



Lab Course / “Praktikum”: *Project Management and Software Development for Medical Applications*

Documentation, Tests, Design Patterns & Integration Strategy – WS2020

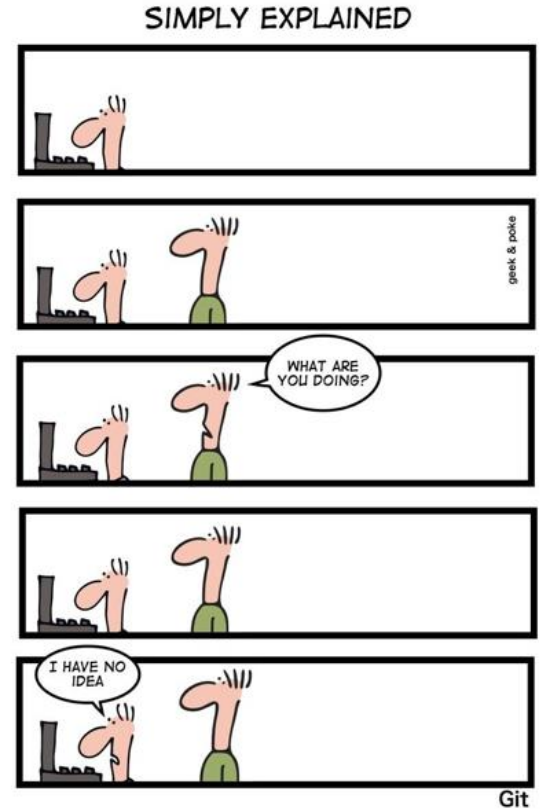
Ardit Ramadani

Munich, 23 November 2020



Disclaimer

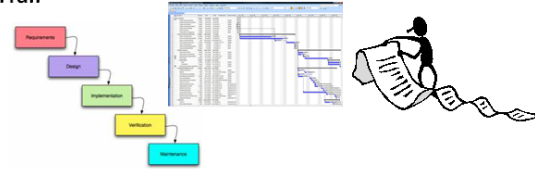
- This talk will not cover all aspects of SE!
- Familiarize with concepts and ideas
- Not every single detail matters



Software Engineering approaches

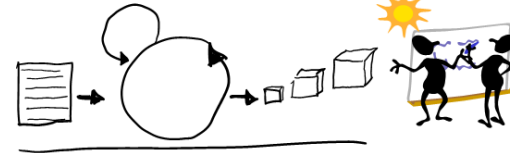
- Software Engineering can be a religion:
- Sometimes it is applied rigidly
- Many different contrasting ideas
- Do not get your attention drawn away from the problem at hand!

Waterfall



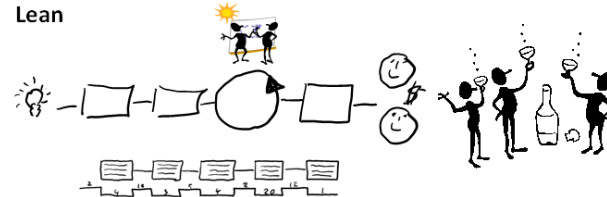
Schedule large work orders and align people by workflow

