Introduction to Git

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Latest version available on Github:

Beamer theme Falkor:	https://github.com/Falkor/beamerthemeFalkor
Generic Makefiles:	https://github.com/Falkor/Makefiles
LaTeX Sources of the slides (Markdown):	https://github.com/ULHPC/documents
UL HPC School:	https://hpc.uni.lu/hpc-school/
UL HPC Tutorials:	http://ulhpc-tutorials.readthedocs.org/

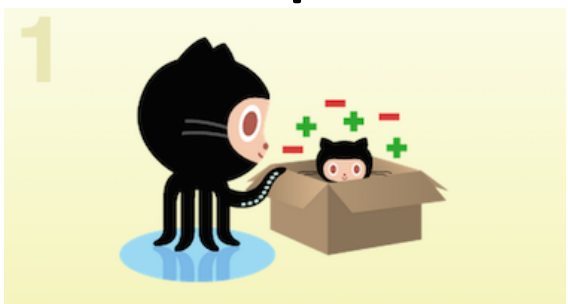
Summary

Github

github.com

(Reference) web-based Git repository hosting service

Set up Git



Create Repository

Fork repository

Work together

git-scm.com --everything-is-local

Git – the simple Guide

http://rogerdudler.github.io/git-guide/

git - the simple guide

just a simple guide for getting started with git. no deep shit ;)

Tweet 4,747

download the cheat sheet now. it's free!

by Roger Dudler

credits to @tfnico, @fhd and Namics

this guide in deutsch, español, français, indonesian, italiano, nederlands, polski, português, русский, türkçe, မြန်မာ, 日本語, 中文, 한국어 Vietnamese

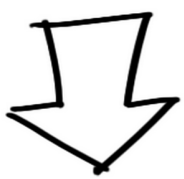
please report issues on github

want a simple but powerful git client for your mac?

Are You a Front-End Developer?
by Roger Dudler, Author of the Git Simple Guide

Try Frontify

Now Free with Github Integration!

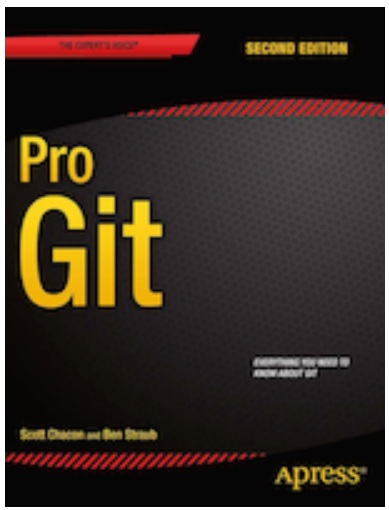


Atlassian Tutorials

https://www.atlassian.com/git/tutorials/

Pro Git Book – progit.org

- Open-Source Book on Git by S. Chacon and B. Straub
  - ↪ Sources (on Github)
  - ↪ Online Reading – PDF
- See also Git Internal, also by S. Chacon



- **Note**: Most images of this talk comes from this book
  - ↪ more precisely the first edition

Summary

Why use Version Control?

- Version Control = Revision Control = Source Control
  - ↪ lets you track your files over time.
- you probably cooked up your own!
  - ↪ ever get files like `main-v2.tex`, `CORE-proposal.doc.old` or `2015-03-cv.pdf`?

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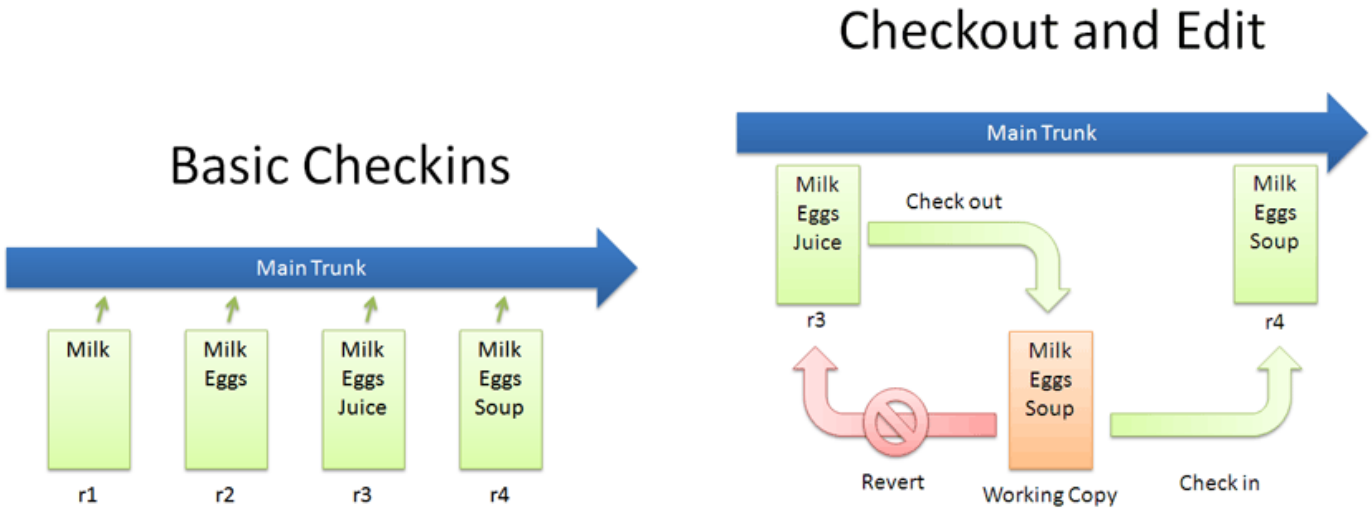
Version Control System (VCS)

- Integrated fool-proof framework for:
  - ↪ Backup and Restore
  - ↪ Synchronization / Collaborating
  - ↪ Short and long-term undo / Tracking changes
  - ↪ Sandboxing

Typical VCS Workflow



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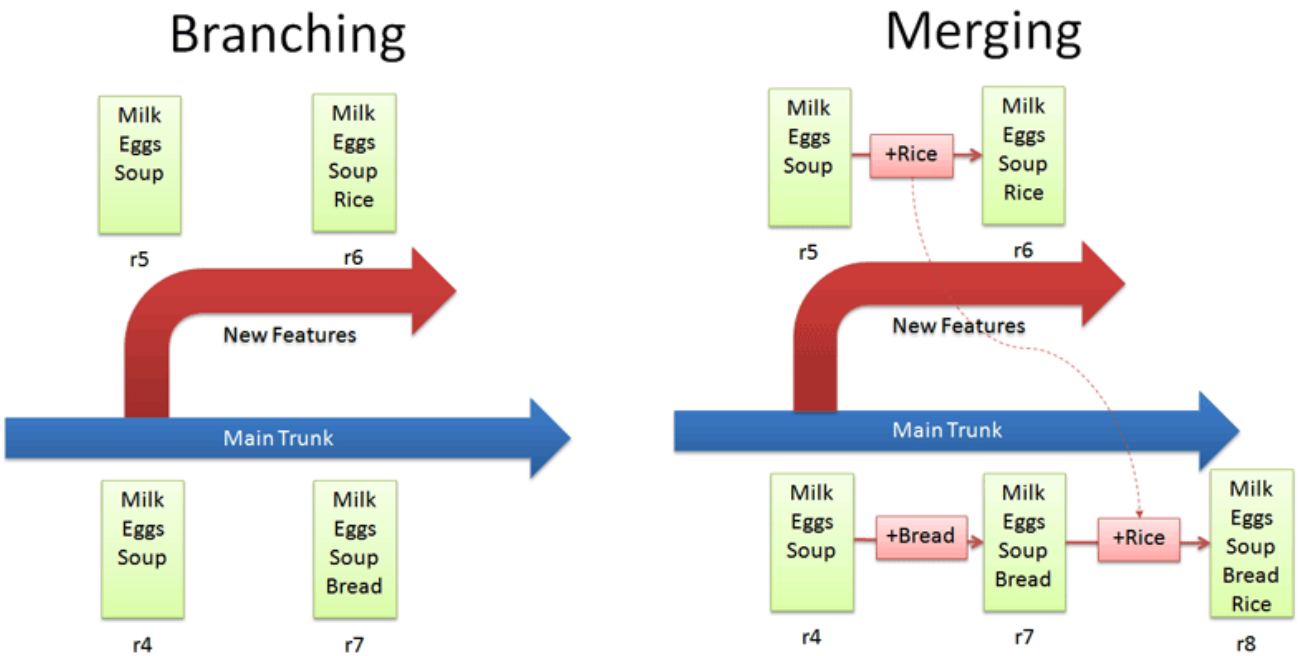
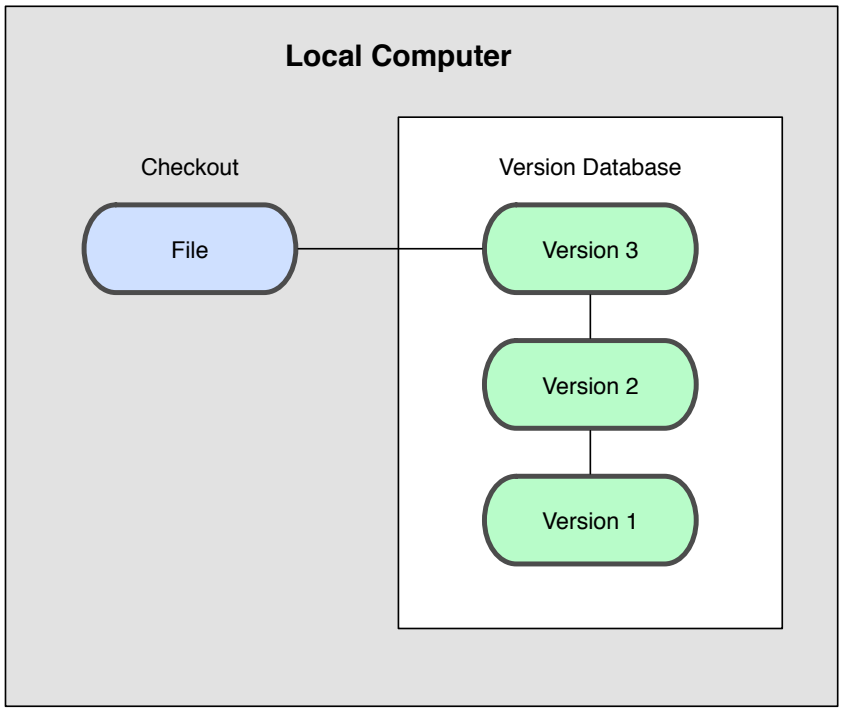
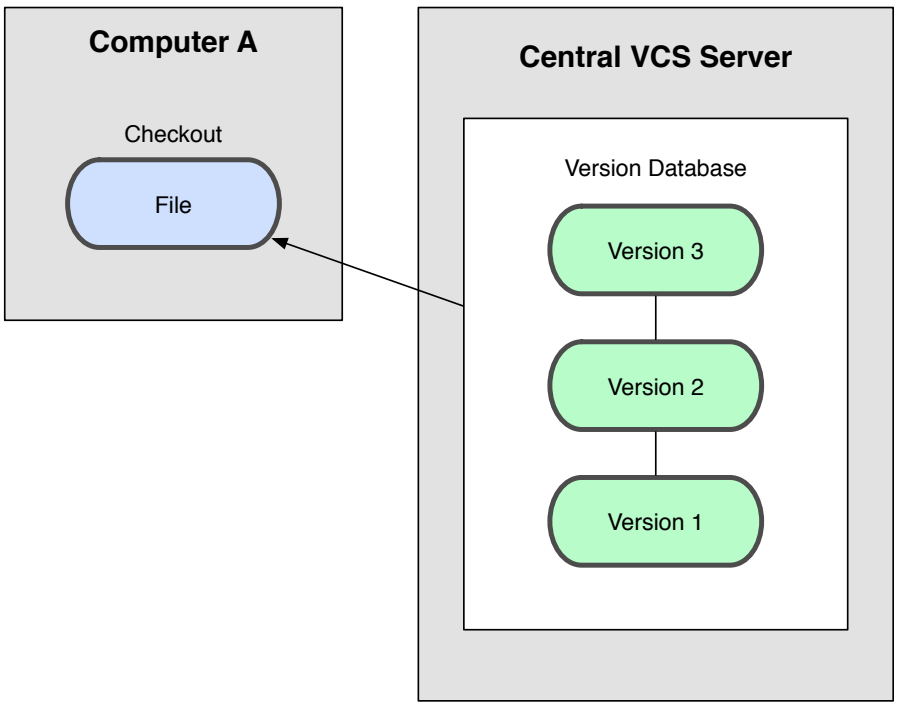


Local VCS – RCS, Mac OS Versions



Centralized VCS – CVS, SVN



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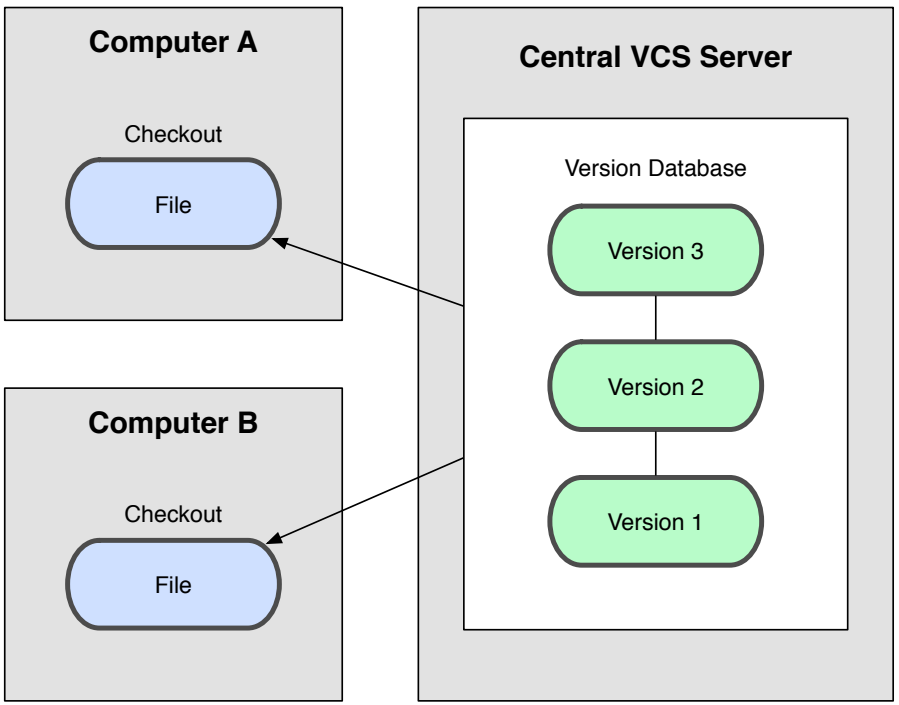
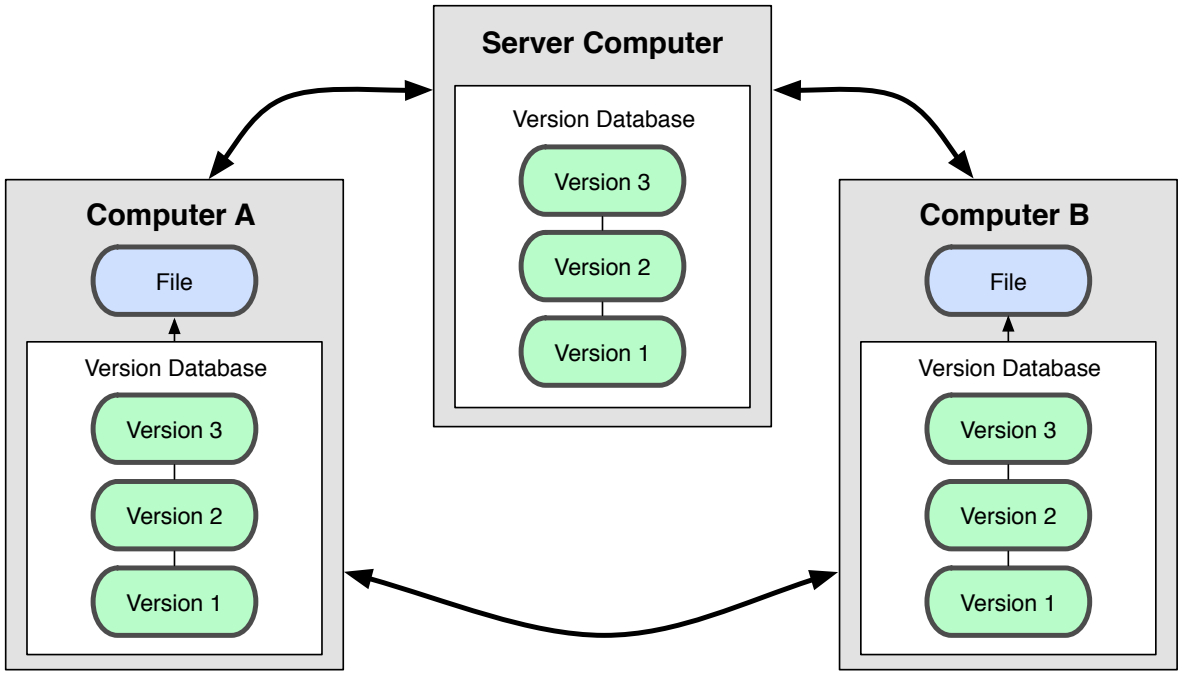
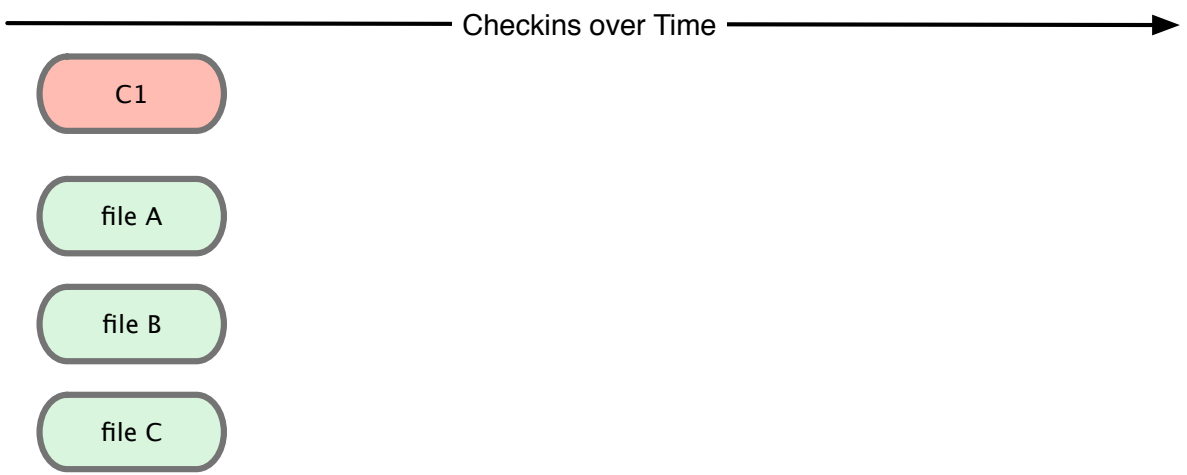


Distributed VCS – Git



Everybody has the full history of commits

Tracking changes (most VCS)



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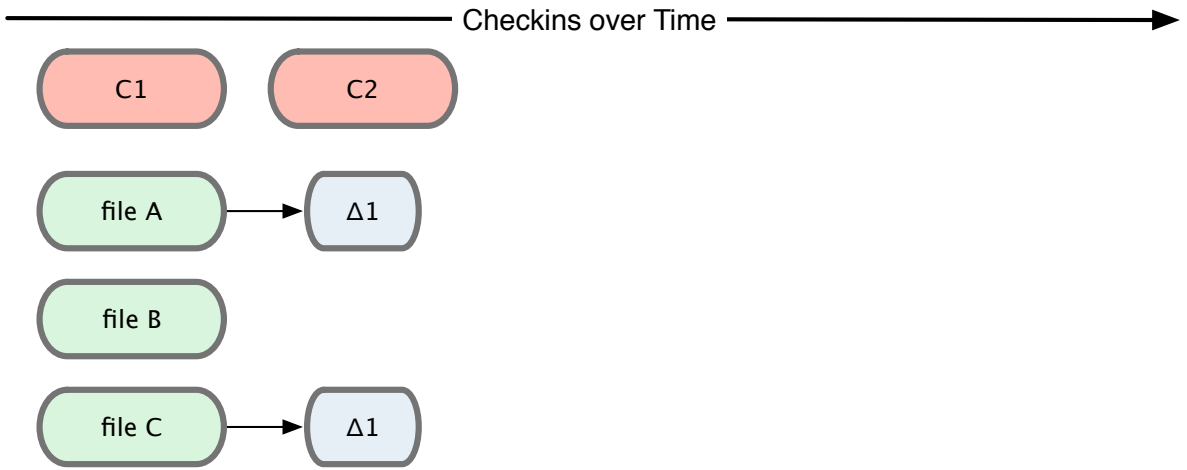

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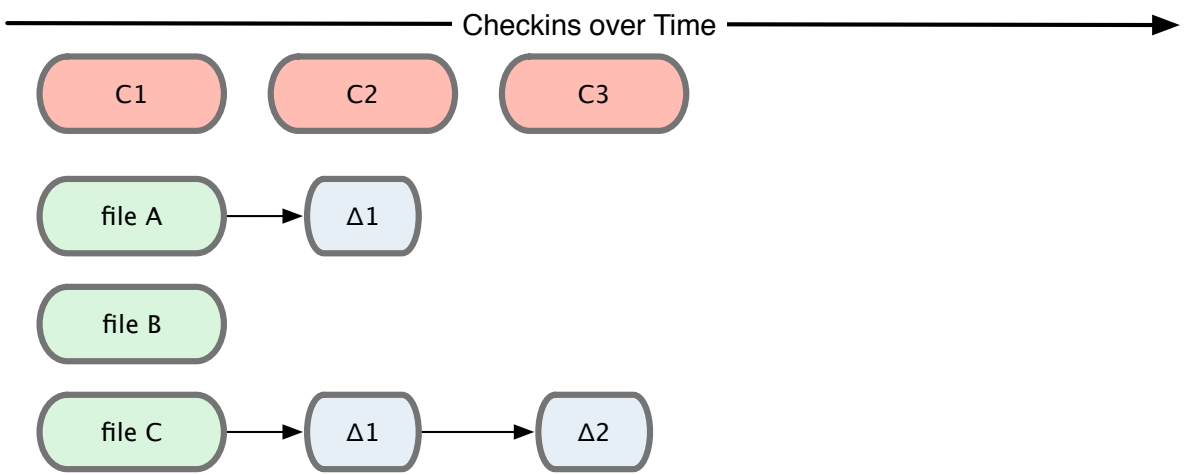

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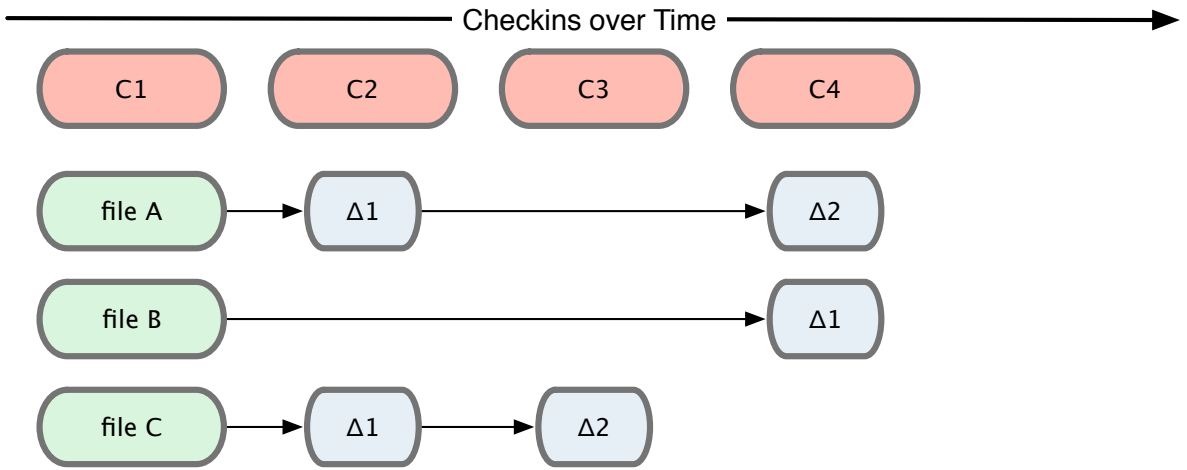

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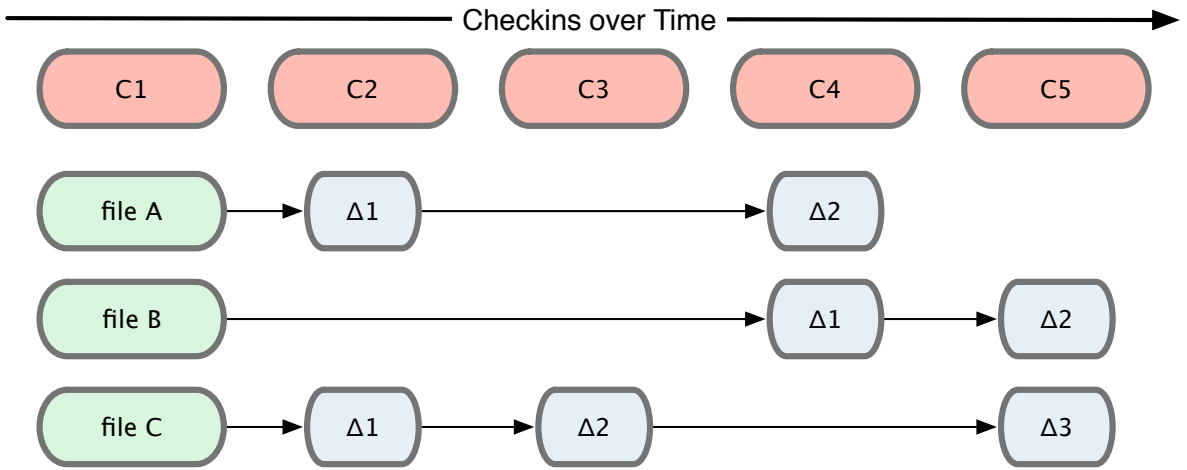

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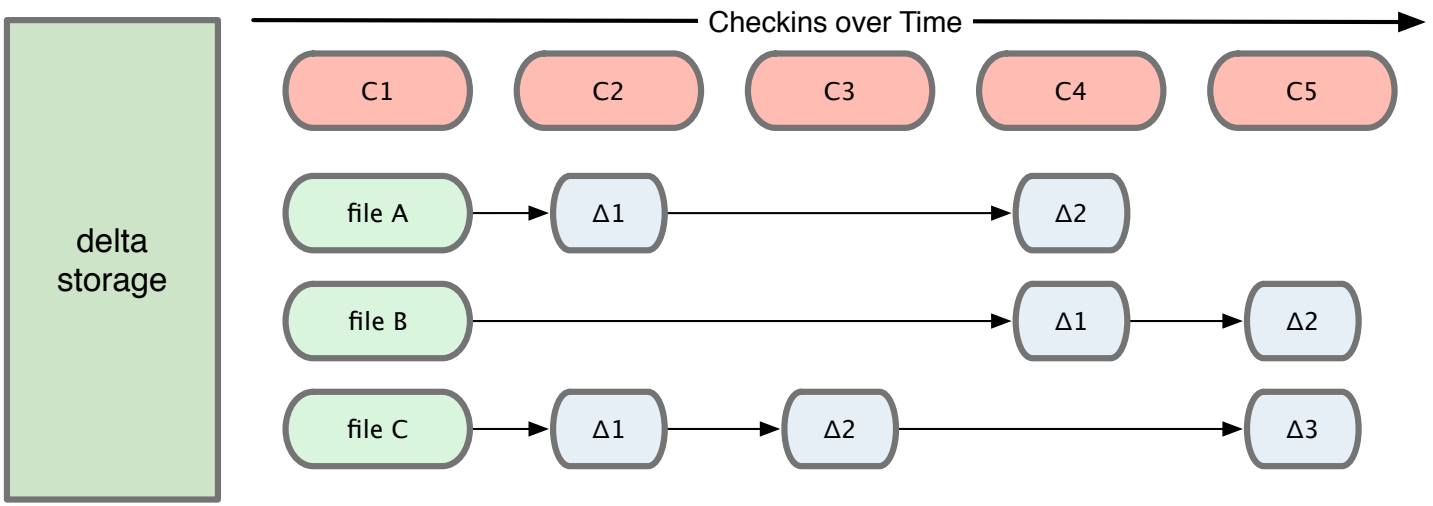

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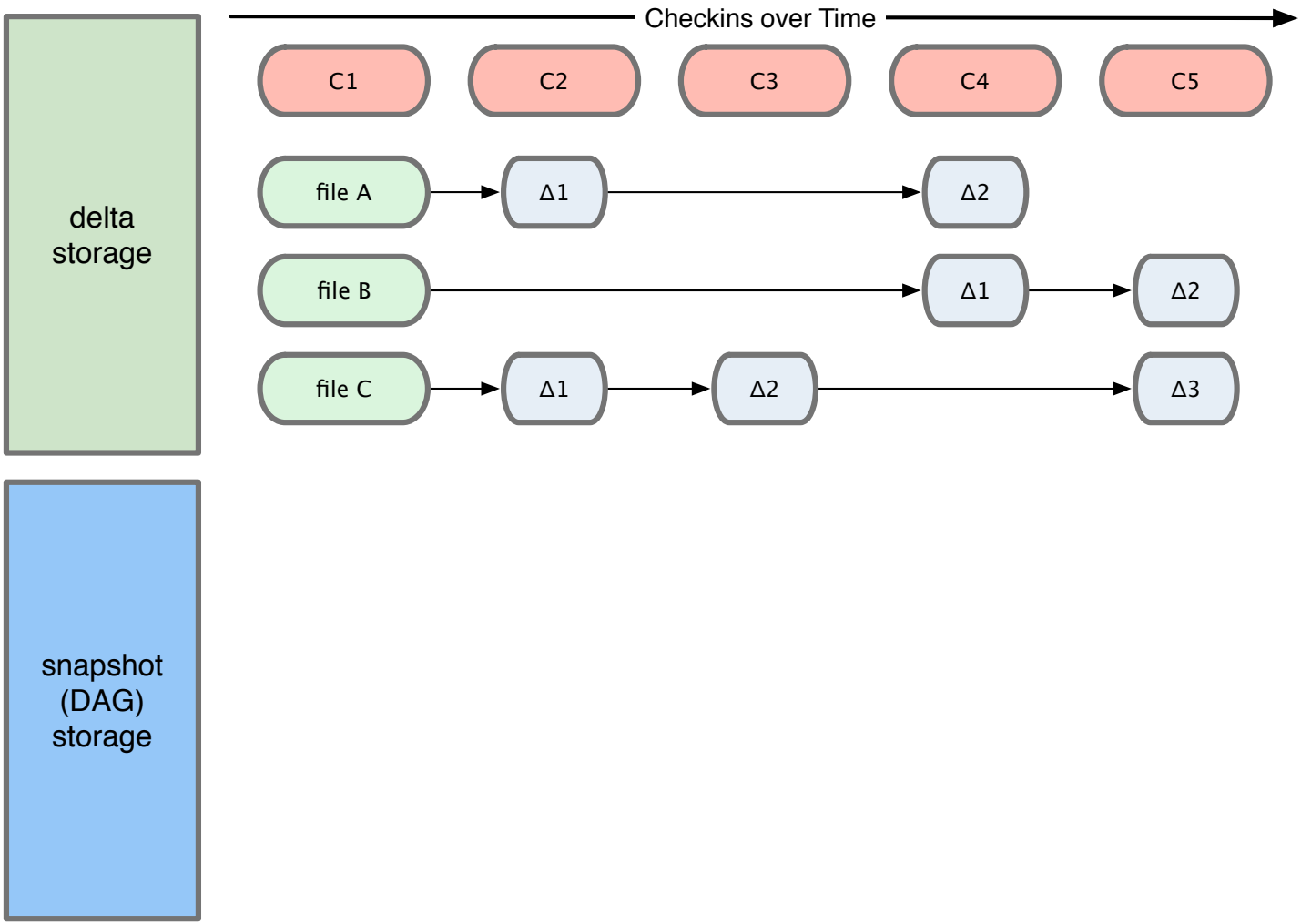

