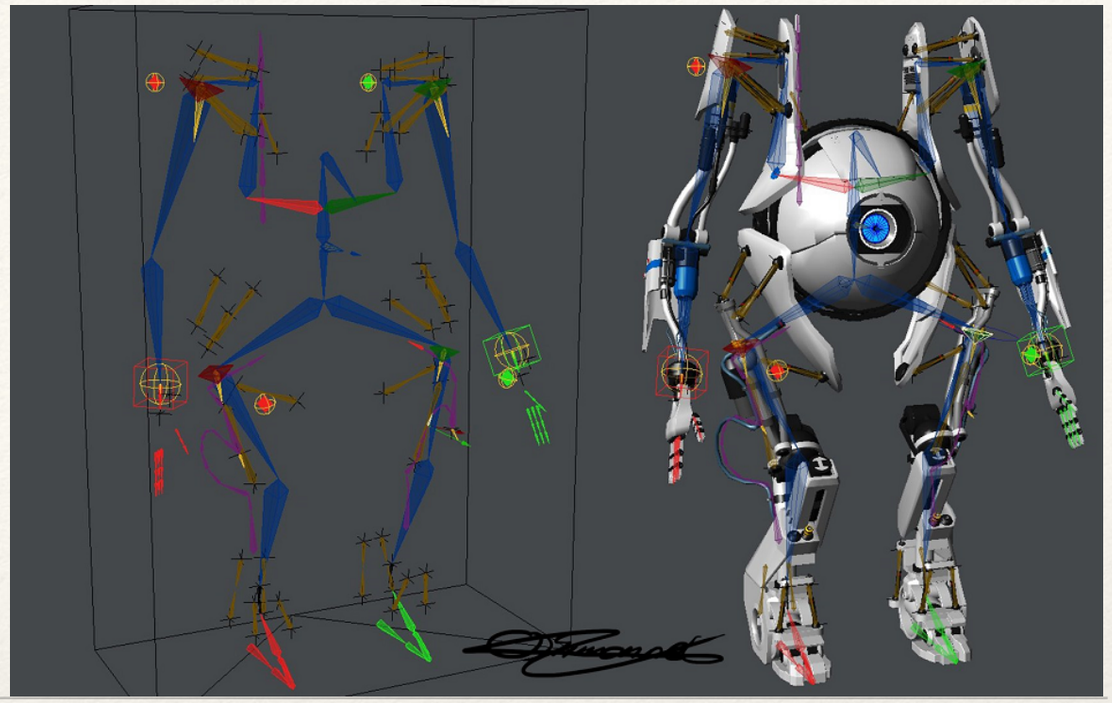
Dr. Sarah Abraham
University of Texas at Austin
Computer Science Department



