Understanding Layout Managers - AWT

Understanding Layout Managers

All of the components that we have shown so far have been positioned by the default layou manager. As we mentioned at the beginning of this chapter, a layout manager automaticall arranges your controls within a window by using some type of algorithm. If you hav programmed for other GUI environments, such as Windows, then you may have laid out you controls by hand. While it is possible to lay out Java controls by hand, too, you generally won want to, for two main reasons. First, it is very tedious to manually lay out a large number o components. Second, sometimes the width and height information is not yet available when yo need to arrange some control, because the native toolkit components haven’t been realized. Th is a chicken-and-egg situation; it is pretty confusing to figure out when it is okay to use the siz of a given component to position it relative to another.

Each **Container** object has a layout manager associated with it. A layout manager is an instanc of any class that implements the **LayoutManager** interface. The layout manager is set b the **setLayout( )** method. If no call to **setLayout( )** is made, then the default layout manager used. Whenever a container is resized (or sized for the first time), the layout manager is used t position each of the components within it.

The **setLayout( )** method has the following general form: voi **setLayout(LayoutManager *layoutObj*)**

Here, *layoutObj* is a reference to the desired layout manager. If you wish to disable the layou manager and position components manually, pass **null** for *layoutObj*. If you do this, you wi need to determine the shape and position of each component manually, using the **setBound)** method defined by **Component**. Normally, you will want to use a layout manager.

Each layout manager keeps track of a list of components that are stored by their names. Th layout manager is notified each time you add a component to a container. Whenever th container needs to be resized, the layout manager is consulted via its **minimumLayoutSiz)** and **preferredLayoutSize( )** methods. Each component that is being managed by a layou manager contains the **getPreferredSize( )** and **getMinimumSize( )** methods. These return th preferred and minimum size required to display each component. The layout manager will hono these requests if at all possible, while maintaining the integrity of the layout policy. You ma override these methods for controls that you subclass. Default values are provided otherwise.

Java has several predefined **LayoutManager** classes, several of which are described next. Yo can use the layout manager that best fits your application.

FlowLayout

FlowLayout is the default layout manager. This is the layout manager that th preceding examples have used. **FlowLayout** implements a simple layout style, which is simila to how words flow in a text editor. The direction of the layout is governed by the container component orientation property, which, by default, is left to right, top to bottom. Therefore, b default, components are laid out line-by-line beginning at the upper-left corner. In all case when a line is filled, layout advances to the next line. A small space is left between eac component, above and below, as well as left and right. Here are the constructo for **FlowLayout**:

FlowLayout( )

FlowLayout(int *how*)

FlowLayout(int *how*, int *horz*, int *vert*)

The first form creates the default layout, which centers components and leaves five pixels o space between each component. The second form lets you specify how each line is aligne Valid values for *how* are as follows:

FlowLayout.LEFT

FlowLayout.CENTER

FlowLayout.RIGHT

FlowLayout.LEADING

FlowLayout.TRAILING

These values specify left, center, right, leading edge, and trailing edge alignment, respectivel The third constructor allows you to specify the horizontal and vertical space left betwee components in *horz* and *vert*, respectively.

Here is a version of the **CheckboxDemo** applet shown earlier in this chapter, modified so th it uses left-aligned flow layout:

```
// Use left-aligned flow layout.
import java.awt.*;

import java.awt.event.*; import java.applet.*; /*

<applet code="FlowLayoutDemo" width=240 height=200> </applet>

*/

public class FlowLayoutDemo extends Applet implements ItemListener {

String msg = "";

Checkbox windows, android, solaris, mac;

public void init() {

// set left-aligned flow
layout setLayout(new FlowLayout(FlowLayout.LEFT));

windows = new Checkbox("Windows", null, true); android = ne
Checkbox("Android");
```

```
solaris = new Checkbox("Solaris"); mac = new Checkbox("Mac OS");

add(windows);

add(android);

add(solaris);

add(mac);

// register to receive item events
windows.addItemListener(this);
android.addItemListener(this); solaris.addItemListener(this);
 mac.addItemListener(this);

}

 //Repaint when status of a check box changes.
 public void itemStateChanged(ItemEvent ie) {

repaint();

}

 //Display current state of the check boxes.
 public void paint(Graphics g) {

msg = "Current state: "; g.drawString(msg, 6, 80);
```

```
msg = " Windows: " + windows.getState(); g.drawString(msg, 6, 100);

msg = " Android: " + android.getState(); g.drawString(msg, 6, 120);

msg = " Solaris: " + solaris.getState(); g.drawString(msg, 6, 140);

msg = " Mac: " + mac.getState(); g.drawString(msg, 6, 160);

}

}
```

Here is sample output generated by the **FlowLayoutDemo** applet. Compare this with the outpu from the **CheckboxDemo** applet, shown earlier in Figure 26-2.

