Version Control with git and github

R. Pastor-Satorras

Departament de Física
UPC

Eines Informàtiques Avançades / EIA

Version control systems

From computer science:

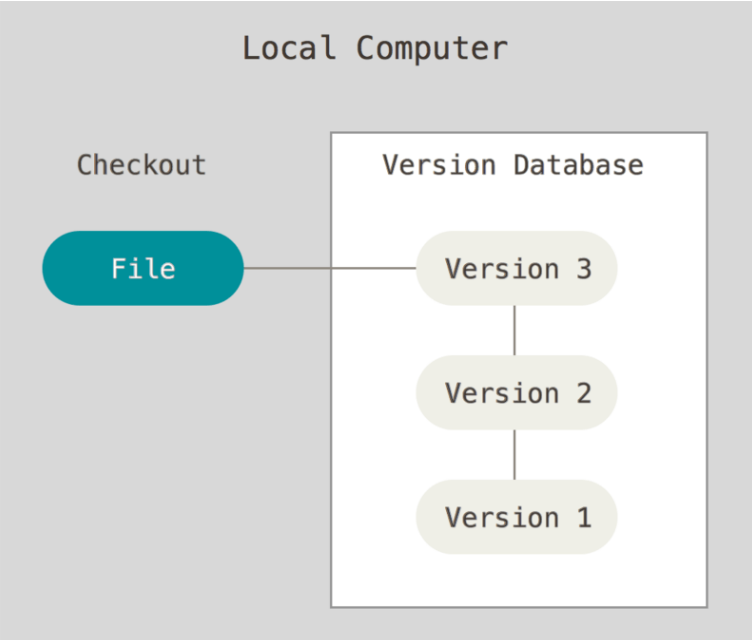
- Version control is a system than records changes performed to a file or set of files in time, and that allows to recall specific versions later

Version control systems permit:

- Revert files back to a previous state
- Revert an entire project back to a previous state
- Compare changes over time
- Know who and when last modified something that does not work
- Recover if you screw things up severely
- Work on different, parallel branches of the code, implementing and experimenting new ideas
- Manage work in the code by a team of people

Local version control systems

Poor-man's VCS

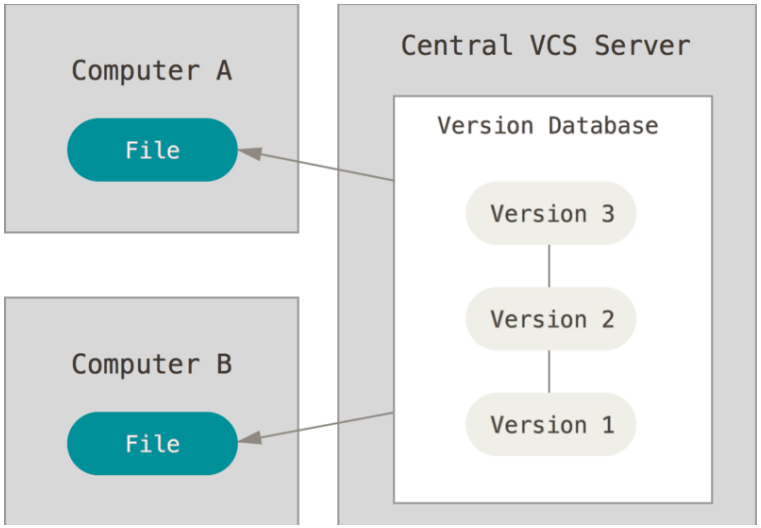


- Copy files into another time-stamped directory
- Allows to keep safe different versions of the code, separated from our working directory
- Error prone
  - Easy to forget in which directory you are, and mess with your saved versions
- Drawback: Everything is on the same disk, if it fails, all is lost

And how do you collaborate is this framework?

Centralized version control systems

Specially to favor collaboration, but can be used stand-alone

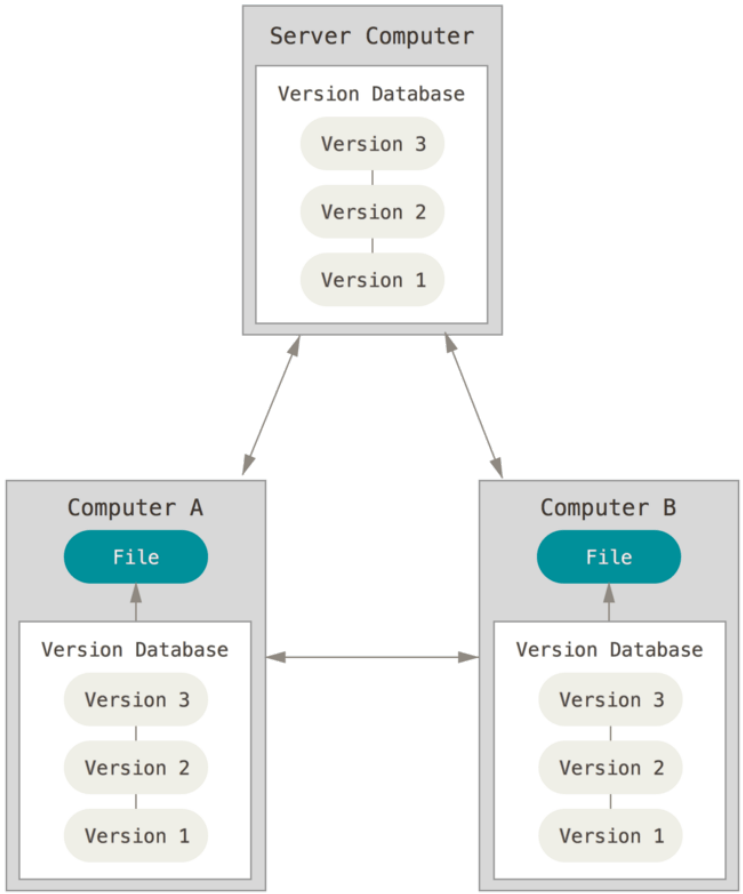


- A single server contains all versioned files
- A number of clients check out files from the server
- The files are updated and later committed back to the server
- Drawback: the single point of failure that the centralized server represents
- If the disk of the server becomes corrupted, all is lost

Distributed version control systems

Latest, most popular VCS technology

- Clients don't just check out the latest version of files, they fully mirror the repository
- Every client is a clone of the server repository; if any server dies, any of the client repositories can be copied back up to the server to restore it
- Clients can work in parallel on different parts of the code, and commit the changes to the central server when they are done



The git distributed version control systems

git is one of the most popular distributed version control systems.

Developed by Linus Torvalds in need of a VCS capable for the development of the Linux kernel

git is extremely powerful

- Ex. code base of Linux kernel (mainline 6.2): 2.6 million lines of code distributed over 79.400 files and 1.4 Gb of disk space, subject by all kinds of complex manipulations by hundreds of contributors simultaneously

However ...

Git is a saw with no guard that makes it easy to cut your own arm off.
But it also comes with an easy arm reattachment kit.
And you can even attach the arm to your knee if you want.

—Wayne Conrad

We have to work carefully with git

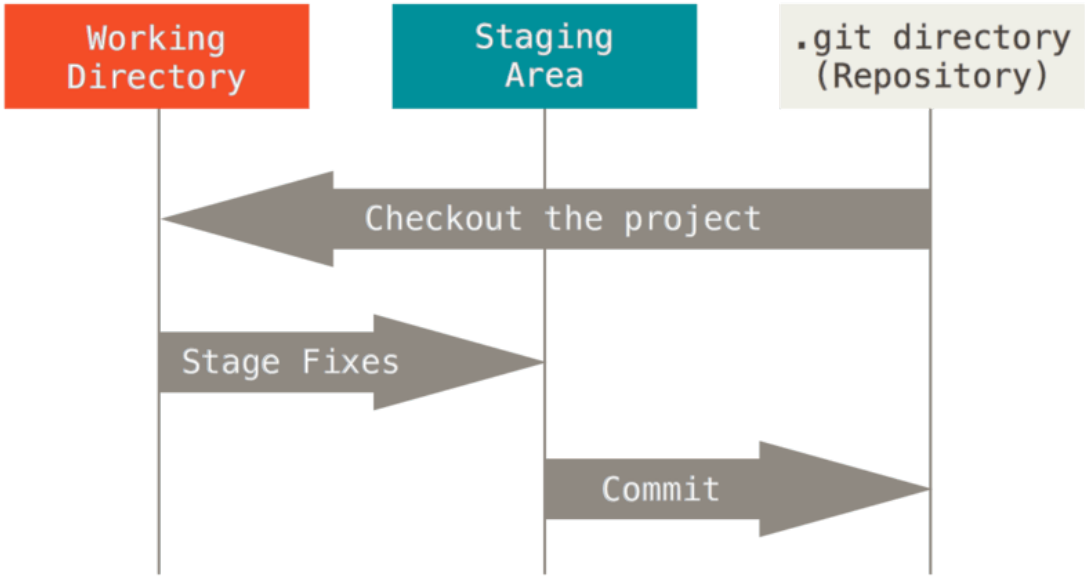
How git works

- git stores complete snapshots of a project, identified by a *repository*, i.e. a folder
- Operations consist essentially in adding data to create and update the different snapshots. Since there are no deletions, it is very difficult to destroy your work
- git performs a check-sum of the data, so that is impossible to change the contents of the folder without git knowing it
- git identifies many things by a SHA-1 (*Secure Hash Algorithm*) hash string, of the form

  `24b9da6552252987aa493b52f8696cd6d3b00373`

  We refer to these strings (just the first few characters) to identify the different changes and snapshots

