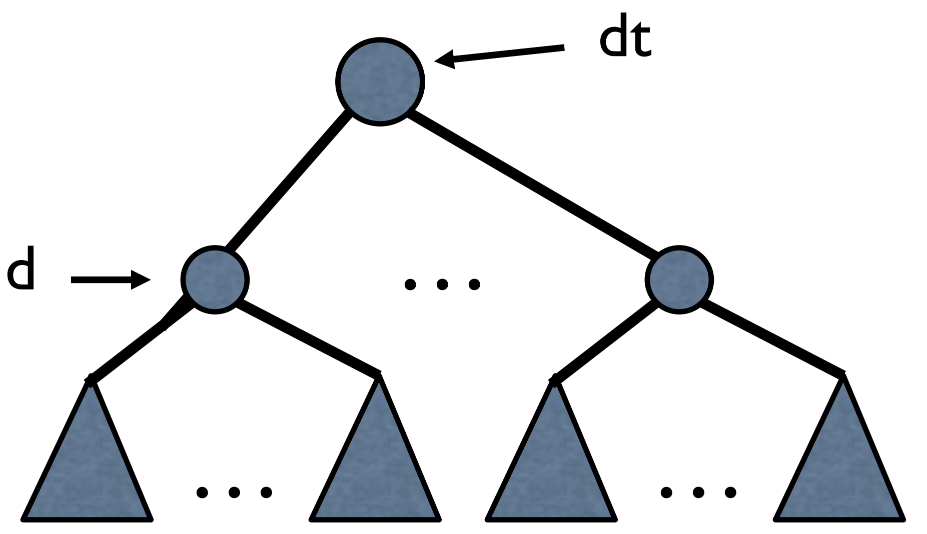
CS2110. GUIS: Listening to Events

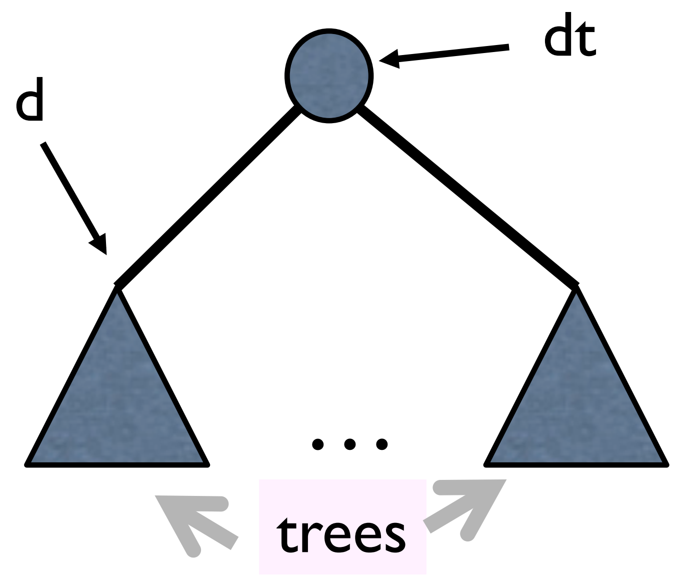
Also

anonymous classes

Download the demo zip file from course website and look at the demos of GUI things: sliders, scroll bars, combobox listener, etc

