CSc 133 Lecture Notes

8 - GUI Basics

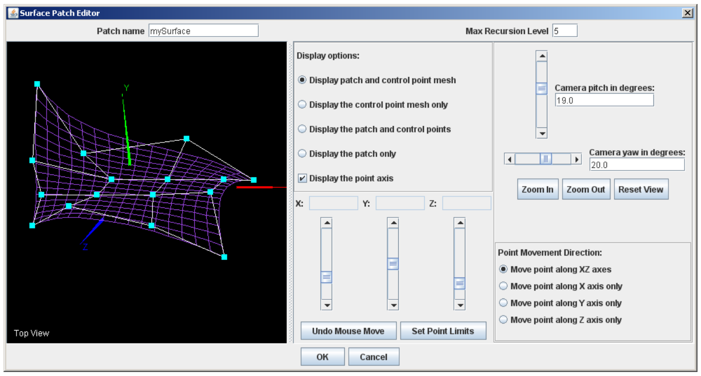
Computer Science Department
California State University, Sacramento

Overview

- **Displays and Color**
- **The UI Package of CN1**
- **UI Components: Form, Button, Label, Checkbox, ComboBox, TextField …**
- **Layout Managers**
- **Containers**
- **Side Menus**

Modern Program Characteristics

- Graphical User Interfaces ("GUIs")
- "Event-driven" interaction


Surface Patch Editor

Patch name: mySurface

Max Recursion Level: 5

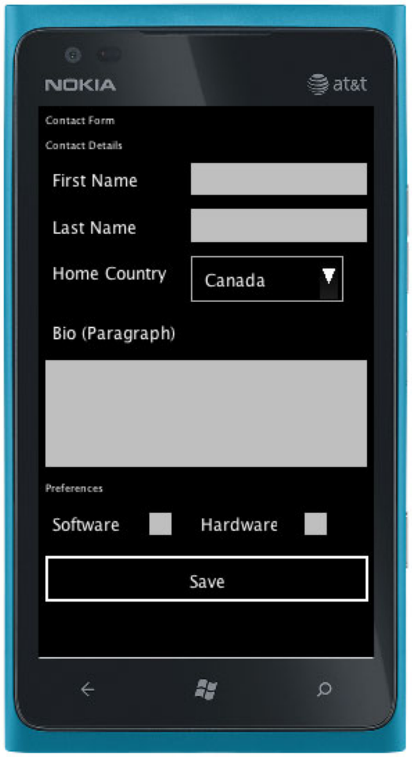
Display options:
- ● Display patch and control point mesh
- ○ Display the control point mesh only
- ○ Display the patch and control points
- ○ Display the patch only
- ☑ Display the point axis

Camera pitch in degrees: 19.0

Camera yaw in degrees: 20.0

X: Y: Z:

Point Movement Direction:
- ● Move point along XZ axes
- ○ Move point along X axis only
- ○ Move point along Y axis only
- ○ Move point along Z axis only


Contact Form

Contact Details

First Name

Last Name

Home Country: Canada

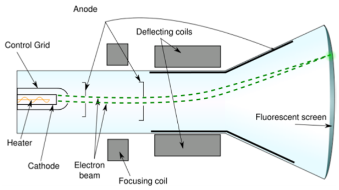
Bio (Paragraph)

Preferences

Software □ Hardware □

Common Display Types

- CRT (Cathode Ray Tube)



- LCD (Liquid Crystal Display)

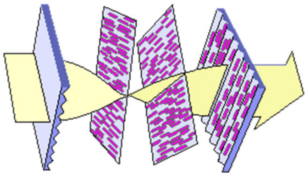
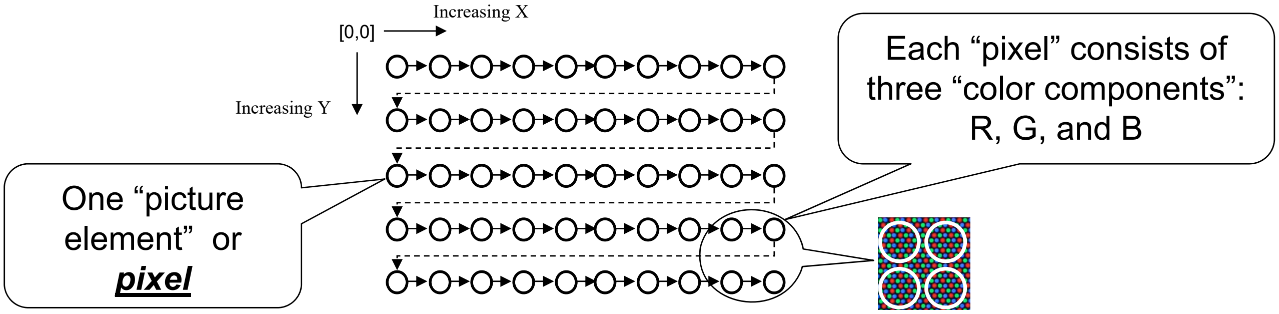


Image credits: Wikimedia Commons (http://commons.wikimedia.org);
http://www.pctechguide.com/07panels.htm

Raster vs. Random Scan Devices

- Random scan: arbitrary movement
  - Oscilloscopes, pen-plotters, searchlights, laser light shows
- Raster scan: fixed ("raster") pattern
  - OLEDs, Plasma panels, LCDs, CRTs, printers



Each "pixel" consists of three "color components": R, G, and B

One "picture element" or ***pixel***

RGB Additive Color Model

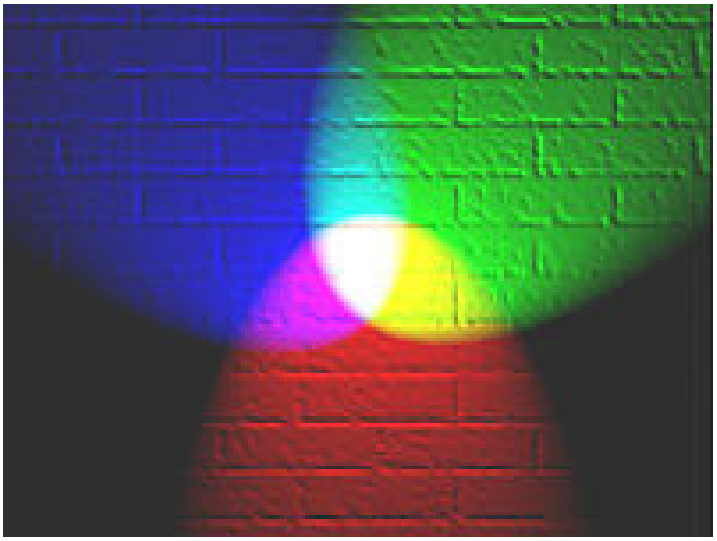


Image credit: http://en.wikipedia.org/wiki/RGB_color_model

The RGB Color Cube

- Each axis represents one of (Red, Green, Blue)
- Distance along axis = intensity (0 to max)
- Locations within cube = different colors
  - Values of equal RGB intensity are grey

