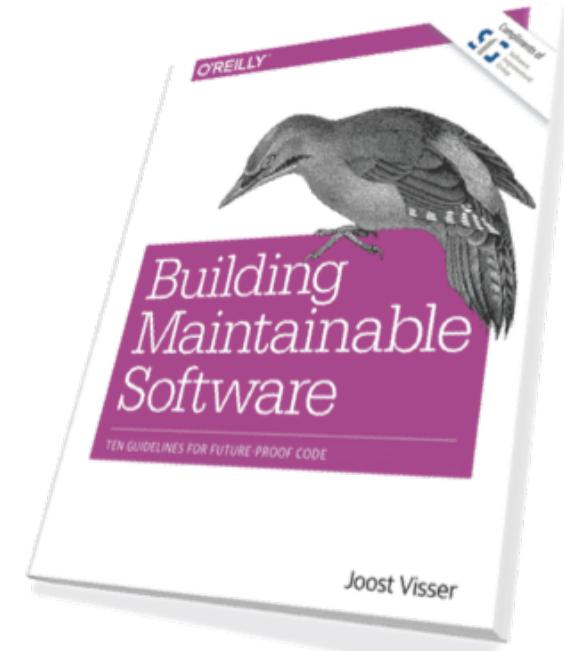


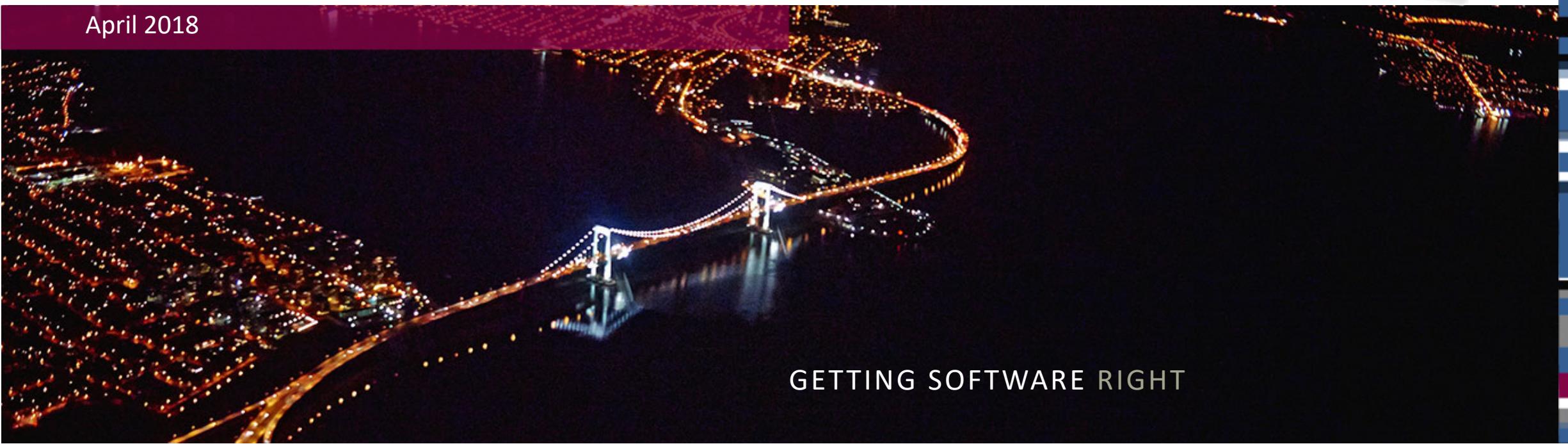
Writing Clean Code

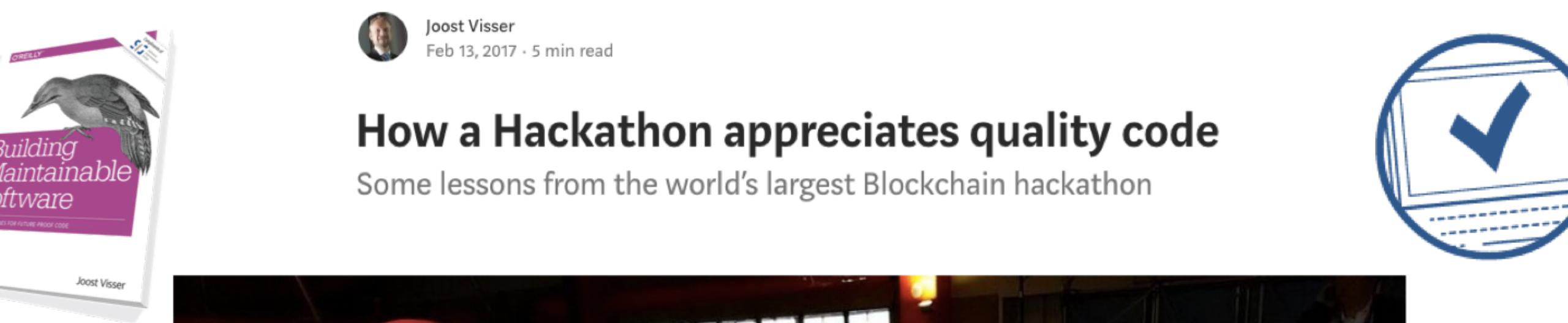
-- Why blockchain needs maintainable code

Prof. dr. Joost Visser • Software Improvement Group & Radboud University Nijmegen



April 2018





Joost Visser
Feb 13, 2017 • 5 min read

How a Hackathon appreciates quality code

Some lessons from the world's largest Blockchain hackathon



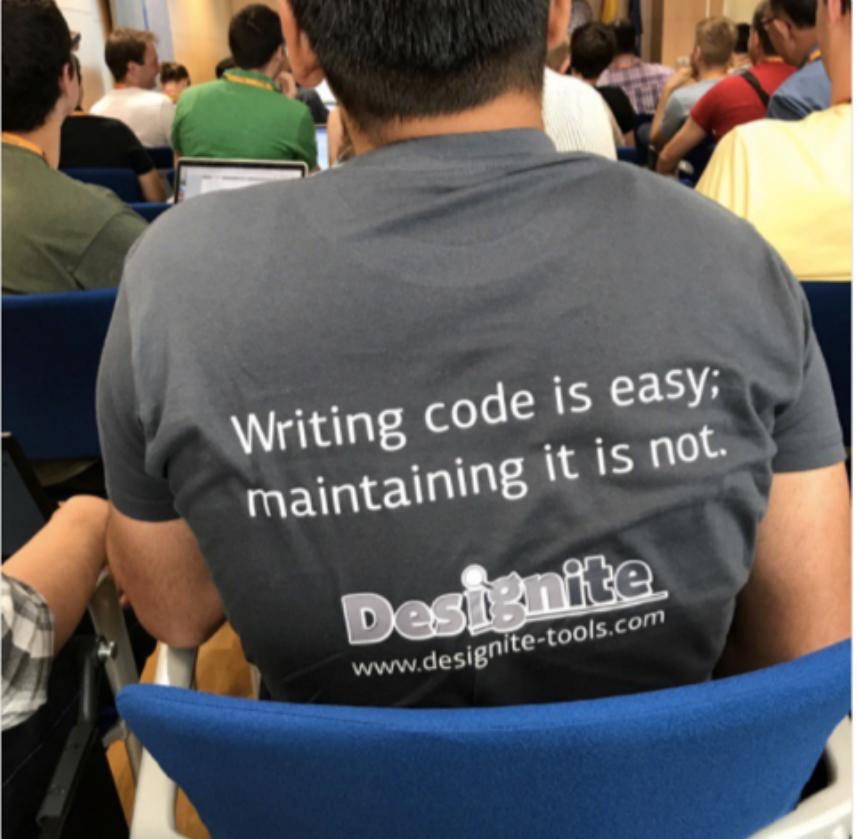
Robin Knaapen of team DC Cicero shows off their 10 out of 10 score on code quality at the worlds largest Blockchain hackathon. Image courtesy of [Page 2 of 38](#)
[Drenthe College](#).

Relevance of code quality – maintenance

 **Marco di Biase**
@mardibiase

Following ▾

@Sharma__Tushar gets it, right? @sig_eu
@jstvssr @MajielBruntink #sattose17



RETWEETS 7 LIKES 13

2:07 AM - 8 Jun 2017

Tushar Sharma

What if we could make it easy to write **maintainable** code?



