Karlsruhe Institute of Technology

Version Control with Git

Eileen Kühn, David Kunz, Sarah Müller, Robin Roth

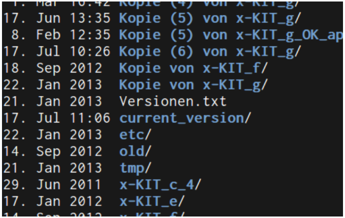
KSETA Doktorandenworkshop, 23.07.2014

Plead guilty!

It’s easy to copy digital content, so why not re-create it over and over again?

Plead guilty!

It’s easy to copy digital content, so why not re-create it over and over again?

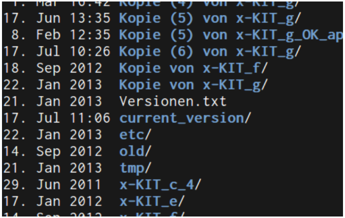


```
 1. Mar 10:42 Kopie (4) von x-KIT_g/
17. Jun 13:35 Kopie (5) von x-KIT_g/
 8. Feb 12:35 Kopie (5) von x-KIT_g_OK_ap
17. Jul 10:26 Kopie (6) von x-KIT_g/
18. Sep 2012  Kopie von x-KIT_f/
22. Jan 2013  Kopie von x-KIT_g/
21. Jan 2013  Versionen.txt
17. Jul 11:06 current_version/
22. Jan 2013  etc/
14. Sep 2012  old/
21. Jan 2013  tmp/
29. Jun 2011  x-KIT_c_4/
17. Jan 2012  x-KIT_e/
14. Sep 2012  x-KIT_f/
```

“One of these folders *must* contain the latest version . . . ”

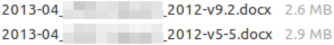
Plead guilty!

It’s easy to copy digital content, so why not re-create it over and over again?



```
 1. Mar 10:42 Kopie (4) von x-KIT_g/
17. Jun 13:35 Kopie (5) von x-KIT_g/
 8. Feb 12:35 Kopie (5) von x-KIT_g_OK_ap
17. Jul 10:26 Kopie (6) von x-KIT_g/
18. Sep 2012  Kopie von x-KIT_f/
22. Jan 2013  Kopie von x-KIT_g/
21. Jan 2013  Versionen.txt
17. Jul 11:06 current_version/
22. Jan 2013  etc/
14. Sep 2012  old/
21. Jan 2013  tmp/
29. Jun 2011  x-KIT_c_4/
17. Jan 2012  x-KIT_e/
14. Sep 2012  x-KIT_f/
```

“One of these folders *must* contain the latest version . . . ”



```
2013-04_[redacted]_2012-v9.2.docx  2.6 MB
2013-04_[redacted]_2012-v5-5.docx  2.9 MB
```

“Here is the latest version of the proposal/paper/report.” — “Thanks.”

Obvious disadvantages

- No meta data about *what* was changed *when* by *whom*
- You lose track of what’s going on
- You cannot easily roll-back to a working state
- Poor solution for collaboration

Version control

- *Track* files
- Record (*commit*) changes
- Share changes with others
- Roll-back to an earlier state
- Implicit backup

Why Git?

Karlsruhe Institute of Technology

- De-facto standard for open source software
- Probably the fastest version control system out there
- GitHub: web based collaboration platform
- Works well both with central and distributed repositories
- Easy to learn

Git Basics

Configuration

- Tell git who you are

```
$ git config --global user.name <name>
$ git config --global user.email <email>
```

- Configure auto correct for git commands

```
$ git config --global help.autocorrect 1
```

- Use colors to show git information

```
$ git config --global color.ui auto
```

Single User Workflow

1. Create a repository and a branch “master”

```
$ git init
```

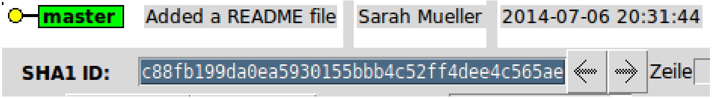
2. Create a commit

   2.1 Add something to the commit

   ```
   $ git add README.txt
   ```

   2.2 Perform the commit

   ```
   $ git commit -m "Added a README file"
   ```



master Added a README file Sarah Mueller 2014-07-06 20:31:44

SHA1 ID: c88fb199da0ea5930155bbb4c52ff4dee4c565ae

Commits

Everytime you make a change, you create a commit containing:

