Principles of Computer Game Design and Implementation

Lecture 5

We already knew

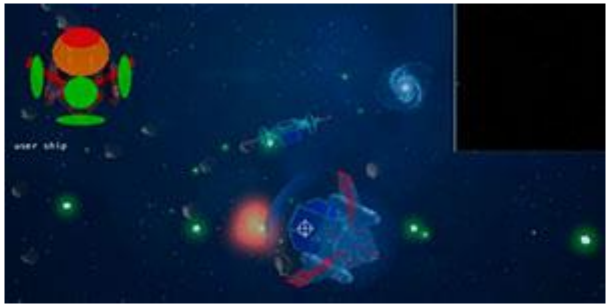
- Introduction to this module
- History of video
- High-level information of a game
- Designing information for a game
- Execution of a game (Game loop)

jMonkeyEngine

Architecture and Mathematical Concepts

jMonkeyEngine

- A high performance scene graph based graphics API
- Completely open source (BSD License)
- Written in pure Java



jMonkeyEngine graphics

jMonkeEngine History

- Started in 2003 by Mark Powell inspired by a C++ book *“3D Game Engine Design”*
- 2008 jMonkeyEngive v. 2.0
- 2009 Development stalled. Project forked.

jMonkeEngine v. 3.0

- Community-driven project
- New people joint
- Integration with free tools

Ardor 3D

- Commercial development
