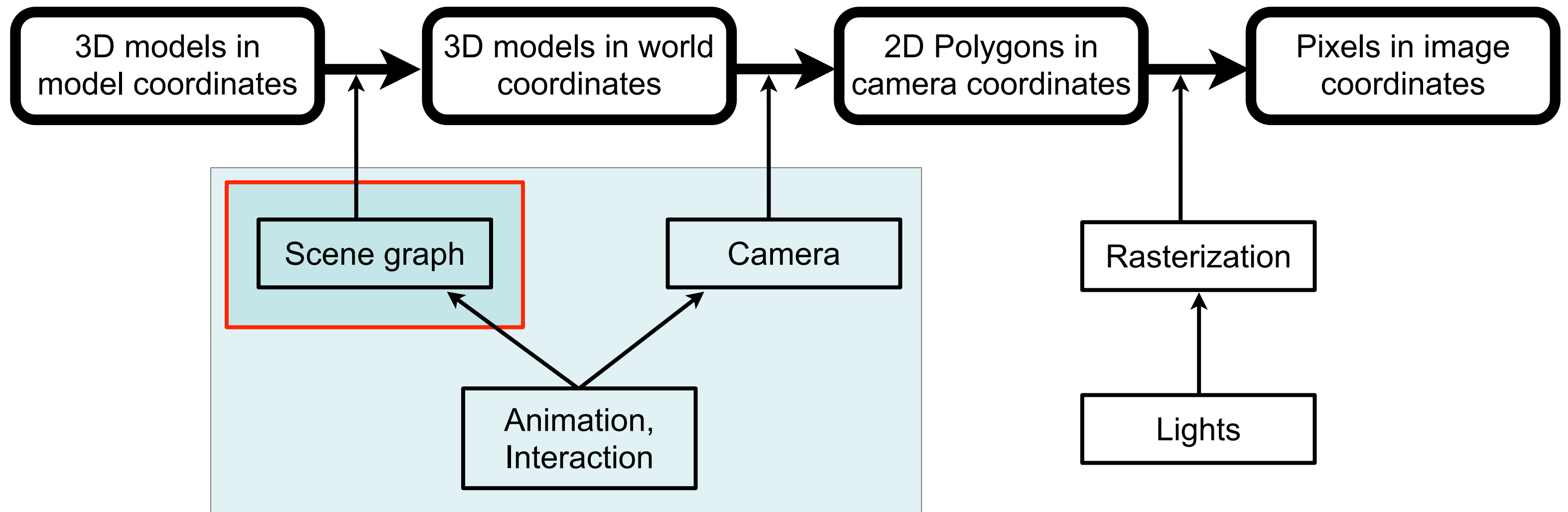


Chapter 6 - The Scene Graph

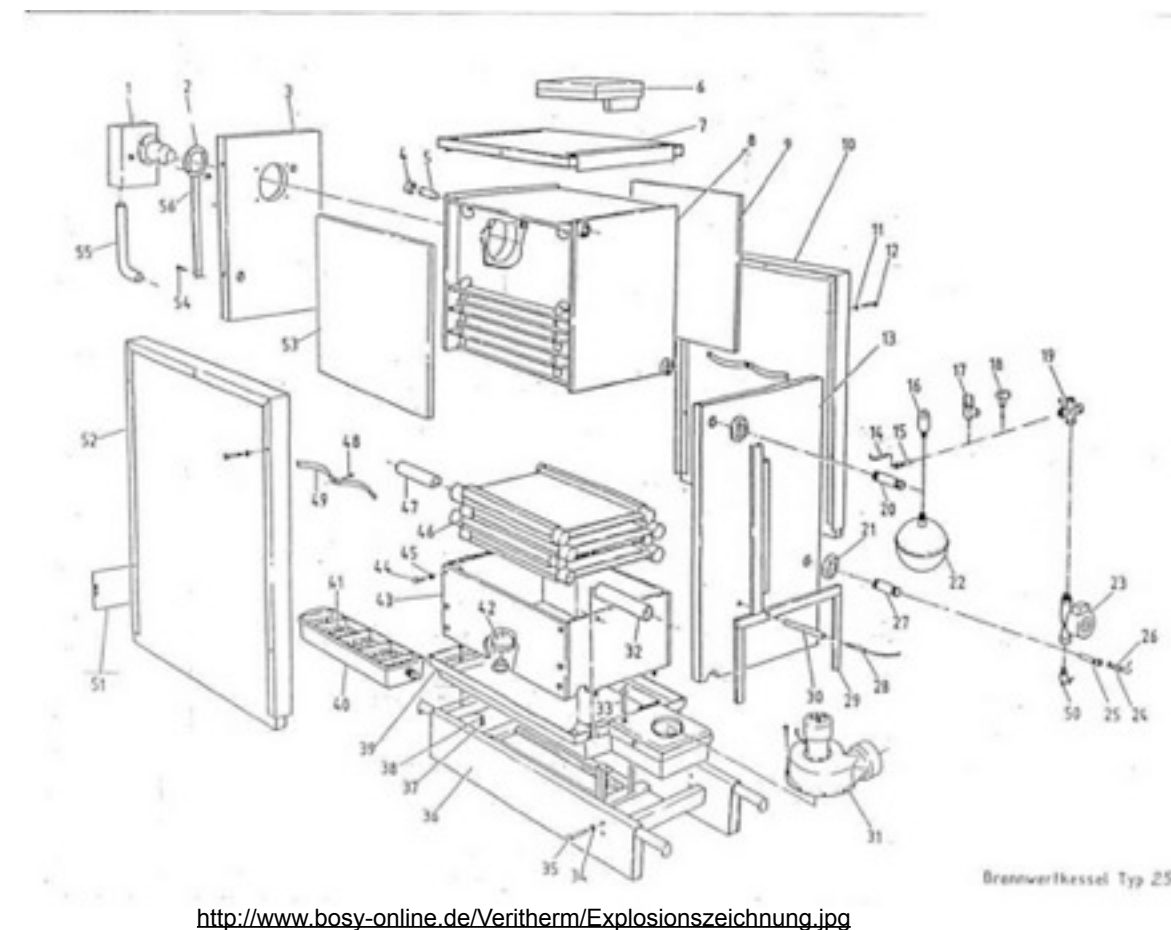
- Why a scene graph?
- What is stored in the scene graph?
 - objects
 - appearance
 - camera
 - lights
- Rendering with a scene graph
- Practical example

