GUIs and Event-Driven Programs

February 29–March 1, 2012
CS 60: Principles of Computer Science

Assignment 6 due March 5: Spampede!
Midterm out March 5–6
Midterm due back 5pm Friday, March 9

Explain the Difference (1)

```
class Dog {
  private String name;

  public Dog(String dname)
  {
    this.name = dname;
  }

  public void speak()
  {
    System.out.println
     (this.name + ": woof");
  }
}
```

```
class Cat {
  private String name;

  public Cat(String cname)
  {
    this.name = cname;
  }

  public void speak()
  {
    System.out.println
     (this.name + ": meow");
  }
}
```

```
class Animal {
  protected String name;
  public Animal(String n)
  {
     name = n;
  }

  protected void say(String s)
  {
    System.out.println
       (name + ":" + s);
  }
}
```

```
class Dog extends Animal {
  public Dog(String dname)
  {
    super(dname);
  }

  public void speak()
  {
    this.say("woof");
  }
}
```

```
class Cat extends Animal {
  public Cat(String cname)
  {
    super(cname);
  }

  public void speak()
  {
    this.say("meow");
  }
}
```

Explain the Difference (2)

```
class Animal {
  protected String name;
  public Animal(String n)
  {
     this.name = n;
  }

  protected void say(String s)
  {
    System.out.println
     (this.name + ":" + s);
  }
}
```

```
class Dog extends Animal {
  public Dog(String dname)
  {
    super(dname);
  }

  public void speak()
  {
    this.say("woof");
  }
}
```

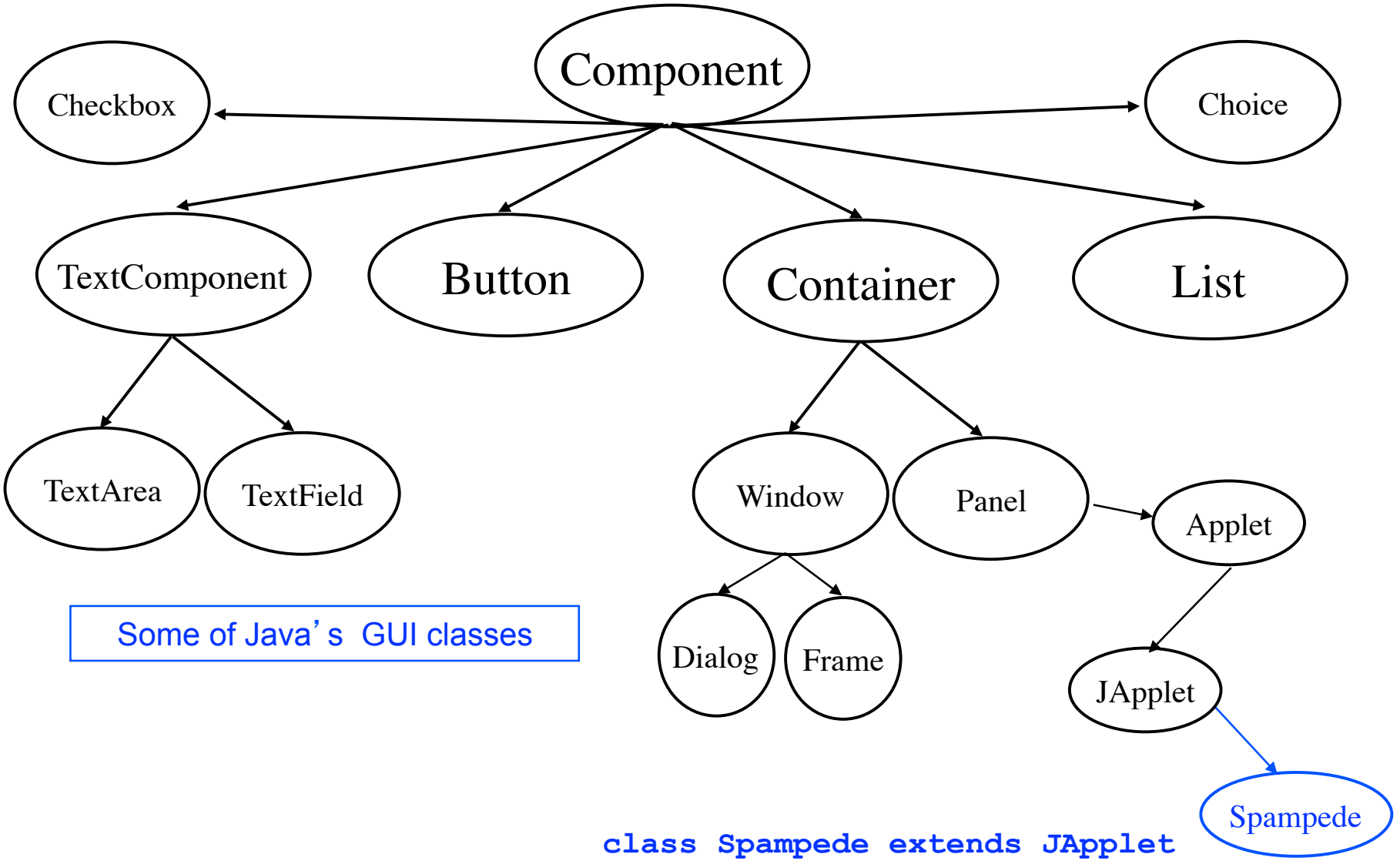
```
class Cat extends Animal {
  public Cat(String cname)
  {
    super(cname);
  }

  public void speak()
  {
    this.say("meow");
  }
}
```

```
interface Animal {
  public void speak();
}
```

```
class Dog implements Animal {
  private String name;

  public Dog(String dname)
  {
    this.name = dname;
  }

  public void speak()
  {
    System.out.println
     (this.name + ": woof");
  }
}
```

```
class Cat implements Animal {
  private int ears;

  public Cat(int e)
  {
    this.ears = e;
  }

  public void speak()
  {
    System.out.println
     (this.ears + ": meow");
  }
}
```