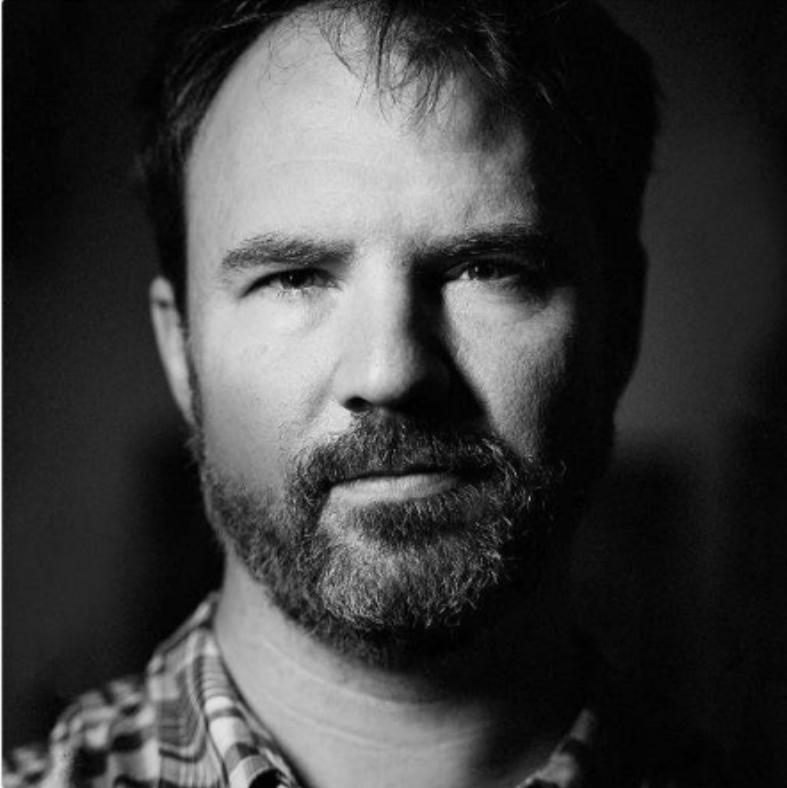
“Improving maintainability does not require magic or rocket science. A combination of relatively simple skills and knowledge, plus the discipline and environment to apply them, leads to the largest improvement in maintainability.” [p. xi]

Relevance of code quality – speed

 **Rich Rogers**
@RichRogersIoT

Following

Current development speed is a function of past development quality. - [@brianm](#)



RETWEETS 36 LIKES 29

10:00 AM - 6 Mar 2017

Brian McAllister



Relevance of code quality – investor value



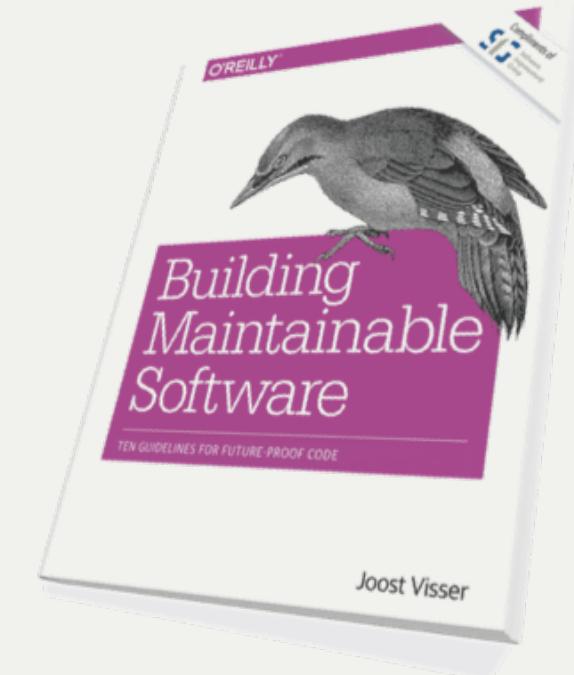
Introductions



Prof. dr. Joost Visser

CTO at SIG

- Professor of “Large-scale Software Systems” at Radboud University
- Member of advisory group on Cyber Security education and research
- Author of 100+ publications on software quality and related topics



Software Improvement Group

IT Management Advisory and Measurement Lab

- ISO 25010 software product inspections
- ISO 17025 lab analyses 25 million lines of code each week
- Translate technical findings into actionable recommendations