Agile



Schedule small work orders and align people by schedule

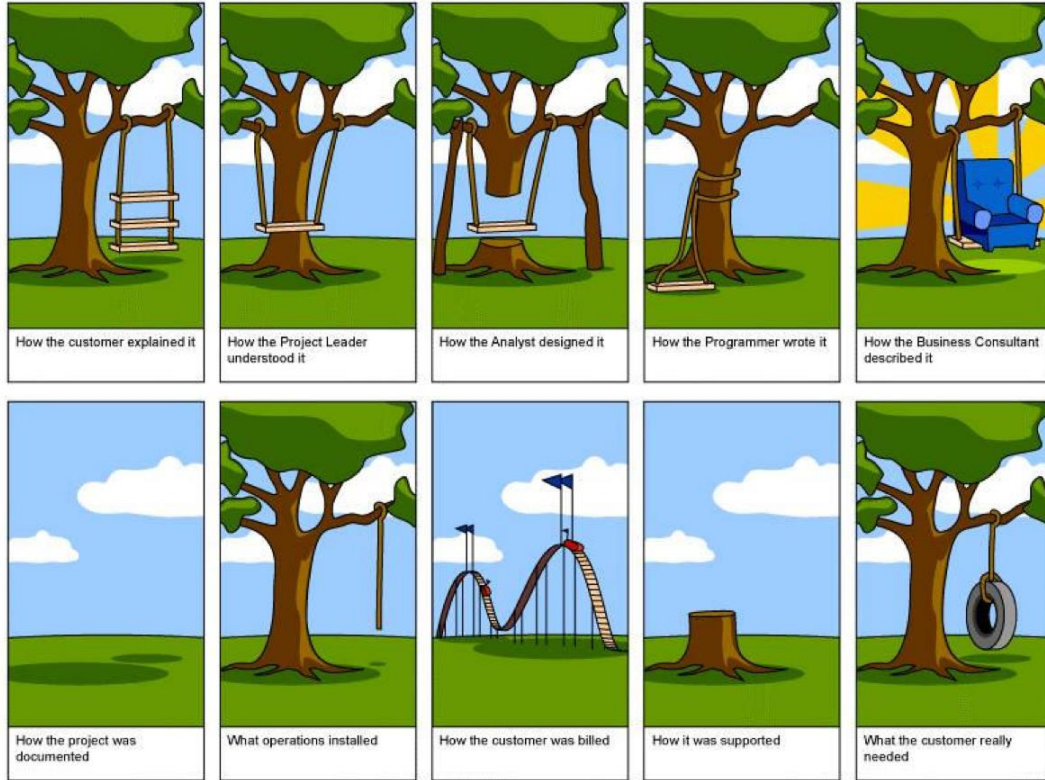
Lean



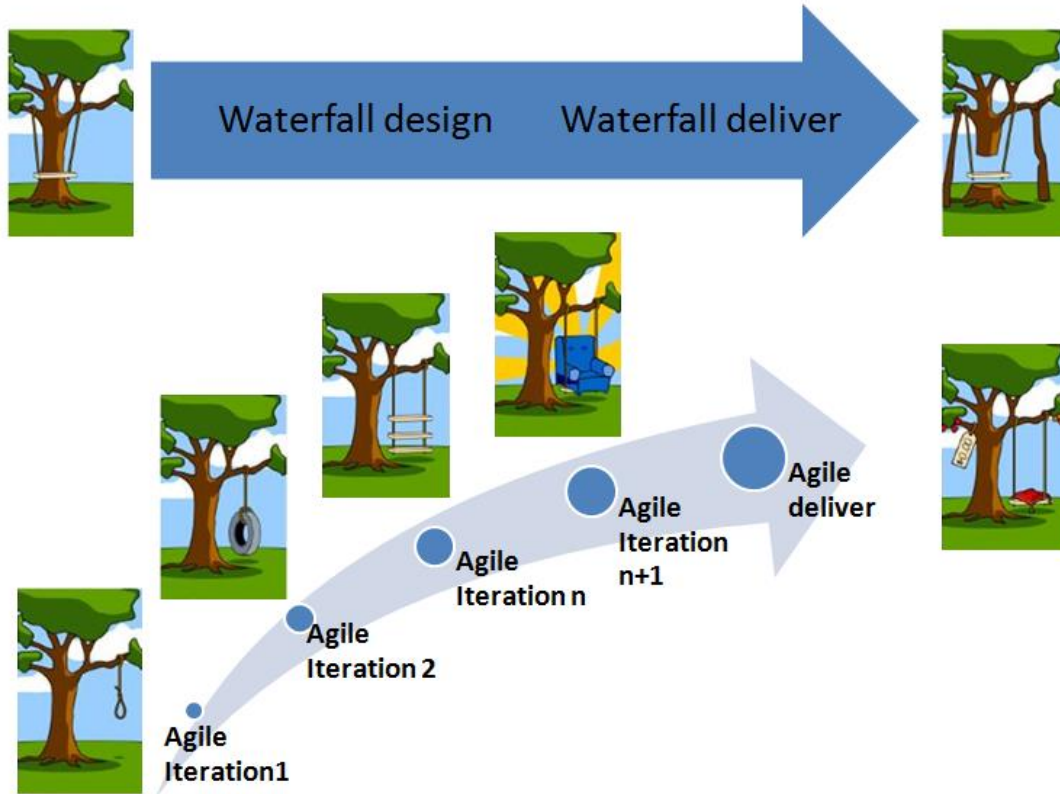
Schedule small work orders and align people by workflow



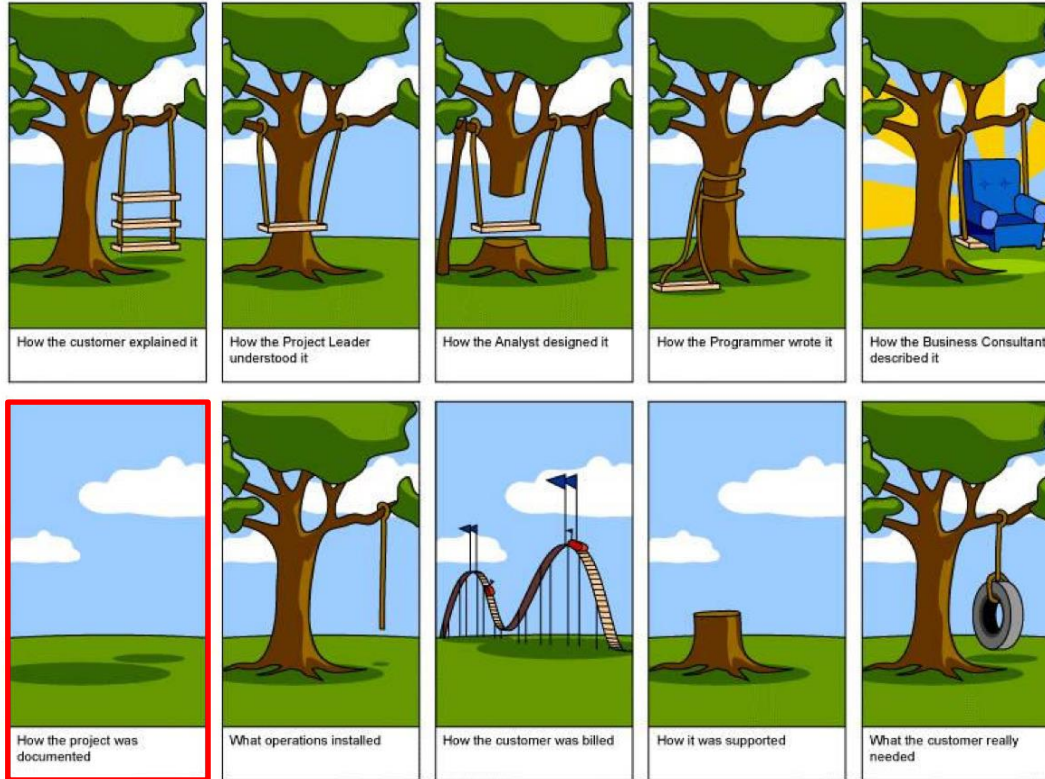
How Software Design and Engineering really works..