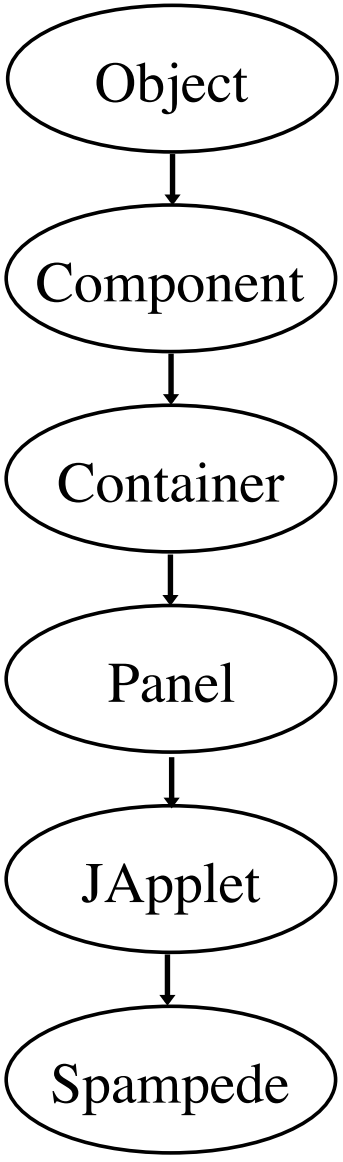
Some Inheritance in Java



Some of Java's GUI classes

```
class Spampede extends JApplet
```

Spampede Inheritance




```
public void requestFocus()
public void addKeyListener()
public void repaint()
```

reuse

```
public void add(Component c)
```

```
public void init()
```

override

```
public void init()
public void paint()
```

```
void drawEnvironment()
void displayMessage()
void reset()
```

extend

Homework Assignment 6

Spampede

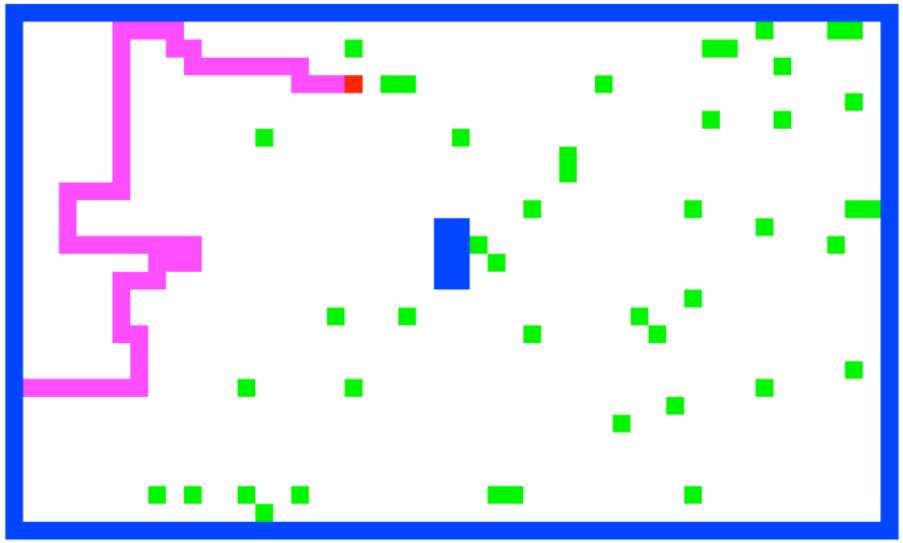
1. Improvements `Maze.java`
   (including changes to permit inheritance)

2. Subclass `SpamMaze.java`
   (support for updates to spam and pede)

3. Graphics and user interface: `Spampede.java`

Step 1: `Maze.java` 2.0

1. Improve the interfaces of `Maze` and `MazeCell`
2. Put the maze in the code (Web applets generally can't read files)
3. Find the *nearest* destination cell among many

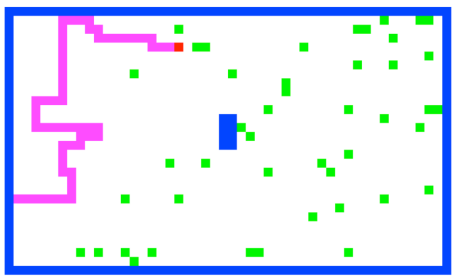


New Maze Methods

Find the *nearest* destination cell among many:

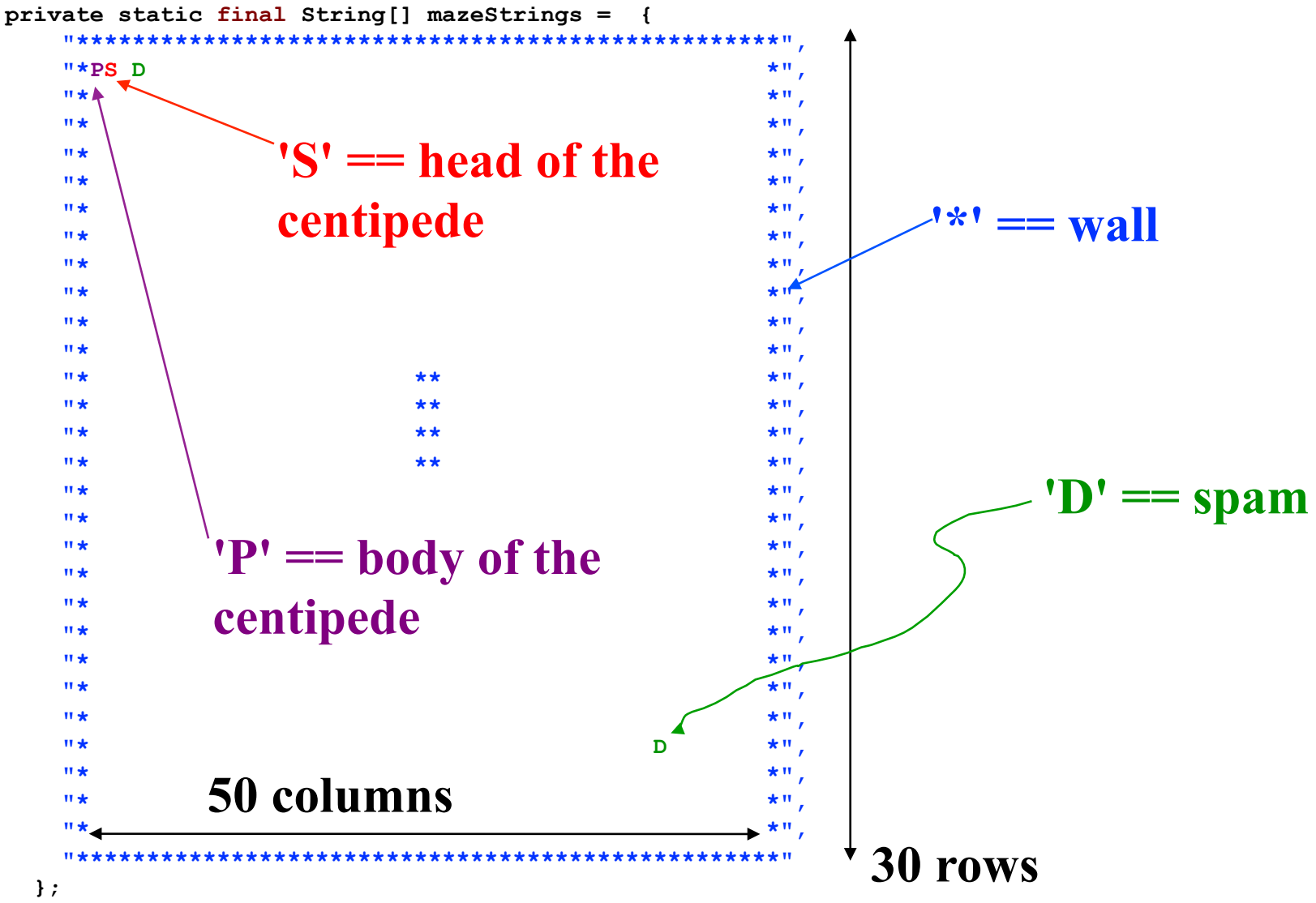
```
class Maze extends Object
{
  ...
  public MazeCell multiBFS(MazeCell start, char dest) { ... }
}
```

Why is `dest` no longer a `MazeCell`?
Why does the method return a `MazeCell`?
What cells must we avoid now?
What if there's no solution?



For testing: be able to print the maze with the path you found, but *remove* the path before returning!

mazeStrings



Note: Avoid Magic Constants!

Named *constants* make code easier to read and easier to modify, *e.g.*,

```
public static final char SPAM  = 'D';
public static final char START = 'S';
public static final char WALL  = '*';
public static final char PEDE  = 'P';
```

```
multiBFS( start, Maze.SPAM );
```

Assignment Part 2: `SpamMaze` class

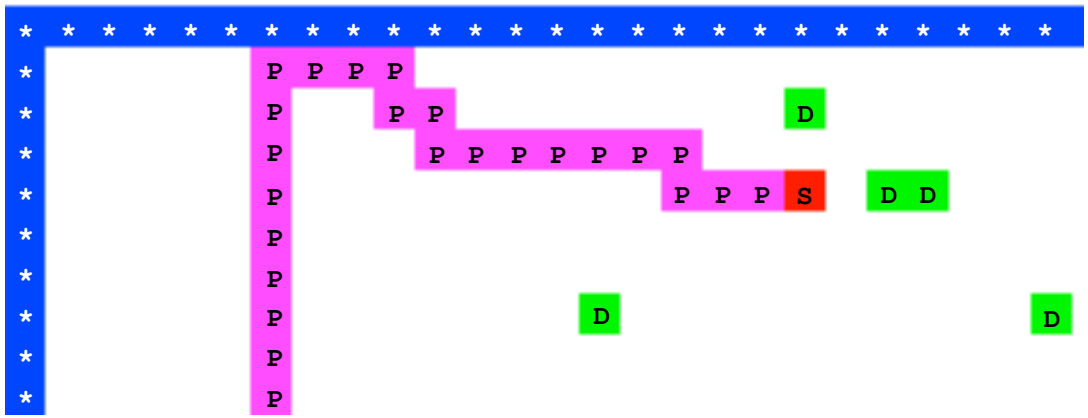
```
class SpamMaze extends Maze { ... }
```

Additional fields:

