CSE 331

Model/View Separation and Observer Pattern

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based on materials by M. Ernst, S. Reges, D. Notkin, R. Mercer, Wikipedia
http://www.cs.washington.edu/331/

Model and view

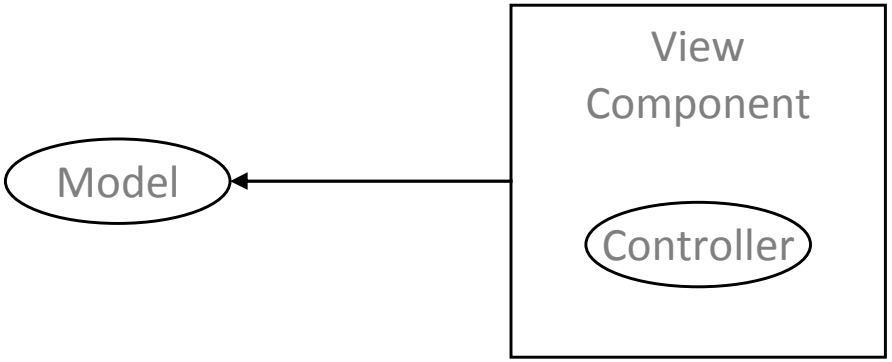
- **model**: Classes in your system that are related to the internal representation of the state and behavior of the system.
  - often part of the model is connected to file(s) or database(s)
  - examples (card game): Card, Deck, Player
  - examples (bank system): Account, User, UserList

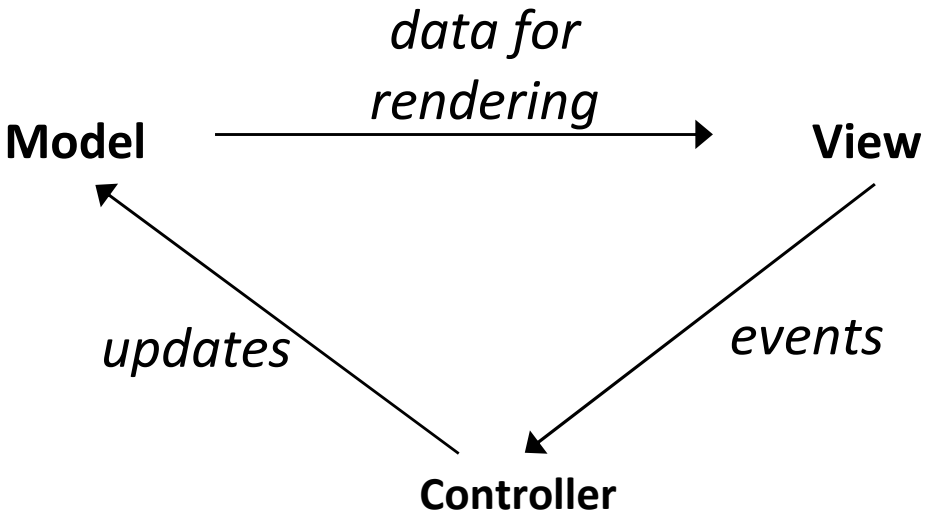
- **view**: Classes in that display the state of the model to the user.
  - generally, this is your GUI (could also be a text UI)
  - should not contain crucial application data
  - Different views can represent the same data in different ways
    - Example: Bar chart vs. pie chart
  - examples: PokerGUI, PacManCanvas, BankApplet

Model-view-controller

- **model-view-controller (MVC)**: Design paradigm for graphical systems that promotes strict separation between model and view.

- **controller**: classes that connect model and view
  - defines how user interface reacts to user input (events)
  - receives messages from view (where events come from)
  - sends messages to model (tells what data to display)





Model/view separation

- Your model classes should NOT:
  - import graphical packages (java.awt.*, javax.swing.*)
  - store direct references to GUI classes or components
  - know about the graphical classes in your system
  - store images, or names of image files, to be drawn
  - drive the overall execution of your program

- Your view/controller classes should:
  - store references to the model class(es)
  - call methods on the model to update it when events occur

- *Tricky part:* Updating all aspects of the view properly when the state of the model changes...

Pattern: Observer

objects that listen for updates to the state of others

Observer pattern

- **observer**: An object that "watches" the state of another object and takes action when the state changes in some way.

- *Problem:* You have a model object with a complex state, and the state may change throughout the life of your program.
  - You want to update various other parts of the program when the object's state changes.

