Hierarchical modeling

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Lecture Overview

Hierarchical models

Many graphical objects are structured

Structure often naturally hierarchical

Exploit structure for

- efficient rendering e.g. tree leaves
- concise specification of model parameters e.g. joint angles
- physical realism

Instance transformations

Often we need several instances of an object

- wheels of a car
- arms or legs of a character
- chess pieces
- chairs and desks in a lecture hall

Instance transformations

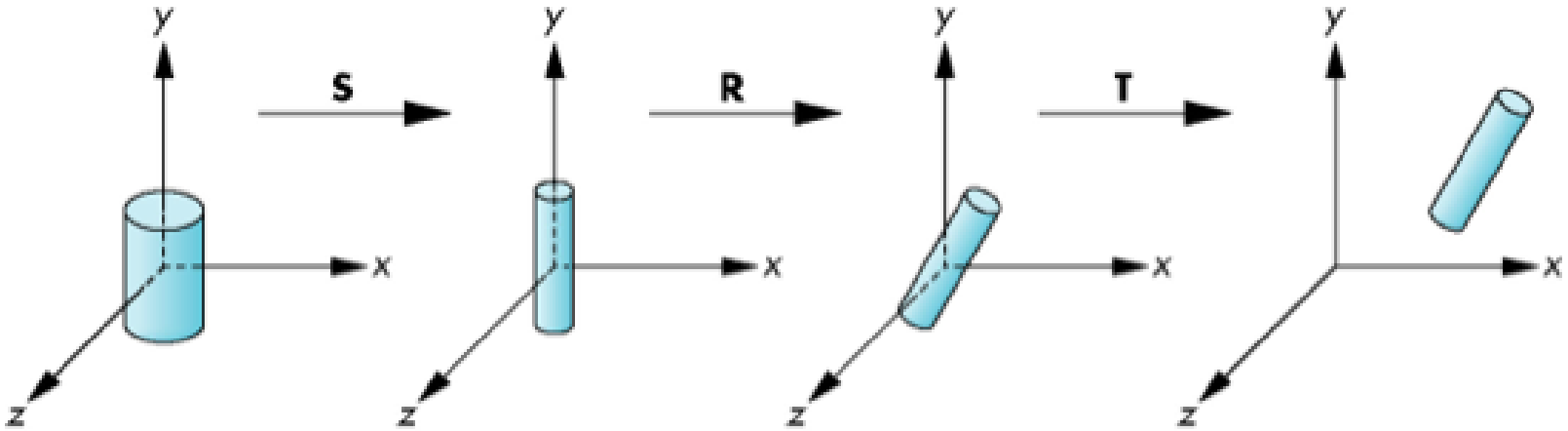
Instances can be shared across space or time

Write a function that renders the object in "standard" configuration (object space)

Apply transformations to different instances (world space)

- typical order $\rightarrow$ scaling, rotation, translation

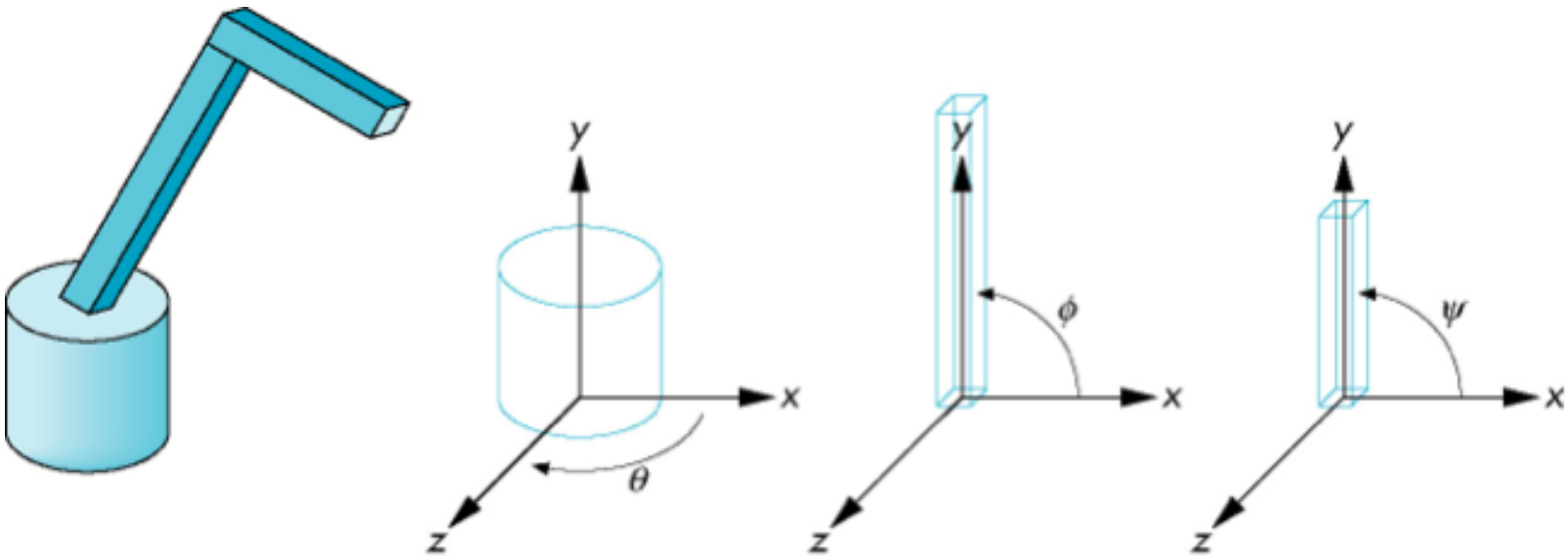
Sample instance transformation



Example

- Live demo - Autodesk Maya
- parent - child relation $\rightarrow$ inherit transformations

Robot arm: drawing a compound object



robot arm

parts in their own coodinate systems

Articulated models

Robot arm is an example of an articulated model

- parts connected at joints
- can specify state of model by giving all joint angles

Relationships in robot arm

Base rotates independently $\rightarrow$ single angle determines position

Lower arm attached to base $\rightarrow$ its position depends on rotation of base; must also translate relative to base and rotate about connecting joint

Upper arm attached to lower arm $\rightarrow$ its position depends on both base and lower arm; must translate relative to lower arm and rotate about joint connecting to lower arm

Required matrices

Rotation of base: R_b

Apply $M = R_b$ to base

Translate lower arm relative to base: T_{lu}

Rotate lower arm around joint: R_{lu}

Apply $M = R_b T_{lu} R_{lu}$ to lower arm

Translate upper arm relative to upper arm: T_{uu}

Rotate upper arm around joint: R_{uu}

Apply $M = R_b T_{lu} R_{lu} T_{uu} R_{uu}$ to upper arm