Chap 9 - GUIs Part II

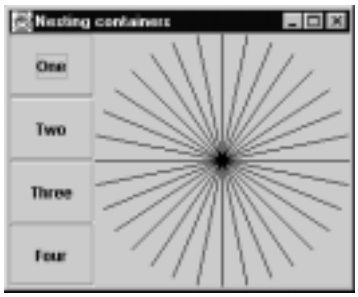
- Arranging components with JPanel.
- Resizing.
- More about Graphics.
- Graphics2D
- Menus

Note that the import statements have been exclueded from many of the slides in this chapter to save space on the slide.

BorderLayout Layout Manager

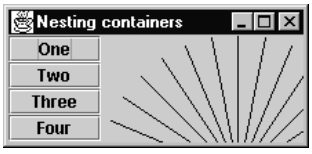

```
class BorderLayoutTest {
  public static void main(String[] args) {
    JFrame frame = new JFrame("BorderLayout");
    Container pane = frame.getContentPane();
    pane.add(
      new JButton("North Button"),BorderLayout.NORTH);
    pane.add(
      new JButton("South Button"),BorderLayout.SOUTH);
    pane.add(
      new JButton("East Button"), BorderLayout.EAST);
    pane.add(
      new JButton("West Button"), BorderLayout.WEST);
    pane.add(
      new JButton("Center Button"),BorderLayout.CENTER);
    frame.pack();
    frame.show();
  }
}
```


Nesting Containers



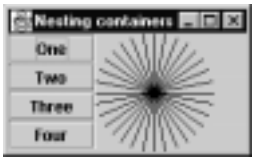

```
class Nesting {
  public static void main(String[] args) {
    JFrame frame = new JFrame("Nesting containers");
    Container pane = frame.getContentPane();
    JPanel panel = new JPanel();
    panel.setLayout(new GridLayout(4, 1));
    panel.add(new JButton("One"));
    panel.add(new JButton("Two"));
    panel.add(new JButton("Three"));
    panel.add(new JButton("Four"));
    pane.add(panel, BorderLayout.WEST);
    pane.add(new Star(), BorderLayout.CENTER);
    frame.pack();
    frame.show();
  }
}
```


Resizing



The JButtons resized but the Star did not.

```
class Star2 extends JComponent {
  public void paint(Graphics g) {
    //same as in earlier Star class
  }
  public void setBounds(int x, int y,
                        int width, int height)
  {
    radius = Math.min(width, height) / 2;
    super.setBounds(x, y, width, height);
    repaint();
  }
  public Dimension getMinimumSize() {
    return new Dimension(2 * radius, 2 * radius);
  }
  public Dimension getPreferredSize() {
    return new Dimension(2 * radius, 2 * radius);
  }
  private int radius = 100;
```

An Example: A Plot Component

- Create a component to plot any function of one variable.
- The component will be given a range of values or which to plot the function.
- The component will have a default size and will adjust the scaling of the plot to just fill the alloted screen space.
- When resized, the plot component will readjust its scaling so that the plot continues to just fill the alloted space.

How do we specify the function?

- We can use an interface.

```
//Function.java
interface Function {
  public double valueAt(double x);
}
```



```
public class Plot extends JComponent {
  private Dimension dim;
  private double fmin, fmax;
  private double xScale, yScale;
  private double from, to, delta;
  private Function function;

  public Plot(Function f, double start, double end,
              double deltaX)
  {
    function = f;
    delta = deltaX;
    from = start;
    to = end;
    findRange(); // find max and min of f(x)
    setSize(200, 100); // default width, height
  }
```



```
public void paint(Graphics g)
{
  double x = from;
  double f_of_x = function.valueAt(x);
  while (x < to - delta) {
    double f_of_x_plus_delta;
    f_of_x_plus_delta = function.valueAt(x + delta);
    drawLine(g, x, f_of_x,
             x + delta, f_of_x_plus_delta);
    x = x + delta;
    f_of_x = f_of_x_plus_delta;
  }
  drawLine(g, x, f_of_x, to, function.valueAt(to));
}
```

```
  public void setBounds(int x, int y,
                        int width, int height)
  {
    xScale = (width - 2) / (to - from);
    yScale = (height - 2) / (fmax - fmin);
    dim = new Dimension(width, height);
    super.setBounds(x, y, width, height);
    repaint();
  }
  public Dimension getMinimumSize() {
    return dim;
  }

  public Dimension getPreferredSize() {
    return getMinimumSize();
  }
```

