



Measure and improve code quality

Using automation

What is Code Quality?



David Garvin

Five Dimensions of Quality

- 1 Transcendental
- 2 Product
- 3 User
- 4 Manufacturing
- 5 Value



Transcendental

Plato

A characteristic of an object that could not be described. But could be learned when one is exposed to a succession of high quality objects.



Transcendental

Aristotle

Quality is not an act, but a habit.



Transcendental

Pirsig

I think there is such a thing as Quality, but that as soon as you try to define it, something goes haywire. You can't do it.



Transcendental

Pirsig

No way to explain, but everybody knows it through repeated exposure to low / high quality product



Product: Precise measurement of known variable

Ice Cream

More butterfat → higher quiality



Product: Precise measurement of known variable

Persian rugs

More knots per square inch → higher quality



User

More desirable products are of higher quality.



User

Better selling products are of higher quality.



Manufacturing

Conformance to well defined standard.



Manufacturing

Lower variance → higher quality.



Value : Monetary

More expensive products are of higher quality.



Value : Monetary

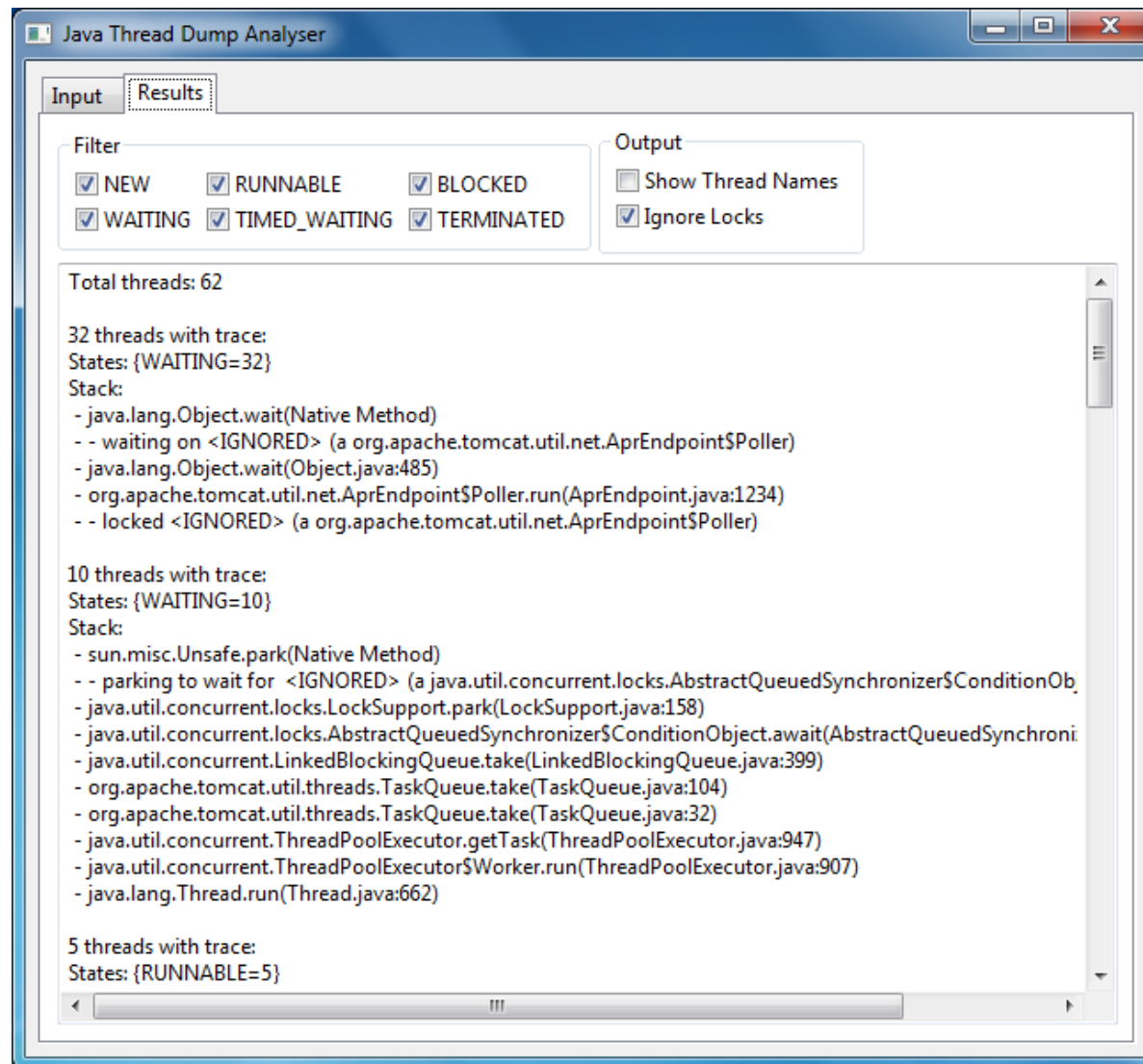
Ferrari is of higher quality than Pinto.



