

SCENE GRAPHS AND CONSTRUCTIVE AREA GEOMETRY

2011 Introduction to Graphics

Lecture 7

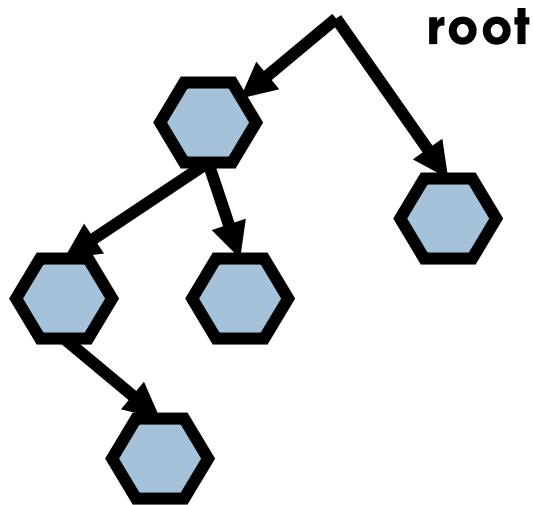
Summary



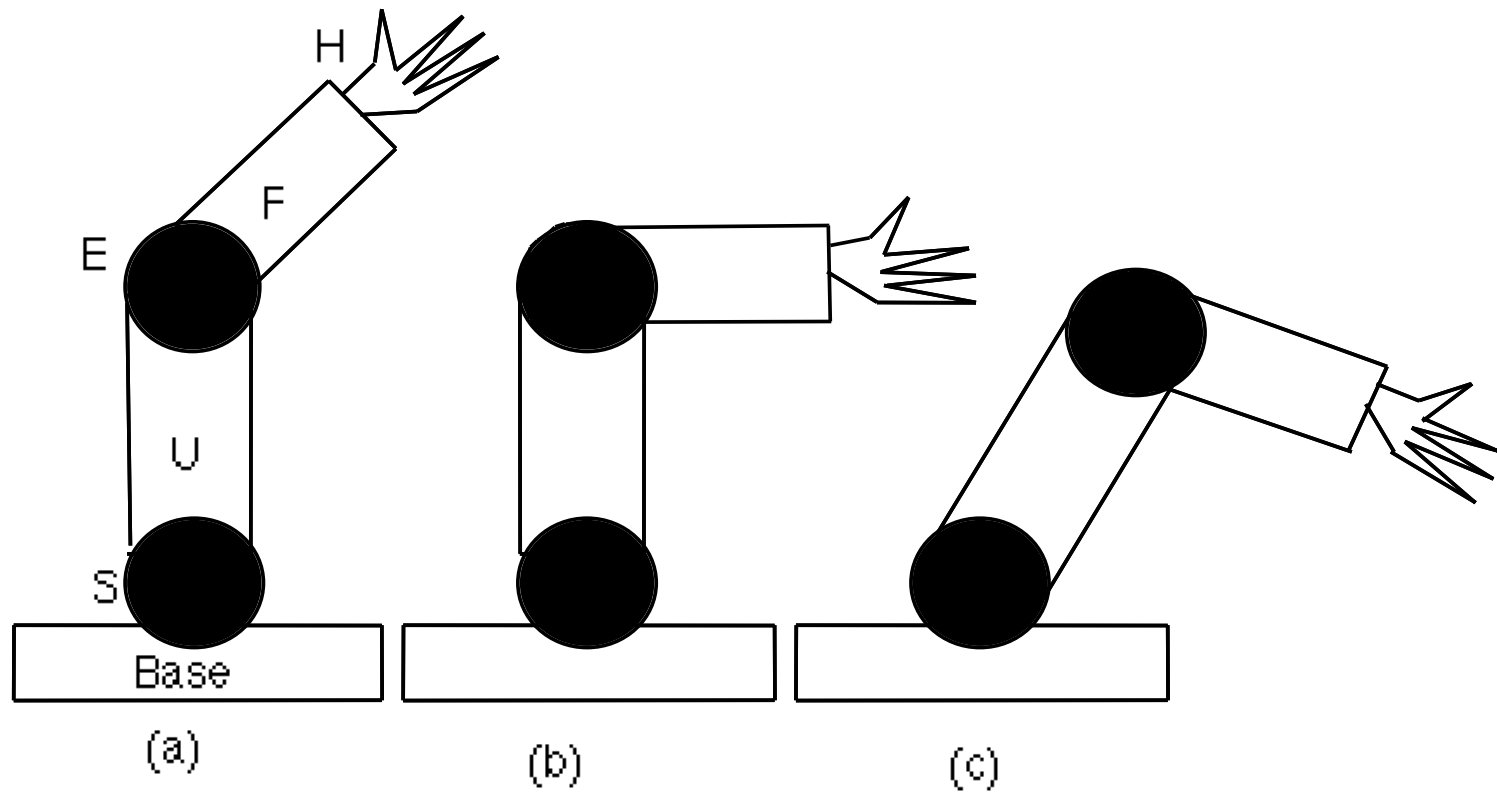
- Hierarchical Scene Structures
 - ▣ Traversal
 - ▣ Grouping
 - ▣ Examples
- Constructive Area Geometry