BorderLayout

The BorderLayout class implements a common layout style for top-level windows. It has four narrow, fixe width components at the edges and one large area in the center. The four sides are referred to as north, sout east, and west. The middle area is called the center. Here are the constructors defined by BorderLayout:

BorderLayout( ) BorderLayout(int horz, int vert)

The first form creates a default border layout. The second allows you to specify the horizontal and vertical spac left between components in horz and vert, respectively.

BorderLayout defines the following constants that specify the regions:

BorderLayout.CENTER

BorderLayout.EAST

BorderLayout.NORTH

BorderLayout.SOUTH

BorderLayout.WEST

When adding components, you will use these constants with the following form of **add( )**, whic is defined by **Container**:

void add(Component *compRef*, Object *region*)

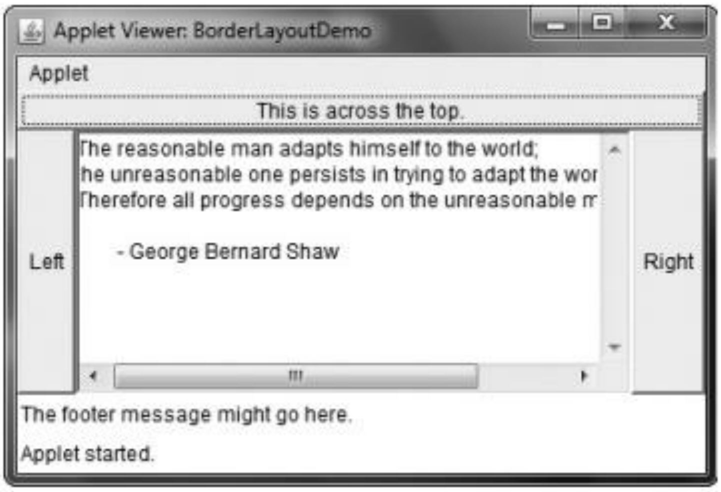
Here, *compRef* is a reference to the component to be added, and *region* specifies where th component will be added.

Here is an example of a **BorderLayout** with a component in each layout area:

```
// Demonstrate BorderLayout.

import java.awt.*;

import java.applet.*;

import java.util.*; /*


<applet code="BorderLayoutDemo" width=400 height=200> </applet>
```

```
*/

public class BorderLayoutDemo extends Applet { public void init() {

setLayout(new BorderLayout());

add(new Button("This is across the top."), BorderLayout.NORTH);

add(new Label("The footer message might go here."), BorderLayout.SOUTH);

add(new Button("Right"), BorderLayout.EAST); add(new Button("Left")
BorderLayout.WEST);

String msg = "The reasonable man adapts " + "himself to the world;\n" +

"the unreasonable one persists in " + "trying to adapt the world t
himself.\n" + "Therefore all progress depends " +

"on the unreasonable man.\n\n" +

"          - George Bernard Shaw\n\n";

add(new TextArea(msg), BorderLayout.CENTER);

}

}
```

Sample output from the **BorderLayoutDemo** applet is shown here:



Using Insets

Sometimes you will want to leave a small amount of space between the container that holc your components and the window that contains it. To do this, override the **getInsets( )** metho that is defined by **Container**. This method returns an **Insets** object that contains the top, botton left, and right inset to be used when the container is displayed. These values are used by th layout manager to inset the components when it lays out the window. The constructo for **Insets** is shown here:

Insets(int *top*, int *left*, int *bottom*, int *right*)

The values passed in *top*, *left*, *bottom*, and *right* specify the amount of space between th container and its enclosing window.