Code Quality

- External
- Internal

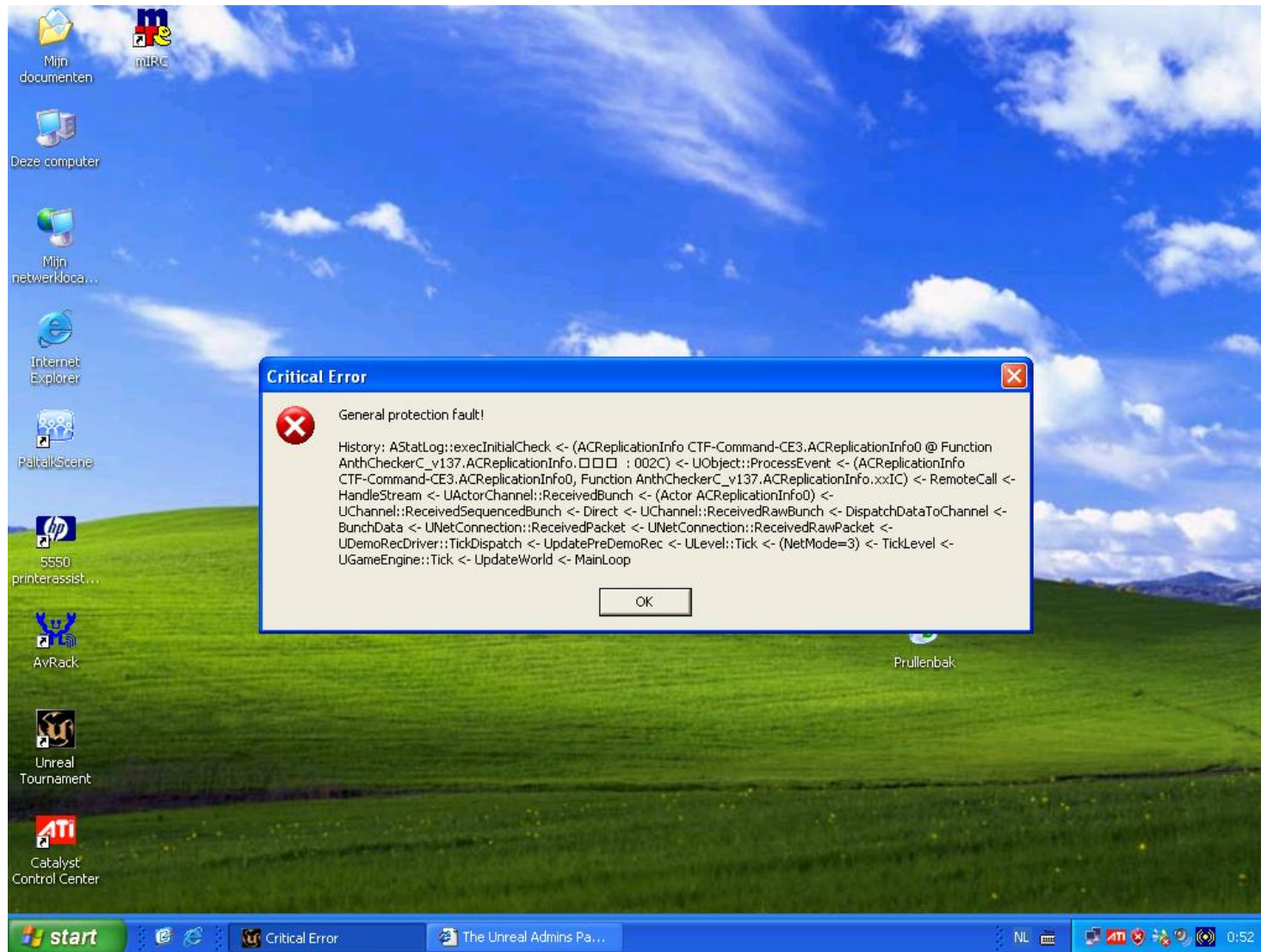
External Code Quality



External Code Quality



External Code Quality



External Code Quality



External Code Quality

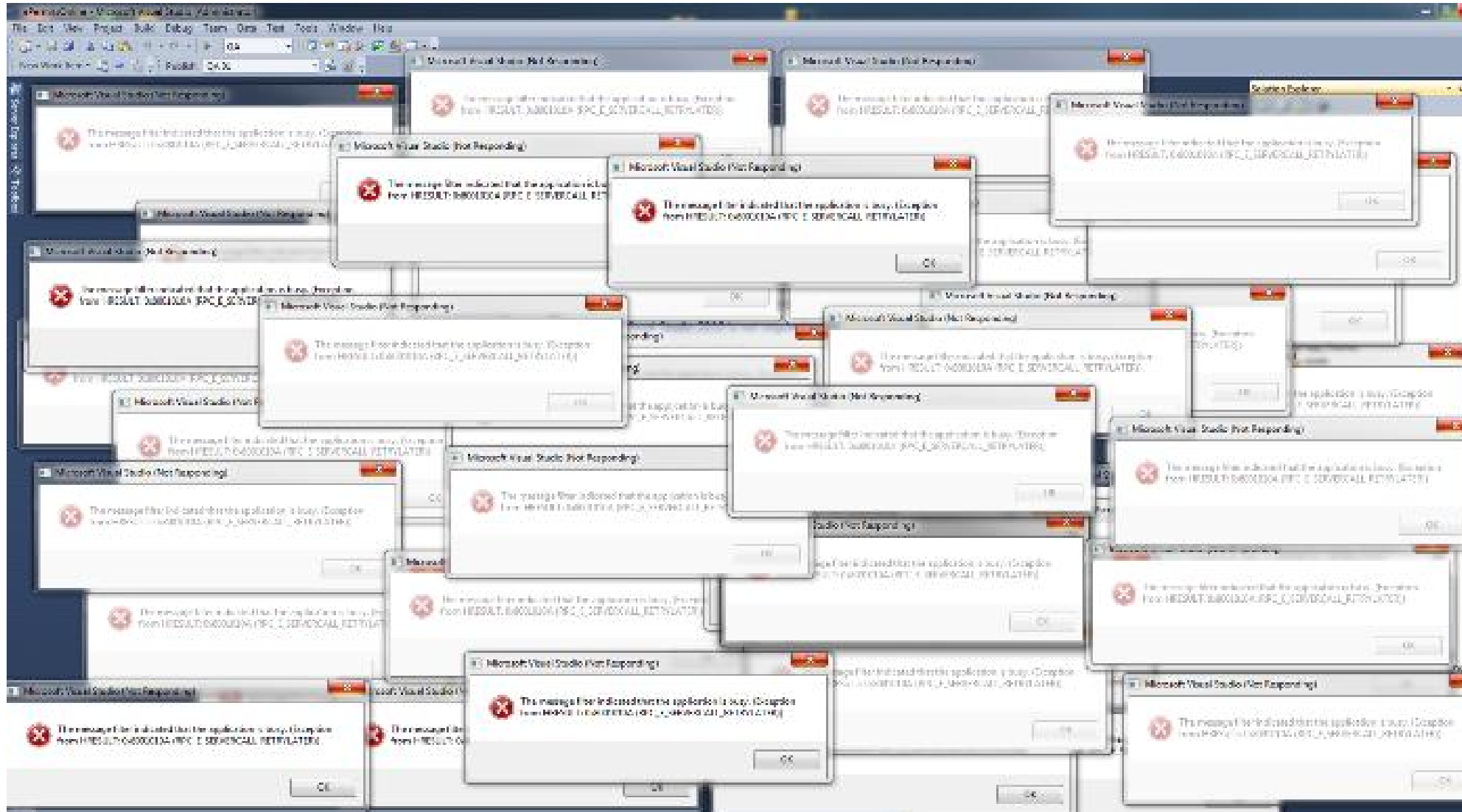
```
hub.c: new USB device 00:1d.7-6.2, assigned address 5
input: USB HID v1.10 Keyboard [Weltrend Bar Code Reader] on usb1:5.0
Unable to handle kernel NULL pointer dereference at virtual address 00000048
printing eip:
f977dee6
*pde = 00000000
Ops: 0000
CPU: 0
EIP: 0010:[<f977dee6>] Tainted: P
EFLAGS: 00210207
eax: 00000000 ebx: f75e3400 ecx: f50ae300 edx: 00000000
esi: 00010011 edi: f47fdc50 ebp: f50ae300 esp: c0341eb0
ds: 0018 es: 0018 ss: 0018
Process swapper (pid: 0, stackpage=c0341000)
Stack: f50a1300 f75e3400 f977d281 f75e3400 f50ae300 350a1300 00088141 f50ae340
0177f666 00000000 00000001 00000001 f50ae34c f50a1060 00000000 00000000
f50ae300 00000437 f977f64a f75e3400 f50ae300 c0341fa0 00000008 f50a0210
Call Trace: [<f977d281>] [<f977f64a>] [<f977ff89>] [<f977733a>] [<c01087f5>]
[<c01089f9>] [<c01052c0>] [<c010aea8>] [<c01052c0>] [<c01052e3>] [<c0105372>]
[<c0105000>]

Code: 8b 42 48 39 c8 75 f7 8b 01 89 02 8b 41 48 89 42 48 8b 83 00
<0>Kernel panic: Aiee, killing interrupt handler!
In interrupt handler - not syncing
<0>Rebooting in 30 seconds..
```

External Code Quality



External Code Quality





External Code Quality

- Ad hoc tests



External Code Quality

- Ad hoc tests
- QA Tests



External Code Quality

- Ad hoc tests
- QA Tests
- Regression tests



External Code Quality

- Ad hoc tests
- QA Tests
- Regression tests
- User reports



External Code Quality

- Ad hoc tests
- QA Tests
- Regression tests
- User reports
- Your boss comes up to you saying :



External Code Quality

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- Your boss comes up to you saying :
 - 1 All systems are down



External Code Quality

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 - 1 All systems are down
 - 2 The system is crediting wrong accounts



External Code Quality

- Ad hoc tests
- QA Tests
- Regression tests
- User reports
- Your boss comes up to you saying :
 - 1 All systems are down
 - 2 The system is crediting wrong accounts
 - 3 The system is delivering messages to the wrong users



Internal Code Quality

When you're a carpenter making a beautiful chest of drawers, you're not going to use a piece of plywood on the back, even though it faces the wall and nobody will ever see it. You'll know it's there, so you're going to use a beautiful piece of wood on the back. For you to sleep well at night, the aesthetic, the quality, has to be carried all the way through.

