UNIT 2 GRAPHICS AND USER INTERFACES

Structure **Page Nos.**

2.0 INTRODUCTION

We all wonder that on seeing 2D or 3D movies or graphics, even on the Internet, we see and admire good animation on various sites. The java technology provides you the platform to develop these graphics using the Graphics class. In this unit you have to overview several java capabilities for drawing two-dimensional shapes, colors and fonts. You will learn to make your own interface, which will be user-interactive and friendly. These interfaces can be made either using java AWT components or java SWING components. In this unit you will learn to use some basic components like button, text field, text area, etc.

Interfaces using GUI allow the user to spend less time trying to remember which keystroke sequences do what and allow spend more time using the program in a productive manner. It is very important to learn how you can beautify your components placed on the canvas area using FONT and COLOR class. For placing components on different layouts knowing use of various Layout managers is essential.

2.1 OBJECTIVES

Our objective is to give you the concept of making the look and feel attractive. After going through this unit, you will be able to:

- explain the principles of graphical user interfaces;
- differentiate between AWT and SWING components;
- design a user friendly Interface;
- applying color to interfaces;
- using Font class in programs;
- use the Layout Manager, and
- use Container Classes.

2.2 GRAPHICS CONTEXTS AND GRAPHICS OBJECTS

How can you build your own animation using Graphics Class? A Java graphics context enables drawing on the screen. A Graphics object manages a graphics context by controlling how objects are drawn. Graphics objects contain methods for drawing, font manipulation, color manipulation and the other related operations. It has been developed using the Graphics object g (the argument to the applet's paint method) to manage the applet's graphics context. In other words you can say that Java's Graphics is capable of:

- Drawing 2D shapes
- Controlling colors
- Controlling fonts
- Providing Java 2D API
- Using More sophisticated graphics capabilities
- Drawing custom 2D shapes
- Filling shapes with colors and patterns.

Before we begin drawing with Graphics, you must understand Java's coordinate system, which is a scheme for identifying every possible point on the screen. Let us start with Graphics Context and Graphics Class.

Graphics Context and Graphics Class

- Enables drawing on screen
- Graphics object manages graphics context
- Controls how objects is drawn
- Class Graphics is abstract
- Cannot be instantiated
- Contributes to Java's portability
- Class Component method paint takes Graphics object.

The *Graphics* class is the abstract base class for all graphics contexts. It allows an application to draw onto components that are realized on various devices, as well as on to off-screen images.

Public Abstract Class Graphics Extends Object

You have seen that every applet performs drawing on the screen.

Graphics Objects

In Java all drawing takes place via a Graphics object. This is an instance of the class *java.awt.Graphics*.

Initially the Graphics object you use will be passed as an argument to an applet's paint() method. The drawing can be done Applet Panels, Frames, Buttons, Canvases etc.

Each Graphics object has its own coordinate system, and methods for drawing strings, lines, rectangles, circles, polygons etc. Drawing in Java starts with particular Graphics object. You get access to the Graphics object through the *paint(Graphics g)* method of your applet.

Each draw method call will look like

g.drawString("Hello World", 0, 50);

Where g is the particular Graphics object with which you're drawing.
For convenience sake in this unit the variable g will always refer to a pre-existing object of the Graphics class. It is not a rule you are free to use some other name for the particular Graphics context, such as myGraphics or applet-Graphics or anything else.

2.2.1 Color Control

It is known that Color enhances the appearance of a program and helps in conveying meanings. To provide color to your objects use class Color, which defines methods and constants for manipulation colors. Colors are created from **red**, **green** and **blue** components **RGB** values.

All three RGB components can be integers in the range 0 to 255, or floating point values in the range 0.0 to 1.0

The first part defines the amount of *red*, the second defines the amount of *green* and the third defines the amount of *blue*. So, if you want to give dark red color to your graphics you will have to give the first parameter value 255 and two parameter zero.

Some of the most common colors are available by name and their RGB values in *Table 1*.

Table 1: Colors and their RGB values

Color Constant	Color	RGB Values
Public final static Color ORANGE	Orange	255, 200, 0
Public final static Color PINK	Pink	255, 175, 175
Public final static Color CYAN	Cyan	0, 255, 255
Public final static Color MAGENTA	Magenta	255, 0, 255
Public final static Color YELLOW	Yellow	255, 255, 0
Public final static Color BLACK	Black	0, 0, 0
Public final static Color WHITE	White	255, 255, 255
Public final static Color GRAY	Gray	128, 128, 128
Public final static Color LIGHT_GRAY	light gray	192, 192, 192
Public final static Color DARK_GRAY	dark gray	64, 64, 64
Public final static Color RED	Red	255, 0, 0
Public final static Color GREEN	Green	0, 255, 0
Public final static Color BLUE	Blue	0, 0, 255

Color Methods

To apply color in your graphical picture (objects) or text two Color methods get Color and set Color are provided. Method get Color returns a Color object representing the current drawing color and method set Color used to sets the current drawing color.

Color constructors

public Color(int r, int g, int b)**:** Creates a color based on the values of red, green and blue components expressed as integers from 0 to 255.

public Color (float r, float g, float b) **:** Creates a color based the values of on red, green and blue components expressed as floating-point values from 0.0 to 1.0.

Color methods:

public int getRed(): Returns a value between 0 and 255 representing the red content
public int getGreen(): Returns a value between 0 and 255 representing the green content
public int getBlue() . Returns a value between 0 and 255 representing the blue content.

Graphics Methods For Manipulating Colors

public Color getColor (): Returns a Color object representing the current color for the graphics context.
public void setColor (Color c): Sets the current color for drawing with the graphics context.
As you do with any variable you should preferably give your colors descriptive names. For instance

```
Color medGray = new Color(127, 127, 127);
Color cream = new Color(255, 231, 187);
Color lightGreen = new Color(0, 55, 0);
```

You should note that Color is not a property of a particular rectangle, string or other object you may draw, rather color is a part of the Graphics object that does the drawing. You change the color of your Graphics object and everything you draw from that point forward will be in the new color, at least until you change it again.

When an applet starts running , its color is set to *black by default*. You can change this to red by calling *g.setColor(Color.red)*. You can change it back to black by calling *g.setColor(Color.black)*.

☞ Check Your Progress 1

1) What are the various color constructors?

……

……

2) Write a program to set the Color of a String to red.

……

……

3) What is the method to retrieve the color of the text? Write a program to retrieve R G B values in a given color.

……

……

Now we will discuss about how different types of fonts can be provided to your strings.

2.2.2 Fonts

You must have noticed that until now all the applets have used the default font. However unlike HTML Java allows you to choose your fonts. Java implementations

are guaranteed to have a *serif font* like *Times* that can be accessed with the name *"Serif"*, a monospaced font like *courier* that can be accessed with the name *"Mono"*, and a *sans serif* font like *Helvetica* that can be accessed with the name *"SansSerif"*.

How can you know the available fonts on your system for an applet program? You can list the fonts available on the system by using the *getFontList()* method from *java.awt.Toolkit*. This method returns an array of strings containing the names of the available fonts. These may or may not be the same as the fonts to installed on your system. It is implementation is dependent on whether or not all the fonts in a system are available to the applet.

Choosing a font face is very easy. You just create a new Font object and then call. setFont(Font f).

To instantiate a Font object the constructor

public Font(String name, int style, int size)

can be used. ***name*** is the name of the font family, e.g. "Serif", "SansSerif", or "Mono".
size is the size of the font in points. In computer graphics a point is considered to be equal to one pixel. 12 points is a normal size font.

style is an mnemonic constant from *java.awt.Font* that tells whether the text will be bold, italics or plain. The three constants are Font.PLAIN, Font.BOLD, and Font.ITALIC.

In other words, The Class Font contains methods and constants for font control. Font constructor takes three arguments

Font name	Monospaced, SansSerif, Serif, etc.
Font style	Font.PLAIN, Font.ITALIC and Font.BOLD
Font size	Measured in points (1/72 of inch)

Graphics method for Manipulating Fonts

public Font get Font(): Returns a Font object reference representing the current Font.
public void setFont(Font f): Sets the current font, style and size specified by the Font object reference f.

2.2.2.1 FontMetrics

Sometimes you will need to know how much space a particular string will occupy. You can find this out with a FontMetrics object.

FontMetrics allow you to determine the height, width or other useful characteristics of a particular string, character, or array of characters in a particular font. In *Figure 1* you can see a string with some of its basic characteristics.