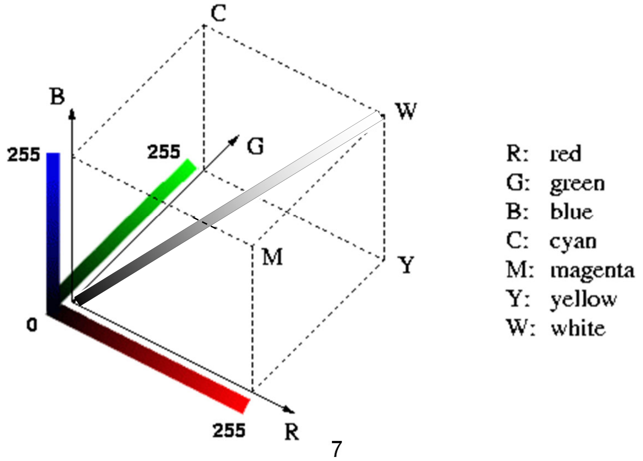
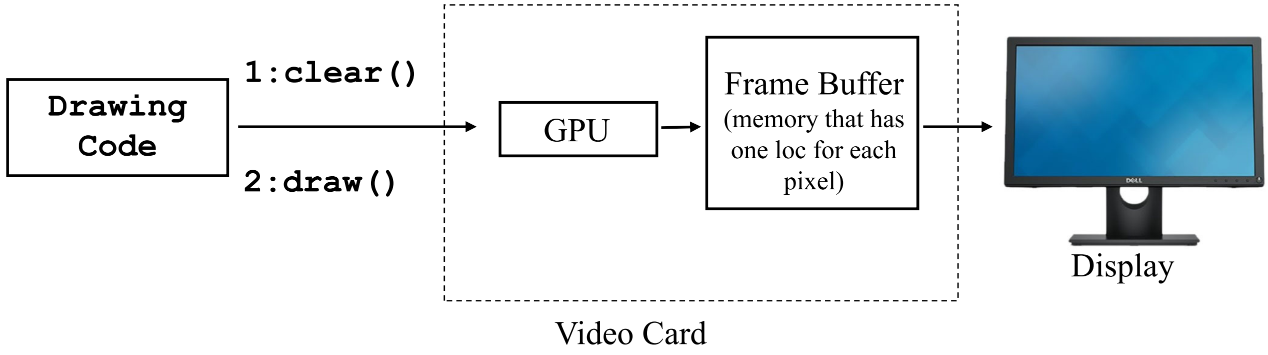


Image credit: http://gimp-savvy.com

Frame Buffers

- Graphical Processing Unit (GPU) processes the commands sent from the drawing code and writes to the "*frame buffer*"
- The screen is refreshed from the frame buffer


Drawing Code

1:clear()

2:draw()

GPU

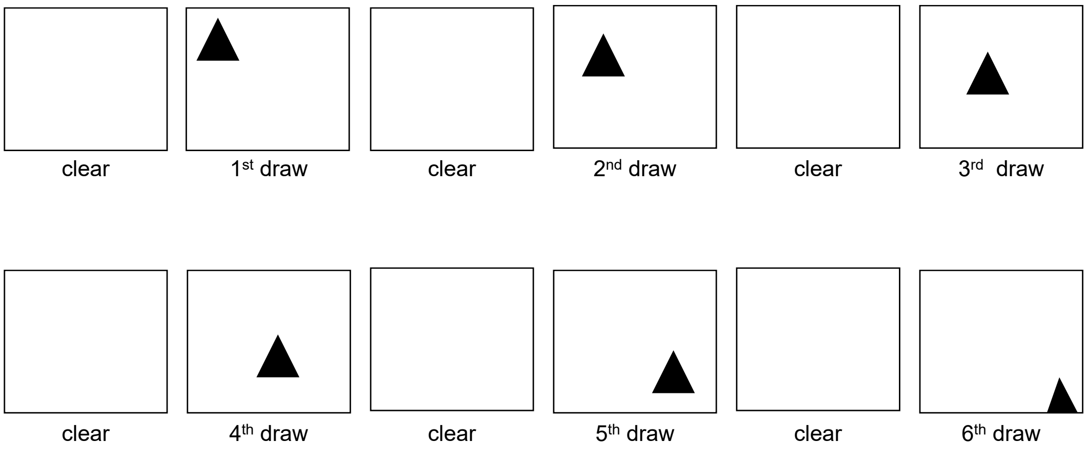
Frame Buffer (memory that has one loc for each pixel)

Display

Video Card

Flicker

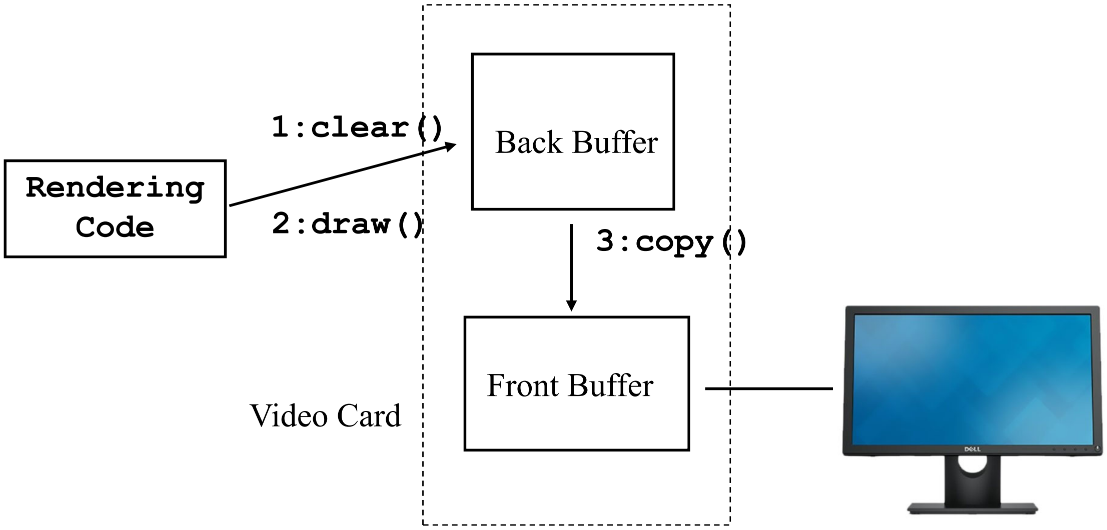
- Suppose the drawn output contains a triangle, continually changing location:



clear
1st draw
clear
2nd draw
clear
3rd draw
clear
4th draw
clear
5th draw
clear
6th draw

