CSc 133 Lecture Notes

10 - Interactive Techniques

Computer Science Department

California State University, Sacramento

Overview

- `Definition`
- `Graphics` Class (and object)
- Component Repainting, `paint()`
- Graphics State Saving
- Onscreen Object Selection

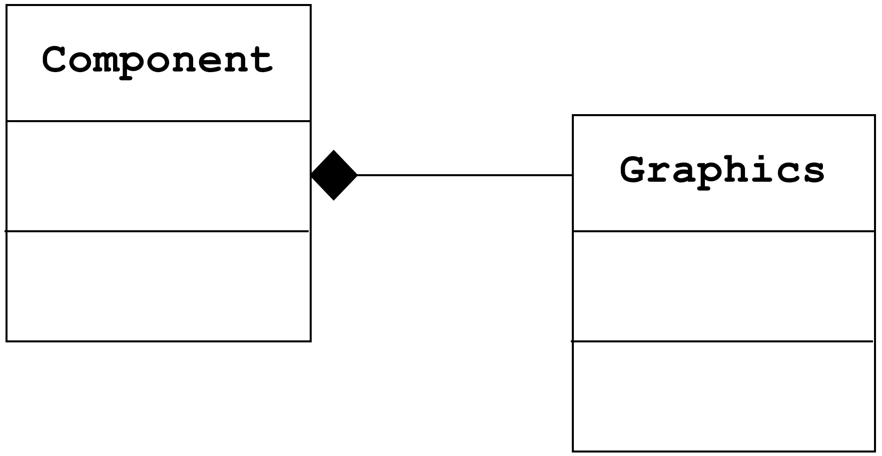
Definition

- **An interaction technique, user interface technique or input technique is a combination of hardware and software elements that provides a way for computer users to accomplish a single task.**

Source: https://en.wikipedia.org/wiki/Interaction_technique

Component Graphics

- Every `Component` contains an object of type `Graphics`



- `Graphics` objects know how to draw on the component

Graphics Class

- **`Graphics`** objects contain methods to draw on their components

  - `drawLine (int x1, int y1, int x2, int y2);`
  - `drawRect (int x, int y, int width, int height);`
  - `fillRect (int x, int y, int width, int height);`
  - `drawArc (int x, int y, int width, int height, int startAngle, int arcAngle);`

    e.g., to draw a filled circle with radius r:

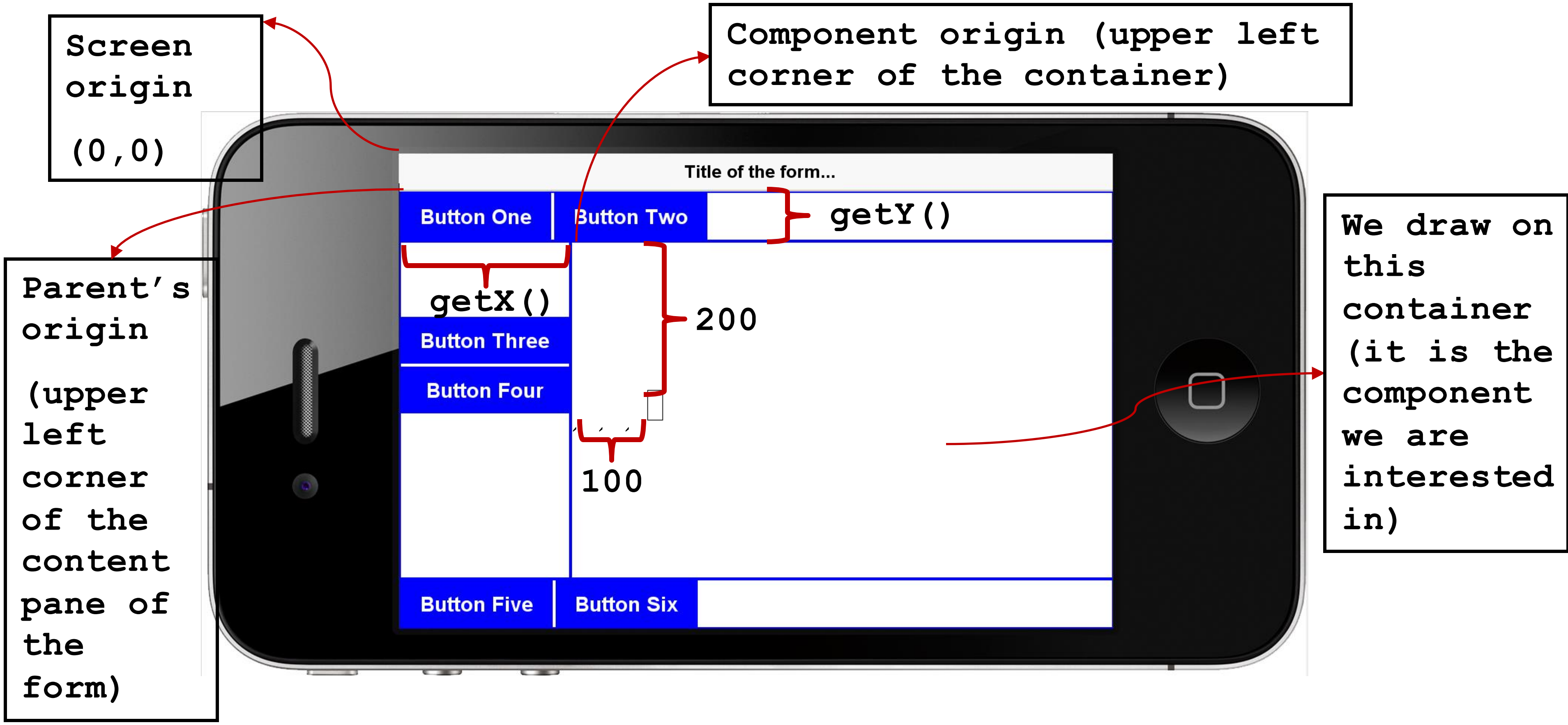
    ```
    fillArc(x, y, 2*r, 2*r, 0, 360);
    ```
  - `drawPolygon(int[] xPoints, int[] yPoints, int nPoints)`

    e.g., you can draw a triangle using the drawPolygon()...
  - `drawString (String str, int x, int y);`
  - `setColor (int RGB);`
  - `. . .`

Drawing Coordinates

- Drawing coordinates (e.g. x/y in **`drawLine()`**) indicate the location of upper left corner of the shape that is being drawn.
- Drawing coordinates are **relative to the component's parent's "origin" (not the component's origin … it's parent's origin)**
- Parent is the container that holds the component. If we add a component (e.g. container) to a form, content pane of the form would be the parent of the component.
- Origin of the parent/component is at its upper left corner.
- **`getX()/getY()`** methods of **`Component`** return the component's origin location relatively to its parent's origin location.