The 3D Rendering Pipeline (our version for this class)



Why a Scene Graph?

- Naive approach:
 - for each object in the scene, set its transformation by a single matrix (i.e., a tree 1 level deep and N nodes wide)
 - advantage: very fast for rendering
 - disadvantage: if several objects move, all of their transforms change
- Observation: Things in the world are made from parts
- Approach: define an object hierarchy along the *part-of* relation
 - transform all parts only relative to the whole group
 - transform group as a whole with another transform
 - parts can be groups again



<http://www.bosy-online.de/Veritherm/Explosionszeichnung.jpg>

Chapter 6 - The Scene Graph

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Geometry in the Scene Graph

- Leaves are basic 3D objects (polygon meshes, primitives, ...)

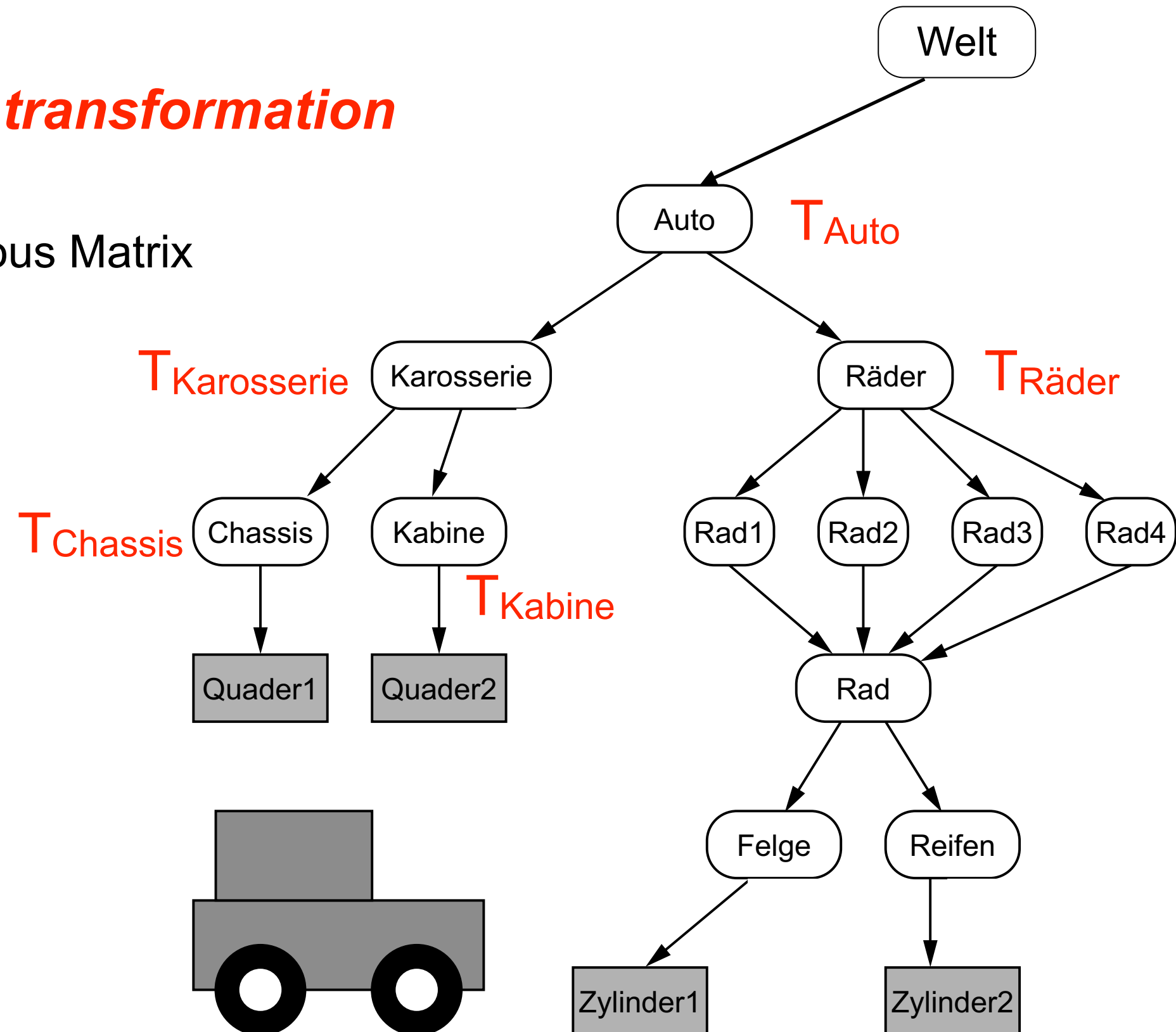
- Non-leaf nodes (groups) contain a **transformation**

