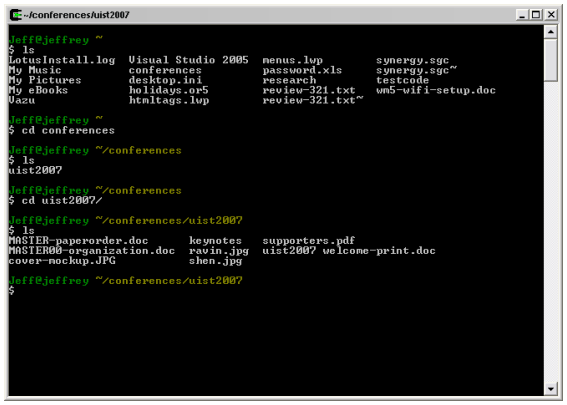
MOBILE COMPUTING

CSE 40814/60814
Spring 2021

How many of you…

have implemented a command-line user interface?



How many of you…

have implemented a **graphical user** interface?

- HTML/CSS
- Java Swing
- .NET Framework
- Mozilla's XUL
- Mobile platform (iOS, Android, Blackberry, …)
- Something else?

What's the difference?

Command-line model (e.g., UNIX shell, DOS)

- Interaction controlled by system
- User queried when input is needed

Event-driven model (e.g., GUIs)

- Interaction controlled by the user
- System waits for user actions and then reacts
- More complicated programming and architecture
- Need to build the "look" and "feel" of interface

Component/Container Model

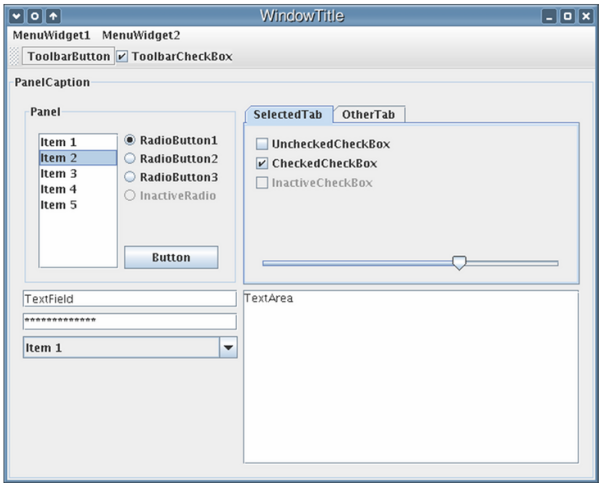
Component (aka widget, control, etc.)

- Encapsulation of an interactive element
- Drawn using the 2D graphics library
- Low-level input event processing
- Repaint management
- In OOP systems, each component is implemented as a sub-class of a base "Component" class

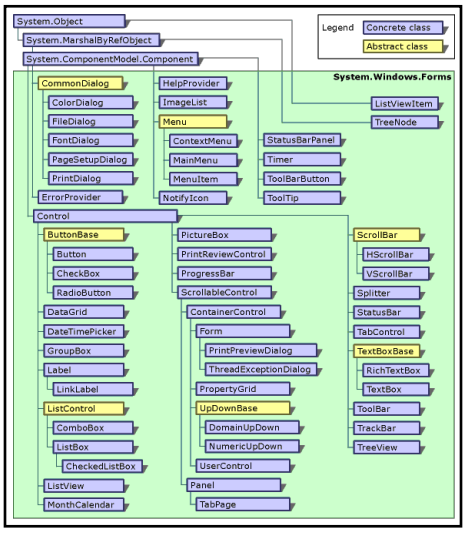
Examples of Components

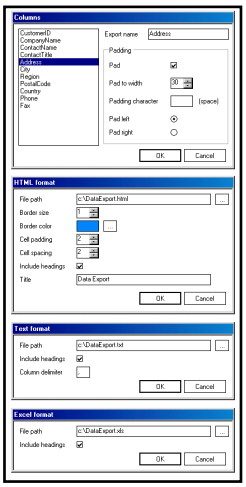
- Button
- Checkbox
- Radio button
- Text box
- Combo box (drop-down list)
- List box
- Scrollbar
- Slider
- Menu
- Menu item
- NumericPicker
- DateTimePicker
- …