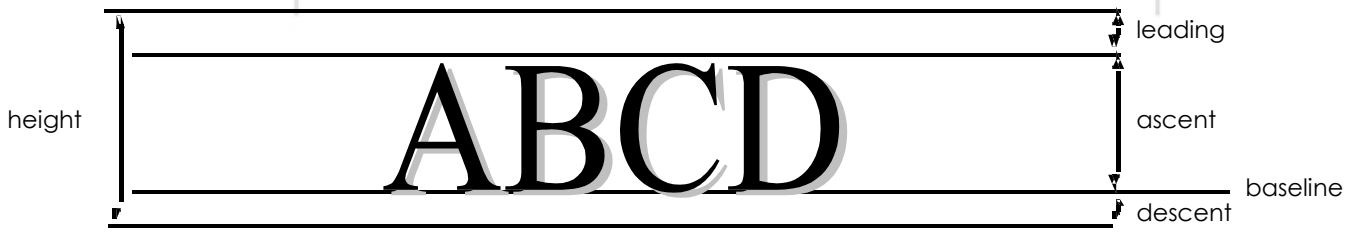


Figure 1: String Characteristics

In order to tell where and whether to wrap a String, you need to measure the string, not its length in characters, which can be variable in its width, and height in pixels. Measurements of this sort on strings clearly depend on the font that is used to draw the string. All other things being equal a 14-point string will be wider than the same string in 12 or 10-point type.

To measure character and string sizes you need to look at the FontMetrics of the current font. To get a FontMetrics object for the current Graphics object you use the *java.awt.Graphics.getFontMetrics()* method.

java.awt.FontMetrics provide method *stringWidth(String s)* to return the width of a string in a particular font, and method *getLeading()* to get the appropriate line spacing for the font. There are many more methods in java.awt.FontMetrics that let you measure the height and width of specific characters as well as ascenders, descenders and more, but these three methods will be sufficient for basic programs.

☞ Check Your Progress 2

1) Write a program to set the font of your String as font name as "Arial",font size as 12 and font style as FONT.ITALIC.

……

……

2) What is the method to retrieve the font of the text? Write a program for font retrieval.

……

……

3) Write a program that will give you the Fontmetrics parameters of a String.

……

……

Knowledge of co-ordinate system is essential to play with positioning of objects in any drawing. Now you will see how coordinates are used in java drawings.

2.2.3 Coordinate System

By Default the upper left corner of a GUI component (such as applet or window) has the coordinates (0,0). A Coordinate pair is composed of x-coordinate (the horizontal coordinate) and a y-coordinate (the vertical coordinate). The x-coordinate is the horizontal distance moving right from the upper left corner.

The y-coordinate is the vertical distance moving down from the upper left corner. The x-axis describes every horizontal coordinate, and the y-axis describes every vertical coordinate. You must note that different display cards have different resolutions (i.e. the density of pixels varies). *Figure 2* represents coordinate system. This may cause graphics to appear to be different sizes on different monitors.

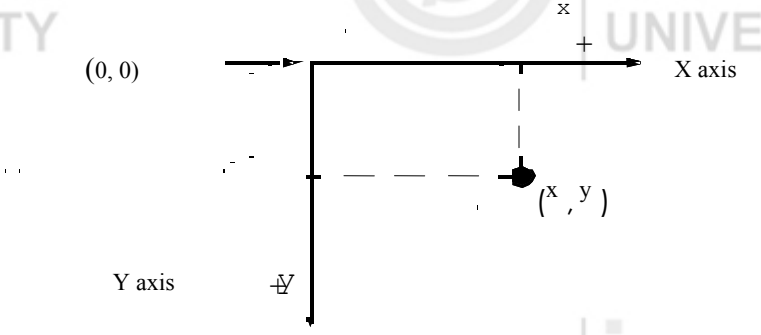


Figure 2: Co-ordinate System

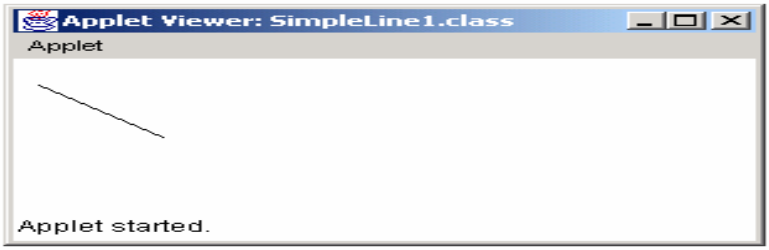
Now we will move towards drawing of different objects. In this section, I will demonstrate drawing in applications.

2.2.3.1 Drawing Lines

Drawing straight lines with Java can be done as follows:
call
g.drawLine(x1,y1,x2,y2)
method, where (x1, y1) and (x2, y2) are the endpoints of your lines and g is the Graphics object you are drawing with. The following program will result in a line on the applet.

```
import java.applet.*;
import java.awt.*;
public class SimpleLine extends Applet
{
 public void paint(Graphics g)
 {
  g.drawLine(10, 20, 30, 40);
} }
```

Output:



2.2.3.2 Drawing Rectangle

Drawing rectangles is simple. Start with a Graphics object g and call its drawRect() method:

public void drawRect(int x, int y, int width, int height)

The first argument int is the left hand side of the rectangle, the second is the top of the rectangle, the third is the width and the fourth is the height. This is in contrast to some APIs where the four sides of the rectangle are given.

Remember that the upper left hand corner of the applet starts at (0, 0),
not at (1, 1). This means that a 100 by 200 pixel applet includes the points with x coordinates between 0 and 99, not between 0 and 100. Similarly the y coordinates are between 0 and 199 inclusive, not 0 and 200.

2.2.3.3 Drawing Ovals and Circles

Java has methods to draw outlined and filled ovals. These methods are called drawOval() and fillOval() respectively. These two methods are:

public void drawOval(int left, int top, int width, int height)
public void fillOval(int left, int top, int width, int height)

Instead of dimensions of the oval itself, the dimensions of the smallest rectangle, which can enclose the oval, are specified. The oval is drawn as large as it can be to touch the rectangle's edges at their centers. *Figure 3* may help you to understand properly.

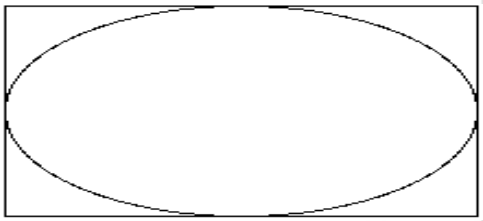


Figure 3: An Oval

The arguments to drawOval() are the same as the arguments to drawRect(). The first int is the left hand side of the enclosing rectangle, the second is the top of the enclosing rectangle, the third is the width and the fourth is the height. There is no special method to draw a circle. Just draw an oval inside a square.

2.2.3.4 Drawing Polygons and Polylines

You have already seen that in Java rectangles are defined by the position of their upper left hand corner, their height, and their width. However it is implicitly assumed that there is in fact an upper left hand corner. What's been assumed so far is that the sides of the rectangle are parallel to the coordinate axes. You can't yet handle a rectangle that has been rotated at an arbitrary angle.

There are some other things you can't handle either, triangles, stars, rhombuses, kites, octagons and more. To take care of this broad class of shapes Java has a **Polygon** class.

Polygons are defined by their corners. No assumptions are made about them except that they lie in a 2-D plane. The basic constructor for the Polygon class is

public Polygon(int[] xpoints, int[] ypoints, int npoints)

xpoints is an array that contains the x coordinates of the polygon. **ypoints** is an array that contains the y coordinates. Both should have the length **npoints**. Thus to construct a right triangle with the right angle on the origin you would type

```
int[] xpoints = {0, 3, 0};
int[] ypoints = {0, 0, 4};
Polygon myTriangle = new Polygon(xpoints, ypoints, 3);
```

To draw the polygon you can use java.awt.Graphics's drawPolygon(Polygon p) method within your paint() method like this:

```
g.drawPolygon(myTriangle);
```

You can pass the arrays and number of points directly to the drawPolygon() method if you prefer:

```
g.drawPolygon(xpoints, ypoints, xpoints.length);
```

There's also an overloaded fillPolygon() method, you can call this method like

```
g.fillPolygon(myTriangle);
g.fillPolygon(xpoints, ypoints, xpoints.length());
```

To simplify user interaction and make data entry easier, Java provides different controls and interfaces. Now let us see some of the basic user interface components of Java.

2.3 USER INTERFACE COMPONENTS

Java provides many controls. Controls are components, such as buttons, labels and text boxes that can be added to containers like frames, panels and applets. The Java.awt package provides an integrated set of classes to manage user interface components.