Double-Buffering

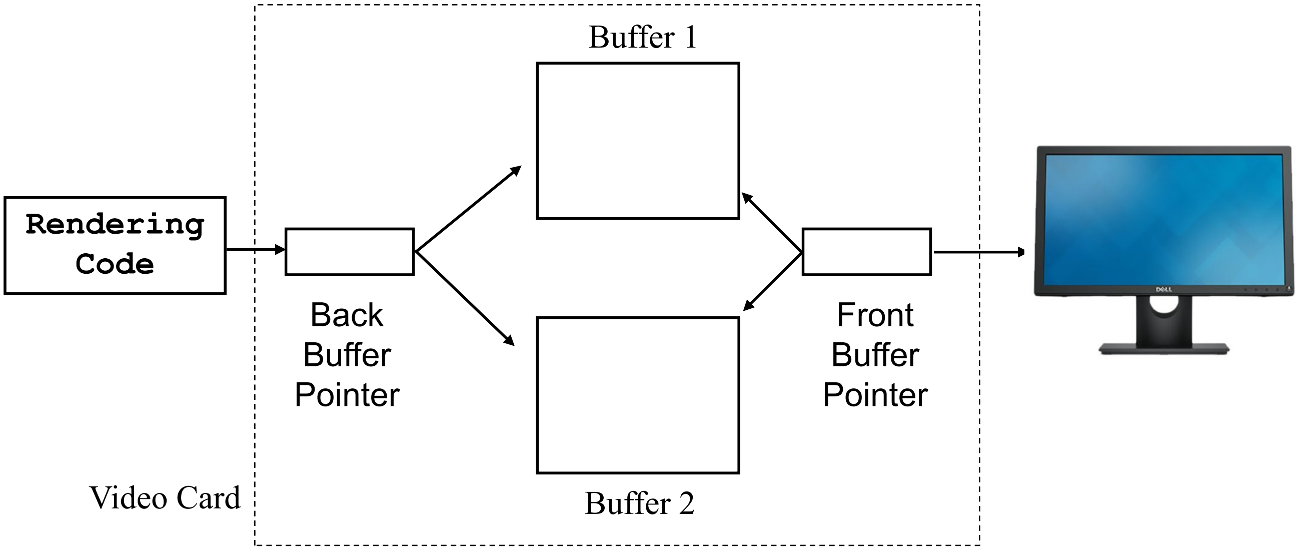
- Avoiding flicker:
  - Write to secondary or "back" buffer
  - Copy back buffer to "front" buffer when done



Rendering Code
1:clear()
2:draw()
Back Buffer
3:copy()
Front Buffer
Video Card

Page-Flipping

- Avoid copy() by changing a *pointer*



Rendering Code

Buffer 1

Back Buffer Pointer

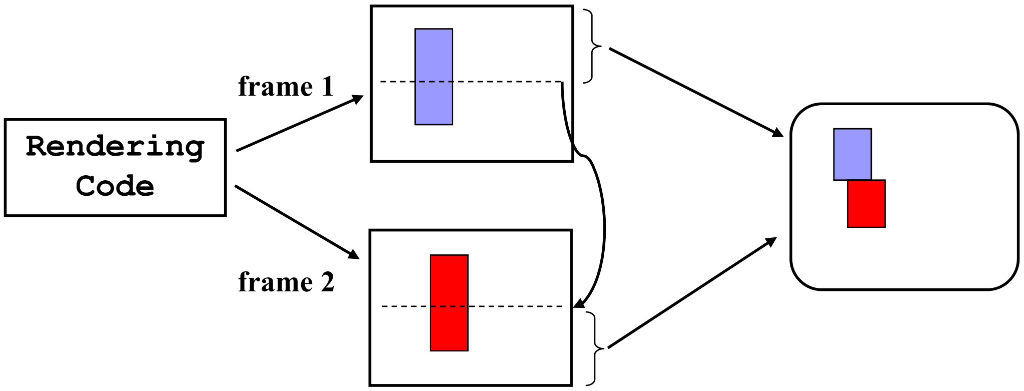
Front Buffer Pointer

Buffer 2

Video Card

Tearing

- Problem: swapping ½ way through scan
- Result: “torn image”
- Solution: hold off swap until “VSync”
    - Drawback: slows down renderer



Rendering Code

frame 1

frame 2

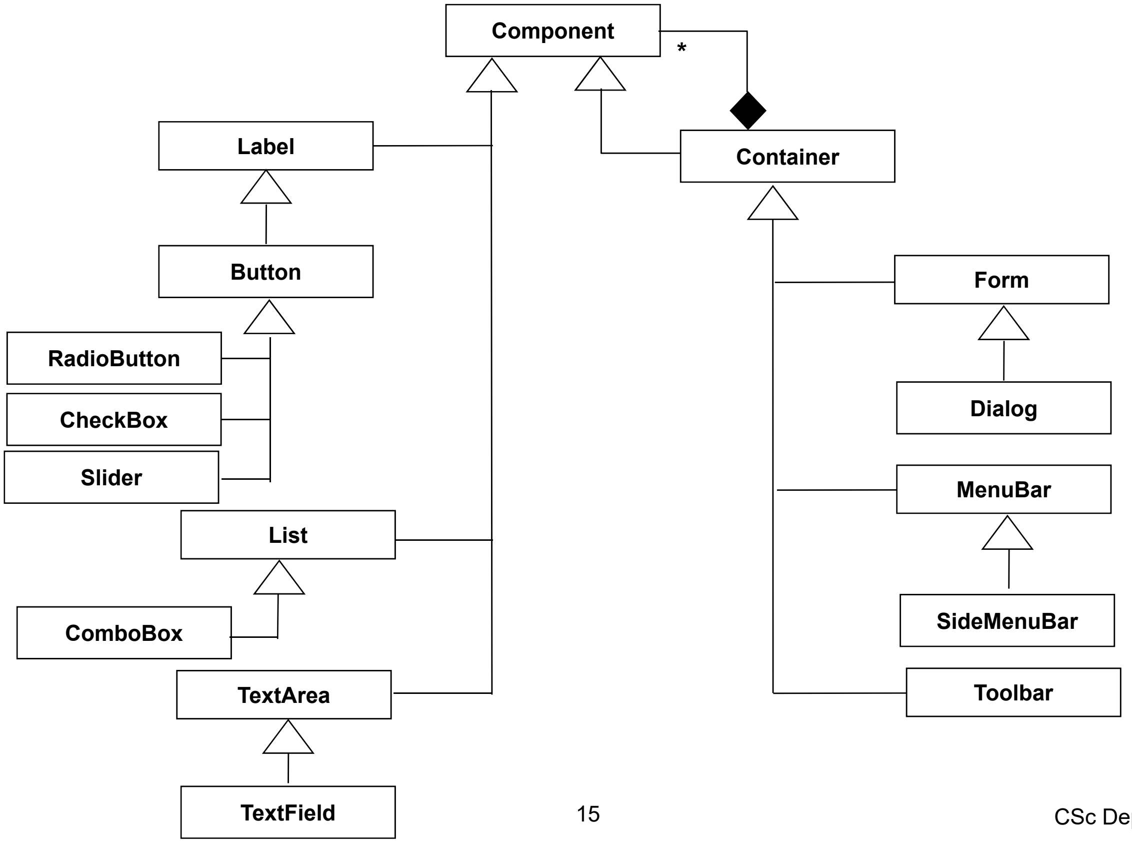
GUI Frameworks

- Collection of classes that take care of low-level details of drawing “things” on screen. Provides:
  - A *set of reusable screen components*
    - “Component”: an object having a *graphical representation*
    - Usually has the ability to *interact* with the user
  - An *event mechanism* connecting “actions” to “code”
  - *Containers* and *Layout Managers* for arranging things on screen
  - Some other packages…

Examples of GUI Frameworks

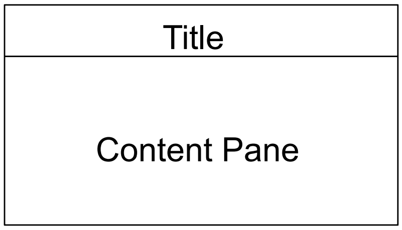
- Microsoft Foundation Classes (**MFC**): designed for C++ development on Windows (it is not built-in to C++)
- **AWT**: Java’s first (inefficient) built-in GUI package
- JFC/**Swing**: Java’s efficient built-in GUI package
- **UI**: CN1’s GUI package (very similar to Swing)
- “Things” are called controls (MFC), components (AWT/Swing/CN1), widgets (X-Windows on Linux)

Important CN1- UI Components



Creating a Form in CN1

- The top-level container of CN1 (like `JFrame` in Swing)
- Only one form can be visible at any given time
- Form contains title and a content pane (and optionally a menu bar which we will not utilize in the assignments):



- Calling to `myForm.addComponent()` is actually invoking `myForm.getContentPane().addComponent()`
- Hence, content pane is the “parent” container of all components you add to the form.

