INTRO TO GIT AND GITHUB

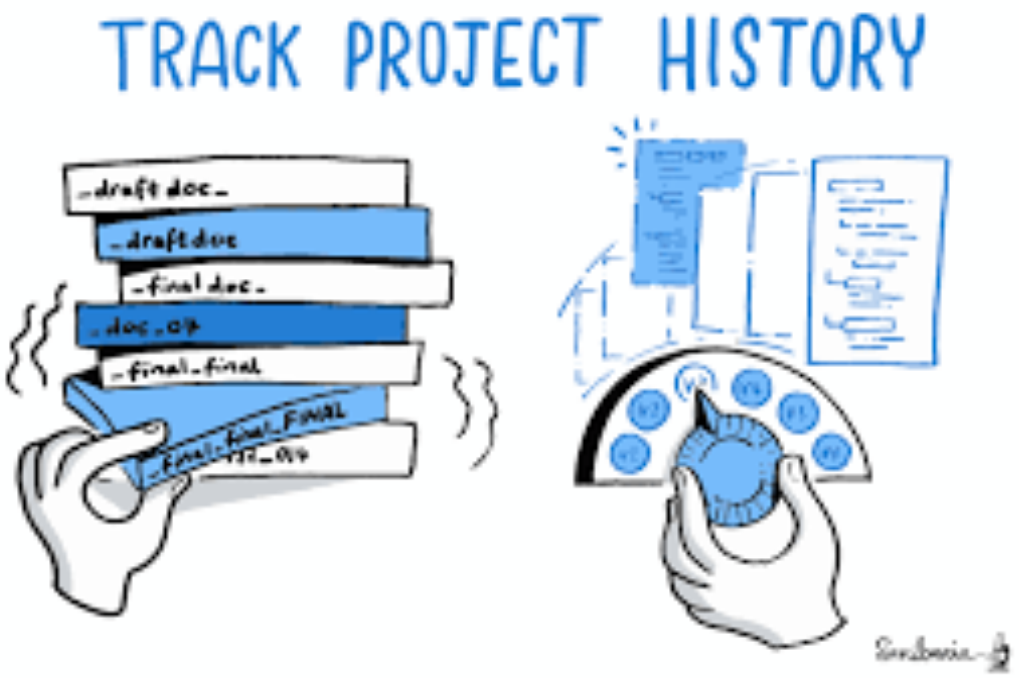
Selin Group Meeting

24 February 2023

Emmie Le Roy

Version control systems

- Track the history of changes to a set of files and its contents
- Facilitate collaboration
- Maintains meta-data (author, timestamp of changes)
- Supports reproducible research!



https://the-turing-way.netlify.app/reproducible-research/vcs.html

Today's tutorial

- Intro to Git Internals
- Basic Git commands
- Git demo
- GitHub demo

The missing semester of your CS education
https://missing.csail.mit.edu/2020/version-control/

https://xkcd.com/1597/

GIT'S DATA MODEL

Selin Group Meeting

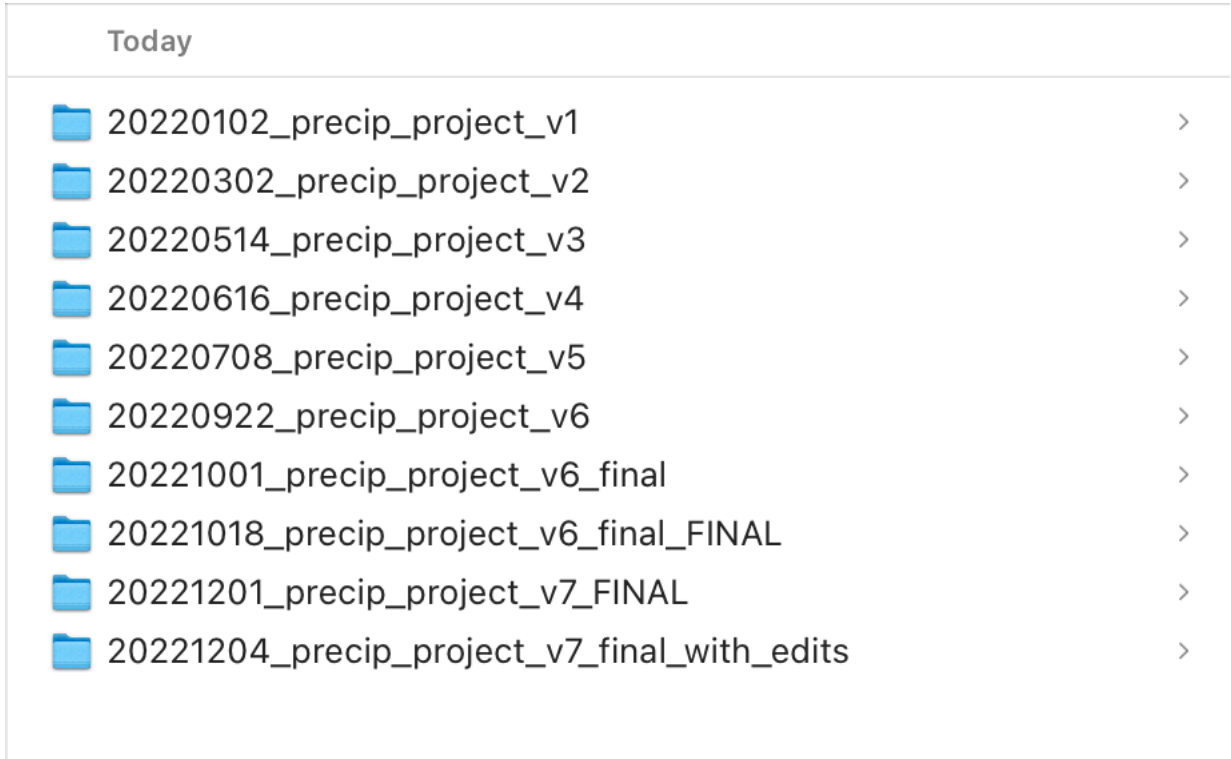
24 February 2023

Emmie Le Roy

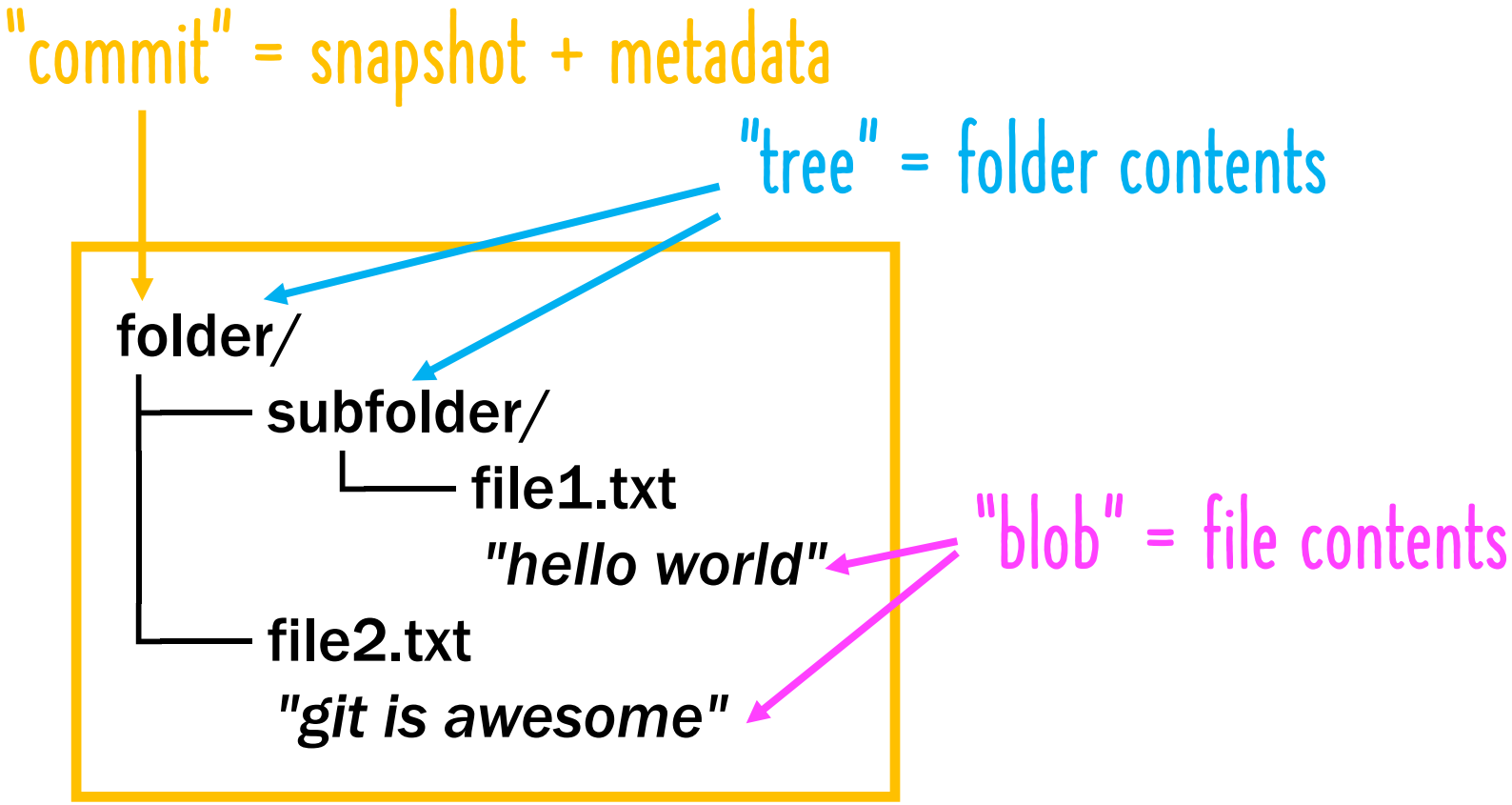
A “snapshot” of a generic project folder

```
folder/
├── subfolder/
│   └── file1.txt
│           "hello world"
└── file2.txt
        "git is awesome"
```

“Save As” is one way to take snapshots of your project



Git's version of "Save As" stores data as three object types: blobs, trees, and commits



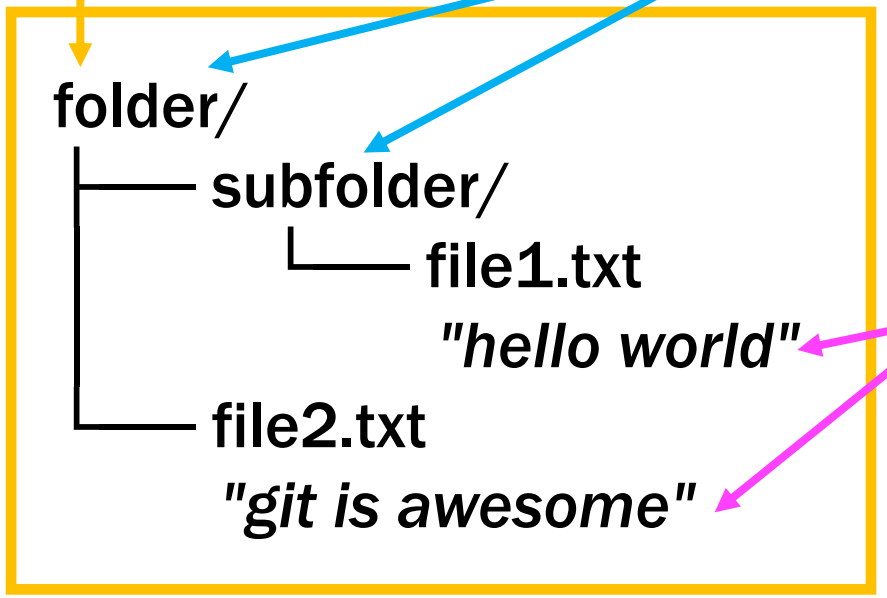
A commit is a “snapshot” of what the entire directory looks like at a given time

type = struct{
 snapshot: top-level tree
 parents: array<commit>,
 author: string,
 message: string,
}

"commit" = snapshot + metadata

"tree" = folder contents

type = map<string, tree | blob>



"blob" = file contents

type = array<byte>

commit

tree

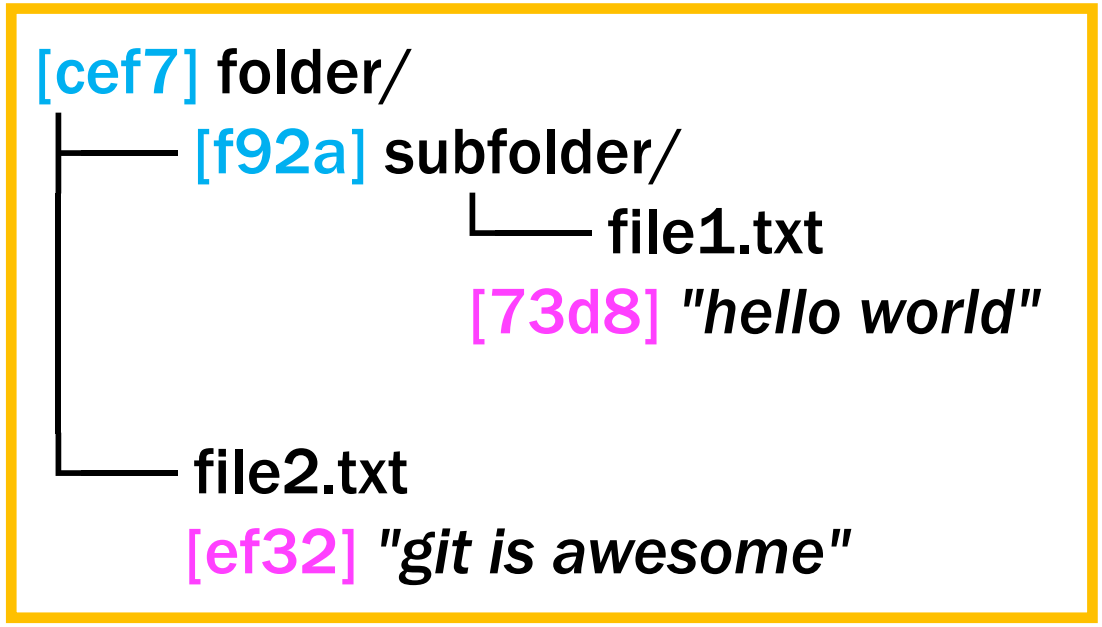
blob

```
~/tutorials/demo/.git/objects/3b  single_line
 git cat-file -p 8426bf9a7042b8dabf531b0b91772f8fab0db2fa
tree 68aba62e560c0ebc3396e8ae9335232cd93a3f60
author emmleroy <47359313+emmleroy@users.noreply.github.com> 1677040055 -0500
committer emmleroy <47359313+emmleroy@users.noreply.github.com> 1677040055 -0500

Initial commit

~/tutorials/demo/.git/objects/3b  single_line
 git cat-file -p 68aba62e560c0ebc3396e8ae9335232cd93a3f60
100644 blob 3b18e512dba79e4c8300dd08aeb37f8e728b8dad    hello.txt

~/tutorials/demo/.git/objects/3b  single_line
 git cat-file -p 3b18e512dba79e4c8300dd08aeb37f8e728b8dad
hello world
```

What is “a1337c4664981e4397625791c8ea3bbb5f2279a3”?

Each object is identified by the SHA-1 hash of its contents

commit [a133]



A **hash function** takes variable sized data as input and returns a fixed-size hash value as output

Rossby waves, also known as planetary waves, are a type of inertial wave naturally occurring in rotating fluids. They were first identified by Sweden-born American meteorologist Carl-Gustaf Arvid Rossby. They are observed in the atmospheres and oceans of planets owing to the rotation of the planet.