Components are placed on the user interface by adding them to a container. A container itself is a component. The easiest way to demonstrate interface design is by using the container you have been working with, i.e., the Applet class. The simplest form of Java AWT component is the basic *User Interface Component*. You can create and add these to your applet without any need to know anything about creating containers or panels. In fact, your applet, even before you start painting and drawing and handling events, is an AWT container. Because an applet is a container, you can put any of AWT components, and (or) other containers, in it.

In the next section of this Unit, you will learn about the basic User Interface components (controls) like labels, buttons, check boxes, choice menus, and text fields. You can see in Table 2a, a list of all the Controls in Java AWT and their respective functions. In Table 2b list of classes for these control are given.

2.4 BUILDING USER INTERFACE WITH AWT

In order to add a control to a container, you need to perform the following two steps:

1. Create an object of the control by passing the required arguments to the constructor.
2. Add the component (control) to the container.

Table 2a: Controls in Java

CONTROLS	FUNCTIONS
Textbox	Accepts single line alphanumeric entry.
TextArea	Accepts multiple line alphanumeric entry.
Push button	Triggers a sequence of actions.
Label	Displays Text.
Check box	Accepts data that has a yes/no value. More than one checkbox can be selected.
Radio button	Similar to check box except that it allows the user to select a single option from a group.
Combo box	Displays a drop-down list for single item selection. It allows new value to be entered.
List box	Similar to combo box except that it allows a user to select single or multiple items. New values cannot be entered.

Table 2b: Classes for Controls

CONTROLS	CLASS
Textbox	TextField
TextArea	TextArea
Push button	Button
Check box	CheckBox
Radio button	CheckboxGroup with CheckBox
Combo box	Choice
List box	List

The Button

Let us first start with one of the simplest of UI components: the button. Buttons are used to trigger events in a GUI environment (we have discussed Event Handling in detail in the previous Unit: Unit 1 Block 4 of this course). The Button class is used to create buttons. When you add components to the container, you don't specify a set of coordinates that indicate where the components are to be placed. A layout manager in effect for the container handles the arrangement of components. The default layout for a container is flow layout (for an applet also default layout will be flow layout). More about different layouts you will learn in later section of this unit. Now let us write a simple code to test our button class.

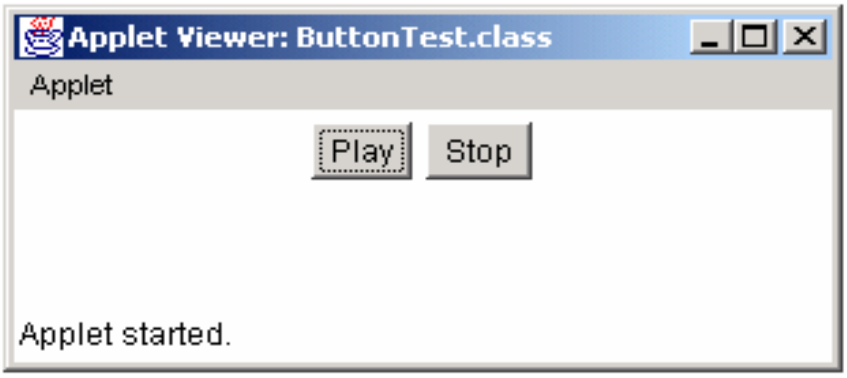
To create a button use, one of the following constructors:

Button() creates a button with no text label.
Button(String) creates a button with the given string as label.

Example Program:

```
/*
<Applet code= "ButtonTest.class"
Width = 500
Height = 100>
</applet>
*/
import java.awt.*;
import java.applet.Applet;
public class ButtonTest extends Applet
{
Button b1 = new Button ("Play");
Button b2 = new Button ("Stop");
public void init(){
add(b1);
add(b2);
}
}
```

Output:



As you can see this program will place two buttons on the Applet with the caption Play and Stop.

The Label

Labels are created using the Label class. Labels are basically used to identify the purpose of other components on a given interface; they cannot be edited directly by the user. Using a label is much easier than using a drawString( ) method because

labels are drawn automatically and don't have to be handled explicitly in the paint( ) method. Labels can be laid out according to the layout manager, instead of using [x, y] coordinates, as in drawString( ).

To create a Label, use any one of the following constructors:
Label( ): creates a label with its string aligned to the left.
Label(String): creates a label initialized with the given string, and aligned left.
Label(String, int): creates a label with specified text and alignment indicated by any one of the three int arguments. Label.Right, Label.Left and Label.Center.
getText( ) method is used to indicate the current label's text setText( ) method to change the label's and text. setFont( ) method is used to change the label's font.

The Checkbox

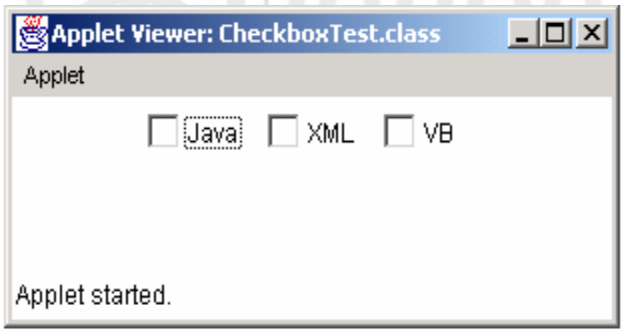
Check Boxes are labeled or unlabeled boxes that can be either "Checked off" or "Empty". Typically, they are used to select or deselect an option in a program.

Sometimes Check are *nonexclusive*, which means that if you have six check boxes in a container, all the six can either be checked or unchecked at the same time. This component can be organized into Check Box Group, which is sometimes called radio buttons. Both kinds of check boxes are created using the Checkbox class. To create a nonexclusive check box you can use one of the following constructors:
Checkbox() creates an unlabeled checkbox that is not checked.
Checkbox(String) creates an unchecked checkbox with the given label as its string.

After you create a checkbox object, you can use the setState(boolean) method with a true value as argument for checked checkboxes, and false to get unchecked. Three checkboxes are created in the example given below, which is an applet to enable you to select up to three courses at a time.

```
import java.awt.*;
public class CheckboxTest extends java.applet.Applet
{
Checkbox c1 = new Checkbox ("Java");
Checkbox c2 = new Checkbox ("XML");
Checkbox c3 = new Checkbox ("VB");
public void init(){
add(c1);
add(c2);
add(c3);
 }
}
```

Output:



The Checkbox group

CheckboxGroup is also called like a radio button or exclusive check boxes. To organize several Checkboxes into a group so that only one can be selected at a time,

you can create CheckboxGroup object as follows:
CheckboxGroup radio = new CheckboxGroup ();

The CheckboxGroup keeps track of all the check boxes in its group. We have to use this object as an extra argument to the *Checkbox* constructor.

Checkbox (String, CheckboxGroup, Boolean) creates a checkbox labeled with the given string that belongs to the CheckboxGroup indicated in the second argument. The last argument equals true if box is checked and false otherwise.

The set Current (checkbox) method can be used to make the set of currently selected check boxes in the group. There is also a get Current () method, which returns the currently selected checkbox.

The Choice List

Choice List is created from the Choice class. List has components that enable a single item to be picked from a pull-down list. We encounter this control very often on the web when filling out forms.
The first step in creating a Choice
You can create a choice object to hold the list, as shown below:

```
Choice cgender = new Choice();
```

Items are added to the Choice List by using addItem(String) method the object. The following code adds two items to the gender choice list.

```
cgender.addItem("Female");
cgender.addItem("Male");
```

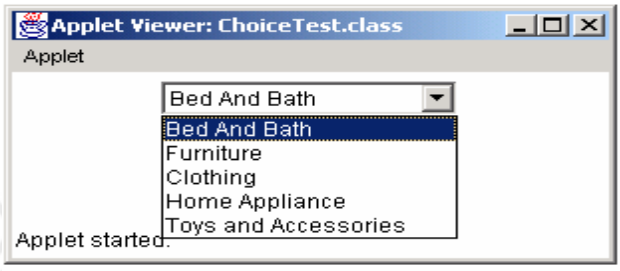
After you add the Choice List it is added to the container like any other component using the add() method.

The following example shows an Applet that contains a list of shopping items in the store.

```
import java.awt.*;
Public class ChoiceTest extends java.applet.Applet
{
Choice shoplist = new Choice();

Public void init(){
shoplist.addItem("Bed And Bath");
shoplist.addItem("Furniture");
shoplist.addItem("Clothing");
shoplist.addItem("Home Appliance");
shoplist.addItem("Toys and Accessories");
add(shoplist);
}
```

Output:



The choice list class has several methods, which are given in *Table 3*.