Making use of the recursive definition of a tree in a recursive function



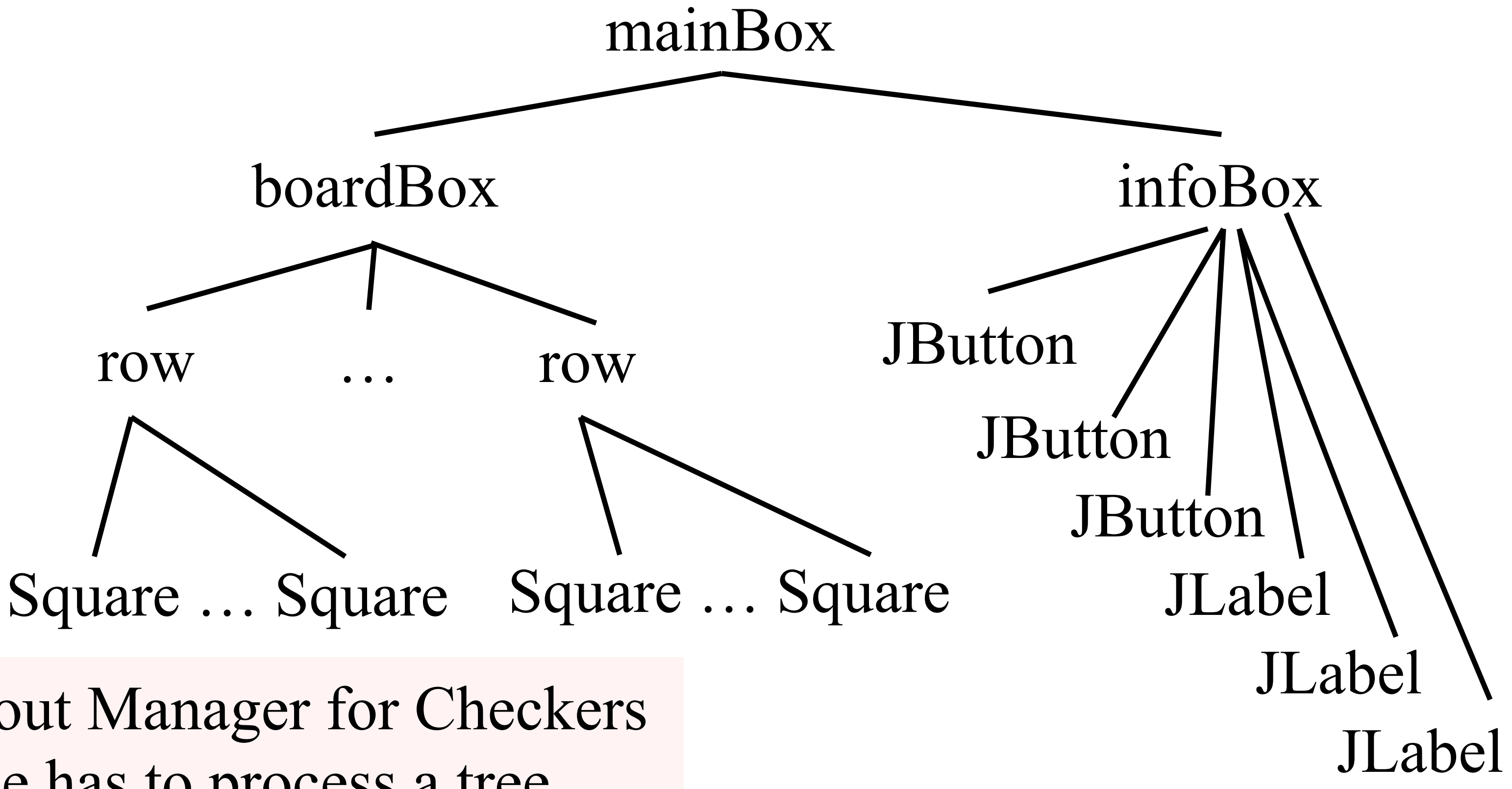


```
for (DiseaseTree d : dt.children) {
    if (d.root == p) { … }
}
```

(in some cases it may be ok, but rarely)

Testing d.root or any field of d complicates the picture terribly. Destroys the natural recursive definition. Don't do it!

Trees are everywhere



Layout Manager for Checkers game has to process a tree

pack(): Traverse the tree, determining the space required for each component

boardBox: vertical Box
row: horizontal Box
Square: Canvas or JPanel
infoBox: vertical Box

Listening to events: mouse click, mouse movement into or out of a window, a keystroke, etc.

- An event is a mouse click, a mouse movement into or out of a window, a keystroke, etc.
- To be able to "listen to" a kind of event, you have to:

1. Have some class C implement an interface IN that is connected with the event.
2. In class C, override methods required by interface IN; these methods are generally called when the event happens.
3. Register an object of class C as a *listener* for the event. That object's methods will be called when event happens.

We show you how to do this for clicks on buttons, clicks on components, and keystrokes.

