Simulation in Computer Graphics

Exercises

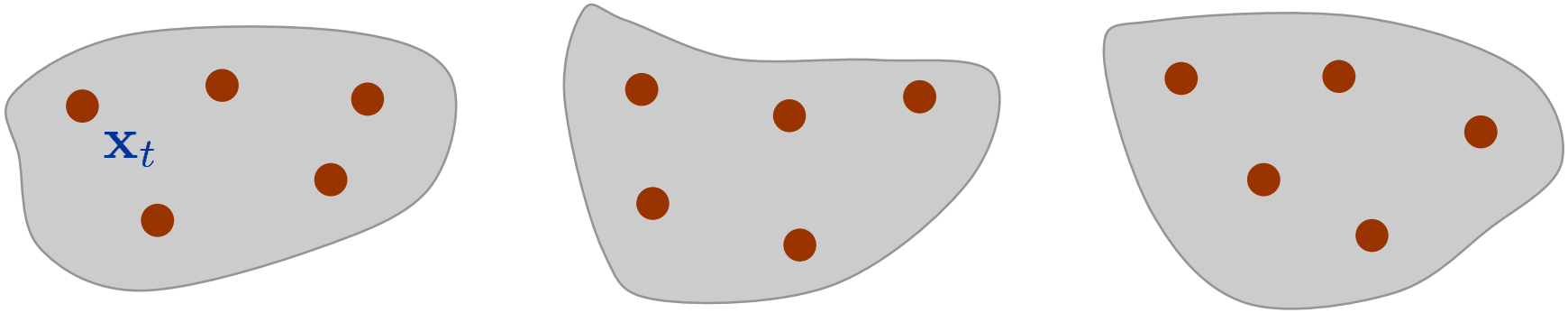
Matthias Teschner

Computer Science Department
University of Freiburg

UNI FREIBURG

General Concept

- simulation of a set of particles
  - update particle positions $\mathbf{x}_t$ per time step t