- ✓ `spamCells`
- ✓ `pedeCells`

Additional methods

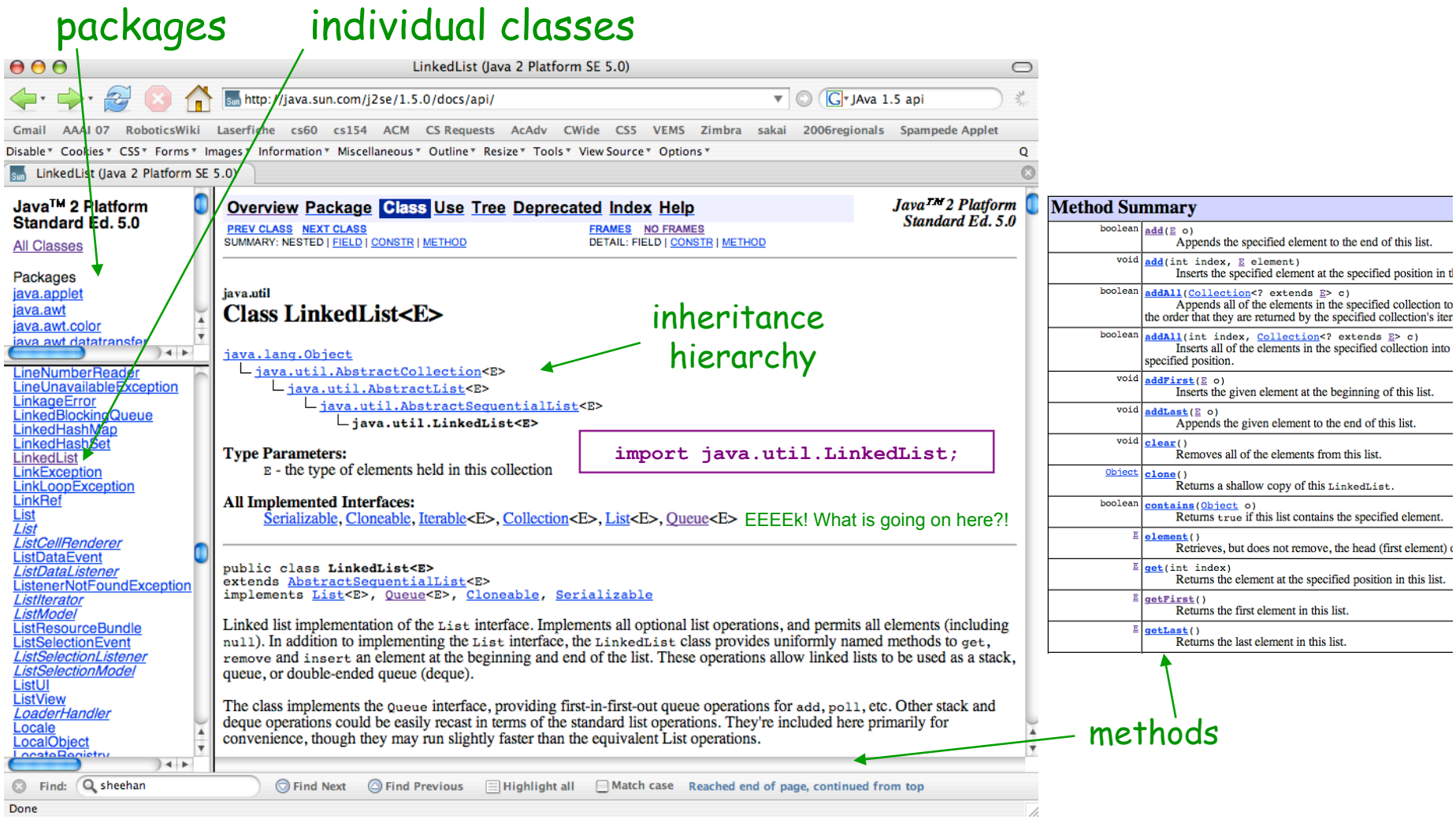
- ✓ `addSpam`
- ✓ `removeSpam`
- ✓ `advancePede`
- ✓ `reversePede`



What type should `spamCells` and `pedeCells` be?

Code Reuse: Java's `LinkedList<…>` class

`http://docs.oracle.com/javase/6/docs/api/`



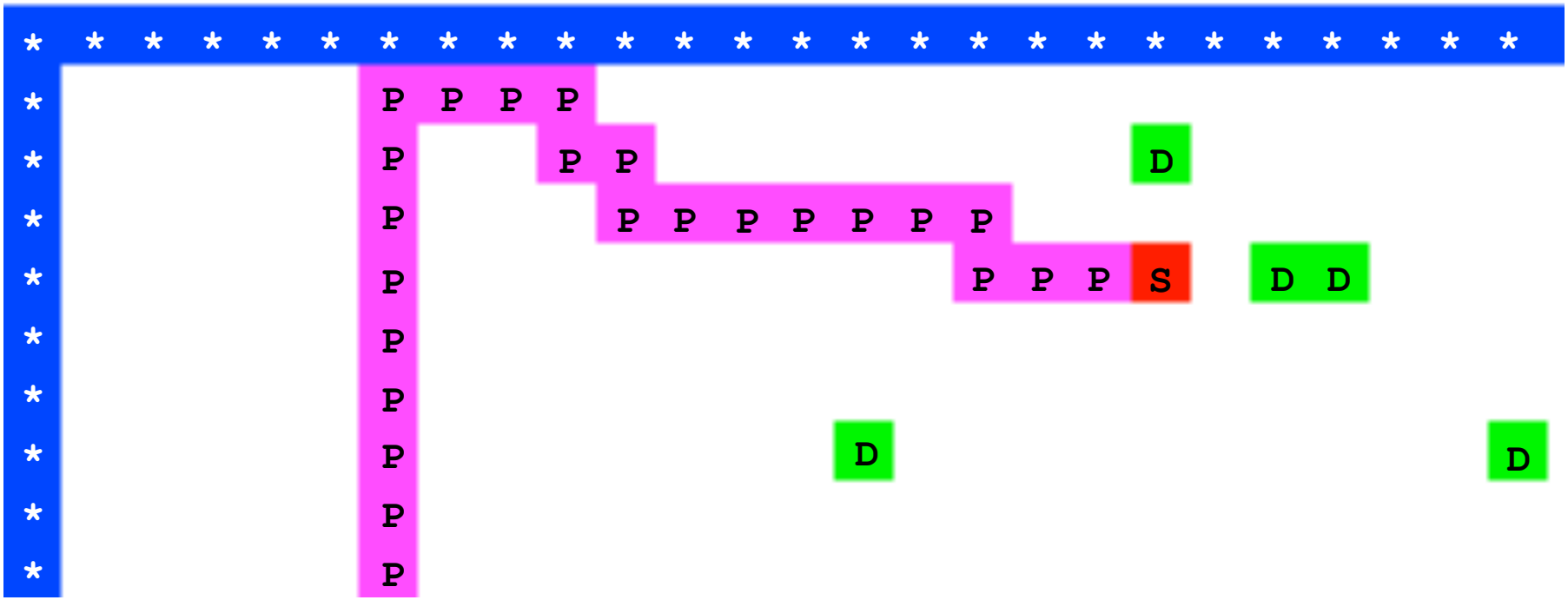
Usage

```
import java.util.LinkedList;

...

LinkedList<MazeCell> pedeCells

...
pedeCells = new LinkedList<MazeCell>();
pedeCells.addFirst(maze[1][2]);
pedeCells.addLast(maze[1][1]);

MazeCell head = pedeCells.getFirst(); // peek
```

