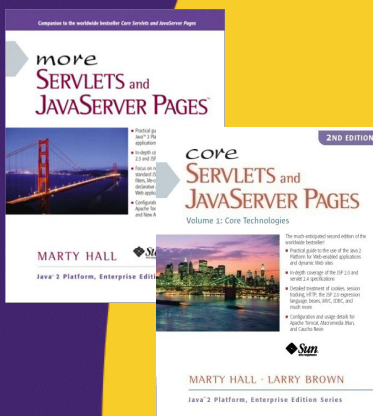




# The Spring Framework: Foundations

Originals of Slides and Source Code for Examples:  
<http://courses.coreservlets.com/Course-Materials/spring.html>

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- Courses developed and taught by Marty Hall
  - Java 5, Java 6, intermediate/beginning servlets/JSP, advanced servlets/JSP, Struts, JSF, Ajax, GWT, custom mix of topics
- Courses developed and taught by coreservlets.com experts (edited by Marty)
  - Spring, Hibernate/JPA, EJB3, Ruby/Rails

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# Topics in This Section

- Motivation
- Spring Hello World
- POJO development
- Runtime environment
- Dependency injection
- Inversion of control

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## Motivation

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# Software Development Challenges

- **Solutions are complex**
- **Requirements are constantly in flux**
- **Software architecture must be flexible**
- **Software components must be verifiable**

# EJB 2.0 Approach

- **Complex products**
- **Unmaintainable systems**
- **Non-portable, framework-committed business components**
- **Unpredictable systems**

## Spring Approach

- **Products based on simplicity**
- **Maintainable systems**
- **Framework-independent software**
- **Portable components**
- **Testable components**
- **Reliable and predictable systems**

## Pure Java

- **Founded on POJO-based development**
  - Ordinary Java classes that follow no special APIs
- **Non-invasive for pre-existing POJOs**
- **Rewards framework-independent business logic**
- **Encourages new software to be written as POJOs**
- **Results in highly portable, reusable, and verifiable software**

# More With Less Custom Code

- **Expand capabilities with less code**
- **Extensive and tested service abstractions**
  - Email
  - JMS
  - JMX
  - JSF
  - JDBC
  - etc...
- **Replaces generic corporate libraries**
- **Mitigates custom integration activities**
- **Consistency eases integration because spring platform is easy to use**

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# Modular

- **Helps only where needed**
  - Modularity allows only relevant components to be introduced into the application
  - For instance choose one:
    - Spring BeanFactory
    - Spring JMX
    - Spring JDBC
  - Framework can be interfaced in deep or shallow layers.
  - Interfaces are consistent at each layer
- **Turn-key solution**
  - Spring components can be integrated quickly, with minimal effort and predictable results
  - Interfaces are clear and consistent

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## Widely Available

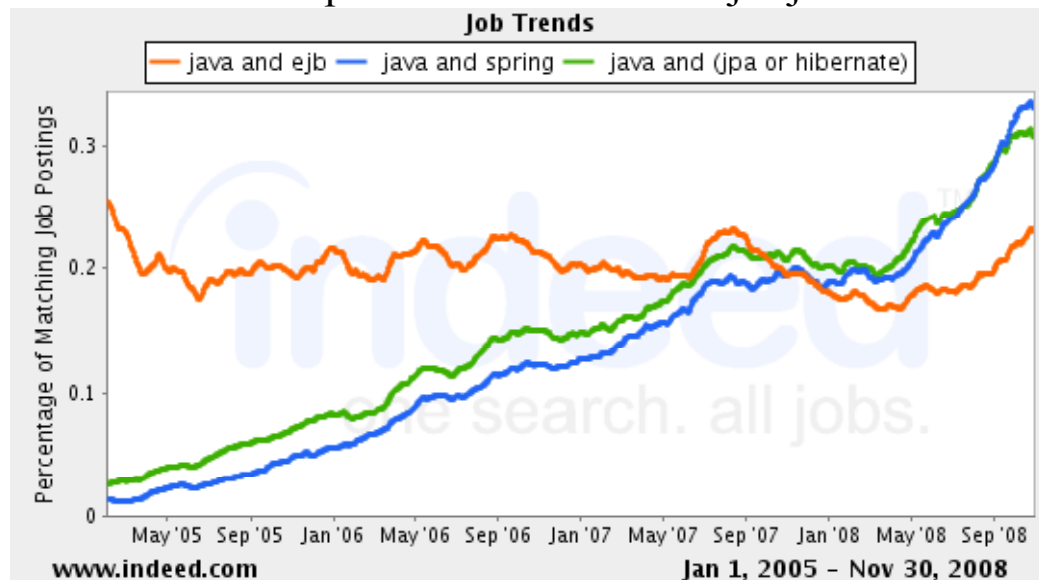
- Spring is integrated into numerous frameworks
- Broad adoption possible because the container is portable and lightweight
  - The container itself is designed as a POJO
- Integration without third-party support
- Performance overhead is rarely a consideration