- added/removed lines in files
- a comment summarizing what was changed
- an author
- a date
- a checksum (SHA-hash) to identify the commit
- a reference to the previous state of your files (parent(s))

Single User Workflow

1. Change something, and inspect the difference to the last commit

```
$ vi README.txt
$ git diff
```

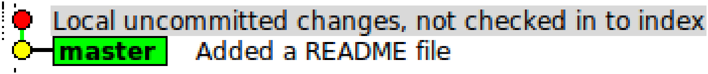
2. Create a commit (as before)

   2.1 Add some changes to the commit

   ```
   $ git add README.txt
   ```

   2.2 Perform the commit

   ```
   $ git commit -m "Added project description"
   ```


Local uncommitted changes, not checked in to index

Added a README file

Single User Workflow

1. Change something, and inspect the difference to the last commit

```
$ vi README.txt
$ git diff
```

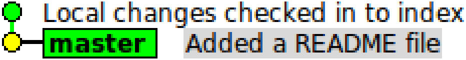
2. Create a commit (as before)

   2.1 Add some changes to the commit

   ```
   $ git add README.txt
   ```

   2.2 Perform the commit

   ```
   $ git commit -m "Added project description"
   ```



Local changes checked in to index but not committed

master Added a README file

Single User Workflow

1. Change something, and inspect the difference to the last commit

```
$ vi README.txt
$ git diff
```

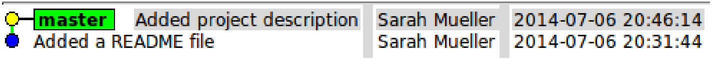
2. Create a commit (as before)

   2.1 Add some changes to the commit

   ```
   $ git add README.txt
   ```

   2.2 Perform the commit

   ```
   $ git commit -m "Added project description"
   ```



```
○─ master  Added project description    Sarah Mueller   2014-07-06 20:46:14
●  Added a README file                  Sarah Mueller   2014-07-06 20:31:44
```

How to commit

- Small logical units
- Several times an hour
- Check the status before committing
- Write descriptive commit messages and keep 50/72 limits

⇒ Allows you to retrace your steps

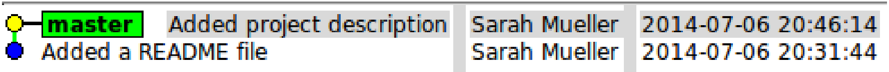
Branching

- Keep master branch free from “questionable” code
  - Working on independent features at the same time
  - Trying incompatible changes
  - Quick and dirty work without changing the master branch
- Cheap, instant and easy
- Create and destroy often
- Integral part of a typical Git workflow

Branching

- Create two branches from master

```
$ git checkout master
$ git checkout -b featureA
$ ...change & commit something
$ git checkout master
$ git checkout -b featureB
$ ...change & commit something
```

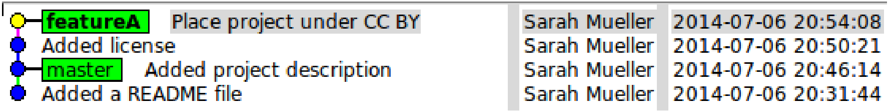


```
master  Added project description   Sarah Mueller   2014-07-06 20:46:14
Added a README file                 Sarah Mueller   2014-07-06 20:31:44
```

Branching

- Create two branches from master

```
$ git checkout master
$ git checkout -b featureA
$ ...change & commit something
$ git checkout master
$ git checkout -b featureB
$ ...change & commit something
```

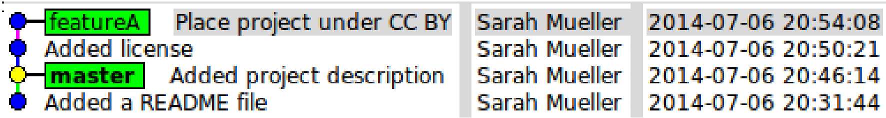


```
featureA  Place project under CC BY   Sarah Mueller  2014-07-06 20:54:08
Added license                         Sarah Mueller  2014-07-06 20:50:21
master  Added project description     Sarah Mueller  2014-07-06 20:46:14
Added a README file                   Sarah Mueller  2014-07-06 20:31:44
```