Java Swing Components

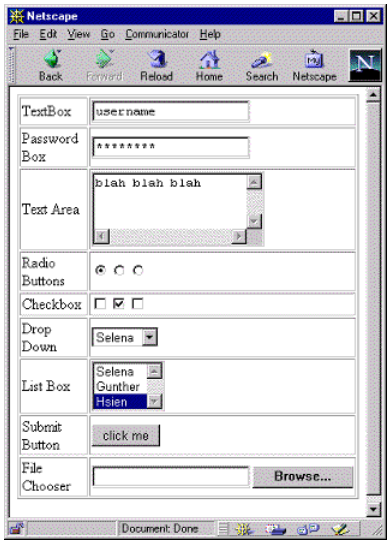


.NET Framework Controls





HTML Form Controls

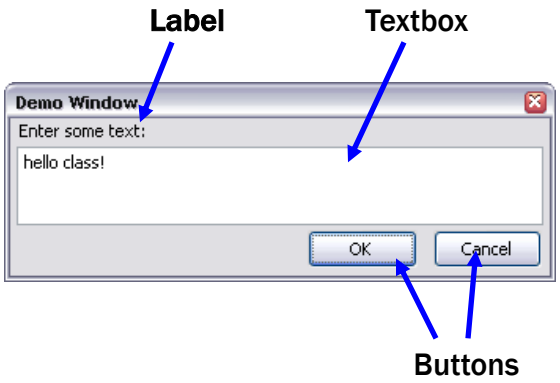


Component/Container Model

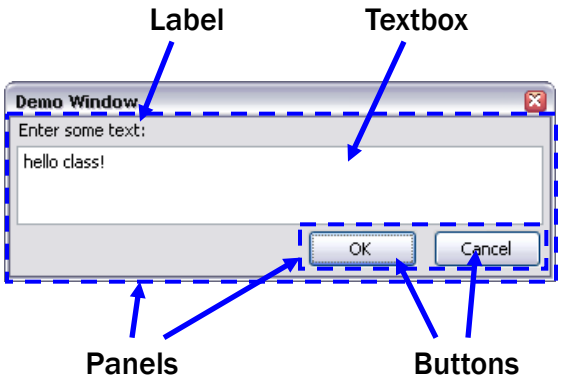
Container

- Component that contains one or more other components
- Creates the structure of the user interface
- Manages child components
  - Layout, painting, event dispatch
- Some have interactive features (e.g., tab panel)