Table 3: Choice List Class Methods

Method	Action
getItem()	Returns the string item at the given position (items inside a choice begin at 0, just like arrays)
countItems()	Returns the number of items in the menu
getSelectedIndex()	Returns the index position of the item that's selected
getSelectedItem()	Returns the currently selected item as a string
select(int)	Selects the item at the given position
select(String)	Selects the item with the given string

The Text Field

To accept textual data from user, AWT provided two classes, *TextField and TextArea*. The TextField handles a single line of text and does not have scrollbars, whereas the TextArea class handles multiple lines of text. Both the classes are derived from the TextComponent class. Hence they share many common methods.
TextFields provide an area where you can enter and edit a single line of text. To create a text field, use one of the following constructors:

TextField(): creates an empty TextField with no specified width.
TextField(int): creates an empty text field with enough width to display the specified number of characters (this has been depreciated in Java2).
TextField(String): creates a text field initialized with the given string.
TextField(String, int) :creates a text field with specified text and specified width.

For example, the following line creates a text field 25 characters wide with the string "Brewing Java" as its initial contents:
TextField txtfld = new TextField ("Brewing Java", 25); add(txtfld);

TextField, can use methods like:
setText(): Used to set the text in text field.
getText(): Used to get the text currently contained by text field.
setEditable(): Used to provide control whether the content of text field may be modified by user or not.
isEditable(): It return **true** if the text in text filed may be changed and **false** otherwise.

Text Area

The TextArea is an editable text field that can handle more than one line of input. Text areas have horizontal and vertical scrollbars to scroll through the text. Adding a text area to a container is similar to adding a text field. To create a text area you can use one of the following constructors:

TextArea(): creates an empty text area with unspecified width and height.
TextArea(int, int): creates an empty text area with indicated number of lines and specified width in characters.
TextArea(String): creates a text area initialized with the given string.
TextField(String, int, int): creates a text area containing the indicated text and specified number of lines and width in the characters.
The TextArea, similar to TextField, can use methods like setText(), getText(), setEditable(), and isEditable().
In addition, there are two more methods like these. The first is the insertText(String, int) method, used to insert indicated strings at the character index specified by the

second argument. The next one is replaceText(String, int, int) method, used to replace text between given integer position specified by second and third argument with the indicated string.

The basic idea behind the AWT is that a graphical Java program is a set of nested components, starting from the outermost window all the way down to the smallest UI component. Components can include things you can actually see on the screen, such as windows, menu bars, buttons, and text fields, and they can also include containers, which in turn can contain other components.

Hope you have got a clear picture of Java AWT and its some basic UI components, In the next section of the Unit we will deal with more advance user interface components.

2.5 SWING - BASED GUI

You must be thinking that when you can make GUI interface with AWT package then what is the purpose of learning Swing-based GUI? Actually Swing has *lightweight* components and does not write itself to the screen, but redirects it to the component it builds on. On the other hand AWT are heavyweight and have their own view port, which sends the output to the screen. Heavyweight components also have their own z-ordering (look and feel) dependent on the machine on which the program is running. This is the reason why you can't combine AWT and Swing in the same container. If you do, AWT will always be drawn on top of the Swing components.

Another difference is that Swing is pure Java, and therefore platform independent. Swing looks identically on all platforms, while AWT looks different on different platforms.

See, basically Swing provides a rich set of GUI components; features include model-UI separation and a plug able look and feel. Actually you can make your GUI also with AWT but with Swing you can make it more user-friendly and interactive. Swing components make programs efficient.

Swing GUI components are packaged into Package javax.swing. In the Java class hierarchy there is a class
Class Component which contains method paint for drawing Component onscreen
Class Container which is a collection of related components and contains method add for adding components and Class JComponent which has
Pluggable look and feel for customizing look and feel
Shortcut keys (*mnemonics*)
Common event-handling capabilities

The Hierarchy is as follows:

Object-----→ Component--→Container---→JComponent

In Swings we have classes prefixed with the letter 'J' like
JLabel -> Displays single line of read only text

JTextField -> Displays or accepts input in a single line

JTextArea -> Displays or accepts input in multiple lines

JCheckBox ->Gives choices for multiple options
JButton -> Accepts command and does the action

JList - > Gives multiple choices and display for selection
JRadioButton - > Gives choices for multiple option, but can select one at a time.

☞ Check Your Progress 3

1) Write a program which draws a line, a rectangle, and an oval on the applet.
……
……

2) Write a program that draws a color-filled line, a color-filled rectangle, and a color filled oval on the applet.
……
……

3) Write a program to add various checkboxes under the CheckboxGroup
……
……

4) Write a program in which the Applet displays a text area that is filled with a string, when the programs begin running.
……
……

5) Describe the features of the Swing components that subclass J Component. What are the difference between Swing and AWT?
……
……

Now we will discuss about different layouts to represent components in a container.

2.6 LAYOUTS AND LAYOUT MANAGER

When you add a component to an applet or a container, the container uses its *layout manager* to decide where to put the component. Different LayoutManager classes use different rules to place components.

java.awt.LayoutManager is an interface. Five classes in the java packages implement it:

- FlowLayout
- BorderLayout
- CardLayout
- GridLayout
- GridBagLayout
- plus javax.swing.BoxLayout

FlowLayout

A FlowLayout arranges widgets from left to right until there's no more space left. Then it begins a row lower and moves from left to right again. Each component in a FlowLayout gets as much space as it needs and no more.
This is the *default LayoutManager* for applets and panels. FlowLayout is the default layout for java.awt.Panel of which java.applet.Applet is a subclasses.
Therefore you don't need to do anything special to create a FlowLayout in an applet. However you do need to use the following constructors if you want to use a FlowLayout in a Window.LayoutManagers have constructors like any other class.

The constructor for a FlowLayout is
public FlowLayout()
Thus to create a new FlowLayout object you write
FlowLayout fl;
fl = new FlowLayout();
As usual this can be shortened to
FlowLayout fl = new FlowLayout();

You tell an applet to use a particular LayoutManager instance by passing the object to the applet's setLayout() method like this: this.setLayout(fl);

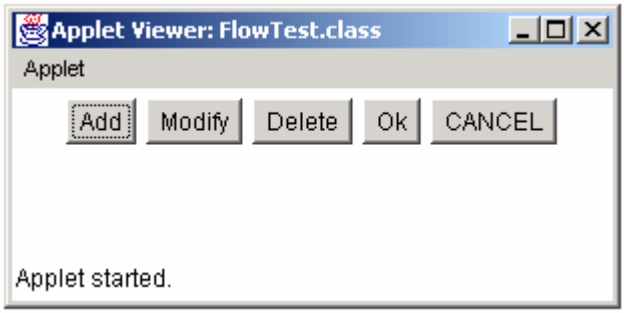
Most of the time setLayout() is called in the init() method. You normally just create the LayoutManager right inside the call to setLayout() like this

this.setLayout(new FlowLayout());

For example the following applet uses a FlowLayout to position a series of buttons that mimic the buttons on a tape deck.

```
import java.applet.*;
import java.awt.*;
public class FlowTest extends Applet {
  public void init() {
    this.setLayout(new FlowLayout());
    this.add( new Button("Add"));
    this.add( new Button("Modify"));
    this.add( new Button("Delete"));
    this.add( new Button("Ok"));
    this.add( new Button("CANCEL"));
  }
}
```

Output:



You can change the alignment of a FlowLayout in the constructor. Components are normally centered in an applet. You can make them left or right justified. To do this just passes one of the defined constants FlowLayout.LEFT, FlowLayout.RIGHT or FlowLayout.CENTER to the constructor, e.g.
this.setLayout(new FlowLayout(FlowLayout.LEFT));

Another constructor allows you spacing option in FlowLayout:
public FlowLayout(int alignment, int horizontalSpace, int verticalSpace);

For instance to set up a FlowLayout with a ten pixel horizontal gap and a twenty pixel vertical gap, aligned with the left edge of the panel, you would use the constructor
FlowLayout fl = new FlowLayout(FlowLayout.LEFT, 20, 10);
Buttons arranged according to a center-aligned FlowLayout with a 20 pixel horizontal spacing and a 10 pixel vertical spacing

BorderLayout

A BorderLayout organizes an applet into North, South, East, West and Center sections. North, South, East and West are the rectangular edges of the applet. They're continually resized to fit the sizes of the widgets included in them. Center is whatever is left over in the middle.