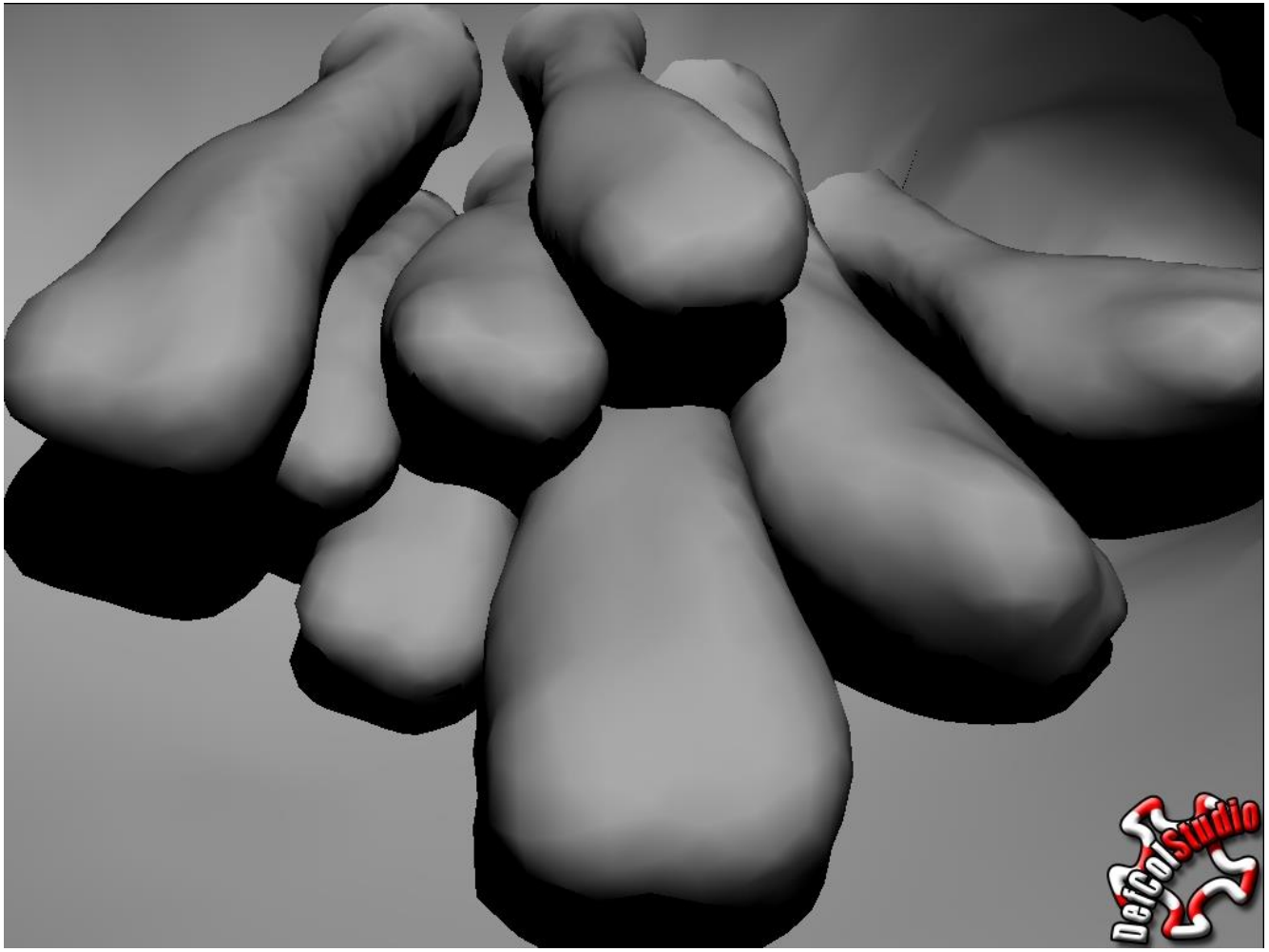
deformable object fluid rigid object

- visualization
  - of dynamically changing particle positions
  - of additional properties, e.g. velocities or force