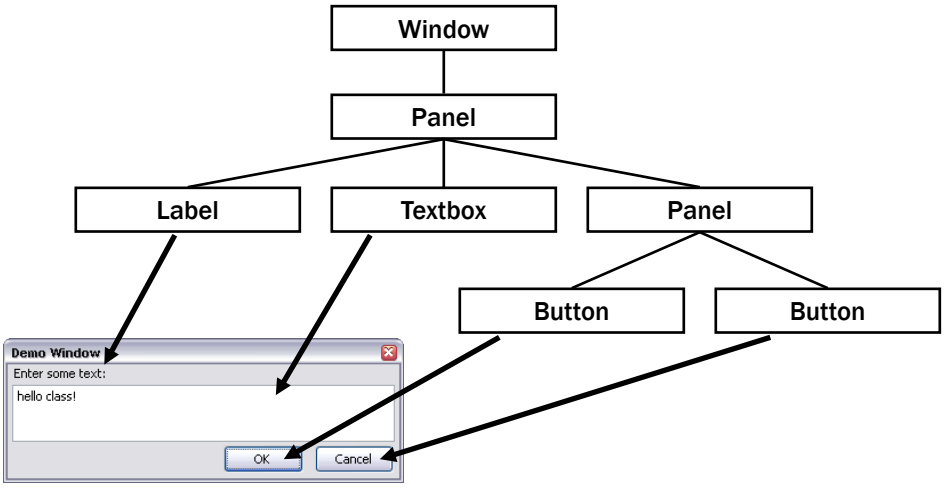
Container Structure



Container Structure

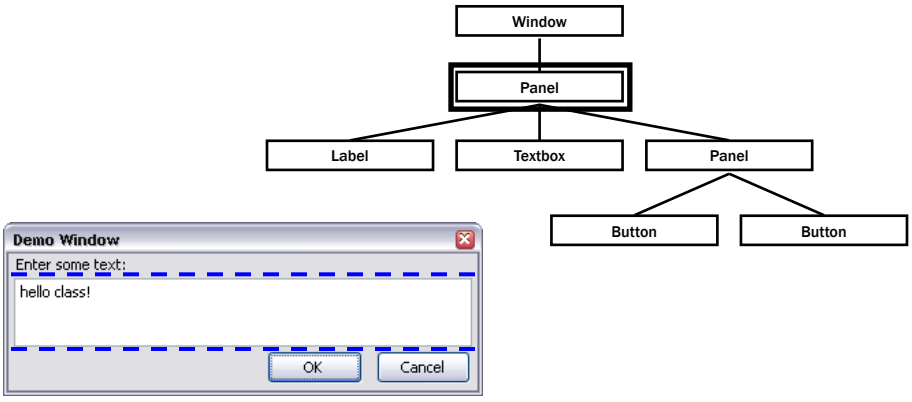


Container Structure



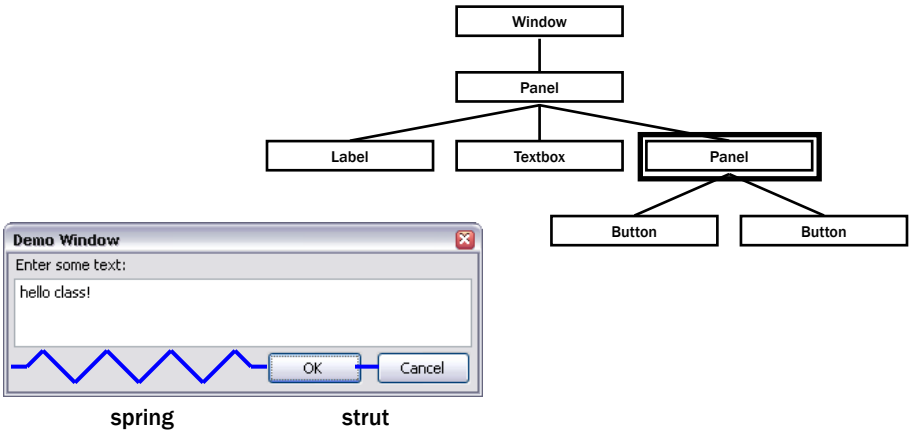
Layout

Containers specify layout of their children



Layout

Containers specify layout of their children



"Feel": Events

User input is modeled as "events" that must be handled by the system

Examples?

- Mouse
  button down, button up, button clicked, entered, exited, moved, dragged
- Keyboard
  key down, key up, key pressed
- Window
  movement, resizing
- Touchscreen
  Touching, swiping, dragging, pinching

Anatomy of an Event

An event encapsulates the information needed for handlers to react to the input

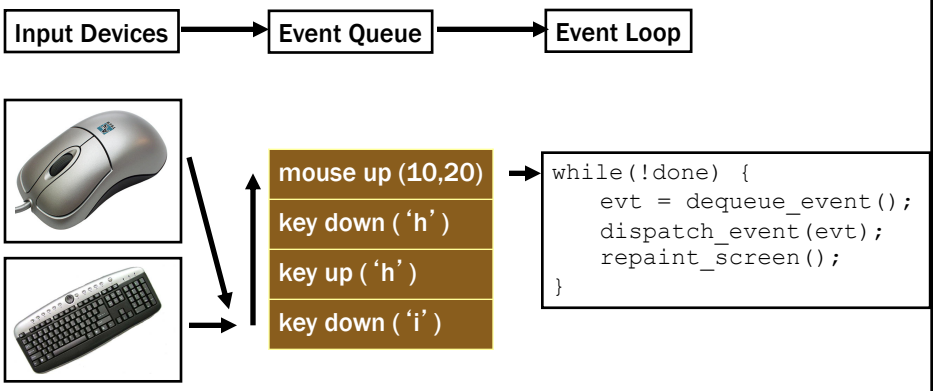
- Event type (mouse button down, key up, etc.)
- Event target (component in which event occurred)
- Timestamp
- Modifiers (Ctrl, Shift, Alt, etc.)
- Type-specific content
  - Mouse: x,y coordinates, # clicks
  - Keyboard: key code

Event Handlers

Events are dispatched to components

- Application developers can specify **code to be executed** when the event occurs (**callbacks**)
- **Built-in components** will have code to handle most keyboard and mouse events
  - Buttons handle mouse up/down to change graphic
  - Text boxes update their contents on key press
- Built-in components often generate new "high-level" events from combinations of low-level events
  - Text boxes generate "change" events when content changes and focus is lost
  - Sliders generate "change" events when thumb is dragged

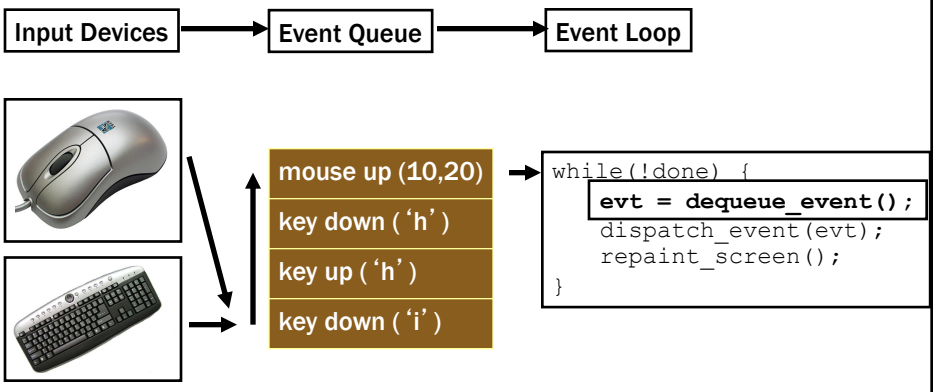
Event Loop



Exists in every application

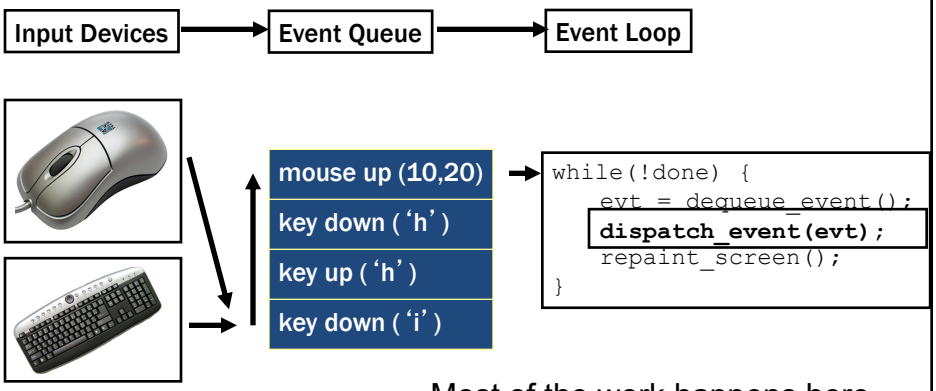
Usually handled for you by **UI framework**

