

# CS2110. GUI: Listening to Events

Also

Example of Stepwise Refinement  
and  
Anonymous classes

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

## Developing the prelim string problem

```
/** s is a sequence of words with each pair of words separated  
 * by one or more blanks. Return a list of the Pig-Latin  
 * translations of the words, with no duplicates */  
public static ArrayList<String> m(String s) {
```

### **A few points to be constantly aware of**

- Focus on one thing at a time.
- Use abstraction.
- Keep things simple
- Avoid case analysis where possible
- Don't introduce a variable unless you need it.

Word: a sequence of  $\geq 1$  lowercase letters

## Use a loop to process string s

```
/** s is a sequence of words with each pair of words separated  
 * by one or more blanks. Return a list of the Pig-Latin  
 * translations of the words, with no duplicates */  
public static ArrayList<String> m(String s) {
```

Which kind of loop?

```
for (int k= 0; k < s.length(); k= k+1) {}
```

```
int k= 0;  
while ( ) {}
```

Problem is stated in terms of a sequence of words. Therefore, the loop is best written with each iteration processing one word. For-loop leads to disaster!

Word: a sequence of  $\geq 1$  lowercase letters

# Use abstraction to allow focus on one thing

For now, forget about what to do with each word and concentrate on just “processing” each word, using a loop. Later, figure out what “processing” means.

```
while ( ) {  
    Find first word in s, process it, and remove it from s  
}
```

But: what about blanks before and after first word. Best if we get rid of blanks before the word.

```
use s= s.trim();    // don't know about it? Write a loop
```

Word: a sequence of  $\geq 1$  lowercase letters

## Outline the while-loop

```
s= s.trim();
```

```
// inv: All processed words have been removed from s,  
//      and s has no surrounding blanks
```

```
while ( s.length() > 0 ) {  
    Process first word of s and remove it from s  
  
}
```

Word: a sequence of  $\geq 1$  lowercase letters

## Outline the while-loop

```
s= s.trim();  
// inv: All processed words have been removed from s,  
//      and s has no surrounding blanks  
while (s.length() > 0) {  
    // Process first word of s and remove it from s  
    int k= s.indexOf(" "); // # of chars in first word  
    if (k < 0) k= s.length();  
    String word= s.substring(0, k);  
    s= s.substring(k).trim();  
    Process word  
}
```

Problem: the  
last word has  
no blank after  
it!

Whenever you write  
`b[k]` or `s.charAt[k]` or `s.substring(h, k)` or `list.get(k)`, etc.  
ask yourself whether index `k` is in bounds.

# Stepwise refinement

```
s= s.trim();  
// inv: All processed words have been removed from s,  
//      and s has no surrounding blanks  
while (s.length() > 0) {  
    // Get first word of s into word and remove it from s  
    int k= s.indexOf(" ");  
    if (k < 0) k= s.length();  
    String word= s.substring(0, k);  
    s= s.substring(k).trim();  
  
    // Process word  
    ...  
}
```

Now we can work on processing a word, which has to do with constructing the ArrayList and adding the Pig Latin of non-duplicate words.

Stepwise refinement: Take one (small) step at a time.  
Focus on the most important one at the moment.