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## Spring Jobs

- From indeed.com
  - Claims to compile data from most major job sites



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# Spring Setup

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## Spring Download

- **<http://www.springframework.org/download>**
  - Current version: 2.5.5 (6/2008)
    - Requires JDK 1.4+
  - spring-framework-2.5.5-with-dependencies.zip
    - Spring Framework binaries and source
    - Third-party binaries
    - Documentation
      - API
      - HTML reference
      - Project samples
      - HOW-TO guides

# Spring Blank Project

- **spring-blank.zip**

- Available from  
<http://courses.coreservlets.com/Course-Materials/spring.html>

Path	Description
<b>src</b>	Empty applicationContext.xml. For new Java source files.
<b>lib</b>	Minimum Spring JARs for API and runtime access to the Spring IoC container
<b>build.xml</b>	Optional Apache ANT build configuration
<b>pom.xml</b>	Optional Maven 2 build configuration

# Spring Blank Project and Eclipse

- **Download spring-blank.zip**

- <http://courses.coreservlets.com/Course-Materials/spring.html>

- **Import archive as an existing project into the current workspace**

- From the Eclipse menu bar select **File** and **Import**
- From the **Import (Select)** dialog, select **Existing Projects into Workspace** and **Next**
- From the **Import (Import Projects)** dialog, select the radio button **Select archive file** and **Browse**
- Locate and select **spring-blank.zip** and select **Open**
- Verify the project entry, **spring-blank**, to be present in the project list
- Select **Finish**



# Spring Blank Project and Apache Ant

- Download and unpack spring-blank.zip
- Install Apache Ant, version 1.6.5+
- Execute various Ant build commands

Command	Description
<b>clean</b>	Removes the build directory <b>target</b> and all nested build artifacts
<b>compile</b>	Compiles production Java source contents under <b>src/main/java</b> and places class binaries into <b>target/classes</b>
<b>test</b>	Executes the <b>compile</b> command and compiles and executes tests found under <b>src/test/java</b>
<b>package</b>	Packages production Java source and resource contents into a jar file. The jar package is placed in the build directory, <b>target</b>

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# Spring Blank Project and Maven 2

- Download and unpack spring-blank.zip
- Execute various Maven commands

Command	Description
<b>clean</b>	Removes the build directory <b>target</b> and all nested build artifacts
<b>compile</b>	Compiles production Java source contents under <b>src/main/java</b> and places class binaries into <b>target/classes</b>
<b>test</b>	Executes the <b>compile</b> command and compiles and executes tests found under <b>src/test/java</b>
<b>package</b>	Packages production Java source and resource contents into a jar file. The jar package is placed in the build directory, <b>target</b>

- See pom.xml configuration for additional dependency options

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# Spring Documentation

- **Top-level documentation page**
  - <http://www.springframework.org/documentation>
- **Wiki**
  - <http://opensource.atlassian.com/confluence/spring>
- **Forum**
  - <http://forum.springframework.org>
- **Books**
  - *Spring Recipes*. APress 2008
  - *Spring in Action*. Manning 2007
  - *Agile Java Development with Spring, Hibernate and Eclipse*. Sams 2006

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## Spring Hello World

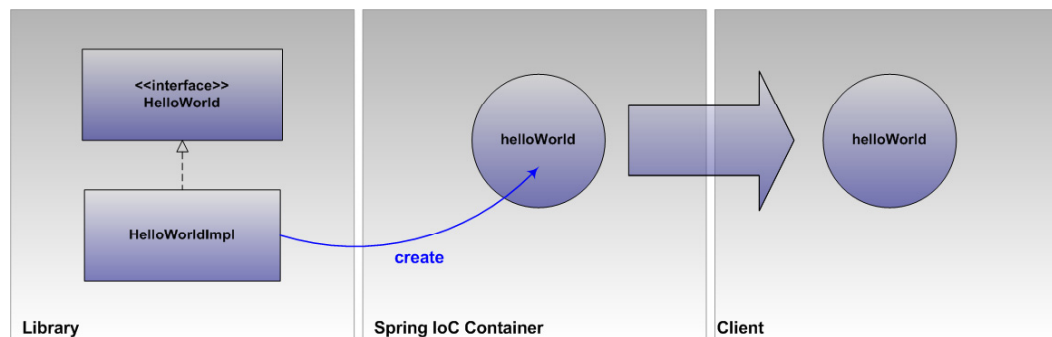
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# Spring Hello World

- **Code a plain Java class model**
  - Use the interface pattern by coding a **HelloWorld** interface and a **HelloWorldImpl** implementation
- **Configure the Spring IoC container**
- **Instantiate the Spring IoC container**
- **Acquire the object from the Spring IoC container**
  - The client must only have knowledge of the interface, **HelloWorld**