Drawing Coordinates (cont.)


Screen origin
(0,0)
Component origin (upper left corner of the container)
Parent's origin
(upper left corner of the content pane of the form)
We draw on this container (it is the component we are interested in)
Title of the form…
Button One
Button Two
getY()
getX()
200
Button Three
Button Four
100
Button Five
Button Six

So to draw a rectangle at 100 pixels right and 200 pixels down of the origin of the component:

```
drawRect(getX()+100, getY()+200, width, height)
```

Getting a reference to the `Graphics` object

- But how can we get a hold of **`Graphics`** object of a component to call the draw methods on it??
- “Component repainting” mechanism allows us to get a hold of this reference…

Component Repainting

- **Every `Component` has a `repaint()` method**
  - Tells a component to update its screen appearance
  - Called automatically whenever the component needs redrawing
    - e.g., app is opened for the first time, user switched back to the app while multi-tasking among different apps, a method such as **`setBgColor(int RGB)`** is called…
  - Can also be called manually by the application code to force a redraw

Component Repainting (cont.)

- `Component` also contain a method named `paint()`
  - **`repaint()` passes the `Graphics` object to the component's `paint()` method**
  - `paint()` is responsible for the actual drawing (using `Graphics`)
  - Never invoke `paint()` directly; always call `repaint()` since repaint() does other important operations…

Differences between Java and CN1

- Java AWT/Swing component has **`getGraphics()`** method which returns **`Graphics`** object of the component.

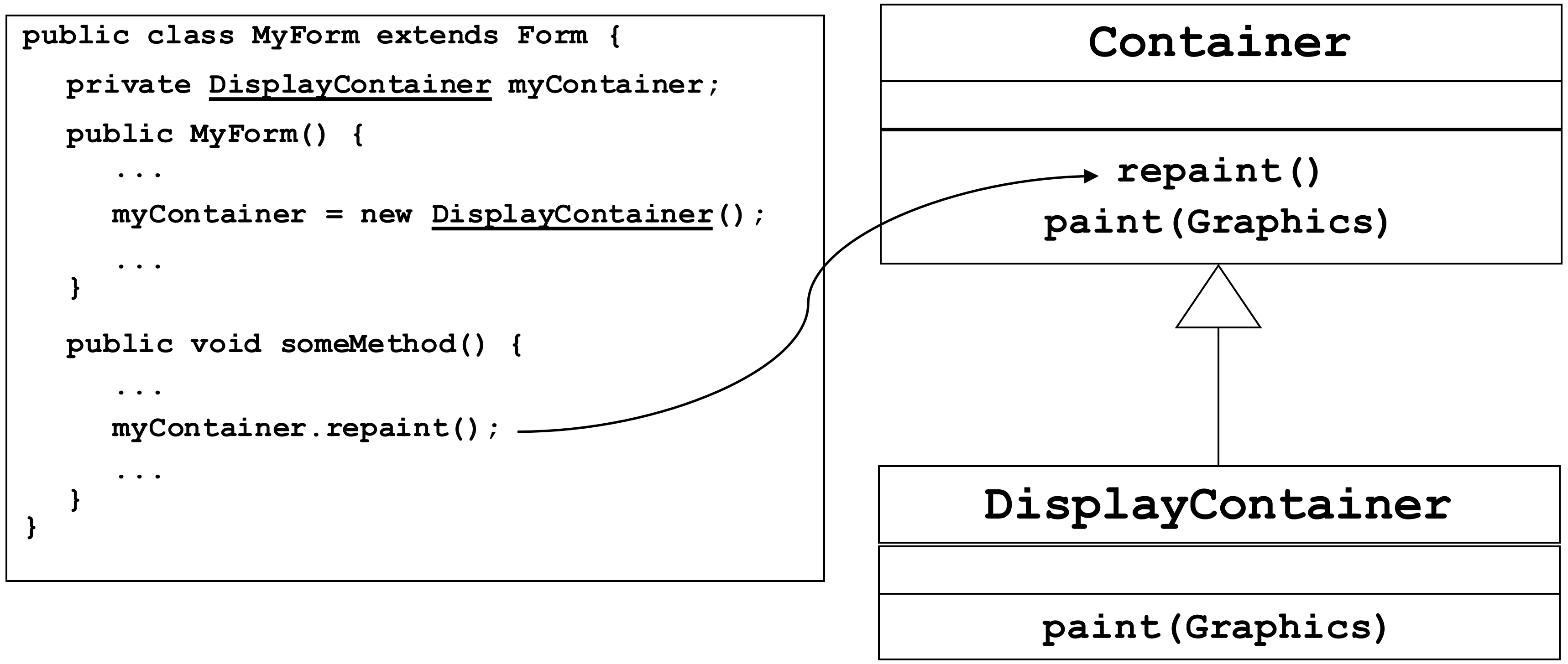
- CN1 UI component does not have this method....

- Only way to get a hold of **`Graphics`** object is through overriding **`paint()`** method.

Overriding `paint()`

- Consider the following organization
  - Which **`paint()`** get invoked?

```
public class MyForm extends Form {
   private DisplayContainer myContainer;
   public MyForm() {
      ...
      myContainer = new DisplayContainer();
      ...
   }
   public void someMethod() {
      ...
      myContainer.repaint();
      ...
   }
}
```



Overriding `paint()`(cont.)

- Always perform the drawing in the overriden **`paint()`** method.
  - Never save the **`Graphics`** object and use it in another method to draw things! If you do so:
    - Drawn things would vanish the next time **`repaint()`** is called …
    - Drawn things would be located in wrong positions…
- The first line of the overriden **`paint()`** method <u>**must**</u> be **`super.paint()!`**
    - default **`paint()`** method performs other important operations necessary for updating component's screen appearance…

