课程目标

1、了解看源码最有效的方式，先猜测后验证，不要一开始就去调试代码。

2、浓缩就是精华，用 300 行最简洁的代码提炼 Spring 的基本设计思想。

3、结合设计模式，掌握 Spring 框架的基本脉络。

内容定位

1、具有 1 年以上的 SpringMVC 使用经验。

2、希望深入了解 Spring 源码的人群，对 Spring 有一个整体的宏观感受。

3、全程手写实现 SpringMVC 的核心功能，帮助大家更深刻地理解设计模式。从最简单的 v1 版本一步一步优化为 v2 版本，最后到 v3 版本。

实现思路

先来介绍一下 Mini 版本的 Spring 基本实现思路，如下图所示：

自定义配置

配置 application.properties 文件

为了解析方便，我们用 application.properties 来代替 application.xml 文件，具体配置内容如下：

```
scanPackage=com.gupaoedu.demo
```

配置 web.xml 文件

大家都知道，所有依赖于 web 容器的项目，都是从读取 web.xml 文件开始的。我们先配置好 web.xml 中的内容。

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns="http://java.sun.com/xml/ns/j2ee" xmlns:javaee="http://java.sun.com/xml/ns/javaee"
   xmlns:web="http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd"
   xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd"
   version="2.4">
```

```
   <display-name>Gupao Web Application</display-name>
   <servlet>
      <servlet-name>gpmvc</servlet-name>
      <servlet-class>com.gupaoedu.mvcframework.v1.servlet.GPDispatcherServlet</servlet-class>
      <init-param>
         <param-name>contextConfigLocation</param-name>
         <param-value>application.properties</param-value>
      </init-param>
      <load-on-startup>1</load-on-startup>
   </servlet>
   <servlet-mapping>
      <servlet-name>gpmvc</servlet-name>
      <url-pattern>/*</url-pattern>
   </servlet-mapping>
</web-app>
```

其中 GPDispatcherServlet 是有自己模拟 Spring 实现的核心功能类。

自定义 Annotation

@GPService 注解：

```
package com.gupaoedu.mvcframework.annotation;
import java.lang.annotation.*;
@Target({ElementType.TYPE})
@Retention(RetentionPolicy.RUNTIME)
@Documented
public @interface GPService {
    String value() default "";
}
```

@GPAutowired 注解：

```
package com.gupaoedu.mvcframework.annotation;
import java.lang.annotation.*;
@Target({ElementType.FIELD})
@Retention(RetentionPolicy.RUNTIME)
@Documented
public @interface GPAutowired {
    String value() default "";
}
```

@GPController 注解：

```
package com.gupaoedu.mvcframework.annotation;
```

```
import java.lang.annotation.*;
@Target({ElementType.TYPE})
@Retention(RetentionPolicy.RUNTIME)
@Documented
public @interface GPController {
    String value() default "";
}
```

@GPRequestMapping 注解：

```
package com.gupaoedu.mvcframework.annotation;
import java.lang.annotation.*;
@Target({ElementType.TYPE,ElementType.METHOD})
@Retention(RetentionPolicy.RUNTIME)
@Documented
public @interface GPRequestMapping {
    String value() default "";
}
```

@GPRequestParam 注解：

```
package com.gupaoedu.mvcframework.annotation;
import java.lang.annotation.*;
@Target({ElementType.PARAMETER})
@Retention(RetentionPolicy.RUNTIME)
@Documented
public @interface GPRequestParam {
    String value() default "";
}
```

配置 Annotation

配置业务实现类 DemoService：

```
package com.gupaoedu.demo.service.impl;
import com.gupaoedu.demo.service.IDemoService;
import com.gupaoedu.mvcframework.annotation.GPService;
/**
 * 核心业务逻辑
 */
@GPService
public class DemoService implements IDemoService{
   public String get(String name) {
      return "My name is " + name;
   }
```

