Configuration management with Git

SOftEng
http://softeng.polito.it

Outline

- Configuration Management
- Introduction to Git
- Git basic commands
- Git branching

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- **Configuration Management**
- Introduction to Git
- Git basic commands
- Git branching

Configuration Management System (CMS)

- System that records changes to a file or set of files over time so that you can recall specific versions later

CMS Functionalities

- Revert files back to a previous state
- Revert the entire project back to a previous state
- Compare changes over time
- Monitor who last modified something that might be causing a problem
- Monitor who introduced an issue and when

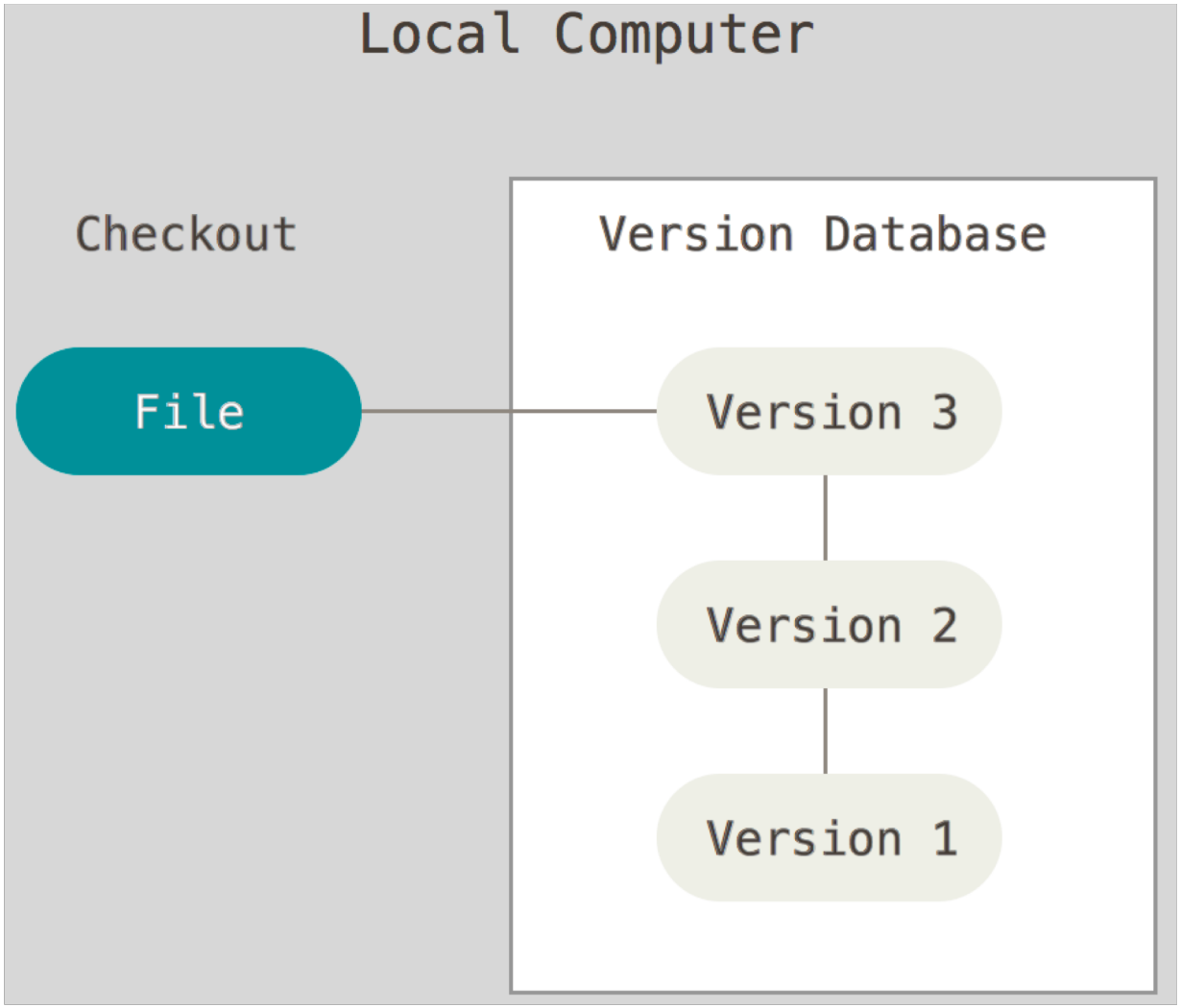
CMS Taxonomy

- Local CMS
  - A simple database that kept all the changes to files under revision control
- Centralized CMS
  - A single server that contains all the versioned files, and a number of clients that check out files from that central place
- Distributed CMS
  - clients fully mirror the repository

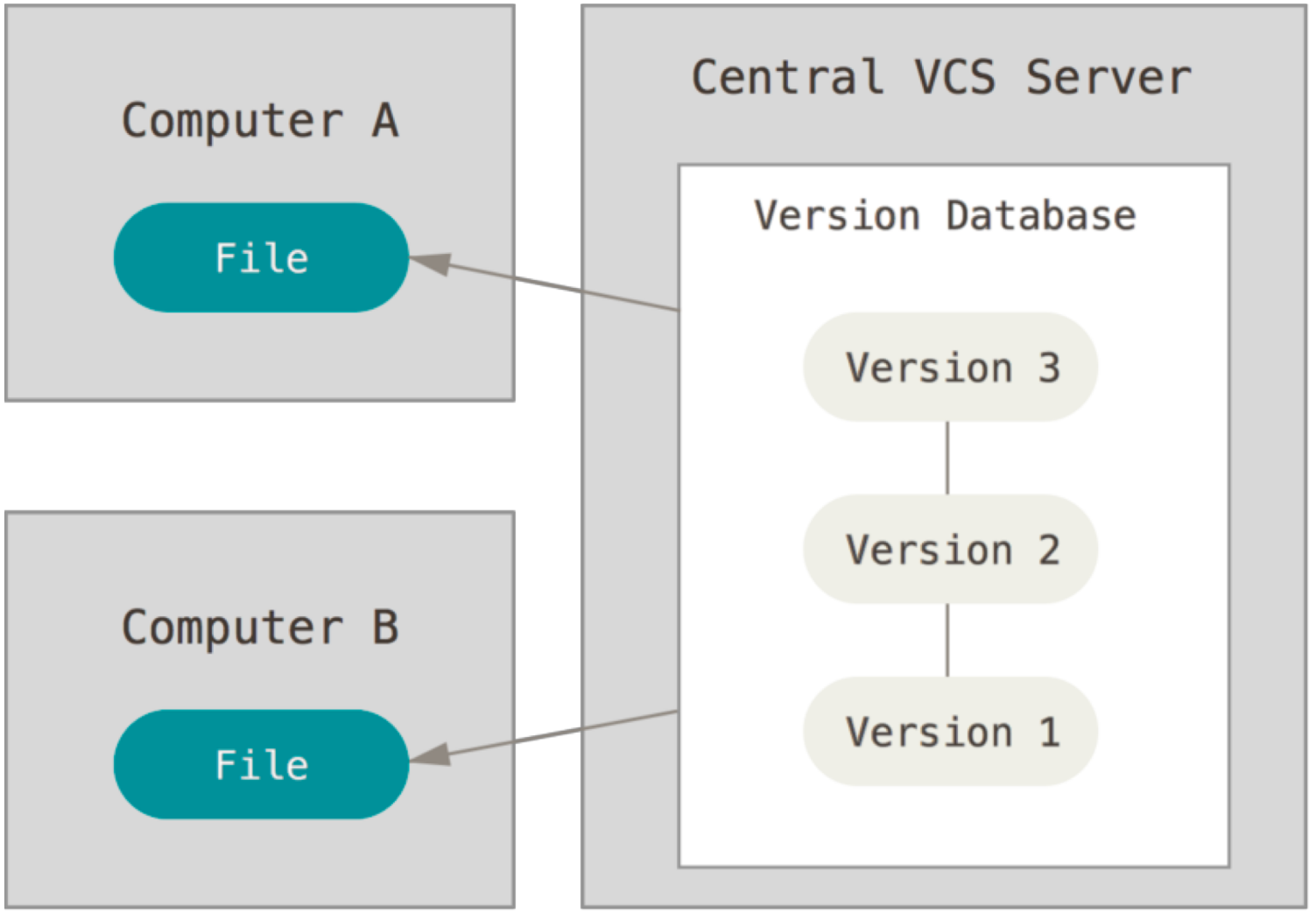
CMS Taxonomy

- Local CMS
  - RCS
- Centralized CMS
  - CVS, Subversion, and Perforce
- Distributed CMS
  - Git, Mercurial, Bazaar or Darcs