- Neater but less features

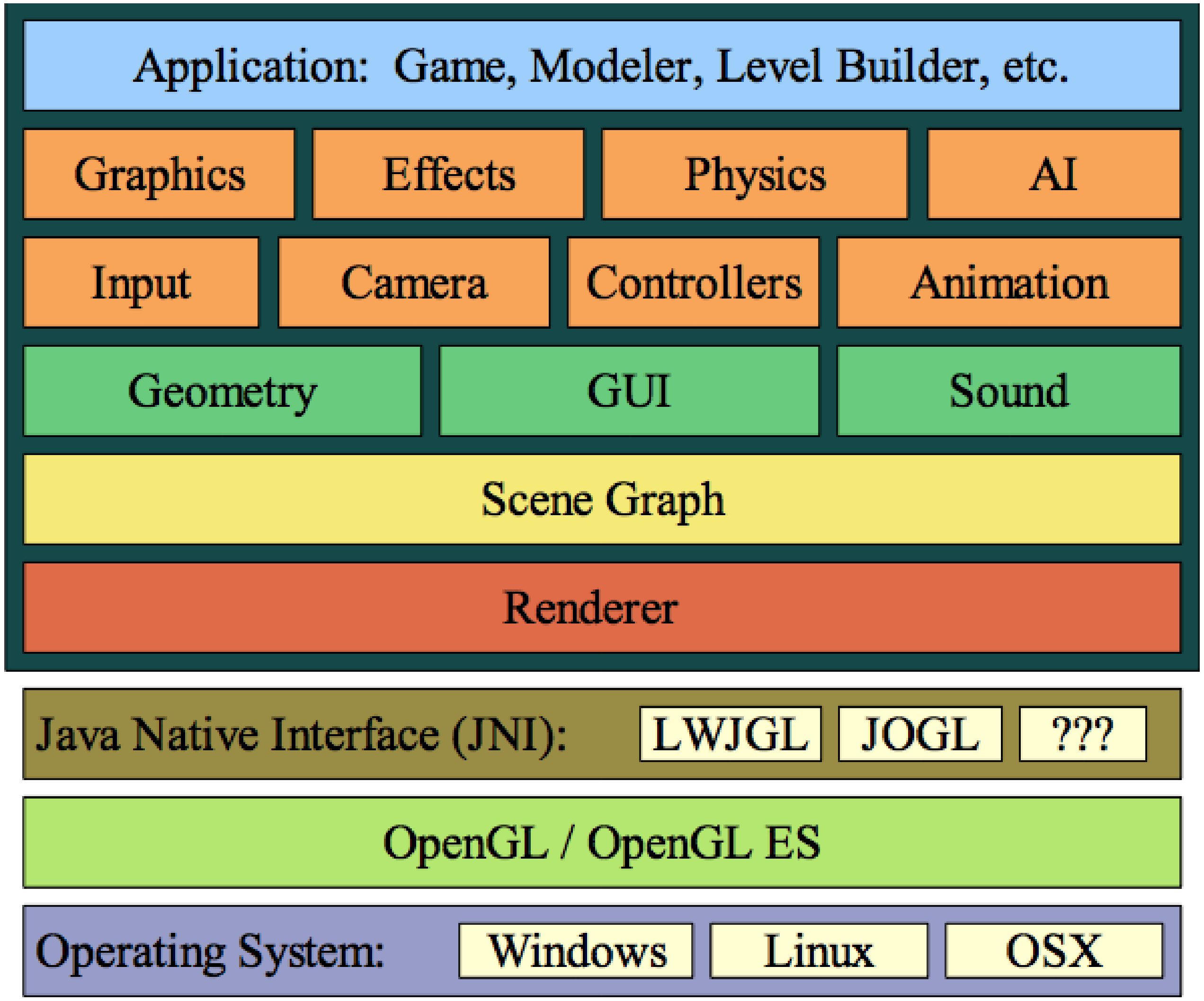
Version Differences

- jME v2.0
  - Stable
  - Uses OpenGL 1. Runs on *any* hardware
- jMe v2.1
  - Final release in the 2.x branch
- jME v3.0
  - Uses OpenGL 2. Runs well on *modern* hardware
  - **Shader** based
  - Physics engine integrated
  - jMonkeyPlatform
  - Supports Android devices

jME Documentation

- Official site: http://www.jmonkeyengine.org

jME Architecture



the picture is largely out-dated, but it still conveys the idea

Where Will It Run?

- jME is 100% Java.
- It depends on a JNI platform.
  - LWJGL is currently the only supported JNI platform.
  - LWJGL runs on Linux, OSX, and Win32.
- Implemented over OpenGL

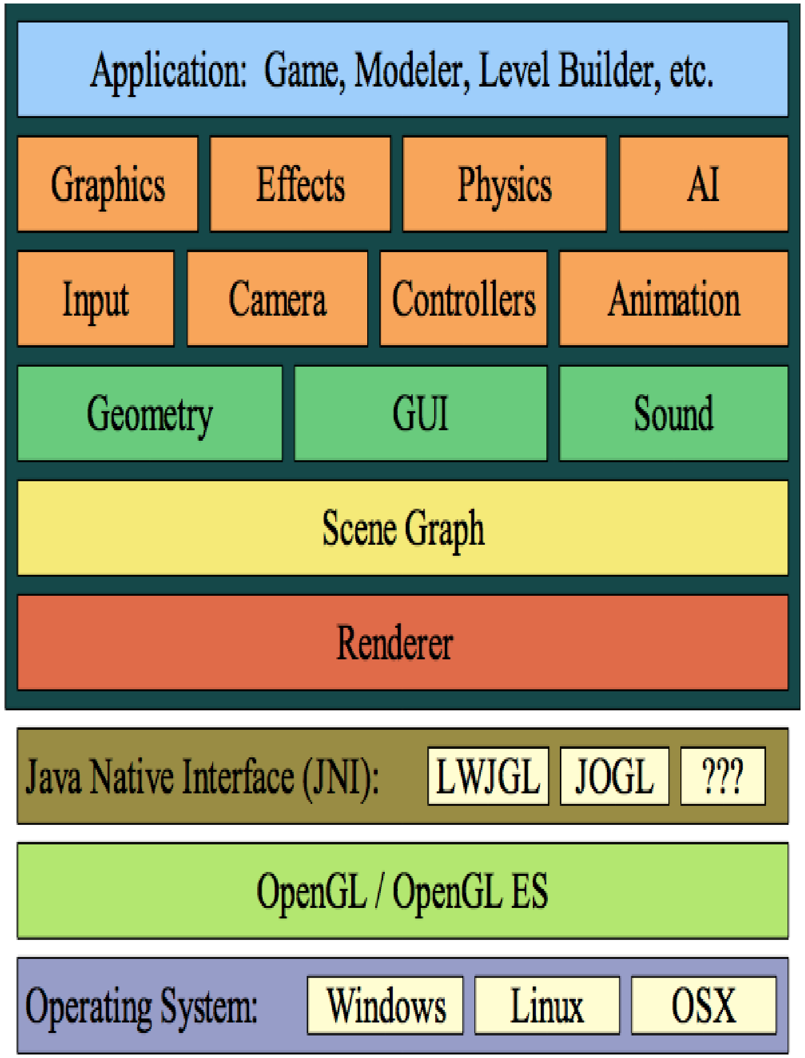
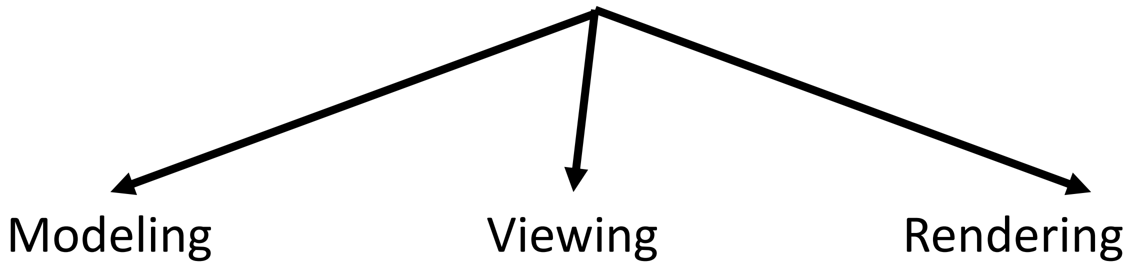