Scene Hierarchies

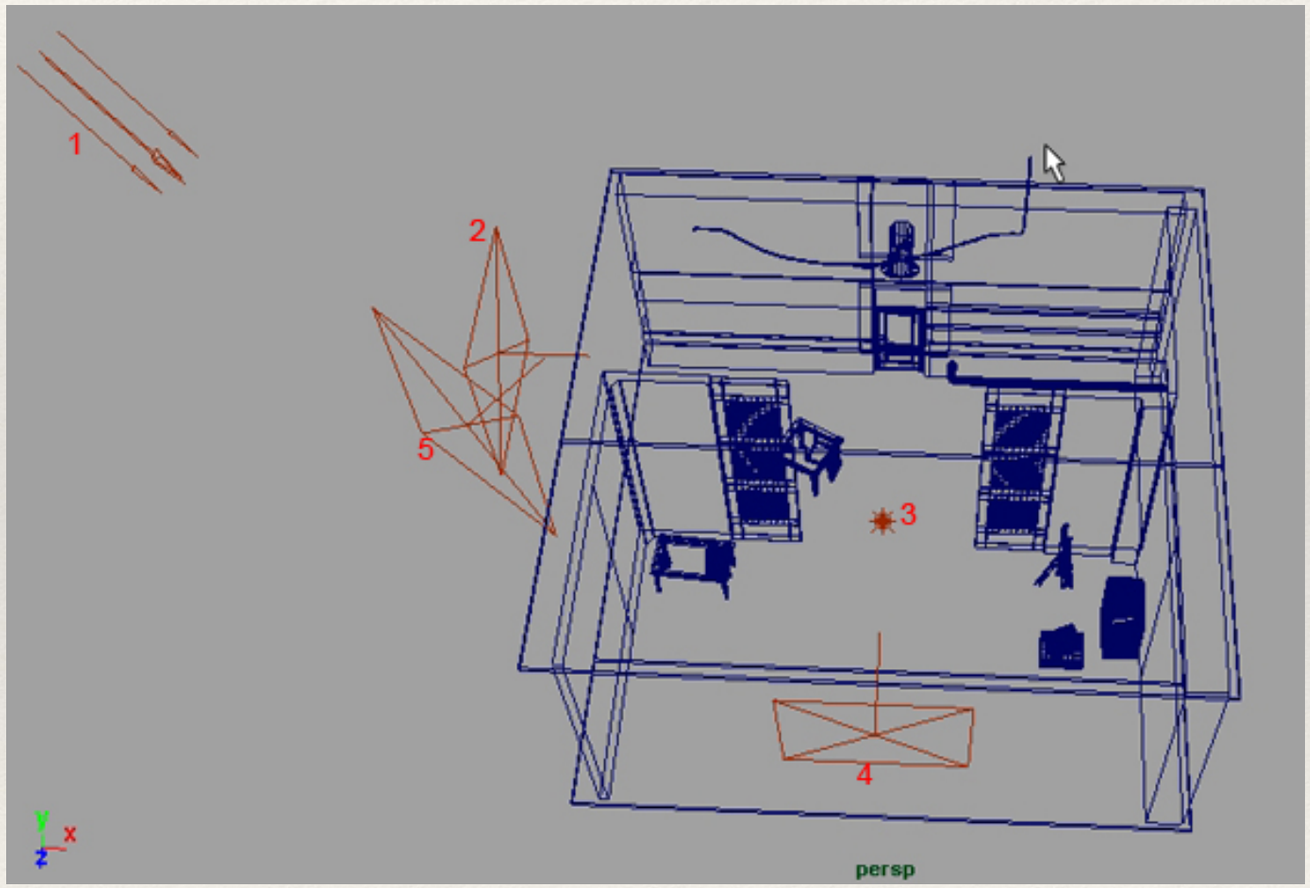
Elements of Graphics
CS324e

What is a Scene?

- A space we want to depict (render) on our screen
- Can be 3D or 2D
- What can a scene include?
  - Objects
  - Lights
  - Camera

Scenes in Games and Movies

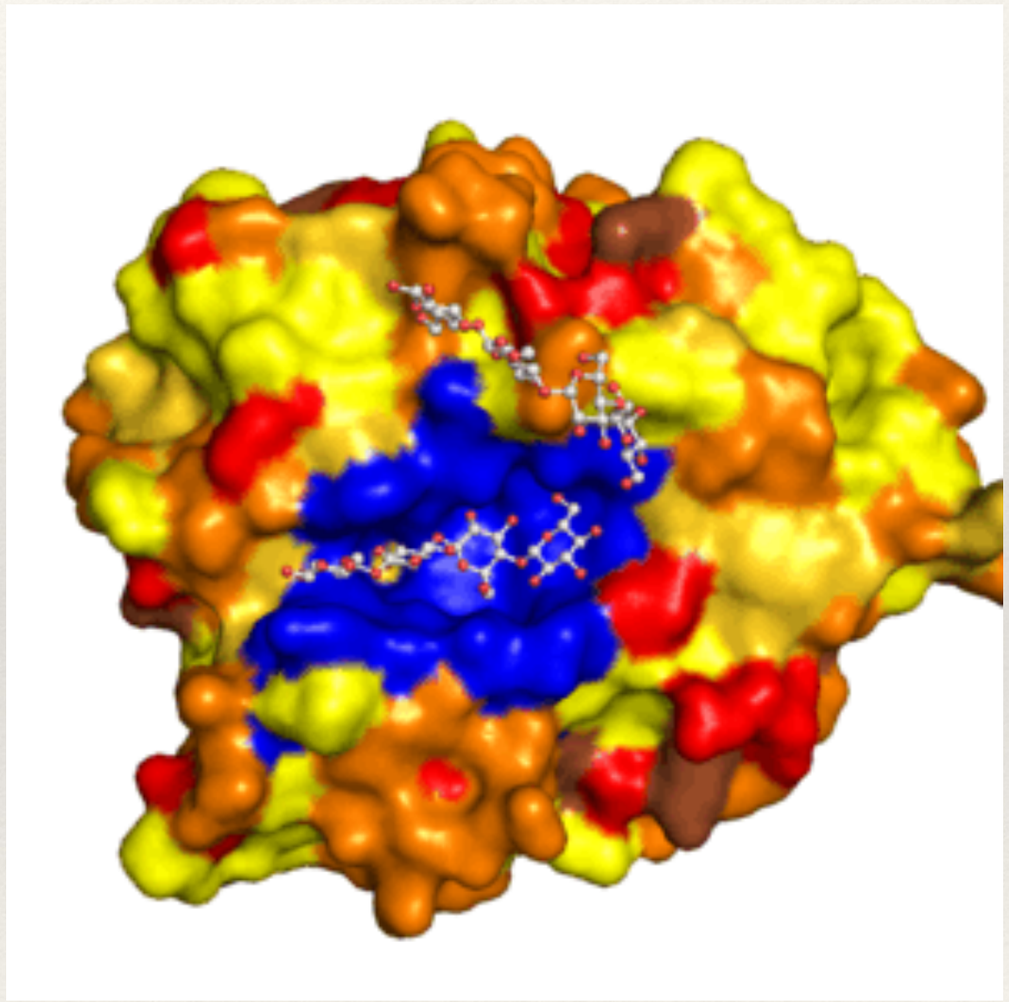
- Much like a movie set:
- Agents (actors)
  - Scripted
  - Player-controlled
- Props for interactions
- Lights for shading
- Camera for rendering



Maya scene (Parik Gulati)

