Universität Stuttgart

J. Valentin
F. Lindner

IPVS

SGS

SimTech
Cluster of Excellence

The Gist of Git – A Git Overview Pointlessly Littered with Memes

Numerische Simulation

Nov 2, 2016


ONE DOES NOT SIMPLY
LEARN GIT
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About Commits

Workspace, Staging Area, Repository

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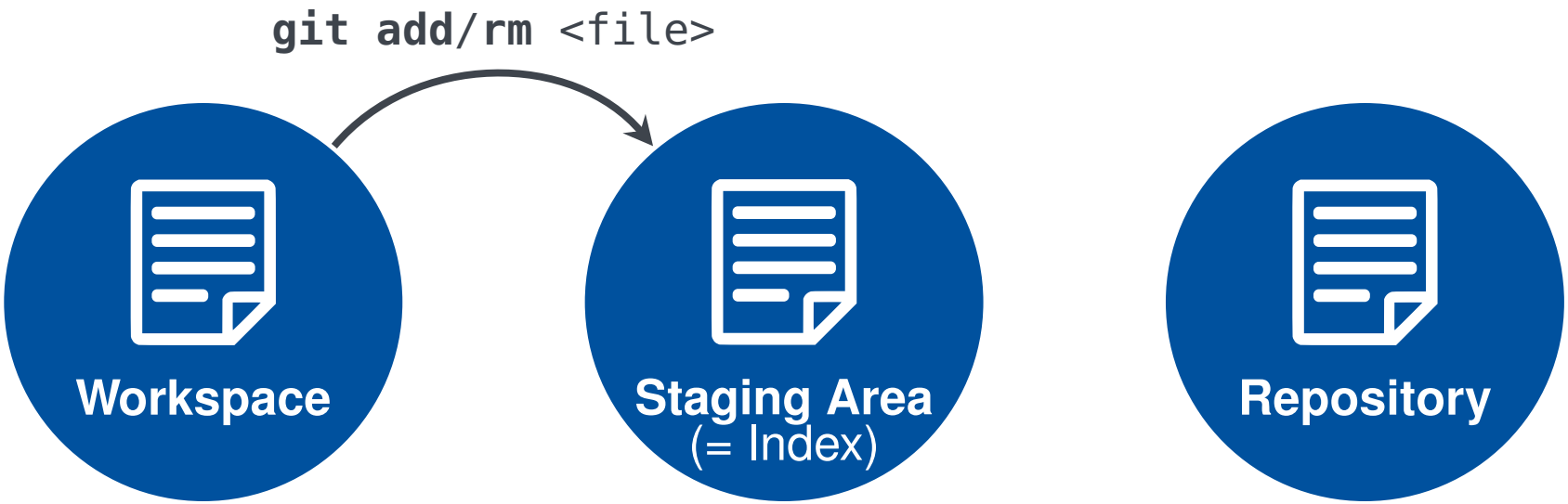

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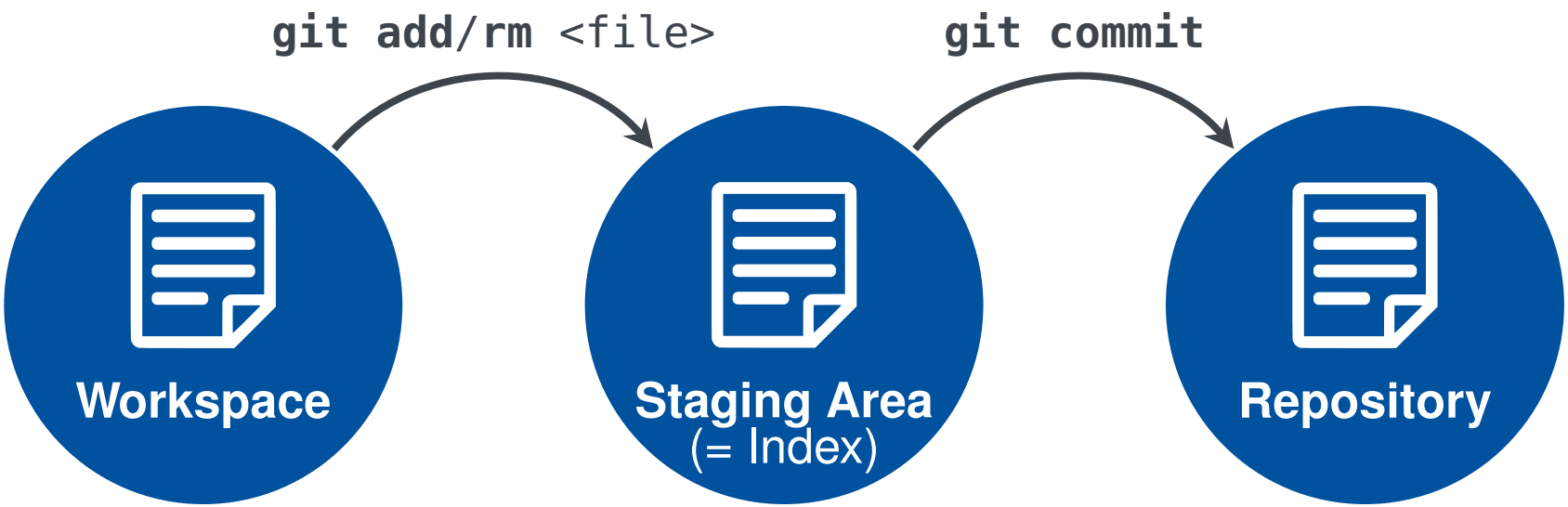

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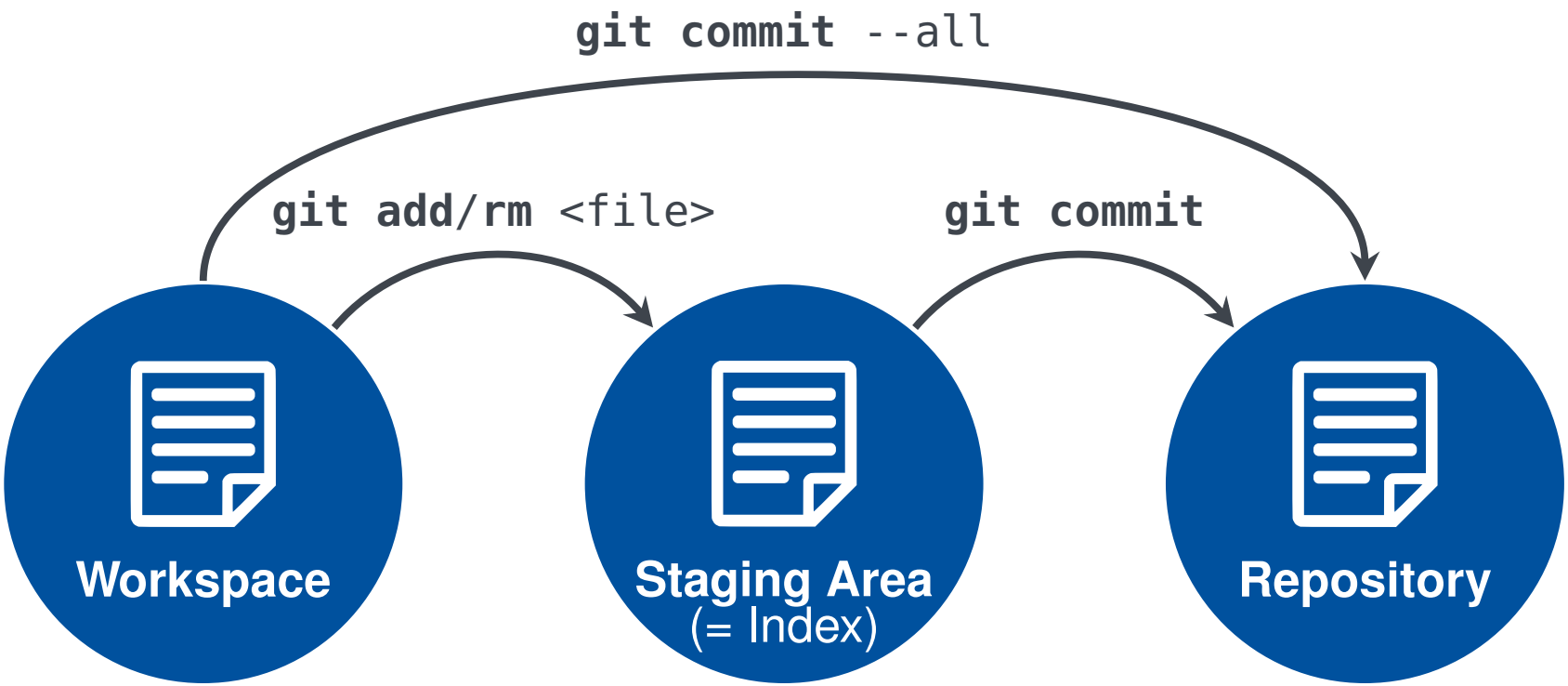

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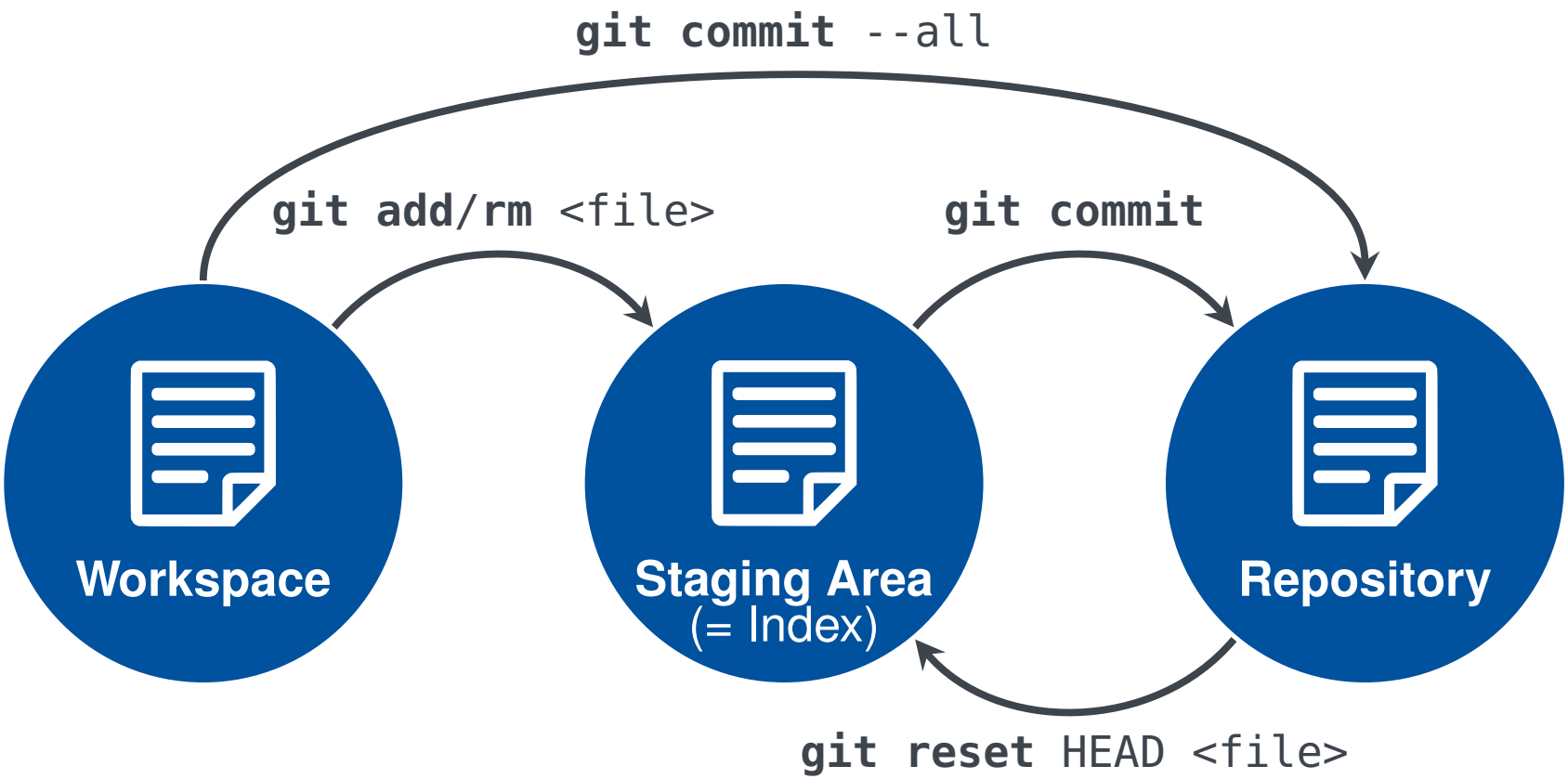