```
}
```

配置请求入口类 DemoAction：

```
package com.gupaoedu.demo.mvc.action;
import java.io.IOException;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import com.gupaoedu.demo.service.IDemoService;
import com.gupaoedu.mvcframework.annotation.GPAutowired;
import com.gupaoedu.mvcframework.annotation.GPController;
import com.gupaoedu.mvcframework.annotation.GPRequestMapping;
import com.gupaoedu.mvcframework.annotation.GPRequestParam;
@GPController
@GPRequestMapping("/demo")
public class DemoAction {
   @GPAutowired private IDemoService demoService;
   @GPRequestMapping("/query")
   public void query(HttpServletRequest req, HttpServletResponse resp,
               @GPRequestParam("name") String name){
      String result = demoService.get(name);
      try {
         resp.getWriter().write(result);
      } catch (IOException e) {
         e.printStackTrace();
      }
   }
   @GPRequestMapping("/add")
   public void add(HttpServletRequest req, HttpServletResponse resp,
            @GPRequestParam("a") Integer a, @GPRequestParam("b") Integer b){
      try {
         resp.getWriter().write(a + "+" + b + "=" + (a + b));
      } catch (IOException e) {
         e.printStackTrace();
      }
   }
   @GPRequestMapping("/remove")
   public void remove(HttpServletRequest req,HttpServletResponse resp,
               @GPRequestParam("id") Integer id){
   }
}
```

至此，配置阶段就已经完成。

容器初始化

实现 V1 版本

所有的核心逻辑全部写在一个 init()方法中。

```
package com.gupaoedu.mvcframework.v1.servlet;
import com.gupaoedu.mvcframework.annotation.GPAutowired;
import com.gupaoedu.mvcframework.annotation.GPController;
import com.gupaoedu.mvcframework.annotation.GPRequestMapping;
import com.gupaoedu.mvcframework.annotation.GPService;
import javax.servlet.ServletConfig;
import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import java.io.File;
import java.io.IOException;
import java.io.InputStream;
import java.lang.reflect.Field;
import java.lang.reflect.Method;
import java.net.URL;
import java.util.*;

public class GPDispatcherServlet extends HttpServlet {
    private Map<String,Object> mapping = new HashMap<String, Object>();
    @Override
    protected void doGet(HttpServletRequest req, HttpServletResponse resp) throws ServletException,
IOException {this.doPost(req,resp);}
    @Override
    protected void doPost(HttpServletRequest req, HttpServletResponse resp) throws ServletException,
IOException {
        try {
            doDispatch(req,resp);
        } catch (Exception e) {
            resp.getWriter().write("500 Exception " + Arrays.toString(e.getStackTrace()));
        }
    }
    private void doDispatch(HttpServletRequest req, HttpServletResponse resp) throws Exception {
        String url = req.getRequestURI();
        String contextPath = req.getContextPath();
```

```
        url = url.replace(contextPath, "").replaceAll("/+", "/");
        if(!this.mapping.containsKey(url)){resp.getWriter().write("404 Not Found!!");return;}
        Method method = (Method) this.mapping.get(url);
        Map<String,String[]> params = req.getParameterMap();
        method.invoke(this.mapping.get(method.getDeclaringClass().getName()),new
Object[]{req,resp,params.get("name")[0]});
    }
    @Override
    public void init(ServletConfig config) throws ServletException {
        InputStream is = null;
        try{
            Properties configContext = new Properties();
            is =
this.getClass().getClassLoader().getResourceAsStream(config.getInitParameter("contextConfigLocat
ion"));
            configContext.load(is);
            String scanPackage = configContext.getProperty("scanPackage");
            doScanner(scanPackage);
            for (String className : mapping.keySet()) {
                if(!className.contains(".")){continue;}
                Class<?> clazz = Class.forName(className);
                if(clazz.isAnnotationPresent(GPController.class)){
                    mapping.put(className,clazz.newInstance());
                    String baseUrl = "";
                    if (clazz.isAnnotationPresent(GPRequestMapping.class)) {
                        GPRequestMapping requestMapping =
clazz.getAnnotation(GPRequestMapping.class);
                        baseUrl = requestMapping.value();
                    }
                    Method[] methods = clazz.getMethods();
                    for (Method method : methods) {
                        if (!method.isAnnotationPresent(GPRequestMapping.class)) {  continue; }
                        GPRequestMapping requestMapping =
method.getAnnotation(GPRequestMapping.class);
                        String url = (baseUrl + "/" + requestMapping.value()).replaceAll("/+", "/");
                        mapping.put(url, method);
                        System.out.println("Mapped " + url + "," + method);
                    }
                }else if(clazz.isAnnotationPresent(GPService.class)){
                        GPService service = clazz.getAnnotation(GPService.class);
                        String beanName = service.value();
                        if("".equals(beanName)){beanName = clazz.getName();}
                        Object instance = clazz.newInstance();
                        mapping.put(beanName,instance);
```