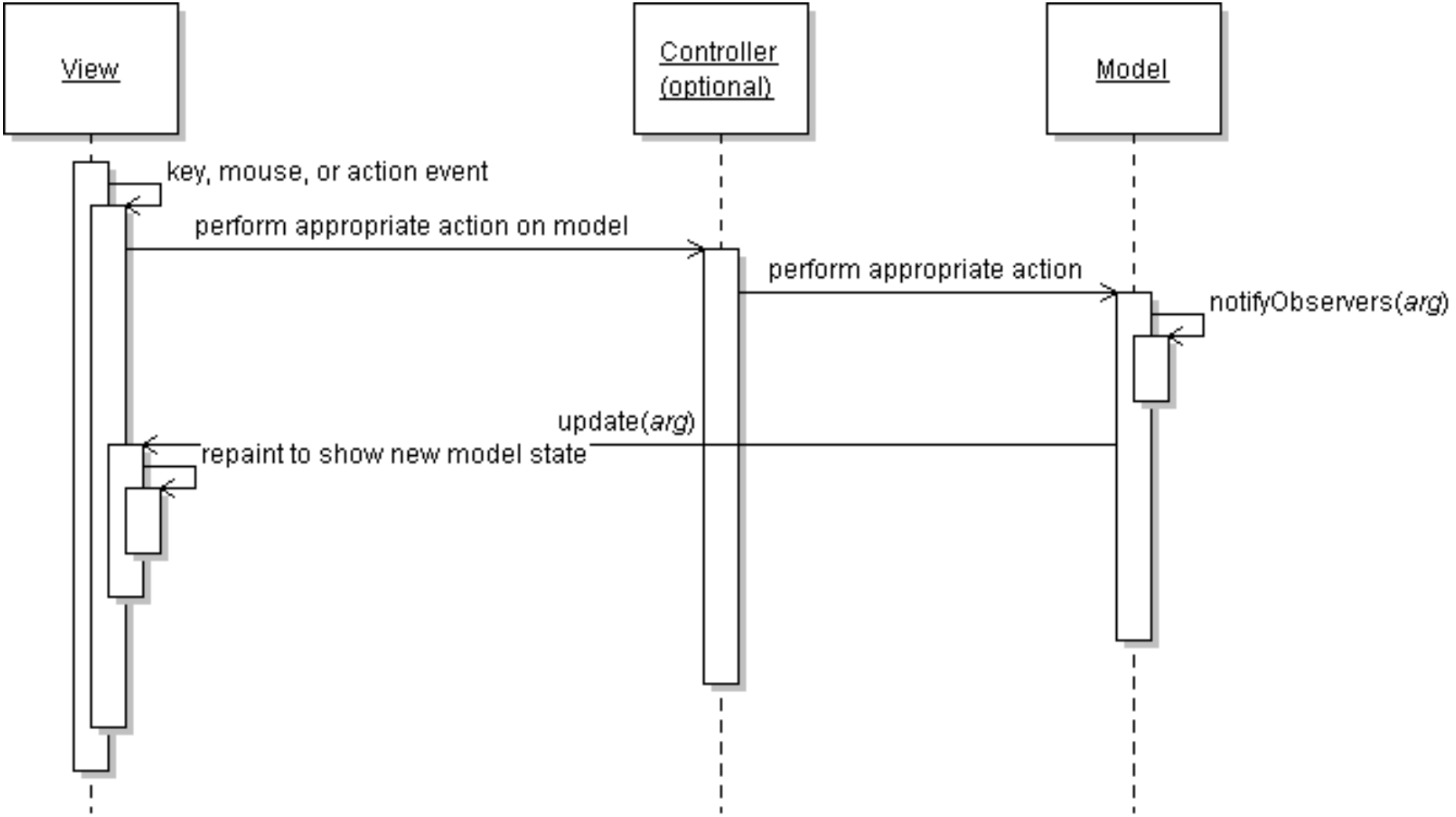
- *Solution:* Make the complex model object observable.

- **observable** object: An object that allows observers to examine it (notifies its observers when its state changes).
  - Permits customizable, extensible event-based behavior for data modeling and graphics.

Benefits of observer

- Abstract coupling between subject and observer; each can be extended and reused individually.
- Dynamic relationship between subject and observer; can be established at run time (can "hot-swap" views, etc) gives more programming flexibility.
- Broadcast communication: Notification is broadcast automatically to all interested objects that subscribed to it.
- Can be used to implement model-view separation in Java easily.

