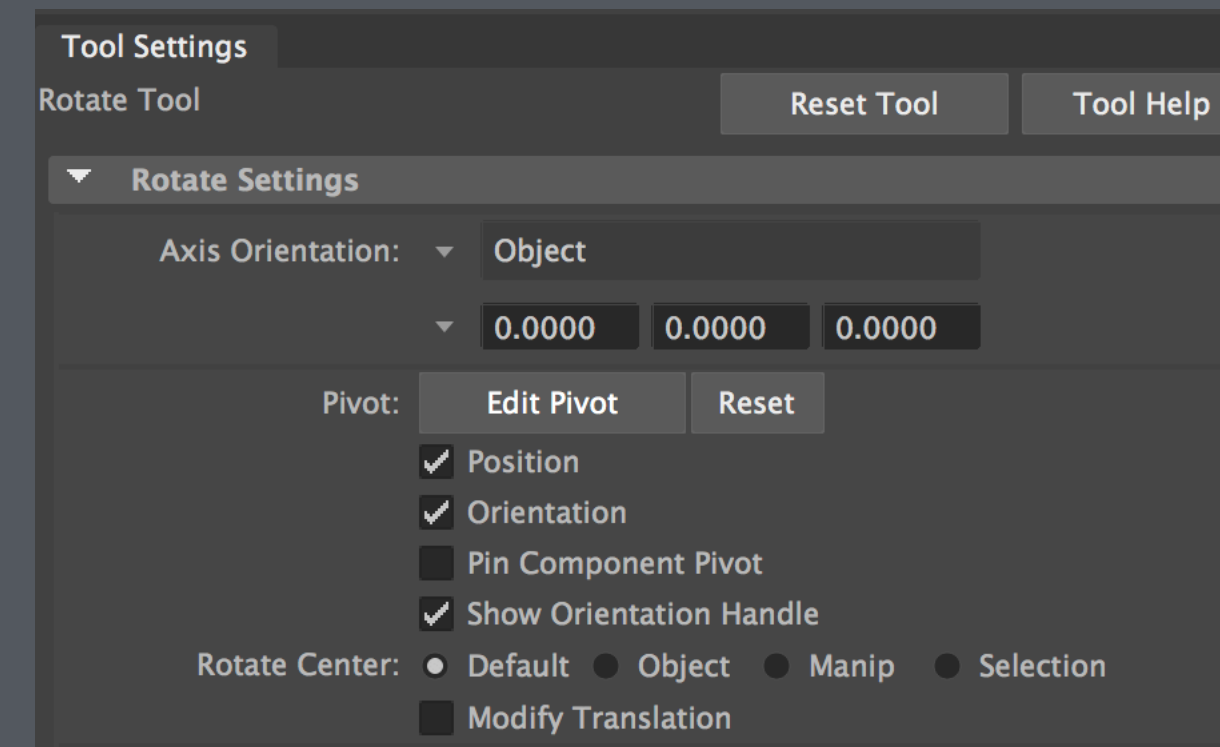Notice that the rotation axis is not aligned with the direction of the leg

Adjusting Local Rotation Axis Automatically
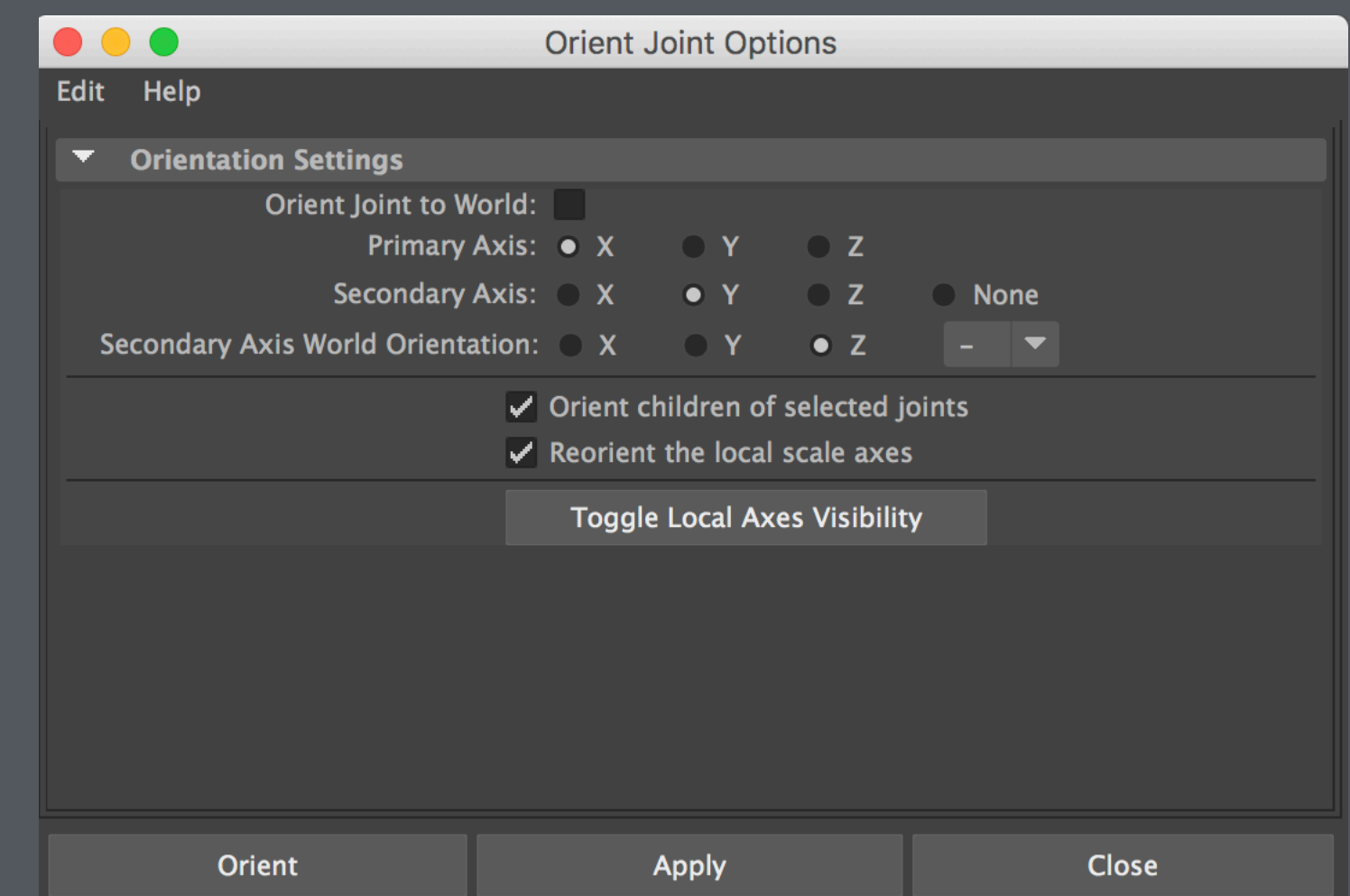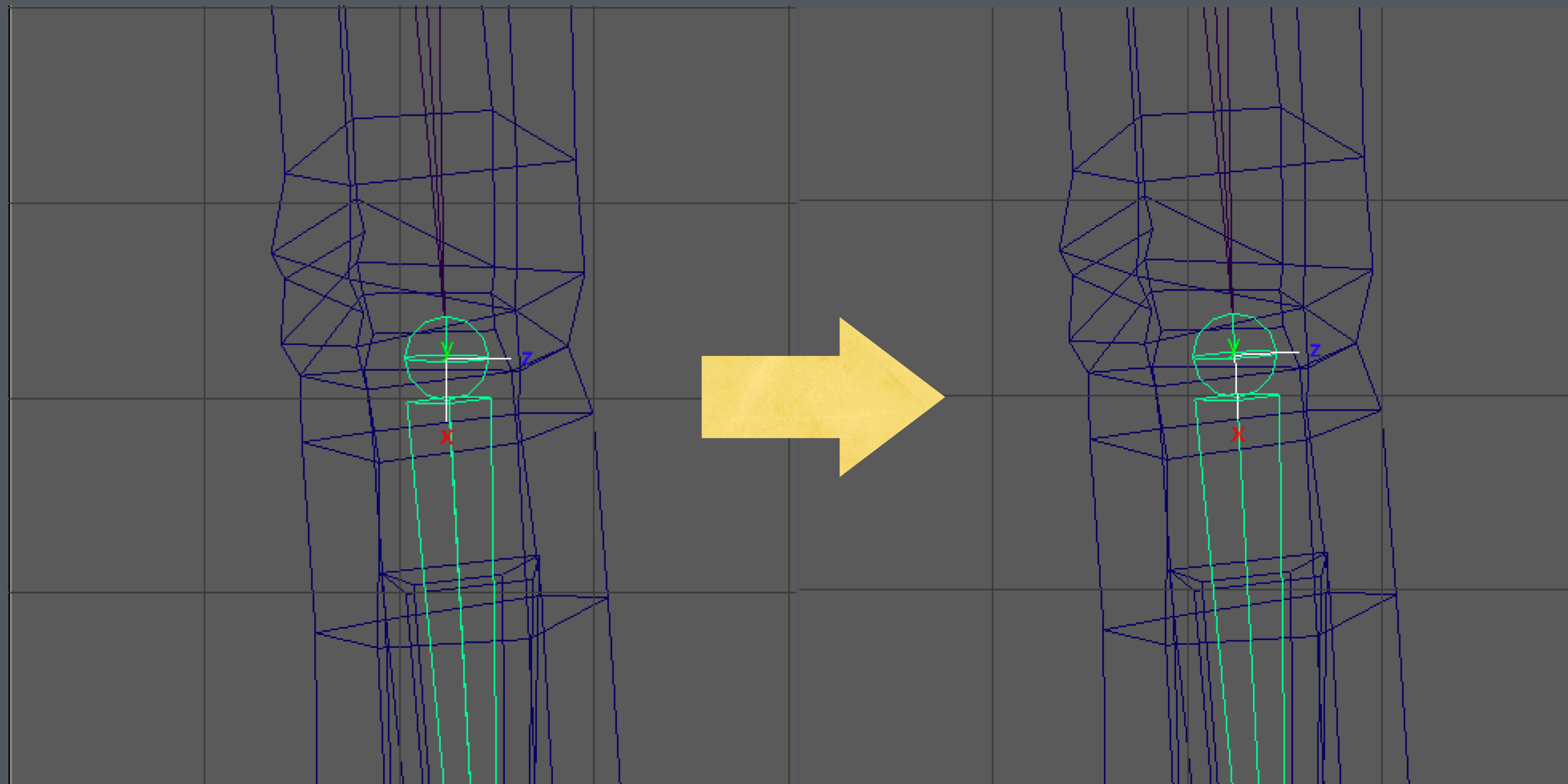
Adjusting Local Rotation Axis Manually