GETTING SOFTWARE RIGHT

we help clients improve the software their business depends on

some clients



some numbers



>200

supported technologies

>2,500

systems monitored

>10 billion

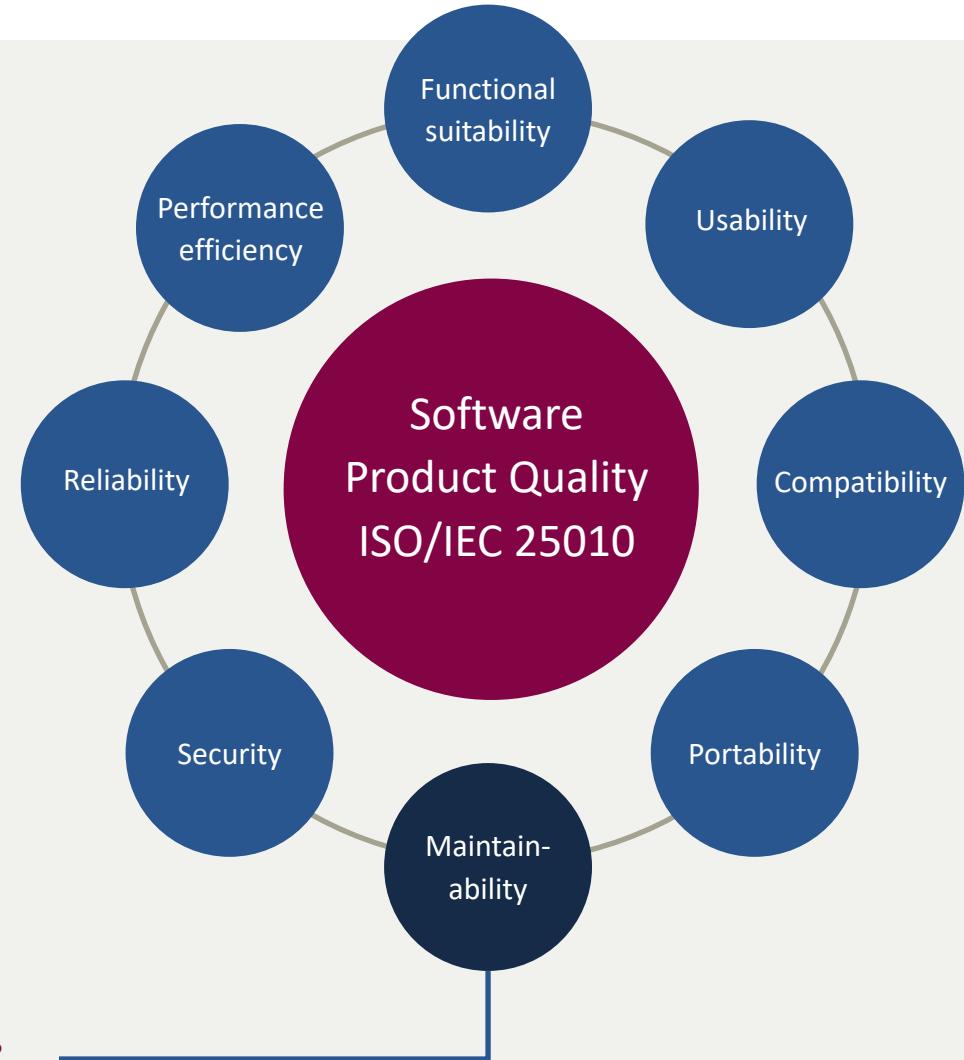
lines of code in benchmark

Maintainability is key

Sustainable business requires
maintainable software

Quality
product – process – people
measurement – management – education

continuous change

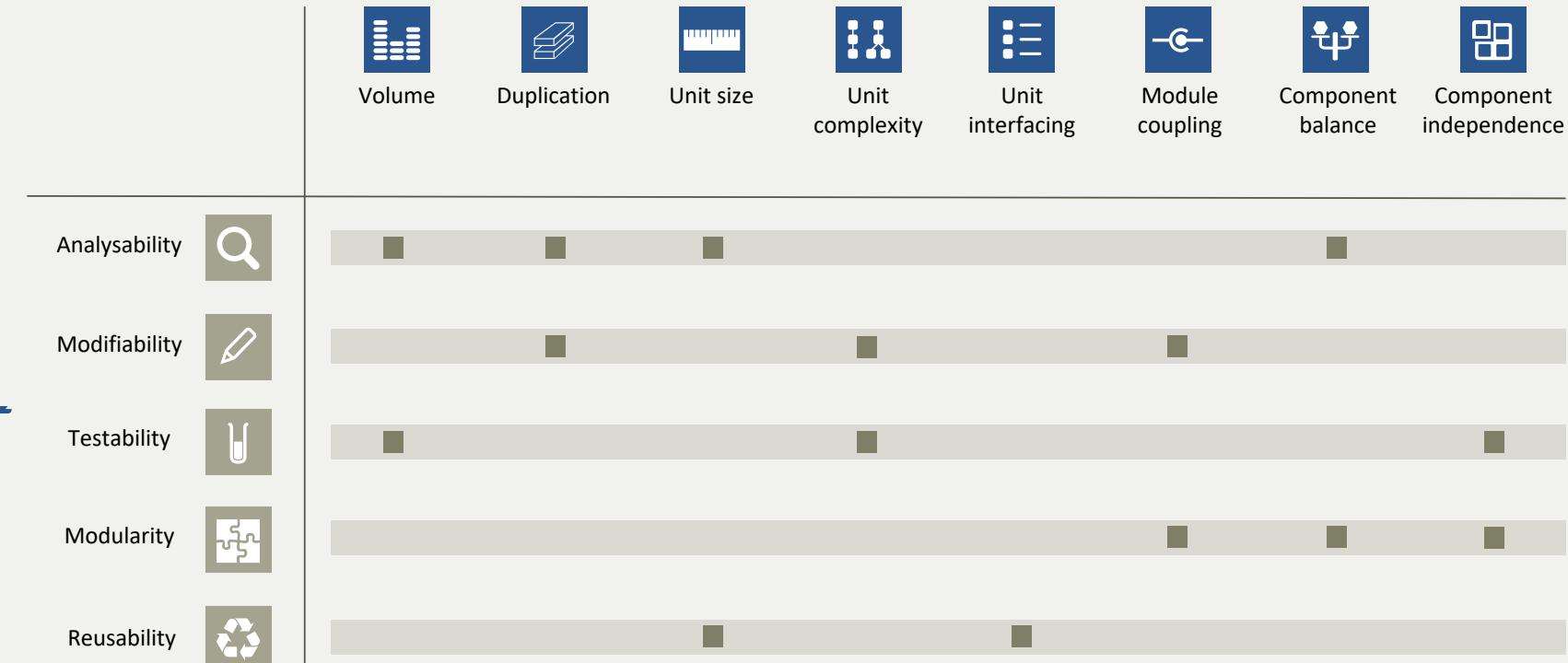


SIG Quality Model • Maintainability

Operationalization of ISO 25010 (was: ISO 9126)

First published as “A practical model for measuring maintainability”, Heitlager, Kuipers, Visser, QUATIC 2007.

Most Influential Paper

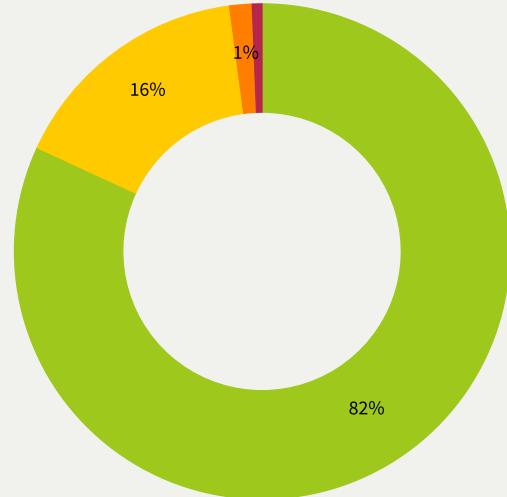


The sub-ratings are aggregated to an overall maintainability rating,
where ★★★★☆ is market average.

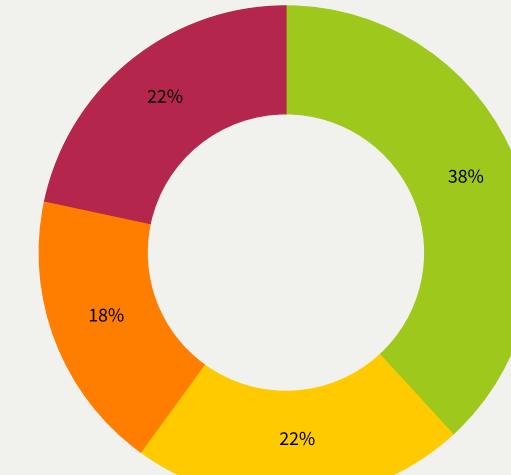
Source code measurements are aggregated in statistically sound “quality profiles” and then rated on a calibrated scale from ★★★★☆ to ★★★★★.

Quality profiles: percentage of code in various risk categories

Quality profiles for Unit Size



Maintainable

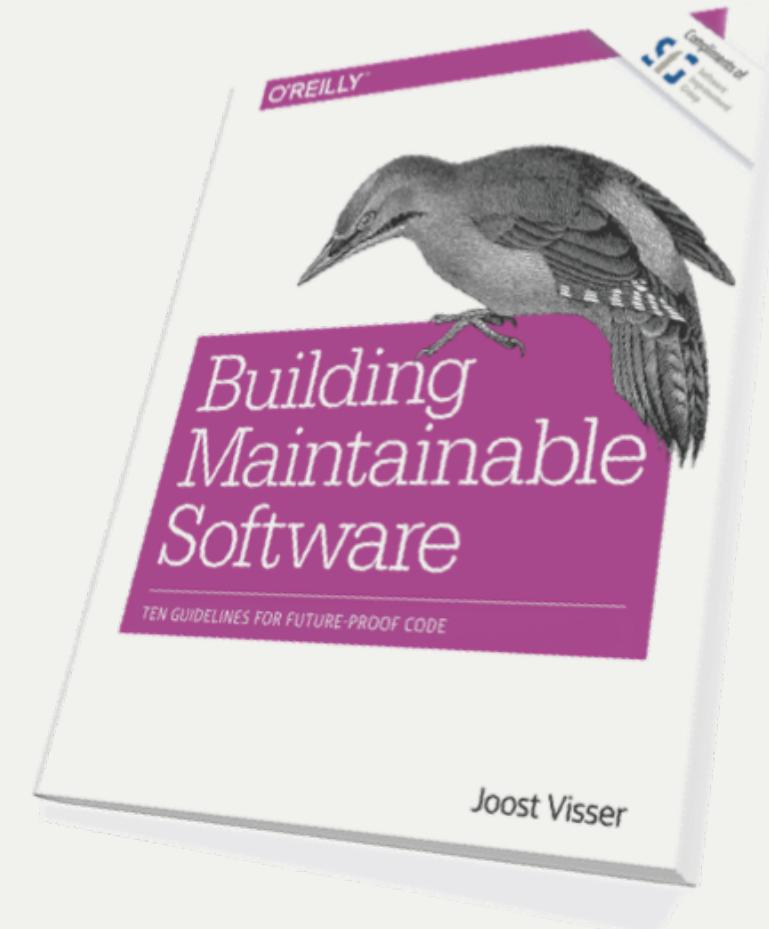


Unmaintainable

Future-proof software starts today!

“Improving maintainability does not require magic or rocket science. A combination of relatively simple skills and knowledge, plus the discipline and environment to apply them, leads to the largest improvement in maintainability.” [p. xi]

“Maintainability is not an afterthought, but should be addressed from the very beginning of a development project. Every individual contribution counts.” [p. 4]