Concept of Scene Graph

- Objects placed relative to one another
- Objects made of similar components
- Directed acyclic graph

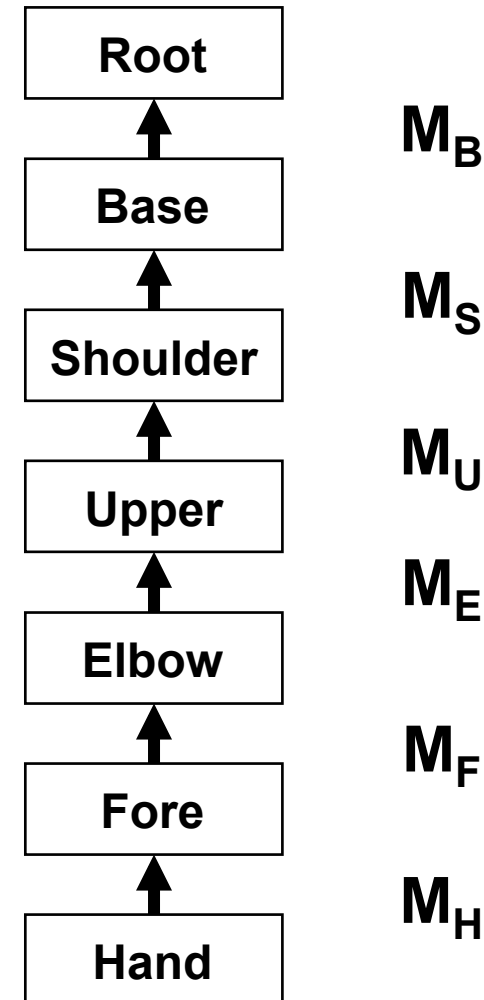


Use for Animation/Modelling



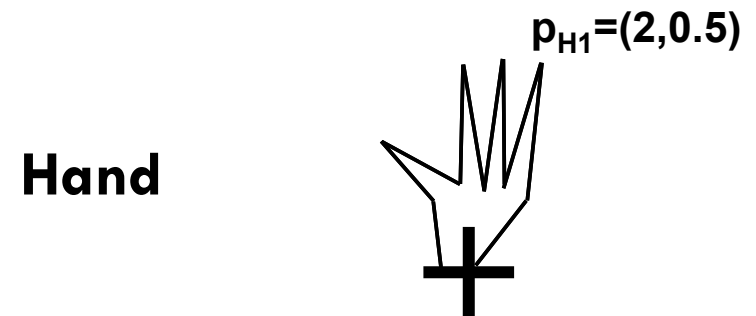
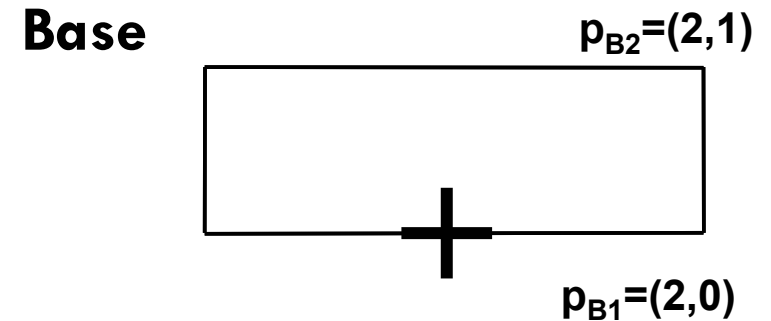
Robot as a Graph