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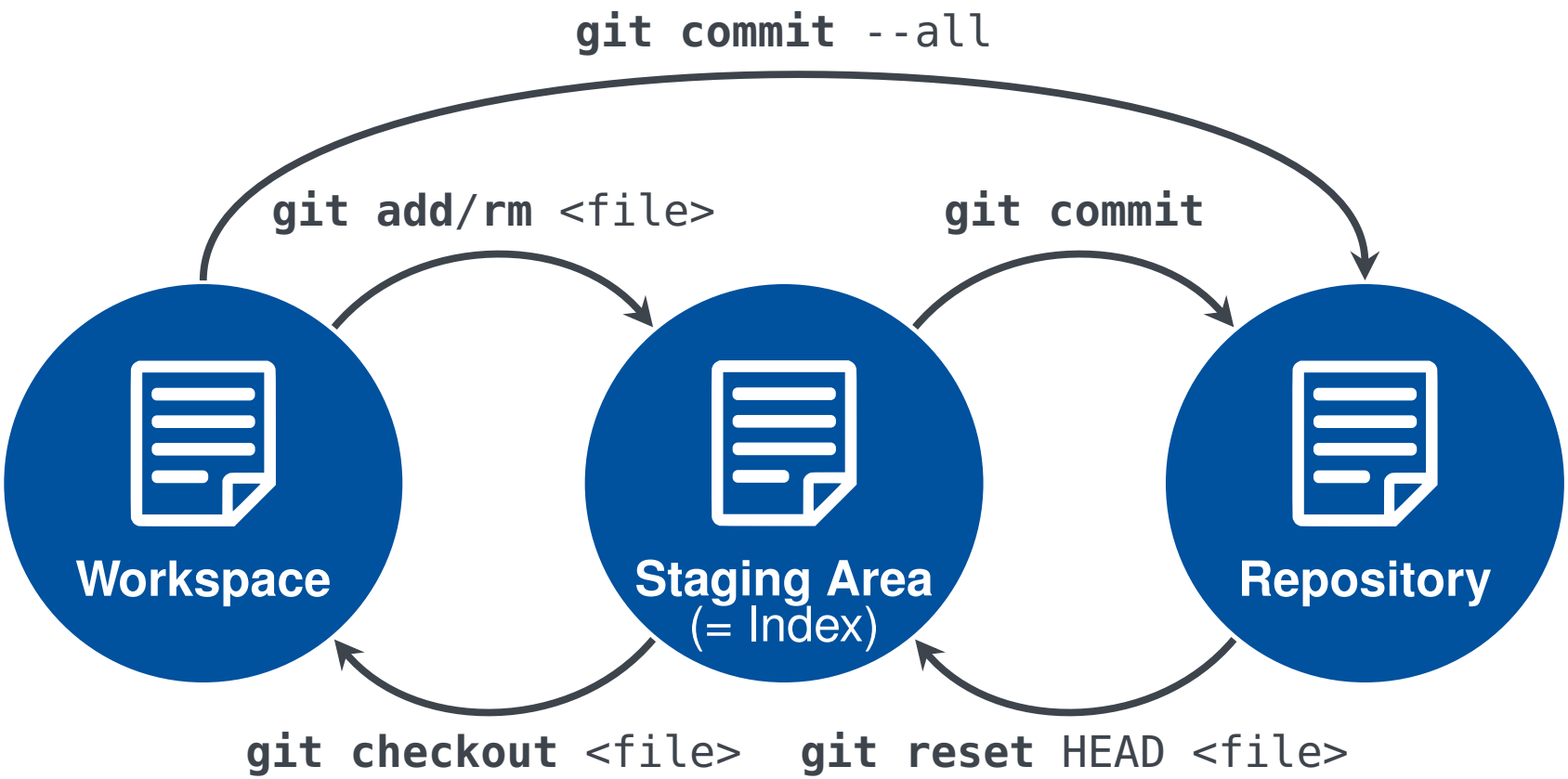

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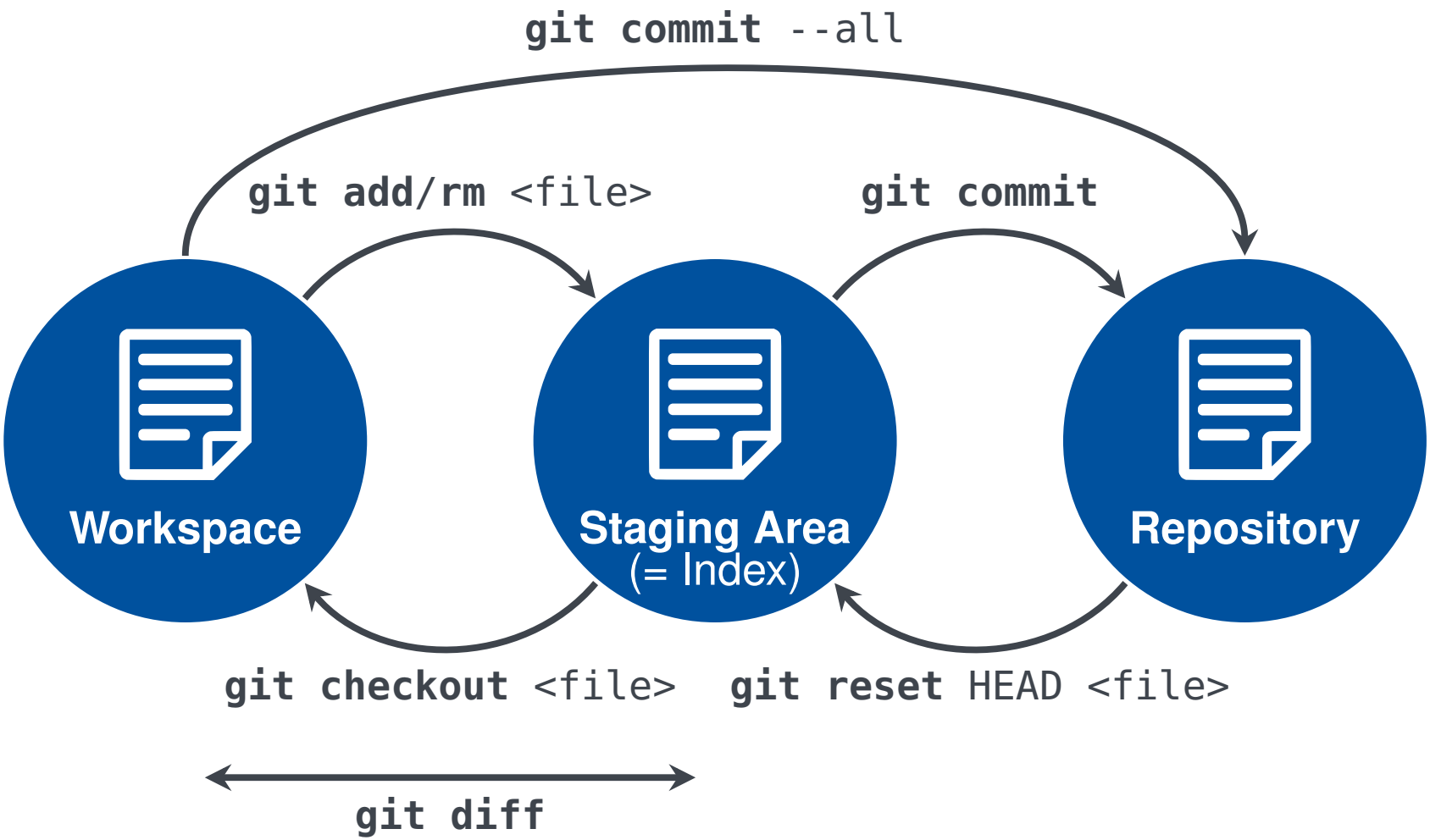

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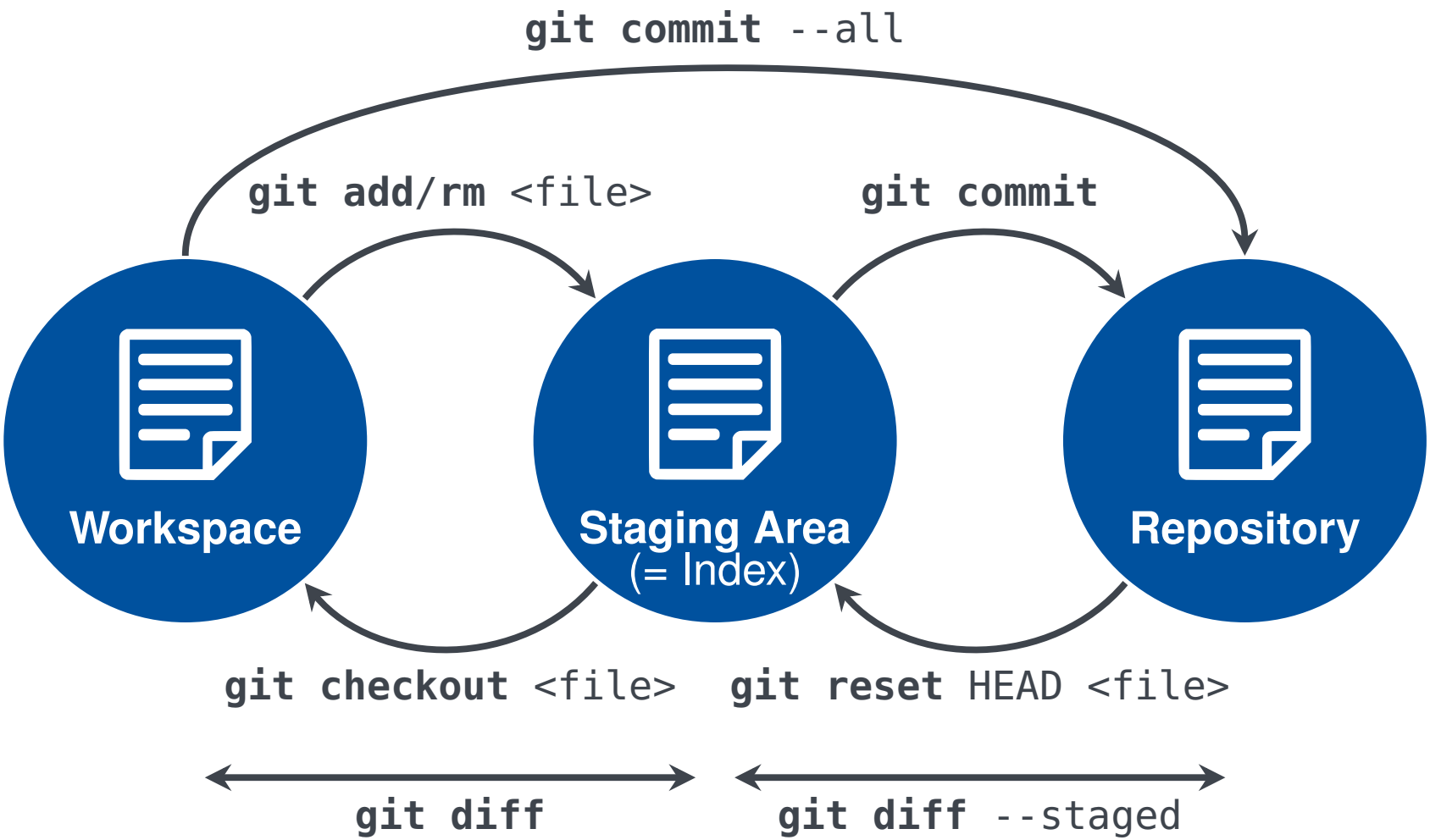

Status of Workspace and Staging Area

`git status`: Show status of workspace and staging area

- *Changes to be committed:*
  Change is in workspace and staging area
- *Changes not staged for commit:*
  Change is in workspace, but not in staging area
- *Untracked files:*
  New file is in workspace, but not in staging area