10 guidelines for future-proof code

Code

Write small units of code

Write simple units of code

Write code once

Keep unit interfaces small

Architecture

Separate concerns in modules

Couple architecture components loosely

Keep architecture components balanced

Keep your codebase small

Way of working

Automate tests

Write clean code

10 guidelines for future-proof code

Code

Limit units to 15 lines of code

Limit branch points per unit to 4

Do not copy code longer than 6 lines

Limit parameters per unit to 4

Architecture

Avoid modules larger than 400 lines of code

Hide classes from other components, no cycles

Aim for 6-12 top-level components

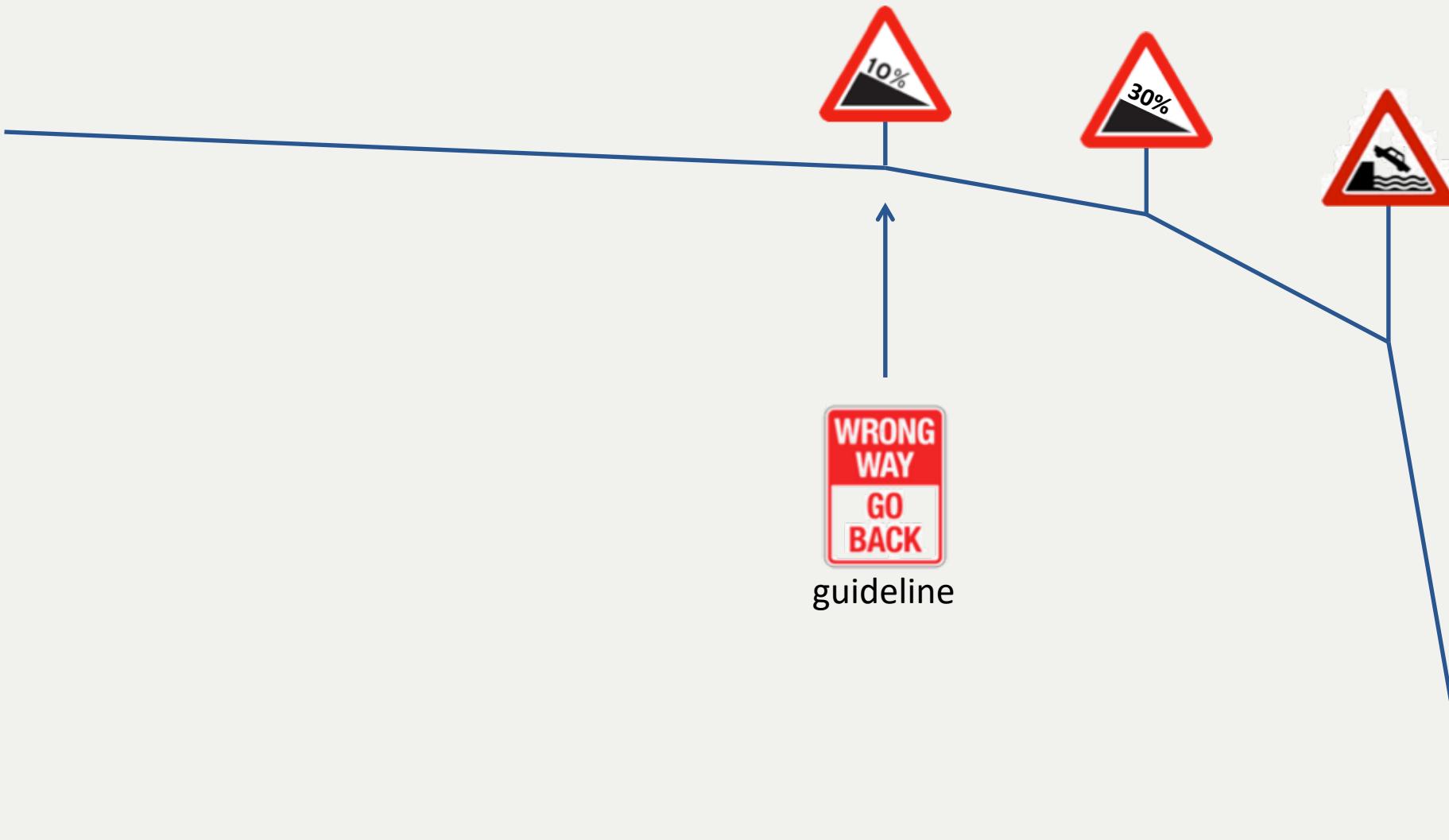
Keep codebase below 200,000 lines of code

Way of working

Write automated tests that cover all code

Stick to the seven “boy scout rules”

Identifying Tipping Points



Examples of guideline compliant code

Source code from <https://github.com/jenkinsci/jenkins>

```
public AutoCompletionCandidates doAutoCompleteLabel(@QueryParameter String value) {  
    AutoCompletionCandidates c = new AutoCompletionCandidates();  
    Set<Label> labels = Jenkins.getInstance().getLabels();  
    List<String> queries = new AutoCompleteSeeder(value).getSeeds();  
  
    for (String term : queries) {  
        for (Label l : labels) {  
            if (l.getName().startsWith(term)) {  
                c.add(l.getName());  
            }  
        }  
    }  
    return c;  
}
```

This unit has 13 lines of code, 3 branch points and 1 parameter

```
public static boolean isMultiPartForm(@CheckForNull String contentType) {  
    if (contentType == null) {  
        return false;  
    }  
  
    String[] parts = contentType.split(";");  
    if (parts.length == 0) {  
        return false;  
    }  
  
    for (int i = 0; i < parts.length; i++) {  
        if ("multipart/form-data".equals(parts[i])) {  
            return true;  
        }  
    }  
  
    return false;  
}
```

This unit has 15 lines of code, 4 branch points and 1 parameter

What we observe in practice, code that is beyond the tipping point

```
public void doGet(HttpServletRequest req, HttpServletResponse resp)
throws ServletException, IOException {
resp.setContentType("application/json");
try {
Connection conn = DriverManager.
    getConnection(this.conf.getProperty("handler.jdbcurl"));
ResultSet results =
    conn.createStatement()
    .executeQuery(
        "SELECT account, balance FROM ACCTS WHERE id="
        + req.getParameter(conf.
            getProperty("request.parametername")));
float totalBalance = 0;
resp.getWriter().print("{\"balances\":[");
while (results.next()) {
    // Assuming result is 9-digit bank account number,
    // validate with 11-test:
    int sum = 0;
    for (int i = 0; i < results.getString("account")
        .length(); i++) {
        sum = sum + (9 - i)
            * Character.getNumericValue(results.getString(
                "account").charAt(i));
    }
}
}
```

```
if (sum % 11 == 0) {
    totalBalance += results.getFloat("balance");
    resp.getWriter().print(
        "{\"" + results.getString("account") + "\":"
        + results.getFloat("balance") + "}");
}
if (results.isLast()) {
    resp.getWriter().println("],");
} else {
    resp.getWriter().print(",");
}
resp.getWriter().println("\total\:" + totalBalance + "]");
} catch (SQLException e) {
    System.out.println("SQL exception: " + e.getMessage());
}
}
```



Units with
15+ lines of code



Units with
4+ branch points

This unit has
38 lines of
code and 5
branch
points

Code that is far beyond the tipping point

```
public void doGet(HttpServletRequest request, HttpServletResponse response) throws ServletException, IOException {  
    response.setContentType("application/json");  
    try {  
        Connection conn = DriverManager.getConnection("jdbc:mysql://127.0.0.1:3306/test", "root", "password");  
        ResultSet results = conn.createStatement().executeQuery("SELECT account, balance FROM accounts");  
        float totalBalance = 0;  
        while (results.next()) {  
            // Assuming result is valid  
            // validate with some logic  
            int sum = 0;  
            for (int i = 0; i < results.getString("account").length(); i++) {  
                sum = sum + Character.getNumericValue(results.getString("account").charAt(i));  
            }  
            if (sum == 5) {  
                response.getWriter().print("{\"account\": " + results.getString("account") + ", \"balance\": " + results.getFloat("balance"));  
            }  
        }  
        response.getWriter().print("}");  
    } catch (SQLException e) {  
        response.getWriter().print(e.getMessage());  
    }  
}
```



```
at("balance");  
"account") + "\": " +  
"balance") + "});  
;  
+ totalBalance + "});  
e.getMessage());
```

This unit has
38 lines of
code and 5
branch
points

Small violations are quickly made but also quickly fixed

Source code from our own repository

Solution: Extract method

```
@Override  
public Map<String, String> getVariableToTypeMapping(ScopeContainer scopeContainer) {  
    Map<String, String> result = new HashMap<String, String>();  
    TokenIterator tokens = getInterestingTokens(scopeContainer);  
  
    Matcher matcher = new Matcher(tokens);  
    matcher.setExpression(TYPE_DECLARATION);  
    matcher.setFindShortestMatch(false);  
    Pattern p = matcher.findNext();  
    while (p != null) {  
        Token variableNameToken = (Token)p.getObject(NAME);  
        Token variableTypeToken = (Token)p.getObject(TYPENAME);  
        result.put(variableNameToken.toString(), variableTypeToken.toString());  
        p = matcher.findNext();  
    }  
  
    return result;  
}  
  
  


```
private Map<String, String> extractMapping(TokenIterator parameterTokens) {
 Map<String, String> result = new HashMap<String, String>();
 Matcher matcher = new Matcher(parameterTokens);
 matcher.setExpression(TYPE_DECLARATION);
 matcher.setFindShortestMatch(false);
 Pattern p = matcher.findNext();
 while (p != null) {
 Token variableNameToken = (Token)p.getObject(NAME);
 Token variableTypeToken = (Token)p.getObject(TYPENAME);
 result.put(variableNameToken.toString(), variableTypeToken.toString());
 p = matcher.findNext();
 }
 return result;
}

Map<String, String> getParameterTypes(TokenIterator functionHeader) {
 Map<String, String> result = new HashMap<String, String>();
 functionHeader.copy();
 TokenIterator tokens = functionHeader.getTokens();
 Matcher matcher = new Matcher(tokens);
 matcher.setExpression(TYPE_DECLARATION);
 matcher.setFindShortestMatch(false);
 Pattern p = matcher.findNext();
 while (p != null) {
 Token variableNameToken = (Token)p.getObject(NAME);
 Token variableTypeToken = (Token)p.getObject(TYPENAME);
 result.put(variableNameToken.toString(), variableTypeToken.toString());
 p = matcher.findNext();
 }
 return result;
}
```


```

This unit has 15 lines of code, 2 parameters, 1 branch point and 10 lines of code duplicated.