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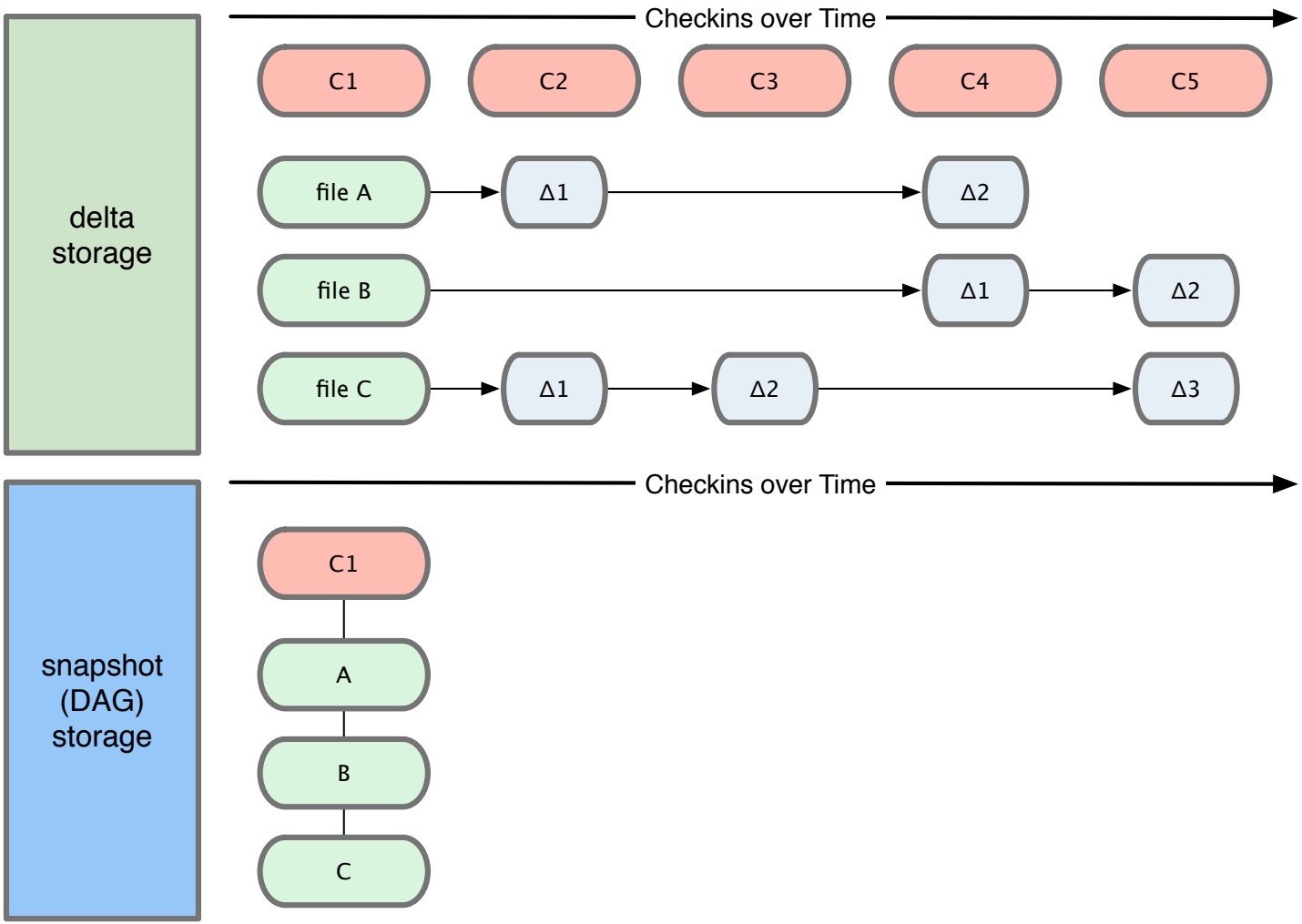

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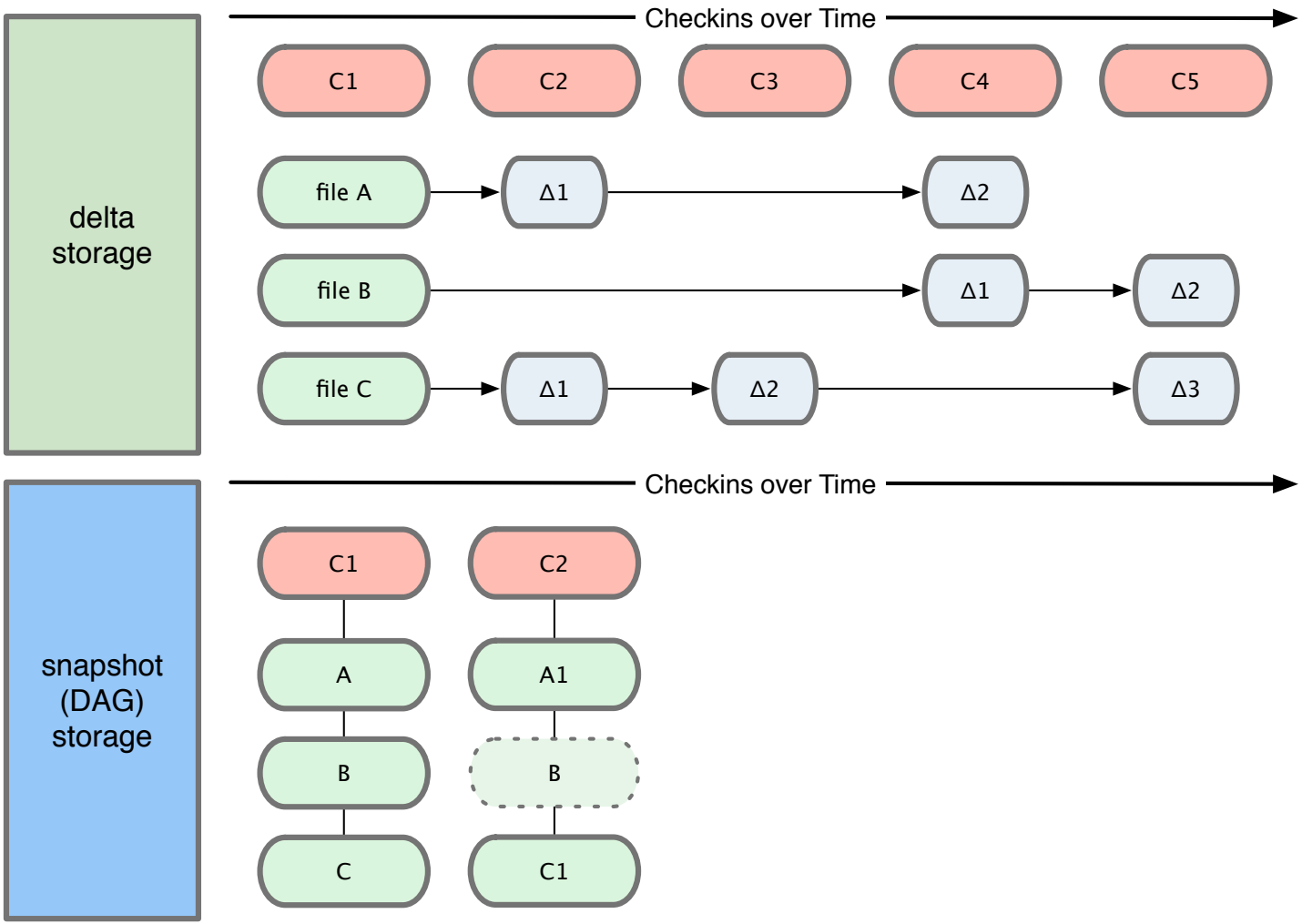

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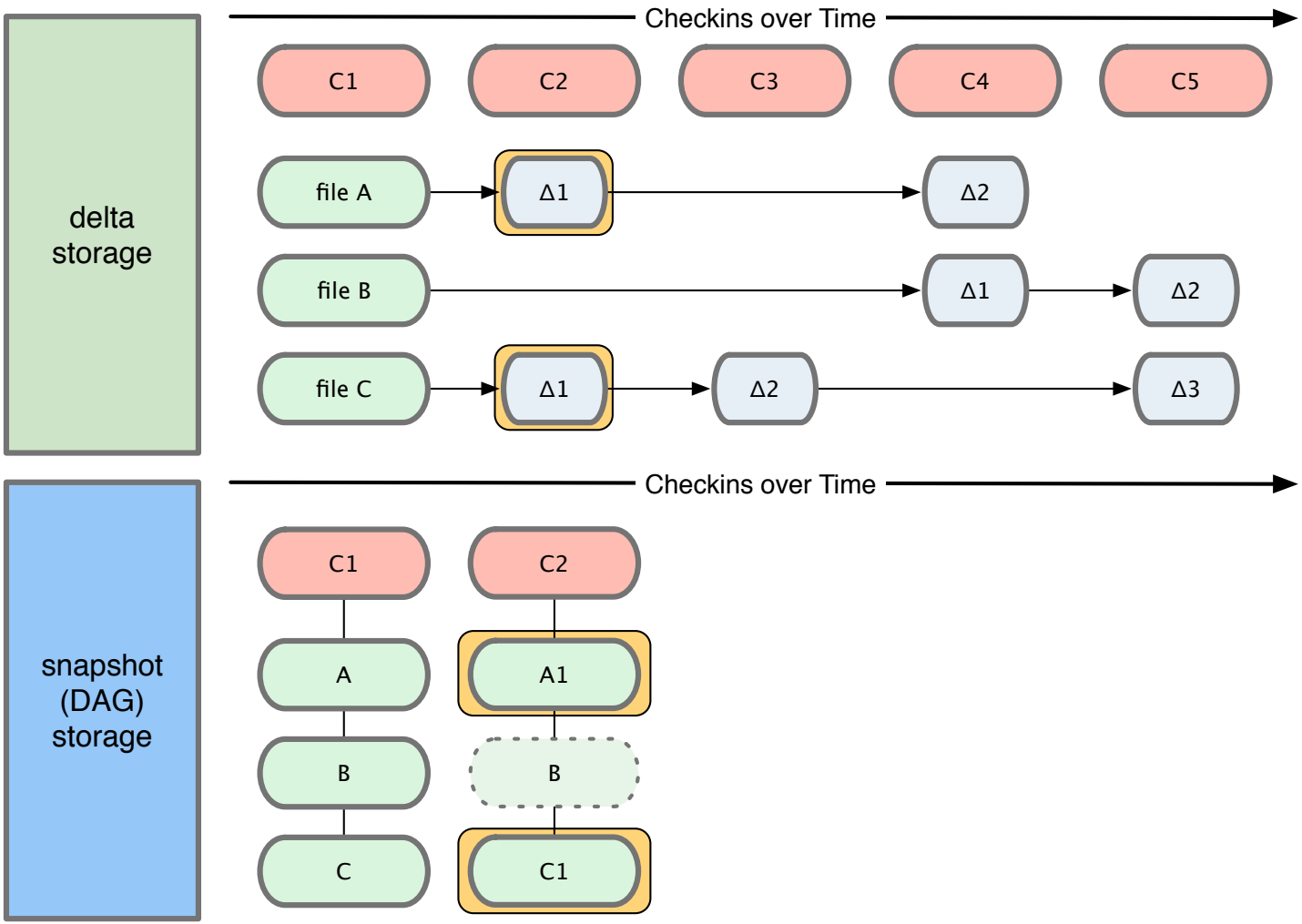

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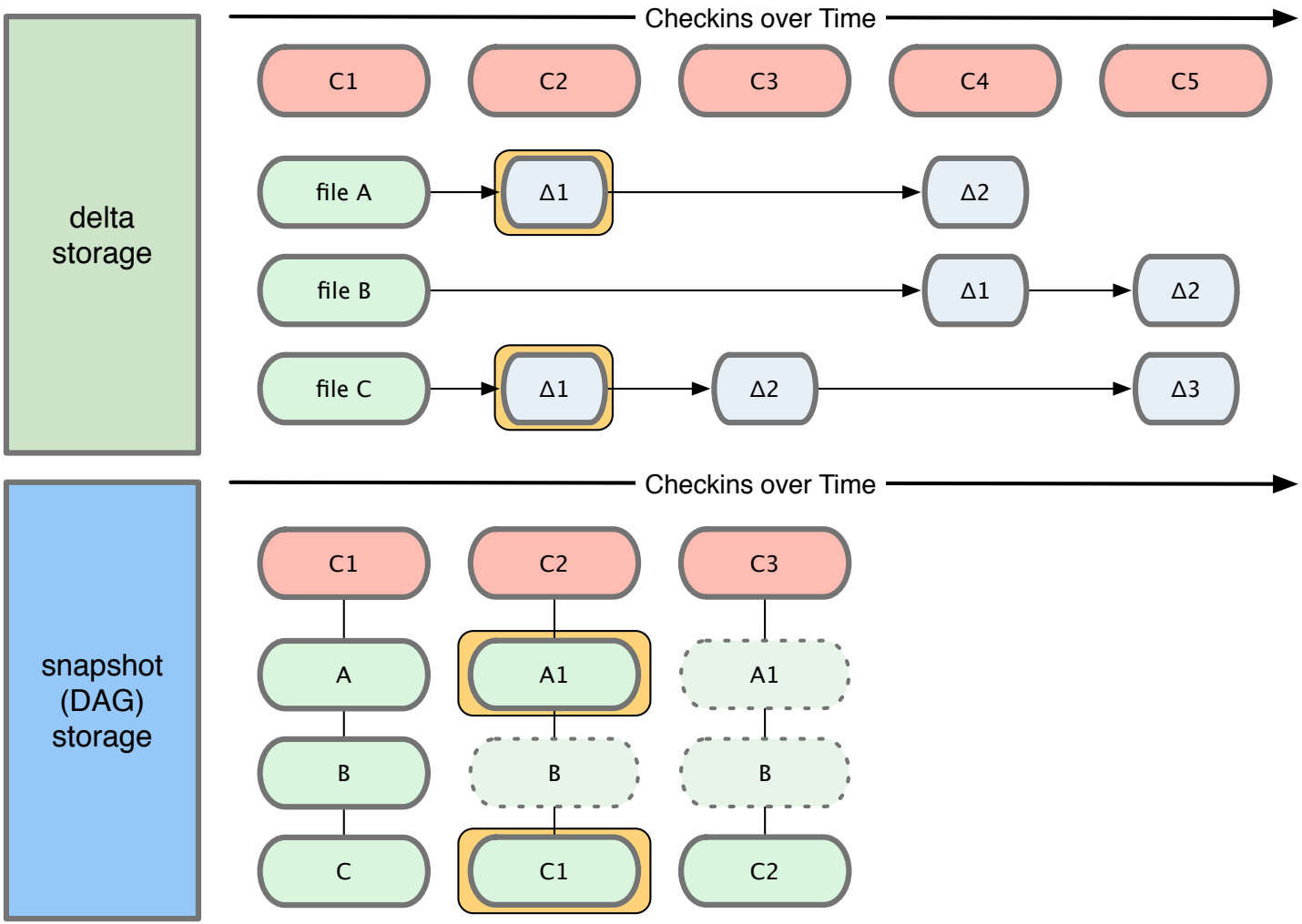

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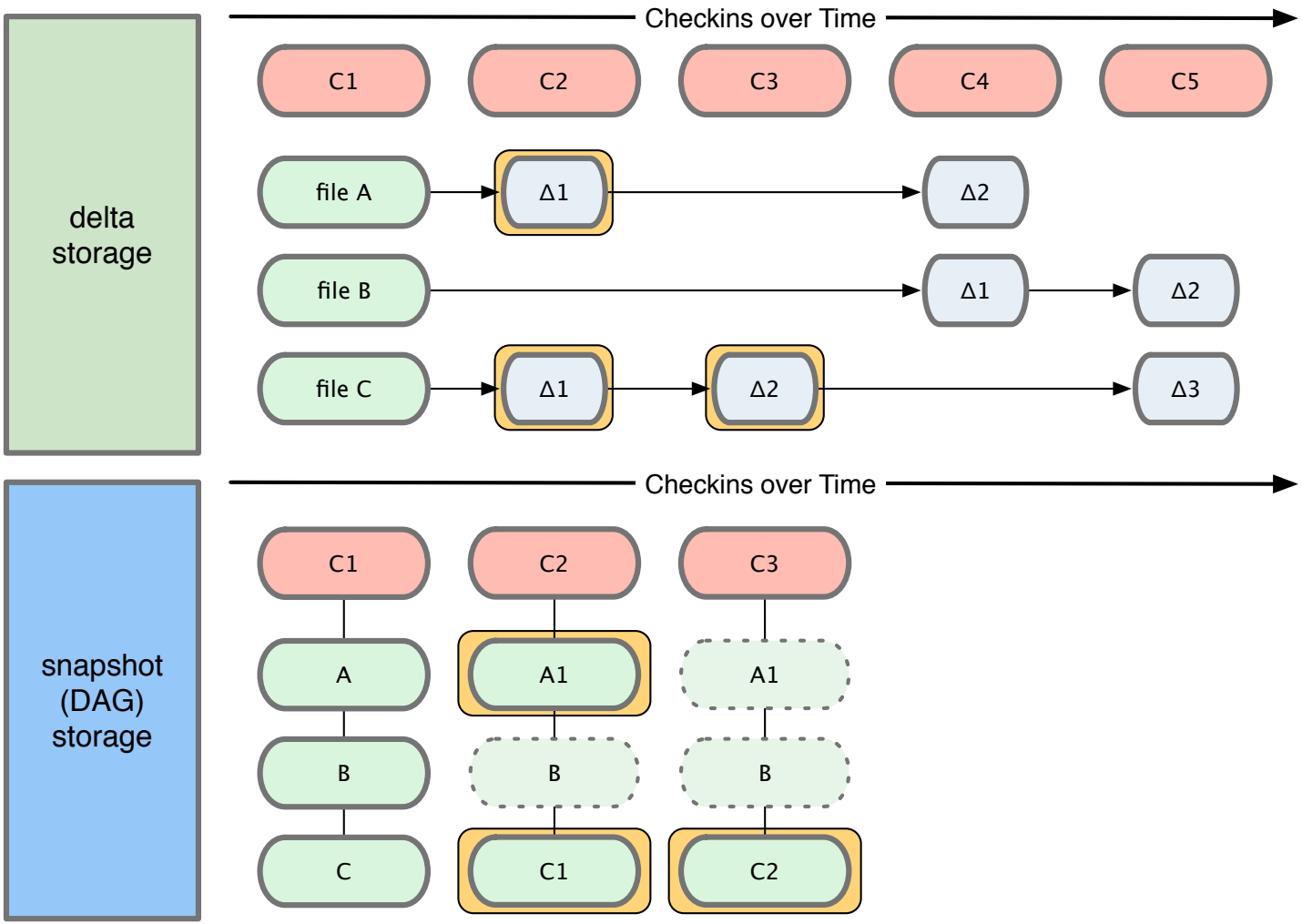

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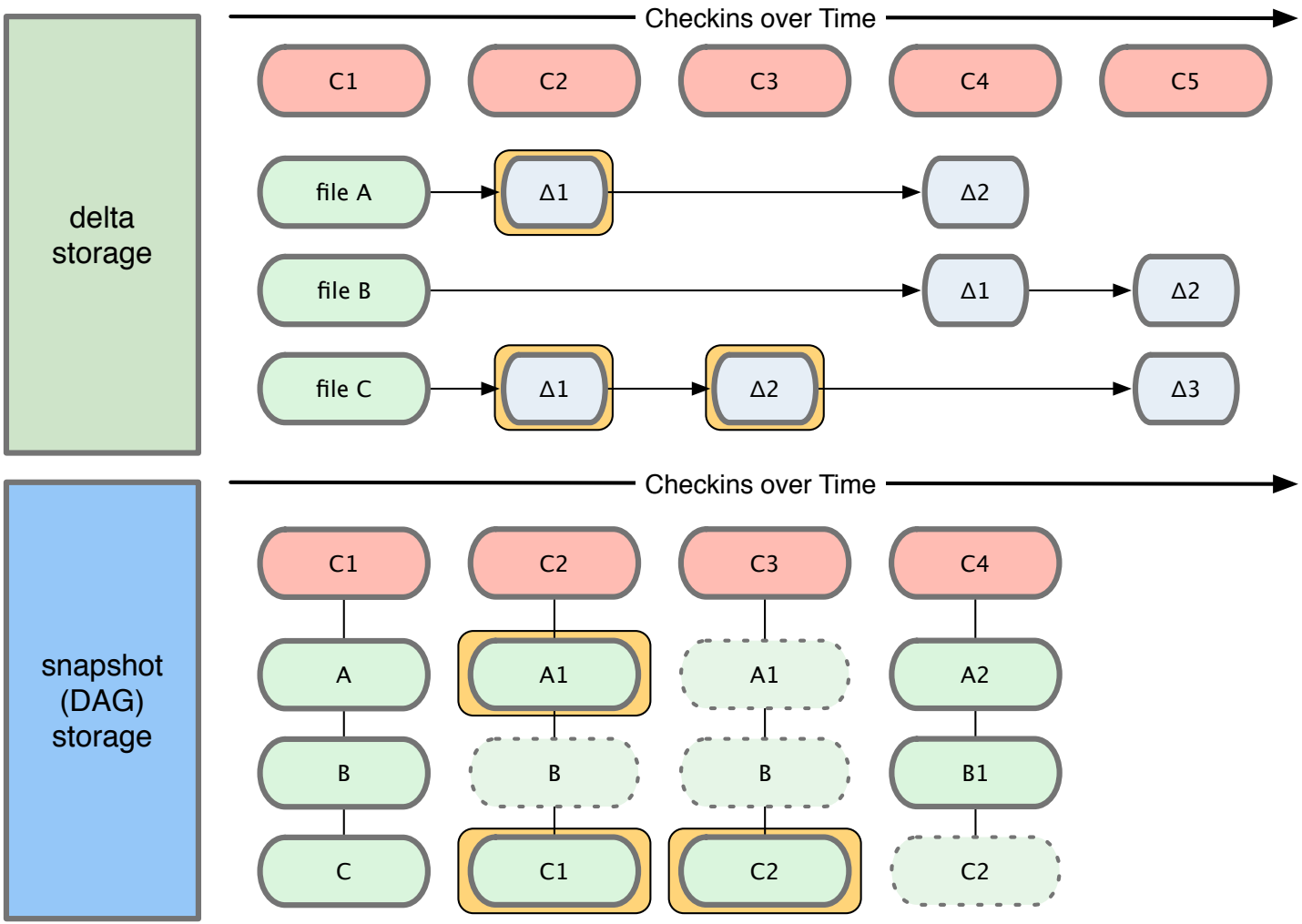

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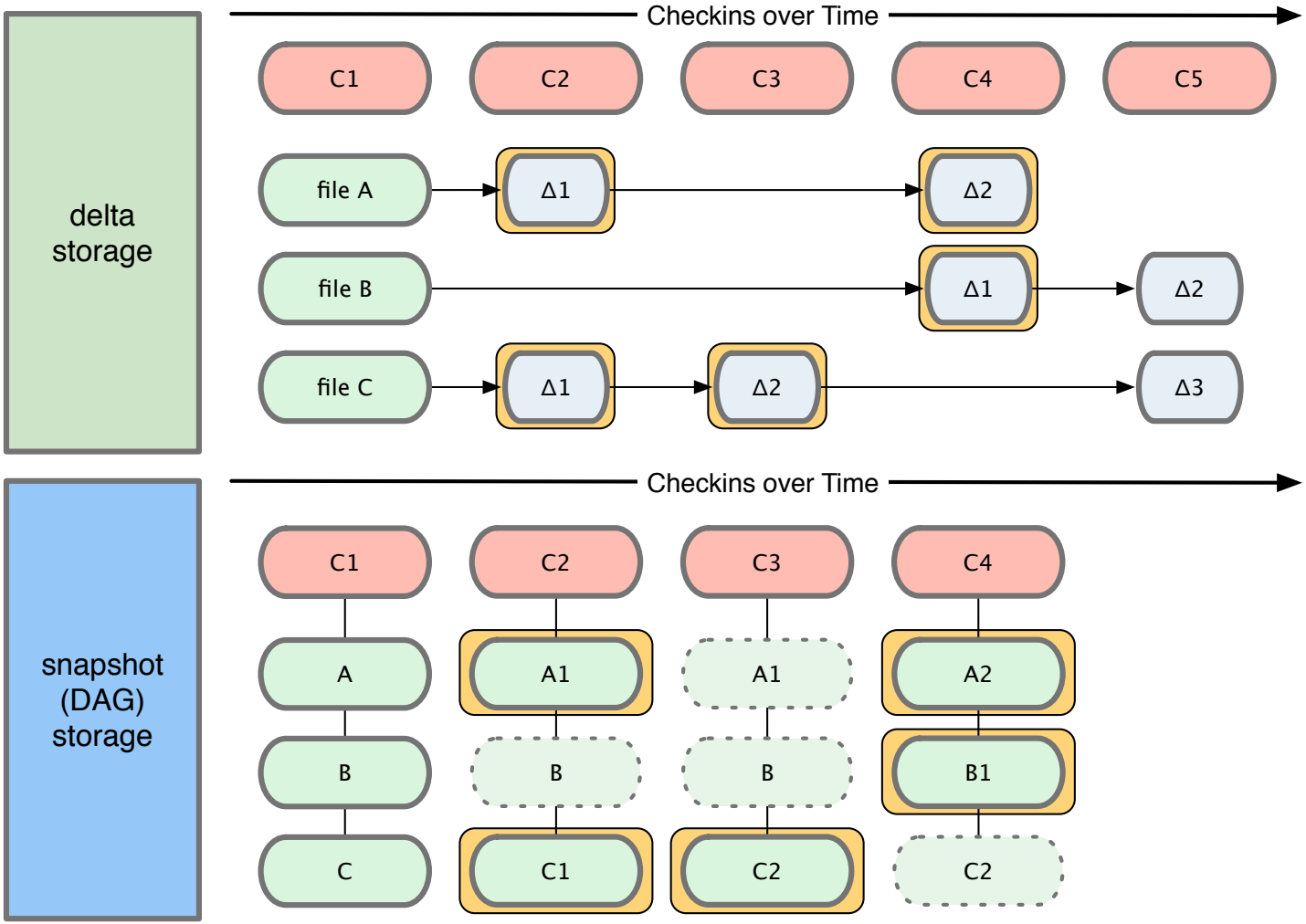

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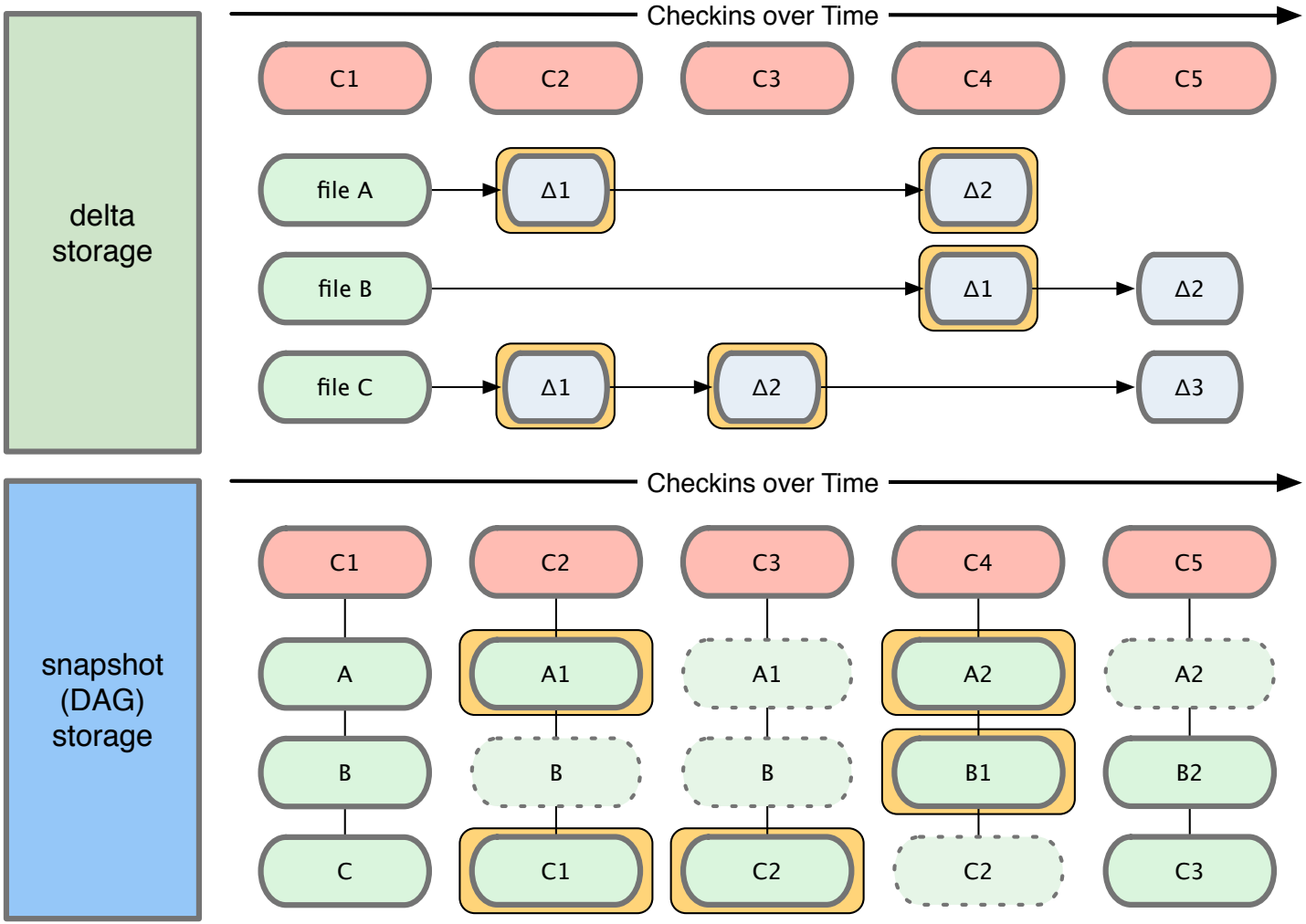

