CSC 240 Computer Graphics
Video 13: Hierarchical Models

Nick Howe
Smith College

Some slides & content courtesy Sara Mathieson & Eitan Mendelowitz

Thought Exercise

How many items are in this scene? How would you group them?

Hierarchical Models

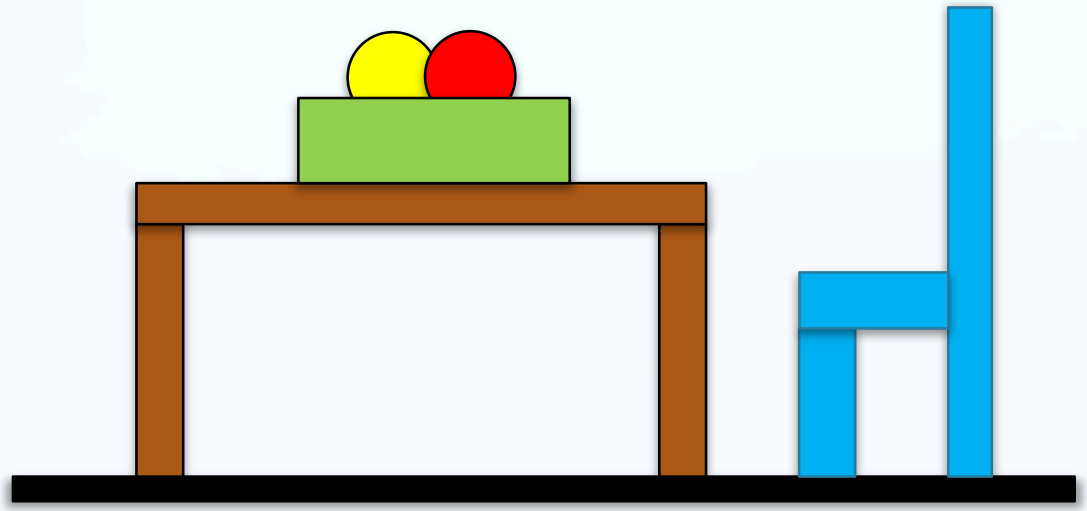
Hierarchical models organize a scene into parts and subparts.

- Useful for keeping track of all the pieces
- Subpart position is measured relative to parent
- Move parent ⇒ move all subparts with it

https://www.deviantart.com/skyriderr/art/vanellope-3D-Model-animation-test-606840588