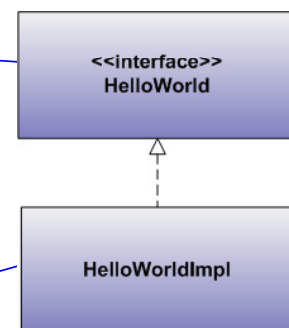


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# Plain Java Class Model

```
public interface HelloWorld {  
    public void execute();  
}  
  
public class HelloWorldImpl  
    implements HelloWorld {  
    public void execute() {  
        System.out.println("Hello World!");  
    }  
}
```



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# Spring IoC Configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-2.5.xsd">

    <bean id="helloWorld"
          class="coreservlets.HelloWorldImpl" />

</beans>
```

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# Executing Spring Hello World

```
import org.springframework.beans.factory.*;
import org.springframework.context.support.*;

public class Main{
    public static void main(String[] args) {
        BeanFactory beanFactory =
            new ClassPathXmlApplicationContext(
                "applicationContext.xml");

        HelloWorld helloWorld =
            (HelloWorld) beanFactory.getBean("helloWorld");

        helloWorld.execute();
    }
}
```

Spring IoC container

HelloWorld Interface

Spring-managed bean name

Standard output

```
Hello World!
```

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# Background: POJO Development

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## Introduction

- **Plain Old Java Object**
- **What is it?**
  - Business logic
  - Framework independent
- **What it's not**
  - Limited to the value object pattern
  - Framework implementation software
- **Features**
  - Portable
  - Testable
  - Flexible

# POJO Development Process

- **Describe the system agents and interactions**
  - POJO behavioral classes, domain model, and dependencies
- **Determine component responsibilities**
  - Methods