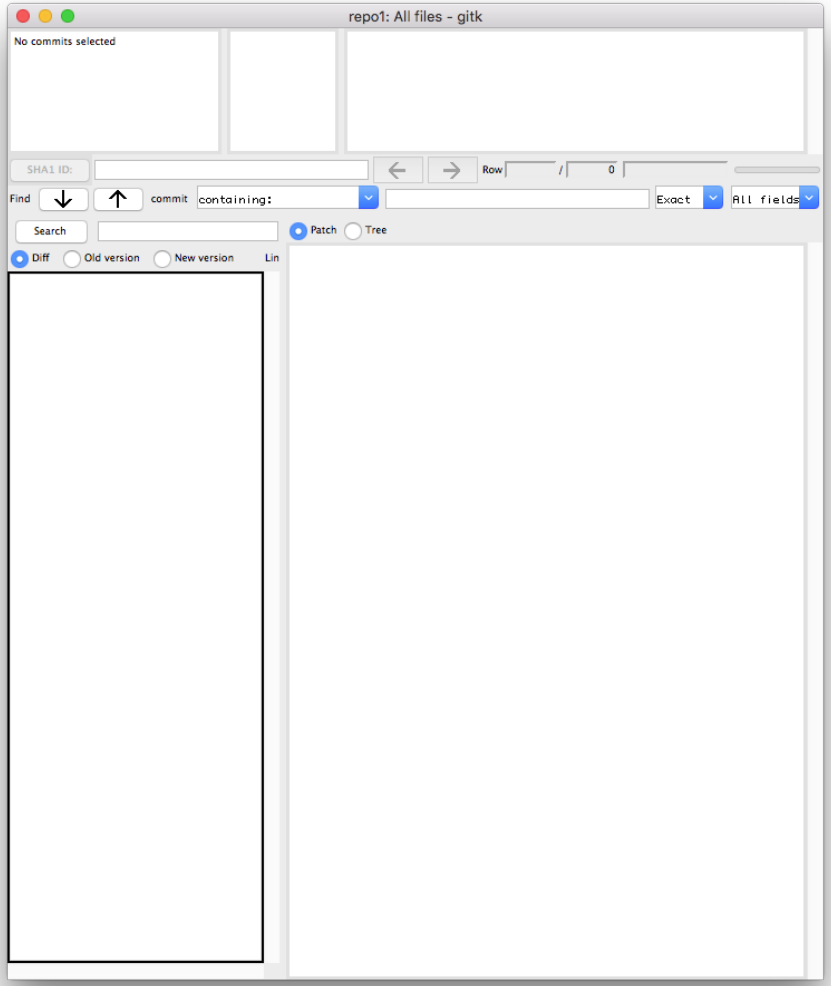
The three states of git



- Define a folder as a repository
- Modify files on the folder (working directory)
- *Stage* files, as soon as you are done working with them, on the *staging area*. They are not yet saved in this area, just ready to be saved.
- Do a *commit*, taking the files in the staging area and permanently storing a snapshot of the project onto the repository

Local version control with git

- Start version controlling in our computer, to keep track of the work inside a working directory
- We will use git on the command line
- You can also use GUI versions (ex. gitk)



Installing git

- Go to the Git website and follow instructions for your platform
- Use a software package manager, such as `chocolatey`, `homebrew`, `apt`, `yum`, etc

You have it installed in the computers in the room. Open a terminal (preferably in Linux) and get ready to `git`...

The git command

```
:> git --version
git version 2.44.0

:> git --help
usage: git [-v | --version] [-h | --help] [-C <path>] [-c <name>=<value>]
           [--exec-path[=<path>]] [--html-path] [--man-path] [--info-path]
           [-p | --paginate | -P | --no-pager] [--no-replace-objects] [--bare]
           [--git-dir=<path>] [--work-tree=<path>] [--namespace=<name>]
           [--super-prefix=<path>] [--config-env=<name>=<envvar>]
           <command> [<args>]

These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
   clone     Clone a repository into a new directory
   init      Create an empty Git repository or reinitialize an existing one

work on the current change (see also: git help everyday)
   add       Add file contents to the index
   mv        Move or rename a file, a directory, or a symlink
   restore   Restore working tree files
   rm        Remove files from the working tree and from the index

examine the history and state (see also: git help revisions)
   bisect    Use binary search to find the commit that introduced a bug
   diff      Show changes between commits, commit and working tree, etc
   grep      Print lines matching a pattern
   log       Show commit logs
   show      Show various types of objects
   status    Show the working tree status
```

Initializing git

First of all, we can provide some initial information about ourselves to git:

```
:> git config --global user.name "R Pastor"
:> git config --global user.email romualdo.pastor@upc.edu
:> git config --global core.editor vim
```

git will use the information to tag our commits.

Checking the status

```
:> git config --list
credential.helper=osxkeychain
user.name=R Pastor
user.email=romualdo.pastor@upc.edu
core.editor=vim
```

Creating a repository

```
:> mkdir project
:> cd project/

:project> git init
hint: Using 'master' as the name for the initial branch. This default branch name
hint: is subject to change. To configure the initial branch name to use in all
hint: of your new repositories, which will suppress this warning, call:
hint:
hint:         git config --global init.defaultBranch <name>
hint:
hint: Names commonly chosen instead of 'master' are 'main', 'trunk' and
hint: 'development'. The just-created branch can be renamed via this command:
hint:
hint:         git branch -m <name>
Initialized empty Git repository in $FOLDER/project/.git/

:project> git status
On branch master

No commits yet

nothing to commit (create/copy files and use "git add" to track)
```

You can change the default initial branch name with the command

```
:> git config --global init.defaultBranch main
```

Inside the repository

```
:project> ls -alg
total 0
drwxr-xr-x@ 3 staff   96 Feb 11 12:49 .
drwxr-xr-x@ 3 staff   96 Feb 11 12:48 ..
drwxr-xr-x@ 9 staff  288 Feb 11 12:50 .git
```

Inside the repository

```
:project> ls -alg
total 0
drwxr-xr-x@ 3 staff   96 Feb 11 12:49 .
drwxr-xr-x@ 3 staff   96 Feb 11 12:48 ..
drwxr-xr-x@ 9 staff  288 Feb 11 12:50 .git

:project> ls -alg .git/
total 24
drwxr-xr-x@  9 staff  288 Feb 11 12:50 .
drwxr-xr-x@  3 staff   96 Feb 11 12:49 ..
-rw-r--r--@  1 staff   23 Feb 11 12:49 HEAD
-rw-r--r--@  1 staff  137 Feb 11 12:49 config
-rw-r--r--@  1 staff   73 Feb 11 12:49 description
drwxr-xr-x@ 15 staff  480 Feb 11 12:49 hooks
drwxr-xr-x@  3 staff   96 Feb 11 12:49 info
drwxr-xr-x@  4 staff  128 Feb 11 12:49 objects
drwxr-xr-x@  4 staff  128 Feb 11 12:49 refs
```

Staging files

```
:project> vim hello.f08     # Adding a file
:project> cat hello.f08
program hello
  implicit none

  print *, "Hello World!"
end program hello

:project> git add hello.f08     # staging a file

:project> git status    # checking the status
On branch master

No commits yet

Changes to be committed:
  (use "git rm --cached <file>..." to unstage)
        new file:   hello.f08

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        hello.f08~
```

Ignoring files

Text editors usually create back-up files (the *.*~ file in the present case), which we do not want to keep track of

We can specify files to ignore in a `.gitignore` file

```
:project> vim .gitignore      # Edit .gitignore
:project> cat .gitignore
*~
.*

:project> git status     # check status again
On branch master

No commits yet

Changes to be committed:
  (use "git rm --cached <file>..." to unstage)
        new file:   hello.f08
```

Saving (committing) a snapshot

```
# committing staged files
:project> git commit -m "Initial file"
[master (root-commit) b2d7f48] Initial file
 1 file changed, 5 insertions(+)
 create mode 100644 hello.f08

# checking
:project> git status
On branch master
nothing to commit, working tree clean
```

The git commit command

- Saves the snapshot, officially called a "revision"
- Gives that snapshot a unique ID number (a revision hash), here b2d7f48, which we use to identify it
- Names you as the author of the changes
- Allows you, the author, to add a message [-m "Initial file"]

Viewing the history

```
:project> git log
commit b2d7f4886d917ede42791f8dc6156b4c5ab9d83d (HEAD -> master)
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 13:02:54 2023 +0100

    Initial file
```

The `git log` command

- Prints the logged metadata for each commit
- Each commit possesses a unique (hashed) identification number that can be used to refer to that commit (b2d7f48, the first numbers are enough)
- Records the date and time at which the commit occurred.
- The log message for each commit is printed along with that commit.