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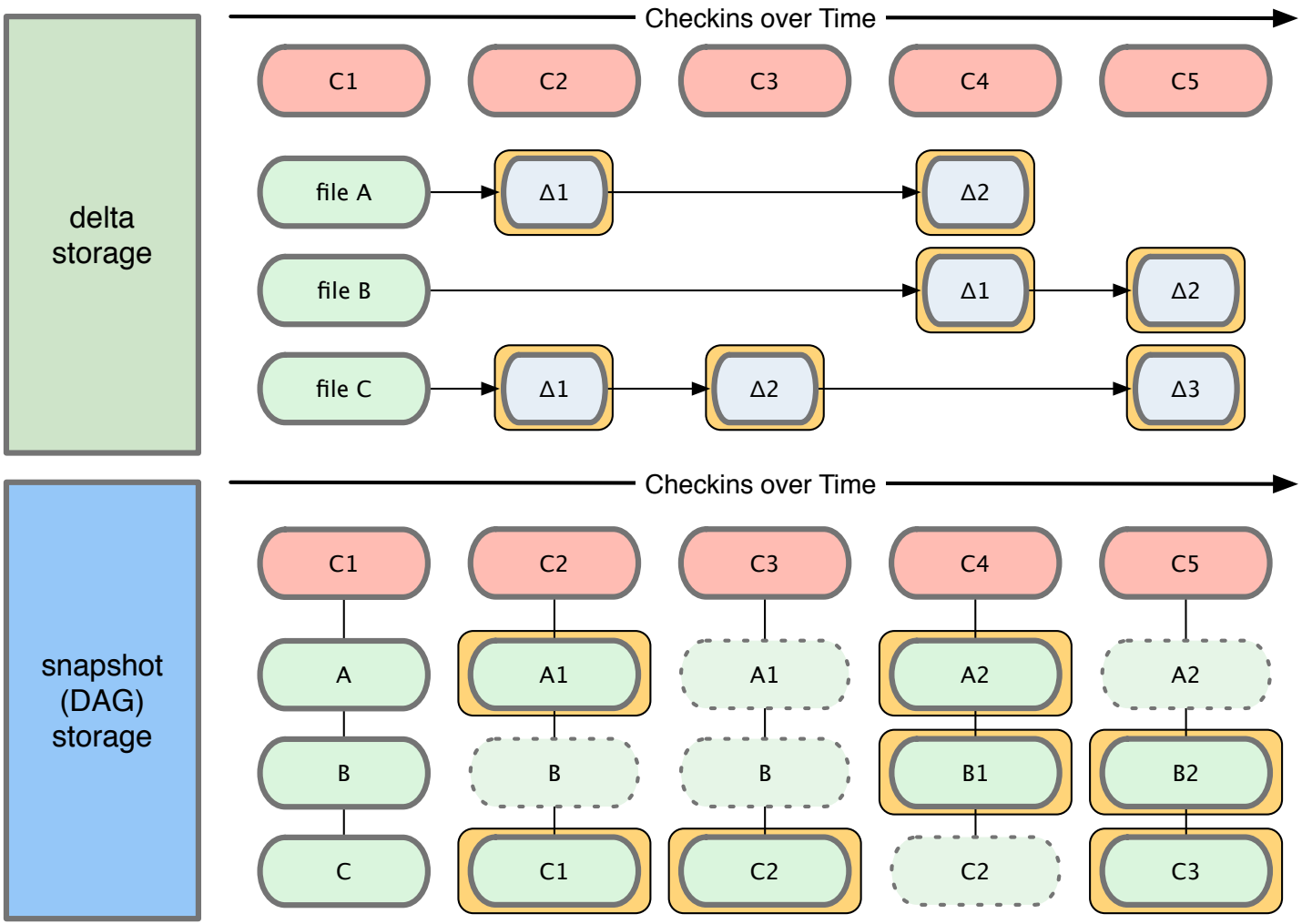
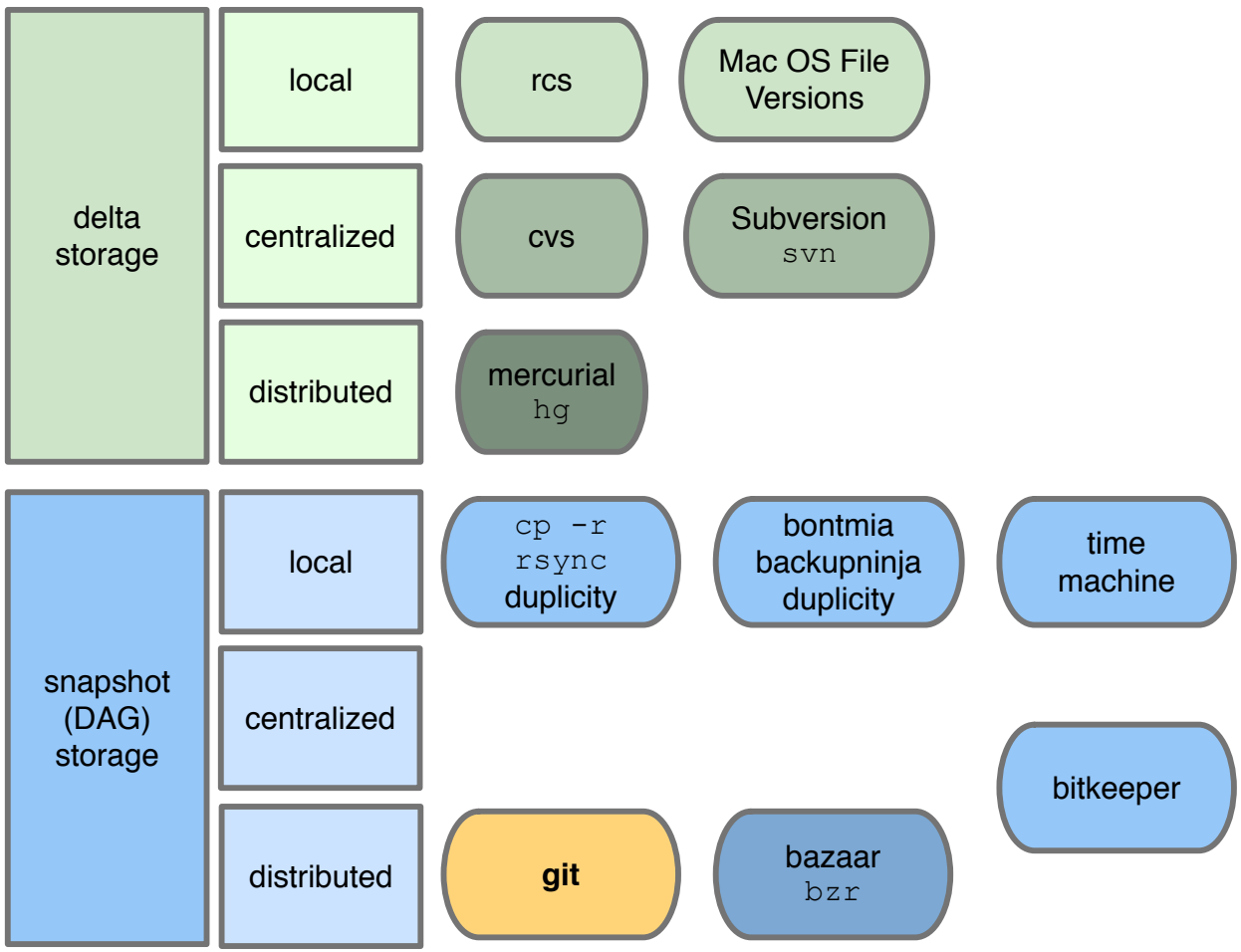


VCS Taxonomy



So what makes Git so useful?

(almost) Everything is local

- everything is fast
- every clone is a backup
- you work **mainly offline**

Ultra Fast, Efficient & Robust

- Snapshots, not patches (deltas)
- **Cheap branching and merging**
  - ↪ Strong support for thousands of parallel branches
- Cryptographic integrity everywhere

Other Git features

- **Git doesn't delete**
  - ↪ **Immutable** objects, Git generally only adds data
  - ↪ If you mess up, you can usually recover your stuff
    - ✓ Recovery can be tricky though

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Git Tools / Extension

- cf. **Git submodules** or **subtrees**
- **Introducing git-flow**
  - ↪ workflow with a strict branching model
  - ↪ offers the `git` commands to follow the workflow

```
$> git flow init
$> git flow feature { start, publish, finish } <name>
$> git flow release { start, publish, finish } <version>
```

Summary

Summary

Installation Notes

git-scm.com

Linux / Mac OS

```
$> apt-get install git-core git-flow        # On Debian-like systems
$> yum install git gitflow                  # On CentOS-like systems
$> brew install git git-flow              # On Mac OS, using Homebrew
```

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Windows MsysGit

- Incl. Git Bash/GUI & Shell Integration
  - ↪ use PLINk from Putty
  - ↪ install **Git bash** + command prompt
  - ↪ select checkout windows / commit unix

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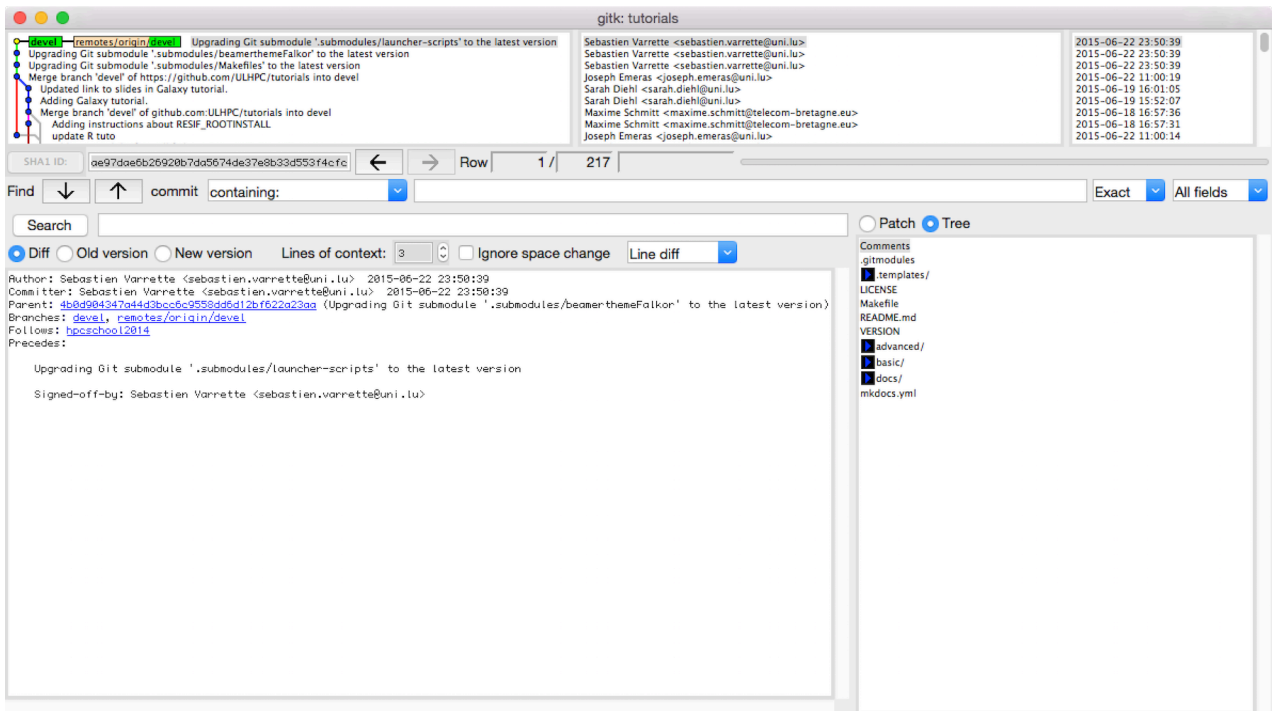
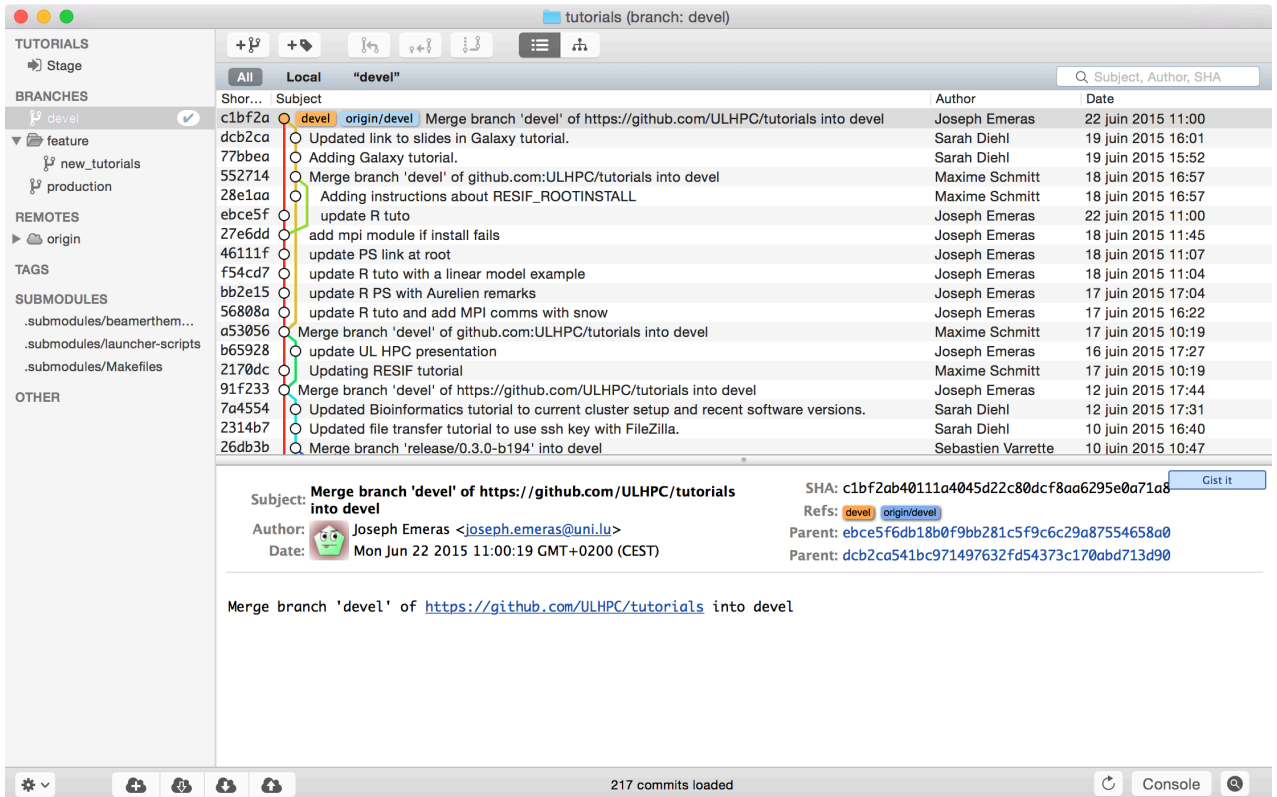
Your Turn! Ensure you have git installed

Git GUI (default) Gitk

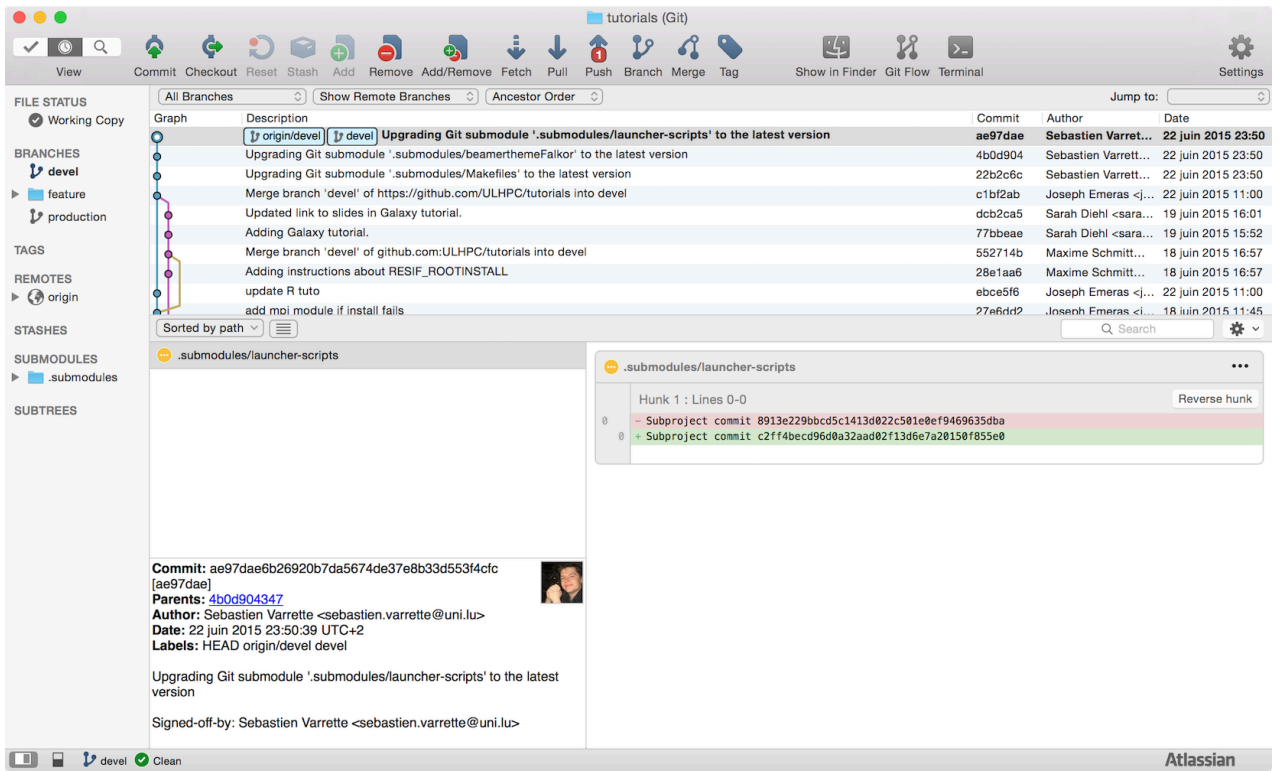


Git GUI (Mac OS) GitX-dev



http://rowanj.github.io/gitx/

Git GUI (Windows/Mac) SourceTree



http://www.sourcetreeapp.com/

1. Let it install a default git ignore file
2. make it load your SSH key created with Putty

Preliminary Configurations

- Global Git configuration are stored in `~/.gitconfig`
  - ↪ **Ex**: see my personal `.gitconfig`
- You **SHOULD** at least configure your name and email to commit
  - ↪ open a terminal (Git bash under windows) for the below commands

```
$> git config --global user.name "Firstname LastName"
$> git config --global user.email "Firstname.LastName@uni.lu"
$> git config --global color.ui true                    # Colors
$> git config --global core.editor vim                  # Editor
```

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```

Your Turn!

- Then check the changes by: `git config -l | grep user`

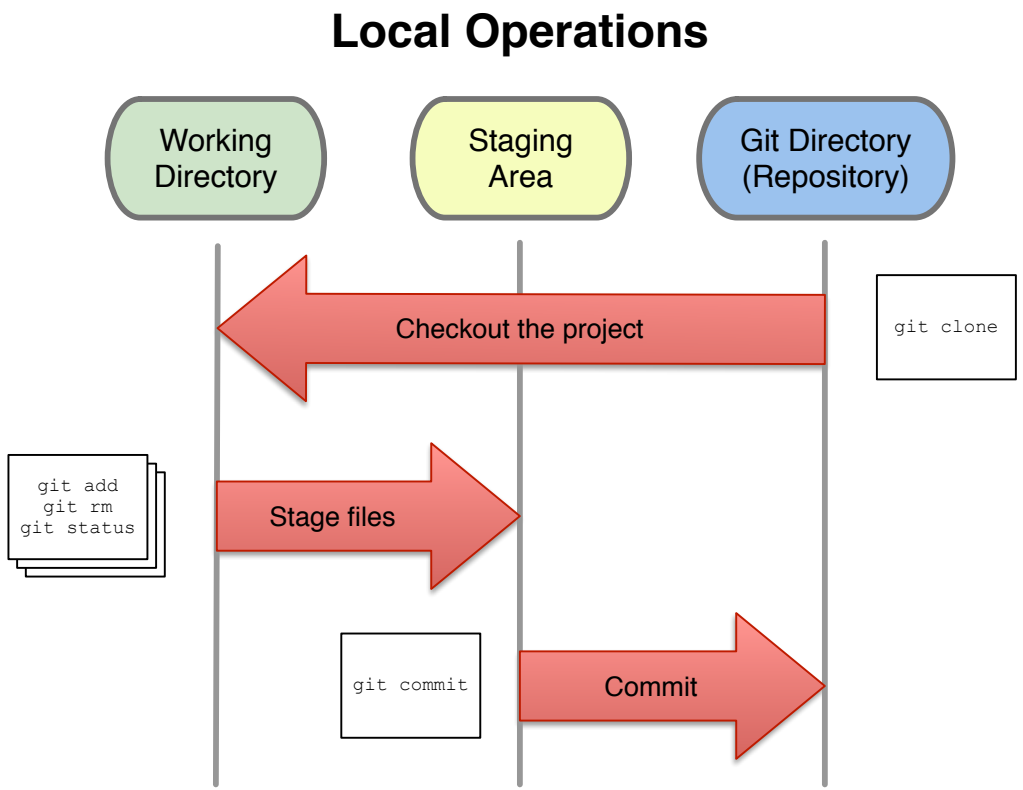
Git Commands Aliases

- You can also create git command aliases in `~/.gitconfig`.
  - ↪ **Ex** copy/paste from my personal `.gitconfig`

```
[alias]
    up = pull origin
    pu = push origin
    st = status
    df = diff
    ci = commit -s
    co = checkout
    br = branch
    w  = whatchanged --abbrev-commit
    ls = ls-files
    gr = log --graph --oneline --decorate
    amend = commit --amend
```

Summary

The Three (local) States



- The local repository lives in the `.git` directory.
- The **staging area** tracks what will go into the next commit
  - ↪ AKA "the index"

Summary

Creating a Repository

```
$> git [flow] init
```

- Initializes a new git (flow) repository in the current directory

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Your Turn!

```
$> cd /tmp
$> mkdir firstproject
$> cd firstproject

$> git init
Initialized empty Git repository in /private/tmp/firstproject/.git/
```

Cloning a Repository

```
$> git clone [--recursive] <url> [<path>]
```

Type	URL Format / Example	Port
Local	`/path/to/project.git`	n/a
SSH	`git+ssh://user@server:port/project.git`	22
Git	`git://server/project.git`	9418
HTTPS	`https://github.com/Falkor/falkorlib.git`	443

Cloning a Repository

```
$> git clone [--recursive] <url> [<path>]
```

Your Turn!

```
$> cd /tmp
$> git clone https://github.com/ULHPC/tutorials.git
Cloning into 'tutorials'...
remote: Counting objects: 1247, done.
remote: Compressing objects: 100% (63/63), done.
remote: Total 1247 (delta 32), reused 0 (delta 0), pack-reused 1181
Receiving objects: 100% (1247/1247), 15.74 MiB | 3.08 MiB/s, done.
Resolving deltas: 100% (588/588), done.
Checking connectivity... done.
$> git clone --recursive \
      https://github.com/ULHPC/tutorials.git /tmp/tutorials2
```

Inspecting a Repository

```
$> git status [-s]          # -s:  short / simplified output
```

Inspecting a Repository

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Your Turn!

```
$> cd /tmp/firstproject
$> git status
On branch master

Initial commit

nothing to commit

# Create an empty file
$> touch README.md
```

```
$> git status
On branch master

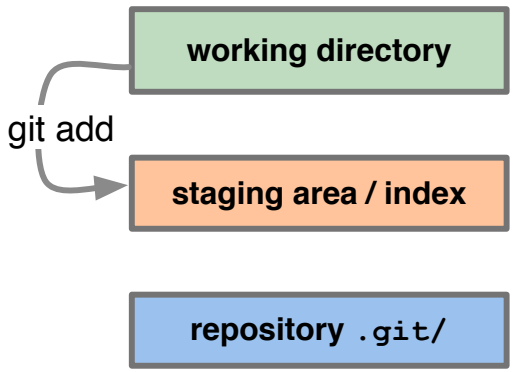
Initial commit

Untracked files:
    README

nothing added to commit but untracked
files present
$> git status -s
?? README
```

Add / Tracking [new] file(s)

```
$> git add [-f] <pattern>
```



- Adds changes to the index
  - ↪ Add a specific file: `git add README`
  - ↪ Add a set of files: `git add *.py`
- Beware that empty directory cannot be added **directly**
  - ↪ due to the internal file representation (**blobs**)
  - ↪ **Tips**: add an hidden file `.empty` (or `.gitignore`)

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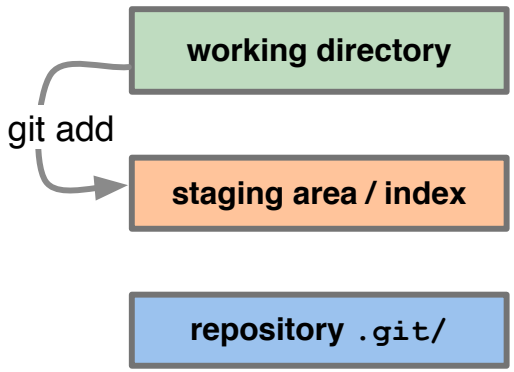

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Your Turn!

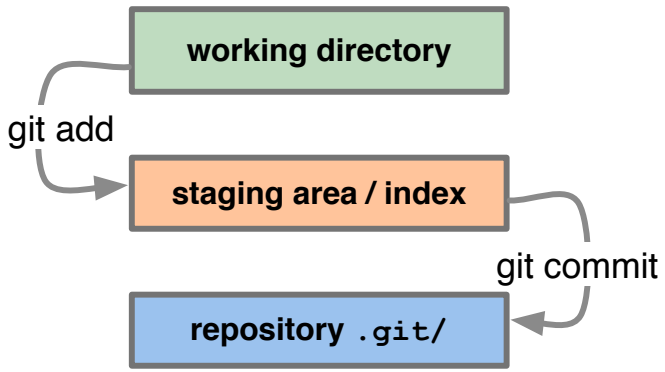
```
$> cd /tmp/firstproject
$> git status -s
?? README
```

```
$> git add README
$> git status -s
A  README
```

Committing your changes

```
$> git commit [-s] [-m "msg"]
```

- Commit all changes: `git commit -a`



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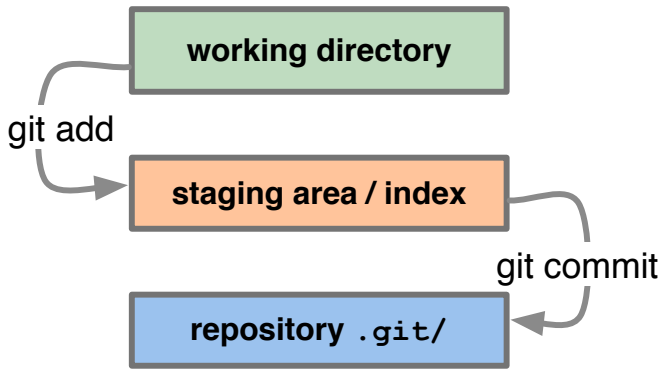

- Commit all changes: `git commit -a`

Your Turn!

```
$> cd /tmp/firstproject
$> git commit -s -m "add README"    # OR git ci -m "add README"
[master (root-commit) ee60f53] add README
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 README
$> git status               # OR git st
On branch master
nothing to commit, working directory cleant
```

Removing Files

```
$> git rm [-rf] [--cached] <file>
```

- `--cached`: remove from Staging area
  - ↪ otherwise (default): from index **and** file system

Ignoring Files

Ignoring files from staging: '.gitignore'

- you can create a `.gitignore` file listing patterns to ignore
  - ↪ Blank lines or lines starting with \# are ignored
  - ↪ End pattern with slash (/) to specify a directory
  - ↪ Negate pattern with exclamation point (!)
- Collection of useful `.gitignore` templates

```
.DS_Store
*~
```

```
*.asv
*.m~
*.mex*
tmp/*
```

- LaTeX `.gitignore`
- Python `.gitignore`
- Ruby `.gitignore`

Moving Files

```
$> git mv <source> <destination>
```

```
# Equivalent of:
mv <source> <destination>
git rm <source>
git add <destination>
```

Moving Files

```
$> git mv <source> <destination>
```

```
# Equivalent of:
mv <source> <destination>
git rm <source>
git add <destination>
```

Your Turn!

```
$> cd /tmp/firstproject
$> git mv README README.md
$> git status
On branch master
Changes to be committed:
    renamed:    README -> README.md
$> git commit -m "a first move"
```

Check the Commit History

```
$> git log [-p] [--stat] [--graph --oneline --decorate]
```

- `-p` / `--stat`: show the differences introduced in each commit
- You can also perform some date filtering

  ```
  $> git log --since=2.weeks
  ```

- Ncurses-based text-mode interface: `tig`

Check the Commit History

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- `-p` / `--stat`: show the differences introduced in each commit
- You can also perform some date filtering

  ```
  $> git log --since=2.weeks
  ```

- Ncurses-based text-mode interface: `tig`

Your Turn!

```
$> cd /tmp/firstproject
$> git log --oneline --graph --decorate     # OR git gr
* f1f0c27 (HEAD -> master) a first move
* ee60f53 add README
$> git log -p -1          # only the last commit OR git show
$> tig
```

Show differences

```
$> git diff [--cached] [<ref>]
```

- Check **un-staged** changes: `git diff`
  - ↪ `--cached`: check **staged** changes
- Relative to a specific revision:

```
$> git diff 1776f5
$> git diff HEAD^
```

Undoing Things

```
$> git commit --amend                    # Change the last commit
```

Undoing Things

```
$> git commit --amend                    # Change the last commit
```

```
$> git unstage <file>                    # or git reset HEAD <file>
```

Undoing Things

```
$> git commit --amend                    # Change the last commit
```

```
$> git unstage <file>                    # or git reset HEAD <file>
```

```
$> git checkout -- <file>   # DANGER! Un-modify modified file
```

- Restore to the last committed/cloned version: **all** changes are lost!