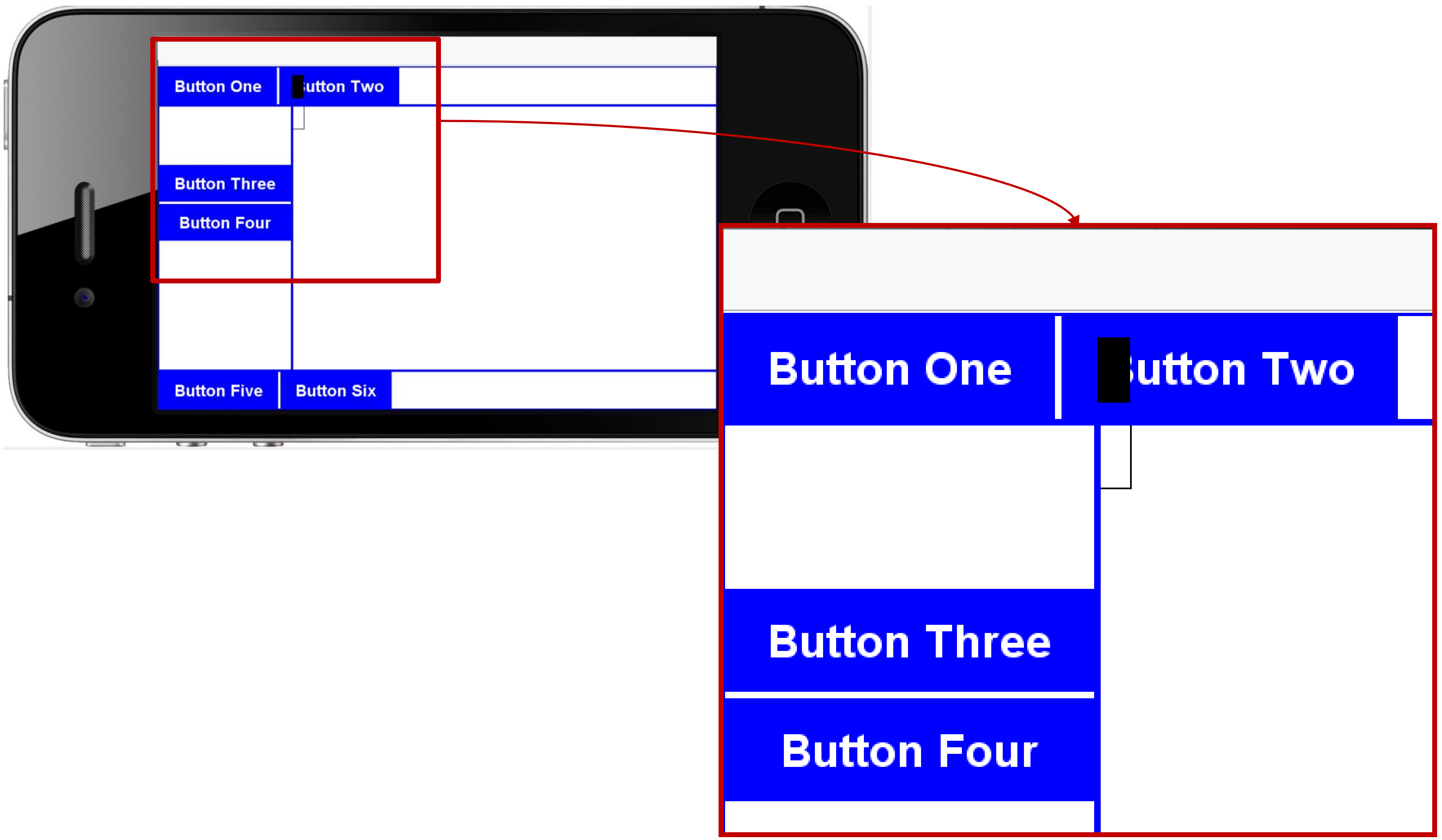
Non-working example

```
public class NonWorkingGraphics extends Form implements ActionListener{
CustomContainer myCustomContainer = new CustomContainer();
 public NonWorkingGraphics() {
  //... [use border layout and add north, east, south containers (each
  //include two styled buttons)]
  buttonOne.addActionListener(this);
  this.add(BorderLayout.CENTER, myCustomContainer);
 }
 public void actionPerformed(ActionEvent evt) {
  myCustomContainer.drawObj();
 }
}
```

Non-working example (cont.)

```
public class CustomContainer extends Container{
 private Graphics myGraphics;
 public void paint(Graphics g){
  myGraphics = g;
  super.paint(g);
  myGraphics.setColor(ColorUtil.BLACK);
  //empty rectangle appears in the CORRECT place (at the origin of this)
  myGraphics.drawRect(getX(), getY(), 20, 40);
 }
 public void drawObj(){
  repaint();
  myGraphics.setColor(ColorUtil.BLACK);
  //filled rectangle appears in the WRONG place and disappears next time
  //repaint() is called
  myGraphics.fillRect(getX(), getY(), 20, 40);
 }
}
```

Non-working example (cont.)



Importance of getX()/getY()

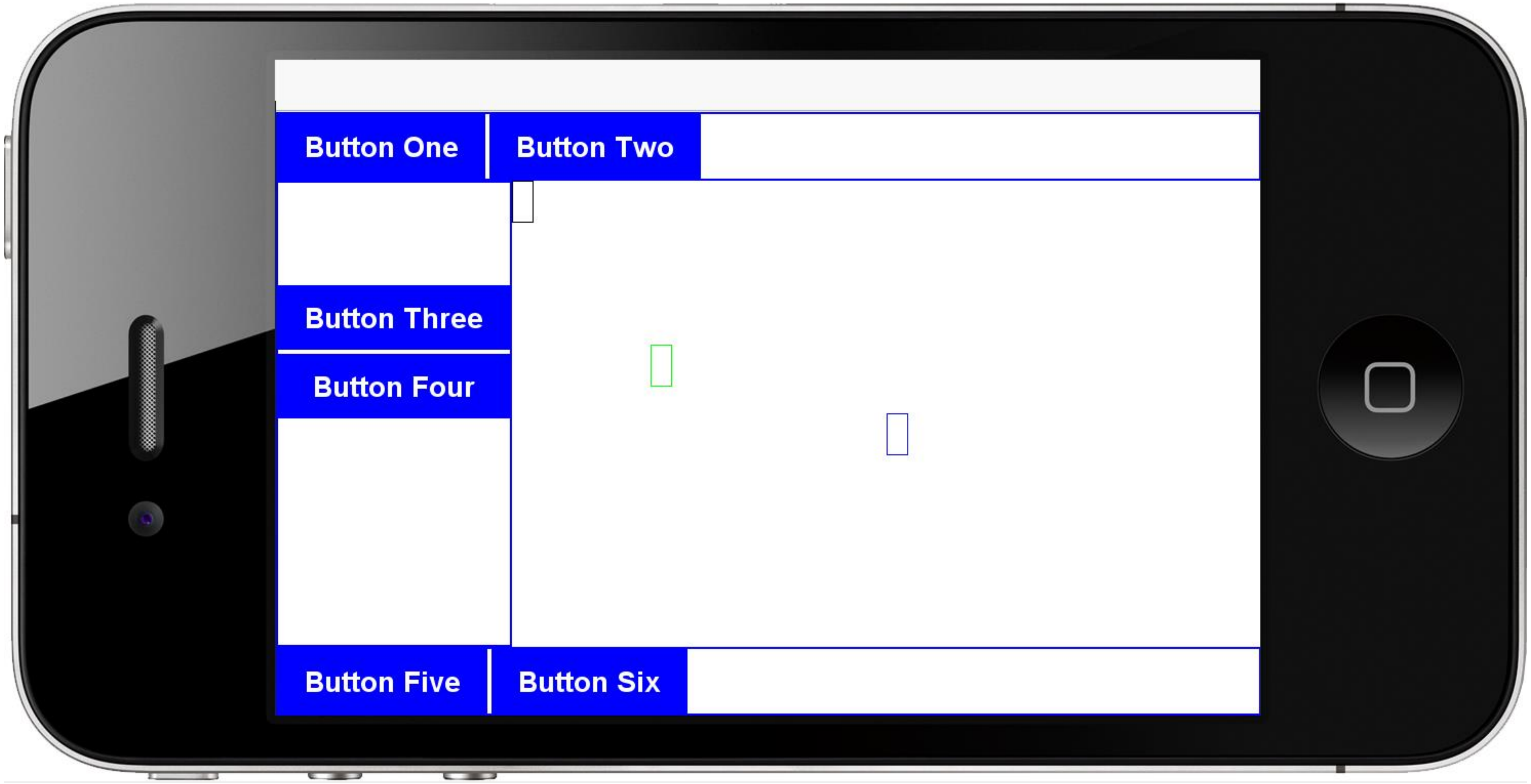
Assume we would like to draw a rectangle in the middle of **`CustomContainer`**.

