4 Fundamental Issues in Multimedia Programming

4.1 Multimedia Programming in Context

4.2 History of Multimedia Programming

4.3 A Radically Alternative Approach: Squeak

- Etoys
- Video: Squeak in a School Project (Gravity)
- Smalltalk: A Brief Introduction

4.4 The Programmers’ Way: Multimedia Frameworks for Java

4.5 Trends and Visions

Literature:

Mark Guzdial, Kim Rose: Squeak - Open Personal Computing and Multimedia, Prentice-Hall 2002

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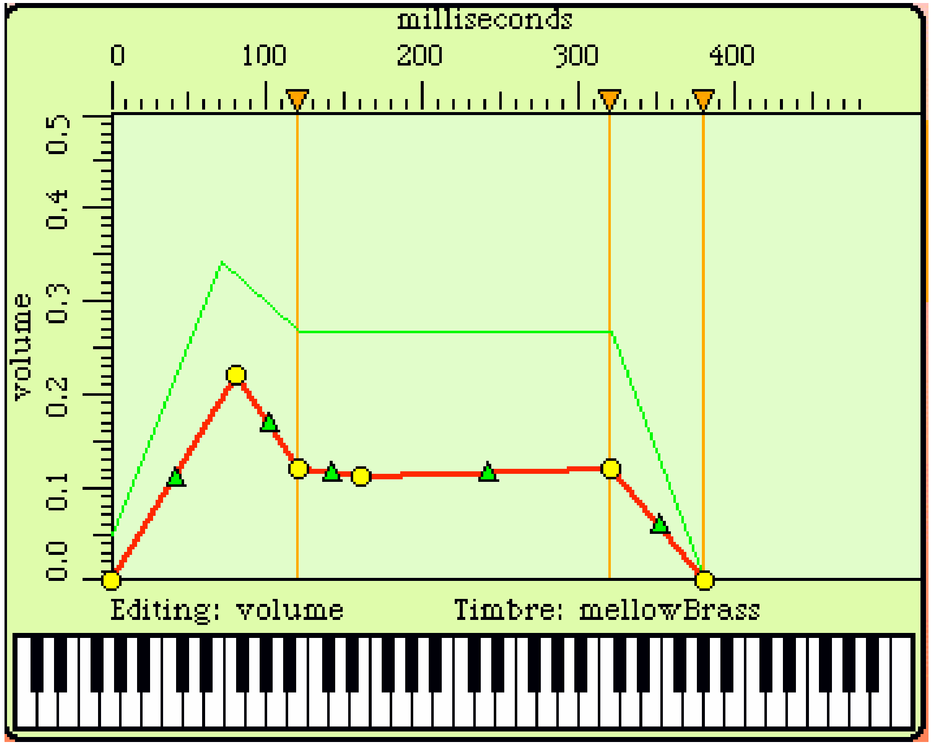
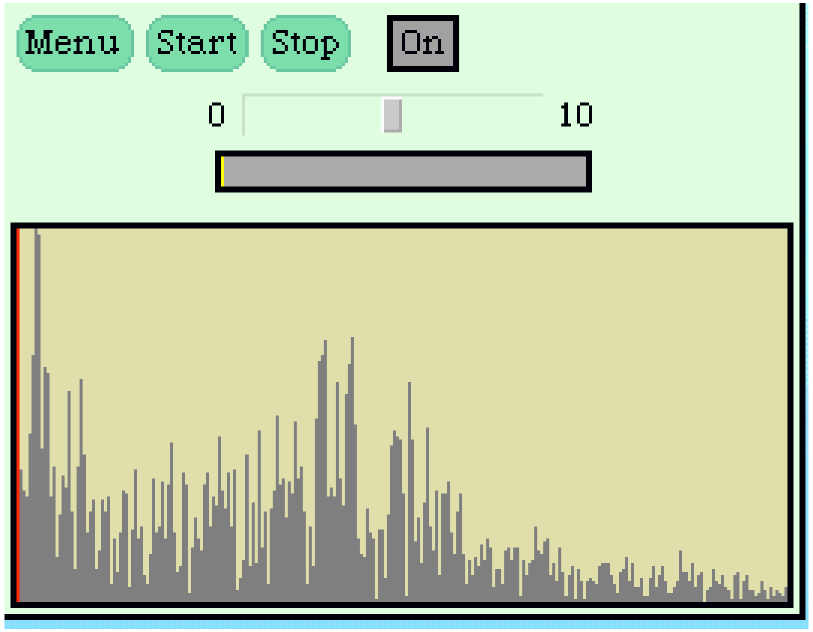
Target Persons for Multimedia Programming Technology

Intended activities	Non-technical people	Experts
Passive consumption	**Flash**	—
Design of complex systems	Squeak	**Flash**
Experimentation, learning	EToys	Squeak