- **Identify information items discovered during program execution**
  - Method parameters
- **Identify information available during initialization**
  - Initialization parameters for constructor, setter, or factory

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## POJO Development Process Example



- **Agents**
  - BookLibrary and Client
- **Interactions**
  - Client uses BookLibrary
  - BookLibrary aggregates Book
- **Responsibilities**
  - BookLibrary must search for books by title
  - Clients must supply search parameters; i.e. title values

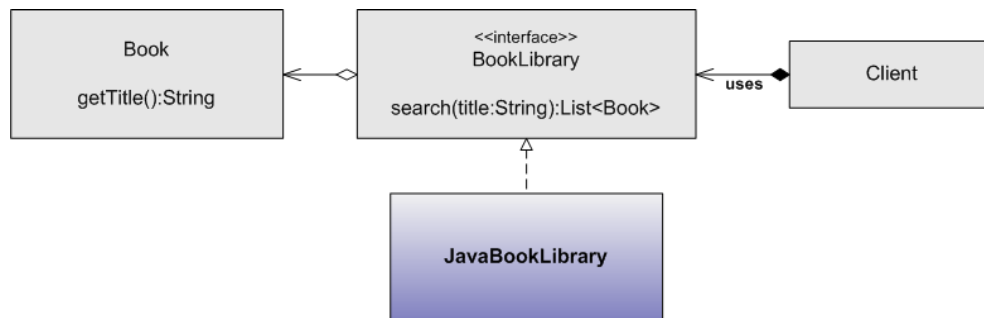
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# POJO Development Process

- Develop implementation

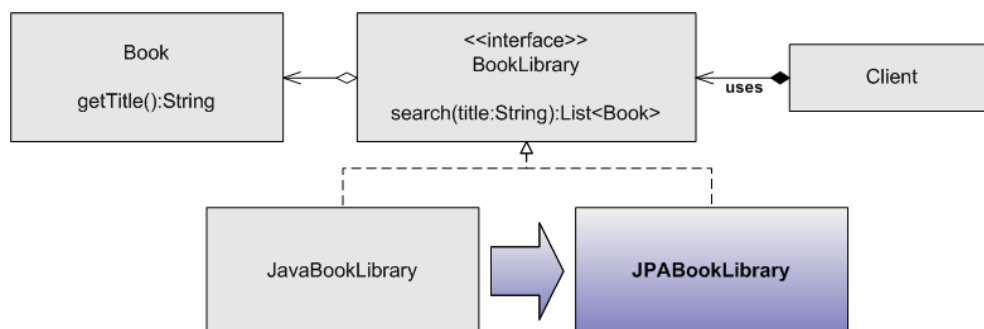


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# POJO Development Process

- Plan for change

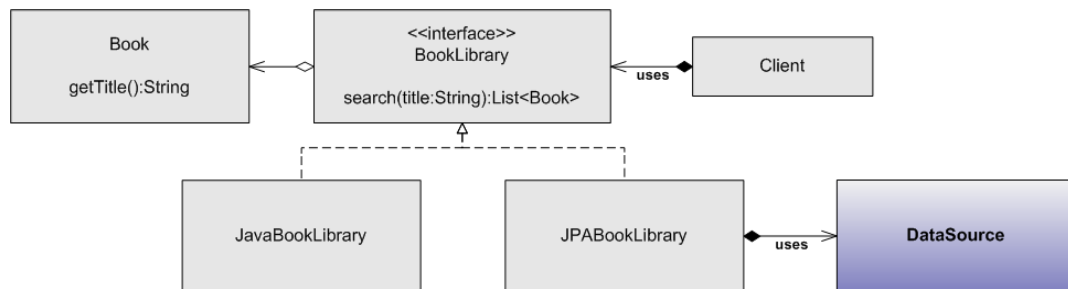


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# POJO Development Process

- Plan for new and additional dependencies

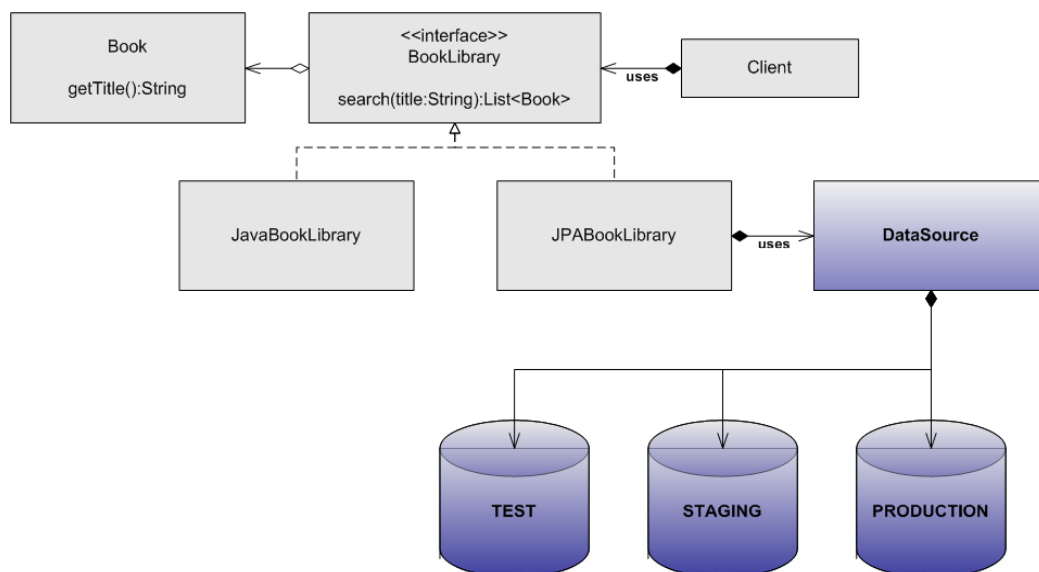


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# POJO Development Process

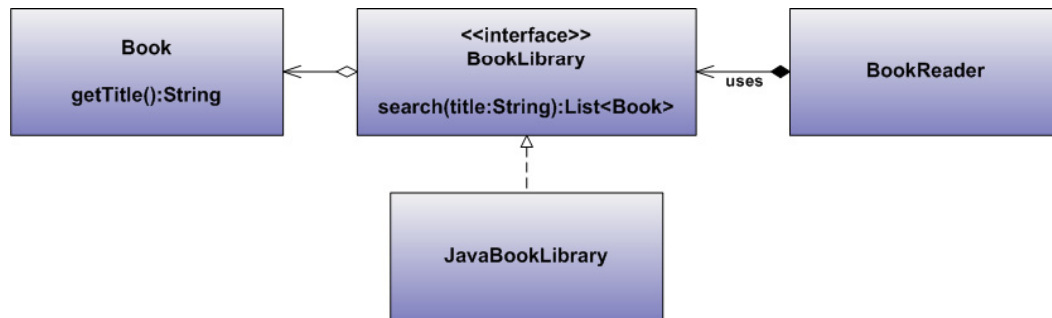
- Plan for complex configuration requirements



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# POJO Implementation Example

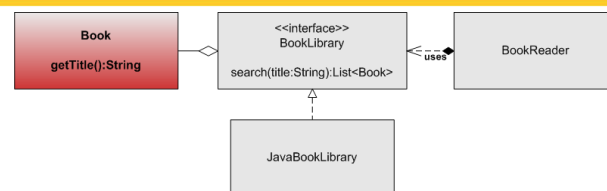


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# Book Implementation

```
public class Book {  
  
    private String title;  
  
    public Book(String title) {  
        this.title = title;  
    }  
  
    public String getTitle() {  
        return title;  
    }  
  
    public String toString() {  
        return title;  
    }  
}
```



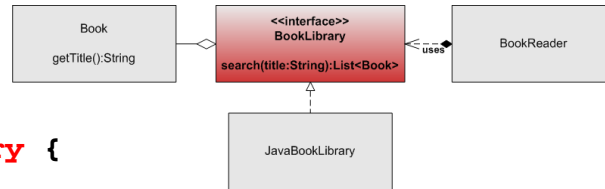
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# BookLibrary Implementation