Linked list support the "double-ended queue" operations: adding to the front and back, removing from the front and back, peeking at the front and back

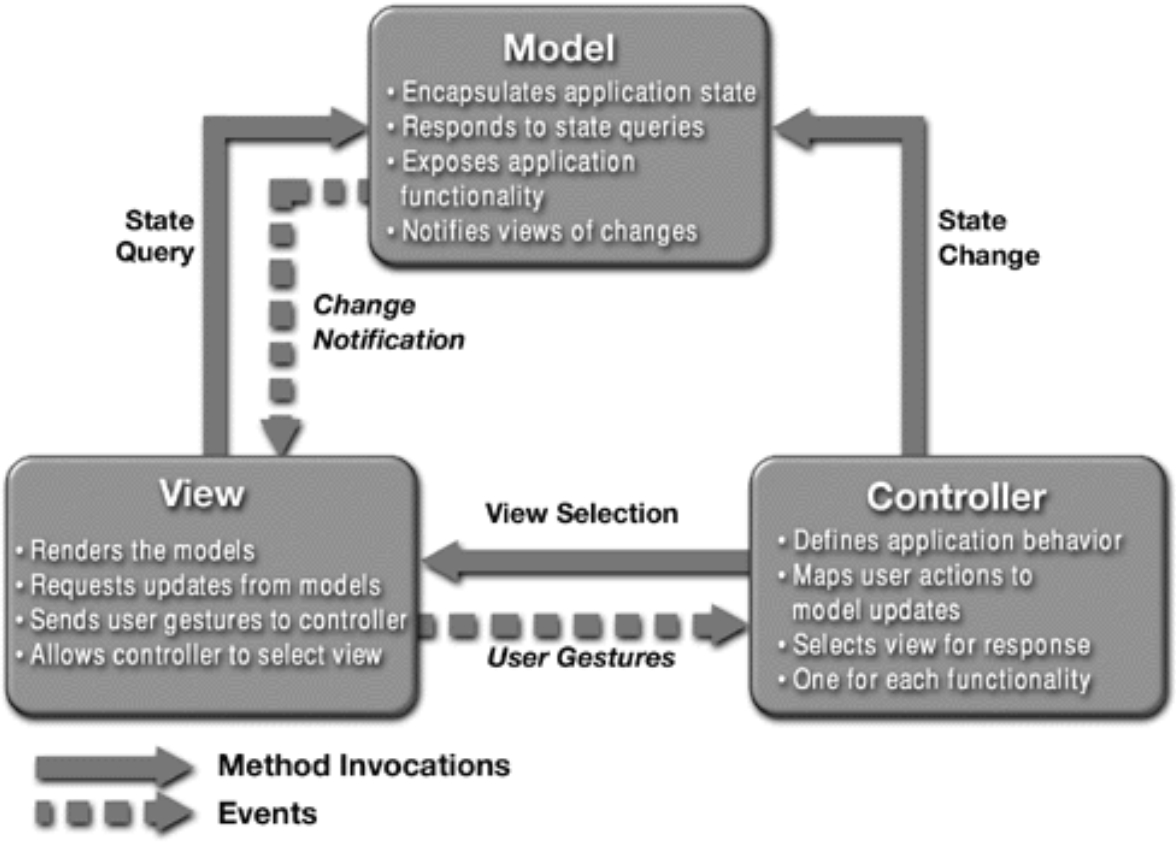
Moving the Centipede

```
updatePede(char dir)
```



