core WEB programming

Layout Managers

Arranging Elements in Windows

Agenda

- **How layout managers simplify interface design**
- **Standard layout managers**
  - FlowLayout, BorderLayout, CardLayout, GridLayout, GridBagLayout, BoxLayout
- **Positioning components manually**
- **Strategies for using layout managers effectively**
- **Using invisible components**

Layout Managers

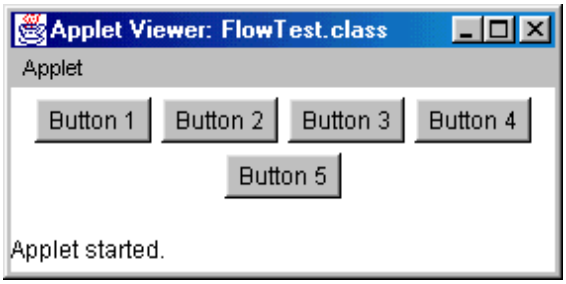
- **Assigned to each Container**
  - Give *sizes* and *positions* to components in the window
  - Helpful for windows whose size changes or that display on multiple operating systems
- **Relatively easy for simple layouts**
  - But, it is surprisingly hard to get complex layouts with a single layout manager
- **Controlling complex layouts**
  - Use nested containers (each with its own layout manager)
  - Use invisible components and layout manager options
  - Write your own layout manager
  - Turn some layout managers off and arrange some things manually

FlowLayout

- **Default layout for `Panel` and `Applet`**
- **Behavior**
  - Resizes components to their preferred size
  - Places components in rows left to right, top to bottom
  - Rows are centered by default
- **Constructors**
  - **`FlowLayout()`**
    - Centers each row and keeps 5 pixels between entries in a row and between rows
  - **`FlowLayout(int alignment)`**
    - Same 5 pixels spacing, but changes the alignment of the rows
    - `FlowLayout.LEFT, FlowLayout.RIGHT, FlowLayout.CENTER`
  - **`FlowLayout(int alignment, int hGap, int vGap)`**
    - Specify the alignment as well as the horizontal and vertical spacing between components (in pixels)

FlowLayout: Example

```
public class FlowTest extends Applet {
  public void init() {
    // setLayout(new FlowLayout()); [Default]
    for(int i=1; i<6; i++) {
      add(new Button("Button " + i));
    }
  }
}
```



BorderLayout

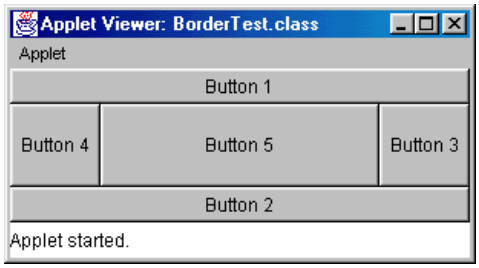
- **Default layout for `Frame` and `Dialog`**
- **Behavior**
  - Divides the `Container` into five regions
  - Each region is identified by a corresponding `BorderLayout` constant
    - `NORTH`, `SOUTH`, `EAST`, `WEST`, and `CENTER`
  - NORTH and SOUTH respect the preferred height of the component
  - EAST and WEST respect the preferred width of the component
  - CENTER is given the remaining space
- **Is allowing a maximum of five components too restrictive? Why not?**

BorderLayout (Continued)

- **Constructors**
  - BorderLayout()
    - Border layout with no gaps between components
  - BorderLayout(int hGap, int vGap)
    - Border layout with the specified empty pixels between regions
- **Adding Components**
  - add(component, BorderLayout.*REGION*)
  - Always specify the region in which to add the component
    - CENTER is the default, but specify it explicitly to avoid confusion with other layout managers

BorderLayout: Example

```
public class BorderTest extends Applet {
  public void init() {
    setLayout(new BorderLayout());
    add(new Button("Button 1"), BorderLayout.NORTH);
    add(new Button("Button 2"), BorderLayout.SOUTH);
    add(new Button("Button 3"), BorderLayout.EAST);
    add(new Button("Button 4"), BorderLayout.WEST);
    add(new Button("Button 5"), BorderLayout.CENTER);
  }
}
```



