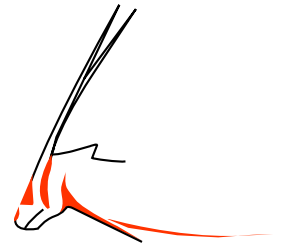


Using Tomcat (a Java Web Server) to Create and Run Web Server Programs Written in ooRexx



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Agenda

- Java based web servers
 - Brief overview
 - Servlets
 - Java server pages (JSP), taglibs
- BSF4ooRexx and Tomcat
 - Setup Tomcat
 - [ScriptTagLibs.jar](#) (javax, jakarta)
 - Nutshell samples
- Roundup, outlook, URLs



Java Based Web Servers, 1

- Specifications modularized
 - Java based web servers implement these, e.g.
 - Adobe "Cold Fusion", Apache "Tomcat", Caucho "Resin", Eclipse "Glassfish" (formerly Oracle), Eclipse "Jetty", IBM "WebSphere", Oracle "WebLogic" (formerly BEA), Red Hat "WildFly" (formerly JBoss), ...
 - Everything is and needs to be implemented in Java
 - "Servlets"
 - Subclass abstract class "`{javax|jakarta}.servlet.http.HttpServlet`"
 - Therefore small Java programs that serve client requests

Java Based Web Servers, 2

- "Java Server Pages (JSP)"
 - Java code injected into HTML/XML text
 - Gets rewritten as a Java Servlet and then compiled
 - Repeated if JSP source changes
 - Taglibs – "JSP Tag Libraries"
 - Custom tags in JSPs
 - Java implemented tag handlers
 - Allows extending JSP functionalities
 - E.g. JSP Standard Tag Library (STL) for easing control structures, accessing SQL databases etc.

Apache Tomcat (<https://tomcat.apache.org>), 1

- Java web server
 - Original reference implementation of specifications (Sun)
 - Open-source, now by Apache Software Foundation (ASF)
 - Can be deployed as a
 - Fully fledged, standalone web server
 - Component in complex web server configurations
 - E.g. in Apache [httpd](#), [NINGX](#)
- Flexible installations
 - Configurable at various levels in a "cascading" manner
 - Deploying/removing web applications without restart, ...

Apache Tomcat (<https://tomcat.apache.org>), 2

- Tomcat modules
 - "Catalina"
 - Servlet container component that implements and hosts the servlet and Java server pages specifications and manages users defined in "realms"
 - "Jasper"
 - JSP component to manage tag libraries, compile and recompile JSPs
 - "Coyote"
 - Connector component that allows access via http, making Tomcat effectively a web server

Apache Tomcat (<https://tomcat.apache.org>), 3

- Tomcat directory layout (in `CATALINA_HOME`)
 - `bin`: start, stop Tomcat from commandline
 - `conf`: Tomcat configuration files like `server.xml`, `config.xml`, `tomcat-users.xml`
 - `lib`: jar files available to all deployed web applications
 - `logs`, `temp`, `work`: log files, temporary and work directories
 - `webapps`: root for "web applications" and "web application archives" (`war`) files
 - Copying a `xyz.war` file deploys (and explodes) the web application "`xyz`"
 - Deleting a `xyz.war` file undeploys (and deletes) the web application "`xyz`"
 - Predefined web apps (subdirectories): `docs` (Tomcat documentation), `manager` (Tomcat manager, must be enabled see URL section), `ROOT` (default web app)

Apache Tomcat (<https://tomcat.apache.org>), 4

- Web application archive (war)
 - A zip/jar (Java archive) file that includes all resources for the application
 - "[xyz.war](#)": "[xyz](#)" name of the web application (url: "<http://server/xyz>")
 - Deployment will explode the archive into the subdirectory named "[xyz](#)"
 - Any files and subdirectories that constitute the web application
 - File "[index.html](#)", optional, returned by default if browsing "<http://server/xyz>"
 - Directory "[WEB-INF](#)", optional may contain
 - The file "[web.xml](#)" (title, configuration, additional resource definitions),
 - The directory "[classes](#)" (web app specific Java classes),
 - The directory "[lib](#)" (web app specific jar files), taglib definitions, ...
 - Directory "[META-INF](#)", optional may contain
 - The file "[config.xml](#)" (web app related configurations)

Apache Tomcat (<https://tomcat.apache.org>), 5

- "Java EE" vs. "Jakarta EE"
 - Oracle insists on using exclusively the top level name **javax**
 - Approached the open-source community
 - Eclipse foundation new owner of "EE" specifications uses the top level name **jakarta**
 - All specifications and Java class libraries need to be changed! :-)
 - Hence, up to and including *Tomcat 9* ("Java EE") use
 - **javax**.ScriptTagLibs.jar
 - *Tomcat 10 or later* ("Jakarta EE") use
 - **jakarta**.ScriptTagLibs.jar



- Apache httpd (<https://httpd.apache.org/>)
 - "Classic" web server, for decades leading the pack
 - Implemented in C, C++
 - CGI (common gateway interface)
 - Each client request served in a proper process, rather expensive
 - Communicating request information via environment variables
 - ooRexx can be used out of the box
 - Apache httpd *modules*
 - Each client request served in a thread, quite efficient
 - Allows processing each Apache stage in request and response



- Java based web servers
 - No support for non-Java programming languages like ooRexx
 - To empower WU students to create web server programs a tag library was created by the author (summer of 2020): [ScriptTagLibs.jar](#)
 - Tag library to add two tags to JSPs for supporting script languages
 - Tags "[script](#)" and "[expr](#)"
 - Supporting Apache BSF and Java's newer [javax.script](#) framework
 - Allows ooRexx to be used for creating
 - "Rexx Servlets" (scripts always get the Servlet arguments supplied)
 - RSPs ("Rexx server pages")
 - Can be used for *any* script language that implements [javax.script](#) (a.k.a. "[JSR-223](#)", Java specification request # 223)

