Fast and Precise Value-Flow Analysis for Containers via Memory Orientation

Supplementary Material

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Table 1. Number of anchored containers in the top 10 modification cases of Java EE containers in GitHub.

ID	Name	Modification Interface	#AC/#C
1	ServletContext	{setAttribute, removeAttribute}	7/10
2	ServletRequest	{setAttribute, removeAttribute}	9/10
3	HttpServletRequest	{setAttribute, removeAttribute}	8/10
4	HttpServletResponse	{setHeader, addHeader}	10/10
5	HttpServletRequestWrapper	{setAttribute, removeAttribute}	4/10
6	HttpServletResponseWrapper	{setHeader, addHeader}	6/10
7	HttpSession	{setAttribute, removeAttribute}	10/10
8	JspContext	{setAttribute, removeAttribute}	9/10
9	PageContext	{setAttribute, removeAttribute}	5/10

A Empirical Data of Java EE Containers

This document presents the detailed empirical data of Java EE containers. To show the prevalence of anchored containers, we utilize the built-in search engine of GitHub to count the anchored containers in the top 10 modification cases listed in the searching result. The empirical data contains little bias, and the cases are not selected subjectively, as we just depend on the cases searched in GitHub instead of selecting the programs manually.

More concretely, we search the cases for each Java EE container by specifying Java as the programming language and the name of the container with its modification interfaces [1]. A Java EE container might be a combination of multiple position- or value-dependent containers. In the empirical study, we only concern one component, and specify the modification interfaces related to the component.

Table 1 shows the numbers of the anchored containers in the searched cases, of which the entries are listed in Table 2. Mostly, the indexes of the modifications can be determined as constant directly based on the literal values of the parameters. For other cases, we utilize the built-in indexing of GitHub to determine whether the value must be constant.

Containers in other frameworks, such as the collections in JCF, also share the similar idiom. Particularly, almost all the Stack and the LinkedList objects conform to the idiom, as they are often manipulated at the beginning or the end. Other container types, such as HashMap, might be generic and manipulated more flexibly. Even though the keys of a HashMap object are often general comparable objects, it is still quite common-used with constant keys in the configuration modules of the real-world systems.

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[1]An example of searching modification cases of ServletContext: https://github.com/search?l=Java&q=ServletContext+setAttribute+removeAttribute&type=Code

Table 2. Top 10 modification cases of JavaEE containers. **IsAC** indicates whether the case is an anchored container or not.