- can have one or several children
- transformation is given by a homogeneous Matrix

- Root is the entire world

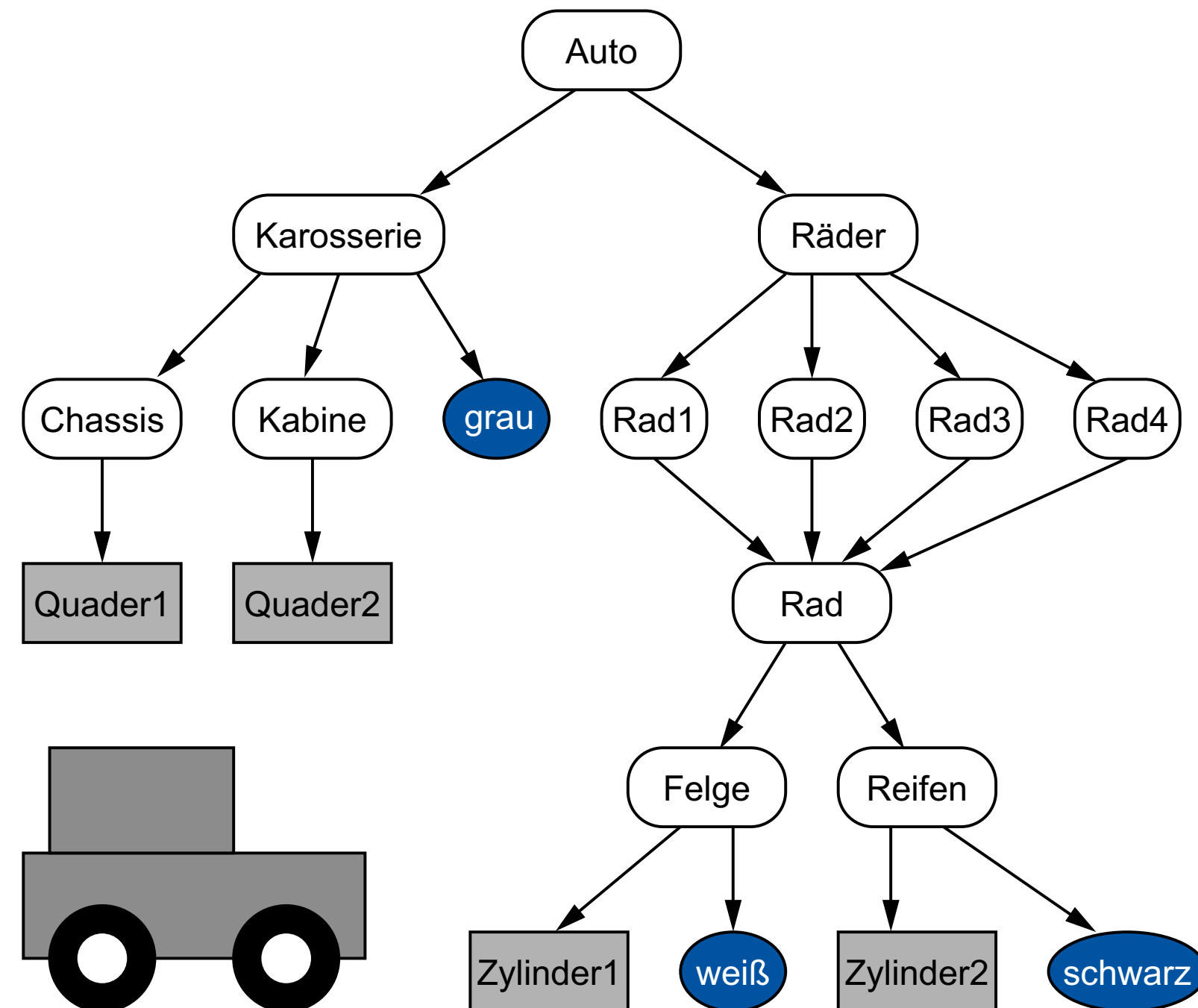
- Nodes can be the child of several groups

