CSE1720

Week 04, Lecture 08; Week 05 Lecture 09

Winter 2014 ◆ Thursday, Jan 29, 2015/Tuesday, Feb 03, 2015

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Big picture recap…

- via the services of the `RasterImage` class
  - our app asks the window manager for a window
  - the constructor creates and places a blank "canvas" inside this window
  - this canvas has an associated `Graphics2D` object, which we can access via `getGraphics2D()`
- via the services of the `Graphics2D` class
  - we use the services of this class to modify the *current settings*
  - we use the services of this component to perform drawing of shape primitives and text

The VM and the window manager **coordinate** with one another in order to do the drawing

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Shooter Games…

- Shooting is a basic behaviour that is a defining characteristic of shooter games
- We will employ encapsulation:
  - encapsulate the shooter
  - encapsulate the projectile
  - encapsulate the target
- Shooting entails:
  - waiting for user input
  - rendering the trajectory over a sequence of frames
  - collision behaviours

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Frame Drawing…

- We need functionality to implement repeated frame drawing
- frames need to be drawn whether the user is performing actions or not
- we need a service that will **dispatch events** repeatedly, each of which signals "draw new frame"

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Suspension of Disbelief

- Humans will suspend judgment about the implausibility of a narrative in order to engage with the material
  - this alternative is that human does not suspend judgment, disengages and rejects premise of the material
- Video games require suspension of disbelief
  - game mechanics are unrealistic (by design or by technological limitation)
- Designs seek to support suspension of disbelief and try to remove aspects that interfere with suspension of disbelief
  - uncanny valley interferes with suspension of disbelief
  - high motion interferes with suspension of disbelief

5

Motion Perception

- High motion:
  - when moving images do not blur or strobe even when tracked closely by the eye
  - is the characteristic of video or film footage displayed possessing a sufficiently high frame rate

6

Motion Perception

- how do a a succession of still images give the illusion of a motion?
- why do we not see the "blanks" in between successive still images?

7

Motion Perception

- we don't see the "blanks" in between successive still images because of **persistence of vision**
  - the afterimage persists on the retina for a small period of time (like 40 msec)
  - fireworks leave what we perceive to be trails of light; there is no trail, it is a creation of the mind, which retains a perception of the light stimulus for a fraction of a second longer

8

Motion Perception

- how do a a succession of still images give the illusion of a motion?
  - apparent motion: when an object is perceived as moving when, in fact, a series of stationary images is being presented
    - this is the "beta movement" percept
  - illusory "object": something is perceived, but it is an illusion
    - our brains fill in the gap with something
    - the phi phenomena
  - the two percepts are often confused and conflated

http://www1.psych.purdue.edu/Magniphi/PhiIsNotBeta/phi2.html
http://blog.production-now.com/2008/08/phi-vs-beta.html
http://en.wikipedia.org/wiki/File:Lilac-Chaser.gif

Frame Rate

- The speed at which frames are drawn is called the **frame rate**
  - **TV: 60 fps**
  - **Movies: 24 fps**
  - **The Hobbit 3D experiment: 48 fps**
  - **Lower threshold : 10-12 fps, phi phenomenon**
  - **Upper threshold : ~66 fps**

How can we implement frames?

- let's start with a simple example
- we want to animate a dot moving in a diagonal
- start with the dot at the origin:

```
private final int DIA = 10;
Point p = new Point(0, 0);
```

for each frame, draw the dot at the current anchor point

```
Ellipse2D.Double dot = new Ellipse2D.Double(p.x, p.y,
DIA, DIA);
```

also update the anchor point (for the next frame)

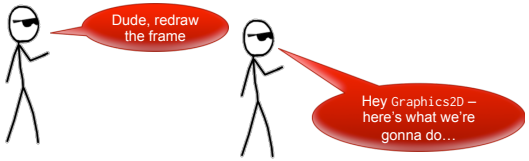
```
p = new Point(p.x + 1, p.y + 1);
```


Separation of Concerns

there are two tasks here:
1. triggering the new frame
2. specifying what is to be drawn on the frame

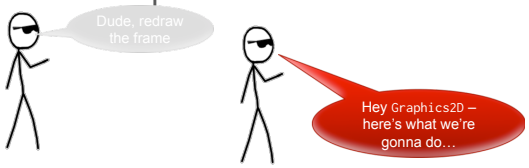
We want to delegate each of these tasks to different services

How can we implement frames?