Branching

- Create two branches from master

```
$ git checkout master
$ git checkout -b featureA
$ ...change & commit something
$ git checkout master
$ git checkout -b featureB
$ ...change & commit something
```

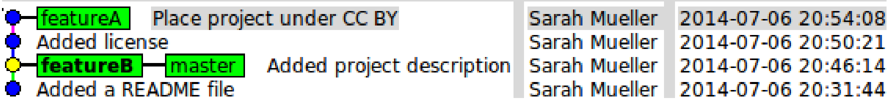


featureA Place project under CC BY	Sarah Mueller	2014-07-06 20:54:08
Added license	Sarah Mueller	2014-07-06 20:50:21
master Added project description	Sarah Mueller	2014-07-06 20:46:14
Added a README file	Sarah Mueller	2014-07-06 20:31:44

Branching

- Create two branches from master

```
$ git checkout master
$ git checkout -b featureA
$ ...change & commit something
$ git checkout master
$ git checkout -b featureB
$ ...change & commit something
```

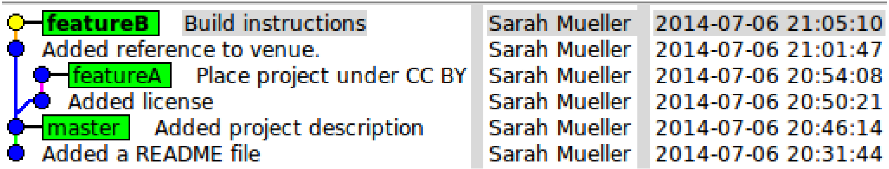


```
featureA  Place project under CC BY                     Sarah Mueller  2014-07-06 20:54:08
Added license                                           Sarah Mueller  2014-07-06 20:50:21
featureB  master  Added project description            Sarah Mueller  2014-07-06 20:46:14
Added a README file                                     Sarah Mueller  2014-07-06 20:31:44
```

Branching

- Create two branches from master

```
$ git checkout master
$ git checkout -b featureA
$ ...change & commit something
$ git checkout master
$ git checkout -b featureB
$ ...change & commit something
```



```
featureB  Build instructions              Sarah Mueller  2014-07-06 21:05:10
Added reference to venue.                 Sarah Mueller  2014-07-06 21:01:47
  featureA  Place project under CC BY     Sarah Mueller  2014-07-06 20:54:08
  Added license                           Sarah Mueller  2014-07-06 20:50:21
master  Added project description         Sarah Mueller  2014-07-06 20:46:14
Added a README file                       Sarah Mueller  2014-07-06 20:31:44
```

Branching

- Switch back to master branch

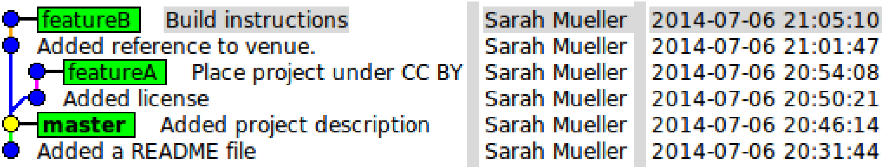
```
$ git checkout master
```

- Merge your changes into master

```
$ git merge featureA # fast forward
$ git merge --no-ff featureA #
$ git merge featureB # merge
```

- Delete merged branches

```
$ git branch -d featureA featureB
```



```
featureB Build instructions              Sarah Mueller  2014-07-06 21:05:10
Added reference to venue.                Sarah Mueller  2014-07-06 21:01:47
  featureA Place project under CC BY     Sarah Mueller  2014-07-06 20:54:08
  Added license                          Sarah Mueller  2014-07-06 20:50:21
master Added project description         Sarah Mueller  2014-07-06 20:46:14
Added a README file                      Sarah Mueller  2014-07-06 20:31:44
```