Undoing Things

```
$> git commit --amend                    # Change the last commit
```

```
$> git unstage <file>                    # or git reset HEAD <file>
```

```
$> git checkout -- <file>   # DANGER! Un-modify modified file
```

```
$> git revert <commit>                   # revert a <commit>
```

- Make a new commit that undoes all changes made in <commit>

Undoing Things

```
$> git commit --amend                    # Change the last commit
```

```
$> git unstage <file>                    # or git reset HEAD <file>
```

```
$> git checkout -- <file>   # DANGER! Un-modify modified file
```

```
$> git revert <commit>                   # revert a <commit>
```

Your Turn!

```
$> cd /tmp/firstproject
$> git commit --amend
$> echo 'toto' >> README.md
```

```
$> cat README.md && git status
$> git checkout -- README
$> git status
```

Summary

Basic Workflow

Edit files	`vim` / `emacs` / `subl` ...
Stage the changes	`git add`
Review your changes	`git status`
Commit the changes	`git commit`

Summary

For cheaters: A Basicerer Workflow

Edit files	`vim` / `emacs` / `subl` ...
Stage & commit the changes	`git commit -a`

Summary

For cheaters: A Basicerer Workflow

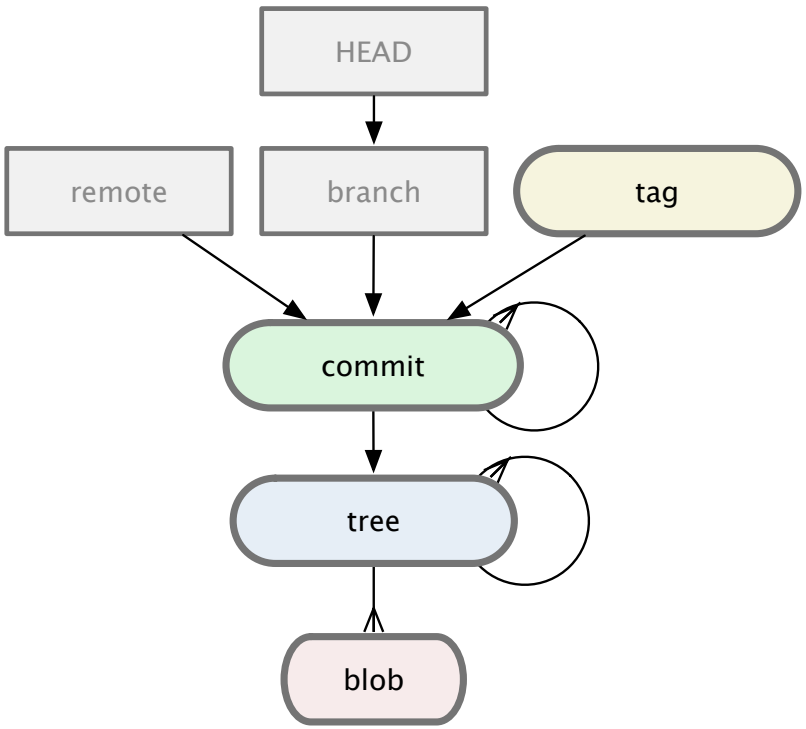
Edit files	`vim` / `emacs` / `subl` ...
Stage & commit the changes	`git commit -a`

Advices

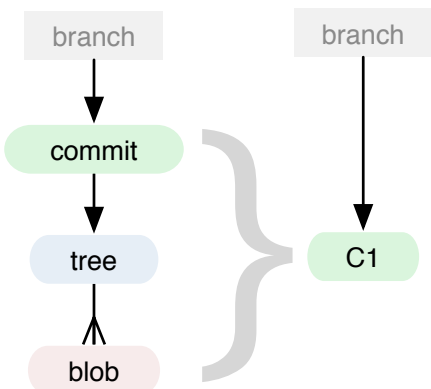
- **Commit early, commit often!**
  - ↪ commits = save points
  - ↪ use descriptive commit messages
- Don't get out of sync with your collaborators
- Commit the sources, not the derived files

Summary

Data Model



- **Immutable** objects
  - ↪ **Blob**: File content
  - ↪ **Tree**: Directory List
  - ↪ **Commit**: Pointer to a snapshot / tree
  - ↪ **Tag**: Pointer to commit
- **Git Branch**: Lighweight, movable pointer to a commit (`HEAD`: current branch)



Data Model Example

README.md

```
'Hello' Project
===================
This is Seb's first
Git project

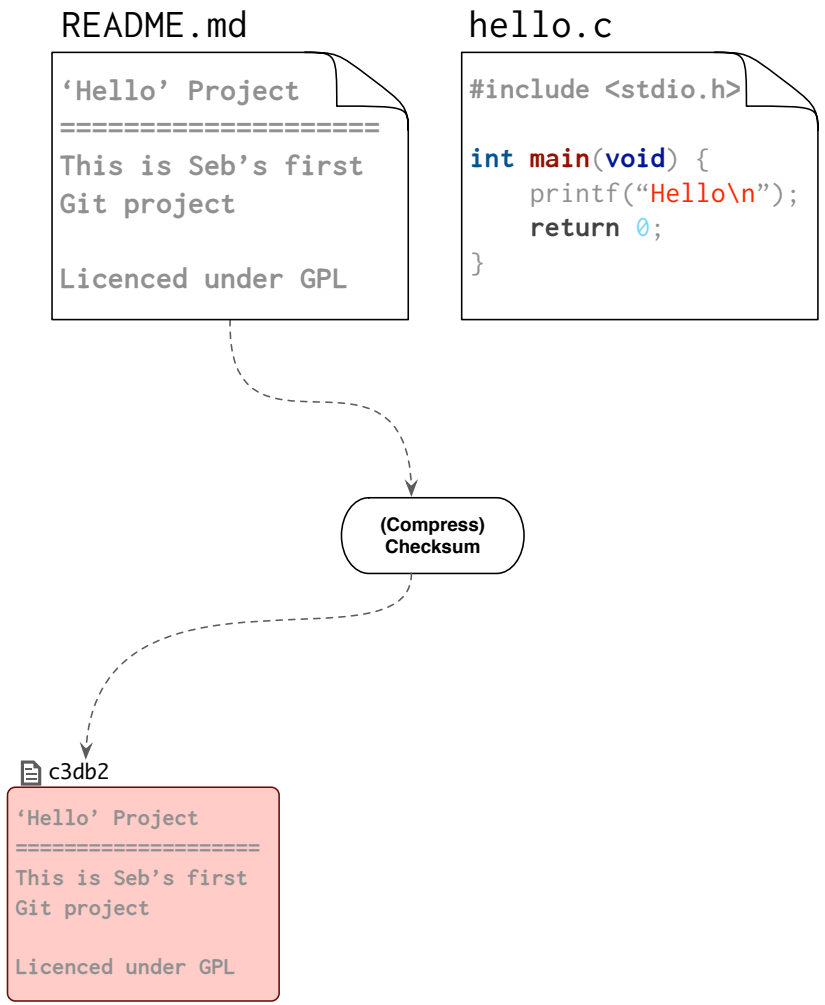
Licenced under GPL
```

hello.c

```c
#include <stdio.h>

int main(void) {
    printf("Hello\n");
    return 0;
}
```

Data Model Example



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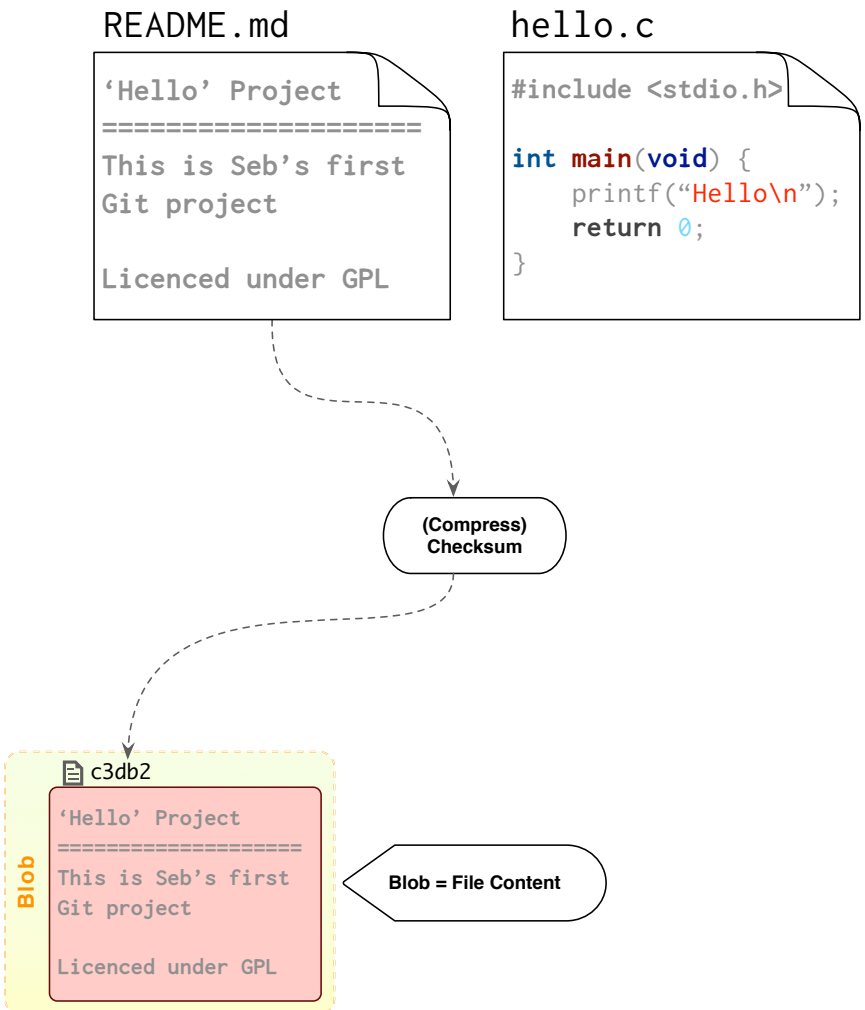

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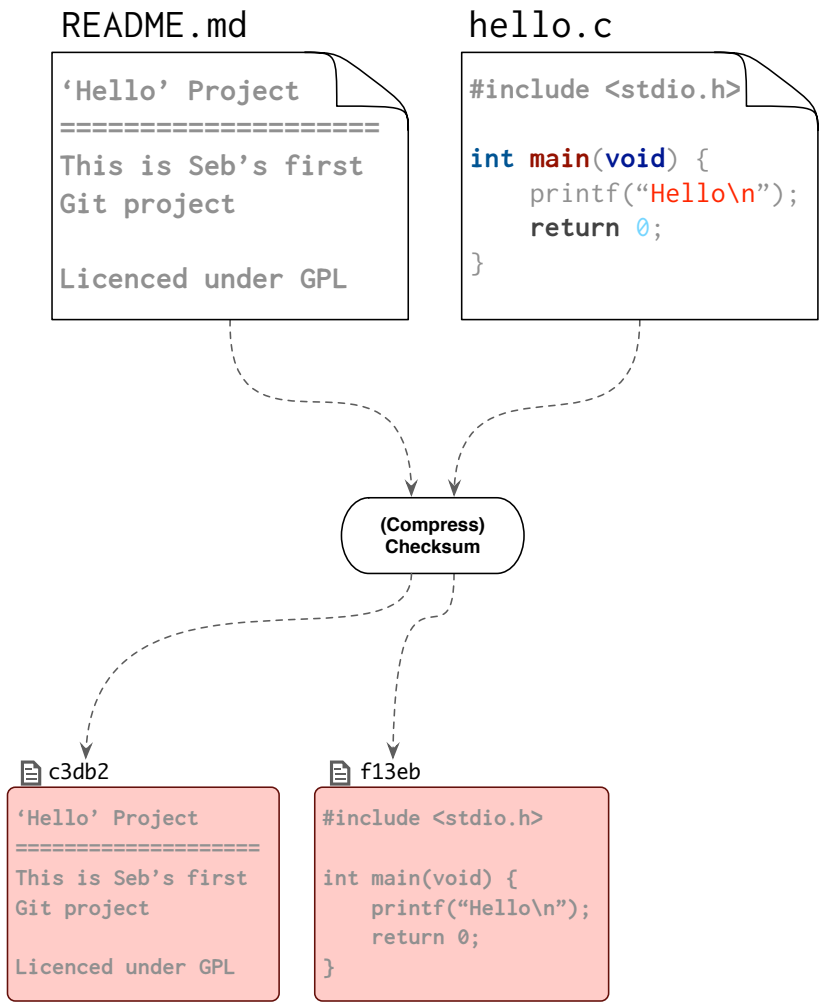

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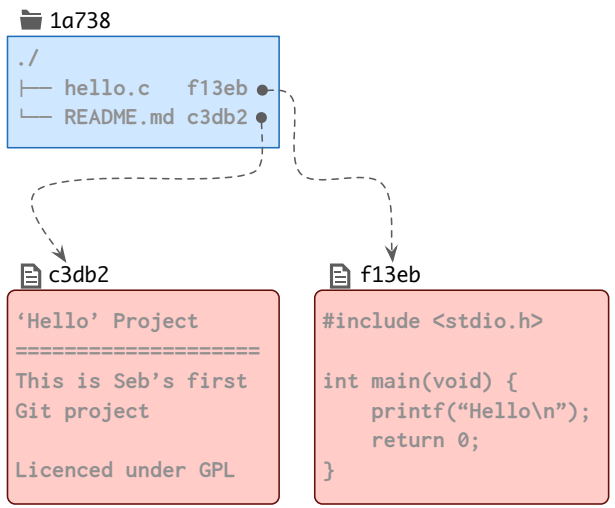

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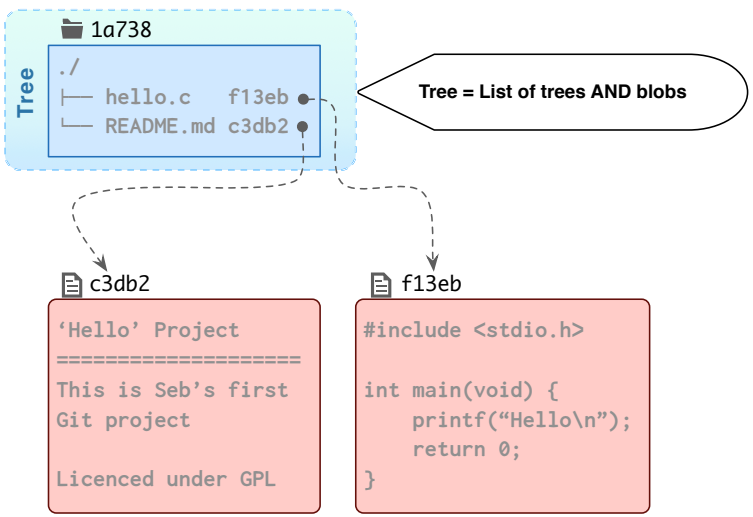

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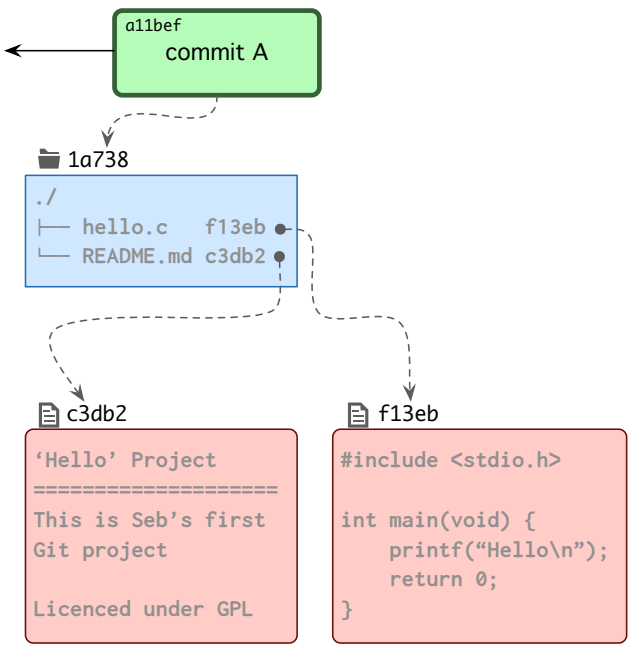

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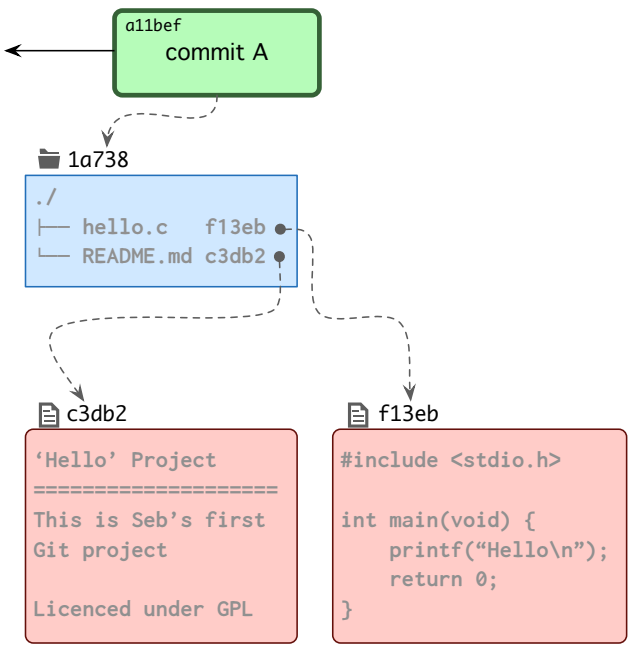

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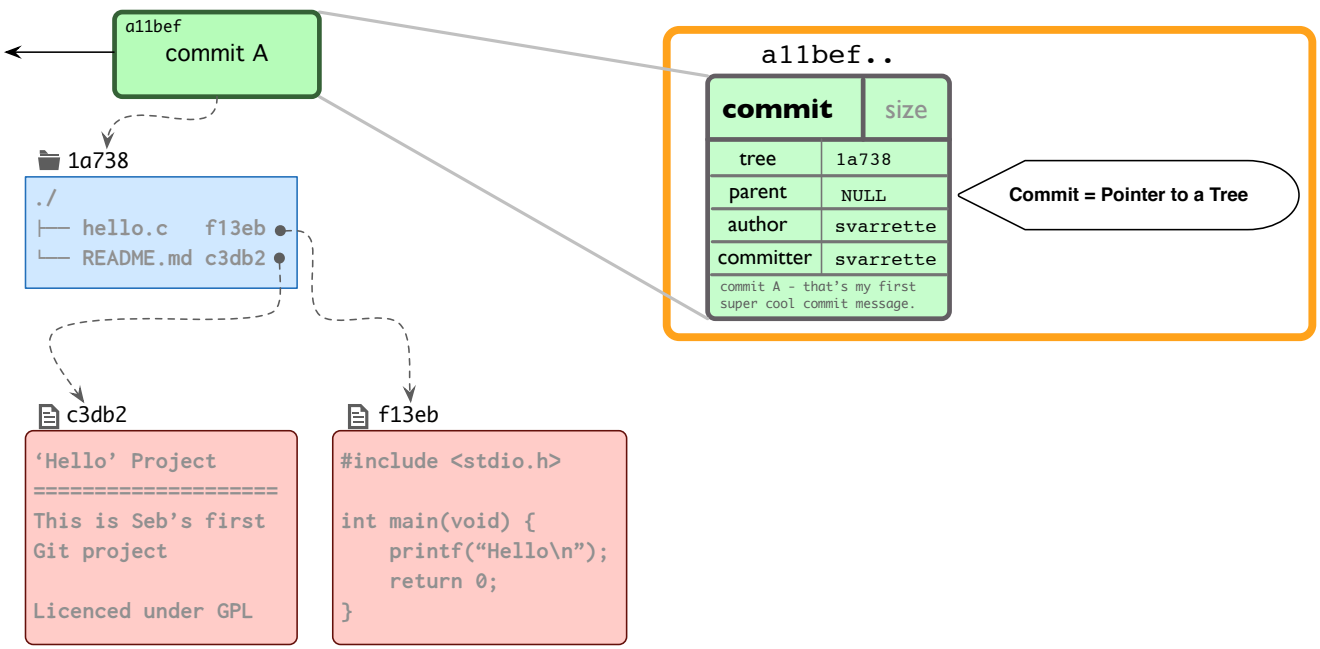

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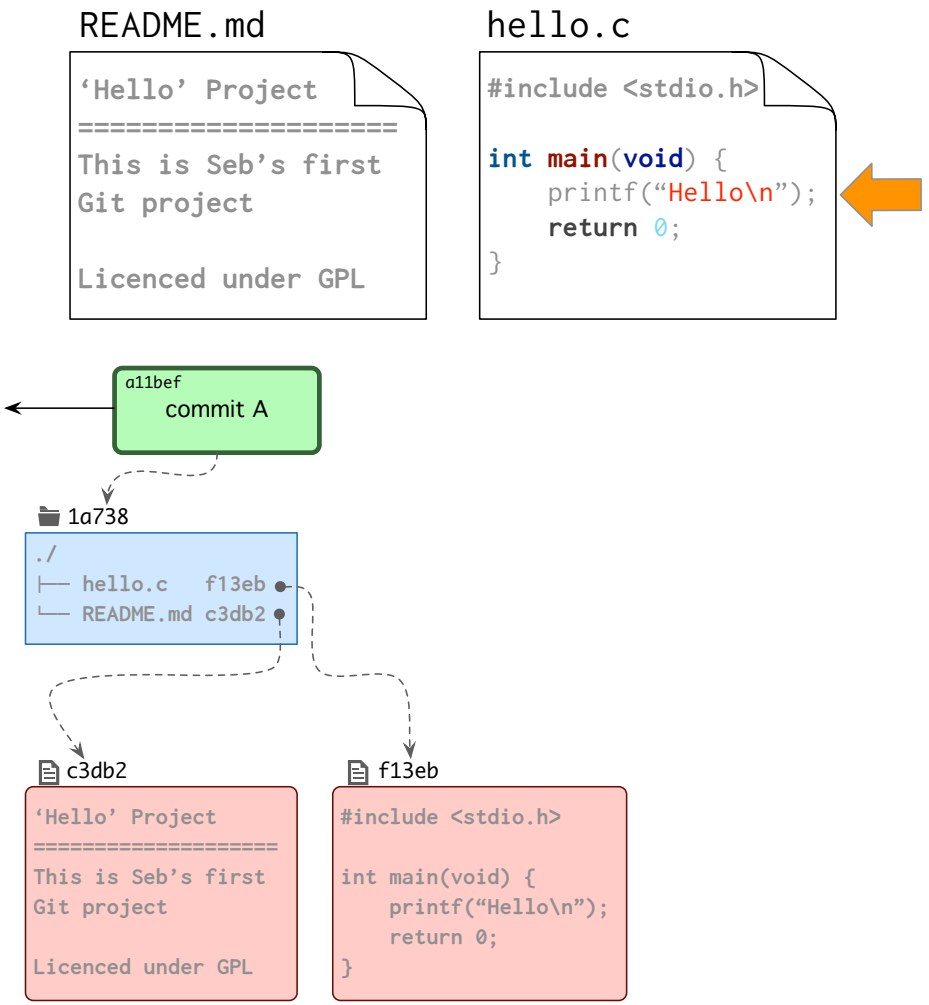

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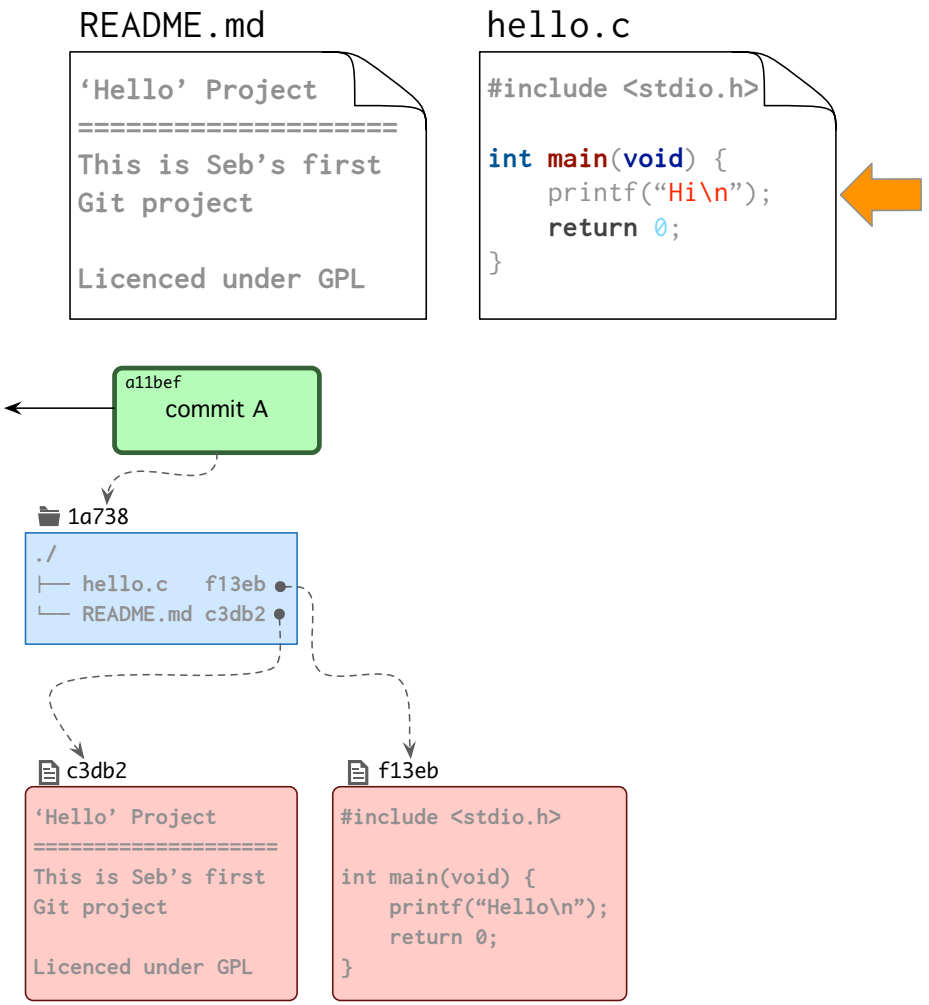

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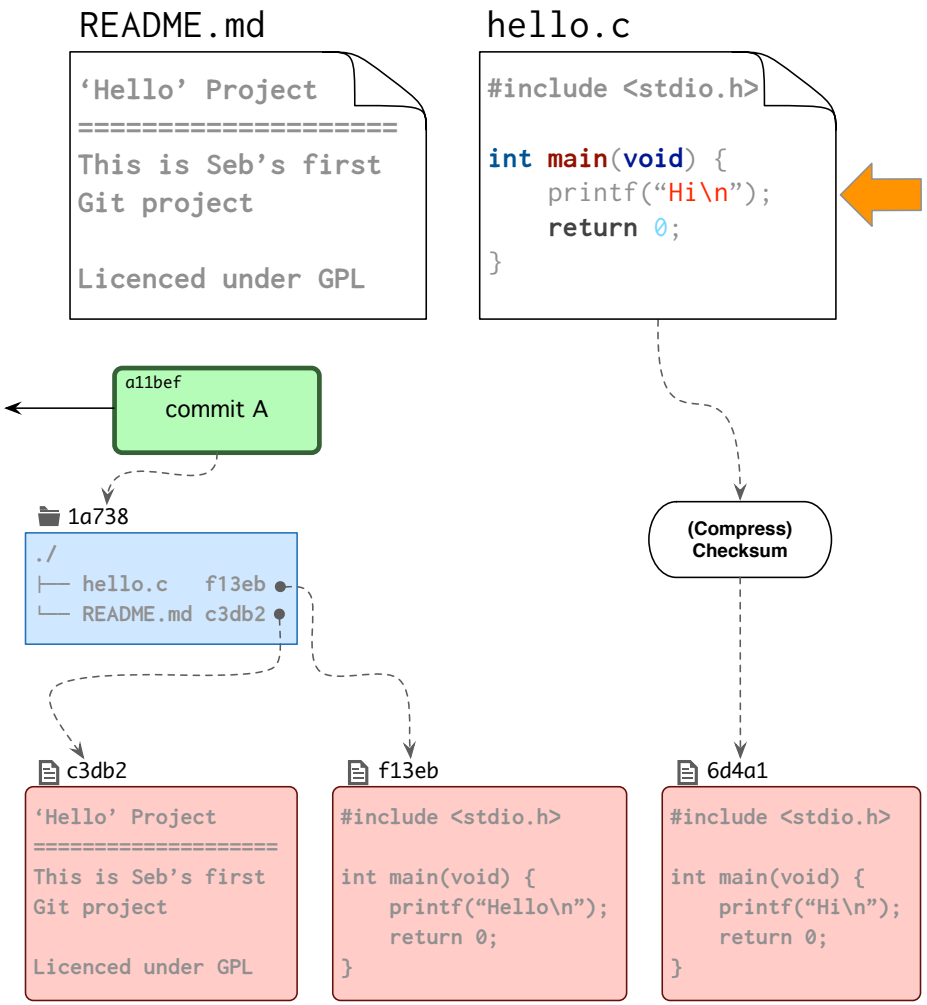

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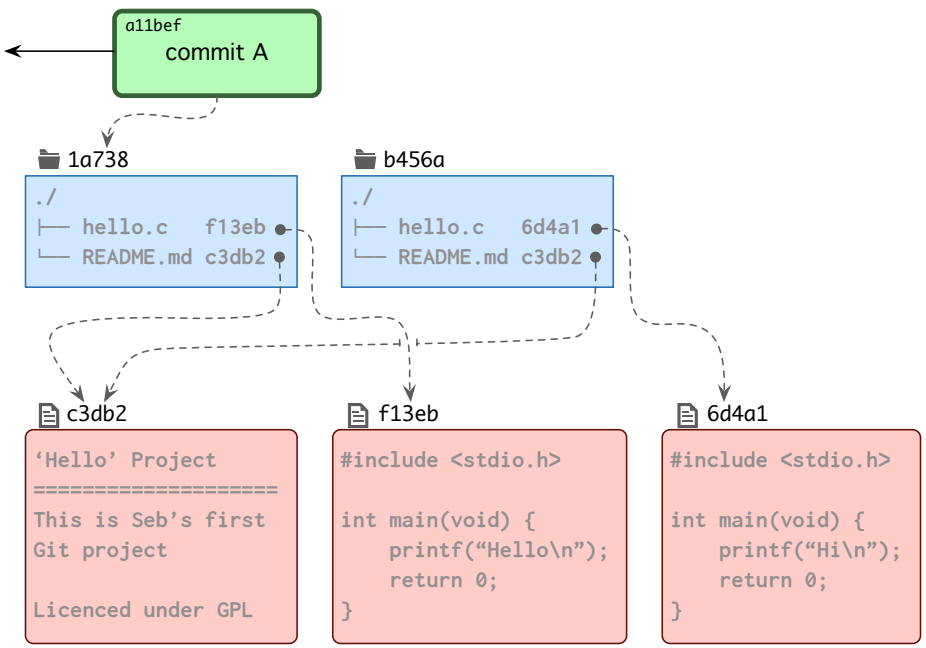

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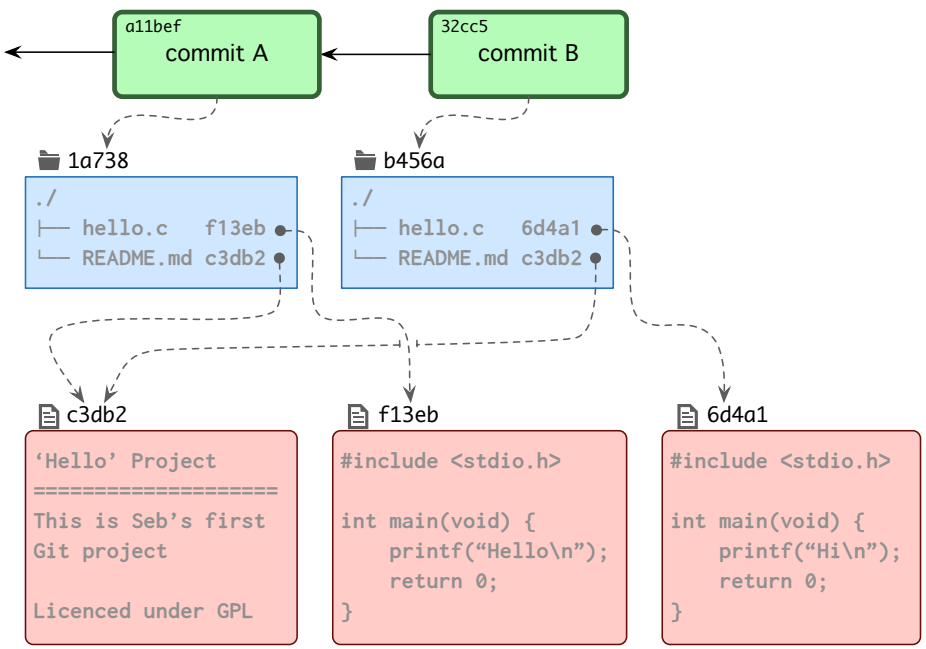

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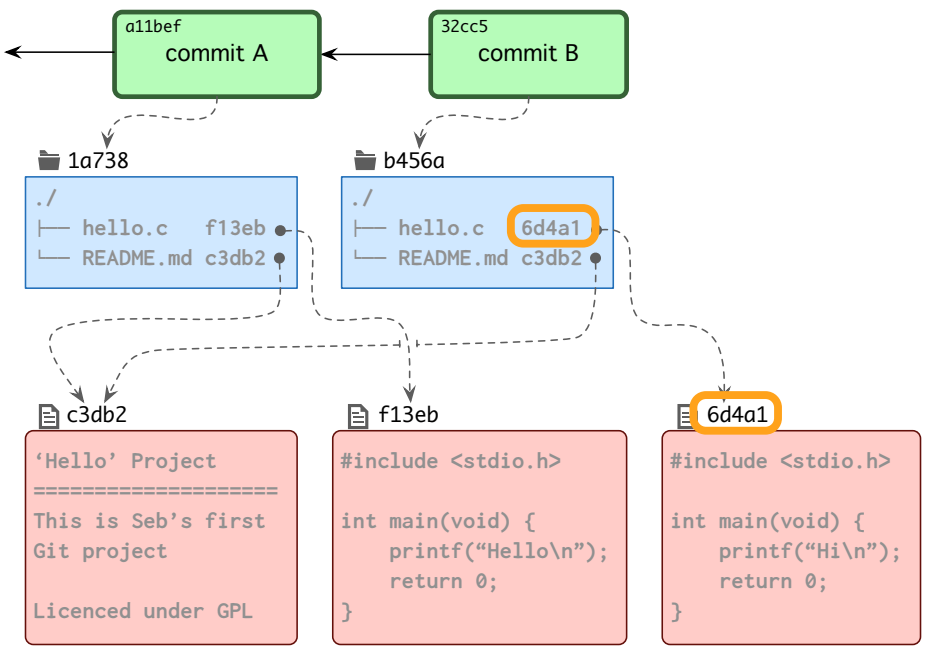