```
import java.util.List;
```

```
public interface BookLibrary {  
  
    public List<Book> search(String title);  
  
}
```

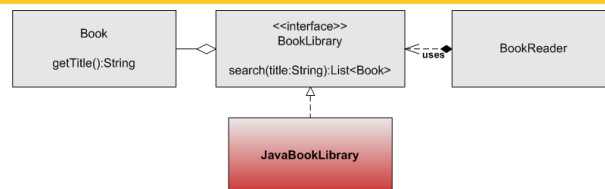


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# BookLibrary Implementation

```
public class JavaBookLibrary  
    implements BookLibrary {  
  
    private List<Book> books;  
  
    public JavaBookLibrary() {  
        this.books = Arrays.<Book>asList(  
            new Book("Core Servlets and JavaServer Pages"),  
            new Book("More Servlets and JavaServer Pages"));  
    }  
  
    public List<Book> search(String title) {  
        List<Book> results = new ArrayList<Book>();  
        for(Book book : books){  
            if(book.getTitle().contains(title)){  
                results.add(book);  
            }  
        }  
        return results;  
    }  
}
```



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# Client Implementation

```
public class BookReader {
```

```
    private BookLibrary bookLibrary;
```

```
    public BookReader() {
```

```
        this.bookLibrary = new JavaBookLibrary();
```

```
    }
```

```
    public List read() {
```

```
        List<Book> books = bookLibrary.search("Java");
```

```
        for(Book book : books) {
```

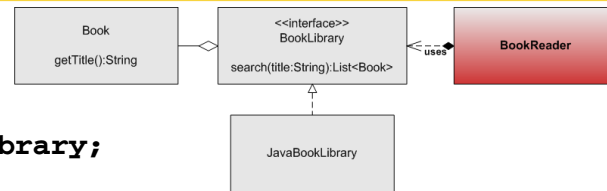
```
            System.out.printf("Reading: %s%n", book);
```

```
        }
```

```
        return books;
```

```
    }
```

```
}
```



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# Runtime Environment

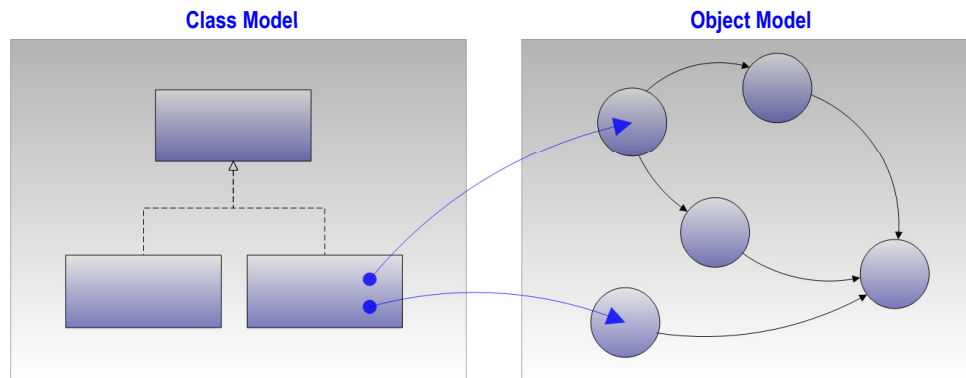
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# Runtime Model

- Transition from a class system to an object system
- An object model provides a unique and specific instantiation of the class specification

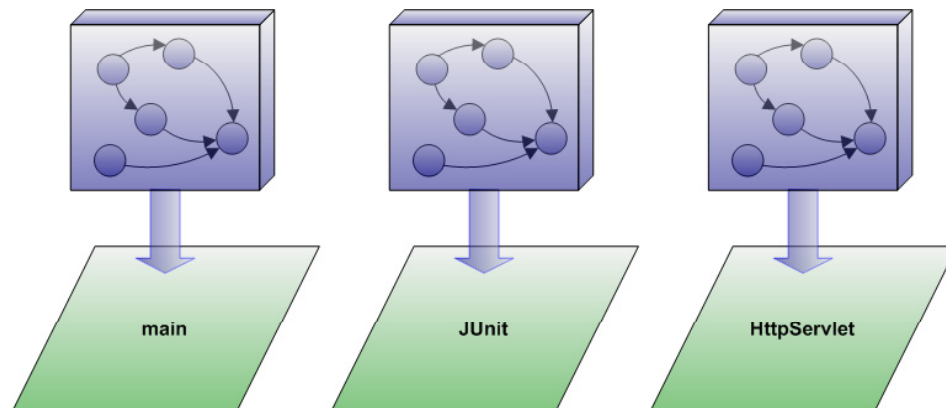


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# Runtime Context

- Multiple deployment contexts
- Complex object models should be portable
- Object models should be configurable to support changes between environments



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# Runtime Example