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```
  // scale and translate the points from the
  // user's coordinate space to Java's
  private void drawLine(Graphics g,
                        double x1, double y1,
                        double x2, double y2)
  {
    g.drawLine(
               (int)Math.round((x1 - from) * xScale),
               (int)Math.round((fmax - y1) * yScale),
               (int)Math.round((x2 - from) * xScale),
               (int)Math.round((fmax - y2) *yScale));
  }
```

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```
  // determine the minimum and maximum values of
  // f(x) with x varying between from and to
  private void findRange() {
    fmin = fmax = function.valueAt(from);
    for (double x = from + delta;
        x < to - delta;
        x = x + delta)
    {
      double f_of_x = function.valueAt(x);
      if (f_of_x < fmin)
        fmin = f_of_x;
      if (f_of_x > fmax)
        fmax = f_of_x;
    }
  }
}
```

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```
//SinFunction.java
class SinFunction implements Function {
  public double valueAt(double x) {
    return Math.sin(x);
  }
}
```

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```
//PlotTest.java
import java.awt.*;
import javax.swing.*;

class PlotTest {
  public static void main(String[] args) {
    Function f = new SinFunction();
    JFrame frame = new JFrame("PlotTest");
    Container pane = frame.getContentPane();
    Plot plot = new Plot(f, 0, 2 * Math.PI, 0.1);
    pane.add(plot);
    frame.pack();
    frame.show();
  }
}
```

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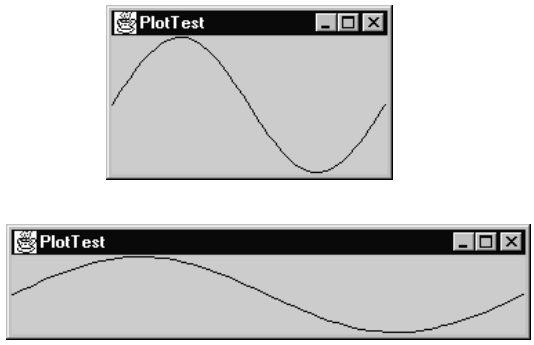

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java.awt.Graphics

- Handles basic drawing.
- Supports colors.
- Supports different text fonts.
- Draws lines, ovals, polygons, rectangles, and arcs, both filled and unfilled.

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Minor variants of this class are used throughout section 9.4 to test components that draw different shapes.

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

class DrawingLines {
  public static void main(String[] args) {
    JFrame frame = new JFrame("DrawingLines");
    Container pane = frame.getContentPane();
    pane.add(new DrawTriangle());
    frame.pack();
    frame.show();
  }
}
```

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```
// This class is miss named. It draws a triangle and a W.
class DrawTriangle extends JComponent {

  public void paint(Graphics g) {
    // draw a triagle
    g.drawLine(10, 10, 100, 60);
    g.drawLine(100, 60, 50, 80);
    g.drawLine(50, 80, 10, 10);
    // draw a W
    int[] x = {120, 140, 160, 180, 200};
    int[] y = {10, 80, 10, 80, 10};
    g.drawPolyline(x, y, 5);
  }

  public Dimension getMinimumSize() { return dim;}
  public Dimension getPreferredSize() {return dim;}
  private Dimension dim = new Dimension(220, 100);
}
```

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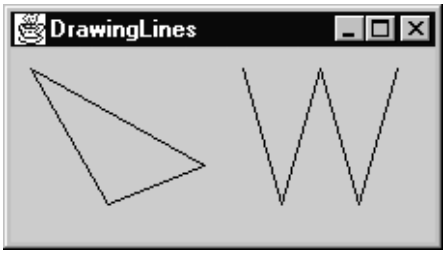