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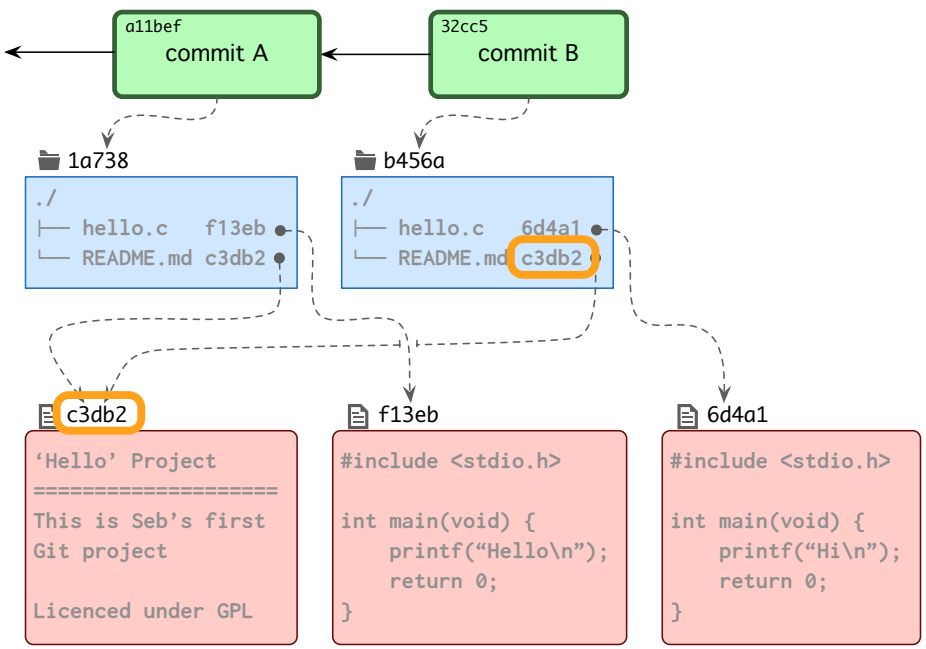

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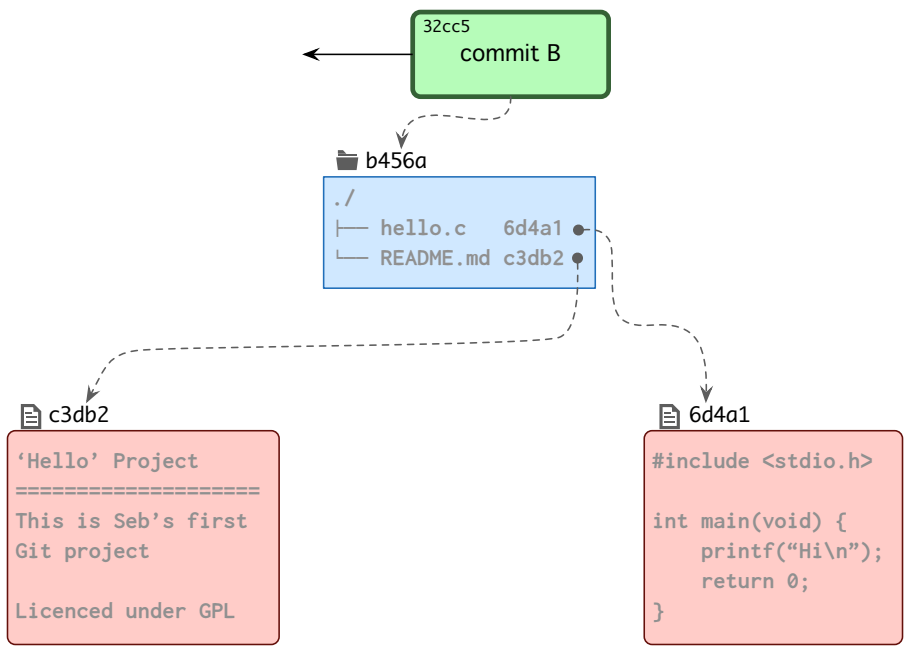

Data Model Example

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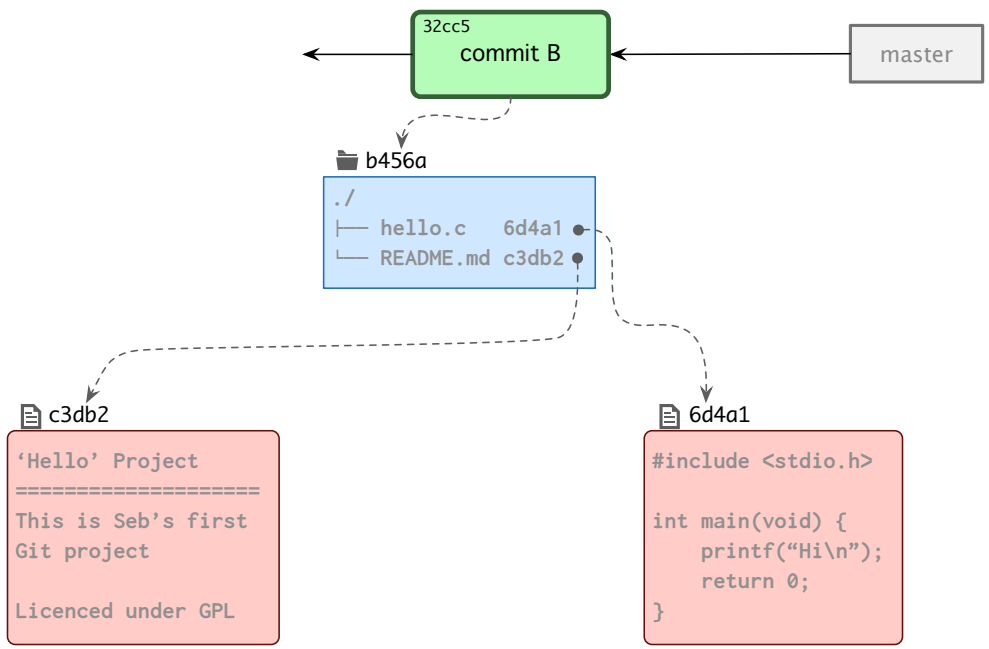

Data Model Example

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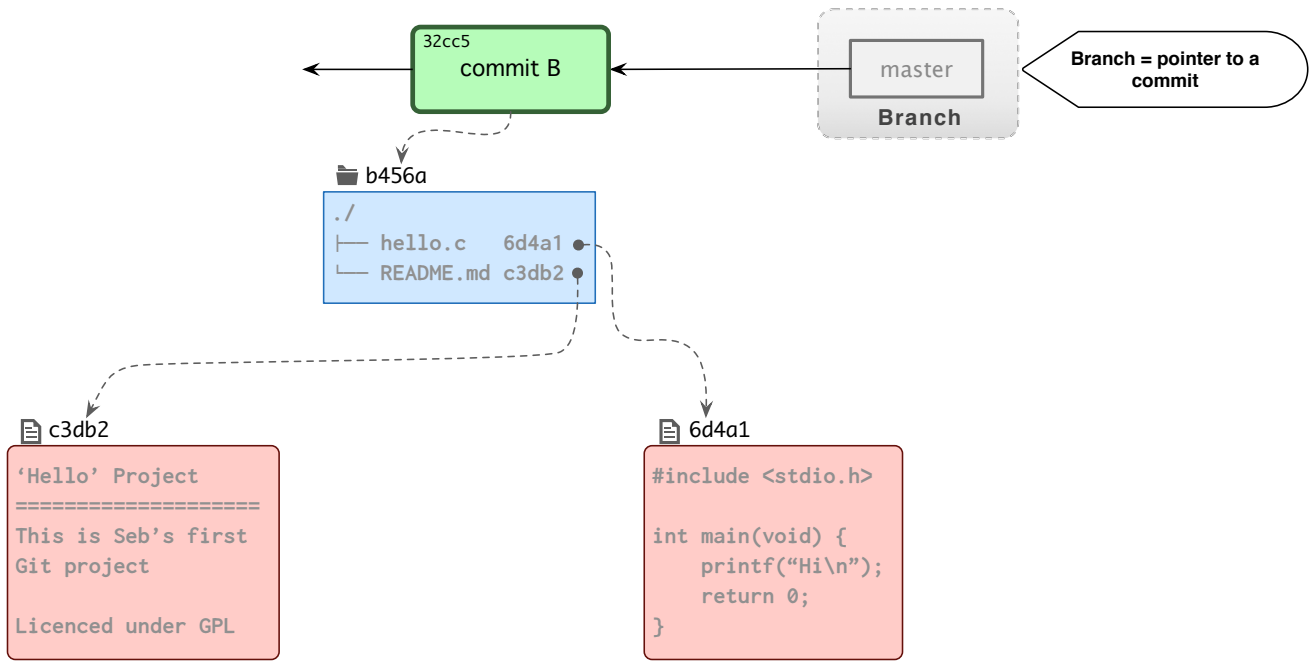
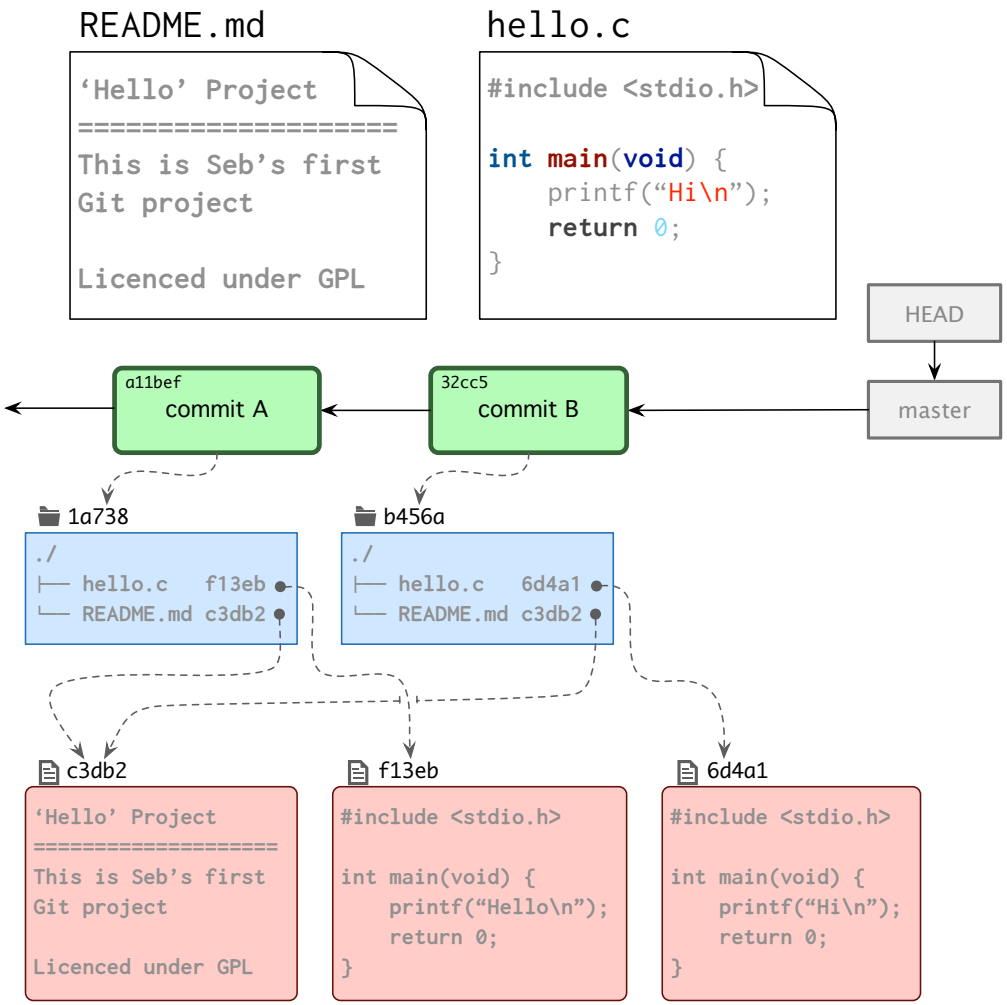


Data Model Example



Branching

```
$> git branch <name>                    # create a branch <name>
```

Branching

```
$> git branch <name>                    # create a branch <name>
```

```
$> git branch -d <name>                  # delete the branch <name>
```

- use `-D` instead of `-d` to force deletion

Branching

```
$> git branch <name>                    # create a branch <name>
```

```
$> git branch -d <name>                 # delete the branch <name>
```

```
$> git branch [-a]                      # List [all] the branches
```

Branching

```
$> git branch <name>                    # create a branch <name>
```

```
$> git branch -d <name>                 # delete the branch <name>
```

```
$> git branch [-a]                      # List [all] the branches
```

```
$> git checkout [-b] <name>     # swicth to the branch <name>
```

- -b: create the branch before switching
- changes commited through `git commit` are committed to `HEAD`

Branching

```
$> git branch <name>                    # create a branch <name>
```

```
$> git branch -d <name>                 # delete the branch <name>
```

```
$> git branch [-a]                      # List [all] the branches
```

```
$> git checkout [-b] <name>             # swicth to the branch <name>
```

- **Switching** branches **changes** the files in your Working directory
  - ↪ since you change the `HEAD` snapshot...

Tags

```
$> git tag [-s] <name> [-m 'msg']
```

- `-s`: GPG-signed tag, assuming you have configured your signing key

```
$> git config --global user.signingkey 0xDD01D5C1
```

Tags

```
$> git tag [-s] <name> [-m 'msg']
```

- `-s`: GPG-signed tag, assuming you have configured your signing key

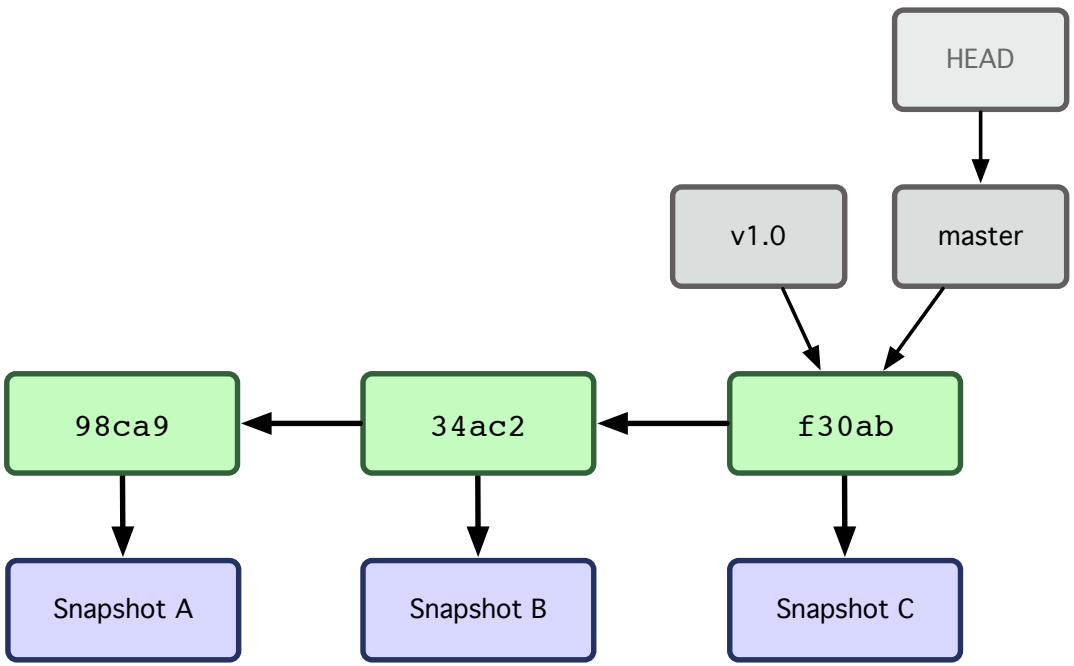
```
$> git config --global user.signingkey 0xDD01D5C1
```

Your Turn!

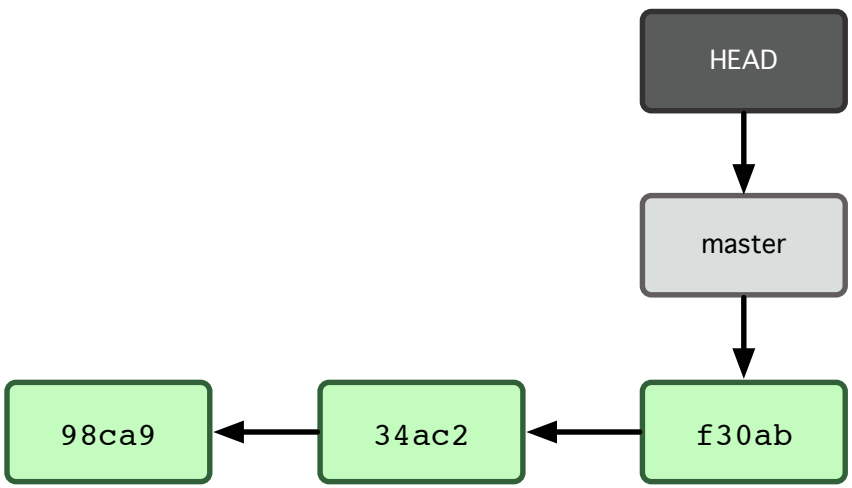
Branch and Tags Hands-on

```
$> cd /tmp/firstproject
$> git branch
* master
$> git tag v1.0 -m 'first tag'
$> git gr
* f31c173 (HEAD -> master, tag: v1.0) a first move with amend
* ee60f53 add README
$> git branch testing
$> git checkout testing   # Move to the 'testing' branch
$> echo 'testing' >> README.md && git commit -a -m "testing 1"
[testing 7afa96d] testing 1
 1 file changed, 1 insertion(+)
$> git checkout master   # return to 'master'
$> echo 'master' >> README.md && git commit -a -m "master"
[master 72d4d5f] master
 1 file changed, 1 insertion(+)
$> git gr
$> gitx   # or gitk
```

Daily Branching Example

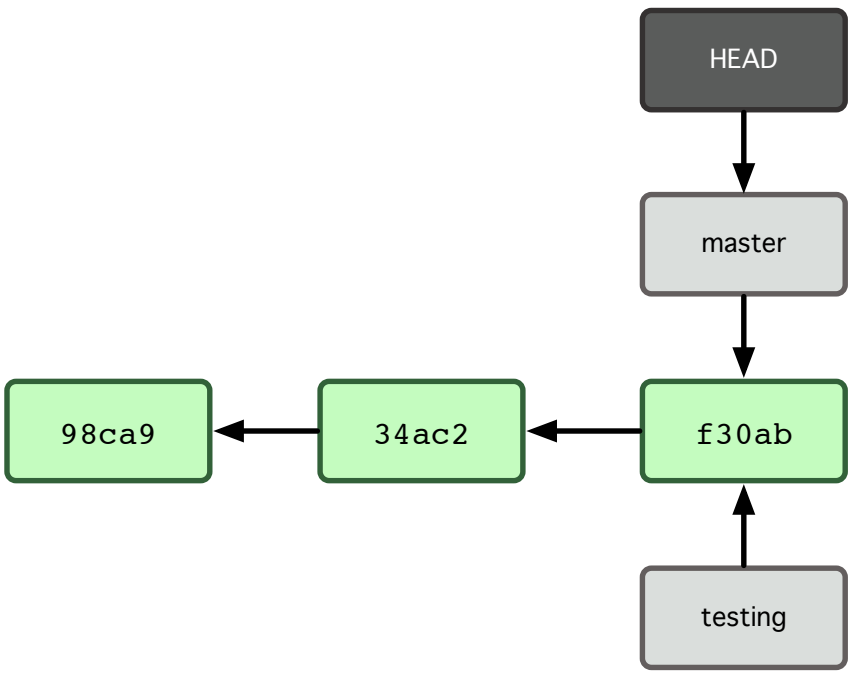


Daily Branching Example



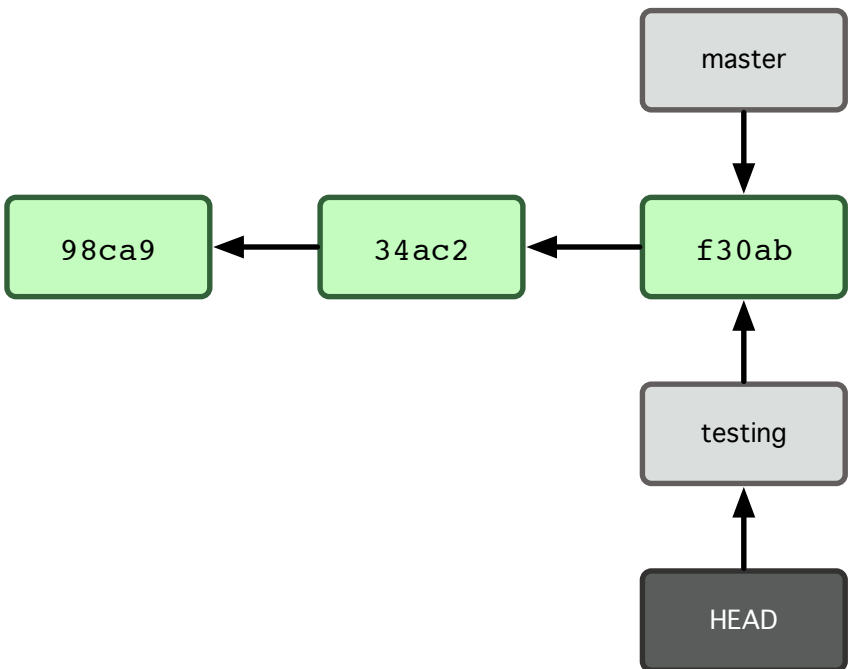
Daily Branching Example

```
(master)$> git branch testing          # create a branch named 'testing'
```



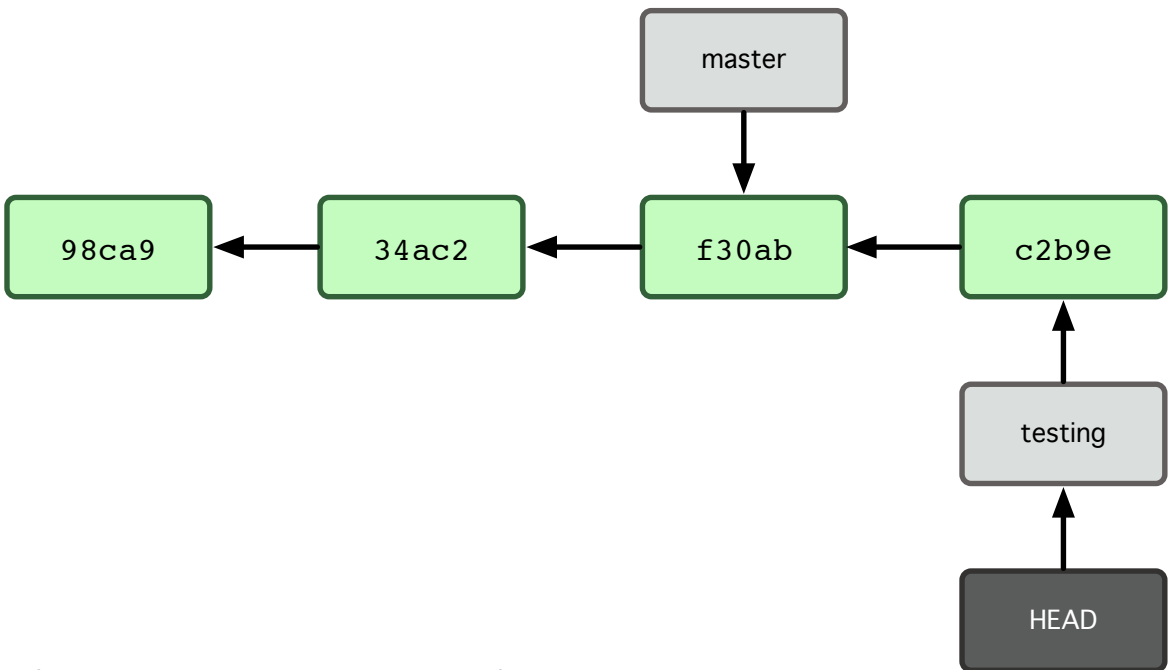
Daily Branching Example

```
(master)$> git checkout testing          # switch to the 'testing' branch
```



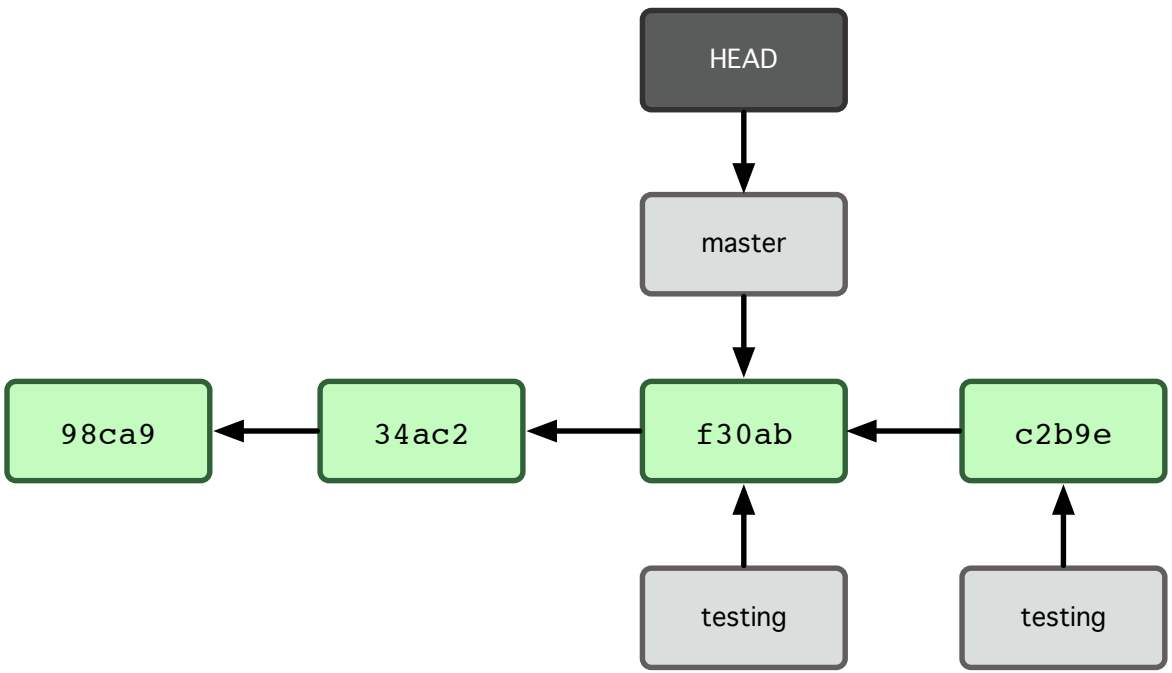
Daily Branching Example

```
(testing)$> vim README.md                          # make some edits...
(testing)$> git commit -a -m "made a change"       # and commit them
```



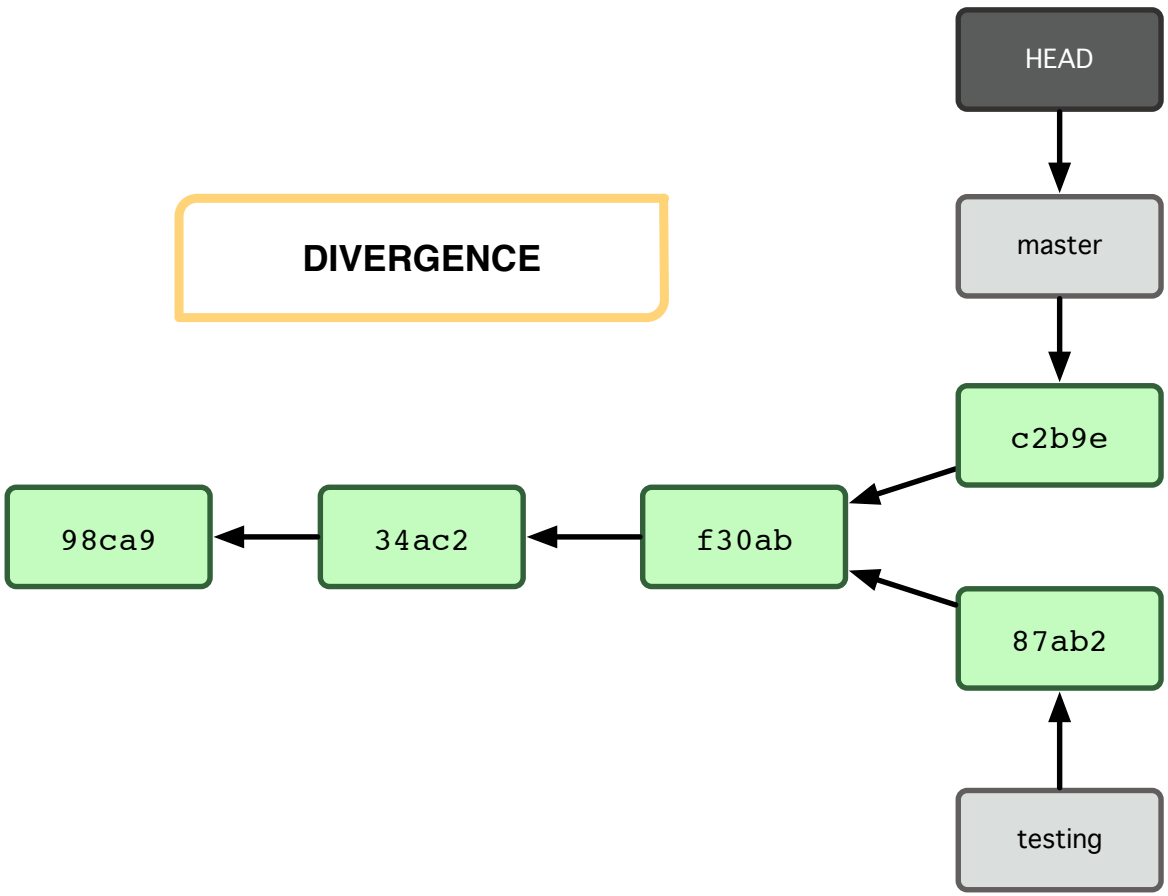
Daily Branching Example

```
(testing)$> git checkout master          # switch back to 'master' branch
```



Daily Branching Example

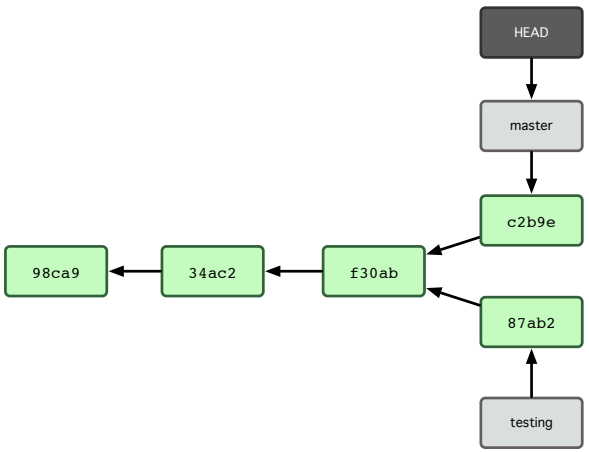
```
(testing)$> vim README.md                    # make some edits
(testing)$> git commit -a -m "intro"         # introduce divergence!
```



Diverging / Converging (Fork-Join)

Diverging

- Changes are committed into two branches independently
  - ↪ Then the branches **diverge**



Diverging / Converging (Fork-Join)