Creating a Form in CN1 (cont.)

```
// Contents of File  DemoSimpleForm.java:
/** This class is a driver for running the SimpleForm class. It creates a Form.
It is the “Main” class of CN1 project (created with “native” theme and “Hello
World(Bare Bones)” template).
*/
//default import statements...
public class DemoSimpleForm {
private Form current;
//default implementations of methods like init(), stop(), destroy() ...
  public void start() {
     if(current != null){
               current.show();
               return;
            }
     //change the default implementation of start()
     new SimpleForm();
  }
}
```

Creating a Form in CN1 (cont.)

```
// Contents of File  SimpleForm.java:
import com.codename1.ui.Form;
/** This class creates a simple "Form"  by extending an existing
 *  class "Form", defined in the CN1’s UI package.
 */
public class SimpleForm extends Form{
  public SimpleForm() {
     this.show();
  }
```

Titled Form in CN1

```
import com.codename1.ui.*;
/** This class creates a "Form" that has a title specified by the user
 *  User types the title on a "TextField" on a "Dialog"
 */
public class TitledForm extends Form {
    public TitledForm() {
       Command cOk = new Command("Ok");
       Command cCancel = new Command("Cancel");
       Command[] cmds = new Command[]{cOk, cCancel};
       TextField myTF = new TextField();
       Command c = Dialog.show("Enter the title:", myTF, cmds);
       //[if you only want to display the okay option, you do not need to
       //create "cmds", just use Dialog.show("Enter the title:", myTF, cOk);]
       if (c == cOk)
         this.setTitle(myTF.getText());
       else
         this.setTitle("Title not specified");
       this.show();
    }
}
```

Closing App in CN1

```
import com.codename1.ui.*; //not listed in the rest of the examples
/** This class creates a "Form" that has a title "Closing App Demo"
 *  Then it pops up a "Dialog" confirming closing of the application
 */
public class ClosingApp extends Form {
  public ClosingApp() {
    this.setTitle("Closing App Demo");
    Boolean bOk = Dialog.show("Confirm quit", "Are you sure you want to quit?",
"Ok", "Cancel");
    //[in a dialog if you only want to display the okay option,
    //use Dialog.show("Title of dialog", "Text to display on dialog", "Ok", null);]
    if (bOk){
         //instead of System.exit(0), CN1 recommends using:
         Display.getInstance().exitApplication();
         }
    this.show();
  }
}
```

CN1 `Display` class

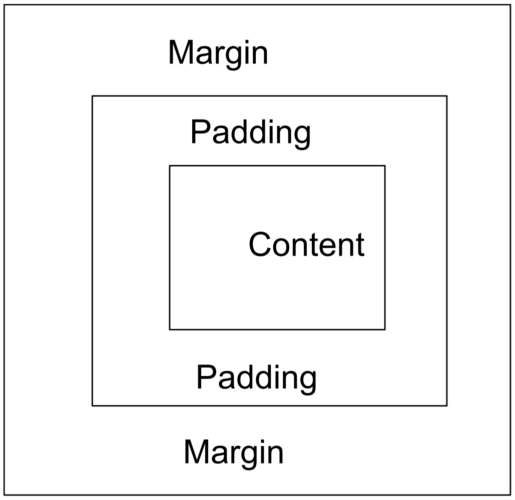
- Central class that manages rendering/events and is used to place top level components (Form) on the display.
- Has static **`getInstance()`** method which return the **`Display`** instance.
- To get the resolution of your display, you can call: **`Display.getInstance().getDisplayWidth()`** or …**`Height()`**
- **`Display.getInstance().getCurrent()`** return the form currently displayed on the screen or null if no form is currently displayed.

Adding Components to Form

```
public class FormWithComponents extends Form {
  public FormWithComponents () {
  // create a new label object
  Label myLabel = new Label("I am a Label");
  // add the label to the "content pane" of the form
  this.getContentPane().addComponent(myLabel);
  // [you can also call this.addComponent(myLabel) or simply this.add(myLabel)]
  // create a button and add
  Button myButton = new Button("I am a Button");
  this.addComponent(myButton);
  // create a checkbox and add
  CheckBox myCheck = new CheckBox("I am a CheckBox");
  this.addComponent(myCheck);
  // add a combo box (drop-down list) and add
  ComboBox myCombo = new ComboBox("Choice 1","Choice 2","Choice 3");
  this.addComponent(myCombo);
  this.show();
  }
}
```

CN1 `Style` class

Represents the look of a given component: colors, fonts, transparency, margin and padding & images.



Margin

Padding

Content

Padding

Margin

Setting style of a Component

```
public class ComponentsWithStyle extends Form {
  public ComponentsWithStyle () {
    Button button1 = new Button("Plain button");
    Button button2 = new Button("Button with style");
     //change background and foreground colors of the unselected style of the button
    button2.getUnselectedStyle().setBgTransparency(255);
    button2.getUnselectedStyle().setBgColor(ColorUtil.BLUE);
    button2.getUnselectedStyle().setFgColor(ColorUtil.WHITE);
button2.getUnselectedStyle().setBorder(Border.createLineBorder(3,ColorUtil.BLACK));
    //[use button2.getAllStyles() to set all styles (selected, pressed, disabled, etc.) of the
component at once]
    //add padding to all styles of button2
    button2.getAllStyles().setPadding(Component.TOP, 10);
    button2.getAllStyles().setPadding(Component.BOTTOM, 10);
    //[you can also add padding to left and right by using Component.LEFT and Component.RIGHT]
    addComponent(button1);
    addComponent(button2);
     show(); //not listed in the rest of the examples
  }
}
```

Setting style of a Component (cont.)

```
public class ComponentsWithStyle extends Form {
  public ComponentsWithStyle () throws IOException { //for Image.createImage()
   //add button1 and button2 as shown in the previous example
  //set a background image for all styles of the form
  InputStream is = Display.getInstance().getResourceAsStream(getClass(),
                                                            "/BGImage.jpg");
  Image i = Image.createImage(is);
  this.getAllStyles().setBgImage(i);
  //set an image for the unselected style of the button
  Button button3 = new Button("Expand");
  button3.getAllStyles().setPadding(Component.TOP, 10);
  //[if necessary, also add padding to bottom, left, right, etc]
  is = Display.getInstance().getResourceAsStream(getClass(), "/expand.gif");
  //[copy the images directly under “src” directory]
  i = Image.createImage(is);
  button3.getUnselectedStyle().setBgImage(i);
  addComponent(button3);
  }
}
```

Layout Managers

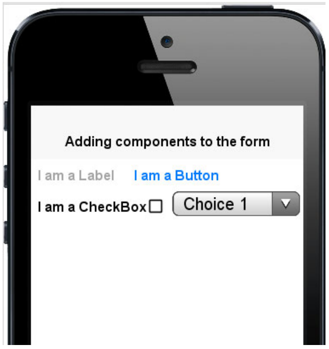
- Determine rules for positioning components in a container
  - Components which do not fit according to the rules may be hidden !!
- Layout Managers are classes
  - Must be instantiated and attached to their containers:

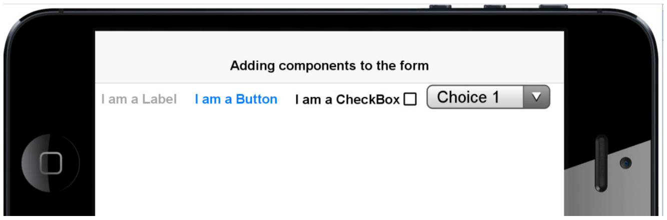
    `myContainer.setLayout( new BorderLayout() );`
- Components can have a preferred *size*
  - `setPreferredSize()` of `Component` is deprecated
  - override `calcPeferredSize()` of `Component` to reach similar functionality (do not use this in the assignments)
  - Layout managers *may or may not* respect preferred size either entirely or partially (e.g., `FlowLayout` respects it whereas `BoxLayout` does not respect it entirely…)

Layout Managers (cont.)

- Example: **`FlowLayout`**
  - Arranges components left-to-right, top-to-bottom (by default)
  - Components appear in the order they are added
  - Respects *preferred size*
  - Components that don't fit may be *hidden*
  - You can center components in the component by using:

```
myContainer.setLayout(new FlowLayout(Component.CENTER));
```

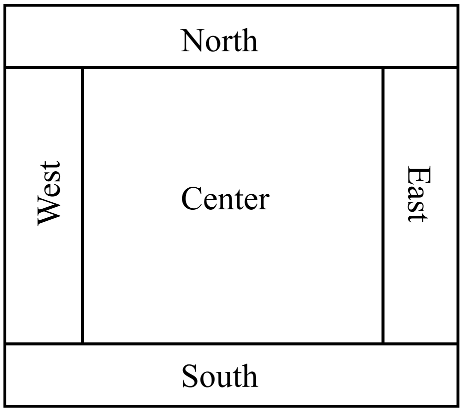




Layout Managers (cont.)

- Example: **`BorderLayout`**
  - Adds components to one of five "regions" of the container:
    North, South, East, West, or Center
  - Region must be specified when component is added

```
myContainer.add(BorderLayout.CENTER, myComponent);
```



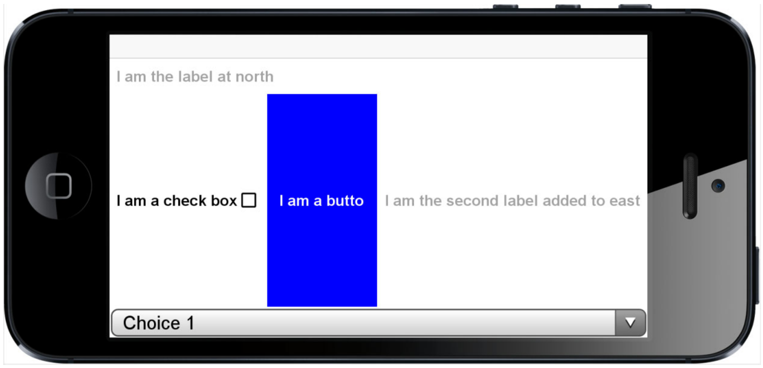
Layout Managers (cont.)

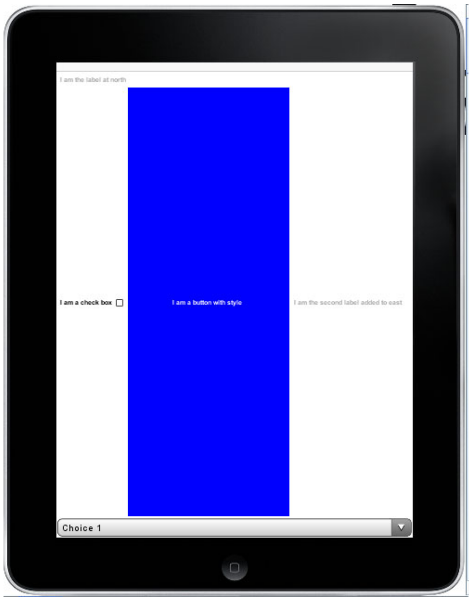
- **`BorderLayout`** (cont.)

```
public class BorderLayoutForm extends Form{//not listed in the rest
  public BorderLayoutForm() {               //of the examples
    //default layout for container is FlowLayout, change it to BorderLayout
    this.setLayout(new BorderLayout());
    //add a label to the top area of border layout
    Label myLabel = new Label("I am the label at north");
    this.add(BorderLayout.NORTH, myLabel);
    //... [add a check box to BorderLayout.WEST, a combo box to BorderLayout.SOUTH]
    //create a button to add to the center area
    Button myButton = new Button("I am a button with style");
    //...[set style of the button and add it to BorderLayout.CENTER]
    //add other labels to the left area of border layout
    Label myLabel2 = new Label("I am the first label added to east");
    this.add(BorderLayout.EAST, myLabel2);
    //[THIS LABEL WILL NOT BE VISIBLE, see upcoming slides for a solution]
    Label myLabel3 = new Label("I am the second label added to east");
    this.add(BorderLayout.EAST, myLabel3);}
}
```

Layout Managers (cont.)

- **`BorderLayout`** (cont.)
  - Stretches North and South to fit, then East and West
    - Center gets what space is left (if any!)





Layout Managers (cont.)

- Example: **`BoxLayout`**
  - Adds components to a horizontal or a vertical line that doesn't break the line
  - Box layout accepts an axis in its constructor:

```
myContainer.setLayout(new BoxLayout(BoxLayout.X_AXIS));
myContainer.setLayout(new BoxLayout(BoxLayout.Y_AXIS));
```

  - Components are stretched along the opposite axis, e.g. X_AXIS box layout will place components horizontally and stretch them vertically.

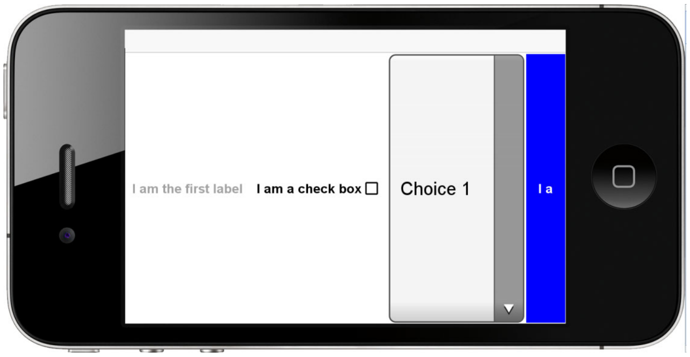
Layout Managers (cont.)