If we have the following **`paint()`** method:

```
public void paint(Graphics g){
 super.paint(g);
 int w = getWidth();
 int h = getHeight();
 g.setColor(ColorUtil.BLACK);
 g.drawRect(getX(), getY(), 20, 40);
 g.setColor(ColorUtil.GREEN);
 g.drawRect(w/2, h/2, 20, 40);
 g.setColor(ColorUtil.BLUE);
 g.drawRect(getX()+w/2, getY()+h/2, 20, 40);
}
```

Importance of getX()/getY() (cont.)

Only the blue rectangle would appear in the center of the `CustomContainer`…



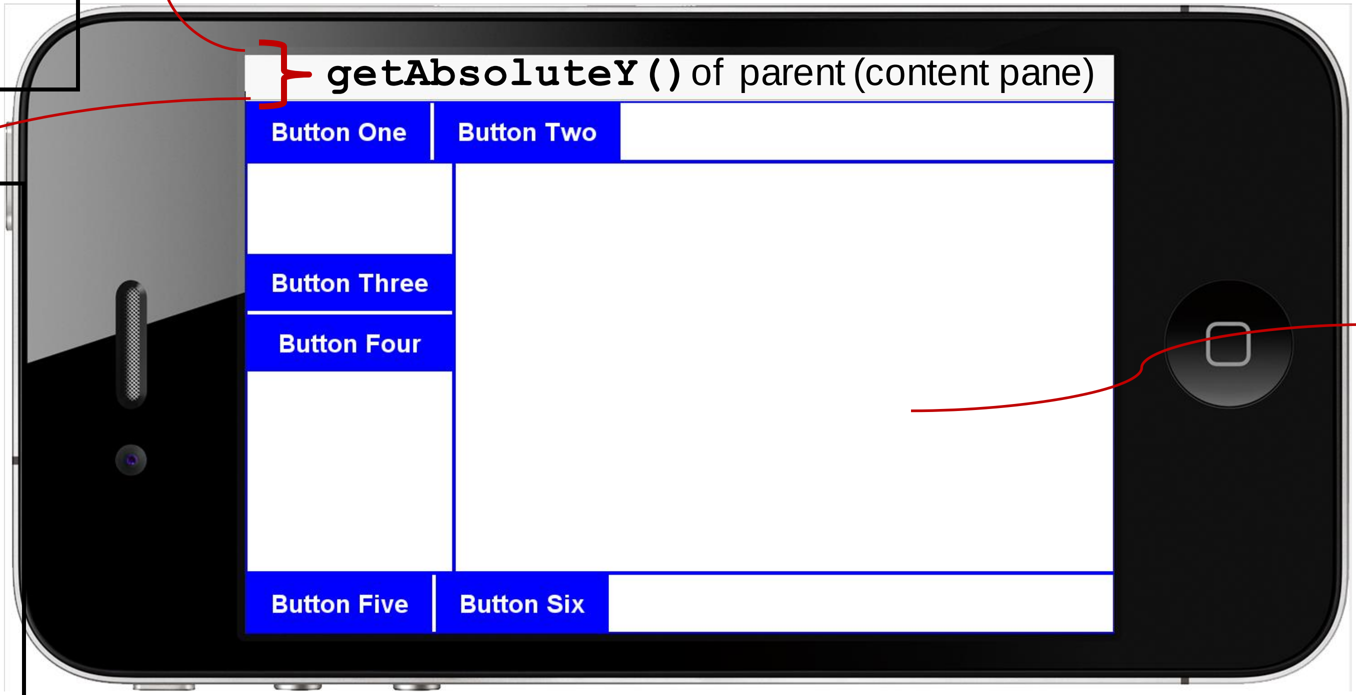
Pointer Graphics

- We would like to draw a rectangle where ever the user presses on the **`CustomContainer`**.
- Pointer pressed gets coordinates relative to the screen origin (upper left corner of the screen).
- However draw methods expects coordinates relative to the component's parent's origin.
- You can convert screen coordinate to parent coordinate using **`getAbsoluteX() and getAbsoluteY()`** methods of the parent container.
- You can get the parent using **`getParent()`** method of the component.

Pointer Graphics (cont.)

Screen origin

(0,0)



Parent's origin

(upper left corner of the content pane of the form)

We draw on this container (it is the component we are interested in)