Change to Component mode, enable the selection mask for Local Rotation Axis

Tool Settings

Rotate Tool   Reset Tool   Tool Help

▼ **Rotate Settings**

Axis Orientation: Object

     0.0000   0.0000   0.0000

Pivot: **Edit Pivot**   Reset

☑ Position
☑ Orientation
☐ Pin Component Pivot
☑ Show Orientation Handle

Rotate Center: ● Default ○ Object ○ Manip ○ Selection

☐ Modify Translation

Use the Rotate Tool to adjust the Local Rotation Axis

Note: To rotate the Local Rotation Axis, the Axis Orientation cannot be set to Gimbal. Use Object or World
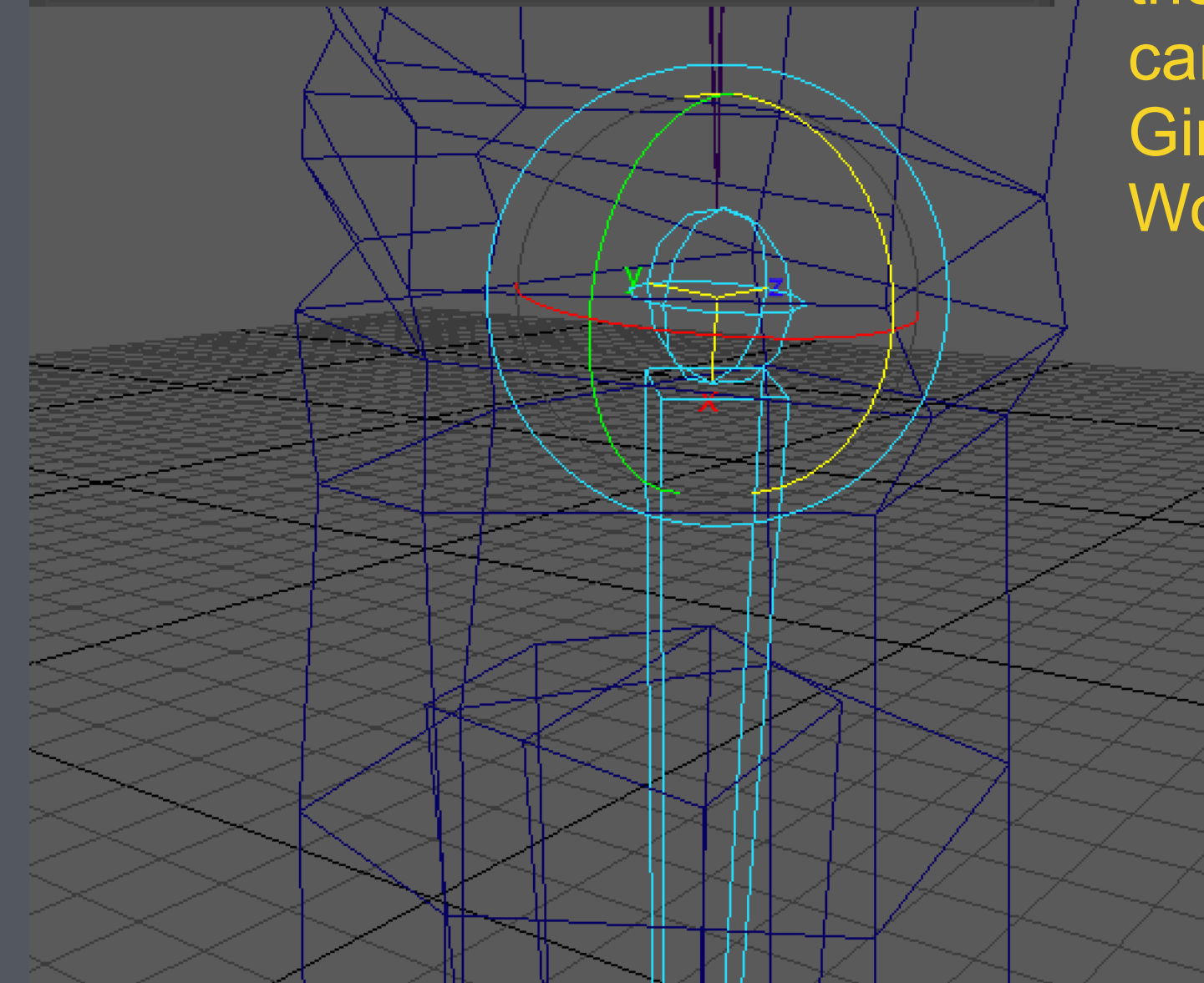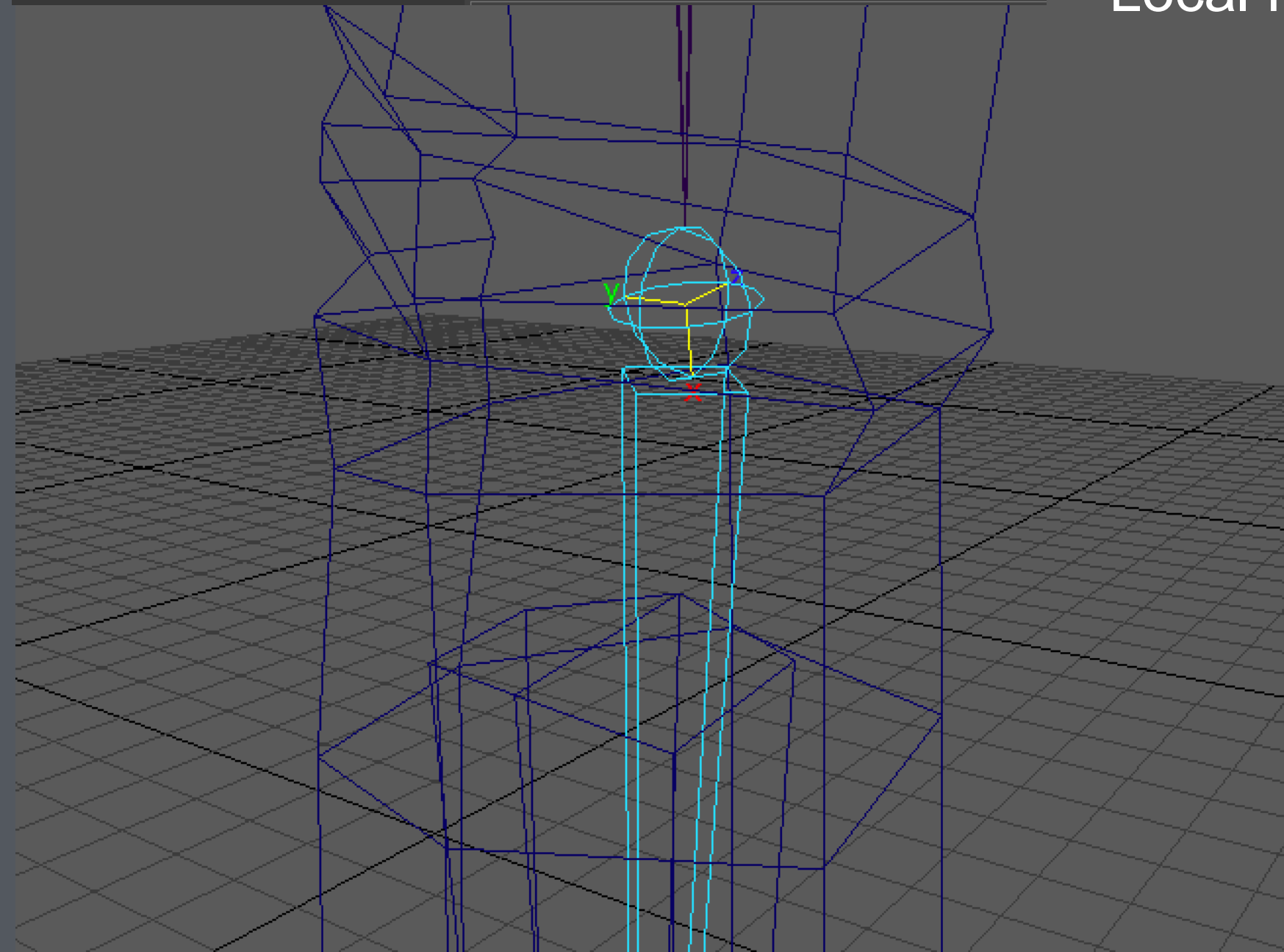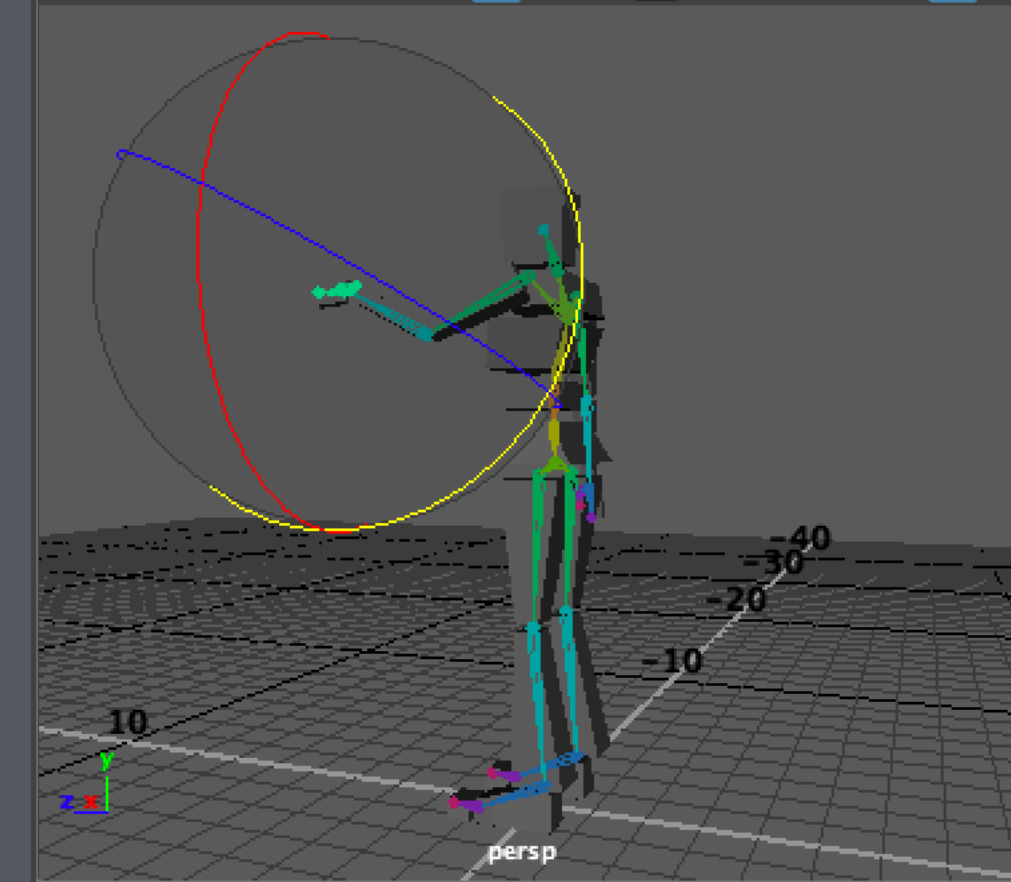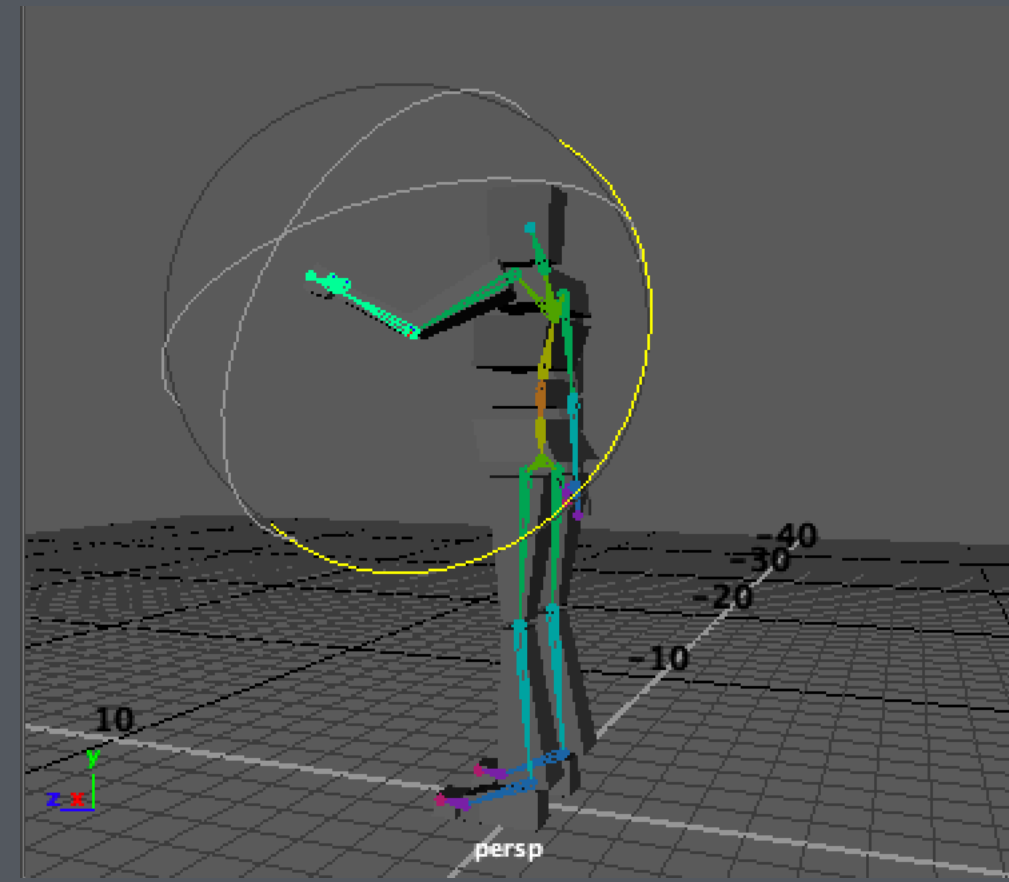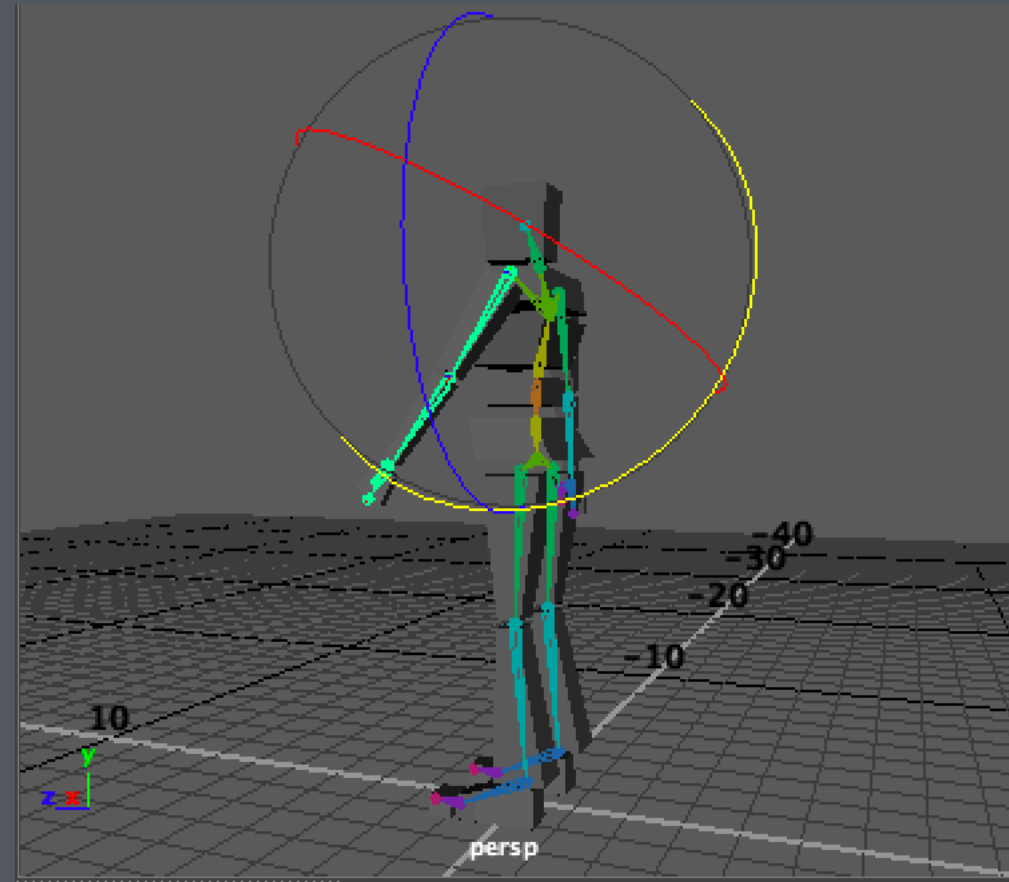
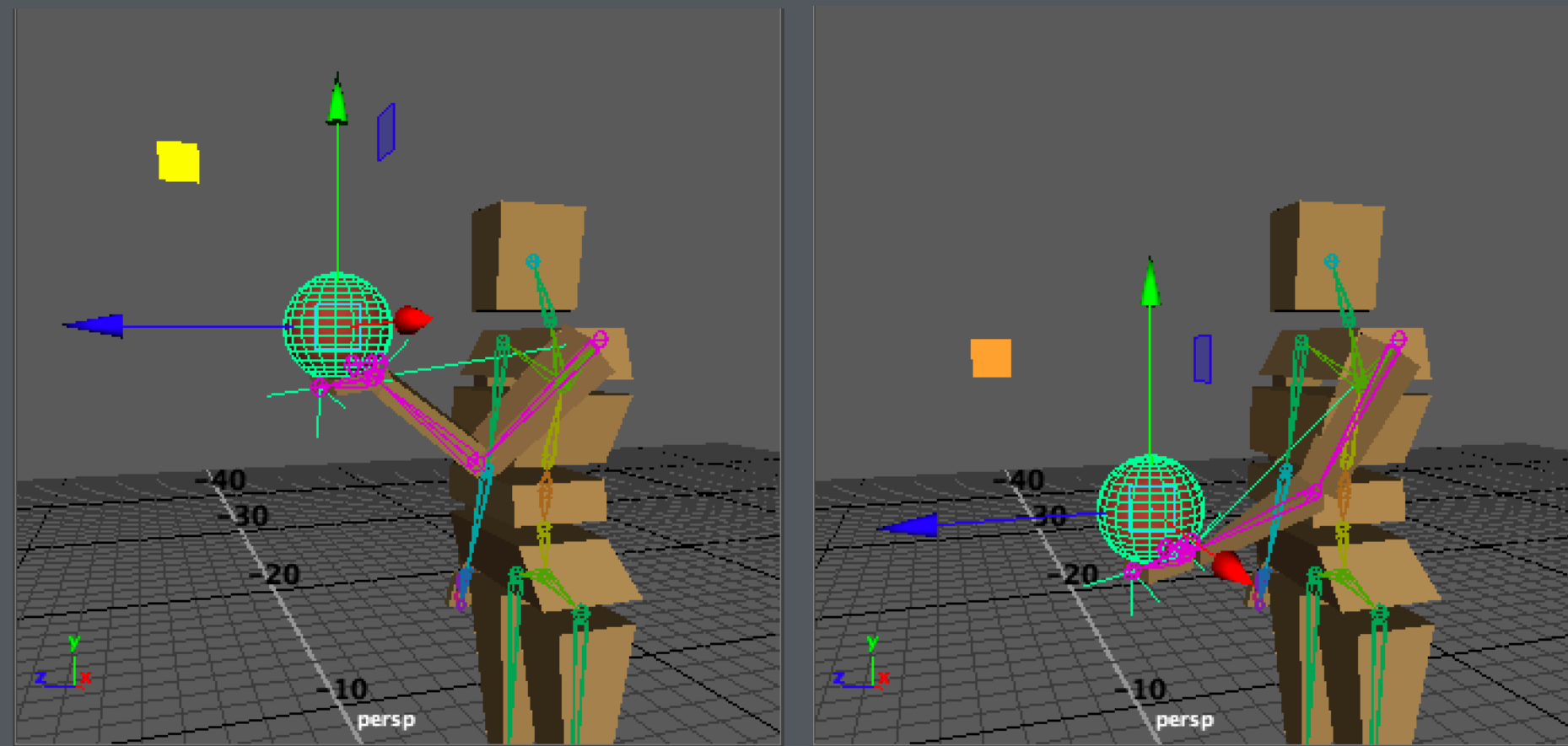# Forward Kinematics (FK)
vs.
# Inverse Kinematics (IK)

