Fields: scope, visibility, encapsulation

- Fields are accessible to all code in all the (ordinary) methods in the class.
- Should they be accessible to methods in other classes?
  - ⇒ **visibility**: public or private
  - public means that methods in other classes can access the fields

    cfg1.figX = 30   in the CartoonStory class would be OK
  - private means that methods in other classes **cannot** access the fields

    cfg1.figX = 30   in the CartoonStory class would be an error.

The principle of encapsulation says

- Keep fields private.
- Provide methods to access and modify the fields, if necessary

Final: fields that don't vary

- If a place will hold a value that should not change (a "constant"):
  - signal it to reader
  - ensure that no code changes it by mistake
- final is a modifier on field or variable declarations
  - means that it can only be assigned to once.

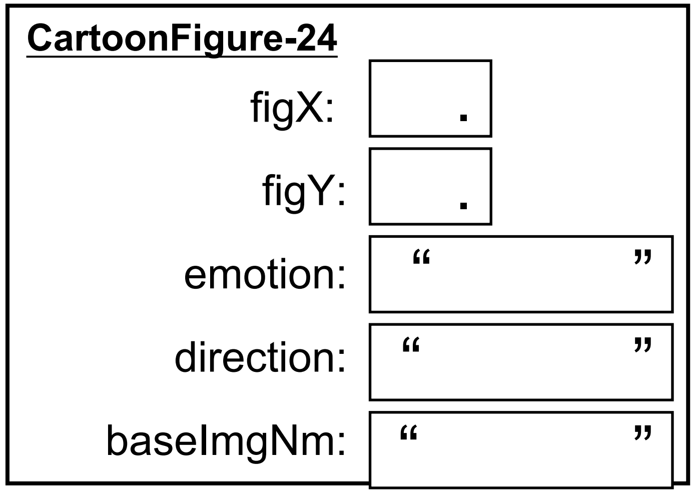
```
public class CartoonFigure {
    private double figX,  figY;
    private String direction = "right";
    private String emotion = "smiling";
    private final String imagePrefix;
    private final double wd = 40
    private final double  ht = 80;

    public CartoonFigure(double x, double y, String img ){
        this.imagePrefix = img   // fine – this is the first assignment
        ~~this.wd = 50;~~              // NO!!! Can't change the previous value
```

public static final: class wide constants

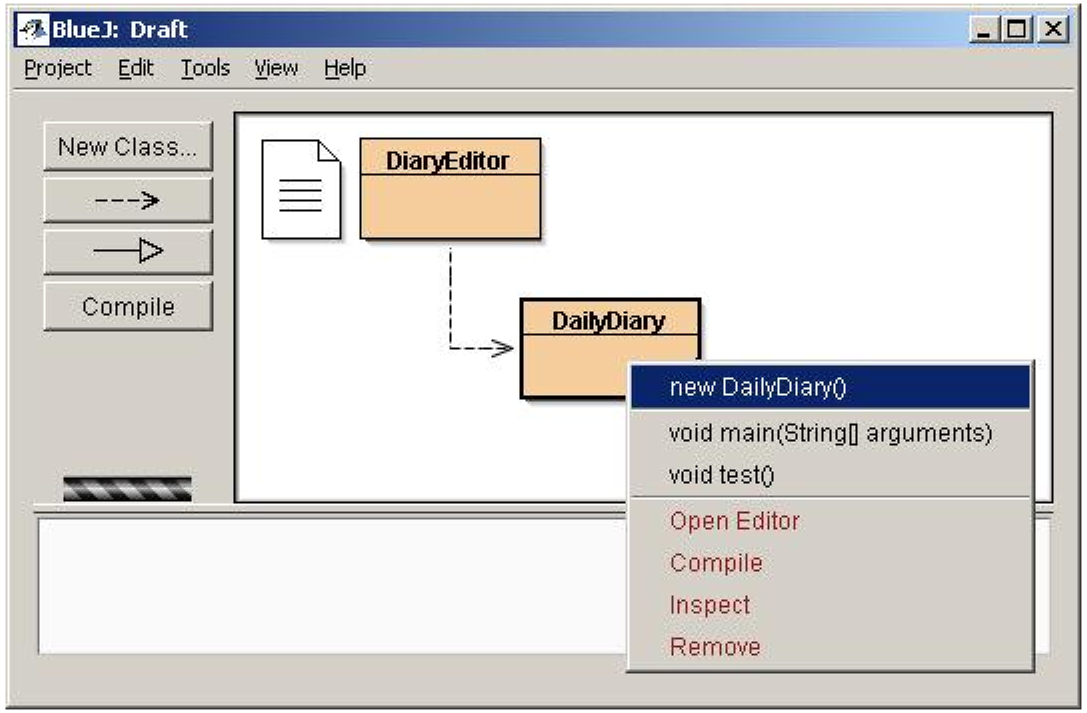
- Constants: public static final fields
  - public – can be accessed by code outside this class
  - static – single place belonging to the class, not a separate place for each object
  - final – value can't be changed once assigned

```
public class CartoonFigure {
    private double figX;
    private double figY;
    private String direction = "right";
    private String emotion = "smiling";
    private final String baseImgNm;
    public static final double WD = 40
    public static final double HT=80;
```