Branching

- Switch back to master branch

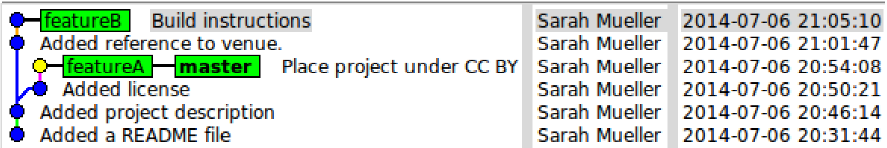
```
$ git checkout master
```

- Merge your changes into master

```
$ git merge featureA # fast forward
$ git merge --no-ff featureA #
$ git merge featureB # merge
```

- Delete merged branches

```
$ git branch -d featureA featureB
```


```
featureB  Build instructions                    Sarah Mueller   2014-07-06 21:05:10
Added reference to venue.                       Sarah Mueller   2014-07-06 21:01:47
  featureA  master  Place project under CC BY   Sarah Mueller   2014-07-06 20:54:08
  Added license                                 Sarah Mueller   2014-07-06 20:50:21
Added project description                       Sarah Mueller   2014-07-06 20:46:14
Added a README file                             Sarah Mueller   2014-07-06 20:31:44
```

Branching

- Switch back to master branch

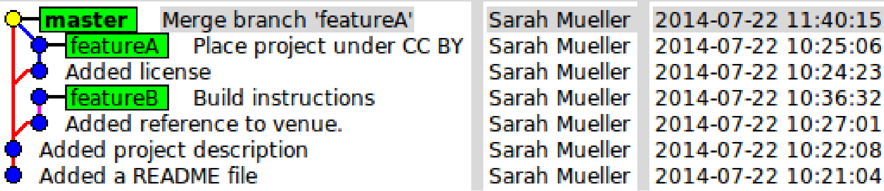
```
$ git checkout master
```

- Merge your changes into master

```
$ git merge featureA # fast forward
$ git merge --no-ff featureA #
$ git merge featureB # merge
```

- Delete merged branches

```
$ git branch -d featureA featureB
```



master Merge branch 'featureA'	Sarah Mueller	2014-07-22 11:40:15
featureA Place project under CC BY	Sarah Mueller	2014-07-22 10:25:06
Added license	Sarah Mueller	2014-07-22 10:24:23
featureB Build instructions	Sarah Mueller	2014-07-22 10:36:32
Added reference to venue.	Sarah Mueller	2014-07-22 10:27:01
Added project description	Sarah Mueller	2014-07-22 10:22:08
Added a README file	Sarah Mueller	2014-07-22 10:21:04

Branching

- Switch back to master branch

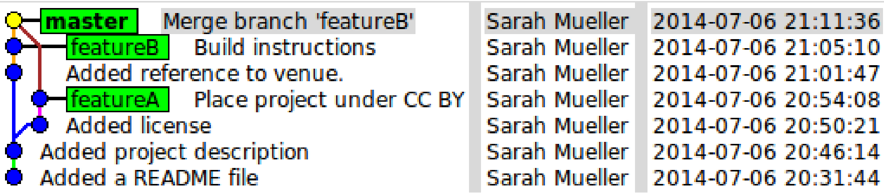
```
$ git checkout master
```

- Merge your changes into master

```
$ git merge featureA # fast forward
$ git merge --no-ff featureA #
$ git merge featureB # merge
```

- Delete merged branches

```
$ git branch -d featureA featureB
```



```
master    Merge branch 'featureB'       Sarah Mueller   2014-07-06 21:11:36
featureB     Build instructions         Sarah Mueller   2014-07-06 21:05:10
          Added reference to venue.     Sarah Mueller   2014-07-06 21:01:47
featureA     Place project under CC BY  Sarah Mueller   2014-07-06 20:54:08
          Added license                 Sarah Mueller   2014-07-06 20:50:21
        Added project description       Sarah Mueller   2014-07-06 20:46:14
        Added a README file             Sarah Mueller   2014-07-06 20:31:44
```