Interactive Add

- **`git add --interactive`:** Change staging area interactively
  - `update`: Add changes of a file to staging area
  - `revert`: Remove changes of a file from staging area
  - `patch`: Add individual hunks to staging area (choose which changed lines of a file to add)

```
$ git add --interactive
           staged     unstaged path
1:          +0/-1      nothing TODO
2:          +1/-1      nothing index.html
3:    unchanged         +5/-1 lib/simplegit.rb

*** Commands ***
1: status     2: update      3: revert     4: add untracked
5: patch      6: diff        7: quit       8: help
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```

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How to Write Good Commit Messages

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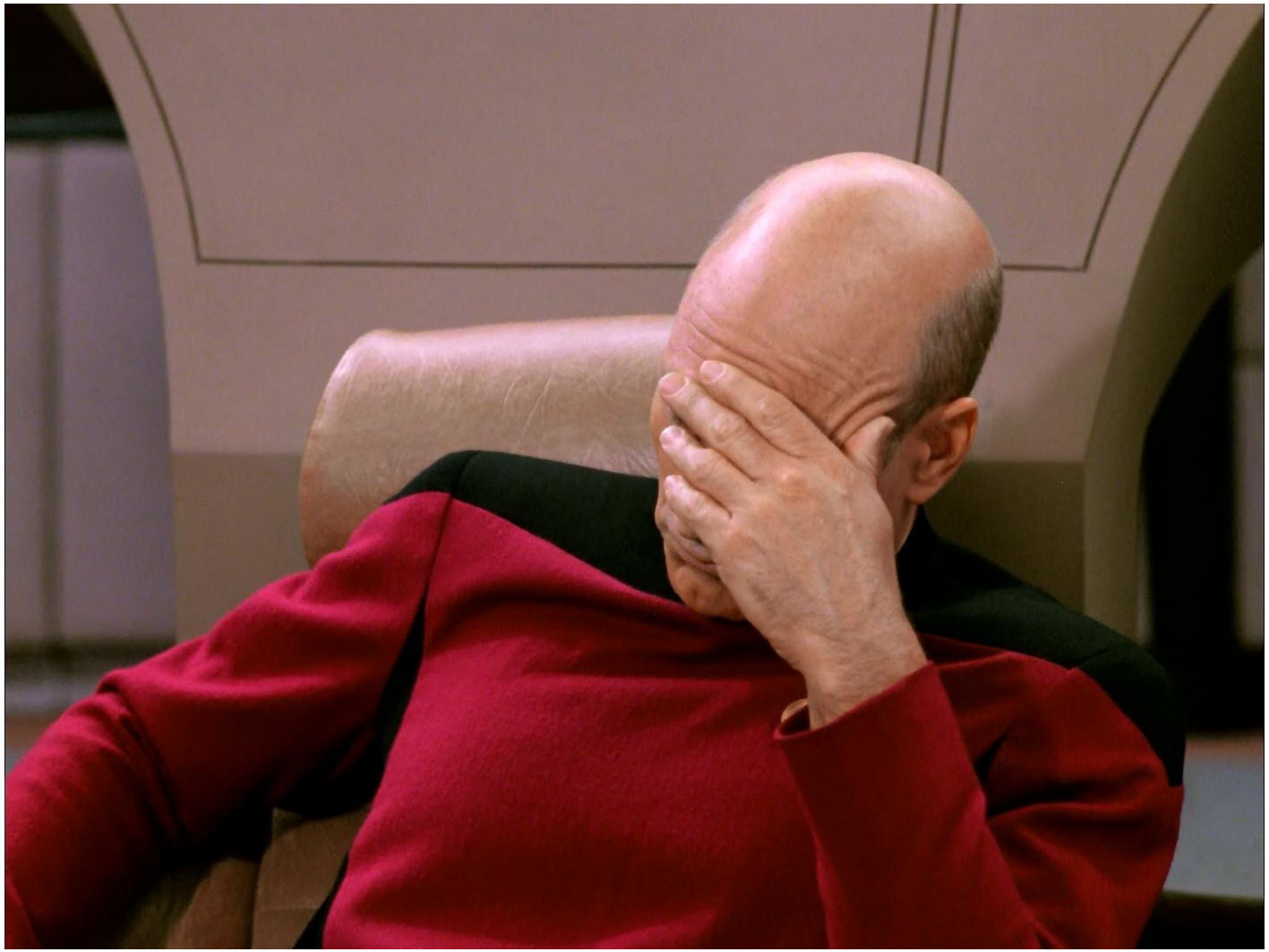
How to Write Good Commit Messages



How to Write Good Commit Messages

Seven rules for a good commit message
(from `http://chris.beams.io/posts/git-commit/`):

```
Summarize changes in 50 characters or less

Separate subject from body with a blank line. Capitalize the
subject line. Don't end the subject line with a period. Use the
imperative mood in the subject line. Wrap the body at 72
characters. Use the body to explain what and why vs. how.
```

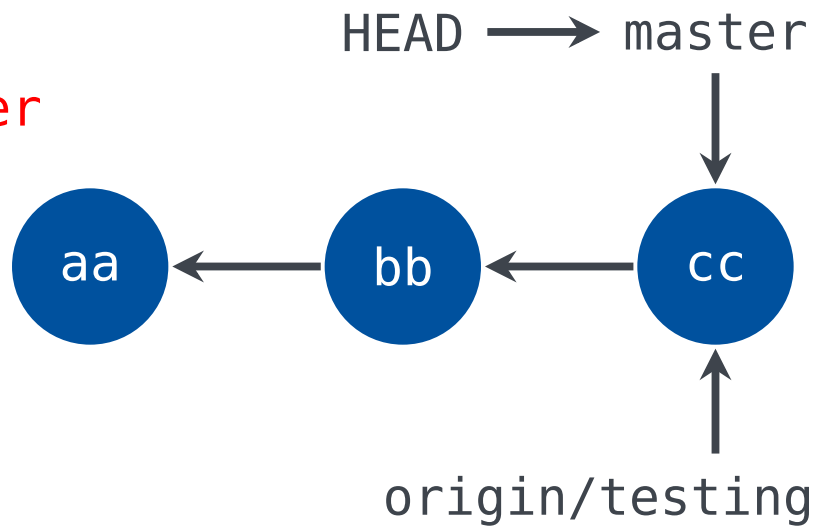
All Things Branches


WHAT IF I TOLD YOU
GIT BRANCHES ARE JUST NAMED COMMITS
imgflip.com

Branching

- Every commit knows its parent(s)
- **Branch:** pointer to a commit
- **`HEAD`:** pointer to a branch (or to a commit, “detached `HEAD`”), branch is automatically moved forward on committing, change branch with **`git checkout`** `<branch>`

```
git checkout master
git commit
git fetch
```



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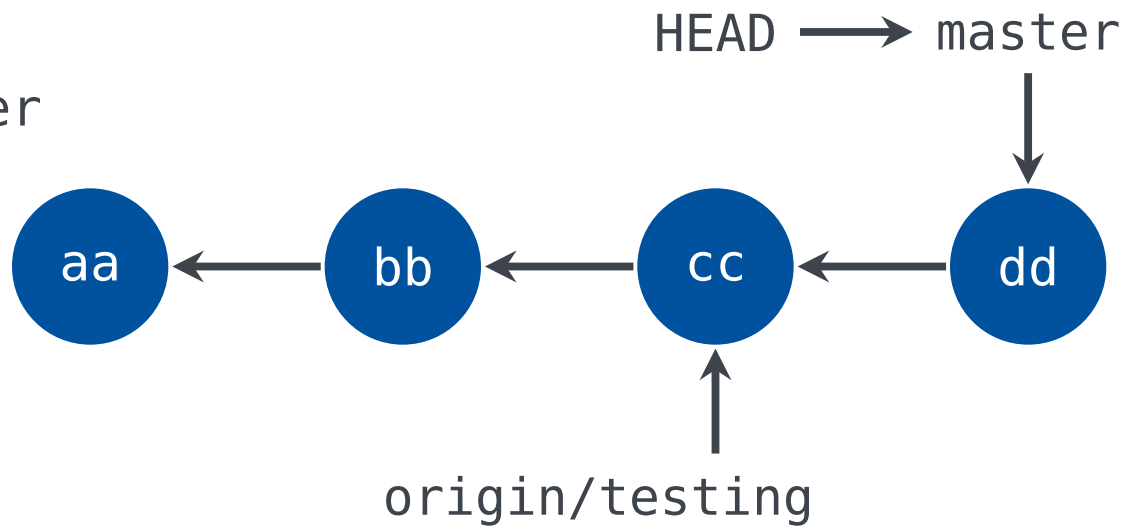

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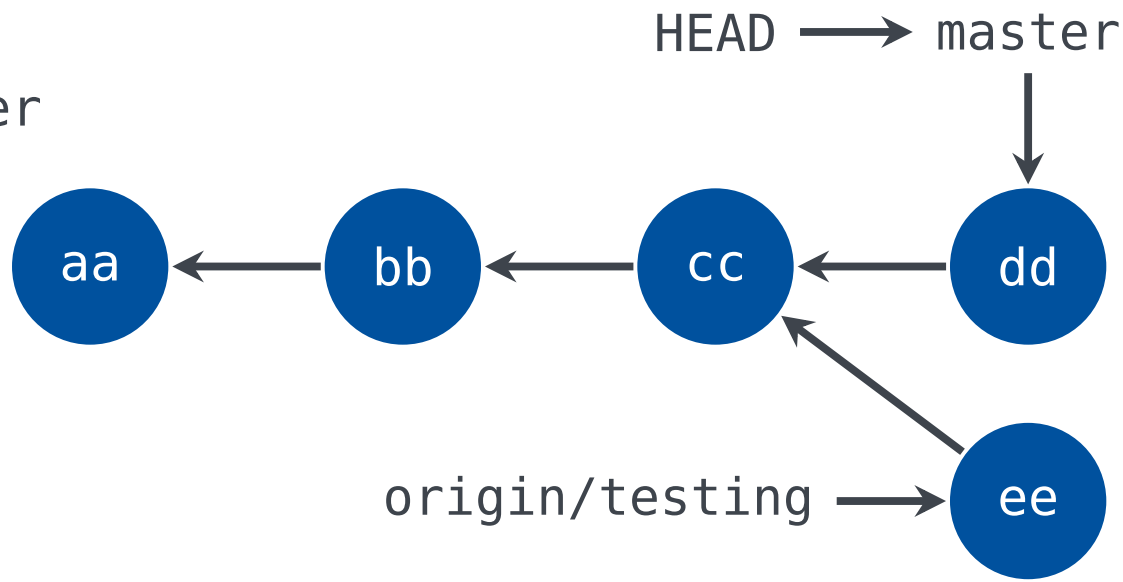
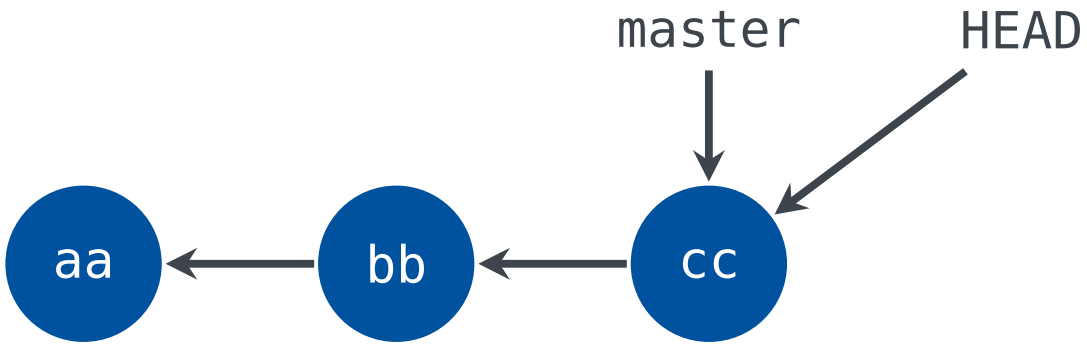


Detached HEAD

- **Detached HEAD:** HEAD points to a commit instead of a branch