GUI’s and Event driven input

- In a GUI, the interaction is controlled by the user, not by the program
- User initiates "events"
  - buttons
  - menus
  - mouse press/release/drag
  - text fields
  - sliders
  - keys
- Program responds



Buttons using the ecs100 library

```
public class MyClass {
    public void setupGUI(){
        UI.addButton("Clear", UI::clearGraphics);
        UI.addButton("Go", this::runFireworks);
        UI.addButton("Quit", UI::quit);
    }

    public void runFireworks(){
        …….
    }

    public static void main(String[ ] args){
        MyClass mc = new MyClass();
        mc.setupGUI();
    }
}
```

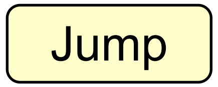
More kinds of events.

- Buttons
- Text fields
- Menus
- Mouse press/release/drag
- Sliders
- Keys
- …..
- How does Java respond to events etc?
  - When event occurs (button pressed / text entered in box / slider changed / mouse clicked/…)
    - Java looks up the object & method attached to the event (the "listener")
    - Calls the method on the object
      - passing any information involved in the event as arguments.

Event driven input:

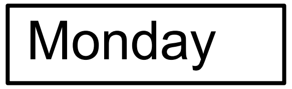
Simplest event: "do it"

- Buttons:
  - must specify what method to call on what object
  - no further information available



Events with information attached

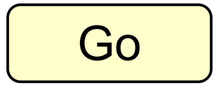
- TextFields:
  - user enters a text value
  - must specify the method to call, and
  - ensure that the text value gets passed to the method



- Mouse events:
  - presses, releases, clicks, drags, moves
  - must specify what method to call
  - ensure the kind of action and the position of the mouse gets passed to the method.

Setting up event-driven input

- Setting up the GUI:
  - To add a button to the UI:
    - specify name of button and method to call (must be a method with no parameters)



(*object* ::*method* or *class* ::*method*)

```
eg:  UI.addButton("Go", this::startGame);
     UI.addButton("End", UI::quit);
```

```
public void startGame(){…..
```

  - To add a textfield to the UI:
    - Specify name of textfield and method to call (must be a method with one String parameter)

```
eg   UI.addTextField("name", this::setName);
```