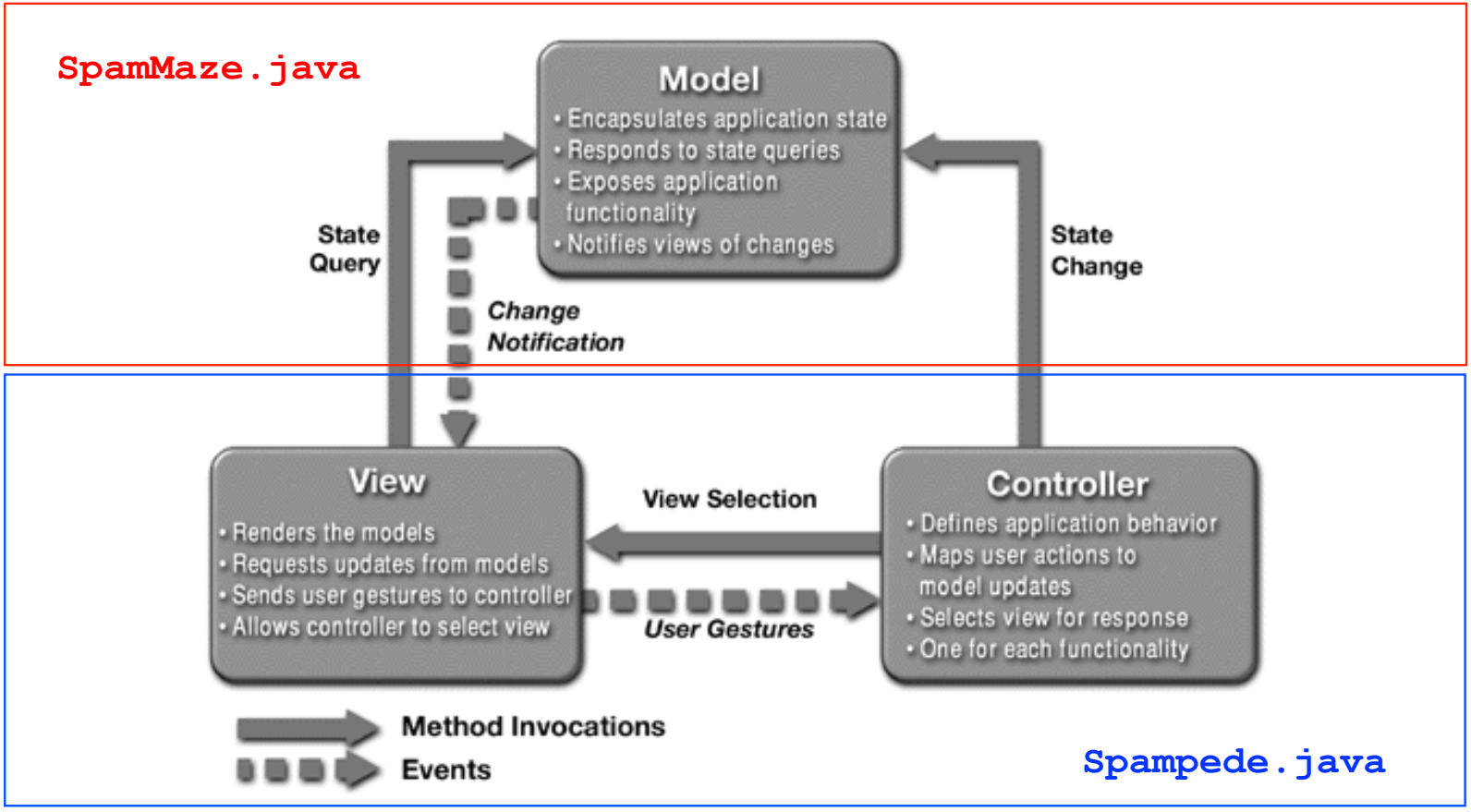
How might we update the double-ended queue as the centipede moves? (eats?)

Big Idea 1: The Model-View-Controller Pattern



This design pattern separates three basic functional components so that…

Big Idea 1: The Model-View-Controller Pattern



so that the programmer can ***take a narrower focus*** in building, revising, etc.!

Big Idea 2: Event-Driven Programming

All user-interface "events," e.g.,

- ✓ Key presses
- ✓ Mouse clicks
- ✓ Window resizes

are gathered into an *event queue*.

The system (here, Java Swing) examines each event.

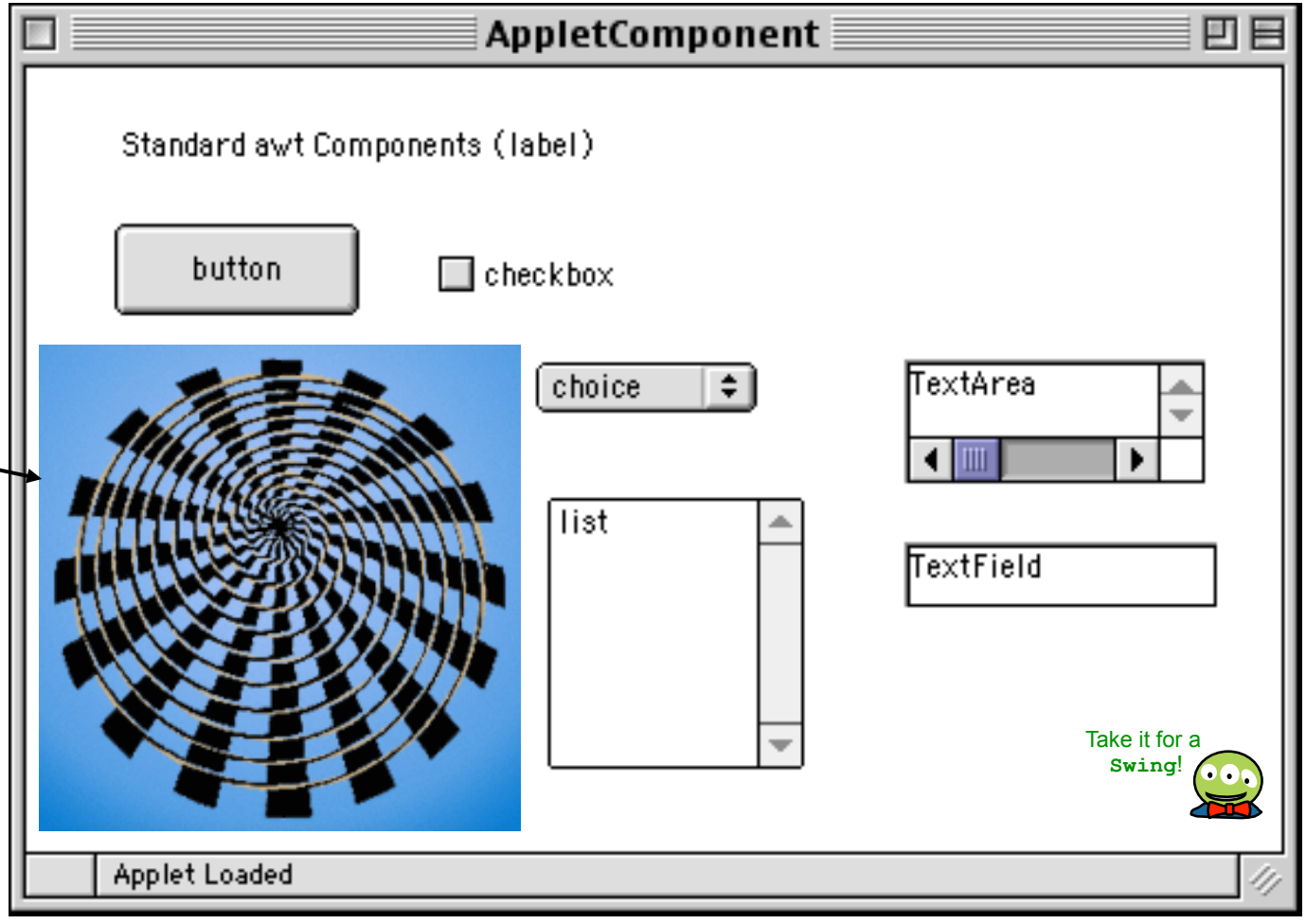
If you've said you care about this kind of event, the system will let your program know (via a *callback*). If not, the event is ignored and discarded.

