03 Object Composition

Keyboard/Mouse Input

Mouse variables – Processing maintains the several useful global variables for tracking mouse position and the state of the mouse's buttons: `mouseX`, `mouseY`, `mousePressed`, `pmouseX`, `pmouseY`, etc. For example.

```
// Draw a line if the left mouse button is pressed
if (mousePressed && (mouseButton == LEFT))
    line(pmouseX, pmouseY, mouseX, mouseY);
```

Mouse events – Special functions can be defined that are called if the mouse is clicked, moved or dragged, e.g.:

```
void mousePressed() {
   println("mouse pressed");
}
```

Keyboard variables/events – Global variables and functions such as `keyDown` and `keyPressed()` can allow keyboard input to be managed:

```
void keyPressed() {
   println("a key was pressed, code "+keyCode);
}
```

Designing UI Controls

Control design – controls such as buttons, lists and textboxes are perfect examples of objects. They have fields – e.g. state of the button (pressed/not pressed), contents of the textbox – and methods – e.g. click, type a character.

	Button	Textbox
Sample Fields	text position size textColor	text position size focused textColor selected
Sample Methods	draw clickStart clickEnd	draw keyTyped

Object interaction – when designing classes its important to know how they will interact with the rest of the program. For example, buttons need to know when the user starts and ends a click so that the button can adjust its state accordingly. Conversely the rest of program needs to know when the button was successfully clicked so that things can happen, e.g. clicking a "Start" button begins a game.

Here is a sketch of a Button class:

```
class Button {

   // Properties
   public final int STATE_NORMAL=0, STATE_CLICKED=1;
   private int state;

   // Constructor
   public Button(float x, float y, float w, float h) {
      /*  … code… */
   }

   // Methods
   public void draw(){
      /*  … code… */
   }

   public void clickStart(float x, float y) {
      /*  … code… */
   }

   public void clickEnd(float x, float y) {
      /*  … code… */
   }
}
```

State field – can be in one of two states, `STATE_NORMAL` or `STATE_CLICKED`. The button gets informed about click events from the main program and updates itself whenever `clickStart()` and `clickEnd()` are called. The state properties also determines what the `draw()` method draws.

Helper methods – these are *private* methods. They are not used outside of the class. A useful helper method for this class is to determine if an arbitrary point (*x,y*) lies inside the rectangle of the button:

```
class Button {
/* … code… */

  private boolean pointInRegion(float x, float y) {
    return x>=position.x-size.x/2
           && x<=position.x+size.x/2
           && y>=position.y-size.y/2
           && y<=position.y+size.y/2;
  }

/* … code… */
}
```

We can then use a helper method to determine when to change the state of the button to STATE_CLICKED:

```
class Button {
/* … code… */

  public void clickStart(float x, float y) {
    if (pointInRegion(x, y))
      state=STATE_CLICKED;
  }

/* … code… */
}
```

The `clickEnd()` method then communicates back to the main program when a click is completed, and resets the state to normal:

```
class Button {
/* … code… */

  public void clickEnd(float x, float y) {
    if (state==STATE_CLICKED)
      exampleButtonClicked();  // Main program function
    state=STATE_NORMAL;
  }

/* … code… */
}
```

The main program must be then setup to (i) create the button object, (ii) send click messages at the right time, (iii) draw the button, and (iv) receive notifications when the button was clicked:

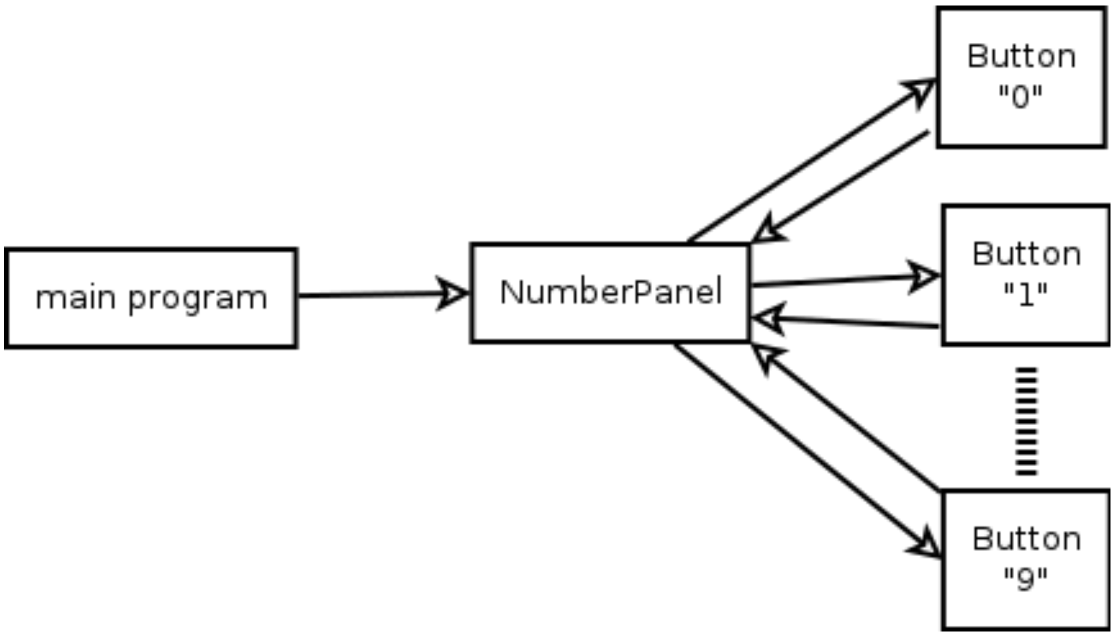
```
Button exampleButton;

void setup(){
   exampleButton = new Button(…);
}
void draw(){
   exampleButton.draw();
}
void mousePressed(){
   exampleButton.clickStart(mouseX, mouseY);
}
void mouseReleased(){
   exampleButton.clickEnd(mouseX, mouseY);
}
void exampleButtonClicked() {
   println("example button clicked");
}
```

Object Composition

Object Composition – a common design technique in which many simple objects are contained inside or compose one larger object. For example, a body composed of smaller parts: arms, legs, head, torso, organs etc, all which are connected to each other and interact in different ways. A body may also be though of as a single complex object.

For example, a PIN number panel is composed of 10 buttons (0-9 inclusive). Each button is an individual object. Each button should respond to clicks, but in a slightly different way.

Object interaction – is slightly more complex now, as the constituent objects communicate back to their containing object, not the main program. This makes the main program appear to be very simple.



`this` keyword – is a special keyword that can be used inside an object and always evaluates to the current object. For example to set the properties and call methods of whatever object is executing now:

```
this.text=”something”;
this.draw();
```

Number panel design – main public field is the PIN so far, but hidden inside the object are the buttons. Calls to draw and click events pass straight through to the buttons. The buttons talk back to the panel when they are pressed.

Setting up the two-way communication – this can be achieved by using object reference fields inside the classes, e.g.:

```
class NumberPanel {

    private ArrayList<Button> buttons;
}


class Button {

    public NumberPanel panel;

}
```

Next, the objects themselves must be created and linked together. In this example, the linking is done inside the constructor of the number panel:

```
class NumberPanel {

   private ArrayList<Button> buttons;

   public NumberPanel() {
      buttons = new ArrayList<Button>();
      float size = width/3;
      for (int index=0; index<10; index++) {
        // Determine x,y position of the button
        float x=(index%3)*size+size/2;
        float y=(index/3)*size+size/2;
        // Create the button
        Button button = new Button(x, y, size, size);
        button.text=""+index;
        button.panel=this;       // Button to panel
        // Add the button to the collection
        buttons.add(button);     // Panel to buttons
      }
  }
}
```

Panel to button communication – access the buttons from the array list, e.g.

```
for (Button button: buttons)
    button.draw();
```

Button to panel communication – call a method on the panel, passing `this` as a parameter so that the panel knows which button was clicked, e.g.

```
if (state==STATE_CLICKED)
   if (panel!=null)
      panel.buttonClicked(this);
```

This requires a special method to be set up on the panel:

```
public void buttonClicked(Button whichOne) {
    text+=whichOne.text;
    if (text.length()>4)
      text=text.substring(text.length()-4);
  }
```