```
git checkout cc
git commit
git checkout master
git commit
```



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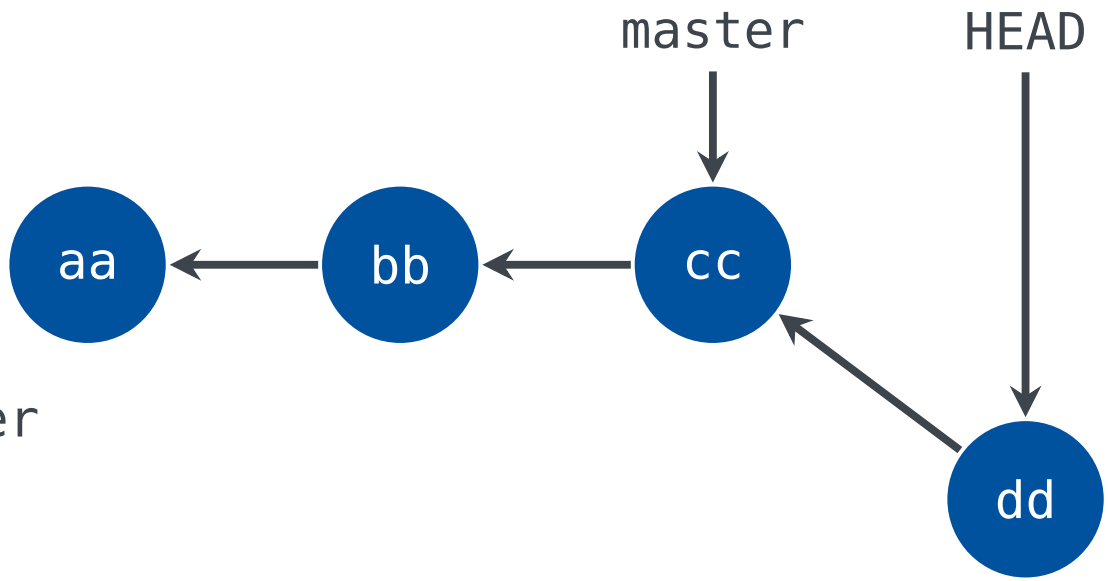

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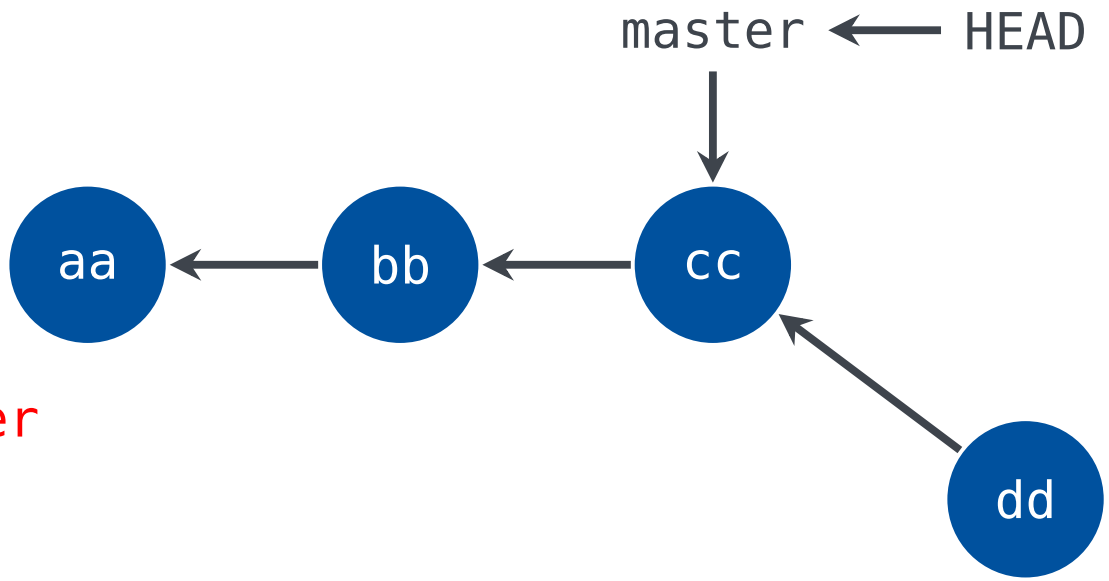

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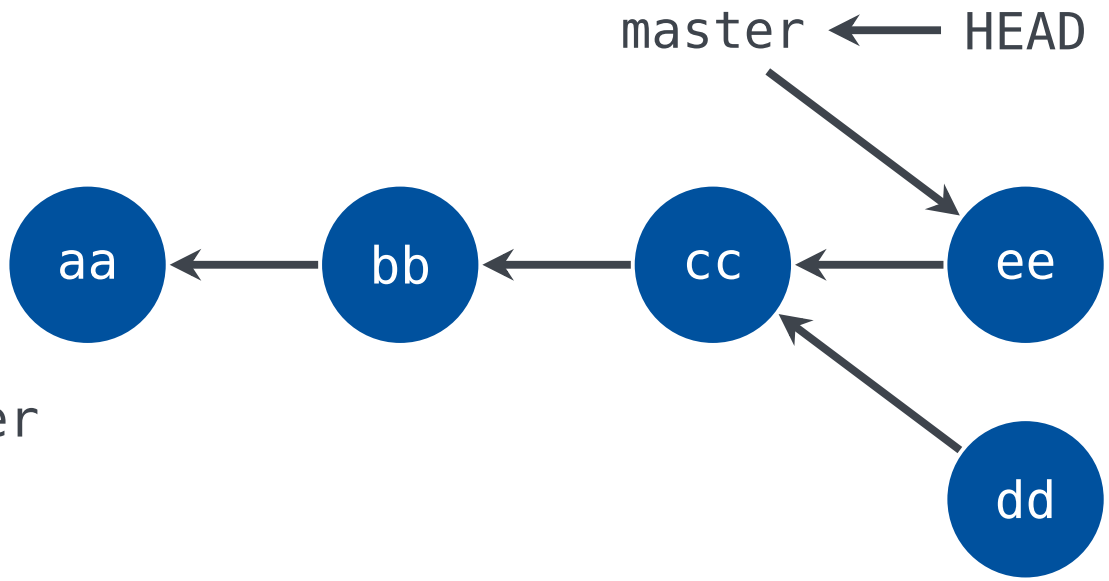

Branching

- List branches with **`git branch --list -avv`**