```
                    for (Class<?> i : clazz.getInterfaces()) {
                        mapping.put(i.getName(),instance);
                    }
                }else {continue;}
            }
            for (Object object : mapping.values()) {
                if(object == null){continue;}
                Class clazz = object.getClass();
                if(clazz.isAnnotationPresent(GPController.class)){
                    Field [] fields = clazz.getDeclaredFields();
                    for (Field field : fields) {
                        if(!field.isAnnotationPresent(GPAutowired.class)){continue; }
                        GPAutowired autowired = field.getAnnotation(GPAutowired.class);
                        String beanName = autowired.value();
                        if("".equals(beanName)){beanName = field.getType().getName();}
                        field.setAccessible(true);
                        try {
                            field.set(mapping.get(clazz.getName()),mapping.get(beanName));
                        } catch (IllegalAccessException e) {
                            e.printStackTrace();
                        }
                    }
                }
            }
        } catch (Exception e) {
        }finally {
            if(is != null){
                try {is.close();} catch (IOException e) {
                    e.printStackTrace();
                }
            }
        }
        System.out.print("GP MVC Framework is init");
    }
    private void doScanner(String scanPackage) {
        URL url = this.getClass().getClassLoader().getResource("/" +
scanPackage.replaceAll("\\.","/"));
        File classDir = new File(url.getFile());
        for (File file : classDir.listFiles()) {
            if(file.isDirectory()){ doScanner(scanPackage + "." +  file.getName());}else {
                if(!file.getName().endsWith(".class")){continue;}
                String clazzName = (scanPackage + "." + file.getName().replace(".class",""));
                mapping.put(clazzName,null);
            }
```

```
        }
    }
}
```

实现 V2 版本

在 V1 版本上进了优化，采用了常用的设计模式（工厂模式、单例模式、委派模式、策略模式），将 init()方法中的代码进行封装。按照之前的实现思路，先搭基础框架，再填肉注血，具体代码如下：

```
@Override
public void init(ServletConfig config) throws ServletException {
    //1、加载配置文件
    doLoadConfig(config.getInitParameter("contextConfigLocation"));
    //2、扫描相关的类
    doScanner(contextConfig.getProperty("scanPackage"));
    //3、初始化所有相关的类的实例，并且放入到 IOC 容器之中
    doInstance();
    //4、完成依赖注入
    doAutowired();
    //5、初始化 HandlerMapping
    initHandlerMapping();
    System.out.println("GP Spring framework is init.");
}
```

声明全局的成员变量，其中 IOC 容器就是注册时单例的具体案例：

```
//存储 aplication.properties 的配置内容
private Properties contextConfig = new Properties();
//存储所有扫描到的类
private List<String> classNames = new ArrayList<String>();
//IOC 容器，保存所有实例化对象
private Map<String,Object> ioc = new HashMap<String,Object>();
//保存 Contrller 中所有 Mapping 的对应关系
private Map<String,Method> handlerMapping = new HashMap<String,Method>();
```

实现 doLoadConfig()方法：

```
private void doLoadConfig(String contextConfigLocation) {
    InputStream fis = null;
    try {
        fis = this.getClass().getClassLoader().getResourceAsStream(contextConfigLocation);
        //1、读取配置文件
        contextConfig.load(fis);
    }catch(Exception e){
```

```
            e.printStackTrace();
        }finally{
            try {
                if(null != fis){fis.close();}
            } catch (IOException e) {
                e.printStackTrace();
            }
        }
    }
```

实现 doScanner()方法：

```
    private void doScanner(String scanPackage) {
        //包传过来包下面的所有的类全部扫描进来的
        URL url = this.getClass().getClassLoader()
                .getResource("/" + scanPackage.replaceAll("\\.","/"));
        File classPath = new File(url.getFile());
        for (File file : classPath.listFiles()) {
            if(file.isDirectory()){
                doScanner(scanPackage + "." + file.getName());
            }else {
                if(!file.getName().endsWith(".class")){ continue; }
                String className = (scanPackage + "." + file.getName()).replace(".class","");
                classNames.add(className);
            }
        }
    }
```

实现 doInstance()方法，doInstance()方法就是工厂模式的具体实现：

```
    private void doInstance() {
        if(classNames.isEmpty()){return;}
        try {
            for (String className : classNames) {
                Class<?> clazz = Class.forName(className);
                if(clazz.isAnnotationPresent(GPController.class)) {
                    Object instance = clazz.newInstance();
                    String beanName = toLowerFirstCase(clazz.getSimpleName());
                    ioc.put(beanName, instance);
                }else if(clazz.isAnnotationPresent(GPService.class)){
                    //1、默认的类名首字母小写
                    String beanName = toLowerFirstCase(clazz.getSimpleName());
                    //2、自定义命名
                    GPService service = clazz.getAnnotation(GPService.class);
```