- We will have two "players" here
  - Dude#1: says when it is time to redraw
  - Dude#2: says what happens to the drawing surface when it is time to draw a frame

How we implement frames



- Dude #2: says what happens to the drawing surface when it is time to draw a frame

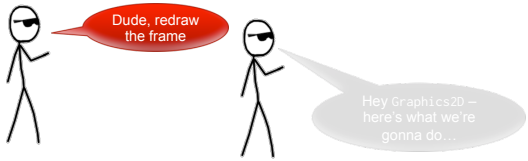
for each frame, draw the dot at the current anchor point

```
Ellipse2D.Double dot = new Ellipse2D.Double(p.x, p.y,
DIA, DIA);
graphics.draw(dot);
theCanvas.repaint();
```

update the anchor point (for the next frame)

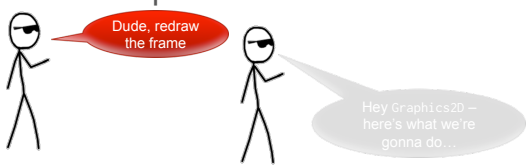
```
p = new Point(p.x + 1, p.y + 1);
```


How we implement frames



- Dude#1: says when it is time to redraw
  - we need to define the inter-frame interval (*x* msec)
  - we need to launch a thread for Dude#1 so he can start running his process
    - every *x* msec Dude#1 will announce it is time for a new frame
  - we need to set up Dude#2 to listen to Dude#1

How we implement frames



- we need to set up Dude#2 to listen to Dude#1
- Dude#2 is the observer, Dude#1 is the observee

- Dude#1 can make announcements till the cows come home; if no one is listening, nothing will happen
- it's like broadcasting a radio station; the listening public has to tune their radio to the right station

How to set things up…

1. Identify the **observee** component
   - this is the component that is dispatching events that you care about
2. Create an **observer** component
   - this will be a component that is capable of "listening" to those types of events
   - this is like "tuning" to the station
3. Use the services of the **observee** to tell it that it has an **observer**

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The Observee component

Class Observee

java.lang.Object
  simulation_BasicVersion.Observee

```
public class Observee
extends java.lang.Object
```

This class encapsulates services for launching a new thread and starting a process on that thread that dispatches events at the specified rate. Objects of this type can support a single observer (additional observers cannot be installed).

Author:

mb

Constructor Summary

Constructors

Constructor and Description
`Observee(int numberEventsToBeDispatchedPerSecond, java.awt.event.ActionListener theObserver)` Instantiates an object that dispatches events and that can be observed (an observee).

The Observer component

Class Observer

java.lang.Object
  simulation_BasicVersion.Observer

All Implemented Interfaces:

java.awt.event.ActionListener, java.util.EventListener

```
public class Observer
extends java.lang.Object
implements java.awt.event.ActionListener
```

This class encapsulates functionality for drawing successive 500x500 frames. From one frame to the next, a red dot travels along a diagonal from an upper-left to lower-right direction, starting at the origin. This class encapsulates functionality as an ActionListener, so that objects of this type can listen for events that trigger the drawing of the successive frames.

Author:

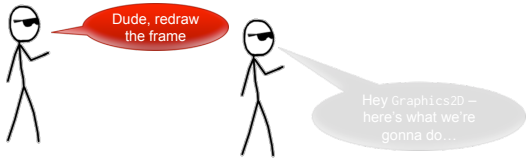
mb

Constructor Summary

Constructors

Constructor and Description
`Observer()`

How we implement frames



- Dude#1: says when it is time to redraw
  - dude#1 is encapsulated by the `Observee` class definition
  - we specify the number of frames per second
  - services the class provides:
    - derives the the inter-frame interval (msec)
    - instantiates a `Timer` object, which in turn launches a new thread
    - constructor of a `Timer` object requires a listener
    - the thread **fires events** at the specified inter-frame interval

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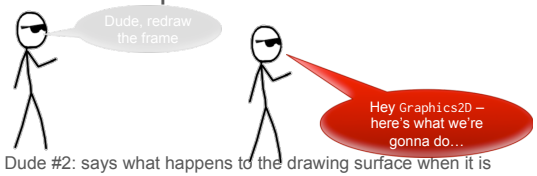
How we implement frames



- Dude #2: says what happens to the drawing surface when it is time to draw a frame
  - dude#2 is encapsulated by the `Observer` class definition
  - services the class provides:
    - sets up the `RasterImage`, initializes values
    - implements an `actionPerformed(ActionEvent)` method
    - the body of the `actionPerformed(ActionEvent)` method is invoked each time an event is dispatched by this object's observee
    - the body of the `actionPerformed(ActionEvent)` specifies each frame to be drawn

Interfaces

- Examine the API for the `Observer` class, notice the following

```
public class Observer
extends java.lang.Object
implements java.awt.event.ActionListener
```

- the `implements` keyword is important
- it signals that objects of type `Observer` can be treated as though they are of the type `ActionListener`
- constructor creates objects that have **two** types, both at the same time!!!
- review code example `L09_Ex2`

What services does the `ActionEvent` class provide?