Event Loop



Blocks until an event arrives

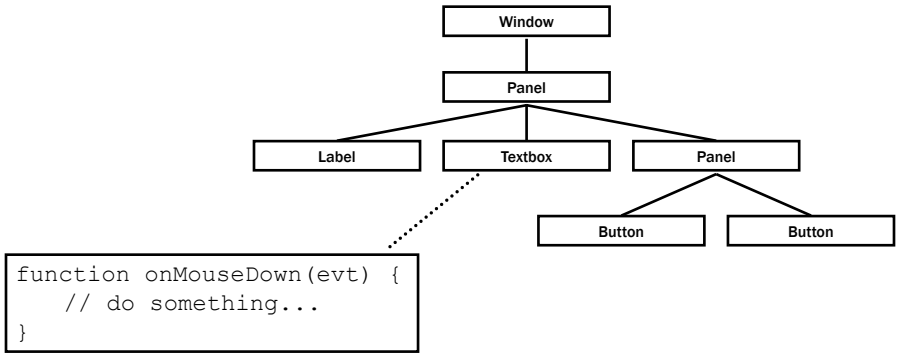
Event Loop



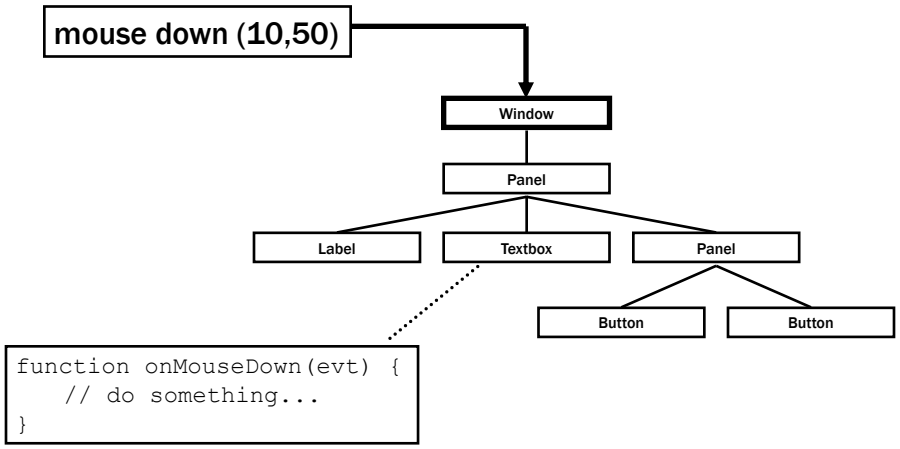
Most of the work happens here

Dispatching Events

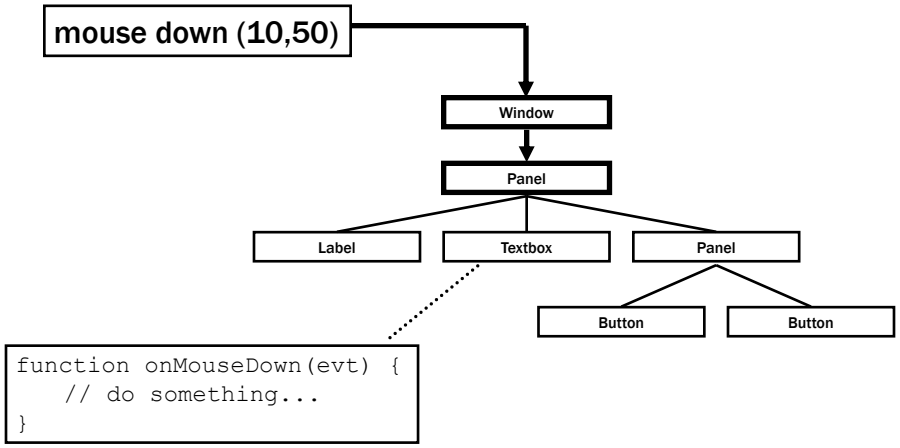
mouse down (10,50)