GridLayout

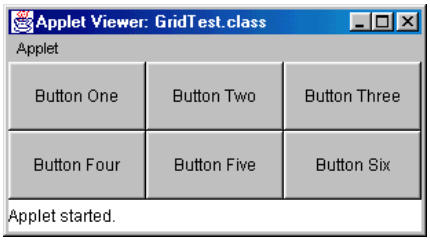
- **Behavior**
  - Divides window into equal-sized rectangles based upon the number of rows and columns specified
  - Items placed into cells left-to-right, top-to-bottom, based on the order added to the container
  - Ignores the preferred size of the component; each component is resized to fit into its grid cell
  - Too few components results in blank cells
  - Too many components results in extra columns

GridLayout (Continued)

- **Constructors**
  - `GridLayout()`
    - Creates a single row with one column allocated per component
  - `GridLayout(int rows, int cols)`
    - Divides the window into the specified number of rows and columns
    - Either rows or cols (but not both) can be zero
  - `GridLayout(int rows, int cols, int hGap, int vGap)`
    - Uses the specified gaps between cells

GridLayout, Example

```
public class GridTest extends Applet {
  public void init() {
    setLayout(new GridLayout(2,3)); // 2 rows, 3 cols
    add(new Button("Button One"));
    add(new Button("Button Two"));
    add(new Button("Button Three"));
    add(new Button("Button Four"));
    add(new Button("Button Five"));
    add(new Button("Button Six"));
  }
}
```

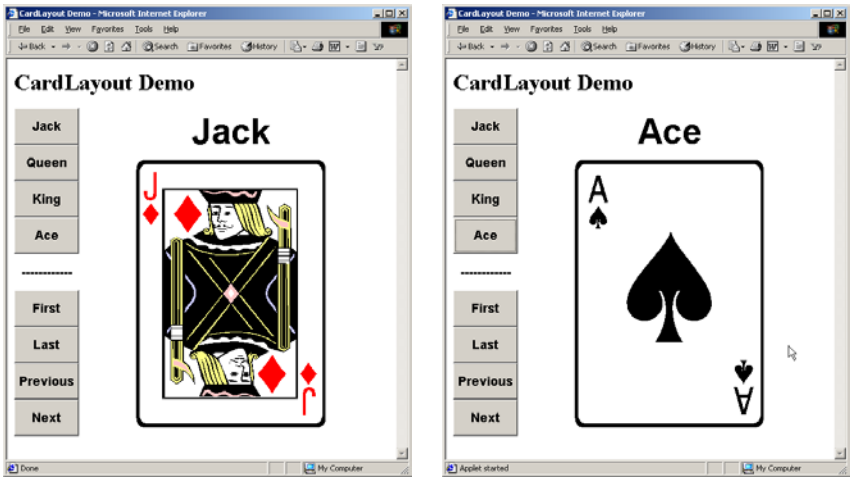


CardLayout

- **Behavior**
  - Stacks components on top of each other, displaying the top one
  - Associates a name with each component in window

```
Panel cardPanel;
CardLayout layout new CardLayout();
cardPanel.setLayout(layout);
...
cardPanel.add("Card 1", component1);
cardPanel.add("Card 2", component2);
...
layout.show(cardPanel, "Card 1");
layout.first(cardPanel);
layout.next(cardPanel);
```

CardLayout, Example



GridBagLayout

- **Behavior**
  - Divides the window into grids, without requiring the components to be the same size
    - About three times more flexible than the other standard layout managers, but *nine* times harder to use
  - Each component managed by a grid bag layout is associated with an instance of `GridBagConstraints`
    - The `GridBagConstraints` specifies:
      - How the component is laid out in the display area
      - In which cell the component starts and ends
      - How the component stretches when extra room is available
      - Alignment in cells

GridBagLayout: Basic Steps

- Set the layout, saving a reference to it

```
GridBagLayout layout = new GridBagLayout();
setLayout(layout);
```

- Allocate a `GridBagConstraints` object

```
GridBagConstraints constraints =
  new GridBagConstraints();
```

- Set up the `GridBagConstraints` for component 1

```
constraints.gridx = x1;
constraints.gridy = y1;
constraints.gridwidth = width1;
constraints.gridheight = height1;
```

- Add component 1 to the window, including constraints

```
add(component1, constraints);
```