- Events are objects that encapsulate some sort of "happening"
- Examples include:
  - the user did something
    - e.g., performed a mouse or keyboard action
  - the window manager did something
    - e.g., opened a window, shifted focus
- `ActionEvent` provides the most basic services to represent any sort of action with respect to any sort of component within a window

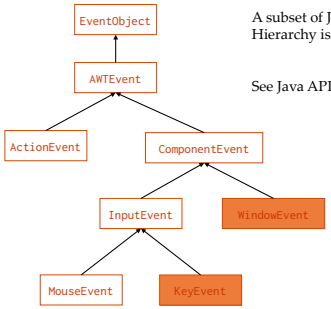
Event vs Exception

- Events are *sorta* like Exceptions
- Exceptions
  - encapsulate some sort of happening
  - The term exception is shorthand for the phrase "exceptional event."
  - can be thrown/caught
- Events
  - encapsulate some sort of happening
  - many different types of happenings (mouse events, keyboard events, window events, etc, etc)
  - **cannot** be thrown/caught
  - instead, are passed as parameters to methods

Event vs Exception

- Exceptions
  - encapsulate some sort of happening
  - The term exception is shorthand for the phrase "exceptional event."
  - can be thrown/caught
  - Exception classes are defined in a hierarchy
- Exceptions
  - encapsulate some sort of happening
  - many different types of happenings (mouse events, keyboard events, window events, etc, etc)
  - **cannot** be thrown/caught
  - instead, are passed as parameters to methods
  - Event classes are defined in a hierarchy

Java's Event Class Hierarchy



A subset of Java's Event Class Hierarchy is shown here

See Java API for full hierarchy

Attributes of `ActionEvent` objects

- Objects of type `ActionEvent` have the following attributes:
  - which component was the source of the event (e.g., which keyboard button, which GUI element, etc)
  - when the event was triggered (the timestamp)
  - the command that is associated with the event
    - for instance an on-screen button may be labeled "beep", and the associated command would be "play beep"
  - which modifiers were used (e.g., alt, control, shift keys)

Are Attributes Even that Important?

- sometimes the client doesn't care about an `ActionEvent`'s attributes
- A client may only care that an action event occurred, as opposed to any of the details about the event that occurred
- For instance, dude #1 uses `ActionEvent` to encapsulate "it is time to advance the frame"
- dude #2 receives those events and reacts; dude #2 doesn't care much about the who/what/when

The `actionPerformed(ActionEvent)` method

- review code example `L09_Ex3`

The Event Dispatching Thread

- code example `L09_Ex3` can drive our animation, but it is not a correct implementation
- why not? because all event-handling code should be executed on the *event dispatching thread*, not the *initial thread*.

Threads & Concurrency

- We take it for granted that our systems can do more than one thing at a time.
  - e.g., continue to work in a word processor, while other applications download files, manage the print queue, and stream audio.
  - e.g., word processor is always be ready to respond to keyboard and mouse events, no matter how busy it is reformatting text or updating the display.
- Software that can do such things is known as *concurrent* software.

source: **Concurrency Lesson,** The Java™ Tutorials

Threads & Concurrency

- A thread is a basic unit of execution; code is executed on a thread
- An app may have several active threads; If so, the app can perform several operations *concurrently*
- Example of tasks an app may need to perform concurrently:
  - respond to keyboard and mouse events
  - updating its graphical display
  - performs calculations
  - perform read/write to the file system

source: **Concurrency Lesson,** The Java™ Tutorials

GUI Apps

- Typically have at least **two** threads
  - the main thread
    - the thread that executes the initial application code
  - the event dispatching thread
    - the thread that executes the code the responds to events
  - (optional) additional worker/background threads
    - the thread(s) that execute code the performs time-consuming tasks
      - perform calculations
      - perform read/write to the file system
      - managing network connections
      - etc…

source: **Concurrency Lesson,** The Java™ Tutorials

GUI Apps

- What services does the Timer constructor provide?
  - instantiate a Timer object
  - takes the second parameter (an ActionListener) and sets it up so that it is listening for any events that the Timer object may be dispatching
  - launches code the recurrently dispatches events
    - this code runs on the event dispatching thread
- In `L09_Ex3`, our action listener object is launched on the main thread
  - this means that event handling is taking place on the main thread, not the event dispatching thread
  - in the next version of our code base, this problem will be fixed.

Tasks

- slow down the projectile to have a slower trajectory
- make the projectile expire before it reaches the edge of the screen
- make the projectile wrap around the screen
- introduce random movement