The **getInsets( )** method has this general form: Insets getInsets( )

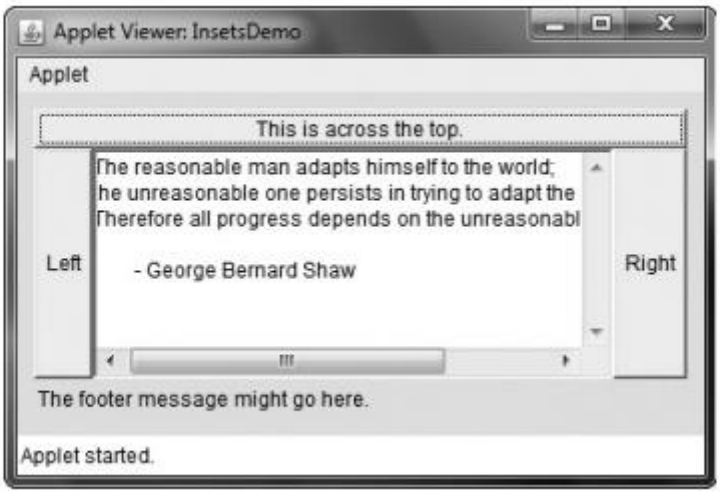
When overriding this method, you must return a new **Insets** object that contains the ins spacing you desire.

Here is the preceding **BorderLayout** example modified so that it insets its components te pixels from each border. The background color has been set to cyan to help make the insets mor visible.

```
// Demonstrate BorderLayout with insets.
import java.awt.*;

import java.applet.*; import java.util.*; /*

<applet code="InsetsDemo" width=400 height=200> </applet>

*/

public class InsetsDemo extends Applet { public void init() {

// set background color so insets can be easily seen
setBackground(Color.cyan);

setLayout(new BorderLayout());

add(new Button("This is across the top."), BorderLayout.NORTH);

add(new Label("The footer message might go here."), BorderLayout.SOUTH);

add(new  Button("Right"),  BorderLayout.EAST);  add(new  Button("Left"),
BorderLayout.WEST);

String msg = "The reasonable man adapts " + "himself to the world;\n"
"the unreasonable one persists in " + "trying to adapt the world t
```

```
himself.\n" + "Therefore all progress depends " + "on the unreasonabl
man.\n\n" +

"                                                         -   Georg
Bernard Shaw\n\n";

add(new TextArea(msg), BorderLayout.CENTER);

}

// add insets

public Insets getInsets() {

return new Insets(10, 10, 10, 10);

}

}
```

Sample output from the **InsetsDemo** applet is shown here:



GridLayout

GridLayout lays out components in a two-dimensional grid. When you instantia a **GridLayout**, you define the number of rows and columns. The constructors supporte by **GridLayout** are shown here:

GridLayout( )

GridLayout(int *numRows*, int *numColumns*)

GridLayout(int *numRows*, int *numColumns*, int *horz*, int *vert*)

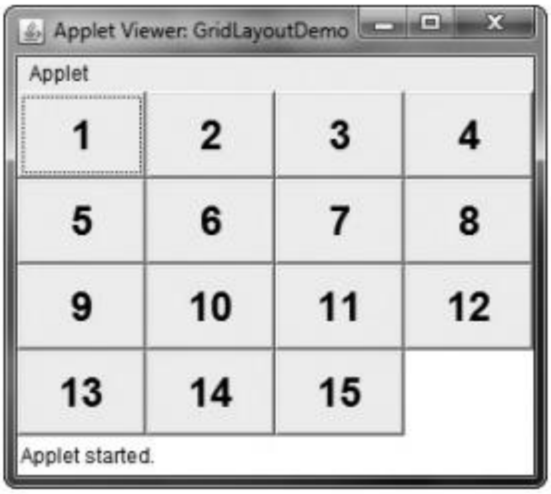
The first form creates a single-column grid layout. The second form creates a grid layout wit the specified number of rows and columns. The third form allows you to specify the horizont and vertical space left between components in *horz* and *vert*, respectivel Either *numRows* or *numColumns* can be zero. Specifying *numRows* as zero allows fo unlimited-length columns. Specifying *numColumns* as zero allows for unlimited-length rows.

Here is a sample program that creates a 4×4 grid and fills it in with 15 buttons, each labeled wit its index:

```
// Demonstrate GridLayout

import java.awt.*; import java.applet.*;


/*


<applet code="GridLayoutDemo" width=300 height=200> </applet>


*/

public class GridLayoutDemo extends Applet { static final int n = 4;
```

```
public void init() {

setLayout(new GridLayout(n, n));

setFont(new Font("SansSerif", Font.BOLD, 24));

for(int i = 0; i < n; i++) { for(int j = 0; j < n; j++) {

int k = i * n + j; if(k > 0)

add(new Button("" + k));

}

}

}

}
```

Following is sample output generated by the **GridLayoutDemo** applet:



CardLayout

The **CardLayout** class is unique among the other layout managers in that it stores severa different layouts. Each layout can be thought of as being on a separate index card in a deck tha can be shuffled so that any card is on top at a given time. This can be useful for user interface with optional components that can be dynamically enabled and disabled upon user input. Yo can prepare the other layouts and have them hidden, ready to be activated when needed.