8950 4e47 0d0a 1a0a 0000 000d 4948 4452 0000
000a 0000 000a 0806 0000 008d 32cf bd00 0000
98dc 1bc1 f62c e660 310f a99c 469a dafc 8d7a

```
def my_function():
  print("Hello from a function")
```

Hash Function

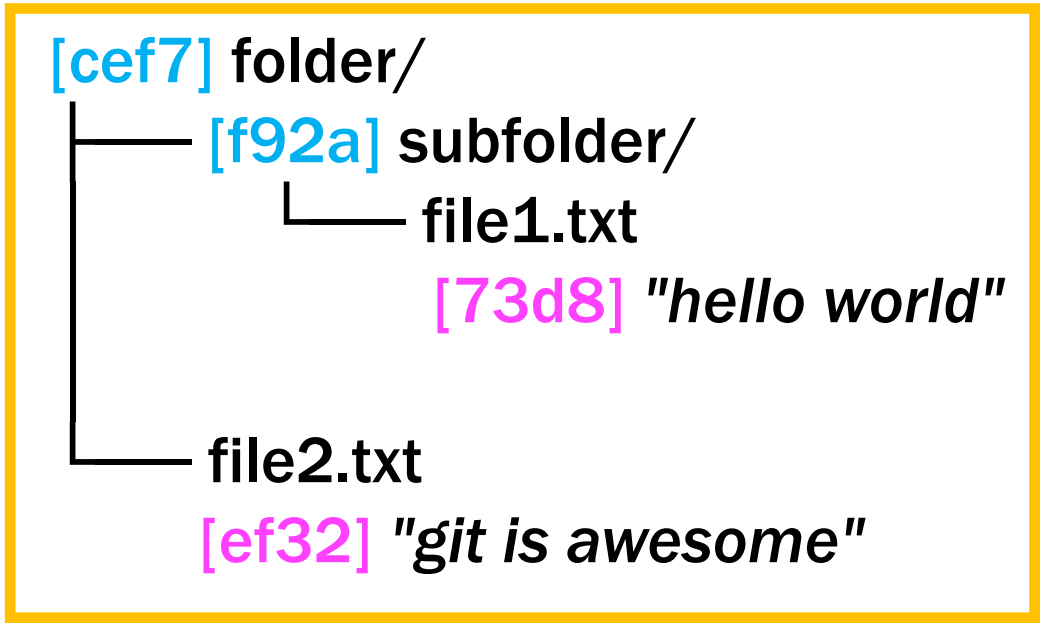
9bceaac05c772aff8150740333398f431aab689a

8426bf9a7042b8dabf531b0b91772f8fab0db2fa

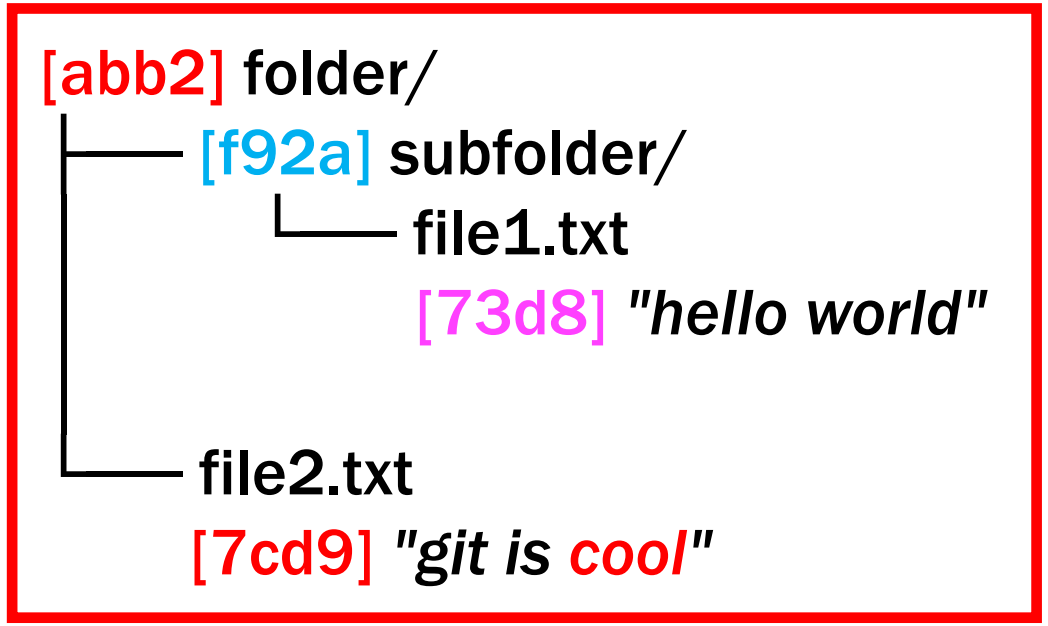
fdfe486da15df52af3478ec8eeeeac049b7a9762

Git can quickly check if two objects are identical and only store unique objects

commit [a133]

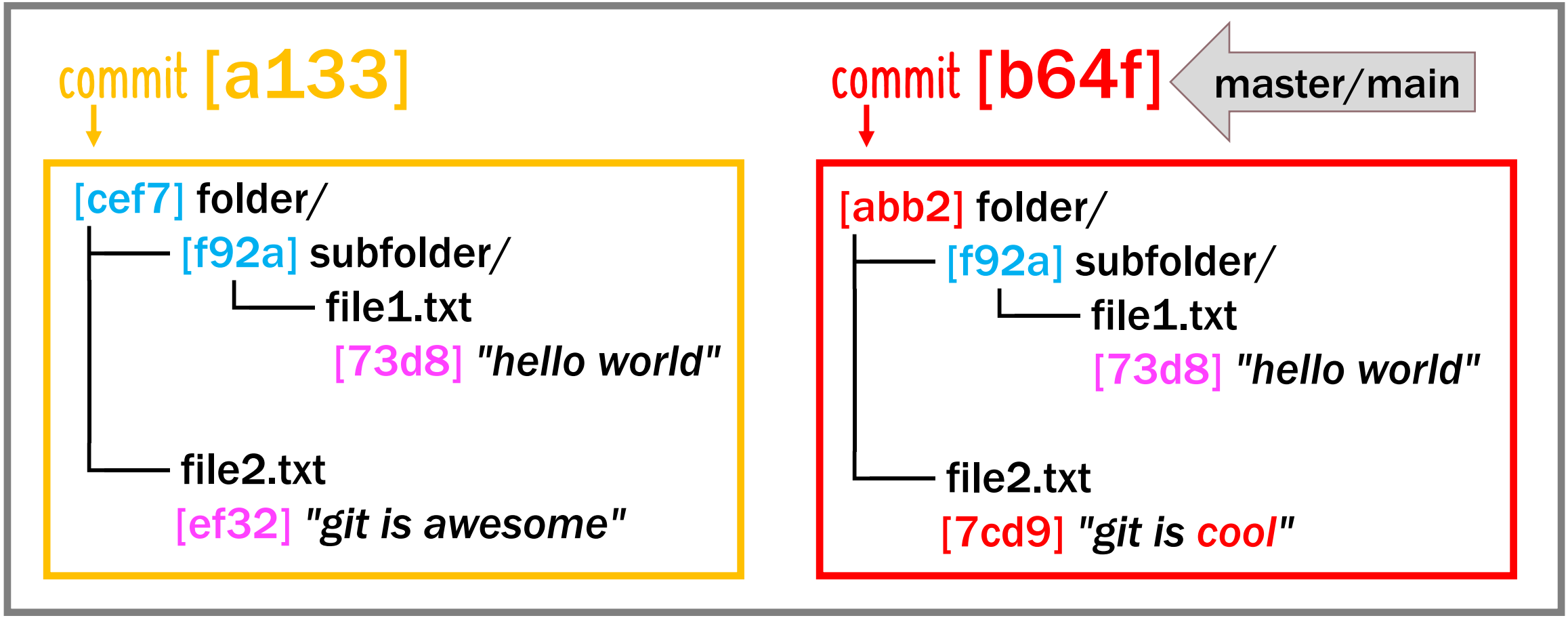


commit [b64f]



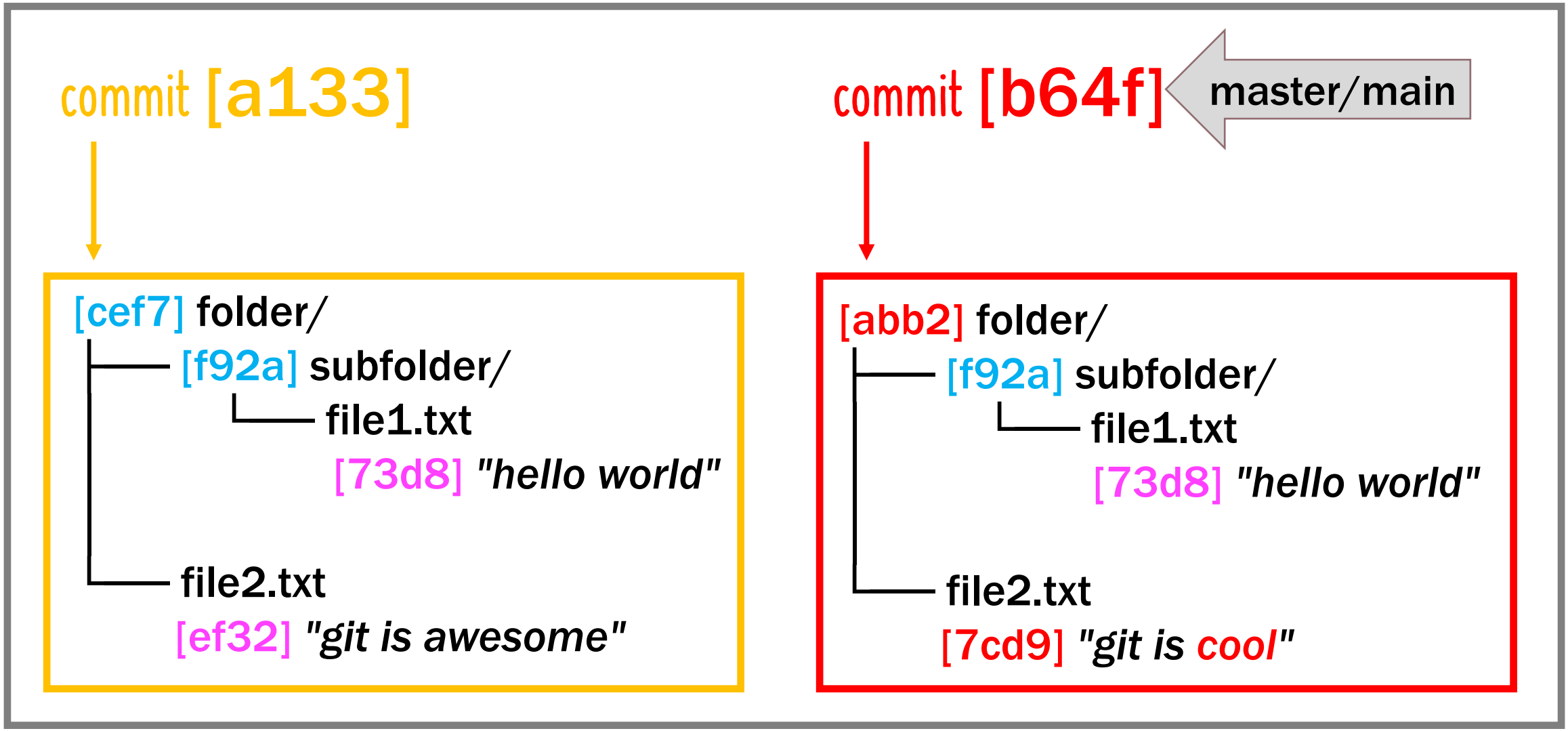
A reference is a human-readable name for a git commit

References are simply pointers to commits.



```
~/tutorials/demo/.git/refs/heads  single_line
└─ cat main
916f13a398331c11d83267213ddcab36809032a2
```

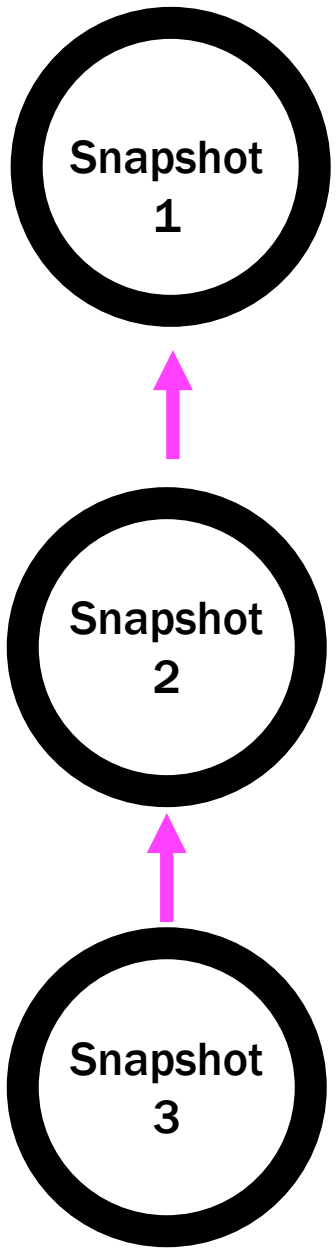
A git repository is a collection of objects and references



```
~/tutorials/demo  single_line
ls .git
COMMIT_EDITMSG  config       hooks   info   objects
HEAD            description  index   logs   refs
```

Git's Data Model

- A commit is a "snapshot" in time
- To track history, each commit points to a set of parent commits
- A git repository is a collection of commits and references



commit [a133]
tree: cef7
parents
author: Emmie

commit [b64f]
tree: abb2
parents: a133
author: Emmie

commit [d7ee]
tree: a912
parents: b64f
author: Emmie

USEFUL GIT COMMANDS

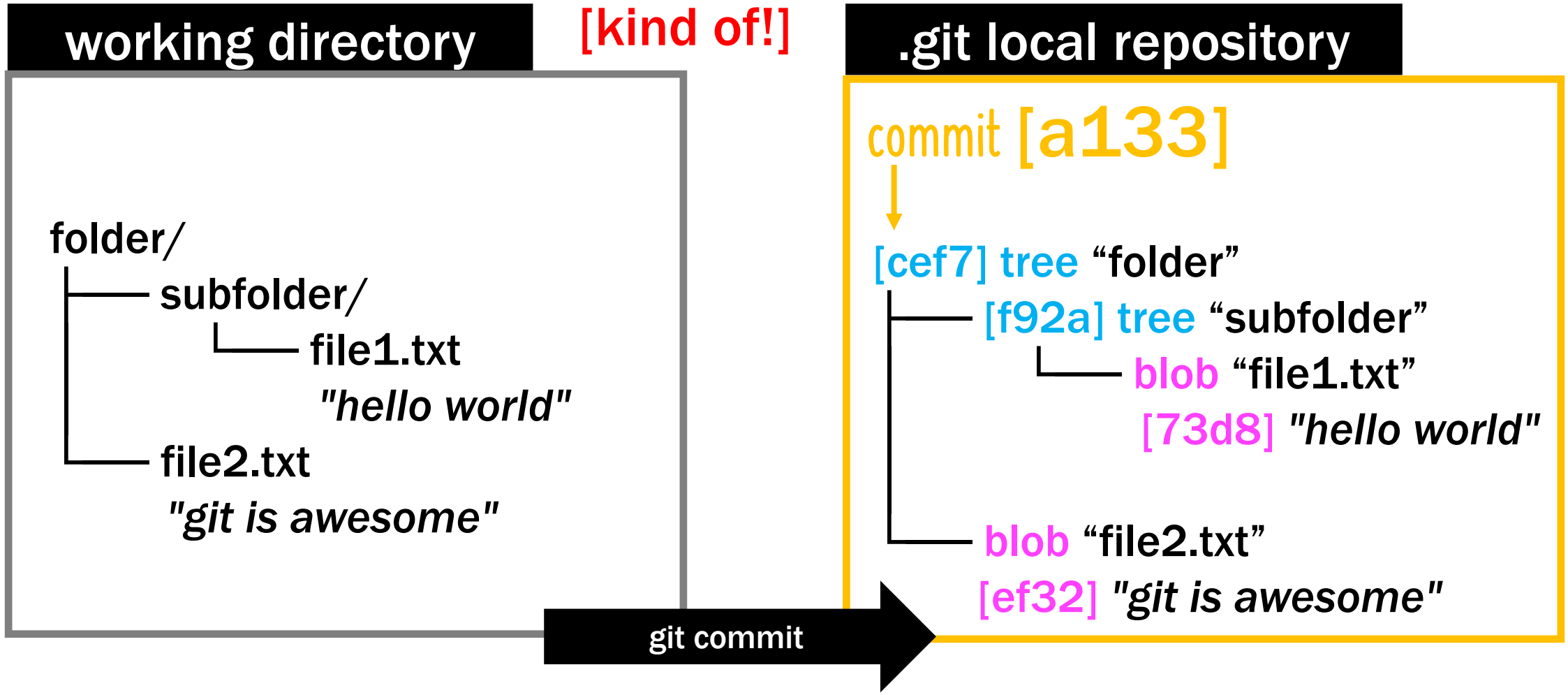
Selin Group Meeting

24 February 2023

Emmie Le Roy

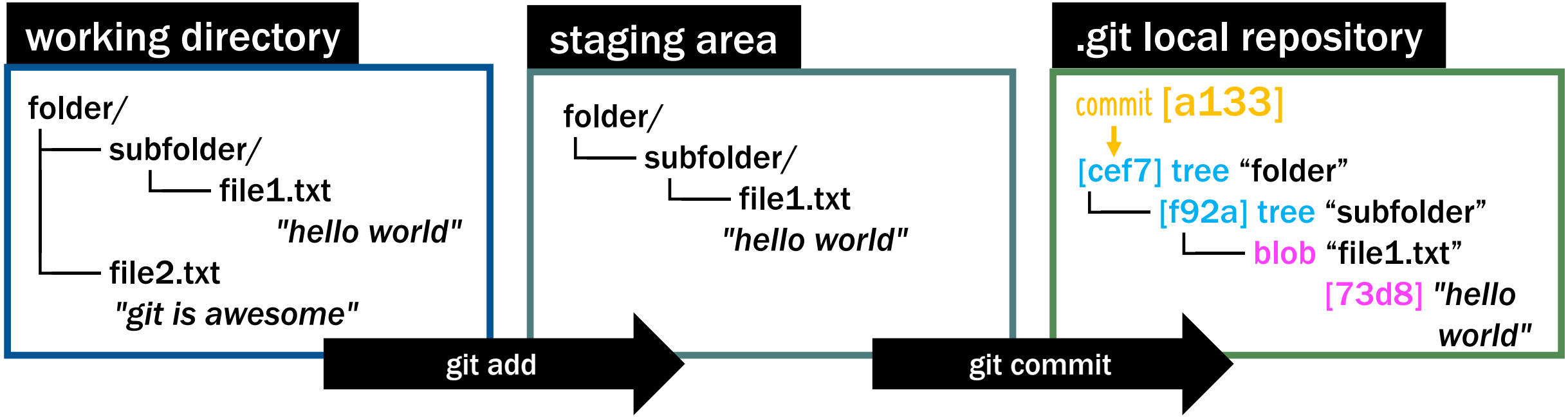
`git commit` creates a snapshot of your current working directory

It saves a collection of objects in the local .git repository



But Git has a staging area!