Keep the problem as small as possible!



How Software Design and Engineering really works..





Documentation

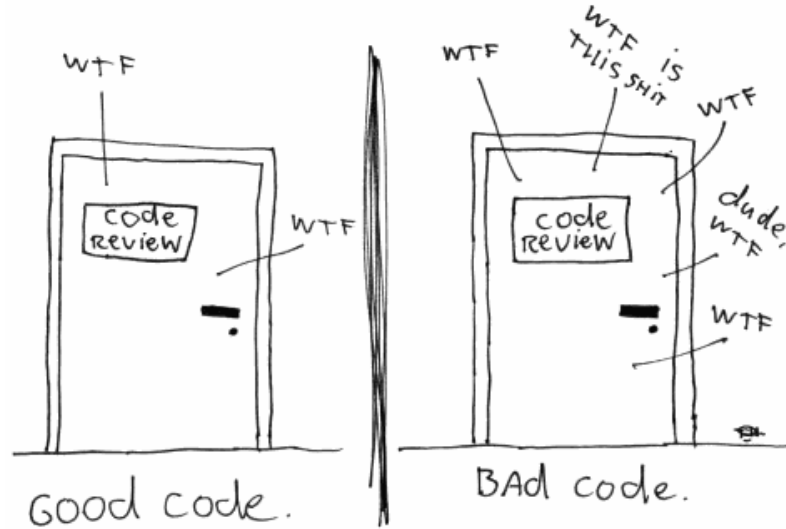


Documentation for developers

This includes:

- Your customers
- Your team
- Yourself!

The ONLY VALID MEASUREMENT
OF CODE QUALITY: WTFs/MINUTE

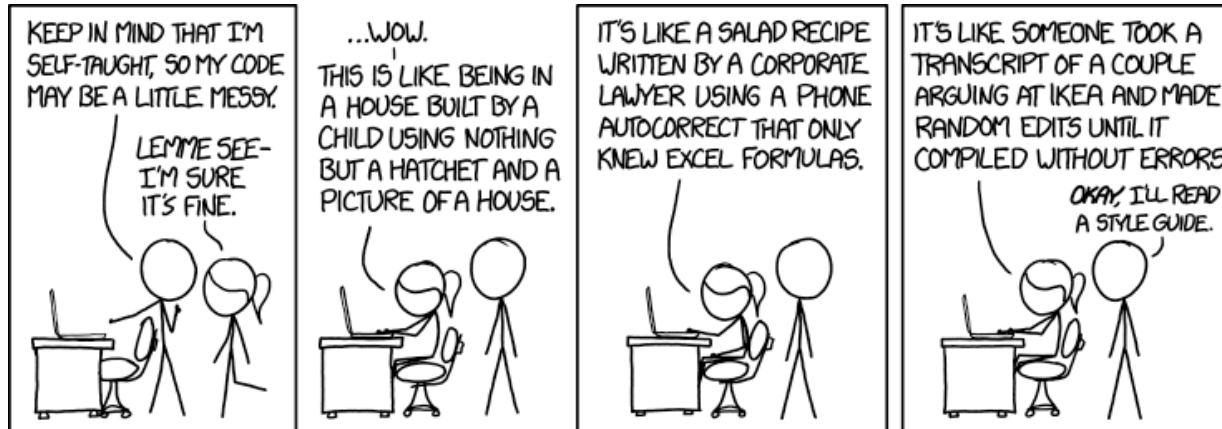


(c) 2008 Focus Shift



Documentation for developers – Code style

- Code is written once, but read many more times
- Don't be lazy:
 - Good variable names
 - Refactor code
 - Keep modular and generic



Documentation for developers – Comments

- No trivial comments
- Explain:
 - Assumptions
 - Corner cases
 - Non-trivial use of language features

BAD:

```
//Apply style.  
apply(style);
```

GOOD:

```
// Unlike the others, this image needs to be drawn in the user-requested style  
apply(style);
```



Documentation for developers – Doxygen

- Creates static docs from comments
- Close to source code, so USUALLY less out-of-date
- Useful only with non-trivial content

```
class Time {  
  
    public:  
  
        /**  
         * Constructor that sets the time to a given value.  
         *  
         * @param timemillis Number of milliseconds  
         *                 passed since Jan 1, 1970.  
         */  
        Time (int timemillis) {  
            // the code  
        }  
}
```



Documentation for developers – Doxygen

[Main Page](#) | [Class List](#) | [Class Members](#)

Time Class Reference

[List of all members.](#)

Public Member Functions

`Time (int timemillis)`

Static Public Member Functions

`Time now ()`

Detailed Description

The time class represents a moment of time.



Documentation for users

- Users as seen by developers:



- Usually the cause is bad documentation!
- You make a lot of assumptions that are clear in your head, but not to a new user



Design Patterns (and anti-Patterns)



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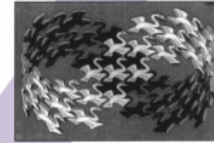
Design Patterns

- Reusable code structures
- Solve common problems
- Proven to work, common vocabulary
- Mostly created to work around rigid Object-Oriented type systems
- BUT: focus on the problem rather than where to stuff them in your program!