Squeak as an Experimentation Platform

- Example: Sound in Squeak



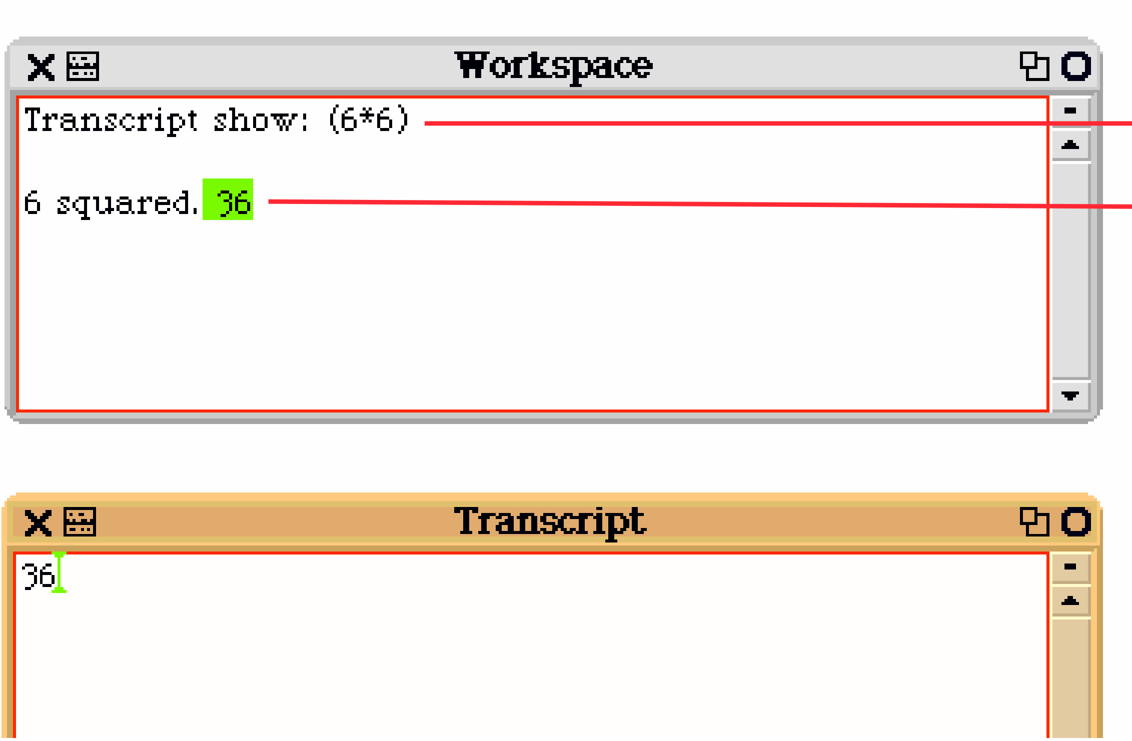


Smalltalk Interpreter in Squeak

- Smalltalk:
  - The language of the first systems with a graphical user interface
- Smalltalk-80:
  - Standardized syntax for Smalltalk
- Smalltalk in Squeak:
  - Squeak system contains a full interpreter for Smalltalk-80 syntax
  - Squeak system is written in Squeak mostly (and cross-complied to C)
    - » 95% of the system is in Squeak
  - Smalltalk is the serious programming language in Squeak
    - » Squeak scripting is just for kids...

Smalltalk Programming is Open & Interactive

- Smalltalk programs are always ready for execution, even small parts of the code can be evaluated instantly
- The interpreter state is saved/loaded in an “image” file.
- The full code of the runtime system can be inspected at any time.



```
Transcript show: (6*6)

6 squared. 36
```

```
36
```

“do it” (ctrl-d)

“print it” (ctrl-p)

Basic Rules of Smalltalk

- Every variable is an object.
  - There are no basic types which are not objects!
- Squeak code is always triggered by sending a message to an object.
- All methods return a value.
- There are three types of messages
  - Unary, e.g. **`3 negated.`**
  - Binary, e.g. **`a + b.`**
  - Keyword, e.g. **`Transcript show: a.`**
    - » **`show`** message with parameter **`a`** is sent to object **`Transcript`**
- All code is evaluated from left to right.
  - Unary messages first, then binary, then keyword messages
  - There are no operator precedence rules.
- Assignment evaluates right hand side and assigns the result to left hand side.

Smalltalk Blocks

-
  ```
  a := [2 + 3].
  a value.
  ```
  Result: 5

-
  ```
  c := [:a :b | a + b].
  c value: 5 value: 7.
  ```
  Result: 12
  (a multiple-part message)

-
  ```
  x := 3.
  y := 5.
  (x = y)
    ifTrue: [Transcript show: 'equal']
    ifFalse: [Transcript show: 'not equal'].
  ```
  Control flow realized by message passing mechanism

Example: Playing Musical Notes in Smalltalk

```
instr := AbstractSound soundNamed: 'oboe1'.
note1 := instr soundForPitch: #c4 dur: 0.5 loudness: 0.4.
note2 := instr soundForPitch: #ef4 dur: 0.5 loudness: 0.4.
note3 := instr soundForPitch: #g4 dur: 0.5 loudness: 0.4.
(note1, note2, note3) play.
(note1 + note2 + note3) play.

song := AbstractSound noteSequenceOn: instr from: #(
    (c4 0.35 400)
    (c4 0.15 400)
    (d4 0.5 400)
    (c4 0.5 400)
    (f4 0.5 400)
    (e4 1.0 400)).
song play.
```

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- Java 2D + Advanced Imaging
- Java Sound
- Java Media Framework

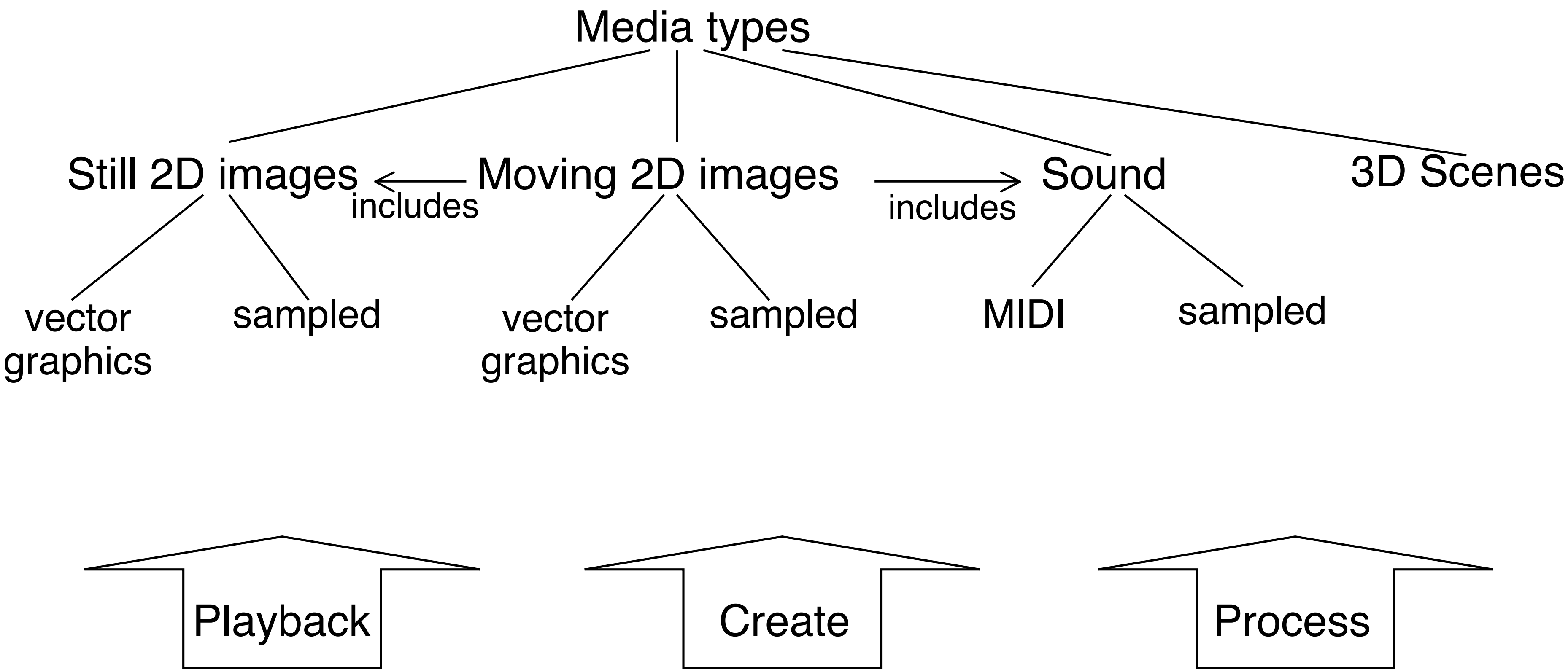
4.5 Trends and Visions

Literature:

J. Knudsen, Java 2D Graphics, O'Reilly 1999

http://java.sun.com/products/java-media/2D/

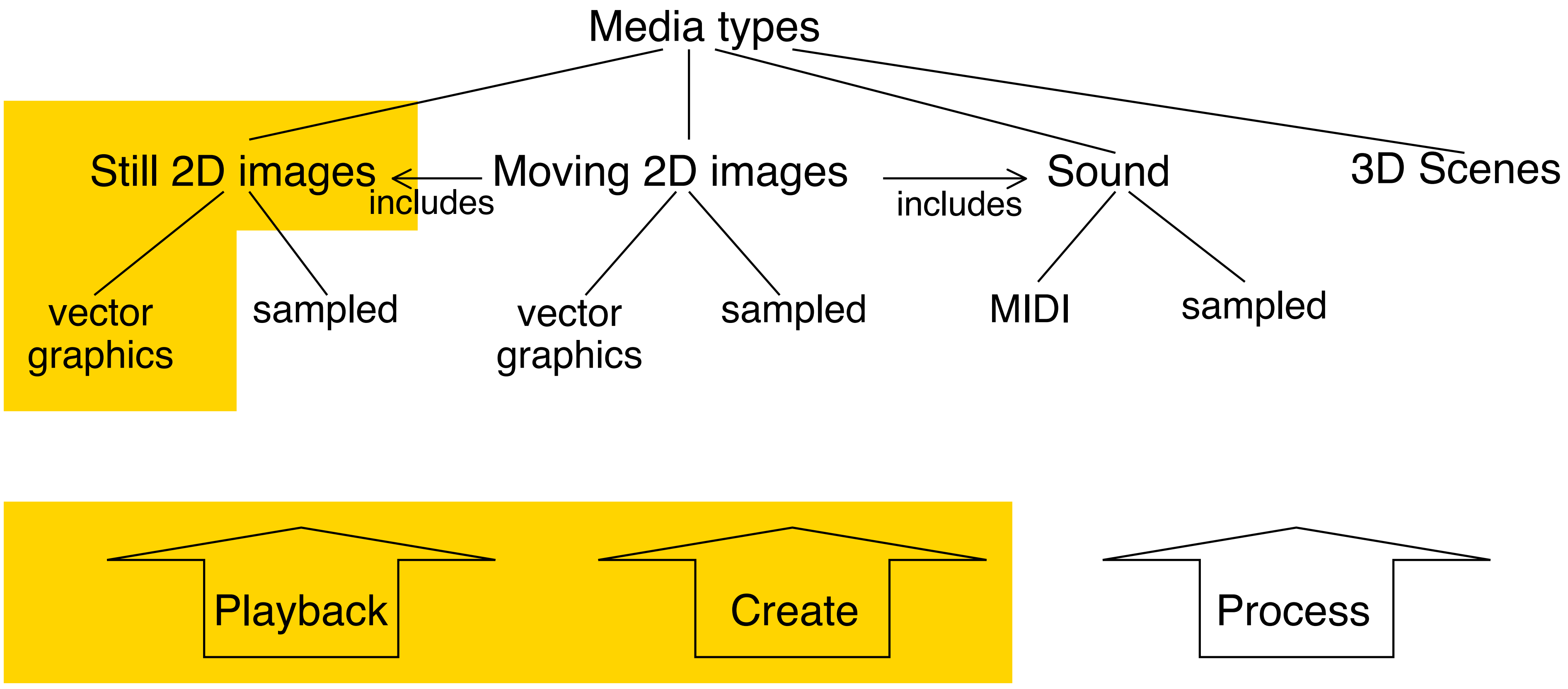
Types of Multimedia Features for Programs