CardLayout provides these two constructors:

CardLayout( )

CardLayout(int *horz*, int *vert*)

The first form creates a default card layout. The second form allows you to specify the horizont and vertical space left between components in *horz* and *vert*, respectively.

Use of a card layout requires a bit more work than the other layouts. The cards are typically hel in an object of type **Panel**. This panel must have **CardLayout** selected as its layout manage The cards that form the deck are also typically objects of type **Panel**. Thus, you must create panel that contains the deck and a panel for each card in the deck. Next, you add to th appropriate panel the components that form each card. You then add these panels to the pane for which **CardLayout** is the layout manager. Finally, you add this panel to the window. Onc these steps are complete, you must provide some way for the user to select between cards. On common approach is to include one push button for each card in the deck.

When card panels are added to a panel, they are usually given a name. Thus, most of the tim you will use this form of **add( )** when adding cards to a panel:

void add(Component *panelRef*, Object *name*)

Here, *name* is a string that specifies the name of the card whose panel is specified by *panelRe*

After you have created a deck, your program activates a card by calling one of the followin methods defined by **CardLayout**:

void first(Container *deck*) void last(Container *deck*) void next(Container *deck*) voi previous(Container *deck*)

void show(Container *deck*, String *cardName*)

Here, *deck* is a reference to the container (usually a panel) that holds the cards, and *cardName* the name of a card. Calling **first( )** causes the first card in the deck to be shown. To show th last card, call **last( )**. To show the next card, call **next( )**. To show the previous car call **previous( )**. Both **next( )** and **previous( )** automatically cycle back to the top or bottom o the deck, respectively. The **show( )** method displays the card whose name is passe in *cardName*.

The following example creates a two-level card deck that allows the user to select an operatin system. Windows-based operating systems are displayed in one card. Mac OS and Solaris ar displayed in the other card.

```
// Demonstrate CardLayout.

import java.awt.*;


import java.awt.event.*; import java.applet.*; /*


<applet code="CardLayoutDemo" width=300 height=100> </applet>
```

```
*/

public class CardLayoutDemo extends Applet implements ActionListener
MouseListener {

Checkbox windowsXP, windows7, windows8, android, solaris, mac; Pane
osCards;

CardLayout cardLO; Button Win, Other;

public void init() {

Win = new Button("Windows"); Other = new Button("Other"); add(Win);

add(Other);

cardLO = new CardLayout(); osCards = new Panel();

osCards.setLayout(cardLO); // set panel layout to card layout

windowsXP = new Checkbox("Windows XP", null, true); windows7 = ne
Checkbox("Windows 7", null, false); windows8 = new Checkbox("Windows 8"
null, false); android = new Checkbox("Android");

solaris = new Checkbox("Solaris"); mac = new Checkbox("Mac OS");

 //add Windows check boxes to a panel
 Panel winPan = new Panel(); winPan.add(windowsXP); winPan.add(windows7)
winPan.add(windows8);

 //Add other OS check boxes to a panel
```

```
 Panel otherPan = new Panel(); otherPan.add(android);
otherPan.add(solaris); otherPan.add(mac);

 //add panels to card deck

 panel osCards.add(winPan, "Windows"); osCards.add(otherPan, "Other");

 //add cards to main applet

 panel add(osCards);

 //register to receive action events

 Win.addActionListener(this); Other.addActionListener(this);

 register mouse events addMouseListener(this);

}

// Cycle through panels.

public void mousePressed(MouseEvent me) { cardLO.next(osCards);

}
// Provide empty implementations for the other MouseListener methods.
public void mouseClicked(MouseEvent me) {

}

public void mouseEntered(MouseEvent me) {
```

```
}

public void mouseExited(MouseEvent me) {

}

public void mouseReleased(MouseEvent me) {

}

public void actionPerformed(ActionEvent ae) { if(ae.getSource() == Win) {

cardLO.show(osCards, "Windows");

}

else {

cardLO.show(osCards, "Other");

}

}

}
```

Here is sample output generated by the **CardLayoutDemo** applet. Each card is activated b pushing its button. You can also cycle through the cards by clicking the mouse.