```
                if(!"".equals(service.value())){
                    beanName = service.value();
                }
                Object instance = clazz.newInstance();
                ioc.put(beanName, instance);
                //3、根据类型注入实现类，投机取巧的方式
                for (Class<?> i : clazz.getInterfaces()) {
                    if(ioc.containsKey(i.getName())){
                        throw new Exception("The beanName is exists!!");
                    }
                    ioc.put(i.getName(),instance);
                }
            }else {
                continue;
            }
        }
    }catch (Exception e){
        e.printStackTrace();
    }
}
```

为了处理方便，自己实现了 toLowerFirstCase 方法，来实现类名首字母小写，具体代码如下：

```
private String toLowerFirstCase(String simpleName) {
    char [] chars = simpleName.toCharArray();
    chars[0] += 32;
    return  String.valueOf(chars);
}
```

实现 doAutowired()方法：

```
private void doAutowired() {
    if(ioc.isEmpty()){ return; }
    for (Map.Entry<String, Object> entry : ioc.entrySet()) {
        //拿到实例对象中的所有属性
        Field[] fields = entry.getValue().getClass().getDeclaredFields();
        for (Field field : fields) {
            if(!field.isAnnotationPresent(GPAutowired.class)){ continue; }
            GPAutowired autowired = field.getAnnotation(GPAutowired.class);
            String beanName = autowired.value().trim();
            if("".equals(beanName)){
                beanName = field.getType().getName();
            }
            //不管你愿不愿意，强吻
            field.setAccessible(true); //设置私有属性的访问权限
            try {
```

```
                //执行注入动作
                field.set(entry.getValue(), ioc.get(beanName));
            } catch (Exception e) {
                e.printStackTrace();
                continue ;
            }
        }
    }
}
```

实现 initHandlerMapping()方法，handlerMapping 就是策略模式的应用案例：

```
private void initHandlerMapping() {
    if(ioc.isEmpty()){ return; }
    for (Map.Entry<String, Object> entry : ioc.entrySet()) {
        Class<?> clazz = entry.getValue().getClass();
        if(!clazz.isAnnotationPresent(GPController.class)){ continue; }
        String baseUrl = "";
        //获取 Controller 的 url 配置
        if(clazz.isAnnotationPresent(GPRequestMapping.class)){
            GPRequestMapping requestMapping = clazz.getAnnotation(GPRequestMapping.class);
            baseUrl = requestMapping.value();
        }
        //获取 Method 的 url 配置
        Method[] methods = clazz.getMethods();
        for (Method method : methods) {
            //没有加 RequestMapping 注解的直接忽略
            if(!method.isAnnotationPresent(GPRequestMapping.class)){ continue; }
            //映射 URL
            GPRequestMapping requestMapping = method.getAnnotation(GPRequestMapping.class);
            String url = ("/" + baseUrl + "/" + requestMapping.value())
                    .replaceAll("/+", "/");
            handlerMapping.put(url,method);
            System.out.println("Mapped " + url + "," + method);
        }
    }
}
```

到这里位置初始化阶段就已经完成，接下实现运行阶段的逻辑，来看 doPost/doGet 的代码：

```
@Override
protected void doGet(HttpServletRequest req, HttpServletResponse resp) throws ServletException,
IOException {
    this.doPost(req,resp);
}
@Override
```

```
protected void doPost(HttpServletRequest req, HttpServletResponse resp) throws ServletException,
IOException {
    //派遣，分发任务
    try {
        doDispatch(req,resp);
    } catch (Exception e) {
        e.printStackTrace();
        resp.getWriter().write("500 Excetion Detail:" +Arrays.toString(e.getStackTrace()));
    }
}
```

doPost()方法中，用了委派模式，委派模式的具体逻辑在 doDispatch()方法中：

```
private void doDispatch(HttpServletRequest req, HttpServletResponse resp)throws Exception {
    String url = req.getRequestURI();
    String contextPath = req.getContextPath();
    url = url.replaceAll(contextPath,"").replaceAll("/+","/");
    if(!this.handlerMapping.containsKey(url)){
        resp.getWriter().write("404 Not Found!!");
        return;
    }
    Method method = this.handlerMapping.get(url);
    //第一个参数：方法所在的实例
    //第二个参数：调用时所需要的实参