Java Media APIs

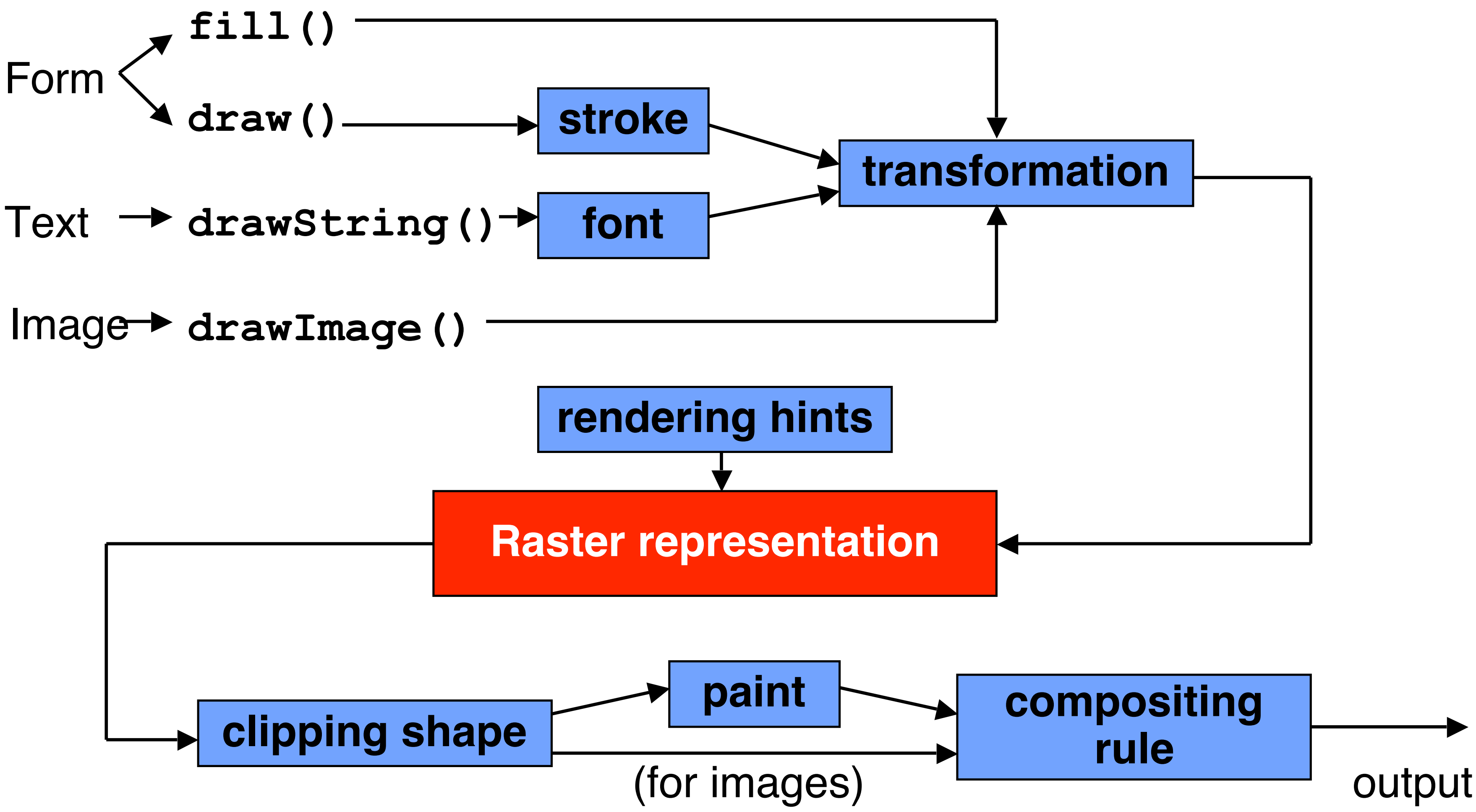
- Java was from its beginnings intended as a multimedia programming language:
  - “Oak”, Java’s predecessor:
    designed to control Set Top Boxes for Interactive TV
- Java Media APIs
  - Loose collection of APIs defined and maintained by Sun
  - Main APIs: Advanced Imaging (JAI), Java Media Framework (JMF), Java 3D
  - APIs which have become part of standard distribution: Java 2D, Java Sound
- Style rather heterogeneous
- Not all multimedia programming tasks covered
  - E.g. animation
  - “Unofficial” APIs and implementations try to fill the gap

Vector Graphics Framework



Example: Java 2D

Rendering-Pipeline, Example Java 2D

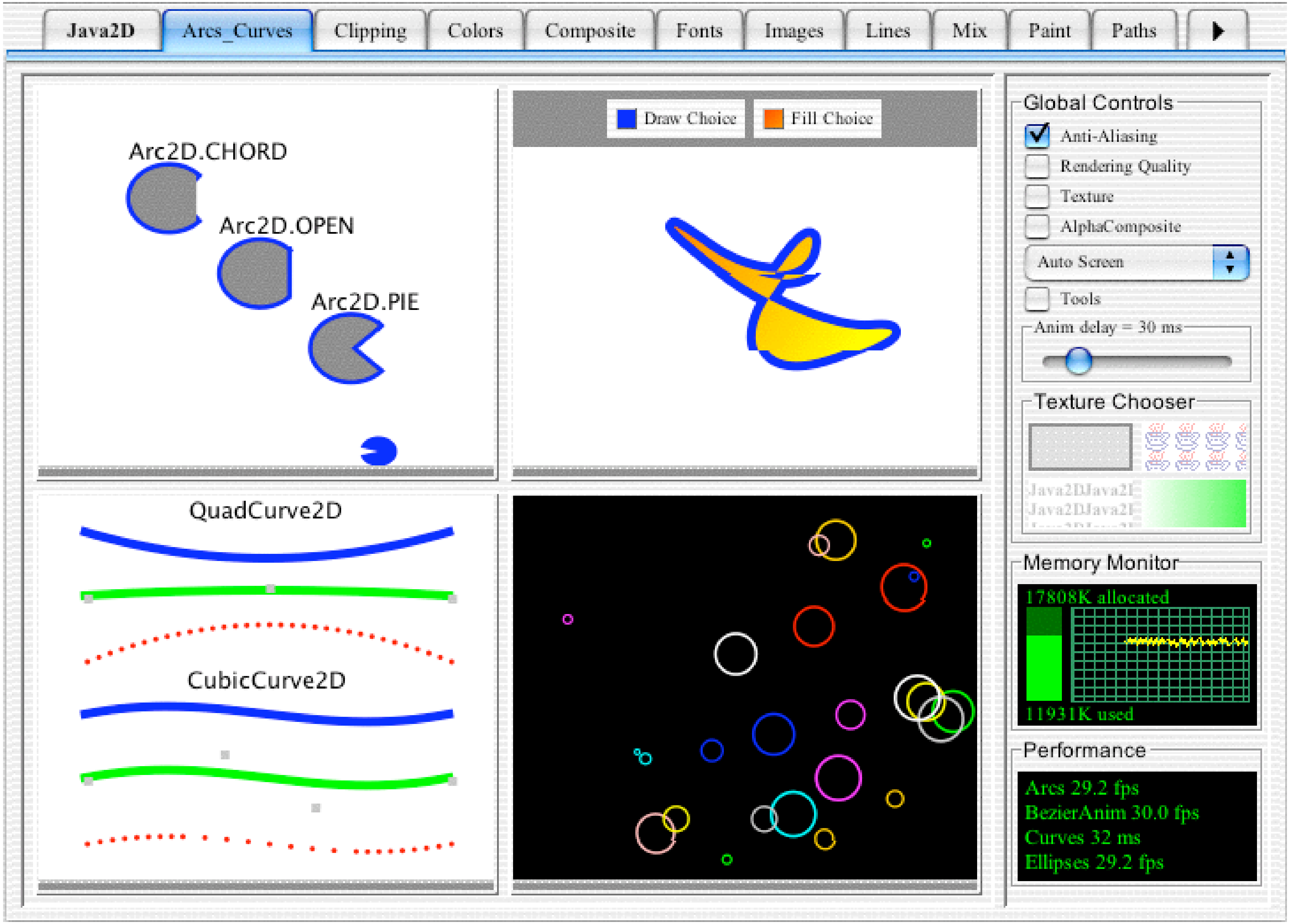


Example: Drawing a Path

```java
import java.awt.*;
import java.awt.event.*;
import java.awt.geom.*;

public class Path extends Frame  {
  public static void main(String[] args) {
    new Path();
  }
  public Path() {
    setSize(500, 400); setLocation(200, 200); setVisible(true); ...
  }
  public void paint(Graphics g) {
    Graphics2D g2 = (Graphics2D)g;

    GeneralPath p = new GeneralPath();
    p.moveTo(50, 50);
    p.lineTo(70, 44);
    p.curveTo(100, 10, 140, 80, 160, 80);
    p.lineTo(190, 40);
    p.lineTo(200, 56);
    p.quadTo(100, 150, 70, 60);
    p.closePath();
    g2.draw(p);
  }
}
```



