Scene Hierarchies
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
  \[
  \text{point}(x, y);
  \]
- Multiple vertices can define a polygon or shape
  \[
  \text{quad}(0, 0, 10, 0, 20, 10, 5, 10);
  \]
- Polygons and vertices represent an object in \textit{world space} rather than just \textit{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 do 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 != OO concept of inheritance
- But they can be used on the same “object”
  - Object has animation hierarchy to determine how it moves and looks
  - Object 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?
Instapoll Question: Scene Graphs

❖ How many nodes do we need to create a scene graph of this robot?
❖ 5
❖ 7
❖ 9
❖ 12
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)