Karlsruhe Institute of Technology

Sustainable Software Development in an Academic Setting

4th International Symposium on Research and Education of Computational Science (RECS)
University of Tokyo, October 1st, 2019

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Steinbuch Centre for Computing (SCC)

What we cover today

- *Versioning systems*
- *Git workflow*
- *Git hosting sites*
- *Continuous Integration (CI)*
- *GitLab runners*
- *Automated Testing*
- *Unit Testing with Googletest*
- *Software Documentation with Doxygen*

To interactively participate in this course, you need a GitLab account.

- *Please create an account (choose your name carefully!)*
- *Please log in*
- *https://gitlab.com/*

GitLab

For complete interactive participation (on Linux Systems):

```
apt-get install git cmake g++ gcovr
```

Interactive webinar with the help of


Terry Cojean


Thomas Grützmacher


Pratik Nayak


Tobias Ribizel


Mike Tsai

What is a version control system?

Version control system for tracking changes in computer files.

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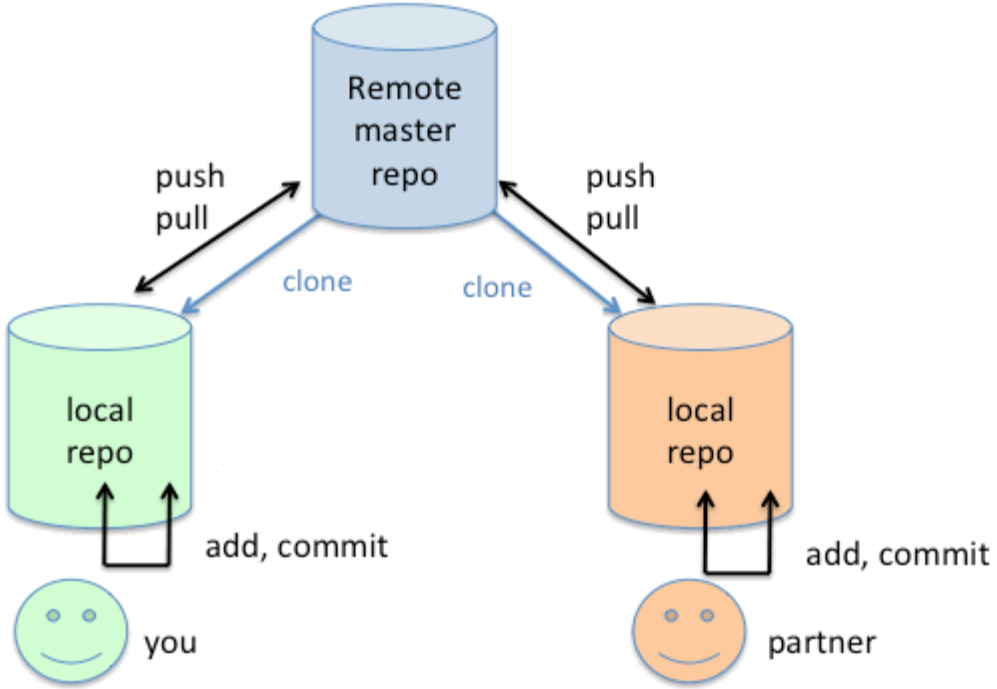
Version control system for tracking changes in computer files.