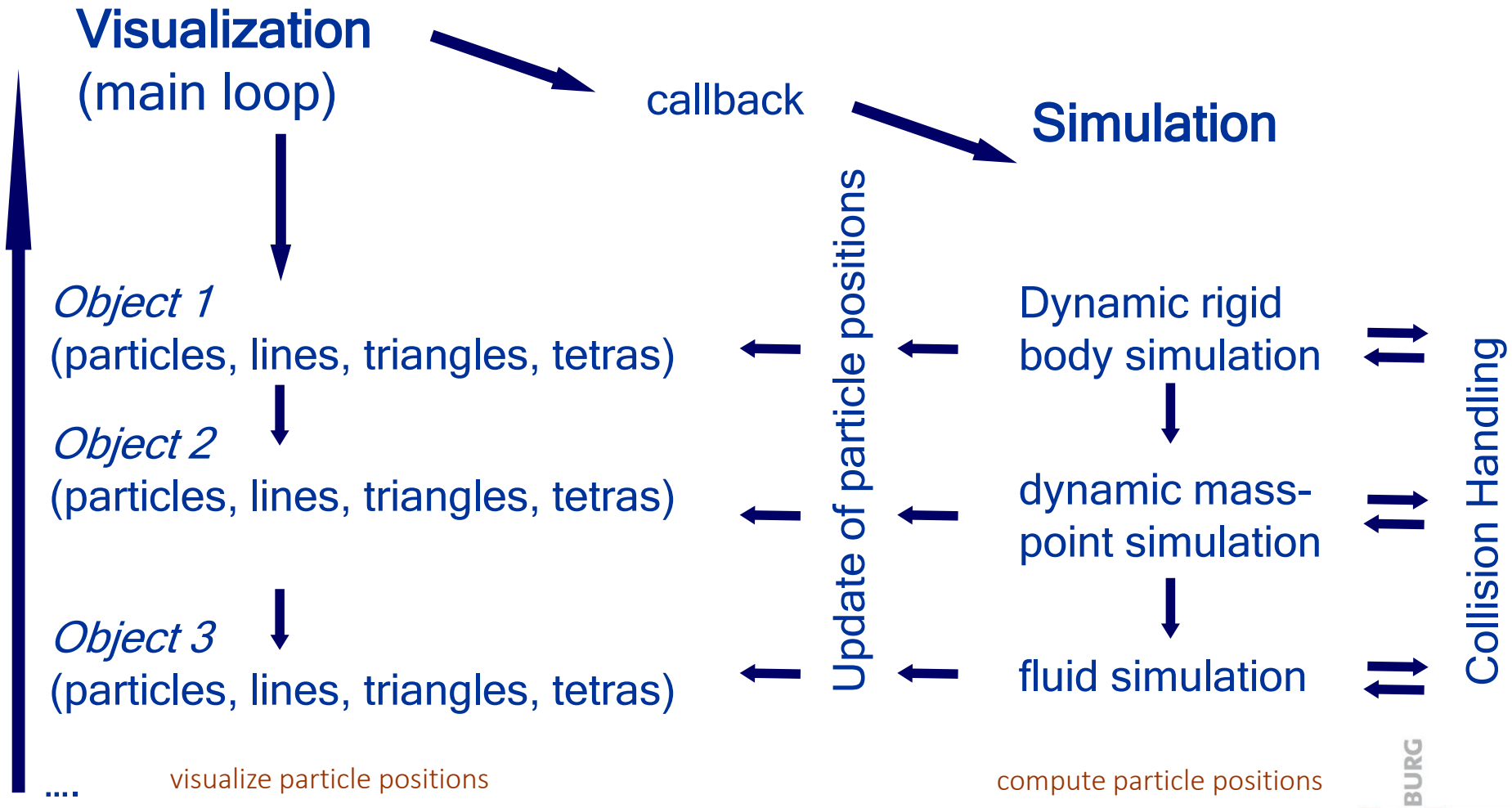
Visualization Primitives

- points
  - to illustrate particle positions
  - simple representation, e.g. cube, tetrahedron, or sphere
- line segments
  - to illustrate particle connections, e.g. springs
- triangles
  - to illustrate the simulation domain (triangle mesh)
- tetrahedra
  - to illustrate volumetric elements in deformable objects

