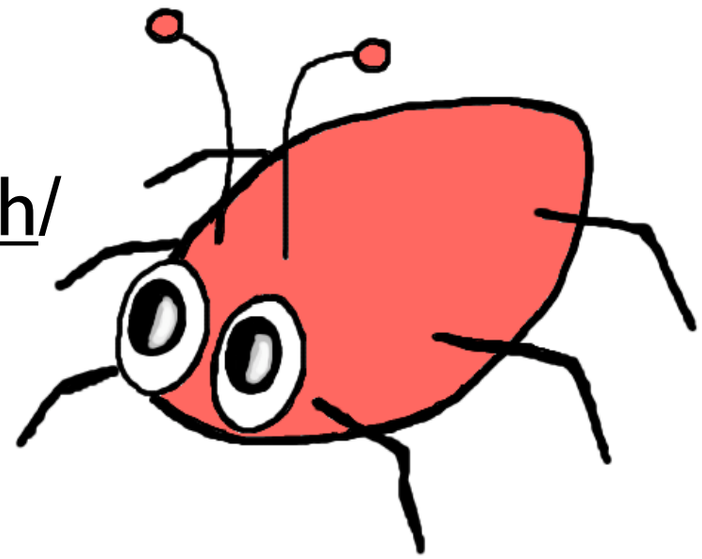
FindBugs
review of Glassfish v2 b09

William Pugh

Univ. of Maryland

http://www.cs.umd.edu/~pugh/



FindBugs

- Open source static analysis tool for finding defects in Java programs
  - Analyzes classfiles
  - Generates XML or text output
    - can run in Netbeans/Swing/Eclipse/Ant/SCA
  - Total downloads from SourceForge: 231,861+

What is FindBugs?

- Static analysis tool to find defects in Java code
  - not a style checker
- Can find hundreds of defects in each of large apps such as Bea WebLogic, IBM Websphere, Sun's JDK
  - real defects, stuff that should be fixed
  - hundreds is conservative, probably *thousands*
- Doesn't focus on security
  - lower tolerance for false positives

Common Wisdom about Bugs

- Programmers are smart
- Smart people don't make dumb mistakes
- We have good techniques (e.g., unit testing, pair programming, code inspections) for finding bugs early
- So, bugs remaining in production code must be subtle, and require sophisticated techniques to find

Would You Write Code Like This?

```
if (in == null)
    try {
        in.close();
    ...
```

- Oops
- This code is from Eclipse
  - You may be surprised what is lurking in your code

Why Do Bugs Occur?

- Nobody is perfect
- Common types of errors:
  - Misunderstood language features, API methods
  - Typos (using wrong boolean operator, forgetting parentheses or brackets, etc.)
  - Misunderstood class or method invariants
- Everyone makes syntax errors, but the compiler catches them
  - What about bugs one step removed from a syntax error?

JDK 1.6.0-b92 results

- 44 classes that define equals() but inherit hashCode() from Object
- 31 equals methods that don't handle null
- 6 statements that always throw a NPE
- 46 branches that if taken guaranteed a NPE
- 11 comparisons of unrelated types
- 7 ignored return values
- 1 infinite recursive loop

Demo

- Live code review of glassfish-v2-b09
- Available as Java Webstart from
  - http://www.cs.umd.edu/~pugh/glassfish/

Bug Patterns

Hashcode/Equals

- Equal objects must have equal hash codes
  - Programmers sometimes override equals() but not hashCode()
    - Or, override hashCode() but not equals()
  - Objects violating the contract won't work in hash tables, maps, sets
- Examples (53 bugs in 1.6.0-b29)
  - javax.management.Attribute
  - java.awt.geom.Area

Fixing hashCode

- What if you want to define equals, but don't think your objects will ever get put into a HashTable?
- Suggestion:

```
public int hashCode() {
  assert false : "hashCode method not designed";
  return 42;
  }
```

Null Pointer Dereference

- Dereferencing a null value results in NullPointerException
  - Warn if there is a statement or branch that if executed, guarantees a NPE
- Example:

```
// Eclipse 3.0.0M8

Control c = getControl();

if (c == null && c.isDisposed())

    return;
```

Bad Binary operations

```
if ((f.getStyle () & Font.BOLD) == 1) {
      sbuf.append ("<b>");
      isBold = true;
      }

if ((f.getStyle () & Font.ITALIC) == 1) {
      sbuf.append ("<i>");
      isItalic = true;
      }
```

Doomed Equals

```
public static final ASDDVersion
  getASDDVersion(BigDecimal version) {

if(SUN_APPSERVER_7_0.toString()
      .equals(version))
  return SUN_APPSERVER_7_0;
```

Unintended regular expression

```
String[] valueSegments
  = value.split("."); // NOI18N
```