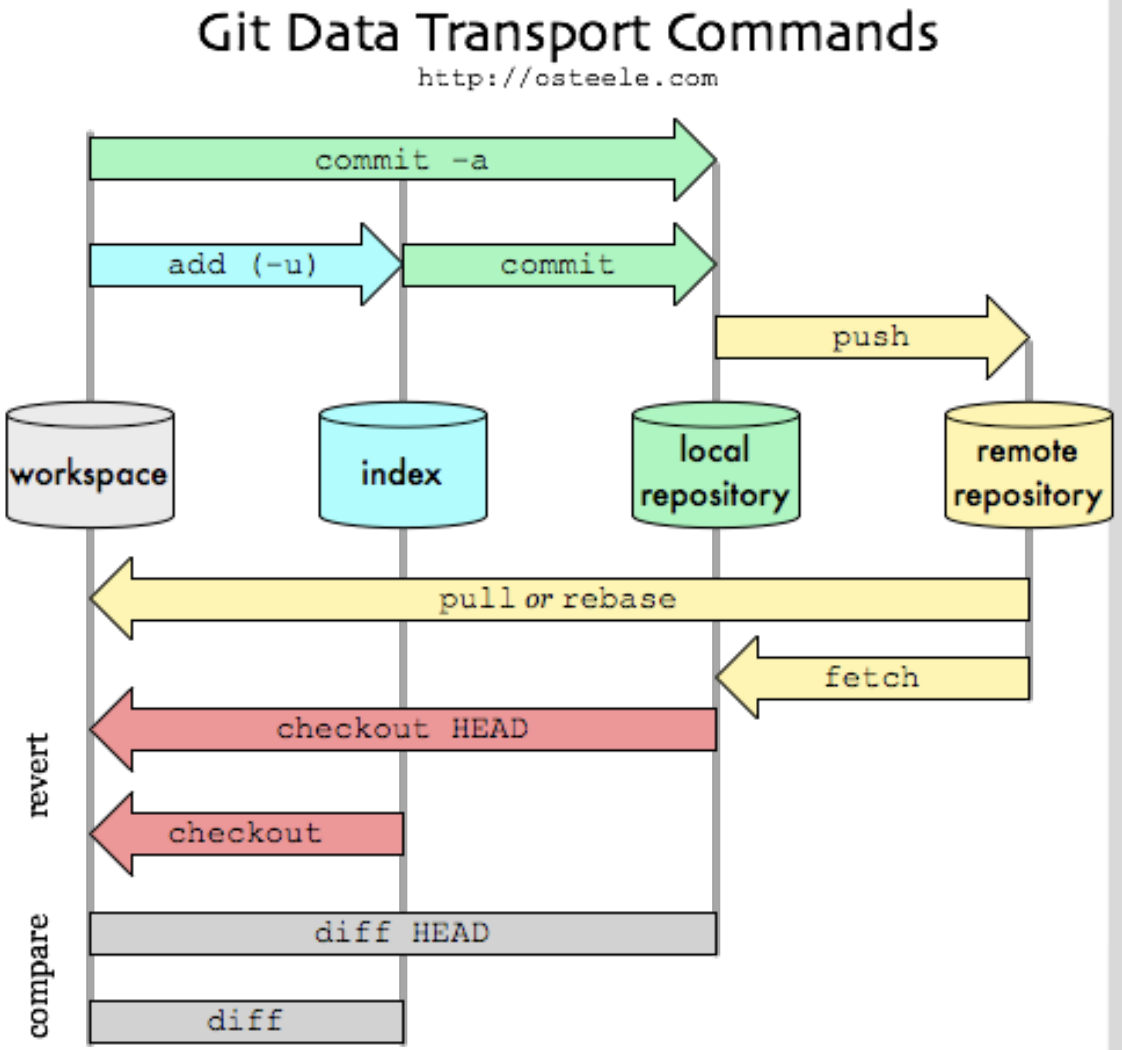
- Distributed version control
- Coordinates work between multiple developers
- Who made what changes and when
- Revert back at any time
- Local and remote repos



- ✓ Keeps track of code history
- ✓ Takes “snapshots” of your files
- ✓ You decide when to take a snapshot by making a ”commit”
- ✓ You can visit any snapshot at any time

Git Versioning System

- git init // Initialize local git repository
- git add *files // Add file(s) to snapshot
- git status // Check changes not yet in the snapshot
- git commit *files // Take snapshot (commit changes)
- git commit –m 'put a comment on this commit' *files



Git Cheat Sheet: https://www.git-tower.com/blog/git-cheat-sheet/

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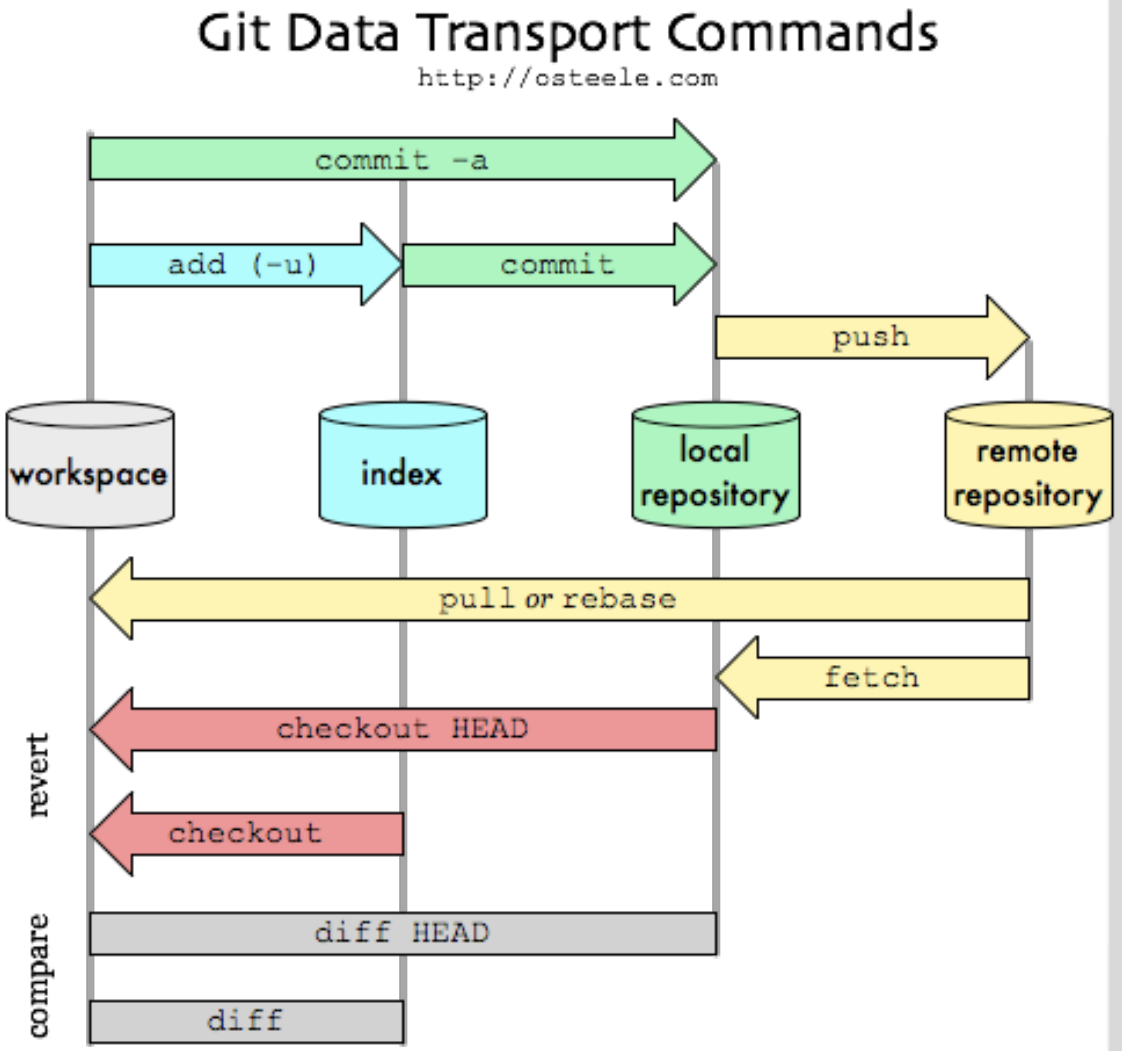
Local Repository