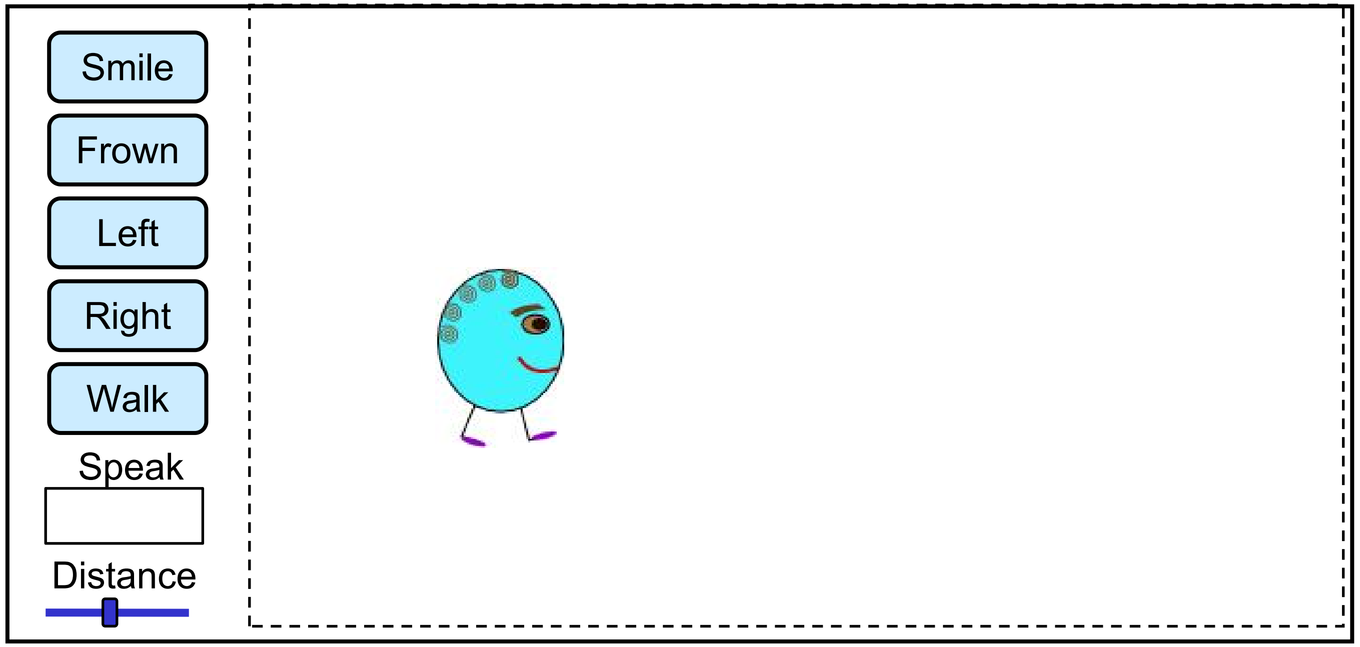
```
public void setName(String n){…..
```

  - To add a slider to the UI:
    - Specify name of slider, min, max, initial values, and method to call (must be a method with one double parameter)

```
eg   UI.addSlider("speed", 10, 50, 20, this::setSpeed); );
```

```
public void setSpeed(double v){…..
```

PuppetMaster

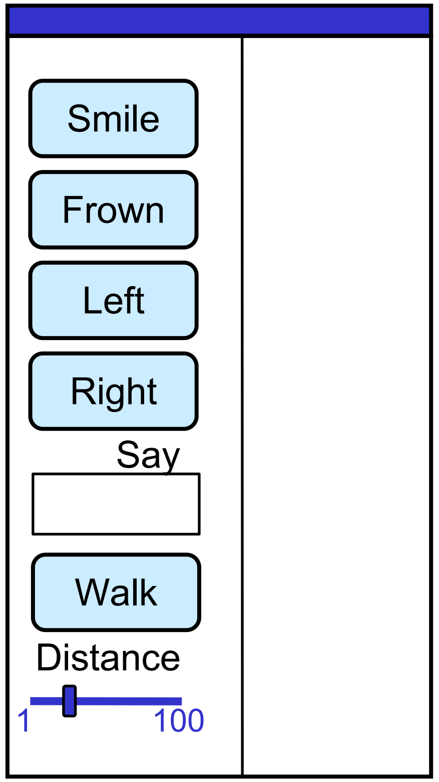


PuppetMaster: setting up Buttons etc

```
public class PuppetMaster   …   {
  // fields

  /** set up the GUI */
  public void setupGUI (){
    UI.addButton( "Smile", this::doSmile);
    UI.addButton( "Frown", this::doFrown);
    UI.addButton( "Left", this::doLeft);
    UI.addButton( "Right", this::doRight);
    UI.addTextField( "Say", this::doSpeak);
    UI.addButton( "Walk", this::doWalk);
    UI.addSlider( "Distance", 1, 100, 20, this::setDist);
        …
  }
  // methods to respond

  public static void main (String[ ] args){
    new PuppetMaster().setupGUI();
}
```



Responding to buttons and textFields

```
public class PuppetMaster {
    public void doSmile(){
        // tell the CartoonCharacter to smile
    }
    public void doFrown(){
        // tell the CartoonCharacter to frown
    }
    public void doSpeak(String words){
        // tell the CartoonCharacter to say the words
    }
    public void setDist(double value){
        // remember the value
    }
    public void setupGUI(){
        UI.addButton("Smile", this::doSmile);
        UI.addButton("Frown", this::doFrown);  …..
        UI.addTextField("Say", this::doSpeak);
        UI.addSlider( "Distance", 1, 100, 20, this::setDist);
    }
```

Methods called by buttons must have no parameters

Methods called by a textField must have one String parameter

Methods called by a slider must have one double parameter

Event driven input and fields

- Each event will make a new method call.
- ⇒ can't remember anything between events in local variables in the methods.