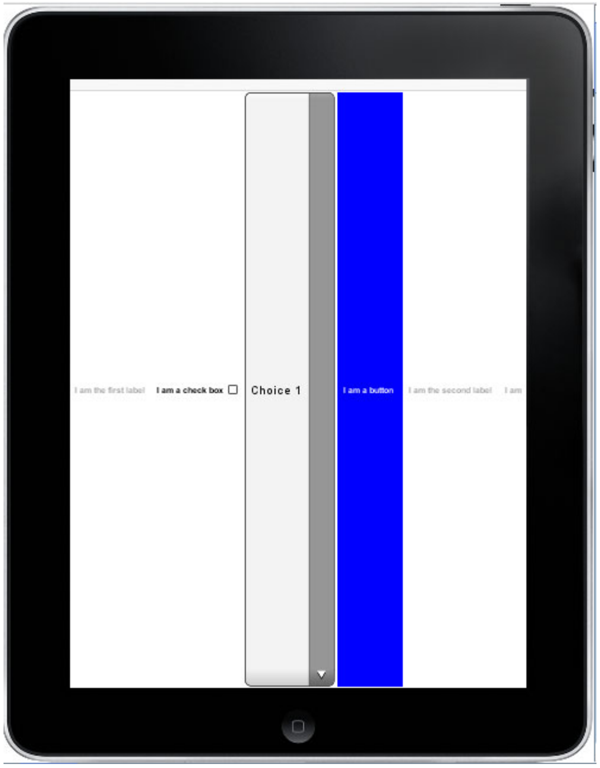
- Example: **`BoxLayout`** (cont.)

```
/* Code for a form with box layout */
setLayout(new BoxLayout(BoxLayout.X_AXIS));
//add a label as the first item
Label myLabel = new Label("I am the first label");
add(myLabel);
//... [add a check box as the second, a combo box as the third item
Button myButton = new Button("I am a button");
//...[set style of the button and add it as the fourth item]
//add other labels as fifth and sixth items
Label myLabel2 = new Label("I am the second label");
add(myLabel2);
Label myLabel3 = new Label("I am the third label");
add(myLabel3);
```

Layout Managers (cont.)

- Example: **`BoxLayout`** (cont.)





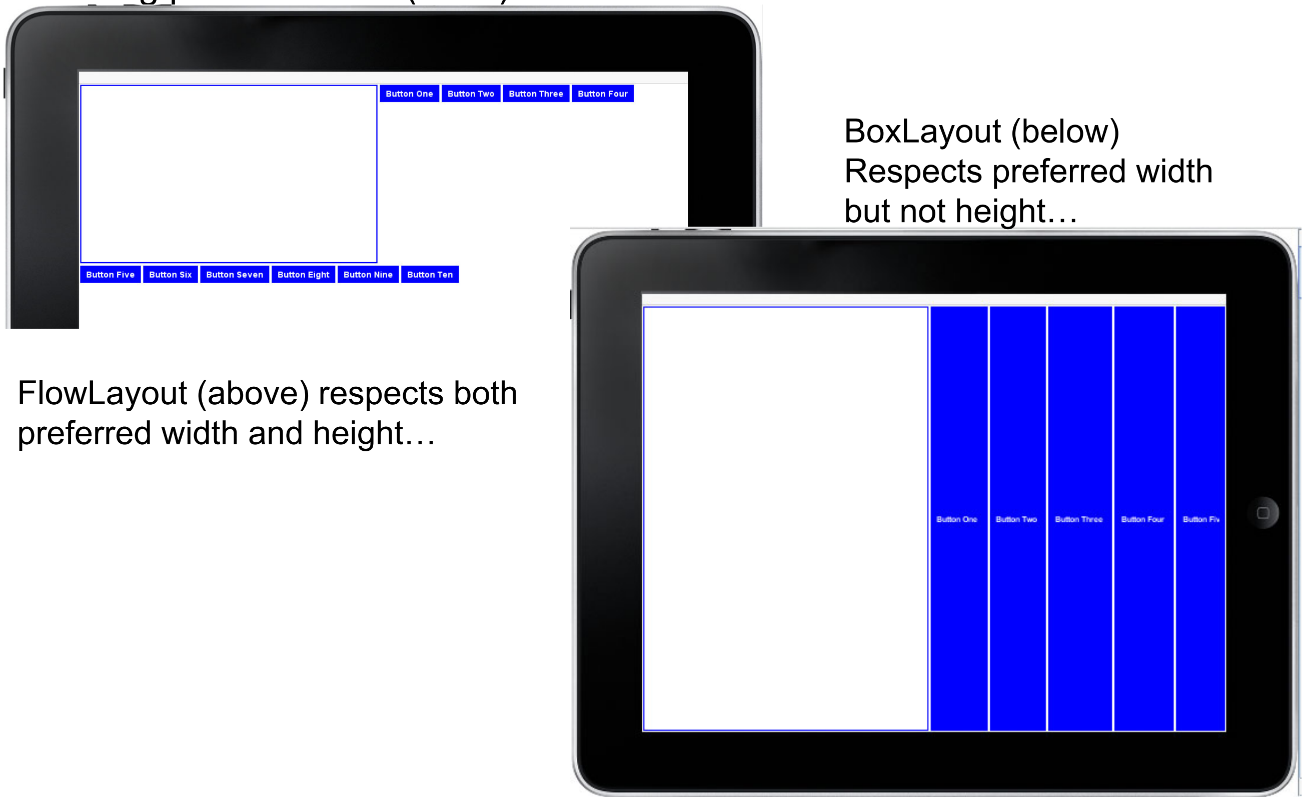
Layout Managers (cont.)

Setting preferred size (do not use this in the assignments, instead use **`setPadding()`** of **`Style`** class to change size of your buttons etc):

```
public class MyComponent extends Component{
@Override
protected Dimension calcPreferredSize(){
  return new Dimension(500, 300);}
public MyComponent() {
  //this is an empty component with a blue border
  this.getAllStyles().setBorder(Border.createLineBorder(2, ColorUtil.BLUE));}
}
-------------------- below is the code for a form with default layout
//using default flow layout, first add a MyComponent
MyComponent myComponent = new MyComponent();
add(myComponent);
//then add several buttons with styles
-------------------- below is the code for a form with box layout
//using X_AXIS box layout
setLayout(new BoxLayout(BoxLayout.X_AXIS));
//add MyComponent as the first item, and then then add several buttons with styles
```

Layout Managers (cont.)

Setting preferred size (cont.):



BoxLayout (below)
Respects preferred width
but not height…

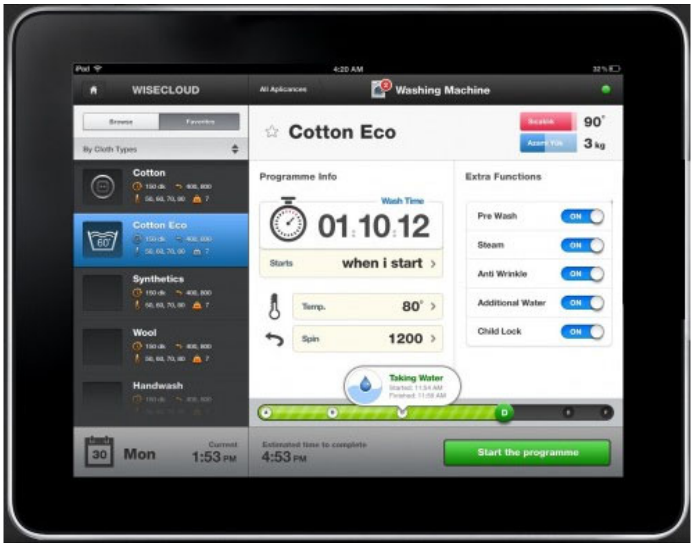
FlowLayout (above) respects both preferred width and height…

Layout Managers (cont.)