Making and committing changes

```
# edit the file
:project> vim hello.f08
:project> cat hello.f08
program hello
  implicit none
  character(len=50) :: name

  print *, "Enter your name"
  read *, name

  print *, "Hello ", name, "!"
end program hello

# checking status
:project> git status
On branch master
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   hello.f08

no changes added to commit (use "git add" and/or "git commit -a")
```

Making and committing changes

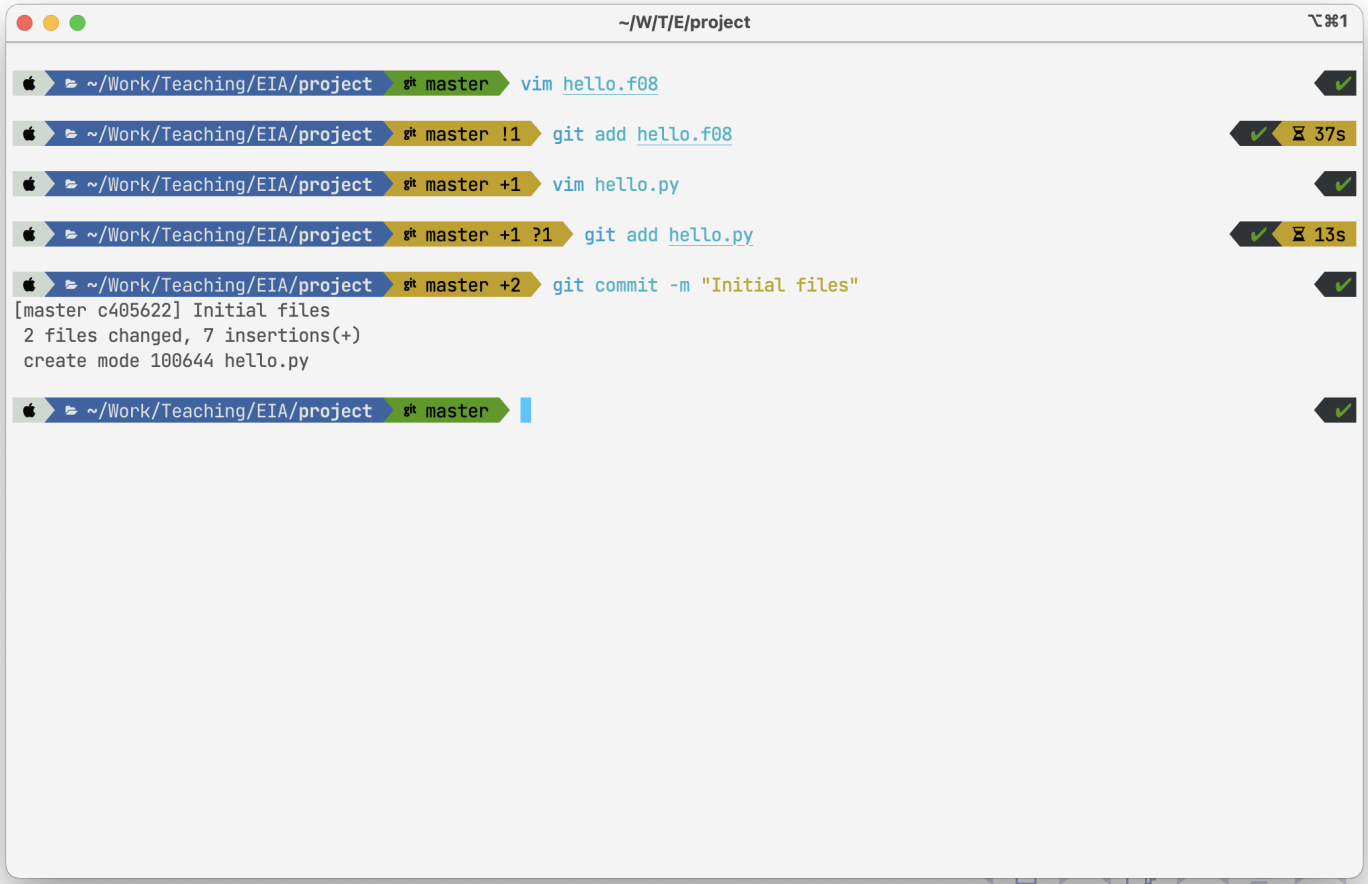
```
# stage for the snapshot
:project> git add hello.f08
# commit
:project> git commit -m "Improved program with name"
[master 303135f] Improved program with name
 1 file changed, 4 insertions(+), 2 deletions(-)
```

Tools for git

At some point, we might be lost as to whether we have stuff in the stage area, if we have to make a commit, etc.

Some shells in the terminal can help us at this point

- `fish` shell with *tide* prompt



What have we done?

```
# check status
:project> git status
On branch master
nothing to commit, working directory clean
:project> git log
commit 303135fb1ab18ac95447812e214be66284c6fc4b (HEAD -> master)
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:09:12 2023 +0100

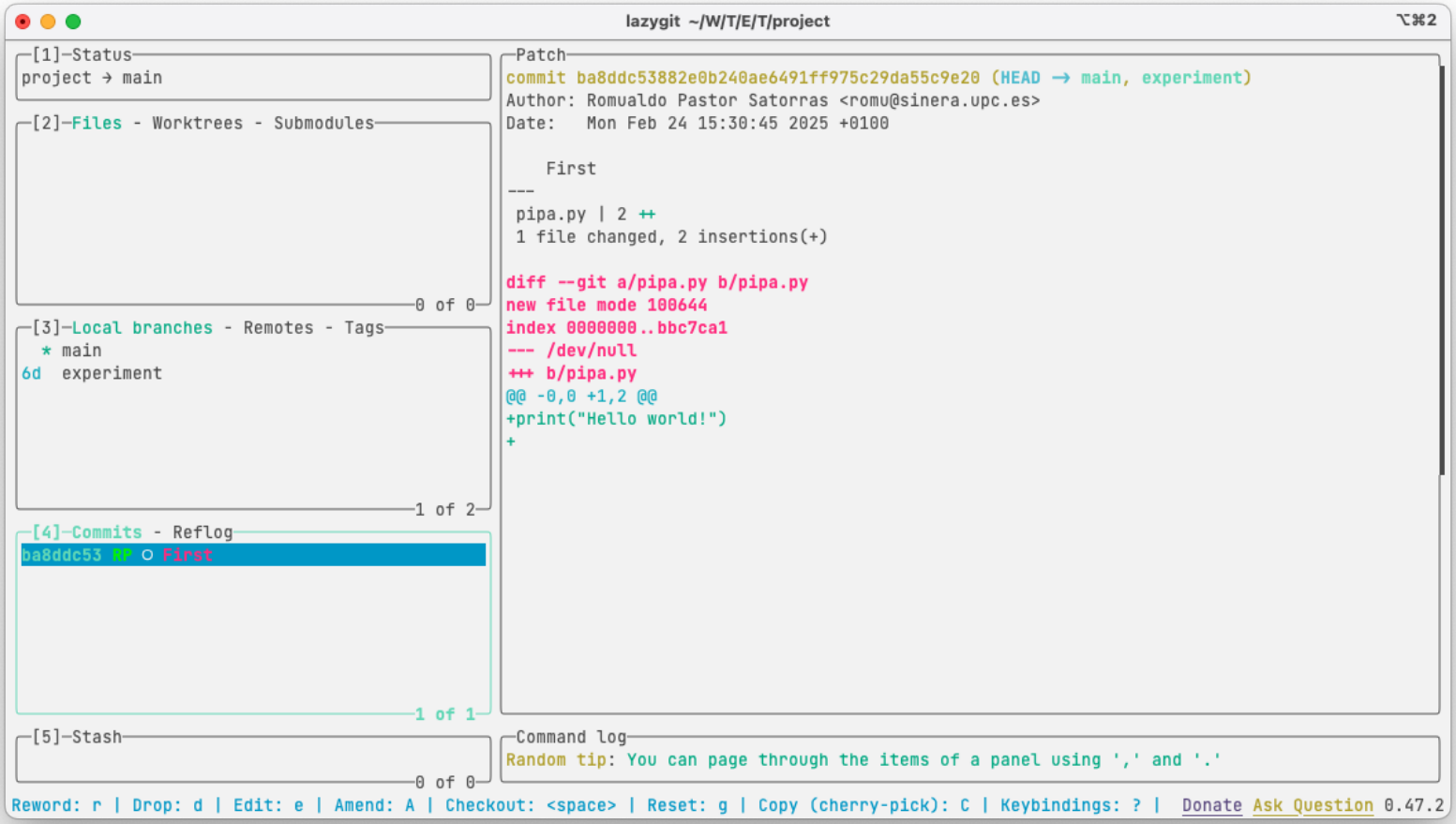
    Improved program with name

commit b2d7f4886d917ede42791f8dc6156b4c5ab9d83d
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 13:02:54 2023 +0100

    Initial file
```

Tools for git

`lazygit` is a useful terminal command to summarize the status of a git repository



Making more commits

```
:project> vim hello.f08
:project> cat hello.f08
program hello
  implicit none
  character(len=50) :: name, surname

  print *, "Enter your name"
  read *, name
  print *, "Enter your surname"
  read *, surname

  print *, "Hello ", name, surname,  "!"
end program hello

:project> git add hello.f08

:project> git commit -m "More improvements"
[master 4da8be2] More improvements
 1 file changed, 5 insertions(+), 6 deletions(-)
```

- Now we have three snapshots, each corresponding to the three commits (hash numbers) made

Looking at the differences

```
#  status of the repository, with differences in snapshots
:project> git log -p
commit 4da8be2b7cb696ee1a6154ed09d181e5517139a5 (HEAD -> master)
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:11:19 2023 +0100

    More improvements

diff --git a/hello.f08 b/hello.f08
index 51c2cb0..86c700d 100644
--- a/hello.f08
+++ b/hello.f08
@@ -1,7 +1,6 @@
 program hello
-  implicit none
-  character(len=50) :: name
-  print *, "Enter your name"
-  read *, name
-  print *, "Hello ", name, "!"
-end program hello
+implicit none
+character(len=50) :: name, surname
+print *, "Enter your name" read *, name
+print *, "Enter your surname" read *, surname
+print *, "Hello ", name, surname, "!" end program hello

commit 303135fb1ab18ac95447812e214be66284c6fc4b
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:09:12 2023 +0100

    Improved program with name

diff --git a/hello.f08 b/hello.f08
```

Reverting to a previous snapshot

```
#  log in one line format
:project> git log --pretty=oneline
4da8be2b7cb696ee1a6154ed09d181e5517139a5 (HEAD -> master) More improvements
303135fb1ab18ac95447812e214be66284c6fc4b Improved program with name
b2d7f4886d917ede42791f8dc6156b4c5ab9d83d Initial file
```

`HEAD -> master` indicates the present snapshot

```
# present file
:project> cat hello.f08
program hello
  implicit none
  character(len=50) :: name, surname

  print *, "Enter your name"
  read *, name
  print *, "Enter your surname"
  read *, surname

  print *, "Hello ", name, surname,  "!"
end program hello
```

Reverting to a previous snapshot

```
# bring the first version, identified by the first 7 digits of the hash
:project> git reset --hard 8715df
HEAD is now at b2d7f48 Initial file

:project> cat hello.f08
program hello
  implicit none

  print *, "Hello World!"
end program hello
# bring again the last version
:project> git reset --hard 4da8be2b7cb696
HEAD is now at 4da8be2 More improvements
```

You can use more than seven characters of the SHA string

Branches in git

Branches are parallel instances of a repository that can be edited and version controlled in parallel.

