The Java Beans Design Pattern

Jeff Offutt

http://www.cs.gmu.edu/~offutt/

SWE 642

Software Engineering for the World Wide Web

Java Server Pages and Beans

- Use JSPs to define look of web pages, and fill them with information from Java Beans
- This helps separate presentation (HTML) from content (variables)
- Beans are based on
  - Events
  - Properties
  - Methods
- The JavaBeans API specification:
  - http://www.oracle.com/technetwork/java/javase/documentation/spec-136004.html

Java Beans Purpose

- Java Beans provide design patterns to :
  - Set and retrieve properties
  - Pass events between objects
  - Create instances of objects
  - Store objects using serialization (lists)
- Also possible to describe information about the bean (meta-info)
- The concepts have developed from graphical programming
  - Specifically from the event-notify pattern

Java Beans and Properties

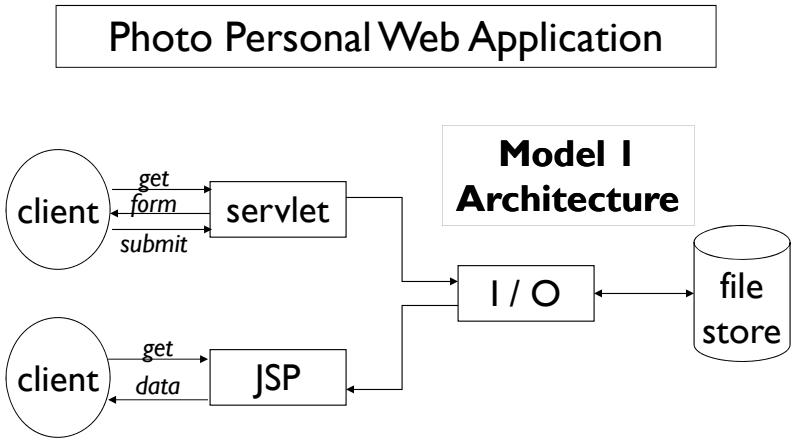
Web programming often uses properties

- From the outside : properties store and retrieve values
- From the inside : values can be stored in variables, files, databases, computed, or retrieved from another object
- Properties have two common accessor methods:
  - public void setAge (int age)
  - public int getAge ()
- Java introspection : given a name (age) and a type (int), accessor methods are assumed to exist
- JSP syntax—two equivalent types of statements
  1. <jsp: getProperty id="user" property="age" />
  2. <%= user.getAge() %>

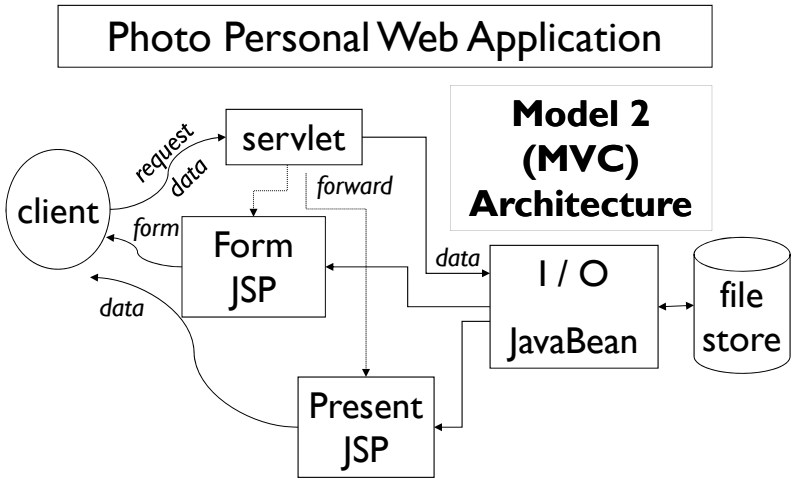
Java Bean Overview

- A component is a reusable software building block :
  - *A pre-built piece of encapsulated application code that can be combined with other components and with handwritten code to rapidly produce a custom application*
  - There are many definitions … mostly fairly similar
- A component architecture defines
  - How a collection of components should divide up functions
  - How the components should communicate
- The J2EE platform defines *JavaBeans* for component architectures
  - Conventions for how software components interact
  - Some built-in Java classes

Example Component Architecture



Example Component Architecture



What are JavaBeans?