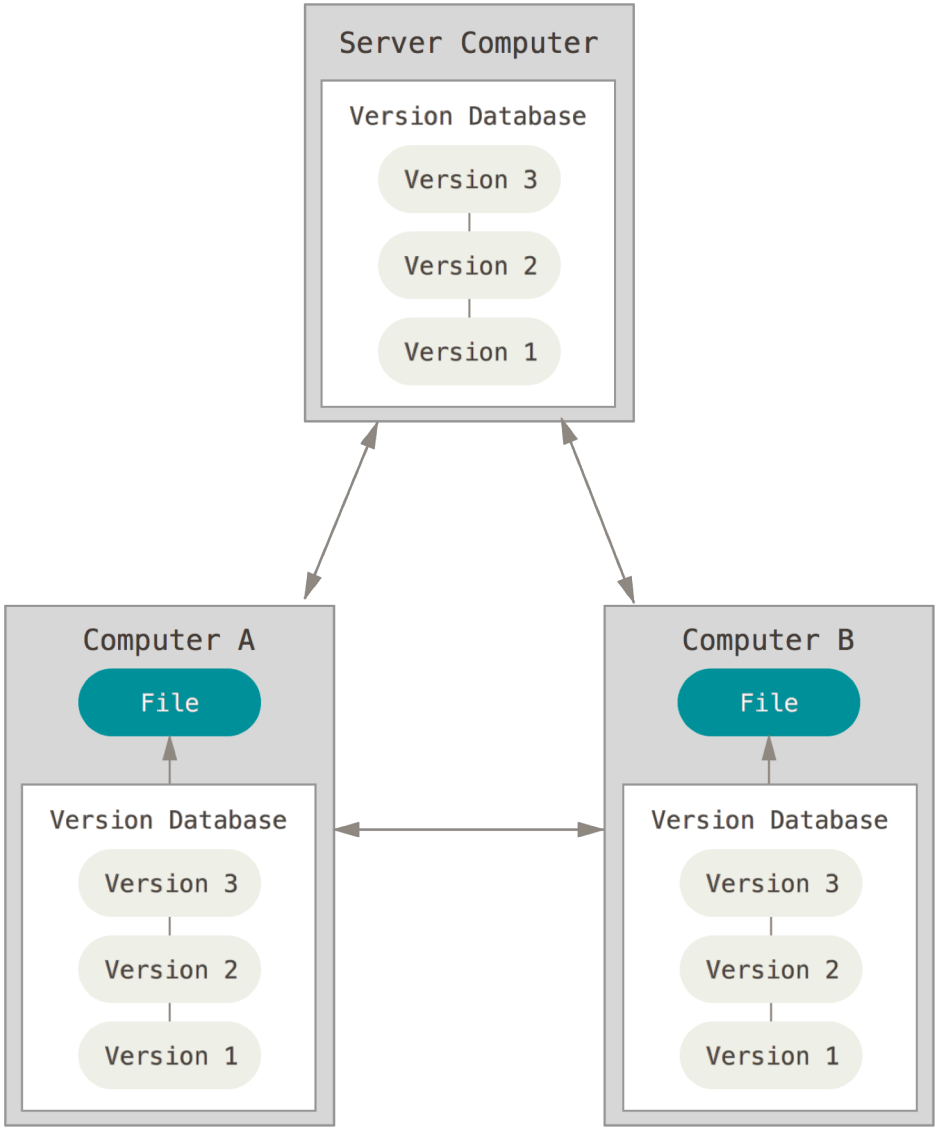
Local CMS


Local Computer
Checkout
Version Database
File
Version 3
Version 2
Version 1

Centralized CMS



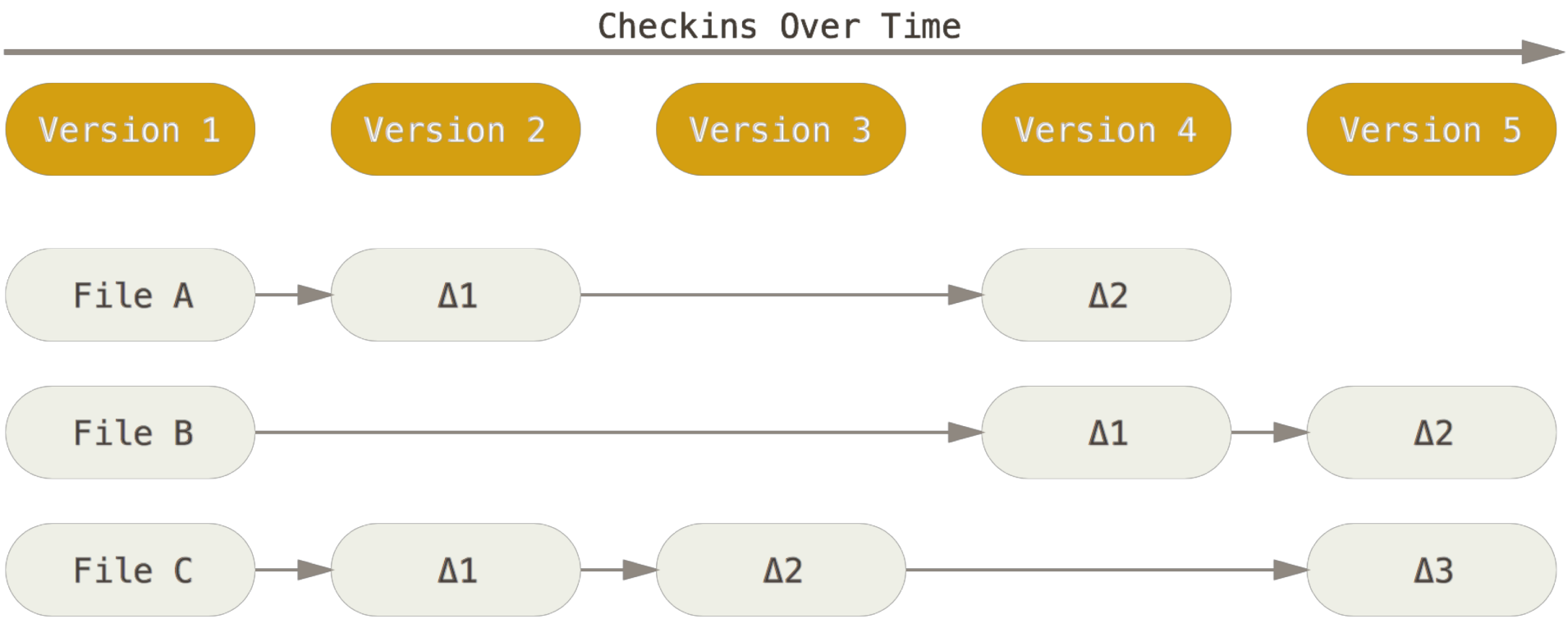
Distributed CMS



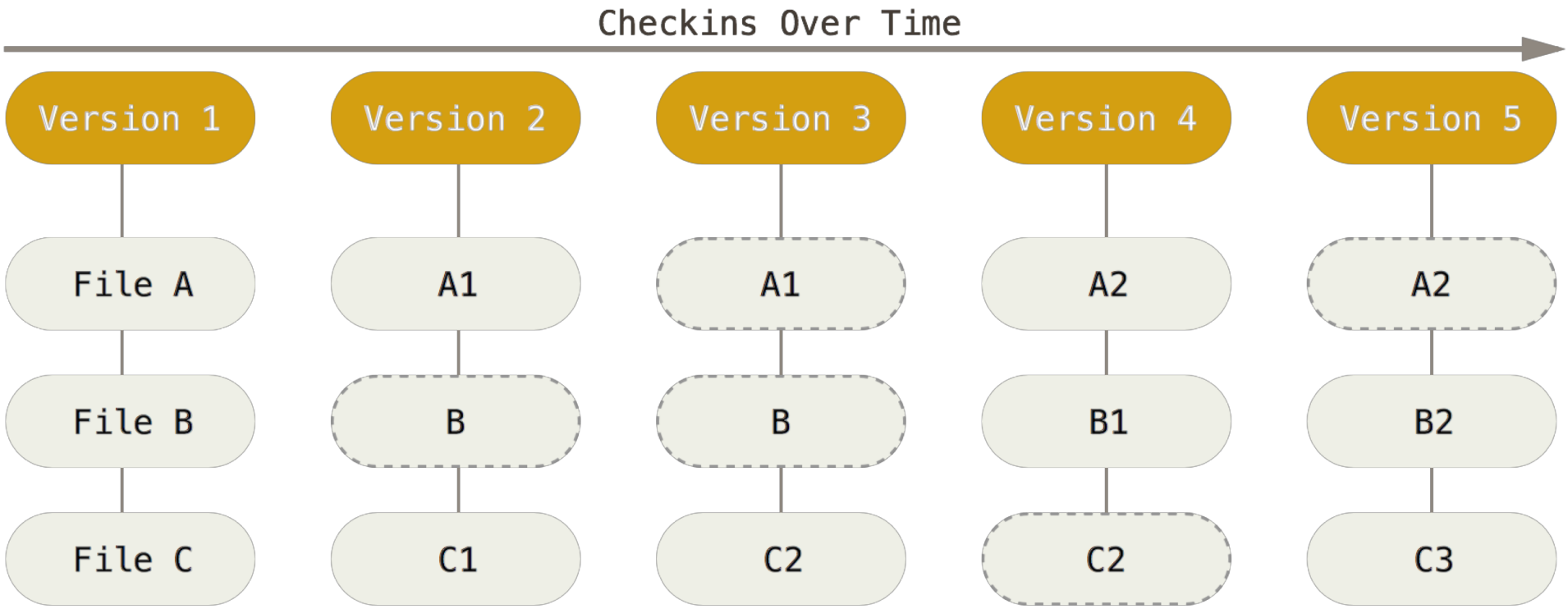
Data Management Models

- Differences
  - Information is kept as a set of files and the changes made to each file over time.
- Snapshots
  - Every commit, a picture of what all your files look like at that moment is taken and the system stores a reference to that snapshot
  - If files have not changed, system stores just a link to the previous identical file

Differences



Snapshots


Checkins Over Time
Version 1
Version 2
Version 3
Version 4
Version 5
File A
File B
File C
A1
B
C1
A1
B
C2
A2
B1
C2
A2
B2
C3

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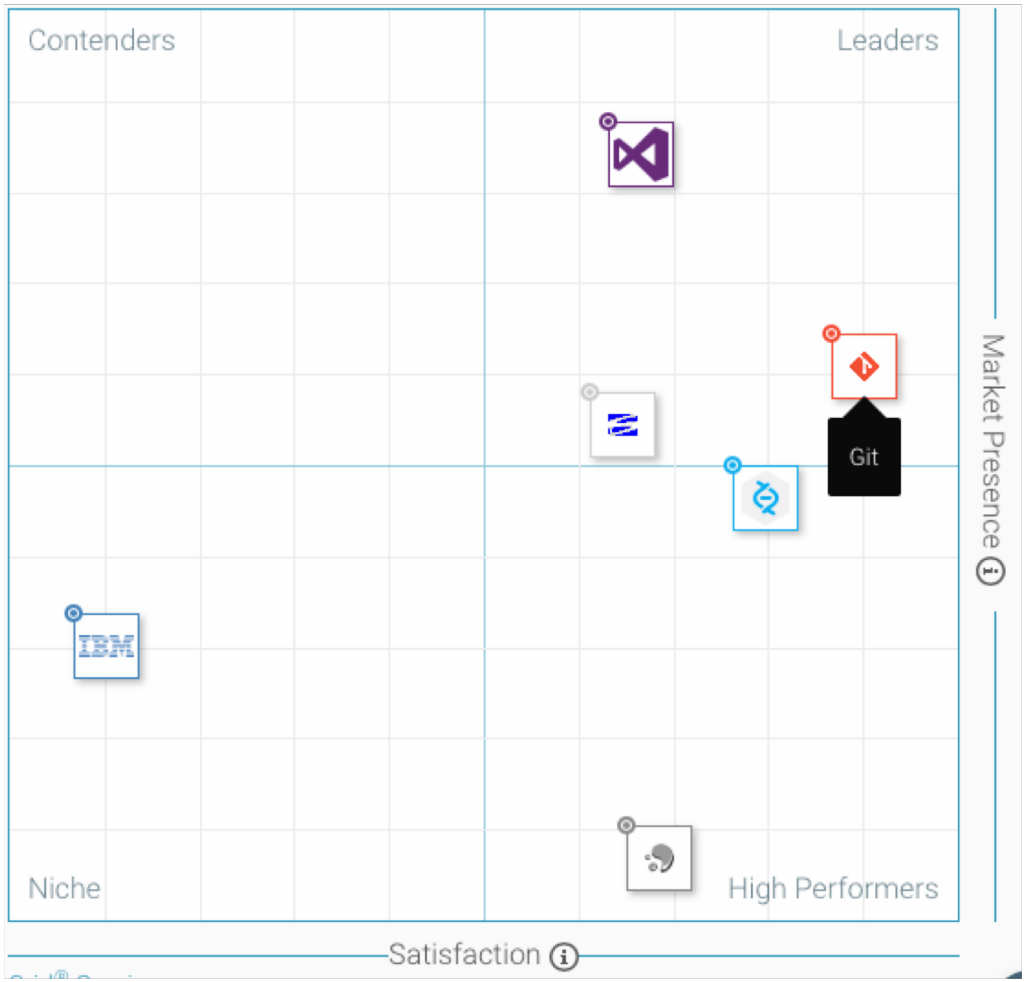
- **Introduction to Git**
- Git basic commands
- Git branching

Why Git



Src: g2crowd.com

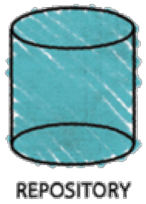
Github

- Online code hosting service built on top of git
- Mainly used by OSS projects
- Commercial use is growing
  - Used by

Git

- Distributed CMS
- Uses snapshots
- Exploits local operations
  - generally no information is needed from another computer on your network
- Has integrity
  - Everything is check-summed before it is stored and is referred to by that checksum
  - No untracked change of any file or directory

Basic Concepts: Repository

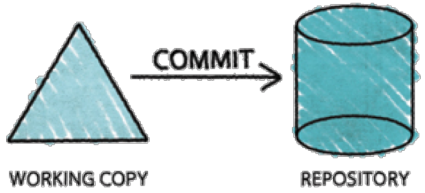


- Place where you store all your work
- It contains every version of your work that has ever existed
  - files
  - directories layout
  - history
- It can be shared by the whole team

Basic Concepts: Working Copy

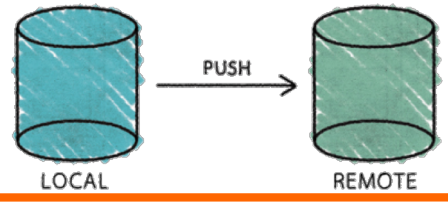
- It is a snapshot of the repository where the changes happen
- It is private, not shared by the team
- It also contains some metadata so that it can keep track of the state of things
  - has a file been modified?
  - is this file new?
  - has a file been deleted?

Basic Concepts: Commit



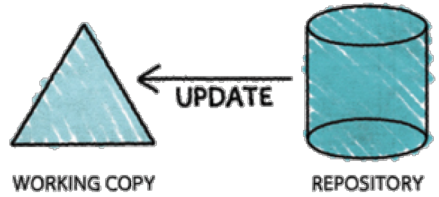
- Modifies the repository
- It is atomically performed by modern version control tools
  - The integrity of the repository is assured
- It is typical to provide a log message (or comment) when you commit
  - to explain the changes you have made
  - the message becomes part of the history of the repository

Basic Concepts: Push



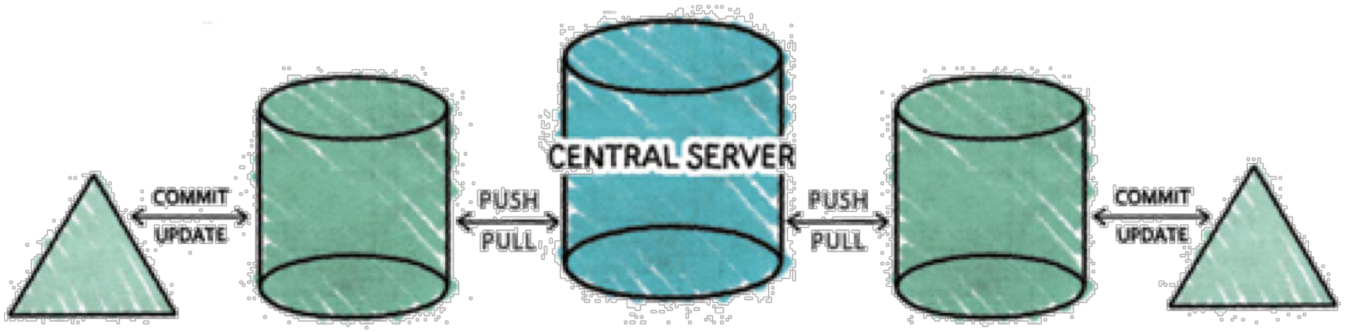
- Pushes copy changesets from a local repository instance to a remote one
  - synchronization between two repository instances

Basic Concepts: Update



- Updates the working copy with respect to the repository
  - applies changes from the repository
  - merge such changes with the ones you have made to your working copy, if necessary

Example

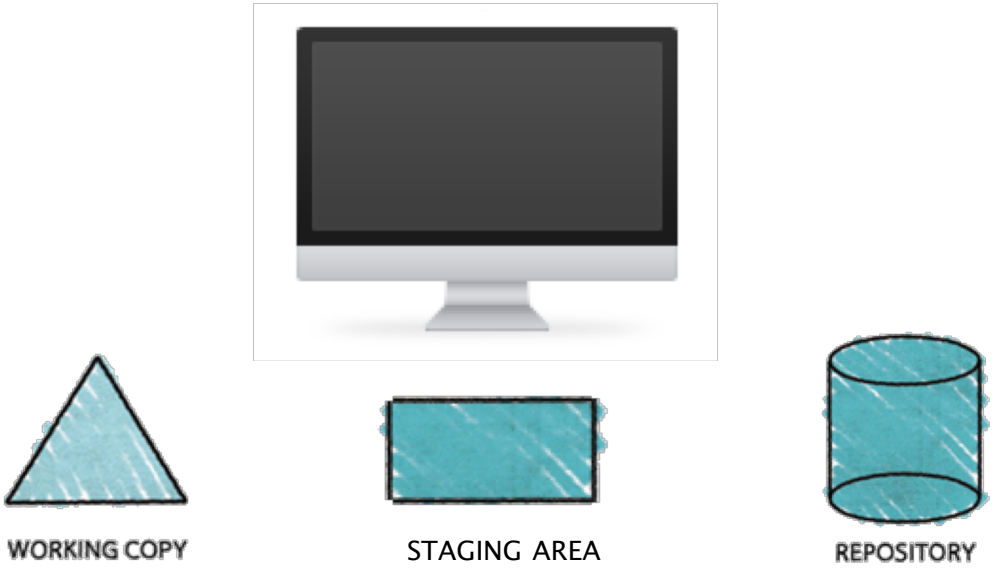


- Marco and Dave have to do the Software Engineering course project.
- They use Git for version control.