For flexibility!

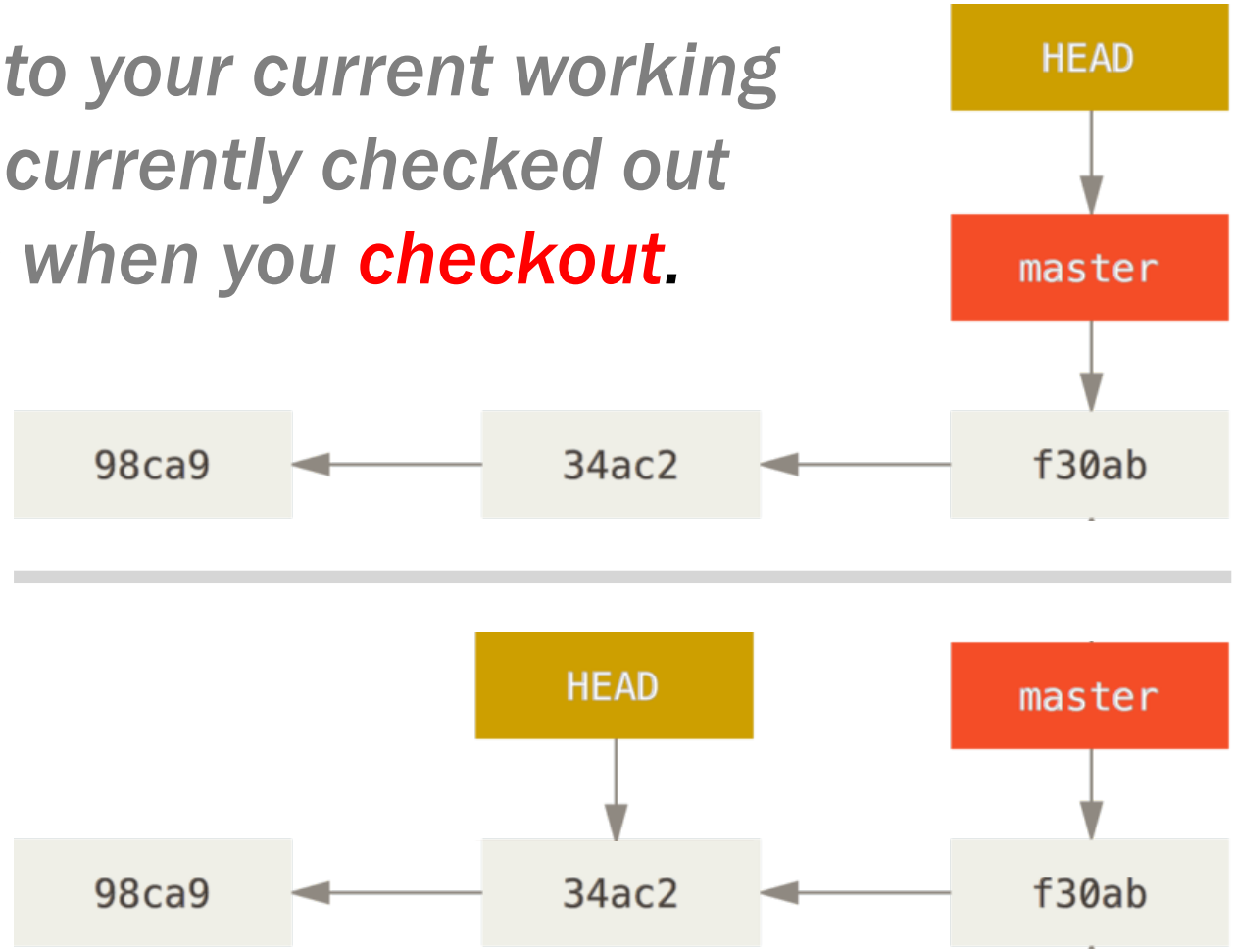


`git add` tells git what changes to include in the next commit

`git commit` commits the staged changes to the local repository

`git checkout` allows you to move around in your version history

***HEAD** is a pointer to your current working directory (i.e., the currently checked out commit), it moves when you **checkout**.*

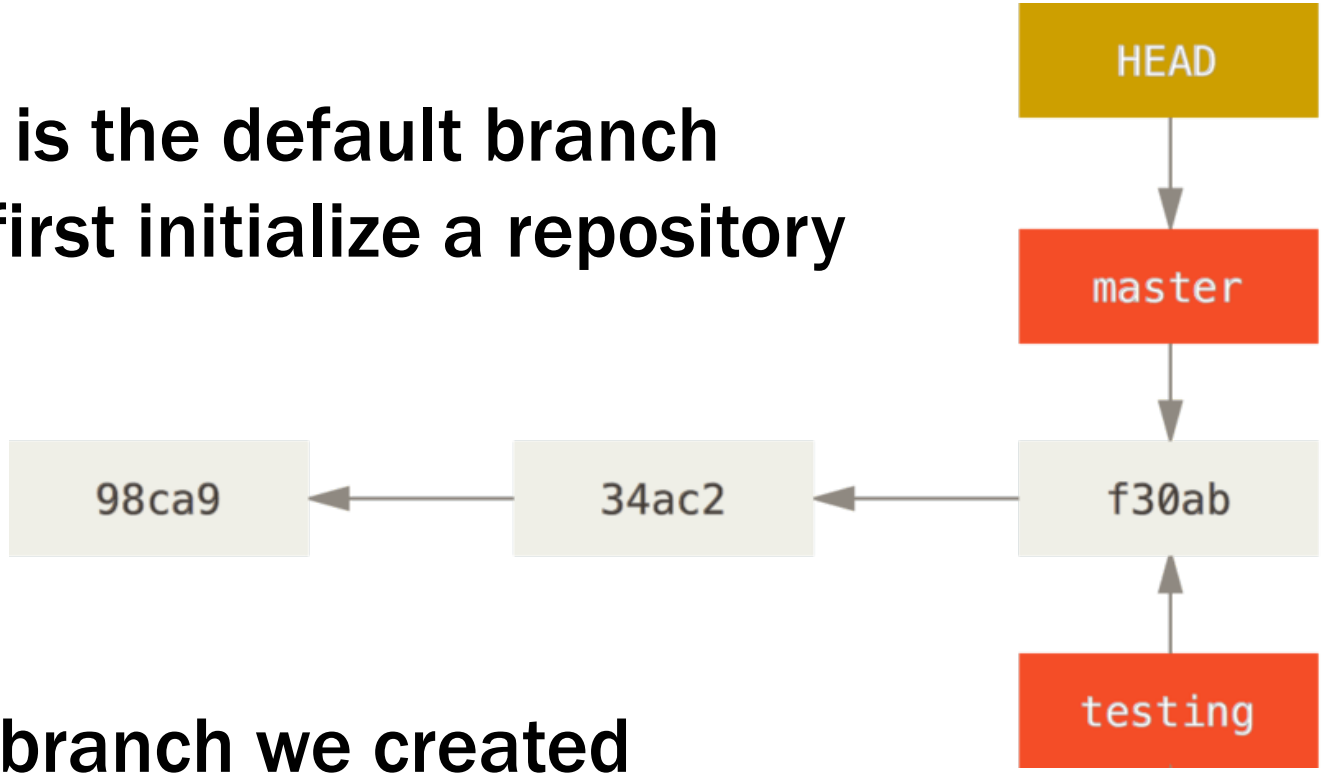


A “detached HEAD”

`git branch` allows you to experiment without breaking the project.

Creating a branch creates a pointer to a particular commit

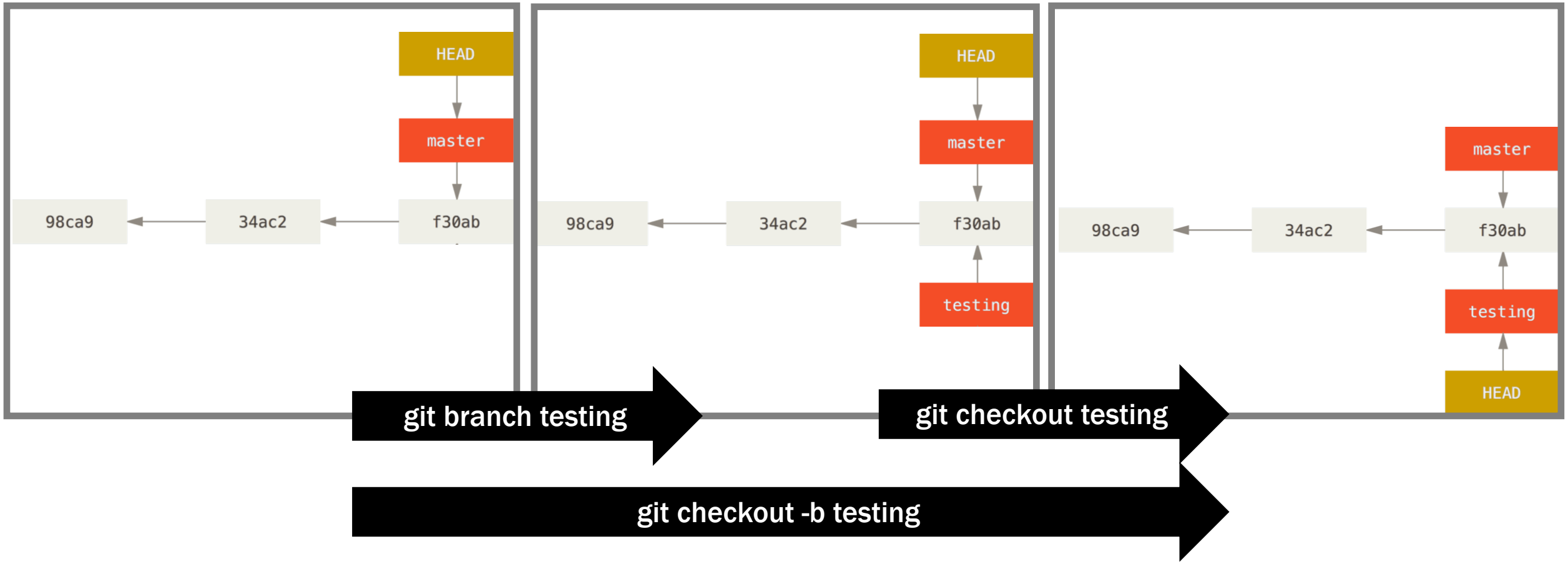
master (or main) is the default branch name when you first initialize a repository



testing is a NEW branch we created while checking out the master branch

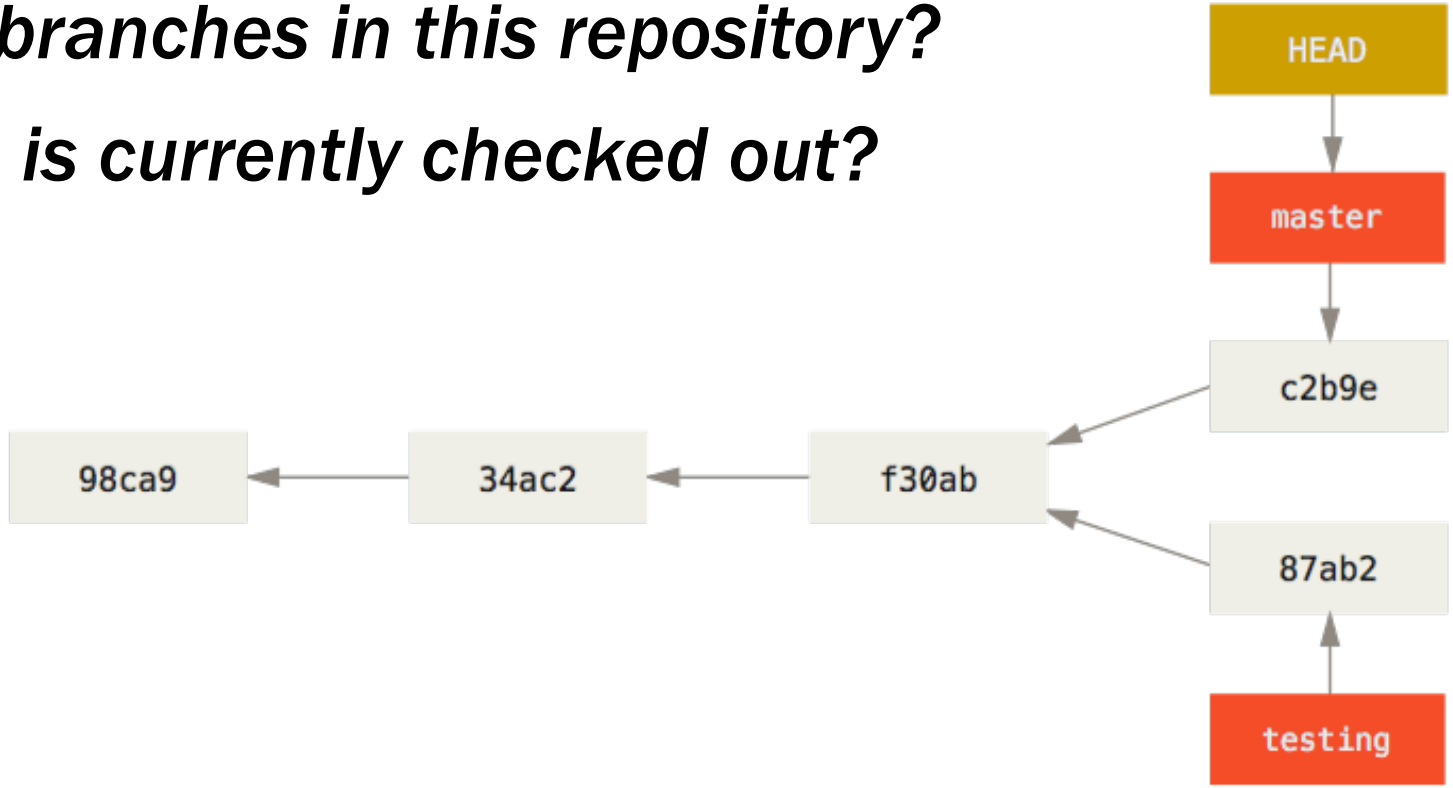
`git checkout -b <new_branch>`

creates a new branch and checks it out



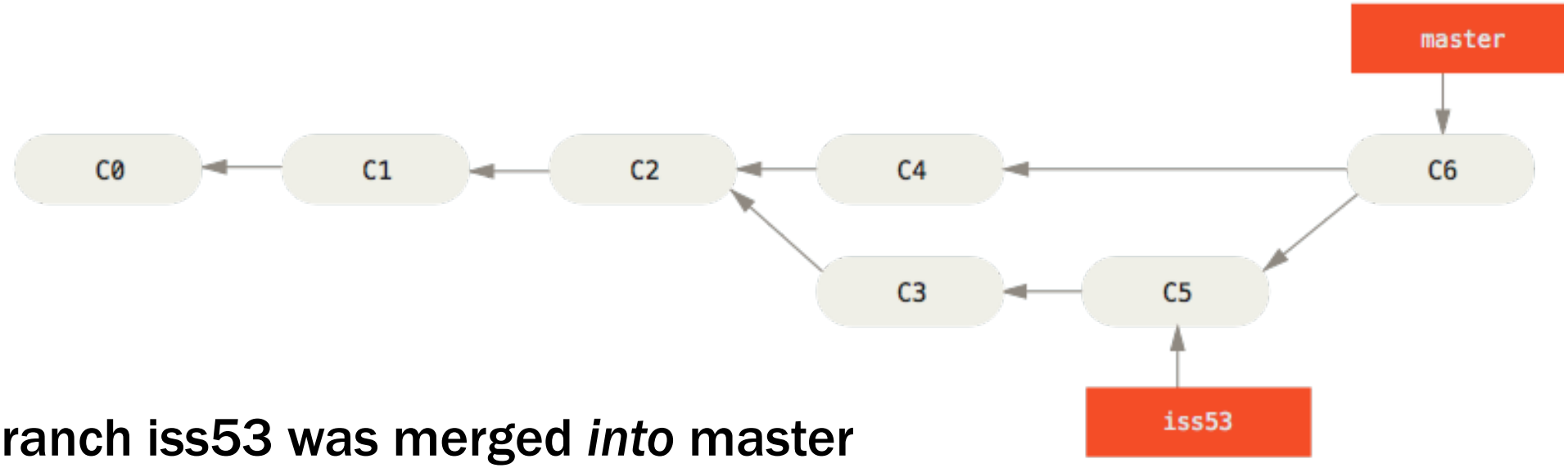
What are the branches in this repository?