ID	Case Entry	IsAC
1	https://github.com/jacrylodai/SecuritySystemNew/blob/master/SecuritySystem/src/com/ldp/security/util/servlet/InitSystemServlet.java	yes
1	https://github.com/zlatinb/muwire/blob/master/webui/src/main/java/com/muwire/webui/MuWireClient.java	yes
1	https://github.com/GoodWellGitHub/source/blob/master/spring-framework-5.1.3.RELEASE/spring-web/src/main/java/org/springframework/web/context/support/ServletContextResource.java	yes
1	https://github.com/DevStreet/FinanceAnalytics/blob/master/projects/OG-Web/src/main/java/com/opengamma/web/analytics/push/WebPushServletContextUtils.java	yes
1	https://github.com/lexspoon/scalagwt-gwt/blob/master/dev/core/src/com/google/gwt/dev/shell/HostedModeServletContextProxy.java	no
1	https://github.com/XerO00/AllJarFiles/blob/master/SpringRelatedJars/spring-framework-2.0.5/dist/org/springframework/web/context/support/ServletContextPropertyPlaceholderConfigurer.java	no
1	https://github.com/XerO00/AllJarFiles/blob/master/SpringRelatedJars/spring-framework-2.0.5/dist/org/springframework/web/context/support/ServletContextResource.java	yes
1	https://github.com/omnifaces/omnifaces/blob/master/src/main/java/org/omnifaces/facesviews/FacesViews.java	yes
1	https://github.com/AnthonyCC/sf-temp-ui/blob/master/projects/TransportationAdmin/src/com/freshdirect/transadmin/web/json/JsonRpcServletContext.java	no
1	https://github.com/Badmoon-mySun/EatBook/blob/master/src/main/java/ru/itis/eatbook/listeners/AppContextListener.java	yes
2	https://github.com/xiaowei0312/moc/blob/master/moc/src/com/sram/filter/AuthenticationFilter.java	yes
2	https://github.com/mashenghao/spring/blob/master/spring-web/src/test/java/org/springframework/web/context/request/ServletWebRequestHttpMethodsTests.java	yes
2	https://github.com/zh69183787/wd-investCost/blob/master/src/java/com/wonders/ic/dwContract/action/DwContractDestoryNumberAction.java	yes
2	https://github.com/chenhonghaovip/spring-framework-master/blob/master/spring-webmvc/src/test/java/org/springframework/web/servlet/function/RequestPredicatesTests.java	yes
2	https://github.com/yantarou/backend/blob/master/com.openexchange.server/src/com/openexchange/tools/servlet/CountingHttpServletRequest.java	no
2	https://github.com/tiagoslg/dspace-covemg/blob/master/dspace-src/dspace-services/src/main/java/org/dspace/services/sessions/model/HttpRequestImpl.java	yes
2	https://github.com/0812-rolly/Servlet-Task/blob/master/Java/src/structure/controller/ValidationFilter.java	yes
2	https://github.com/octomonoli1/tfg-us-2017/blob/master/portal-master/portal-impl/src/com/liferay/portal/servlet/ThreadLocalFacadeServletRequestWrapper.java	yes
2	https://github.com/WILLJAY0127/spring-learning/blob/master/spring-framework-5.3.13/spring-webmvc/src/test/java/org/springframework/web/servlet/function/DefaultServerRequestTests.java	yes
2	https://github.com/marshall62/mathspring/blob/master/woServer/src/edu/umass/ckc/wo/handler/TutorAdminHandler.java	yes
3	https://github.com/contactvikas1/todowebapp/blob/main/src/main/java/com/technovihaan/jee/login/LoginServlet.java	yes
3	https://github.com/joansmith3/uPortal/blob/master/uportal-war/src/main/java/org/jasig/portal/portlet/rendering/worker/GuardingHttpServletRequest.java	yes
3	https://github.com/kkonda74/athenz/blob/master/libs/java/server_common/src/test/java/com/yahoo/athenz/common/server/rest/HttpTest.java	no
3	https://github.com/contactvikas1/todowebapp/blob/main/src/main/java/com/technovihaan/login/LoginServlet.java	yes
3	https://github.com/saullas/user-ms/blob/master/src/main/java/rsoapp/userms/interceptors/RequestLoggingFilter.java	yes
3	https://github.com/yhhazr/userPlatform/blob/master/up-service/src/main/java/com/sz7road/web/servlet/HeadlessHttpServlet.java	yes
3	https://github.com/renbz/MyBlog/blob/master/src/main/java/com/ren/controller/blog/MyBlogController.java	yes
3	https://github.com/openMEDIADESK/openMEDIADESK/blob/master/src/main/java/com/stumpner/mediadesk/web/mvc/StatViewController.java	yes
3	https://github.com/kjy1004kln/semiproject/blob/master/semi_0603/src/user/controller/User_LoginController.java	yes
