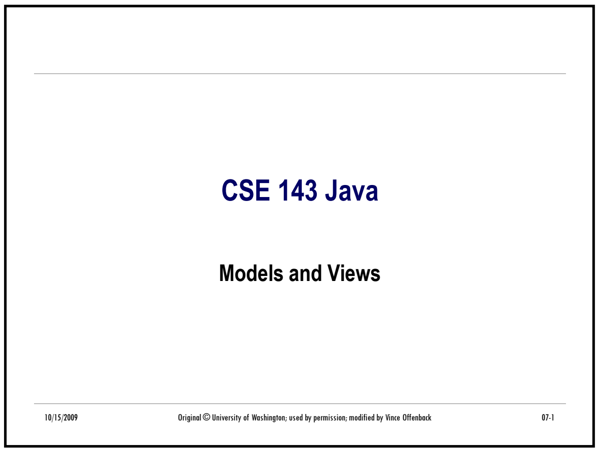
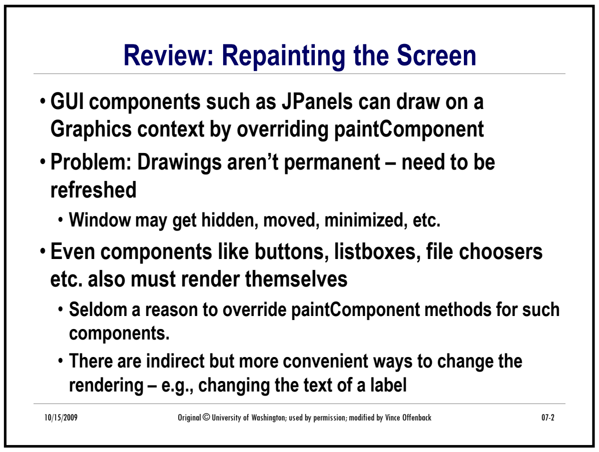


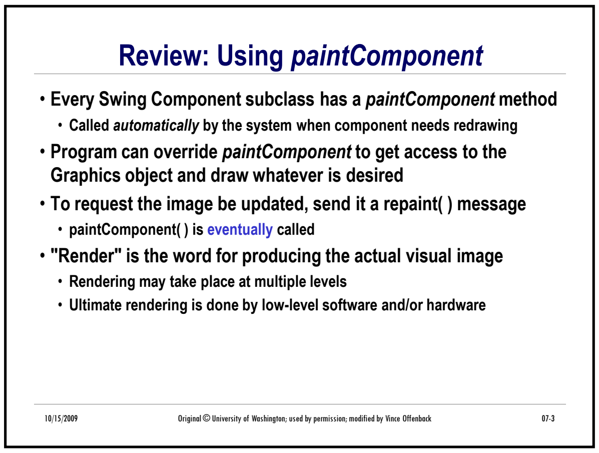
CSE 143 Java

Models and Views



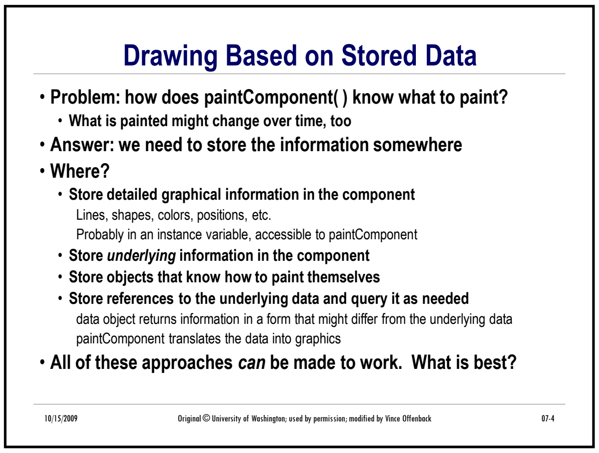
Review: Repainting the Screen

- GUI components such as JPanels can draw on a Graphics context by overriding paintComponent
- Problem: Drawings aren't permanent – need to be refreshed
  - Window may get hidden, moved, minimized, etc.
- Even components like buttons, listboxes, file choosers etc. also must render themselves
  - Seldom a reason to override paintComponent methods for such components.
  - There are indirect but more convenient ways to change the rendering – e.g., changing the text of a label