A BorderLayout places objects in the North, South, East, West and center of an applet. You create a new BorderLayout object much like a FlowLayout object, in the init() method call to setLayout like this:
this.setLayout(new BorderLayout());

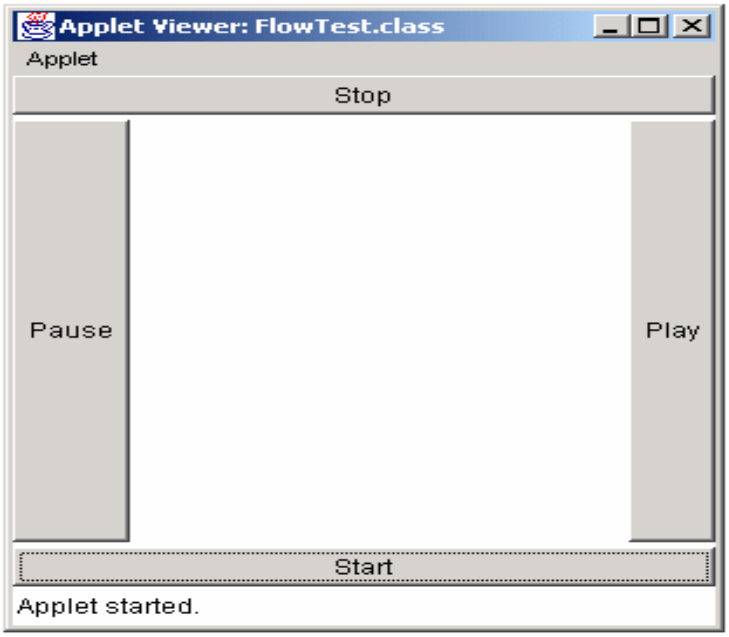
There's no centering, left alignment, or right alignment in a BorderLayout. However, you can add horizontal and vertical gaps between the areas. Here is how you would add a two pixel horizontal gap and a three pixel vertical gap to a BorderLayout:
this.setLayout(new BorderLayout(2, 3));

To add components to a BorderLayout include the name of the section you wish to add them to do like done in the program given below.

this.add("South", new Button("Start"));

```
import java.applet.*;
import java.awt.*;
public class BorderLayouttest extends Applet
{
public void init() {
this.setLayout(new BorderLayout(2, 3));
this.add("South", new Button("Start"));
this.add("North", new Button("Stop"));
this.add("East", new Button("Play"));
this.add("West", new Button("Pause"));
}
```

}



Card Layout

A CardLayout breaks the applet into a deck of cards, each of which has its own Layout Manager. Only one card appears on the screen at a time. The user flips between cards, each of which shows a different set of components. The common analogy is with HyperCard on the Mac and Tool book on Windows. In Java this might

be used for a series of data input screens, where more input is needed than will comfortably fit on a single screen.

Grid Layout

A GridLayout divides an applet into a specified number of rows and columns, which form a grid of cells, *each equally sized and spaced.* It is important to note that each is equally sized and spaced as there is another similar named Layout known as GridBagLayout .As Components are added to the layout they are placed in the cells, starting at the upper left hand corner and moving to the right and down the page. Each component is sized to fit into its cell. This tends to squeeze and stretch components unnecessarily.

You will find the GridLayout is great for arranging Panels. A GridLayout specifies the number of rows and columns into which components will be placed. The applet is broken up into a table of equal sized cells.

GridLayout is useful when you want to place a number of similarly sized objects. It is great for putting together lists of checkboxes and radio buttons as you did in the Ingredients applet. GridLayout looks like *Figure 3*.

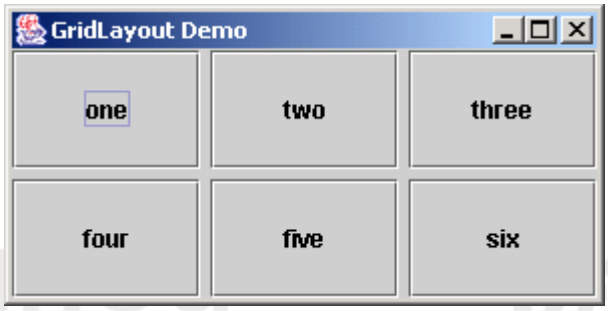


Figure 3: GridLayout Demo

Grid Bag Layout

GridBagLayout is the most precise of the five AWT Layout Managers. It is similar to the GridLayout, but components do not need to be of the same size. Each component can occupy one or more cells of the layout. Furthermore, components are not necessarily placed in the cells beginning at the upper left-hand corner and moving to the right and down.

In simple applets with just a few components you often need only one layout manager. In more complicated applets, however, you will often split your applet into panels, lay out the panels according to a layout manager, and give each panel its own layout manager that arranges the components inside it.
The GridBagLayout constructor is trivial, GridBagLayout() with no arguments.

GridBagLayout gbl = new GridBagLayout();

Unlike the GridLayout() constructor, this does not say how many rows or columns there will be. The cells your program refers to determine this. If you put a component in row 8 and column 2, then Java will make sure there are at least nine rows and three columns. (Rows and columns start counting at zero.) If you later put a component in row 10 and column 4, Java will add the necessary extra rows and columns. You may have a picture in your mind of the finished grid, but Java does not need to know this when you create a GridBagLayout.

Unlike most other LayoutManagers you should not create a GridBagLayout inside a cell to setLayout(). You will need access to the GridBagLayout object later in the applet when you use a GridBagConstraints.

A **GridBagConstraints** object specifies the location and area of the component's display area within the container (normally the applet panel) and how the component is laid out inside its display area. The GridBagConstraints, in conjunction with the component's minimum size and the preferred size of the component's container, determines where the display area is placed within the applet.

The GridBagConstraints() constructor is trivial

GridBagConstraints gbc = new GridBagConstraints();

Your interaction with a GridBagConstraints object takes place through its eleven fields and fifteen mnemonic constants.

gridx and gridy

The gridx and gridy fields specify the x and y coordinates of the cell at the upper left of the Component's display area. The upper-left-most cell has coordinates (0, 0). The mnemonic constant GridBagConstraints.RELATIVE specifies that the Component is placed immediately to the right of (gridx) or immediately below (gridy) the previous Component added to this container.

Gridwidth and Gridheight

The gridwidth and gridheight fields specify the number of cells in a row (gridwidth) or column (gridheight) in the Component's display area. The mnemonic constant GridBagConstraints.REMAINDER specifies that the Component should use all remaining cells in its row (for gridwidth) or column (for gridheight). The mnemonic constant GridBagConstraints.RELATIVE specifies that the Component should fill all but the last cell in its row (gridwidth) or column (gridheight).

Fill

The GridBagConstraints fill field determines whether and how a component is resized if the component's display area is larger than the component itself. The mnemonic constants you use to set this variable are
GridBagConstraints.NONE :Don't resize the component
GridBagConstraints.HORIZONTAL: Make the component wide enough to fill the display area, but don't change its height.
GridBagConstraints.VERTICAL: Make the component tall enough to fill its display area, but don't change its width.
GridBagConstraints.BOTH: Resize the component enough to completely fill its display area both vertically and horizontally.

Ipadx and Ipady

Each component has a minimum width and a minimum height, smaller than which it will not be. If the component's minimum size is smaller than the component's display area, then only part of the component will be shown.

The ipadx and ipady fields let you increase this minimum size by padding the edges of the component with extra pixels. For instance setting ipadx to two will guarantee that the component is at least four pixels wider than its normal minimum. (ipadx adds two pixels to each side.)

Insets

The insets field is an instance of the java.awt.Insets class. It specifies the padding between the component and the edges of its display area.

Anchor

When a component is smaller than its display area, the anchor field specifies where to place it in the grid cell. The mnemonic constants you use for this purpose are similar to those used in a BorderLayout but a little more specific.

They are

GridBagConstraints.CENTER
GridBagConstraints.NORTH
GridBagConstraints.NORTHEAST
GridBagConstraints.EAST
GridBagConstraints.SOUTHEAST
GridBagConstraints.SOUTH
GridBagConstraints.SOUTHWEST
GridBagConstraints.WEST
GridBagConstraints.NORTHWEST
The default is GridBagConstraints.CENTER.