Diverging

- Changes are committed into two branches independently
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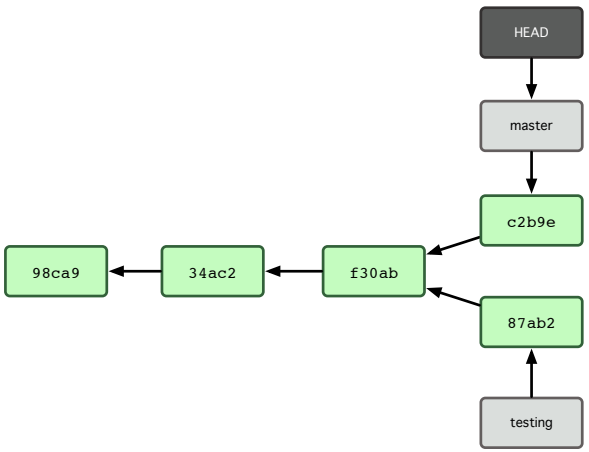


Converging to join branches

1. `merge` (if possible in **fast-forward** mode)
2. `rebase`

Merging

```
$> git merge [--no-ff] <branch>
```

- Different auto-merge strategies
  - ↪ **fast-forward** (if possible)
  - ↪ **3-ways** (regular)
- Usually painless ;)

Merging

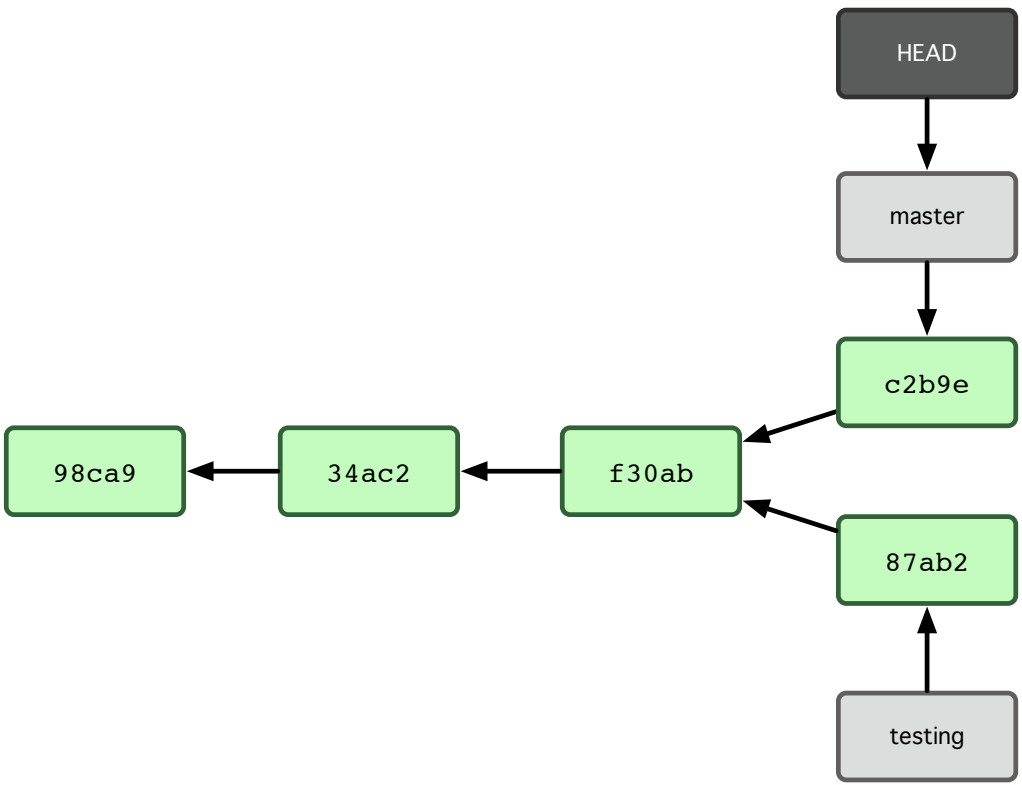
```
$> git merge [--no-ff] <branch>
```

- Different auto-merge strategies
  - ↪ **fast-forward** (if possible)
  - ↪ **3-ways** (regular)
- Usually painless ;)

```
<<<<<<< HEAD
master
=======
testing
>>>>>>> testing
```

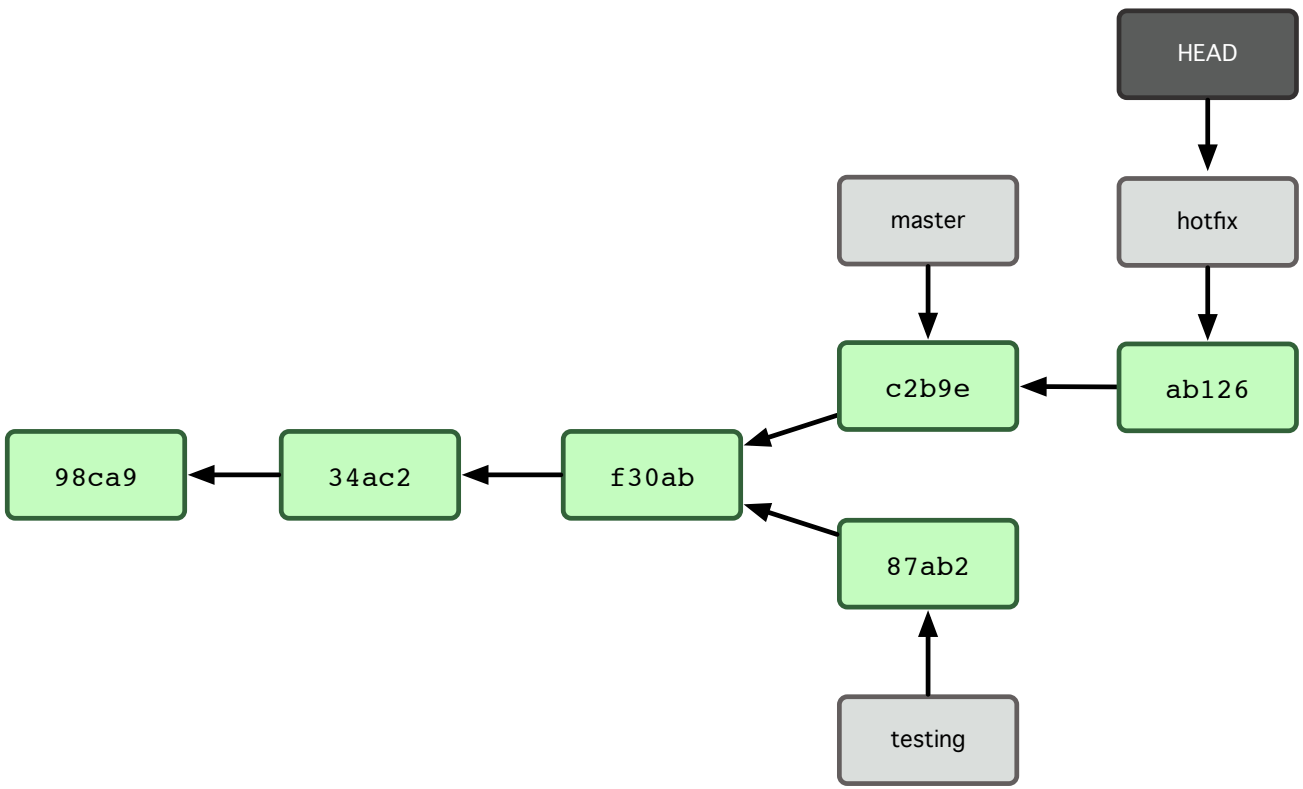
- **In case of conflicts**:
  - ↪ Resolve the conflicts manually — `vim` / `emacs` / `subl` ...
    - ✓ check for the sequence <<< in the text
  - ↪ then mark as resolved — `git add <file>`
  - ↪ and trigger the merge commit — `git commit`

Daily Branching Example



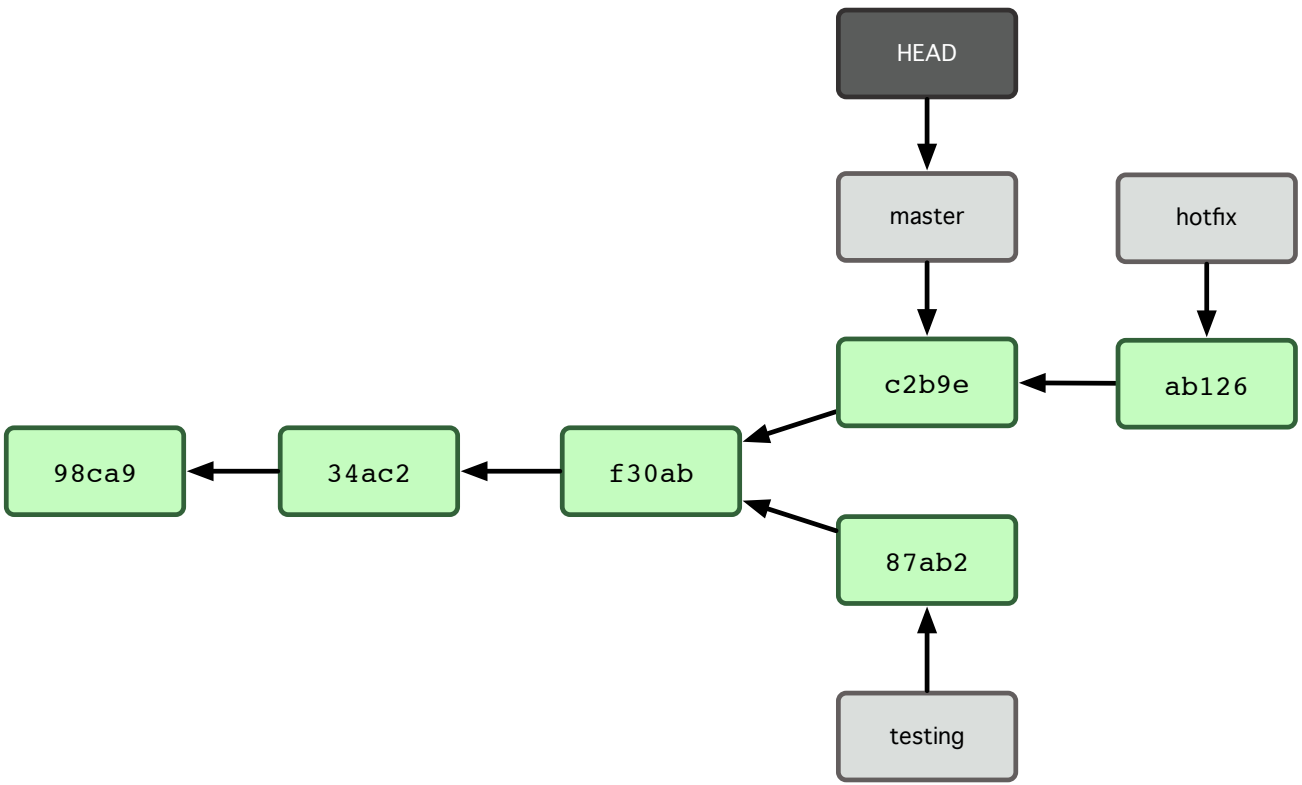
Daily Branching Example

```
(master)$> git checkout -b hotfix        # create and switch to 'hotfix'
(hotfix)$> vim test.rb                      # make some edits...
(hotfix)$> git commit -a -m "hotfix"           # and commit them
```



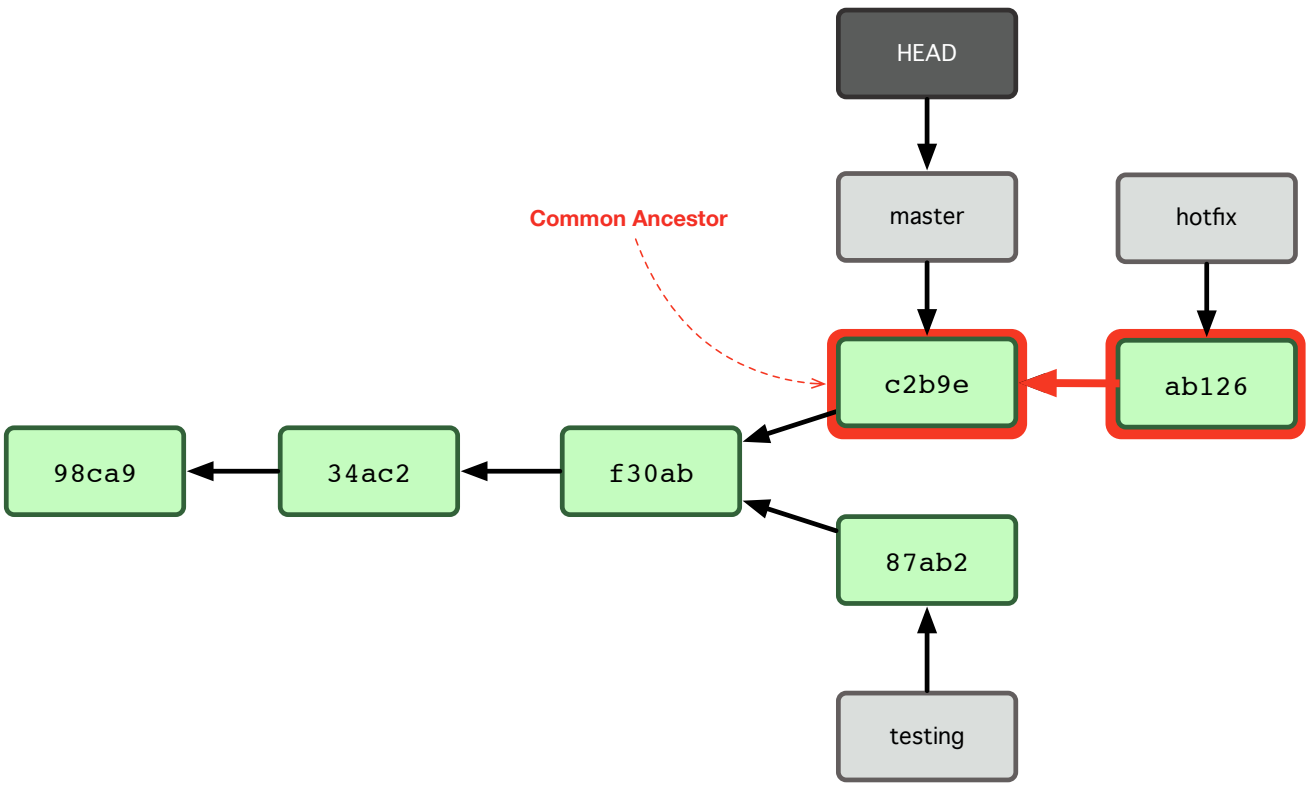
Daily Branching Example

```
(hotfix)$> git checkout master          # swicth back to 'master' branch
```



Daily Branching Example

```
(master)$> git merge hotfix   # merge the 'hotfix' branch (fast-forward)
```



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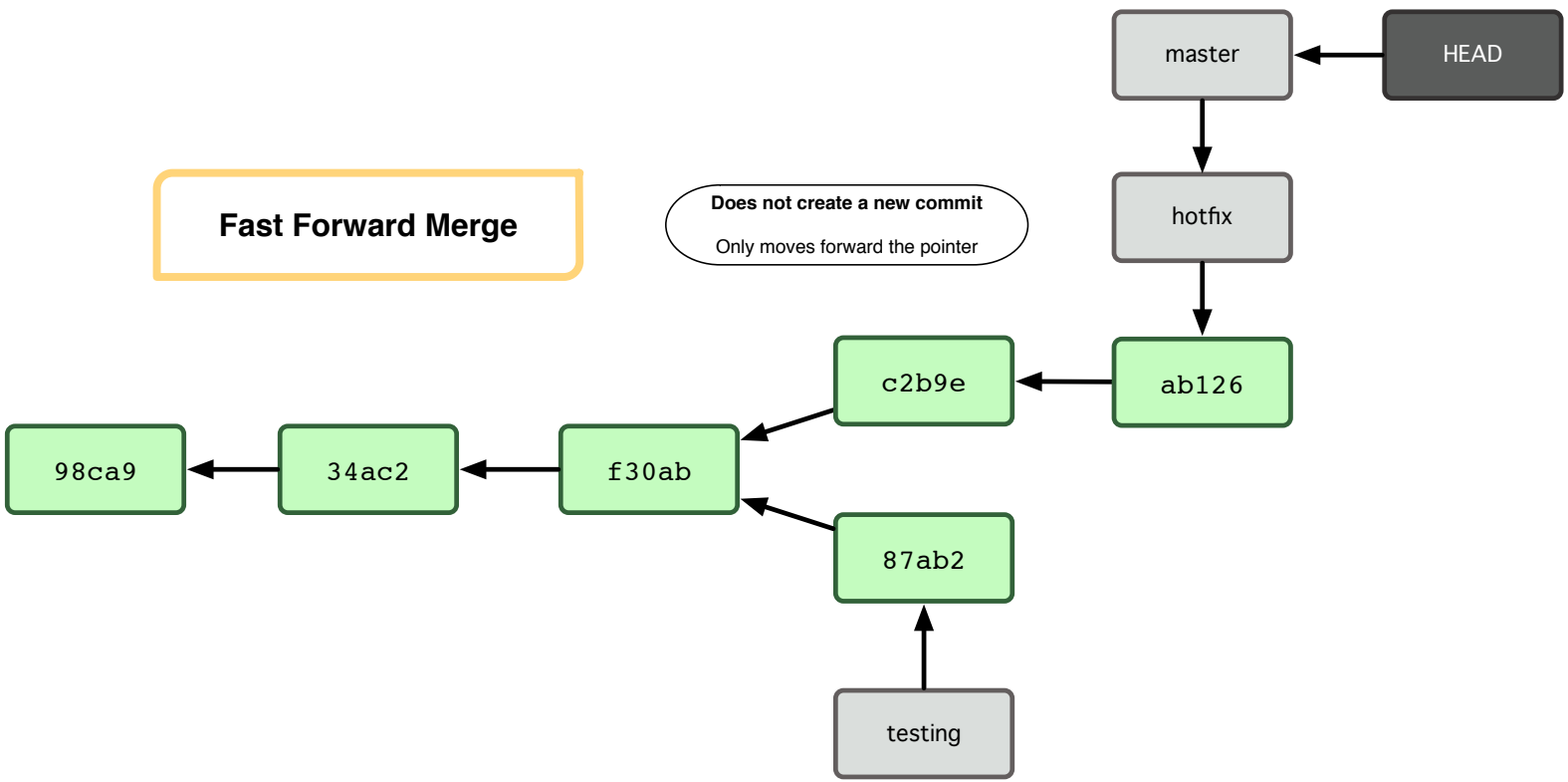

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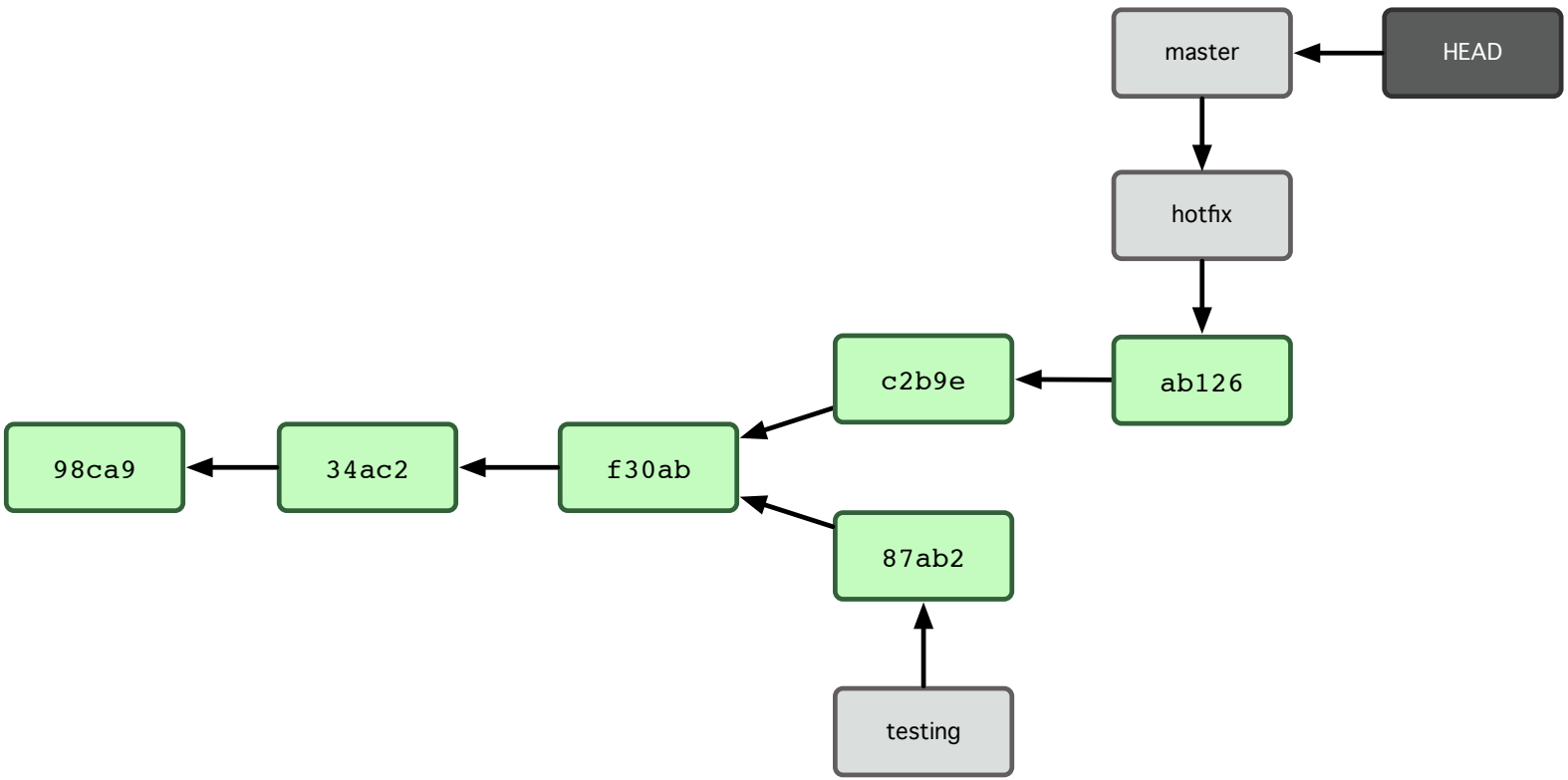
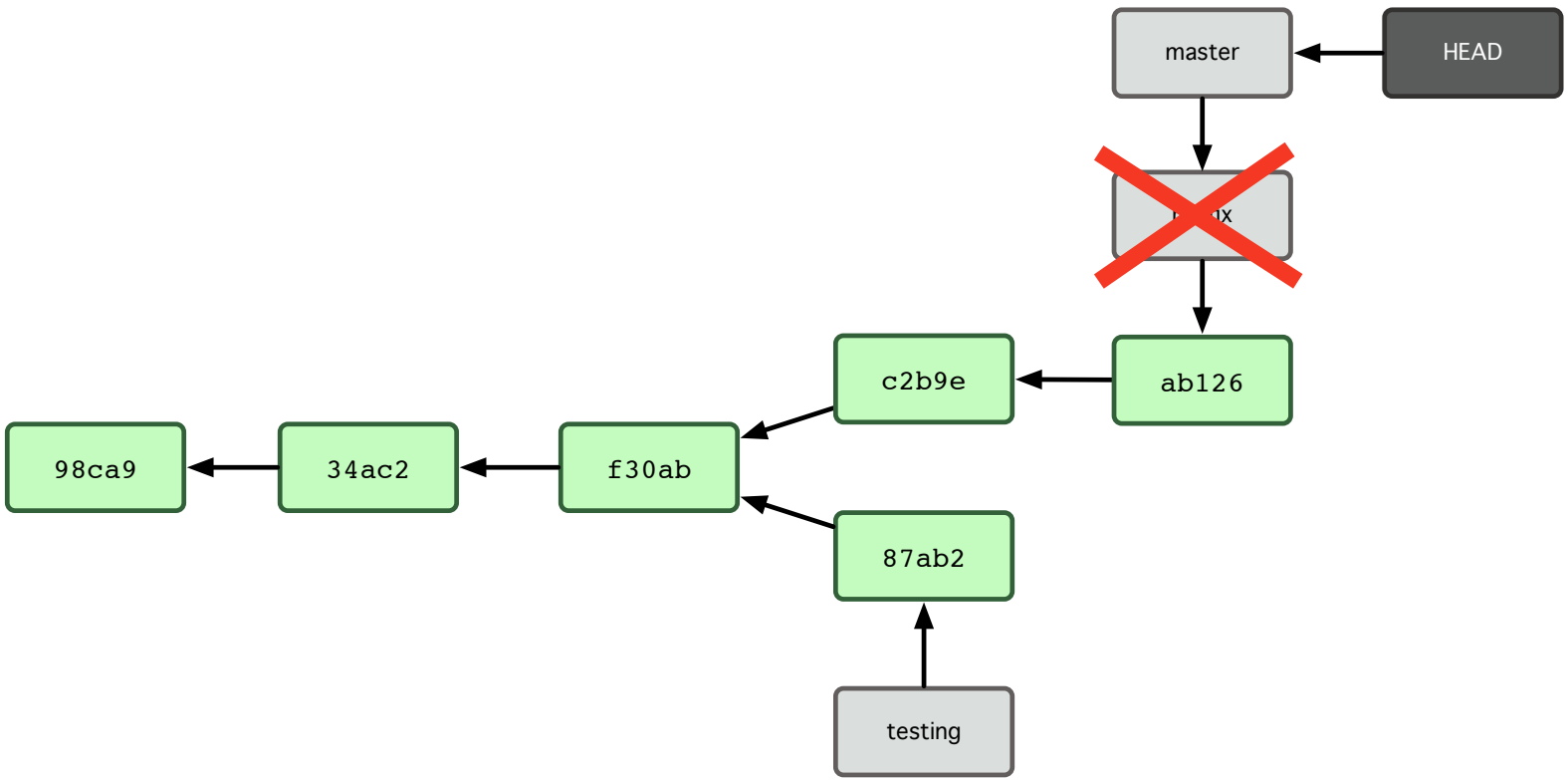


Daily Branching Example

```
(master)$> git branch -d hotfix    # delete the (useless) 'hotfix' branch
```



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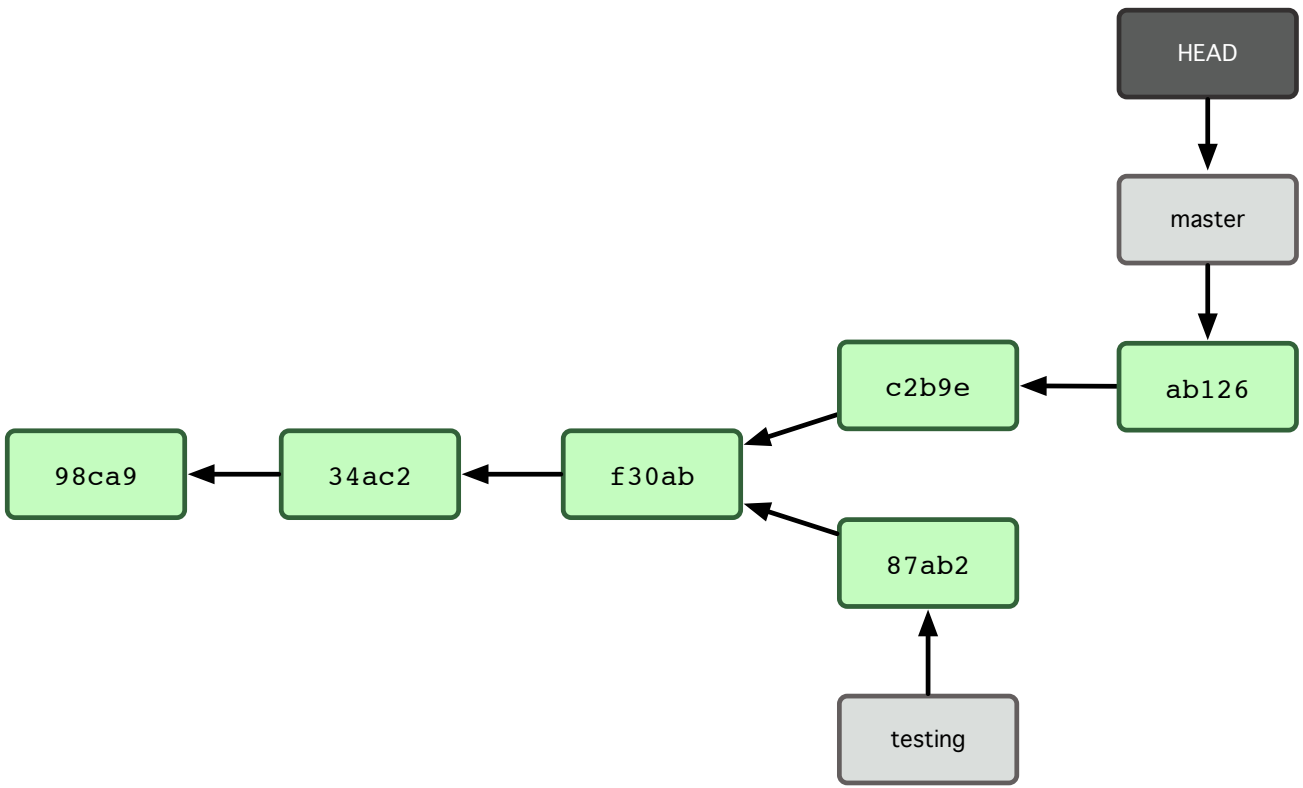