- Repeat the last two steps for each remaining component

GridBagConstraints

- Copied when component added to window
- Thus, can reuse the `GridBagConstraints`

```
GridBagConstraints constraints =
  new GridBagConstraints();
constraints.gridx = x1;
constraints.gridy = y1;
constraints.gridwidth = width1;
constraints.gridheight = height1;
add(component1, constraints);
constraints.gridx = x2;
constraints.gridy = y2;
add(component2, constraints);
```

GridBagConstraints Fields

- **gridx, gridy**
  - Specifies the top-left corner of the component
  - Upper left of grid is located at (gridx, gridy)=(0,0)
  - Set to **GridBagConstraints.RELATIVE** to auto-increment row/column

```
GridBagConstraints constraints =
   new GridBagConstraints();
constraints.gridx =
  GridBagConstraints.RELATIVE;
container.add(new Button("one"),
                constraints);
container.add(new Button("two"),
                constraints);
```


GridBagConstraints Fields (Continued)

- **gridwidth, gridheight**
  - Specifies the number of columns and rows the Component occupies

```
constraints.gridwidth = 3;
```

  - **GridBagConstraints.REMAINDER** lets the component take up the remainder of the row/column
- **weightx, weighty**
  - Specifies how much the cell will stretch in the x or y direction if space is left over

```
constraints.weightx = 3.0;
```

  - Constraint affects the cell, not the component (use `fill`)
  - Use a value of 0.0 for no expansion in a direction
  - Values are relative, not absolute

GridBagConstraints Fields (Continued)

- **`fill`**
  - Specifies what to do to an element that is smaller than the cell size

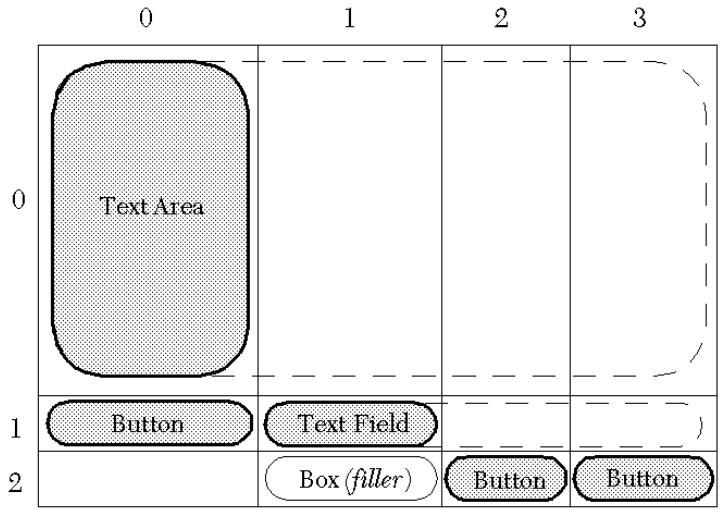
```
constraints.fill = GridBagConstraints.VERTICAL;
```

  - The size of row/column is determined by the widest/tallest element in it
  - Can be `NONE`, `HORIZONTAL`, `VERTICAL`, or `BOTH`
- **anchor**
  - If the fill is set to `GridBagConstraints.NONE`, then the `anchor` field determines where the component is placed

```
constraints.anchor = GridBagConstraints.NORTHEAST;
```

  - Can be `NORTH`, `EAST`, `SOUTH`, `WEST`, `NORTHEAST`, `NORTHWEST`, `SOUTHEAST`, or `SOUTHWEST`

GridBagLayout: Example



GridBagLayout: Example

```
public GridBagTest() {
    setLayout(new GridBagLayout());
    textArea = new JTextArea(12, 40);  // 12 rows, 40 cols
    bSaveAs = new JButton("Save As");
    fileField = new JTextField("C:\\Document.txt");
    bOk = new JButton("OK");
    bExit = new JButton("Exit");
    GridBagConstraints c = new GridBagConstraints();
    // Text Area.
    c.gridx      = 0;
    c.gridy      = 0;
    c.gridwidth  = GridBagConstraints.REMAINDER;
    c.gridheight = 1;
    c.weightx    = 1.0;
    c.weighty    = 1.0;
    c.fill       = GridBagConstraints.BOTH;
    c.insets     = new Insets(2,2,2,2); //t,l,b,r
    add(textArea, c);
    ...
```