Which branch is currently checked out?



`git merge` creates a commit with multiple parents

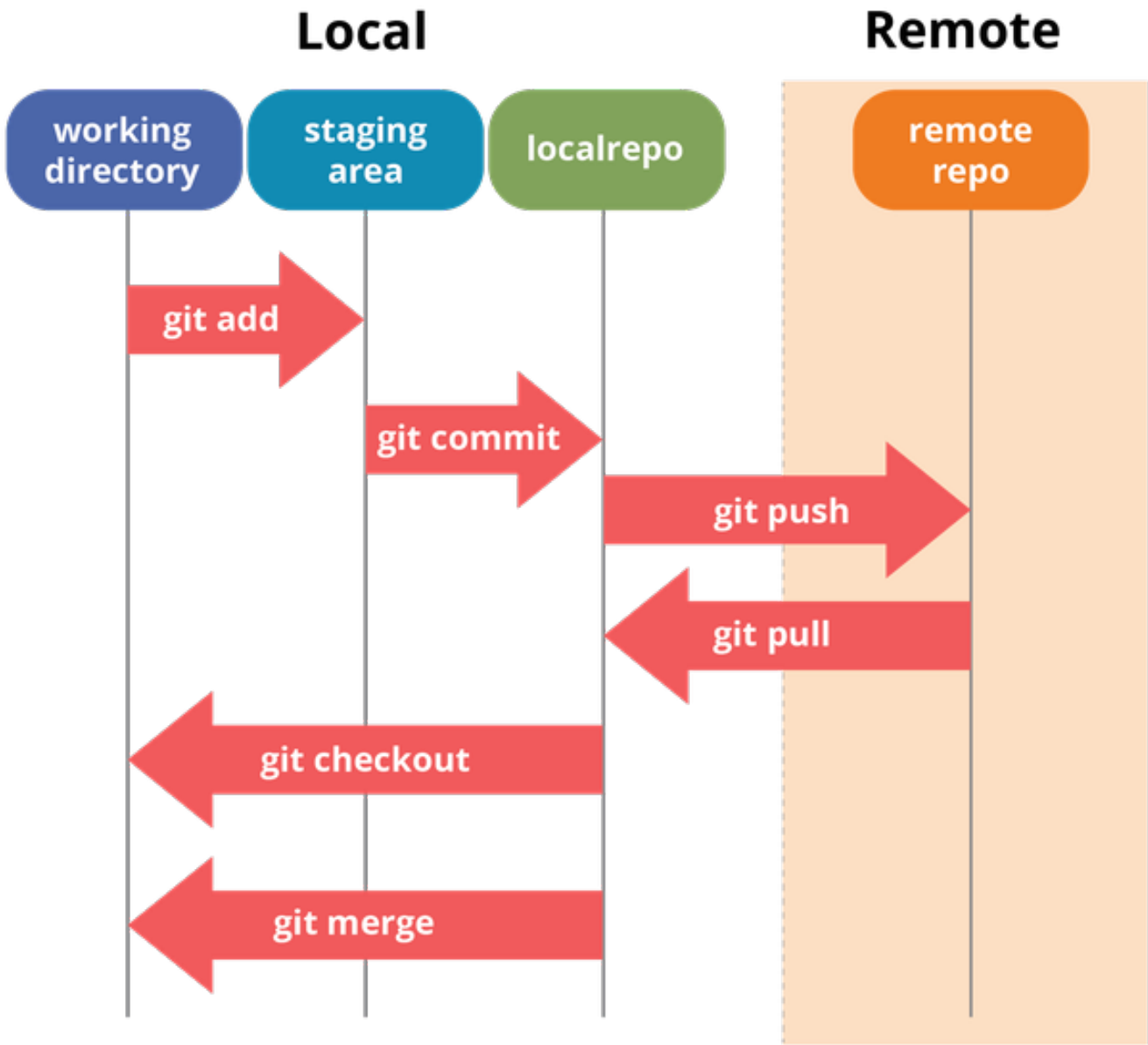
Rule of thumb: *You always merge into the current branch*

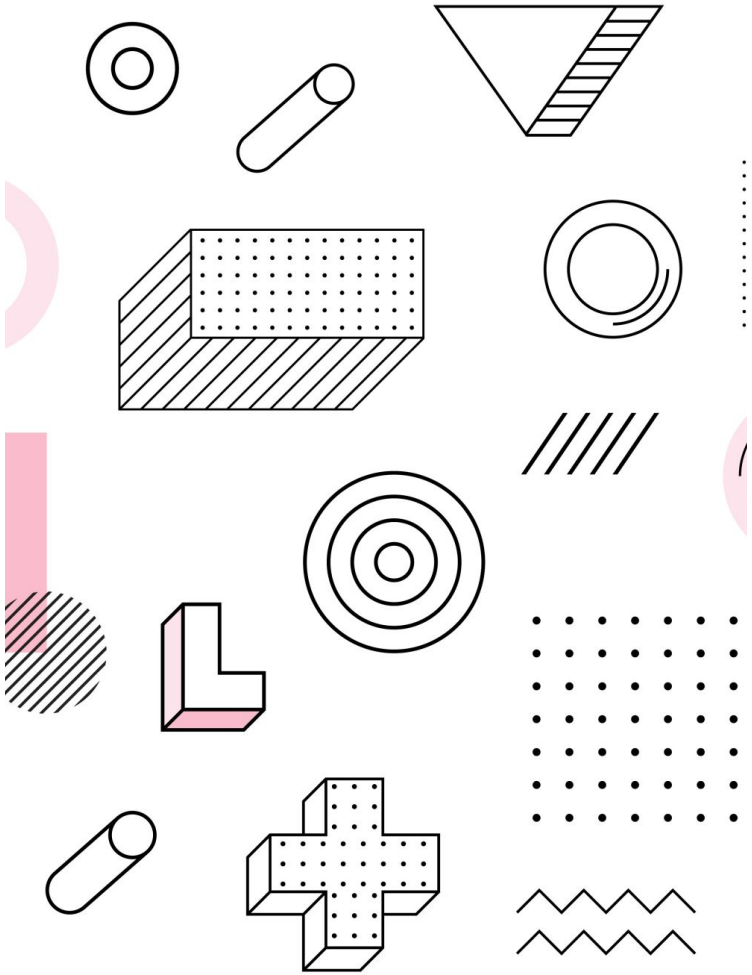


branch iss53 was merged *into* master

$ git checkout master (checkout the branch you want to merge *into*)
$ git merge iss53 (merge the branch you want to merge *from*)

https://git-scm.com/book/id/v2/Git-Branching-Basic-Branching-and-Merging


Local
Remote
working directory
staging area
localrepo
remote repo
git add
git commit
git push
git pull
git checkout
git merge



GIT COMMANDS

- git checkout switches the working directory to a different branch by moving HEAD
- git branch gives a name to a particular commit to branch off a new line of development
- git merge creates a commit with multiple parents
- HEAD is a pointer to the current working directory

git help <command>: get help for a git command

git init: initialize a git repository

git add <filename>: add files to staging area

git diff <filename>: shows changes you made relative to the staging area

git commit –m <commit_message>: create a new commit

git status: tells you what’s going on

git log: show a flatten log of history

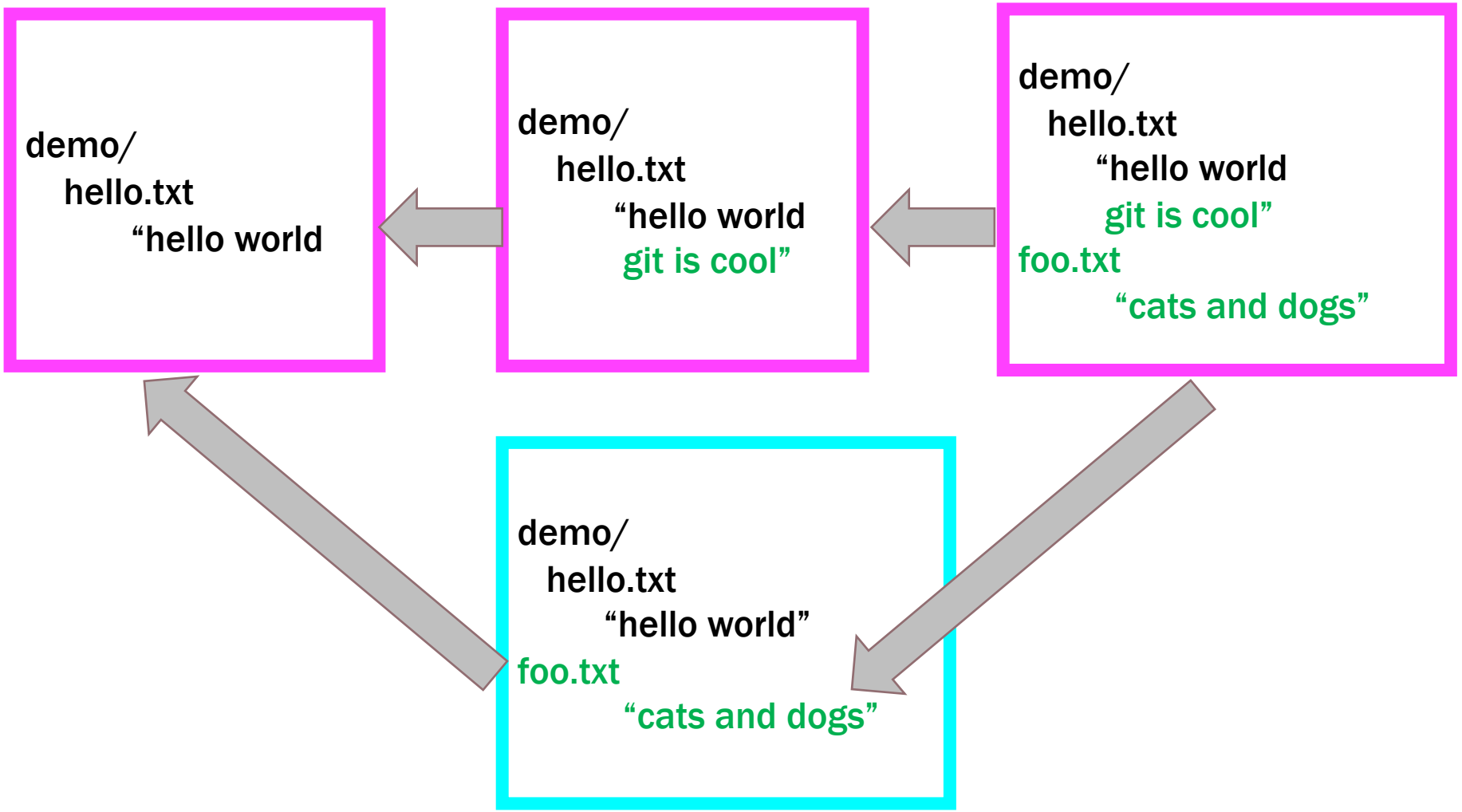
git branch: list the local branches

git branch <new_branch> : creates a branch

git checkout <existing_branch >: switch current branch and HEAD

git checkout –b <new_branch>: create a branch and switch to it

git merge <existing_branch>: merge existing_branch into current branch


demo/
hello.txt
“hello world
demo/
hello.txt
“hello world
git is cool”
demo/
hello.txt
“hello world
git is cool”
foo.txt
“cats and dogs”
demo/
hello.txt
“hello world”
foo.txt
“cats and dogs”

```
$ mkdir tutorial/
$ mkdir demo/
$ cd demo
$ echo “hello world” > hello.txt
$ ls
$ git init
$ ls
$ ls -a
$ cd .git
$ cd ..
$ git status
$ git add hello.txt
$ git status
$ git commit -m “Initial commit”
```

demo/
hello.txt
“hello world

```
$ git status
$ git log
$ git cat-file -p <SHA-1 hash>
$ echo "git is cool" >> hello.txt
$ cat hello.txt
$ git status
$ git diff hello.txt
$ git commit -m ”Add another line to
$ hello.txt”
$ git add “hello.txt”
$ git commit -m ”Add another line to hello.txt”
$ git status
$ git log
```

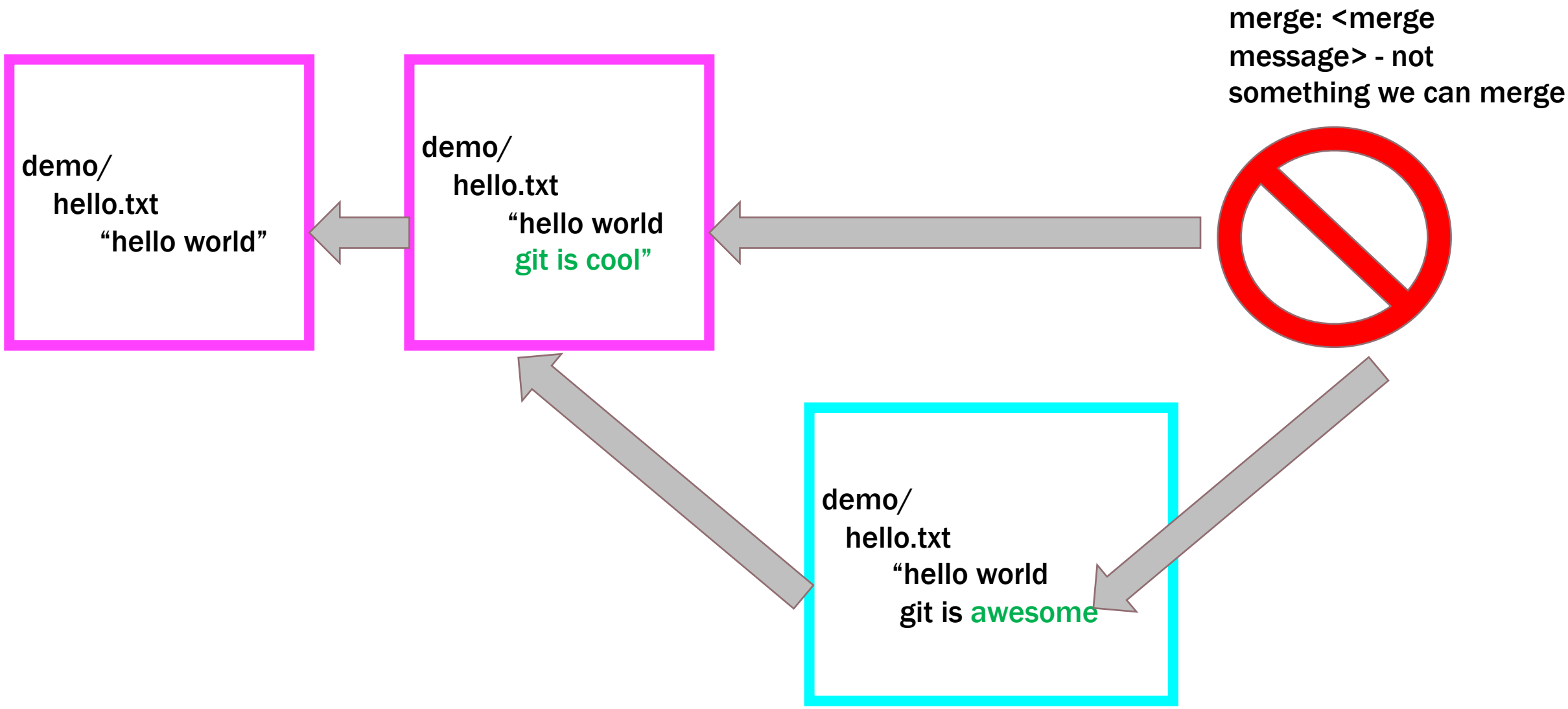
demo/
hello.txt
“hello world
git is cool”

```
$ git checkout 5c6979d38e203e58a9eb16f55444b6f4e89e80ad
$ git log
$ git status
$ git branch dev
$ git log
$ git status
$ git checkout dev
$ git log
$ git status
$ echo "cats and dogs" > foo.txt
$ ls
$ git status
$ git add foo.txt
$ git commit -m “Create foo.txt”
$ git status
$ git log
$ cat hello.txt
```

demo/
hello.txt
“hello world”
foo.txt
“cats and dogs”

```
$ git checkout master
$ git merge dev -m "Merge dev into master"
$ git log --all --graph -decorate
$ git branch -d dev
```

demo/
hello.txt
"hello world
git is cool"
foo.txt
"cats and dogs"


merge: <merge message> - not something we can merge
demo/
hello.txt
"hello world"
demo/
hello.txt
"hello world
git is cool"
demo/
hello.txt
"hello world
git is awesome