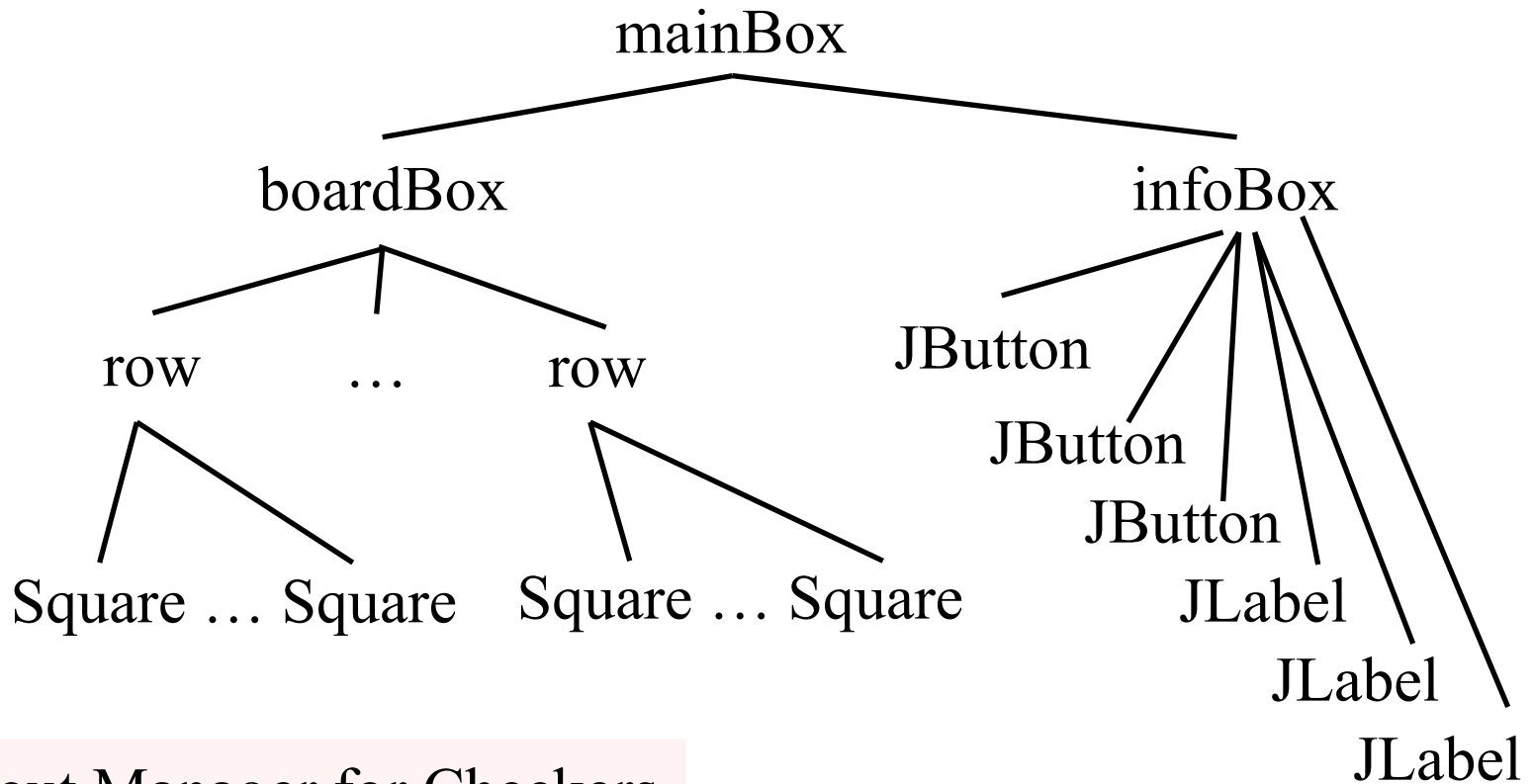
# Stepwise refinement

Stepwise refinement: Take one (small) step at a time. **Focus on the most important one at the moment.**

Examples of steps:

- Implement an English statement by a sequence of statements
- Decide on using a loop
- Stub in a new method (Specification and header, with empty body) because of duplicate code or to remove complexity
- Add a local variable or field
- Replace an English statement by an equivalent Java statement





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,
                             // which 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);
```

```
/** Object has two buttons. Exactly one is enabled. */
```

```
class ButtonDemo1 extends JFrame  
    implements ActionListener {
```

**red: listening**

**blue: placing**

```
/** 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, BorderLayout.WEST);
```

```
    cp.add(eastB, BorderLayout.EAST);
```

```
    westB.setEnabled(false);
```

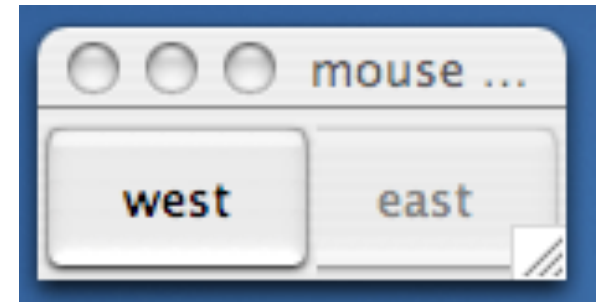
```
    eastB.setEnabled(true);
```

```
    westB.addActionListener(this);
```

```
    eastB.addActionListener(this);
```

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