    Map<String,String[]> params = req.getParameterMap();
    //投机取巧的方式
    String beanName = toLowerFirstCase(method.getDeclaringClass().getSimpleName());
    method.invoke(ioc.get(beanName),new Object[]{req,resp,params.get("name")[0]});
    //System.out.println(method);
}
```

在以上代码中，doDispatch()虽然完成了动态委派并反射调用，但对 url 参数处理还是静态代码。要实现 url 参数的动态获取，其实还稍微有些复杂。我们可以优化 doDispatch()方法的实现逻辑，代码如下：

```
private void doDispatch(HttpServletRequest req, HttpServletResponse resp)throws Exception {
    String url = req.getRequestURI();
    String contextPath = req.getContextPath();
    url = url.replaceAll(contextPath,"").replaceAll("/+","/");
    if(!this.handlerMapping.containsKey(url)){
        resp.getWriter().write("404 Not Found!!");
        return;
    }
    Method method = this.handlerMapping.get(url);
    //第一个参数：方法所在的实例
```

```
    //第二个参数：调用时所需要的实参
    Map<String,String[]> params = req.getParameterMap();
    //获取方法的形参列表
    Class<?> [] parameterTypes = method.getParameterTypes();
    //保存请求的 url 参数列表
    Map<String,String[]> parameterMap = req.getParameterMap();
    //保存赋值参数的位置
    Object [] paramValues = new Object[parameterTypes.length];
    //按根据参数位置动态赋值
    for (int i = 0; i < parameterTypes.length; i ++){
        Class parameterType = parameterTypes[i];
        if(parameterType == HttpServletRequest.class){
            paramValues[i] = req;
            continue;
        }else if(parameterType == HttpServletResponse.class){
            paramValues[i] = resp;
            continue;
        }else if(parameterType == String.class){
            GPRequestParam requestParam =
(GPRequestParam)parameterType.getAnnotation(GPRequestParam.class);
            if(parameterMap.containsKey(requestParam.value())) {
                for (Map.Entry<String,String[]> param : parameterMap.entrySet()){
                    String value = Arrays.toString(param.getValue())
                            .replaceAll("\\[|\\]","")
                            .replaceAll("\\s",",");
                    paramValues[i] = value;
                }
            }
        }
    }
    //投机取巧的方式
    String beanName = toLowerFirstCase(method.getDeclaringClass().getSimpleName());
    method.invoke(ioc.get(beanName),new Object[]{req,resp,params.get("name")[0]});
}
```

实现 V3 版本

在 V2 版本中，基本功能以及完全实现，但代码的优雅程度还不如人意。譬如 HandlerMapping 还不能像 SpringMVC 一样支持正则，url 参数还不支持强制类型转换，在反射调用前还需要重新获取 beanName，在 V3 版本中，下面我们继续优化。

首先，改造 HandlerMapping，在真实的 Spring 源码中，HandlerMapping 其实是一个 List 而非 Map。List 中的元素是一个自定义的类型。现在我们来仿真写一段代码，先定义一个内部类 Handler 类：

```
/**
    * Handler 记录 Controller 中的 RequestMapping 和 Method 的对应关系
    * @author Tom
    * 内部类
    */
   private class Handler{
      protected Object controller;   //保存方法对应的实例
      protected Method method;      //保存映射的方法
      protected Pattern pattern;
      protected Map<String,Integer> paramIndexMapping;   //参数顺序
      /**
       * 构造一个 Handler 基本的参数
       * @param controller
       * @param method
       */
      protected Handler(Pattern pattern,Object controller,Method method){
         this.controller = controller;
         this.method = method;
         this.pattern = pattern;
         paramIndexMapping = new HashMap<String,Integer>();
         putParamIndexMapping(method);
      }
      private void putParamIndexMapping(Method method){
         //提取方法中加了注解的参数
         Annotation [] [] pa = method.getParameterAnnotations();
         for (int i = 0; i < pa.length ; i ++) {
            for(Annotation a : pa[i]){
               if(a instanceof GPRequestParam){
                  String paramName = ((GPRequestParam) a).value();
                  if(!"".equals(paramName.trim())){
                     paramIndexMapping.put(paramName, i);
                  }
               }
            }
         }
         //提取方法中的 request 和 response 参数
         Class<?> [] paramsTypes = method.getParameterTypes();
         for (int i = 0; i < paramsTypes.length ; i ++) {
            Class<?> type = paramsTypes[i];
            if(type == HttpServletRequest.class ||
```