They are useful for pursuing various implementations experimentally or maintaining a stable core while developing separate sections of a code base.

List the branches in a repository

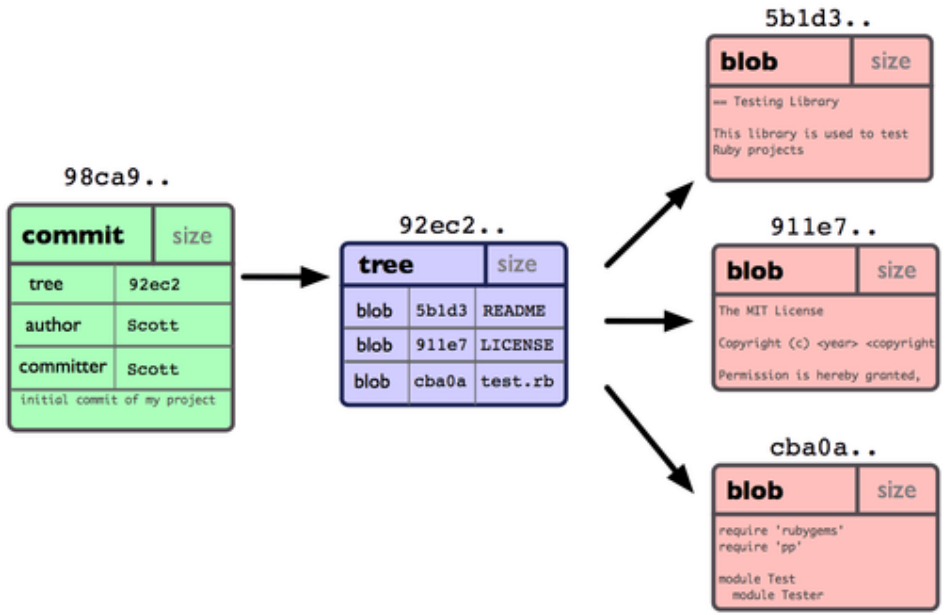
```
# Listing branches
:project> git branch
* master
```

The "master" branch is created when the repository is initialized and the first commit made.

This is the default branch and is conventionally used to store a clean master version of the source code.

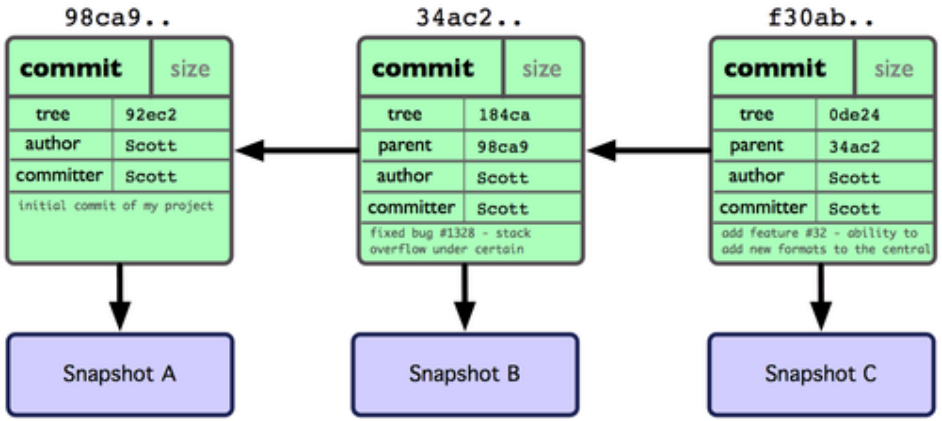
Summary: how git works

A Git repository with an initial commit contains objects: one blob for the contents of each of your files, one tree that lists the contents of the directory and specifies which file names are stored as which blobs, and one commit with a pointer to that root tree and all the commit metadata.



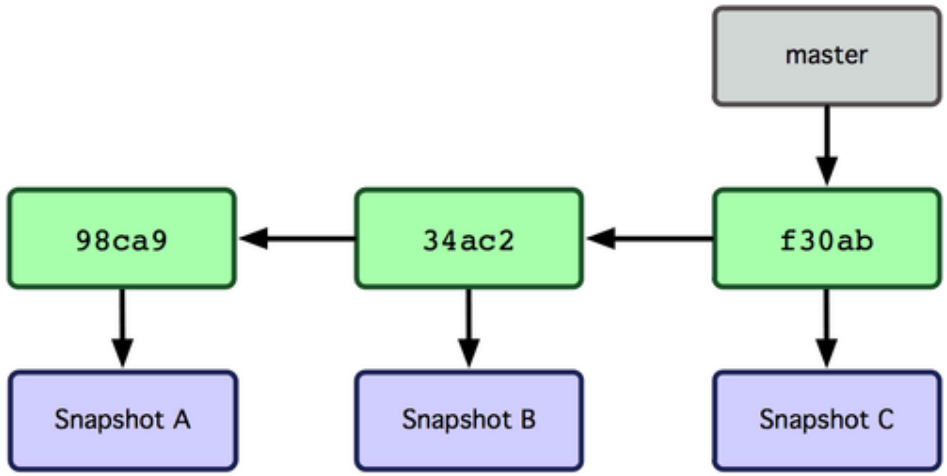
Summary: how git works

If you make some changes and commit again, the next commit stores a pointer to the commit that came immediately before it. After two more commits, your history might look something like this



Summary: how git works

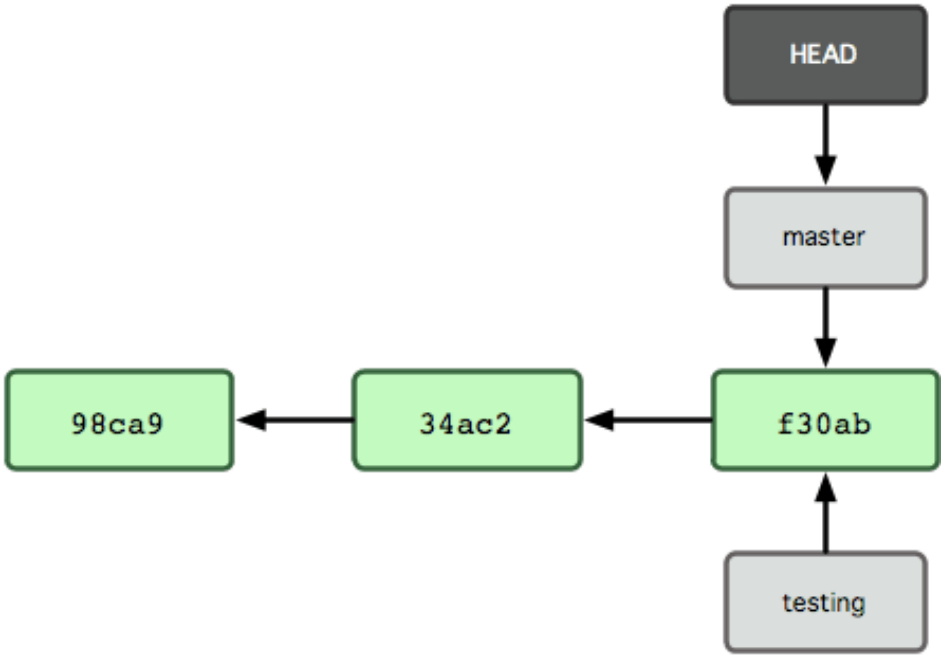
A branch in Git is simply a lightweight movable pointer to one of these commits. The default branch name in Git is `master`. As you initially make commits, you're given a `master` branch that points to the last commit you made. Every time you commit, it moves forward automatically.