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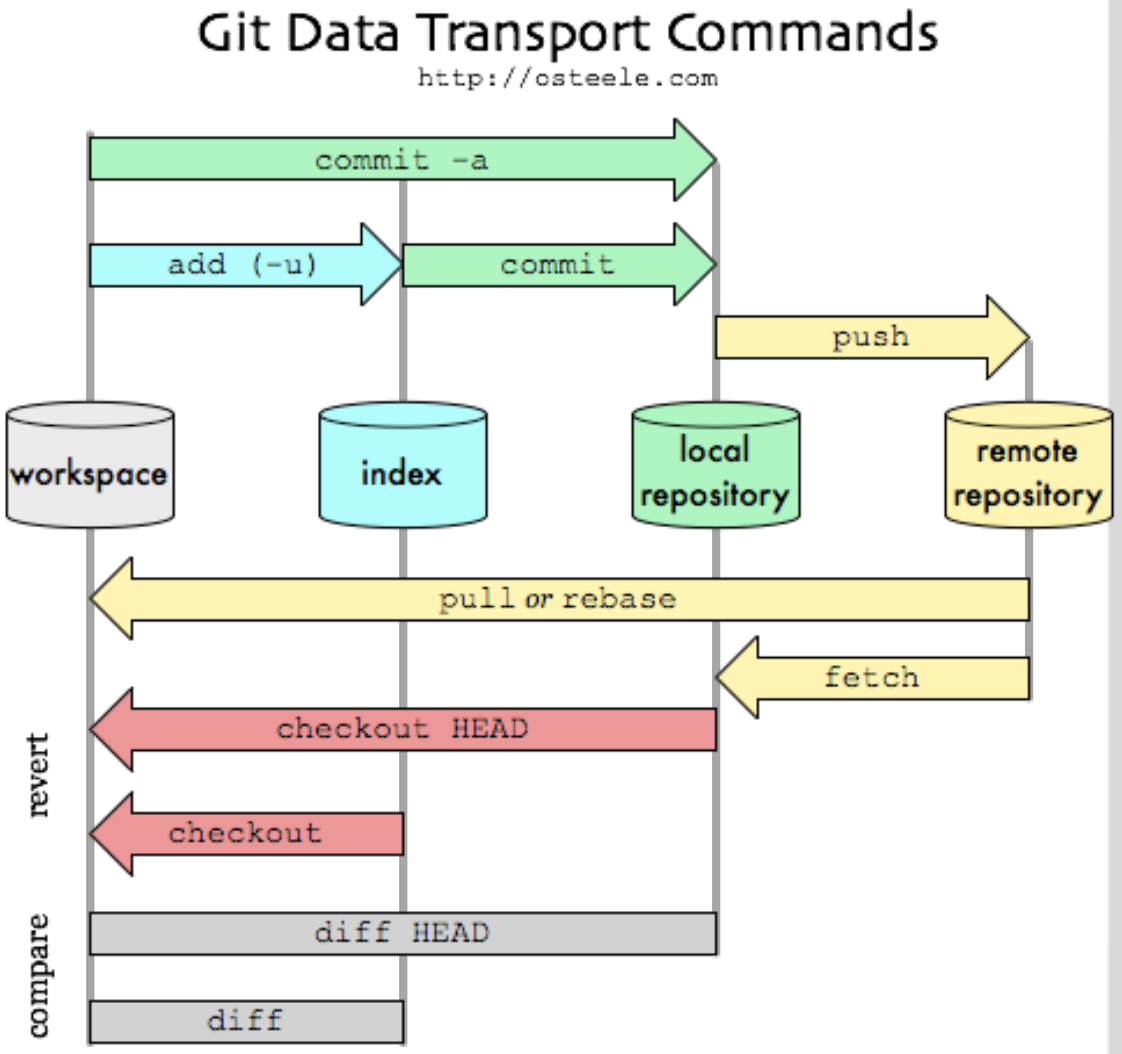
Local Repository

- git push // Push local snapshots to remote repo
- git pull // Get latest snapshot from remote repo
- git clone *path/to/repo // Clone an existing remote repository

Remote Repository



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Git Hosting Sites

They offer the environment for the remote repository.