```
}
```



```
public void actionPerformed  
    (ActionEvent e) {
```

```
    boolean b=  
        eastB.isEnabled();
```

```
    eastB.setEnabled(!b);
```

```
    westB.setEnabled(b);
```

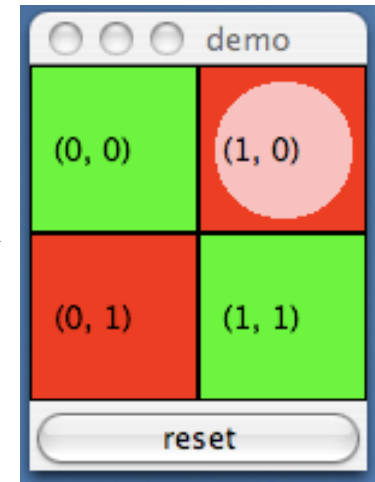
```
}
```

```
}
```

**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));
```

```
}
```

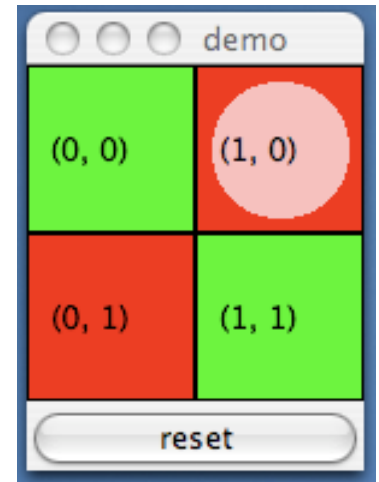
```
/** Complement the "has pink disk" property */
```

```
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:

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

*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

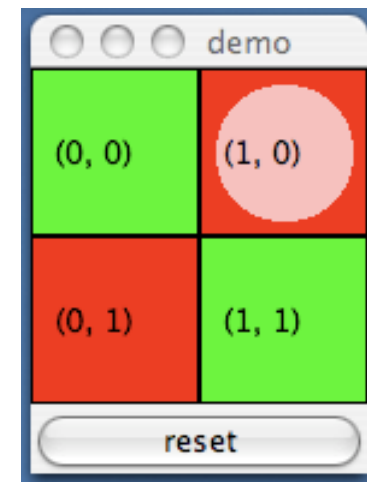


## continuation of class Square

```
/* 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);
}
}
```

## Class Square

```
/** 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 { In package java.awt.event  
    void mouseClicked(MouseEvent e);  
    void mouseEntered(MouseEvent e);  
    void mouseExited(MouseEvent e);  
    void mousePressed(MouseEvent e);  
    void mouseReleased(MouseEvent e);  
}
```

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 a painless.

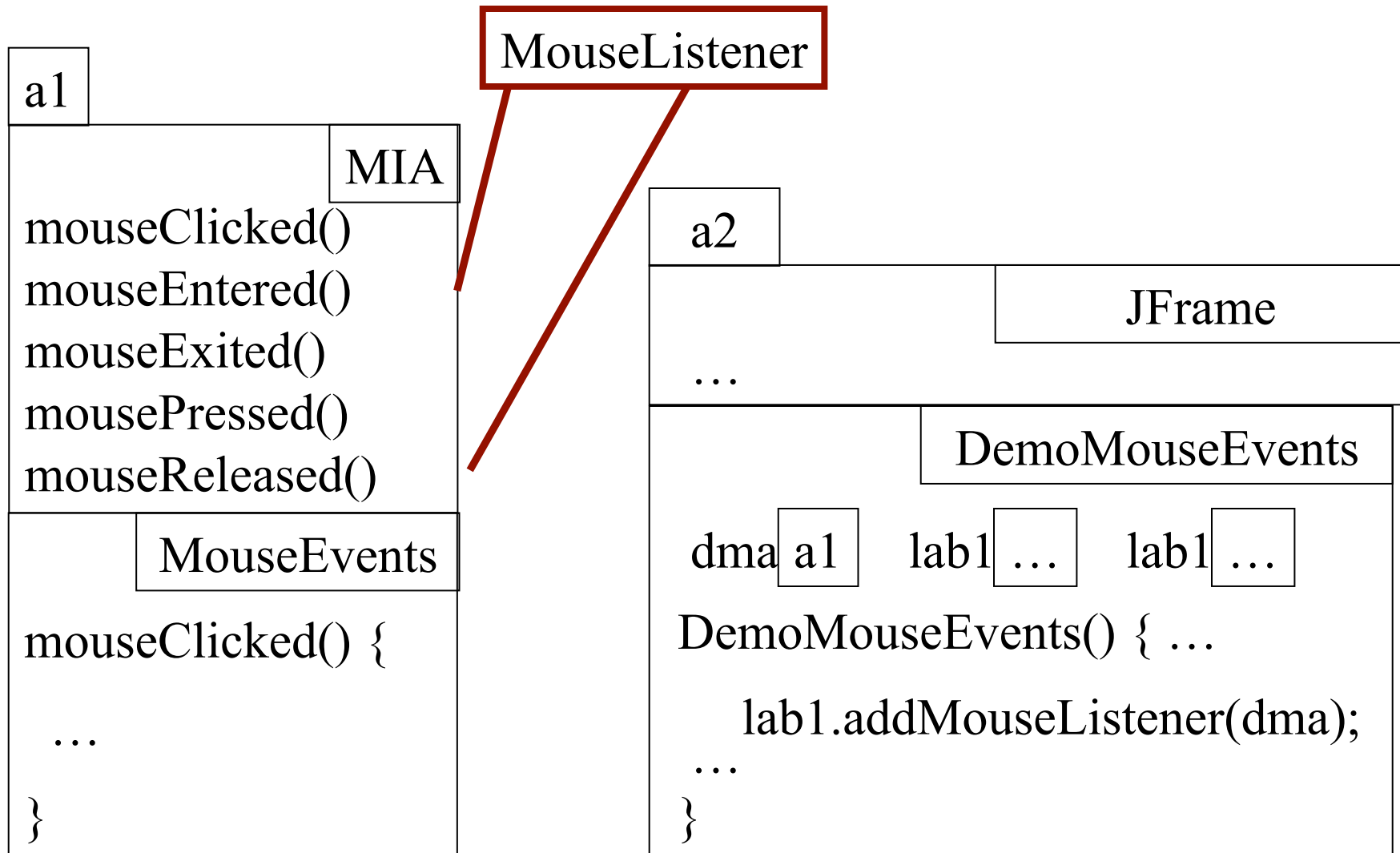
## Listen to mouse event (click, press, release, enter, leave on a component)

In package java.swing.event