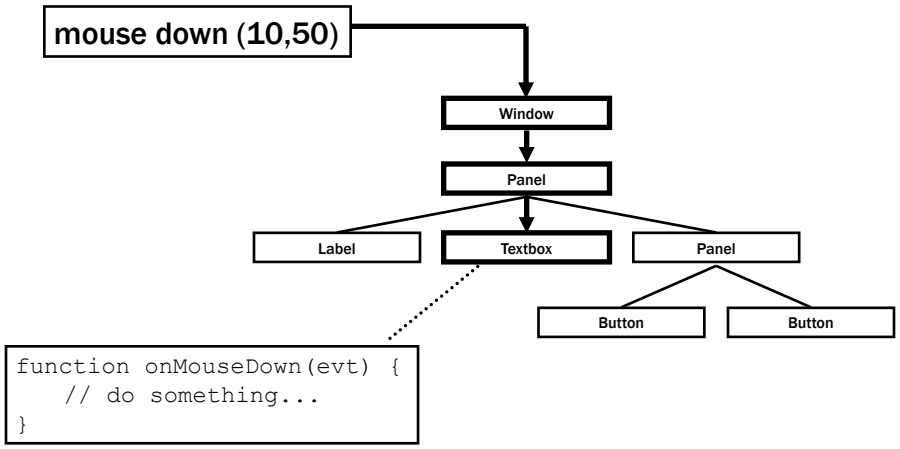
Dispatching Events



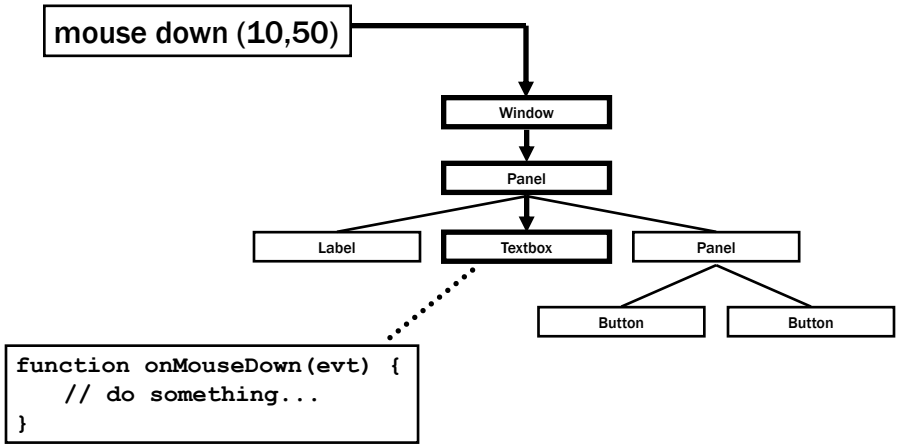
Dispatching Events



Dispatching Events

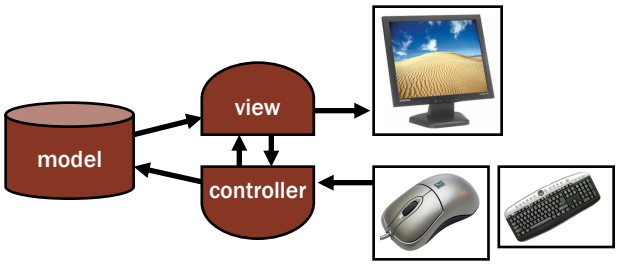


Dispatching Events



MODEL VIEW CONTROLLER (MVC)

- Architecture for interactive apps
- Partitions application in a way that is
  - Scalable
  - Maintainable



MVC

- Architectural design pattern which works to separate data and UI for a more cohesive and modularized system

- Presented by Trygve Reenskaug in 1979
- First used in the Smalltalk-80 framework
  - Used in making Apple interfaces (Lisa and Macintosh)

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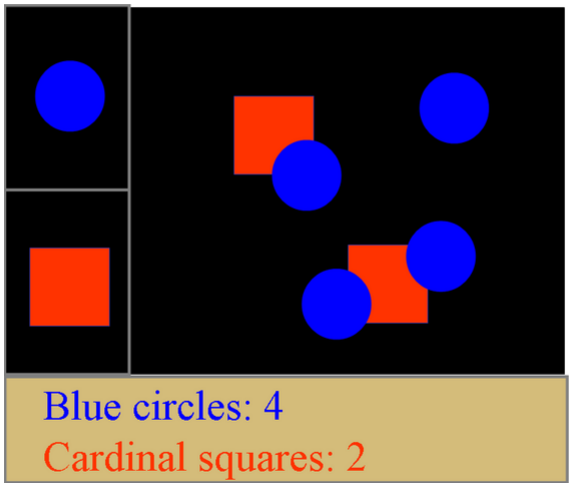
MVC

- **Model**: data model
  - manages behavior and data of the application domain
- **View**: screen(s) shown to the user
  - manages the graphical and/or textual output to the portion of the bitmapped display that is allocated to its application
- **Controller**: interactions from the user that changes the data and the view
  - interprets the mouse and keyboard inputs from the user, commanding the model and/or the view to change as appropriate