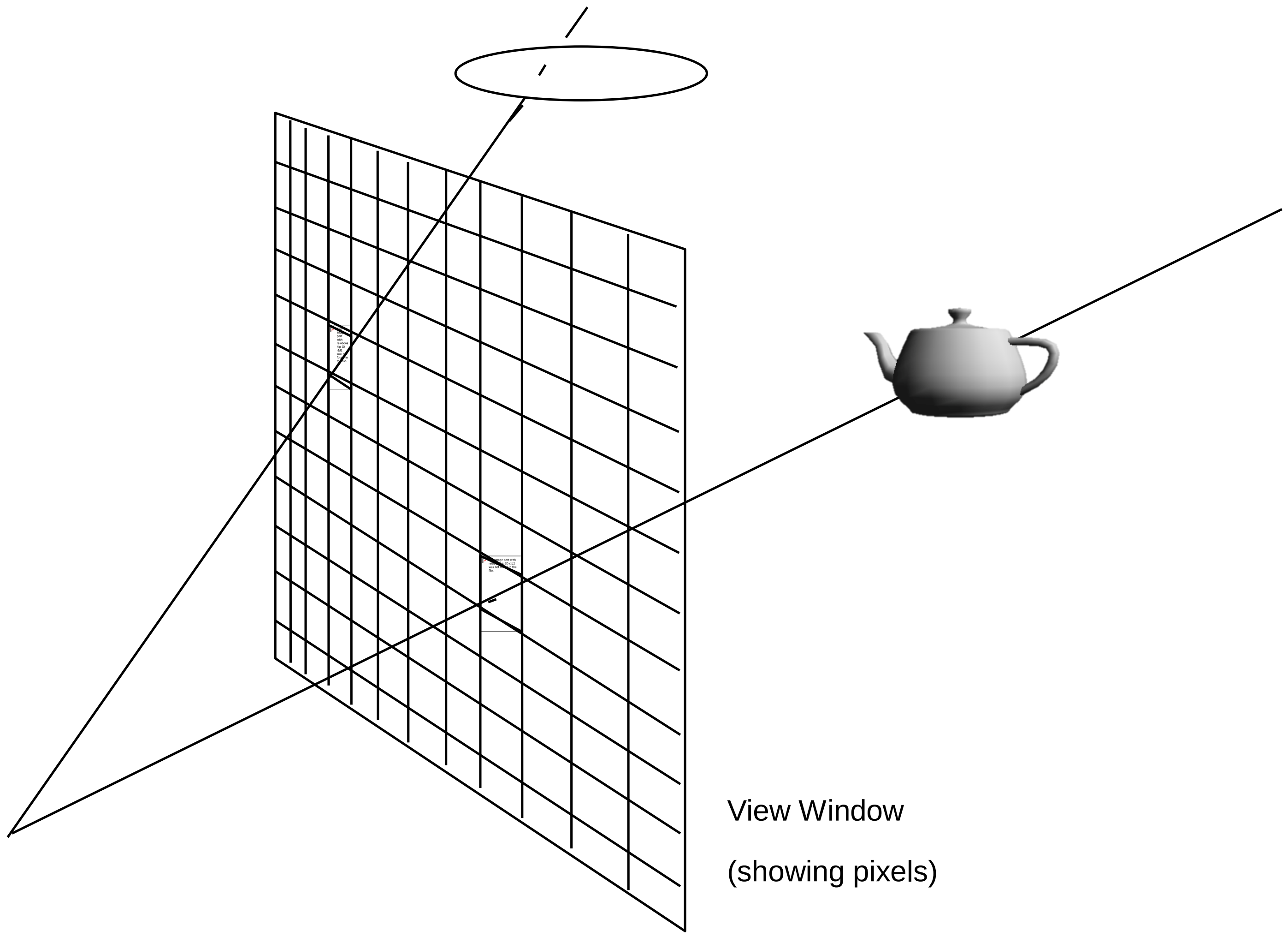
Image Synthesis



Separation of **Scene Specification**, **Viewing** and **Rendering**

- **Scene** is modelled independent of any view
- **Views** are unconstrained
- There are many possible **rendering** methods given a scene and a view