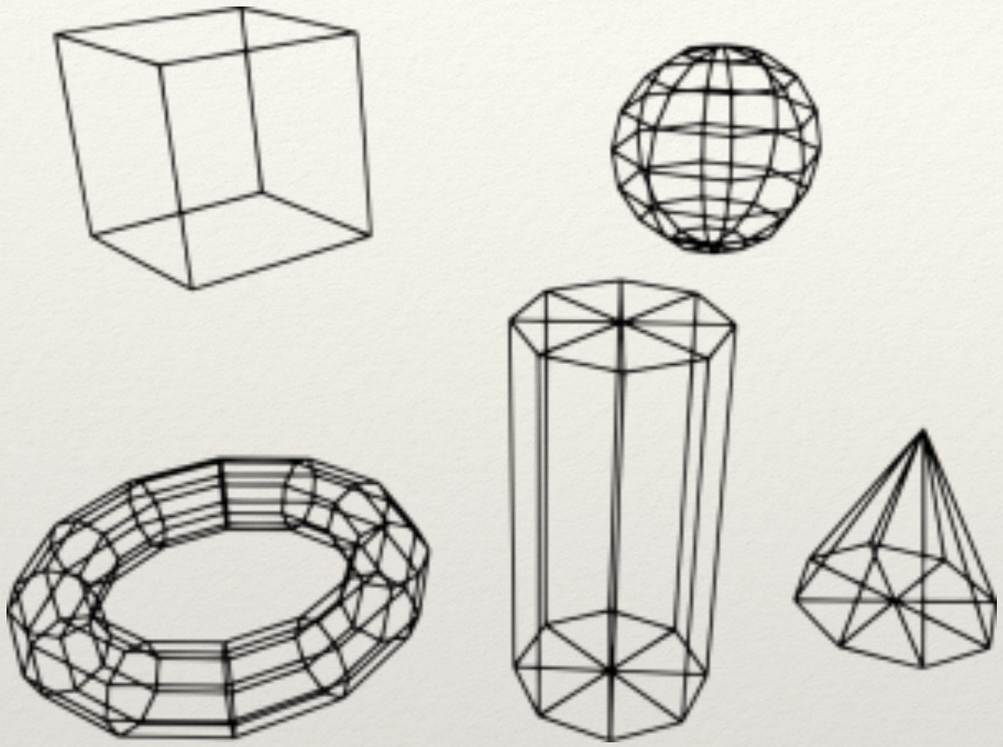
Scenes for Visualization

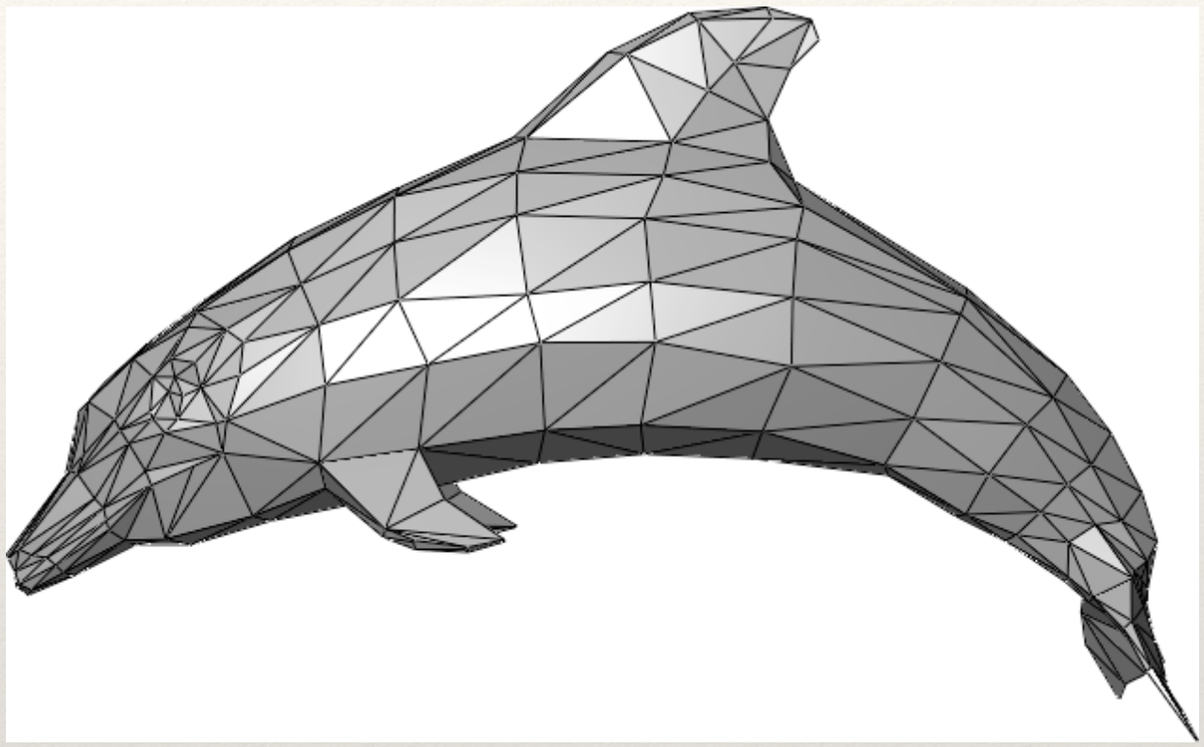
- Still involve agents, props, lights and cameras
- Same overall structure



Protein rotation
(structuralbioinformatician.wordpress.com)

How Do We Define Shape?