- Other Layout Managers
  - `GridLayout`
  - Etc..
- You can change the layout manager of the container in runtime:
  - Example of the *Strategy* Design Pattern

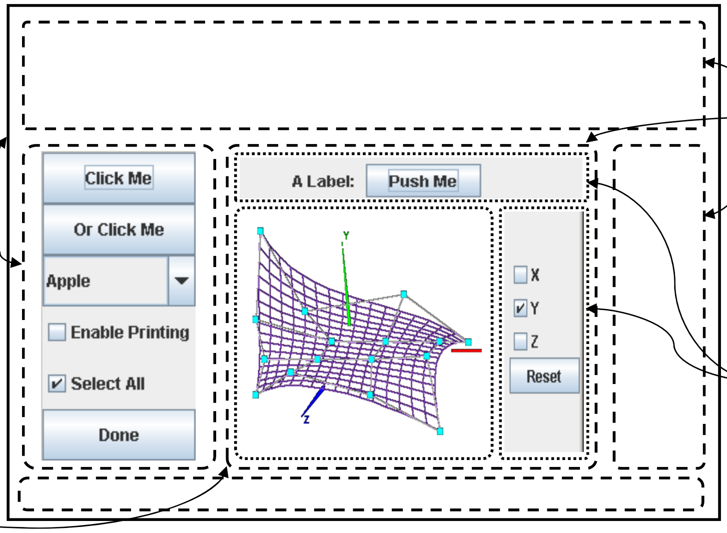
GUI Layout

GUIs usually have multiple “areas”



CN1 Container Class

- `Container` (like `JPanel` in Swing): an *invisible* component that…
  - Can be assigned to an area
  - Can have a layout manager assigned to it
  - Can hold other components (`Container` is-a `Component` and has-a `Component`)



`Form` with <u>`BorderLayout`</u> (`Form` is-a `Container`)

West `Container` with components in <u>`BoxLayout`</u>

Center `Container` with <u>`BorderLayout`</u>

<u>Containers</u> (dashed) in N/S/E/W/C of `Form`

Containers (dotted) in Center `Container`

Container Example

```
/* Code for a form with containers in different layout arrangements */
setLayout(new BorderLayout());
//top Container with the GridLayout positioned on the north
Container topContainer = new Container(new GridLayout(1,2));
topContainer.add(new Label("Read this (t)"));
topContainer.add(new Button("Press Me (t)"));
//Setting the Border Color
topContainer.getAllStyles().setBorder(Border.createLineBorder(4,
                                                    ColorUtil.YELLOW));
add(BorderLayout.NORTH,topContainer);
//left Container with the BoxLayout positioned on the west
Container leftContainer = new Container(new BoxLayout(BoxLayout.Y_AXIS));
//start adding components at a location 50 pixels below the upper border of the container
leftContainer.getAllStyles().setPadding(Component.TOP, 50);
leftContainer.add(new Label("Text (l)"));
leftContainer.add(new Button("Click Me (l)"));
leftContainer.add(new ComboBox("Choice 1","Choice 2","Choice 3"));
leftContainer.add(new CheckBox("Enable Printing (l)"));
leftContainer.getAllStyles().setBorder(Border.createLineBorder(4,
                                                    ColorUtil.BLUE));
add(BorderLayout.WEST,leftContainer);
     ... continued
```

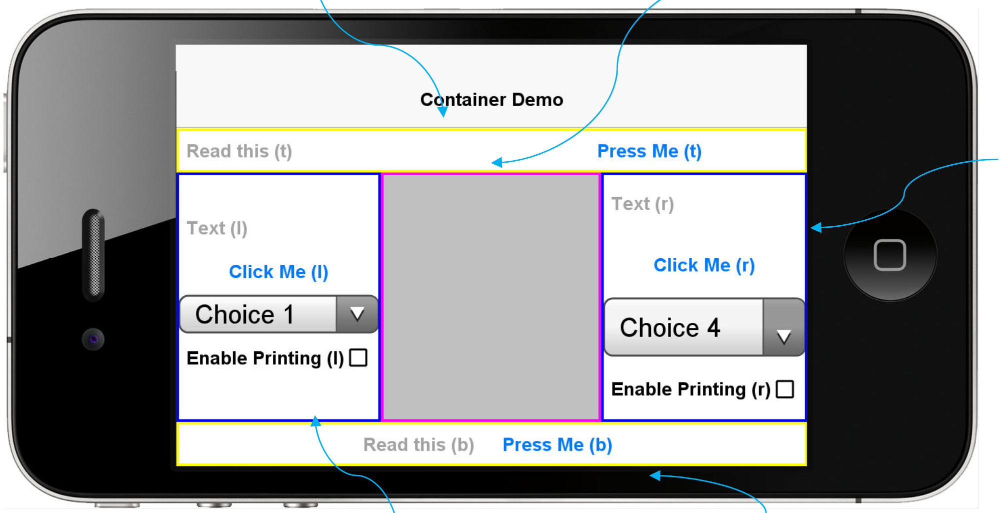
Container Example (cont.)

```
... continued
//right Container with the GridLayout positioned on the east
Container rightContainer = new Container(new GridLayout(4,1));
//...[add similar components that exists on the left container]
add(BorderLayout.EAST,rightContainer);
//add empty container to the center
Container centerContainer = new Container();
//setting the back ground color of center container to light gray
centerContainer.getAllStyles().setBgTransparency(255);
centerContainer.getAllStyles().setBgColor(ColorUtil.LTGRAY);
//setting the border Color
centerContainer.getAllStyles().setBorder(Border.createLineBorder(4,
                                                    ColorUtil.MAGENTA));
add(BorderLayout.CENTER,centerContainer);
//bottom Container with the FlowLayout positioned on the south, components are laid out
//at the center
Container bottomContainer = new Container(new FlowLayout(Component.CENTER));
//...[add similar components that exists on the top container]
add(BorderLayout.SOUTH,bottomContainer);
```

Container Example – Output

`Container` in North with `GridLayout` (space is divided to two equally-sized cells)

Empty `Container` in Center with (with light gray background)



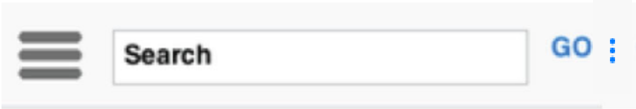
`Container` in East with `GridLayout` (space is divided to four equally-sized cells)

`Container (with padding)` in West with `BoxLayout` (components are positioned 50 pixels below the top border of the container)

`Container (with padding)` in South with `FlowLayout` (components are positioned at the center)

CN1 `Toolbar` class

- Provides deep customization of the title bar area of your form.