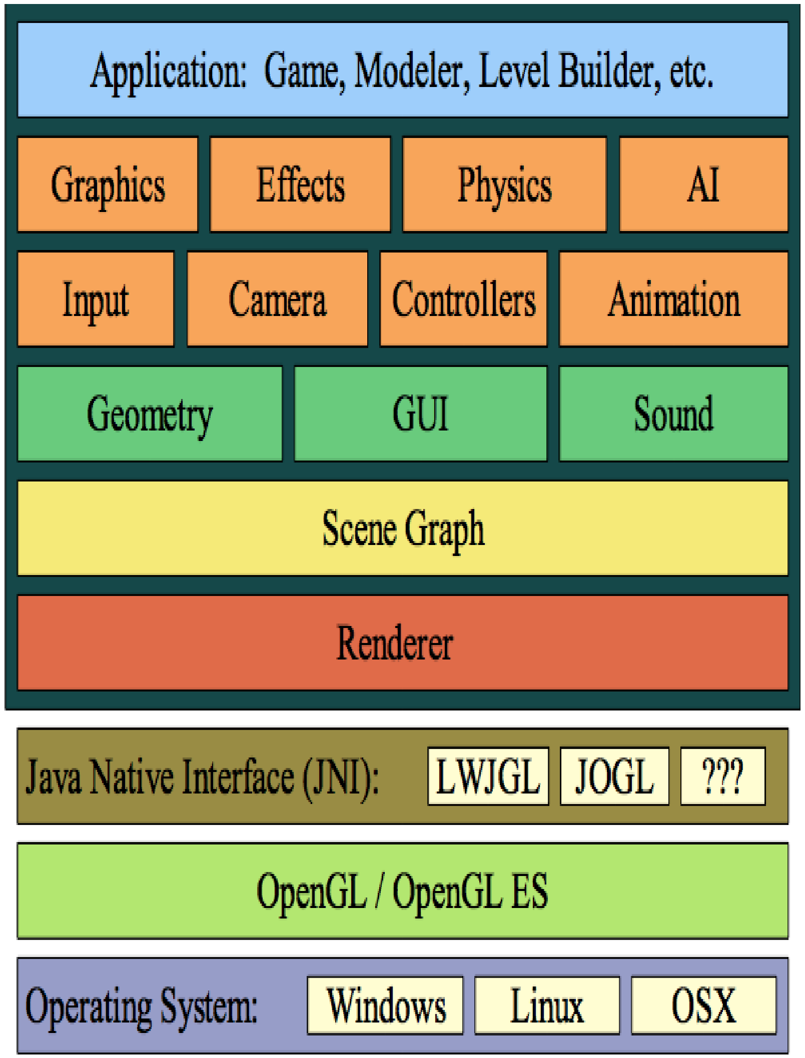
Model to Screen



Renderer

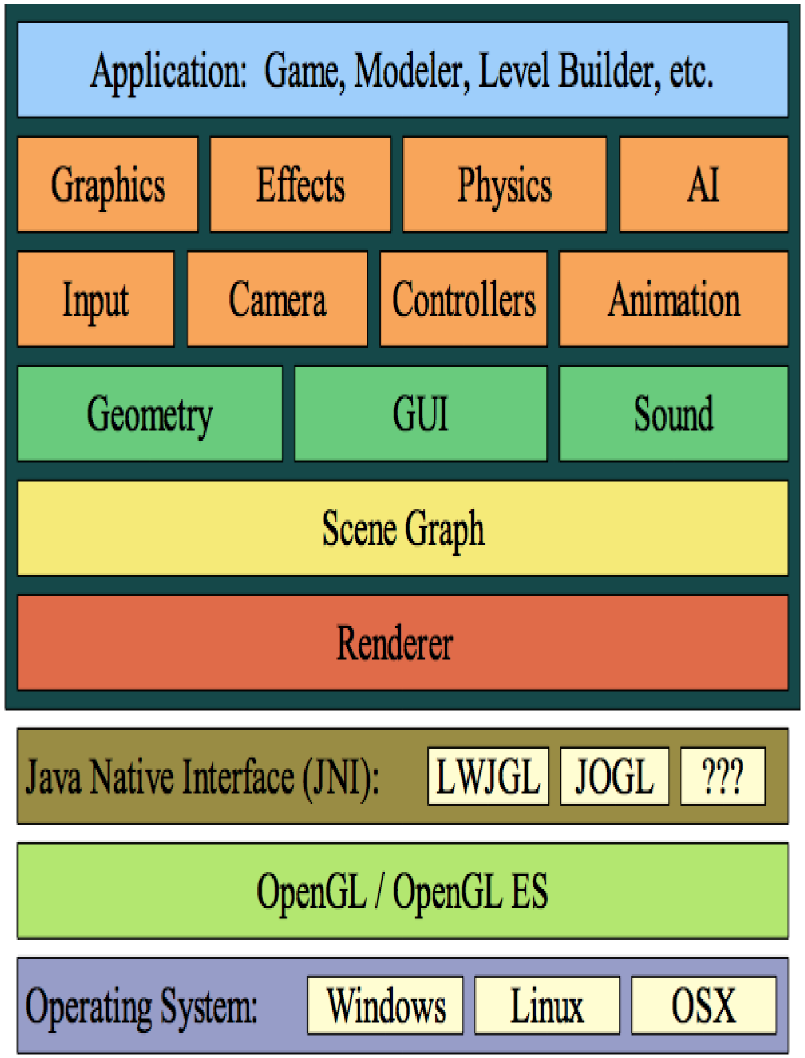
- Transforms geometry from world space to screen space
- Eliminates “hidden” objects
- Draws the transformed scene