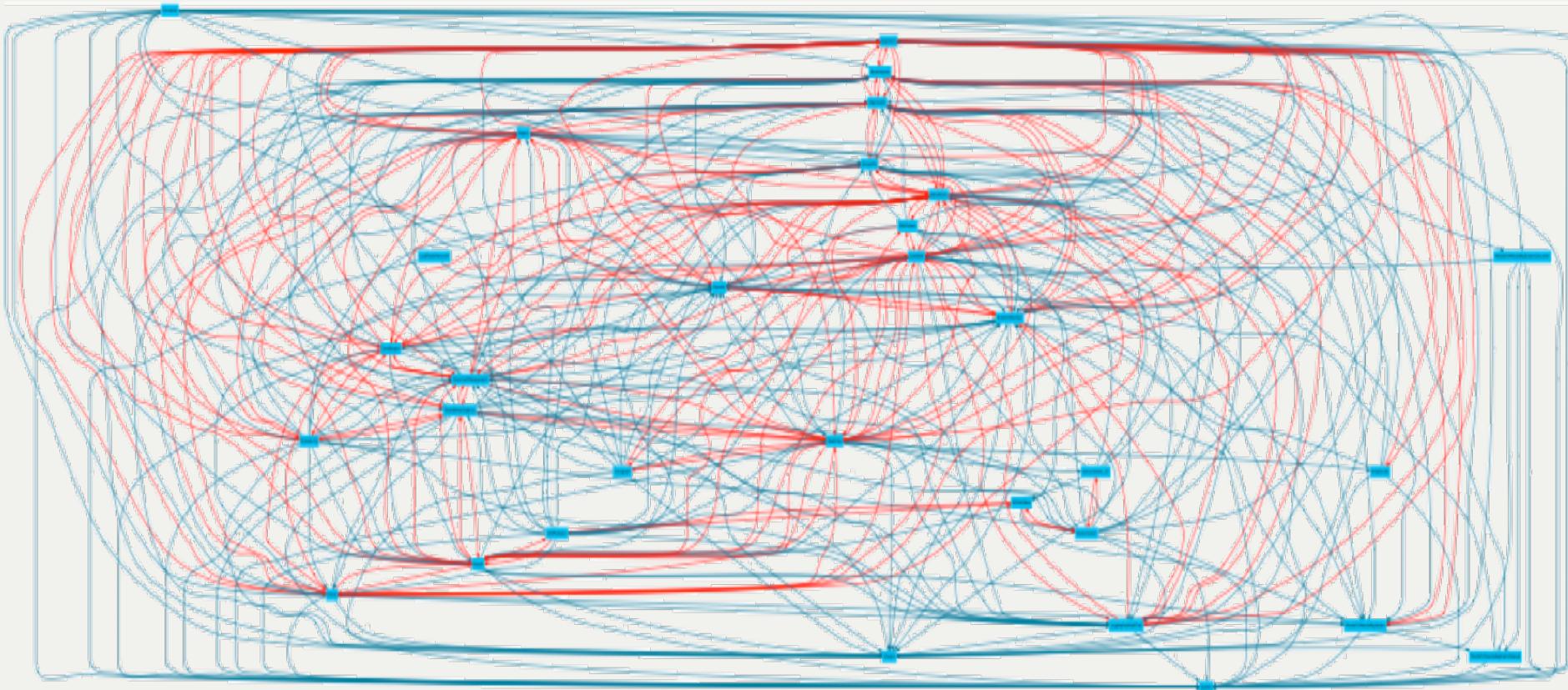
Copy & Paste

This unit has 15 lines of code, 1 parameter, 1 branch point and 10 lines of code duplicated.



Duplicated code blocks ≥ 7 lines of code

Drawing the high-level architecture on a whiteboard should take 5 minutes



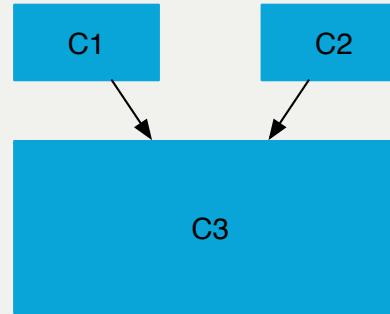
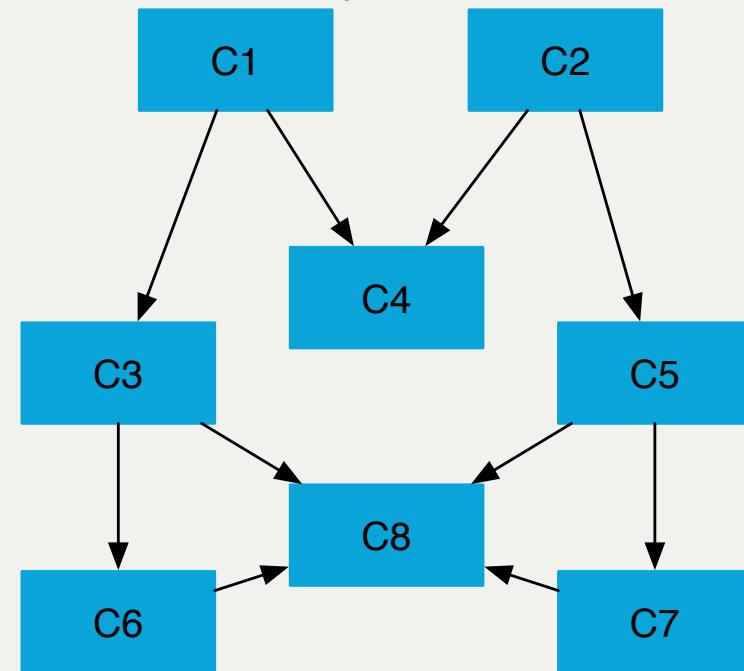
Unbalanced components,
aim for **6 to 12**
components of
approximate equal size



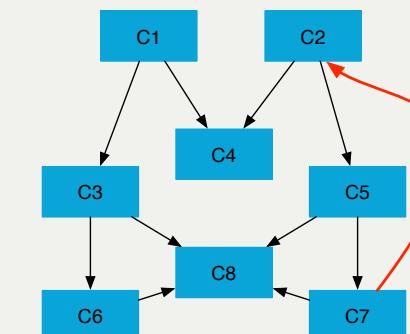
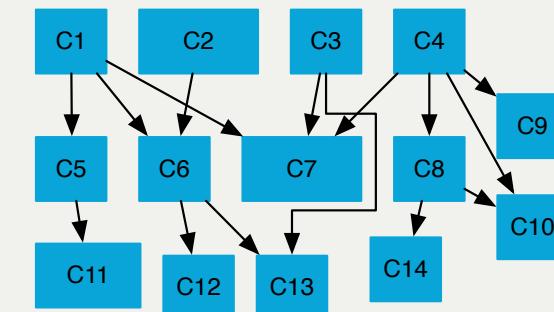
Cyclic dependencies
between architecture
components