Steve Jobs



Internal Code Quality

- How do we measure it?



Internal Code Quality

- How do we measure it?
- What's our equivalent of plywood?



7 Axes of Code Quality

- Bad Patterns [Bugs]



7 Axes of Code Quality

- Bad Patterns [Bugs]
- Bad Style [Coding Rules]



7 Axes of Code Quality

- Bad Patterns [Bugs]
- Bad Style [Coding Rules]
- Tests / Tests coverage



7 Axes of Code Quality

- Bad Patterns [Bugs]
- Bad Style [Coding Rules]
- Tests / Tests coverage
- Duplicated Code [Cut and paste]



7 Axes of Code Quality

- Bad Patterns [Bugs]
- Bad Style [Coding Rules]
- Tests / Tests coverage
- Duplicated Code [Cut and paste]
- Comments



7 Axes of Code Quality

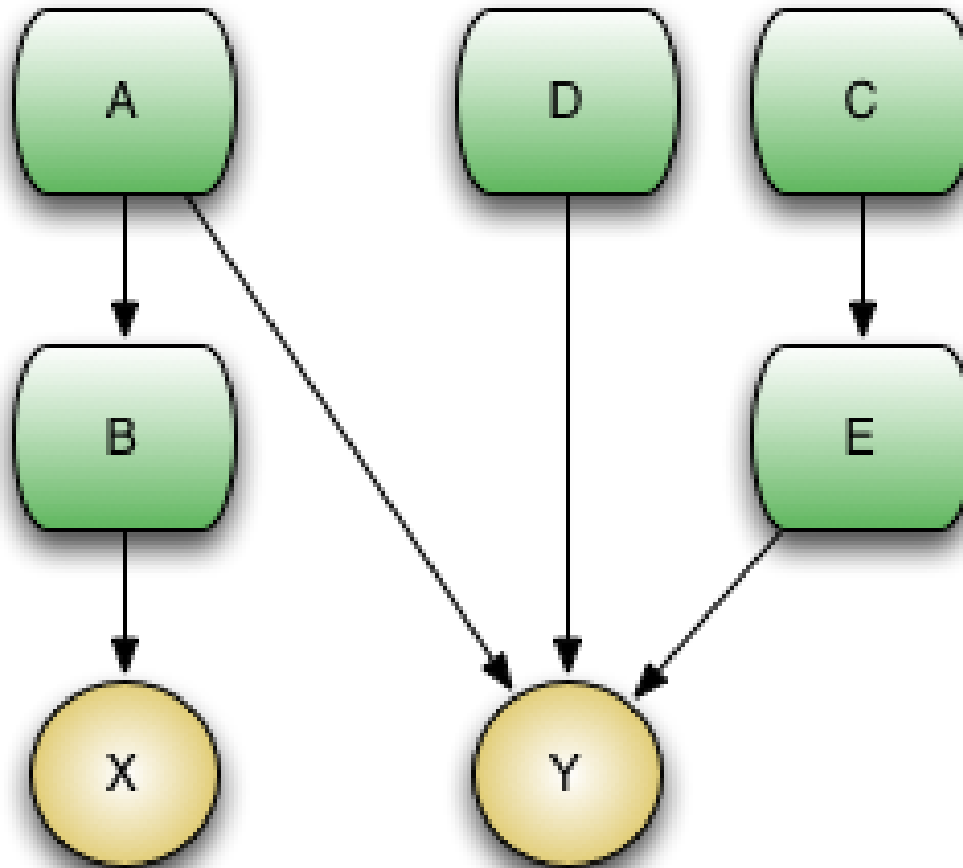
- Bad Patterns [Bugs]
- Bad Style [Coding Rules]
- Tests / Tests coverage
- Duplicated Code [Cut and paste]
- Comments
- Architecture
 - Lack of Cohesion of Methods
 - Circular dependencies



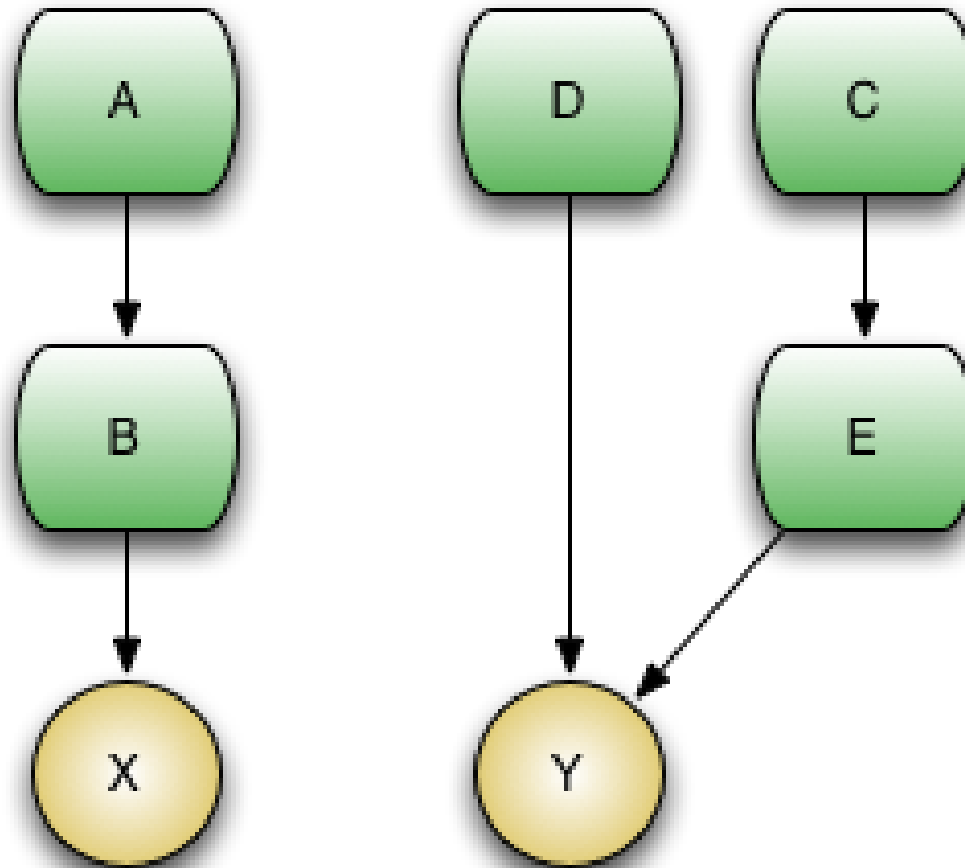
7 Axes of Code Quality

- Bad Patterns [Bugs]
- Bad Style [Coding Rules]
- Tests / Tests coverage
- Duplicated Code [Cut and paste]
- Comments
- Architecture
 - Lack of Cohesion of Methods
 - Circular dependencies
- Complexity
 - God classes
 - God methods

Lack of Cohesion of Methods [LCOM4]



Lack of Cohesion of Methods [LCOM4]





Code Complexity



Response for Class

What is RFC?