GitHub

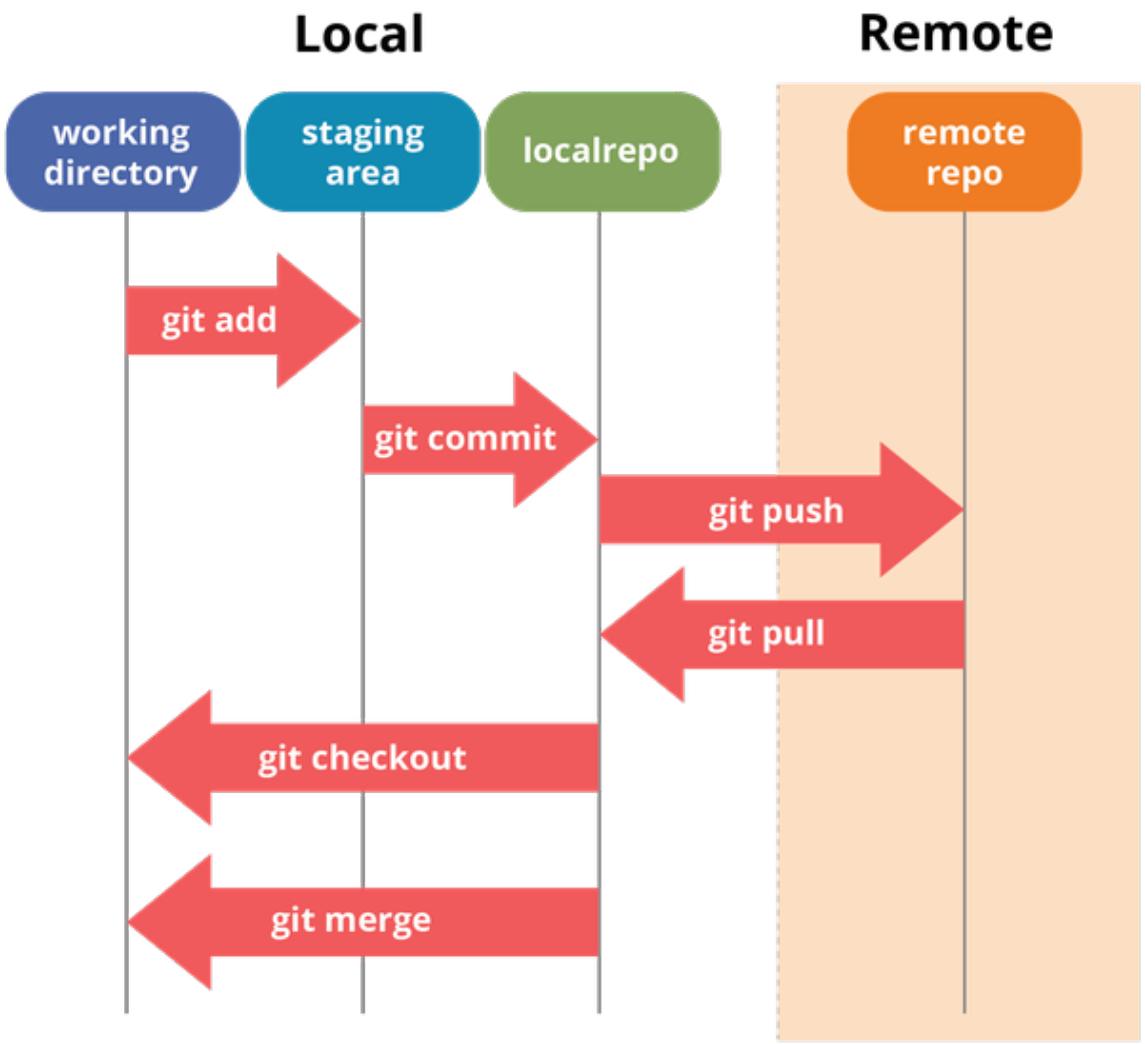
Selin Group Meeting

24 February 2023

Emmie Le Roy

What is GitHub?

- GitHub is not Git
- GitHub is a sharing and collaboration platform
- GitHub is an online hosting service for Git repositories



Local vs Remote repositories

Remote repo: lives on GitHub, where others can make a copy

REMOTE

A GitHub repo
github.com/emmleroy

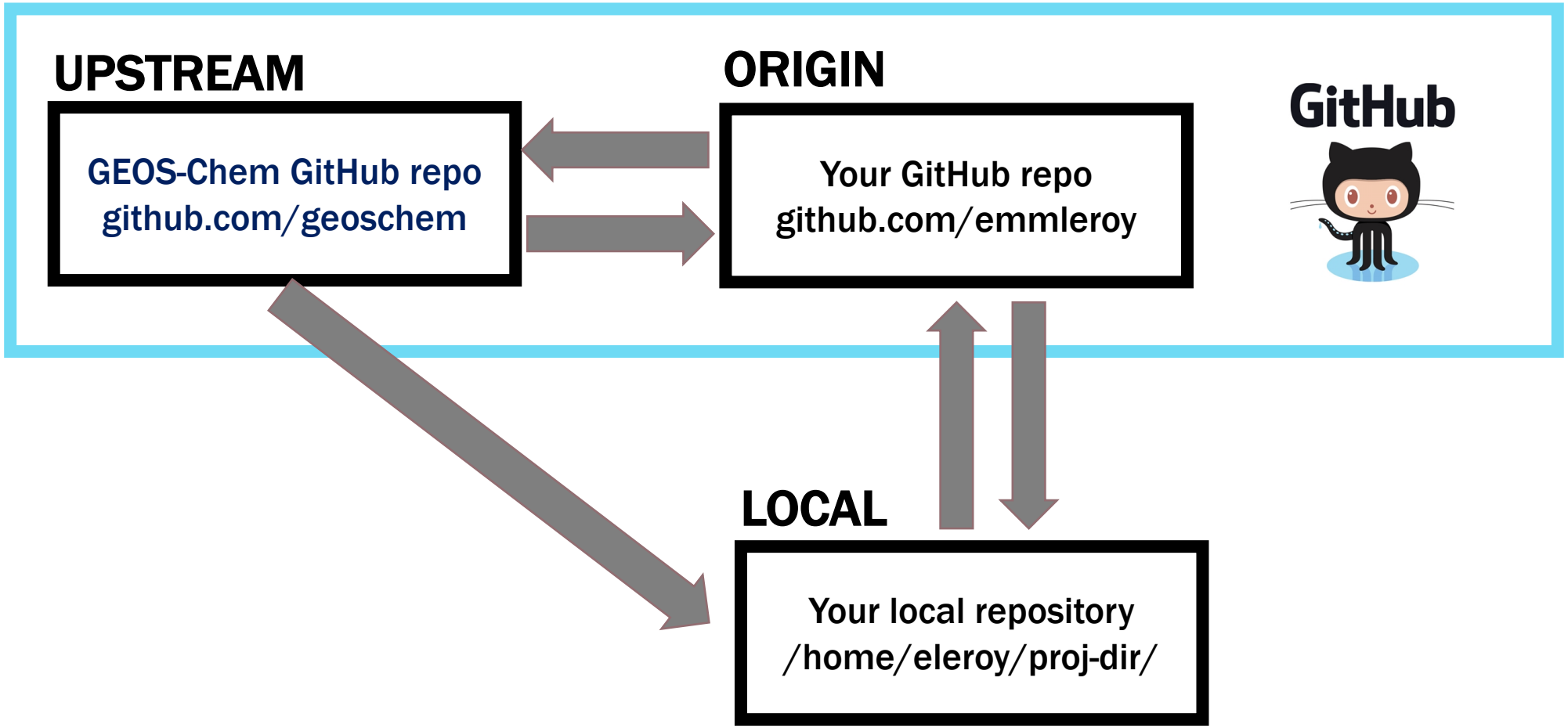
Local repo: lives on your machine, where we make our changes and do our development

LOCAL

Your local repository
/home/eleroy/proj-dir/

Remote repositories provide us with a backup copy hosted online and allows us to share and publish our code

Remote repositories can belong to you or to someone else



GitHub

Part 1. I have a local project that I want to share with others

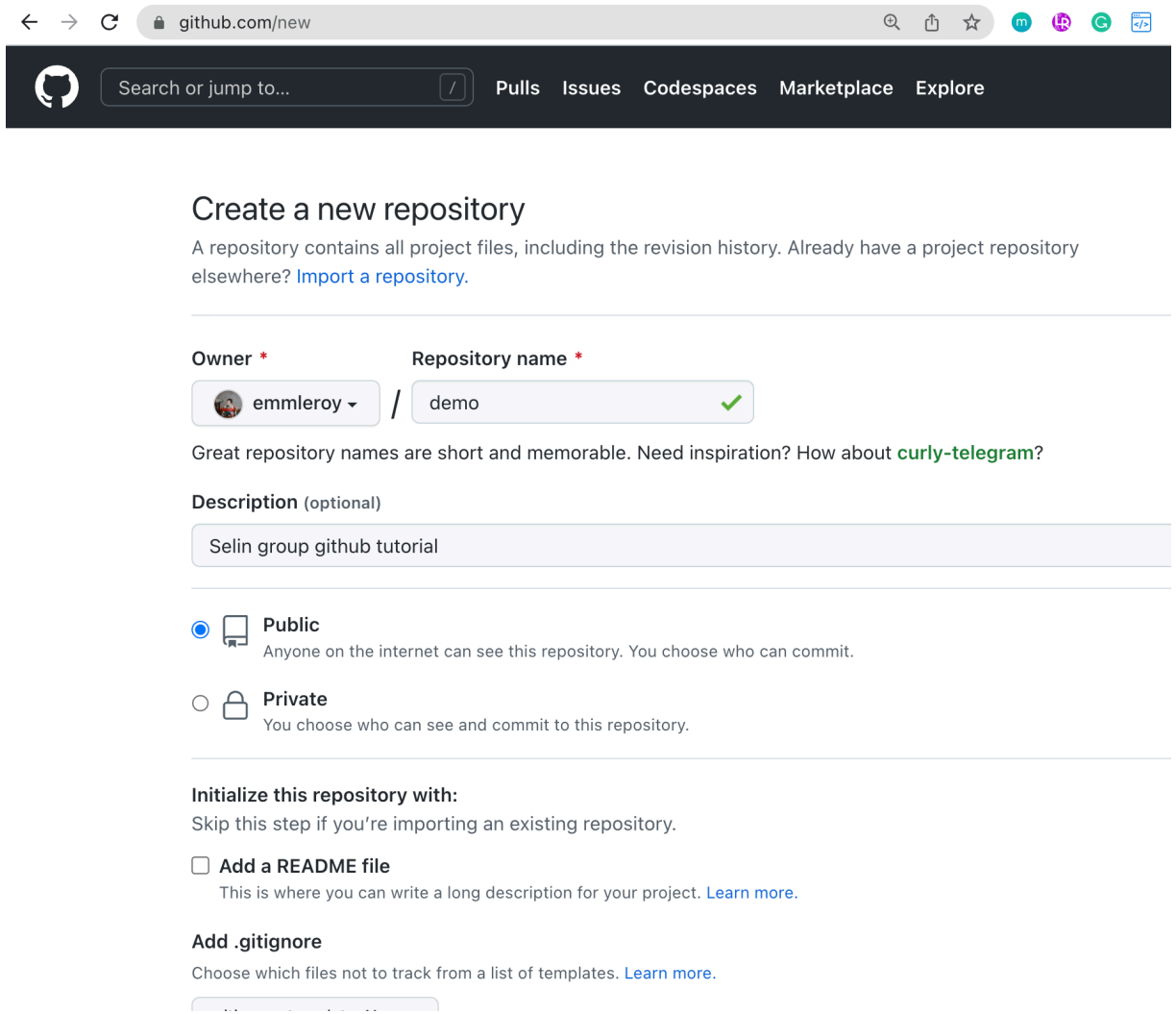
Part 2. I want to create my own changes to someone else's project

GitHub

Getting Started

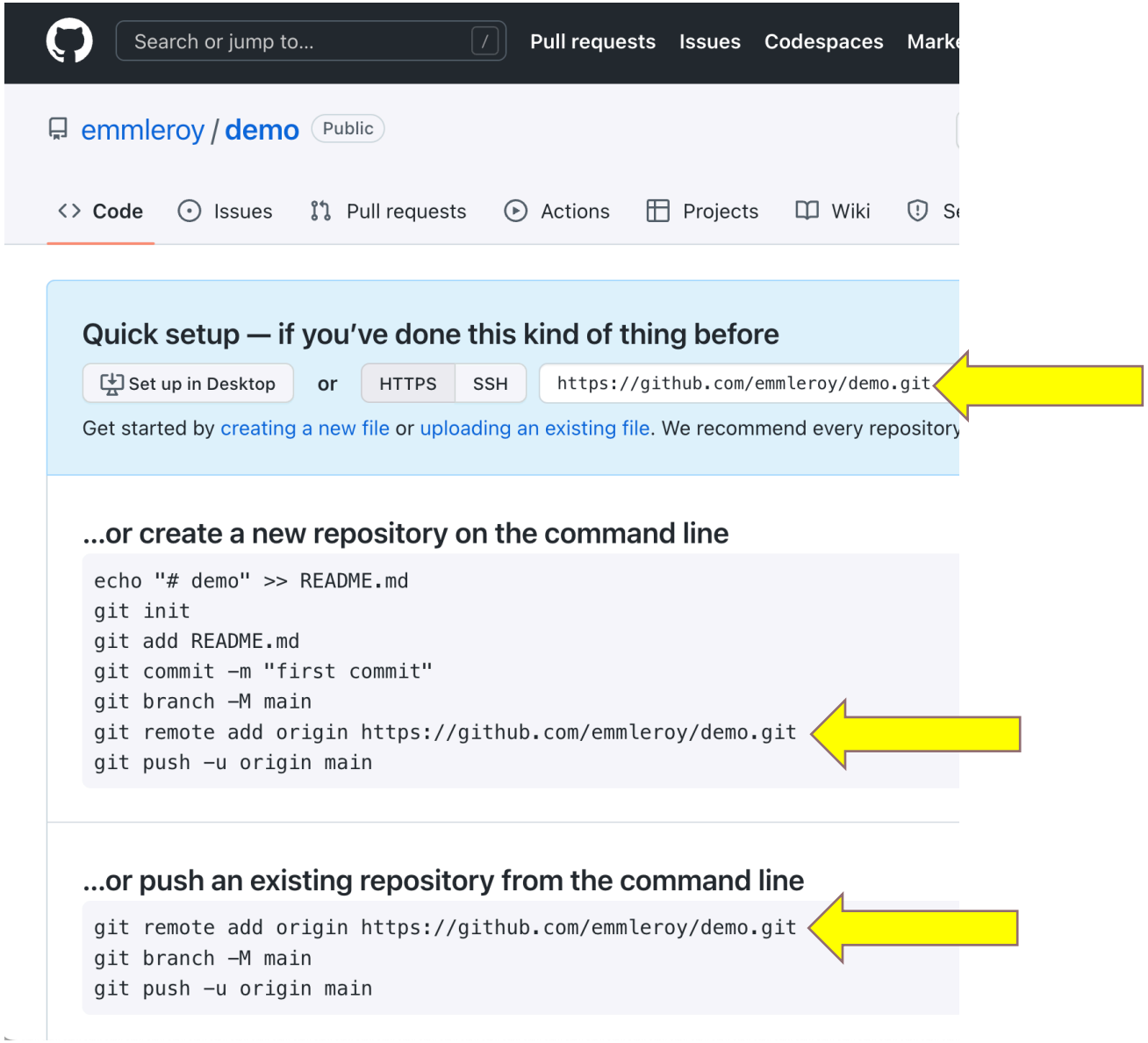
1. Create a free account on GitHub.com
2. Generate a personal access token at https://github.com/settings/tokens

Create a GitHub repository at github.com/new



GitHub provides two URLs: a **HTTPS URL** and a **SSH/git URL**

Copy the *HTTPS URL*



`git remote add <remote> <URL>` to link an existing local repository to a remote repository

```
$ cd demo/
$ git remote add origin https://github.com/<myUserName>/demo.git
$ git remote -v
```