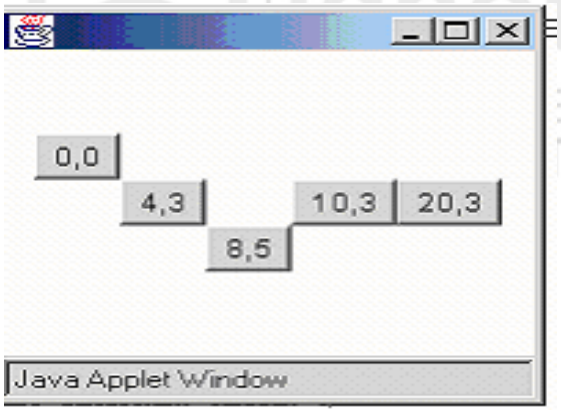
weightx and weighty

The weightx and weighty fields determine how the cells are distributed in the container when the total size of the cells is less than the size of the container. With weights of zero (the default) the cells all have the minimum size they need, and everything clumps together in the center. All the extra space is pushed to the edges of the container. It doesn't matter where they go and the default of center is fine.
See the program given bellow for visualizing GridbagLayout.

```
import java.awt.*;
public class GridbagLayouttest extends Frame
{
Button b1,b2,b3,b4,b5;
GridBagLayout gbl=new GridBagLayout();
GridBagConstraints gbc=new GridBagConstraints();
public GridbagLayouttest()
{
setLayout(gbl);
gbc.gridx=0;
gbc.gridy=0;
gbl.setConstraints(b1=new Button("0,0"),gbc);
gbc.gridx=4;   //4th column
gbc.gridy=3;   //3rd row
gbl.setConstraints(b2=new Button("4,3"),gbc);
gbc.gridx=8;   //8th column
gbc.gridy=5;   //5rd row
gbl.setConstraints(b3=new Button("8,5"),gbc);
gbc.gridx=10;   //10th column
gbc.gridy=3;   //3rd row
gbl.setConstraints(b4=new Button("10,3"),gbc);
gbc.gridx=20;   //20th column
gbc.gridy=3;   //3rd row
gbl.setConstraints(b5=new Button("20,3"),gbc);
add(b1);
```

```
add(b2);
add(b3);
add(b4);
add(b5);
setSize(200,200);
setVisible(true);
}
public static void main(String a[])
{
GridbagLayouttest gb=  new GridbagLayouttest();
}
}
```

Output:



Now we will discuss about different containers.

2.7 CONTAINER

You must be thinking that container will be a thing that contains something, like a bowl. Then you are right!! Actually container object is derived from the java.awt.Container class and is one of (or inherited from) three primary classes: java.awt.Window, java.awt.Panel, java.awt.ScrollPane.

The Window class represents a standalone window (either an application window in the form of a java.awt.Frame, or a dialog box in the form of a java.awt.Dialog). The java.awt.Panel class is not a standalone window by itself; instead, it acts as a background container for all other components on a form. For instance, the java.awt.Applet class is a direct descendant of java.awt.Panel.

The three steps common for all Java GUI applications are:

1. Creation of a container
2. Layout of GUI components.
3. Handling of events.

The Container class contains the setLayout() method so that you can set the default LayoutManager to be used by your GUI. To actually add components to the container, you can use the container's add() method:

```
Panel p = new java.awt.Panel();
Button b = new java.awt.Button("OK");
p.add(b);
```

A JPanel is a Container, which means that it can contain other components. GUI design in Java relies on a layered approach where each layer uses an appropriate layout manager.

FlowLayout is the default for JPanel objects. To use a different manager use either of the following:

```
JPanel pane2 = new JPanel()         // make the panel first
pane2.setLayout(new BorderLayout()); // then reset its manager
JPanel pane3 = new JPanel(new BorderLayout()); // all in one!
```

☞ Check Your Progress 4

1) Why do you think Layout Manager is important?

……

……

……

……

2) How does repaint() method work with Applet?

……

……

……

3) Each type of container comes with a default layout manager. Default for a Frame,Window or Dialog is _____

4) Give examples of stretchable components and non-stretchable components

……

……

……

……

5) The Listener interfaces inherit directly from which package.

……

……

……

……

……

6) How many Listeners are there for trapping mouse movements.

……

……

……

……

……

2.8 SUMMARY

This unit is designed to know about the graphical interfaces in Java. In this unit you become familiar with AWT and SWING packages, which are used to add components in the container or a kind of tray. Swings are lightweight components and more flexible as compared to AWT. You learned to beautify your text by using Font class and Color class. For Geometric figures various in built classes of Java like for drawing line, circle, polygons etc are used. You learned to place the components in various

layouts. Java provides various layouts some of which are: FlowLayout, GridBagLayout, GridLayout, CardLayout, BorderLayout.

2.9 SOLUTONS/ANSWERS

Check Your Progress 1

1) Java defines two constructors for the Color Class of which one constructor takes three integer arguments and another takes three float arguments.

public Color (int r, int g, int b)

Creates a color based on red, green and blue components expressed as integers from 0 to 255. Here, the r, g, b means red, green and blue contents respectively.

public Color(float r, float g, float b) Creates a color based on red, green and blue components expressed as floating-point values from 0.0 to 1.0. Here, the r, g, b means red, green and blue contents respectively.

2)

```
import java.awt.*;
import java.applet.Applet;
public class ColorText extends Applet
{
 public void paint(Graphics g)
{
    g.setColor(Color.red);
   g.drawString("My Red color String",40,50);

  }
}
```

Output:

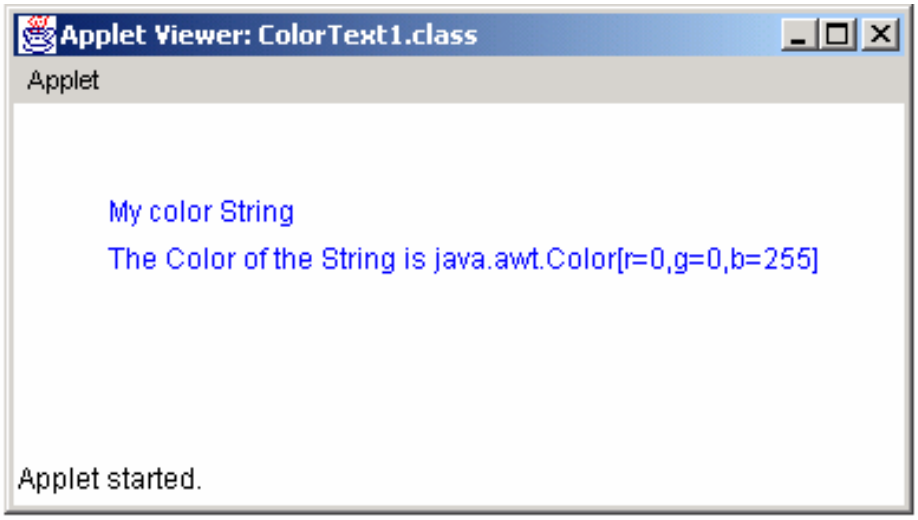
3) If you want to retrieve the Color of a text or a String you can use the method public int getColor().
It returns a value between 0 and 255 representing the color content.

The Program given bellow is written for getting RGB components of the color
import java.awt. *

```
import java.applet.Applet;
public class ColorText extends Applet
{
 public void paint(Graphics g)
{
int color;
g.drawString("My Pink color String",40,50);
```

```
color = getColor(g);
g.drawString("The Color of the String is "+color , 40,35);
 }
}
```

Output:

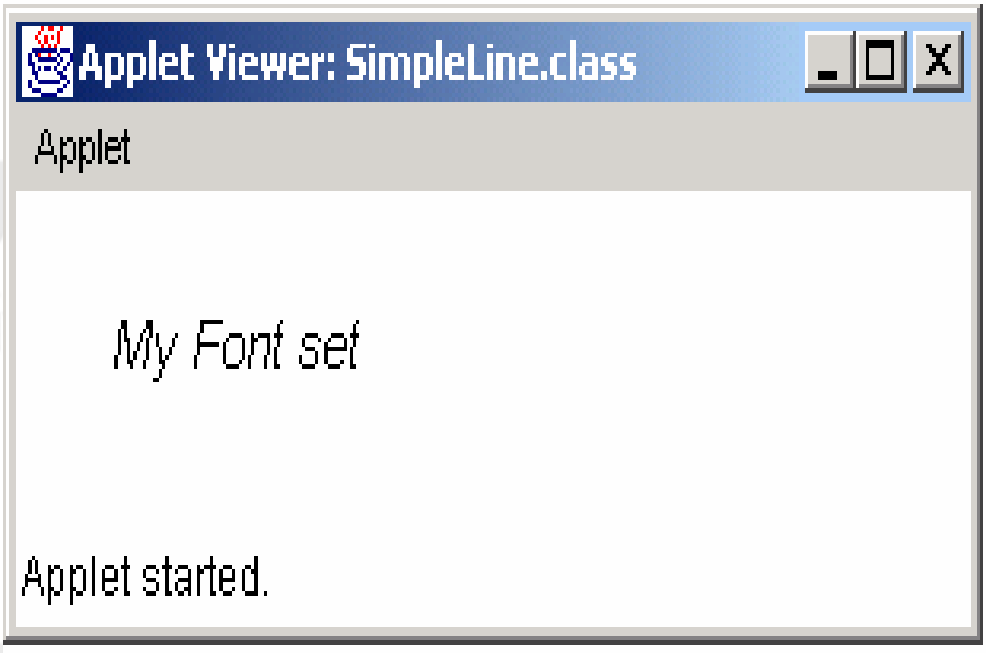


Check Your Progress 2

1)

```
import java.applet.*;
import java.awt.*;
public class SimpleLine extends Applet
{
 public void paint(Graphics g)
 {
  g.drawString("My Font set" , 30, 40);
  g.setFont("Arial",Font.ITALIC,15);
  }
}
```