https://polycount.com/discussion/204764/starting-a-new-project-tiny-mech

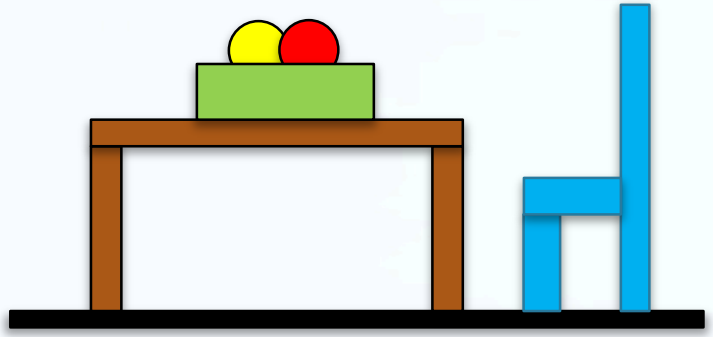
How to Group

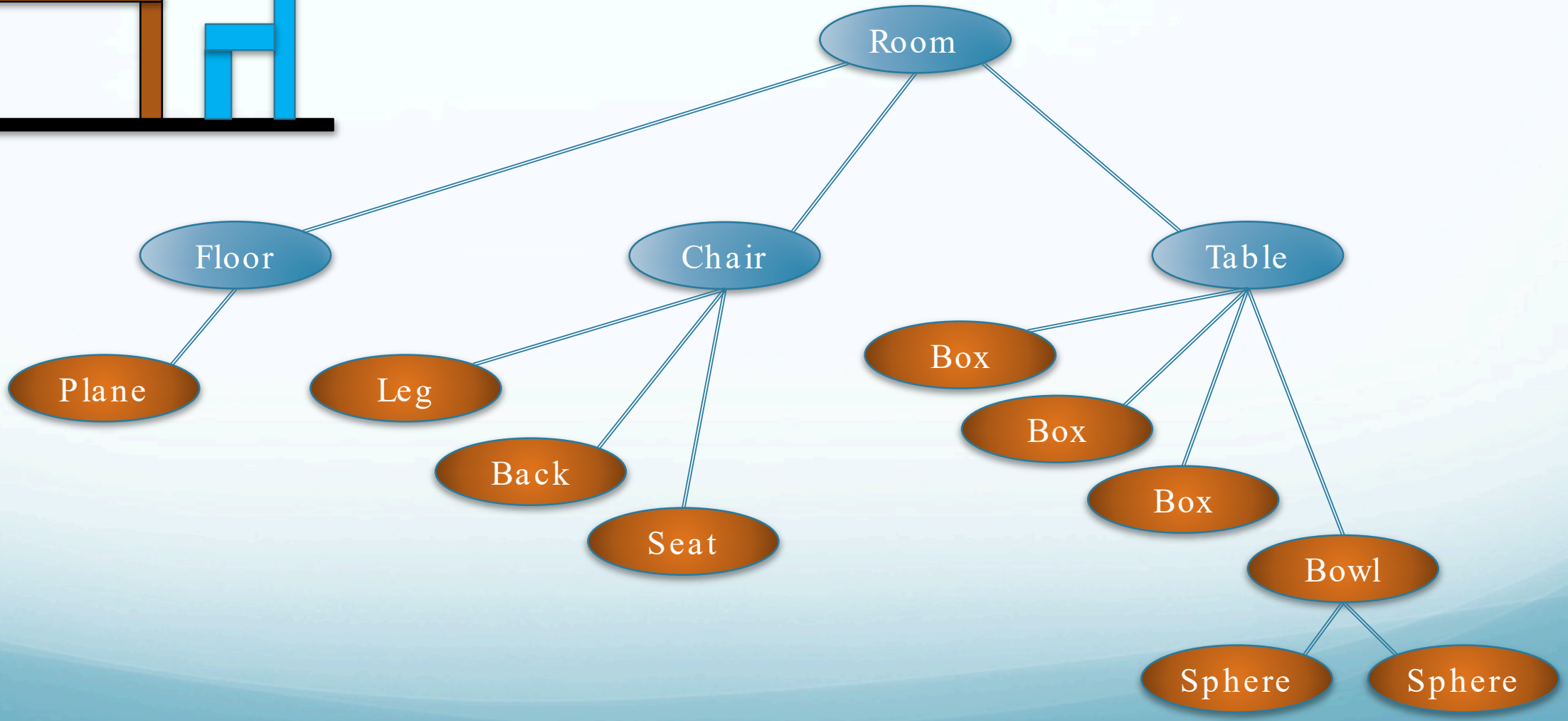


Scene Organization:

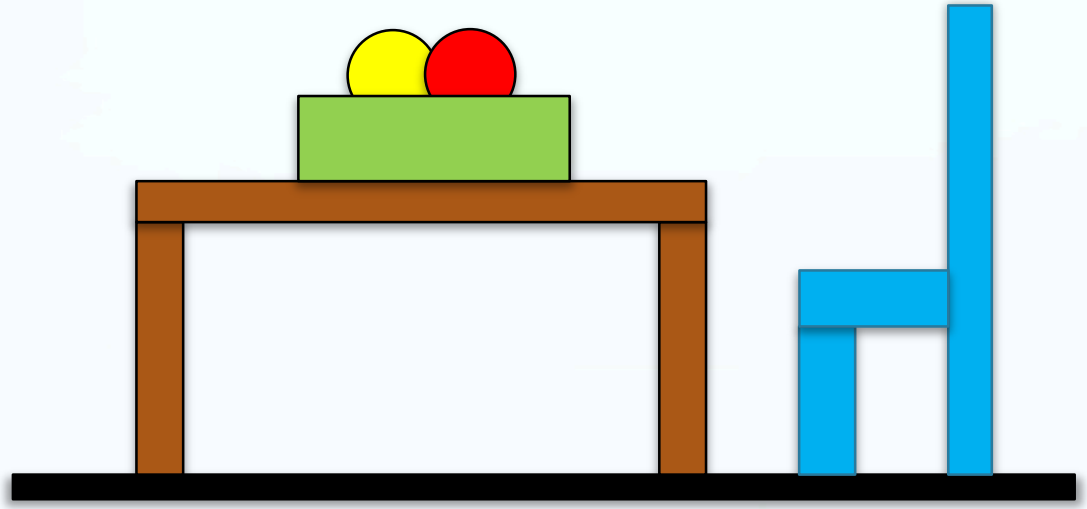
- Room
  - Floor
    - Plane
  - Chair
    - Leg
    - Seat
    - Back
  - Table
    - Bowl
      - Sphere
      - Sphere
    - Box
    - Box
    - Box