RFC stands for Response For Class. RFC measures the complexity of the class in terms of method calls.

For each class, it counts:

- +1 for each method
- +1 for each call of a distinct method (note that getters and setters are not considered as methods)

Example:

```
1  public class ClassA
2  {
3      private ClassB classB = new ClassB();    // call (constructor of class B) => +1
4      public void doSomething(){                // method declaration => +1
5          System.out.println ( "doSomething"); // call (System.out.println) => +1
6      }
7      public void doSomethingBasedOnClassB(){    // method declaration => +1
8          System.out.println (classB.toString()); // call (System.out.println) => 0 because already counted on line 5 + cal
9      }
10 }
11
12 // default constructor of ClassA => +1
13 // RFC = 6
```



Cyclomatic Complexity

- Keywords that increment complexity:

if, for, while, case, catch, throw, return (that is not the last statement of a method), conditionals, else

- Keywords that don't increment complexity:

default, finally

```
public void process(Car myCar){           // +1
    if(myCar.isNotMine()){                 // +1
        return;                           // +1
    }
    car.paint("red");
    car.changeWheel();
    while(car.hasGazol() && car.getDriver().isNotStressed()){ // +2
        car.drive();
    }
    return;
}
```




Sonar



What is Sonar?

- Web based tool.



What is Sonar?

- Web based tool.
- Collects collects metrics from multiple projects



What is Sonar?

- Web based tool.
- Collects collects metrics from multiple projects
- Repository of rules



What is Sonar?

- Web based tool.
- Collects collects metrics from multiple projects
- Repository of rules
- Ticketing system for quality improvement



What is Sonar?

- Web based tool.
- Collects collects metrics from multiple projects
- Repository of rules
- Ticketing system for quality improvement
- Dashboards / Reports



Why should I use sonar ?

Tester: Pinpoint the weak spots

- Overly complex code
- No coverage



Why should I use sonar ?

Developer: Education

- Thread Safety
- Resource management
- Language subtleties



Why should I use sonar ?

Developer: Maintainability

- Readability
- Complexity
- Missing or incorrect documentation



Why should I use sonar ?

Developer: Adherence to standards

- Naming convention
- Formatting
- Use of bad methods *System.out.println*
- Coding rule compliance
- Boilerplate code



Why should I use sonar ?

Architect: Is design being degraded?

- Circular dependencies
- Lack of cohesion
- Over complex classes and methods



Why should I use sonar ?

Big Boss



Why should I use sonar ?