Observer sequence diagram



Observer interface

```
// import java.util.*;

public interface Observer {
    public void update(Observable o, Object arg);
}

public class Observable { ... }
```

- Basic idea:
  - Make your view code implement `Observer`.
  - Make your main model class extend `Observable`.
  - Attach the view to the model as an observer.
  - The view's `update` method will be called when the observable model changes, so write code to handle the change inside `update`.

Observable class

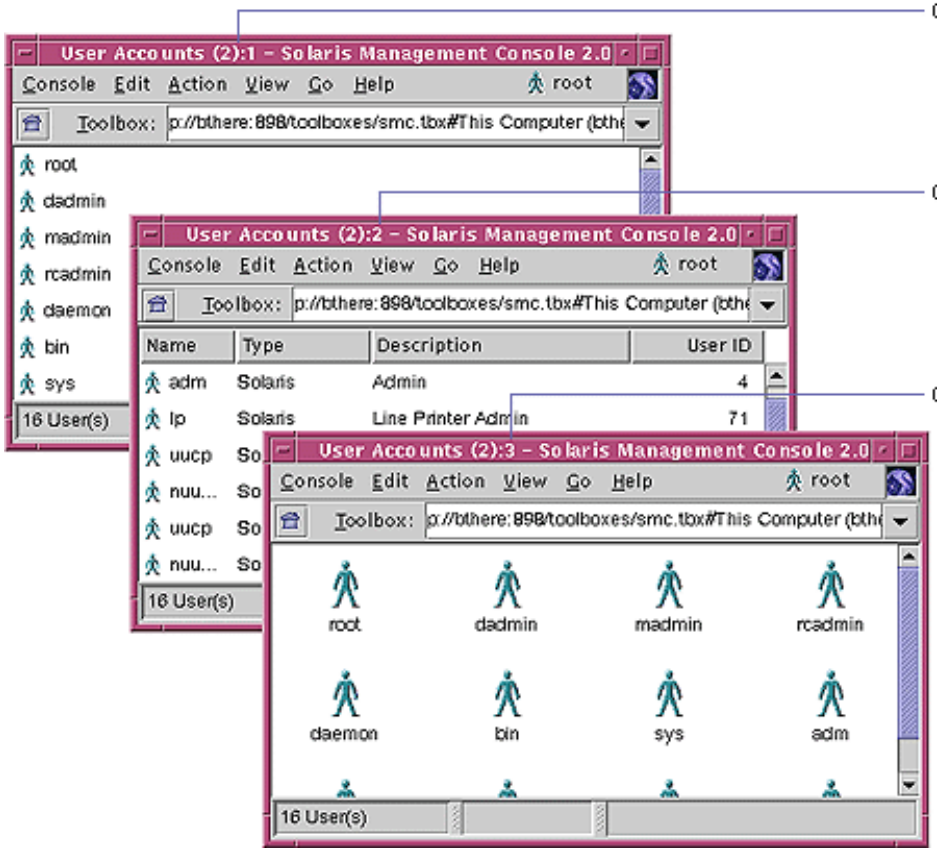
Method name	Description
`addObserver(`**Observer**`)`	adds an Observer to this object; its update method is called when notifyObservers is called
`deleteObserver(`**Observer**`)`	removes an Observer from this object
`notifyObservers()` `notifyObservers(`**arg**`)`	inform all observers about a change to this object; can pass optional object with more information
`setChanged()`	flags that this object's state has changed; *must* be called prior to each call to notifyObservers

Multiple views

- Make an `Observable` model.
- Write an abstract `View` superclass which is a `JComponent`.
  - make `View` an observer
- Extend `View` for all of your actual views.
  - Give each its own unique inner components and code to draw the model's state in its own way.
- Provide a mechanism in GUI to set the view (perhaps via menus).
  - To set the view, attach it to observe the model.

Multiple views examples

- File explorer (icon view, list view, details view)
- Games (overhead view, rear view, 3D view)
- Graphs and charts (pie chart, bar chart, line chart)



Model/view exercise

- Let's develop a graphical game of Rock-Paper-Scissors.
  - Write a GUI for the game using Swing.
  - Represent the game state as a model separate from the view.
  - Make the model observable and make the view observe it.