```
public class Main {  
  
    public static void main(String[] args) {  
  
        BookReader client = new BookReader();  
  
        List<Book> books = client.read();  
  
        System.out.printf("Client read: %s books%n",  
                           books.size());  
  
    }  
}
```

Standard output

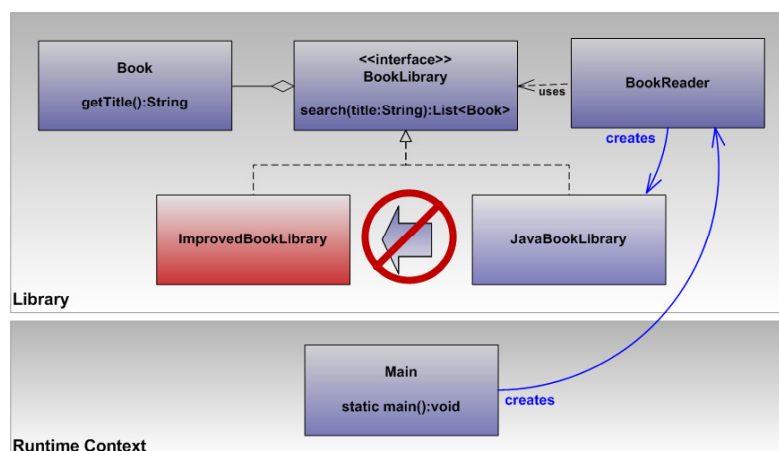
```
Reading: Core Servlets and JavaServer Pages  
Reading: More Servlets and JavaServer Pages  
Client read: 2 books
```

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# Model Analysis

- **Hard-coded implementation choices**
  - Object model **cannot** be reconfigured
  - Future implementation types **cannot** be used without modifying and rebuilding BookReader

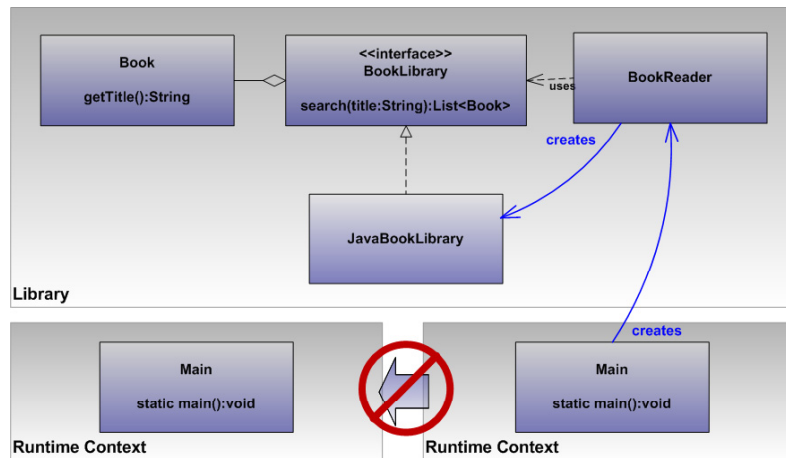


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# Model Analysis

- **Hard-coded model configuration**
  - Object model is **not** portable



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## Manual (Non-Spring) Dependency Injection

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# Dependency Injection

- **Delivers object dependencies at runtime**
- **Encourages the separation of responsibilities**
- **When used with the interface pattern**
  - Isolates implementations from clients
  - Minimizes the impact on clients when implementations evolve

# Dependency Injection Process

- **Design depending types to receive implementations**
  - Allow dependencies to be supplied using property setters or constructors
    - Other dependency injection methods are also available, such as field injection, but requires third-party or Java reflection support
- **Avoid constructing objects from the client to fulfill dependencies**
  - For example, do not use the **new** operator to manage services

# Dependency Injection Candidate

```
public class BookReader {
```

```
    private BookLibrary bookLibrary;
```

```
    public BookReader() {
```

```
        this.bookLibrary = new JavaBookLibrary();
```

```
    }
```

```
    public List read() {
```

```
        List<Book> books = bookLibrary.search("Java");
```

```
        for(Book book : books){
```

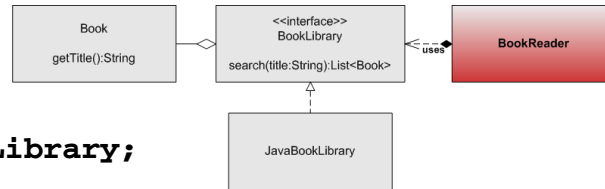
```
            System.out.printf("Reading: %s%n", book);
```

```
        }
```

```
        return books;
```

```
    }
```

```
}
```



Creates dependency

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# Dependency Injection Example