Git

- Only adds data
  - Every time adds a new snapshot
- Three states
  - Committed: data is safely stored in your local database
  - Modified: changed the file but have not committed it to your database yet
  - Staged: a modified file is marked in its current version to go into your next commit

Staging Area



- A sort of loading dock
- It can contain things that are neither in the working copy nor in the repository instance
- Also called “index”

Exclude files from version control

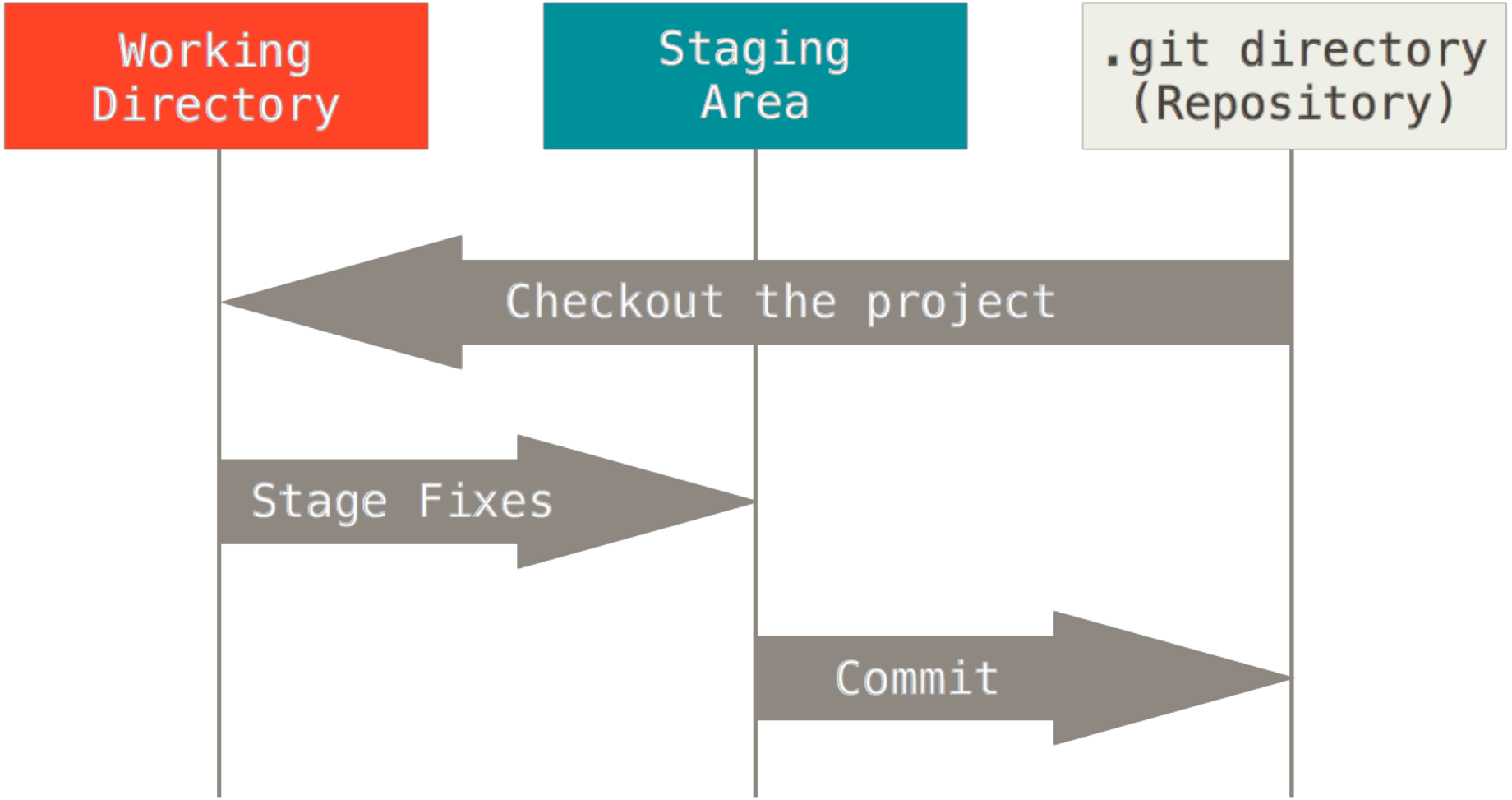
- It is possible to exclude permanently from version control some files in the project folder

- These files have to be listed in the .gitignore file so that such files and folders will not be staged

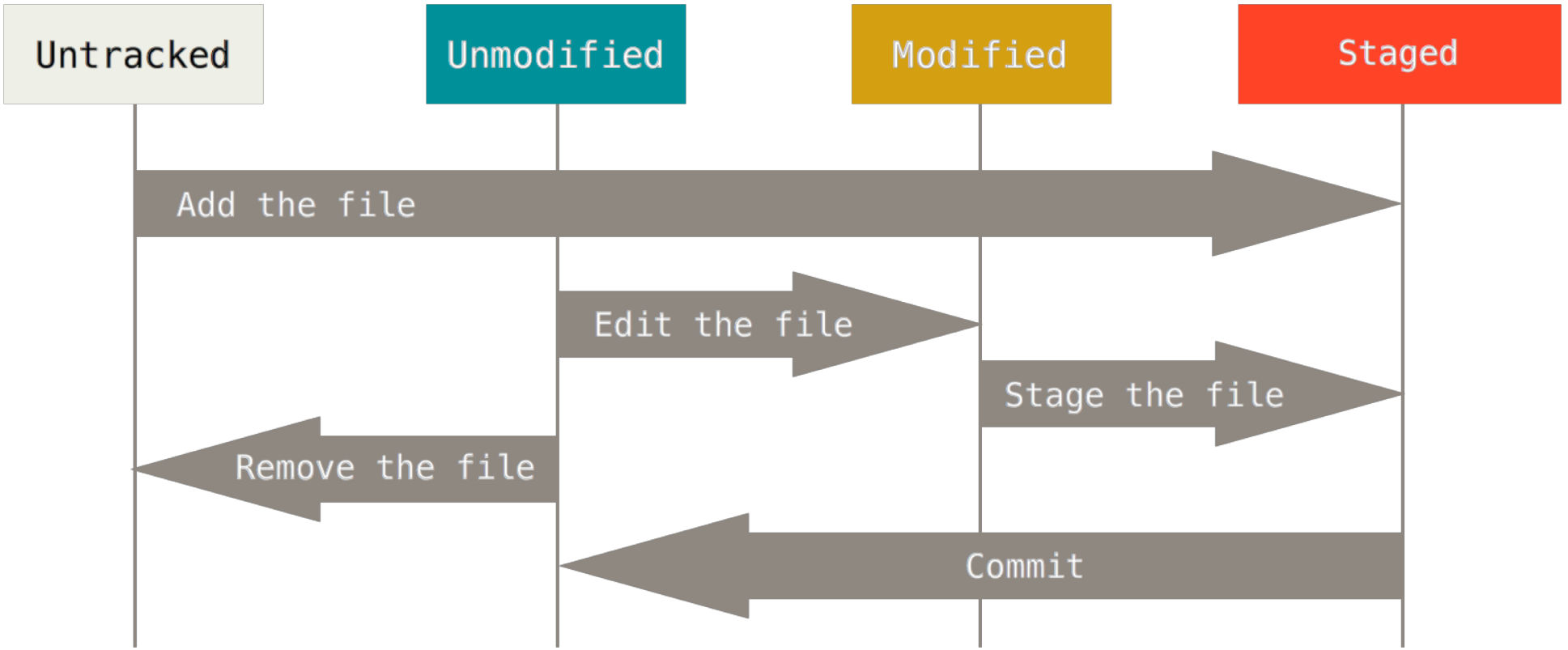
Typical workflow

1. Modify files in your working directory
2. Stage the files, adding snapshots of them to your staging area
3. Do a commit, which takes the files as they are in the staging area and stores that snapshot permanently to your Git directory.

Typical workflow



Lifecycle of files



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- **Git basic commands**
- Git branching

Basic Commands

- git init
  - Initializes an empty Git repository in the current folder
  - It creates a .git directory inside it
- git remote add origin http://server.com/project.git
  - Adds a new remote repository
  - Origin is the ‘standard’ name for indicating the principal remote

Recording Changes

- Git status
  - Determine which files are in which state
- Git add
  - Track a new file
- Git diff
  - Know exactly what you changed
- Git commit
  - Commit changes

Recording Changes

- Git rm
  - Remove a file from your tracked files and also from your working directory
- Git mv
  - Rename a file
  - Git doesn’t explicitly track file movement. If you rename a file in Git, no metadata is stored in Git that tells it you renamed the file

Viewing the Commit History

- Git log
  - look back to see what has happened in a repository

Working with Remotes

- Git pull
  - Automatically fetch and then merge a remote branch into your current branch
- Git push
  - Share the changes, i.e. transfer them on the server

In practice

```
echo "# tmp" >> README.md

git init

git add README.md

git commit -m "first commit"

git remote add origin
git@github.com:user/tmp.git

git push -u origin master
```

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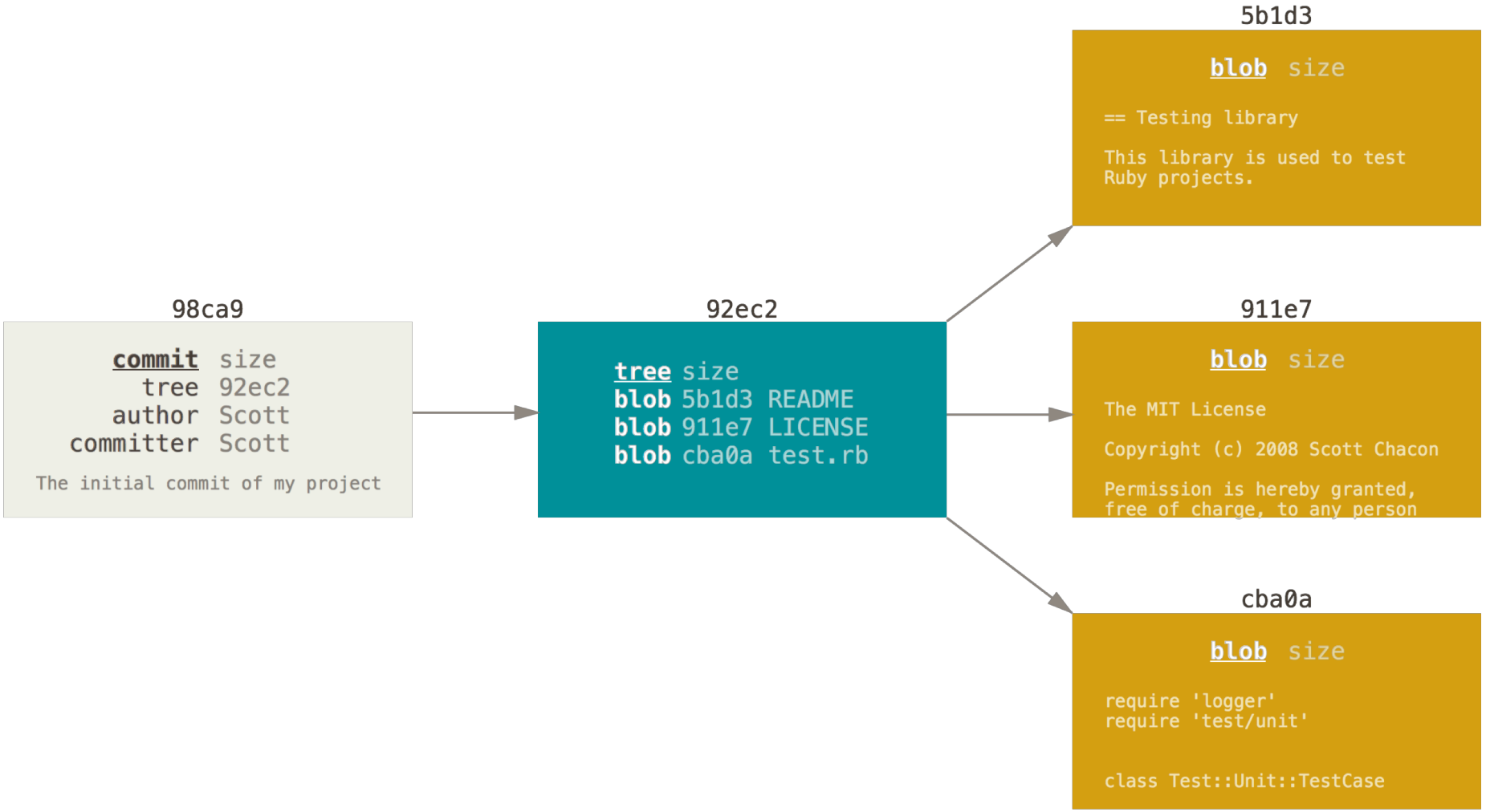
Data storage in Git

- Git stores a commit object that contains
  - a pointer to the snapshot of the content you staged
  - pointers to the commit or commits that directly came before this commit (its parent or parents)
- Staging the files
  - checksums each one
  - stores that version of the file (blobs)
  - adds that checksum to the staging area

Example

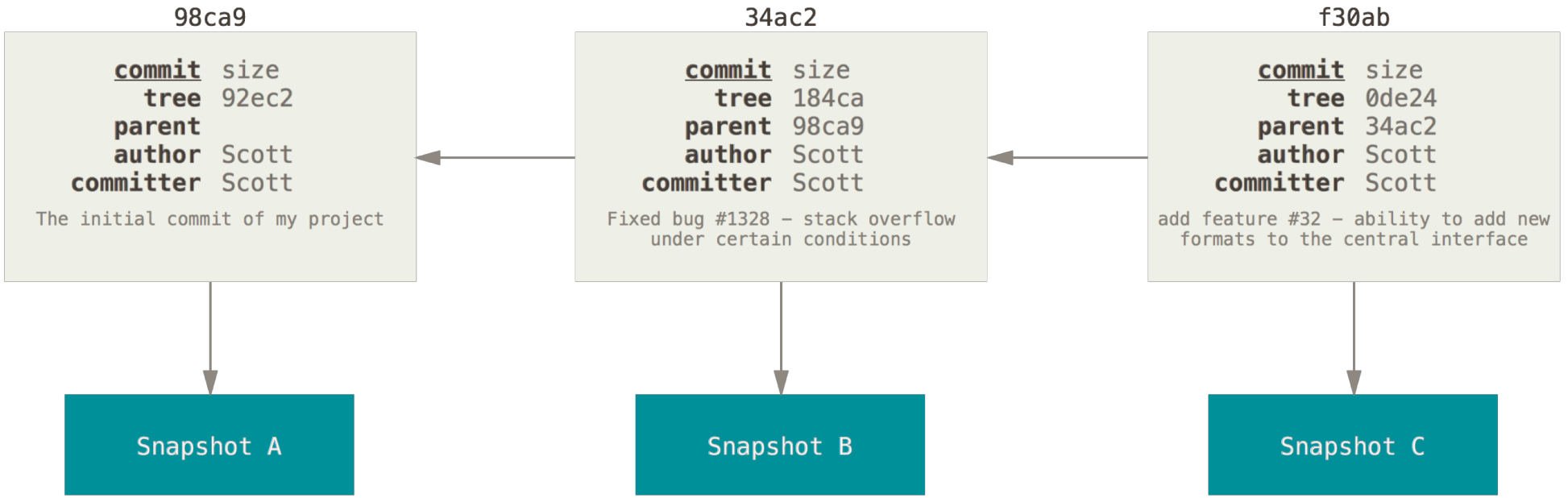
- Given a directory containing three files, stage them all and commit
- Git repository now contains five objects
  - one blob for the contents of each of the three files
  - one tree that lists the contents of the directory and specifies which file names are stored as which blobs
  - one commit with the pointer to that root tree and all the commit metadata