- Typically, need fields in the object to remember information between events.
  - eg: PuppetMaster has to remember the CartoonCharacter object in a field

PuppetMaster: Design

Structure of the PuppetMaster class:

```
public class PuppetMaster  {

    // fields to store values between events/method calls
    private ….

    // set up GUI
    public void setupGUI() {
        // set up the buttons, slider, textField, to call methods on the object
    }

    // methods to respond to the buttons,  slider, textField

    public  void …


    public static void main (String[] args){

        // make a PuppetMaster object and call setupGUI
    }
```

PuppetMaster: Using Fields

Actions on the CartoonCharacter happen in response to different events

⇒ will be in different method calls

⇒ need to store character in a field, not a local variable.

```
public  class  PuppetMaster{
    // fields
    private CartoonCharacter cc = new CartoonCharacter(200, 100, "blue");

    public void doSmile(){
        this.cc.smile();
    }
    public void doFrown(){
        this.cc.frown();
    }
    public void setupGUI(){
        UI.addButton("Smile", this::doSmile);
        UI.addButton("Frown", this::doFrown);
                ⋮
    }
```

PuppetMaster: TextFields (boxes)

```
public  class  PuppetMaster{
      private CartoonCharacter cc = new CartoonCharacter(200, 100, "blue");

      public void doSmile(){
            this.cc.smile();
      }
                  :
      public void doSpeak(String words){
            this.cc.speak(words);
      }

      public void setupGUI(){
            UI.addButton("Smile", this::doSmile);
            UI.addButton("Frown", this::doFrown);

            UI.addTextField("Say", this::doSpeak);
      }
```

PuppetMaster: Sliders

```
public  class  PuppetMaster {
    private CartoonCharacter cc = new CartoonCharacter(200, 100, "blue");
    private double walkDist = 20 ;

    public void doWalk() {
        this.cc.walk(this.walkDist);
    }
    public void setDist(double value){
        this.walkDist = value;
    }
    public void setupGUI(){
        UI.addButton("Smile", this::doSmile);
        UI.addButton("Frown", this::doFrown);

              :
        UI.addButton("Walk", this::doWalk);
        UI.addSlider( "Distance", 1, 100, 20, this::setDist);
    }
              .
```

Typical design:
field to store value
from one event,
for use by another event

A method called by
a slider must have
one double parameter

PuppetMaster: Using Fields

Listeners in the buttons etc don't *have* to call methods on this or UI:

```
public  class  PuppetMaster{
    // fields
    private CartoonCharacter cc = new CartoonCharacter(200, 100, "blue");
    // constructor
    public void setupGUI(){
        UI.addButton("Smile",  this::doSmile);
        UI.addButton("Frown", this::doFrown);
            :
    }
    public void doSmile(){
        this.cc.smile();
    }
    public void doFrown(){
        this.cc.frown();
    }
```

GUI: Mouse input

- Just like buttons, except don't have to put anything on screen
  - Each press / release / click on the graphics pane will be an event
  - Must tell UI the listener: the object::method to call when a mouse event occurs

```
    UI.setMouseListener(game::doMouse);
```

  - Must define method to say how to respond to the mouse.
    parameters: kind of mouse event and position of mouse event

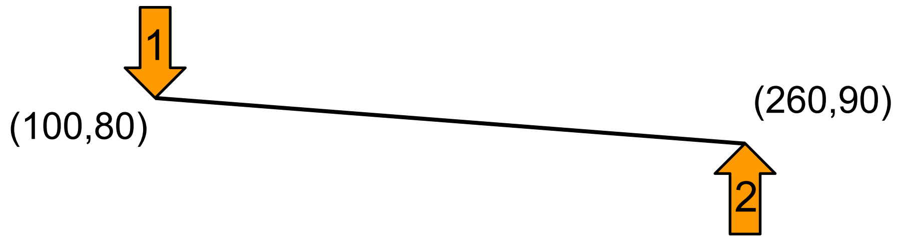
```
    public void doMouse(String action, double x, double y) {
        if (action.equals("pressed") ) {
            // what to do if mouse button is pressed
        }
        else if (action.equals("released") ) {
            // what to do if mouse button is released
        }
        else if (action.equals("clicked") ) {
            // what to do if mouse button is clicked
        }
    }
```

where action occurred

press-release in same place

Using the mouse.