- Vertices form edges
- Edges form faces
- Faces form meshes

Vertices

- A vertex is a point that provides geometric information

```
point(x, y);
```

- Multiple vertices can define a polygon or shape

```
quad(0, 0, 10, 0, 20, 10, 5, 10);
```

- Polygons and vertices represent an object in *world space* rather than just *screen space*

Polygons

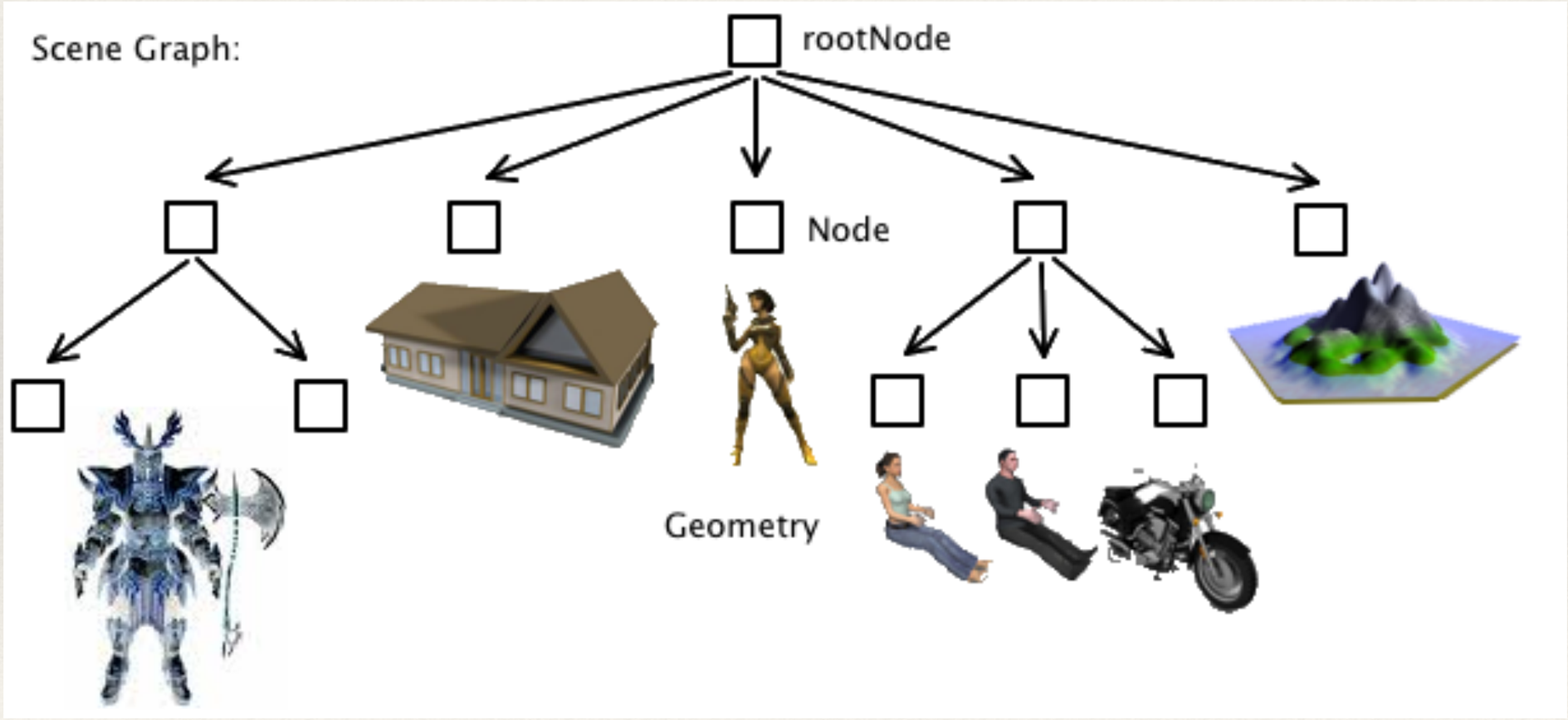
- Common representation for objects in graphics