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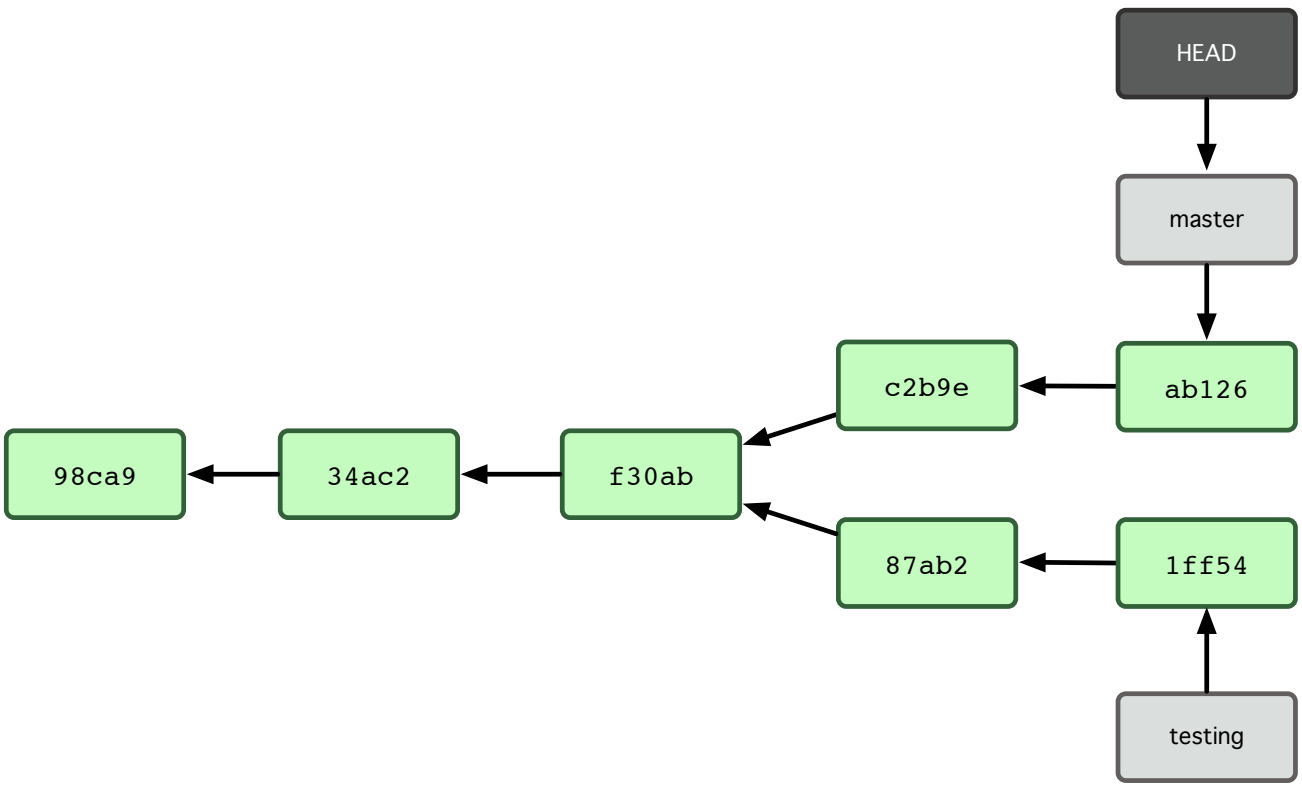
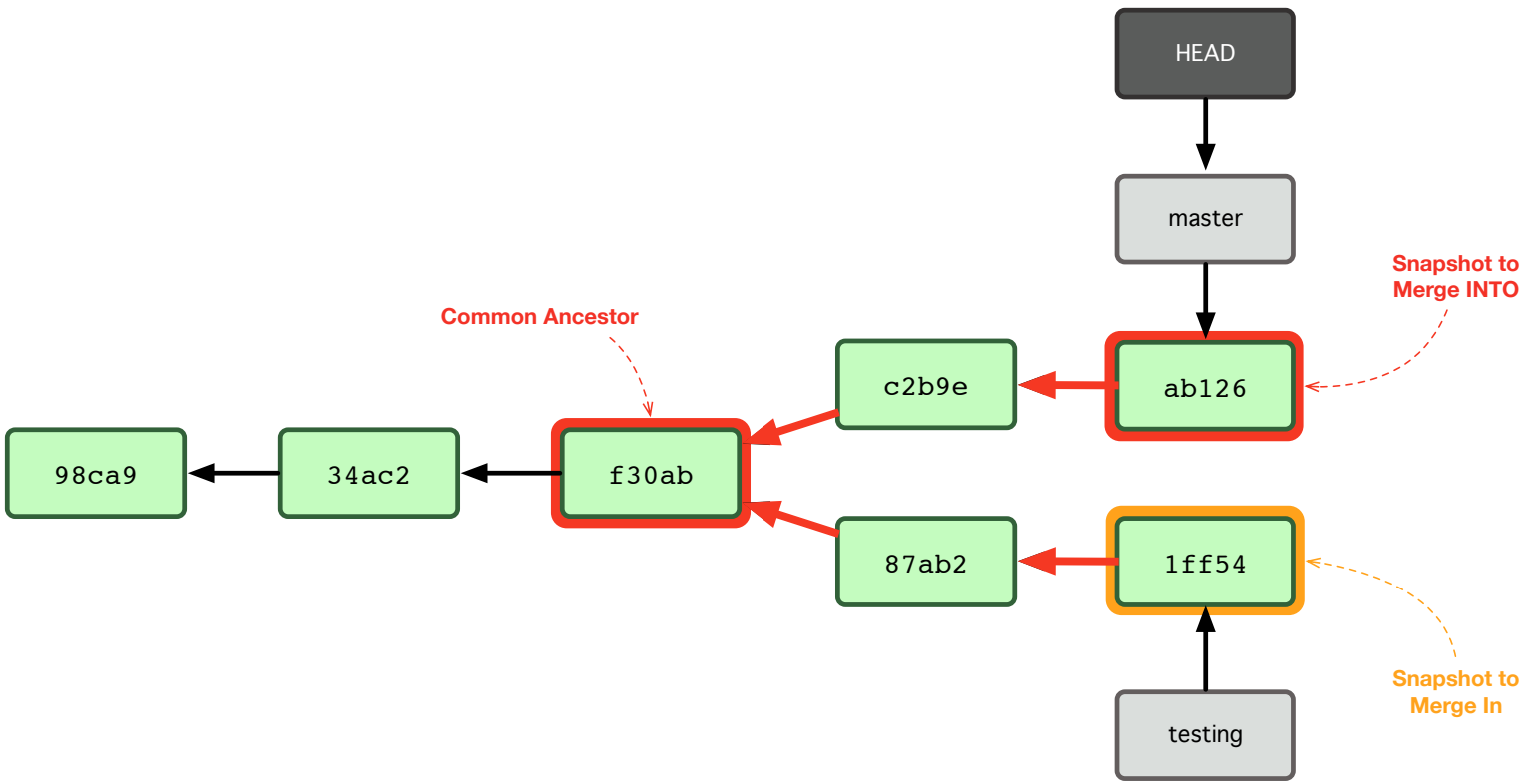


Daily Branching Example

```
(master)$> git merge testing        # merge the 'testing' branch (3-ways)
```



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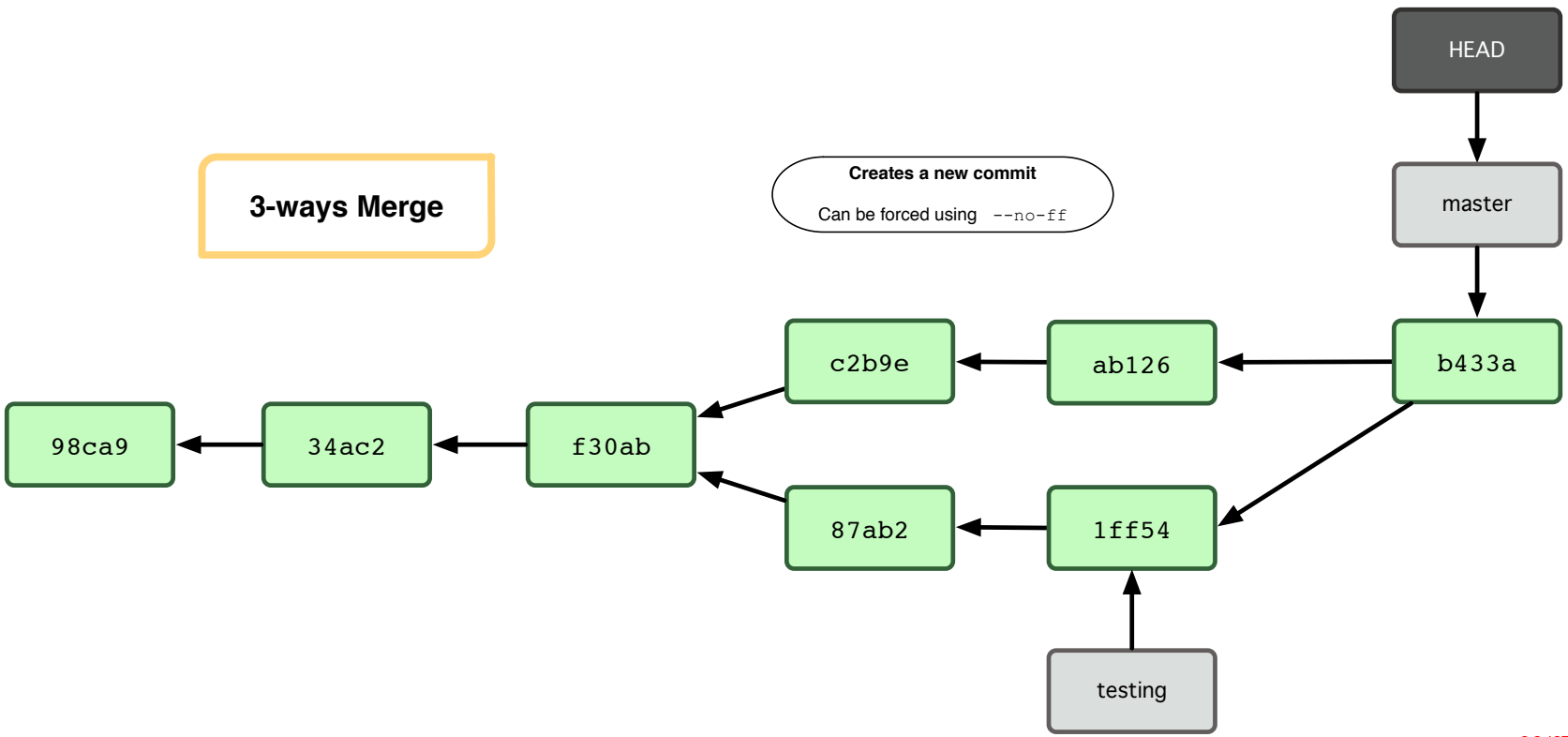

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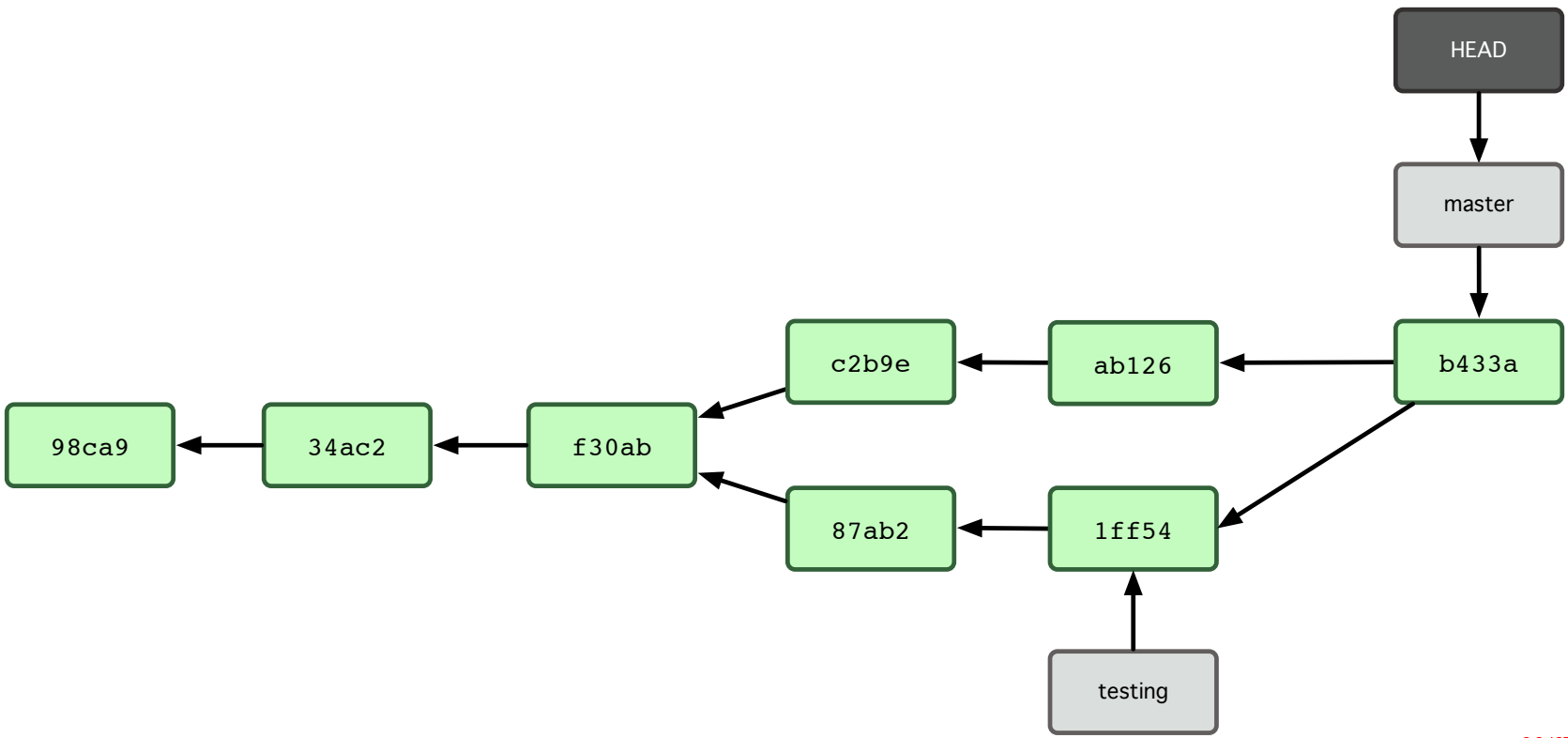


Merging and solving conflicts Hands-on

Your Turn!

Merging and solving conflicts Hands-on

```
$> cd /tmp/firstproject
$> git checkout master
Switched to branch 'master'
$> git checkout -b hotfix
Switched to a new branch 'hotfix'
$> touch test.rb && git add test.rb && git commit -m "hotfix"
[hotfix ac188bd] hotfix
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 test.rb
$> git checkout master
Switched to branch 'master'
$> git gr
* 72d4d5f (HEAD -> master) master
* f31c173 (tag: v1.0) a first move with amend
* ee60f53 add README
```

Merging and solving conflicts Hands-on

- Fast-Forward Merge

```
$> git merge hotfix
Updating 72d4d5f..ac188bd
Fast-forward
 test.rb | 0
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 test.rb
$> git gr
* ac188bd (HEAD -> master, hotfix) hotfix
* 72d4d5f master
* f31c173 (tag: v1.0) a first move with amend
* ee60f53 add README

$> git branch -d hotfix
Deleted branch hotfix (was ac188bd)
```

Merging and solving conflicts Hands-on

- Solving conflicts

```
$> git merge testing
CONFLICT (content): Merge conflict in README.md
Automatic merge failed; fix conflicts and then commit the result.
$> cat README.md
<<<<<<< HEAD
master
=======
testing
>>>>>>> testing
$> vim README.md    # Edit to solve the conflicts
$> cat README.md
master corrected
```

Merging and solving conflicts Hands-on

- Solving conflicts

```
$> git status     # OR git st
On branch master
You have unmerged paths.

Unmerged paths:
    both modified:   README.md

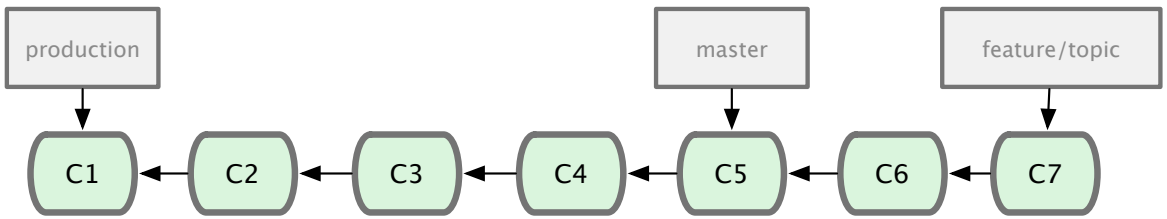
no changes added to commit
```

Merging and solving conflicts Hands-on

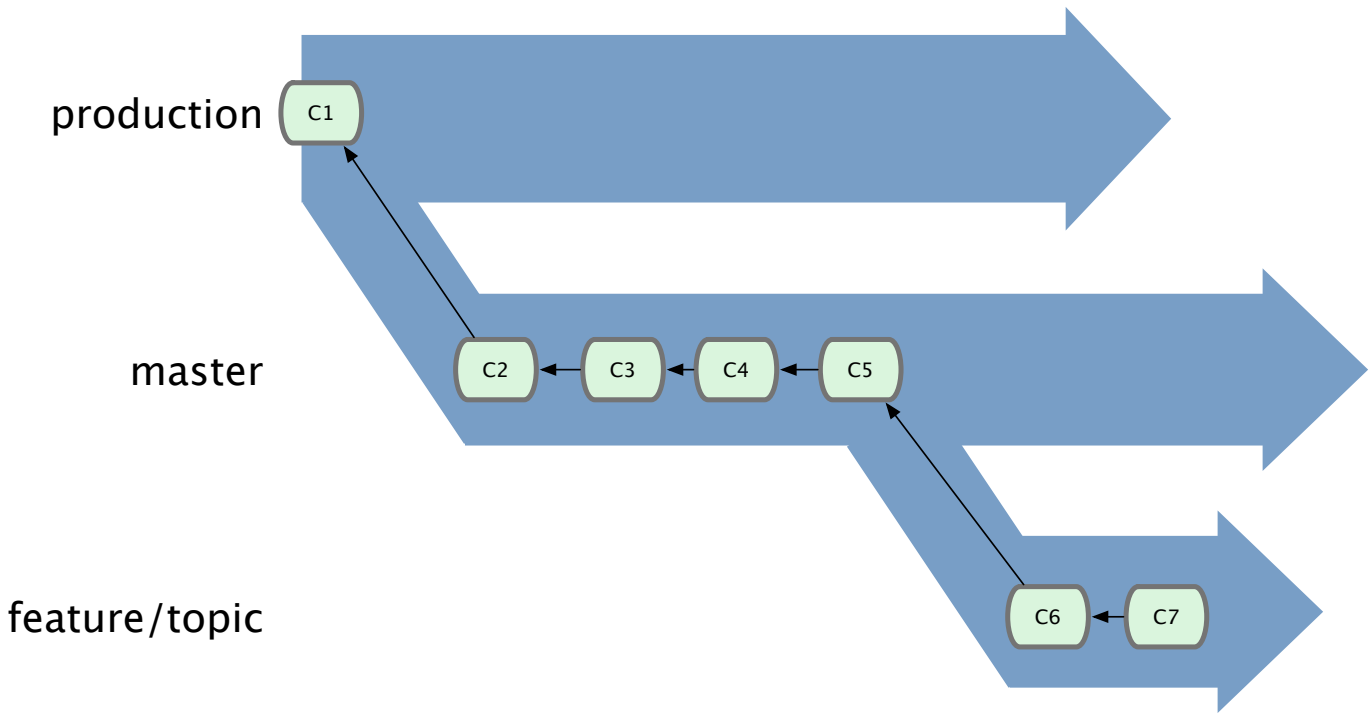
- Solving conflicts and 3-way merge

```
$> git add README.md     # Mark as corrected / conflict solved
$> git commit
Recorded resolution for 'README.md'.
[master ef299b7] Merge branch 'testing'
$> git gr
*   ef299b7 (HEAD -> master) Merge branch 'testing'
|\
| * 7afa96d (testing) testing 1
* | ac188bd hotfix
* | 72d4d5f master
|/
* f31c173 (tag: v1.0) a first move with amend
* ee60f53 add README
```

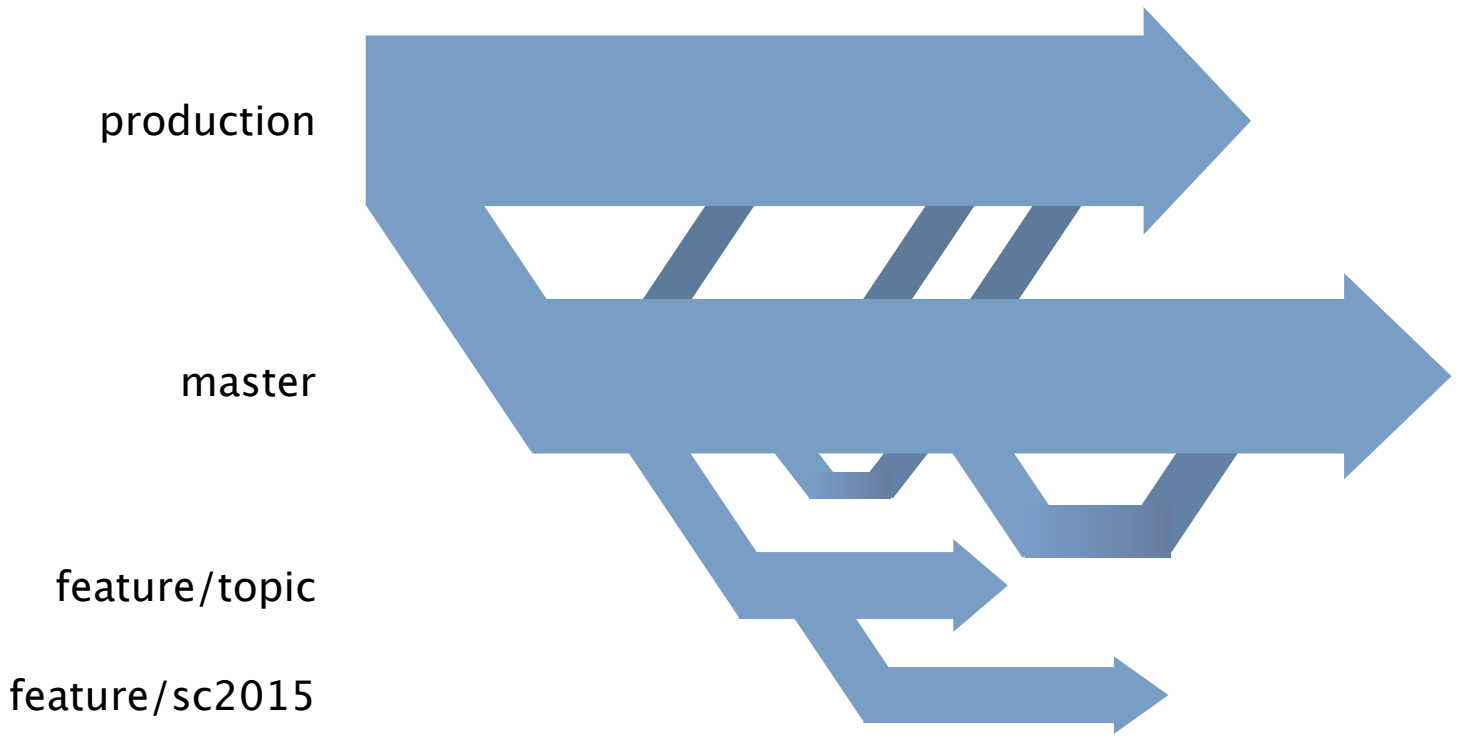
Branching Workflow



Branching Workflow



Branching Workflow



Git-flow to the rescue

http://nvie.com/posts/a-successful-git-branching-model/

```
$> git flow init
```

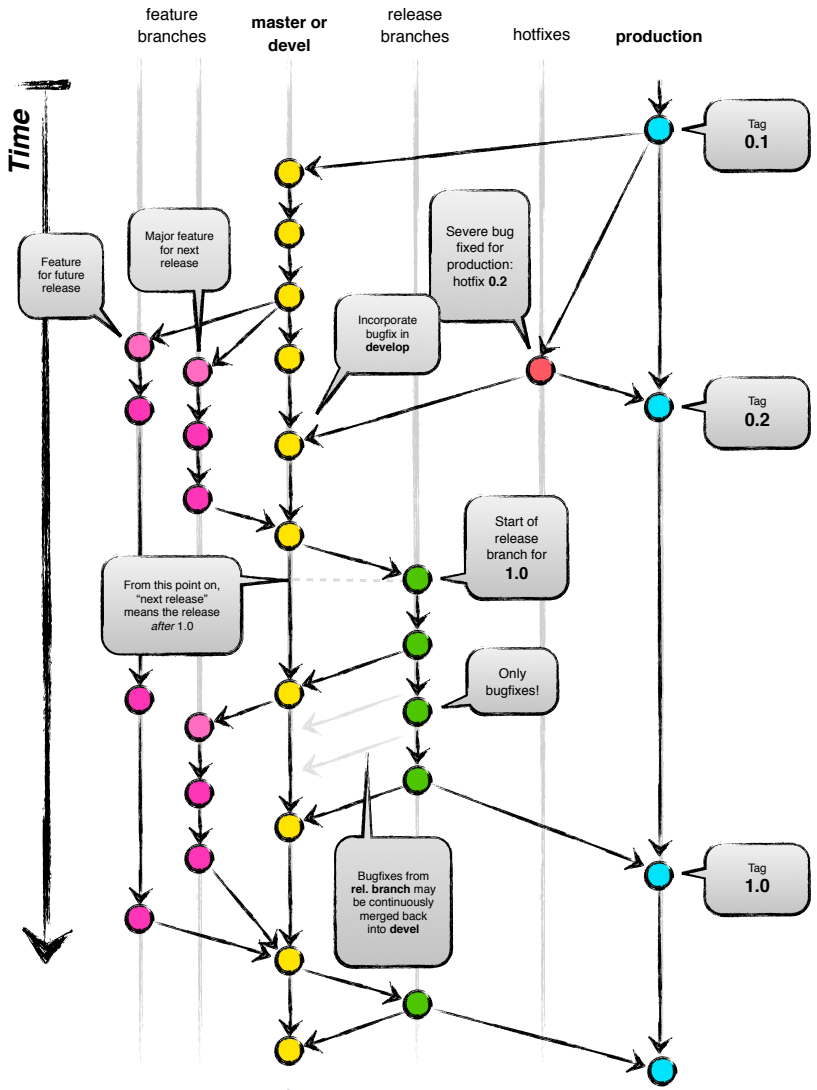
```
$> git flow feature { start, publish, finish } <name>
```

```
$> git flow release { start, publish, finish } <version>
```

- Ensure two long running branches
  - ↪ `production` : the stable branch
    - ✓ ideally holding **only** tags of the successive releases
  - ↪ `master` / `devel`: the **main** branch where the developments occurs
- On demand: make a new feature branch `feature/<name>`
- From time to time, release your code into `production` and tag

Git-flow Illustrated

[Source : Nvie]



Git-flow Setup using FalkorLib

- Initiate a Git-flow-ready repository using FalkorLib
  - ↪ [Personnal] Ruby Library offering the `falkor` binary

```
$> falkor new repo [--rake]     # setup the current directory
```

- The repository is fed with a root `Makefile` (or `Rakefile`)
  - ↪ facilitate repository setup upon cloning

```
$> git clone <url> && cd <cloned_dir>
$> make setup
```

  - ↪ project releasing using Git-flow made easy

```
$> make start_bump_{major,minor,patch}     # bump version with git-flow
$> make release
```

Summary

Working Together

- Sign-up on Github
  - ↪ `http://github.com`
  - ↪ Best place to share **public** repository

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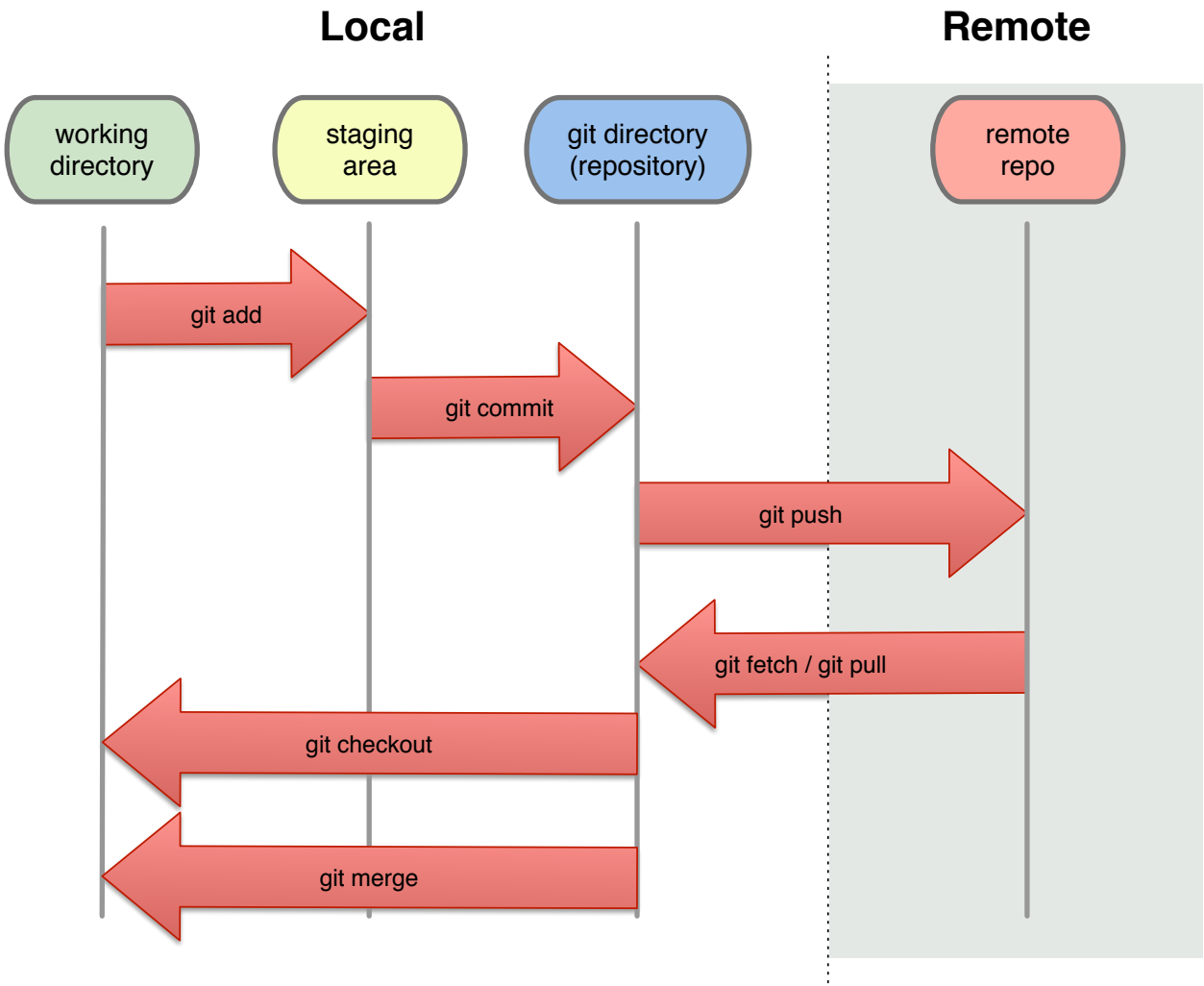
  - ↪ Gforge @ UL `https://gforge.uni.lu/`
  - ↪ (incoming) Gitlab @ UL `https://gitlab.uni.lu/`

- Setup your own Git server: gitolite `https://github.com/sitaramc/gitolite`
  - ↪ Management through the `gitolite-admins` Git repository (!)
  - ↪ A single user (`git`) to interact with all repositories
    - ✓ map users though their (multiple) SSH keys
    - ✓ fine-grained access control

Working with remotes



Remotes

```
$> git remote [-v]
```

- Other clones of the same repository
  - ↪ Can be local (another checkout) or remote (coworker, central server)
  - ↪ default remotes for push and pull actions: `origin`
    - ✓ `origin` is set upon clone

Remotes

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  - ↪ Can be local (another checkout) or remote (coworker, central server)
  - ↪ default remotes for push and pull actions: `origin`
    - ✓ `origin` is set upon clone

Your Turn!

```
$> cd /tmp/tutorials
$> git remote
origin
$> git remote -v
origin  https://github.com/ULHPC/tutorials.git (fetch)
origin  https://github.com/ULHPC/tutorials.git (push)
```

Adding Remotes

```
$> git remote add <name> <url>
```

Adding Remotes

```
$> git remote add <name> <url>
```

Your Turn!

- Fork the ULHPC/tutorials (as <yourlogin>/tutorials)
- Clone and add the upstream remote to the original repository

```
$> git clone https://github.com/<yourlogin>/tutorials.git /tmp/fork
$> cd /tmp/fork
$> git remote add upstream  https://github.com/ULHPC/tutorials.git
$> git remote -v
origin      https://github.com/<yourlogin>/tutorials.git (fetch)
origin      https://github.com/<yourlogin>/tutorials.git (push)
upstream    https://github.com/ULHPC/tutorials.git (fetch)
upstream    https://github.com/ULHPC/tutorials.git (push)
```

Removing Remotes

```
$> git remote rm <name>
```

Removing Remotes

```
$> git remote rm <name>
```

Your Turn!

```
$> cd /tmp/fork
$> git remote
origin
upstream
$> git remove rm upstream
```

Remote Branches

- Branches on remotes are represented locally as: `<remote>/<branch>`
  - ↪ **Ex**: `origin/master`

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  - ↪ **Ex**: `origin/master`

Tracking Remote Branches

- You can track a remote branch `<remote>/<branch>`
  - ↪ assuming you have previously `fetch` the remote `origin`
  - ↪ creates the local branch `<branch>`

```
$> git branch --track <branch> origin/<branch>
```

Tracking Remote Branches

```
$> git branch --track <branch> origin/<branch>
```

Your Turn!

```
$> cd /tmp/tutorials
$> git branch -a
* devel
  remotes/origin/HEAD -> origin/devel
  remotes/origin/devel
  remotes/origin/production
$> git branch --track production origin/production
Branch production set up to track remote branch production from
origin.
$> git branch
* devel
  production
```

Pushing to your remote

```
$> git push [<remote>]
```

- Transfer local commits of the **current** branch to a remote.
  - ↪ push to `origin` by default, assuming the current branch is tracked

Pushing to your remote

```
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```

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Your Turn!

