

Graphical User Interface (GUI)



Nelson Padua-Perez
Chau-Wen Tseng

Department of Computer Science
University of Maryland, College Park

Graphical User Interface (GUI)

- **User interface**
 - Interface between user and computer
 - Both input and output
 - Affects **usability** of computer

- **Interface improving with better hardware**
 - Switches & light bulbs
 - Punch cards & teletype (typewriter)
 - Keyboard & black/white monitor (text)
 - Mouse & color monitor (graphics)

Graphical User Interface (GUI)

■ Goal

- Present information to users clearly & concisely
- Make interface easy to use for users
- Make software easy to implement / maintain for programmers

Graphical User Interface (GUI)

■ Design issues

- Ease of use
- Ease of understanding
- Ability to convey information
- Maintainability
- Efficiency

GUI Topics

- Event-driven programming
- Model-View-Controller (MVC) Pattern
- GUI elements
- Java GUI classes

Event-driven Programming

- Normal (control flow-based) programming
 - Approach
 - Start at main()
 - Continue until end of program or exit()
- Event-driven programming
 - Unable to predict time & occurrence of event
 - Approach
 - Start with main()
 - Build GUI
 - Await events (& perform associated computation)

Event-driven Programming in Java

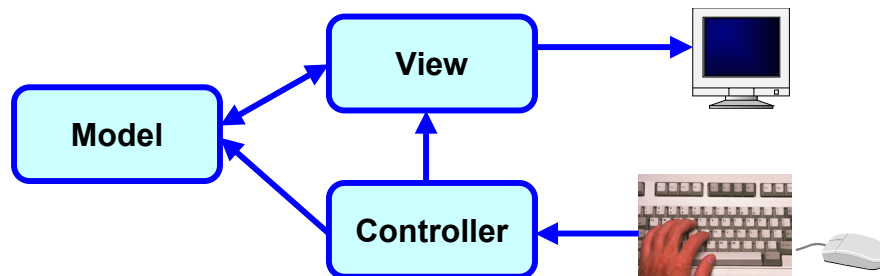
- **During implementation**
 - Implement **event listeners** for each event
 - Usually one event listener class per widget
- **At run time**
 - Register listener object with widget object
 - Java generates **event object** when events occur
 - Java then passes event object to event listener
- Example of **observer** design pattern

Event-driven Programming in Java

- **Example listeners & actions causing event**
 - **ActionEvent** ⇒ clicking button in GUI
 - **CaretEvent** ⇒ selecting portion of text in GUI
 - **FocusEvent** ⇒ component gains / loses focus
 - **KeyEvent** ⇒ pressing key
 - **ItemEvent** ⇒ selecting item from pull-down menu
 - **MouseEvent** ⇒ dragging mouse over widget
 - **TextEvent** ⇒ changing text within a field
 - **WindowEvent** ⇒ closing a window

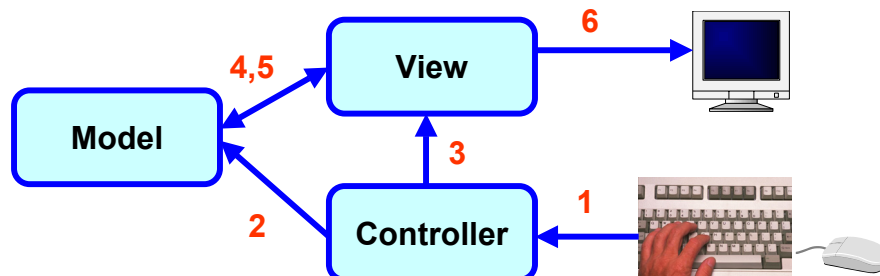
Model-View-Controller (MVC) Pattern

- Developed at Xerox PARC in 1978
- Separates GUI into 3 components
 - Model ⇒ application data
 - View ⇒ visual interface
 - Controller ⇒ user interaction



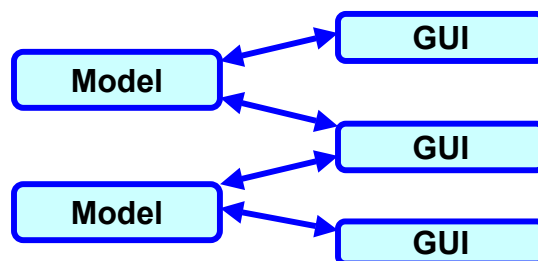
MVC Interaction Order

1. User performs action, controller is notified
2. Controller may request changes to model
3. Controller may tell view to update
4. Model may notify view if it has been modified
5. View may need to query model for current data
6. View updates display for user



MVC Pattern – Advantages

- Separates data from its appearance
 - More robust
 - Easier to maintain
- Provides control over interface
- Easy to support multiple displays for same data



MVC Pattern – Model

- Contains application & its data
- Provide methods to access & update data
- Interface defines allowed interactions
- Fixed interface enable both model & GUIs to be easily pulled out and replaced
- Examples
 - Text documents
 - Spreadsheets
 - Web browser
 - Video games

MVC Pattern – View

- Provides visual representation of model
- Multiple views can display model at same time
 - Example: data represented as table and graph
- When model is updated, all its views are informed & given chance to update themselves

MVC Pattern – Controller

- Users interact with the controller
- Interprets mouse movement, keystrokes, etc.
- Communicates those activities to the model
- Interaction with model indirectly causes view(s) to update

Principles of GUI Design

- **Model**
 - Should perform actual work
 - Should be independent of the GUI
 - But can provide access methods
- **Controller**
 - Lets user **control** what work the program is doing
 - Design of controller depends on model
- **View**
 - Lets user see what the program is doing
 - Should not display what controller **thinks** is happening (base display on model, not controller)

Principles of GUI Design

- **Combining controller & view**
 - Appropriate if very interdependent
 - Especially in small programs
- **Separation of concerns**
 - **Never** mix model code with GUI code
 - View should represent model as it really is
 - Not some remembered status
 - Controller should talk to model and view
 - Avoid manipulate them directly