Branches in git

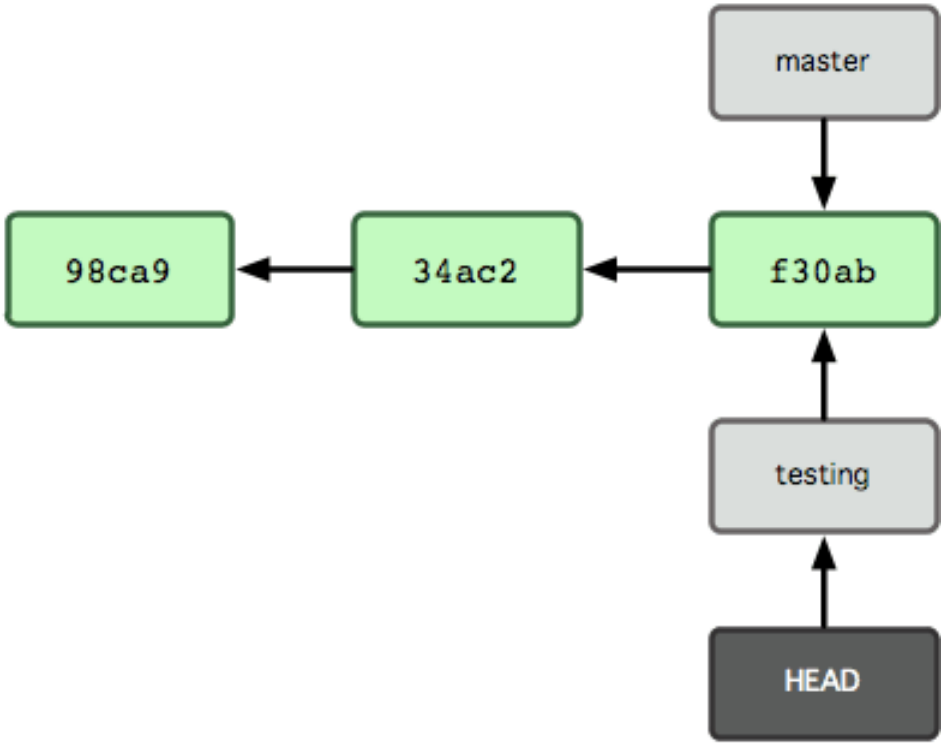
When you create a new branch, a new pointer is created for you to move around.

Git knows in which branch you are by keeping a special pointer called HEAD, pointing to the local branch you're currently on



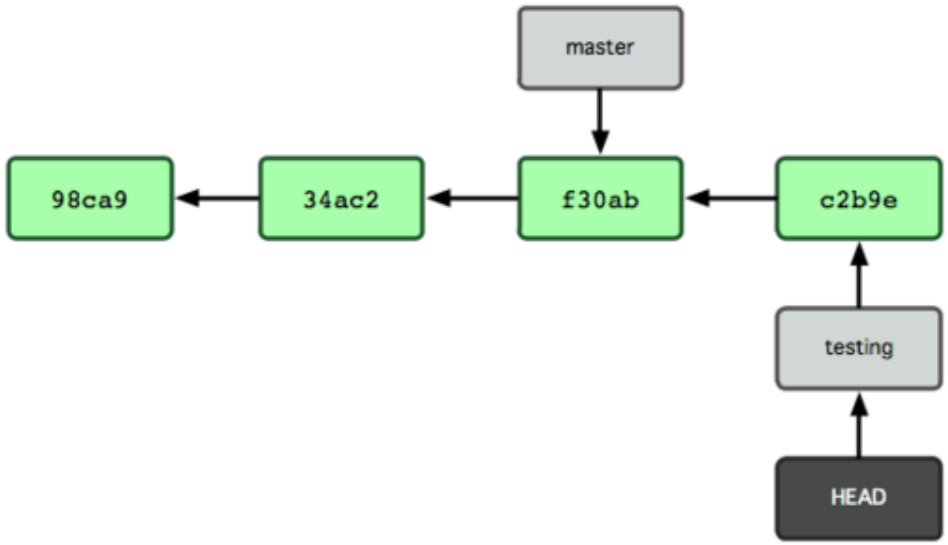
Branches in git

You can move to the newly created branch. HEAD will then point to it. Now you can start performing changes to your code



Branches in git

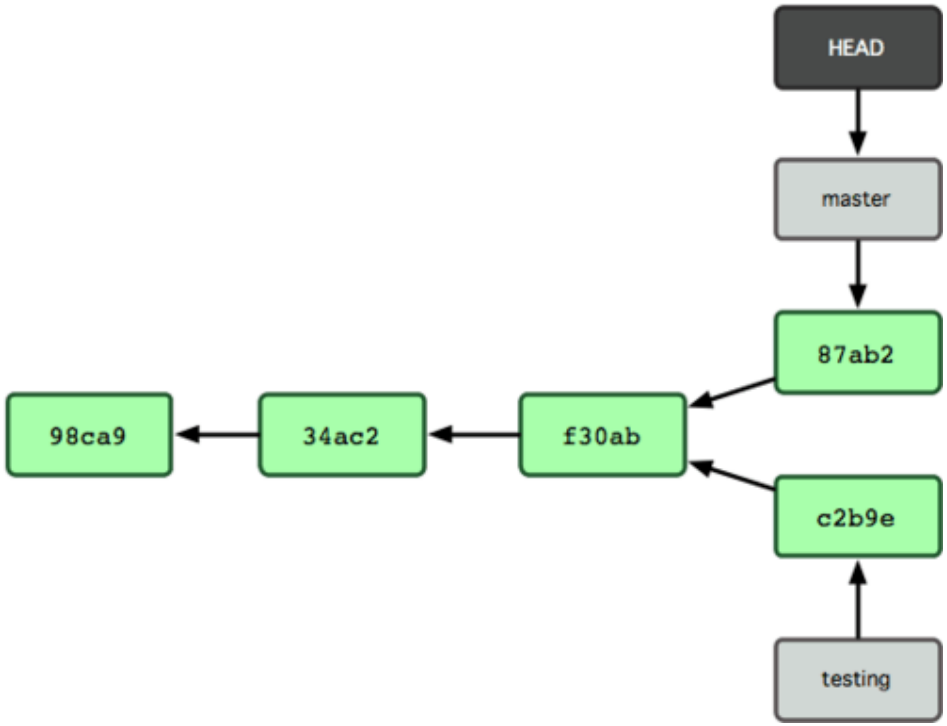
You can start making commits in the new branch. The HEAD in the branch moves forward, but your master branch still points to the commit you were on when you changed to the branch



Branches in git

You can switch back to `master`, perform some more changes and commits. All changes take place in isolated branches, and it is possible to go back and forth among them.

When you are done with the new branch you can delete it, keep it as a separate code base, or merge it with `master`



Creating a branch

```
# Creating a new branch
:project> git branch experiment
# Listing branches
:project> git branch
  experiment
* master
```

We have now two branches, `master` and `experiment`. The star * indicates the branch in which we are

To switch to a branch

```
# Switch to branch
:project> git checkout experiment
Switched to branch 'experiment'
# list
:project> git branch
* experiment
  master
```

Working on a branch

```
# Add a file to the branch
:project> vim hello.c
:project> cat hello.c
#include <stdlib.h>
#include <stdio.h>

int main()
{
  fprintf(stderr, "%s\n", "Hello world!");

  exit(0);

}
:project> git status
On branch experiment
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        hello.c

nothing added to commit but untracked files present (use "git add" to track)
:project> git add hello.c
:project> git commit -m "Added C version"
[experiment 8b1b746] Added C version
 1 file changed, 4 insertions(+)
 create mode 100644 hello.c
```

We can add stuff to the branch, developing some new idea

Switching branches

```
# check where we are
:project> git branch
* experiment
  master
:project> ls -l    # list files in the repository
-rw-r--r--@ 1 romu  staff   65 Feb 11 14:27 hello.c
-rw-r--r--@ 1 romu  staff   0 Feb 11 14:27 hello.c~
-rw-r--r--@ 1 romu  staff  205 Feb 11 14:21 hello.f08
-rw-r--r--@ 1 romu  staff   75 Feb 11 13:00 hello.f08~

# back to master branch
:project> git checkout master
Switched to branch 'master'
:project> git branch
  experiment
* master
:project> ls -l     # list files in the repository
total 16
-rw-r--r--@ 1 romu  staff   0 Feb 11 14:27 hello.c~
-rw-r--r--@ 1 romu  staff  205 Feb 11 14:21 hello.f08
-rw-r--r--@ 1 romu  staff   75 Feb 11 13:00 hello.f08~
```

Back in `master`, observe that the file "hello.c" has disappeared (it's in the `experiment` branch!). Only the back-up file from the text editor remains on the working directory

Merging branches

Once the experiment is finished, if we are happy with it, we can incorporate it to the `master` branch

```
# go to the master branch
:project> git checkout master
Already on 'master'
# merge the branch experiment to the master
:project> git merge experiment
Updating 4da8be2..8b1b746
Fast-forward
 hello.c | 4 ++++
 1 file changed, 4 insertions(+)
 create mode 100644 hello.c
# now "hello.c" is in master
:project> ls -l
-rw-r--r--@ 1 romu  staff   65 Feb 11 14:31 hello.c
-rw-r--r--@ 1 romu  staff    0 Feb 11 14:27 hello.c~
-rw-r--r--@ 1 romu  staff  205 Feb 11 14:21 hello.f08
-rw-r--r--@ 1 romu  staff   75 Feb 11 13:00 hello.f08~
# delete the now useless branch
:project> git branch -d experiment
Deleted branch experiment (was 8b1b746).
```

Must be done inside the branch `master`

Merging branches

```
# final status
:project> git branch
* master
:project> git log
ommit 8b1b746b0ecf798f7afaa0386a596457206a8d1d (HEAD -> master)
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:28:34 2023 +0100

    Added C version

commit 4da8be2b7cb696ee1a6154ed09d181e5517139a5
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:11:19 2023 +0100

    More improvements

commit 303135fb1ab18ac95447812e214be66284c6fc4b
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:09:12 2023 +0100

commit 303135fb1ab18ac95447812e214be66284c6fc4b
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 14:09:12 2023 +0100

    Improved program with name

commit b2d7f4886d917ede42791f8dc6156b4c5ab9d83d
Author: R Pastor <romualdo.pastor@upc.edu>
Date:   Sat Feb 11 13:02:54 2023 +0100

    Initial file
```

The last commit has been imported from the branch

The power of branches

1. Branches in git allow to make temporal explorations of some coding project, developing different ideas in parallel to explore their potential
2. Once we are satisfied with one or several of them, we can merge them into the master code repository
3. Branches allow also for team coding: Several aspects of the same codebase can be worked by different people using parallel branches, which are finally merged when the different pieces are ready

Merging conflicts

If the contents of both `master` and the branch have been changes, the merge has conflicts, and it is aborted. Conflicts must be resolved by hand.