Big Boss : Metrics



Platforms

■ Java



Platforms

- Java
- .NET



Platforms

- Java
- .NET
- C++



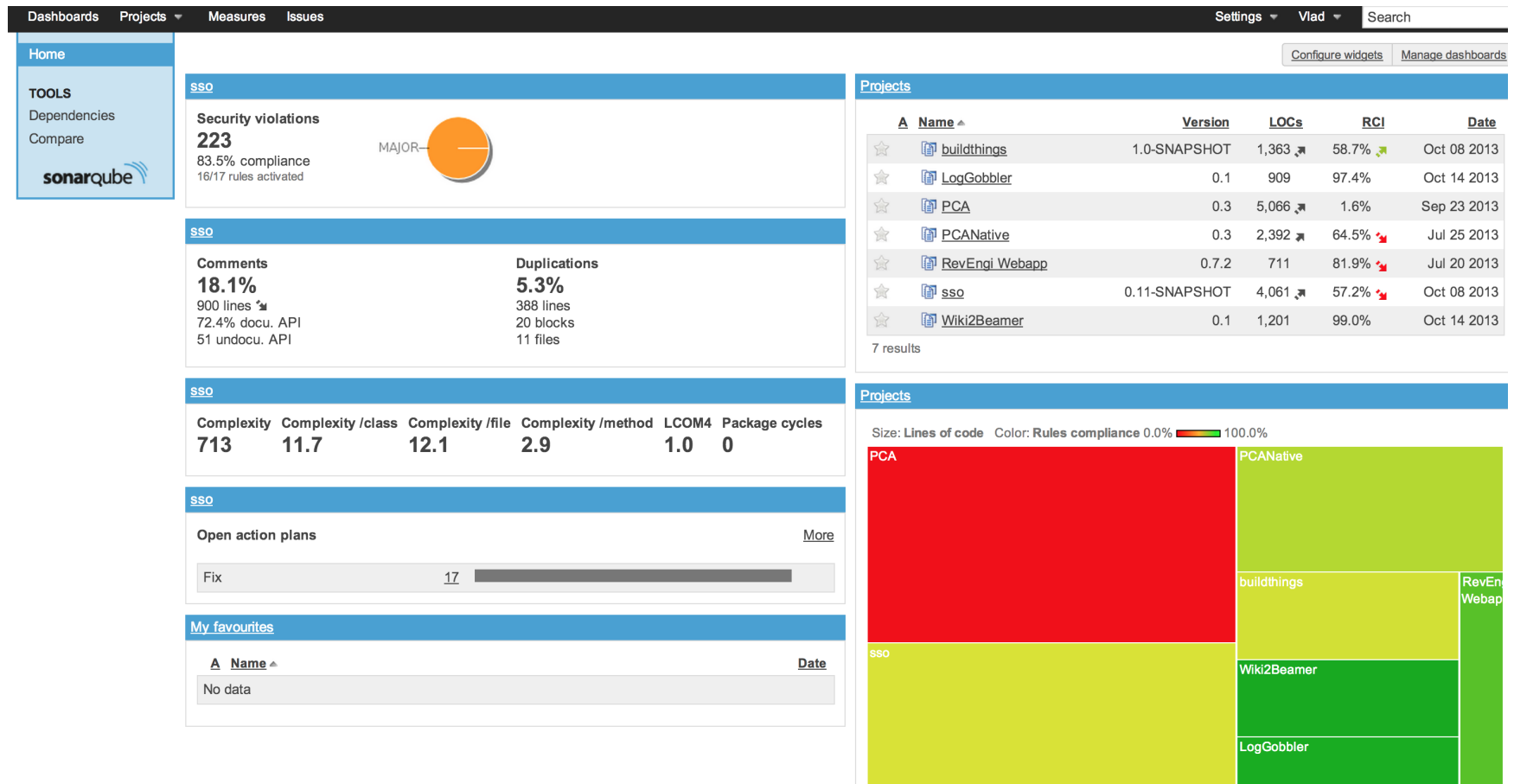
Platforms

- Java
- .NET
- C++
- Python

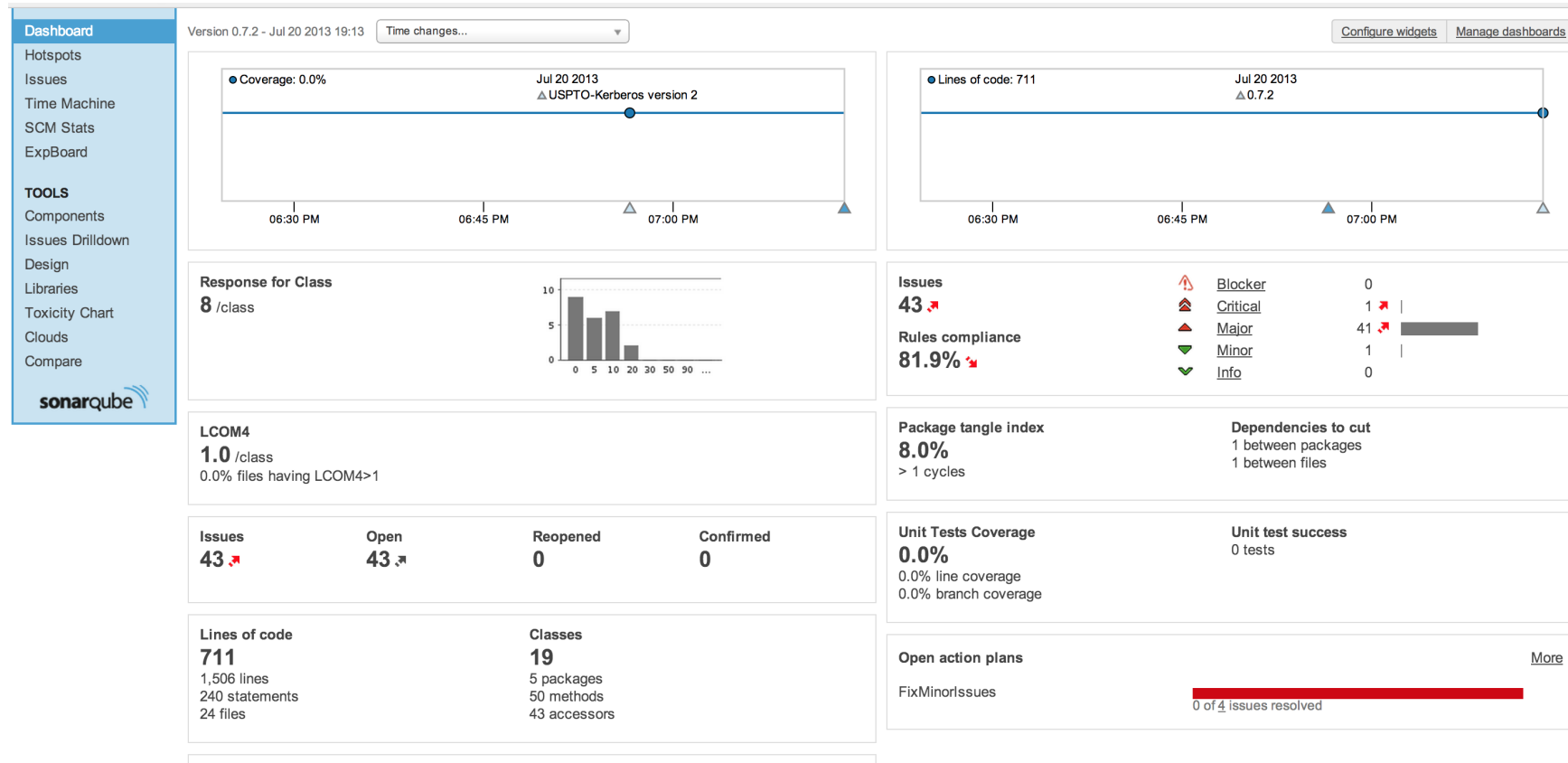


Demo

Main Dashboard



Project Drill-Down



Project Issues Drill-Down

Weighted issues

129

| | | | |
|---------------------------|----|--------------------------|----|
| com.revengi.webapp | 96 | AccountActions | 51 |
| com.revengi.dao.hibernate | 17 | AuthorizationAction | 24 |
| com.revengi.webservice | 7 | HibernateUtil | 11 |
| com.revengi.model | 6 | AuthorizationInterceptor | 9 |
| com.revengi.dao | 3 | TransactionActions | 9 |
| | | AccountService | 7 |

RevEngi Webapp

★ com.revengi.webapp.AccountActions

[Coverage](#) [Dependencies](#) [Duplications](#) **Issues** [LCOM4](#) [Source](#)

[Raw](#) [LP](#)

17 issues ⚠ Blocker: 0 🚨 Critical: 0 🚩 Major: 17 🟢 Minor: 0 🟢 Info: 0

☐ Full source | Time changes... | All issues

⚠ **Non-transient non-serializable instance field in serializable class** | Open | 3 months [LP](#)

Class com.revengi.webapp.AccountActions defines non-transient non-serializable instance field account

[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) | [More actions](#) ▼

⚠ **Non-transient non-serializable instance field in serializable class** | Open | 3 months [LP](#)

Class com.revengi.webapp.AccountActions defines non-transient non-serializable instance field accountList

[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) | [More actions](#) ▼

```
41      * Action to show all accounts.
42      * @return    result ERROR or SUCCESS
43      */
44      public final String view() {
45          System.out.println("View all accounts");
```

⚠ **System Println** | Open | 3 months [LP](#)

System.out.print is used

[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) | [More actions](#) ▼

```
46      try {
```

Project Issues Drill-Down

▲ **Non-transient non-serializable instance field in serializable class** | Open | 3 months

Class com.revengi.webapp.AccountActions defines non-transient non-serializable instance field account

[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) [More actions](#) ▼

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[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) [More actions](#) ▼

```
41      * Action to show all accounts.
42      * @return      result ERROR or SUCCESS
43      */
44      public final String view() {
45          System.out.println("View all accounts");
46
47          try {
48              accountList = accountDao.loadAll();
49              System.out.println("account size: " + accountList.size());
50          } catch (Exception e) {
51              return "Error: " + e.getMessage();
52          }
53          return "Success";
54      }
```