History: Java AWT

canvas for graphics and images

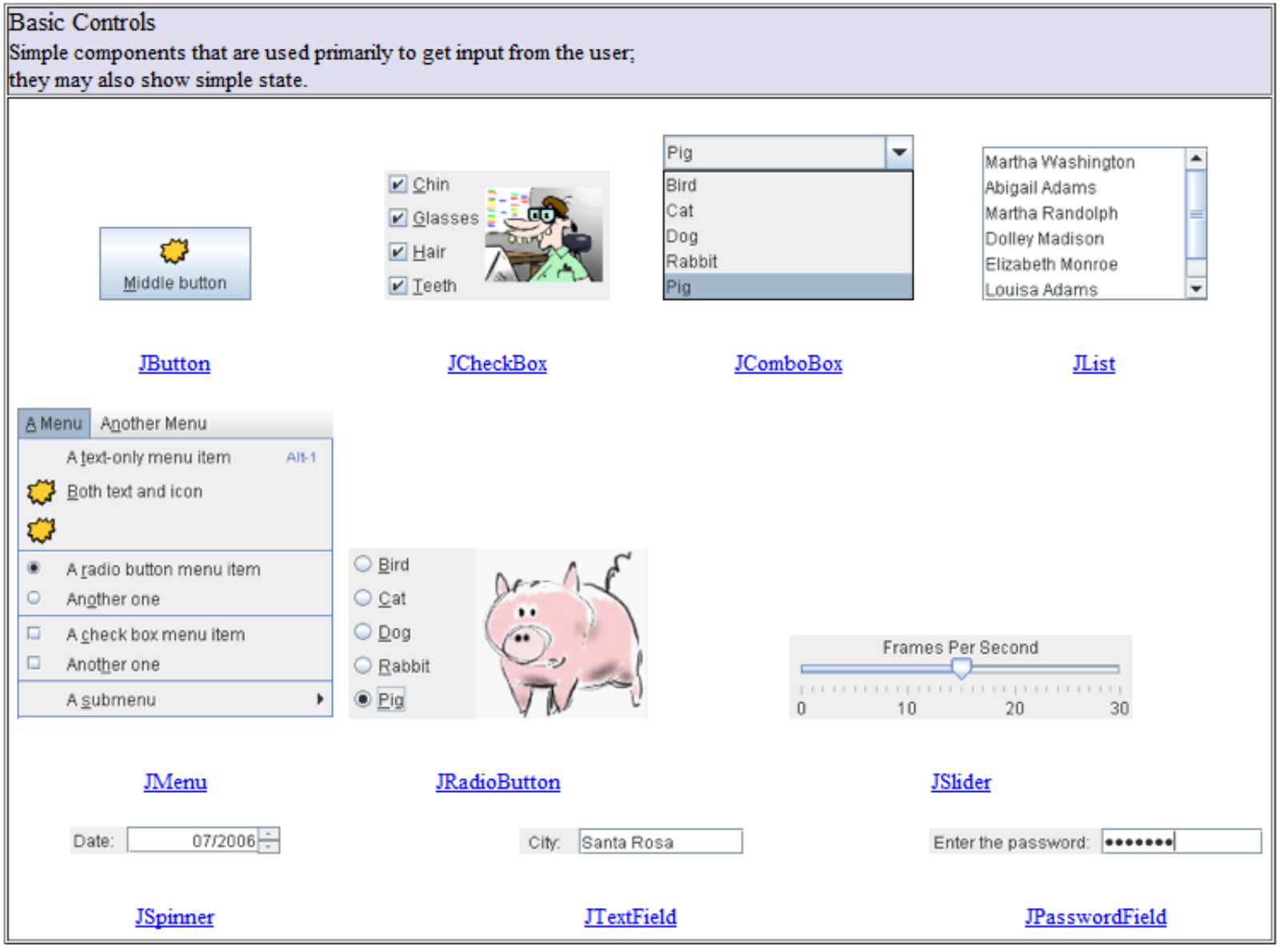
applet "is a" panel

panel contains other components



Wow! this is a really, really old image…

More Modern: Java Swing



Big Idea 3: Callbacks (Don't call me, I'll call you!)

How can we figure out when a button is used?

1. *Polling*

   Hey, is the button being used?
   How about now?
   How about now?
   How about now?
   How about now?