Global Controls

☑ Anti-Aliasing

□ Rendering Quality

□ Texture

□ AlphaComposite

Auto Screen

□ Tools

Anim delay = 30 ms

Texture Chooser

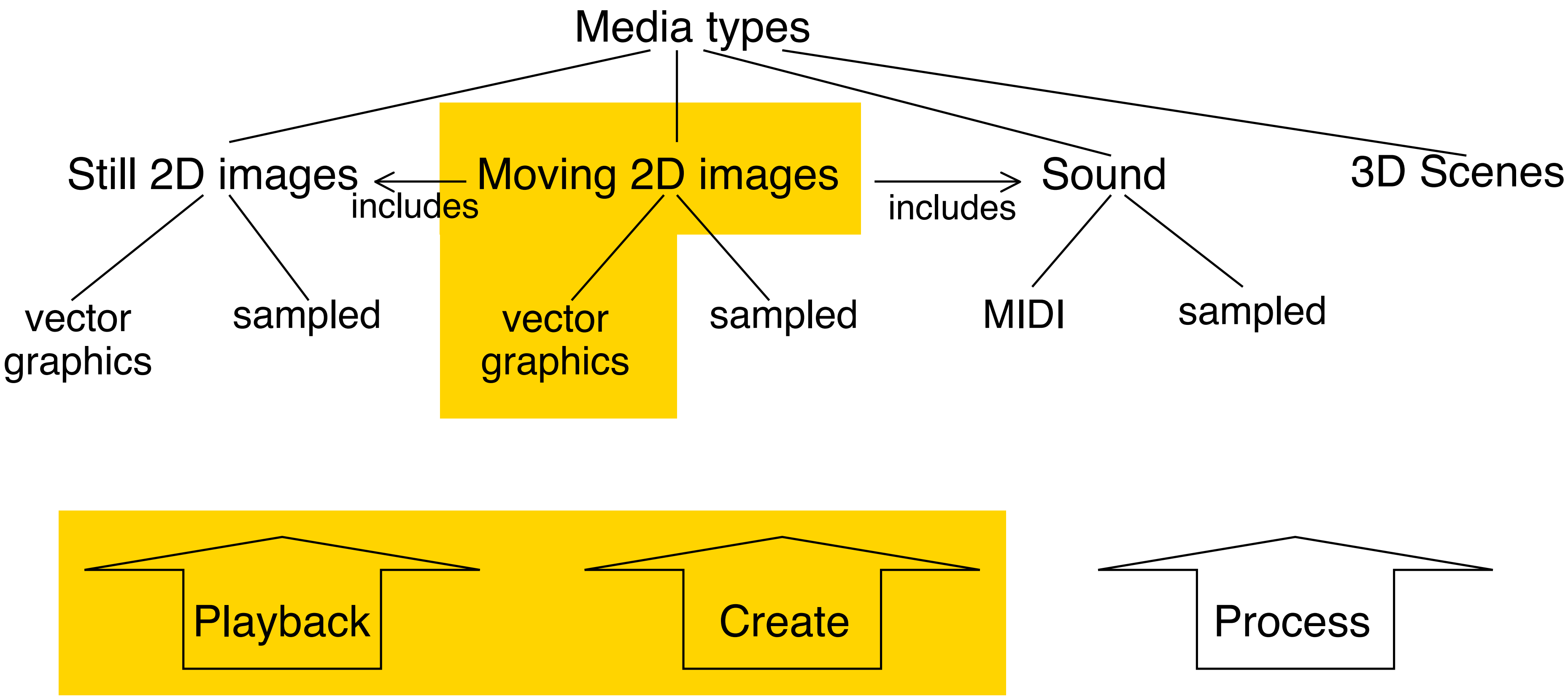
Memory Monitor

```
17808K allocated
11931K used
```

Performance

```
Arcs 29.2 fps
BezierAnim 30.0 fps
Curves 32 ms
Ellipses 29.2 fps
```

Vector Animation Framework



Media types

Still 2D images

includes

Moving 2D images

includes

Sound

3D Scenes

vector graphics

sampled

vector graphics

sampled

MIDI

sampled

Playback

Create

Process

Examples (**Non-official, not widespread**!):

JGoodies (www.jgoodies.com)

SceneBeans (http://www-dse.doc.ic.ac.uk/Software/SceneBeans)

How to Design a Vector Animation Framework?

- Key concepts needed:
  - Clock for time-dependent change
  - Hooks on 2D graphical objects to change parameters
    - Location, orientation, size, colour etc.
- Disadvantage of Java 2D against Smalltalk, Flash:
  - No built-in objects with graphical properties (e.g. color, line thickness)
  - Instead drawing tools to be modified (more procedural approach):

```
        g2.setPaint(Color.red),
        g2.fill(p);
```

- Some design ideas:
  - Interfaces for animation (e.g. in JGoodies)
    - Using event listener mechanism
  - Scene graphs (e.g. in SceneBeans)

JGoodies Example (1)

```
private Animation createAnimation() {
  Animation welcome =
    BasicTextAnimation.defaultFade(
      label1,
      2500,
      "Welcome To",
      Color.darkGray);

  Animation theJGoodiesAnimation =
    BasicTextAnimation.defaultFade(
      label1,
      3000,
      "The JGoodies Animation",
      Color.darkGray);

  Animation description =
    BasicTextAnimations.defaultFade(
      label1,
      label2,
      2000,
      -100,
      "An open source framework|" +
      "for time-based|real-time animations|in Java.",
      Color.darkGray); ... } ... }
```

Location in layout
Duration

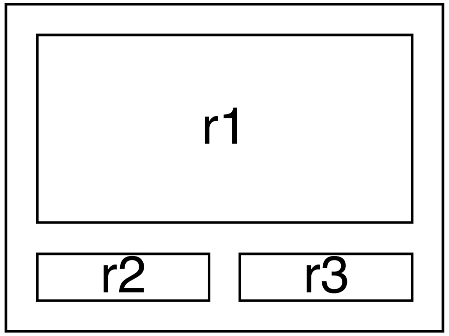
JGoodies Example (2)

```
Animation all =
   Animations.sequential(new Animation[] {
     Animations.pause(1000),
     welcome,
     Animations.pause(1000),
     theJGoodiesAnimation,
     Animations.pause(1000),
     description,
     Animations.pause(1000),
     features,
     Animations.pause(1000),
     featureList,
     Animations.pause(1500),
   });
```