Alternate Tree





Coding with Three.js



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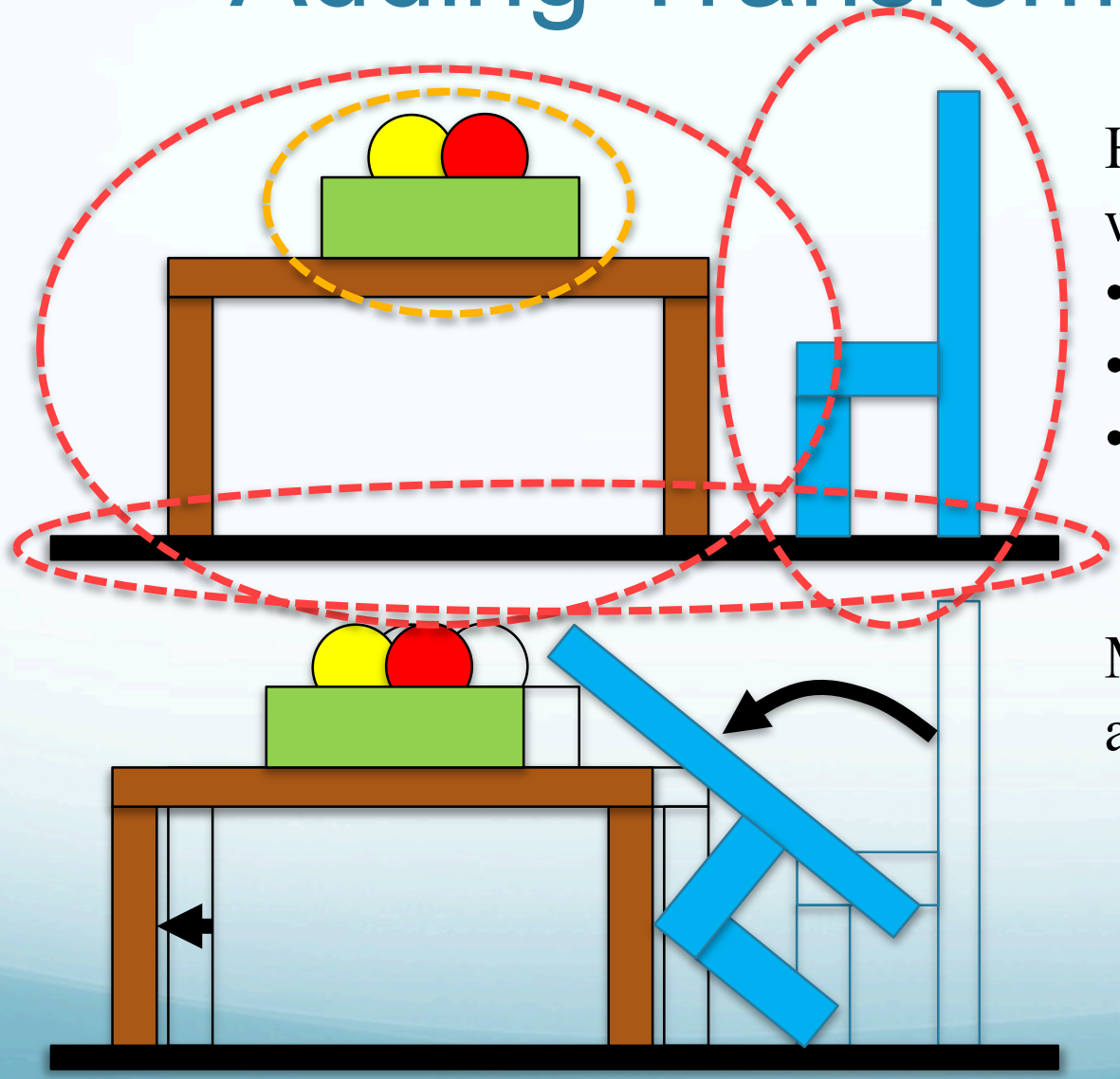
```
floor = new THREE.Object3D();
scene.add(floor);
    plane = new THREE.Mesh(planeGeom,planeMat);
    floor.add(plane)
table = new THREE.Object3D();
scene.add(table);
    bowl = new THREE.Mesh(bowlGeom,bowlMat);
    table.add(bowl);
    // …
```

Adding Transformations



How do groups help us with transformations?

