Lecture 10: Declarative UI

Quiz on Monday

- Topics
  - L1: usability
  - L2: user-centered design, user & task analysis
  - L3: MVC, observer, view hierarchy
  - L4: component, stroke & pixel models, redraw, double-buffering
  - L5: perception, cognition, motor, memory, vision
  - L6: events, dispatch & propagation, finite state controllers, interactors
  - L7: interface styles, direct manipulation, affordances, mapping, visibility, feedback
  - L8: Nielsen's heuristics
  - L9: paper prototyping, fidelity, look/feel, depth/breadth, computer prototyping, Wizard of Oz
  - L10: automatic layout, layout propagation, constraints, model-based user interfaces
- Everything is fair game
  - Class discussion, lecture notes, readings, assignments
- Closed book exam, 80 minutes

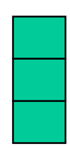
Today's Topics

- Automatic layout
- Constraints
- Model-based UI

Declarative vs. Procedural

- Declarative programming
  - Saying *what* you want
- Procedural programming
  - Saying *how* to achieve it

Declarative
A tower of 3 blocks.



Procedural
1. Put down block A.
2. Put block B on block A.
3. Put block C on block B.

Example: Automatic Layout

- Layout = component positions & sizes
  - Sometimes called geometry
- Declarative layout
  - Declare the components
    - Java: component hierarchy
  - Declare their layout relationships
    - Java: layout managers
- Procedural layout
  - Write code to compute positions and sizes

Reasons to Do Automatic Layout

- Higher level programming
  - Shorter, simpler code
- Adapts to change
  - Window size
  - Font size
  - Widget set (or theme or skin)
  - Labels (internationalization)
  - Adding or removing components

Layout Managers

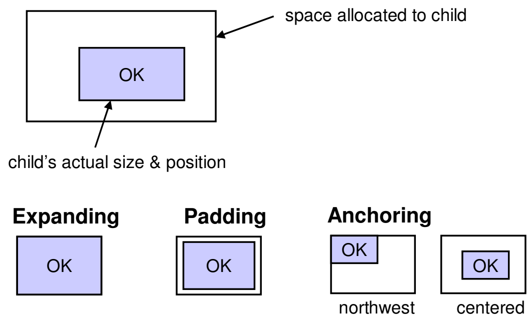
- Layout manager performs automatic layout of a container's children
  - 1D (BoxLayout, FlowLayout, BorderLayout)
  - 2D (GridLayout, GridBagLayout, TableLayout)
- Advantages
  - Captures most common kinds of layout relationships in reusable form
- Disadvantages
  - Can only relate **siblings** in component hierarchy

Layout Propagation

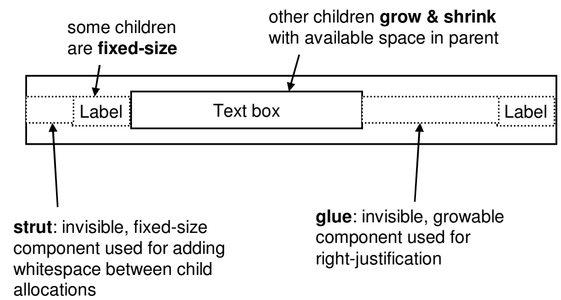
```
computePreferredSize(Container parent)
    for each child in parent,
        computePreferredSize(child)
    compute parent's preferred size from children
        e.g., horizontal layout,
        (prefwidth,prefheight) = (sum(children prefwidth),
                                  max(children prefheight)

layout(Container parent)  requires: parent's size already set
    apply layout constraints to allocate space for each child
      child.(width,height) = (parent.width / #children, parent.height)
    set positions of children
      child[i].(x,y) = (child[i-1].x+child[i-1].width, 0)
    for each child in parent,
        layout(child)
```

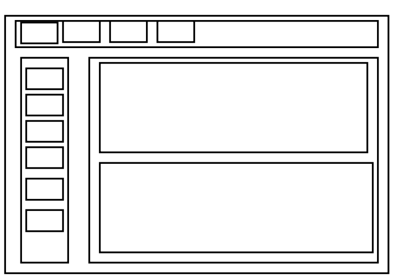
How Child Fills Its Allocated Space



How Child Allocations Grow and Shrink



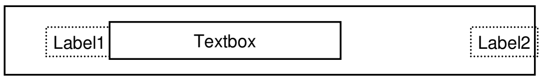
Using Nested Panels for Layout



Constraints

- Constraint = relationship among variables
  - Automatically maintained by system
    - **Constraint propagation:** When a variable changes, other variables are automatically changed to satisfy constraint

Using Constraints for Layout



label1.left = 5
label1.width = textwidth(label1.text, label1.font)
label1.right = textbox.left
label1.left + label1.width = label1.right

textbox.width >= parent.width / 2
textbox.right <= label2.left

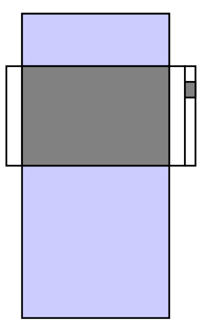
label2.right = parent.width

Using Constraints for Behavior

- Input
  - checker.(x,y) = mouse.(x,y)
    if mouse.button1 && mouse.(x,y) in checker
- Output
  - checker.dropShadow.visible = mouse.button1 &&
    mouse.(x,y) in checker
- Interactions between components
  - deleteButton.enabled = (textbox.selection != null)
- Connecting view to model
  - checker.x = board.find(checker).column * 50

Constraints Are Declarative UI

$$\frac{\text{scrollbar.thumb.y}}{\text{scrollbar.track.height} - \text{scrollbar.thumb.height}} = \frac{\text{-scrollpane.child.y}}{\text{scrollpane.child.height} - \text{scrollpane.height}}$$



Model-Based User Interfaces

- Programmer writes logical model of UI
  - State variables (bool, int, string, list)
  - Commands
- System generates actual presentation
  - Grouping into windows, tabs, panels
  - Widget selection
  - Layout
- Same motivation as other declarative UI
  - Higher-level programming
  - Adapting to change: particularly for devices and users
    - Screen size (watch, phone, PDA, laptop, desktop, wall)
    - Widgets available (phone vs. desktop)
    - Input style (mouse vs. arrow buttons; speech, finger, pen)
    - Output style (speech vs. display)
    - User behavior (uses some components more)

UIML Approach

- Programmer writes XML spec for both model and view
  - Model: <description>
  - Grouping: <structure>
  - Labels: <data>
  - Widget selection & layout: <style>
  - Behavior: <events>
- Separation of concerns allows managing families of interfaces
  - Reuse application parts for multiple devices
  - Reuse device parts for multiple applications

SUPPLE Approach

- Application model
  - Elements: state variables and commands
  - Tree structure: grouping
  - Labels for each element
- Device description
  - Widget set
  - Navigation costs (switch, enter, leave)
  - Manipulation costs (changing value)
- User data
  - Trace of actions by a user
- System automatically searches for a presentation
  - Assignment of widgets to model elements that minimizes cost of user trace