Example Application

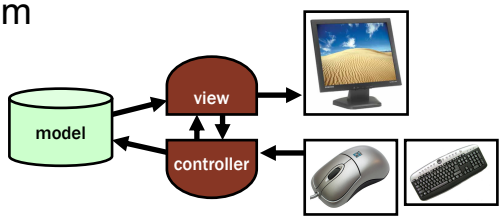


Model

Information the app is trying to manipulate

Representation of real world objects

- Circuit for a CAD program
- Shapes in a drawing program
- List of people in a contact management program

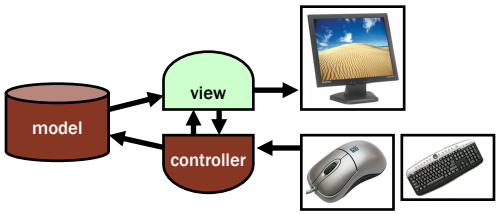


View

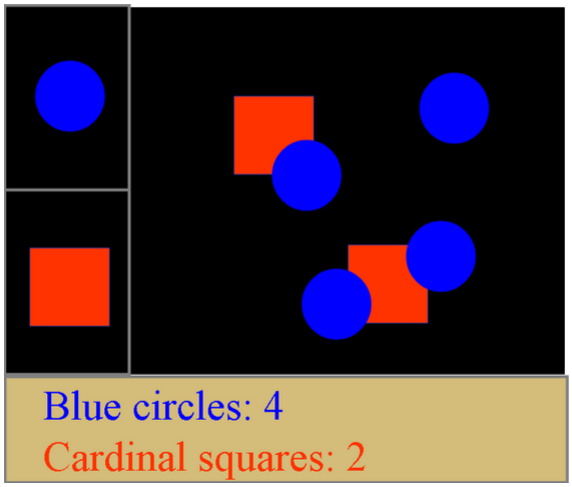
Implements a visual display of the model

May have multiple views

- E.g., shape view and numeric view



Multiple Views



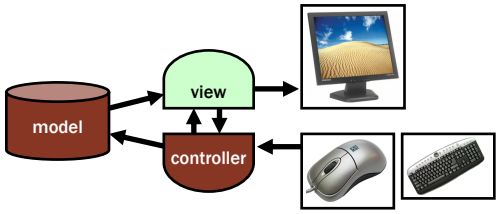
View

Implements a visual display of the model

May have multiple views

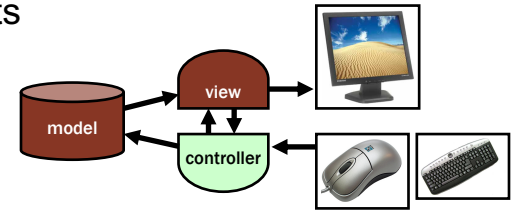
- E.g., shape view and numeric view

Anytime the model is changed, each view must be notified so that it can update *later*

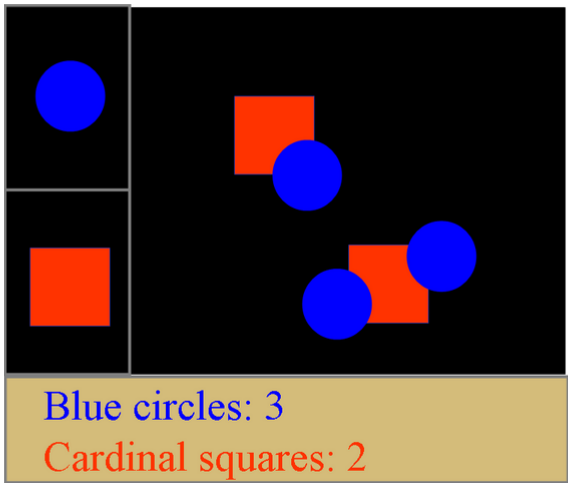


Controller

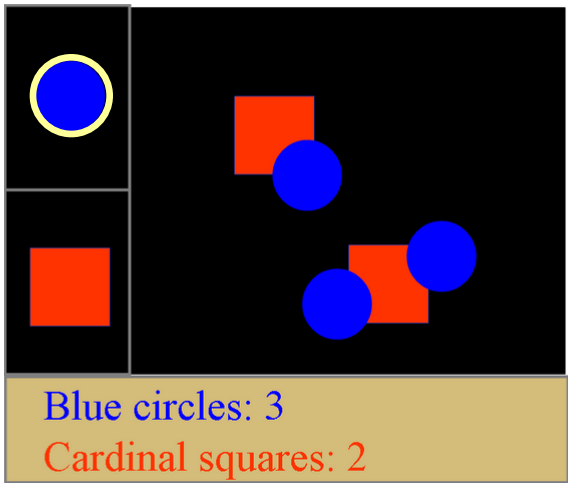
- Receives all input events from the user
- Decides what they mean and what to do
  - Communicates with view to determine the objects being manipulated (e.g., selection)
  - Calls model methods to make changes to objects