What is a JButton?

Instance: associated with a "button" on the GUI, which can be clicked to do something

```
jb1= new JButton()              // jb1 has no text on it
jb2= new JButton("first")       // jb2 has label "first" on it

jb2.isEnabled()                 // true iff a click on button can be
                                // detected
jb2.setEnabled(b);              // Set enabled property

jb2.addActionListener(object); // object must have a method
         // that is called when button jb2 clicked (next page)
```

At least 100 more methods; these are most important

JButton is in package javax.swing

Listening to a JButton

1. Implement interface ActionListener:

```
public class C extends JFrame  implements
                                      ActionListener {
      ...
}
```

2. In class C override actionPerformed, which is to be called when button is clicked:

```
/** Process click of button */
public void actionPerformed(ActionEvent e) {
    ...
}
```

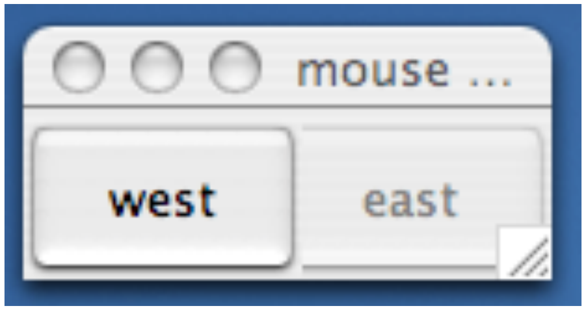
3. Add an instance of class C an “action listener” for button:

```
button.addActionListener(this);
```

red: listening

blue: placing

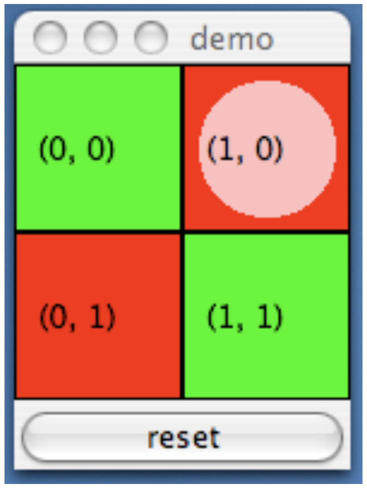
```
/** Object has two buttons. Exactly one is enabled. */
class ButtonDemo1 extends JFrame
                        implements ActionListener {
  /** Class inv: exactly one of eastB, westB is enabled */
  JButton westB= new JButton("west");
  JButton eastB= new JButton("east");

  public ButtonDemo1(String t) {
   super(t);
   Container cp= getContentPane();
   cp.add(westB, BLayout.WEST);
   cp.add(eastB, BLayout, EAST);

   westB.setEnabled(false);
   eastB.setEnabled(true);
   westB.addActionListener(this);
   eastB.addActionListener(this);

   pack(); setVisible(true);
  }
```



```
public void actionPerformed
            (ActionEvent e) {
   boolean b=
           eastB.isEnabled();
   eastB.setEnabled(!b);
   westB.setEnabled(b);
  }
}
```

Listening to a Button

A JPanel that is painted

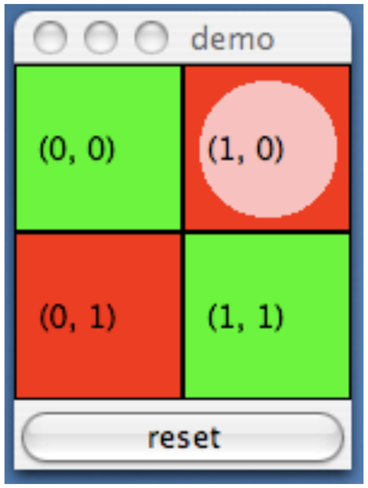


- The JFrame content pane has a JPanel in its CENTER and a "reset" button in its SOUTH.
- The JPanel has a horizontal box b, which contains two vertical Boxes.
- Each vertical Box contains two instances of class Square.
- Click a Square that has no pink circle, and a pink circle is drawn. Click a square that has a pink circle, and the pink circle disappears. Click the rest button and all pink circles disappear.
- This GUI has to listen to:

(1) a click on Button reset
(2) a click on a Square (a Box)

these are different kinds of events, and they need different listener methods

```
/** Instance: JPanel of size (WIDTH, HEIGHT).
               Green or red: */
public class Square extends JPanel {
  public static final int HEIGHT= 70;
  public static final int WIDTH= 70;
  private int x, y; // Panel is at (x, y)
  private boolean hasDisk= false;
  /** Const: square at (x, y). Red/green? Parity of x+y.  */
 public Square(int x, int y) {
    this.x= x;        this.y= y;
   setPreferredSize(new Dimension(WIDTH,HEIGHT));
 }
 /** Complement the "has pink disk" property */
 public void complementDisk() {
    hasDisk= ! hasDisk;
    repaint(); // Ask the system to repaint the square
 }
```



Class Square

continued on later

Class Graphics

An object of abstract class Graphics has methods to draw on a component (e.g. on a JPanel, or canvas).

Major methods:

drawString("abc", 20, 30);	drawLine(x1, y1, x2, y2);
drawRect(x, y, width, height);	fillRect(x, y, width, height);
drawOval(x, y, width, height);	fillOval(x, y, width, height);
setColor(Color.red);	getColor()
getFont()	setFont(Font f);

More methods

You won't create an object of Graphics; you will be given one to use when you want to paint a component

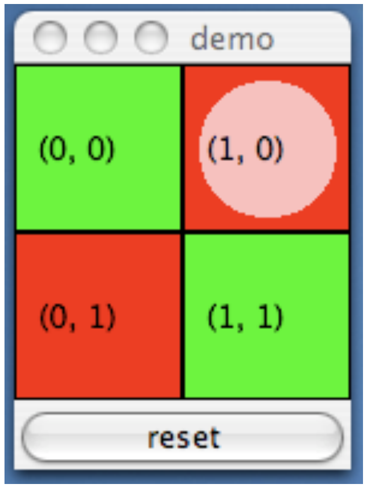
Graphics is in package java.awt

continuation of class Square

Class Square

```
/* paint this square using g. System calls
    paint whenever square has to be redrawn.*/
 public void paint(Graphics g) {
   if ((x+y)%2 == 0) g.setColor(Color.green);
   else g.setColor(Color.red);

   g.fillRect(0, 0, WIDTH-1, HEIGHT-1);

   if (hasDisk) {
     g.setColor(Color.pink);
     g.fillOval(7, 7, WIDTH-14, HEIGHT-14);
   }

   g.setColor(Color.black);
   g.drawRect(0, 0, WIDTH-1,HEIGHT-1);
   g.drawString("("+x+", "+y+")", 10, 5+HEIGHT/2);
 }
}
```

```
/** Remove pink disk
     (if present) */
public void clearDisk() {
   hasDisk= false;
   // Ask system to
   // repaint square
   repaint();
 }
```



Listen to mouse event (click, press, release, enter, leave on a component)

```
public interface MouseListener {
    void mouseClicked(MouseEvent e);
    void mouseEntered(MouseEvent e);
    void mouseExited(MouseEvent e);
    void mousePressed(MouseEvent e);
    void mouseReleased(MouseEvent e);
}
```

In package java.awt.event

Having to write all of these in a class that implements MouseListener, even though you don't want to use all of them, can be a pain. So, a class is provided that implements them in painless way.