GridBagLayout: Example (Continued)

```
   // Save As Button.
    c.gridx      = 0;
    c.gridy      = 1;
    c.gridwidth  = 1;
    c.gridheight = 1;
    c.weightx    = 0.0;
    c.weighty    = 0.0;
    c.fill       = GridBagConstraints.VERTICAL;
    add(bSaveAs,c);

    // Filename Input (Textfield).
    c.gridx      = 1;
    c.gridwidth  = GridBagConstraints.REMAINDER;
    c.gridheight = 1;
    c.weightx    = 1.0;
    c.weighty    = 0.0;
    c.fill       = GridBagConstraints.BOTH;
    add(fileField,c);
    ...
```

GridBagLayout: Example (Continued)

```
  // Exit Button.
  c.gridx      = 3;
  c.gridwidth  = 1;
  c.gridheight = 1;
  c.weightx    = 0.0;
  c.weighty    = 0.0;
  c.fill       = GridBagConstraints.NONE;
  add(bExit,c);

  // Filler so Column 1 has nonzero width.
  Component filler =
    Box.createRigidArea(new Dimension(1,1));
  c.gridx      = 1;
  c.weightx    = 1.0;
  add(filler,c);

  ...
}
```


GridBagLayout: Result

With Box filler at (2,1)

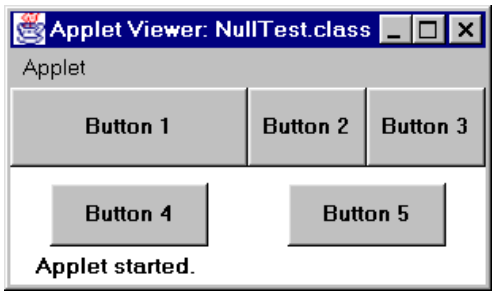
Without Box filler at (2,1)

Disabling the Layout Manager

- **Behavior**
  - If the layout is set to **`null`**, then components must be *sized* and *positioned* by hand
- **Positioning components**
  - *`component`*`.setSize(width, height)`
  - *`component`*`.setLocation(left, top)`
  - or
  - *`component`*`.setBounds(left, top, width, height)`

No Layout Manager: Example

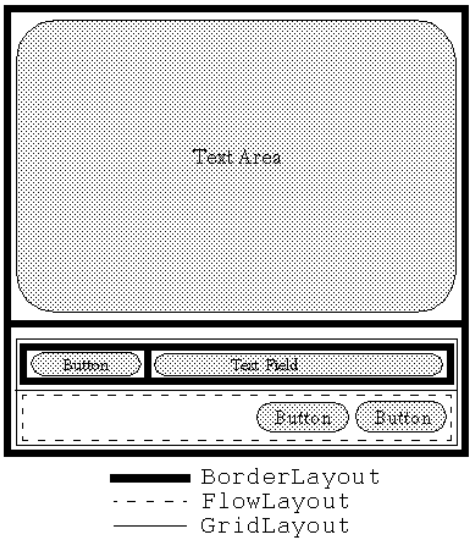
```
setLayout(null);
Button b1 = new Button("Button 1");
Button b2 = new Button("Button 2");
...
b1.setBounds(0, 0, 150, 50);
b2.setBounds(150, 0, 75, 50);
...
add(b1);
add(b2);
...
```



Using Layout Managers Effectively

- **Use nested containers**
  - Rather than struggling to fit your design in a single layout, try dividing the design into sections
  - Let each section be a panel with its own layout manager
- **Turn off the layout manager for *some* containers**
- **Adjust the empty space around components**
  - Change the space allocated by the layout manager
  - Override `insets` in the `Container`
  - Use a `Canvas` or a `Box` as an invisible spacer

Nested Containers: Example



Nested Containers: Example

```
public NestedLayout() {

    setLayout(new BorderLayout(2,2));

    textArea = new JTextArea(12,40);  // 12 rows, 40 cols
    bSaveAs = new JButton("Save As");
    fileField = new JTextField("C:\\Document.txt");
    bOk = new JButton("OK");
    bExit = new JButton("Exit");

    add(textArea,BorderLayout.CENTER);

    // Set up buttons and textfield in bottom panel.
    JPanel bottomPanel = new JPanel();
    bottomPanel.setLayout(new GridLayout(2,1));
```