- GitHub
- GitLab
- Bitbucket
- …

We may just choose GitLab for this course

- *Please create an account (choose your name carefully!)*
- *Please log in*
- *https://gitlab.com/*

https://en.wikipedia.org/wiki/Comparison_of_source-code-hosting_facilities

Name	Code review	Bug tracking	Web hosting	Wiki	Translation system	Shell server	Mailing List	Forum	Personal branch	Private branch	Announce	Build system	Team	Release Binaries	Self-hosting
Assembla	Yes[20]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes[21]	Yes	Yes	Yes	Unknown	No
Bitbucket	Yes[22]	Yes[a]	Yes[23]	Yes	No	No	No	No	Yes	Yes[b]	No	Yes[24]	Yes	No[25]	Commercially (BitBucket Server formerly Stash)[c]
Buddy	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes[d]	Yes	Yes	Yes
CloudForge	Unknown	Yes	Yes	Yes	No	No	No	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	No
GitHub	Yes[26]	Yes[27][e]	Yes[28]	Yes	No	No	No	No	Yes	Yes	Yes	3rd-party (e.g. Travis CI, Appveyor and others)[29]	Yes	Yes	Commercially (GitHub Enterprise)
GitLab	Yes[30]	Yes	Yes[31]	Yes	No	No	No	No	Yes	Yes	Yes	Yes[32]	Yes	Yes[33]	Yes[f]
GNU Savannah	Yes[34]	Yes	Yes	No	No	Yes	Yes	No[35]	No	No	Yes	No	Yes	Unknown	Yes
												Yes, with			

Git Hands-On

1. We create an Account at GitLab and log in.
2. I create a project on GitLab (\git@gitlab.com:hanzt/recs)
3. I add a first source file and make it a public repository
4. You all clone or the project:

   ```
   git clone git@gitlab.com:hanzt/recs
   ```

5. You add your name to the local version of contributors.txt
6. You check your changes:

   ```
   git diff
   ```

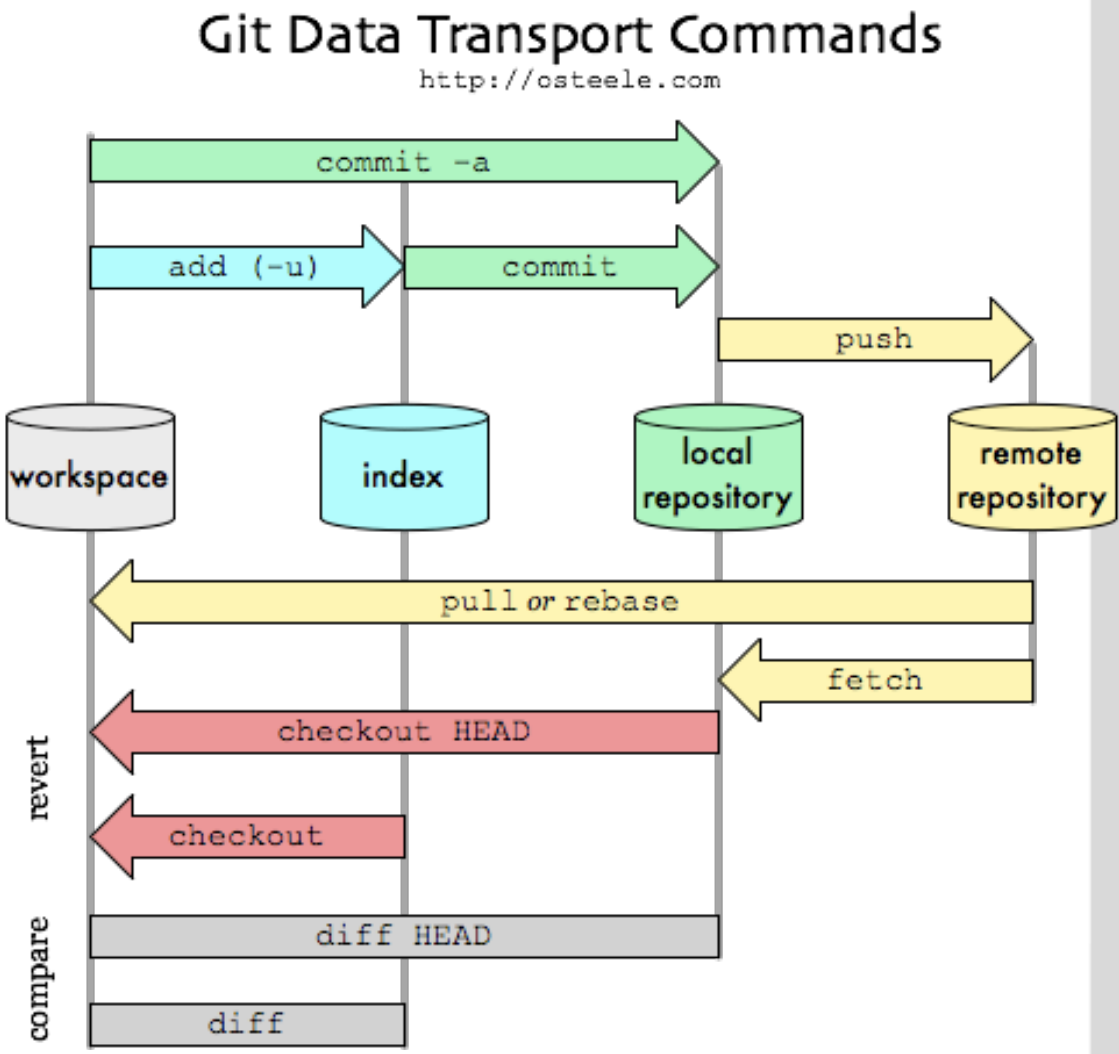
7. You commit your local changes:

   ```
   git commit –m ‘add my name’ contributors.txt
   ```

8. You push your local changes to the remote repository:

   ```
   git push origin master
   ```

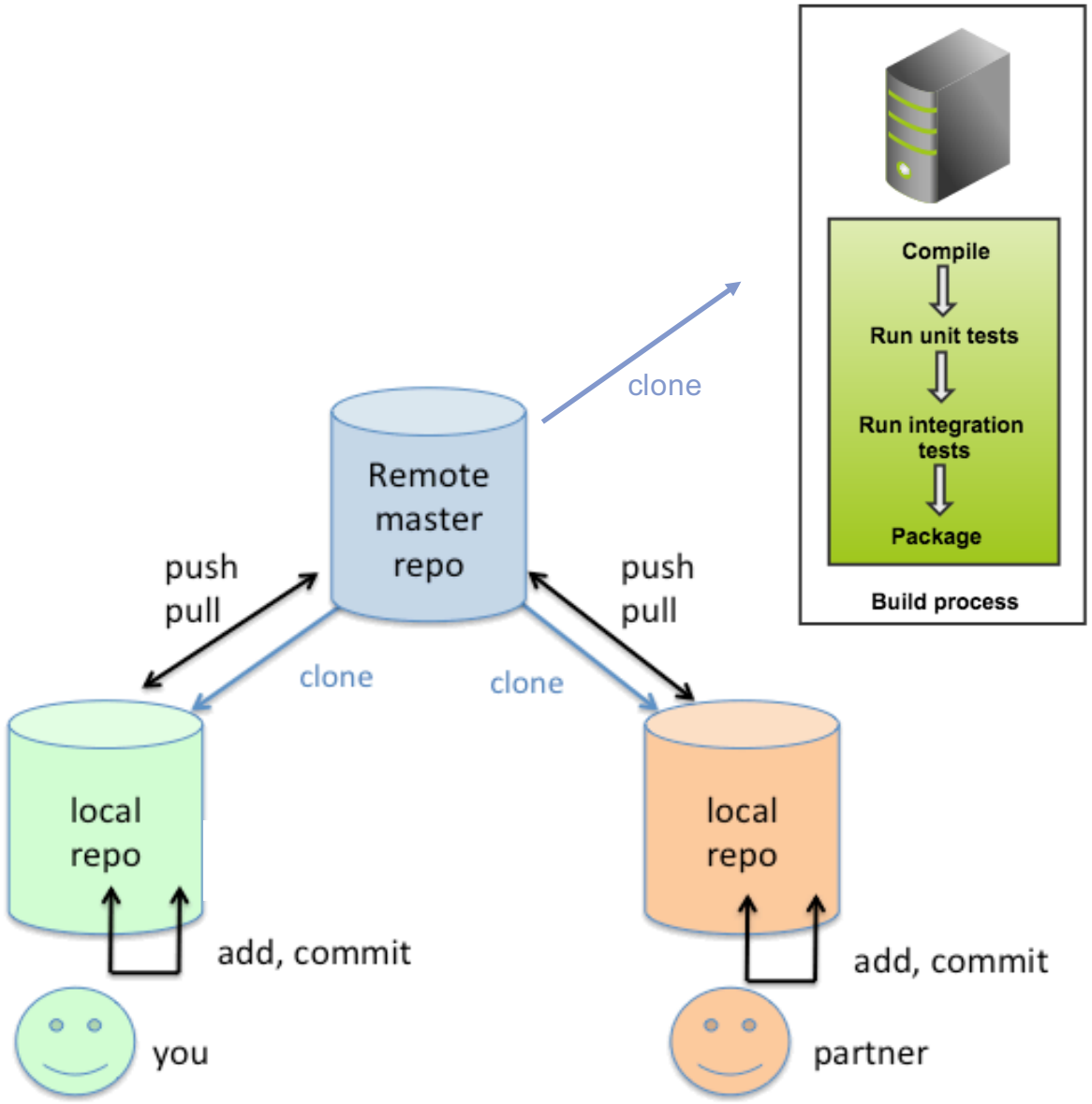
9. You fix ”merge conflicts” ….