Design Patterns

Elements of Reusable
Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides



Foreword by Grady Booch



Some design Patterns

- Singleton: class with only one instance in whole program
- Abstract factory: allows to create an instance of several families of classes
- Observer: way of notifying change to a number of classes
- Decorator: add functionality to class without inheriting
- Facade: single class that represents an entire subsystem



Source: SourceMaking, "Design Patterns," [Online] Available: https://sourcemaking.com/design_patterns

Design anti-Patterns

- Too many (unnecessary) classes
- Functions too long

```
img_filter = ImageFilter()  
img_filter.set_image(img)  
img_filter.set_radius(2.5)  
filtered_img = img_filter.get_output()
```



```
filtered_img = filter_img(img, radius=2.5)
```



Design anti-Patterns

- Too many (unnecessary) classes
- Functions too long
- Mixed functionality
- Reinventing the wheel
- Premature optimization





Testing



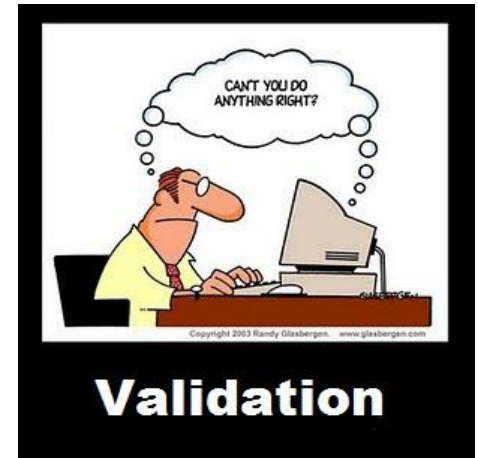
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Testing – Definitions

- Verification and Validation (V&V)
 - **Verification**: The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of the phase [IEEE-STD-610]
 - **Validation**: The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements [IEEE-STD-610]



Testing – Definitions

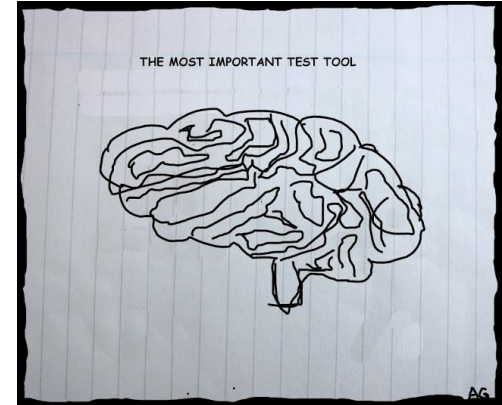
Criteria	Verification	Validation
Definition	The process of evaluating work-products (not the actual final product) of a development phase to determine whether they meet the specified requirements for that phase.	The process of evaluating software during or at the end of the development process to determine whether it satisfies specified business requirements.
Objective	To ensure that the product is being built according to the requirements and design specifications. In other words, to ensure that work products meet their specified requirements.	To ensure that the product actually meets the user's needs, and that the specifications were correct in the first place. In other words, to demonstrate that the product fulfills its intended use when placed in its intended environment.
Question	Are we building the product <i>right</i> ?	Are we building the <i>right</i> product?
Evaluation Items	Plans, Requirement Specs, Design Specs, Code, Test Cases	The actual product/software.
Activities	<ul style="list-style-type: none"> •Reviews •Walkthroughs •Inspections 	<ul style="list-style-type: none"> •Testing



Test types

- Runtime Test: Sanity check for invalid program states during runtime
- Test Run: Developer runs the software and looks for obvious errors
- Systematic Test: Carefully chosen test data, comparison with expected results
- Regression Test: Extended and automated systematic test, run repeatedly (e.g. after every commit), test results are documented
- Performance Test: Testing performance of the software (runtime, memory usage, ...)

Testing may be a pain in the neck, but with the right combination of the above test types you get a good cost-return value



Test levels

- Unit Test: Checks a single piece of code (e.g. class) in isolation
- Integration Test: Verifies the interfaces between components
- System Test: Checks that the whole software meets the requirements
- Operational Acceptance Test: Put the software to test with real end users and in realistic conditions



Unit test

```
import unittest

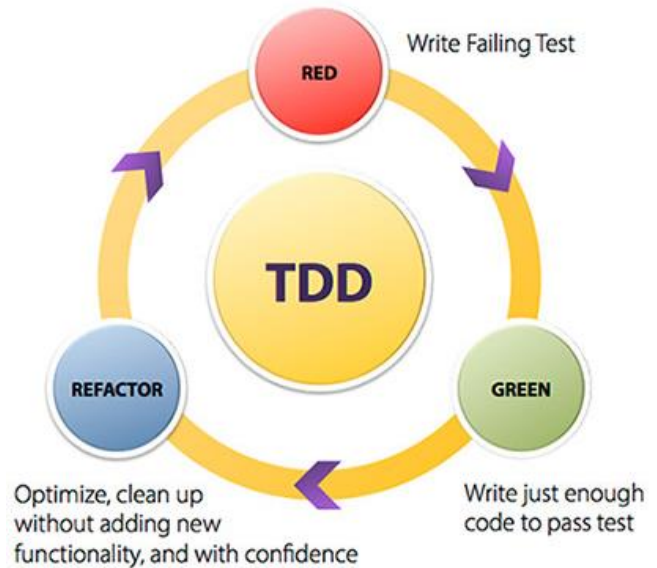
def fun(x):
    return x + 1

class MyTest(unittest.TestCase):
    def test(self):
        self.assertEqual(fun(3), 4)
```