- Want to let user specify input with the mouse,
  - eg: drawing lines



- Typical pattern:
  - On "pressed",
    - just remember the position
  - On "released",
    - do something with remembered position and new position

Mouse Input

```
public class LineDrawer {       /**Let user draw lines on graphics pane with the mouse. */
    private double startX, startY;  // fields to remember "pressed" position
    public void setupGUI(){
        UI.setLineWidth(10);
        UI.setMouseListener(this::doMouse);
        UI.setDivider(0.0);
    }
    public void doMouse(String action, double x, double y) {
        if (action.equals("pressed") ) {
            this.startX = x;
            this.startY = y;
        }
        else if (action.equals("released") ) {
            UI.drawLine(this.startX, this.startY,  x,  y);
        }
    }
```

Mouse Input

Simple mouse events: `UI.setMouseListener(this::doMouse);`

- pressed
- released
- clicked

Mouse movement: `UI.setMouseMotionListener(this::doMouse);`

- pressed, released, clicked
- dragged
- moved

Selecting Colors: JColorChooser

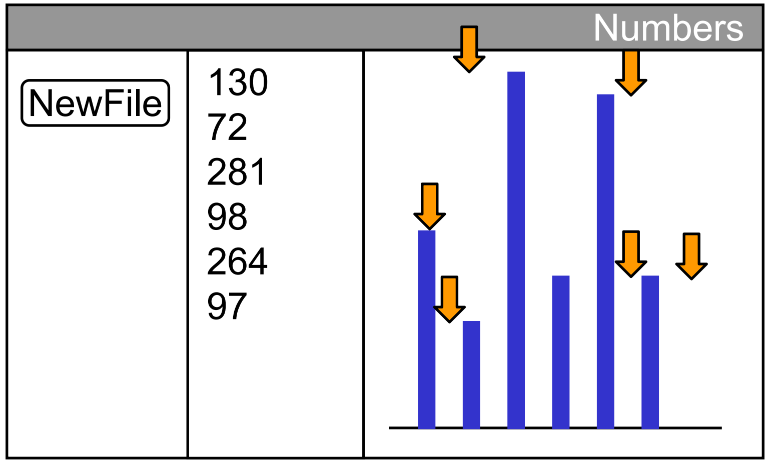
```
public class LineDrawer {

    private double startX, startY;  // fields to remember “pressed” position
    private Color currentColor = Color.black;

    public void doMouse(String action, double x, double y) {
        if (action.equals("pressed") )          {   this.startX = x;  this.startY = y;  }
        else if (action.equals("released") ) {   UI.drawLine(this.startX, this.startY,  x,  y);  }
    }
    public void doChooseColour(){
        this.currentColor = JColorChooser.showDialog(null, "Choose Color", this.currentColor);
        UI.setColor(this.currentColor);
    }
    public static  void main(String[] args){
        UI.setLineWidth(10);
        LineDrawer drawer = new LineDrawer();
        UI.setMouseListener(drawer::doMouse);
        UI.addButton("Color", drawer::doChooseColour);
    }
```