Concepts for Time-Based Animation: SMIL

- E.g. the JGoodies framework clearly relates itself to the ideas of SMIL
- SMIL = Synchronized Multimedia Integration Language
  - XML application
  - Standardized by W3C
  - Not widespread but re-used in many other standards (e.g. MPEG-4)
- Idea:

Layout:



Body:

Contents (here text) appearing over time

Expression with concurrency operators (sequential, parallel)

SMIL Example

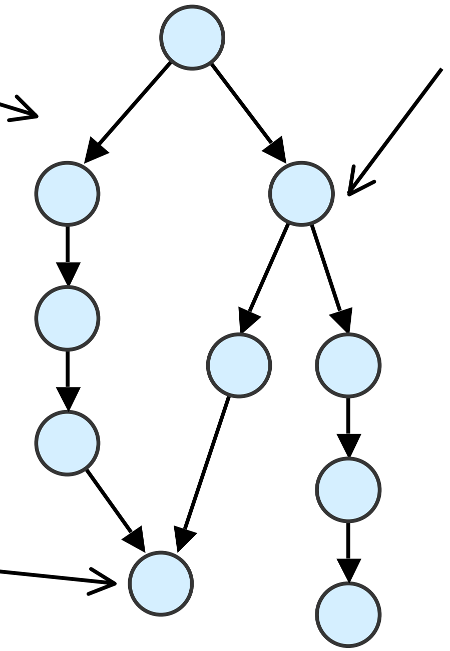
```
<smil xmlns="http://www.w3.org/2001/SMIL20/Language">
  <head>
      <layout>
        <root-layout width="356" height="356"/>
        <region id="img_region" width="256" height="256“
             left="50" top="50"/>
      </layout>
      <transition id="img_wipe" type="barWipe“ dur="3s"/>
  </head>
  <body>
      <par>
         <seq>
            <img region="img_region" src="....jpg" ...
               transIn="img_wipe" fill="transition"/>
            <img region="img_region" src="....jpg" ...
               transIn="img_wipe" fill="transition"/>
            ...
         </seq>
         <audio src....mp3"  end="32s"/>
      </par>
  </body>
</smil>
```

Sub-Types of Vector Graphics Animation

- Layout-bound animation:
  - Similar to the SMIL concepts
  - Basic layout of display regions determined statically
  - Used e.g. in SMIL, JGoodies, ...
- Layout-free animiation:
  - Freely moving animated objects
- (As always) the border is not fully clear:
  - Objects in layout-bound animation may move away from their start positions

Scene Beans

- SceneBeans defines a graphical display using a "*scene graph*".
  - A Java Bean is a simple software component in Java following naming conventions to enable manipulation in authoring systems.



Graphical scenes described by a directed acyclic graph of Java Beans

Parent nodes modify or compose scenes defined by children

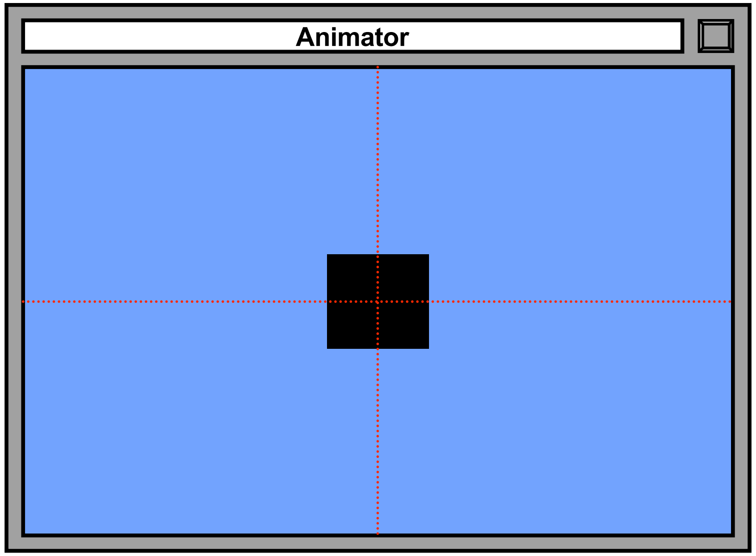
Leaves of the graph represent primitive shapes, text or images

A scene graph defines a tree of nested coordinate spaces.

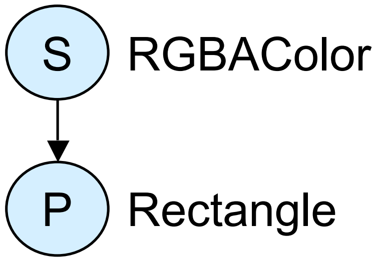
Material on SceneBeans adapted from Nat Bryce