Test Driven Development

- Write tests first, then develop until pass
- Pros:
 - Help focusing on objectives
 - Think about corner cases
 - More rewarding experience
 - More confident about later changes



Testable code

- Keep functions small

```
def add_to_cart(user, article):
    price = database.get_article(article)
    if user.age > 35 and article.category == 'food':
        price *= 0.90
    elif user.city == 'Munich' and article.category == 'electronics':
        price *= 0.85
    database.reduce_availability(article)
    user.add_to_cart(article, price)
```

```
def compute_price(user, price, article):
    if user.age > 35 and article.category == 'food':
        price *= 0.90
    elif user.city == 'Munich' and article.category == 'electronics':
        price *= 0.85
    return price
```

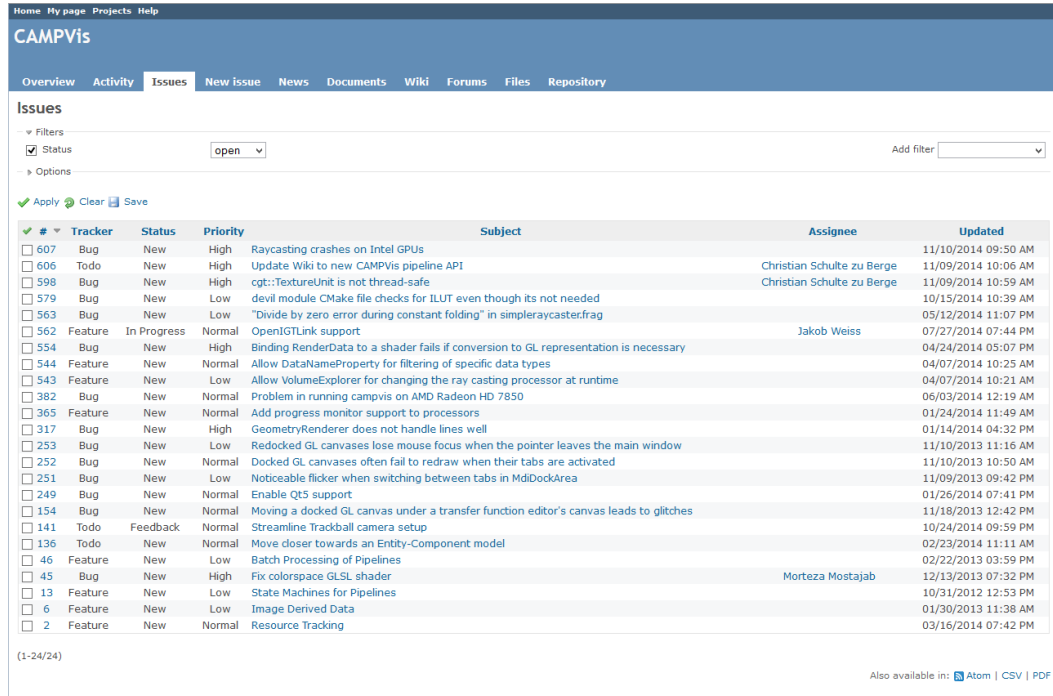
- Do not mix functionality

```
def add_to_cart(user, article):
    price = database.get_article(article)
    price = compute_price(user, price, article)
    database.reduce_availability(article)
    user.add_to_cart(article, price)
```



Bug tracker

- Help tracking defects present in software



The screenshot shows the CAMPVis Issues page. At the top, there are navigation links: Home, My page, Projects, Help. Below that is the CAMPVis logo and a menu with Overview, Activity, Issues (selected), New issue, News, Documents, Wiki, Forums, Files, and Repository. The main content area is titled 'Issues' and includes a filter section with a checked 'Status' dropdown set to 'open' and an 'Add filter' button. Below the filter are 'Apply', 'Clear', and 'Save' buttons. The main part of the page is a table of issues with the following columns: Tracker, Status, Priority, Subject, Assignee, and Updated. The table contains 24 rows of issues, each with a checkbox in the Tracker column. The issues listed are:

Tracker	Status	Priority	Subject	Assignee	Updated
<input type="checkbox"/> 607	Bug	New	High	Raycasting crashes on Intel GPUs	11/10/2014 09:50 AM
<input type="checkbox"/> 606	Todo	New	High	Update Wiki to new CAMPVis pipeline API	Christian Schulte zu Berge 11/09/2014 10:06 AM
<input type="checkbox"/> 598	Bug	New	High	ogt::TextureUnit is not thread-safe	Christian Schulte zu Berge 11/09/2014 10:59 AM
<input type="checkbox"/> 579	Bug	New	Low	devil module CMake file checks for ILUT even though its not needed	10/15/2014 10:39 AM
<input type="checkbox"/> 563	Bug	New	Low	"Divide by zero error during constant folding" in simplercaster.frag	05/12/2014 11:07 PM
<input type="checkbox"/> 562	Feature	In Progress	Normal	OpenGLLink support	Jakob Weiss 07/27/2014 07:44 PM
<input type="checkbox"/> 554	Bug	New	High	Binding RenderData to a shader fails if conversion to GL representation is necessary	04/24/2014 05:07 PM
<input type="checkbox"/> 544	Feature	New	Normal	Allow DataNameProperty for filtering of specific data types	04/07/2014 10:25 AM
<input type="checkbox"/> 543	Feature	New	Low	Allow VolumeExplorer for changing the ray casting processor at runtime	04/07/2014 10:21 AM
<input type="checkbox"/> 382	Bug	New	Normal	Problem in running campvis on AMD Radeon HD 7850	06/03/2014 12:19 AM
<input type="checkbox"/> 365	Feature	New	Normal	Add progress monitor support to processors	01/24/2014 11:49 AM
<input type="checkbox"/> 317	Bug	New	High	GeometryRenderer does not handle lines well	01/14/2014 04:32 PM
<input type="checkbox"/> 253	Bug	New	Low	Redocked GL canvases lose mouse focus when the pointer leaves the main window	11/10/2013 11:16 AM
<input type="checkbox"/> 252	Bug	New	Normal	Docked GL canvases often fail to redraw when their tabs are activated	11/10/2013 10:50 AM
<input type="checkbox"/> 251	Bug	New	Low	Noticeable flicker when switching between tabs in MdDockControl	11/09/2013 09:42 PM
<input type="checkbox"/> 249	Bug	New	Normal	Enable Qt5 support	01/26/2014 07:41 PM
<input type="checkbox"/> 154	Bug	New	Normal	Moving a docked GL canvas under a transfer function editor's canvas leads to glitches	11/18/2013 12:42 PM
<input type="checkbox"/> 141	Todo	Feedback	Normal	Streamline Trackball camera setup	10/24/2014 09:59 PM
<input type="checkbox"/> 136	Todo	New	Normal	Move closer towards an Entity-Component model	02/23/2014 11:11 AM
<input type="checkbox"/> 46	Feature	New	Low	Batch Processing of Pipelines	02/22/2013 03:59 PM
<input type="checkbox"/> 45	Bug	New	High	Fix colorspace GLSL shader	Morteza Mostajab 12/13/2013 07:32 PM
<input type="checkbox"/> 13	Feature	New	Low	State Machines for Pipelines	10/31/2012 12:53 PM
<input type="checkbox"/> 6	Feature	New	Low	Image Derived Data	01/30/2013 11:38 AM
<input type="checkbox"/> 2	Feature	New	Normal	Resource Tracking	03/16/2014 07:42 PM

(1-24/24)

Also available in: [Atom](#) | [CSV](#) | [PDF](#)



Bug tracker

The screenshot shows a bug tracker interface with several key elements and annotations:

- Issue Title:** "Broken URL"
- Assignee:** "No one is assigned" with a gear icon. A red arrow points to this icon with the label "assigned to".
- Milestone:** "No milestone" with a gear icon. A red arrow points to this icon with the label "milestones".
- Content:** "The url is broken". Below this is a text area with the instruction "Attach images by dragging & dropping them or choose an image".
- Buttons:** "Write" and "Preview" are at the top left. A green "Submit new issue" button is at the bottom right. A red arrow points to this button with the label "new issue".
- Milestone Modal:** A modal window titled "Milestone" is open, showing a search filter, "Open" and "Closed" tabs, and a list of milestones:
 - Clear this milestone (highlighted in blue)
 - Version 1 (Due in 24 days)
 - Version 2 (Due in about 1 month)
- Add Labels:** A sidebar on the right titled "Add Labels" lists various labels with colored indicators:
 - bug (red)
 - duplicate (grey)
 - enhancement (blue)
 - invalid (grey)
 - question (purple)
 - wontfix (grey)A red arrow points to the "wontfix" label with the label "labels".





Integration strategies



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The Big-Bang Integration Strategy

- *Unordered implementation of the components / all components implemented at the same time*
- Problems
 - Errors are very hard to locate: Which component is the cause?
 - Design errors (errors in interfaces) not distinguishable from implementation errors
- Always prefer incremental integration strategy



Top-Down Integration Strategy

- *Start with the components from the top-most layer (e.g. GUI). Incrementally add layers further down*
- Pros/Cons
 - Early prototype available (with limited functionality)
 - Design errors can be detected in an early state
 - Many stubs required → cumbersome
 - No functionality until a very late stage



Bottom-Up Integration Strategy

- *Start with the components from the bottom-most layer (e.g. entity classes). Incrementally add upper layers.*
- Pros/Cons
 - No stubs required
 - Functionality available in early stages
 - Nothing to show to customers until the very end
 - Errors may be expensive, because they may be found late and solving them might require cumbersome changes