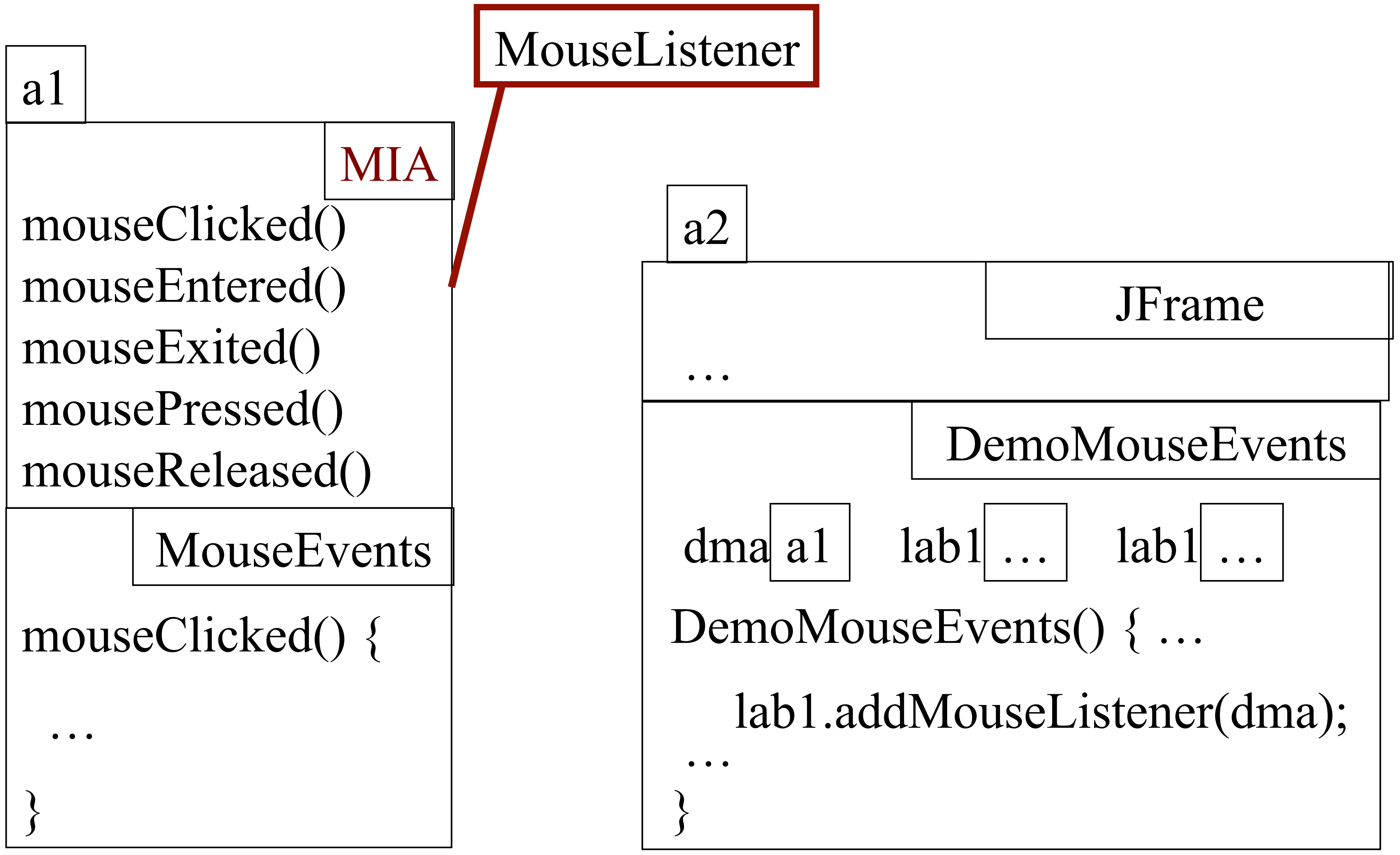
Listen to mouse event
(click, press, release, enter, leave on a component)

In package java.swing.event

```
public class MouseInputAdaptor
        implements MouseListener {
  public void mouseClicked(MouseEvent e) {}
  public void mouseEntered(MouseEvent e) {}
  public void mouseExited(MouseEvent e) {}
  public void mousePressed(MouseEvent e) {}
  public void mouseReleased(MouseEvent e) {}
  …  others …

}
```

So, just write a subclass of MouseInputAdaptor and override only the methods appropriate for the application