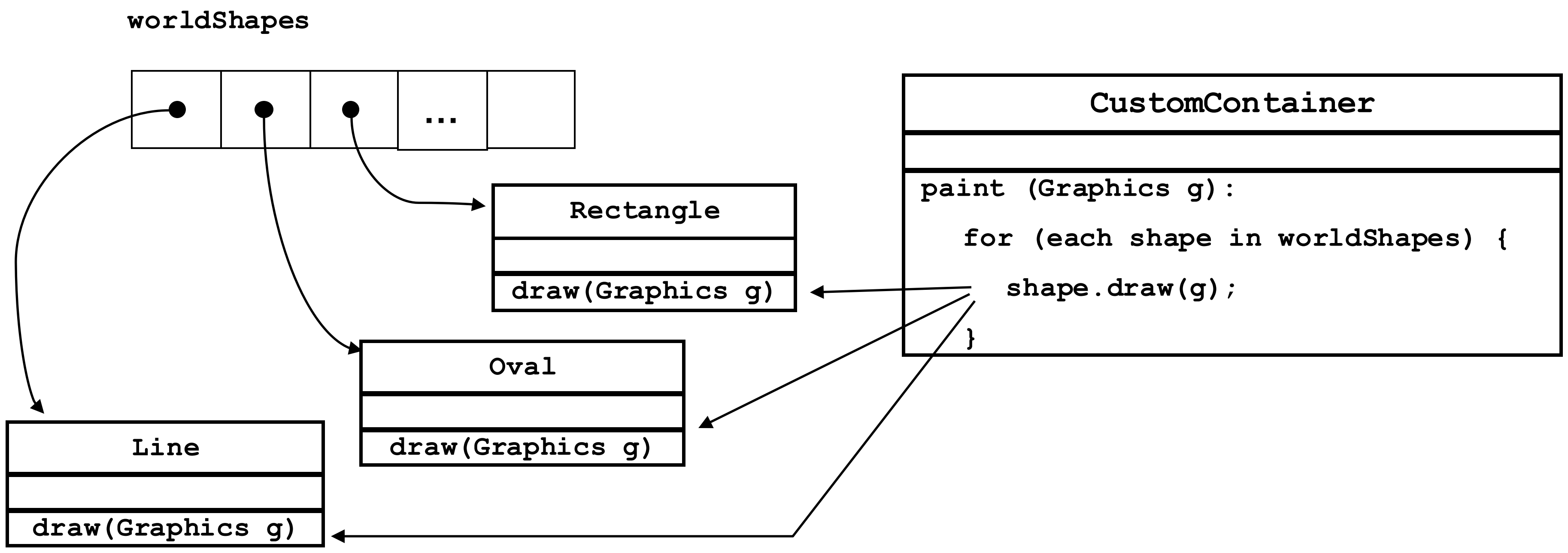
getAbsoluteX() of parent (content pane) is 0 in this example…

Pointer Graphics Example

```
public class CustomContainer extends Container{

  private int iPx = 0;
  private int iPy = 0;

  @Override
  public void paint(Graphics g){
    super.paint(g);
    g.setColor(ColorUtil.BLACK);
    //make the point location relative to the component's parent's origin
    //and then draw the rectangle (below un-filled rect would appear in the CORRECT location)
    g.drawRect(iPx-getParent().getAbsoluteX(),iPy-getParent().getAbsoluteY(),20,40);
    //below filled rect would appear in the WRONG location
    g.fillRect(iPx,iPy, 20,40);
  }

  @Override
  public void pointerPressed(int x,int y){
    //save the pointer pressed location
    //it is relative the to the screen origin
    iPx = x;
    iPy = y;
    repaint();
  }
}
```

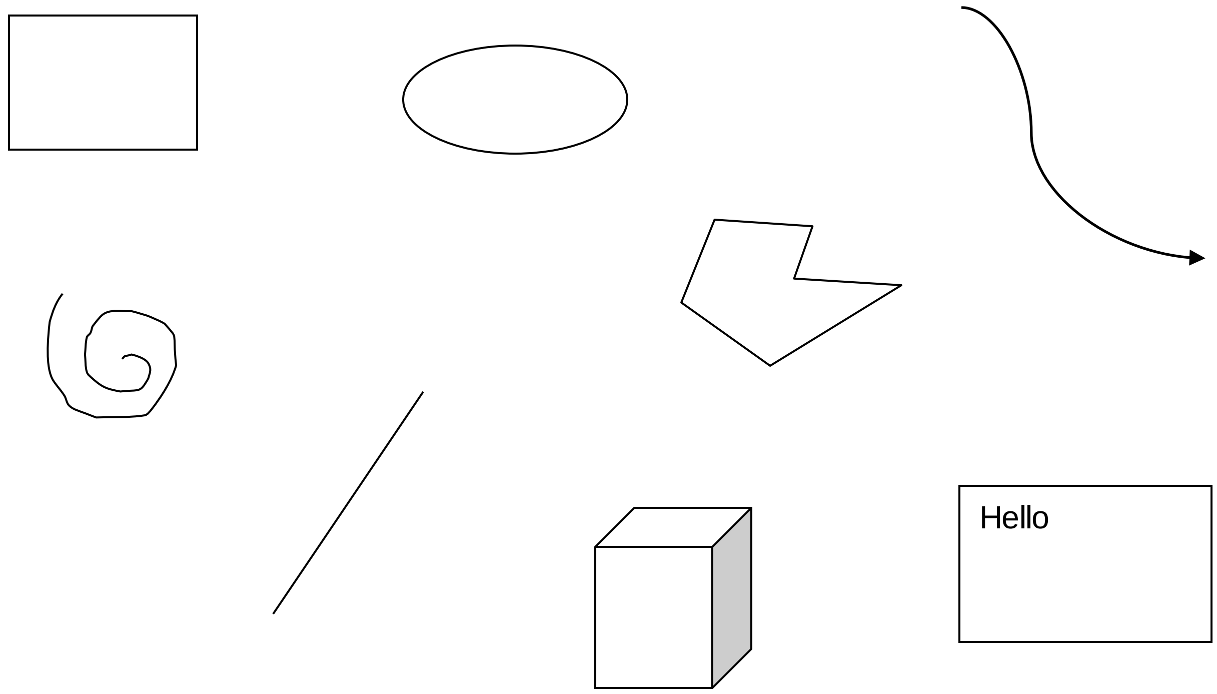
Maintaining Graphical State

- Must assume ***repaint()*** will be invoked
  - Must *keep track of objects you want displayed*
  - Redisplay them in paint().