Output:

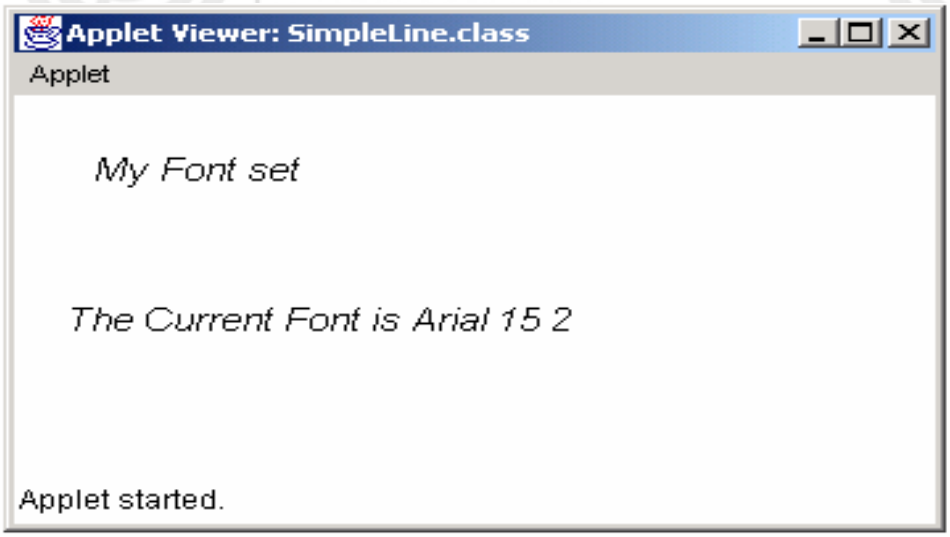


2) To retrieve the font of the string the method **getFont()** is used.

Program for font retrieval:

```
import java.applet.*;
import java.awt.*;
public class SimpleLine extends Applet
{
public void paint(Graphics g)
{
g.drawString("My Font set" , 30, 40);
g.setFont("Arial",Font.ITALIC,15);
g.drawString("current Font is " + g.getFont(),40,50);
g.drawString( g.getFont().getName() + " " + g.getFont().getSize()+" "
+g.getFont().getStyle(), 20, 110 );
 }
}
```

Output:



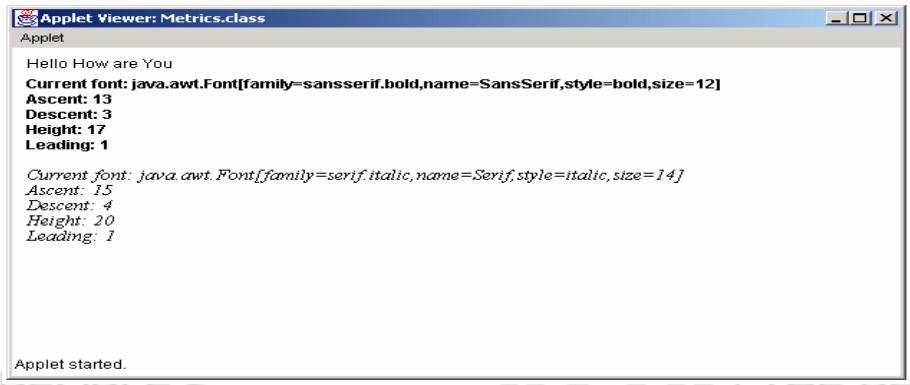
Note: The getStyle() methodreturns the integer value e.g above value 2 represent ITALIC.

3)

```
import java.awt.*;
import java.applet.Applet;
public class Metrics extends Applet {
public void paint(Graphics g)
{
        g.drawString("Hello How are You",50,60);
        g.setFont( new Font( "SansSerif", Font.BOLD, 12 ) );
        FontMetrics metrics = g.getFontMetrics();
        g.drawString( "Current font: " + g.getFont(), 10, 40 );
        g.drawString( "Ascent: " + metrics.getAscent(), 10, 55 );
        g.drawString( "Descent: " + metrics.getDescent(), 10, 70 );
        g.drawString( "Height: " + metrics.getHeight(), 10, 85 );
        g.drawString( "Leading: " + metrics.getLeading(), 10, 100 );
        Font font = new Font( "Serif", Font.ITALIC, 14 );
        metrics = g.getFontMetrics( font );
        g.setFont( font );
        g.drawString( "Current font: " + font, 10, 130 );
        g.drawString( "Ascent: " + metrics.getAscent(), 10, 145 );
        g.drawString( "Descent: " + metrics.getDescent(), 10, 160 );
```

```
        g.drawString( "Height: " + metrics.getHeight(), 10, 175 );
        g.drawString( "Leading: " + metrics.getLeading(), 10, 190 );
      } // end method paint
}
```

Output:

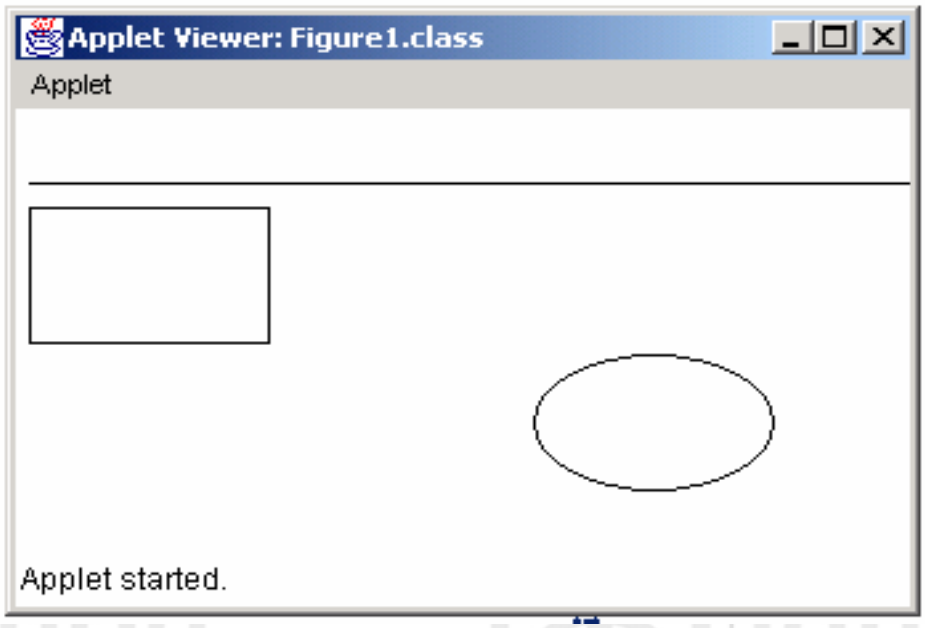


Check Your Progress 3

1)

```
// Drawing lines, rectangles and ovals.
 import java.awt.*;
 import java.applet.Applet;
     public class LinesRectsOvals extends Applet {
       // display various lines, rectangles and ovals
   public void paint( Graphics g )
   {
        g.drawLine( 5, 30, 350, 30 );
        g.drawRect( 5, 40, 90, 55 );
        g.drawOval( 195, 100, 90, 55 );
      } // end method paint
}
```