GridBagLayout

Although the preceding layouts are perfectly acceptable for many uses, some situations wi require that you take a bit more control over how the components are arranged. A good way t do this is to use a grid bag layout, which is specified by the **GridBagLayout** class. What make the grid bag useful is that you can specify the relative placement of components by specifyin their positions within cells inside a grid. The key to the grid bag is that each component can b a different size, and each row in the grid can have a different number of columns. This is wh the layout is called a *grid bag*. It's a collection of small grids joined together.

The location and size of each component in a grid bag are determined by a set of constrain linked to it. The constraints are contained in an object of type **GridBagConstraints**. Constrain include the height and width of a cell, and the placement of a component, its alignment, and i anchor point within the cell.

The general procedure for using a grid bag is to first create a new **GridBagLayout** object ar to make it the current layout manager. Then, set the constraints that apply to each componer that will be added to the grid bag. Finally, add the components to the layout manage

Although **GridBagLayout** is a bit more complicated than the other layout managers, it is sti quite easy to use once you understand how it works.

GridBagLayout defines only one constructor, which is shown here:

GridBagLayout( )

GridBagLayout defines several methods, of which many are protected and not for general us There is one method, however, that you must use: **setConstraints( )**. It is shown here:

void setConstraints(Component *comp*, GridBagConstraints *cons*)

Here, *comp* is the component for which the constraints specified by *cons* apply. This metho sets the constraints that apply to each component in the grid bag.

The key to successfully using **GridBagLayout** is the proper setting of the constraints, whic are stored in a **GridBagConstraints** object. **GridBagConstraints** defines several fields tha you can set to govern the size, placement, and spacing of a component. These are shown i Table 26-1. Several are described in greater detail in the following discussion.

Field	Purpose
int anchor	Specifies the location of a component within a cell. The default is **GridBagConstraints.CENTER**.
int fill	Specifies how a component is resized if the component is smaller than its cell. Valid values are **GridBagConstraints.NONE** (the default), **GridBagConstraints.HORIZONTAL**, **GridBagConstraints.VERTICAL**, **GridBagConstraints.BOTH**.
int gridheight	Specifies the height of component in terms of cells. The default is 1.
int gridwidth	Specifies the width of component in terms of cells. The default is 1.
int gridx	Specifies the X coordinate of the cell to which the component will be added. The default value is **GridBagConstraints.RELATIVE**.
int gridy	Specifies the Y coordinate of the cell to which the component will be added. The default value is **GridBagConstraints.RELATIVE**.
Insets insets	Specifies the insets. Default insets are all zero.
int ipadx	Specifies extra horizontal space that surrounds a component within a cell. The default is 0.
int ipady	Specifies extra vertical space that surrounds a component within a cell. The default is 0.
double weightx	Specifies a weight value that determines the horizontal spacing between cells and the edges of the container that holds them. The default value is 0.0. The greater the weight, the more space that is allocated. If all values are 0.0, extra space is distributed evenly between the edges of the window.
double weighty	Specifies a weight value that determines the vertical spacing between cells and the edges of the container that holds them. The default value is 0.0. The greater the weight, the more space that is allocated. If all values are 0.0, extra space is distributed evenly between the edges of the window.

Table 26-1 Constraint Fields Defined by **GridBagConstraints**

GridBagConstraints also defines several static fields that contain standard constraint value such as **GridBagConstraints.CENTER** and **GridBagConstraints.VERTICAL**.

When a component is smaller than its cell, you can use the **anchor** field to specify where withi the cell the component's top-left corner will be located. There are three types of values that yo can give to **anchor**. The first are absolute:

GridBagConstraints.CENTER

GridBagConstraints.EAST

GridBagConstraints.NORTH

GridBagConstraints.NORTHEAST

GridBagConstraints.NORTHWEST

GridBagConstraints.SOUTH

GridBagConstraints.SOUTHEAST

GridBagConstraints.SOUTHWEST

GridBagConstraints.WEST

As their names imply, these values cause the component to be placed at the specific location. The second type of values that can be given to **anchor** is relative, which means the

values are relative to the container's orientation, which might differ for non-Western language The relative values are shown here:

GridBagConstraints.FIRST_LINE_END

GridBagConstraints.FIRST_LINE_START

GridBagConstraints.LAST_LINE_END

GridBagConstraints.LAST_LINE_START

GridBagConstraints.LINE_END

GridBagConstraints.LINE_START

GridBagConstraints.PAGE_END

GridBagConstraints.PAGE_START

Their names describe the placement.