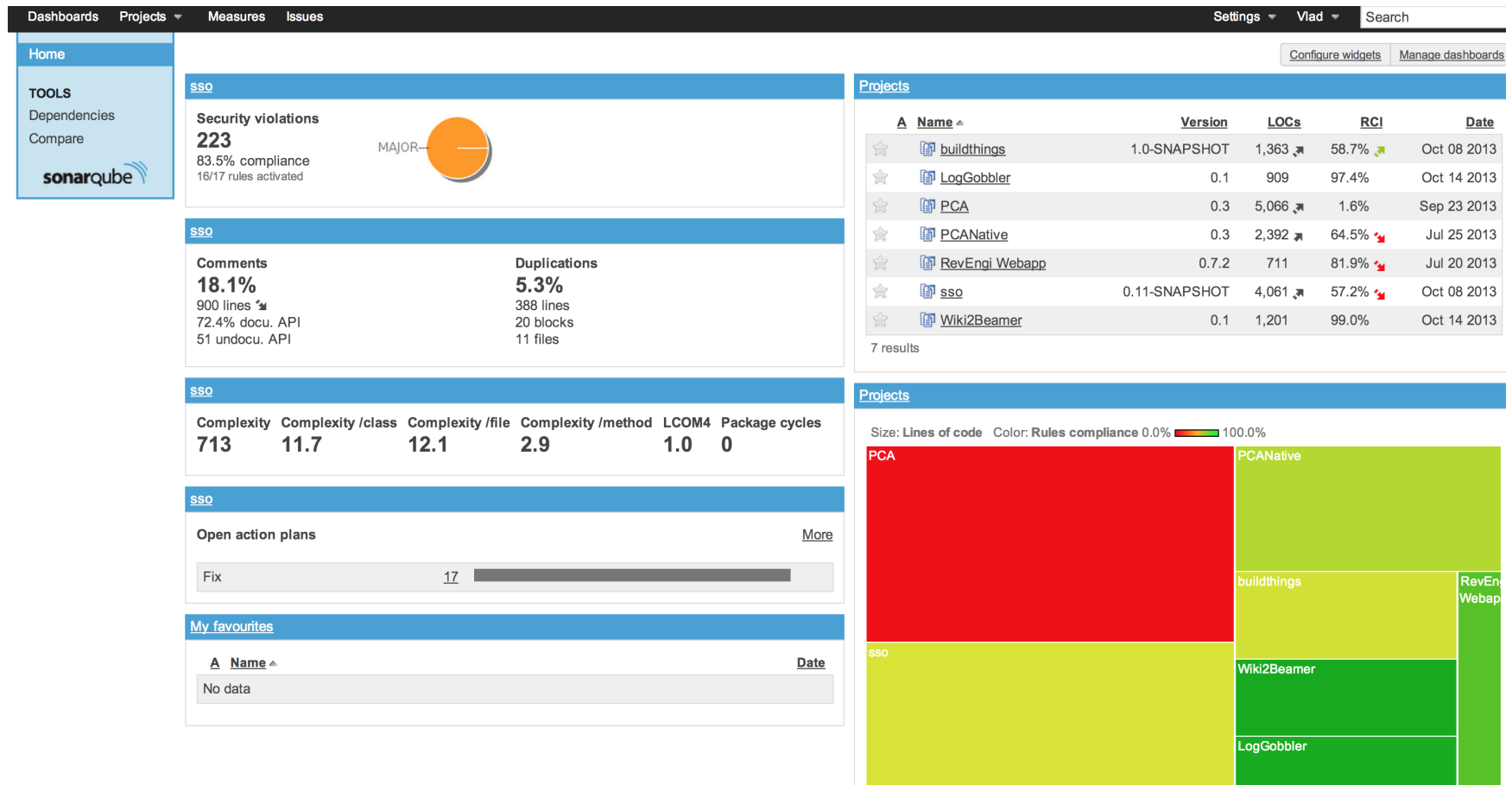
▲ **System Println** | Open | 3 months

System.out.print is used

[Comment](#) | [Assign \[to me\]](#) | [Plan](#) | [Confirm](#) [More actions](#) ▼

▲ **System Println** | Open | 3 months

Issue Tracking





Issue Tracking

Open action plans

[More](#)

FixMinorIssues

0 of 5 issues resolved

Issue Tracking

Dashboards

Projects ▾

Measures

Issues

Settings ▾

Vlad ▾

Search

NEW SEARCH

Project:

Project ▾

Severity:

Severity

Status:

Status

Resolution:

Resolution

Assignee:

Assignee ▾

Reporter:

Reporter ▾

Created since:

Created before:

year-month-day (2013-01-31)

Search

New search

| Se. | Status | Resolution | Description | Project | Component | Assignee | Action plan | Created | Updated |
|-----|-----------|------------|---|----------------|---|---------------|----------------|-------------|-------------|
| ▲ | Confirmed | | Consider simply returning the value vs storing it in local variable 'accounts' | RevEngi Webapp | com.revengi.dao.hibernate.HibernateGenericDao | | FixMinorIssues | Jul 20 2013 | Jul 22 2013 |
| ▲ | Confirmed | | Consider simply returning the value vs storing it in local variable 'transactions' | RevEngi Webapp | com.revengi.dao.hibernate.HibernateTransactionDao | | FixMinorIssues | Jul 20 2013 | Jul 22 2013 |
| ▲ | Confirmed | | System.out.print is used | RevEngi Webapp | com.revengi.webapp.AccountActions | Vlad | FixMinorIssues | Jul 20 2013 | 18:18 |
| ▲ | Confirmed | | The String literal "incorrect symbols in password" appears 4 times in this file; the first occur... | RevEngi Webapp | com.revengi.webapp.AccountActions | Administrator | FixMinorIssues | Jul 20 2013 | Jul 22 2013 |
| ▲ | Confirmed | | The String literal "user" appears 4 times in this file; the first occurrence is on line 40 | RevEngi Webapp | com.revengi.webapp.AuthorizationAction | Administrator | FixMinorIssues | Jul 20 2013 | Jul 22 2013 |

5 results

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Issue Tracking

The screenshot displays a JIRA issue tracking interface. On the left, there is a 'NEW SEARCH' sidebar with filters for Project, Severity, Status, Resolution, Assignee, Reporter, Created since, and Created before. The main area shows a table of issues with columns: Se., Status, Resolution, Description, Project, Component, Assignee, Action plan, Created, and Updated. A modal window is open, showing details for the issue 'System Printin' (Confirmed, 3 months old). The modal includes a code snippet for the 'view()' method in 'com.revengi.webapp.AccountActions'.

| Se. | Status | Resolution | Description | Project | Component | Assignee | Action plan | Created | Updated |
|-----|-----------|------------|--|----------------|---|----------|----------------|-------------|-------------|
| ▲ | Confirmed | | Consider simply returning the value vs storing it in local variable 'accounts' | RevEngi Webapp | com.revengi.dao.hibernate.HibernateGenericDao | | FixMinorIssues | Jul 20 2013 | Jul 20 2013 |
| ▲ | Confirmed | | Consider simply returning the value vs storing it in local variable 'transactions' | RevEngi Webapp | com.revengi.dao.hibernate.HibernateTransactionDao | | FixMinorIssues | Jul 20 2013 | Jul 20 2013 |
| ▲ | Confirmed | | System.out.print is used | RevEngi Webapp | com.revengi.webapp.AccountActions | Vlad | FixMinorIssues | Jul 20 2013 | 18:18 |

Issue Details: System Printin | Confirmed | 3 months

Description: System.out.print is used

Code Snippet:

```
40  /**
41   * Action to show all accounts.
42   * @return result ERROR or SUCCESS
43   */
44  public final String view() {
45      System.out.println("View all accounts");
46      try {
47          accountList = accountDao.loadAll();
48          System.out.println("account size: " + accountList.size());
49          return SUCCESS;
50      } catch (Exception e) {
```

Buttons: Comment, Assigned to Vlad, Planned for FixMinorIssues, Unconfirm, More actions, Close

Cut and Paste

PCANative
★ CMSInterface.cpp

[Duplications](#) [Issues](#) [Source](#)

22.8% Lines: **1,745** Duplicated lines: **398** Duplicated blocks: **16**

| Blocks | Nb Lines | From line | File | Details |
|--------|----------|-----------|------------------|---|
| 2 | 30 | 213 | CMSInterface.cpp | CMSInterface.cpp 637 (*NOTIFIER)("Connecting to CMS"); 638 639 (*NOTIFIER)("In the connection method"); 640 641 LogFile << "Opening service connections to " << host << _T(" port ") << adminPort.c_str(); 642 if(adminPort.compareIgnoreCase(myidPort)!=0) Expand |
| 2 | 41 | 260 | CMSInterface.cpp | CMSInterface.cpp 260 try 261 { 262 (*NOTIFIER)("Beginning the SyncMGR call"); 263 if(syncMgr==NULL !syncMgr->isSessionOpen()) 264 { 265 (*NOTIFIER)("Made it in to SyncMGR call"); Expand |
| 2 | 29 | 502 | CMSInterface.cpp | CMSInterface.cpp 502 if(syncMgr!=NULL) 503 { 504 try 505 { 506 if(syncMgr->isSessionOpen()) 507 { Expand |
| 2 | 32 | 1009 | CMSInterface.cpp | CMSInterface.cpp 1009 CriteriaVector criterias; 1010 criterias.push_back(Criteria(CRITERIA_ID_USERID, CRITERIA_COMPARISON_EQUAL, user)); 1011 (*NOTIFIER)("Search for user."); 1012 UserIdVector* userIds = userMgr->findUserIds(&criterias, 1); 1013 1014 Expand |