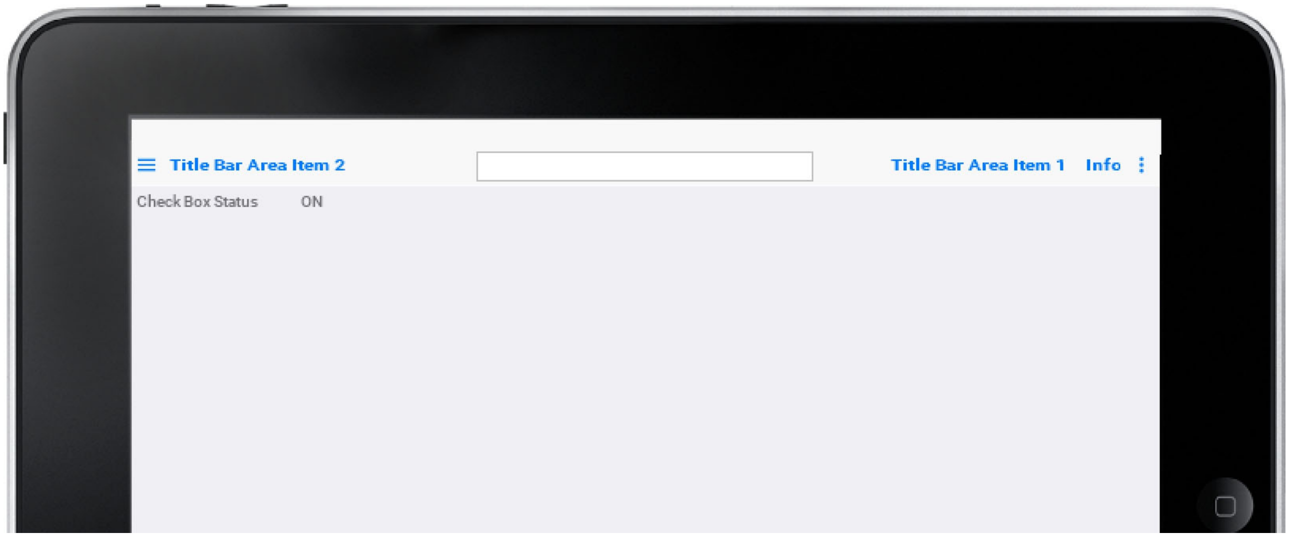


- Set it to your from with: `myForm.setToolbar(toolbar)`
- Allows adding commands to four locations:
  - `addCommandToSideMenu()` (to side menu: ≡)
  - `addCommandToOverflowMenu()` `(to` Android style menu: ⋮)
  - `addCommandToRightBar()` (to right of the title bar area)
  - `addCommandToLeftBar()` (to left of the title bar area)

Adding Items to Title Bar

```
/* Code for a form with a toolbar */
Toolbar myToolbar = new Toolbar();
setToolbar(myToolbar);//make sure to use lower-case "b“, setToolBar() is deprecated
//add a text field to the title
TextField myTF = new TextField();
myToolbar.setTitleComponent(myTF);
//[or you can simply have a text in the title: this.setTitle("Adding Items to Title Bar");]
//add an “empty” item (which does not perform any operation) to side menu
Command sideMenuItem1 = new Command("Side Menu Item 1");
myToolbar.addCommandToSideMenu(sideMenuItem1);
//add an “empty” item to overflow menu
Command overflowMenuItem1 = new Command("Overflow Menu Item 1");
myToolbar.addCommandToOverflowMenu(overflowMenuItem1);
//add an “empty” item to right side of title bar area
Command titleBarAreaItem1 = new Command("Title Bar Area Item 1");
myToolbar.addCommandToRightBar(titleBarAreaItem1);
//add an “empty” item to left side of title bar area
Command titleBarAreaItem2 = new Command("Title Bar Area Item 2");
myToolbar.addCommandToLeftBar(titleBarAreaItem2);
//...[add other side menu, overflow menu, and/or title bar area items]
```

Adding Items to Title Bar (cont.)



Check Box Status ON

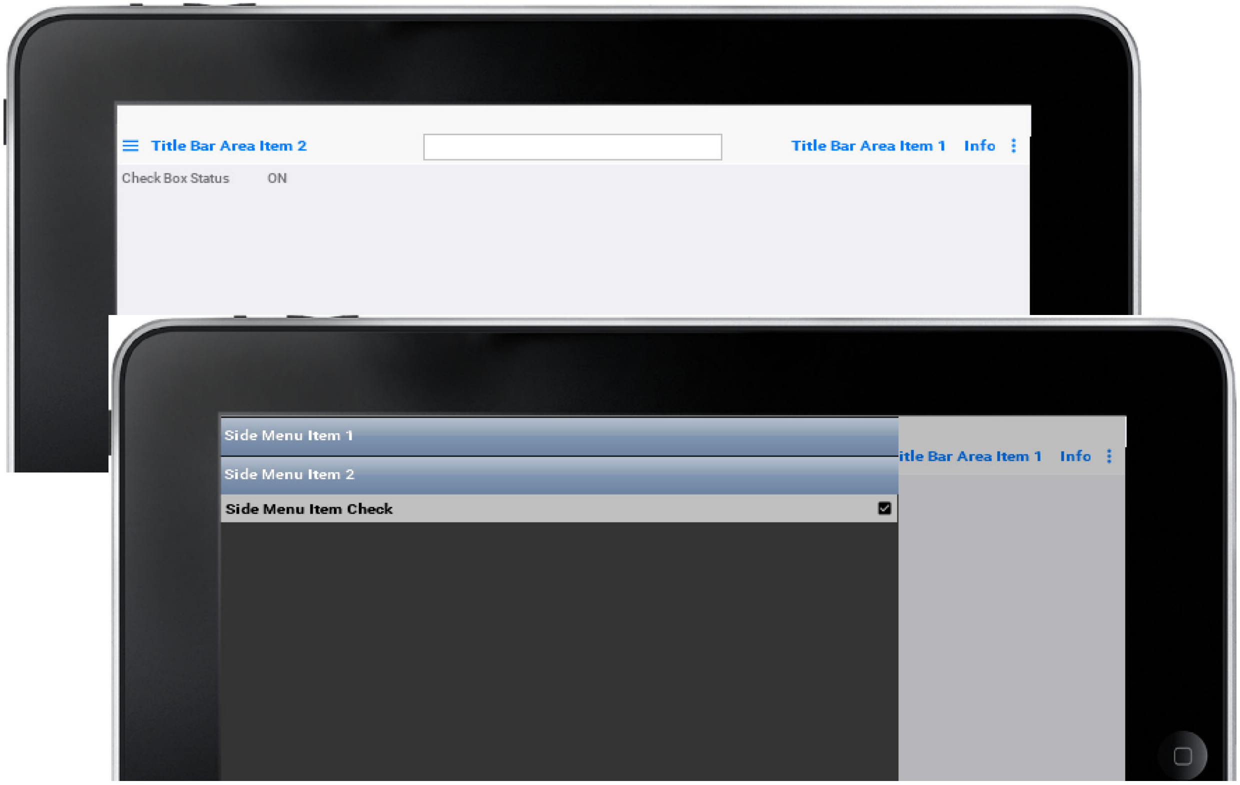
Complex Menus

- Menu items can contain components (like the title area):

```
/* Code for a form which has a CheckBox as a side menu item*/
//add a check box to side menu (which does not perform any operation yet..)
CheckBox checkSideMenuComponent = new CheckBox("Side Menu Item Check");
//set the style of the check box
checkSideMenuComponent.getAllStyles().setBgTransparency(255);
checkSideMenuComponent.getAllStyles().setBgColor(ColorUtil.LTGRAY);
//add the CheckBox component as a side menu item
myToolbar.addComponentToSideMenu(checkSideMenuComponent);
```

- We will later see how to attach operations (set commands) to the components in menus…

Complex Menus (cont.)


Title Bar Area Item 2
Title Bar Area Item 1
Info
Check Box Status
ON
Side Menu Item 1
Side Menu Item 2
Side Menu Item Check ☑
itle Bar Area Item 1
Info