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```
class DrawRectangles extends JComponent
{
  public void paint(Graphics g) {
    g.drawRect(0, 0, 100, 60);
    g.drawRoundRect(110, 0, 100, 60, 40, 20);
    g.setColor(Color.gray);
    g.drawOval(170, 40, 40, 20);
  }
  public Dimension getMinimumSize()
  {
    return dim;
  }
  public Dimension getPreferredSize()
  {
    return dim;
  }
  private Dimension dim = new Dimension(220,70);
}
```

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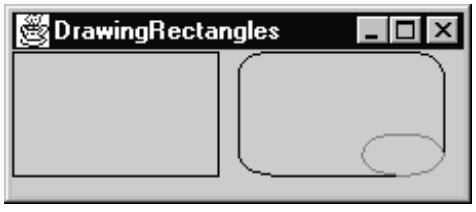
Notice the curvature of the oval and the corners of the "Round Rectangle.



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```
class DrawOvals extends JComponent
{
  public void paint(Graphics g) {
    g.drawRect(10, 10, 100, 60);
    g.drawOval(10, 10, 100, 60);
  }
  public Dimension getMinimumSize()
  { return dim;
  }
  public Dimension getPreferredSize()
  { return dim;
  }
  private Dimension dim = new Dimension(500,100);
}
```

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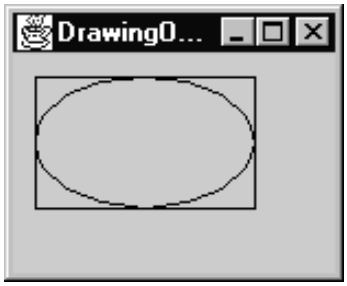
See how the oval fits inside of the rectangle, called the "bounding box".



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```
class DrawArcs extends JComponent
{
  public void paint(Graphics g) {
    g.drawArc(0, 0, 100, 60, 0, 160);
    g.fillArc(110, 0, 60, 60, 45, -135);
  }
  public Dimension getMinimumSize()
  { return dim;
  }
  public Dimension getPreferredSize()
  { return dim;
  }
  private Dimension dim = new Dimension(500,70);
}
```

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Arcs are just incomplete Ovals.

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```
class DrawPolygons extends JComponent
{
  public void paint(Graphics g) {
    Polygon p = new Polygon();
    p.addPoint(10, 10);
    p.addPoint(60, 30);
    p.addPoint(40, 50);
    p.addPoint(25, 40);
    g.drawPolygon(p); // draw a Polygon object
    // draw a polygon using 2 arrays
    int[] x = {110, 160, 140, 125};
    int[] y = {10, 30, 50, 40};
    g.fillPolygon(x, y, 4);
    //move 200 pixels right and 20 down
    p.translate(200, 20);
    g.drawPolygon(p); // draw translated polygon
  }
```

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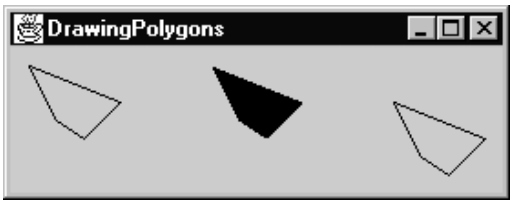

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```
class DrawText extends JComponent
{
  public void paint(Graphics g) {
    g.drawString("Starts at (10, 20)", 10, 20);
    g.fillRect(10, 20, 4, 4);
    g.setFont(new Font("TimesRoman", Font.BOLD, 20));
    g.drawString("20pt bold starting at (100, 40)",
              100, 40);
    g.fillRect(100, 40, 4, 4);
  }
  public Dimension getMinimumSize()
  { return dim;
  }
  public Dimension getPreferredSize()
  { return dim;
  }
  private Dimension dim = new Dimension(220,100);
}
```

31

Notice where the small box is in relation to the text. That is the "location"of the text.

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```
class DrawColors extends JComponent
{
  public void paint(Graphics g) {
    Color c = Color.blue;
    g.setColor(c.brighter());
    g.fillRect(10, 10, 200, 100);
    g.setColor(c);
    g.fillRect(20, 20, 180, 80);
    g.setColor(c.darker());
    g.fillRect(30, 30, 160, 60);
    g.setColor(c.darker().darker());
    g.fillRect(40, 40, 140, 40);
    g.setColor(Color.red);
    g.drawRect(10, 10, 200, 100);
  }
```

33

Color.blue appears to be the brighest blue already, so Color.blue.brighter() didn't do anything.