- not a tree, but a directed acyclic graph (DAG)
- effective reuse of geometry



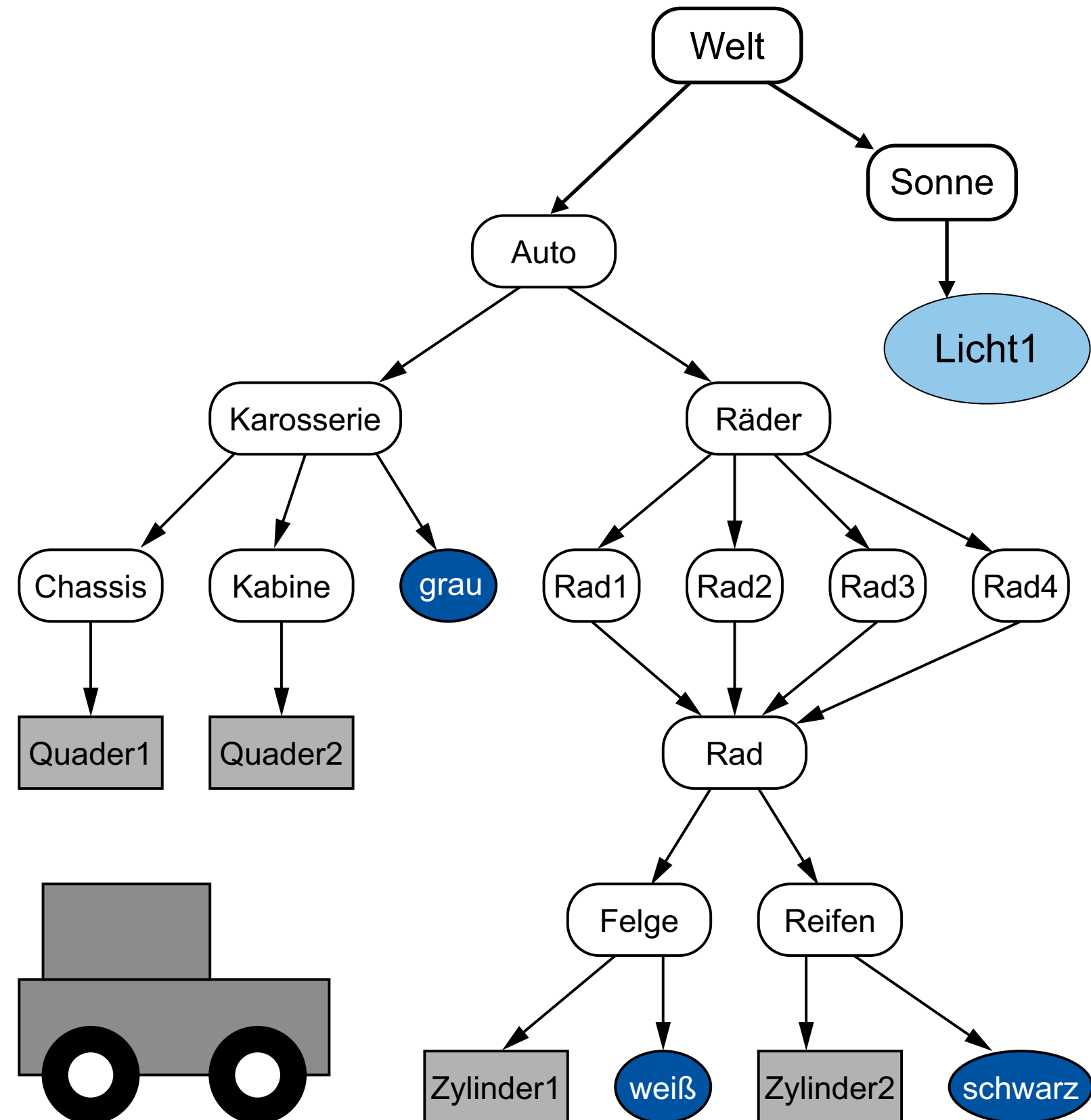
Appearance in the Scene Graph

- Scene graph also contains appearances
 - Appearance: E.g. Color, reflection, transparency, texture
Details see next lecture
 - can be reused similarly to geometry
- Appearance can be only partially specified