More to follow



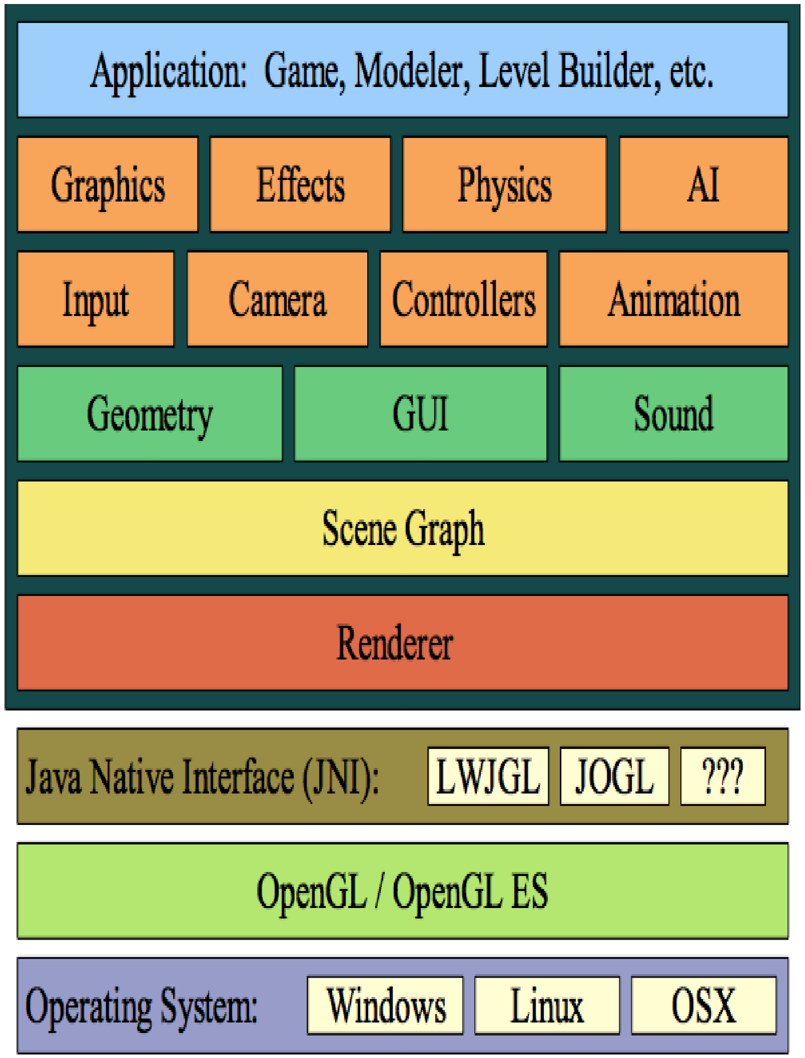
Scene Graph

- A hierarchical data structure used to group data
  - Simplifies management
  - Groups objects into the same spatial region
  - Facilitates transformations & rotations of compound objects



Geometry

- Geometry
  - Geometric data for rendering objects
- GUI
  - Widgets
- Sound
  - Similar to renderer
  - 3D effects



Setting Up jME 3.0

- Download the appropriate version of the jMonkeyEngine SDK
  - http://jmonkeyengine.org/downloads/
- Run the installer

(already available in the labs)

- File -> New Project -> BasicGame

Simplest jME Program

```
package mygame;

import com.jme3.app.SimpleApplication;

public class Main extends SimpleApplication {

    public static void main(String[] args) {
        Main app = new Main();
        app.start();
    }

    public void simpleInitApp() {
    }
}
```