Forward Kinematics (FK)

A joint chain is, by default, a Forward Kinematics system.

In order to move the hand to a certain position, the animator must determine the joint angles of the shoulder, elbow and wrist joints.

Inverse Kinematics (IK)

With IK, an animator doesn't need to determine thee joint angles of the shoulder, elbow and the wrist. She would simply grab the IK handle and move the hand to the desired position, and let the 3D application compute the joint angles.
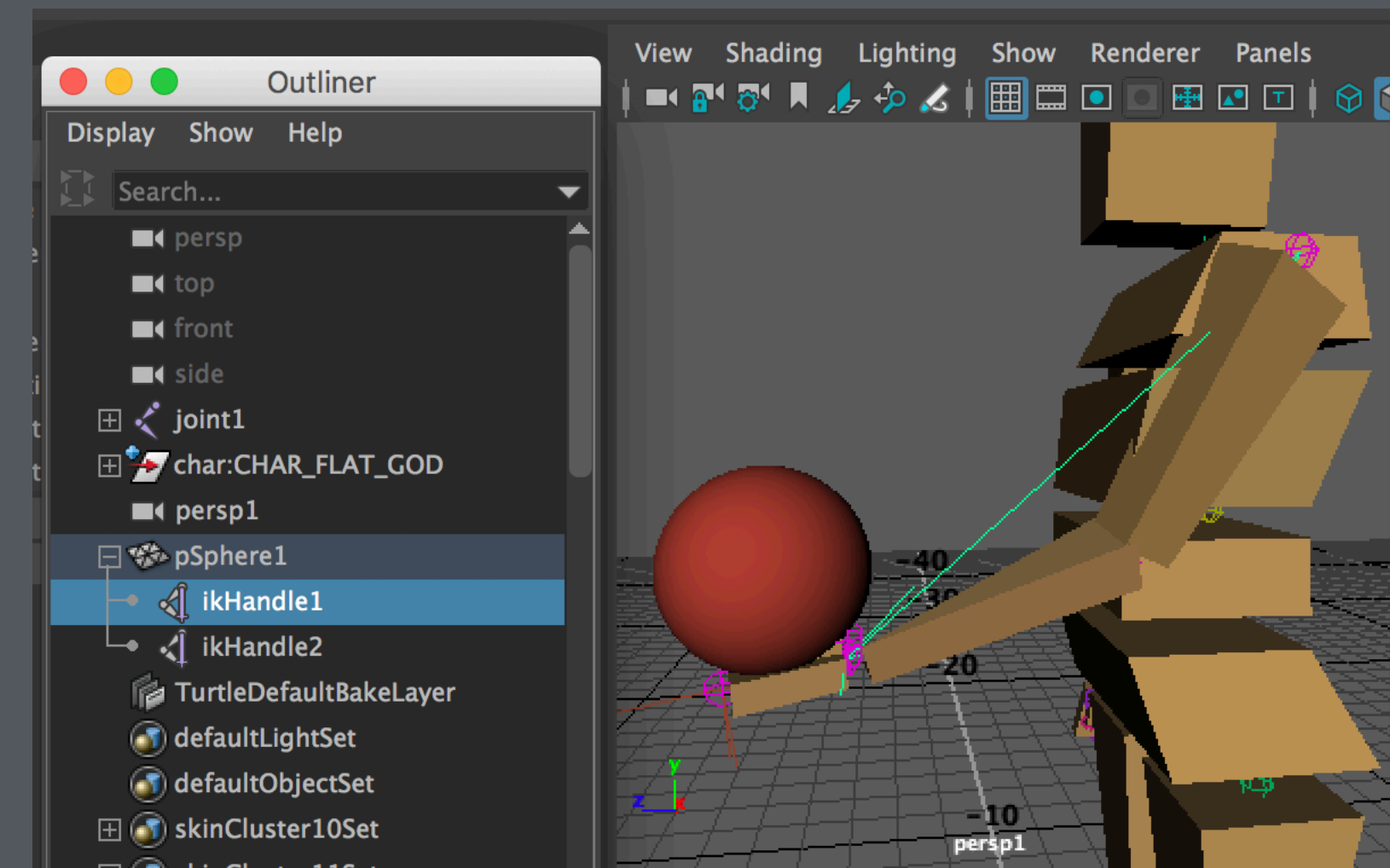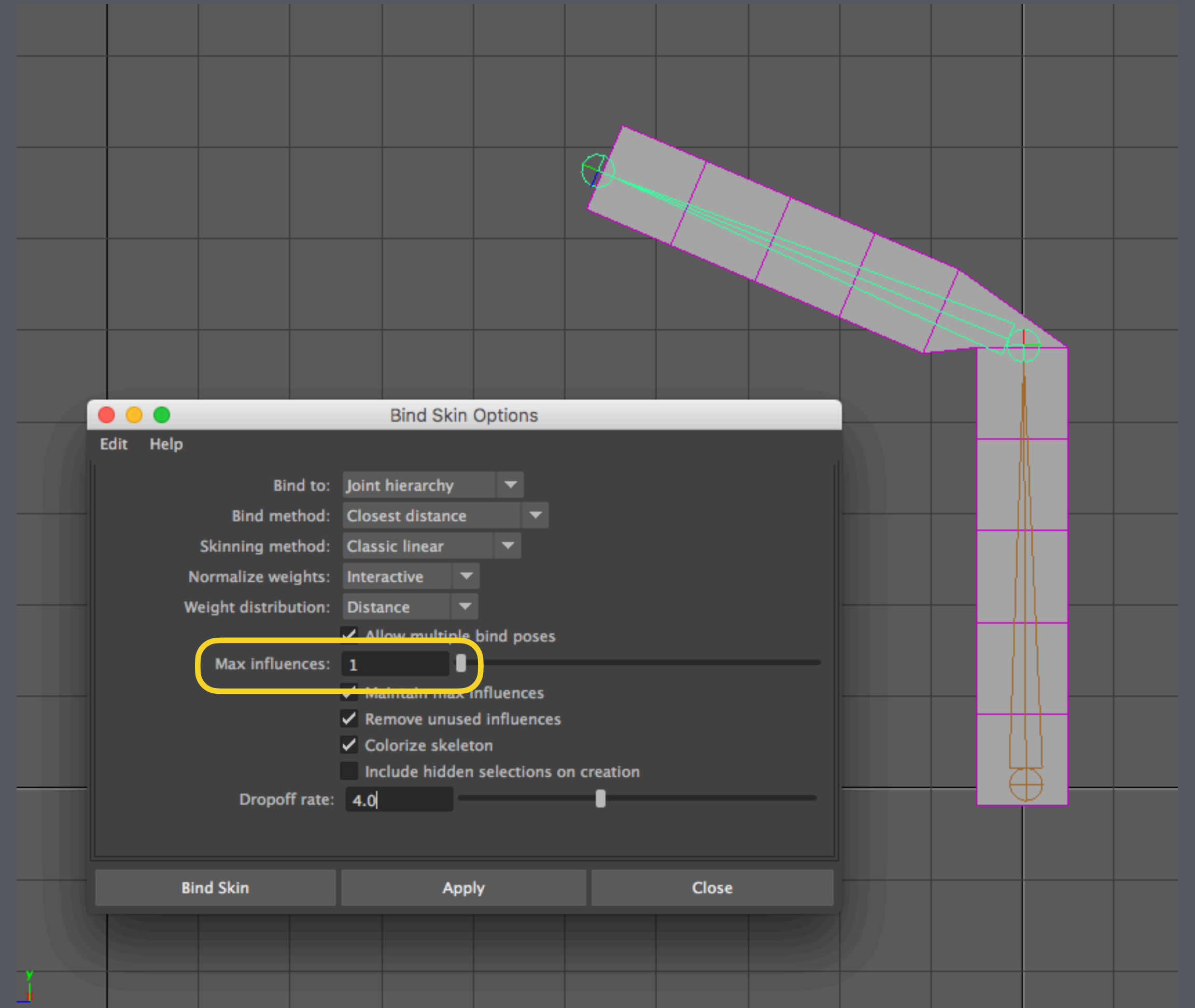
In the example above, the IK handle is parented to the ball, so that when the ball is moved, the hand follows.
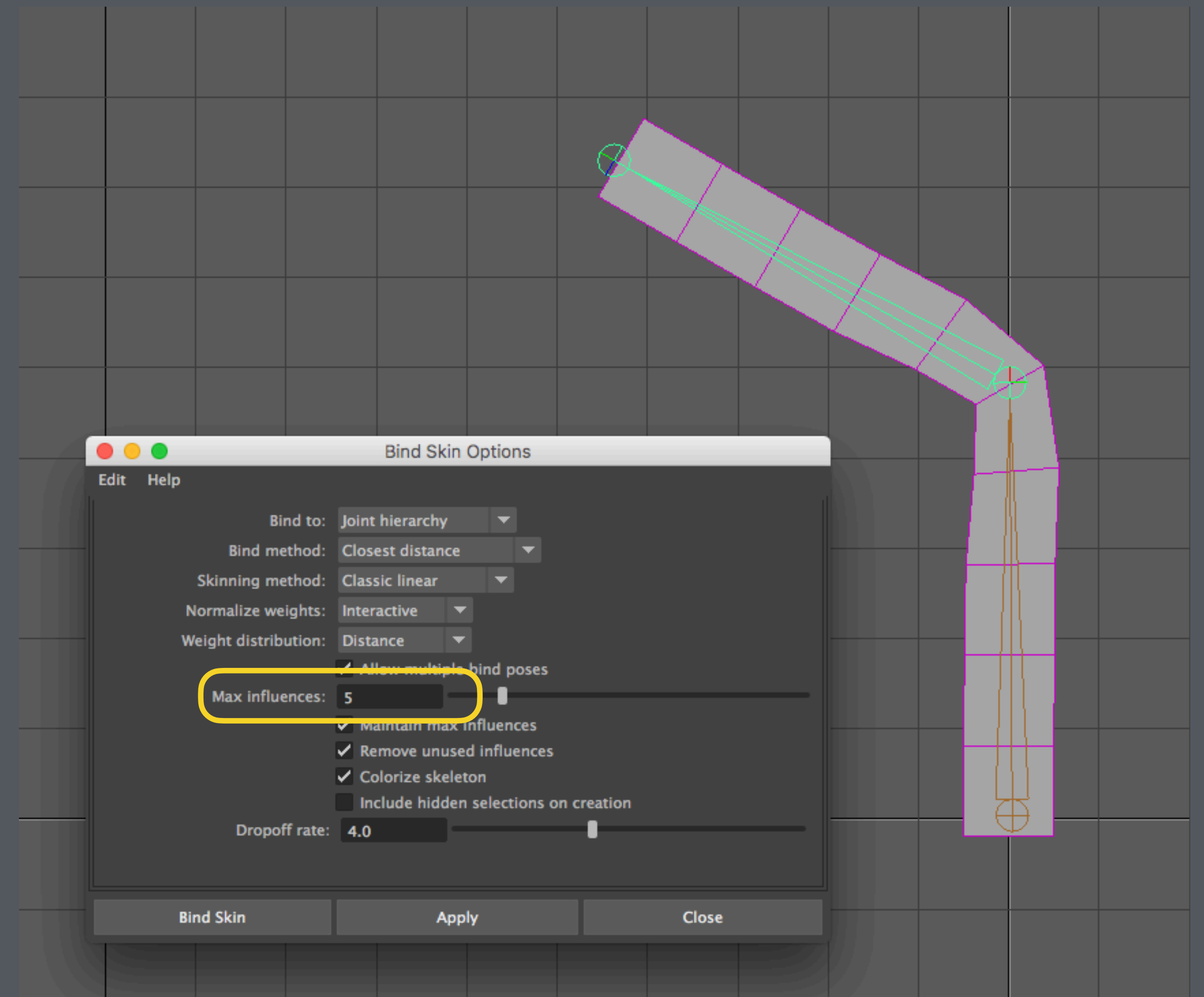
Skin Binding

Rigid Binding

- Each vertex of the geometry is controlled by exactly **one** joint.