Visualization Example



Visualized Simulation



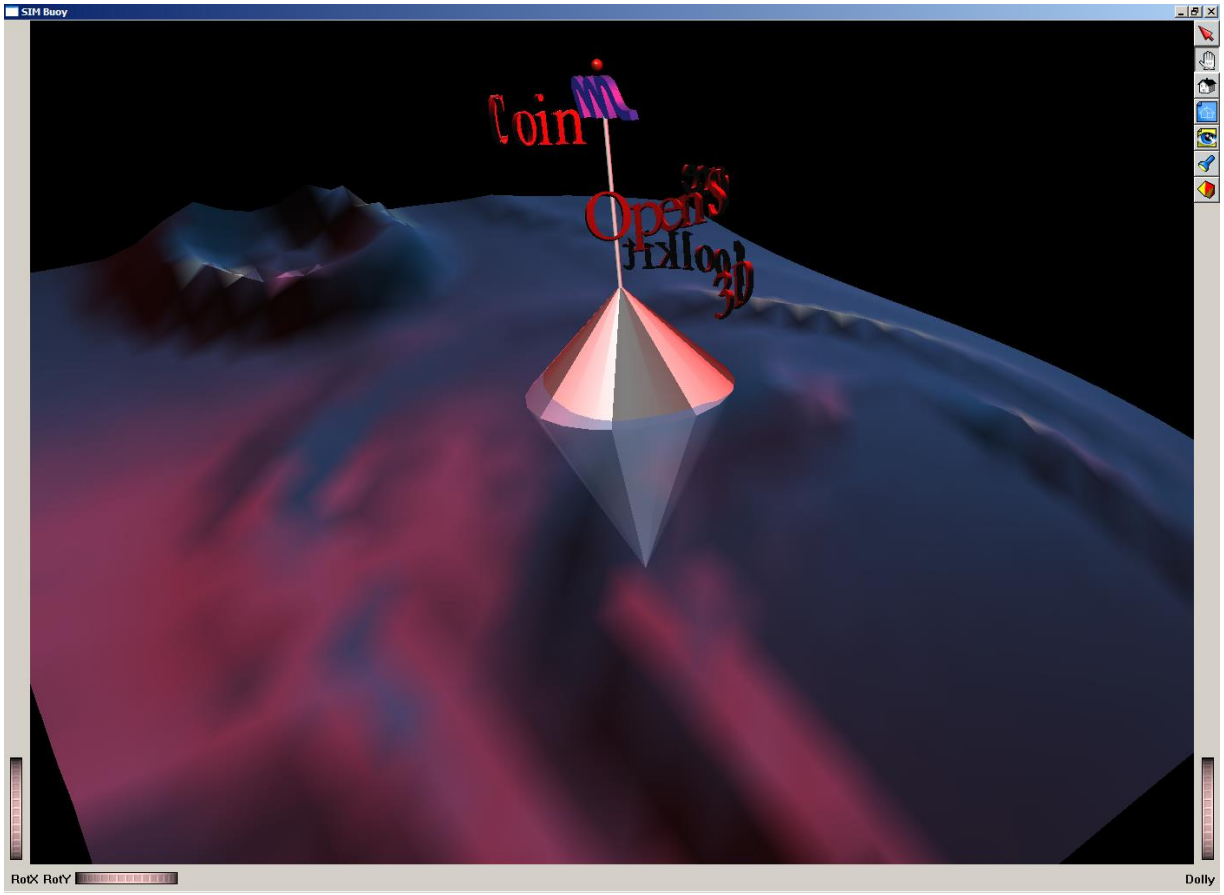
Visualization Tools

- Coin3D bitbucket.org/Coin3D/coin/wiki/Home
- VTK www.vtk.org
- OSG www.openscenegraph.org
- Ogre3D www.ogre3d.org
- …

Visualization Tools