A Default Blue Box

```
package mygame;

import com.jme3.app.SimpleApplication;
import com.jme3.material.Material;
import com.jme3.math.ColorRGBA;
import com.jme3.scene.Geometry;
import com.jme3.scene.shape.Box;

public void simpleInitApp() {
        Box b = new Box(1, 1, 1);
        Geometry geom = new Geometry("Box", b);

        Material mat = new Material(assetManager, "Common/MatDefs/Misc/Unshaded.j3md");
        mat.setColor("Color", ColorRGBA.Blue);
        geom.setMaterial(mat);

        rootNode.attachChild(geom);
    }

public class Main extends SimpleApplication {

    public static void main(String[] args) {
        Main app = new Main();
        app.start();
    }
}
```

Let’s Run It

Demo

Game Loop

```
package mygame;

import com.jme3.app.SimpleApplication;
import com.jme3.material.Material;
import com.jme3.math.ColorRGBA;
import com.jme3.scene.Geometry;
import com.jme3.scene.shape.Box;

public void simpleInitApp() {
        Box b = new Box(1, 1, 1);
        Geometry geom = new Geometry("Box", b);

        Material mat = new Material(assetManager,
                                "Common/MatDefs/Misc/Unshaded.j3md");
        mat.setColor("Color", ColorRGBA.Blue);
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        rootNode.attachChild(geom);
    }

public class Main extends SimpleApplication {

    public static void main(String[] args) {
        Main app = new Main();
        app.start();
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}
```
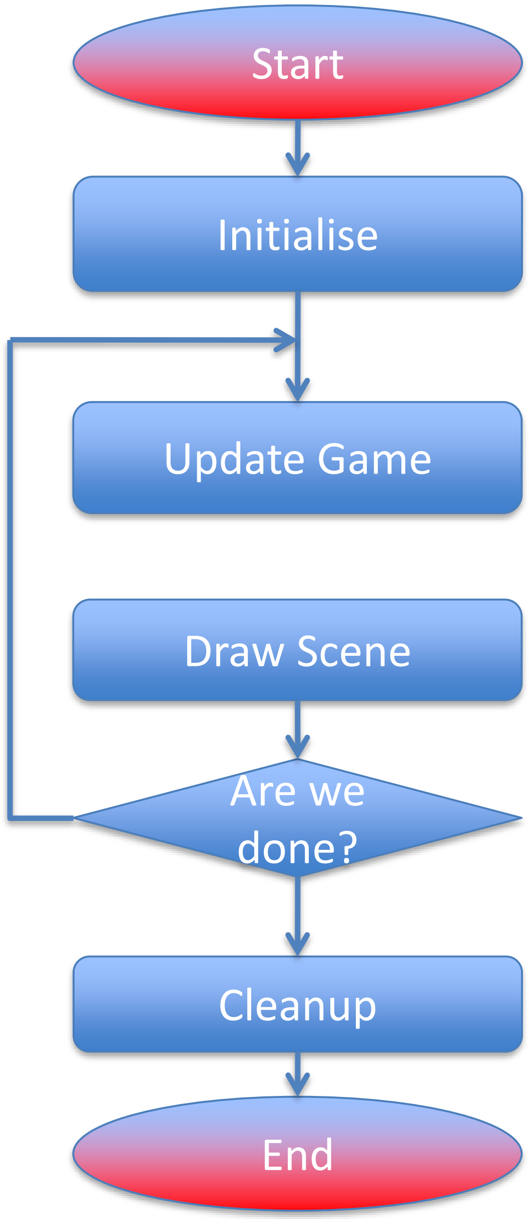