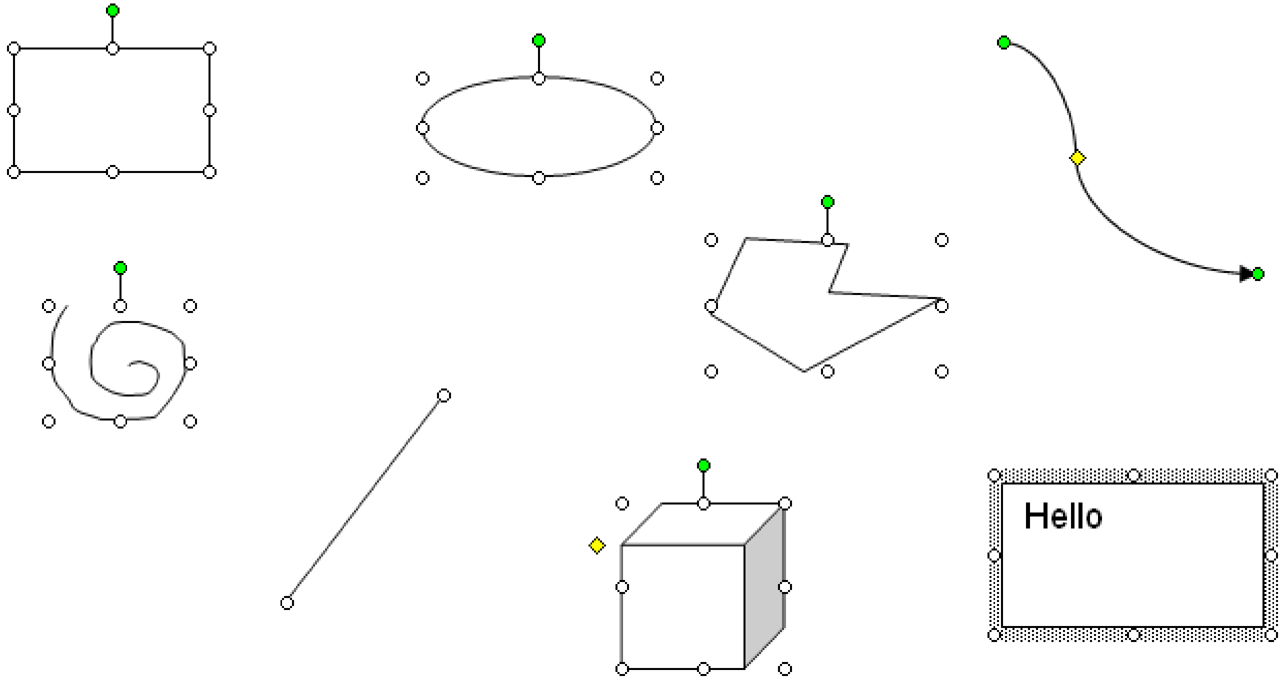
Object Selection

- Various *unselected* objects:



Object Selection (cont.)

- *Selected* versions of the same objects:

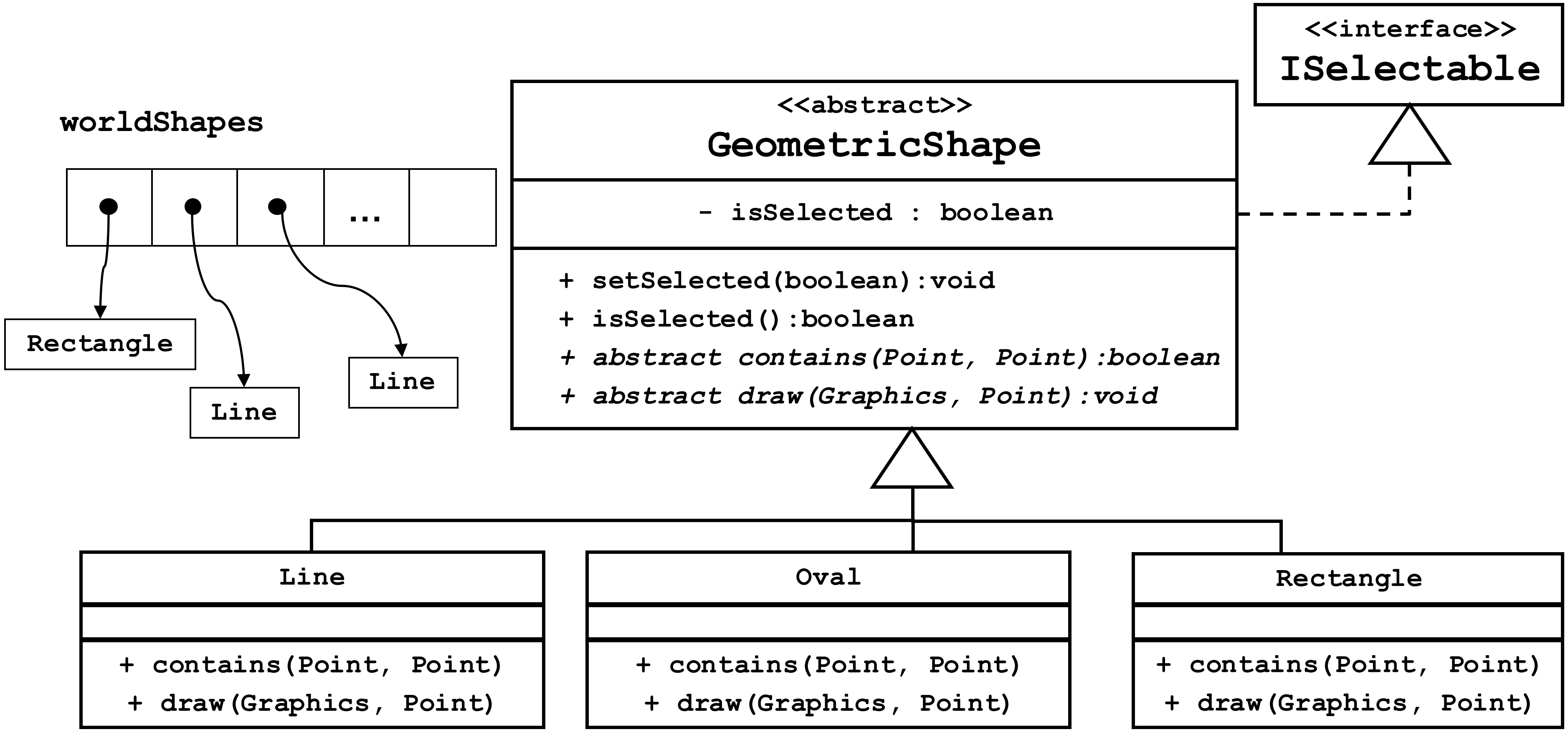


Defining "Selectability"

```
/** This interface defines the services (methods) provided
 *  by an object which is "Selectable" on the screen
 */
public interface ISelectable {

 // a way to mark an object as "selected" or not
 public void setSelected(boolean yesNo);

 // a way to test whether an object is selected
 public boolean isSelected();
 // a way to determine if a pointer is "in" an object
 // pPtrRelPrnt is pointer position relative to the parent origin
 // pCmpRelPrnt is the component position relative to the parent origin
 public boolean contains(Point pPtrRelPrnt, Point pCmpRelPrnt);

 // a way to "draw" the object that knows about drawing
 // different ways depending on "isSelected"
 public void draw(Graphics g, Point pCmpRelPrnt);
}
```

Implementing Object Selection

(1) Expand objects to support selection



Implementing Object Selection (cont.)