- Simple

- Poor deformation

- Suitable for inorganic/rigid objects

Smooth Binding
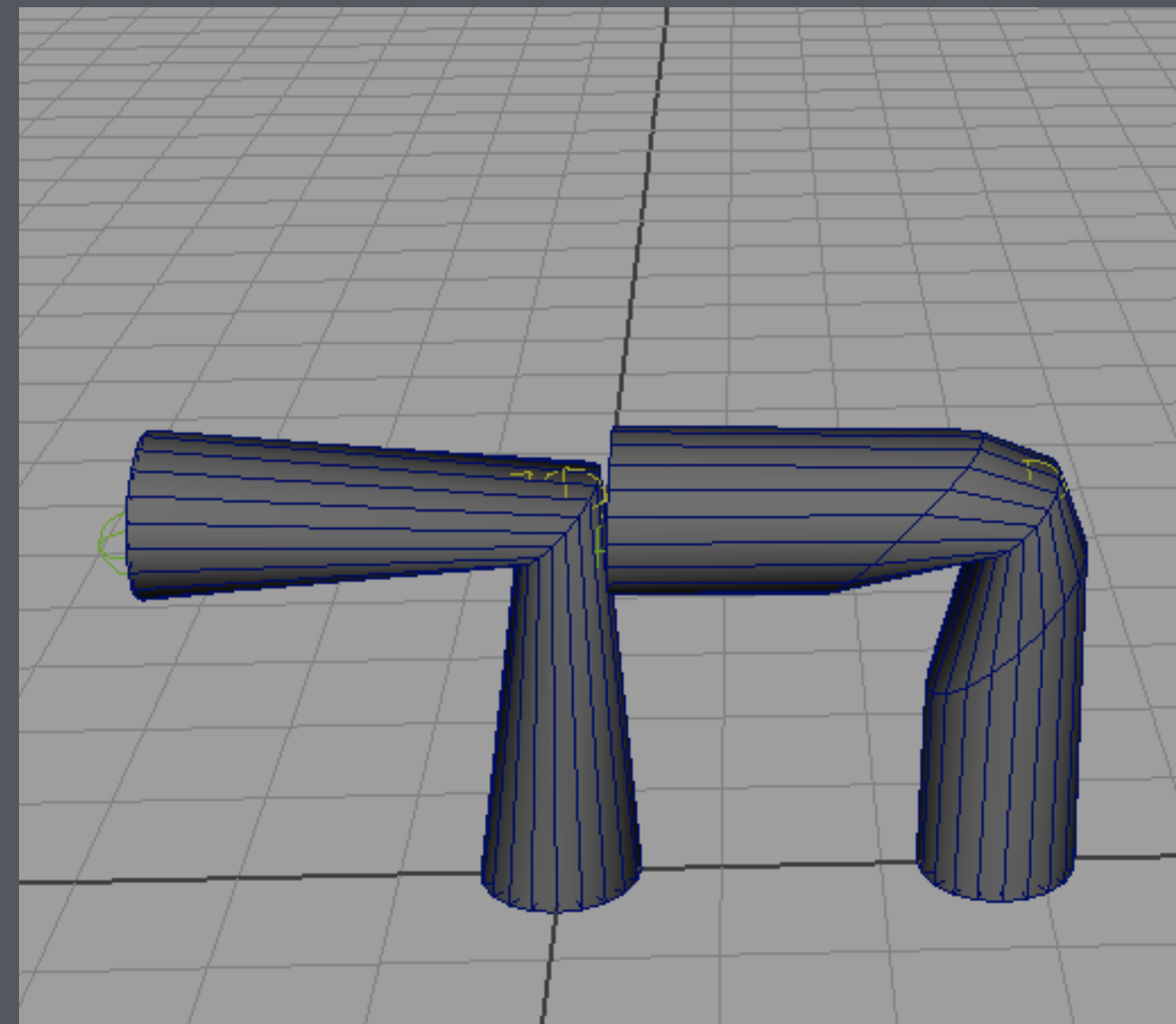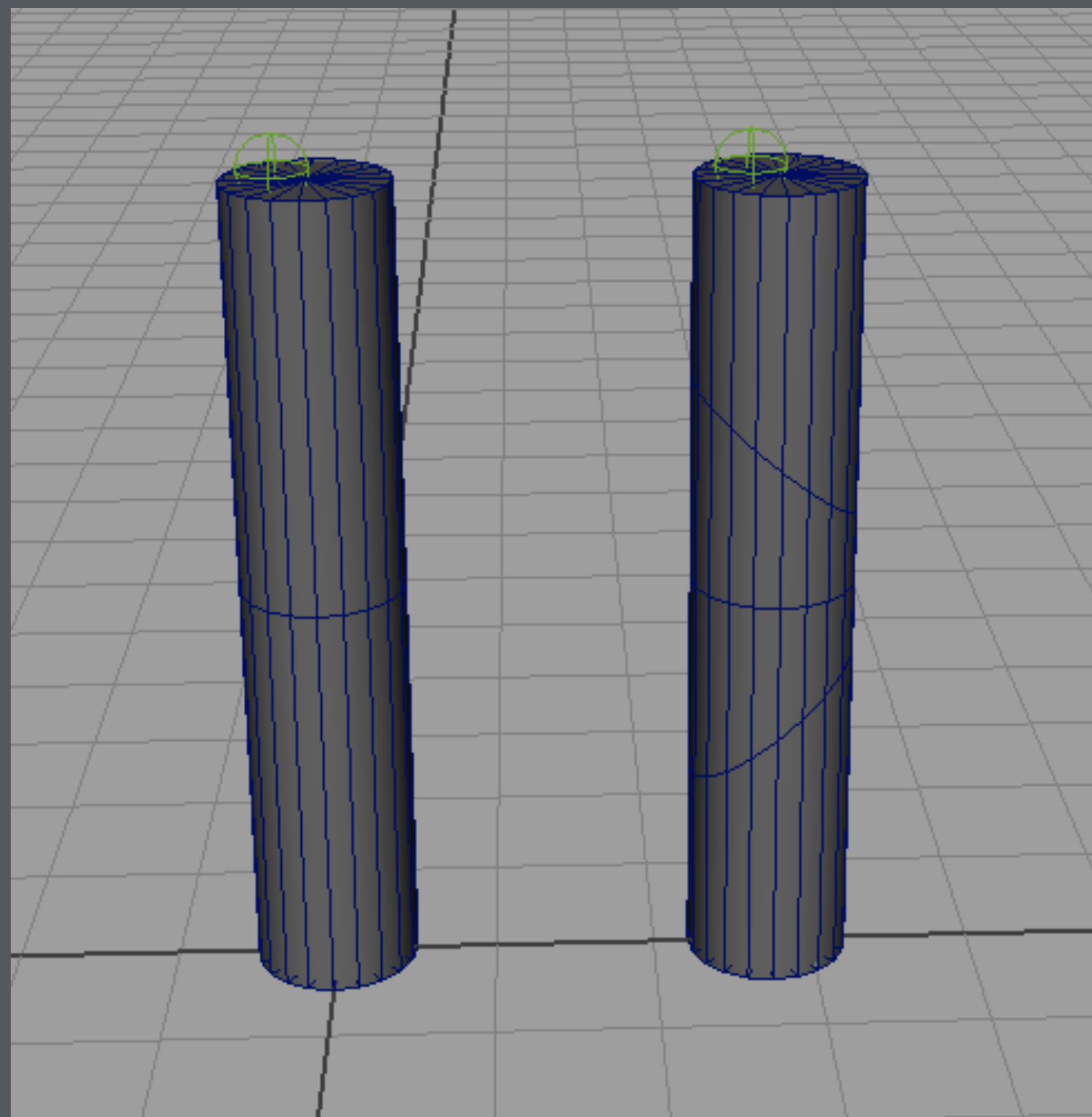
- Each vertex is influenced by more than one joint.

- Each joint has a *weighted* influence on a vertex.