- Definition : "*A JavaBean component is an object that conforms to a communication and configuration protocol, as prescribed by the JavaBeans specification*"
- Standard Java classes versus beans :
  - A Bean is a class or a group of classes that follows the naming convention of the JavaBeans API
  - This allows introspection
- Predefined design patterns to relieve developers from the burden of low and mid-level design
- Ultimately an outgrowth of data abstraction and ADTs

Java Bean Technologies

Five key technologies support the design pattern:

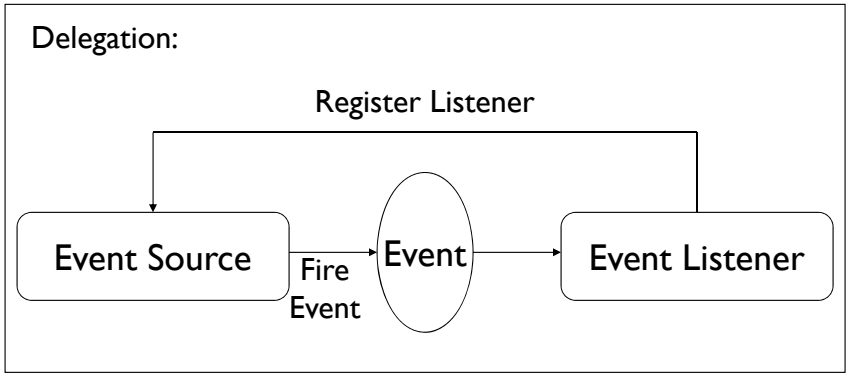
1. Bean events and event handling
2. Bean properties
3. Introspection
4. Customization
5. Persistence

1: Events

- Beans are interconnected via events
- The event model is adopted from the JDK 1.1 AWT event model
- Goals :
  - Make it easier to connect methods to events
  - Use strong typing
  - Use standard "design patterns"
- Event firing
  - Beans must allow "listeners" to register
  - An event "fires" by invoking a named, typed method on a *listener* (another Java class)

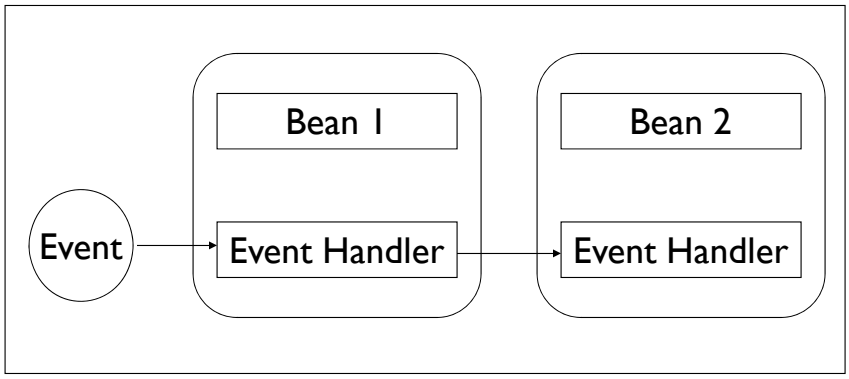
1: Event Handling

- Two types of event sources :
  - Unicast : Allows only one listener to register for events
  - Multicast : Allows multiple listeners to register for events



1: Event Handling

Beans are interconnected by using JDK event handling



2: Bean Properties

- Bean property :
  - A named attribute of a Bean that can affect its behavior or its appearance
  - To speak plainly : A variable
- Accessed via getter / setter methods
- Beans can be connected using properties and methods

2: Bean Properties

- Types of Bean Properties :
  1. Simple : A single value whose changes are independent of any other property
  2. Bound : A change requires another Bean to be notified
     - Example: Change to *address* requires *phone number* to be changed
  3. Constrained ("vetoable") : A change must be *validated* by another Bean
     - The change may be *rejected*
     - Example : A *password* can be changed only if *current user* is authorized
  4. Indexed : A range of values instead of a single value is supported

2: Bean Properties

- Properties can be read-only, write-only, or read-write, according to the accessor methods
- Accessor Methods :

  The name of the Bean property and the names of the property accessor methods depend on each other