```
  master                  fc7f1ed [origin/master] Merge sgopt in...
  peter_schober           89341d4 Add safety check in SubspaceRe...
* sgopt                   f8b42cf [origin/sgopt] Evaluate functi...
  remotes/origin/master   fc7f1ed Merge sgopt into master
  remotes/origin/sgopt    f8b42cf Evaluate function in Operation...
```

- Terminology:
  - **(Local) branch:** Branch in your repo
  - **Remote branch:** Branch in someone else's repo
  - **Remote-tracking branch:** Special local branch indicating remote branch on last **`fetch`**, can't be checked out
  - **Upstream branch:** link between a local and a remote-tracking branch, used for **`pull`**/**`push`**

Merging

- Different types of merging:
  - **Fast-forward merge:** Move branch to descendant commit
  - **Merge commit:** Create commit with two (or more) parents
  - **Rebasing:** Apply one parent patch after another
- Two cases:
  1. One commit is ancestor of the other

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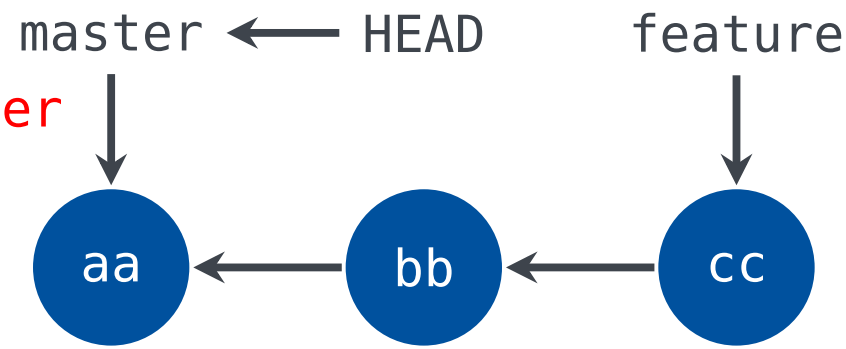

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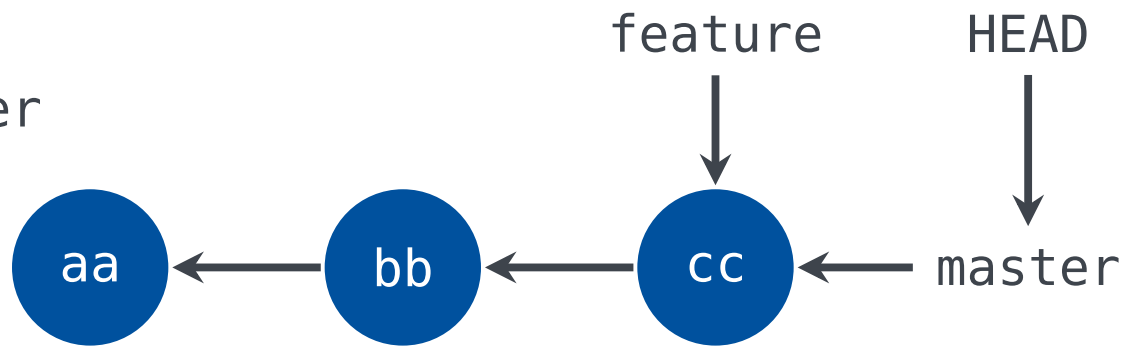

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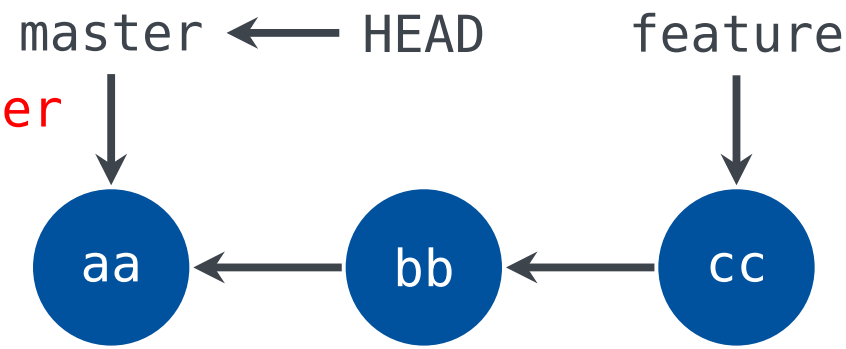

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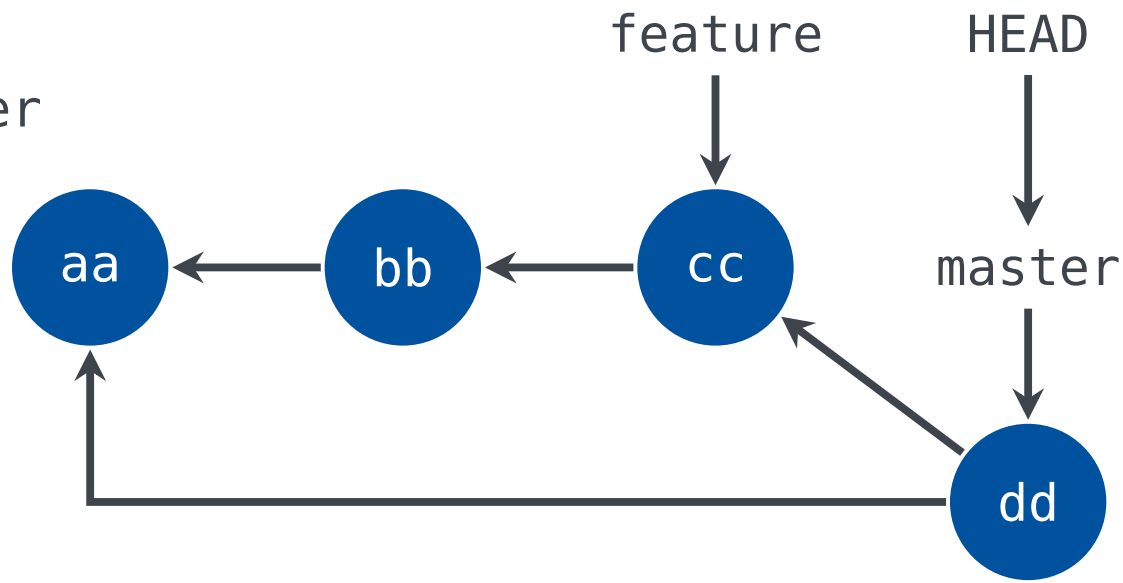

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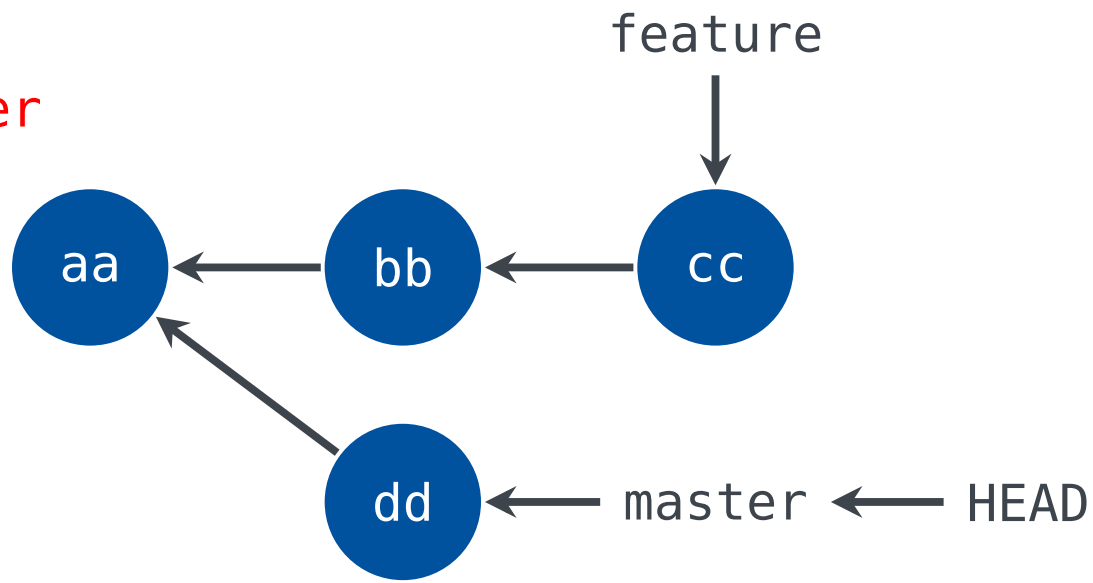

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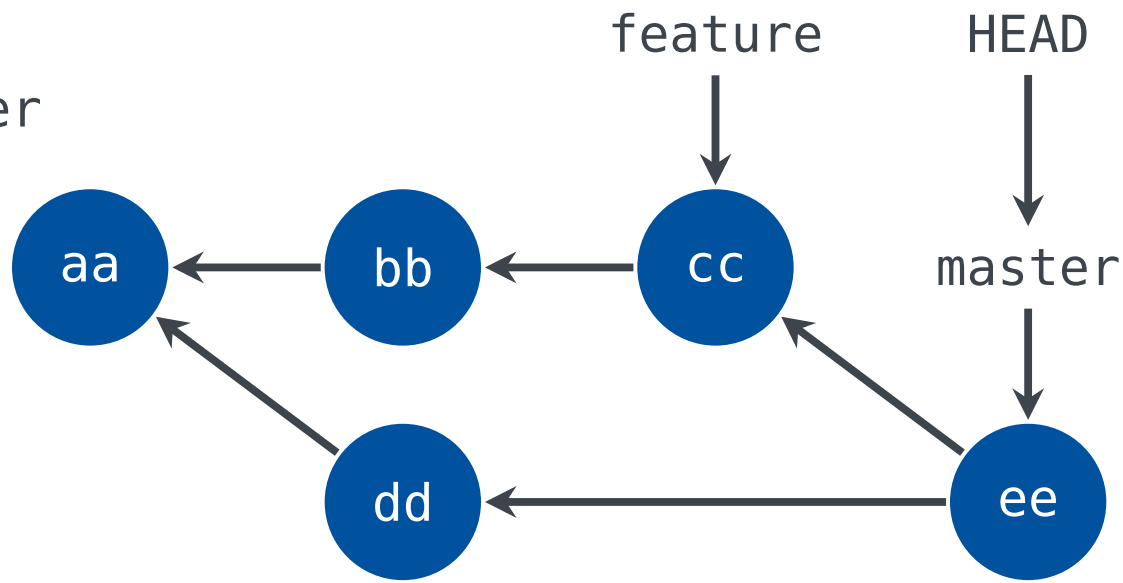

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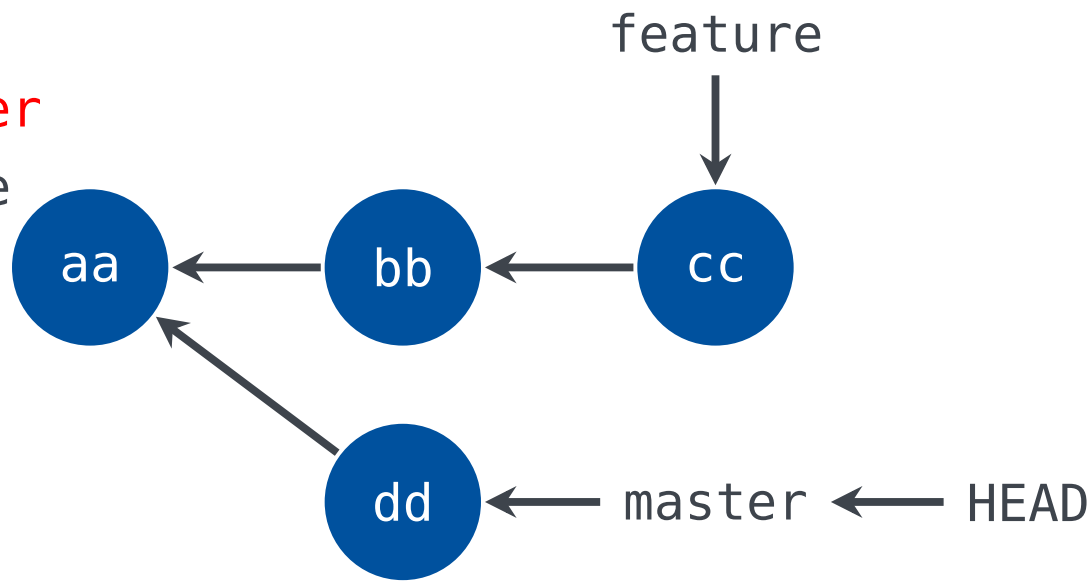

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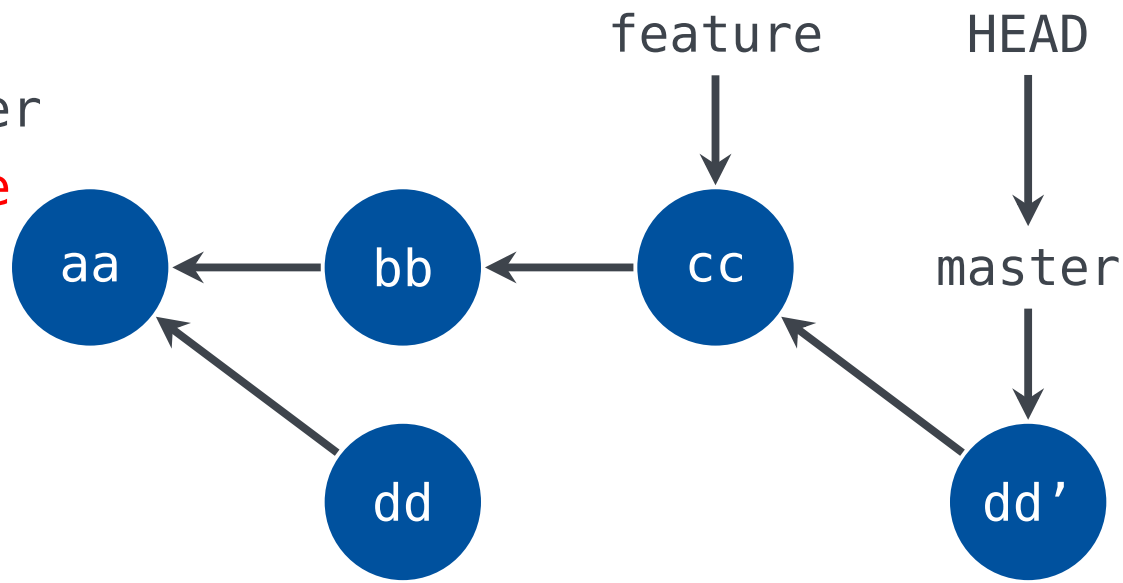

Remotes

- **Git is decentralized:** Every repo is independent of others
- `git fetch`:
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- `git pull`:
  1. `git fetch`
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  Default: Pull upstream counterpart into current branch
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But what should be do when we get merge conflicts?

Use the Force, Luke. (PROTIP: Don't!)

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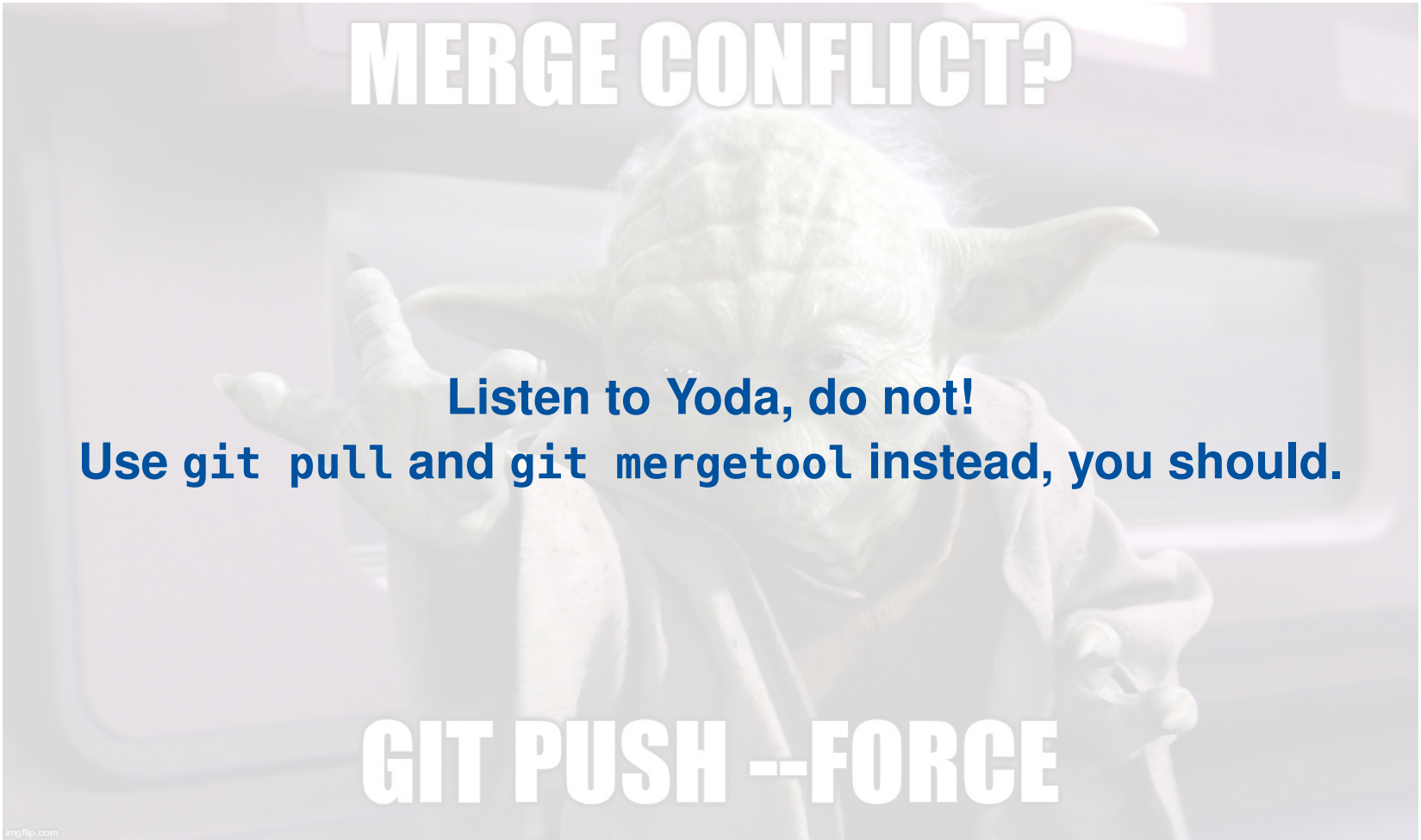


Listen to Yoda, do not!

Use `git pull` and `git mergetool` instead, you should.

Comparing Commits


NOBODY CAN GIT BLAME ME
38
imgflip.com

Log

- **`git log:`** List commit history
  - `--stat`/`--shortstat`: Show statistics for modified files
  - `--name-status`: Which files were modified, added, or deleted?
  - `--42`: Only last 42 commits
  - `--before`/`--after`: Only commits before/after date
  - `--author`/`--committer`/`--grep`: Only commits matching a pattern in author/committer/message field
  - `-G`: Only commits where added/deleted lines contain a pattern
  - `-S`: Only commits which change the number of occurrences of a pattern in a file
- **`git diff:`** Show differences between two commits,
  `git difftool:` Use an external tool like Meld
- **`git blame:`** Show for each line of a file the last commit which changed the line

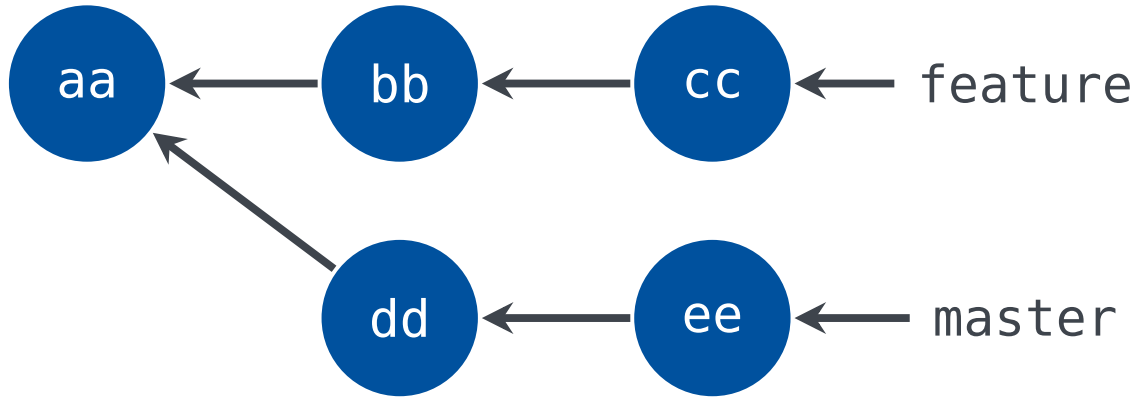
Log Can Also Do Fancy Stuff