- Each node other than root contain a piece of geometry
- Each link is a transformation matrix, M_B , M_S , etc.
- Main concept is that robot can be posed by changing rotation in Shoulder and Elbow



Local Coordinates

- Each part of the robot is modelled in its own local coordinate (LC) system
- Local coordinates are defined by the person modelling the system
- Choice is determined by convenience
- Common choices:
 - ▣ The centre of the object
 - ▣ The centre of the object
 - ▣ A corner of the object



World Coordinates



- Everything is eventually positioned relative to the world coordinates (WC) or room coordinates
- We already know how to convert WC to screen coordinates (SC)
 - ▣ End of a previous lecture

Local Transform

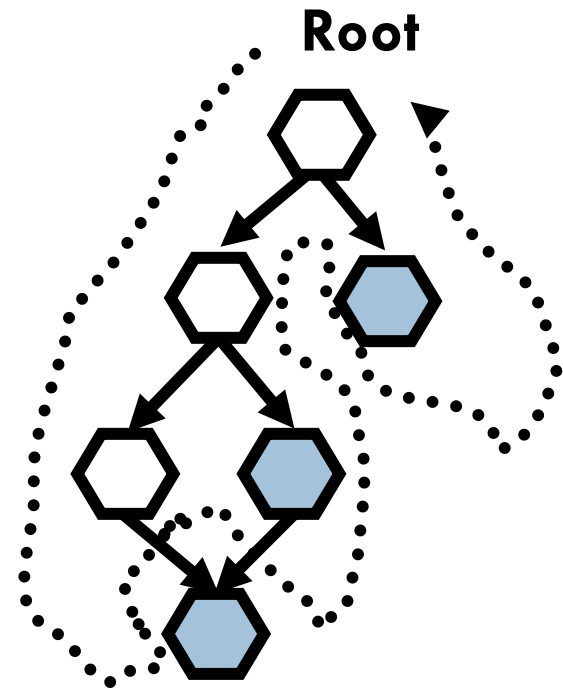
- An object's **local transformation** maps LC to the parent's LC
- For the robot example in position (b)
 - shoulder is translation (0 1) from base (M_S)
 - upper arm is translation (0 3) from shoulder (M_U)
 - elbow is translation (0 3) from upper arm (M_E)
 - fore arm is rotate by -90 then translation (0 2) (M_F)
 - Etc.
- Note that directions such as “up” depend on what transformations have been defined by ancestors in the tree

Rendering Traverse

- Must get object definitions in WC before passing to camera
- For a vertex in the Base object
 - ▣ $p.M_B$ is in WC
- Matrices are inherited down stack
- So for object under shoulder
 - ▣ $p.M_S M_B$ is in WC
 - ▣ (Note that $p.M_S$ is in the local coordinates of the base!)