Consider…

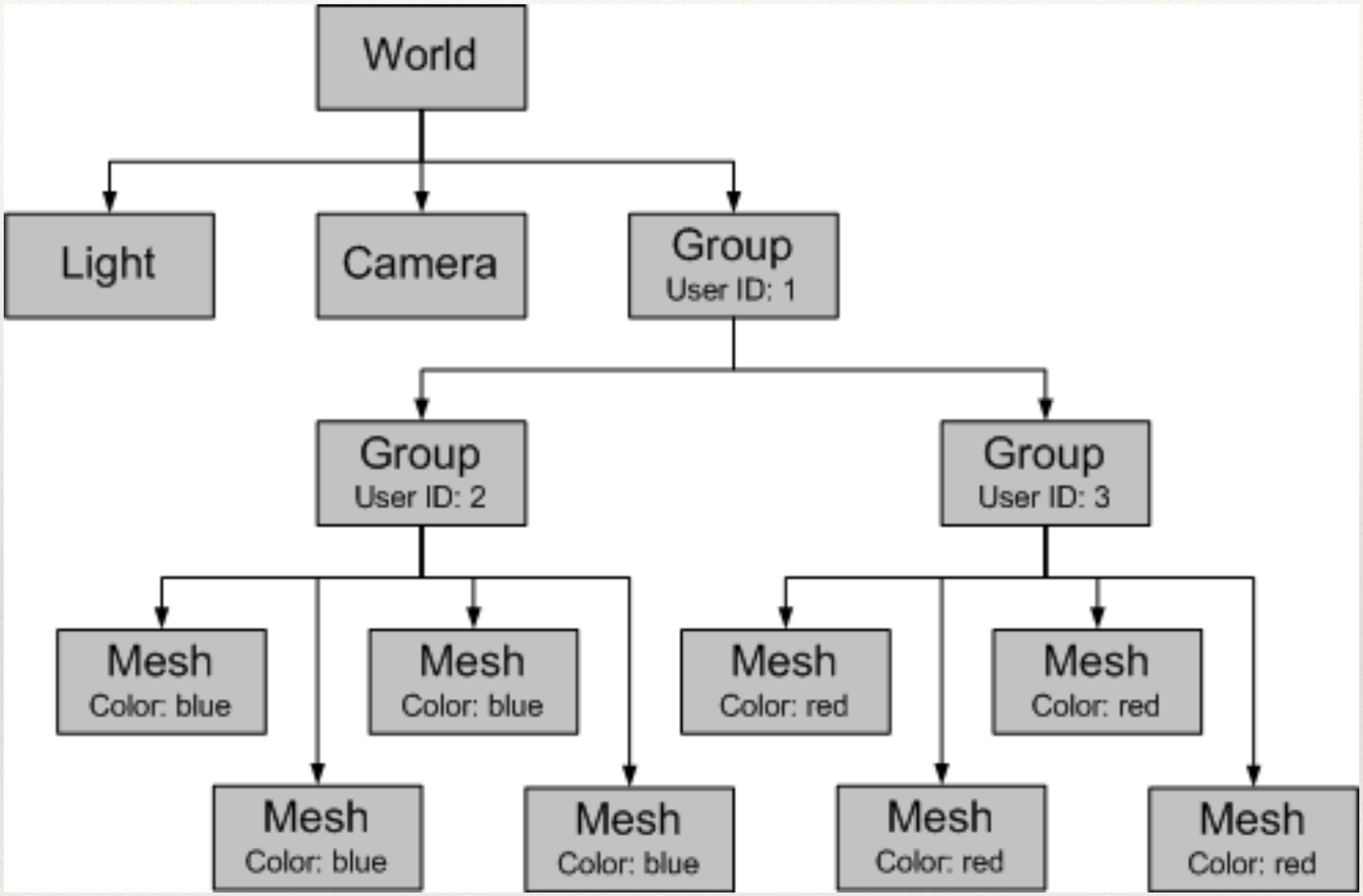
- What are some of the ways things in a scene relate to each other?
- How do polygons relate to each other?
- How to objects relate to each other?

Scene Graphs

- Graph (tree) hierarchy representing the relationship between objects in a scene



Scene graph example (JMonkeyEngine)