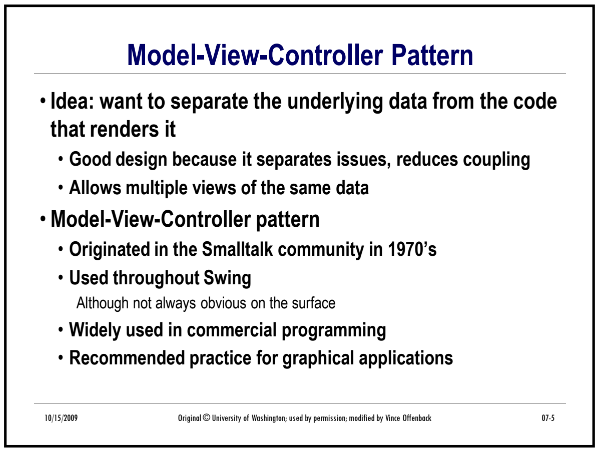
Review: Using *paintComponent*

- Every Swing Component subclass has a *paintComponent* method
  - Called *automatically* by the system when component needs redrawing
- Program can override *paintComponent* to get access to the Graphics object and draw whatever is desired
- To request the image be updated, send it a repaint( ) message
  - paintComponent( ) is eventually called
- "Render" is the word for producing the actual visual image
  - Rendering may take place at multiple levels
  - Ultimate rendering is done by low-level software and/or hardware



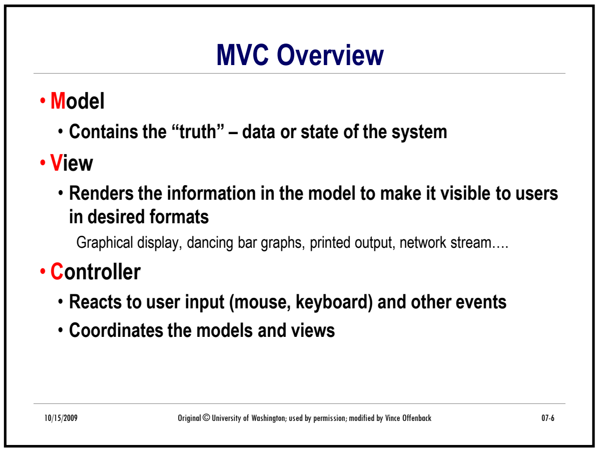
Drawing Based on Stored Data

- Problem: how does paintComponent( ) know what to paint?
  - What is painted might change over time, too
- Answer: we need to store the information somewhere
- Where?
  - Store detailed graphical information in the component
    - Lines, shapes, colors, positions, etc.
    - Probably in an instance variable, accessible to paintComponent
  - Store *underlying* information in the component
  - Store objects that know how to paint themselves
  - Store references to the underlying data and query it as needed
    - data object returns information in a form that might differ from the underlying data
    - paintComponent translates the data into graphics
- All of these approaches *can* be made to work. What is best?



Model-View-Controller Pattern

- Idea: want to separate the underlying data from the code that renders it
  - Good design because it separates issues, reduces coupling
  - Allows multiple views of the same data
- Model-View-Controller pattern
  - Originated in the Smalltalk community in 1970's
  - Used throughout Swing
    - Although not always obvious on the surface
  - Widely used in commercial programming
  - Recommended practice for graphical applications



MVC Overview

- Model
  - Contains the "truth" – data or state of the system
- View
  - Renders the information in the model to make it visible to users in desired formats
    - Graphical display, dancing bar graphs, printed output, network stream….
- Controller
  - Reacts to user input (mouse, keyboard) and other events
  - Coordinates the models and views

MVC Interactions and Roles (1)

- *Model*
  - Maintains the data in some internal representation
  - Maintains a list of interested viewers
  - Notify viewers when model has changed and view update might be needed
  - Supplies data to viewers when requested

    Possibly in a different representation
  - Generally should not know details of the display or user interface details

MVC Interactions and Roles (2)

- *View*
  - Maintains details about the display environment
  - Gets data from the model when it needs to
  - Renders data when requested (by the system or the controller, etc.; in Java, often implements paintComponent to do this)
  - May catch user interface events and notify controller
- *Controller*
  - Intercepts and interprets user interface events
  - Routes information to models and views

MVC vs MV

- Separating Model from View...
  - ...is just good, basic object-oriented design
  - usually not hard to achieve, with forethought
- Separating the Controller from the View is a bit less clear-cut
  - May be overkill in a small system
  - Often the Controller and the View are naturally closely related. Both frequently use GUI Components, which the Model is unlikely to do.
- Model-View Pattern
  - OK to fold the Controller and View together when it makes sense.
  - Fairly common in modern user interface package.

Implementation Note

- Model, View, and Controller are design concepts, not class names
- Might be more than one class involved in each
- Can have multiple views and controllers (only 1 model)
- The View might involve a number of different GUI components
- MVC might apply at multiple levels in a system
  - A Controller might use a listbox to interact with a user.
  - That listbox is part of the Controller
  - However, the listbox *itself* has a Model and a View, and possibly a Controller

Observer Pattern

- The MVC design is a particular instance of a more general idea: the “observer” pattern.
- Key idea: object that might change keeps a list of interested observers and notifies them when something happens.
  - Observers can react however they like
- Support in the Java library: class java.util.Observer and interface java.util.Observable
  - Model implements Observable
  - Observers register themselves with Observable objects and are notified when they change
  - Use this if you want, but can be overkill for simple projects

    CSE143 demo programs do this by hand for clarity