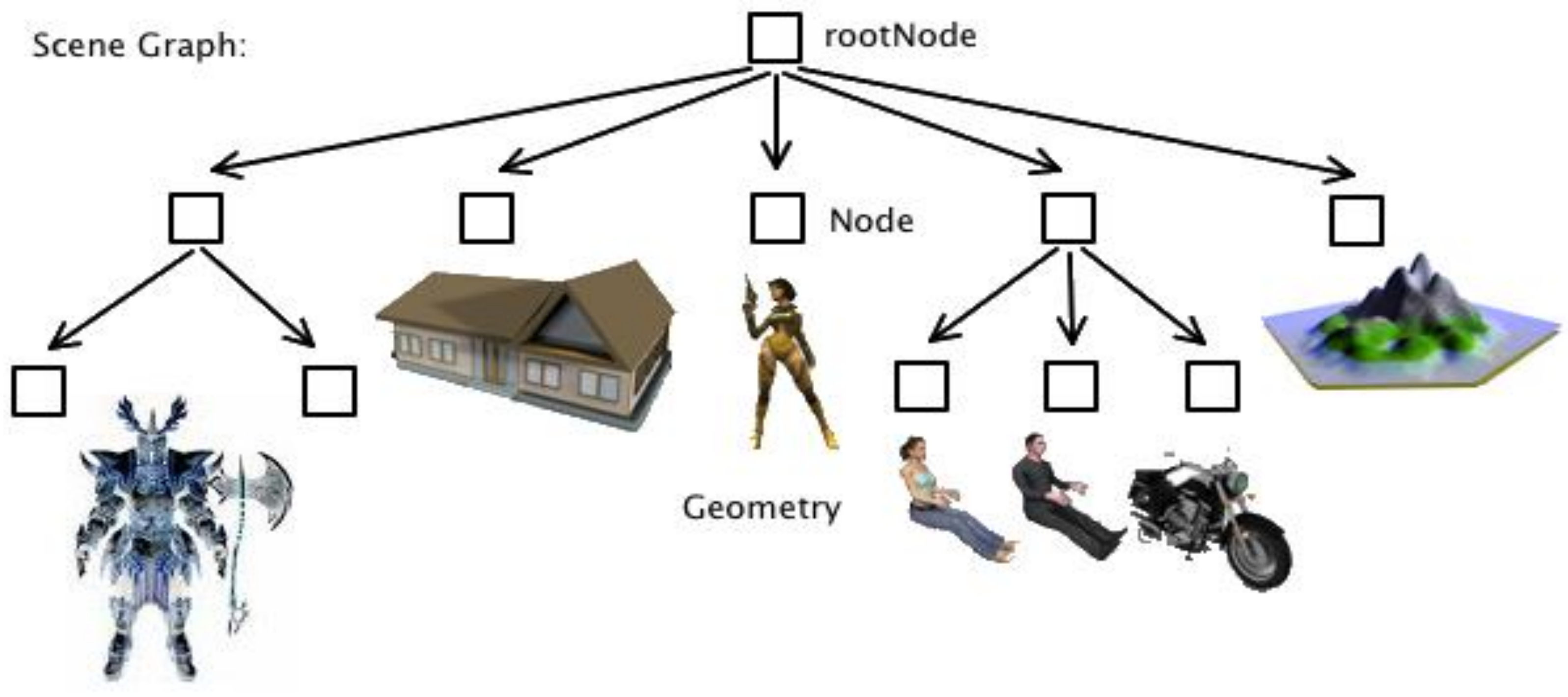
SimpleApplication Provides

- Options dialog (when you first run it)
  - Can ask for it to be always on
- Input handler
- Standard camera
- A timer to compute the frame rate and provide smooth movements

- rootNode

Scene Graph

- The scene graph represents the 3D world
- Leaf nodes (**Geometry**) represent data
- Internal nodes (**Nodes**) group and manage data



Two Geometries

```
public void simpleInitApp() {
    Material mat = new Material(assetManager,
   "Common/MatDefs/Misc/Unshaded.j3md");
    mat.setColor("Color", ColorRGBA.Blue);

    Box b = new Box(1, 1, 1);
    Geometry geom = new Geometry("Box", b);
    geom.setMaterial(mat);

    Sphere s = new Sphere(60, 60, 1.5f);
    Geometry sgeom = new Geometry("Sphere", s);
   sgeom.setMaterial(mat);

    rootNode.attachChild(geom);
    rootNode.attachChild(sgeom);
 }
```

Graphical Model

- Items arranged spatially (grouped together)
  - Placing something (e.g. a light) in a branch affects all branch elements
- A node is a reference point to its children
  - Simplifies rendering
  - Simplifies manipulation
- Simplifies importing models