Continuous Integration (CI)

Sometimes, someone introduces a bug that breaks the code…

- *How do you find out the code is broken?*
- *How do we find out who which code integration introduced the bug?*
- *How can we make sure everything works at any point in time?*



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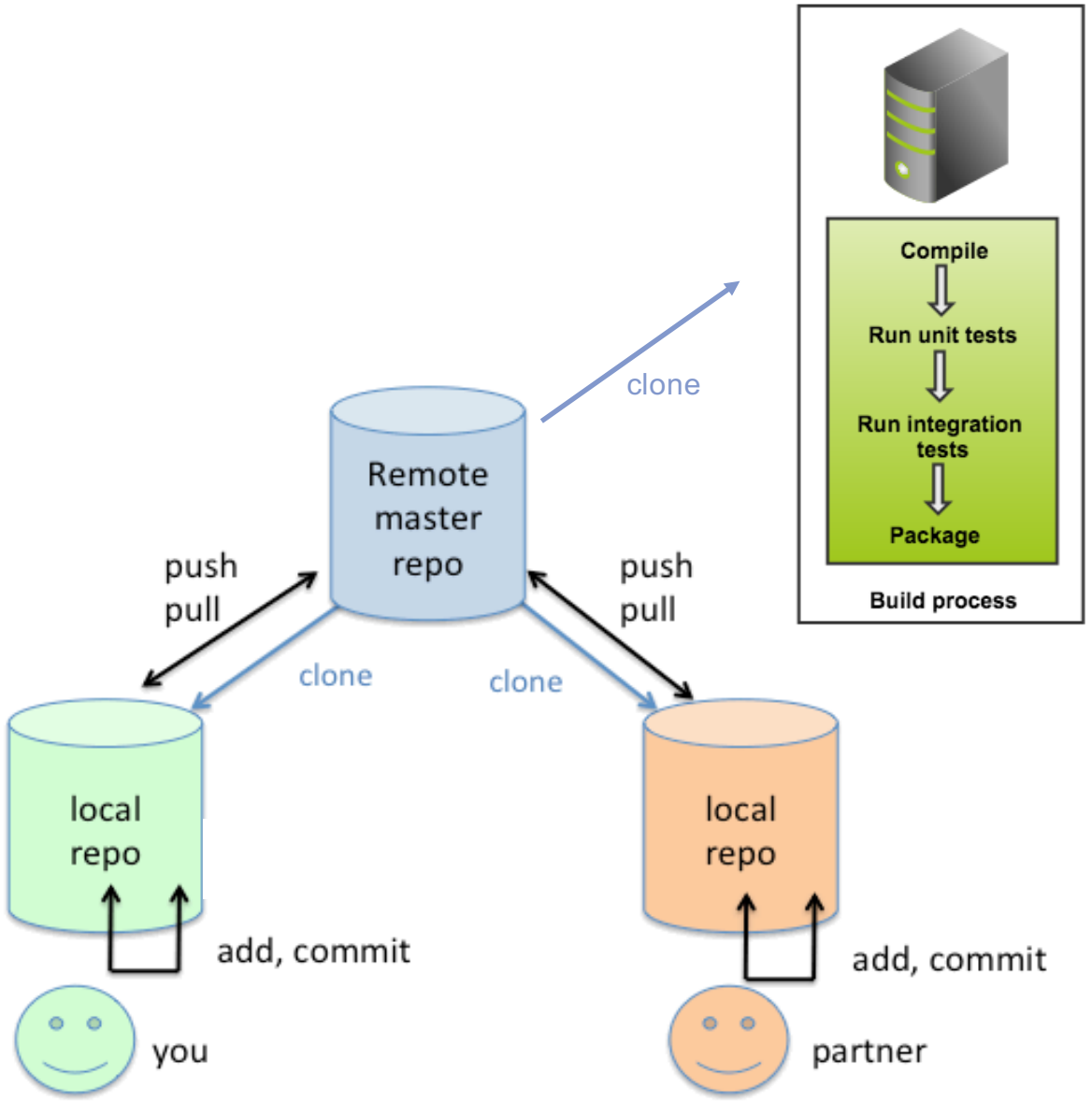
We need a mechanism that constantly checks the functionality of the master "branch".

Continuous Integration

- Sets up a pre-defined environment;
- Clones the remote repository on a server;
- Tries to compile and run all pre-defined tests;
- Reports the outcome;



Continuous Integration on GitLab

- GitLab supports GitLab runners as CI feature.
- They can be configured via adding the file .gitlab-ci.yml

  https://docs.gitlab.com/ee/ci/yaml/

- GitLab runner are set up via web interface.

```
image: ubuntu:14.04

job:
  script:
    - apt-get update
    - apt-get install -y git cmake g++ gcovr
    - git submodule update --init --recursive
    - mkdir build
    - cd build
    - cmake ..
    - make -j
    - gcovr -r ../src/
```

Load image of OS

Update OS

Install packages needed: git cmake g++ gcovr

Create directory

Call CMake

Build library

gcov checks unit test coverage

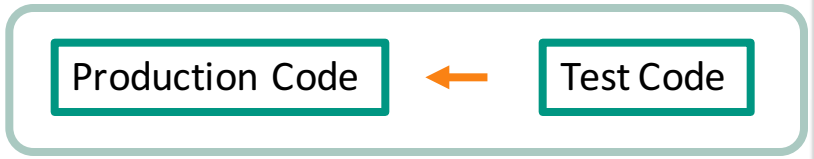
example .gitlab-ci.yml

Hartwig Anzt › hekksagon_test › Pipelines › **#51657453**

passed **Pipeline #51657453** triggered 24 minutes ago by Hartwig Anzt

Software Testing

Automated testing:
The practice of writing code to test the code, and then run those tests in an automated fashion.