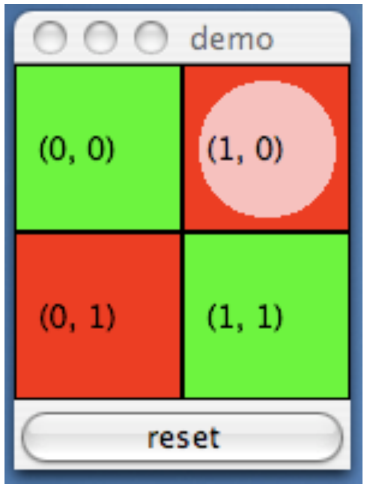
Javax.swing.event.MouseInputAdapter implements MouseListener



A class that listens to a mouseclick in a Square

red: listening

blue: placing



```
import javax.swing.*;
import javax.swing.event.*;
import java.awt.*;
import java.awt.event.*;

/** Contains a method that responds to a
    mouse click in a Square */
public class MouseEvents
                extends MouseInputAdapter {
  // Complement "has pink disk" property
  public void mouseClicked(MouseEvent e) {
     Object ob= e.getSource();
     if (ob instanceof Square) {
        ((Square)ob).complementDisk();
     }
  }
}
```

This class has several methods (that do nothing) that process mouse events:

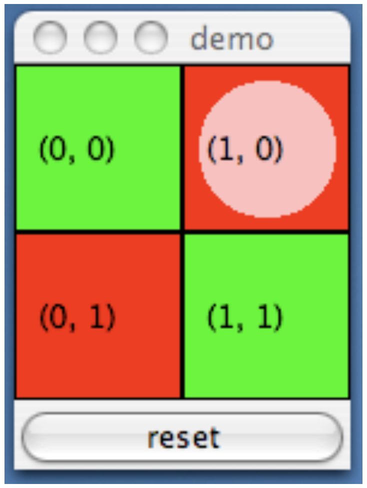
mouse click
mouse press
mouse release
mouse enters component
mouse leaves component
mouse dragged beginning in component

Our class overrides only the method that processes mouse clicks

```
public class MD2 extends JFrame
            implements ActionListener {
  Box b= new Box(…X_AXIS);
  Box leftC= new Box(…Y_AXIS);
  Square b00, b01= new squares;
  Box riteC= new Box(..Y_AXIS);
  Square b10, b01= new squares;
  JButton jb= new JButton("reset");

  MouseEvents me=
          new MouseEvents();
 /** Constructor: … */
 public MouseDemo2() {
   super(t);
   place components on content pane;
   pack, make unresizeable, visible;

   jb.addActionListener(this);
   b00.addMouseListener(me);
   b01.addMouseListener(me);
   b10.addMouseListener(me);
   b11.addMouseListener(me);
 }

 public void actionPerformed (
                 ActionEvent e) {
     call clearDisk() for
     b00, b01, b10, b11
 }
```

red: listening

blue: placing



Class MouseDemo2

Listening to the keyboard

```
import java.awt.*;    import java.awt.event.*;    import javax.swing.*;

public class AllCaps extends KeyAdapter {
  JFrame capsFrame= new JFrame();
  JLabel capsLabel= new JLabel();

  public AllCaps() {
    capsLabel.setHorizontalAlignment(SwingConstants.CENTER);
    capsLabel.setText(":)");
    capsFrame.setSize(200,200);
    Container c= capsFrame.getContentPane();
    c.add(capsLabel);
    capsFrame.addKeyListener(this);
    capsFrame.show();
  }

  public void keyPressed (KeyEvent e) {
    char typedChar= e.getKeyChar();
    capsLabel.setText(("'" + typedChar + "'").toUpperCase());
  }
}
```