Example


98ca9
commit size
tree 92ec2
author Scott
committer Scott
The initial commit of my project
92ec2
tree size
blob 5b1d3 README
blob 911e7 LICENSE
blob cba0a test.rb
5b1d3
blob size
== Testing library
This library is used to test
Ruby projects.
911e7
blob size
The MIT License
Copyright (c) 2008 Scott Chacon
Permission is hereby granted,
free of charge, to any person
cba0a
blob size
require 'logger'
require 'test/unit'
class Test::Unit::TestCase

Example

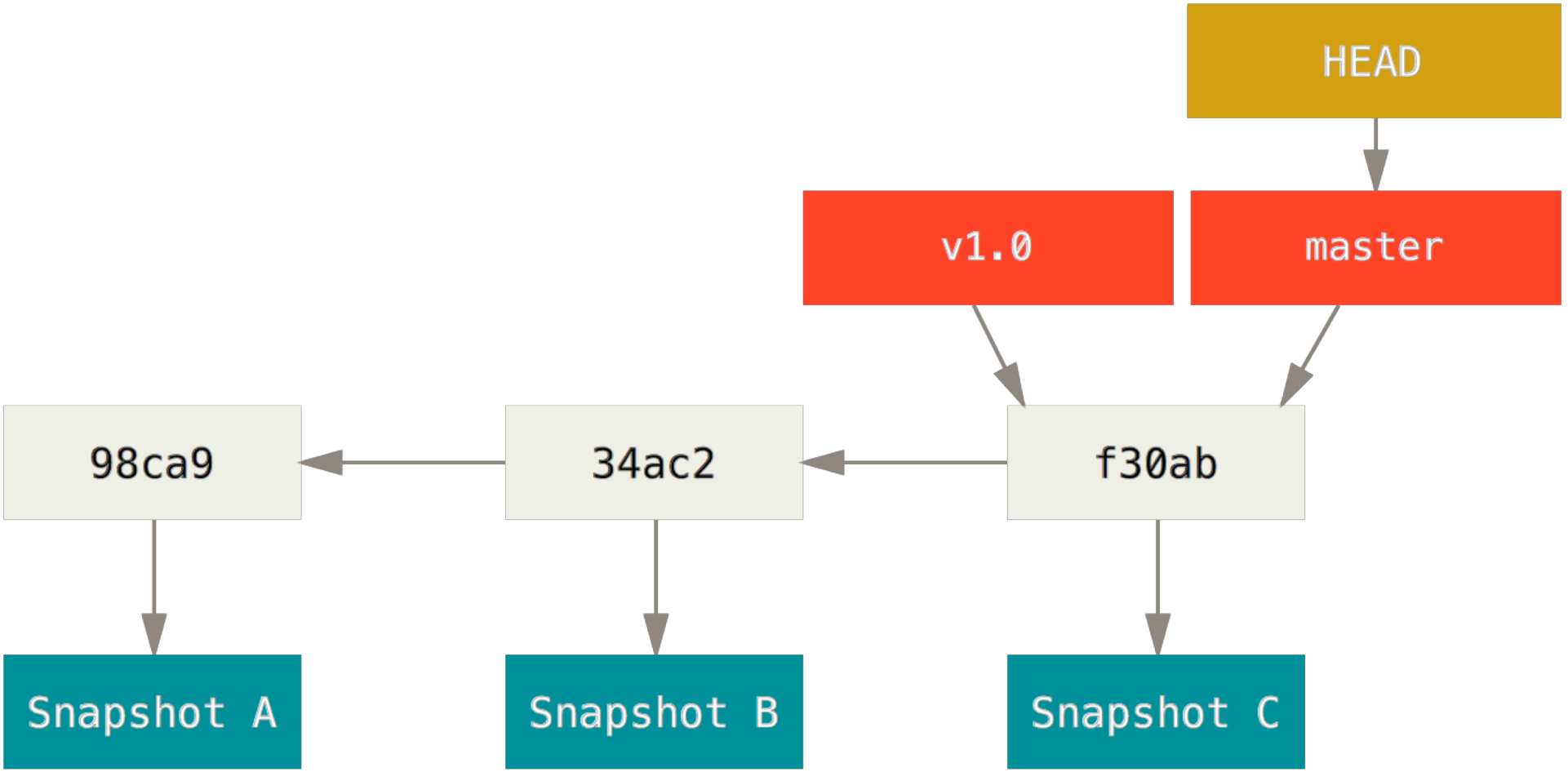
- The next commit stores a pointer to the commit that came immediately before it



Branches

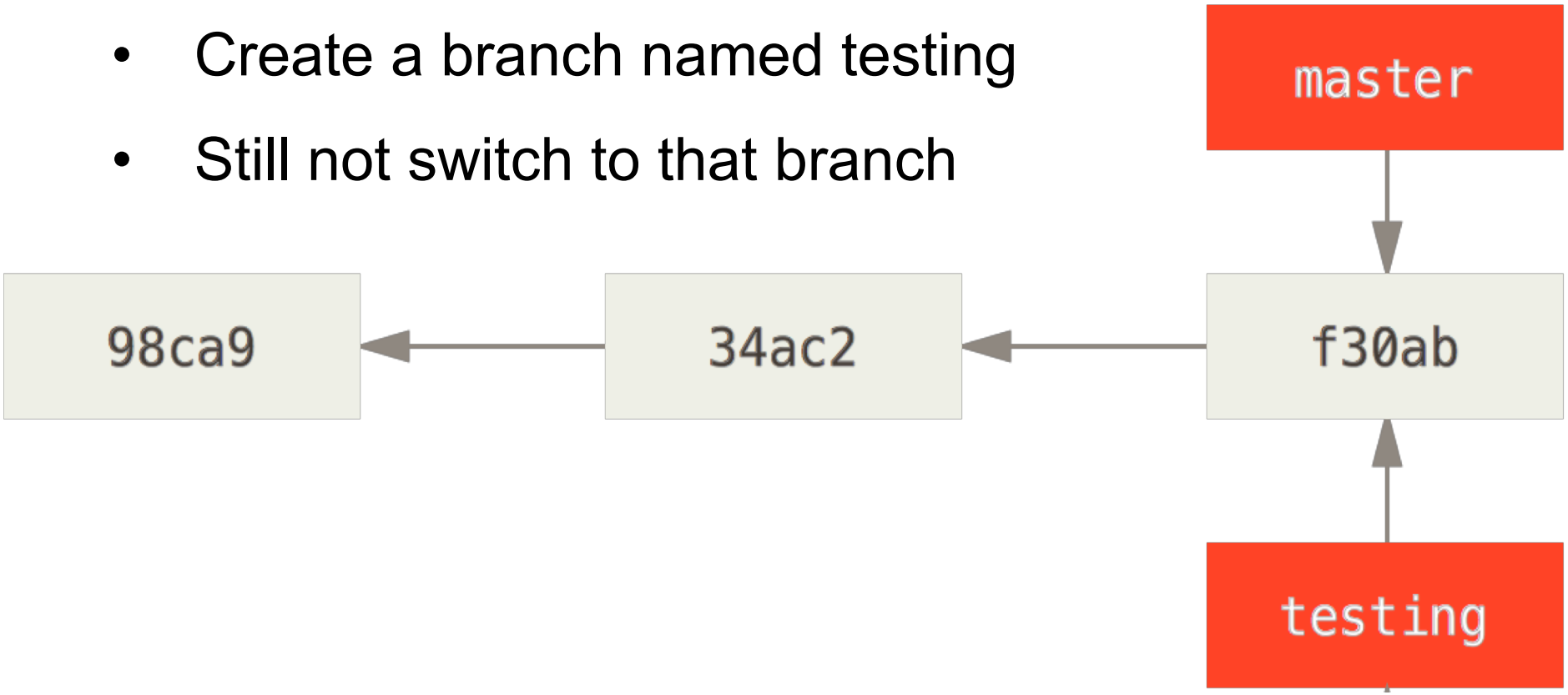
- A branch in Git is simply a lightweight movable pointer to one of these commits
- The default branch name in Git is master
- Every commit, it moves forward automatically

Branches


HEAD
v1.0
master
98ca9
34ac2
f30ab
Snapshot A
Snapshot B
Snapshot C

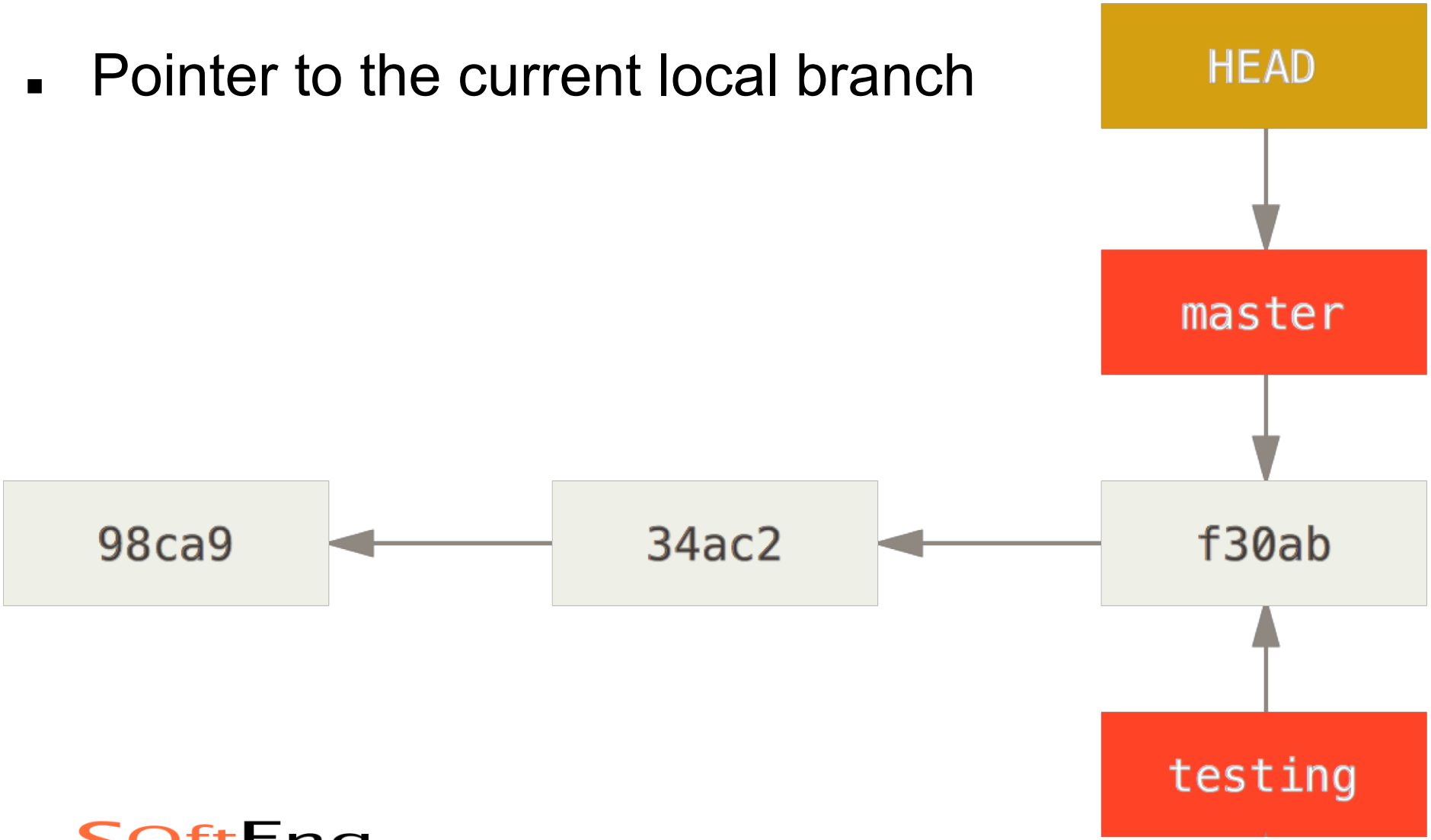
Create a Branch

- Git branch testing
  - Create a branch named testing
  - Still not switch to that branch