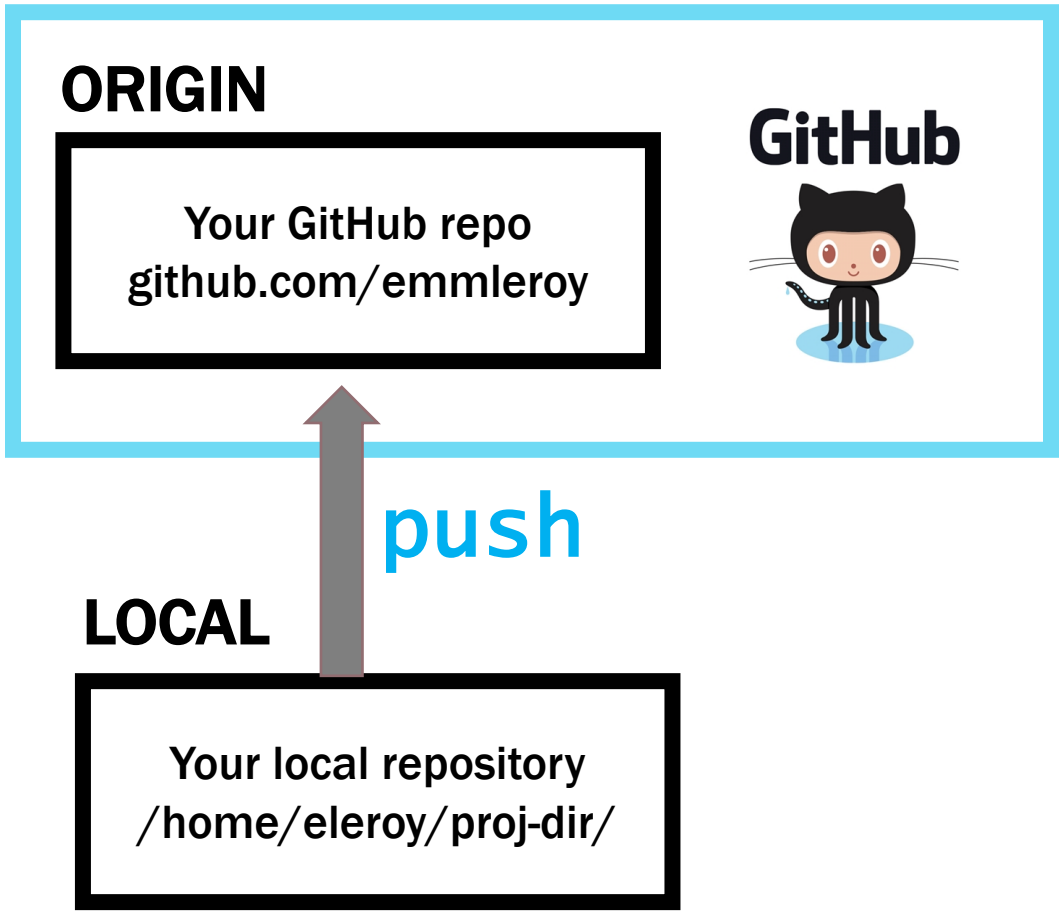
```
(base) [eleroy@fs03 demo]$ git remote add origin https://github.com/emmleroy/demo.git
(base) [eleroy@fs03 demo]$ git remote -v
origin  https://github.com/emmleroy/demo.git (fetch)
origin  https://github.com/emmleroy/demo.git (push)
(base) [eleroy@fs03 demo]$
```

origin is the conventional short name for your remote repository (i.e. <remote>)

`git push` to upload content from your local repository to the remote repository

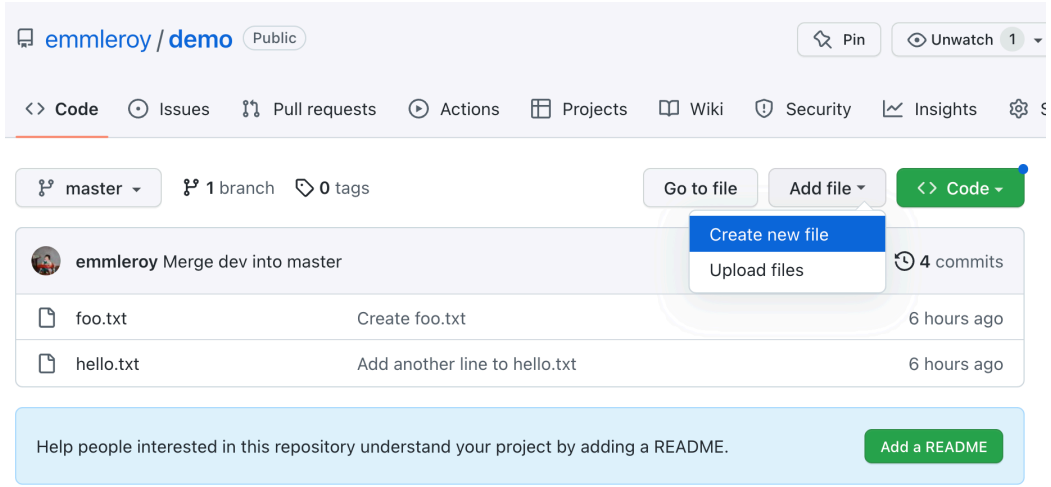
```
$ git push -u <remote> <local_branch>
$ git push -u origin master
```

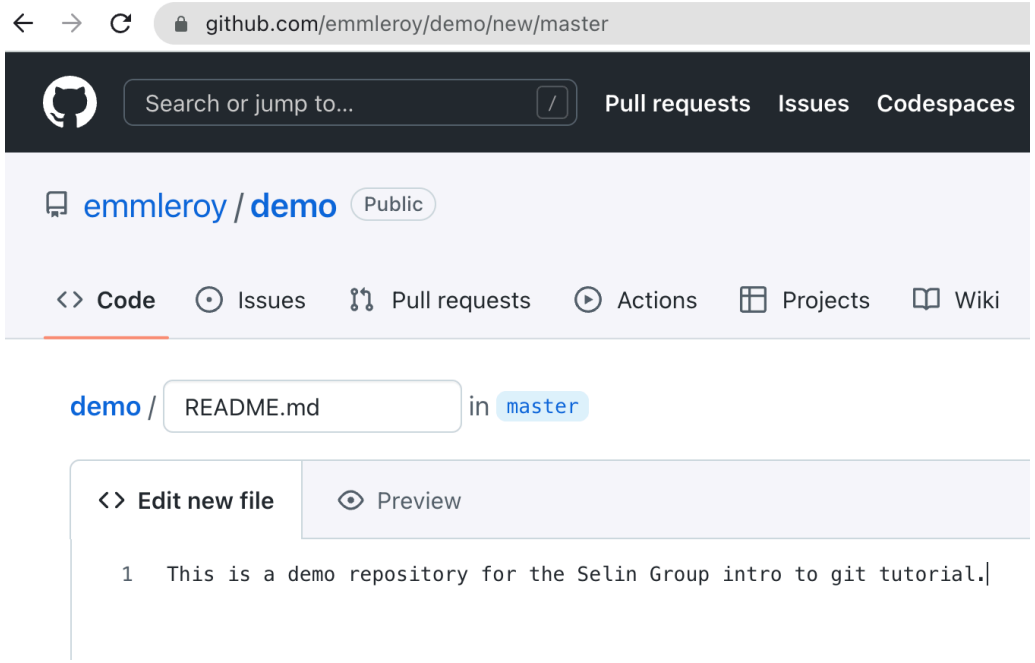
The **-u** flag sets origin/branch as the remote (upstream) target so pushes after that can be called with just "git push" (but it doesn't hurt to be explicit!)



6. Create a README.md file on GitHub.com

In practice, you might not make changes to your files on GitHub.com, but the point here is to simulate a remote change that you will then pull to your local repository.

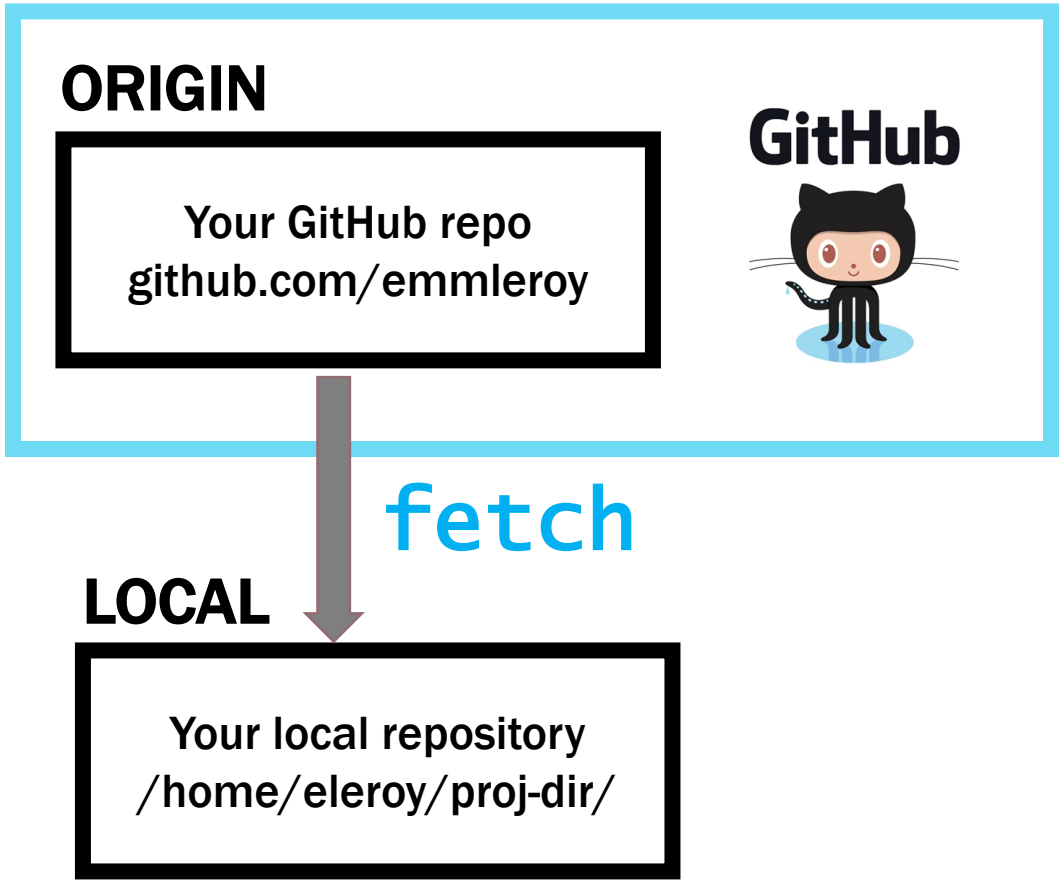




`git fetch` to see what everybody else has been working on *without* merging those changes

```
$ git status
$ git fetch <remote> <remote_branch>
$ git fetch origin master
$ git status
```

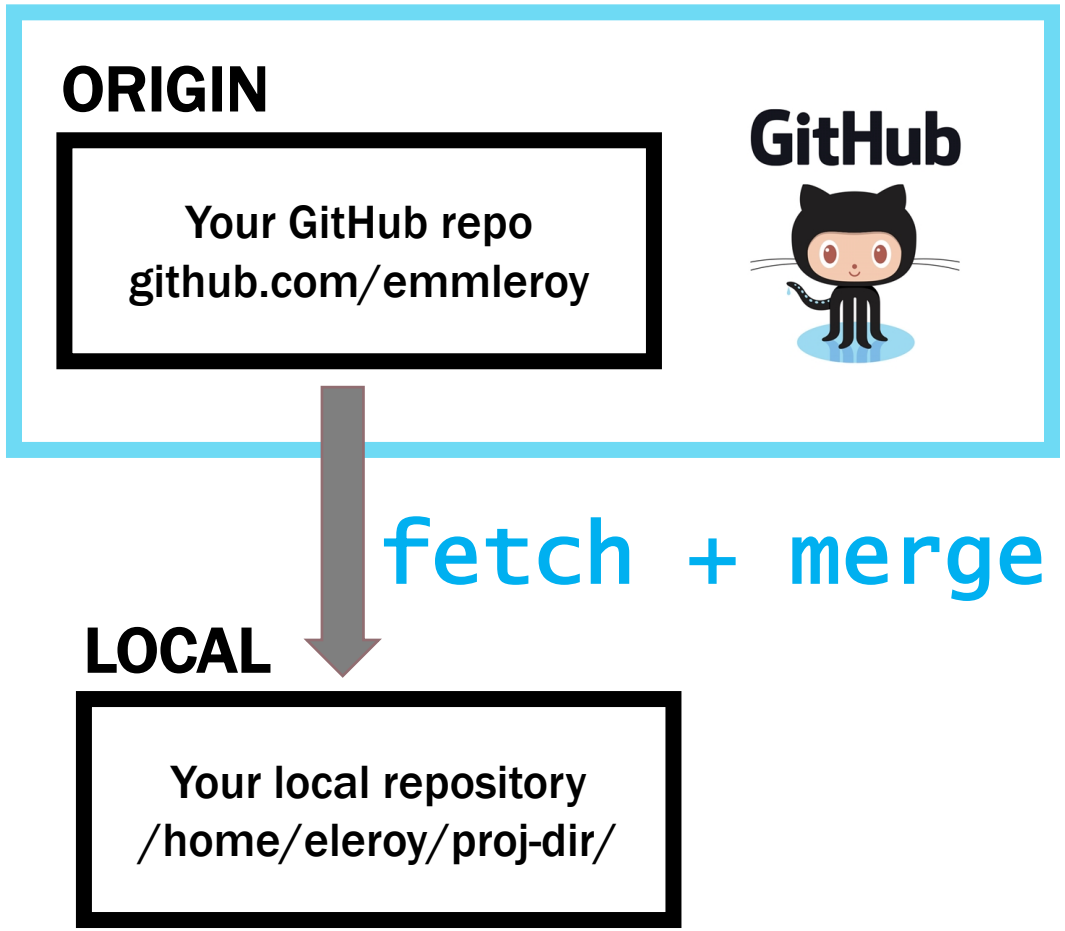
```
(base) [eleroy@fs03 demo]$ git fetch origin master
remote: Enumerating objects: 4, done.
remote: Counting objects: 100% (4/4), done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (3/3), 750 bytes | 375.00 KiB/s, done.
From https://github.com/emmleroy/demo
 * branch            master     -> FETCH_HEAD
   74a6d94..8ec7fd4  master     -> origin/master
(base) [eleroy@fs03 demo]$
```



`git merge` to merge the upstream changes into the currently checked out branch

```
$ git merge <remote>/<remote_branch>
$ git merge origin/master
```

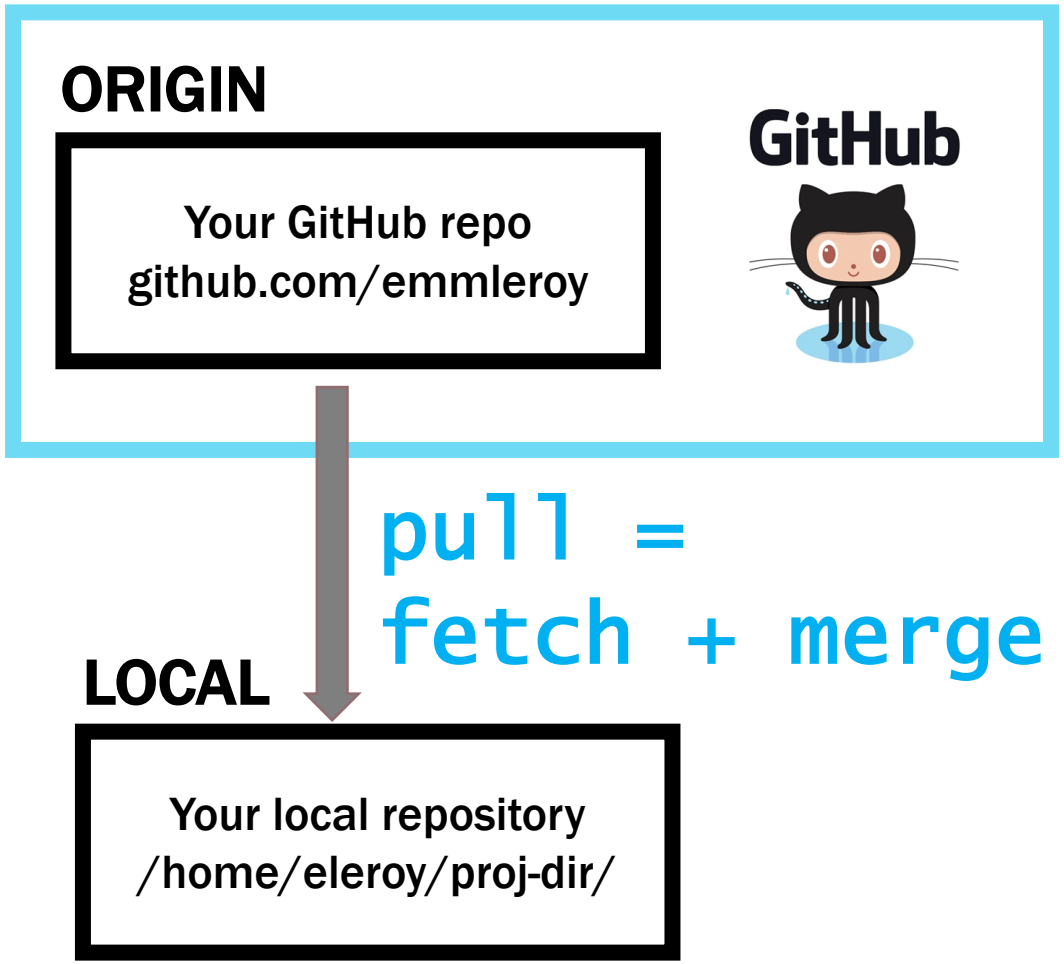
```
(base) [eleroy@fs03 demo]$ git merge origin/master
Updating 74a6d94..8ec7fd4
Fast-forward
 README.md | 1 +
 1 file changed, 1 insertion(+)
 create mode 100644 README.md
(base) [eleroy@fs03 demo]$ ls
foo.txt  hello.txt  README.md
(base) [eleroy@fs03 demo]$
```



git pull = git fetch + git merge

```
$ git pull <remote> <remote_branch>
or
$ git fetch <remote> <remote_branch>
$ git merge <remote>/<remote_branch>
```

```
(base) [eleroy@fs03 demo]$ git pull
warning: Pulling without specifying how to reconcile divergent branches is
discouraged. You can squelch this message by running one of the following
commands sometime before your next pull:

  git config pull.rebase false  # merge (the default strategy)
  git config pull.rebase true   # rebase
  git config pull.ff only       # fast-forward only

You can replace "git config" with "git config --global" to set a default
preference for all repositories. You can also pass --rebase, --no-rebase,
or --ff-only on the command line to override the configured default per
invocation.

Updating 8ec7fd4..b6839ea
Fast-forward
 README.md | 1 +
 1 file changed, 1 insertion(+)
```



```
<remote> = origin
<remote_branch> = master
```