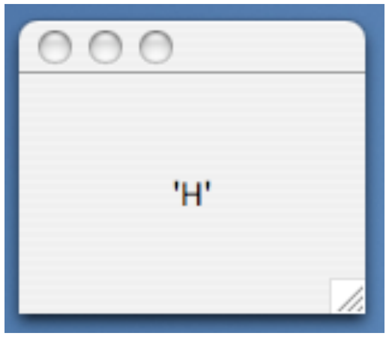
red: listening

blue: placing

1. Extend this class.

3. Add this instance as a key listener for the frame

2. Override this method. It is called when a key stroke is detected.



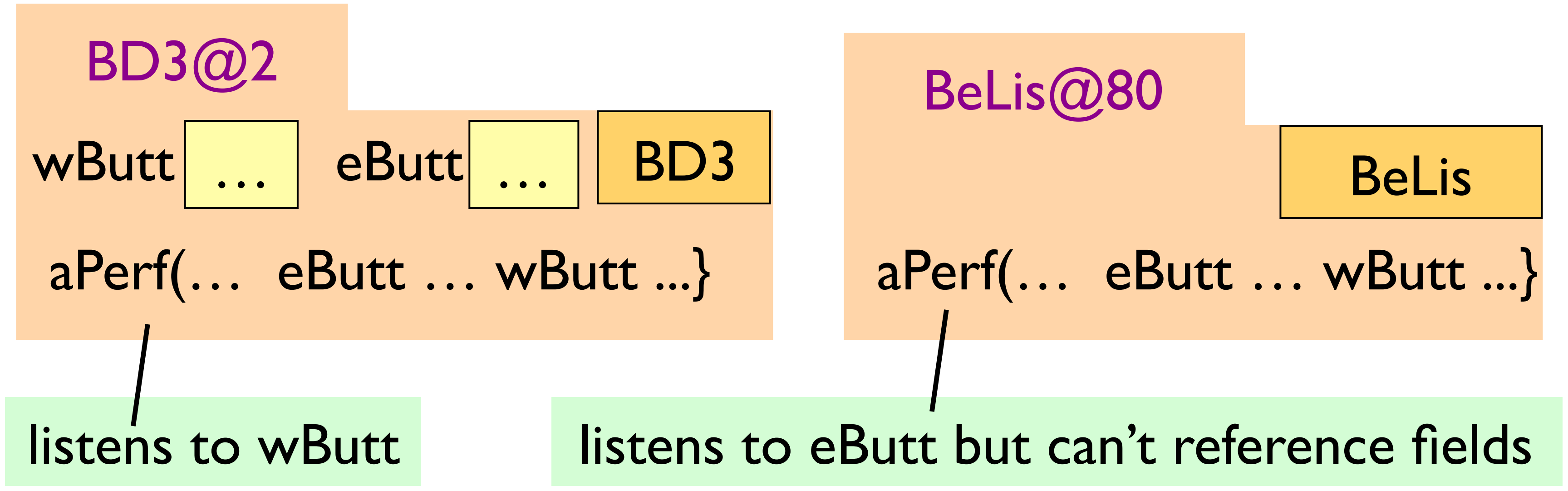
```
public class BDemo3 extends JFrame  implements
ActionListener {
    private JButton wButt, eButt …;

    public ButtonDemo3() {
        Add buttons to content pane, enable
            ne, disable the other
        wButt.addActionListener(this);
        eButt.addActionListener(new BeListener());  }

    public void actionPerformed(ActionEvent e) {
        boolean b= eButt.isEnabled();
        eButt.setEnabled(!b); wButt.setEnabled(b)
 }
```

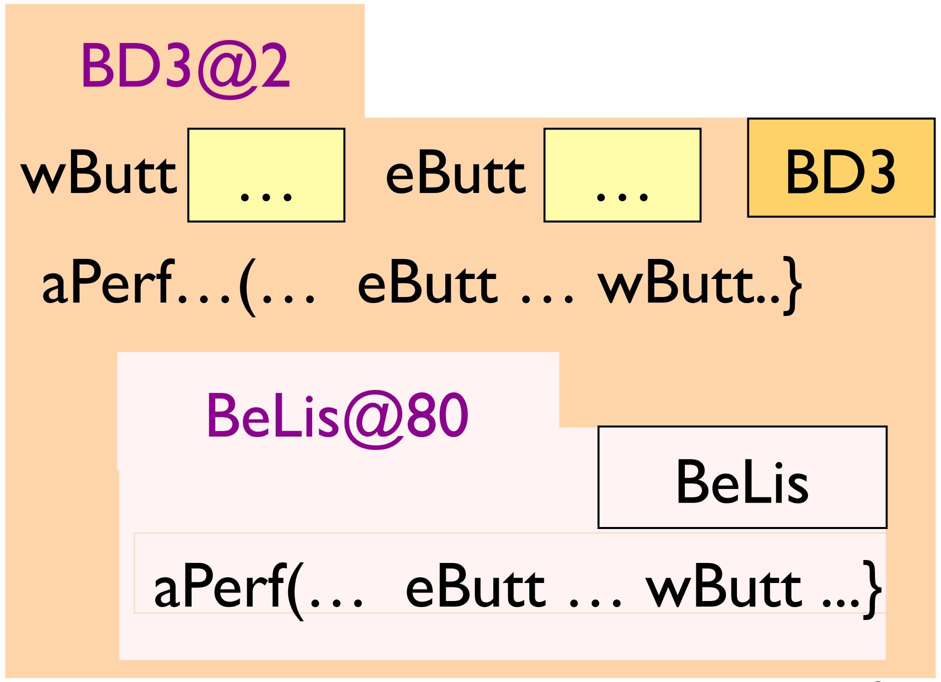
Have a different listener for each button