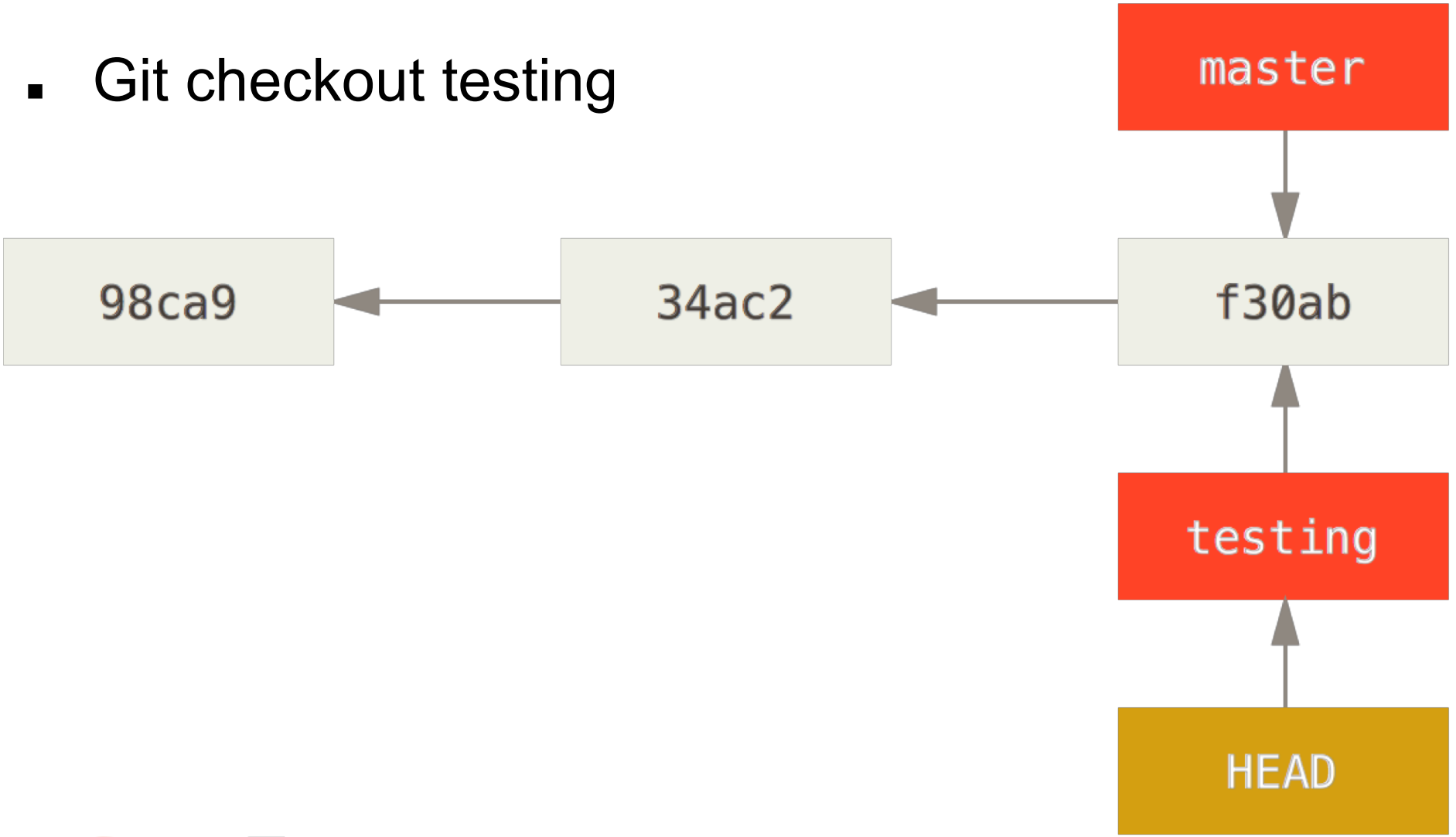
Head pointer

- Pointer to the current local branch



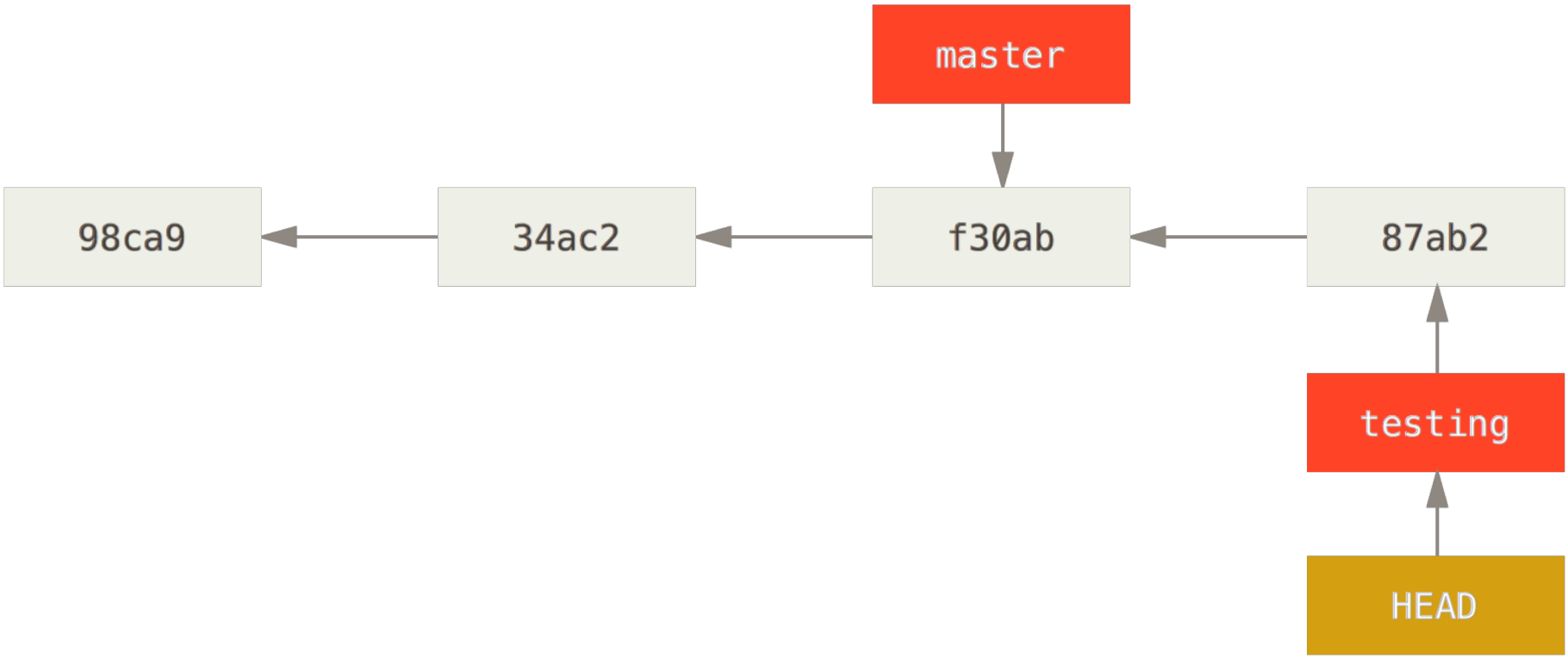
Switching Branches

- Git checkout testing



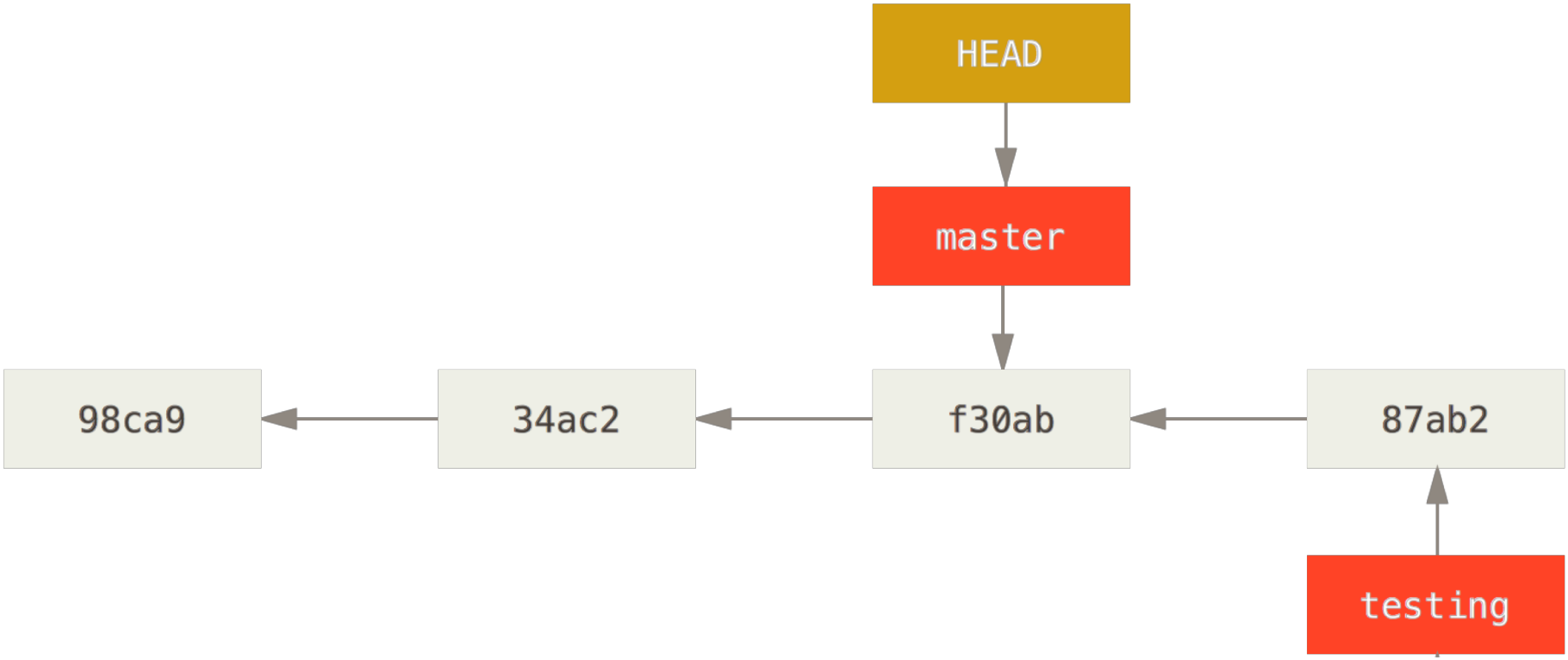
Switching Branches

- After another commit



Switching Branches

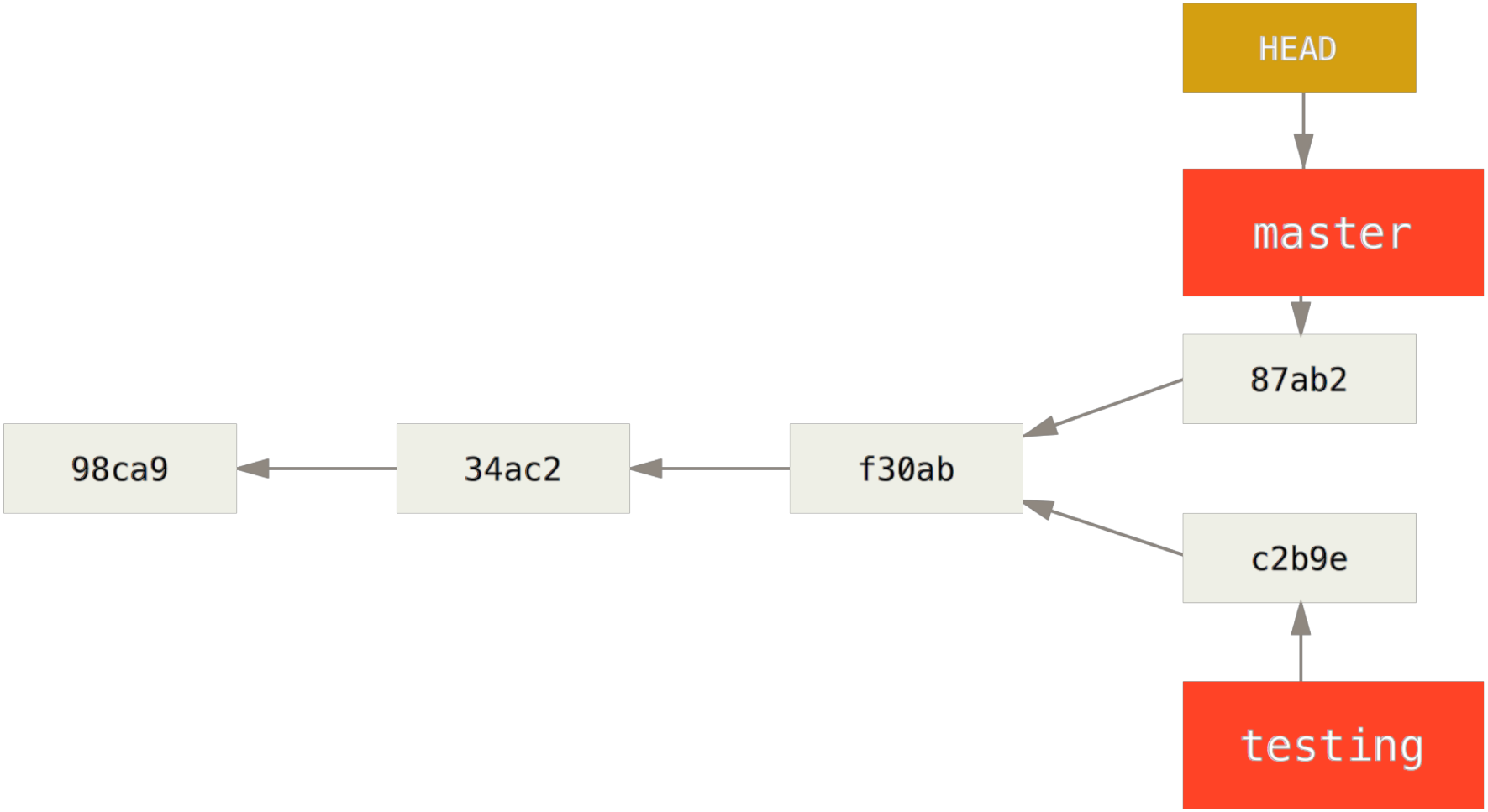
- Git checkout master



Switching Branches

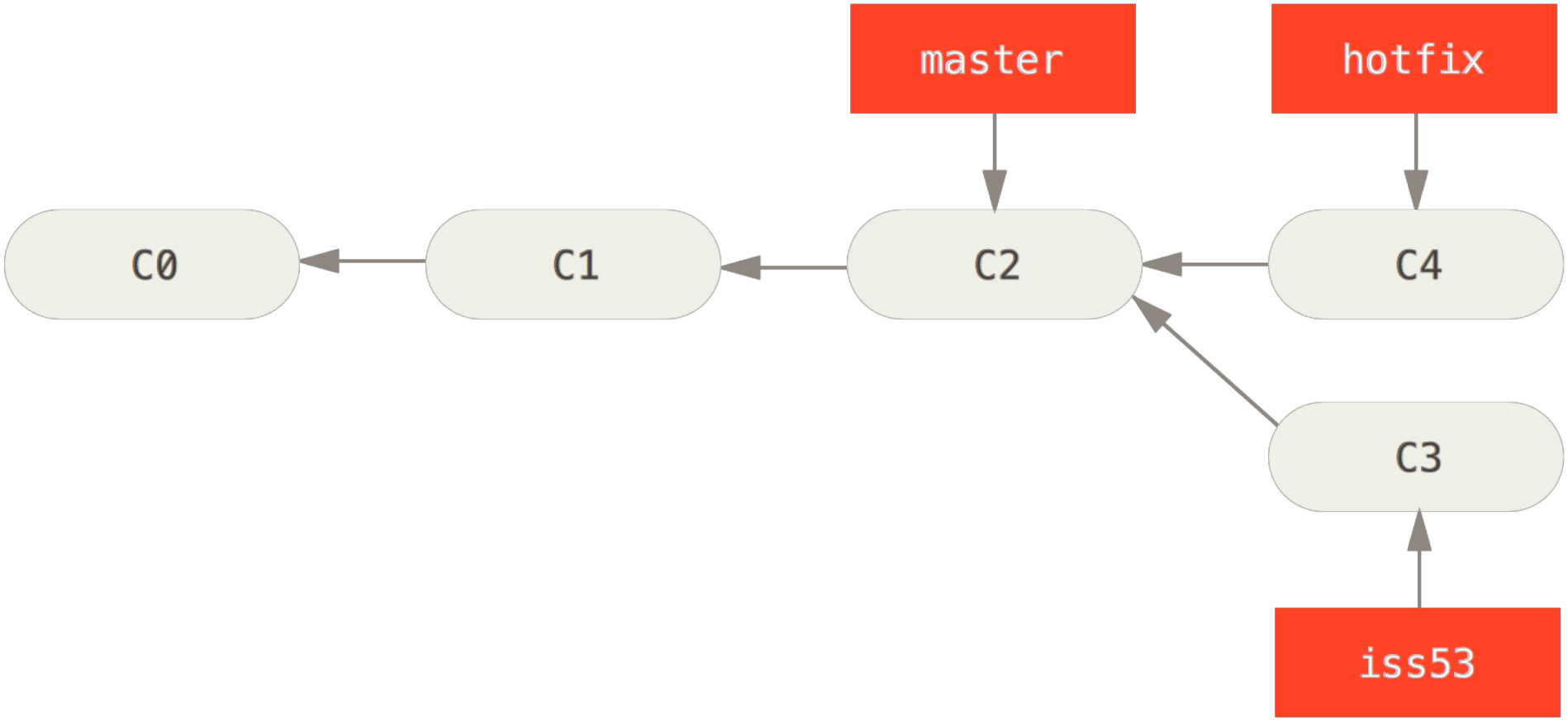
- Revert the files in working directory back to the snapshot that master points to
- The changes made from this point forward will diverge from an older version of the project
- Files in your working directory changes