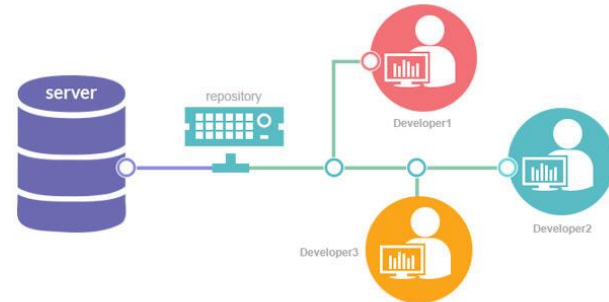


Version control

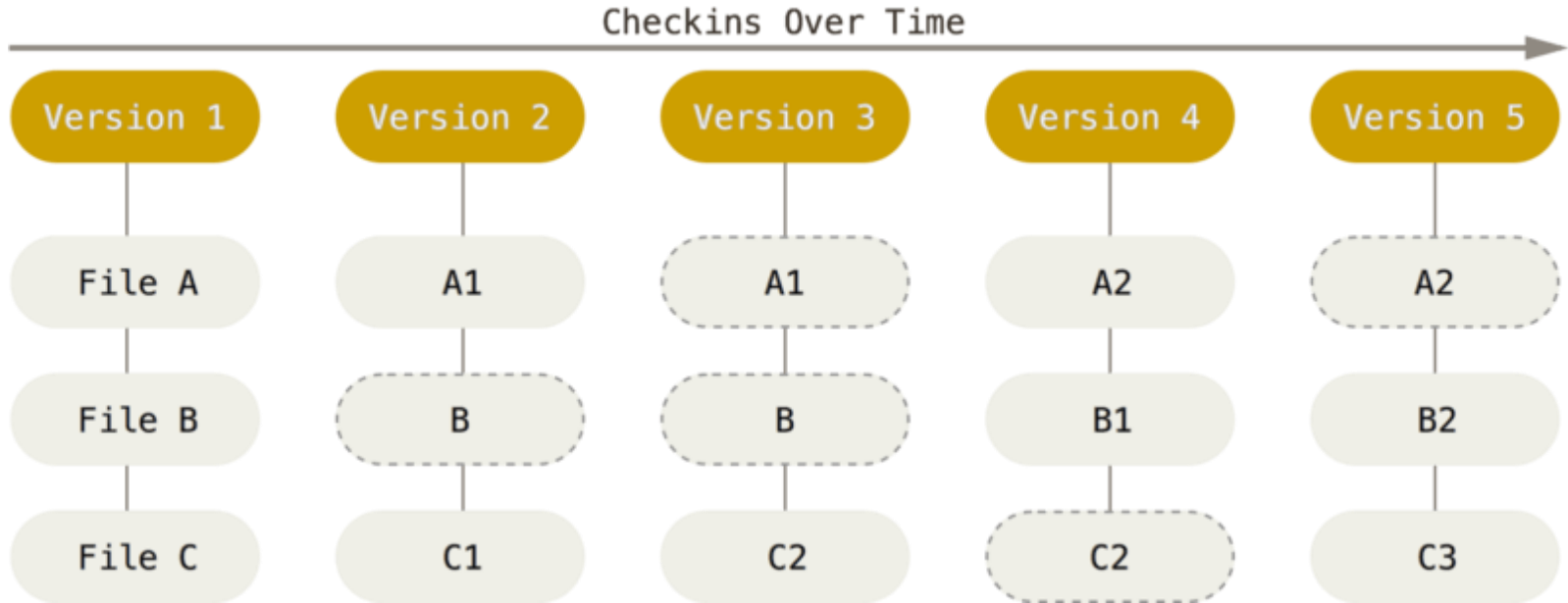


Version Control Systems

- Keep a history of changes to code
- Share code with others
- Integrate changes from others
- Manage concurrent versions



Version history



Changes history

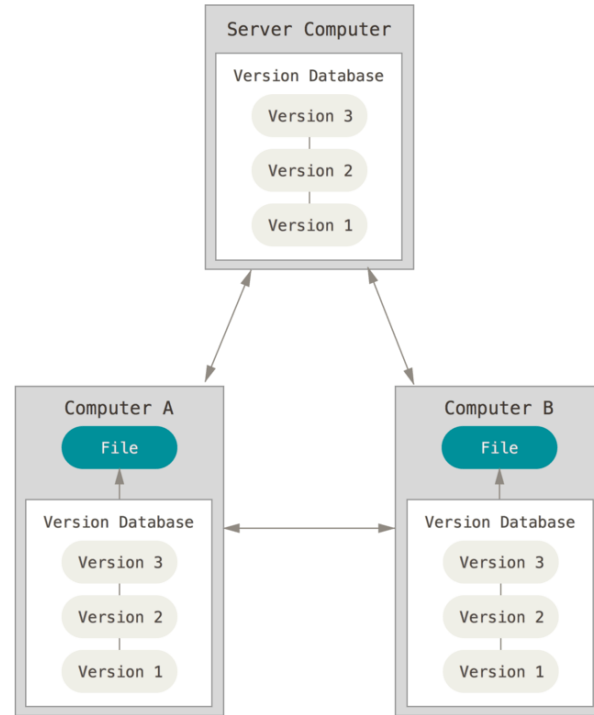
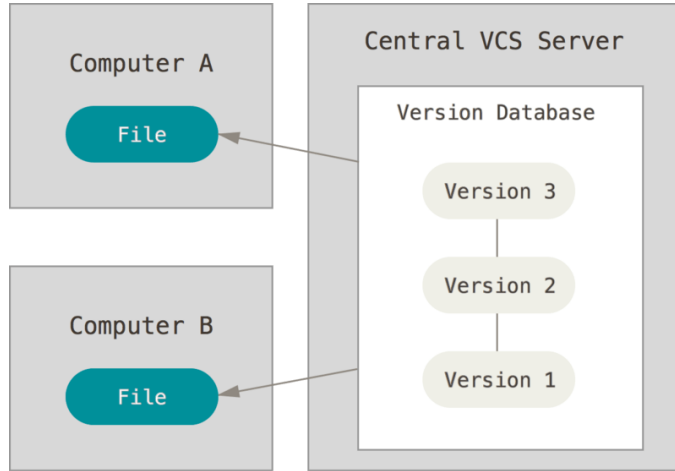
2d4e9353 » streeter 2013-07-18 Add a missing quote so copy/...	6 # "soupselect": "0.2.0"
989e48f7 » nickhammond 2013-05-18 Specify underscore & undesc...	7 # "underscore": "1.3.3" 8 # "underscore.string": "2.3.0"
3406d66b » technicalpickles 2012-06-08 Update "w" help comments	9 # 10 # Configuration: 11 # None 12 # 13 # Commands: 14 # hubot wiki me <query> - Searches for <query> on Wikipedia. 15 # 16 # Author: 17 # h3h
97d63d4a » h3h 2011-11-09 Add a Wikipedia script for p...	18 19 _ = require("underscore") 20 _s = require("underscore.string") 21 Select = require("soupselect").select 22 HTMLParser = require "htmlparser" 23 24 module.exports = (robot) -> 25 robot.respond /(wiki)(me)? (.*)/i, (msg) ->
374b8bfe » nickhammond 2013-05-18 change @http to @robot.http ...	26 wikiMe robot, msg.match[3], (text, url) ->
97d63d4a » h3h 2011-11-09 Add a Wikipedia script for p...	27 msg.send text