A listener for eastButt

Doesn't work! Can't reference eButt, wButt

```
class BeListener implements ActionListener {
     public void actionPerformed(ActionEvent e) {
        boolean b= eButt.isEnabled();
```


BD3@2
wButt …
eButt …
BD3
aPerf(… eButt … wButt ...}
listens to wButt
BeLis@80
BeLis
aPerf(… eButt … wButt ...}
listens to eButt but can't reference fields



Make BeListener an inner class.

Inside-out rule then gives access to wButt, eButt

Solution to problem: Make BeListener an inner class.

```
public class BDemo3 extends Jframe
        implements ActionListener {
    private JButton wButt, eButt …;

    public ButtonDemo3() { … }

    public void actionPerformed(ActionEvent e) { … }

    private class BeListener implements ActionListener { … }
```

Just as you can declare variables and methods within a class, you can declare a class within a class

Inside-out rule says that methods in here
Can reference all the fields and methods

We demo this using ButtonDemo3

Problem: can't give a function as a parameter:

```
public void m() { …
    eButt.addActionListener(aP);
}

public void aP(ActionEvent e) { body }
```

Why not just give eButt the function to call?
Can't do it in Java 7! Can in some other languages and Java 8

```
public void m() { …
    eButt.addActionListener(new C());
}

public class C implements IN {
    public void aP(ActionEvent e) { body }
}
```

Java says: provide class C that wraps method; give eButt an object of class C

C must implement interface IN that has abstract method aP

Have a class for which only one object is created?
Use an **anonymous class**.
Use sparingly, and only when the anonymous class has 1 or 2 methods in it, because the syntax is ugly, complex, hard to understand.

```
public class BDemo3 extends JFrame  implements
ActionListener {
    private JButton wButt, eButt …;

    public ButtonDemo3() { …
        eButt.addActionListener(new BeListener());
    }

    public void actionPerformed(ActionEvent e) { … }

 1 object of BeListener created. Ripe for making anonymous
      public void actionPerformed(ActionEvent e) { body }
    }
}
```

Making class anonymous will replace **new BeListener()**

Expression that creates object of BeListener

```
eButt.addActionListener(  new BeListener ()   );
```

private class BeListener implements ~~ActionListener~~
~~{ declarations in class~~ }
}

1. Write **new**

2. Write **new ActionListener**

3. Write **new ActionListener ()**

4. Write **new ActionListener ()**
{ declarations in class }

2. Use name of interface that BeListener implements

3. Put in arguments of constructor call

4. Put in class body

5. Replace **new** BeListener() by new-expression

with class named and with class anonymous:

```
    public ButtonDemo3() { …
        eButt.addActionListener(new BeListener());
    }

    private class BeListener implements ActionListener {
        public void actionPerformed(ActionEvent e) { body }
    }
}
```

```
    public ButtonDemo3() { …
        eButt.addActionListener(new ActionListener () {
            public void actionPerformed(ActionEvent e) { body }
        });
    }
}
```

Java 8 allows functions as parameters

We won’t talk anymore about functions as parameters.

Perhaps next semester we’ll redo things to cover functions as parameters.