Branching

- Switch back to master branch

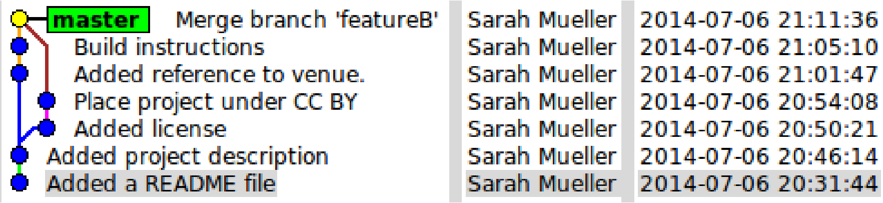
```
$ git checkout master
```

- Merge your changes into master

```
$ git merge featureA # fast forward
$ git merge --no-ff featureA #
$ git merge featureB # merge
```

- Delete merged branches

```
$ git branch -d featureA featureB
```



master Merge branch 'featureB'	Sarah Mueller	2014-07-06 21:11:36
Build instructions	Sarah Mueller	2014-07-06 21:05:10
Added reference to venue.	Sarah Mueller	2014-07-06 21:01:47
Place project under CC BY	Sarah Mueller	2014-07-06 20:54:08
Added license	Sarah Mueller	2014-07-06 20:50:21
Added project description	Sarah Mueller	2014-07-06 20:46:14
Added a README file	Sarah Mueller	2014-07-06 20:31:44

Retracing Your Steps

1. Check the log

```
$ git log # copy the SHA-key
```

2. Show changes to current version

```
$ git diff <paste SHA key>
```

3. Check out old version

```
$ git checkout <paste SHA key>
```

Collaboration

Group Exercises

- Clone a repository, possible protocols: https, ssh, git, file, . . .

```
$ git clone https://github.com/ksetagit/groupproject.git
```

- Copies the complete history of all branches to your disk
- Stores the cloning source as the *remote* “origin”

```
$ git remote show
$ git remote show origin
```

- . . . now work as described before

Incorporate Changes of Collaborators

1. Fetch what others have done

   ```
   $ git fetch
   ```

   Downloads all commits and labels (e.g. “origin/master”) from the server, but leaves local labels unchanged.
2. Decide what to do:
   - Fast-forward your branch if you did not make changes
   - Merge a remote branch into your branch
   - Rebase your branch on top of a remote branch
   - Cherry-pick a commit from a different branch

Merge Other Branch Into Yours

- Trivial merge: fast-forward
- Non-trivial: creates new commit which includes both changes

```
$ git merge origin/master
```

- Almost always works, but may result in *conflicts* if same lines changed in both branch heads
- Note that you can also do

```
$ git pull
```

which is the same as a *fetch* and a consecutive *merge*

Distributing Your Changes

- Upload changes in your branch “featureA” to origin

```
$ git push origin featureA
```

- Does not work if featureA is changed on origin, in this case fetch and merge first
- Does not work if you deleted commits which were on origin, in this case force the update (be careful!):

```
$ git push -f origin featureA
```

Group Tasks

- `https://github.com/ksetagit/groupproject.git`
- Group tasks in Readme.md

If Something Goes Wrong

Things go wrong if changes conflict. You can then:

1. Fix the conflicts, then

```
$ git add <changed files>
$ git merge --continue
```

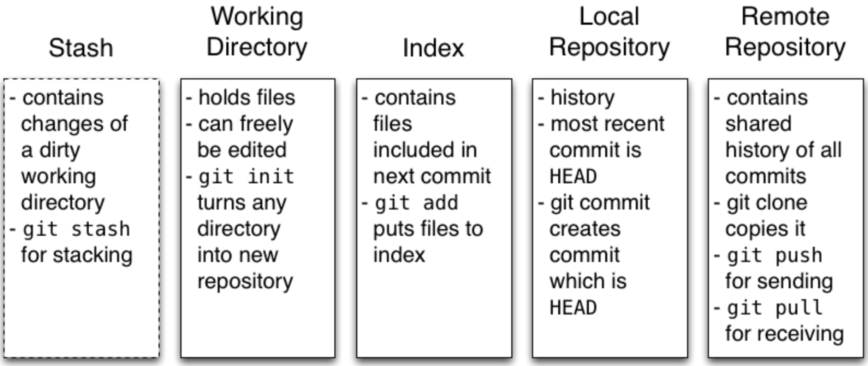
2. Stop the operation

```
$ git merge --abort
```