Why does the syntax differ?

```
$ git fetch origin master
```

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

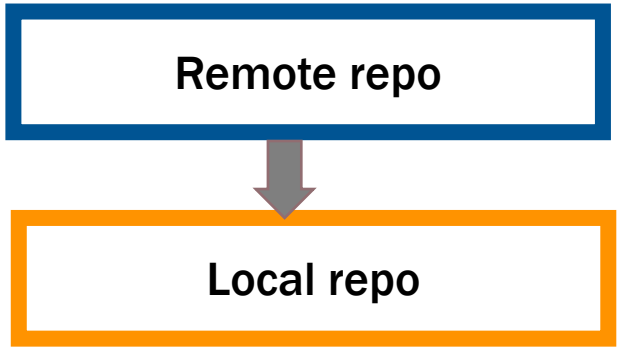
What does main refer to in each case?

```
$ git push origin main
```

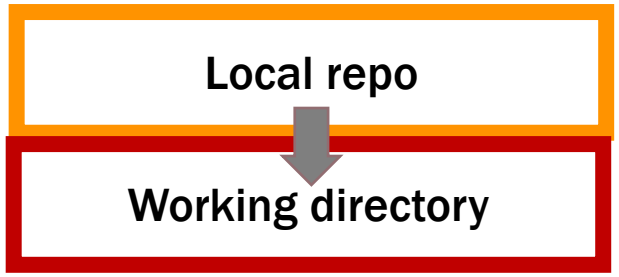
```
$ git pull origin main
```

```
<remote> = origin
<remote_branch> = master
```

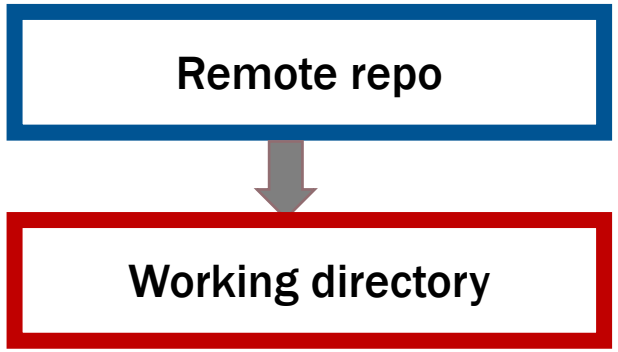
```
$ git fetch origin master
```




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



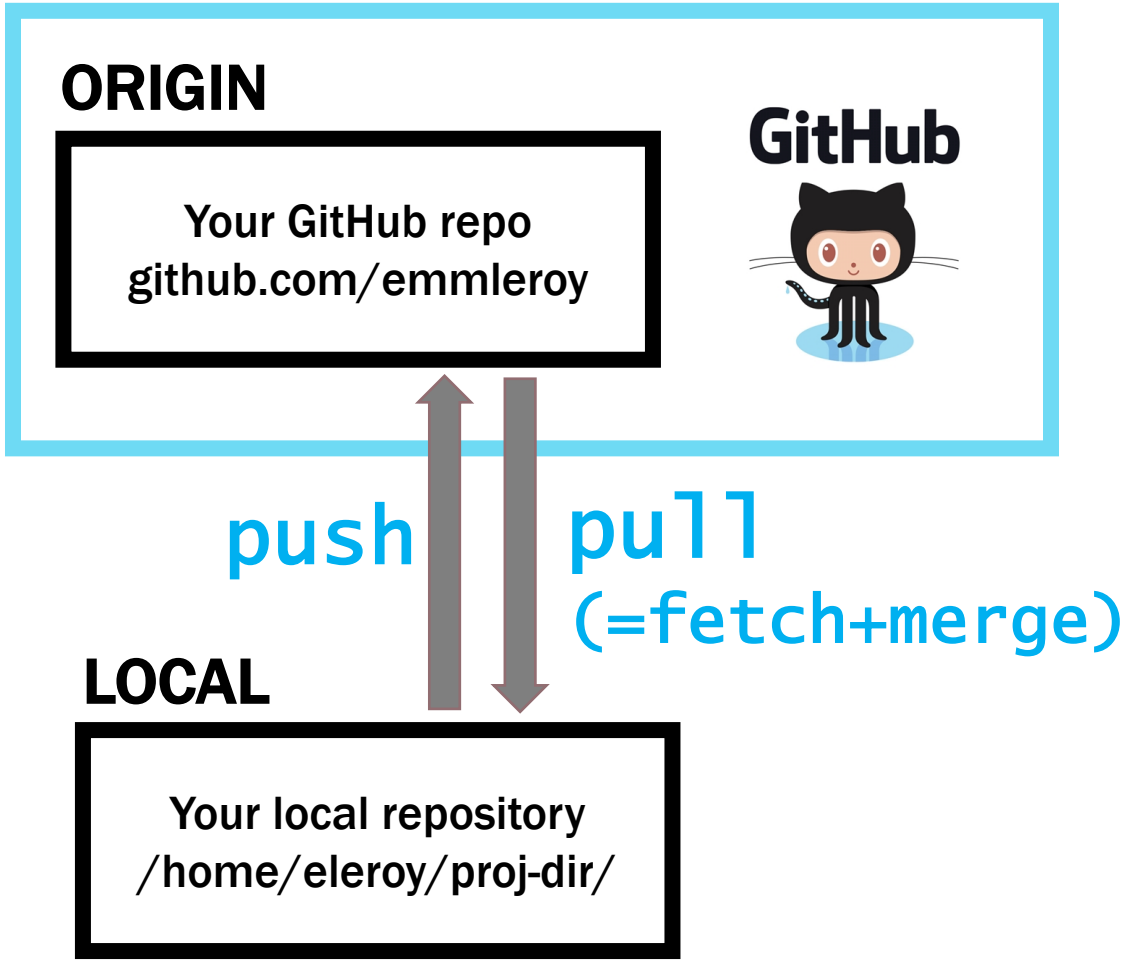

```
$ git pull origin master
```



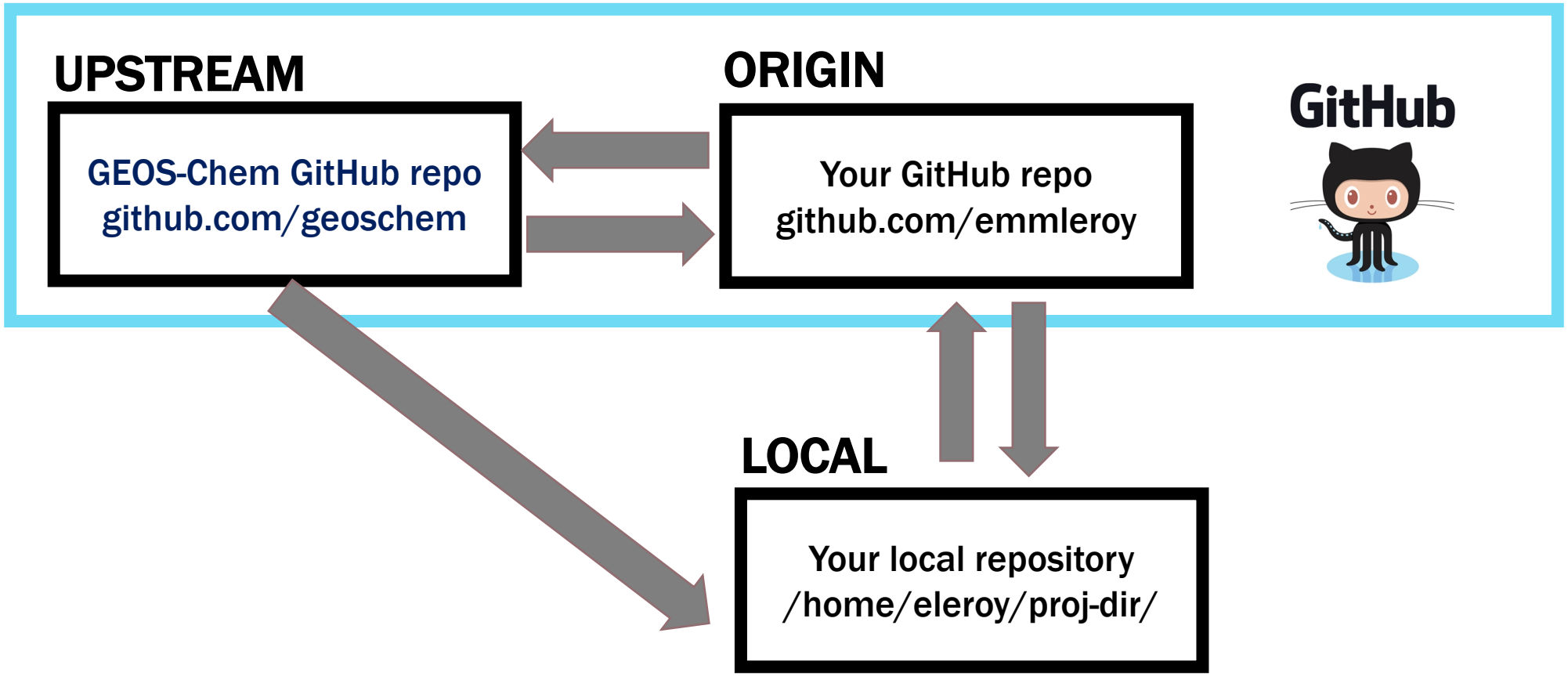

```
$ git pull <remote> <remote_branch>
or
$ git fetch <remote> <remote_branch>
$ git merge <remote>/<remote_branch>
```

GitHub

Part 1. I have a local project that I want to share with others



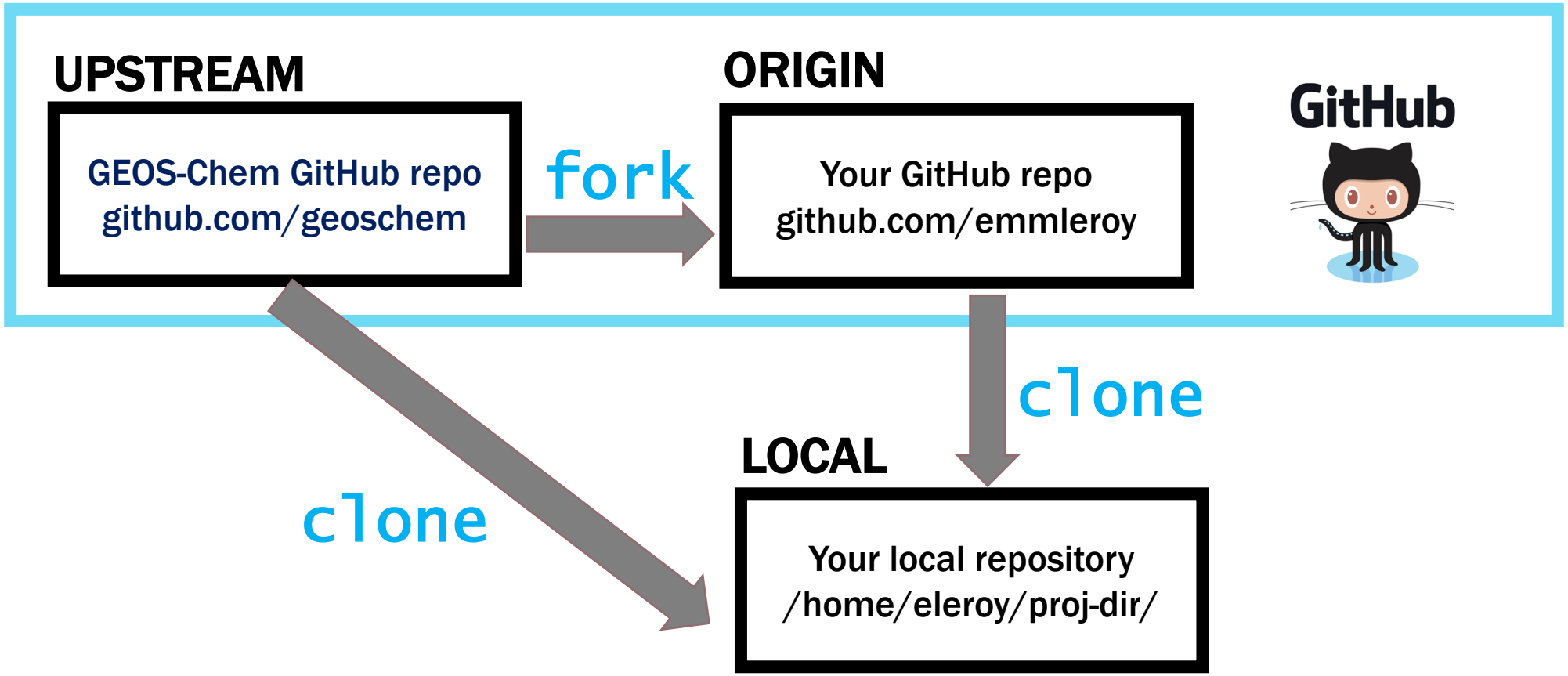
Part 2. I want to create my own changes to someone else's project!