- Suitable for organic objects

Topology

- Topology refers to the organisation of the edges and vertices of a geometry.
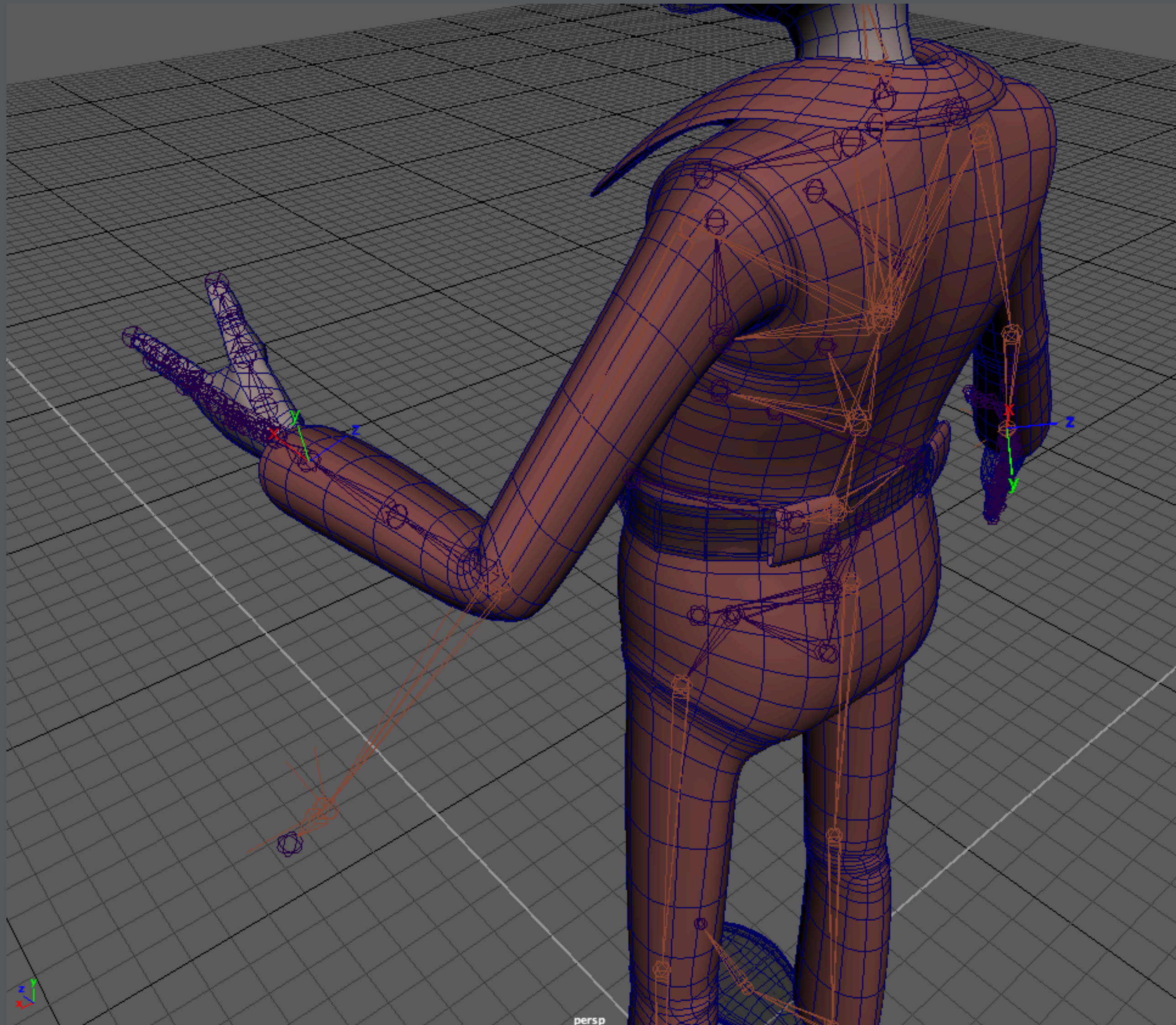
The two models look the same, but have different topologies.
They deformed differently even with the same skeleton setup.
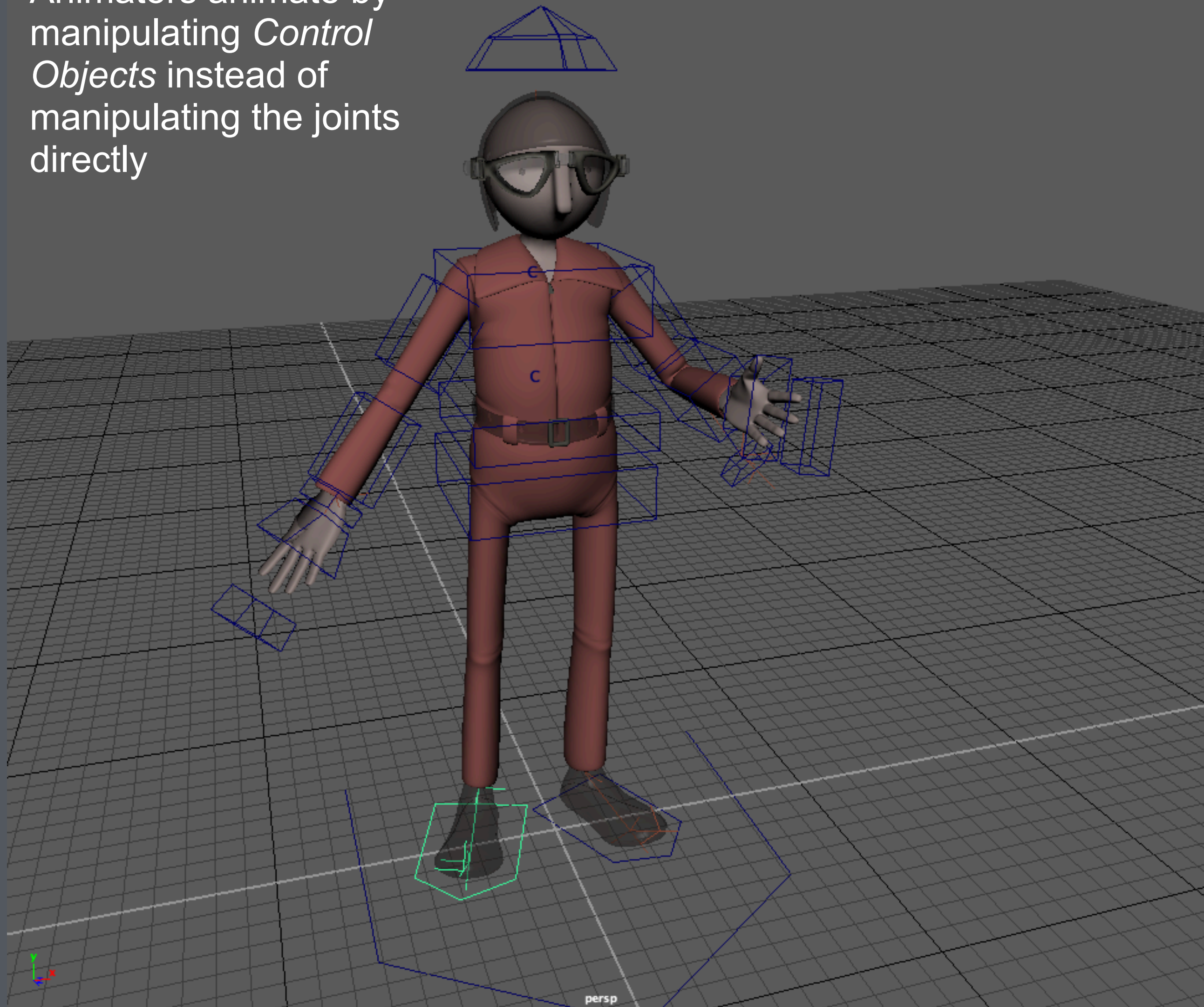
Two major processes of Rigging

- Deformation

- Automation

Deformation

- Creating a skeleton to allow bending and deformation as required by the animation

- Making sure the topology of the geometry meets the requirements for deformation. E.g. Edge loops near a joint to maintain volume when the geometry is bent