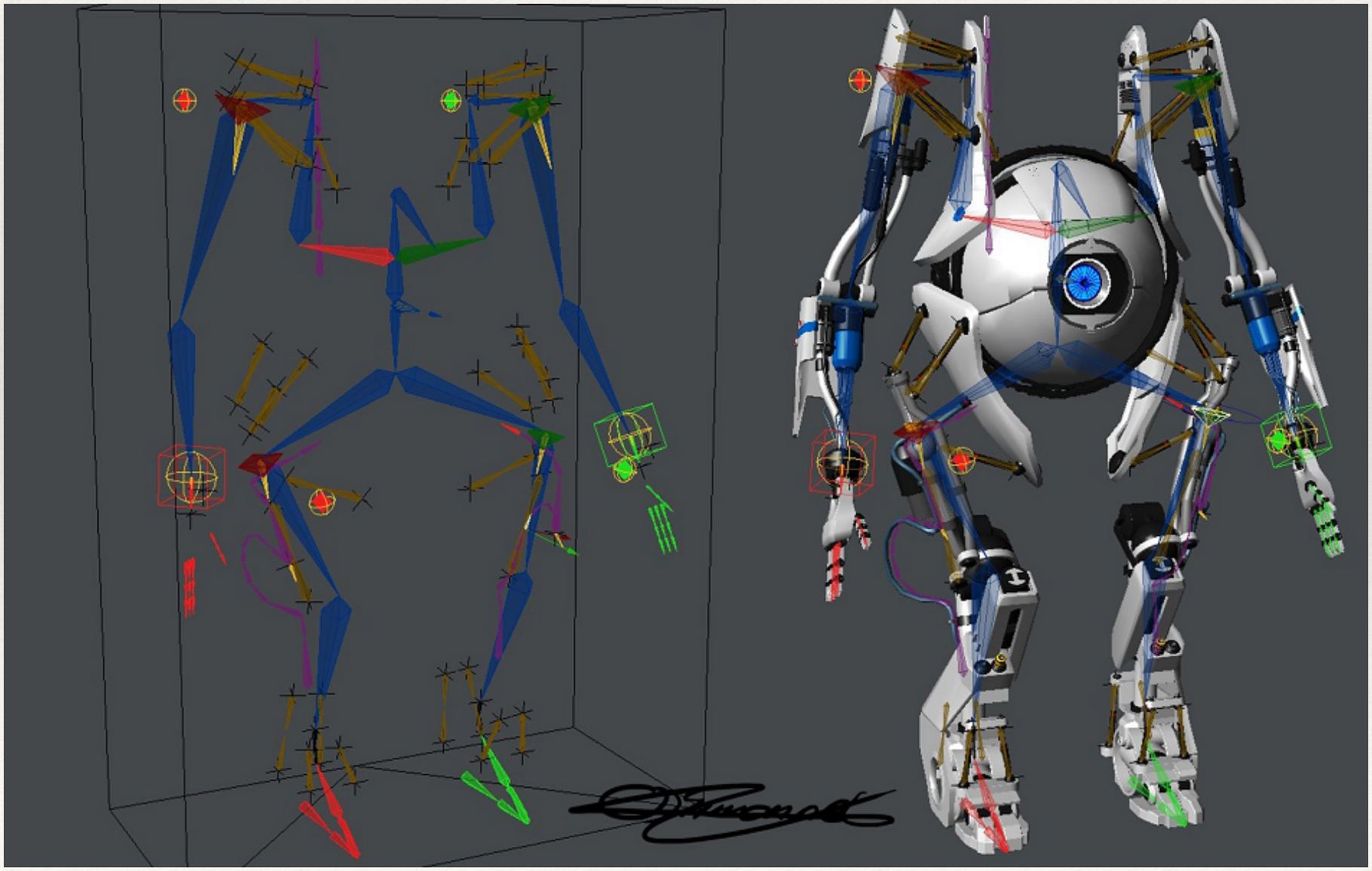
Another scene graph example (http://hadva.blogspot.com/)

Other Hierarchies

- Scene graphs can represent (and facilitate) object interactions at varying levels of granularity:
  - Object animations
  - Polygon transformations
  - Vertex transformations
- We'll get to low-level transformations later, but let's start with animation!