2: Bean Properties

- For a simple read-write property of type Clock :

  public Clock getHour () ;
  public void setHour (Clock p) ;
- Boolean properties :

  isAlarm ()
  setAlarm ()
- Indexed properties :

  public alarmTime getAlarm (int index) ;
  public void setAlarm (int index, alarmTime p) ;
  public alarmTime [ ] getAlarm () ;
  public void setTime (alarmAlarm [ ] p) ;

2: Implementing Bean Properties

Defining simple properties

Bean ColoredBean with one simple property color :

```
public class ColoredBean
{
  private Color myColor = Color.black ;
  public Color getColor ()
  {
     return myColor ;
   }
   public void setColor (Color newColor)
   {
      myColor = newColor ;
   }
} / / ColoredBean
```


2: Implementing Bean Properties

Defining bound properties

- Accessor methods are defined just as for simple properties
- Additionally the Bean has to have : *PropertyChangeEvents*
  - This will notify *PropertyChangeListeners* by calling their *propertyChange* methods

2: Implementing Bean Properties

Defining constrained properties

- The set method is written as follows :
  - Save the old value
  - Notify registered *VetoableChangeListeners*
  - If no listeners veto, set the property to the new value, else throw a *PropertyVetoException*
- When changing the value of a constrained property, the source Bean must :
  - catch exceptions
  - eventually revert the old value, and
  - notify all listeners of the reversion

3: Introspection

- For an application to use a Bean, the application must have certain information about the Bean
- Information must be platform independent and software-readable
- Introspection allows the Beans *properties*, *events* and *methods* to be discovered
- Assumes the standard design conventions are followed
- Explicit information :
  - developers can give specific information about a Bean by supplying an object whose class implements *java.beans.BeanInfo*

3: Introspection
Uses for BeanInfo

Reasons for explicitly adding BeanInfo

- Limit a long list of properties or events to a few important ones
- Provide a GIF image as an icon for the builder's component palette
- Add descriptive, human readable, and possibly localized names for properties
- Make properties "hidden" or "expert" to accommodate different models of development

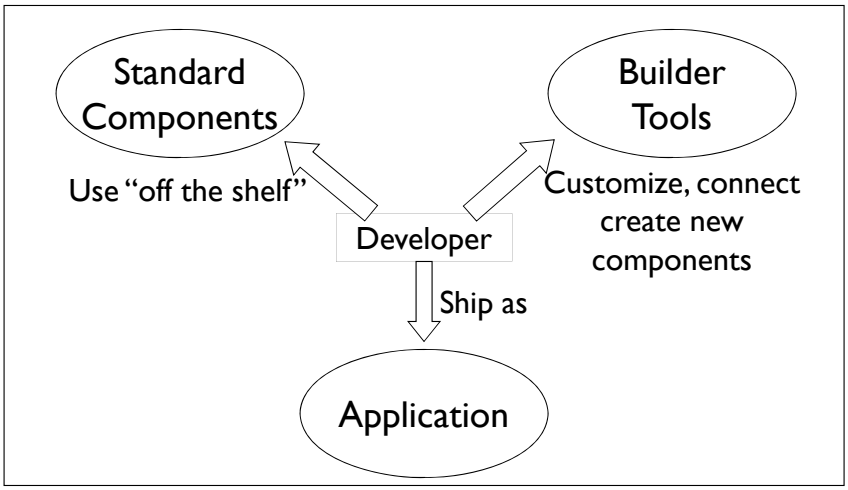
4: Bean Customization

- Beans expose properties so they can be customized at design time
- Customization allows designers to modify Bean properties within an application builder
- Properties are edited through property sheets
- Customization is supported in two ways :
  - using property editors
  - using more sophisticated Bean customizers

5: Bean Persistence

- Bean properties can be stored to disk
- How to store them?
  - Make the Bean object persistent
  - Java supports persistence through serialization
- Serialization :
  - Classes must implement the *Serializable* interface
  - Serializable objects can be written to and read from a stream
  - Example : Store to and read from a file
- By default, serialization includes all fields of an object
  - Fields that must be excluded have to be marked *transient* or *static*

Developing with Beans



JavaBeans Summary

- JavaBeans provide the component architecture of Java
- The technologies JavaBeans builds upon are existing Java features :
  - Object orientation
  - Reflection
  - Serialization
- Beans can be created easily
  - Existing programs are often already programmed in a "Bean-like" way