Nested Containers, Example

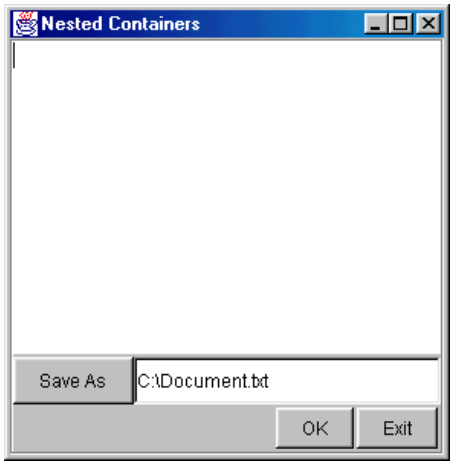
```
    JPanel subPanel1 = new JPanel();
    JPanel subPanel2 = new JPanel();
    subPanel1.setLayout(new BorderLayout());
    subPanel2.setLayout
                (new FlowLayout(FlowLayout.RIGHT,2,2));

    subPanel1.add(bSaveAs,BorderLayout.WEST);
    subPanel1.add(fileField,BorderLayout.CENTER);
    subPanel2.add(bOk);
    subPanel2.add(bExit);

    bottomPanel.add(subPanel1);
    bottomPanel.add(subPanel2);

    add(bottomPanel,BorderLayout.SOUTH);
  }
```

Nested Containers: Result

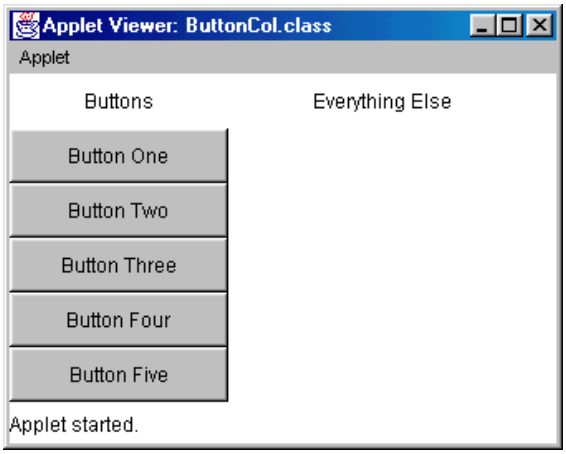


Turning Off Layout Manager for Some Containers: Example

- **Suppose that you wanted to arrange a column of buttons (on the left) that take exactly 40% of the width of the container**

```
setLayout(null);
int width1 = getSize().width*4/10;,
int height = getSize().height;
Panel buttonPanel = new Panel();
buttonPanel.setBounds(0, 0, width1, height);
buttonPanel.setLayout(new GridLayout(6, 1));
buttonPanel.add(new Label("Buttons", Label.CENTER));
buttonPanel.add(new Button("Button One"));
...
buttonPanel.add(new Button("Button Five"));
add(buttonPanel);
Panel everythingElse = new Panel();
int width2 = getSize().width - width1,
everythingElse.setBounds(width1+1, 0, width2, height);
```

Turning Off Layout Manager for Some Containers: Result



Adjusting Space Around Components

- **Change the space allocated by the layout manager**
  - Most `LayoutManagers` accept a horizontal spacing (`hGap`) and vertical spacing (`vGap`) argument
  - For `GridBagLayout`, change the insets
- **Use a `Canvas` or a `Box` as an invisible spacer**
  - For AWT layouts, use a `Canvas` that does not draw or handle mouse events as an "empty" component for spacing.
  - For Swing layouts, add a `Box` as an invisible spacer to improve positioning of components

Invisible Components in Box Class

- **Rigid areas**
  - **`Box.createRigidArea(Dimension dim)`**
    - Creates a two-dimensional invisible `Component` with a fixed width and height

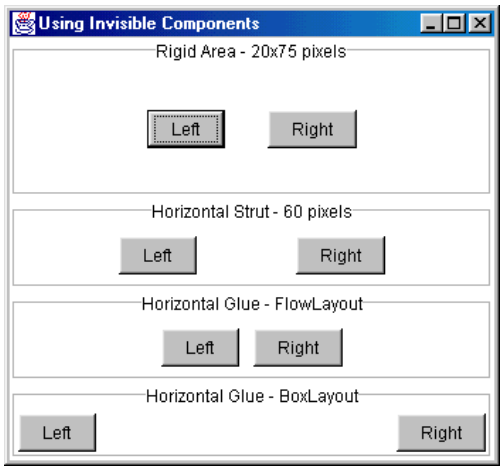
```
Component spacer =
 Box.createRigidArea(new Dimension(30, 40));
```