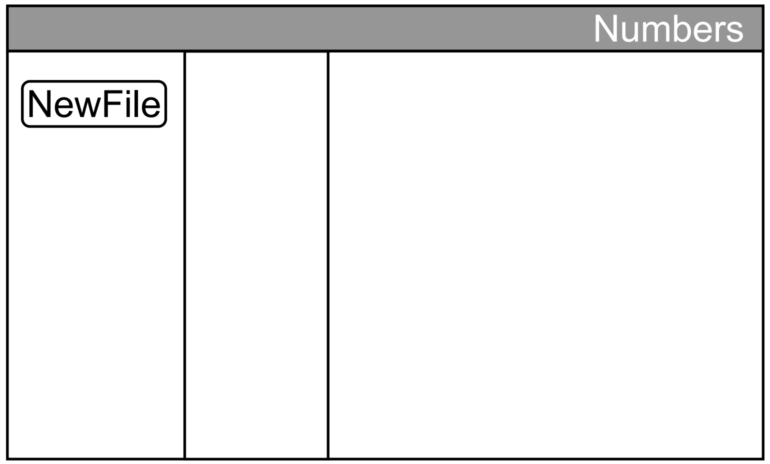
Numbers program

- Program for constructing files of numbers:
  - Allow user to select a new file
  - Allow user to enter a set of numbers with the mouse (height of mouse click is the number)
  - Display numbers as bar chart and list in text pane
  - Save numbers to the file as they are entered
- User Interface:
  - Button to clear screen and select new file.
  - Graphics pane to select (with mouse) and display the numbers
  - Text pane to display list of numbers



Numbers: Design

- Design:
  - When does something happen?
    - button presses
    - mouse clicks
  - Fields
    - to store the file (PrintStream) that the numbers are being saved to
    - to remember the horizontal position of the next bar.
  - Methods to respond to mouse
    - record a new number
  - Method to respond to button
    - clear and start a new file
  - main method
    - create object
    - set up the interface



Numbers: Design

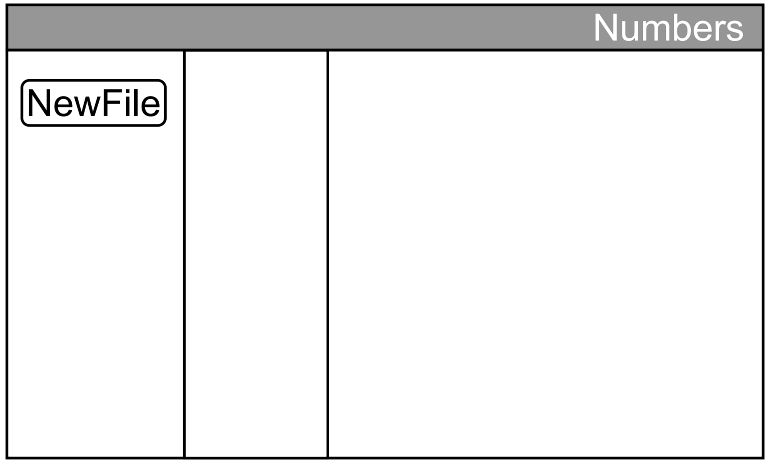
```
public class Numbers {
    private PrintStream output;
    private double barX = 0;
    private static final double BASE= 450;

    public void doNew() {…



    public void doMouse( …

    public static void main(String[ ] args){
        Numbers num = new Numbers();
        UI.setMouseListener(num::doMouse);
        UI.addButton("NewFile", num::doNewFile);
        UI.drawLine(0, BASE, 600, BASE);
    }
}
```

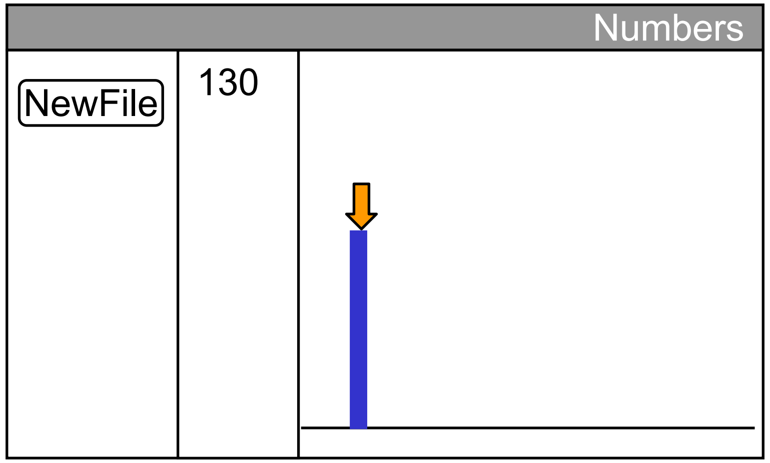


Respond to Mouse:

- When user clicks/releases:
  - work out the number they meant
  - draw a bar on the graphics pane
  - display it in the text pane
  - print it to the file

```
public void doMouse(String action, double x, double y) {
    if (action.equals("released")) {
        double number = BASE - y;
        this.barX = this.barX + 10;
        UI.fillRect(this.barX, y, 5, number);
        UI.println(number);
        this.output.println(number);
    }
}
```

What's the problem?