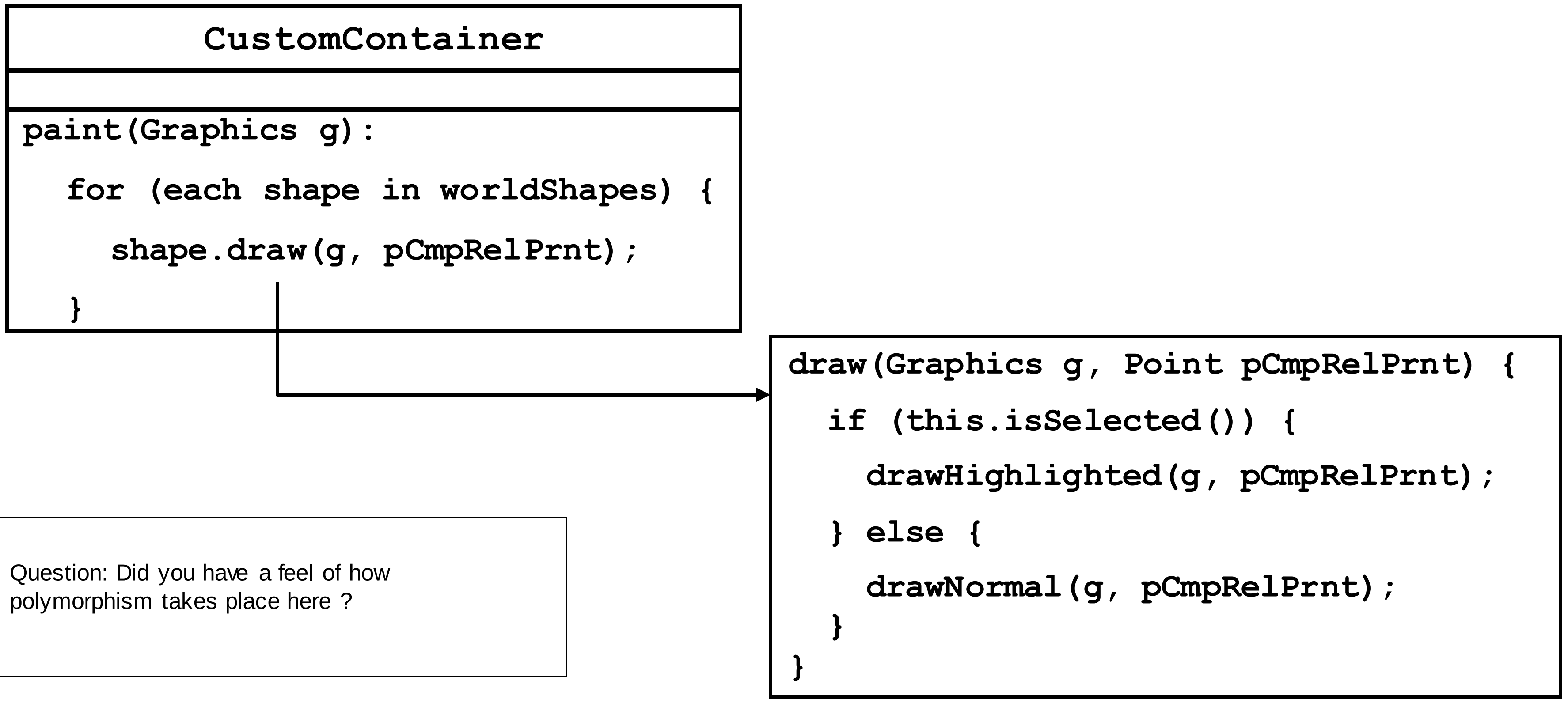
(2) On pointer pressed:

- Determine if pointer is "inside" any shape
  - if shape contains pointer, mark as "selected"
- Repaint container

```
//overriding pointerPressed() in CustomContainer
import com.codename1.ui.geom.Point;
void pointerPressed(int x, int y) {
//make pointer location relative to parent's origin
  x = x - getParent().getAbsoluteX();
  y = y - getParent().getAbsoluteY();
  Point pPtrRelPrnt = new Point(x, y);
  Point pCmpRelPrnt = new Point(getX(), getY());
  for (each shape in worldShapes) {
    if (shape.contains(pPtrRelPrnt, pCmpRelPrnt)) {
      shape.setSelected(true);
    } else {
      shape.setSelected(false);
    }
  }
  repaint();
}
```

Implementing Object Selection (cont.)

(3) Draw “selected” objects in different form



```
CustomContainer

paint(Graphics g):
  for (each shape in worldShapes) {
    shape.draw(g, pCmpRelPrnt);
  }
```

```
draw(Graphics g, Point pCmpRelPrnt) {
  if (this.isSelected()) {
    drawHighlighted(g, pCmpRelPrnt);
  } else {
    drawNormal(g, pCmpRelPrnt);
  }
}
```

Question: Did you have a feel of how polymorphism takes place here ?

Object Selection Example

```
abstract public class GeometricShape implements ISelectable {
  private boolean isSelected;
  public void setSelected(boolean yesNo) { isSelected = yesNo; }
  public boolean isSelected() { return isSelected; }
  abstract void draw(Graphics g, Point pCmpRelPrnt);
  abstract boolean contains(Point pPtrRelPrnt, Point pCmpRelPrnt);
}
```

```
public class MyRect extends GeometricShape {
  //...[assign iShapeX and iShapeY to rect coordinates (upper left corner of rect
  //which is relative to the origin of the component) supplied in the constructor]
  public boolean contains(Point pPtrRelPrnt, Point pCmpRelPrnt) {
    int px = pPtrRelPrnt.getX(); // pointer location relative to
    int py = pPtrRelPrnt.getY(); // parent's origin
    int xLoc = pCmpRelPrnt.getX()+ iShapeX;// shape location relative
    int yLoc = pCmpRelPrnt.getY()+ iShapeY;// to parent's origin
    if ( (px >= xLoc) && (px <= xLoc+width)
      && (py >= yLoc) && (py <= yLoc+height) )
      return true; else return false;}
  public void draw(Graphics g, Point pCmpRelPrnt) {
    int xLoc = pCmpRelPrnt.getX()+ iShapeX;// shape location relative
    int yLoc = pCmpRelPrnt.getY()+ iShapeY;// to parent's origin
    if(isSelected())
      g.fillRect(xLoc, yLoc, width, height);
    else
      g.drawRect(xLoc, yLoc, width, height);}
}
```

Where is iShapeX & iShapeY define?
How the values get here?