Remote version control with git

The full power of git emerges when it is combined with an online repository hosting system, which allows

1. Back up online automatically your code (thus making a security copy outside your computer)
2. Managing files in a collaboration
3. Forking remote repositories to modify or extend code of other people

Repository hosting

There are many repository hosting services online, that serve to store and access repositories

- Launchpad
- Bitbucket
- Google Code
- SourceForge
- GitHub
- GitLab

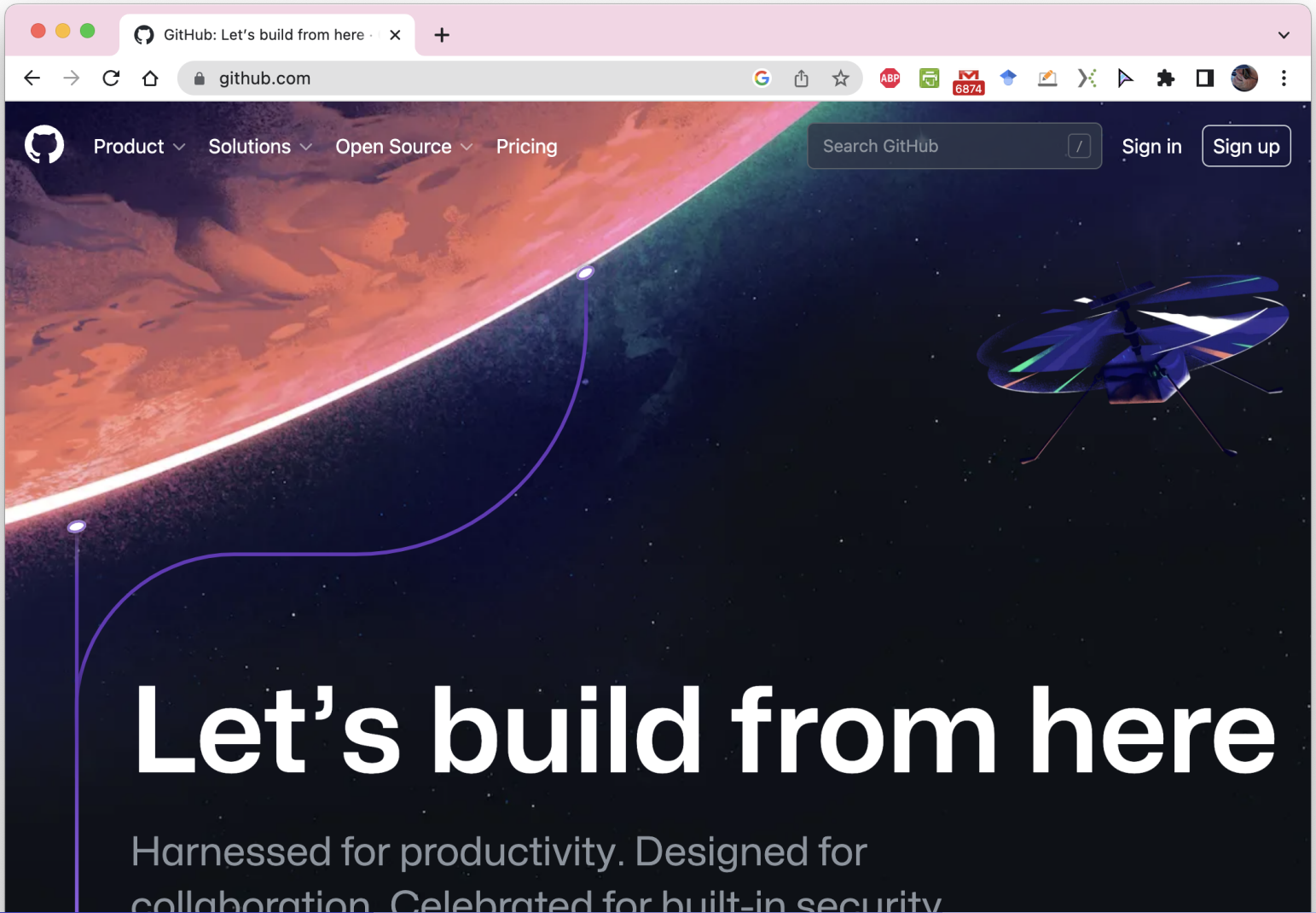
We will use here GitHub, because it is very easy to work in it, providing many tools for browsing, documenting, collaborating, etc

It can be used free, but it has the restriction that all repositories are public (anybody can look at them)

If you want free privacy, go for GitLab

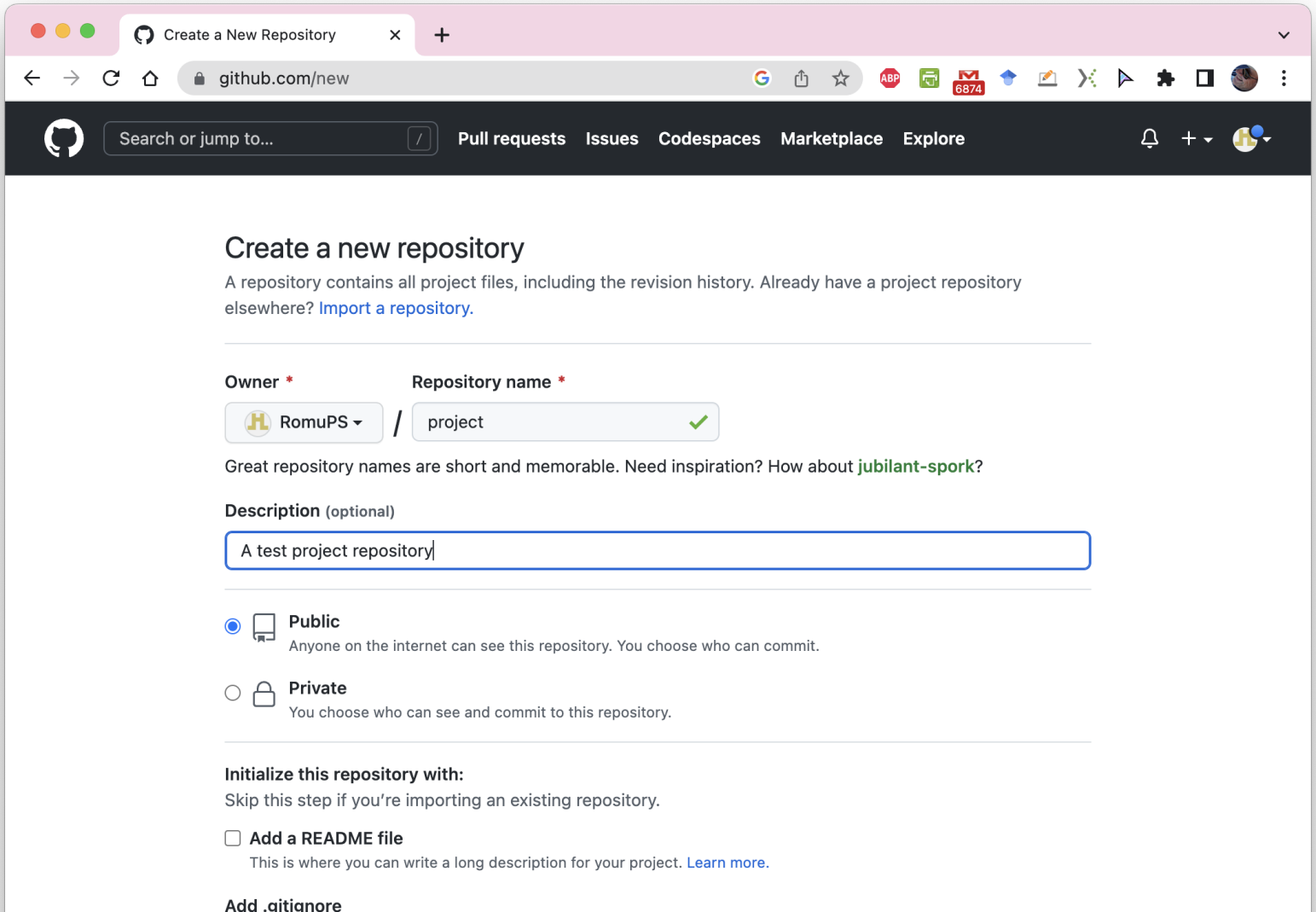
Create a free account on GitHub

Take a moment to create a free account, if you don't have one. You might get email messages at login for confirmation