Switching Branches



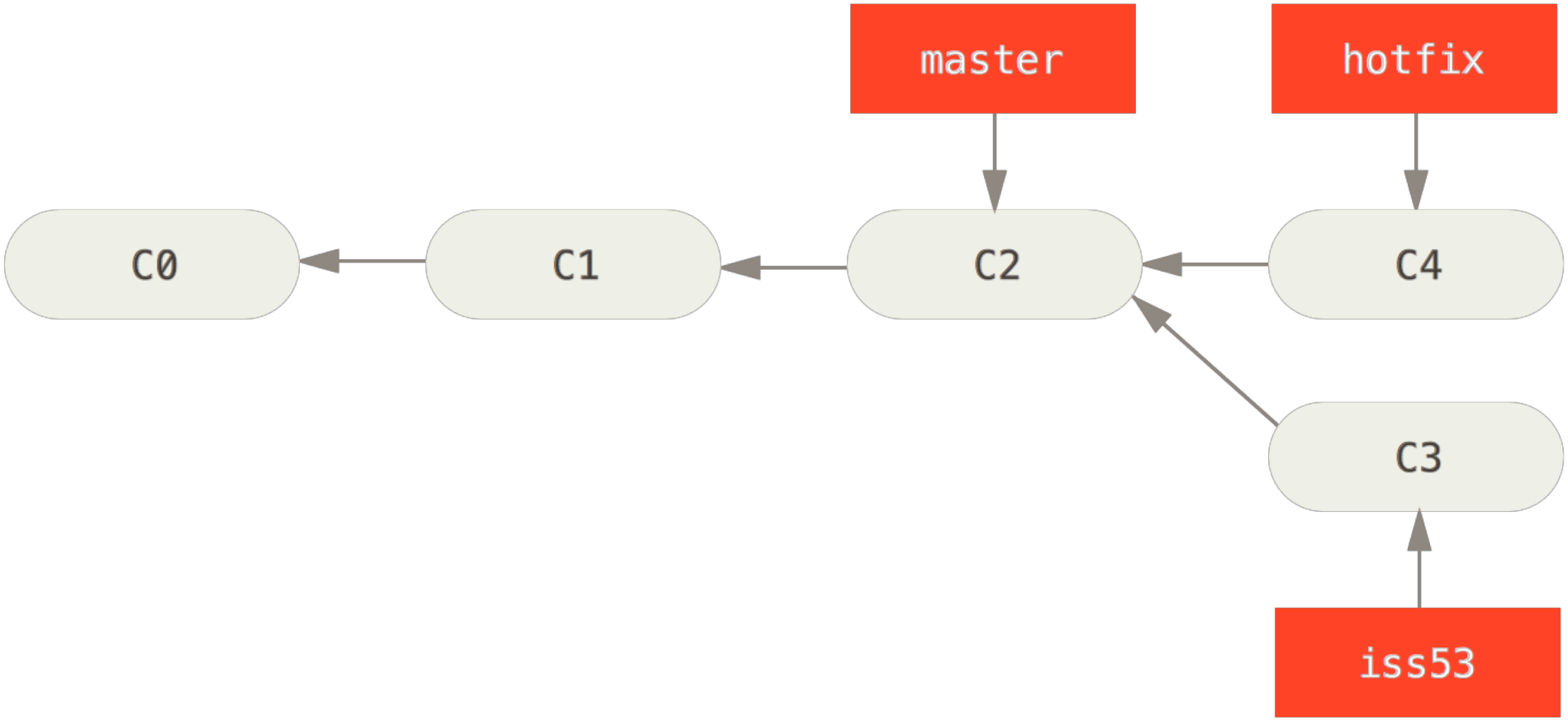
Merging Branches

- Initial situation (current branch is hotfix)