 - unspecified values are inherited



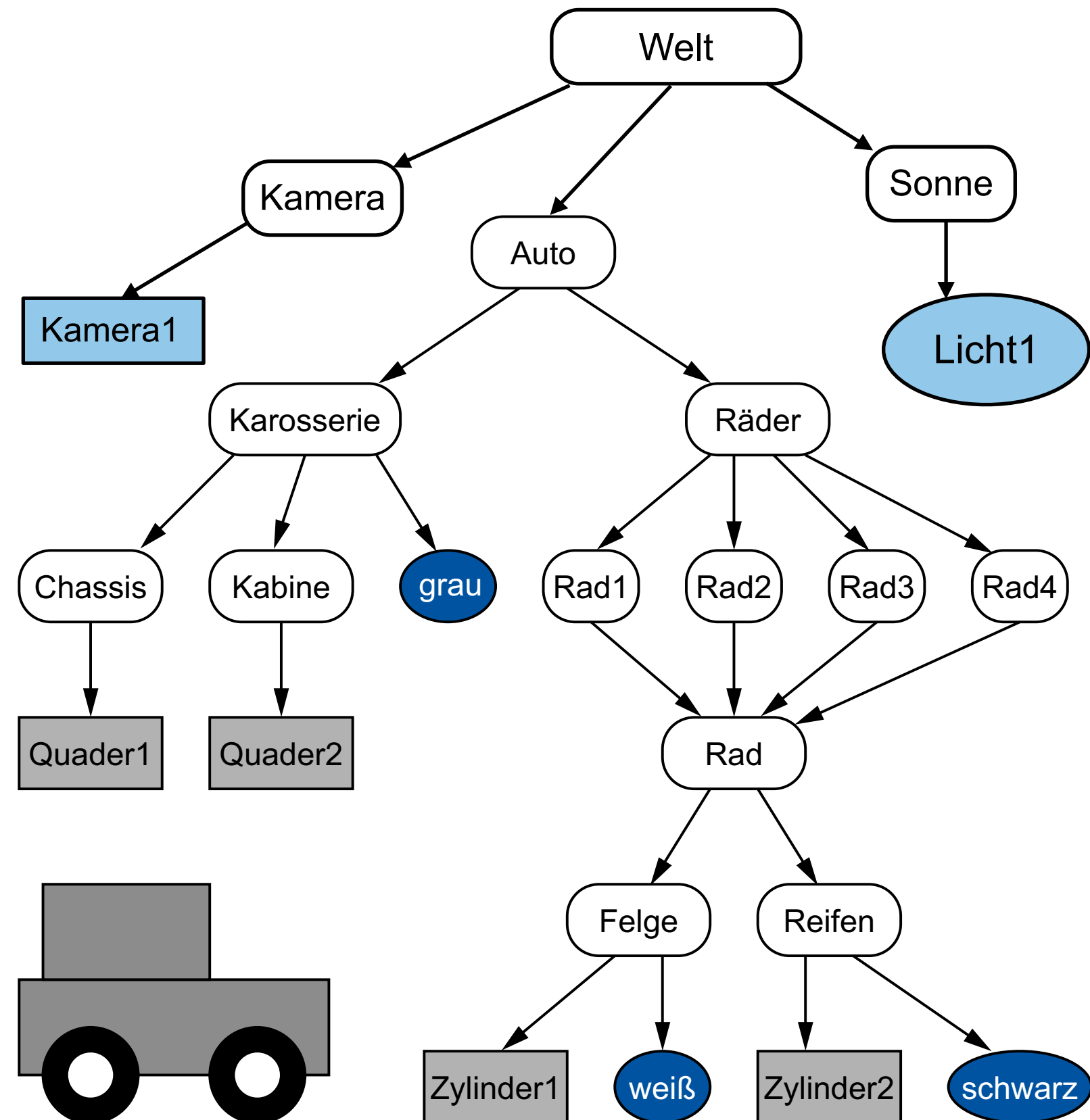
Lights in the Scene Graph

- Light sources also need a position and/or direction
 - Just include them into the scene graph
 - Can be animated just like geometry
- Lights can be in local coordinate systems of geometry groups
 - move with them
 - example: headlamps on a car