- Ten meshes
- One subgroup
- Three groups

Moving a group affects all its components

```
table.position.x -= 15;
chair.rotation.z += 1.6;
```

Questions

PAUSE NOW & ANSWER

1. What principles guide the grouping of objects into a hierarchy?

   Relatedness is one motivation. Shared motion is another.

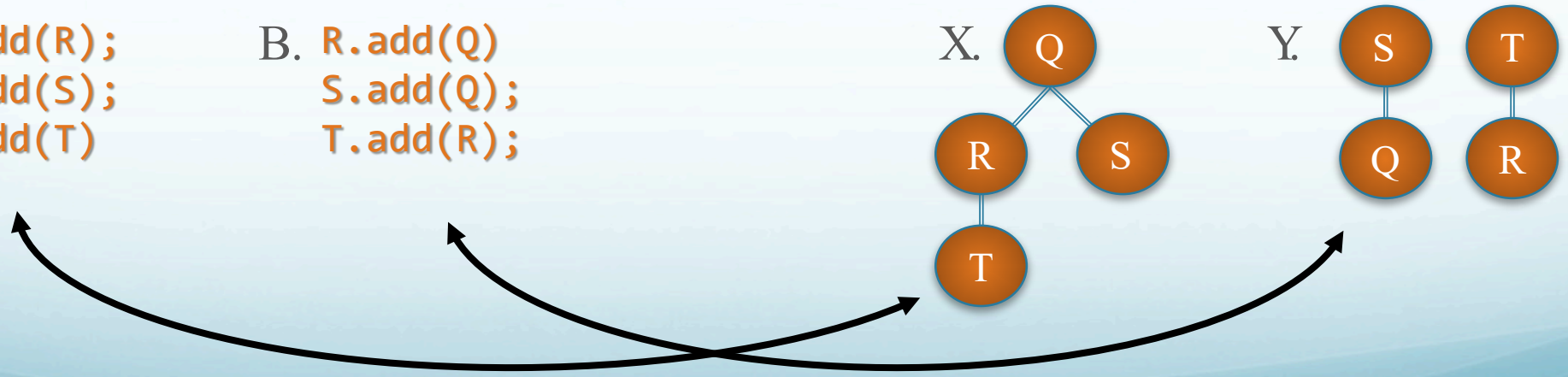
2. What Three.js class is used to represent an object grouping?