- **Struts**
  - **`Box.createHorizontalStrut(int width)`**
  - **`Box.createVerticalStrut(int width)`**
    - Creates an invisible `Component` of fixed width and zero height, and an invisible `Component` of fixed height and zero width, respectively

Invisible Components in Box Class (Continued)

- **Glue**
  - **`Box.createHorizontalGlue()`**
  - **`Box.createVerticalGlue()`**
    - Create an invisible `Component` that can expand horizontally or vertically, respectively, to fill all remaining space
  - **`Box.createGlue()`**
    - Creates a `Component` that can expand in both directions
    - A `Box` object achieves the glue effect by expressing a maximum size of `Short.MAX_VALUE`
    - Only apply `glue` to layout managers that respect the maximum size of a `Component`

Invisible Components: Example



BoxLayout

- **Behavior**
  - Manager from Swing; available only in Java 2
  - Arranges `Components` either in a horizontal row, `BoxLayout.X_AXIS`, or in a vertical column, `BoxLayout.Y_AXIS`
  - Lays out the components in the order in which they were added to the `Container`
  - Resizing the container does not cause the components to relocate
  - Unlike the other standard layout managers, the `BoxLayout` manager cannot be shared with more than one `Container`

```
BoxLayout layout =
  new BoxLayout(container, BoxLayout.X_AXIS);
```

Component Arrangement for BoxLayout

- **Attempts to arrange the components with:**
  - Their preferred widths (vertical layout), or
  - Their preferred heights (horizontal layout)
- **Vertical Layout**
  - If the components are not all the same width, `BoxLayout` attempts to expand all the components to the width of the component with the largest preferred width
  - If expanding a component is not possible (restricted maximum size), `BoxLayout` aligns that component horizontally in the container, according to the x alignment of the component

Component Arrangement for BoxLayout (Continued)

- **Horizontal Layout**
  - If the components are not all the same height, `BoxLayout` attempts to expand all the components to the height of the tallest component
  - If expanding the height of a component is not possible, `BoxLayout` aligns that component vertically in the container, according to the y alignment of the component.

Component Alignment for BoxLayout

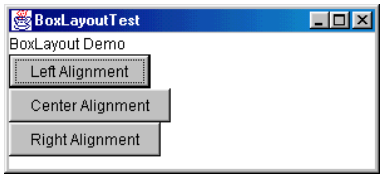
- **Every lightweight Swing component can define an alignment value from `0.0f` to `1.0f`**
  - `0.0` represents positioning the component closest to the axis origin in the container
  - `1.0` represents positioning the component farthest from the axis origin in the container
  - The Component class predefines five alignment values:
    - LEFT_ALIGNMENT (0.0)
    - CENTER_ALIGNMENT (0.5)
    - RIGHT_ALIGNMENT (1.0)
    - TOP_ALIGNMENT (0.0)
    - BOTTOM_ALIGNMENT (1.0)

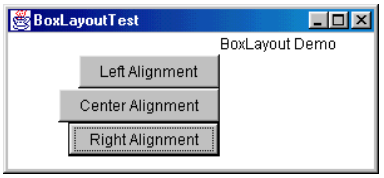
Component Alignment for BoxLayout (Continued)

- **Most Swing components have a default x-axis alignment of center**
  - Exceptions include `JButton`, `JComboBox`, `JLabel`, and `JMenu`, which have x-axis alignment of **`left`**
- **Set the `Component` alignment**

```
component.setAlignmentX(Component.Xxx_ALIGNMENT)
component.setAlignmentY(Component.Xxx_ALIGNMENT)
```

BoxLayout: Example





- All components have a 0.0 (left) alignment

- The label has a 0.0 alignment
- The buttons have a 1.0 (right) alignment

Summary

- **Default layout managers**
  - Applet and Panel: FlowLayout
  - Frame and Dialog: BorderLayout
- **Layout managers respect the preferred size of the component differently**
- **GridBagLayout is the most complicated but most flexible manager**
  - Use `GridBagConstraints` to specify the layout of each component
- **Complex layouts can often be simplified through nested containers**
- **In AWT use a Canvas as a spacer; in Swing use a Box as a spacer**

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Questions?