```
public class BookReader {
```

```
    private BookLibrary bookLibrary;
```

```
    public BookReader(BookLibrary bookLibrary) {
```

```
        this.bookLibrary = bookLibrary;
```

```
    }
```

```
    public List read() {
```

```
        List<Book> books = bookLibrary.search("Java");
```

```
        for(Book book : books){
```

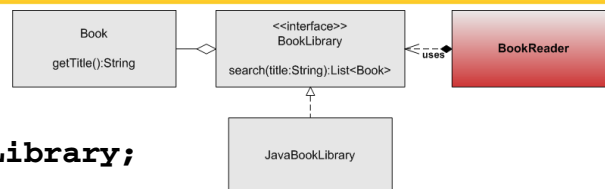
```
            System.out.printf("Reading: %s%n", book);
```

```
        }
```

```
        return books;
```

```
    }
```

```
}
```



Dependency injection interface

Interface type  
NOT the implementation type

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# Runtime Example

```
public class Main {  
    public static void main(String[] args) {  
        BookLibrary service = new JavaBookLibrary();  
        BookReader client = new BookReader(service);  
        List<Book>books = client.read();  
        System.out.printf("Client read: %s books%n",  
                           books.size());  
    }  
}
```

Dependency creation moved out of BookReader

Dependency injection

Standard output

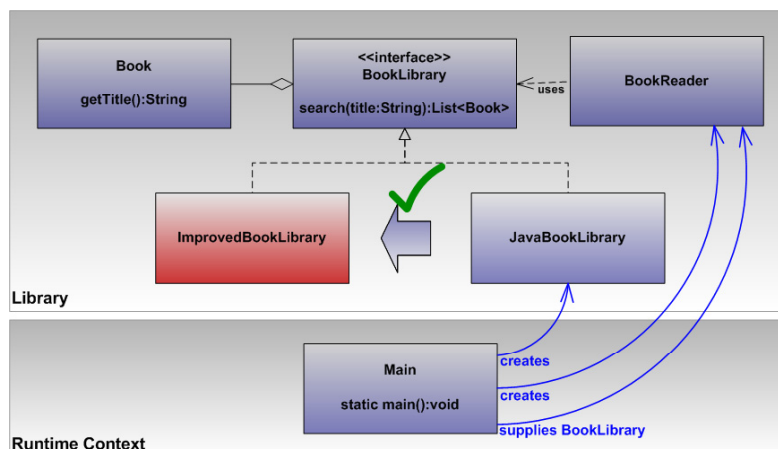
```
Reading: Core Servlets and JavaServer Pages  
Reading: More Servlets and JavaServer Pages  
Client read: 2 books
```

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# Model Analysis

- **Dynamic implementation choices**
  - Object model **can** be reconfigured
  - Future implementation types **can** be used without modifying and rebuilding BookReader

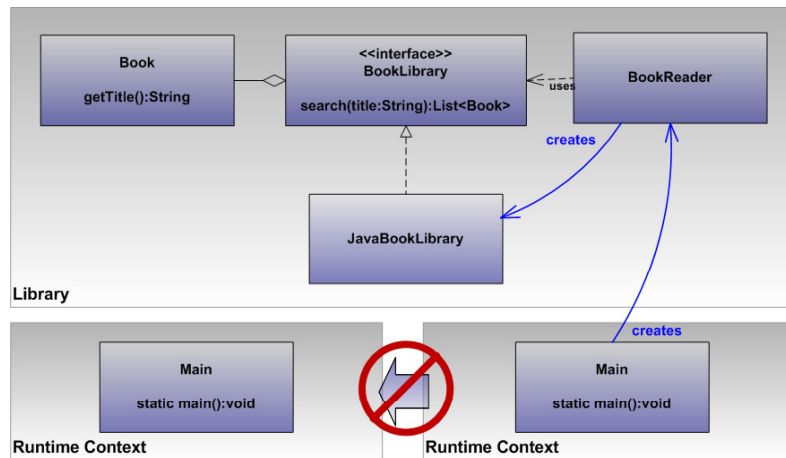


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# Model Analysis

- **Hard-coded model configuration**
  - Object model is **not** portable



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## Manual (Non-Spring) Inversion of Control

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# Introduction

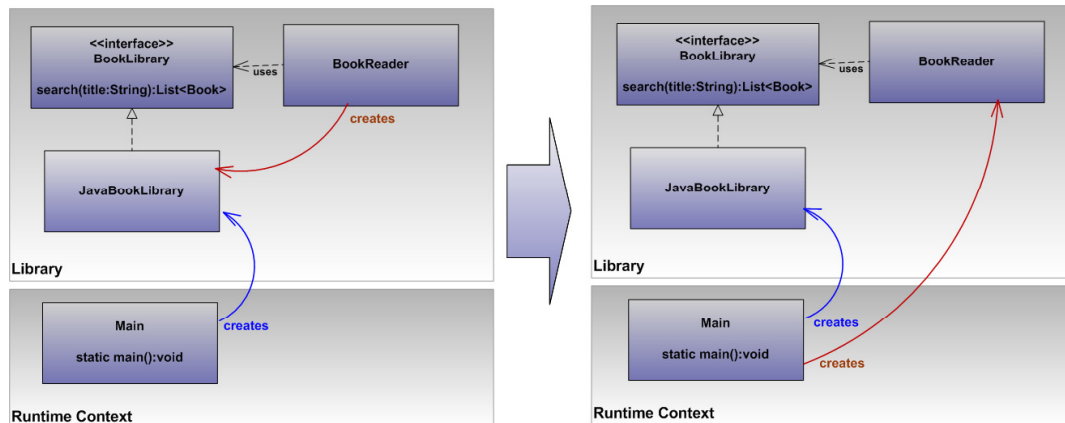
- Inversion of Control
- **Separate program control responsibilities**
  - Object instantiation
  - Dependency injection
- **Dependency injection is a type of IoC**

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## Inversion of Control Example

- **Previously used IoC**
  - Dependency injection example demonstrated inversion of control
  - Moved **JavaBookLibrary** selection and instantiation out of **BookReader** and into **Main**



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# IoC Framework

- **Service provider or plugin framework**

- Interface
- Providers
- **Registration system**
- **Access API**
  - Joshua Bloch from *Effective Java*

- **Process**

- Framework uses supplied APIs
  - Framework handles creation
  - Framework handles dependency injection
- Runtime context uses framework

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# IoC Framework Example