Lack of Cohesion

PCA > Configuration

Dashboard
Hotspots
Issues
Time Machine
SCM Stats
ExpBoard

TOOLS
Components
Issues Drilldown
Design
Libraries
Toxicity Chart
Clouds
Compare

sonarqube

LCOM4
2.9

| | | | | | |
|-----------------------|-----|--------|-----|----------------------|------|
| IDXAIICMSMUnitTest | 7.0 | [root] | 7.0 | cHexEncodingTest.cs | 20.0 |
| IDXAIICMSM | 2.3 | [root] | 2.3 | cActivIdentityCMS.cs | 11.0 |
| PCATestSupport | 2.0 | [root] | 2.0 | cLoggerTest.cs | 4.0 |
| CyberArmed.LogManager | 2.0 | [root] | 2.0 | CMSServiceTest.cs | 3.0 |
| | | | | IOObjectSafety.cs | 2.0 |
| | | | | SecureStringTest.cs | 2.0 |

PCA / IDXAICMSM
cActivIdentityCMS.cs

[Coverage](#) [Dependencies](#) [Duplications](#) [Issues](#) [LCOM4](#) [Source](#) [Raw](#) [Copy](#)

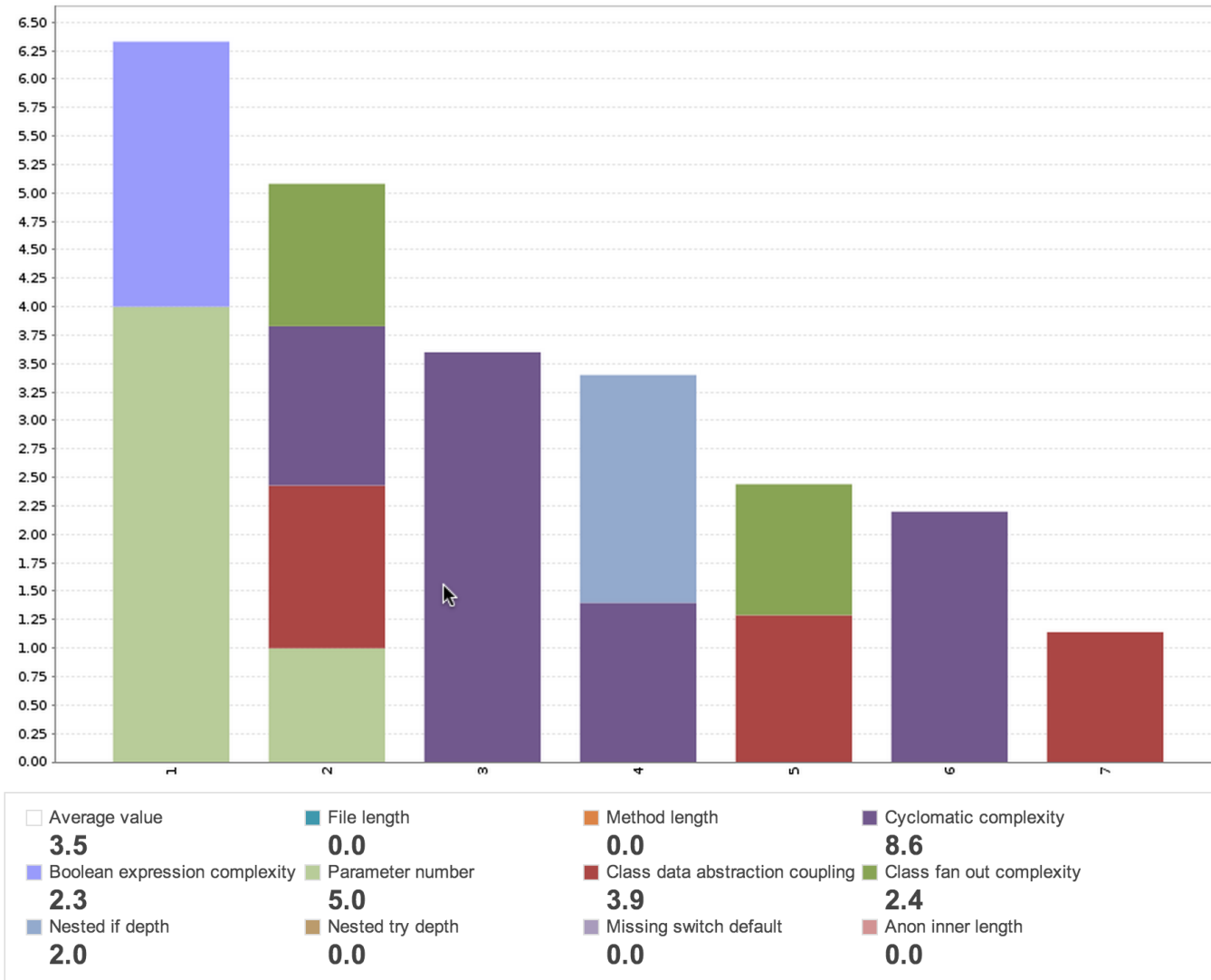
Lack of Cohesion of Methods: **11**

- 1 _isConnected
- CMSConn
- gchCallbackDelegate
- Log
- oEventLogger
- System.Int32 Connect()
- System.Int32 Connect(IDXAICMSM.cCMSConnection)
- System.Int32 ConnectViaServerSSL()
- System.Int32 CreateUser(IDXAICMSM.cCMSUser)
- System.Int32 Disconnect()
- System.Int32 DisconnectViaServerSSL()
- System.Int32 DoesCardRequireSynch(System.String)
- System.Boolean get_IsConnected()
- System.Int32 listDeviceAndCertificateStatus(System.String)
- System.Void OnLog(System.String)