   Object3D

3. Match the code to the picture.

A.
```
Q.add(R);
Q.add(S);
R.add(T)
```

B.
```
R.add(Q)
S.add(Q);
T.add(R);
```



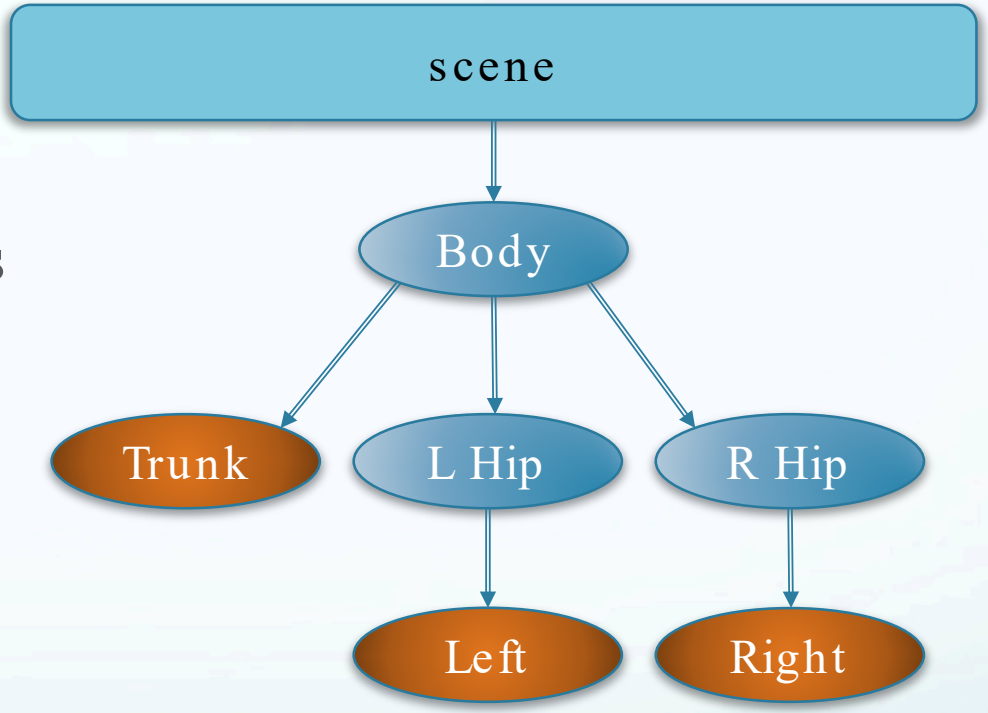
Object Hierarchy

Demo of programming with an object hierarchy

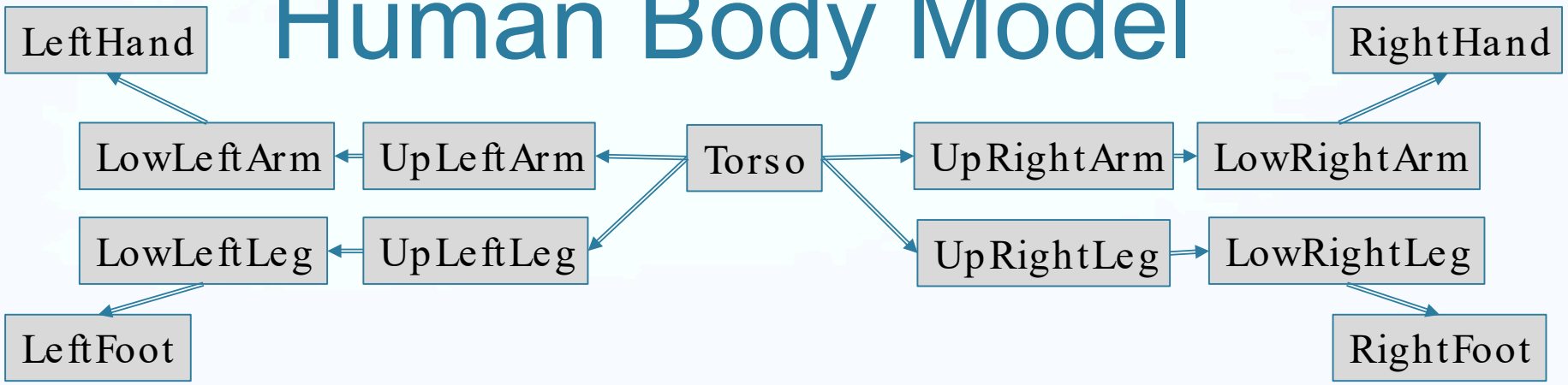
- Motion of `body` object carries all pieces (trunk + both limbs)
- Why do we need `lhip` and `rhip`?
  - Rotation point for the limbs
  - Without it, cube would rotate around its center

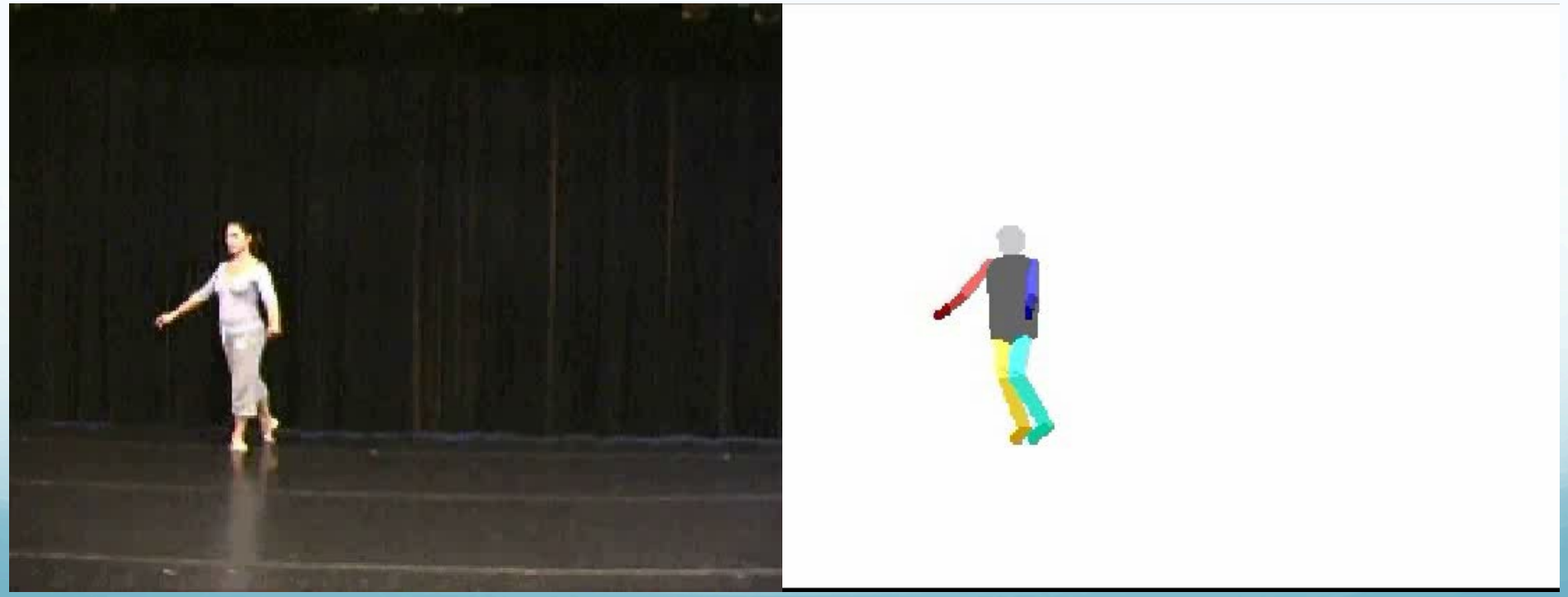
$$C_{Left} = M_{Body} M_{LHip} M_{Left}$$