BSF4ooRexx and Tomcat

Setup Tomcat

- Make *BSF4ooRexx* and the *ScriptTagLibs.jar* available to all Tomcat web applications
 - Tomcat, any version
 - Copy `bsf4ooRexx-v641-20210516-bin.jar` (or newer) to `CATALINA_HOME/lib`
 - Tomcat 9 or earlier (Java EE)
 - Copy `javax.ScriptTagLibs.jar` to `CATALINA_HOME/lib`
 - Tomcat 10 or later (Jakarta EE)
 - Copy `jakarta.ScriptTagLibs.jar` to `CATALINA_HOME/lib`



BSF4ooRexx, Nutshell Example, Code

"rexxla_03_ScriptTagLib/helloworld-jsr223-01.jsp"

```
<%@ page session="false" pageEncoding="ISO-8859-1" contentType="text/html; charset=ISO-8859-1" %>
<%@ taglib uri="http://rexxla.org/taglibs/jsr223" prefix="s" %>

<!DOCTYPE html>
<html>

<head>
  <meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">
  <title>Minimal ScriptTagLibs-JSP</title>
</head>

<body>
  <s:script type="rex" >
    use arg request
    say "<h1>Hello, world (ScriptTagLibs JSP)</h1>"
    say "<p>This JSP was executed, because of the following URL:"
    say "<ul><li>URL <em>request~getRequestURL()</em>: <br>"
    say "<code>"request~getRequestURL~toString"</code>"
    say "<li>its URI being <em>request~getRequestURI()</em>: <br>"
    say "<code>"request~getRequestURI"</code></ul></p>"
  </s:script>
</body>
</html>
```

Code snippet from:

<https://www.rexxla.org/events/2020/presentations/202011-ooRexxAndJavaWebServers-article-code.zip>

Explained in detail in article:

<https://www.rexxla.org/events/2020/presentations/202011-ooRexxAndJavaWebServers-article.pdf>

BSF4ooRexx, Nutshell Example, Result

"rexxla_03_ScriptTagLib/helloworld-jsr223-01.jsp"



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JSP ScriptTagLib Minimal Script http://localhost:8080 Minimal Script localhost:8080 Minir

localhost:8080/rexxla_03_ScriptTagLib/helloWorld-jsr223-01.jsp 110%

Hello, world (ScriptTagLibs JSP)

This JSP was executed, because of the following URL:

- URL *request~getRequestURL()*:
`http://localhost:8080/rexxla_03_ScriptTagLib/helloWorld-jsr223-01.jsp`
- its URI being *request~getRequestURI()*:
`/rexxla_03_ScriptTagLib/helloWorld-jsr223-01.jsp`

Code snippet from:

<https://www.rexxla.org/events/2020/presentations/202011-ooRexxAndJavaWebServers-article-code.zip>

Explained in detail in article:

<https://www.rexxla.org/events/2020/presentations/202011-ooRexxAndJavaWebServers-article.pdf>



- Web applications (see URL section)
 - Can be downloaded from the *ScriptTagLibs* BSF4ooRexx project page (see URL section)
 - Web application "[demoRexx.war](#)"
 - Exploded in [CATALINA_HOME/webapps/demoRexx](#)
 - Demonstrates ooRexx nutshells and Tomcat
 - Contains a few ooRexx utilities
 - Web application "[demoSTL-Core-SQL_ooRexx.war](#)"
 - Exploded in [CATALINA_HOME/webapps/demoSTL-Core-SQL_ooRexx](#)
 - Demonstrates SQL STL, using SQL from web app, CGI with Tomcat



- Live demonstration of (BSF4)ooRexx web applications

...



- Java web servers, Servlets, JSPs
- "ScriptTagLibs"
 - *javax.ScriptTagLibs.jar*, *jakarta.ScriptTagLibs.jar*
- BSF4ooRexx & ScriptTagLibs with Apache Tomcat
 - Use ooRexx instead of Java in JSPs, hence "RSPs" ;-)
 - Possible to create ooRexx "servlet" programs
 - Each script gets the "request", "response" and "out" objects as arguments (in that order)
- WU students can create (BSF4)ooRexx web server applications !
 - And anyone else ...

Links

- Tomcat
 - https://en.wikipedia.org/wiki/Apache_Tomcat
 - <https://tomcat.apache.org/>
 - <https://cwiki.apache.org/confluence/display/TOMCAT/Specifications>
- ScriptTagLibs (with directions installing and configuring Tomcat)
 - <https://sourceforge.net/projects/bsf4oorexx/files/Sandbox/rgf/taglibs/ga/>
 - ScriptTagLibs: **javax**.ScriptTagLibs.jar, **jakarta**.ScriptTagLibs.jar
 - **demoRexx.war** (ooRexx nutshell samples, a few utilities)
 - **demoSTL-Core-SQL_ooRexx.war** (standard taglib library "core" to ease usage of SQL, equivalent use of SQL from ooRexx)
 - JSP Standard Tag Library (STL): <https://tomcat.apache.org/taglibs/standard/>
- ApacheCon 2021 Presentation on the *ScriptTagLibs* library:
"Apache Tomcat: Enabling Scripting Languages in JSPs": <https://epub.wu.ac.at/8303/>
- WU student's Tomcat papers: <http://wi.wu.ac.at/rgf/diplomarbeiten/>
- Article: <https://www.rexxla.org/2020/presentations/202011-ooRexxAndJavaWebServers-article.pdf>
<https://epub.wu.ac.at/8117/>