```
                type == HttpServletResponse.class){
                paramIndexMapping.put(type.getName(),i);
            }
        }
    }
}
```

然后，优化 HandlerMapping 的结构，代码如下：

```
//保存所有的 Url 和方法的映射关系
private List<Handler> handlerMapping = new ArrayList<Handler>();
```

修改 initHandlerMapping()方法：

```
private void initHandlerMapping(){
    if(ioc.isEmpty()){ return; }
    for (Entry<String, Object> entry : ioc.entrySet()) {
        Class<?> clazz = entry.getValue().getClass();
        if(!clazz.isAnnotationPresent(GPController.class)){ continue; }
        String url = "";
        //获取 Controller 的 url 配置
        if(clazz.isAnnotationPresent(GPRequestMapping.class)){
            GPRequestMapping requestMapping = clazz.getAnnotation(GPRequestMapping.class);
            url = requestMapping.value();
        }
        //获取 Method 的 url 配置
        Method [] methods = clazz.getMethods();
        for (Method method : methods) {
            //没有加 RequestMapping 注解的直接忽略
            if(!method.isAnnotationPresent(GPRequestMapping.class)){ continue; }
            //映射 URL
            GPRequestMapping requestMapping = method.getAnnotation(GPRequestMapping.class);
            String regex = ("/" + url + requestMapping.value()).replaceAll("/+", "/");
            Pattern pattern = Pattern.compile(regex);
            handlerMapping.add(new Handler(pattern,entry.getValue(),method));
            System.out.println("mapping " + regex + "," + method);
        }
    }
}
```

修改 doDispatch()方法：

```
/**
 * 匹配 URL
 * @param req
 * @param resp
```

```
 * @return
 * @throws Exception
 */
private void doDispatch(HttpServletRequest req,HttpServletResponse resp) throws Exception{
   try{
      Handler handler = getHandler(req);
      if(handler == null){
         //如果没有匹配上，返回 404 错误
         resp.getWriter().write("404 Not Found");
         return;
      }
      //获取方法的参数列表
      Class<?> [] paramTypes = handler.method.getParameterTypes();
      //保存所有需要自动赋值的参数值
      Object [] paramValues = new Object[paramTypes.length];
      Map<String,String[]> params = req.getParameterMap();
      for (Entry<String, String[]> param : params.entrySet()) {
         String value = Arrays.toString(param.getValue()).replaceAll("\\[|\\]",
"").replaceAll(",\\s", ",");
         //如果找到匹配的对象，则开始填充参数值
         if(!handler.paramIndexMapping.containsKey(param.getKey())){continue;}
         int index = handler.paramIndexMapping.get(param.getKey());
         paramValues[index] = convert(paramTypes[index],value);
      }
      //设置方法中的 request 和 response 对象
      int reqIndex = handler.paramIndexMapping.get(HttpServletRequest.class.getName());
      paramValues[reqIndex] = req;
      int respIndex = handler.paramIndexMapping.get(HttpServletResponse.class.getName());
      paramValues[respIndex] = resp;
      handler.method.invoke(handler.controller, paramValues);
   }catch(Exception e){
      throw e;
   }
}

private Handler getHandler(HttpServletRequest req) throws Exception{
   if(handlerMapping.isEmpty()){ return null; }
   String url = req.getRequestURI();
   String contextPath = req.getContextPath();
   url = url.replace(contextPath, "").replaceAll("/+", "/");
   for (Handler handler : handlerMapping) {
      try{
         Matcher matcher = handler.pattern.matcher(url);
         //如果没有匹配上继续下一个匹配
```

```
            if(!matcher.matches()){ continue; }
            return handler;
        }catch(Exception e){
            throw e;
        }
    }
    return null;
}

private Object convert(Class<?> type,String value){
    if(Integer.class == type){
        return Integer.valueOf(value);
    }
    return value;
}
```

在以上代码中，增加了两个方法，一个是 getHandler()方法，主要负责处理 url 的正则匹配；一个是 convert()方法，主要负责 url 参数的强制类型转换。

至此，手写 Mini 版 SpringMVC 框架就已全部完成。

运行效果演示

在浏览器输入：http://localhost:8080/demo/query.json?name=Tom，就会得到下面的结果：

当然，真正的 Spring 要复杂很多，本课中主要通过手写的形式，了解 Spring 的基本设计思路以及设计模式如何应用，在以后的课程中，我们还会继续手写更加高仿真版本的 Spring2.0。