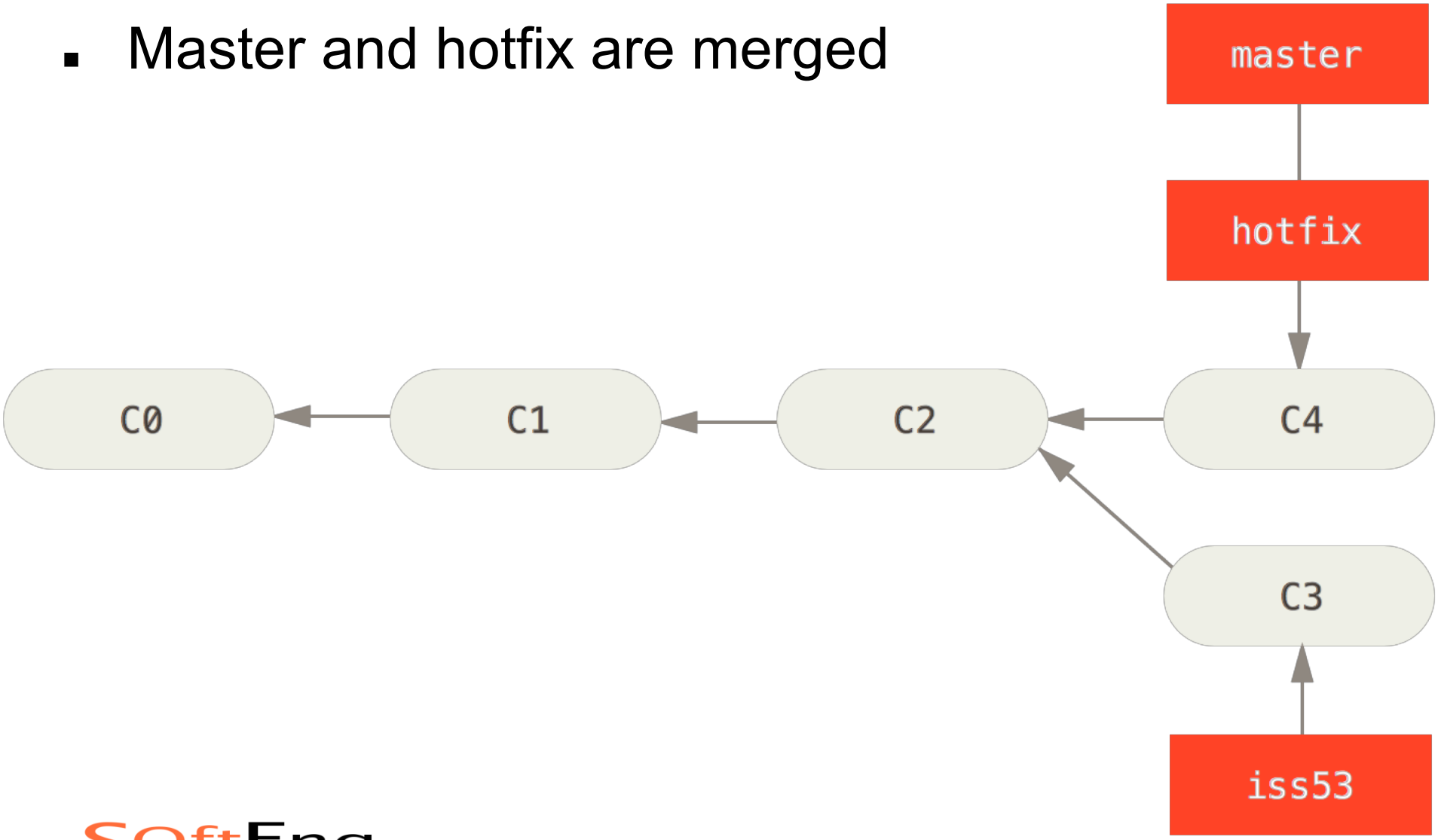
Merging Branches

- Merging hotfix with master: git merge hotfix



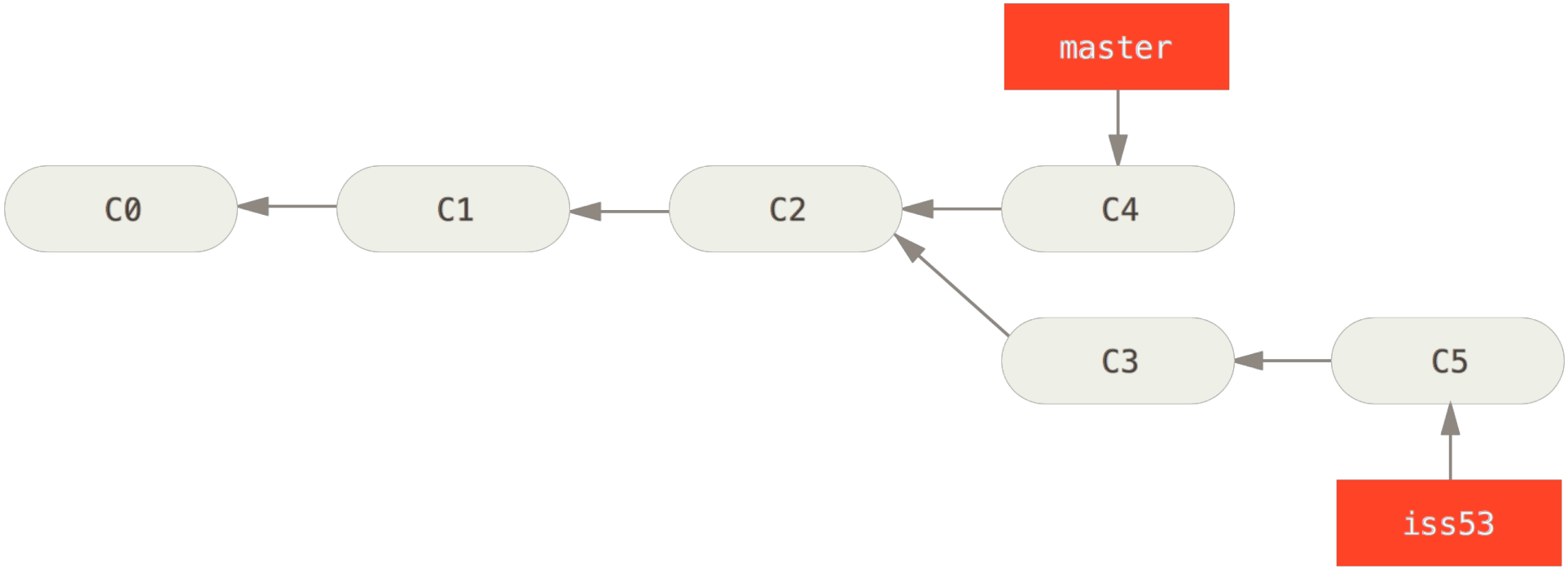
Merging Branches

- Master and hotfix are merged



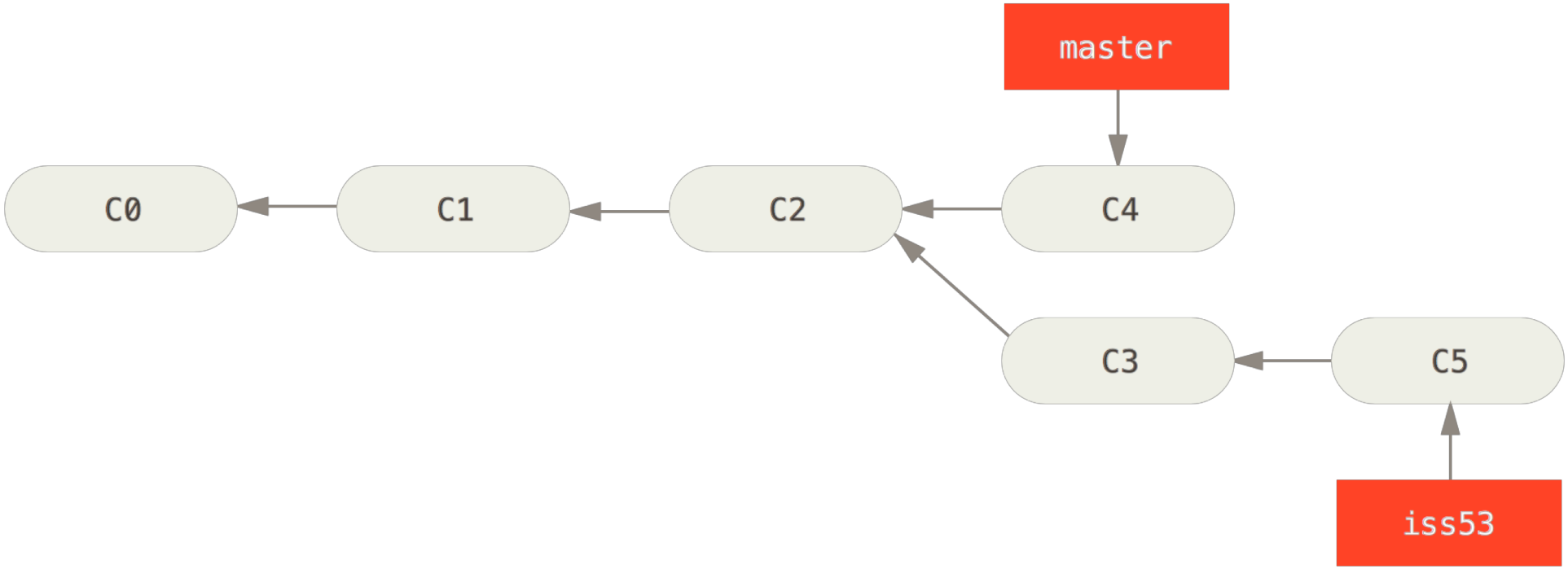
Merging Branches

- New commit on iss53



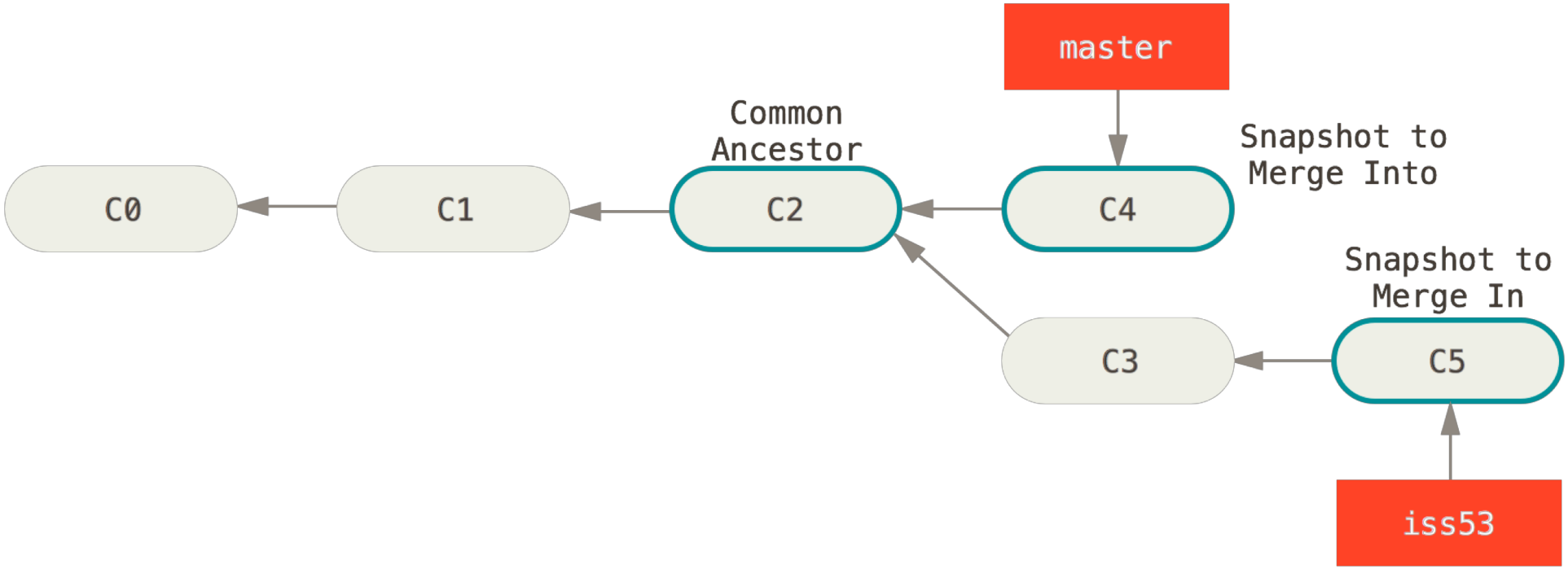
Merging Branches

- New commit on iss53



Merging Branches

- Merging iss53 with master

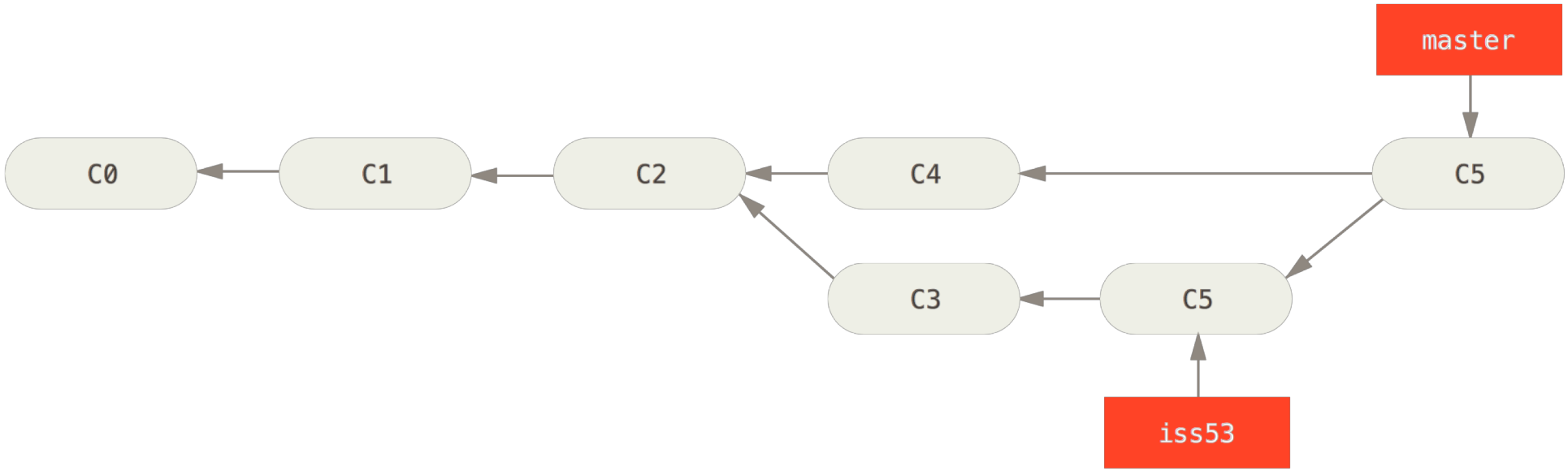


Merging Branches

- Instead of just moving the branch pointer forward, Git creates a new snapshot that results from this three-way merge and automatically creates a new commit that points to it
- This is referred to as a merge commit, and is special in that it has more than one parent
- Git determines the best common ancestor to use for its merge base
- Conflicts are possible, in this case merging not done until conflicts are managed (as for commits)

Merging Branches

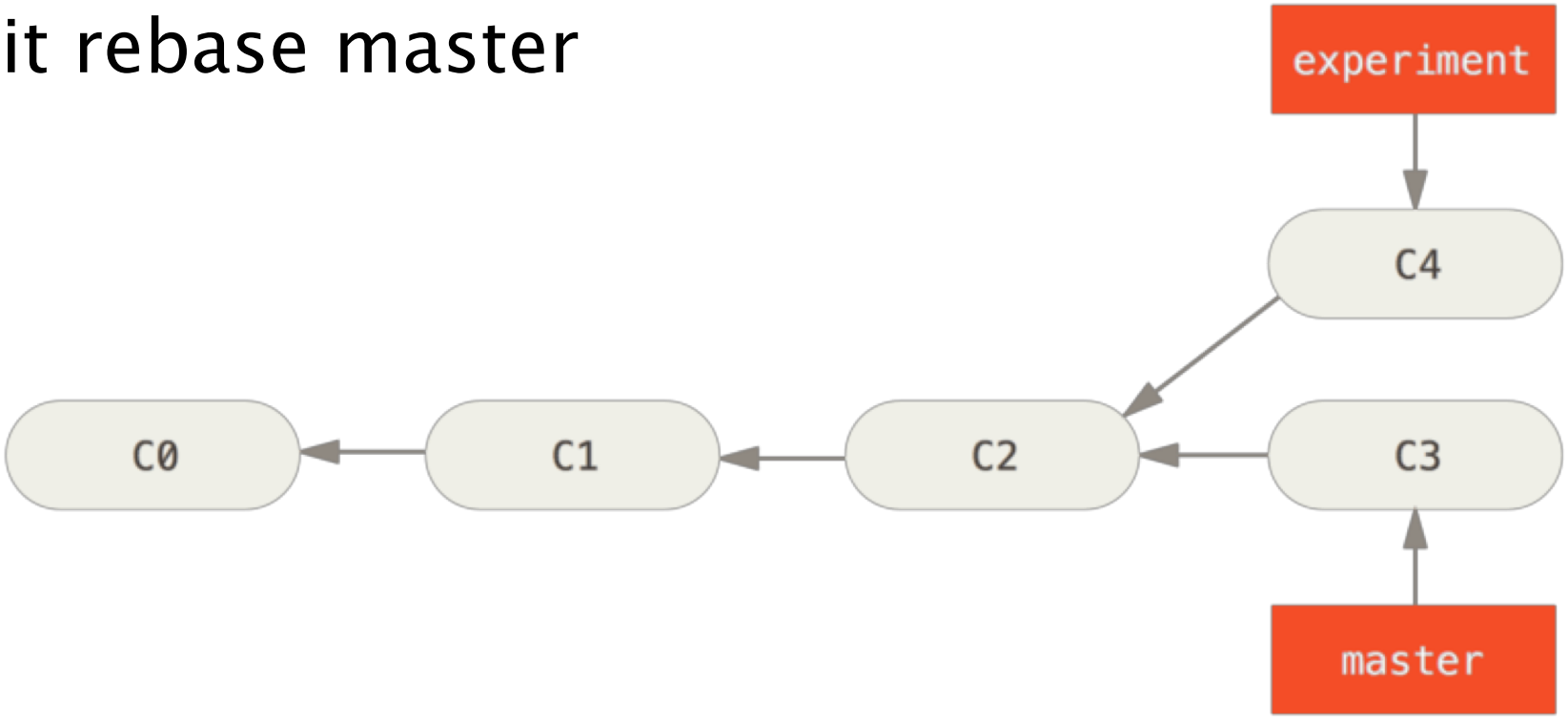
- Final result



Rebase

$ git checkout experiment

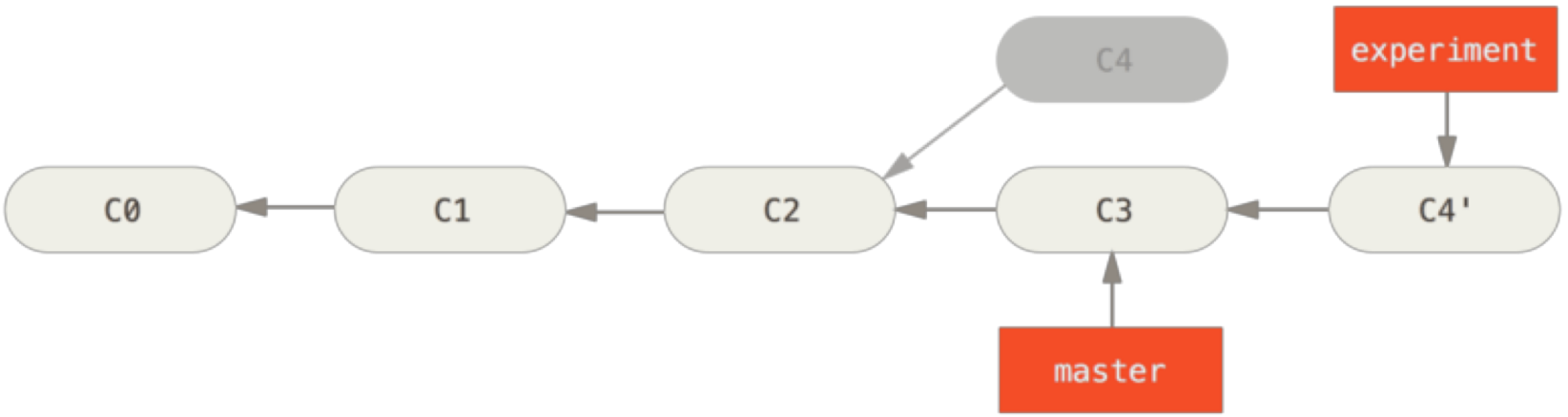
$ git rebase master



Rebase

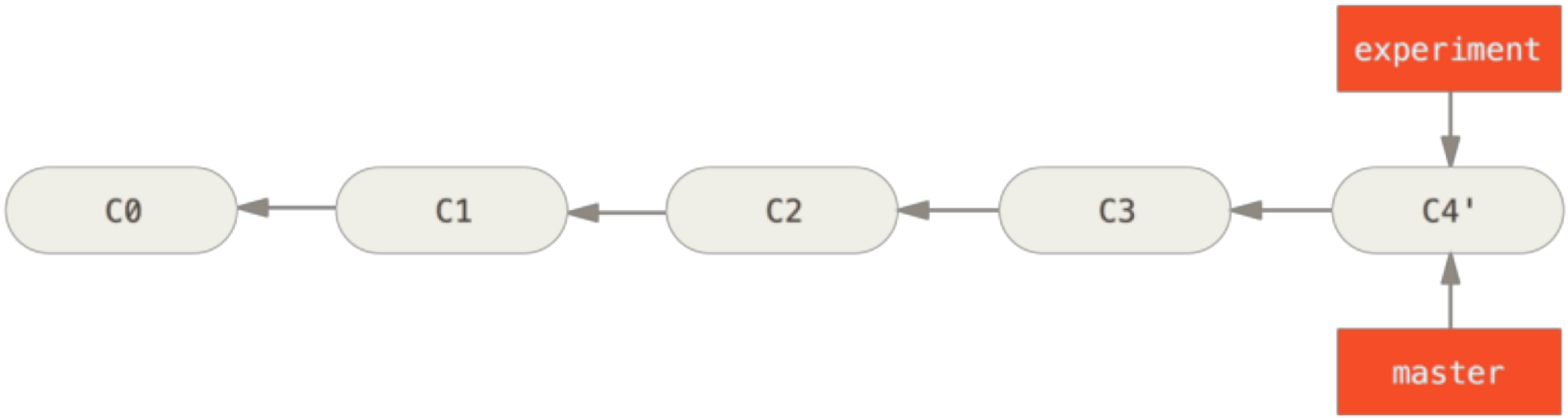
$ git checkout master

$ git merge experiment



Rebase

Result



Be careful, rebase rewrites the repository history!