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Graphics2D

- "This Graphics2D class extends the Graphics class to provide more sophisticated control over geometry, coordinate transformations, color management, and text layout. This is the fundamental class for rendering 2-dimensional shapes, text and images on the Java(tm) platform." [From Standard javadoc documentation of Graphics2D.]

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Changing the drawing "stroke"

- We can control the following parameters of a "brush" stroke.
  - the width of the brush,
  - the dash pattern of the brush,
  - the shape of the end of a brush stroke,
  - what happens when two ends join, and
  - for dashed lines, where in the dash patter does the stroke begin.

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```
class StrokeSampler extends JComponent {
  static final BasicStroke wideStroke =
           new BasicStroke(8.0f);
  static final BasicStroke mediumStroke =
           new BasicStroke(4.0f);
  public void paint(Graphics g) {
    Graphics2D g2d = (Graphics2D)g;
    // draw some rectangles with wide lines
    g2d.setStroke(wideStroke);
    g2d.drawRect(10, 10, 100, 60);
    g2d.setStroke(mediumStroke);
    g2d.drawRoundRect(120, 10, 100, 60, 40, 20);
```

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```
// These definitions are shown out of order.
// They belong outside of the method.


  static final BasicStroke wideRound =
    new BasicStroke(16.0f,
            BasicStroke.CAP_ROUND /* end style */,
            BasicStroke.JOIN_ROUND /* join style */);

  static final BasicStroke wideBevel =
    new BasicStroke(16.0f,
            BasicStroke.CAP_BUTT /* end style */,
            BasicStroke.JOIN_BEVEL /* join style */);
```

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```
    // draw some lines with round ends/joints
    int[] xcoords = {30, 60, 90};
    int[] ycoords = {90, 140, 90};
    g2d.setStroke(wideRound);
    g2d.drawPolyline(xcoords, ycoords, 3);
    // draw some lines with bevel joints
    for (int i = 0; i < xcoords.length; i++)
      xcoords[i] = xcoords[i] + 110;
    g2d.setStroke(wideBevel);
    g2d.drawPolyline(xcoords, ycoords, 3);
```

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```
   // use a dot-dash stroke
   g2d.setStroke(dotDashStroke);
   g2d.drawRect(10, 170, 100, 60);
   g2d.drawRoundRect(120, 170, 100, 60, 40, 20);
}

static float[] dotDash = {10.0f, 5.0f, 5.0f, 5.0f};
static final BasicStroke dotDashStroke =
  new BasicStroke(4.0f /*width*/,
          BasicStroke.CAP_BUTT /*end style*/,
          BasicStroke.JOIN_MITER /*join style*/,
          1.0f /*miter trim limit */,
          dotDash /* pattern array */,
          0.0f /* offset to start of pattern */);
```

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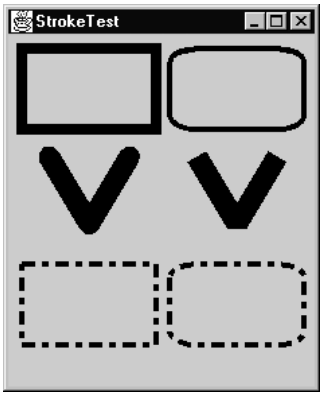

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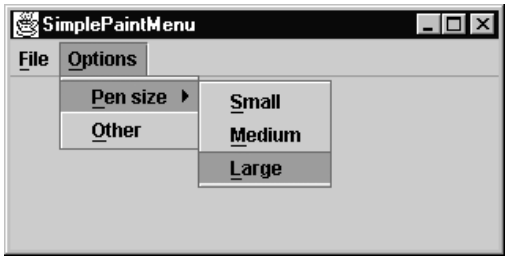
Menus



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SimplePaintMenu

- **SimplePaintMenu** - main().
- **PaintListener3** - extends **PaintListener2**, adding setPenSize().
- **Painter** - an interface that isolates the mouse motion listener, PaintListener3, from the action event listener, PenAdjuster.
- **PenAdjuster** - handles menu selections.
- **DrawingCanvas2** - where the drawing occurs.