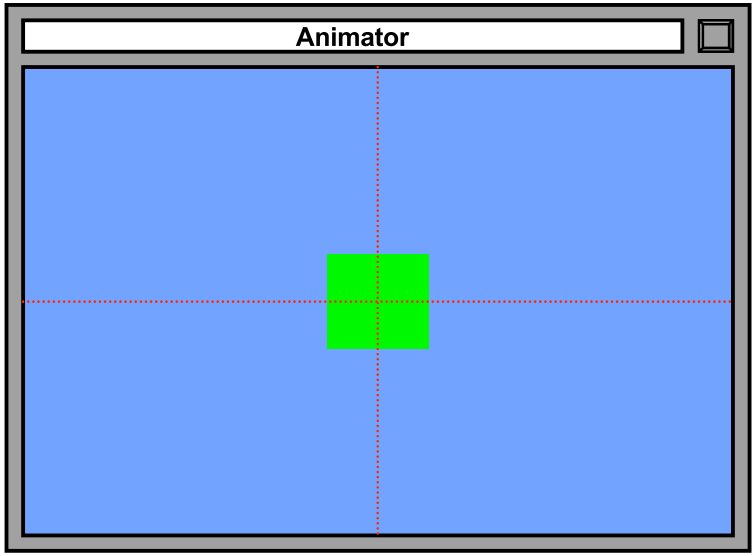
Example: Spinning Square

P Rectangle

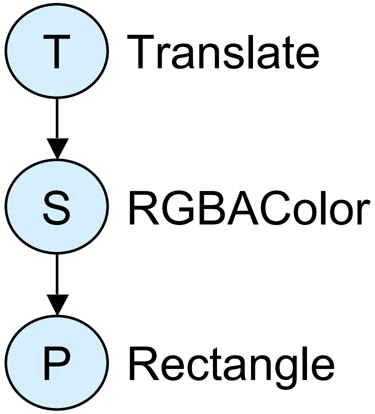


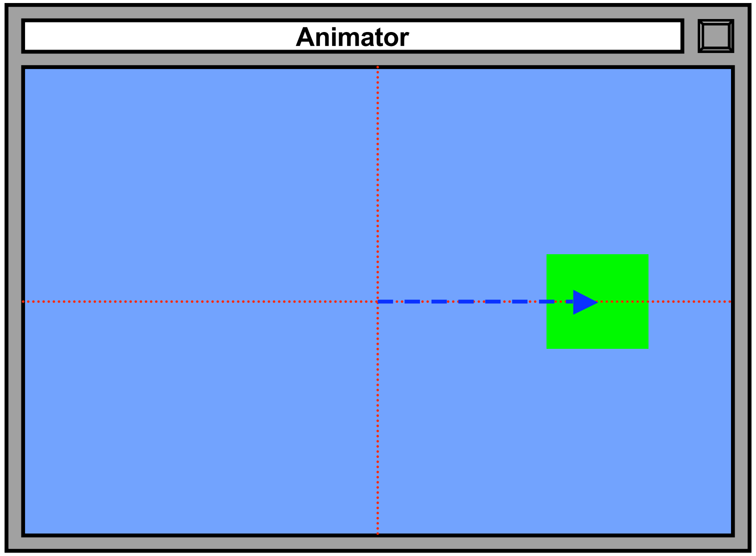
Example: Spinning Square





Example: Spinning Square





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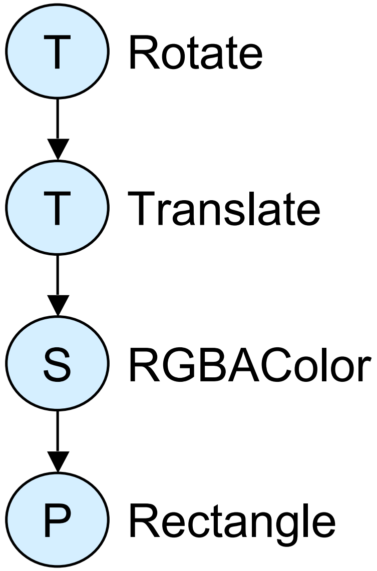

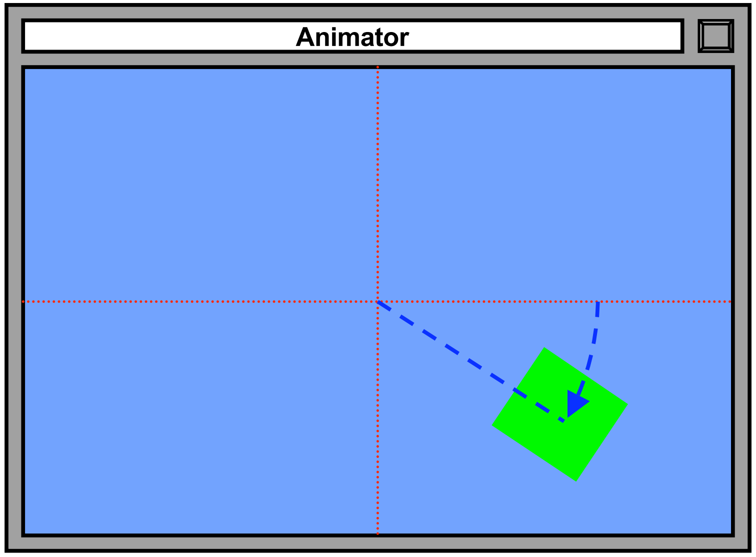

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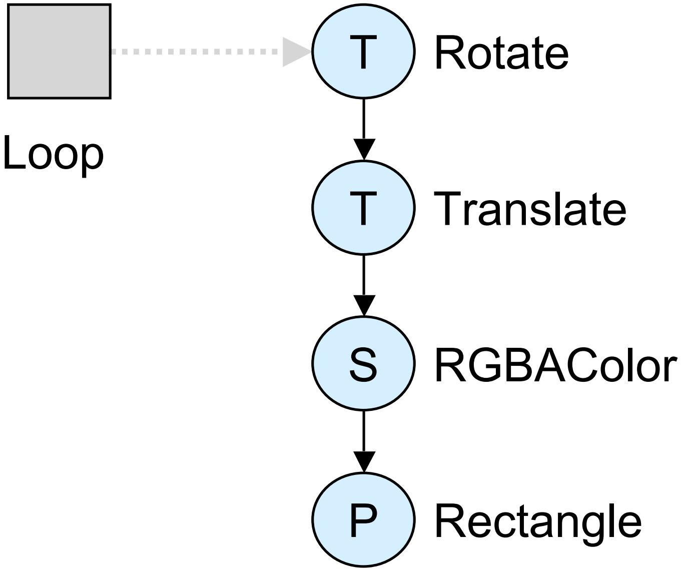