The Camera in the Scene Graph

- Camera also needs a position and direction
 - Just include it into the scene graph
 - Can be animated just like geometry
- Camera can be in local coordinate systems of geometry groups
 - move with them
 - example: driver's view from a car

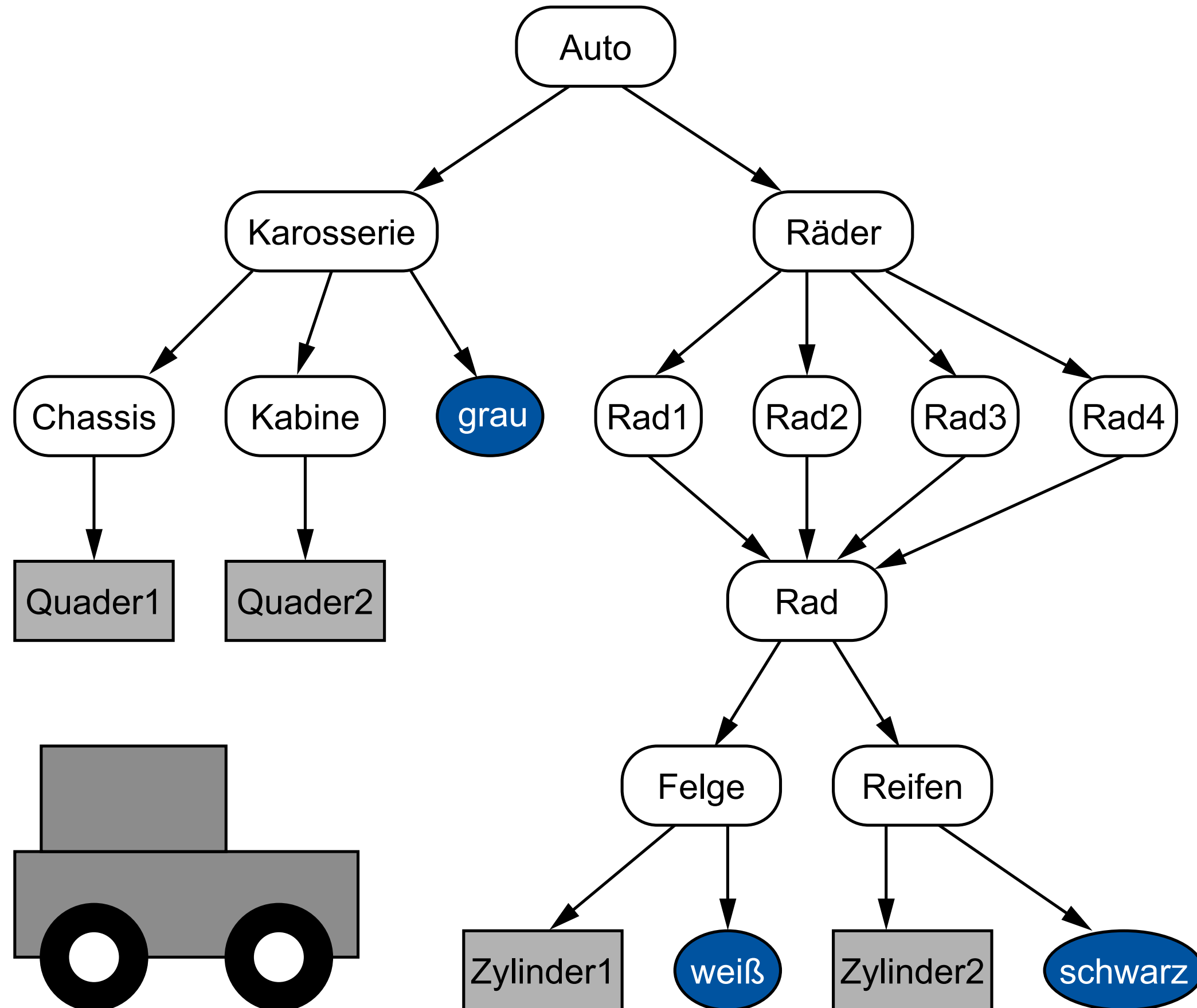


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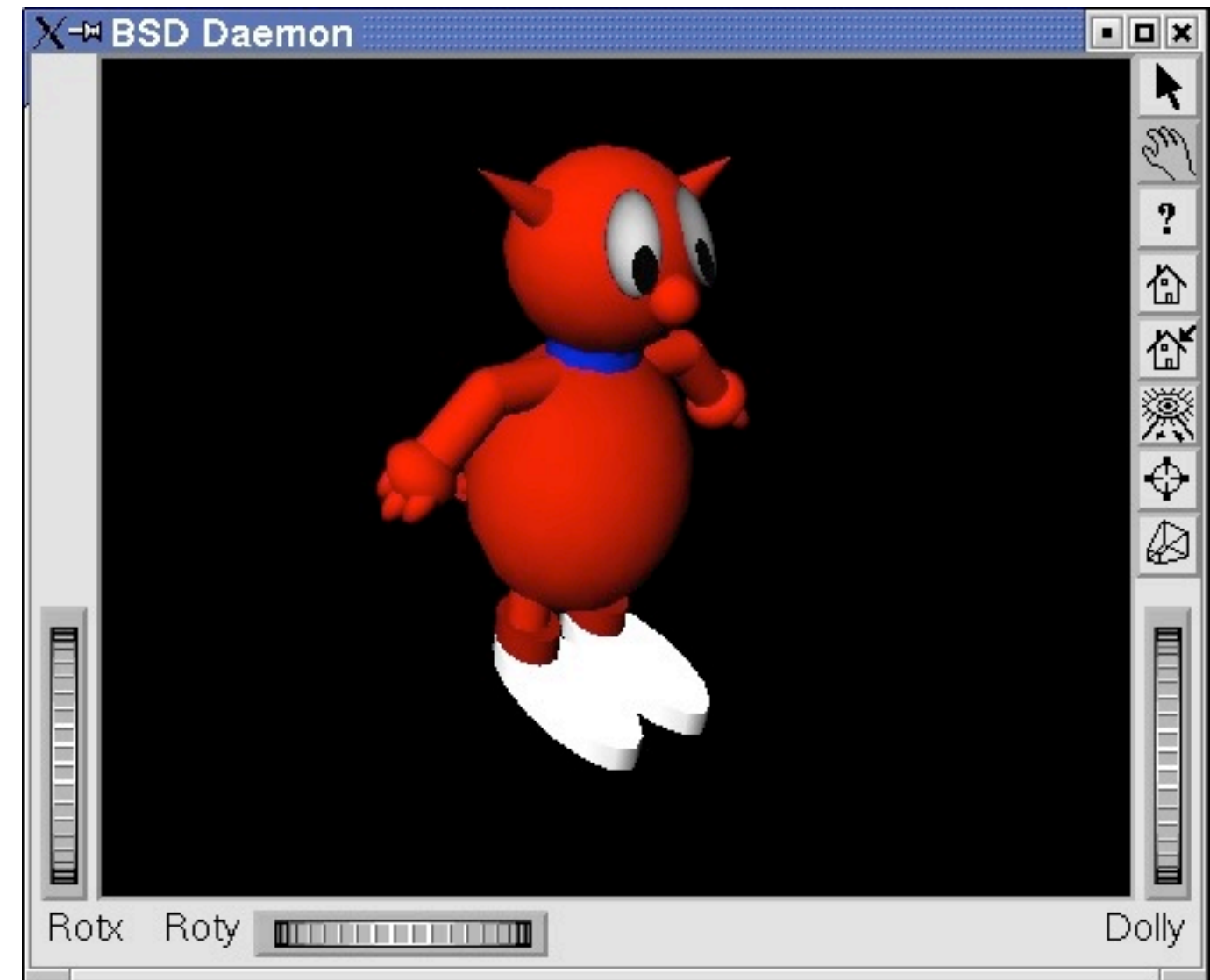
Scene graph traversal for rendering

- set T_{act} to T_{Auto}
- push state
- set T_{act} to $T_{act} \times T_{Karosserie}$
- push state
- set T_{act} to $T_{act} \times T_{Chassis}$
- render Quader1
- pop state
- set T_{act} to $T_{act} \times T_{Kabine}$
- render Quader2
- pop state
- pop state
- set T_{act} to $T_{act} \times T_{Räder}$
- ...