Aim for a balanced architecture and avoid cyclic dependencies

Clear hierarchy, directed dependencies, between 6 – 12 components



Unbalanced components, aim for **6 to 12** components of approximate equal size

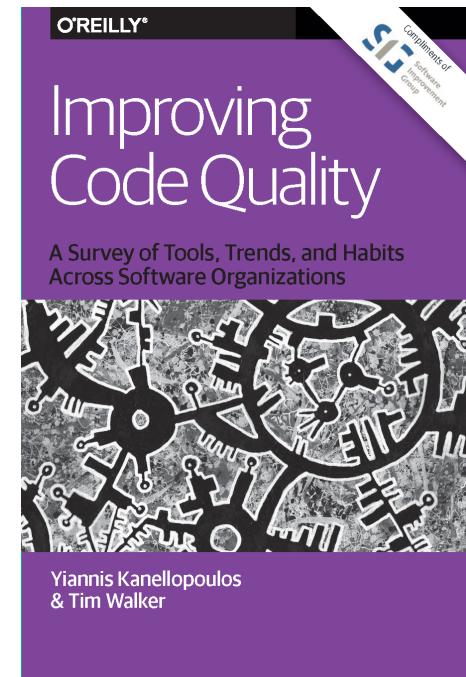
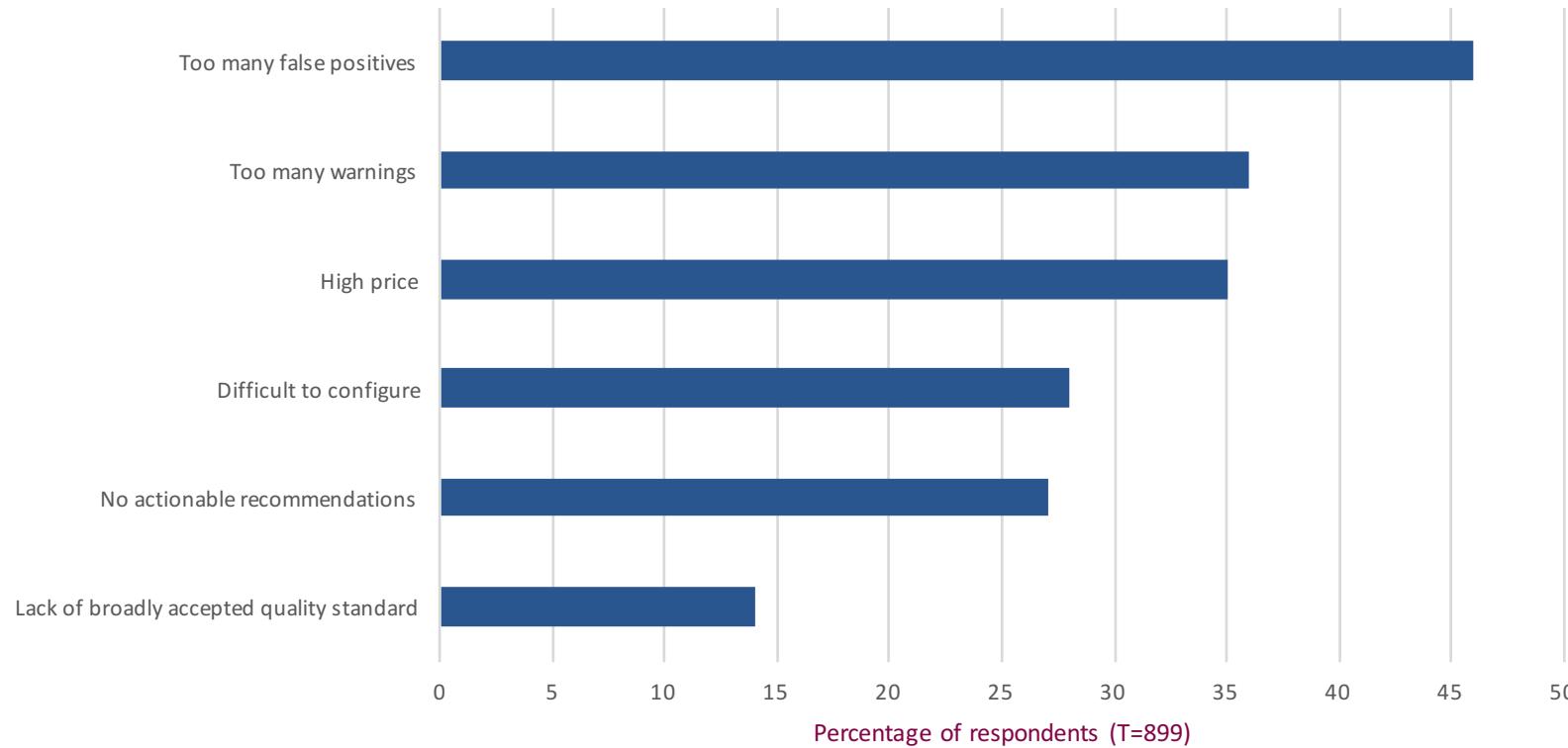


Cyclic dependencies between architecture components

Code quality control – developer tools

Available tools have a number of pitfalls

What are the biggest pitfalls of code quality tools?



Get your **free** trial [here!](#)

Better Code Hub

Slack your GitHub handle and
team name in channel
bettercodehub-support

Spend less time fixing bugs. And more time shipping new features.



Sign in

By signing in, you agree to our [Terms of Service \(PDF\)](#)

And we give you Pro access to
use bettercodehub.com on
private repos



Your repositories

Search

Users and organizations
GipHouse, jstvssr Analyzed only

jstvssr/
puppet-datadog_agent

Last analyzed: 5 minutes ago

7

Actions: Refresh, Settings, Statistics, Details

jstvssr/
configuration-as-code-plugin

Last analyzed: 6 minutes ago

5

Actions: Refresh, Settings, Statistics, Details

jstvssr/
simba-os

Last analyzed: 8 minutes ago

6

Actions: Refresh, Settings, Statistics, Details

GipHouse/
RSD-2018

Last analyzed: 16 hours ago

8

Actions: Refresh, Settings, Statistics, Details

GipHouse/
OptimalPlanet-2018

Last analyzed: 2 days ago

8

Actions: Refresh, Settings, Statistics, Details

GipHouse/
G2GE-2018

Last analyzed: 2 days ago

7

Actions: Refresh, Settings, Statistics, Details

GipHouse/
NGSD-Spring-2017

Last analyzed: 2 days ago

5

Actions: Refresh, Settings, Statistics, Details

GipHouse/
RSPP-2018

Last analyzed: 2 days ago

9

Actions: Refresh, Settings, Statistics, Details

GipHouse/
WFAW-2018

Last analyzed: 2 days ago

8

Actions: Refresh, Settings, Statistics, Details

Does not flood you
with violations

jstvssr/
bigchaindb

Last analysis: 2 months ago
Previous analysis: 2 months ago

Branch: master (default)

Compliance 5 of 10

Rule	Status	Actions
Write Short Units of Code	✗	⋮
Write Simple Units of Code	✗	⋮
Write Code Once	✓	⋮
Keep Unit Interfaces Small	✗	⋮
Separate Concerns in Modules	✓	⋮
Couple Architecture Components Loosely	✗	⋮
Keep Architecture Components Balanced	✗	⋮
Keep Your Codebase Small	✓	⋮
Automate Tests	✓	⋮
Write Clean Code	✓	⋮



Compliance
5 of 10

jstvssr/
bigchaindb

Last analysis: 2 months ago
Previous analysis: 2 months ago

Branch: master (default)

☰ ⚙

Write Short Units of Code X ⋮

Write Simple Units of Code X ⋮

Refactoring candidates

Unit

- DefaultType.DefaultUnit
- Transaction.validate(self,bigchain)
- awsdeploy.sh:\$default
- DefaultType.run_configure(args,skip_if_exists)
- Bigchain.block_election_status(self,block_id,voters)
- Transaction.__init__(self,operation,asset,inputs,outputs,metadata,version)
- Bigchain.get_transaction(self,txid,include_status)
- DefaultType.DefaultUnit
- DefaultType.run_gather_metrics(args)

X

McCabe of at most 5 McCabe above 5 McCabe above 10 McCabe above 25

Provides actionable
refactoring
recommendations ...

GUIDELINE EXPLANATION

Page 25 of 38

Compliance
5 of 10

jstvssr/
bigchaindb

Last analysis: 2 months ago
Previous analysis: 2 months ago

Branch: master (default)

☰ ⚙

 Write Short Units of Code X ⋮

 Write Simple Units of Code X² ⋮

GUIDELINE EXPLANATION

Refactoring candidates

 Unit

- DefaultType.DefaultUnit
- Transaction.validate(self,bigchain)
- awsdeploy.sh:\$default
- DefaultType.run_configure(args,skip_if_exists)
- Bigchain.block_election_status(self,block_id,voters)
- Transaction.__init__(self,operation,asset,inputs,outputs,metadata,version)
- Bigchain.get_transaction(self,txid,include_status)
- DefaultType.DefaultUnit
- DefaultType.run_gather_metrics(args)


McCabe of at most 5 McCabe above 5 McCabe above 10 McCabe above 25

Provides actionable refactoring recommendations ... with real-time impact analysis

The 10 guidelines can be automatically checked on every push and pull

Overview Yours Active Stale All branches

Search branches...

Default branch

master Updated 3 hours ago by Tim Daubensch... Default Change default branch

Active branches

small_improvement Updated 9 minutes ago by S-LE-Blythe Pending: Checking the 10 guidelines... New pull request Delete

Serves as quality gate on pull (merge) requests

The screenshot shows a GitHub pull request interface. At the top, there are three tabs: 'Conversation' (0), 'Commits' (2), and 'Files changed' (1). Below these, a comment from 'bettercodehub-demo' is shown, stating 'No description provided.' A reply from 'S-LE-Blythe' adds two commits: 'reduced length of long units' (98ab0aa) and another commit (ef7d187). A message at the bottom encourages pushing more commits to the 'small_improvement' branch. At the bottom, a green box displays CI status: 'All checks have passed' (1 successful check), 'Better Code Hub — You gained 2 guidelines. Very impressive!', and 'This branch has no conflicts with the base branch'. A red oval highlights the 'All checks have passed' section.

Conversation 0 Commits 2 Files changed 1

bettercodehub-demo commented a minute ago

No description provided.

S-LE-Blythe added some commits 15 minutes ago

reduced length of long units 98ab0aa
reduced length of long units ef7d187

Add more commits by pushing to the `small_improvement` branch on `bettercodehub-demo/training-assignments-simple`.

All checks have passed

1 successful check

Better Code Hub — You gained 2 guidelines. Very impressive!

This branch has no conflicts with the base branch

Only those with write access to this repository can merge pull requests.