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```
// SimplePaintMenu.java - add a menu to SimplePaint2
import java.awt.*;
import javax.swing.*;
import java.awt.event.*;

class SimplePaintMenu {
  public static void main(String[] args) {
    JFrame frame = new JFrame("SimplePaintMenu");
    Container pane = frame.getContentPane();
    // create the canvas and mouse listener
    // just as in SimplePaint2
    DrawingCanvas2 canvas = new DrawingCanvas2();
    PaintListener3 painter = new PaintListener3();
    canvas.addMouseMotionListener(painter);
    pane.add(canvas);
```

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```
   // create the menu bar and top level menus
    JMenuBar menuBar = new JMenuBar();
    JMenu fileMenu = new JMenu("File");
    fileMenu.setMnemonic('F');
    JMenu optionsMenu = new JMenu("Options");
    optionsMenu.setMnemonic('O');
    menuBar.add(fileMenu);
    menuBar.add(optionsMenu);
    frame.setJMenuBar(menuBar);

    // add items to the fileMenu
    JMenuItem exit = new JMenuItem("Exit",'x');
    fileMenu.add(exit);
    exit.addActionListener(new GoodBye());
```

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```
    // create and add items to the optionsMenu
    // the first item is a submenu for pen size
    JMenu penAdjusterMenu = new JMenu("Pen size");
    penAdjusterMenu.setMnemonic('P');
    // create and add items to the pen size sub menu
    JMenuItem smallPen = new JMenuItem("Small", 'S');
    JMenuItem mediumPen = new JMenuItem("Medium",'M');
    JMenuItem largePen = new JMenuItem("Large", 'L');
    penAdjusterMenu.add(smallPen);
    penAdjusterMenu.add(mediumPen);
    penAdjusterMenu.add(largePen);
```

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```
    // add a listener to the pen selection items
    PenAdjuster penAdjuster = new PenAdjuster(painter);
    smallPen.addActionListener(penAdjuster);
    mediumPen.addActionListener(penAdjuster);
    largePen.addActionListener(penAdjuster);
    optionsMenu.add(penAdjusterMenu);
    // for demo purposes add second (unused) item
    optionsMenu.add(new JMenuItem("Other",'O'));

    frame.pack();
    frame.show();
  }
}
```

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```
public class PaintListener3 extends PaintListener2
                            implements Painter
{
  // specify one of three pen sizes, Small, Medium or Large
  // radius and diameter are inherited
  public void setPenSize(String size) {
    if (size.equals("Small")) {
        radius = 0;
        diameter = 1;
    }
    else if (size.equals("Medium")) {
      radius = 3;
      diameter = radius * 2;
    }
    else if (size.equals("Large")) {
      radius = 6;
      diameter = radius * 2;
    }
  }
}
```

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```
// Painter.java -
//   in practice this interface would contain
//   additional methods such as for changing pen
//   shape, color, pattern etc.
interface Painter {
  public void setPenSize(String size);
}
```

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```
// PenAdjuster.java - pass pen adjustment requests
//     to the painter
import java.awt.event.*;