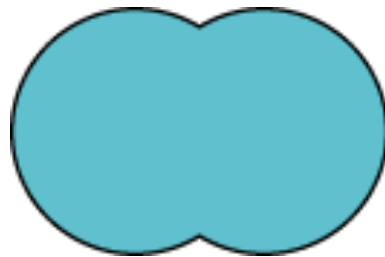
Implementation

- Generally implemented by a straightforward recursive descent
 - “push” on graph descend
 - “pop” on graph ascend
- The concatenation of all LT matrices above a node is called the current transformation matrix (CTM)

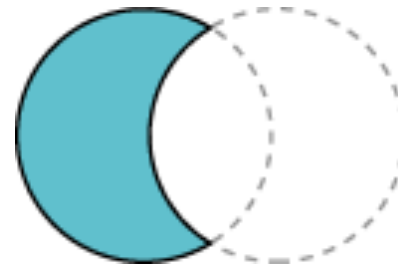


Constructive Area Geometry

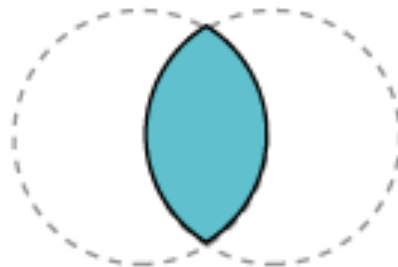
□ Basic operations:



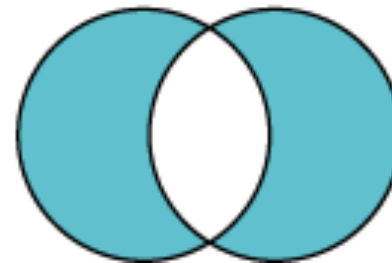
Union



Subtraction

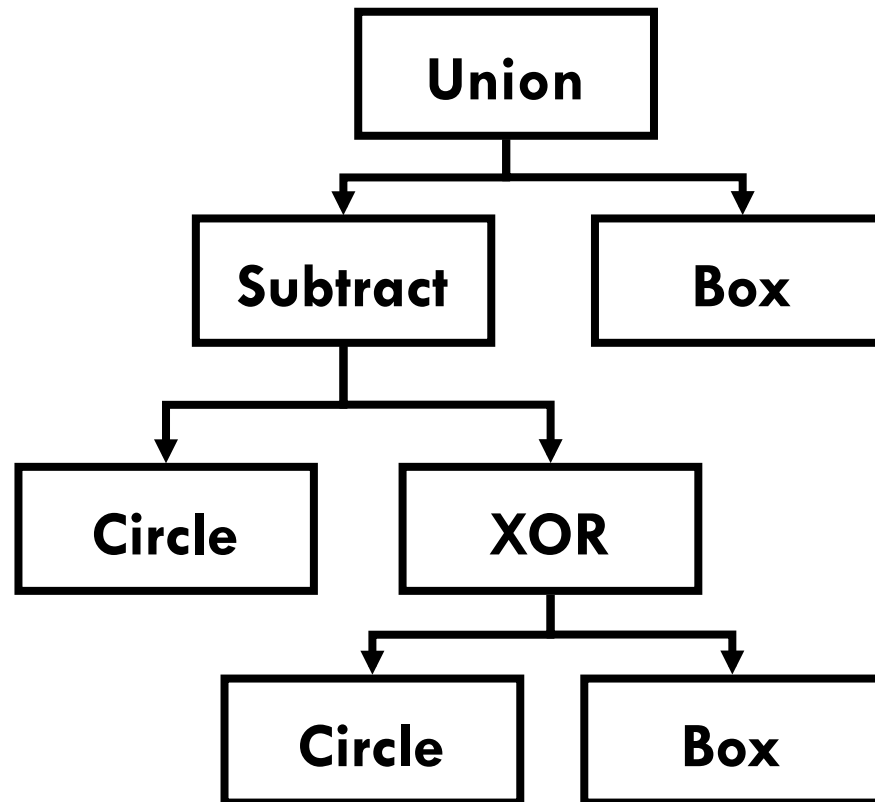


Intersection



Exclusive OR

Hierarchical CAG



Exercise

- Create the following shape out of half-circles



Summary



- Two uses of tree structures for graphics
- Scene Graphs
 - ▣ Allow hierarchical construction of scene from base units
 - ▣ Essential to cope with complexity of animation or editing
- CAG
 - ▣ Useful for complex shape design
 - ▣ Also based upon a hierarchical approach