Overview of pull requests

GipHouse / WFAW-2018 Private

Unwatch 12 Star 4 Fork 0

Code Issues 0 Pull requests 0 Projects 1 Wiki Insights Settings

Filters is:pr Labels Milestones New pull request

0 Open ✓ 11 Closed

adds optimal exposure computation ✓
#11 by deurzen was merged 6 hours ago

adds session awareness ✓
#10 by deurzen was merged 9 hours ago

adds account login functionality ✗
#9 by deurzen was merged 3 days ago

prevents request meddling ✓
#8 by deurzen was merged 3 days ago

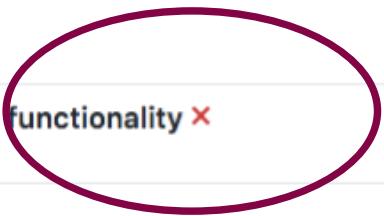
adds account registration and activation functionality ✗
#7 by deurzen was merged 3 days ago

Gen/cleanup ✓
#6 by deurzen was merged 4 days ago

adds input check ✓
#5 by deurzen was merged 5 days ago

Clear current search query, filters, and sorts

Author ▾ Labels ▾ Projects ▾ Milestones ▾ Reviews ▾ Assignee ▾ Sort ▾



Page 29 of 38

Inspect failing check

GipHouse / WFAW-2018 Private

Unwatch 12 Star 4 Fork 0

Code Issues 0 Pull requests 0 Projects 1 Wiki Insights Settings

adds account registration and activation functionality #7

Merged deurzen merged 1 commit into master from feat/register 3 days ago

Conversation 0 Commits 1 Files changed 10 +373 -11

deurzen commented 3 days ago
Adds account registration and activation pages. Registration page allows users to register through their

rq=1

adds account registration and activation functionality

deurzen merged commit 480fb9d into master 3 days ago 1 check failed

[View details](#) [Revert](#)

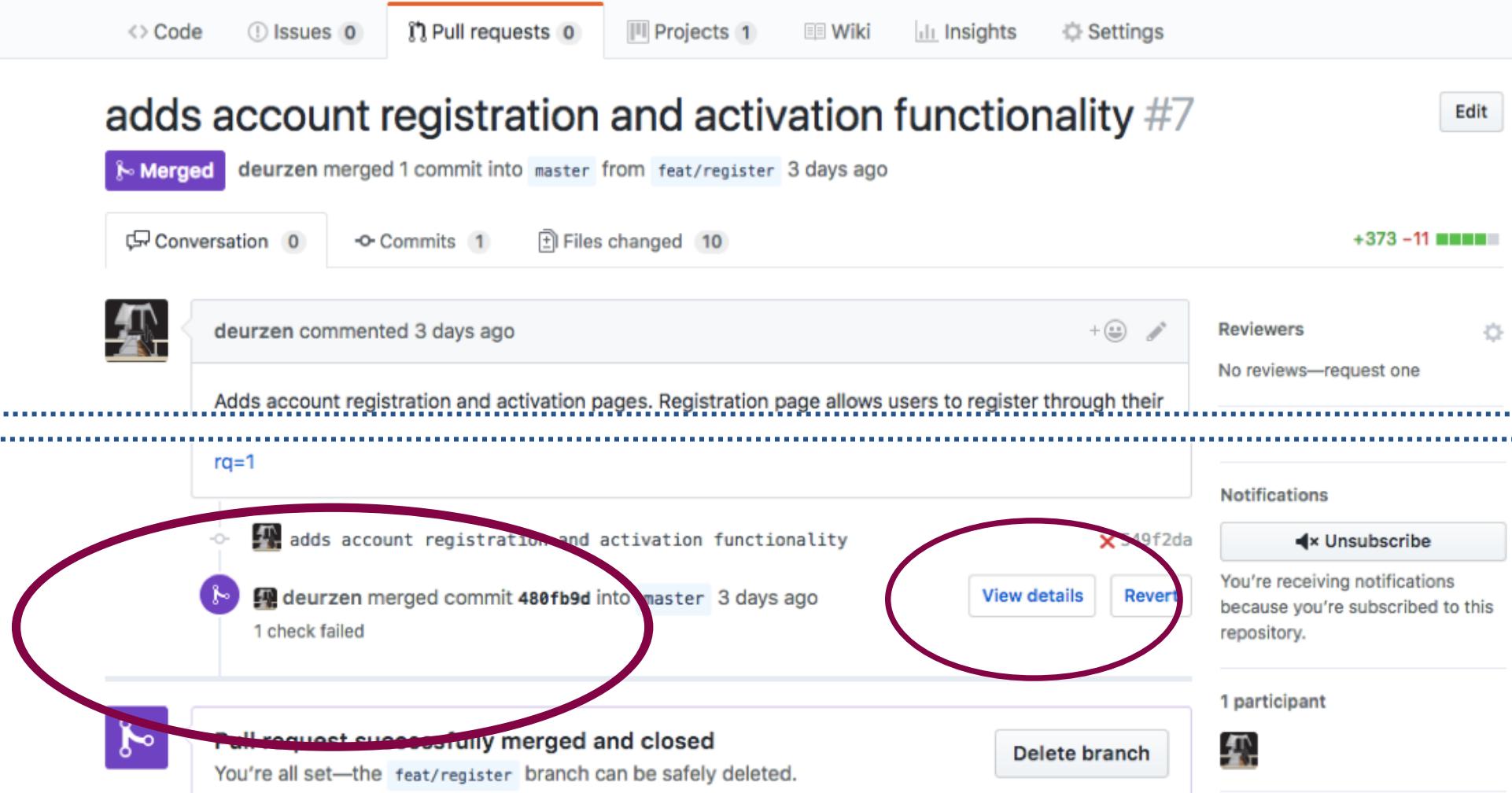
Reviewers No reviews—request one

Notifications Unsubscribe You're receiving notifications because you're subscribed to this repository.

1 participant

Full request successfully merged and closed You're all set—the feat/register branch can be safely deleted. Delete branch

Lock conversation



Inspect failing check

GipHouse / WFAW-2018 Private

Unwatch 12 Star 4 Fork 0

Code Issues 0 Pull requests 0 Projects 1 Wiki Insights Settings

adds account registration and activation functionality #7

Merged deurzen merged 1 commit into master from feat/register 3 days ago

Conversation 0 Commits 1 Files changed 10 +373 -11

deurzen commented 3 days ago
Adds account registration and activation pages. Registration page allows users to register through their

rq=1

adds account registration and activation functionality

deurzen merged commit 480fb9d into master 3 days ago

1 check failed

Better Code Hub ! You lost a guideline

Hide details Revert

Notifications Unsubscribe

You're receiving notifications because you're subscribed to this repository.

