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Automated Runtime Software Repair

Improving resilience in presence of exceptions

Benoit Cornu, Martin Monperrus

Context

The server encountered an internal error ...

- > Observation: many applications crash due to unexpected exceptions
- > Goal: catch those exceptions* in an automated manner with synthesized catch blocks to prevent crashing the application
- > Techniques: code transformation, empirical analysis, code synthesis, data-mining

* whether checked or unchecked/runtime exceptions

```

HTTP Status 500 -
Exception report
message The server encountered an internal error () that prevented it from fulfilling this request.
exception
javax.servlet.ServletException: Servlet execution threw an exception
root cause
java.lang.ClassNotFoundException: org.apache.commons.io.output.DeferredFileOutputStream
org.apache.commons.io.output.DeferredFileOutputStream: java:103
org.apache.catalina.loader.WebappClassLoader.loadClass(WebappClassLoader: java:1209)
java.lang.ClassLoader.loadClassInternal(ClassLoader: java:310)
org.apache.commons.io.output.DeferredFileOutputStream: java:103
org.apache.catalina.loader.WebappClassLoader.loadClass(WebappClassLoader: java:1209)
java.lang.ClassLoader.loadClassInternal(ClassLoader: java:310)
org.apache.commons.io.output.DeferredFileOutputStream: java:103
org.apache.catalina.manager.HTMLManagerServlet.doPost(HTMLManagerServlet: java:157)
javax.servlet.http.HttpServlet.service(HttpServlet: java:710)
javax.servlet.http.HttpServlet.service(HttpServlet: java:803)
NOTE The full stack trace of the root cause is available in the Apache Tomcat/5.5.26 logs.
Apache Tomcat/5.5.26
  
```

Thesis Overview

Legacy Mode

Runtime Exception Analysis Framework

Exception Localization Or Injection

Resilient Catch Taxonomy

Catch Synthesis

Catch Selection

Catch Injection

Resilience Mode

Runtime Exception Analysis

Applicative Goals

- analyze the exception behavior specification
- isolate the catch blocks needed to perform an action
- isolate the catch blocks which are not (or cannot be) used

Technical Goals

- detection of exception sources and their context
- capture of catch block execution and their interplay
- analyze the relationship between causes and treatments

The Spoon library is used to instrument source code

```

try{
    Framework.learn("try-start");
    //developer code
    Framework.learn("try-end");
} catch(RuntimeException re){
    Framework.learn("catch-start", re);
    //developer code
    Framework.learn("catch-end");
}
  
```

Results

Run org.apache.commons.lang Test Suite skipping the catch treatments: (2051 tests)

- 4 failures --> bad assert result
- 125 errors --> unexpected Exception
- 1 crash --> non-ending required Thread

Number of used catch blocks / thrown exceptions to boot

- Vuze: 24 catch – 413 exceptions
- Jabref: 5 catch – 50 exceptions
- Bluej: 0 catch – 1 exceptions

Ongoing Work

Exception injection of appropriate types at relevant place.

- select the place according to execution traces
- for a given place choose the type according to the static and dynamic context
- minimize artificiality / maximize learning

Evaluation

- How many “manually” fixed exception bugs from bug repositories can be automatically repaired by the framework?
- How much can the framework avoid crashing from fault injection?