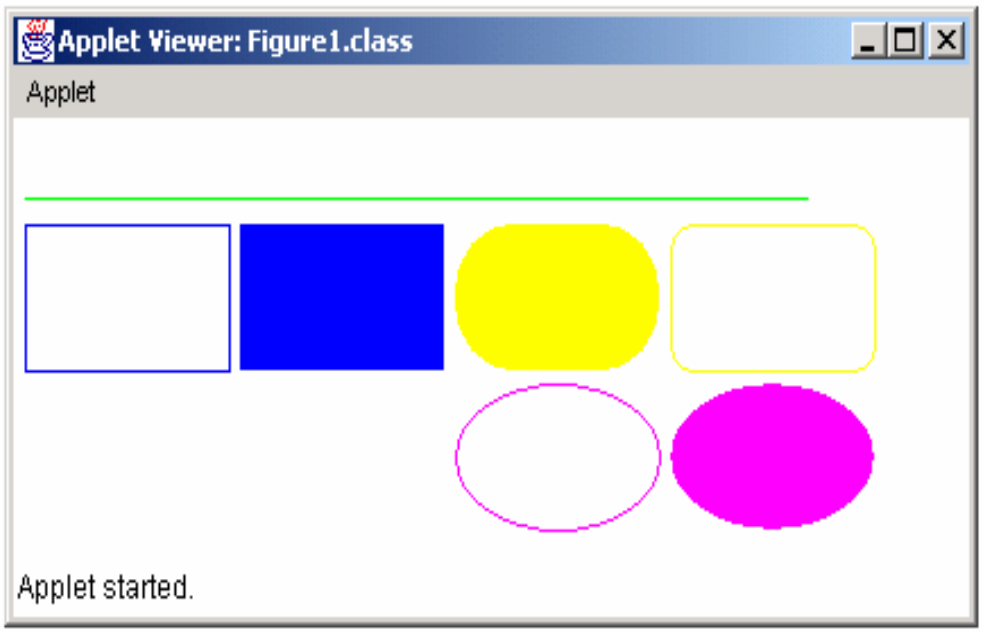
Output:



2)

```
import java.awt.*;
import javax.swing.*;
        public class LinesRectsOvals extends JFrame
        {
        public void paint( Graphics g )
        {
        g.setColor( Color.GREEN );
        g.drawLine( 5, 30, 350, 30 );
        g.setColor( Color.BLUE );
        g.drawRect( 5, 40, 90, 55 );
        g.fillRect( 100, 40, 90, 55 );
//below two lines will draw a filled rounded rectangle with color yellow
        g.setColor( Color.YELLOW );
        g.fillRoundRect( 195, 40, 90, 55, 50, 50 );
//below two lines will draw a rounded figure of rectangle with color Pink
        g.drawRoundRect( 290, 40, 90, 55, 20, 20 );
        g.setColor( Color.PINK);
//below lines will draw an Oval figure with color Magenta
        g.setColor(Color.MAGENTA);
        g.drawOval( 195, 100, 90, 55 );
        g.fillOval( 290, 100, 90, 55 );
}
}
```

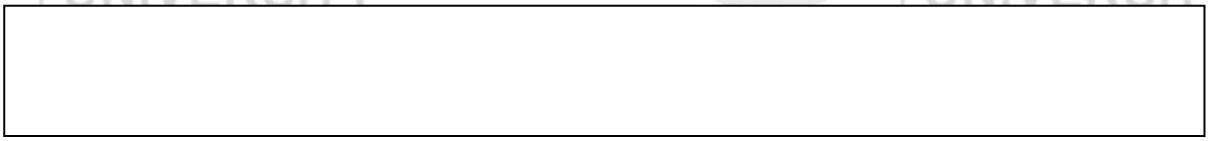
Output:



3)

```
import java.awt.*;
class ChkGroup extends java.applet.Applet
{
CheckboxGroup cbgr = new CheckboxGroup();
Panel panel=new Panel();
Frame fm=new Frame();
Checkbox c1 = new Checkbox ("America Online");
Checkbox c2 = new Checkbox ("MSN");
Checkbox c3 = new Checkbox ("NetZero", cbgr, false);
```

```
Checkbox c4 = new Checkbox ("EarthLink", cbgr, false);
Checkbox c5 = new Checkbox ("Bellsouth DSL", cbgr, false);
public void init()
{
fm.setVisible(true);
fm.setSize(300,400);
fm.add(panel);
panel.add(c1);
panel.add(c2);
panel.add(c3);
panel.add(c4);
panel.add(c5);
}
public static void main(String args[])
{
        ChkGroup ch=new ChkGroup();
        ch.init();
}
}
```

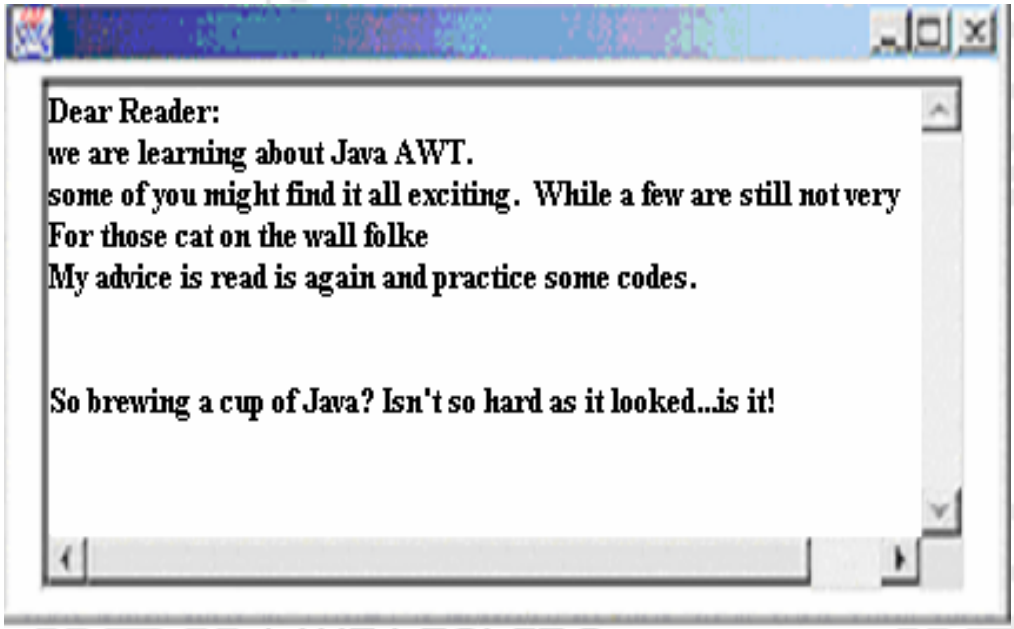


In the above example you will notice that the control which is not in the group has become a checkbox and the control which is in the group has become a radio button because checkbox allows you multiple selection but a radio button allows you a single selection at a time.

4)

```
import java.awt.*;
class TextFieldTest extends java.applet.Applet
{
Frame fm=new Frame();
Panel panel=new Panel();
String letter = "Dear Readers: \n" +
"We are learning about Java AWT. \n" +
"Some of you might find it all exciting, while a few are still not very sure \n" +
"For those cat on the wall folks \n" +
"My advice is read it again and practice some codes. \n \n" +
"So brewing a cup of Java? Isn't so hard as it looked…is it! " ;
TextArea ltArea;
public void init(){
ltArea = new TextArea(letter, 10, 50);
fm.setVisible(true);
fm.setSize(300,400);
fm.add(panel);
panel.add(ltArea);

}
public static void main(String args[])
{
  TextFieldTest tt=new TextFieldTest();
        tt.init();
}
}
```



Basically you will notice that along with the textarea control you will see the scrollbars.

5) Swing components that subclass JComponent has many features, including: A pluggable look and feel that can be used to customize the look and feel when the program executes on different platforms.

We can have Shortcut keys (called) mnemonics) for direct access to GUI components through the keyboard. It has very common event handling capabilities for cases where several GUI components initiate the same actions in the program. It gives the brief description of a GUI component's means (tool tips) that are displayed when the mouse cursor is positioned over the component for a short time. It has a support for technologies such as Braille screen for blind people. It has support for user interface localization-customizing the user interface for display in different languages and cultural conventions.

Check Your Progress 4

1) A LayoutManager rearranges the components in the container based on their size relative to the size of the container.

   Consider the window that just popped up. It has got five buttons of varying sizes. Resize the window and watch how the buttons move. In particular try making it just wide enough so that all the buttons fit on one line. Then try making it narrow and tall so that there is only one button on line. See if you can manage to cover up some of the buttons. Then uncover them. Note that whatever you try to do, the order of the buttons is maintained in a logical way. Button 1 is always before button 2, which is always before button 3 and so on.

   It is harder to show, but imagine if the components changed sizes, as they might if you viewed this page in different browsers or on different platforms with different fonts.

   The layout manager handles all these different cases for you to the greatest extent possible. If you had used absolute positioning and the window were smaller than expected or the components larger than you expected, some components would likely be truncated or completely hidden. In essence a layout manager defers decisions about positioning until runtime.

2) The repaint() method will cause AWT to invoke a component's update() method. AWT passes a Graphics object to update() –the same one that it passes to paint(). So, repaint() calls update() which calls paint().

3) BorderLayout

4) Stretchable: Button, Label and TextField
Non-Stretchable: CheckBox

5) java.awt.event

6) MouseListener and MouseMotionListener