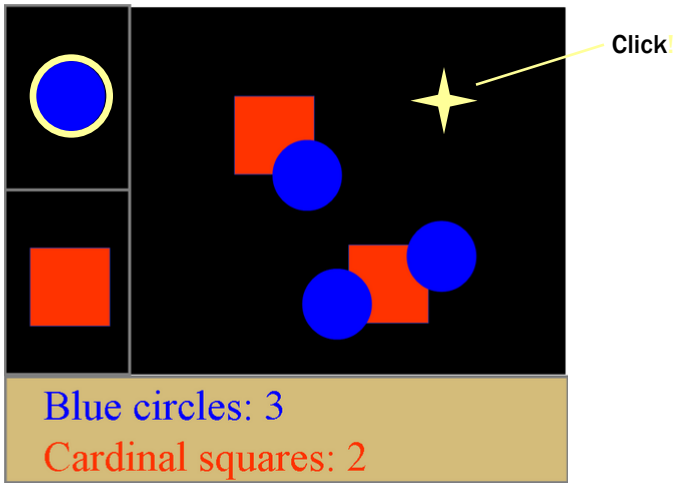
Controller



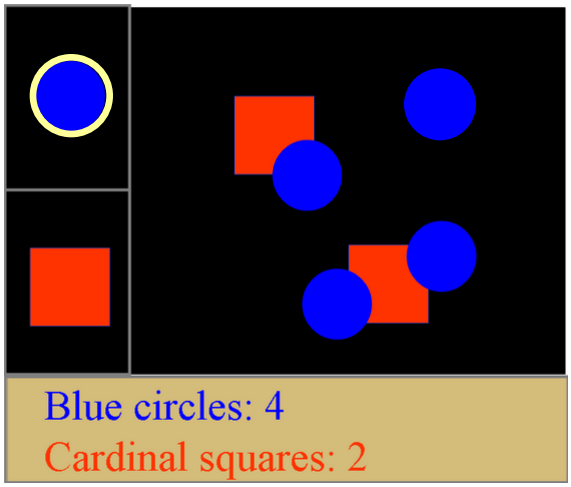
Controller



Controller

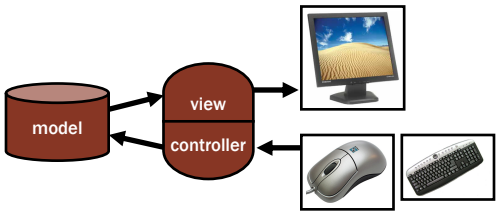


Controller



Combining View & Controller

- View and controller are tightly intertwined
  - Lots of communication between the two
  - E.g. determine what was clicked on
- Almost always occur in pairs
  - i.e., for each view, need a separate controller
- Many architectures combine that into a single unit



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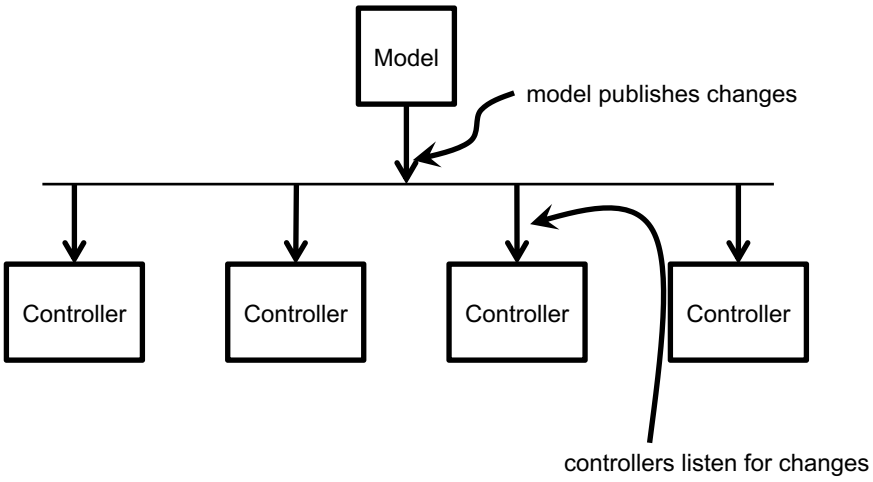
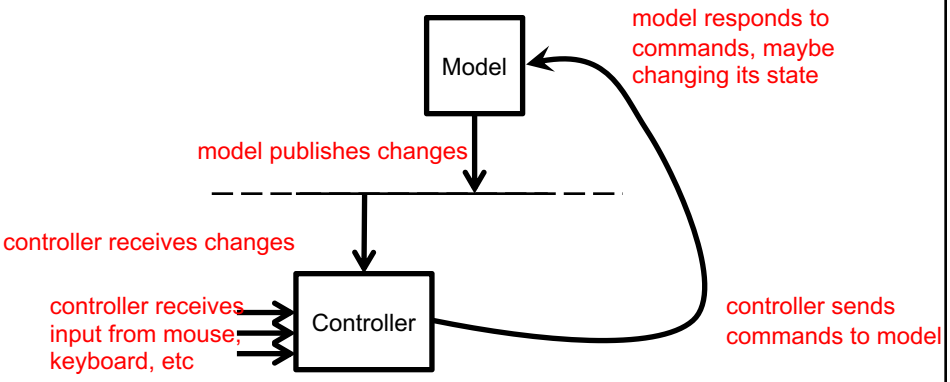
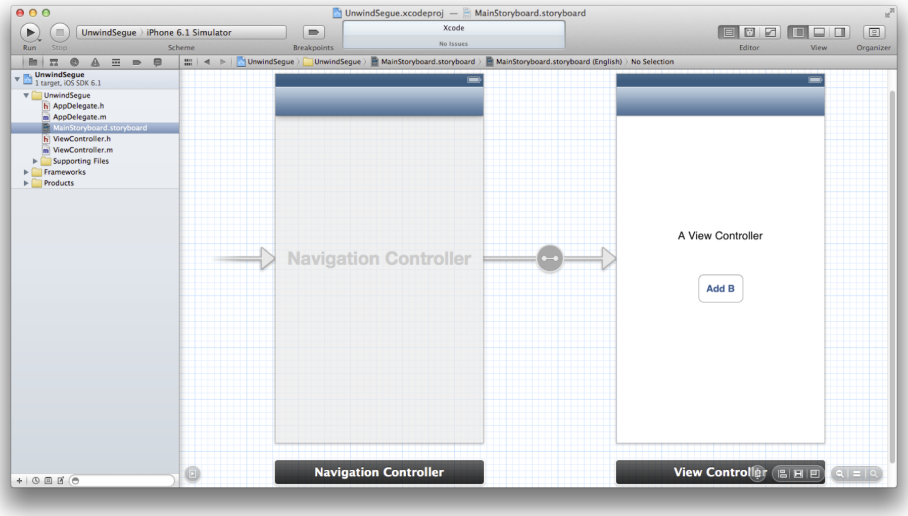
One Model, Many Controllers