3D Modeling and Animation

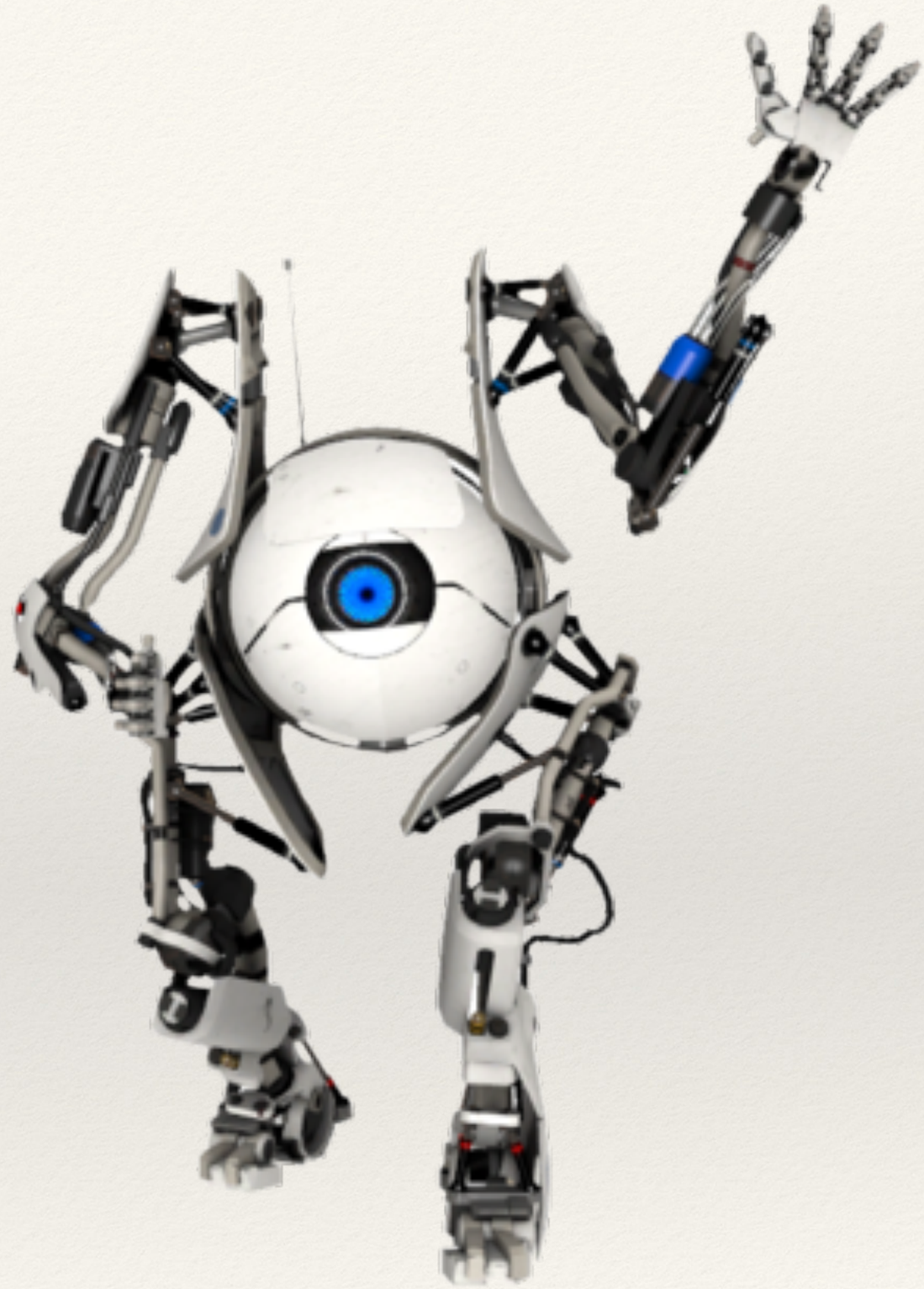
- Consider Atlas from Portal 2…



- His joint movements are in some way relative to each other

- Bending the elbow changes the wrist position…

- Turning the wrist changes the finger orientation…



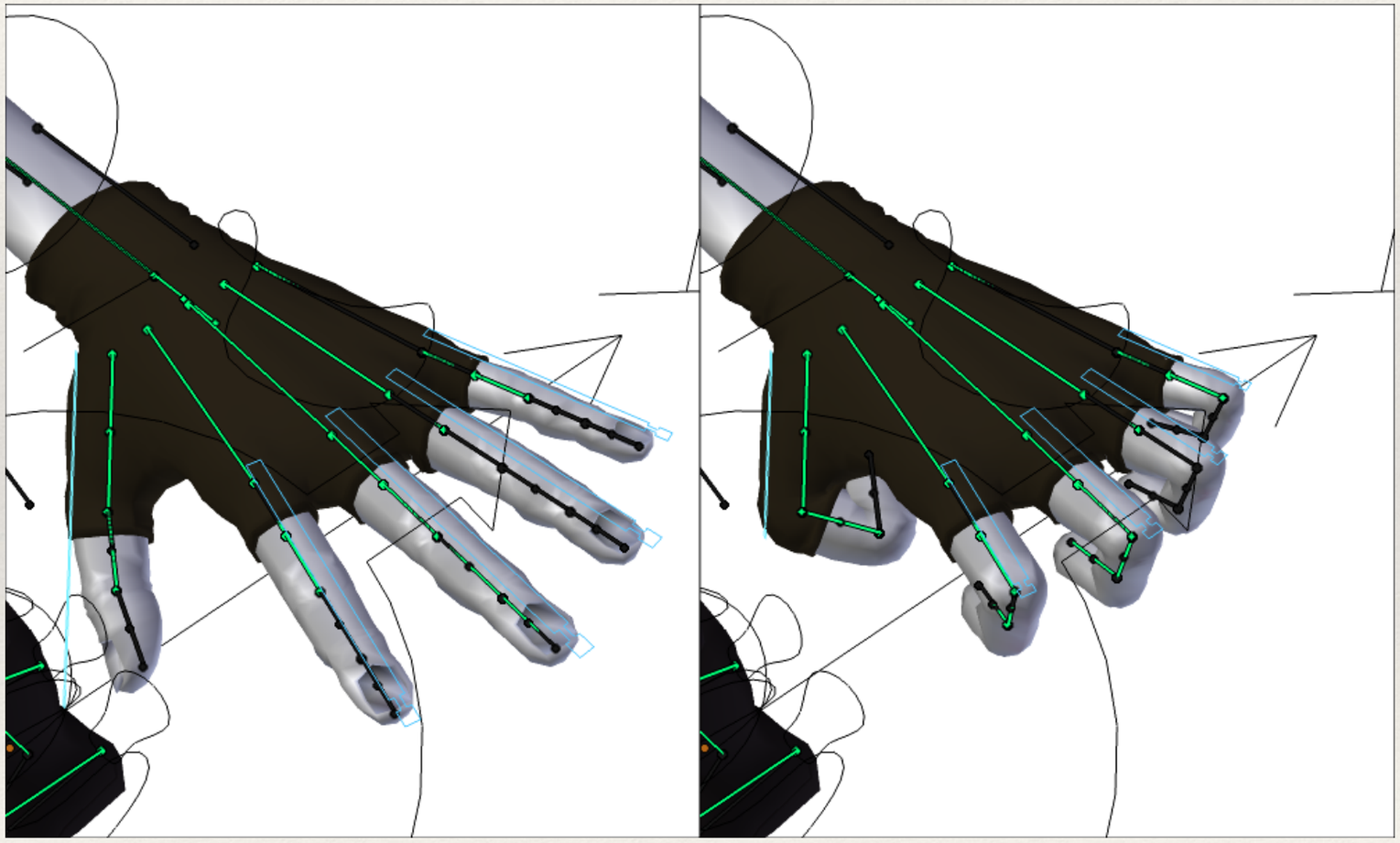
Hierarchical Modeling

- Hierarchical structure avoids moving each "piece" (i.e. vertex) of the object individually
- This structure is based on the object's design — not haphazard or random

What is a hierarchical model that captures the Pixar lamp?