```
public class MouseInputAdaptor  
    implements MouseListener, MouseInputListener {  
    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



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

## A class that listens to a mouseclick in a Square

red: listening

blue: placing

```
/** 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

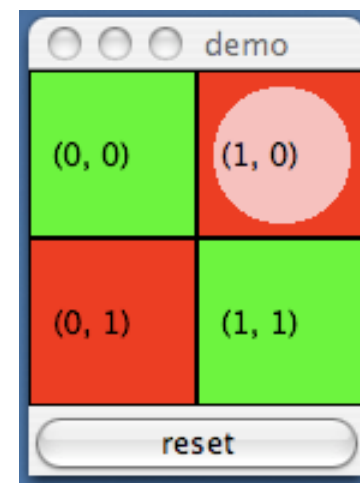
mouse press

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 unresizable, visible;

```

```

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

```

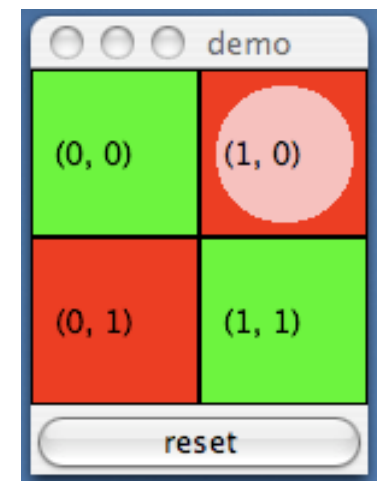
```

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());
```

```
    }
```

```
}
```