MVC Feedback Loop

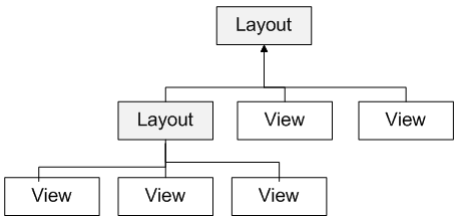


Xcode (iOS) ViewController



Android View Class

- The **View class** is the Android's most basic component from which users interfaces can be created. This element is similar to the Swing **JComponent** class for Java apps.
  - A **View** occupies a rectangular area on the screen and is responsible for *drawing* and *event handling*.
  - **Widgets** are subclasses of View. They are used to create interactive UI components such as buttons, checkboxes, labels, text fields, etc.
  - **Layouts** are invisible containers used for holding other Views and nested layouts.



Graphical UI – XML Layout

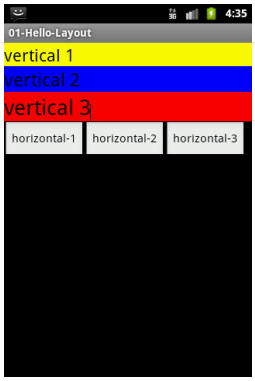
Actual UI displayed by the app

```
<RelativeLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent" >

    <EditText
        android:id="@+id/editText1"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignParentTop="true"
        android:layout_centerHorizontal="true"
        android:hint="Enter you name here"
        android:layout_marginTop="50dp"
        android:ems="10" >

        <requestFocus />
    </EditText>

    <Button
        android:id="@+id/button1"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/editText1"
        android:layout_centerHorizontal="true"
        android:layout_marginTop="24dp"
        android:text=" Go " />

</RelativeLayout>
```

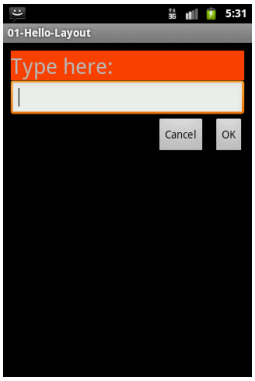
Text version: *activity_main.xml* file

Examples of UI Components

Layouts



Linear Layout
A LinearLayout places its inner views either in horizontal or vertical disposition.



Relative Layout
A RelativeLayout is a ViewGroup that allows you to position elements relative to each other.

Table Layout
A TableLayout is a ViewGroup that places elements using a row & column disposition.

Examples of UI Components

Widgets

TimePicker
AnalogClock
DatePicker
A *DatePicker* is a widget that allows the user to select a month, day and year.

Form Controls
Includes a variety of typical form widgets, like:
image buttons,
text fields,
checkboxes and
radio buttons.

GalleryView

TabWidget

Why MVC?

- Mixing all pieces in one place will not scale
  - Model may have more than one view
    - Each is different and needs update when model changes
- Separation eases maintenance and extensibility
  - Easy to add a new view later
  - Model can be extended, but old views still work
  - Views can be changed later (e.g., add 3D)