```
import coreservlets.BookReader;
import coreservlets.JavaBookLibrary;

public class ServiceProviderFramework {

    private BookReader bookReader;

    public ServiceProviderFramework() {
        this.bookReader =
            new BookReader(new JavaBookLibrary());
    }

    public BookReader getBookReaderInstance() {
        return this.bookReader;
    }
}
```

Implicit registration

Access API

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# IoC Framework Example

```
public class Main {  
    public static void main(String[] args) {  
  
        ServiceProviderFramework framework =  
            new ServiceProviderFramework();  
  
        BookReader client = framework.getBookReaderInstance();  
  
        List books = client.read();  
  
        System.out.printf("Client read: %s books%n",  
                           books.size());  
    }  
}
```

Framework instantiation

Access API

Standard output

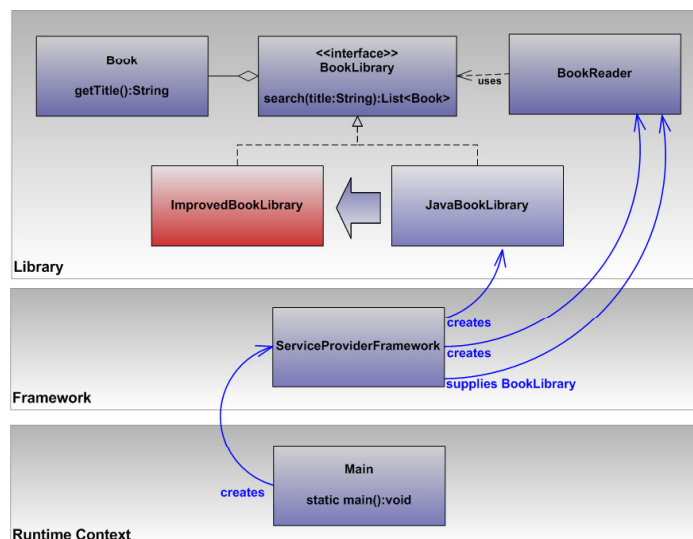
```
Reading: Core Servlets and JavaServer Pages  
Reading: More Servlets and JavaServer Pages  
Client read: 2 books
```

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## Model Analysis

- Dynamic implementation choices
- Portable model configuration



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# Wrapup

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## Summary

- **Develop POJOs**
  - Avoid framework dependencies
  - Capture business logic
  - Avoid implementation commitments by using inversion of control and dependency injection patterns
- **Create a new XML file, `applicationContext.xml`, based on `spring-beans.xsd`**
  - Place `applicationContext.xml` in the classpath
- **Register POJOs**
  - Declare POJOs using XML **bean** elements
  - Use bean attributes **id** and **class** for specifying the name and type, respectively

## Summary (Continued)

- **Instantiate a Spring IoC container**
  - Use the BeanFactory implementation `ClassPathXmlApplicationContext` for integration with configuration files located in the classpath
    - See: `org.springframework.context.support.ClassPathXmlApplicationContext`
- **Access the Spring IoC container**
  - Retrieve objects from the Spring IoC container using the bean accessor methods
    - For example, `BeanFactory#getBean(...):Object`
  - Specify the object name for the method parameter
    - `beanFactory.getBean("bookLibrary");`

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## Questions?

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