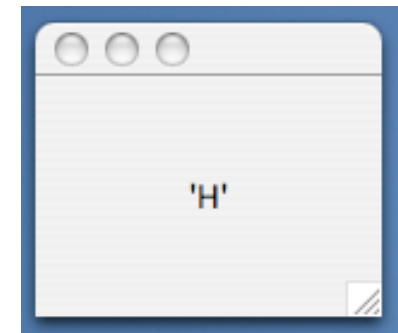
**red: listening**

**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()); }  
}
```

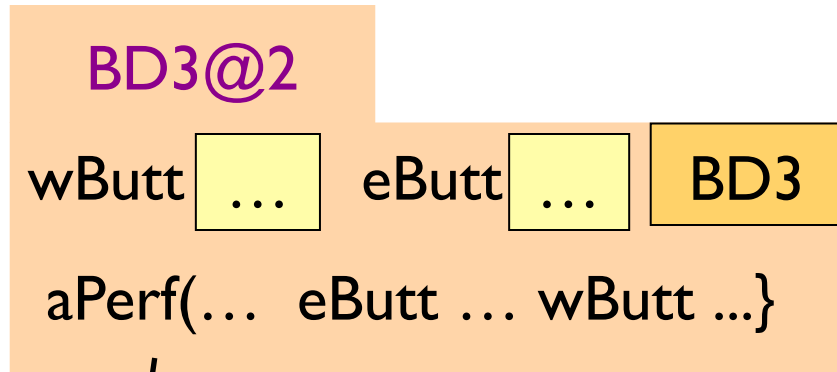
Have a different  
listener for each  
button

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

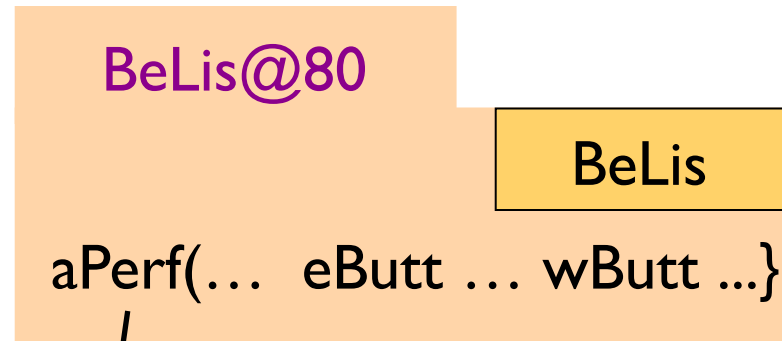
Doesn't work!  
Can't  
reference  
eButt, wButt

```
A listener for eastButt  
class BeListener implements ActionListener {  
    public void actionPerformed(ActionEvent e) {  
        boolean b= eButt.isEnabled();  
        eButt.setEnabled(!b); wButt.setEnabled(b);  
    }  
}
```

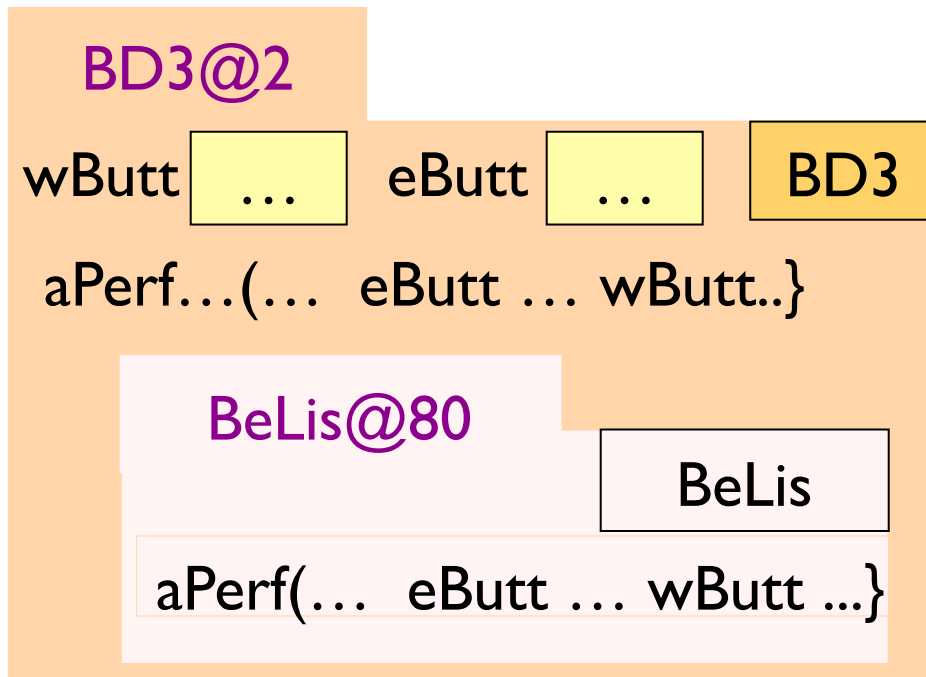




listens to wButt



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
    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!**  
**Can in some  
other languages**

---

```
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) { ... }

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

## 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