Respond to "NewFile" button

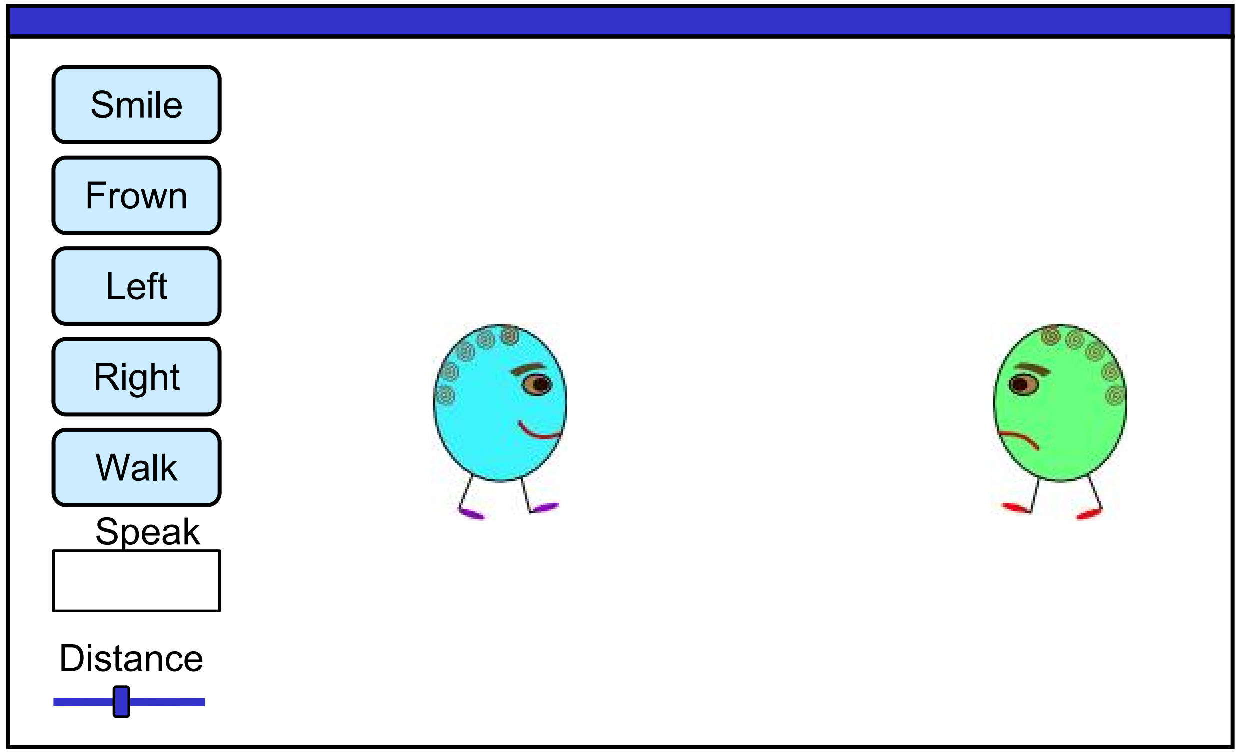
```
public void doNewFile(){
    UI.clearPanes();
    UI.drawLine(0, BASE, 600, BASE);
    this.barX = 0;
    this.output.close();
    try{
        this.output = new PrintStream(UIFileChooser.save());
    } catch(IOException e) { UI.println("File error: "+e); }
}
```

Still a problem!

```
if (this.output != null) {
    this.output.close();
}
```

GUI design: choosing object to act on

Suppose we have two characters!



Problem:

- Which character should smile/turn/walk/speak?

- Event-driven input can be tricky!