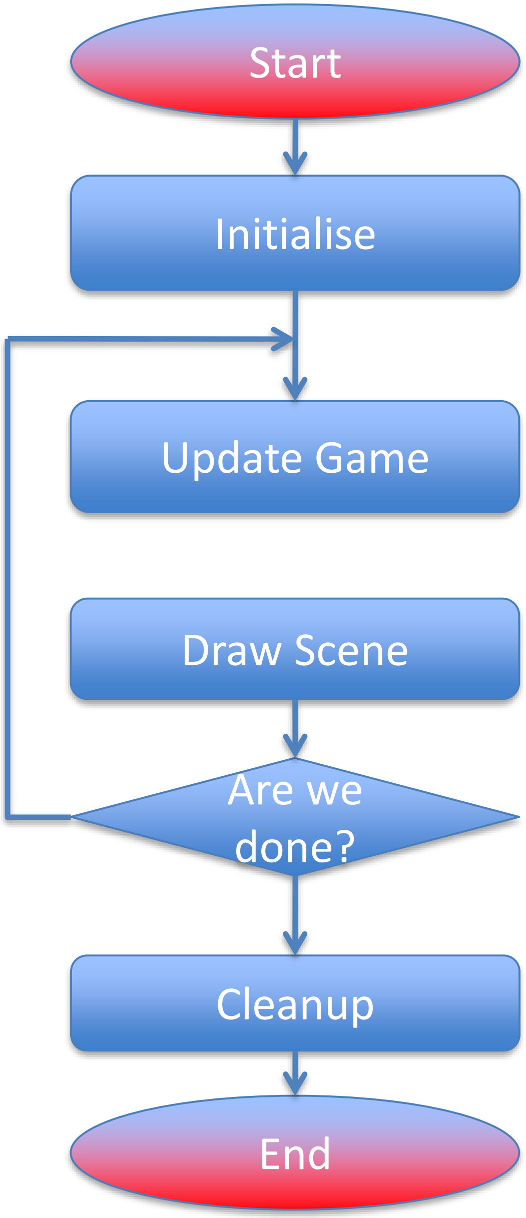
Rendering Scene Graph

- Every node (Nodes and Geometry) defines
  - Transform(ation)s
    - orientation, location and scale
  - BoundingVolume
    - An area containing all sub-nodes
  - Render state
    - Defines how geometry is displayed

Meaningful Game Loop

```
…
protected Geometry g;
…
 public void simpleUpdate(float tpf) {
        geom.move (0.001f, 0, 0));
   }
```

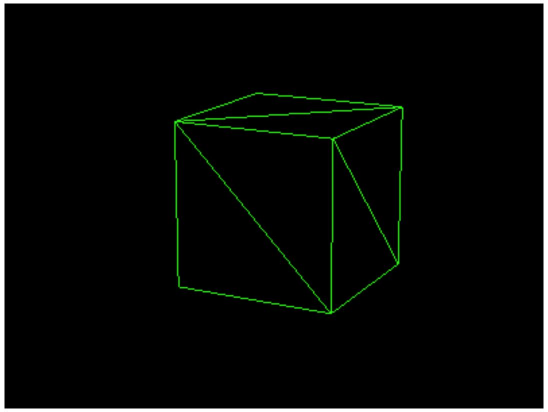
Changes the scene graph



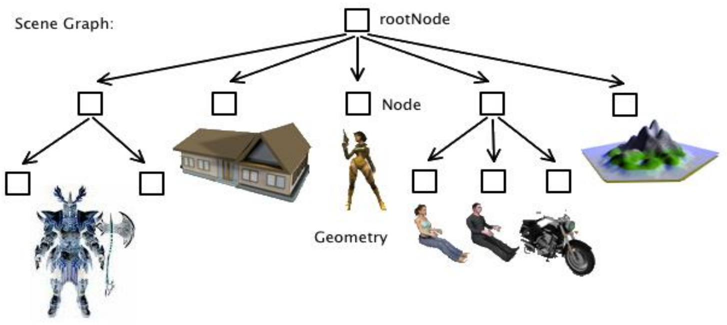
Let’s Run It

Demo

Meshes and Geometries



A collection of *polygons* that can be drawn



Everything that is rendered

Box mesh = new Box(1, 1, 1);

Geometry geom = new Geometry("Box", mesh);

But *how* is it rendered

Meshes, Geometries and Materials

- All Geometries must have *Materials* that defines colour or texture.
- Each Material is based on a Material Definition file (.j3md)
  - Lighting.j3md, Unshaded.j3md

All Materials (except "Unshaded" ones) are **invisible** without a light source.

Example

```
public void simpleInitApp() {
  Box b = new Box(1, 1, 1);
  geom  = new Geometry("Box", b);
  rootNode.attachChild(geom);
  Material mat = new Material(assetManager,
        "Common/MatDefs/Light/Lighting.j3md");
  geom.setMaterial(mat);
  DirectionalLight sun = new 
DirectionalLight();
  sun.setDirection(new Vector3f(1, 0, -2));
  sun.setColor(ColorRGBA.White);
  rootNode.addLight(sun);
}
```

3D Models and Games

- While it is possible to specify the geometry based on basic shapes (we do it), most games *import* scene graphs from a 3D modelling tool
  - Maya
  - 3D Max
  - Blender
  - …

Summary

- jMonkeyEngine is a simple yet powerful Java game engine
- Basic shapes can be combined in a scene graph to create a 3D model
- We need some Maths to manipulate entities