The third type of values that can be given to **anchor** allows you to position components relativ to the baseline of the row. These values are shown here:

GridBagConstraints.BASELINE

GridBagConstraints.BASELINE_TRAILING

GridBagConstraints.ABOVE_BASELINE_LEADING

GridBagConstraints.BELOW_BASELINE

GridBagConstraints. BELOW_BASELINE_TRAILING

GridBagConstraints.BASELINE_LEADING

GridBagConstraints.ABOVE_BASELINE

GridBagConstraints.ABOVE_BASELINE_TRAILING

GridBagConstraints.BELOW_BASELINE_LEADING

The horizontal position can be either centered, against the leading edge (LEADING), or again the trailing edge (TRAILING).

The **weightx** and **weighty** fields are both quite important and quite confusing at first glance. I general, their values determine how much of the extra space within a container is allocated t each row and column. By default, both these values are zero. When all values within a row or column are zero, extra space is distributed evenly between the edges of the window. B increasing the weight, you increase that row or column's allocation of space proportional to th other rows or columns. The best way to understand how these values work is to experiment wit them a bit.

The **gridwidth** variable lets you specify the width of a cell in terms of cell units. The default 1. To specify that a component use the remaining space in a rov use **GridBagConstraints.REMAINDER**. To specify that a component use the next-to-la cell in a row, use **GridBagConstraints.RELATIVE**. The **gridheight** constraint works th same way, but in the vertical direction.

You can specify a padding value that will be used to increase the minimum size of a cell. T pad horizontally, assign a value to **ipadx**. To pad vertically, assign a value to **ipady**.

Here is an example that uses **GridBagLayout** to demonstrate several of the points ju discussed:

```
// Use GridBagLayout.

import java.awt.*; import java.awt.event.*; import java.applet.*; /*

<applet code="GridBagDemo" width=250 height=200> </applet>

*/

public class GridBagDemo extends Applet implements ItemListener {
```

```
String msg = "";

Checkbox windows, android, solaris, mac;

public void init() {

GridBagLayout gbag = new GridBagLayout(); GridBagConstraints gbc = ne
GridBagConstraints(); setLayout(gbag);

// Define check boxes.

windows = new Checkbox("Windows ", null, true); android = ne
Checkbox("Android");

solaris = new Checkbox("Solaris"); mac = new Checkbox("Mac OS");

 //Define the grid bag.

Use default row weight of 0 for first row. gbc.weightx = 1.0;
// use a column weight of 1
gbc.ipadx = 200; // pad by 200 units

gbc.insets = new Insets(4, 4, 0, 0); // inset slightly from top left

gbc.anchor = GridBagConstraints.NORTHEAST;

gbc.gridwidth = GridBagConstraints.RELATIVE; gbag.setConstraints(windows
gbc);
```

```
gbc.gridwidth = GridBagConstraints.REMAINDER; gbag.setConstraints(androic
gbc);

// Give second row a weight of 1.
gbc.weighty = 1.0;

gbc.gridwidth = GridBagConstraints.RELATIVE; gbag.setConstraints(solaris
gbc);

gbc.gridwidth  =  GridBagConstraints.REMAINDER;  gbag.setConstraints(mac
gbc);

 Add the components. add(windows); add(android); add(solaris); add(mac);

 Register   to   receive   item   events.   windows.addItemListener(this)
android.addItemListener(this);              solaris.addItemListener(this)
mac.addItemListener(this);

}

 Repaint  when  status  of  a  check  box  changes.  public  voi
itemStateChanged(ItemEvent ie) {

repaint();

}

 Display current state of the check boxes. public void paint(Graphics g)

msg = "Current state: "; g.drawString(msg, 6, 80);

msg = " Windows: " + windows.getState(); g.drawString(msg, 6, 100);
```

```
msg = " Android: " + android.getState(); g.drawString(msg, 6, 120);

msg = " Solaris: " + solaris.getState(); g.drawString(msg, 6, 140);

msg = " Mac: " + mac.getState(); g.drawString(msg, 6, 160);

}

}
```

Sample output produced by the program is shown here.

In this layout, the operating system check boxes are positioned in a 2×2 grid. Each cell has horizontal padding of 200. Each component is inset slightly (by 4 units) from the top left. Th column weight is set to 1, which causes any extra horizontal space to be distributed evenl between the columns. The first row uses a default weight of 0; the second has a weight of This means that any extra vertical space is added to the second row.

GridBagLayout is a powerful layout manager. It is worth taking some time to experiment wi and explore. Once you understand what the various settings do, you can use **GridBagLayout** t position components with a high degree of precision.