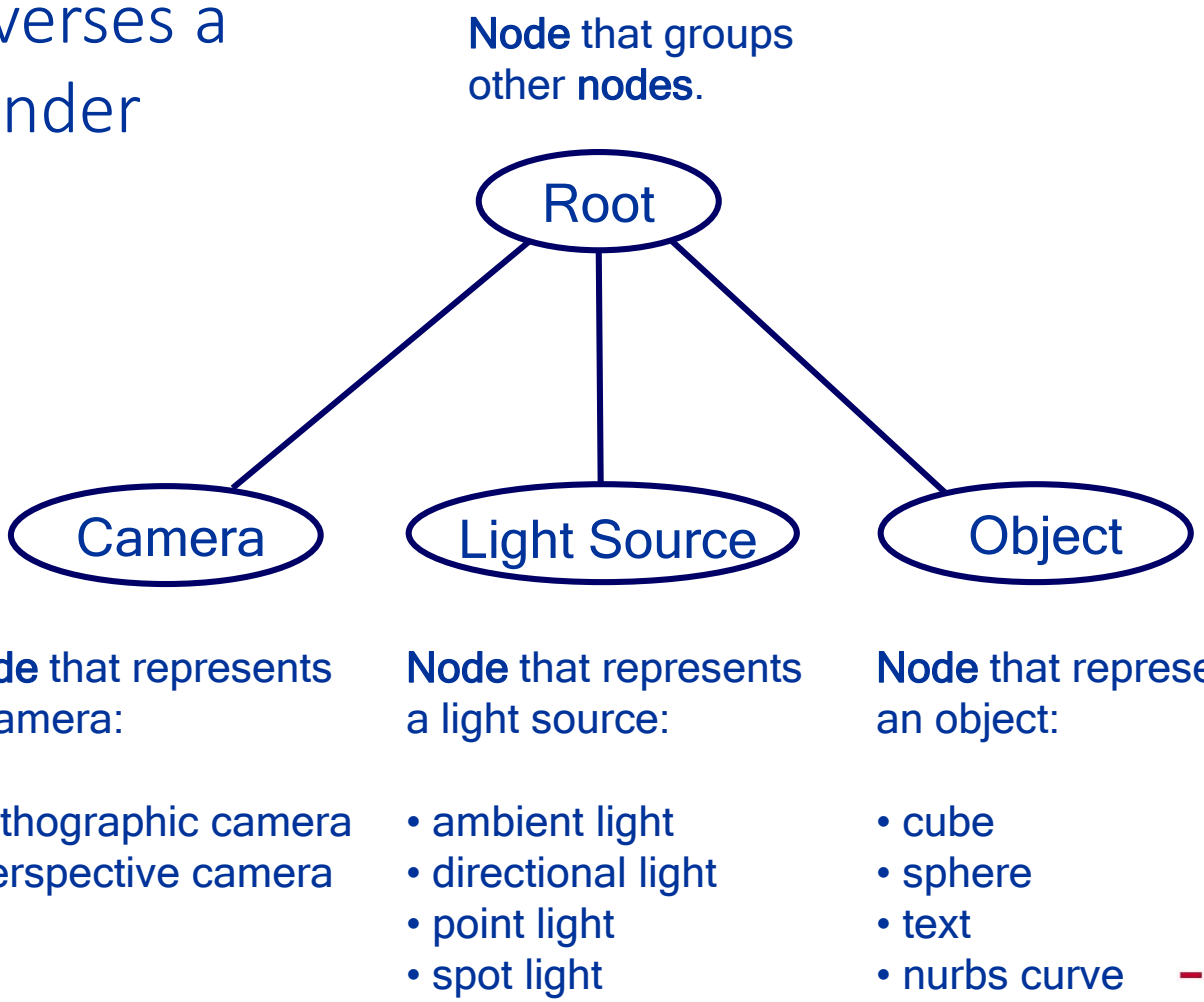
- Coin3D
  - exercises on web page use Coin3D
  - can be difficult to install
- VTK
  - sample setting on web page
  - easy to install and to use
  - supported
  - less optimal documentation
  - better performance compared to Coin3D