GUI design: choosing object to act on

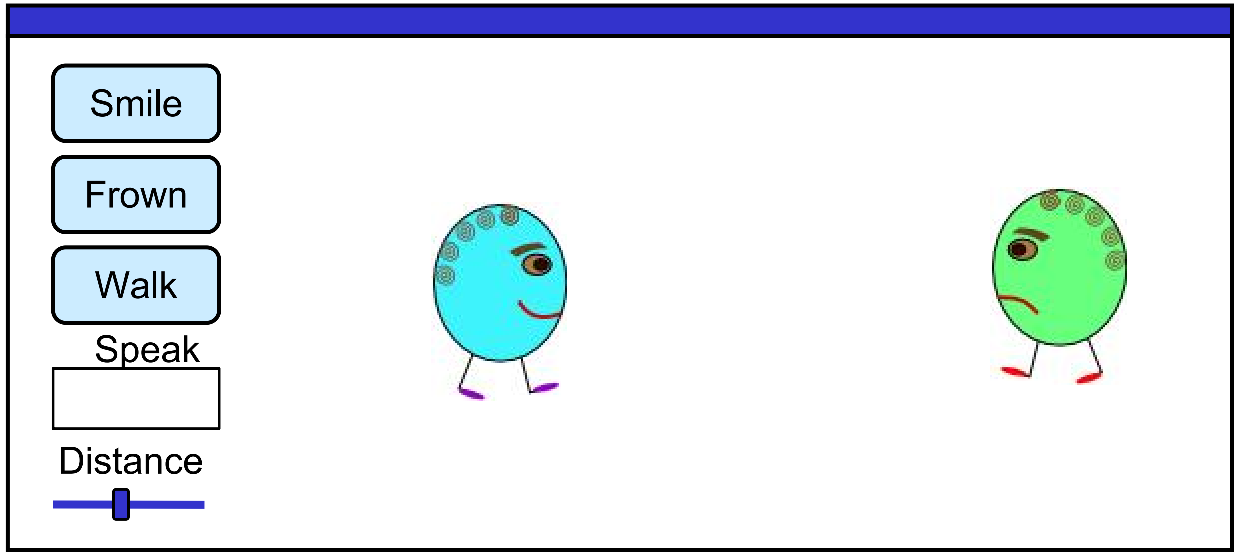
- One typical simple GUI interaction mechanism
  1. Select object you want to act on
  2. Choose action.

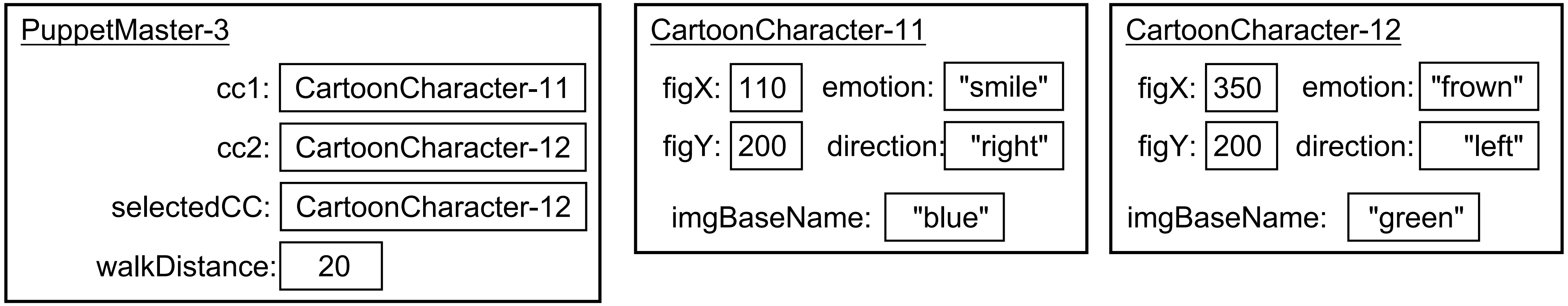
- Must remember the currently selected object:
  - in a field, because the action will be performed in a later method

```
this.selectedCC = cc1;
```

- Typically, the "selected object" doesn't change until user selects another object.

PuppetMaster: two characters


Smile
Frown
Walk
Speak
Distance


PuppetMaster-3
cc1: CartoonCharacter-11
cc2: CartoonCharacter-12
selectedCC: CartoonCharacter-12
walkDistance: 20
CartoonCharacter-11
figX: 110
emotion: "smile"
figY: 200
direction: "right"
imgBaseName: "blue"
CartoonCharacter-12
figX: 350
emotion: "frown"
figY: 200
direction: "left"
imgBaseName: "green"