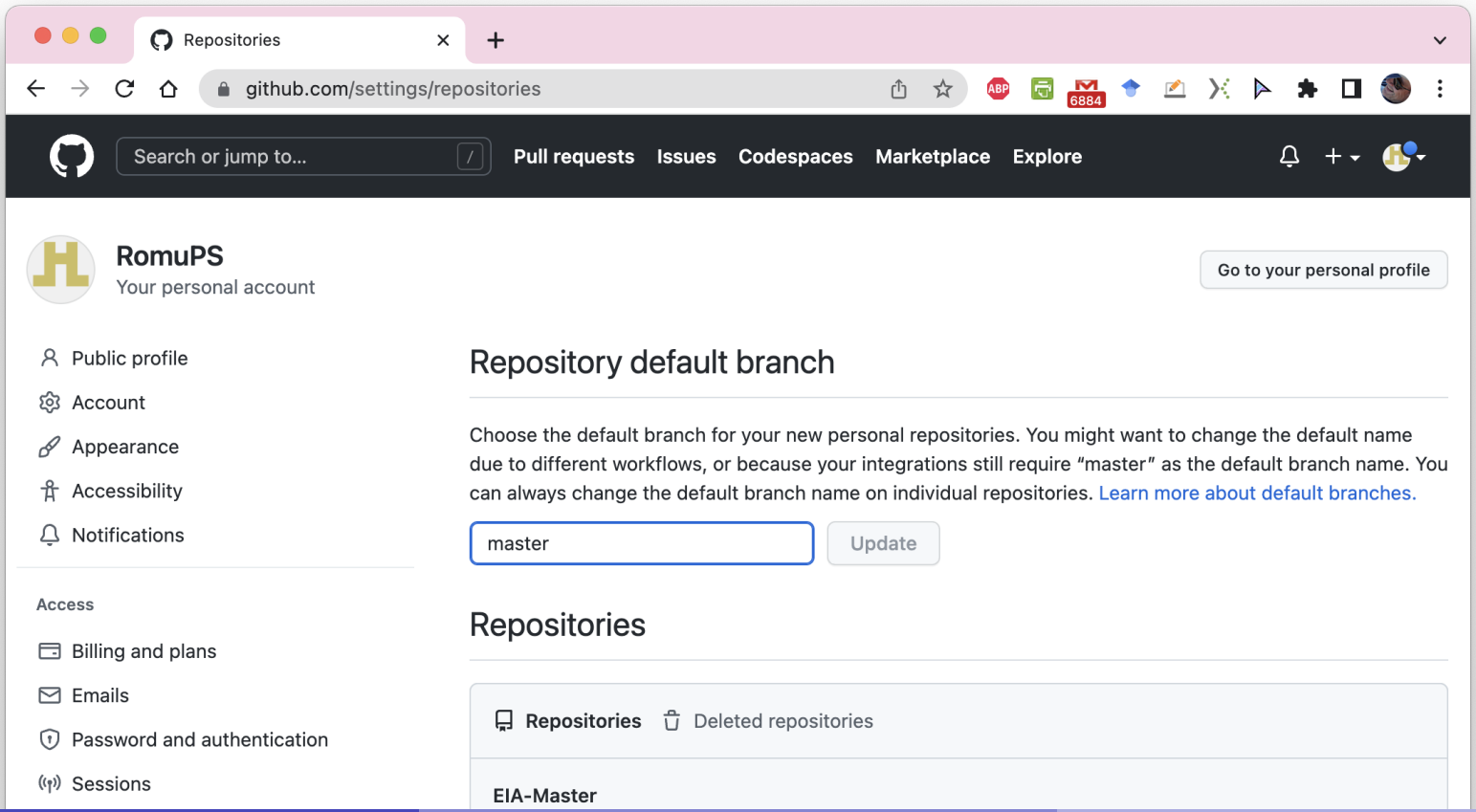
Creating a repository on GitHub

Go to the main page in your GitHub account and create a new project, clicking in the corresponding big green button. Give it the name "project"



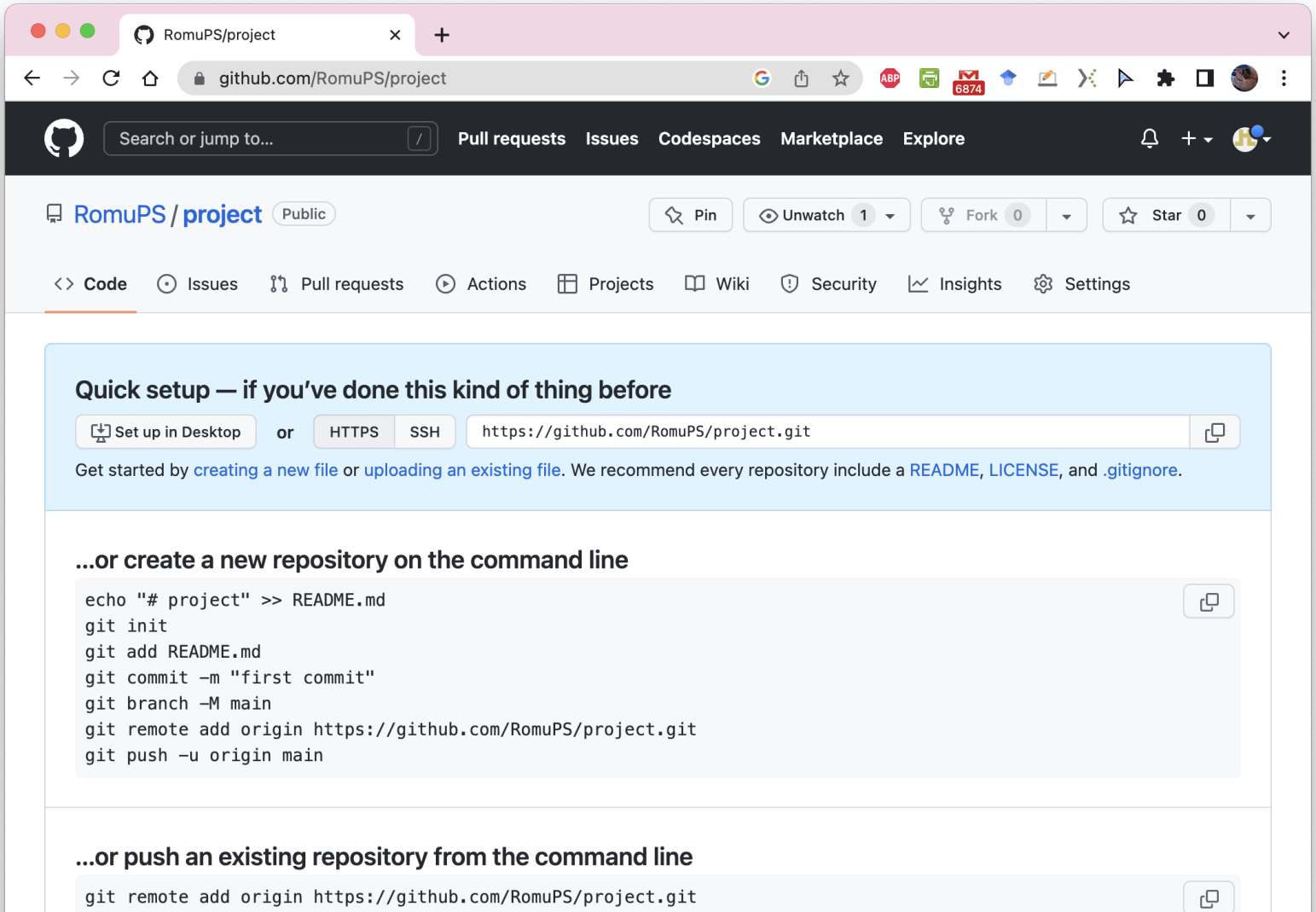
Creating a repository on GitHub

Watch out: Now github by default does not use the branch name `master`, but `main`. This can create conflicts if you try to synchronize local and remote repositories with different name. Be careful, or choose the default github repository branch name in general Settings, to match the one in your local repository



Creating a repository on GitHub

The repository is now empty, and GitHub proposes several ways to fill it. Do nothing for the moment



Declaring a remote

To synchronize changes between a local repository and a remote repository, the location of the remote must be registered on the local repository

```
# declare remote
:project> git remote add origin https://github.com/RomuPS/project.git
```

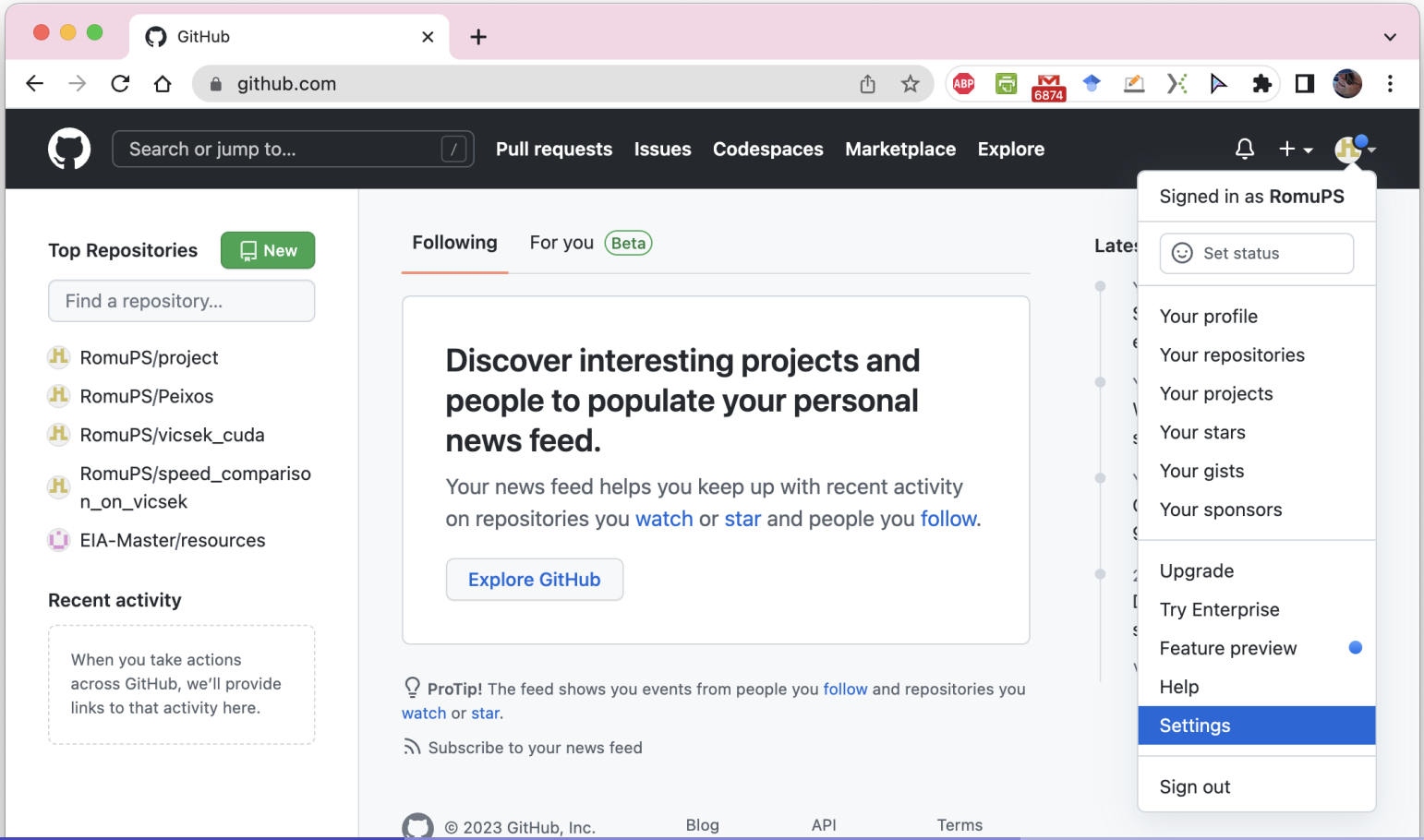
- `remote` makes git register something about a remote repository
- `add` declares the alias of the remote
- `origin` is the conventional alias for the repository
- URL is copied form the GitHub page

```
# check remotes
:project> git remote -v
origin        https://github.com/RomuPS/project.git (fetch)
origin        https://github.com/RomuPS/project.git (push)
```