Coin3D - Example



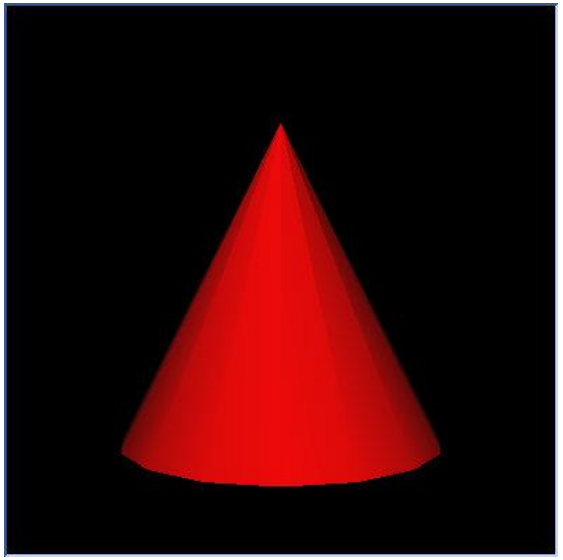
A First Scene Graph

- Coin3D traverses a graph to render the scene

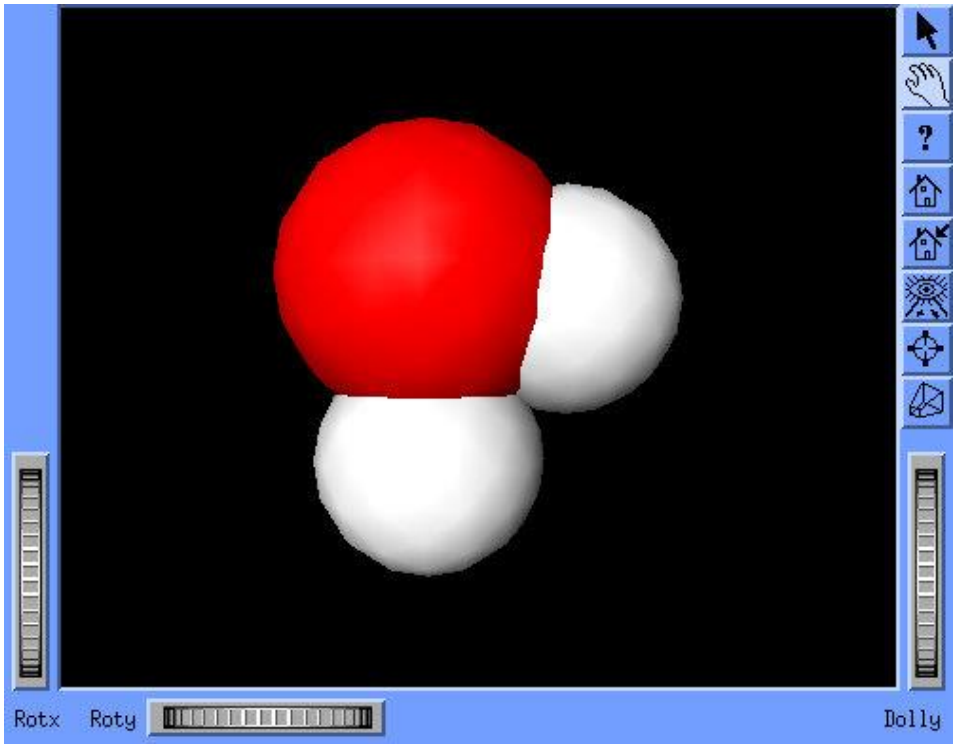


C/C++ Example

```
SoSeparator          *root     = new SoSeparator;
SoPerspectiveCamera  *myCamera = new SoPerspectiveCamera;
SoDirectionalLight   *myLight  = new SoDirectionalLight;
SoCone               *myCone   = new SoCone;

root->addChild (myCamera);
root->addChild (myLight);
root->addChild (myCone);

myCamera->viewAll (root);

SoXtRenderArea *myRenderArea =
new SoXtRenderArea;

myRenderArea->setSceneGraph (root);
myRenderArea->show ();
```



Scene Viewer



selection mode
viewing mode
help
reset camera to home
define current camera as home
set camera to view all
define point to zoom in
orthographic/perspective camera

zoom

rotation

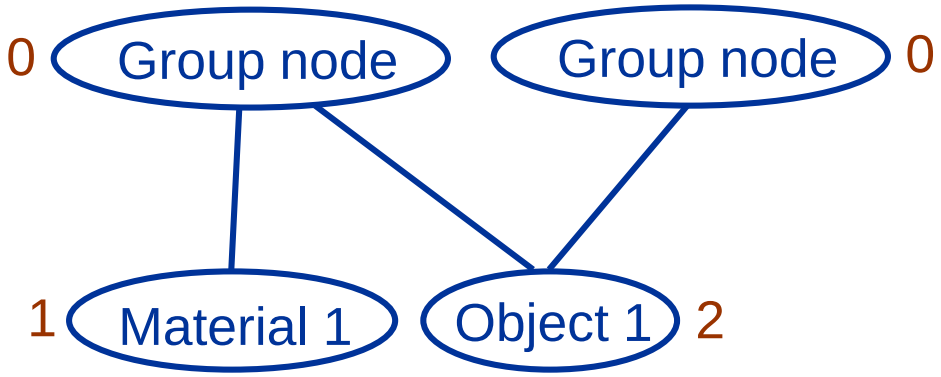
- left mouse: rotation; middle mouse: translation; left and middle: zoom; right mouse: rendering mode

Node Types

- shape nodes (geometry) — SoCone, SoCube, SoCylinder, SoNurbsSurface, SoSphere, SoText3
- appearance nodes (shading) — SoBaseColor, SoMaterial, SoFont, SoDrawStyle
- transform nodes — SoTranslation, SoRotation, SoScale, SoRotationXYZ, SoMatrixTransform, SoResetTransformation
- group nodes — SoSeparator, SoSwitch

Node Reference Counter

- number of references to a node (parent-child links)