Field Self Assignment

```
public TagHelpItem(String name, String file,
                   String startText, int startOffset,
                   String endText, int endOffset,
                   String textBefore, String textAfter){
        this.name = name;
        this.file = file;
        this.startText = startText;
        this.startTextOffset = startTextOffset;
        this.endText = endText;
        this.endTextOffset = endTextOffset;
        this.textBefore = textBefore;
        this.textAfter = textAfter;
        this.identical = null;
    }
```

Confusing/bad naming

- Methods with identical names and signatures
  - but different capitalization of names
  - could mean you don't override method in superclass
  - confusing in general
- Method name same as class name
  - gets confused with constructor

Bad naming in Eclipse

```
package org.eclipse.jface.dialogs;
public abstract class Dialog extends Window {
   protected Button getOKButton() {
      return getButton(IDialogConstants.OK_ID);
      };
   }
public class InputDialog extends Dialog {
   protected Button getOkButton() {
      return okButton;
      };
}
```

Bad naming in BCEL (shipped in jdk1.6.0-b29)

```
/** @return a hash code value
  *for the object.
  */
public int hashcode() {
   return basic_type.hashCode()
          ^ dimensions; }
```

Read Return Value Ignored

- InputStream.read() methods that read into a byte array return the number of bytes read
  - Can be less than the number requested
  - Programmers sometimes fail to check return value
    - May result in uninitialized array elements being used
    - Program can get out of sync with input stream
- Example (GNU Classpath 0.08):

```
// java.util.SimpleTimeZone.readObject()
int length = input.readInt();
byte[] byteArray = new byte[length];
input.read(byteArray, 0, length);
```

Other Return Value Ignored Errors

- Lots of methods for which return value always should be checked
  - E.g., operations on immutable objects
- Examples:

```
// Eclipse 3.0.0M8
String name= workingCopy.getName();
name.replace('/', '.');
```

Ignored Exception Creation

```
/**
 * javax.management.ObjectInstance
 * reference impl., version 1.2.1
 **/
    public ObjectInstance(ObjectName objectName,
                          String className) {
        if (objectName.isPattern()) {
          new RuntimeOperationsException(
            new IllegalArgumentException(
             "Invalid name->"+ objectName.toString()));
        }
        this.name = objectName;
        this.className = className;
    }
```

Inconsistent Synchronization

- Common idiom for thread safe classes is to synchronize on the receiver object ("this")
- We look for field accesses
  - Find classes where lock on "this" is sometimes, but not always, held
  - Unsynchronized accesses, if reachable from multiple threads, constitute a race condition

Inconsistent Synchronization Example

- GNU Classpath 0.08, java.util.Vector

```
public int lastIndexOf(Object elem)
{
  return lastIndexOf(elem, elementCount - 1);
}

public synchronized int lastIndexOf(
  Object e, int index)
{
  ...
}
```

Unconditional Wait

- Before waiting on a monitor, the condition should be almost always be checked
  - Waiting unconditionally almost always a bug
  - If condition checked without lock held, could miss the notification
- Example (JBoss 4.0.0DR3):

```
if (!enabled) {
   try {
     log.debug(...);
     synchronized (lock) {
       lock.wait();
     }
```

condition can become true after it is checked

but before the wait occurs

Warning Density

Warning density

- Density of high and medium priority correctness warnings (excluding HE and SE warnings)

Warnings/KNCSS	Software
0.4	SleepyCat DB
0.5	Eclipse 3.2
0.9	JDK 1.5.0_03
1.0	JDK 1.6.0 b51
1.3	WebSphere

Some new-ish features

Behavior Annotations

- Allow you to provide lightweight specifications through Java 5.0 annotations
- Examples
  - @NonNull
  - @CheckForNull
  - @CheckReturnValue
  - @Tainted/@Untainted/@Detainted
    - proposed

Computing bug history

- Keeps track of when bug are introduced, when they are resolved
- Historical bug data records all bugs reported for any build
- Can see when bugs were introduced and removed
- For example, can report all bugs introduced in the past 3 months

FindBugs
Best Practices

What to look at

- First review high and medium priority correctness
  - Low priority warnings are of questionable value
- Other categories (style, performance) worth examining in a code review, but insisting that they all be reviewed immediately will make people unhappy
- Carefully consider and review FindBugs plugins
  - Others have written plugins, some of which generate a lot more false positives or give bad advice

Incremental analysis and/or marking

- For sustainable use, you need to have some way to deal with false positives
  - mark in database
  - Only review new warnings
- Both of these require matching warnings from one analysis with results from a previous analysis

Developers like incremental analysis

- Developers don't like to be asked to scrub a million line code base and review 1000 warnings
- But they don't mind (as much) if you ask them to review a new warning introduced by a change they just made
  - false positive rate still matters

Questions?