3	https://github.com/apache/struts/blob/master/core/src/main/java/org/apache/struts2/dispatcher/RequestMap.java	no
4	https://github.com/vitaliy0922/cop_che-core/blob/master/platform-api/che-core-api-core/src/main/java/org/eclipse/che/api/core/rest/HttpServletProxyResponse.java	yes
4	https://github.com/tinkinginGitHub/shequsuo/blob/master/anyoujia-web/src/main/java/cn/anyoufang/interceptor/ProcessInterceptor.java	yes
4	https://github.com/RandZwj/BTS/blob/master/TownManagement/src/main/java/com/hkay/weifei/filter/CrossAjax.java	yes
4	https://github.com/sunchs/lyt-hospital/blob/master/hospital-service/src/main/java/com/sunchs/lyt/hospital/UploadInterceptor.java	yes
4	https://github.com/zb1211775489/workspace/blob/master/data-management-api/src/main/java/com/bayee/petition/controller/InterfaceController.java	yes
4	https://github.com/mr-liu-cd/lingyun/blob/master/src/main/java/com/lingyun/security/UnauthenticationEntryPoint.java	yes
4	https://github.com/27017041/java-dodo4.0/blob/master/dodo40/src/com/embraiz/filter/CorsFilter.java	yes
4	https://github.com/wllfengshu/gp-customer/blob/master/src/main/java/app/wllfengshu/util/LimitFilter.java	yes
4	https://github.com/mk0324/RicottaBoard/blob/main/backend_auth/src/main/java/com/hungrybird/back/AuthApp/config/CORSFilter.java	yes
5	https://github.com/imsuperwoman/pivot4j/blob/master/pivot4j-pentaho/src/main/java/org/pivot4j/pentaho/servlet/PluginServletRequest.java	no
5	https://github.com/LinceBI/stolap/blob/master/pivot4j-master/pivot4j/src/main/java/org/pivot4j/pentaho/servlet/PluginServletRequest.java	yes
5	https://github.com/francok29/prova9/blob/master/uPortal-rendering/src/main/java/org/apereo/portal/portlet/rendering/worker/GuardingHttpServletRequest.java	no
5	https://github.com/Smallart/JavaStore/blob/master/Servlet/src/main/java/com/dream/wrapper/HttpRequestWrapperDemo.java	no
5	https://github.com/kinnara-digital-studio/kecak-workflow/blob/master/wflow-commons/src/main/java/org/joget/commons/spring/web/ParameterizedPathFilter.java	yes
5	https://github.com/jcarlos920629/Joget/blob/master/wflow-commons/src/main/java/org/joget/commons/spring/web/ParameterizedPathFilter.java	no
5	https://github.com/jerome-nexedi/nextbi/blob/master/web/plugins/com.seekon.bicp.portal/src/main/java/org/jasig/portal/portlet/rendering/worker/GuardingHttpServletRequest.java	no
5	https://github.com/mihirchandradubey/jogetM/blob/master/wflow-commons/src/main/java/org/joget/commons/spring/web/ParameterizedPathFilter.java	no
5	https://github.com/sparsick/sventon/blob/master/sventon-webapp/base/src/main/java/carbonfive/spring/web/pathparameter/ParameterizedPathFilter.java	yes
5	https://github.com/abulkaware/openbravostaffing/blob/master/OpenbravoERP/modules/org.openbravo.client.kernel/src/org/openbravo/client/kernel/RequestContext.java	yes
6	https://github.com/satish-nag/covid19-tracker-web/blob/master/src/main/java/com/covid19tracker/web/filters/CorsHeaderFilter.java	yes
6	https://github.com/denis554/jetty/blob/master/jetty-http/src/main/java/org/eclipse/jetty/http/gzip/GzipResponseWrapper.java	no
6	https://github.com/rohankumardubey/sonar-java/blob/master/java-checks-test-sources/src/main/java/checks/security/DisclosingTechnologyFingerprints.java	yes
6	https://github.com/NCIP/caaers/blob/master/caAERS/software/web/src/main/java/gov/nih/nci/cabig/caaers/web/filters/CachingFilter.java	yes
6	https://github.com/francok29/prova9/blob/master/uPortal-rendering/src/main/java/org/apereo/portal/portlet/rendering/worker/GuardingHttpServletResponse.java	no
6	https://github.com/rackerlabs/repose/blob/master/repose-aggregator/components/filters/translation-filter/src/test/java/org/openrepose/filters/translation/TranslationFilterTest.java	yes
6	https://github.com/dolfdijkstra/monitoring/blob/master/servlet/src/main/java/com/fatwire/cs/profiling/servlet/filter/HeaderStackTraceFilter.java	no
6	https://github.com/ASU-Capstone/uPortal-Capstone/blob/build_System_Update/uPortal/uportal-war/src/main/java/org/jasig/portal/portlet/rendering/worker/GuardingHttpServletResponse.java	no
6	https://github.com/leofuxiaohui/sonar-java-full/blob/master/java-checks-test-sources/src/main/java/checks/security/DisclosingTechnologyFingerprints.java	yes