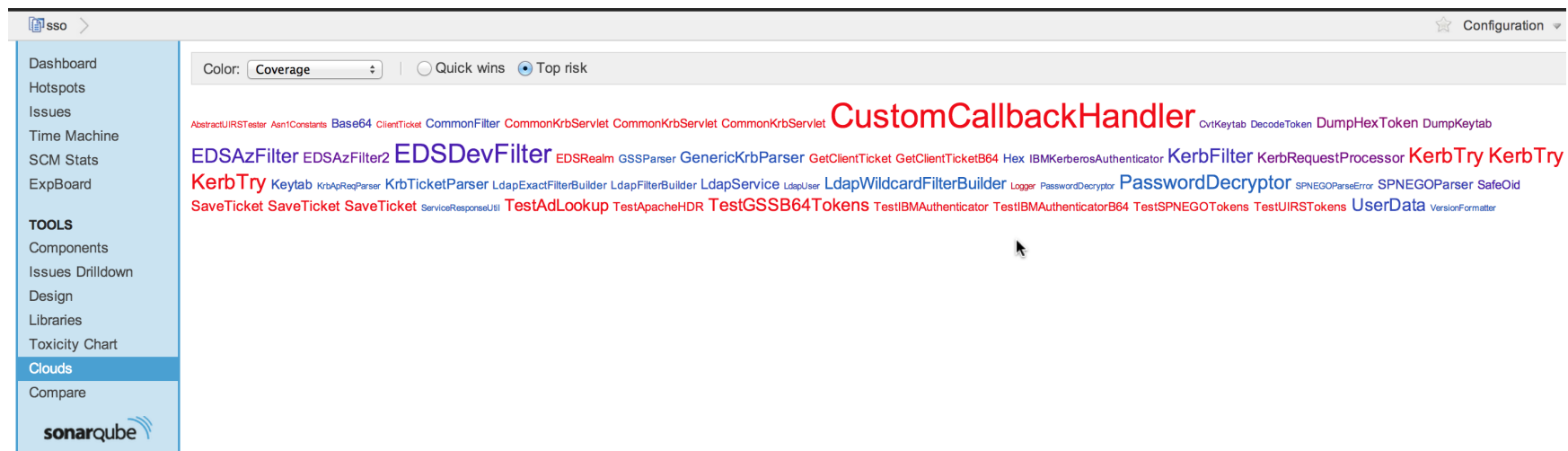
Lack of Cohesion

| | |
|----|--|
| | <div><div></div><div>System.Int32 DisconnectViaServerSSL()</div></div> <div><div></div><div>System.Int32 DoesCardRequireSynch(System.String)</div></div> <div><div></div><div>System.Boolean get_IsConnected()</div></div> <div><div></div><div>System.Int32 listDeviceAndCertificateStatus(System.String)</div></div> <div><div></div><div>System.Void OnLog(System.String)</div></div> <div><div></div><div>System.String RetrieveFingerprintDataFromCms(System.String)</div></div> <div><div></div><div>System.String RetrieveEmailAddressFromCms(System.String)</div></div> <div><div></div><div>System.String RetrieveFullNameFromCms(System.String)</div></div> <div><div></div><div>System.String RetrievePhotoFromCms(System.String)</div></div> <div><div></div><div>System.String ReturnCardIdentificationNumber(System.String)</div></div> <div><div></div><div>System.Void set_IsConnected(System.Boolean)</div></div> |
| 2 | <div><div></div><div>System.String ReturnVersionNumber()</div></div> |
| 3 | <div><div></div><div>System.Int32 SynchronizeCard(IDXAICMSM.cCMSUser, System.Boolean)</div></div> |
| 4 | <div><div></div><div>System.Int32 UpdateCard(IDXAICMSM.cCMSUser)</div></div> |
| 5 | <div><div></div><div>System.Int32 ActivateCard(IDXAICMSM.cCMSUser)</div></div> |
| 6 | <div><div></div><div>System.String CheckCardStatus(System.String)</div></div> |
| 7 | <div><div></div><div>IDXAICMSM.cActivIdentityCMS/ReturnManagedStruct ReturnDetailedDeviceInformation(System.String)</div></div> |
| 8 | <div><div></div><div>System.Void listCertStatus(System.String)</div></div> |
| 9 | <div><div></div><div>System.Void ResetUser(System.String, System.String, System.String)</div></div> |
| 10 | <div><div></div><div>System.Void BindCard(System.String, System.String, System.String)</div></div> |
| 11 | <div><div></div><div>System.Void RequestReplacementRegeust(System.String, System.String, System.String)</div></div> |

Project Health



Project Health





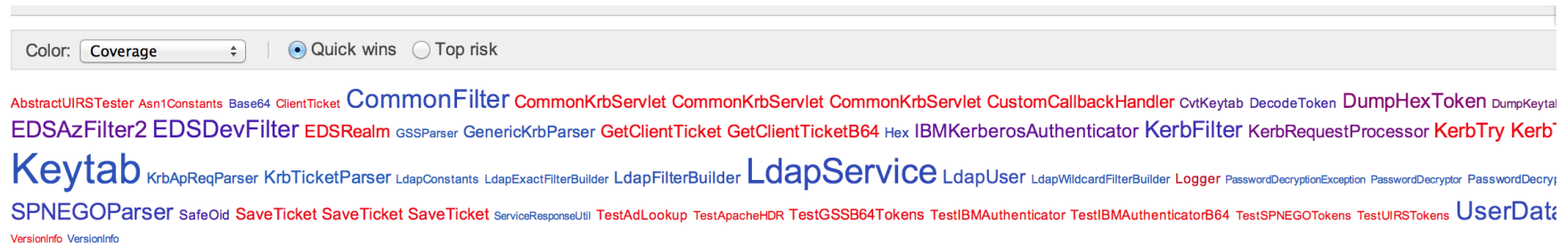
Project Health

Color: Rules compliance | ☐ Quick wins ☒ Top risk

AbstractUIRSTester Asn1Constants Base64 ClientTicket CommonFilter CommonKrbServlet CommonKrbServlet CommonKrbServlet CustomCallbackHandler CvtKeytab Des
EDSAzFilter EDSAzFilter2 EDSDevFilter EDSRealm GSSParser GenericKrbParser GetClientTicket GetClientTicketB64 Hex IBMKerberosAuthenticator KerbFilter K
KerbTry keytab KrbApReqParser KrbTicketParser LdapExactFilterBuilder LdapFilterBuilder LdapService LdapUser LdapWildcardFilterBuilder Logger PasswordDecryptor PasswordDecryp
SaveTicket SaveTicket SaveTicket ServiceResponseUtil TestAdLookup TestApacheHDR TestGSSB64Tokens TestIBMAuthenticator TestIBMAuthenticatorB64 TestSPNEGOTokens Te



Project Health



Quality Profiles

Compare Profiles

Restore Profile

| C# Profiles | | | | | | + Create |
|---------------------------|-------|--------|----------|----------------------|------------|--------------------------|
| Name | Rules | Alerts | Projects | Default | Operations | |
| Sonar way | 328 | 0 | | ✓ Backup Rename Copy | | |

| c++ Profiles | | | | | | + Create |
|-------------------------------------|-------|--------|----------|--|------------|--------------------------|
| Name | Rules | Alerts | Projects | Default | Operations | |
| Default C++ Profile | 613 | 0 | | ✓ Backup Rename Copy | | |
| Sonar way | 628 | 0 | 0 | Set as default Backup Rename Copy Delete | | |

| Java Profiles | | | | | | + Create |
|---|-------|--------|----------|--|------------|--------------------------|
| Name | Rules | Alerts | Projects | Default | Operations | |
| Android Lint | 140 | 0 | 0 | Set as default Backup Rename Copy Delete | | |
| Sonar way | 113 | 0 | | ✓ Backup Rename Copy | | |
| Sonar way with Findbugs | 532 | 0 | 1 | Set as default Backup Rename Copy Delete | | |
| USPTO-Kerberos | 534 | 0 | 2 | Set as default Backup Rename Copy Delete | | |

| JavaScript Profiles | | | | | | + Create |
|---------------------------|-------|--------|----------|----------------------|------------|--------------------------|
| Name | Rules | Alerts | Projects | Default | Operations | |
| Sonar way | 46 | 0 | | ✓ Backup Rename Copy | | |

| Python Profiles | | | | | | + Create |
|---------------------------|-------|--------|----------|----------------------|------------|--------------------------|
| Name | Rules | Alerts | Projects | Default | Operations | |
| Sonar way | 11 | 0 | | ✓ Backup Rename Copy | | |



Quality Profiles

| | | |
|-------------------------------------|------------|---|
| <input checked="" type="checkbox"/> | Critical ▾ | <u>Security - Array is stored directly</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Signature Declare Throws Exception</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Simplify Boolean Expression</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Simplify Boolean Return</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Simplify Conditional</u> |
| <input checked="" type="checkbox"/> | Minor ▾ | <u>Singular Field</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Statements should be on separate lines</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>Static Variable Name</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>String Buffer Instantiation With Char</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>String Instantiation</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>String Literal Equality</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>String To String</u> |
| <input checked="" type="checkbox"/> | Major ▾ | <u>System Println</u> |



End