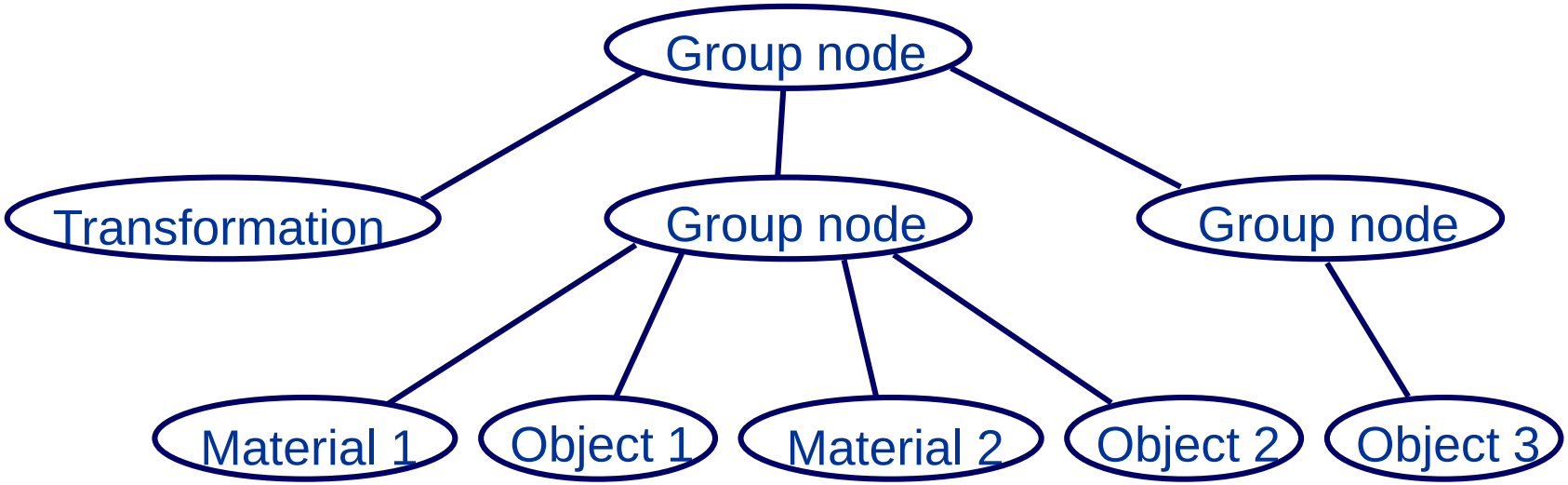
- adding a node as a child to a parent node increments the reference counter of the child node
- removing a child node from a parent node decrements the reference counter of the child node
- the reference counter can be manually changed with ref() and unref()

Node Deletion

- when a node's reference counter decreases from 1 to 0, the node is deleted by Coin3D
- adding a node to a graph: 0 -> 1
- removing it from the graph: 1 -> 0 -> deletion
- simple, but:
  - removing a node from a graph that you want to keep
  - deleting a node with reference counter 0
  - actions applied to a node increase the reference counter and decrease it afterwards
- to solve or avoid these problems the reference counter can be adjusted with ref() and unref()

Groups and Ordering

- group nodes save and restore the traversal state



- transformation is applied to object 1, 2, 3
- material 1 is applied to o. 1, material 2 is applied to o. 2
- neither material 1 nor material 2 is applied to object 3

Scene Interaction

- events — mouse and keyboard events
- sensors — notifications for some reasons

Events

- SoMouseButtonEvent (mouse press and release events)
- SoKeyboardEvent (keyboard press and release events)

```
// Declaration of a callback function
SoEventCallback *myEventCB = new SoEventCallback;
myEventCB->addEventCallback(myKeyPressCB, myUserData);

// Adding the function's node to the scene graph
separator->addChild(myEventCB);

// Implementation of the callback function
void myKeyPressCB(void *userData, SoEventCallback *eventCB)
{
// SoKeyboardEvent
   if (SO_KEY_PRESS_EVENT(event,Q)) exit(0);
}
```

Sensors

- SoSensor
- detect changes to time or to nodes
- incorporate callback functions in alarm cases
- SoAlarmSensor — one-time callback
- SoTimeSensor — repeat callback at regular intervals
- SoNodeSensor — detects node changes or changes to children of group nodes
- SoFieldSensor — attached to a field
- SoIdleSensor — triggered when there is nothing to do

Visualized Simulation