6	https://github.com/nwpushuai/GerritCodeReview/blob/master/gerrit-httpd/src/main/java/com/google/gerrit/httpd/HttpServletResponseRecorder.java	yes
7	https://github.com/ok2fly/atest/blob/master/0/0/0/0/byrt/craftProject/src/com/craft/controller/CommonPCController.java	yes
7	https://github.com/1175477640/repo2/blob/master/StudentInfo/src/main/java/net/fuzui/StudentInfo/handler/LoginHandler.java	yes
7	https://github.com/alexandar89934/BWOil/blob/master/src/java/servlet/loginservlet.java	yes
7	https://github.com/ok2fly/atest/blob/master/0/0/0/0/byrt/craftProject/src/com/craft/controller/commens/CommensController.java	yes
7	https://github.com/1175477640/repo2/blob/master/StudentInfo/src/main/java/net/fuzui/StudentInfo/handler/CoursePlanHandler.java	yes
7	https://github.com/VecJunZhi/NewZSWBEM/blob/master/src_crm/com/zs/crm/web/controller/XsInfoAction.java	yes
7	https://github.com/AMPATH/openmrs-module-drughistory/blob/master/omod/src/main/java/org/openmrs/module/drughistory/web/controller/RegimenFormController.java	yes
7	https://github.com/lukaszspyra/mindhunters/blob/main/src/main/java/com/spyrka/mindhunters/context/ContextHolder.java	yes
7	https://github.com/tkaburagi/springcloud-msa-onlinestore-pcfdev/blob/master/demo-onlinestore-ui/src/main/java/com/example/controller/UiContoller.java	yes
8	https://github.com/Joul1285/idsi-parkfind-server-website/blob/master/target/tomcat/work/localEngine/localhost/ParkingTest1/org/apache/jsp/tag/web/menu/menu_tagx.java	yes
8	https://github.com/PeeAke/simpl4-deployed/blob/master/etc/activemq/web/WEB-INF/src/org/apache/jsp/tag/webjms/forEachConnection_tag.java	yes
8	https://github.com/matheusdaniel97/casadocodigo/blob/master/target/tmp/jsp/org/apache/jsp/tag/web/pageTemplate_tag.java	yes
8	https://github.com/PeeAke/simpl4-deployed/blob/master/etc/activemq/web/WEB-INF/src/org/apache/jsp/tag/webform/forEachMapEntry_tag.java	yes
8	https://github.com/Joul1285/idsi-parkfind-server-website/blob/master/target/tomcat/work/localEngine/localhost/ParkingTest1/org/apache/jsp/tag/web/menu/category_tagx.java	yes
8	https://github.com/stephenfreund/RoadRunner/blob/master/benchmarks/tomcat/scratch/work/Catalina/localhost/examples/org/apache/jsp/tag/web/panel_tag.java	yes
8	https://github.com/mayank1710/security-scan/blob/master/java-web-jsp/src/main/java/com/acme/Date2Tag.java	yes
8	https://github.com/ao-apps/ao-servlet-util/blob/master/src/main/java/com/aoapps/servlet/attribute/AttributeEE.java	no
8	https://github.com/qincloud/QeeSite/blob/master/target/tomcat/work/Tomcat/localhost/jeesite/org/apache/jsp/tag/webact/histoicFlow_tag.java	yes
8	https://github.com/shuiwuyuewu/BugTracker/blob/master/webserver/work/Catalina/localhost/common-bug/org/apache/jsp/tag/webdate_tag.java	yes
9	https://github.com/gruppo4/quercus-upstream/blob/master/modules/resin/src/com/caucho/jstl/el/CoreSetTag.java	yes
9	https://github.com/yugandhargangu/JspMyAdmin2/blob/master/application/jspmyadmin/src/main/java/com/jspmyadmin/framework/taglib/jma/ForLoopTag.java	no
9	https://github.com/joelcambon/PortalExample/blob/master/src/com/agiletec/plugins/jpcalendar/aps/tags/CalendarTag.java	yes
9	https://github.com/nitro1010/liferay/blob/master/util-taglib/src/com/liferay/taglib/theme/DefineObjectsTag.java	yes
9	https://github.com/Thylossus/MyBooks-Bookkeeping/blob/master/src/java/tags/DataListOverview.java	yes
9	https://github.com/dpitkevics/php-to-scala-migration-helper/blob/master/PHP_Transform_Lib/lib-scala-migration/modules/resin/src/com/caucho/jstl/el/CoreSetTag.java	no
9	https://github.com/AnthonyCC/sf-temp-ui/blob/master/projects/ERPSWebApp/src/com/freshdirect/webapp/taglib/fdstore/display/FilterWidgetColumnTag.java	yes
9	https://github.com/BackupTheBerlios/jmws/blob/master/jmws-webapp/src/org/jmws/webapp/taglib/ejb/UseEJBBeanTag.java	no
9	https://github.com/ustory/ofbiz13/blob/master/framework/common/src/org/ofbiz/common/status/StatusWorker.java	no
9	https://github.com/mvali95/groovy/blob/GROOVY-8815/subprojects/groovy-servlet/src/main/java/groovy/servlet/ServletCategory.java	no