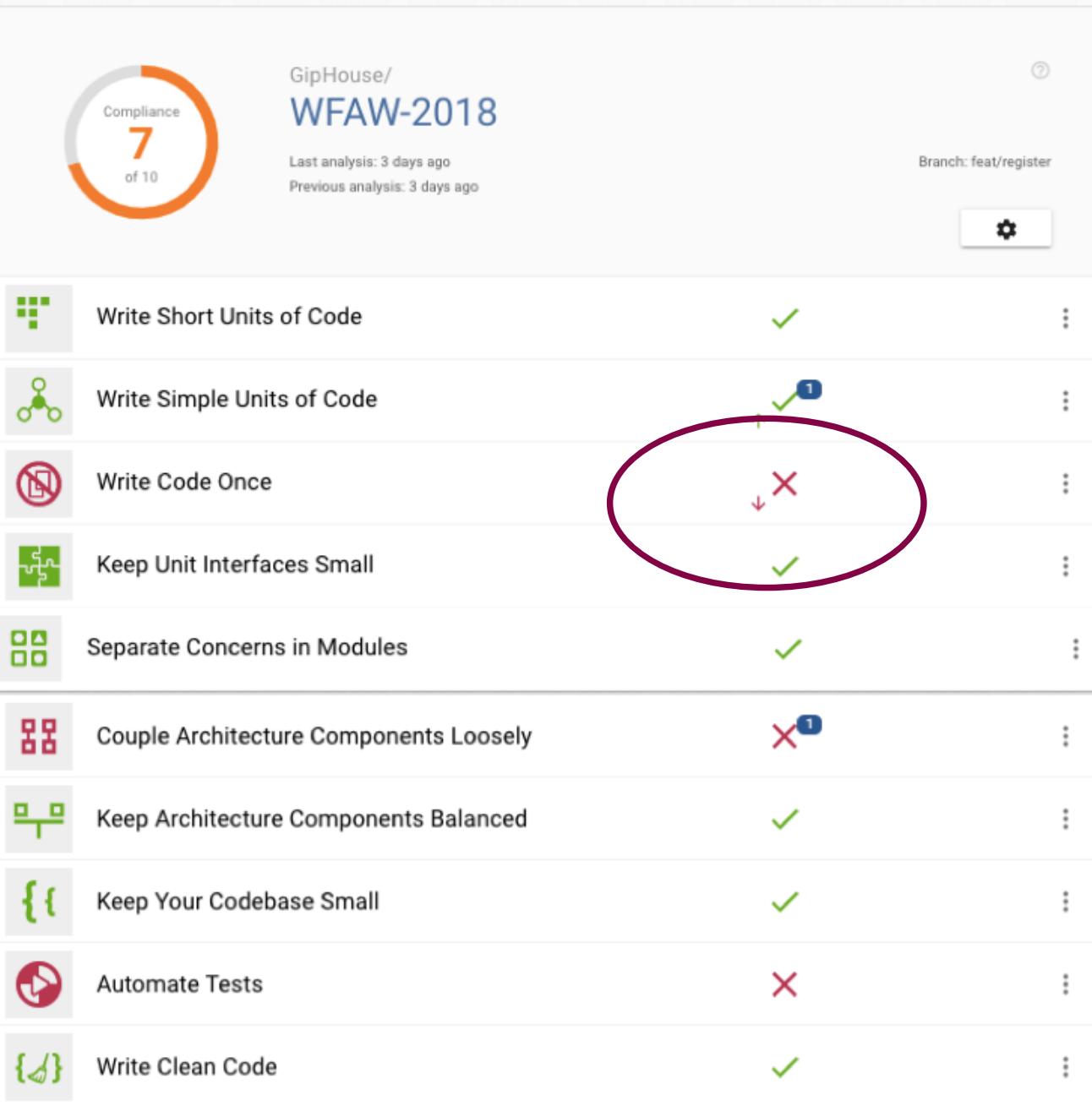
1 participant

Details

Pull request successfully merged and closed

Delete branch Lock conversation

The screenshot shows a GitHub pull request page for a repository named 'GipHouse / WFAW-2018'. The pull request is titled 'adds account registration and activation functionality #7' and is marked as 'Merged'. It has 1 commit and 10 files changed. A comment from 'deurzen' is visible, stating: 'Adds account registration and activation pages. Registration page allows users to register through their'. Below the comment, a commit history is shown: 'rq=1' followed by 'adds account registration and activation functionality' and 'deurzen merged commit 480fb9d into master 3 days ago'. A red oval highlights the '1 check failed' section, which displays a failure from 'Better Code Hub' with the message 'You lost a guideline'. Another red oval highlights the '1 participant' section, which lists 'deurzen' and includes a 'Details' button. The top right corner of the page shows a 'Notifications' section with a message about receiving notifications due to subscription. The bottom right corner shows a 'Page 31 of 38' link.





GipHouse/ WFAW-2018

?

Last analysis: 3 days ago
Previous analysis: 3 days ago

Branch: feat/register



Write Short Units of Code



...



Write Simple Units of Code



...



Write Code Once



...

GUIDELINE EXPLANATION

Refactoring candidates

▼ Duplications

- 8 lines occurring 3 times in 3 files: activate.php, result...
- 8 lines occurring times in header.php
- 6 lines occurring 2 times in database_model.php

Lines of Code

8

8

6

non-duplicated code

duplicated code



Keep Unit Interfaces Small



...



GipHouse/ WFAW-2018



Last analysis: 3 days ago
Previous analysis: 3 days ago

Branch: feat/register



Write Short Units of Code



Write Simple Units of Code



Write Code Once



GUIDELINE EXPLANATION

Refactoring candidates

Duplicates

- 8 lines occurring 3 times in 3 files: activate.php, result..
- 8 lines occurring 1 times in header.php
- 6 lines occurring 2 times in database_model.php

Lines of Code

8

8

6

non-duplicated code

duplicated code



Keep Unit Interfaces Small





8 lines occurring 3 times in 3 files: activate.php, result.php, register.php

GENERATE GITHUB ISSUE

activate.php

result.php

register.php

```
1 <?php
2
3 - class Activate extends Controller {
4
5     private $db_model;
6
7 -     function __construct() {
8         parent::__construct();
9         $this->load_db_model();
10    }
11
12 -     public function token_found($token) {
13         return count($this->db_model->pending_account($token)) > 0;
14    }
15
16 -     public function get_pending_account($token) {
17         return $this->db_model->pending_account($token);
18    }
19
20 -     public function remove_pending_account($token) {
21         return $this->db_model->remove_pending_account($token);
22    }
23
24 -     public function add_account($params) {
25         return $this->db_model->create_account($params);
26    }
27
28 -     public function index() {
29         $this->view->render('activate/index');
30    }
31
32 -     private function load_db_model() {
33         $model = "database_model";
34         $path = "models/${model}.php";
35
36         if (file_exists($path)) {
37             require $path;
38             $this->db_model = new $model($this);
39             return true;
40         }
41         return false;
42    }
43
44 }
```

Note: make sure to
enable **Issues** in your
GitHub repo settings



Refactor 8 lines occurring 3 times in 3 files: activate.php, result.php, register.php

Write

Preview

I've selected for refactoring 8 lines of code which are duplicated in 3 file(s) ([1](#), [2](#), [3](#)). Addressing this will make our codebase more maintainable and improve [Better Code Hub's Write Code Once guideline rating!](#)

Here's the gist of this guideline:

- **Definition**

Do not copy code.

- **Why**

When code is copied, bugs need to be fixed in multiple places. This is both inefficient and a source of regression bugs.

- **How**

Avoid duplication by never copy/pasting blocks of code and reduce duplication by extracting shared code, either to a new unit or introduce a superclass if the language permits.

You can find more info about this guideline in [Building Maintainable Software](#).

To know how many *other* refactoring candidates need addressing to get a guideline compliant, select some by clicking on the next to them. The risk profile below the candidates signals () when it's enough!

Good luck and happy coding!

Styling with Markdown is supported

[Submit new issue](#)

Assignees



No one—assign yourself

Labels



None yet

Projects



None yet

Milestone



No milestone

During the Hackathon

How to get appreciation for code quality

Better Code Hub

- > Get invited to github.com/blockchaingers/<your-team>. Put your private repo there.
- > Enable push&pull toggle on you repo card in Better Code Hub. Act on feedback in GitHub.

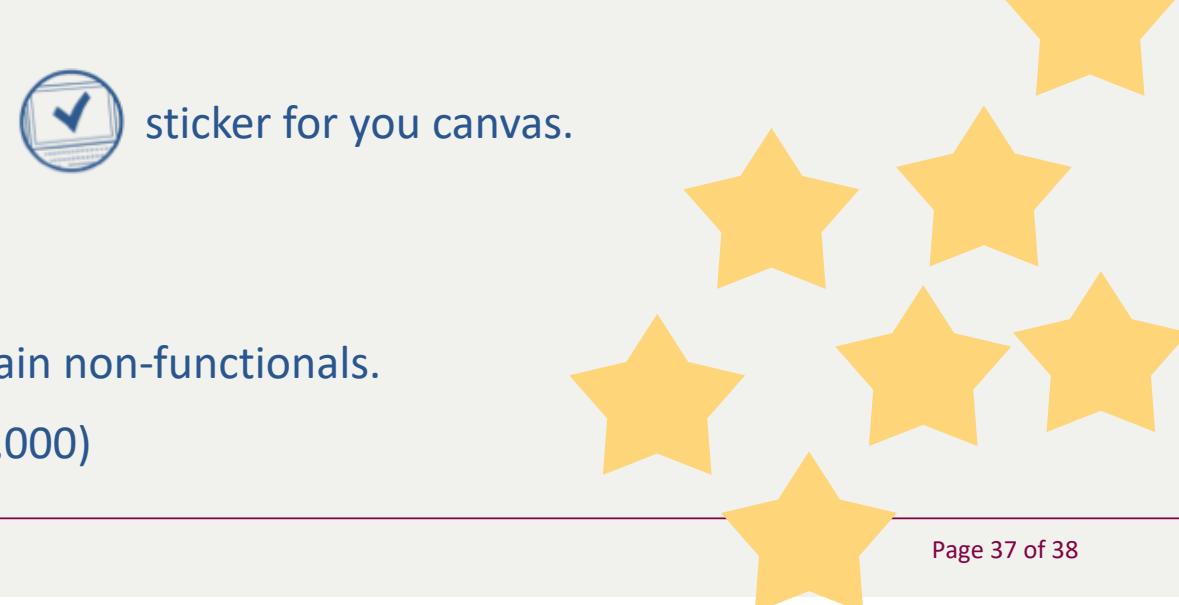


Jedi support

- > Come to the Jedi deck for support, or in bettercodehub-support on Slack.
- > How to use the tool, how to refactor, **how to get Blockchain non-functionals right**

Canvas

- > Before Sunday noon, come show your score and get a  sticker for you canvas.



Win

- > Seven gold-star balloons for teams with best Blockchain non-functionals.
- > Win the SIG Investor Readiness workshop (worth €15,000)

Contact

-  +31 64 63 63 866
-  j.visser@sig.eu
-  [@jstvssr](https://twitter.com/jstvssr)