Automation

Animators animate by manipulating *Control Objects* instead of manipulating the joints directly
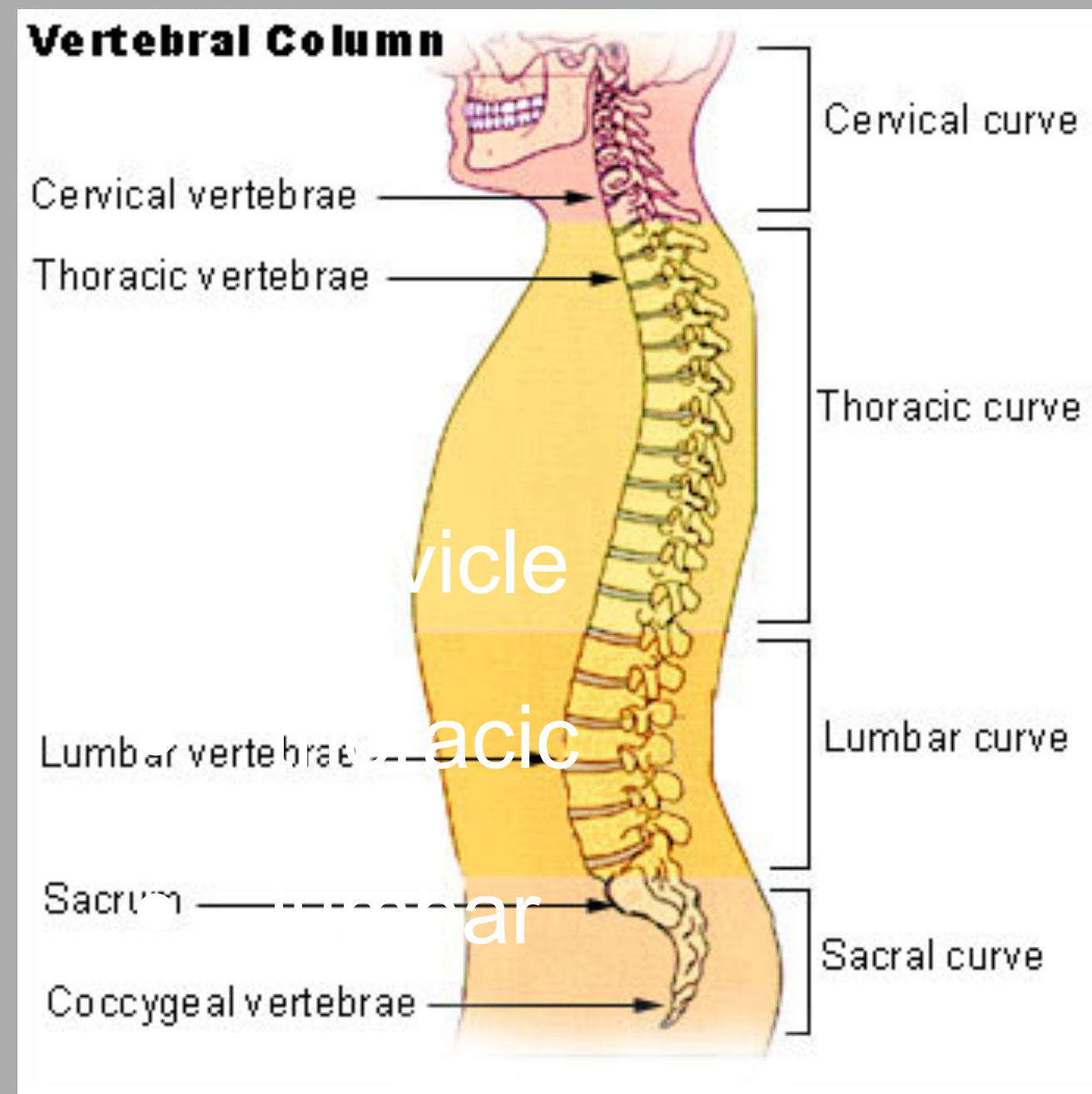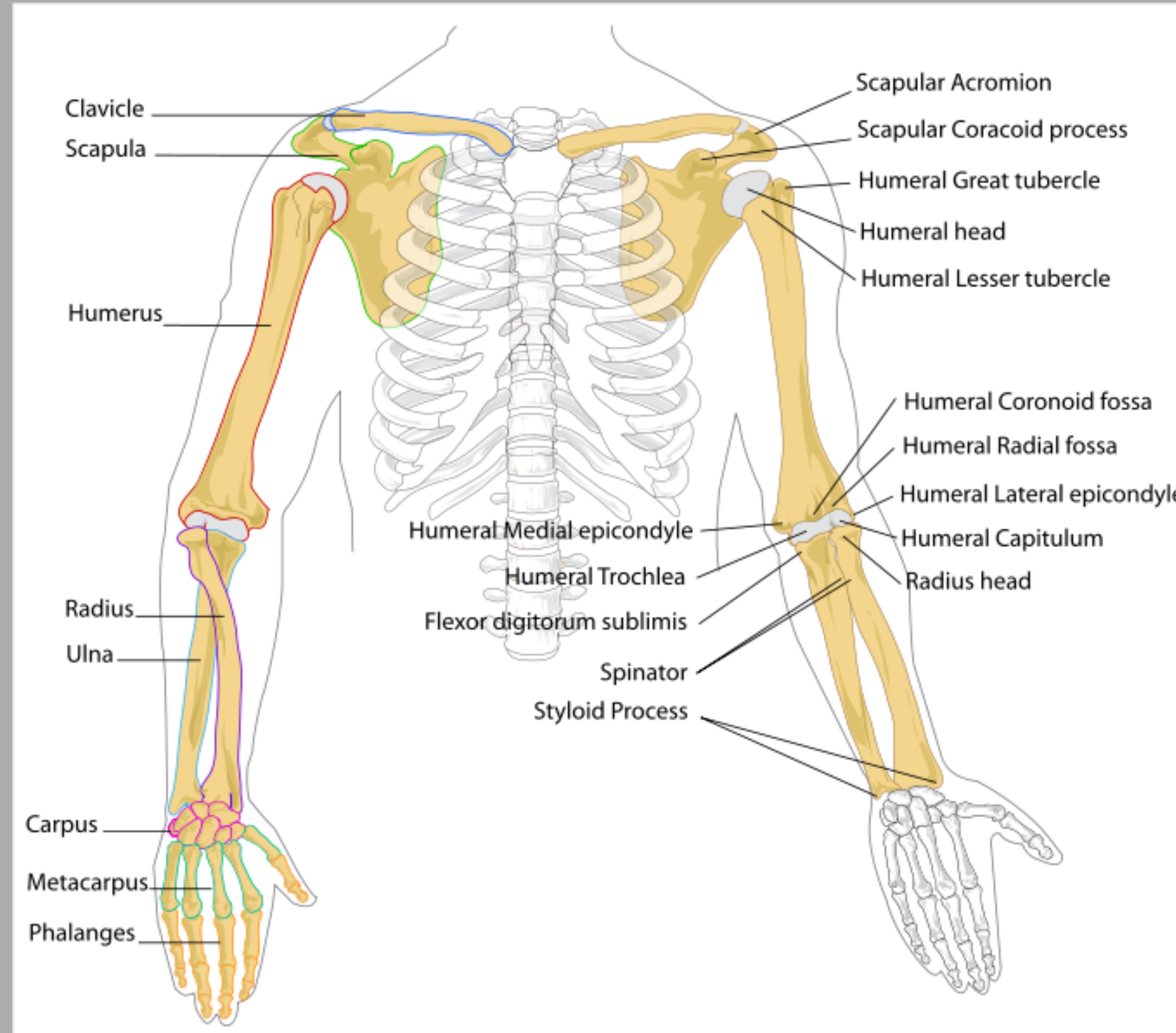
- Animating joints directly can be tedious, when there are hundreds of them in a character

- Therefore we need mechanisms to automate the movements of multiple joints by simply animating a few simple objects or attributes
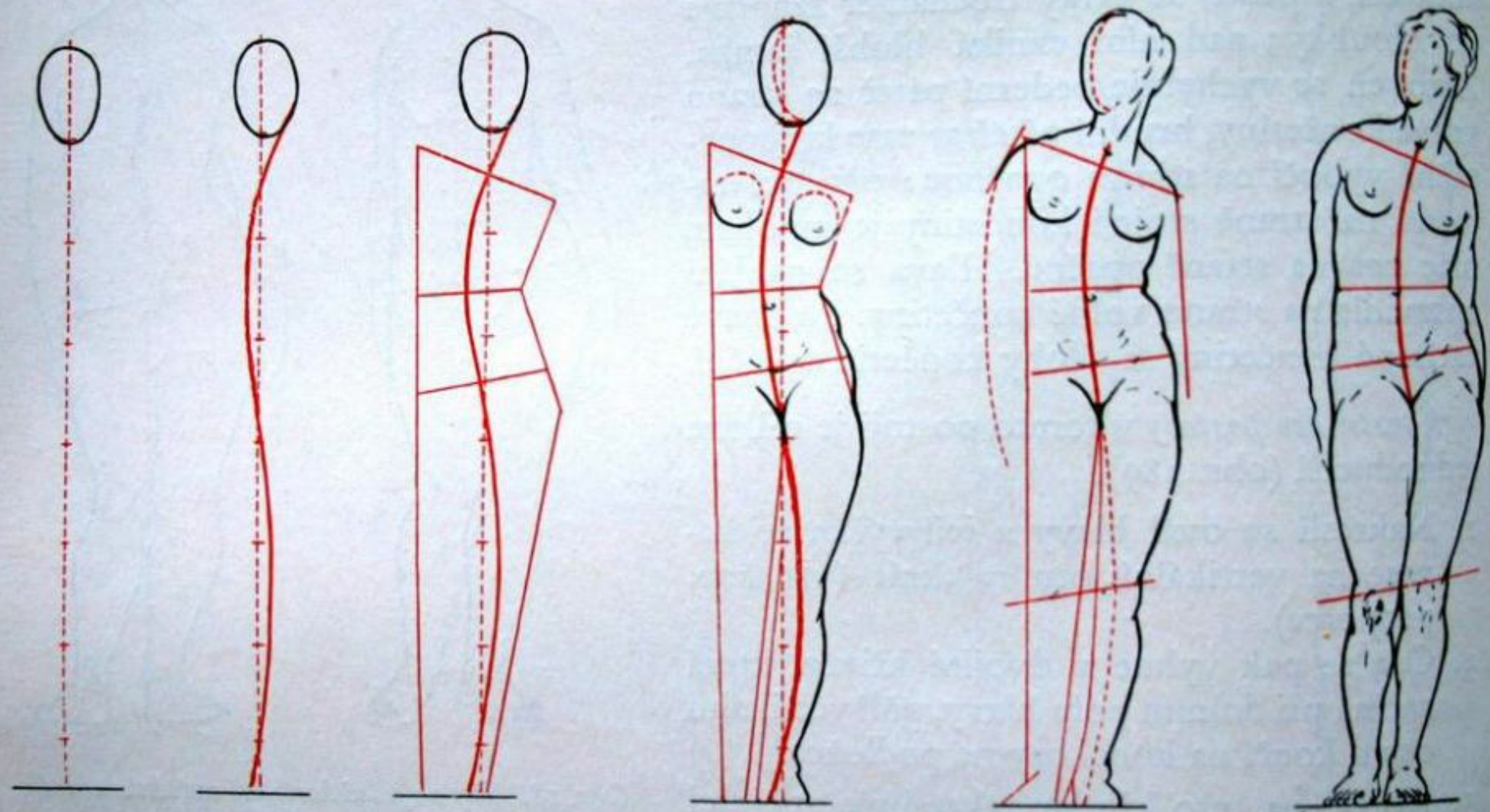
Anatomical references

sections of the spine

clavicle

Obr. 189. Konstrukce ženské postavy při stoji na jedné noze. (Podle Bradburyho.)