```
*   cc24eb Merge remote-tracking branch 'origin/UQ'
|\
| *   9b3cf5 Merge remote-tracking branch 'origin/master' into UQ
| |\
| * | b9b1fe bug fix in dehierarchization of ModPolyBasis -> ...
* | | c92ac9 quasi monte carlo methods removed from master
* | |   e143d1 Merge branch 'master' of https://simsgs.informa...
|\ \ \
| |/ /
|/| /
| |/
| * 711dc8 Temporarily remove shared_ptr wrapping in SWIG
* |   ef252e Merge remote-tracking branch 'origin/master' into UQ
|\ \
| |/
| * 6be35a warnings fixed
| * f87760 sobol sequences removed
* | e6d73d minor changes
|/
*   66ed47 Merge remote-tracking branch 'origin/master' into UQ
```

Commit Navigation

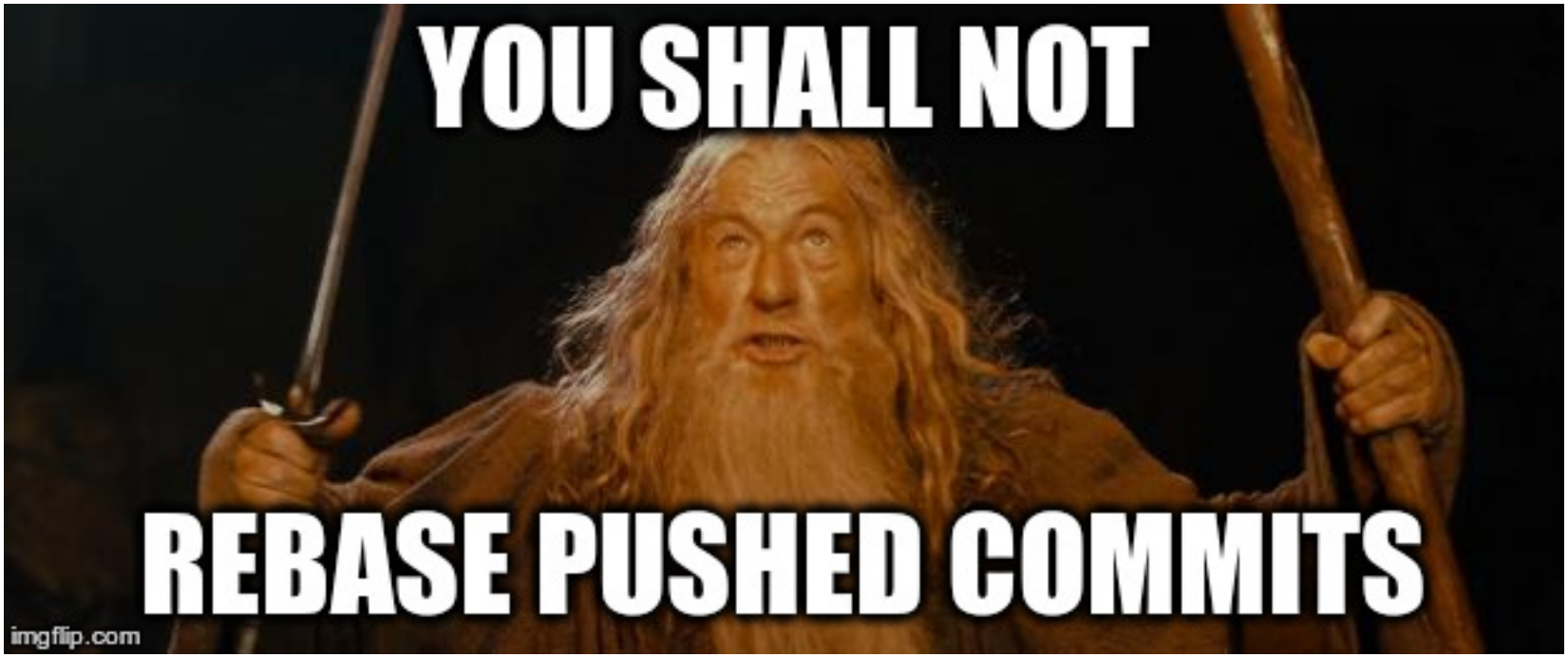
- Many Git commands accept “revisions/ranges“ to specify a commit or a series of commits
- **Single revision:**
  - Short SHA-1: `1c002d` = `1c002dd4b536...`
  - Branch name: `master`
  - Reflog: `HEAD@{5}`, `master@{yesterday}`
  - Parent: `HEAD^`, `HEAD^2` $\neq$ `HEAD^^`
  - First ancestor: `HEAD~`, `HEAD~2` = `HEAD~~`
  - ...

Commit Navigation



- **Commit ranges:**
  - `master..feature`: All commits from the merge base to `feature` (bb, cc)
  - `feature..master`: All commits from the merge base to `master` (dd, ee)
  - `master...feature`: All commits from the merge base to `feature` or `master` (bb, cc, dd, ee)
  - Omit one side to use `HEAD`
- Exception: **`git diff`** compares two *endpoints*
  - **`git diff`** `A..B` = **`git diff`** `A B`
  - **`git diff`** `A...B` = **`git diff`** `$(`**`git merge-base`** `A B) B`
- Type `man gitrevisions` for more info

Rebasing Commits

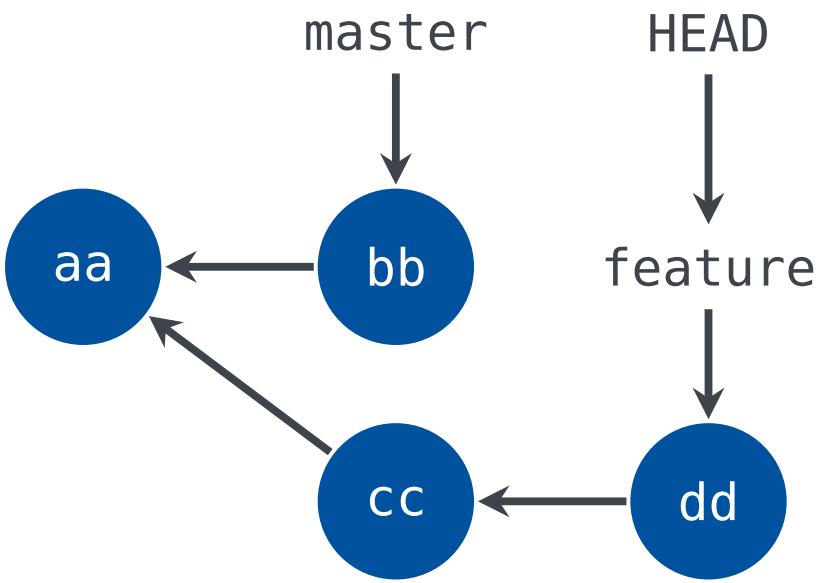

YOU SHALL NOT
REBASE PUSHED COMMITS
imgflip.com

Rebasing

- **`git rebase`:** Create new commits with same changes/patch, but different message/order/parents
- **`git cherry-pick`:** Cherry-pick single commits (bugfixes) on other branch (`release`)
- **Gandalf:** Never rebase commits pushed somewhere else!

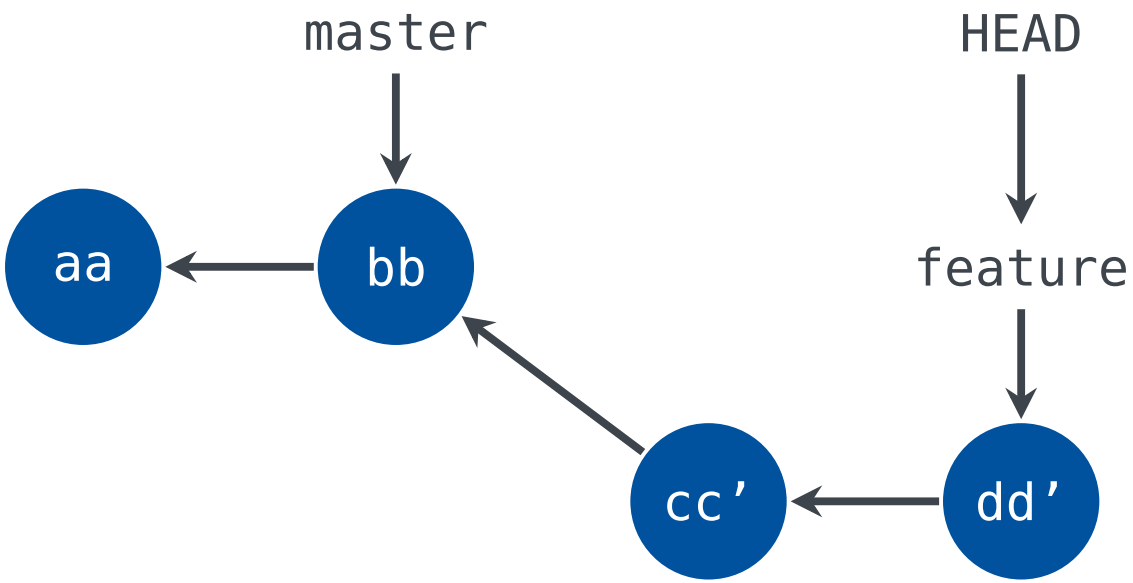
Rebase

```
git checkout feature
git rebase master
```



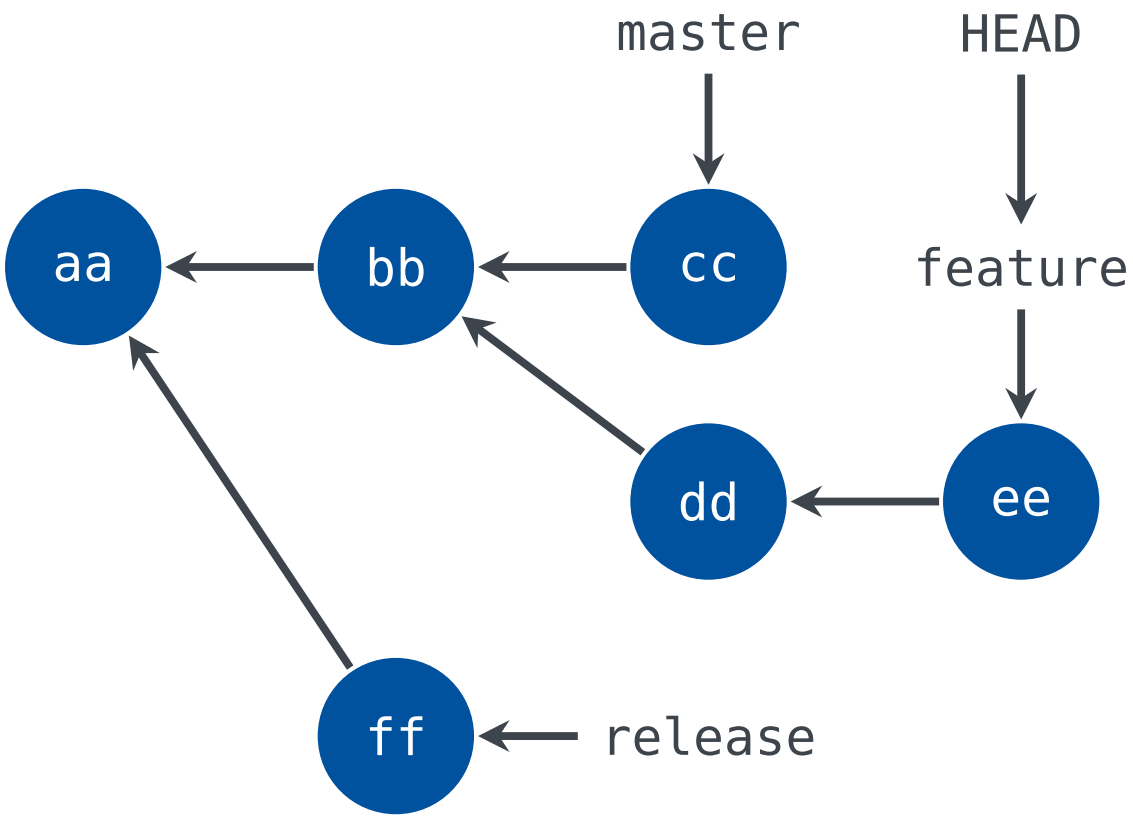
Rebase

```
git checkout feature
git rebase master
```



Rebase

```
git checkout feature
git rebase --onto release master
```



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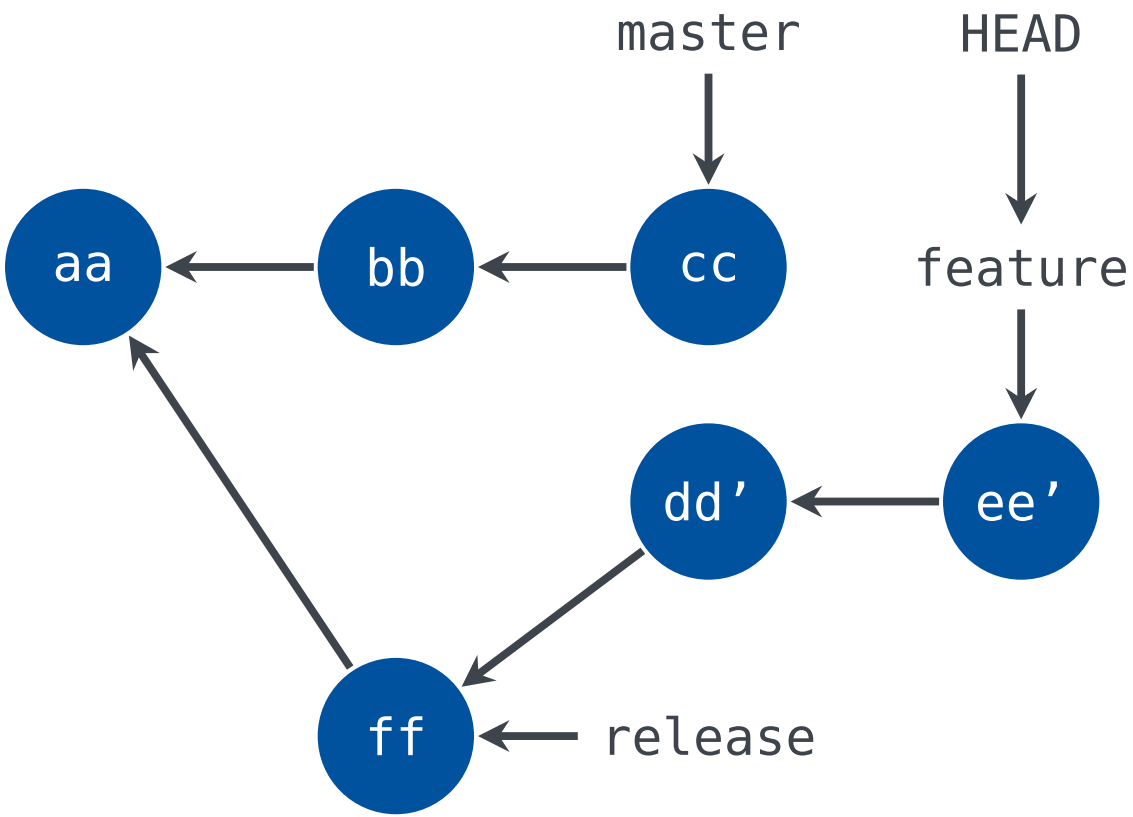


Interactive Rebase

- **Interactive rebase: `git rebase -i HEAD~3`**

