

## CS2110. GUI: Listening to Events

Also anonymous classes versus Java 8 functions

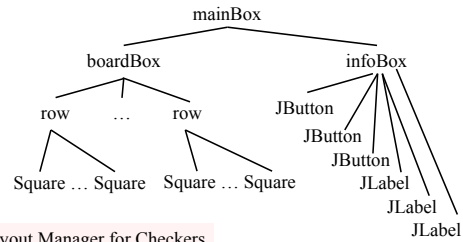
Pick up prelim in Gates 216!! Usually noon to 4:30.

Regrade requests will be processed as they are turned in and as we find time to process them!

Lunch with instructors, Tuesday or Thursday?  
Visit Piazza pinned post @275.

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

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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

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### 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.

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### 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

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### Listening to a JButton

1. Implement interface ActionListener:

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

So, C must implement actionPerformed, and it will be called when the button is clicked

```
public interface ActionListener extends ... {
    /** Called when an action occurs. */
    public abstract void actionPerformed(ActionEvent e);
}
```

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### Listening to a JButton

1. Implement interface ActionListener:

```
public class C extends JFrame
    implements ActionListener { ... }
```
2. In C override actionPerformed --called when button is clicked:

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

```
public interface ActionListener extends EventListener {
    /** Called when an action occurs. */
    public abstract void actionPerformed(ActionEvent e);
}
```

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### Listening to a JButton

1. Implement interface ActionListener:  

```
public class C extends JFrame
    implements ActionListener { ... }
```
2. In C override actionPerformed --called when button is clicked:  

```
/** Process click of button */
public void actionPerformed(ActionEvent e) { ... }
```
3. Add an instance of class C as an "action listener" for button:  

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

```
Method JButton.addActionListener
public void addActionListener(ActionListener l)
```

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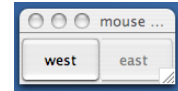
```
/** Object has two buttons. Exactly one is enabled. */
class ButtonDemo1 extends JFrame
    implements ActionListener {

    /** 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, 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
```



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### 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 reset 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



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```
/** 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
```



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### 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

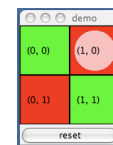
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### continuation of class Square

```
/* 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);
}

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

Class Square
```



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**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.

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

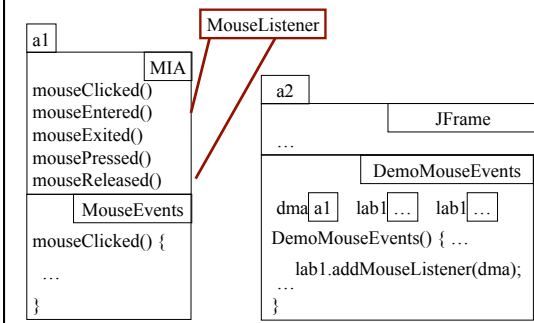
In package java.swing.event

```
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

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javax.swing.event.MouseInputAdaptor implements MouseListener



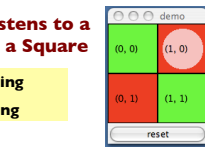
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**A class that listens to a mouseclick in a Square**

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) to 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

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```
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



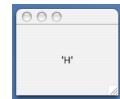
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**Listening to the keyboard**

red: listening  
blue: placing

```
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 + "");
}
}
```

1. Extend this class.  
2. Override this method. It is called when a key stroke is detected.  
3. Add this instance as a key listener for the frame



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```

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

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

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

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

```

Have a different listener for each button

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

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```

A listener for eastButt
public class BDemo5 extends JFrame {
    private JButton eButt;

    public ButtonDemo5() {
        Add button to content pane ...
        eButt.addActionListener(new BeListener());
    }
}

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

```

Doesn't work!  
By inside-out rule, can't reference eButt

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```

A listener for eastButt as an inner class
public class BDemo5 extends JFrame {
    private JButton eButt;

    public ButtonDemo5() {
        Add button to content pane ...
        eButt.addActionListener(new BeListener());
    }

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

```

Make it an inner class  
By inside-out rule, it CAN reference eButt

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```

WHY DO WE HAVE TO HAVE CLASS BeListener?
Why can't we just put method actionPerformed as an argument to addActionListener?

Two solutions:
1. An anonymous class
2. Since Java 8. A function as argument

public class BDemo5 extends JFrame {
    private JButton eButt;

    public ButtonDemo5() {
        Add button to content pane ...
        eButt.addActionListener(new BeListener());
    }
}

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

```

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```

Since Java 8: Have a function as argument
public class BDemo5 extends JFrame
    private JButton eButt;

    public ButtonDemo5() {
        Add button to content pane ...
        eButt.addActionListener(e -> { boolean b= eButt.isEnabled();
            eButt.setEnabled(!b);
        });
    }
}

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

```

We don't expect you to master this. It's here only to give you an idea of what is possible, what you might see in a Java program.

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ANONYMOUS CLASS

You will see anonymous classes in A5 and other GUI programs

Use sparingly, and only when the anonymous class has 1 or 2 methods in it, because the syntax is ugly, complex, hard to understand.

The last two slides of this ppt show you how to eliminate BeListener by introducing an anonymous class.

You do not have to master this material

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ANONYMOUS CLASS IN A5.  
PaintGUI.setUpMenuBar, fixing item "New"

```

Save new JMenuItem
JMenuItem newItem= new JMenuItem("New");
newItem.setMnemonic(KeyEvent.VK_N);
newItem.setAccelerator(KeyStroke.getKeyStroke(KeyEvent.VK_N,
ActionEvent.CTRL_MASK));
newItem.addActionListener(new ActionListener() {
    public void actionPerformed(ActionEvent e) {
        newAction(e);
    }
});

```

Fix it so that control-N selects this menu item

new ActionListener() { ... } declares an anonymous class and creates an object of it. The class implements ActionListener. Purpose: call newAction(e) when actionPerformed is called

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Using an A5 function (only in Java 8!).  
PaintGUI.setUpMenuBar, fixing item "New"

```

Save new JMenuItem
JMenuItem newItem= new JMenuItem("New");
newItem.setMnemonic(KeyEvent.VK_N);
newItem.setAccelerator(KeyStroke.getKeyStroke(KeyEvent.VK_N,
ActionEvent.CTRL_MASK));
newItem.addActionListener(e -> { newAction(e); });

```

Fix it so that control-N selects this menu item

argument e -> { newAction(e); } of addActionListener is a function that, when called, calls newAction(e).

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ANONYMOUS CLASS VERSUS FUNCTION CALL  
PaintGUI.setUpMenuBar, fixing item "New"

The Java 8 compiler will change this:

```
newItem.addActionListener(e -> { newAction(e); });
```

back into this:

```

newItem.addActionListener(new ActionListener() {
    public void actionPerformed(ActionEvent e) {
        newAction(e);
    }
});

```

and actually change that back into an inner class

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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

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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 }
  5. Replace new BeListener() by new-expression
2. Use name of interface that BeListener implements
3. Put in arguments of constructor call
4. Put in class body

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