3. Undo broken merges:

```
$ git reflog
$ git checkout HEAD@{1}
```

How it works



Stash

- contains changes of a dirty working directory
- `git stash` for stacking

Working Directory

- holds files
- can freely be edited
- `git init` turns any directory into new repository

Index

- contains files included in next commit
- `git add` puts files to index

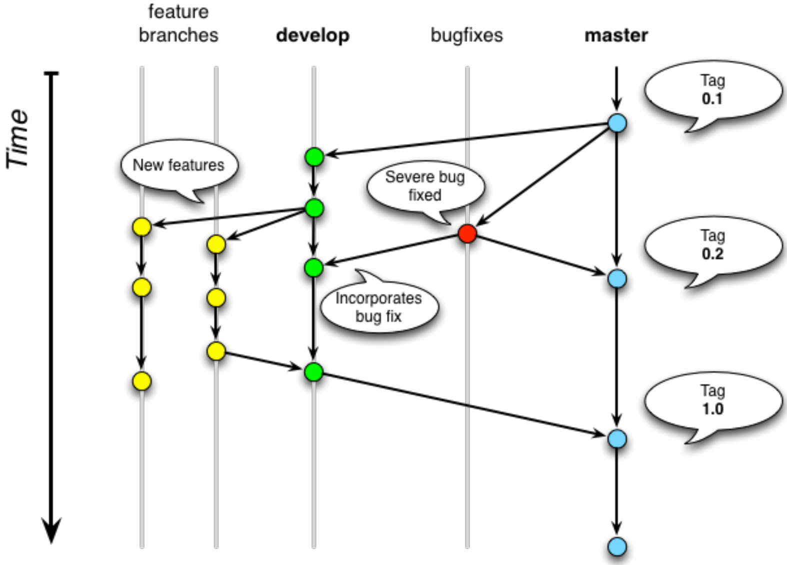
Local Repository

- history
- most recent commit is HEAD
- git commit creates commit which is HEAD

Remote Repository

- contains shared history of all commits
- git clone copies it
- `git push` for sending
- `git pull` for receiving

Best Practice Workflow

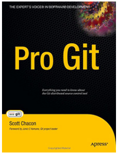


Best Practice

- Do commit early and often
- Do not panic (as long as you commited [or even added] your work)
- Do not change published history (reset/rebase can be evil)
- Do divide your work into different repositories
- Do useful commit messages
- Do keep up to date

Further reads

- `$ man git`
- Free Pro Git book at `http://git-scm.com/book`
- Different aspects from beginners to pros: `http://gitready.com`
- Git cheat sheet: `http://www.cheat-sheets.org/saved-copy/git-cheat-sheet.pdf`
- Interactive git tutorial: `https://try.github.io`
- Get these slides from: `http://github.com/ksetagit/kseta-dvcs-talk`



Advanced Git Operations

Stashing Your Work

- Get rid of uncommitted changes temporarily

```
$ git stash
```

- Resets your working copy to the last committed version C
- Creates a “stash commit” whose parent is C
- Puts the stash commit on a stack
- Top-most stash commit can be applied again using

```
$ git stash pop
```

Rebase Your Branch on Other Branch

- Most complex operation in git:

```
$ git rebase origin/master
```

- Detach a commit from its parent and attach it to another commit
- Pre-condition is that changes can be applied to new parent
- Pro: Does not result in a merge-commit
- Contra: May create cascades of conflicts during rebase

Cherry-Picking

- Take a commit from another branch and apply it to yours as well

```
$ git cherry-pick <SHA>
```

- Pre-condition is that you did not change same lines
- Git keeps track of commits by SHA and can ignore double commits

Other Interesting Commands

Append some changes to the last commit (use only if not pushed):

```
$ git commit --amend
```

Select only some of the changes to a file for a commit:

```
$ git add --patch/-p
```

Graphical tool to select changes to include in a commit:

```
$ git gui
```

Rewrite the history: reorder commits, combine them, . . . :

```
$ git rebase -i
```