$$C_{Left} = M_{Body} T_{LHip} R_{LHip} T_{Left} R_{Left}$$



Human Body Model

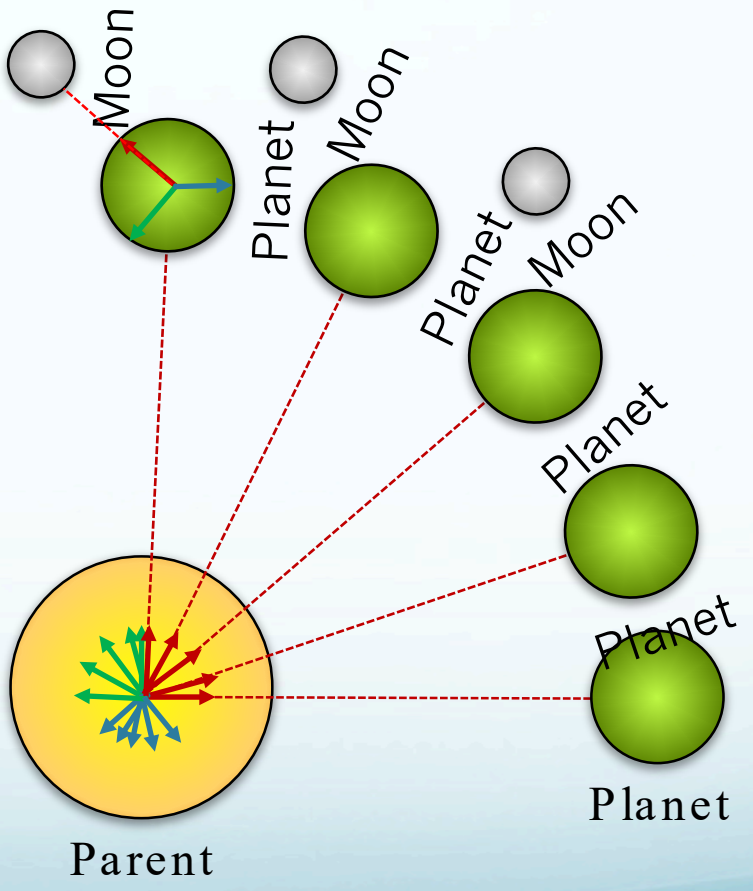




Homework Preview

Use hierarchical structure

- Coordinate system for planet centered on parent
- Planet is offset relative to this
- Rotate coordinates to follow orbit
- Moons move with planet
- Similar strategy for moon orbit



Questions

PAUSE NOW & ANSWER

1. What are the advantages of grouping objects together as children of a virtual object?

   They can all be moved and manipulated as a single entity.

2. Besides grouping, what is another reason for having a virtual object in the scene?

   We can apply a rotation to a translated piece.

Review

After watching this video you should be able to…

- Propose sensible groupings of objects and object parts
- Build scenes as hierarchies of Object3D
- Employ object hierarchies to efficiently produce a desired animation

Music: https://www.bensound.com