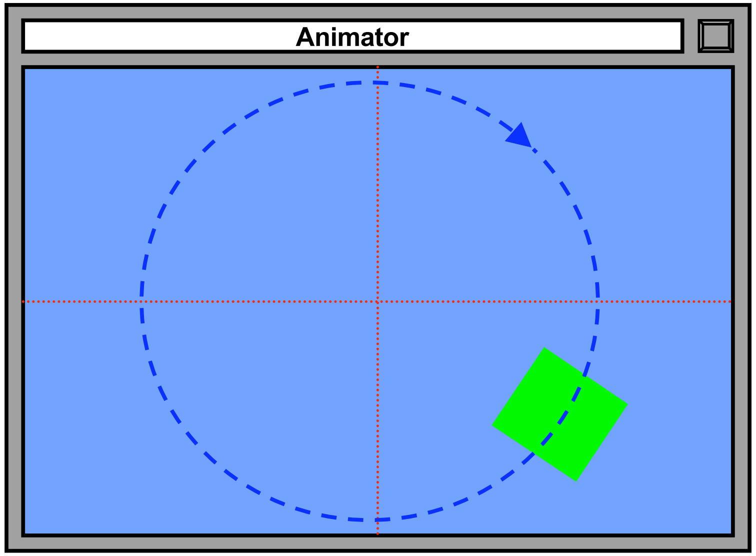

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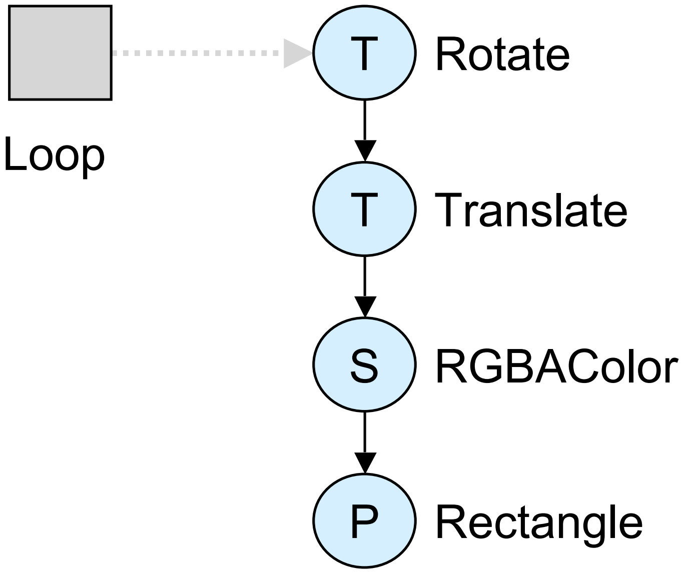
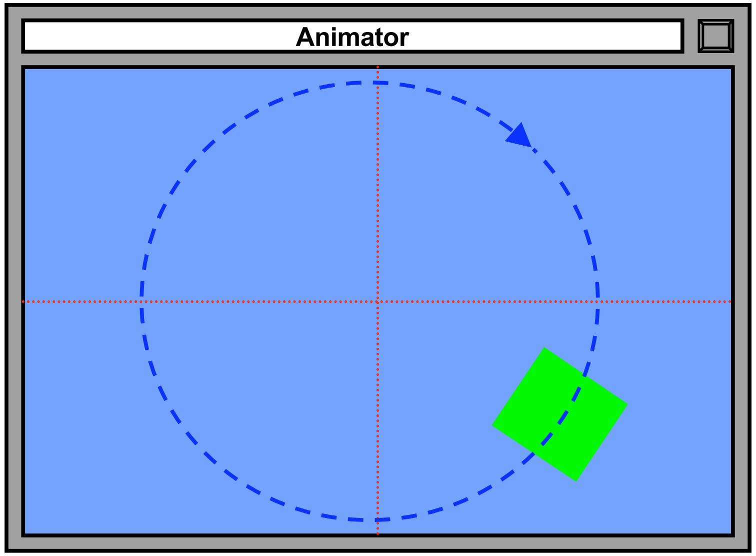
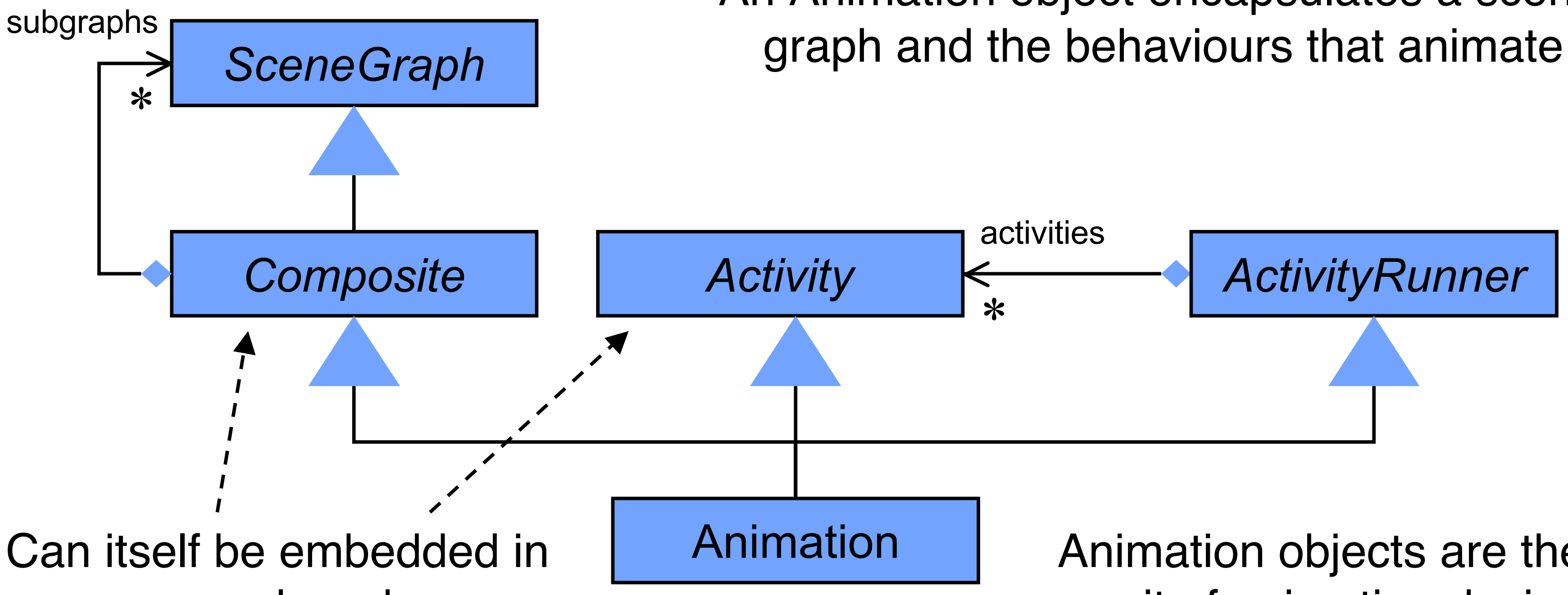




Composable Animations

An Animation object encapsulates a scene graph and the behaviours that animate it



Can itself be embedded in a scene graph and run as an activity

Animation objects are the unit of animation design and reuse

XML File Format

- It’s not practical to create animations by programming Java
  - Non-programmers are not able to create animations
  - Frustrating edit/compile/debug cycle while fine-tuning animation parameters

- Therefore SceneBeans defines a file format for loading animations
  - based on XML

- XML document is used as a “wiring language”
  - Defines configuration of scene graph and behaviour beans
  - Beans dynamically loaded on demand
  - Animations not limited to fized set of beans

- XML Processing instructions are used to introduce new packages of beans
  - Can load beans across the network - useful if animation is in an applet