```
pick 58955e5 Fix Doxygen warnings
pick 222bc86 Try to fix renames in non-C++ code
pick 429d079 Fix SWIG Java typemaps in optimization

# Rebase de5b6b4..429d079 onto de5b6b4 (3 command(s))
#
# Commands:
# p, pick = use commit
# r, reword = use commit, but edit the commit message
# e, edit = use commit, but stop for amending
# s, squash = use commit, but meld into previous commit
# f, fixup = like "squash", but discard this commit's log message
# x, exec = run command (the rest of the line) using shell
# d, drop = remove commit
#
# These lines can be re-ordered; they are executed from top to bottom.
# If you remove a line here THAT COMMIT WILL BE LOST.
# However, if you remove everything, the rebase will be aborted.
```

Undoing Stuff

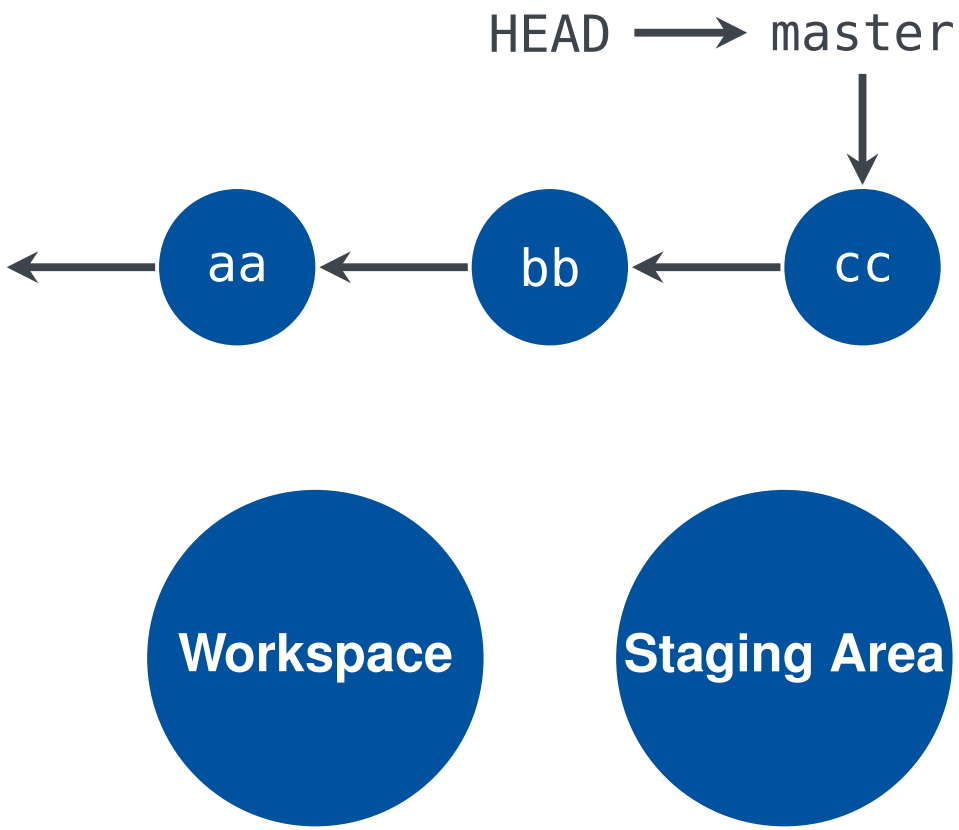

GIT CHECKOUT, GIT RESET, ...
..., GIT RESET --SOFT,
GIT RESET --HARD, ...
WHAT THE HELL
SHOULD I USE?
imgflip.com

Reset and Checkout

- **`git reset`** and **`git checkout`** both change the contents of staging area and/or working directory to other commits.

Initial setting

```
git reset --soft bb
git reset bb
git reset --hard bb
git checkout bb
```



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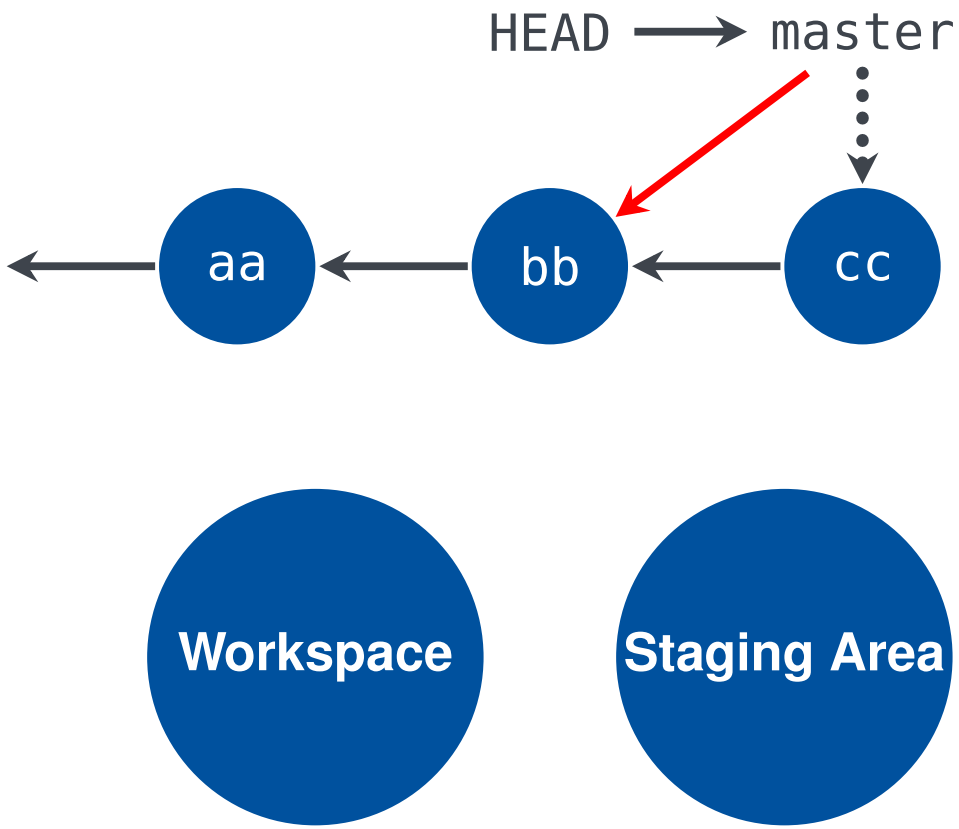

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`git reset` `--hard bb`

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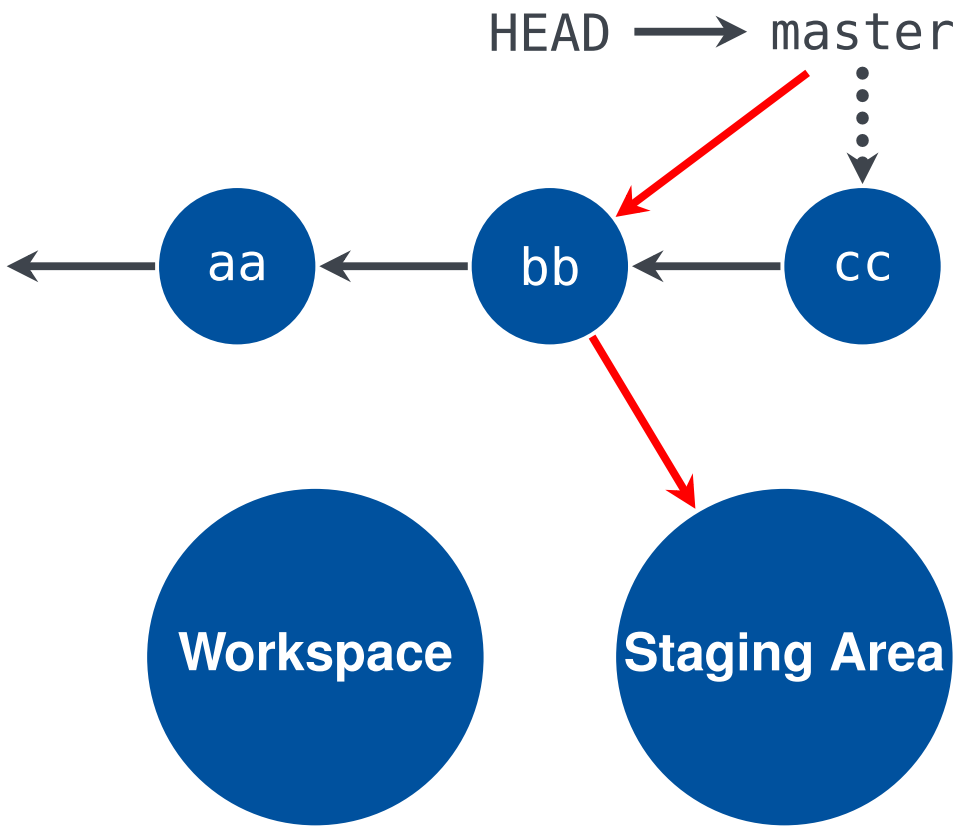

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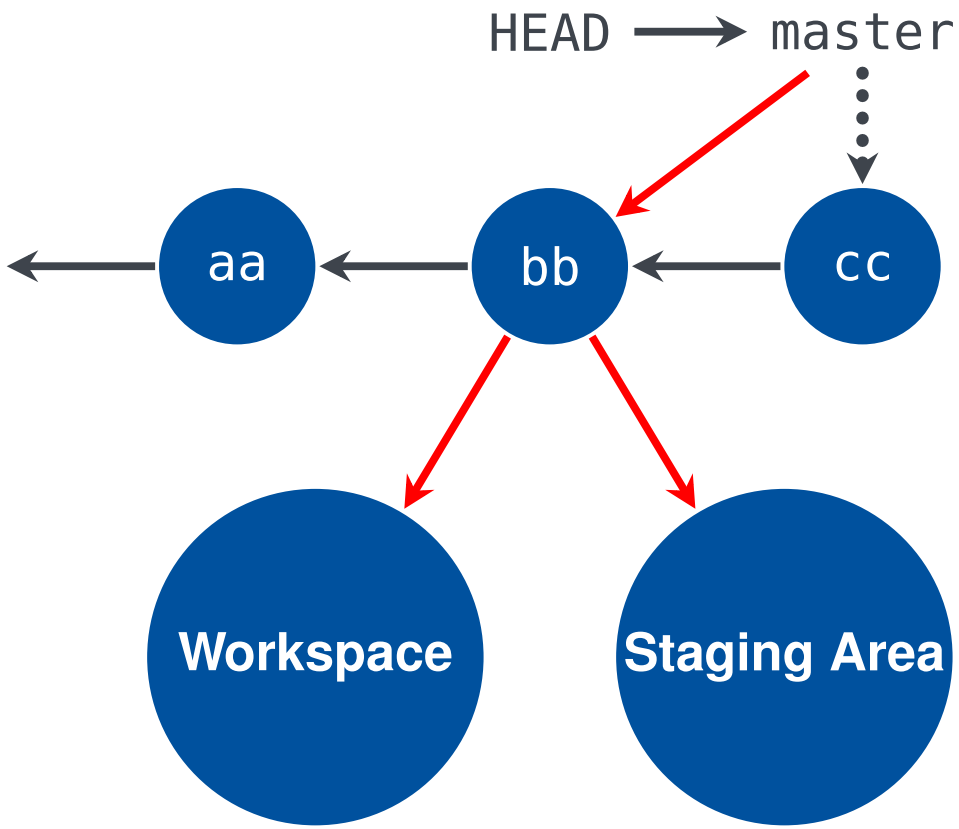

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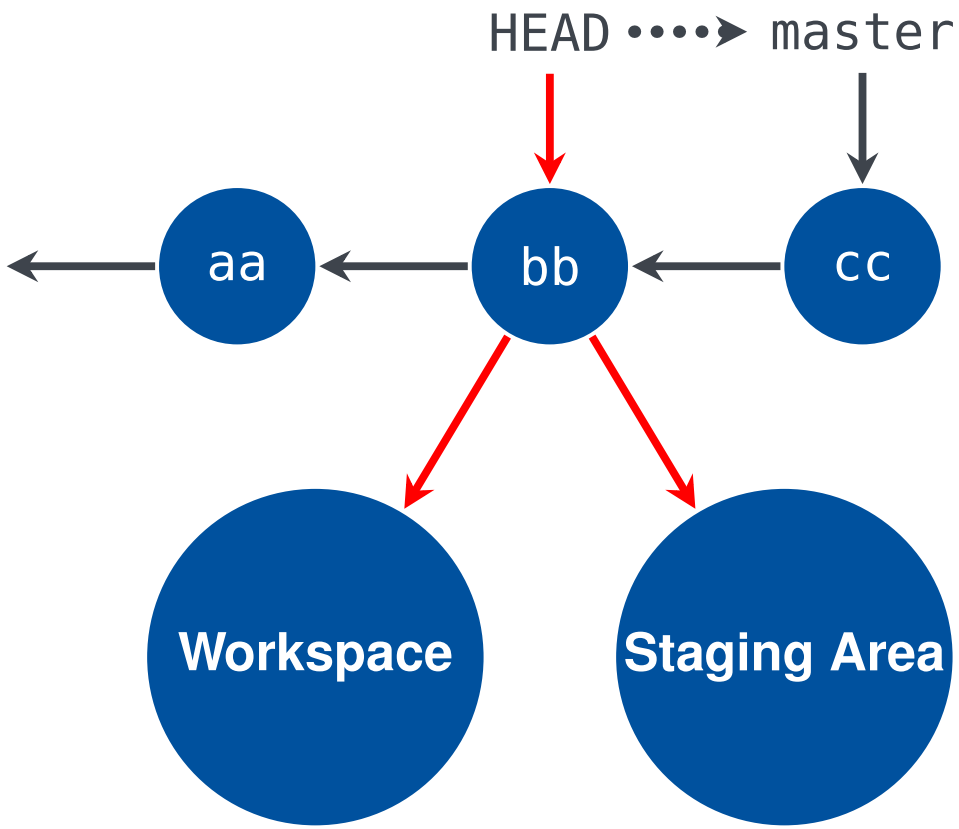

Reset and Checkout

- **Overview** (from `https://git-scm.com/book/en/v2/Git-Tools-Reset-Demystified#Summary`):

Command	Changes	Index	Workspace
Commit Level			
reset `--soft <commit>`	branch	no	no
reset `<commit>`	branch	yes	no
reset `--hard <commit>`	branch	yes	yes
checkout `<commit>`	HEAD	yes	yes
File Level			
reset `<commit> <file>`	–	yes	no
checkout `<commit> <file>`	–	yes	yes

Stashing and Reverting

- **`git stash`:** Temporarily save changes of working directory and staging area
  - `--include-untracked`: Also stash untracked files
  - `--keep-index`: Only stash working directory changes
  - `--patch`: Stash individual hunks of changed files