Branches

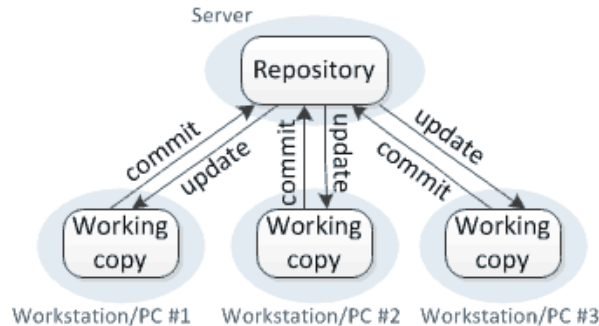


Centralized vs Distributed Version Control Systems

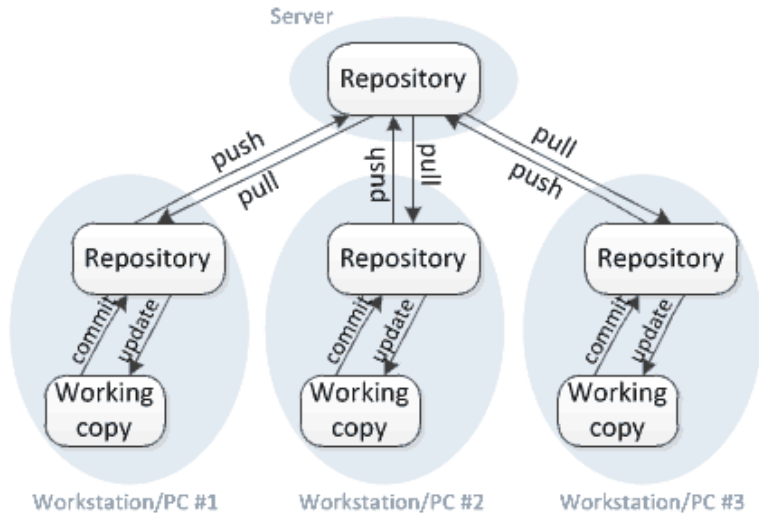


Centralized vs Distributed Version Control Systems

Centralized version control



Distributed version control



Software Configuration Management Guide, "Centralized vs Distributed Version Control Systems,"
[Online] Available: <https://scmquest.com/centralized-vs-distributed-version-control-systems/>



Continuous Integration

- Compile automatically on every change uploaded to VCS

Jenkins Suchen Christian Schulte zu Berge Abmelden
Jenkins > CAMPVis Jobs > campvis-gtest > **Projekt campvis-gtest**
Building CAMPVis on Linux/GCC

[Beschreibung bearbeiten](#) [Projekt deaktivieren](#)

GNU C Compiler Warnungen Trend

Build #	Count
#22	8
#24	8
#25	8
#26	14
#27	4
#28	4
#29	4
#30	4
#31	4
#32	4
#33	4
#34	4
#35	4
#36	4
#37	4
#38	4
#39	4
#40	4

[Vergrößern](#) [Konfigurieren](#)

Whiteboards are white because Chuck Norris scared them that way.

Trend der Testergebnisse

Build #	Count
#29	0
#30	0
#31	0
#32	0
#33	0
#34	0
#35	0
#36	0
#37	0
#38	0
#39	0
#40	0
#41	30
#42	30
#43	55
#44	55
#45	35
#46	35
#47	35
#48	35
#49	30
#50	30
#51	30
#52	30
#53	30
#54	30
#55	30
#56	30
#57	30
#58	30
#59	30
#60	30
#61	30
#62	30
#63	30
#64	30
#65	30
#66	30
#67	30
#68	30
#69	30
#70	30

[\(Nur Fehlschläge anzeigen\)](#) [Vergrößern](#)

Build-Verlauf (Trend) =>

#	Build #	Time
40	06.05.2014 15:54:31	
39	06.05.2014 14:13:51	
38	06.05.2014 10:52:47	
37	05.05.2014 17:03:46	
36	05.05.2014 14:09:44	
35	05.05.2014 13:21:36	
34	05.05.2014 11:41:36	
33	02.05.2014 11:05:32	
32	30.04.2014 17:32:57	
31	30.04.2014 16:24:52	
30	30.04.2014 16:12:04	
29	28.04.2014 21:45:53	

Permalink

- [Letzter Build \(#40\), vor 5 Tage 17 Stunden](#)
- [Letzter stabiler Build \(#40\), vor 5 Tage 17 Stunden](#)
- [Letzter erfolgreicher Build \(#40\), vor 5 Tage 17 Stunden](#)
- [Letzter fehlgeschlagener Build \(#27\), vor 15 Tage](#)
- [Letzter instabiler Build \(#22\), vor 19 Tage](#)
- [Letzter erfolgloser Build \(#27\), vor 15 Tage](#)





Thank you

Happy coding

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