Rebase

It is also possible to organize/edit your commits

Some useful cases:

- the commit message is wrong or it doesn't make sense.
- the order of the *commits* is not nice regarding to git history.
- there are more than one commit which make similar changes (or even the same thing).
- a commit grouped a lot of different code and it makes sense divide it in smaller *commits*.

Rebase

git rebase -i HEAD~4

- -i => interactive mode
- ~4 =>number of commits we want to target.

Rebase change commit order

git rebase -i HEAD~4

pick 0a0cf97 document
pick d09e470 add paragraph
pick 59b2309 add second document
pick 16013c6 change title

Change the order of these lines

Change commit order

git rebase -i HEAD~4

pick 0a0cf97 document

pick 59b2309 add second document

pick d09e470 add paragraph

pick 16013c6 change title

Edit commit messages

git rebase -i HEAD~4

pick 0a0cf97 document

pick 59b2309 add second document

reword d09e470 add paragraph

pick 16013c6 change title

Change **pick** with **reword** for editing the commit message

Merge commits

git rebase -i HEAD~4

pick 0a0cf97 document

squash 59b2309 add second document

pick d09e470 add paragraph

pick 16013c6 change title

Change **pick** with **squash** for merging the second commit with the first

Merge commits

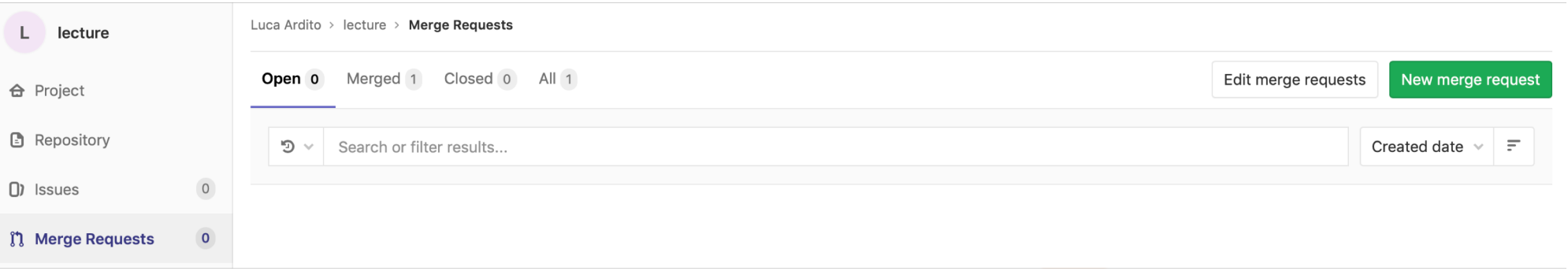
The result will be:

```
# This is a combination of 2 commits.
# The first commit's message is:
document
# This is the 2nd commit message:
add paragraph
# Please enter the commit message for your changes.
```

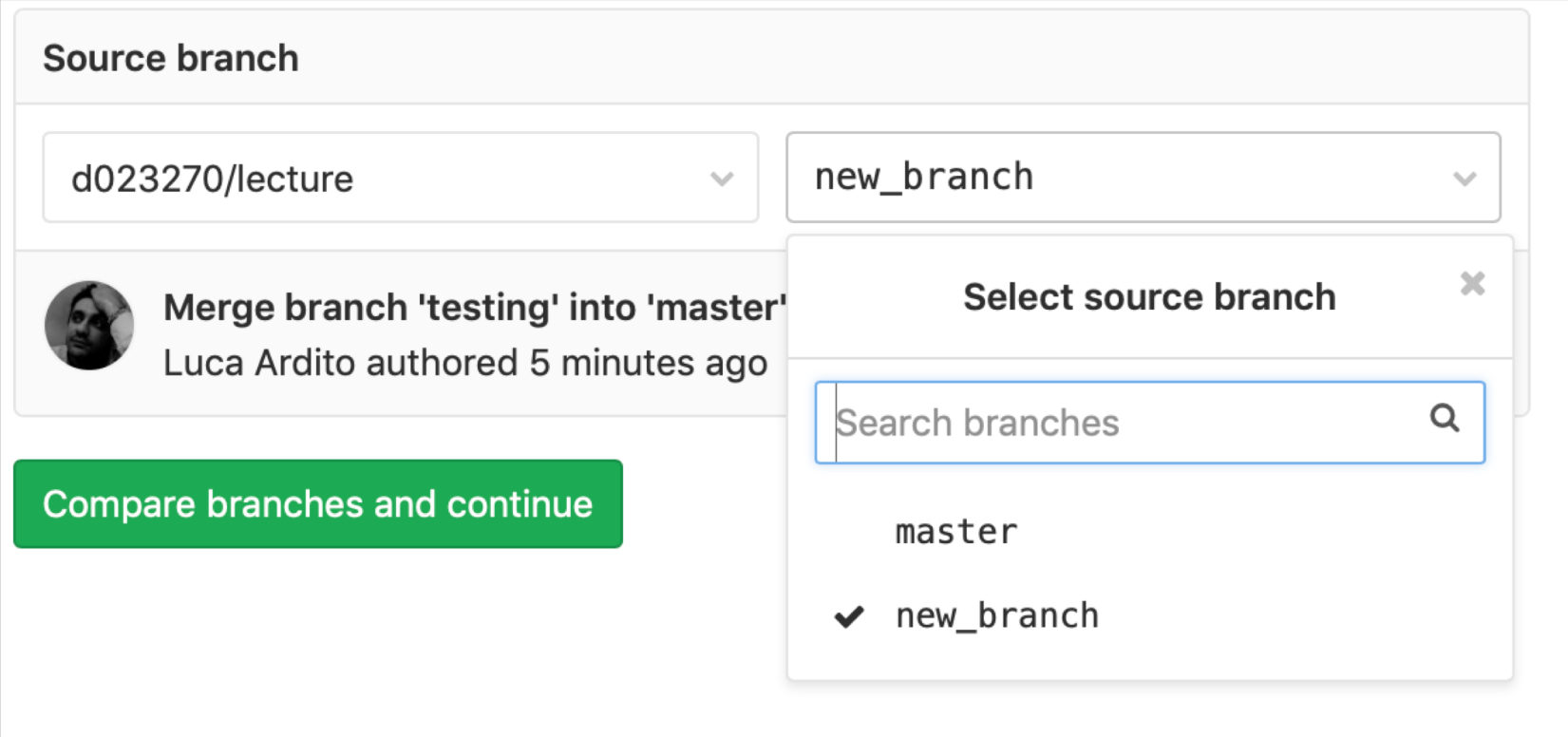
Delete all this lines and write a message for the new commit

Merge Requests

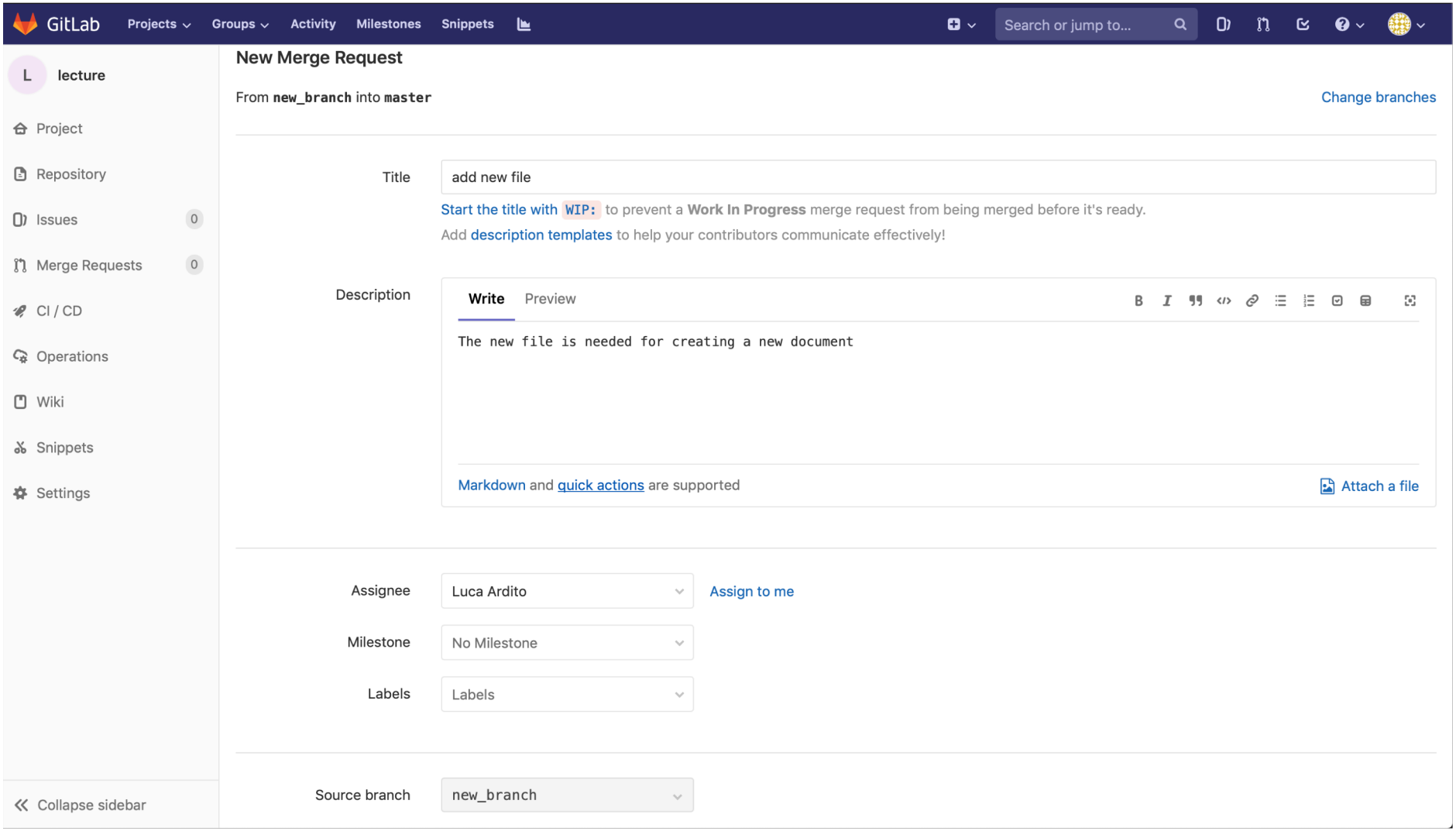
- Create a new branch
- Work on the new branch
- Commit and push your work
- Open the project on Gitlab and create a new merge request



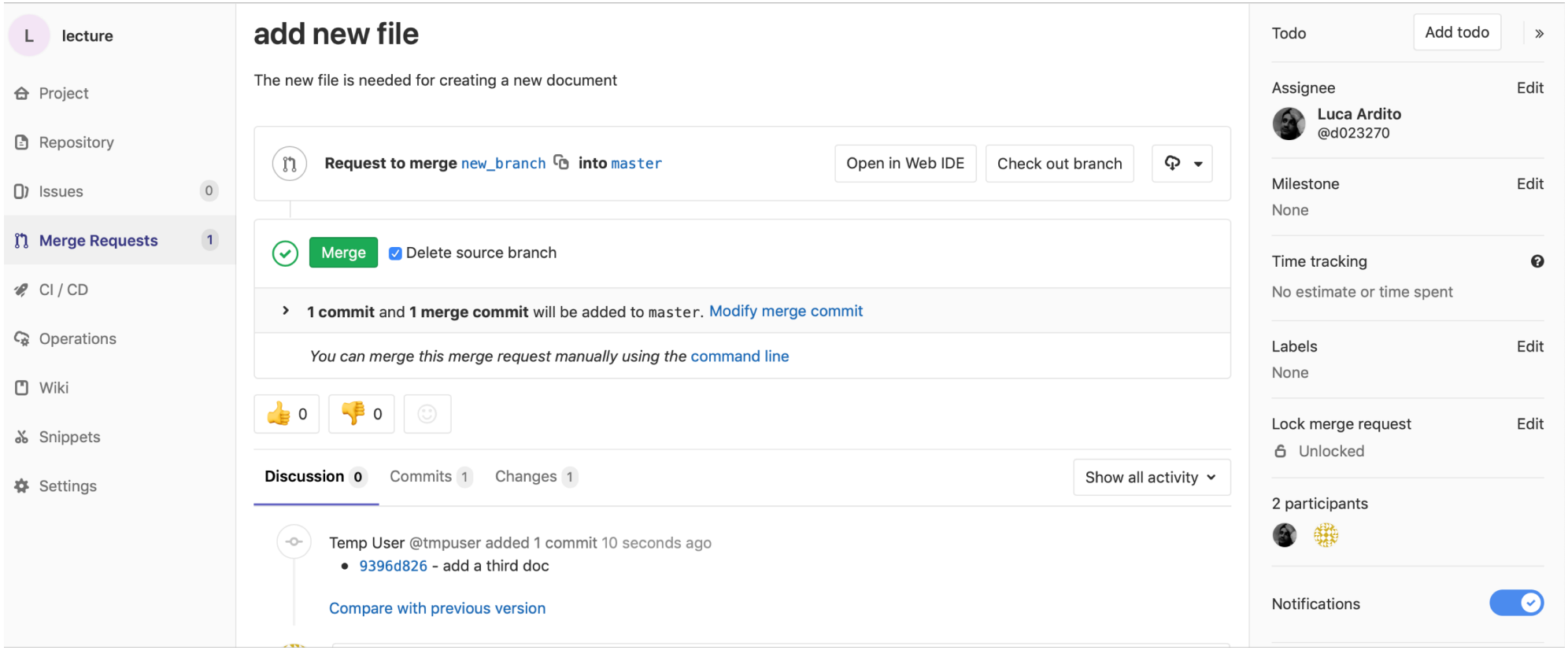
Merge Requests



Merge Requests



Merge Requests



When the merge request is approved, the commit will appear in MASTER

Git additional Resources

- Reference guide
  - http://git-scm.com/doc
- GUI tools for git
  - https://git-scm.com/downloads/guis