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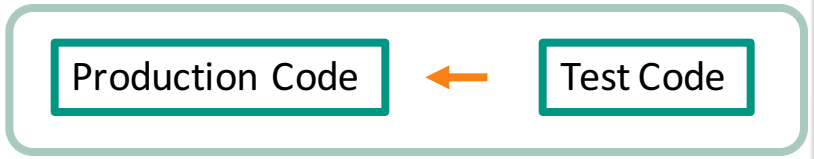

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Unit tests:
Check the functionality and validity of each building block without its external dependencies.

- Track down bugs

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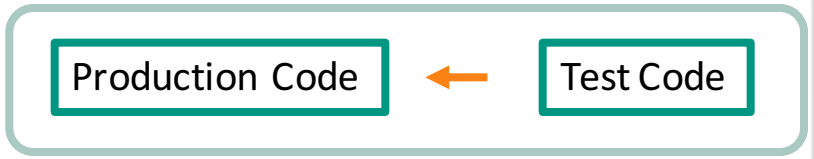

Fewer. Dependencies.

Integration tests:
Check the applications functionality with its external dependencies.
- Give more confidence in complex application.
- Tests units/classes as whole.

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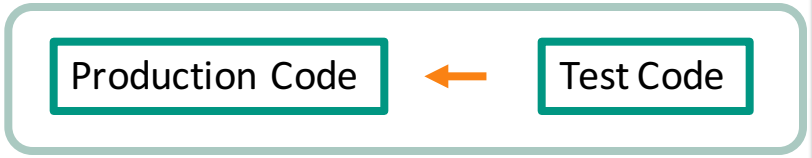

Few. Complex.

End-to-End tests:
Check the applications functionality with its external dependencies and user input.
- Test complete workflow and application interaction.
- Very slow and brittle.

Fewer. Dependencies.

Integration tests:
Check the applications functionality with its external dependencies.
- Give more confidence in complex application.
- Tests units/classes as whole.

Many. Easy-to-write. Execute Fast.

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Check the functionality and validity of each building block without its external dependencies.
- Track down bugs

Unit tests with Googletest

- Framework to facilitate unit testing.
- https://github.com/google/googletest

Let's do an example.

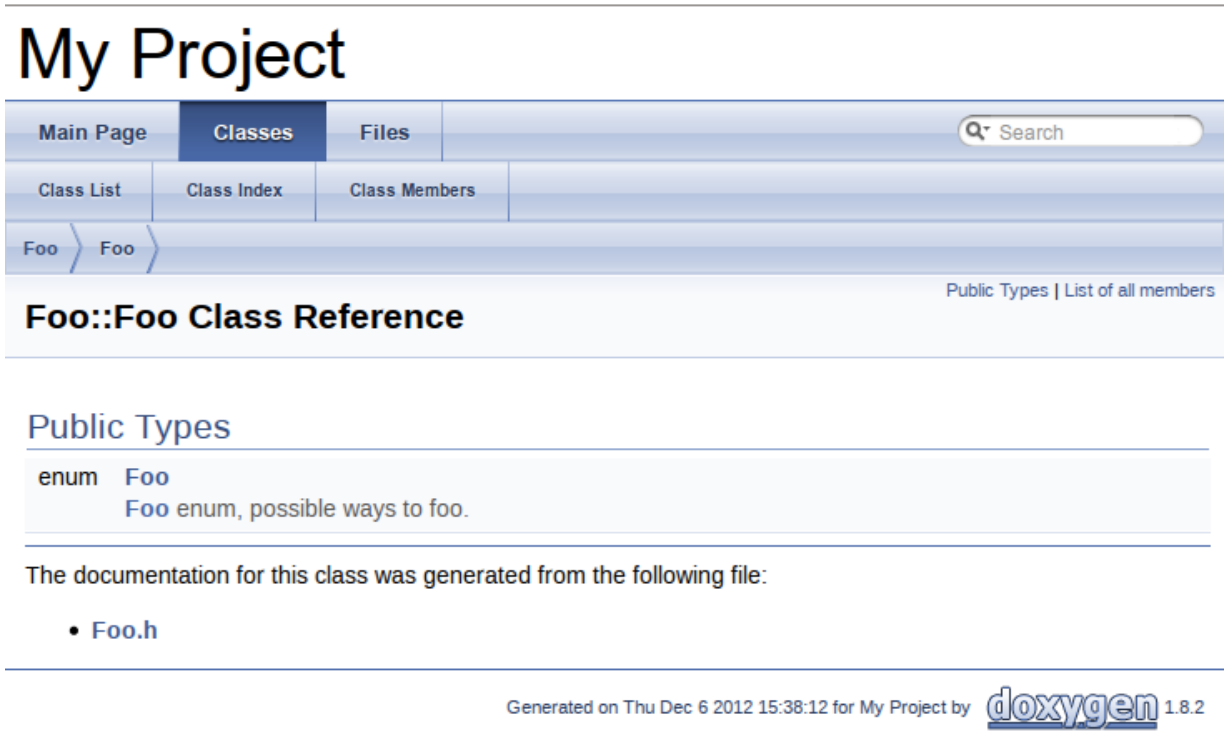
Much of this material is taken from ***Nikolaos Pothitos***
http://cgi.di.uoa.gr/~pothitos/
https://github.com/pothitos/gtest-demo-gitlab

```
[==========] Running 1 test from 1 test case.
[----------] Global test environment set-up.
[----------] 1 test from AddTest
[ RUN      ] AddTest.TwoAndTwo
test2.cc:6: Failure
      Expected: Add(2, 2)
      Which is: 4
To be equal to: 5
[  FAILED  ] AddTest.TwoAndTwo (0 ms)
[----------] 1 test from AddTest (0 ms total)

[----------] Global test environment tear-down
[==========] 1 test from 1 test case ran. (1 ms total)
[  PASSED  ] 0 tests.
[  FAILED  ] 1 test, listed below:
[  FAILED  ] AddTest.TwoAndTwo

 1 FAILED TEST
```