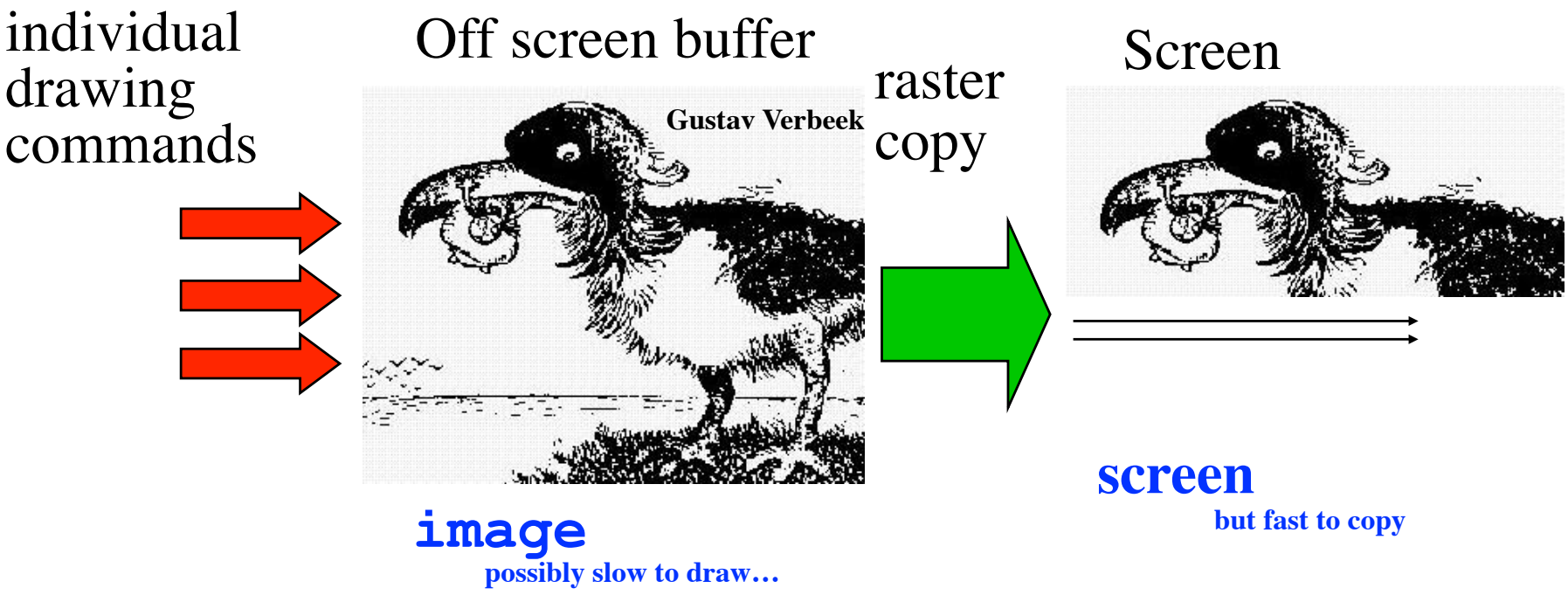
2. *Callbacks*

   Dear Swing, please run the `actionPerformed` method (on this object) when this button is used. Sincerely, `Spampede`

   . . . snoring sounds . . .

Big Idea 4: Double Buffering

At each step, we erase the picture and redraw it from scratch.
This can cause "flickering."
Better: do all the drawing "off screen" and just show the final result.



Some Java Specifics

```
class Spampede {
  Image image;   // off-screen buffer
  Graphics g;    // drawing tools for that buffer
  ...
  public void init()
  {
    this.image = createImage(getSize().width, getSize().height);
    this.g = image.getGraphics();

    pauseButton = new Button("Pause");      // Create a button
    pauseButton.addActionListener(this);    // Register interest in events
    ...
  }
  ...
  g.setColor(Color.red);
  g.fillRect(100,100,10,10);
  ...
}
```

Lots of other drawing commands available. See

- ✓ http://docs.oracle.com/javase/6/docs/api/java/awt/Graphics.html
- ✓ http://docs.oracle.com/javase/6/docs/api/java/awt/Graphics2D.html

Exception Handling

What could go wrong loading sound and image files?

```
try
{
  URL url = getCodeBase();
  audioCrunch = getAudioClip(url,"crunch.au");
  imageSpam = getImage(url,"spam.gif");
  System.out.println("successful loading of audio/images!");
}
catch (Exception e)
{
  System.out.println("problem loading audio/images!");
  audioCrunch = null;
  imageSpam = null;
}
```

Spampede.cycle

```
void cycle()
{
  this.updateCentipede();  // update the Spampede deque
  this.updateSpam();       // update the Spam deque
  this.drawEnvironment();  // draw things to buffer
  this.displayMessage();   // display messages
  repaint();               // send buffer to the screen
  this.cycleNum++;         // One cycle just elapsed
}
```

How could we update the spam more slowly than the spampede?

Name: "Quiz:" Code Treasure Hunt

1. Start by looking over `Spampede`'s fields...
   - 1.1 What is the TYPE and NAME of the data structure holding our `MazeCells`?
   - 1.2 What is the TYPE of `this.dir`? What is the type of `this`?
   - 1.3 Where do `image` and `g` get initialized (assigned to)?
2. Find `cycle` and then find each method that `cycle` calls.
3. Find the code that draws the small red square.
4. What do the four arguments to `fillRect()` mean?
5. How could you use `fillRect` (repeatedly) to draw the maze?
6. At what coordinates is the the spam image being drawn?
7. What keypresses make the large square blue?
8. What keypress is incorrectly identified in the on-screen message?
9. What event produces a hearty spam-consuming crunch sound?
10. EXTRA: How long does it take for the large square to return to magenta?

Applet: A Program Delivered Via a Browser

Spampede.html

```
<html>

<head>
  <title>Spampede Applet</title>
</head>

<body bgcolor = "#dddddd">

  <center>
<APPLET
  CODE = "Spampede.class"
  WIDTH = 700
  HEIGHT = 550
  >
</APPLET>
</center>

</body>
```

Suggested Strategy

1. Finish `Maze` and `SpamMaze` first!
2. Make sure you can change, compile, and run `Spampede.java`

   ```
   appletviewer Spampede.html
   ```

3. Make sure you understand the purpose of the code in `Spampede.java` (including all the fields!)
4. Write `drawEnvironment` and test
5. Write `updatePede` and test
6. Write `keyPressed` and test (one direction at a time?)
7. Add AI (`multiBFS` does almost all the work)
8. Add reversing (least important, and can be a little tricky)