```
stash@{0}: WIP on sgopt: 382334f Rename HashGridStorage methods
stash@{1}: On sgopt: Change Clang to -Weverything
```

- **`git revert`:** Revert commits already pushed to somewhere else, creating new commits
  - **`git revert`** `HEAD~3`: Revert patch introduced by `HEAD~3`
  - **`git revert`** `HEAD~5..HEAD~2`: Analogously
  - **`git revert`** `--mainline 1 <merge-commit>`: Revert merge commit, choosing the first parent

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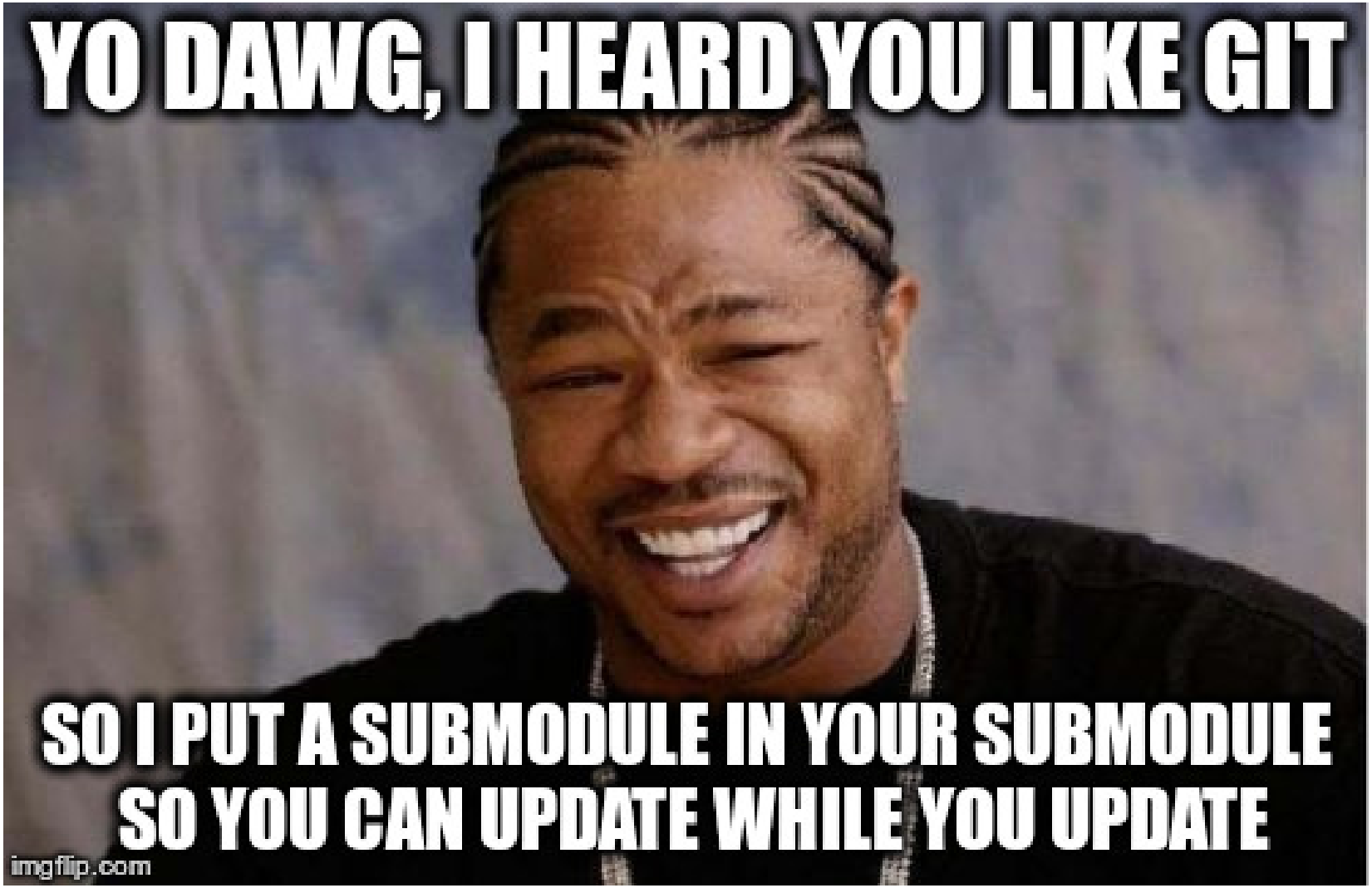
Last But Not Least Some Miscellaneous Things


YO DAWG, I HEARD YOU LIKE GIT
SO I PUT A SUBMODULE IN YOUR SUBMODULE
SO YOU CAN UPDATE WHILE YOU UPDATE
imgflip.com

Miscellaneous (1/3)

- **Submodules/Subtrees:**
  - **`git submodule`**: Include **reference to commit** of other Git repo in a subdirectory (saved in parent repo: URL, commit hash)
  - **`git subtree`**: Include **complete contents** of other Git repo in a subdirectory (saved in parent repo: contents of all commits)
- **`git bisect`:** Find bugs using bisection when you know initial good/bad commits and can tell if a commit in between is good/bad; can be scripted (**`git bisect`** `run`)
- **`git rerere`:** Automatic merge conflict resolution (**re**use **re**corded **re**solution)
- **`git tag`:** Unmovable names for commits (`release-2.1`)
- **`git filter-branch`:** Rewrite commits automatically (rename/delete files, . . .)

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Miscellaneous (2/3)

- **Configuration:**
  - System (`/etc/gitconfig`), user (`~/.gitconfig`), repo (`<REPO>/.git/config`)
  - Many, many possibilities: `core.editor`/`pager`, `commit.template`, `merge.tool`, `core.autocrlf`, `core.whitespace`, `...`
  - Aliases: Shortcuts for longer commands
- **Attributes:** Config. that only applies to specific paths (e.g., which files are considered binary, how to diff `*.docx` files, ...)
- **`.gitignore`:** Prevent binary files from being added
- **Hooks:**
  - Client-side: `pre-commit`, `prepare-commit-msg`, `commit-msg`, `post-commit`, `...`
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- **`git gc`:** Garbage collect, remove unreachable blobs/commits
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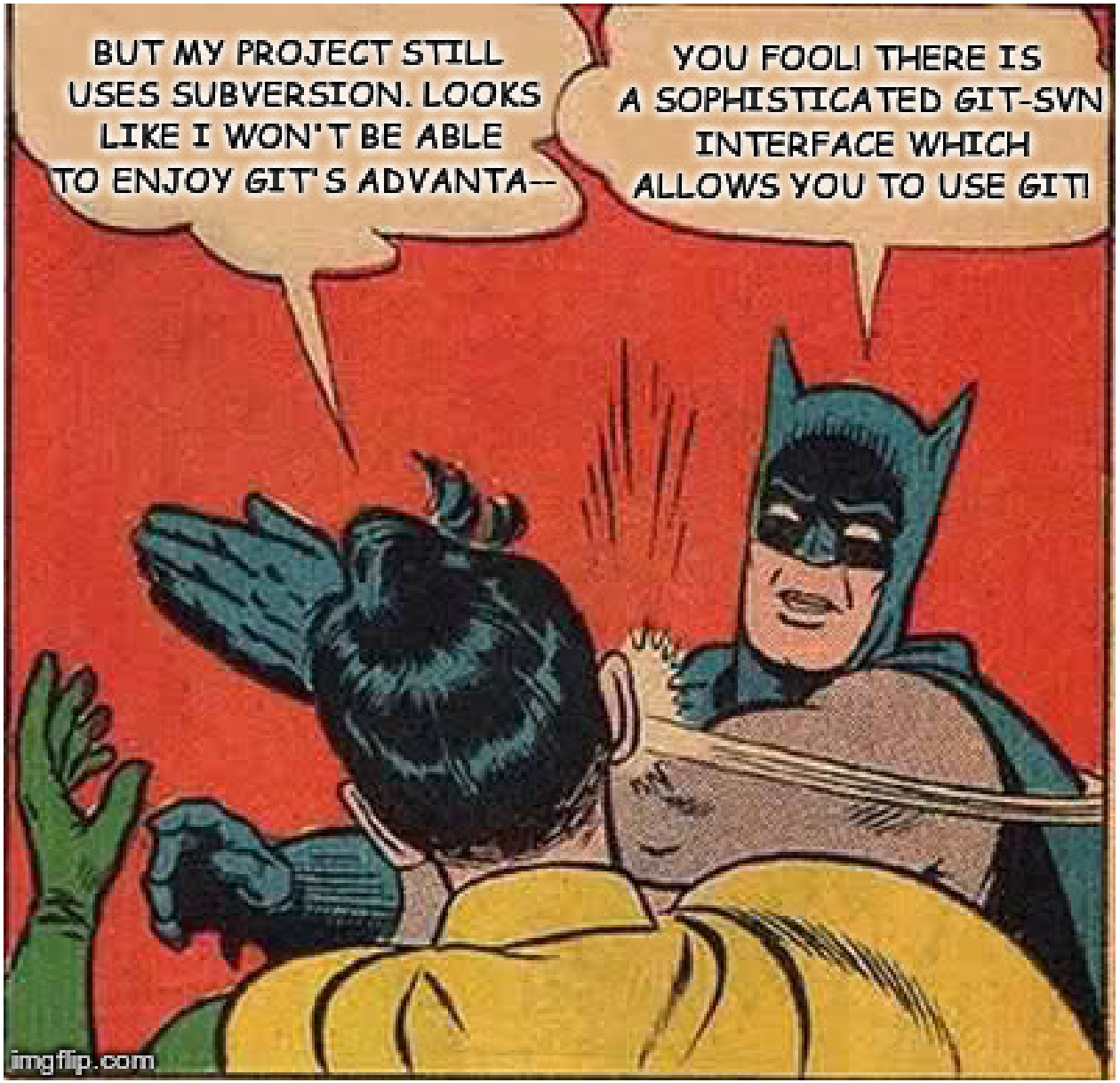
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Thank you for your attention!

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Literature

- S. Chacon and B. Straub. *Pro Git*. 2nd ed. Licensed under CC BY-NC-SA 3.0 Unported. 2016. URL: https://git-scm.com/book/en/v2
- R. Preißel and B. Stachmann. *Git. Dezentrale Versionsverwaltung im Team – Grundlagen und Workflows*. 3rd ed. Heidelberg: dpunkt.verlag, 2016