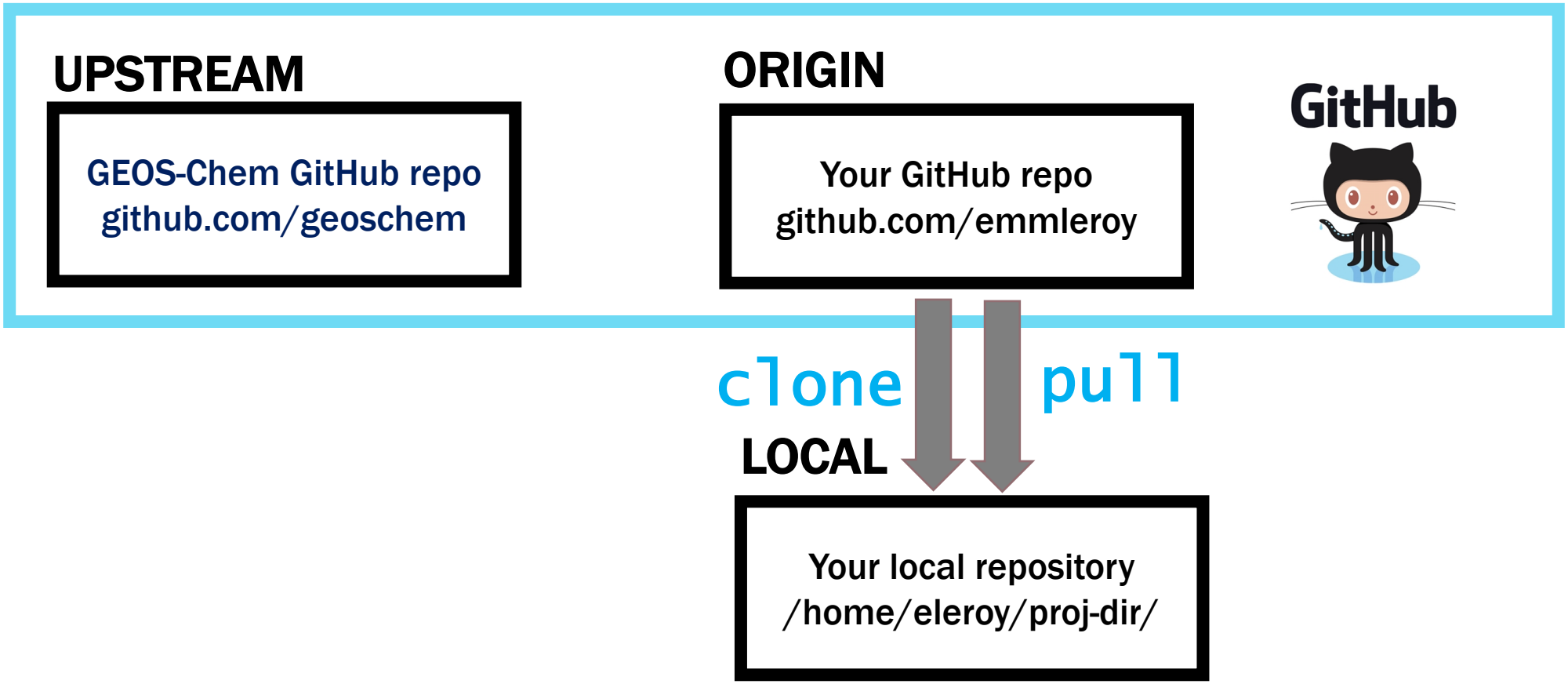
Forking vs Cloning

A forked project is on your online repository

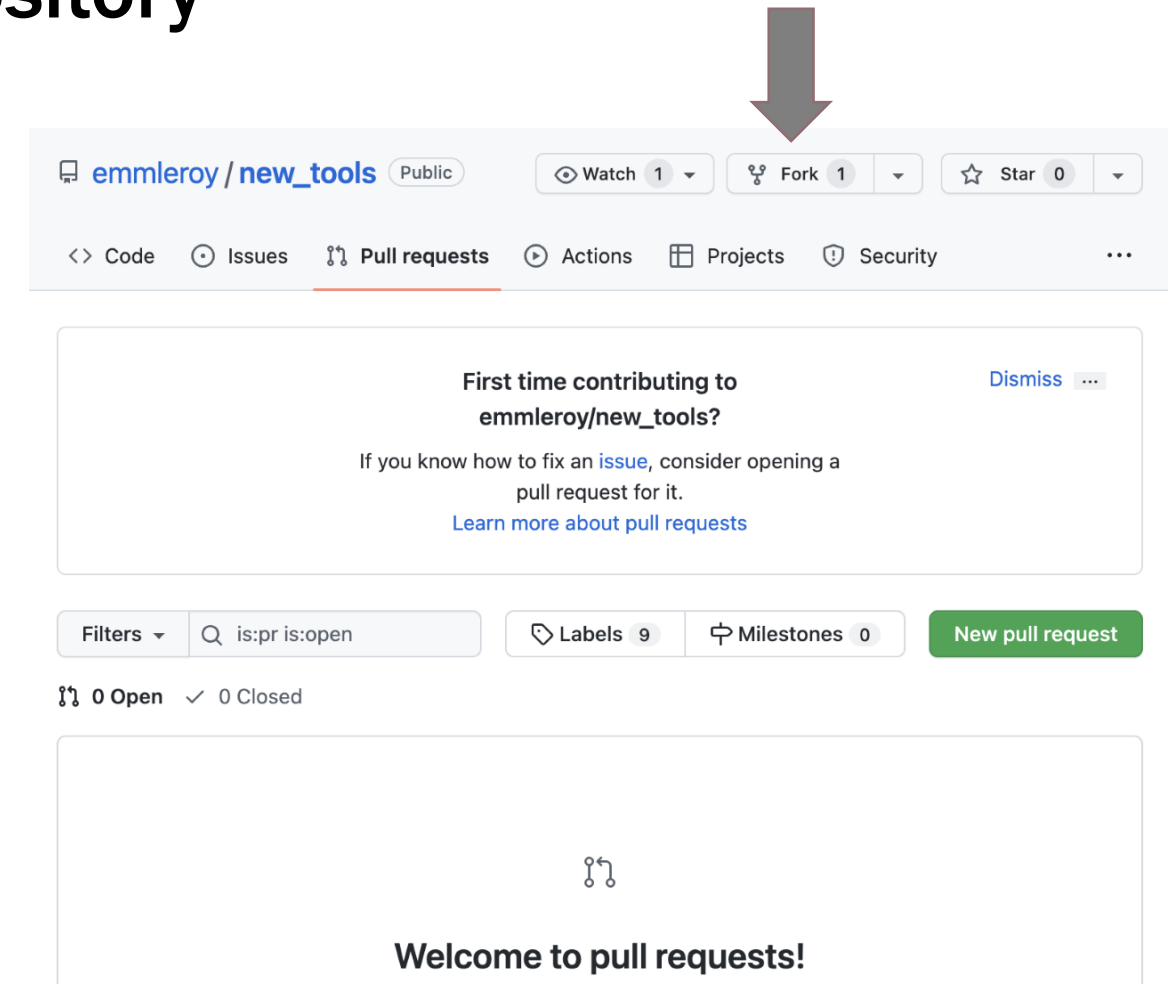
A cloned project is on your local machine (you can clone from someone else's remote or from your own remote)



What's the difference between clone and pull?



Go to https://github.com/emmleroy/new_tools and fork the repository



Create a new fork

A *fork* is a copy of a repository. Forking a repository allows you to freely experiment with changes without affecting the original project. View existing forks.

Owner * **Repository name** *

emmleroy / new_tool

By default, forks are named the same as their upstream repository. You can customize the name to distinguish it further.

Description (optional)

example repository for Selin group github tutorial

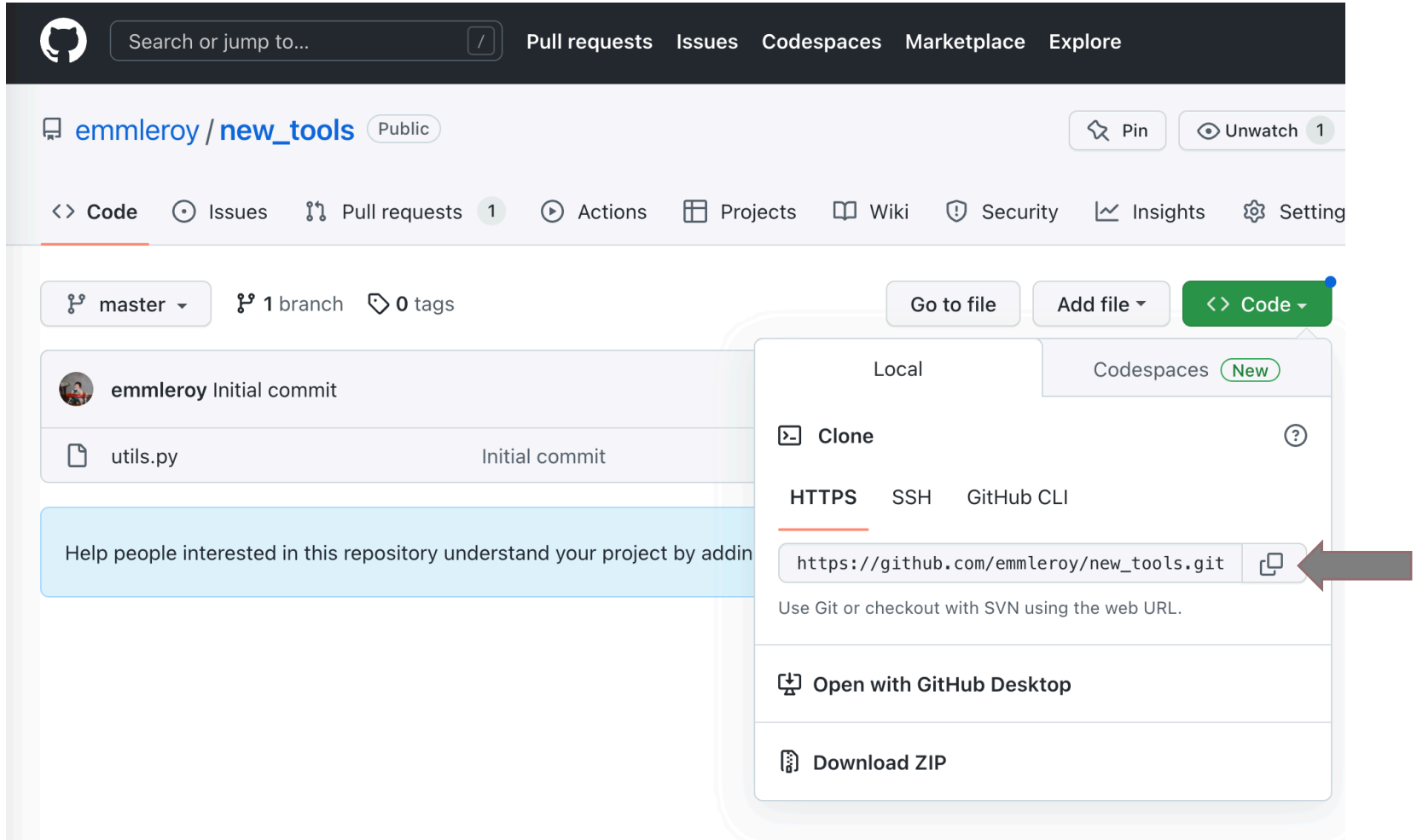
Copy the `main` **branch only**

Contribute back to NCAR/geocat-comp by adding your own branch. Learn more.

You are creating a fork in your personal account.

Create fork

Copy the https URL of the forked repository



git clone <remote_URL>

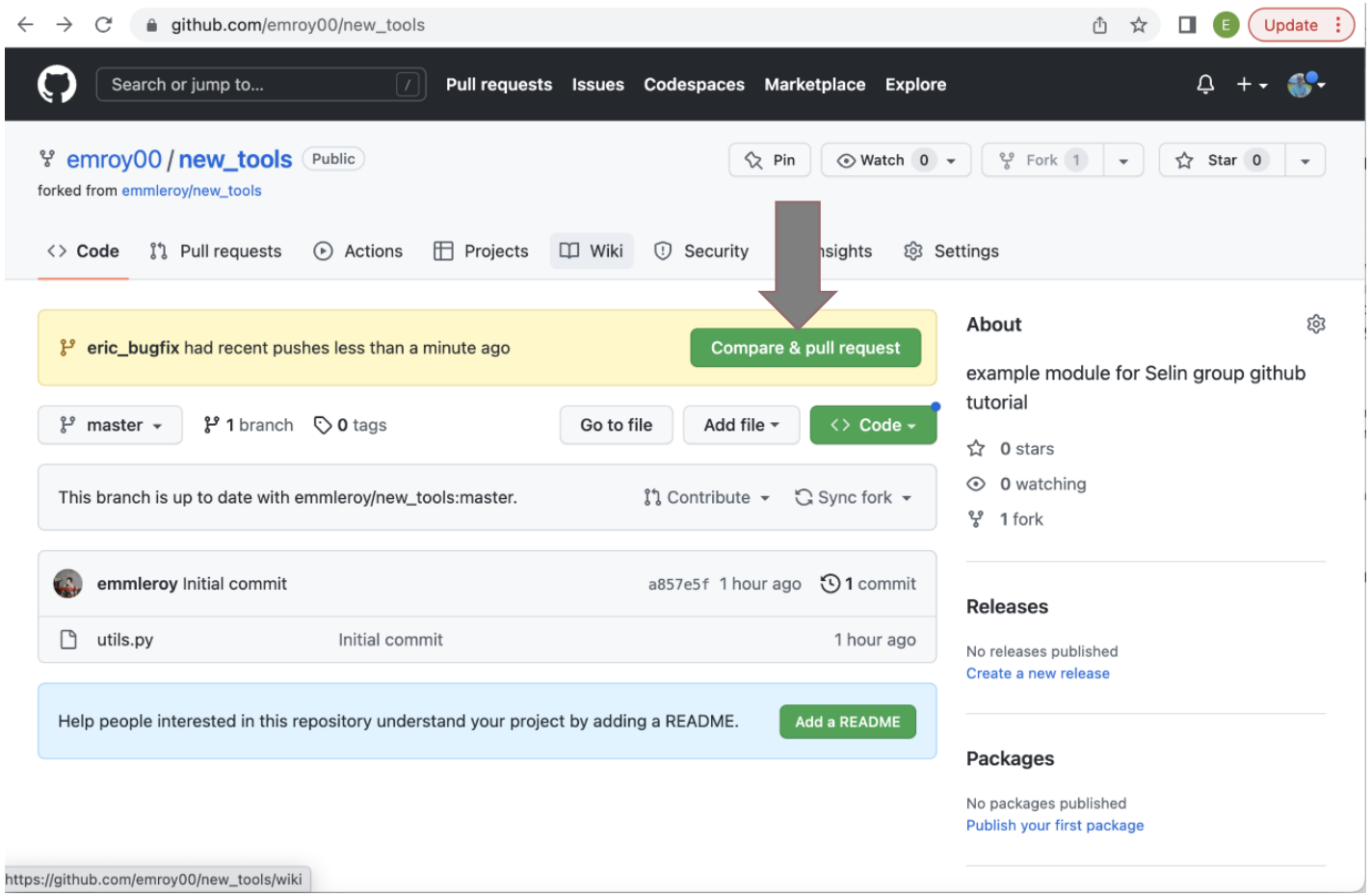
creates a local copy of a remote repository

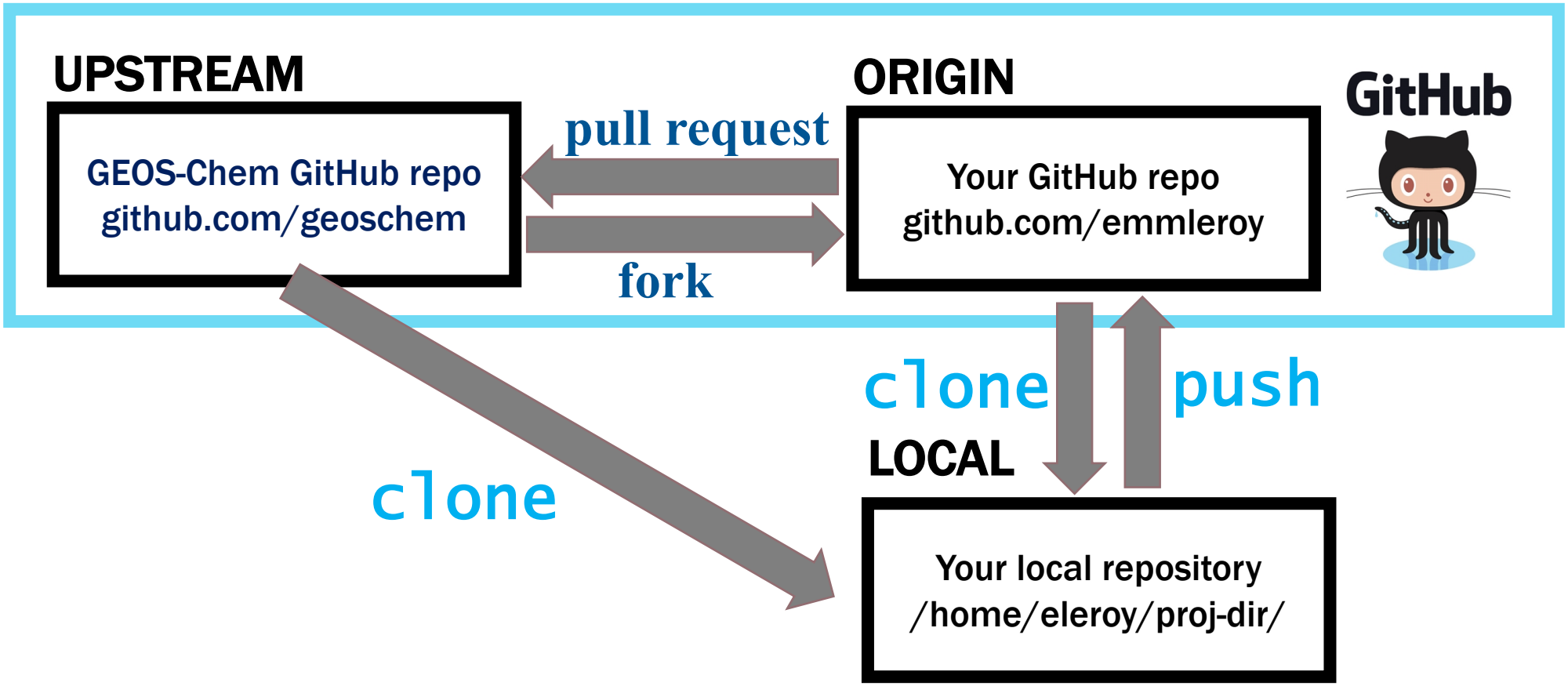
```
$ cd tutorials/
$ git clone https://github.com/emmleroy/new_tools.git
$ cd new_tools/
$ git remote -v
  origin     https://github.com/emmleroy/new_tools.git (fetch)
  origin     https://github.com/emmleroy/new_tools.git (push)
```

Checkout a new branch, make and commit a change, upload the change to your remote forked repository

```
$ git checkout -b Emmie_bugfix
$ echo "# Emmie's contribution" >> utils.py
$ git add
$ git log
$ git commit –m “Add Emmie’s contribution”
$ git remote -v
$ git push –u origin Emmie_bugfix
```

Create a pull request!




UPSTREAM
GEOS-Chem GitHub repo
github.com/geoschem
pull request
fork
ORIGIN
Your GitHub repo
github.com/emmleroy
GitHub
clone
push
LOCAL
clone
Your local repository
/home/eleroy/proj-dir/

```
$ git config --global user.name ‘’Emmie Le Roy”
$ git config --global user.email ‘’eleroy@gmail.com"
```