Object Selection Example

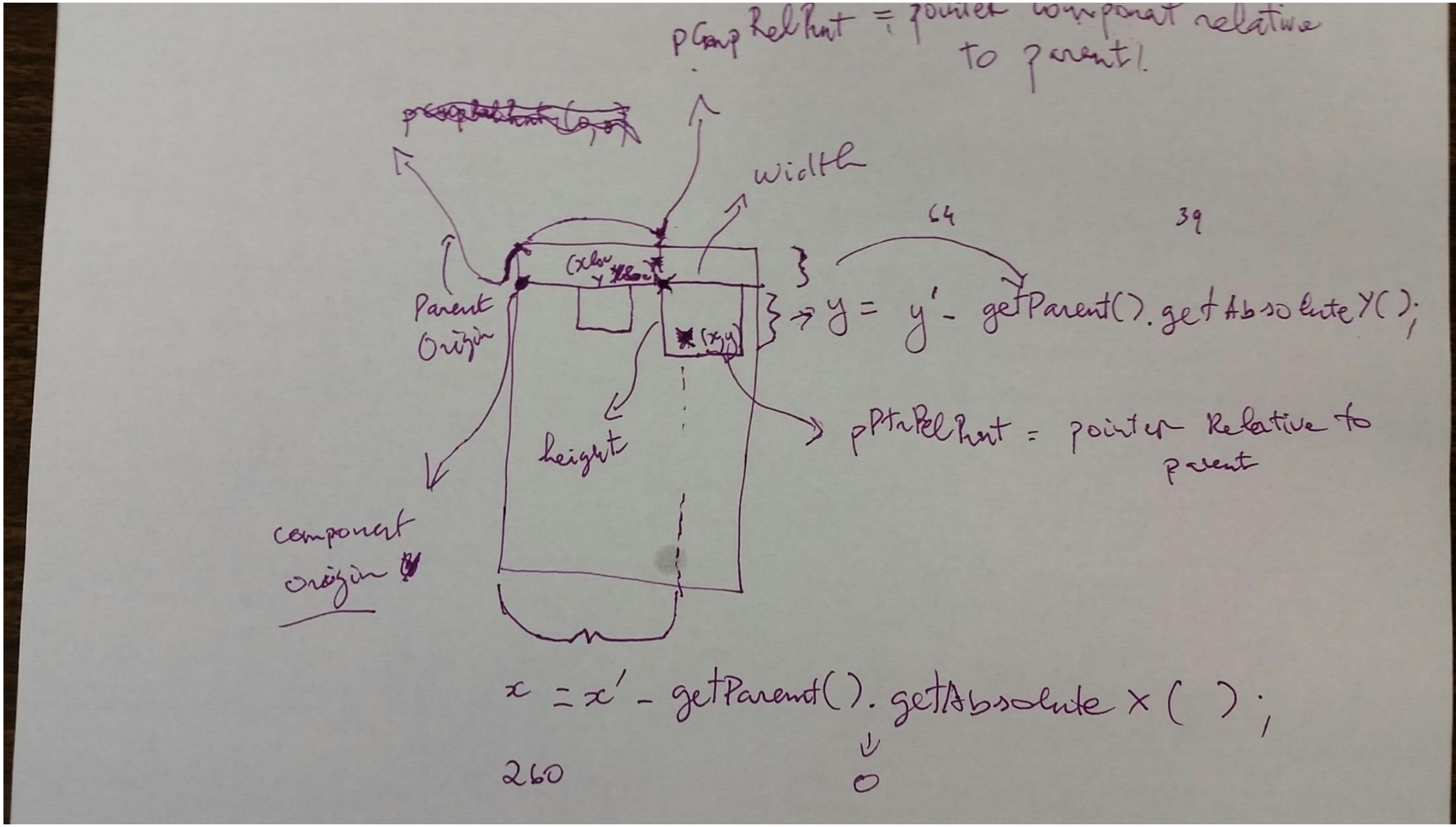
```
abstract public class GeometricShape implements ISelectable {
  private boolean isSelected;
  public void setSelected(boolean yesNo) { isSelected = yesNo; }
  public boolean isSelected() { return isSelected; }
  abstract void draw(Graphics g, Point pCmpRelPrnt);
  abstract boolean contains(Point pPtrRelPrnt, Point pCmpRelPrnt);
}
```

```
public class MyRect extends GeometricShape {
  //...[assign iShapeX and iShapeY to rect coordinates (upper left corner of rect
  //which is relative to the origin of the component) supplied in the constructor]
  public boolean contains(Point pPtrRelPrnt, Point pCmpRelPrnt) {
    int px = pPtrRelPrnt.getX(); // pointer location relative to
    int py = pPtrRelPrnt.getY(); // parent's origin
    int xLoc = pCmpRelPrnt.getX()+ iShapeX;// shape location relative
    int yLoc = pCmpRelPrnt.getY()+ iShapeY;// to parent's origin
    if ( (px >= xLoc) && (px <= xLoc+width)
      && (py >= yLoc) && (py <= yLoc+height) )
      return true; else return false;}
  public void draw(Graphics g, Point pCmpRelPrnt) {
    int xLoc = pCmpRelPrnt.getX()+ iShapeX;// shape location relative
    int yLoc = pCmpRelPrnt.getY()+ iShapeY;// to parent's origin
    if(isSelected())
      g.fillRect(xLoc, yLoc, width, height);
    else
      g.drawRect(xLoc, yLoc, width, height);}
}
```

```
public class ObjectSelectionForm extends Form {
  private Vector<GeometricShape> worldShapes = new Vector<GeometricShape>();
  public ObjectSelectionFrame() {
  // ...code here to initialize the form with a CustomContainer...
  //specify rect coordinates (relative to the origin of component), size, and color
    worldShapes.addElement(new MyRect(100, 100, 50, 50, ColorUtil.BLACK));
    worldShapes.addElement(new MyRect(200, 200, 100, 100, ColorUtil.GREEN));}
}
```

```
public class CustomContainer extends Container {
  //…assume we pass worldShapes to the constructor of CustomContainer
  public void paint(Graphics g) {
        super.paint(g);
        Point pCmpRelPrnt = new Point(getX(), getY());
        for(int i=0; i<worldShapes.size();i++)
            worldShapes.elementAt(i).draw(g, pCmpRelPrnt);}
  public void pointerPressed(int x, int y) {
        x = x - getParent().getAbsoluteX();
        y = y - getParent().getAbsoluteY();
        Point pPtrRelPrnt = new Point(x, y);
        Point pCmpRelPrnt = new Point(getX(), getY());
        for(int i=0;i<worldShapes.size();i++) {
          if(worldShapes.elementAt(i).contains(pPtrRelPrnt, pCmpRelPrnt))
            worldShapes.elementAt(i).setSelected(true);
          else
            worldShapes.elementAt(i).setSelected(false);
        }
        repaint(); }
}
```

Backup Slide


pCmpRelPnt = pointer component relative to parent.
width
64
39
(xloc, yloc)
(x,y)
y = y' - getParent().getAbsoluteY();
Parent Origin
height
pPtrRelPnt = pointer Relative to parent
component origin
x = x' - getParent().getAbsoluteX();
260
0

Exam Preparation

- Review the study guides by subjects:
  - Work with a few friends – quiz one another
  - Review slides based study guide materials + what have been emphasized in lecture

- Review lab 1 and lab 2 – Make sure you understand the context, design ideas, and their implementations. Connect the ideas back to the lecture materials.

- Practice the sample questions – Understanding the concepts – as supposed to memorization.

Exam Problems

- Multiple choices/short questions/answers (covered from beginning to March 9)
- Conceptual question (scenario based) – provide specific example
- CN1/Java coding problem
- Design Problem – Very small scale – Problem solving type