class PenAdjuster implements ActionListener {
  private Painter painter;
  PenAdjuster(Painter thePainter) {
    painter = thePainter;
  }
  public void actionPerformed(ActionEvent e) {
    painter.setPenSize(e.getActionCommand());
  }
}
```

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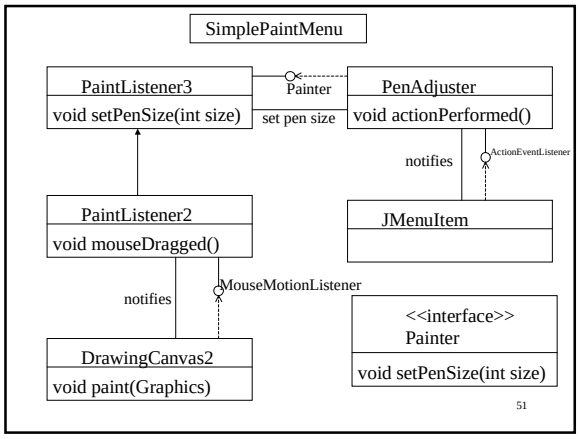

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Template for a Game Board

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```
class GameTest {
  public static void main(String[] args)
  {
    byte[][] state = new byte[20][20];

    JFrame frame = new JFrame("GameTest");
    Container pane = frame.getContentPane();
    GameBoard board = new GameBoard(400, 400, state);
    GameEventHandler actor = new GameEventHandler();
    board.addMouseListener(actor);
    pane.add(board, BorderLayout.CENTER);
    JButton quit = new JButton("Quit");
    quit.addActionListener(actor);
    pane.add(quit, BorderLayout.NORTH);
    frame.pack();
    frame.show();
  }
}
```

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```
class GameEventHandler
    implements MouseListener, ActionListener
{
  public void actionPerformed(ActionEvent e) {
    System.out.println("Goodbye!");
    System.exit(0);
  }
  public void mouseClicked(MouseEvent e)
  {
    GameBoard board = (GameBoard)e.getSource();
    int row = e.getY() / board.getCellHeight();
    int col = e.getX() / board.getCellWidth();
    if (board.getCell(row, col) == board.STATE0)
      board.setCell( row, col, board.STATE1);
    else
      board.setCell( row, col, board.STATE0);
    board.repaint();
  }
```

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

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```
//GameBoard.java
import java.awt.*;
import javax.swing.*;

class GameBoard extends JComponent {
  // the example supports only two valid states
  public static final byte INVALID = -1;
  public static final byte STATE0 = 0;
  public static final byte STATE1 = 1;

  public GameBoard(int width, int height,
                   byte[][] board) {
    this.board = board;
    setSize(new Dimension(width, height));
  }
```

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```
  // draw the cells of the board
  public void paint(Graphics g) {
    for (int row = 0; row<board.length; row++)
      for (int col=0; col < board[row].length; col++){
        select_color(g, board[row][col]);
        g.fillRect(col * cellWidth,
                   row * cellHeight,
                   cellWidth, cellHeight);
      }
  }
  public Dimension getMinimumSize() {
    return dim;
  }
  public Dimension getPreferredSize() {
    return getMinimumSize();
  }
```

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```
  public void setBounds(int x, int y,
                        int width, int height)
  {
    dim = new Dimension(width, height);
    //adjust cell size to fill the new board size
    cellWidth =
        Math.round((float)width / board.length);
    cellHeight = Math.round(
                    (float)height / board[0].length);
    super.setBounds(x, y, width, height);
    repaint();
  }
```

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```
  public void setCell(int row, int col, byte value) {
    board[row][col] = value;
  }
  public byte getCell(int row, int col) {
    return board[row][col];
  }
  public int getCellWidth() { return cellWidth; }
  public int getCellHeight() { return cellHeight; }
  private void select_color(Graphics g, byte cell) {
    if (cell == STATE0)
      g.setColor(Color.white);
    else
      g.setColor(Color.black);
  }
  private byte[][] board;
  private int cellWidth, cellHeight;
  private Dimension dim;
}
```

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Using an Adapter

```
class GameEventHandler2 extends MouseAdapter
    implements ActionListener
{
  public void mouseClicked(MouseEvent e) {
    GameBoard board = (GameBoard)e.getSource();
    int row = e.getY() / board.getCellHeight();
    int col = e.getX() / board.getCellWidth();
    if (board.getCell(row, col) == board.STATE0)
      board.setCell(row, col, board.STATE1);
    else
      board.setCell(row, col, board.STATE0);
    board.repaint();
  }
```

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```
  public void actionPerformed(ActionEvent e) {
    System.out.println("Goodbye!");
    System.exit(0);
  }
}
```

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