From Modeling to Animation

- Modeling (set shape and form)
- Rigging (set underlying bone structure)
- Skinning (mapping the shape to bone)
- Animating (position the bones to move the shape)

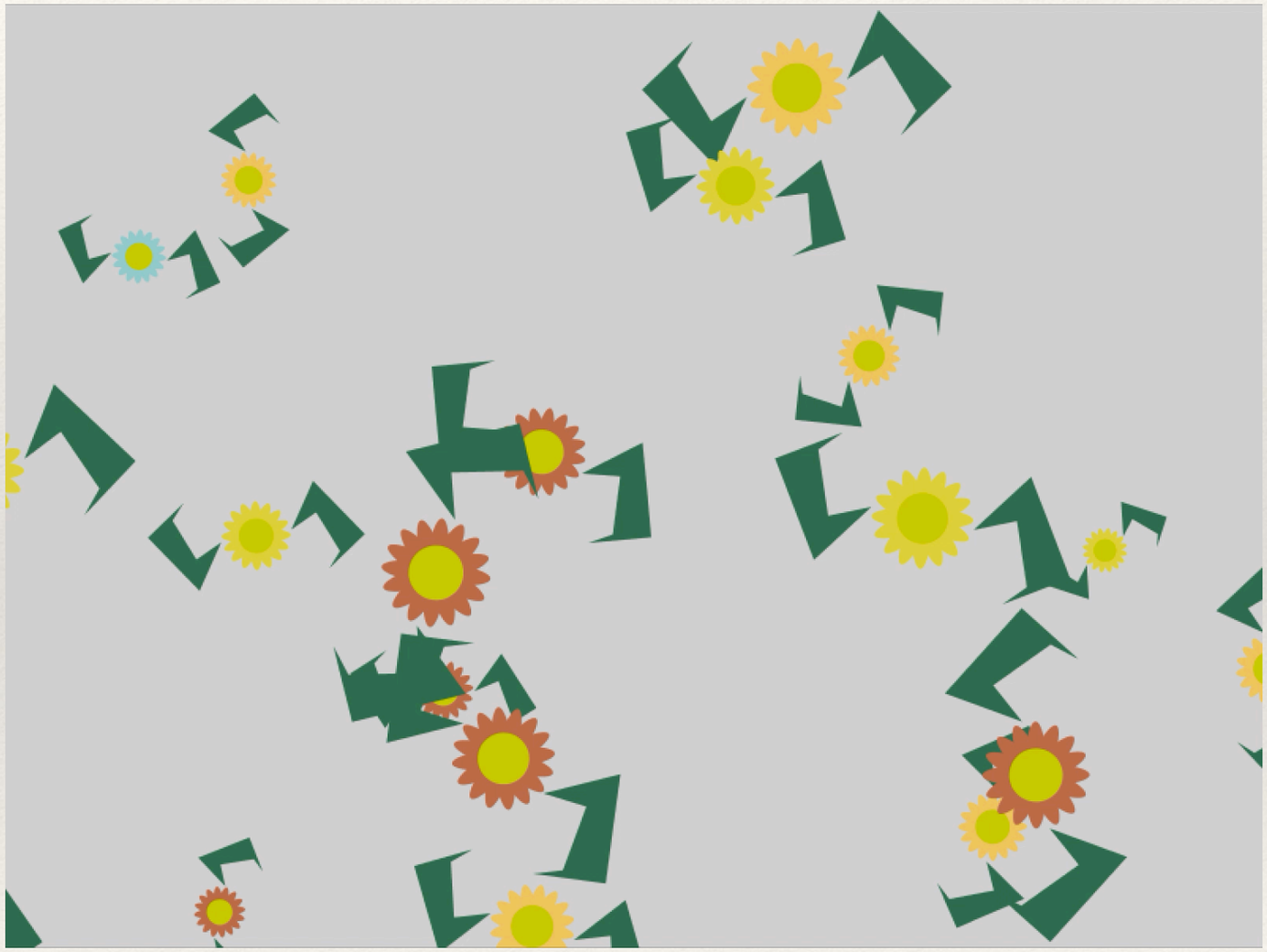


Combining OOP with Scene Graphs?

- Composing scene hierarchies is **not** a type of object-oriented programming
  - **Scene hierarchies is not OOP concept of inheritance!**
- But they can be used in the same class
  - Instance has animation hierarchy to determine how it moves and looks
  - Instance has properties and methods to **change** how it moves and looks

Flower Example

- How is the flower as a whole moving?
- How are the petals moving **relative** to the flower?
- What is the scene hierarchy of all flowers?
- What fields and methods would a Flower class have?



Hands-on: Creating Scene Hierarchies

- Today's activities:

1. Work with your team to design a scene hierarchy for your Assignment 4 project
2. Design the individual objects that will be animated in the scene and show how each object will have two levels of **animation** (the main part and a sub part) of the shape

Note that each group member will work on their own object with its own complete animation hierarchy (including the main object and its subobjects)