```
$> cd /tmp/fork
$> git remote
origin
upstream
$> touch new-file
$> git add new-file
$> git commit -m "add"
```

```
$> git push
Counting objects: 10, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (6/6), done.
Writing objects: 100% (10/10), done.
Total 10 (delta 4), reused 0 (delta 0)
To git@github.com:<yourlogin>/documents.git
   671eb88..c798919  devel -> devel
```

Pulling from remotes

```
$> git pull [--rebase] [<remote>]        # --rebase = DANGER!
```

- fetch all commits from the remote **and** merge (or rebase)
  - ↪ allows for easy to use, equivalent to the **advanced** alternative:

```
$> git fetch [<remote>]
$> git merge <remote>/<branch>     # 'git rebase' if --rebase
```

  - ↪ `fetch`: allows for inspection and manual merging of remote changes

Pulling from remotes

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$> git fetch [<remote>]
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```

  - ↪ `fetch`: allows for inspection and manual merging of remote changes

Your Turn!

```
$> cd /tmp/tutorials
$> git pull          # OR git up
Updating ae97dae..06576e0
[...]
2 files changed, 4 insertions(+), 5 deletions(-)
```

Publish a (local) branch on a remote

```
$> git push -u origin <branch>
```

```
$> git flow feature publish <name>
```

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```
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```

- If you want to **delete** a **remote** branch

```
$> git push origin --delete <branch>                    # DANGER!
```

Publish a (local) branch on a remote

```
$> git push -u origin <branch>
```

```
$> git flow feature publish <name>
```

- If you want to **delete** a **remote** branch

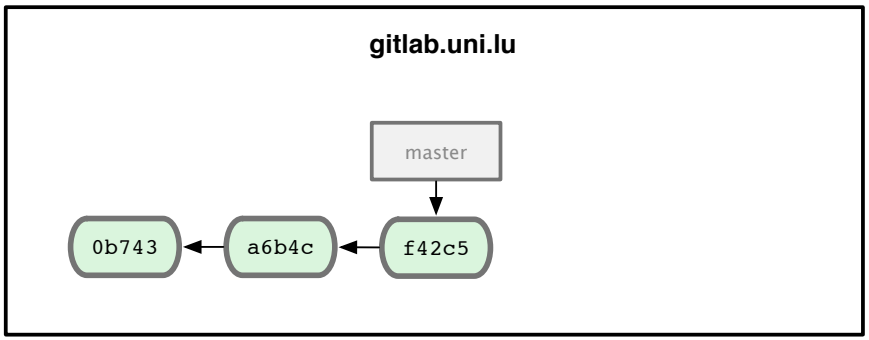
```
$> git push origin --delete <branch>                    # DANGER!
```

Your Turn!

```
$> cd /tmp/fork
$> git flow feature start toto
$> git flow feature publish toto
```

```
$> git branch -a
$> git push origin --delete \
      feature/toto
```

Putting it all together



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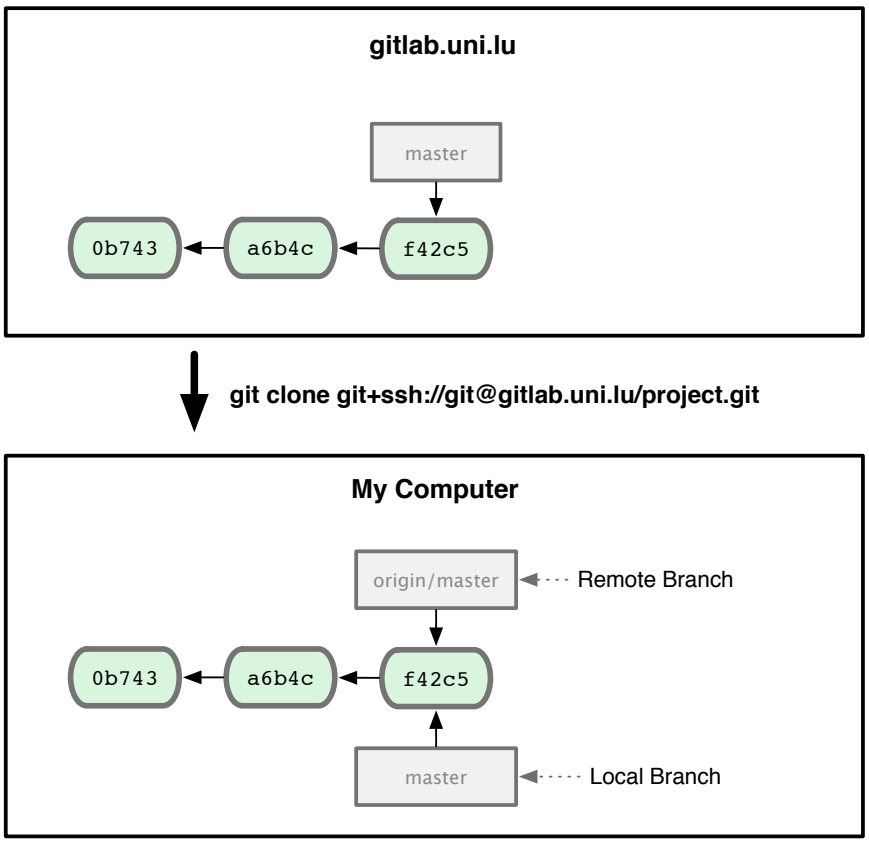

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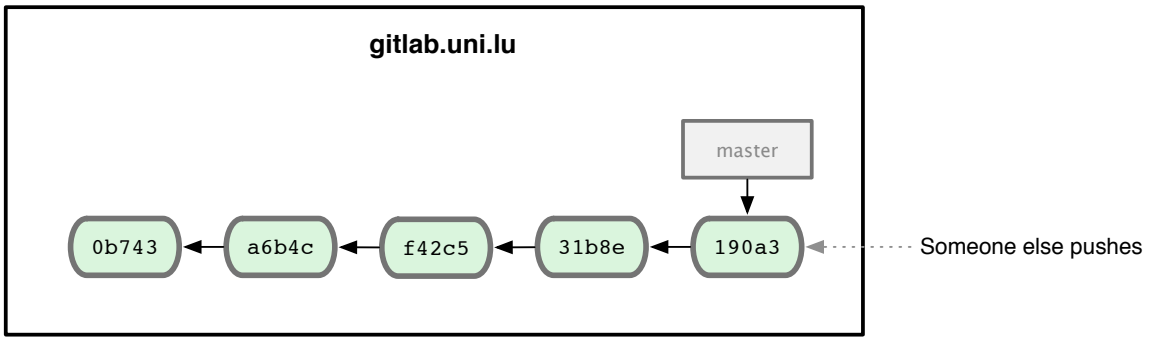

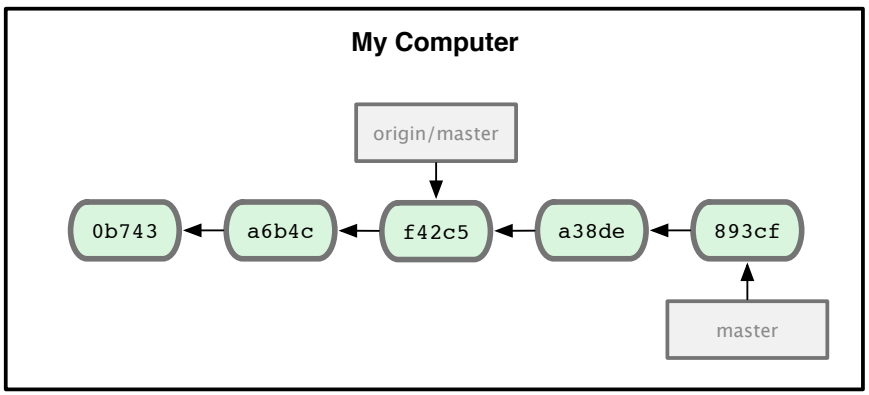

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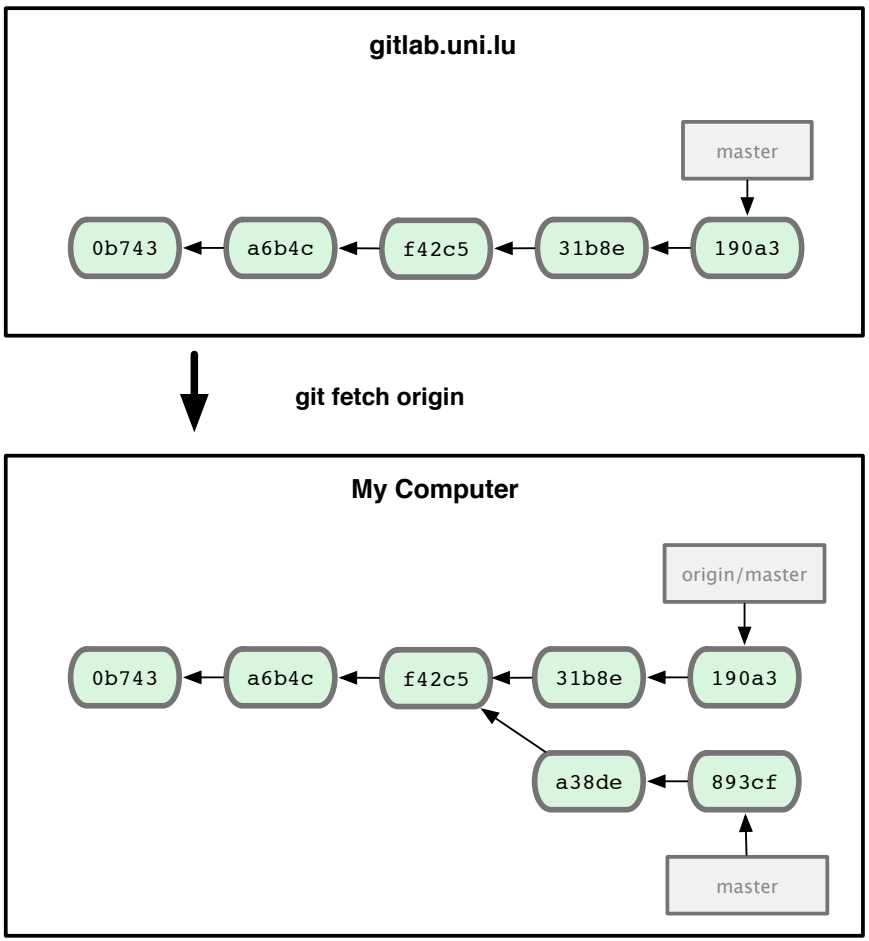

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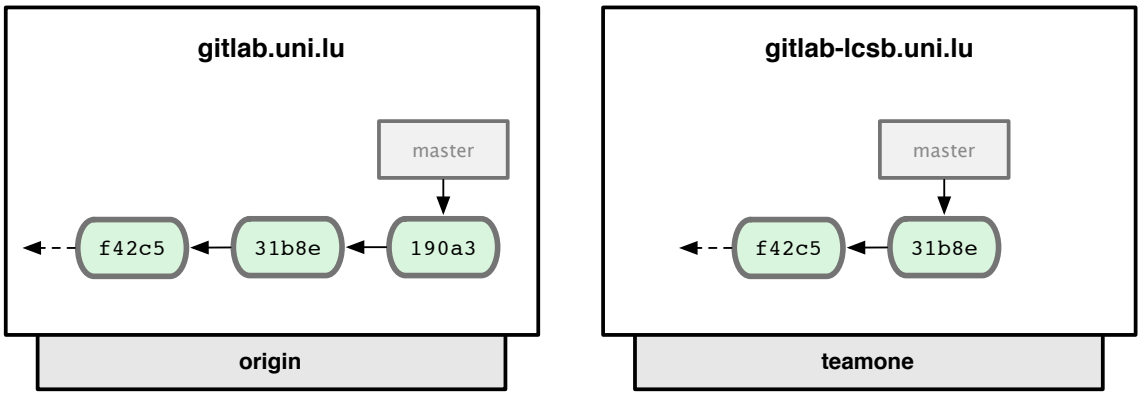
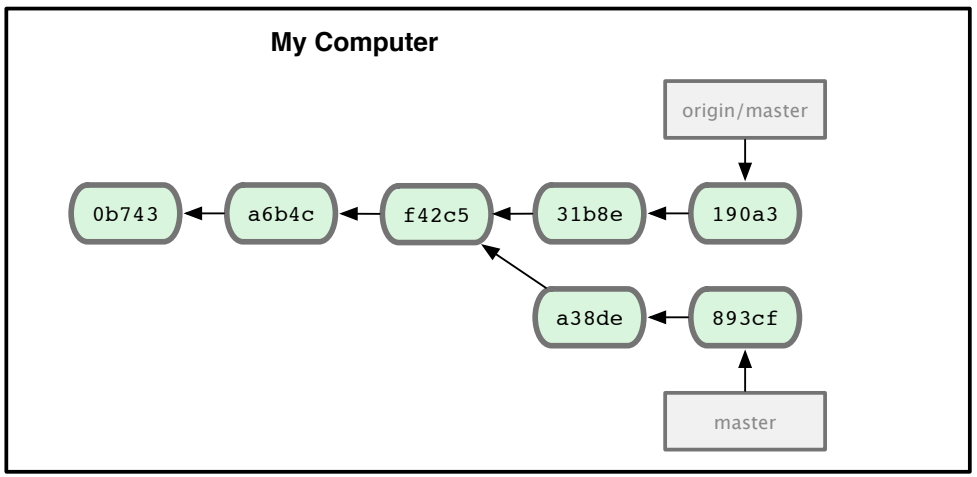


git remote add teamone git://gitlab-lcsb.uni.lu



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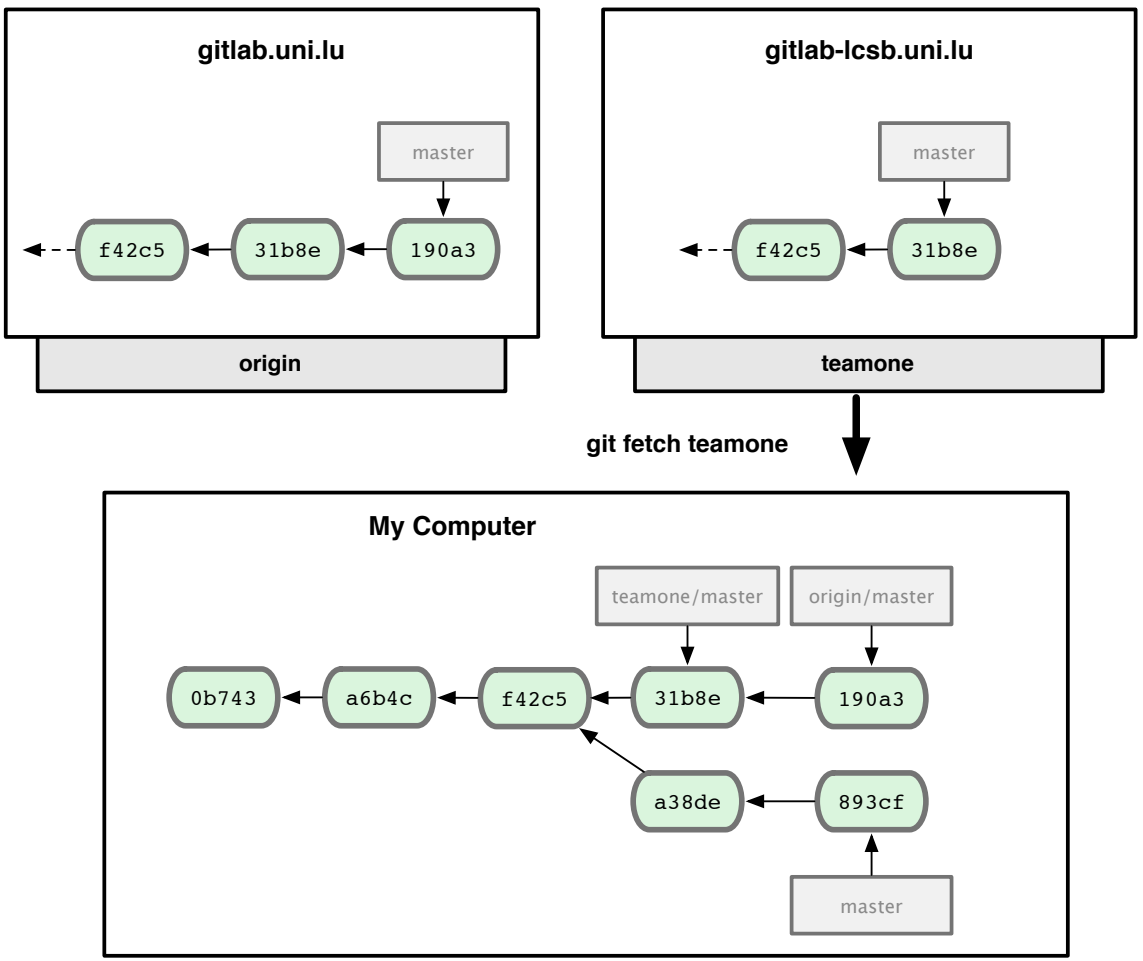


Summary

Summary

Git Submodules

```
$> git submodule add [-b <branch>] <url> <subdir>
```

- **Git submodule**: repository nested within another repository.
  - ↪ see it as a read-only snapshot
  - ↪ make symbolic links to the submodules files
- State saved in `.gitmodules` (git root directory)

```
[submodule ".submodules/Makefiles"]
    path = .submodules/Makefiles
    url = https://github.com/Falkor/Makefiles
```

- Explicit initialization is **mandatory**
  - ↪ **before** cloning `git clone --recursive`
  - ↪ **after** cloning `git submodule init && git submodule updat`

Git Submodules - Update

```
$> git submodule add \
       https://github.com/Falkor/Makefiles .submodules/Makefiles
```

- You might need to **update** the submodules after `fetch` / `pull`
- You might wish to **upgrade** the submodules to the latest version

```
$> git submodule init
$> git submodule update
$> git submodule foreach \
     'git fetch origin; \
      git checkout $(git rev-parse --abbrev-ref HEAD); \
      git reset --hard origin/$(git rev-parse --abbrev-ref HEAD); \
      git submodule update --recursive; git clean -dfx'
```

- See `make upgrade` of this Makefile for repositories

Git subtree

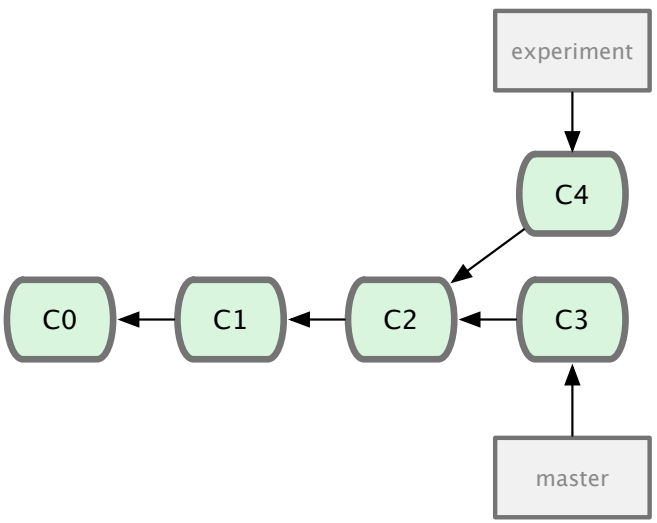
Summary

Rebasing

```
$> git rebase <branch>          # DANGER! Rewrites the tree
```

- Basic (**3-ways**) merging via `git merge` creates a new commit

```
(master)$> git merge experiment
```



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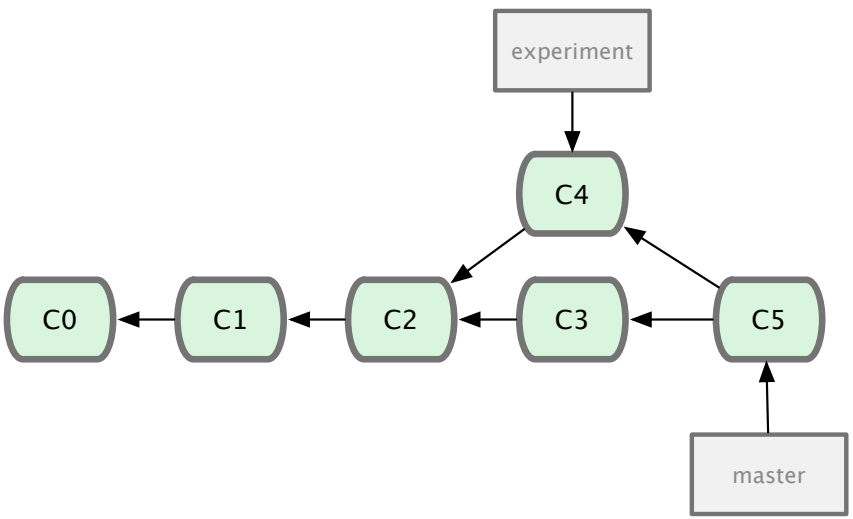

Rebasing

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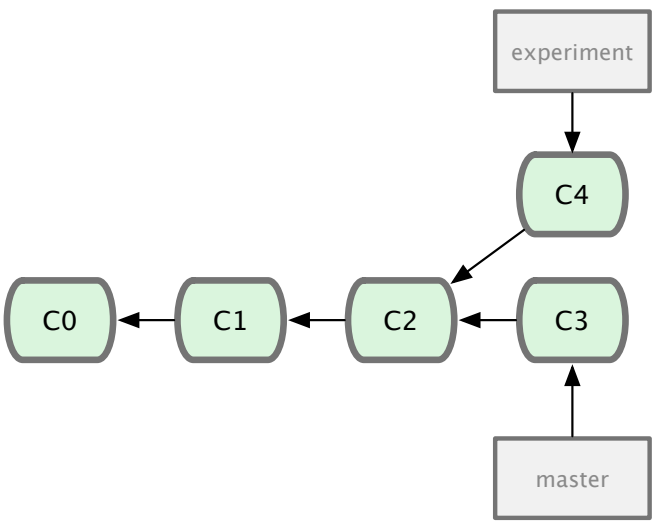
$> git rebase <branch>          # DANGER! Rewrites the tree
```

- **Rebasing**: **Linear** alternative to merging
  - ↪ create a patch of the introduced change (in C4)
  - ↪ reapply it on top (of C3) to create C4'



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```

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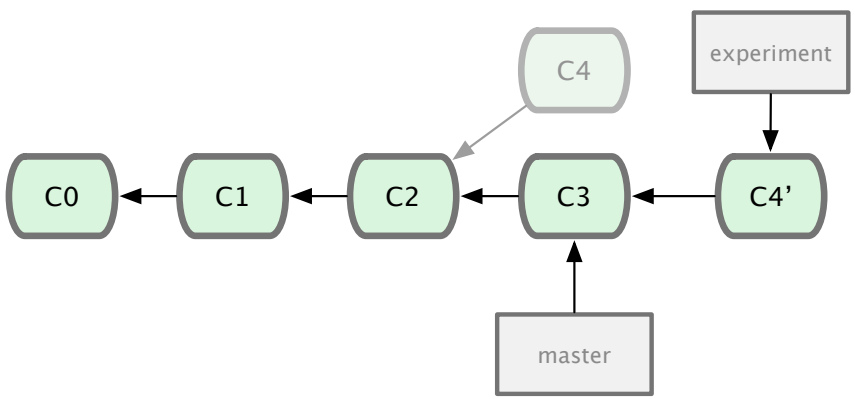
```
(master)$> git checkout experiment
(experiment)$> git rebase master
```



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```

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  - ↪ create a patch of the introduced change (in C4)
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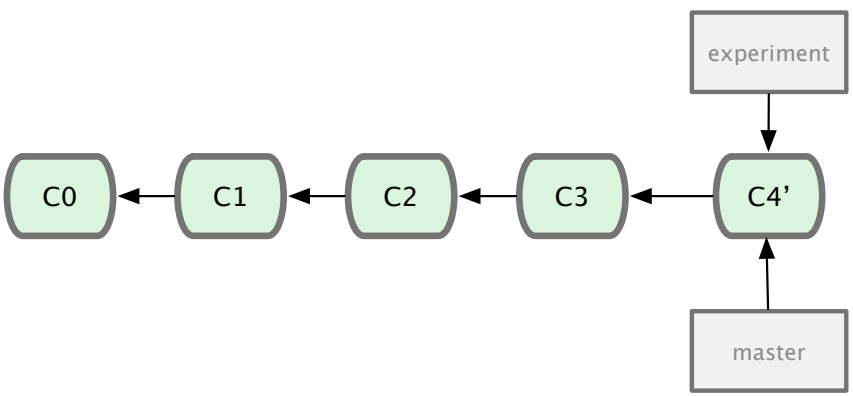
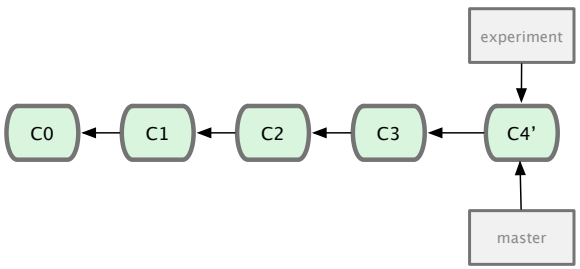
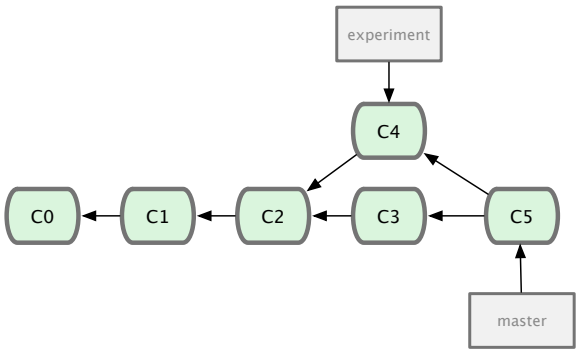
```
(experiment)$> git checkout master
(master)$> git merge experiment
```



Rebasing (left) vs. Merging (right)





- Rebasing ensure your commits apply cleanly on a (remote) branch

Never rebase published code!

Summary

Git-svn: using Git with Subversion

```
$> git svn clone [-s] <svn-url> # checkout an SVN repository
```

- `-s`: standard SVN layout with `trunk/`, `branches/` and `tags/`
- clone into `master` – you **shall** work in another branch **Ex**: `work`

  `$> git checkout -b work`

  ↪ delegate all interactions with SVN repository with `master`

  ↪ thus make all your (local) commits into the `work` branch

Git-svn: using Git with Subversion

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  `$> git checkout -b work`

  ↪ delegate all interactions with SVN repository with `master`

  ↪ thus make all your (local) commits into the `work` branch

```
$> git svn rebase       # fetch revisions from SVN and rebase
```

- **Important**: always do that from the `master` branch!

  `(work)$> git checkout master`

  `(master)$> git svn rebase`

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(work)$> git checkout master
(master)$> git svn rebase
```

1. rebase the master branch with the SVN repository

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(master)$> git checkout work
(work)$> git rebase master
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(work)$> git log -graph -oneline -decorate                    # OR git gr
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master
3. ensure everything is fine

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(work)$> git checkout master
(master)$> git merge -no-ff work
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master
3. ensure everything is fine
4. force 3-ways merge your local commit

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(master)$> git commit -amend
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master
3. ensure everything is fine
4. force 3-ways merge your local commit
5. edit (amend) the last commit for your SVN dudes

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(master)$> git svn dcommit
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master
3. ensure everything is fine
4. force 3-ways merge your local commit
5. edit (amend) the last commit for your SVN dudes
6. **Finally** commit on the SVN server

Git-svn: commit to Subversion

```
$> git svn dcommit   # create an SVN revision for each commit
```

AFTER you sanitize the 'master' branch!

```
(master)$> git checkout work
```

1. rebase the master branch with the SVN repository
2. go back to the work branch and rebase with master
3. ensure everything is fine
4. force 3-ways merge your local commit
5. edit (amend) the last commit for your SVN dudes
6. **Finally** commit on the SVN server
7. Go back to the 'work' branch!

Summary

Shell Integration

- Git Completion – Git flow completion

Colored PS1

- bash: integrate `__git_ps1()` function in your `PS1` variable
  - ↪ normally part of the `bash-completion` package
  - ↪ See integration in the `ULHPC/dotfiles` repository

```
$> export GIT_PS1_SHOWDIRTYSTATE=1    # you probably want that
```

- zsh: agnoster theme / powerline
  - ↪ Mac OS instructions

- On **CentOS/Redhat**, you have to source the correct file

```
$> ln -s /usr/share/git-core/contrib/completion/git-prompt.sh /etc/profile.d/
```

External Merge and Diff Tools

- Git offers visual diff/merge tools, assuming you configured it:

```
$> git config --global merge.tool sourcetree
```

```
$> git difftool [<commit>]                                    diff GUI
```

External Merge and Diff Tools

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```
$> git mergetool [<path>...]      # resolving merge conflicts
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External Merge and Diff Tools

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```

```
$> git difftool [<commit>]                                    diff GUI
```

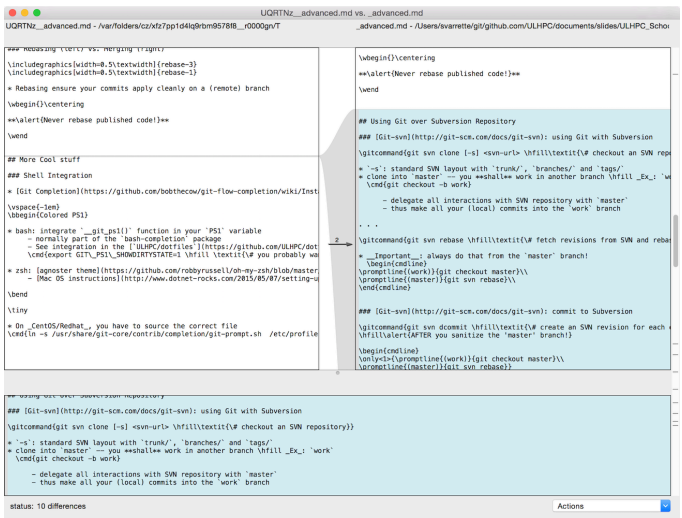
```
$> git mergetool [<path>...]      # resolving merge conflicts
```

- You can set up **another** graphical merge-conflict-resolution tool
  - ↪ List the available tools: `git mergetool --tool-help`
  - ↪ **Mac OS**: `git config --global merge.tool opendiff`
  - ↪ **Linux**: `git config --global merge.tool kdiff3`
  - ↪ Cross-platform: P4Merge (download)

```
$> brew cask install p4merge # on Mac OS, using Homebrew and Cask
```

Using P4Merge as diff/merge tool

```
git config --global merge.tool p4mergetool
git config --global mergetool.p4mergetool.trustexitcode   false
git config --global mergetool.p4mergetool.keeptemporaries false
git config --global mergetool.p4mergetool.keepbackup      false
git config --global mergetool.p4mergetool.cmd \
    $BASE $LOCAL $REMOTE $MERGED
```



- **Alternatives** (mostly Mac OS)
  - ↪ Kaleidoscope
  - ↪ Araxis Merge
  - ↪ DeltaWalker
  - ↪ DiffMerge (free)
  - ↪ SourceTree (free)

Other Cool Stuff

Stashing

- Move changes to a separate "stash".

Interactive Rebase

```
$> git rebase -i <branch>
```

```
$> git stash
$> git stash pop
$> git stash list
$> git stash apply
$> git stash drop
$> git stash clear
```

Other Cool Stuff

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- Move changes to a separate "stash".

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$> git stash
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```

Interactive Rebase

```
$> git rebase -i <branch>
```

- **Git hooks**:
  - ↪ Located in `.git/hooks/`
  - ↪ scripts run at various stages of Git operation
  - ↪ useful to perform lint actions for instance before pushing

Thank you for your attention...

Questions?

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