Scene Graph Libraries

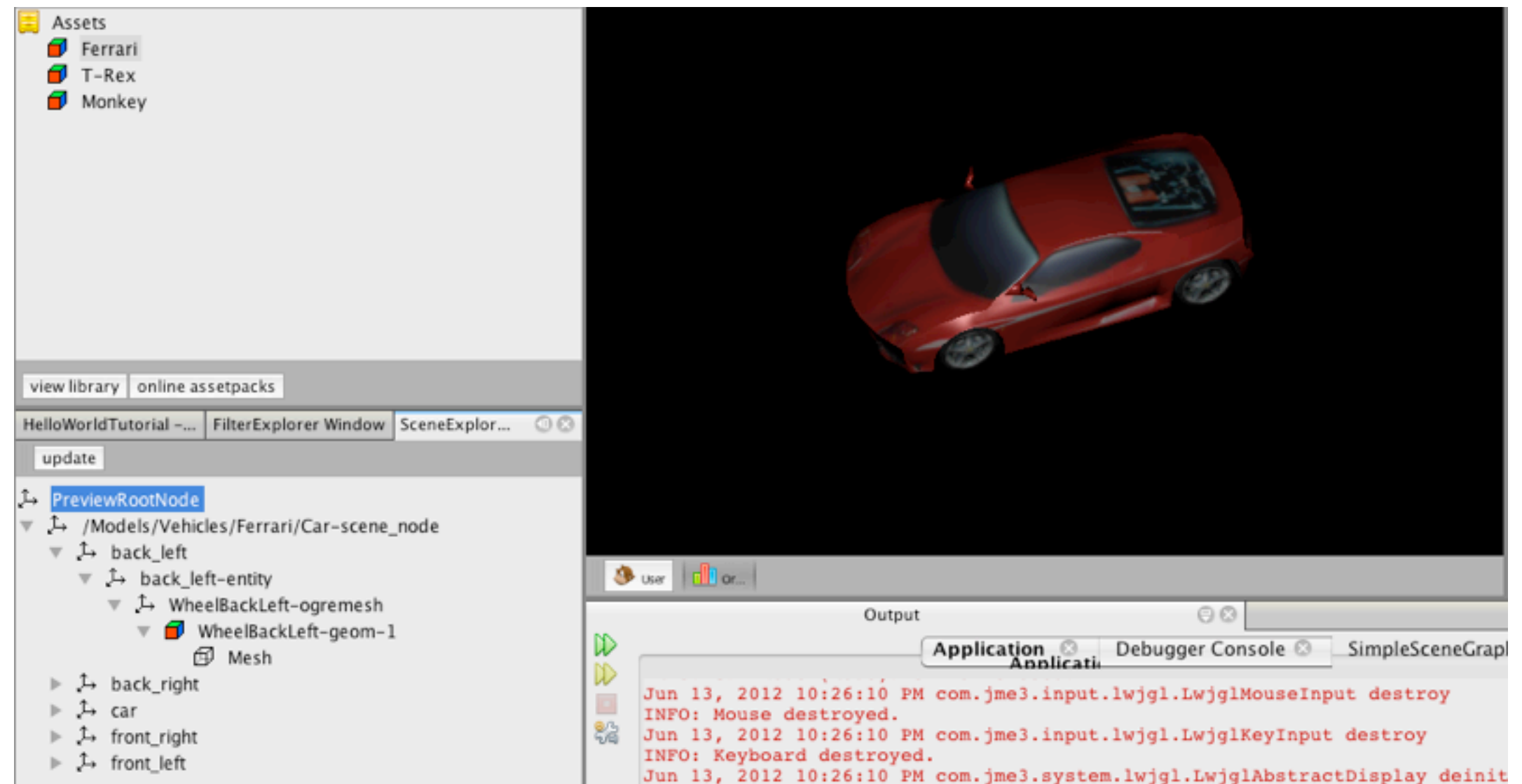
- Scene graphs exist on a more abstract layer than OpenGL!
- VRML/X3D
 - descriptive text format, ISO standard
- OpenInventor
 - based on C++ and OpenGL
 - originally Silicon Graphics, 1988
 - now supported by VSG3d.com
- Java3D
 - provides 3D data structures in Java
 - not supported anymore
- Open Scene Graph (OSG)
- Various Game Engines
 - e.g. JMonkey 3 (scene graph based game engine for Java)



<http://www.shlomifish.org/open-source/bits-and-bobs/open-inventor-bsd-daemon/>

Scene Graphs in Practice

- Creation of scene graphs and objects
 - Specific authoring software (e.g. Blender, Maya, 3DS Max)
- Assets (models, objects) exported to exchange formats
 - E.g. (X3D,) Wavefront OBJ (.obj), 3ds Max (.3ds), Ogre XML (.mesh)
- Objects typically are tessellated
 - Polygon meshes
 - No primitive geometric objects visible/readable anymore
- Example:
 - JME Scene



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Example of a scene graph

- Graph to be drawn together in the lecture
- VRML world linked from the class page