Software Documentation

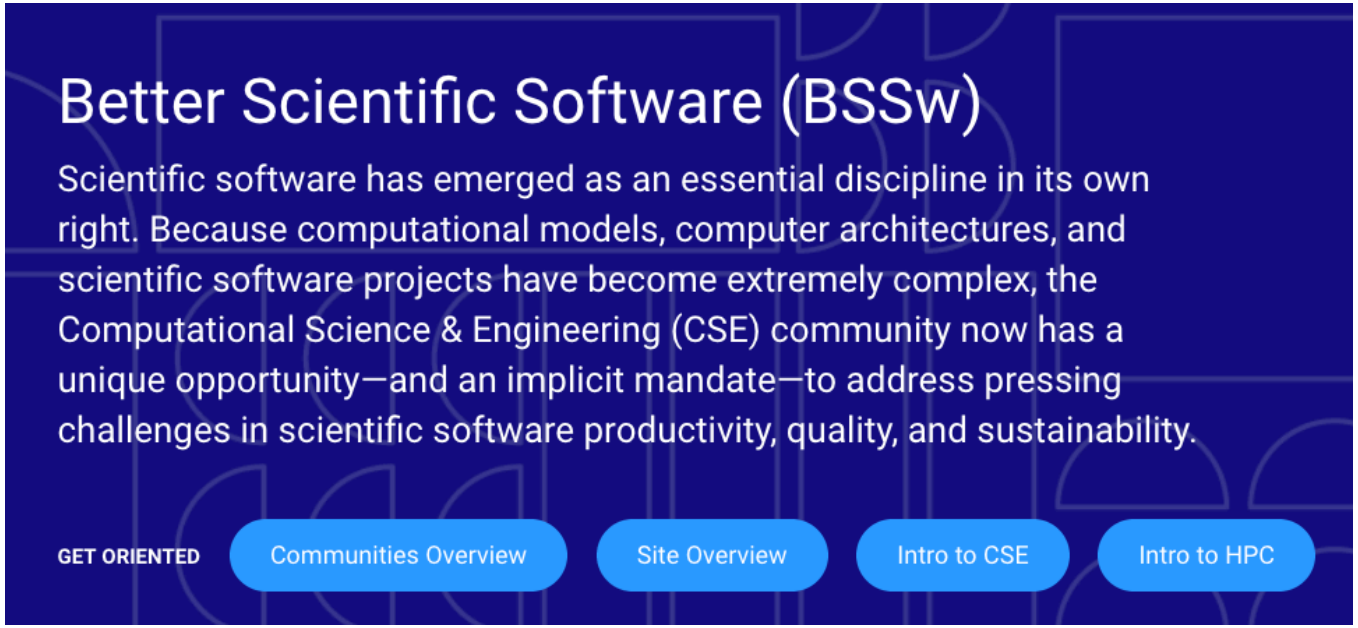
Doxygen is the de facto standard tool for generating documentation from annotated C++ sources, but it also supports other popular programming languages such as C, Objective-C, C#, PHP, Java, Python, IDL (Corba, Microsoft, and UNO/OpenOffice flavors), Fortran, VHDL, Tcl, and to some extent D.

- Automated code documentation tool.
- Converts comments in source code into documentation.
- HTML-oriented.
- http://www.doxygen.nl/
- https://github.com/doxygen/doxygen.git



Example:
https://www.dealii.org/current/doxygen/deal.II/classTorusManifold.html

References & Further Reading



https://bssw.io/

- https://www.git-tower.com/blog/git-cheat-sheet/
- https://github.com/google/googletest
- https://github.com/pothitos/gtest-demo-gitlab
- https://docs.gitlab.com/ee/ci/yaml/
- http://www.doxygen.nl/

These slides are available under: **https://gitlab.com/hanzt/slides/blob/master/SustainableSoftwareDevelopment.pdf**