Accessing github

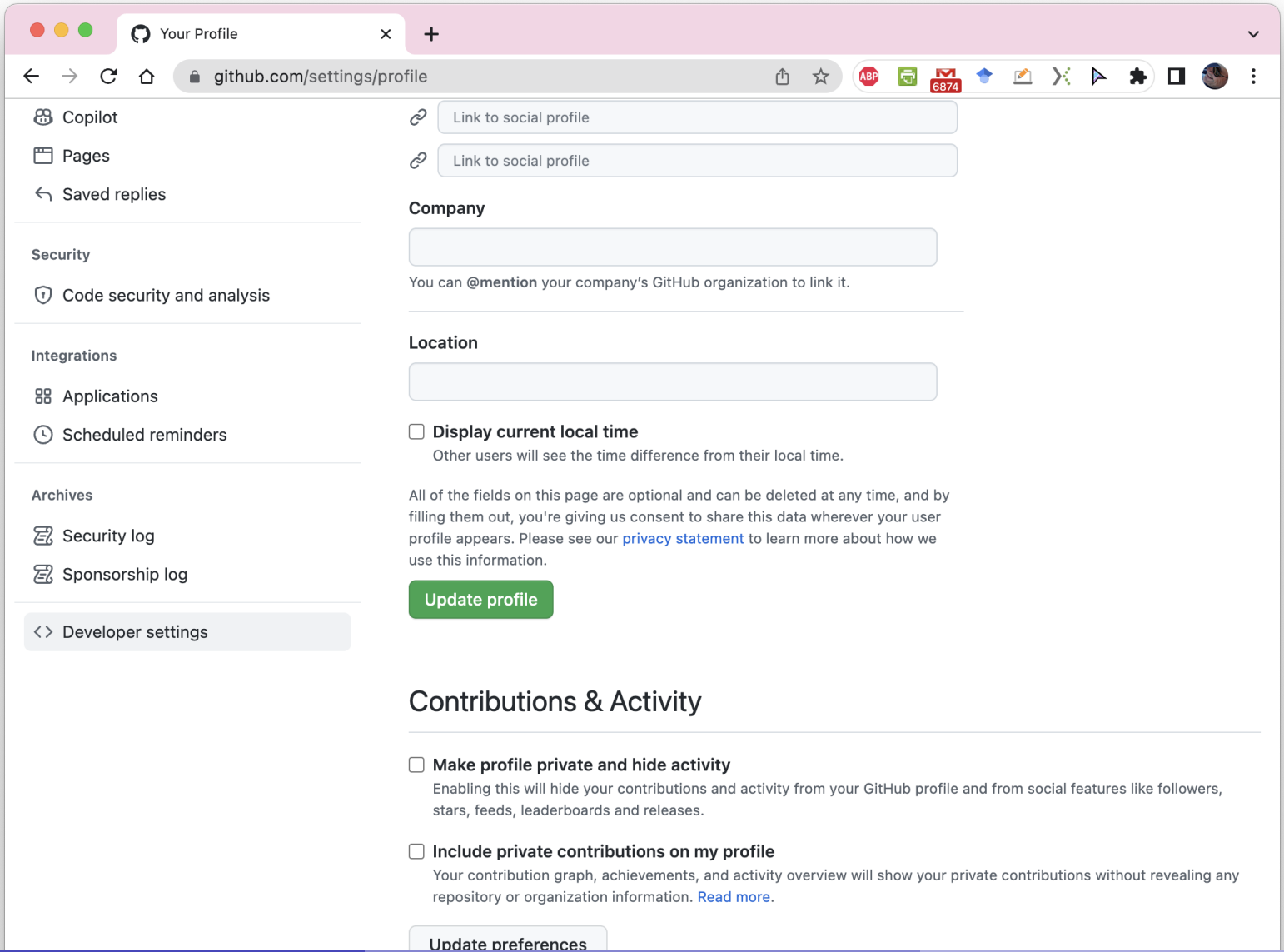
In order to access github for remotely fetching and pushing from your computer, you must create a personal access token for security reasons (no username-password use is possible).

Steps: Access the general Settings of your account



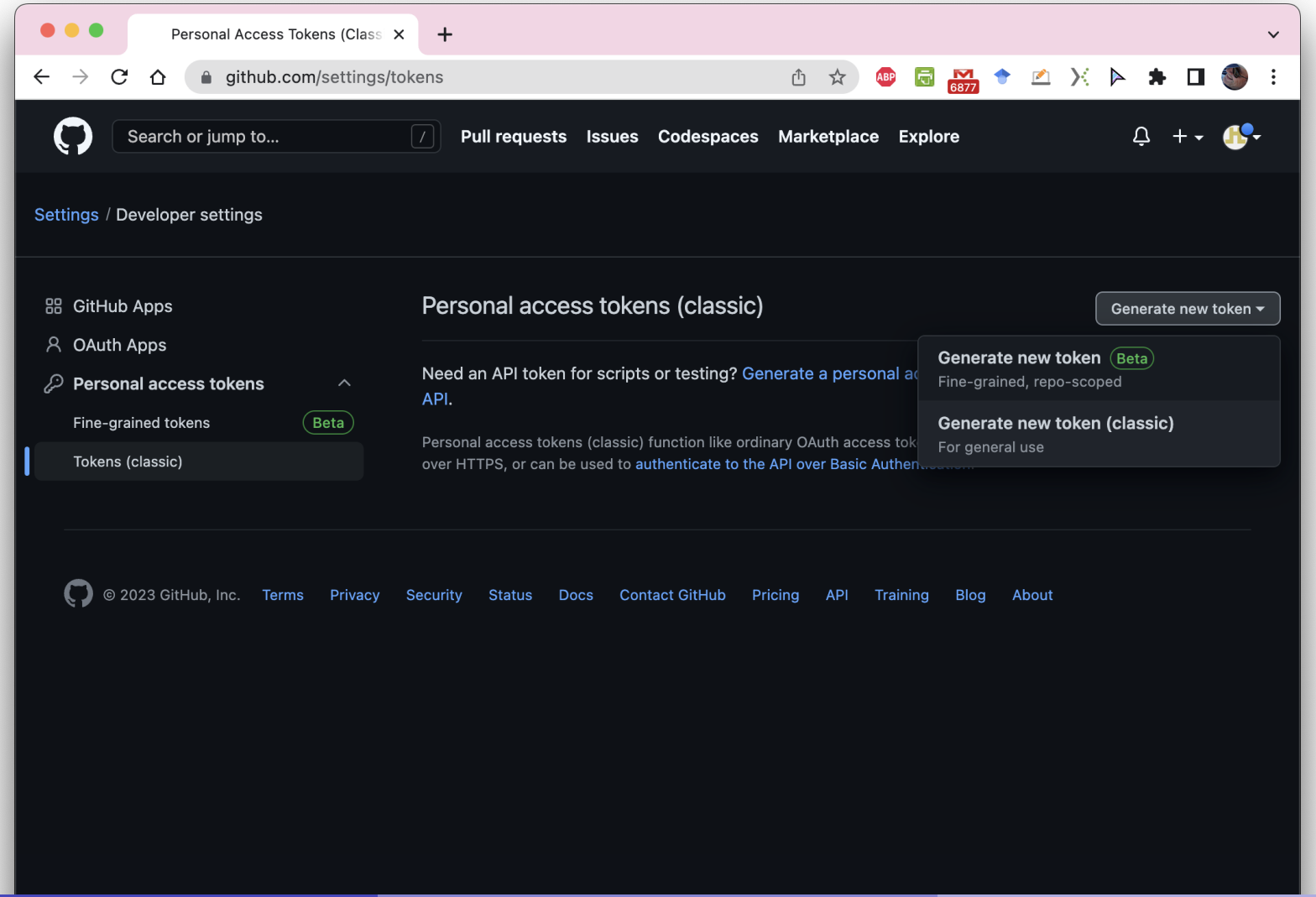
Accessing github

Go to Developer settings (at the bottom of Settings)



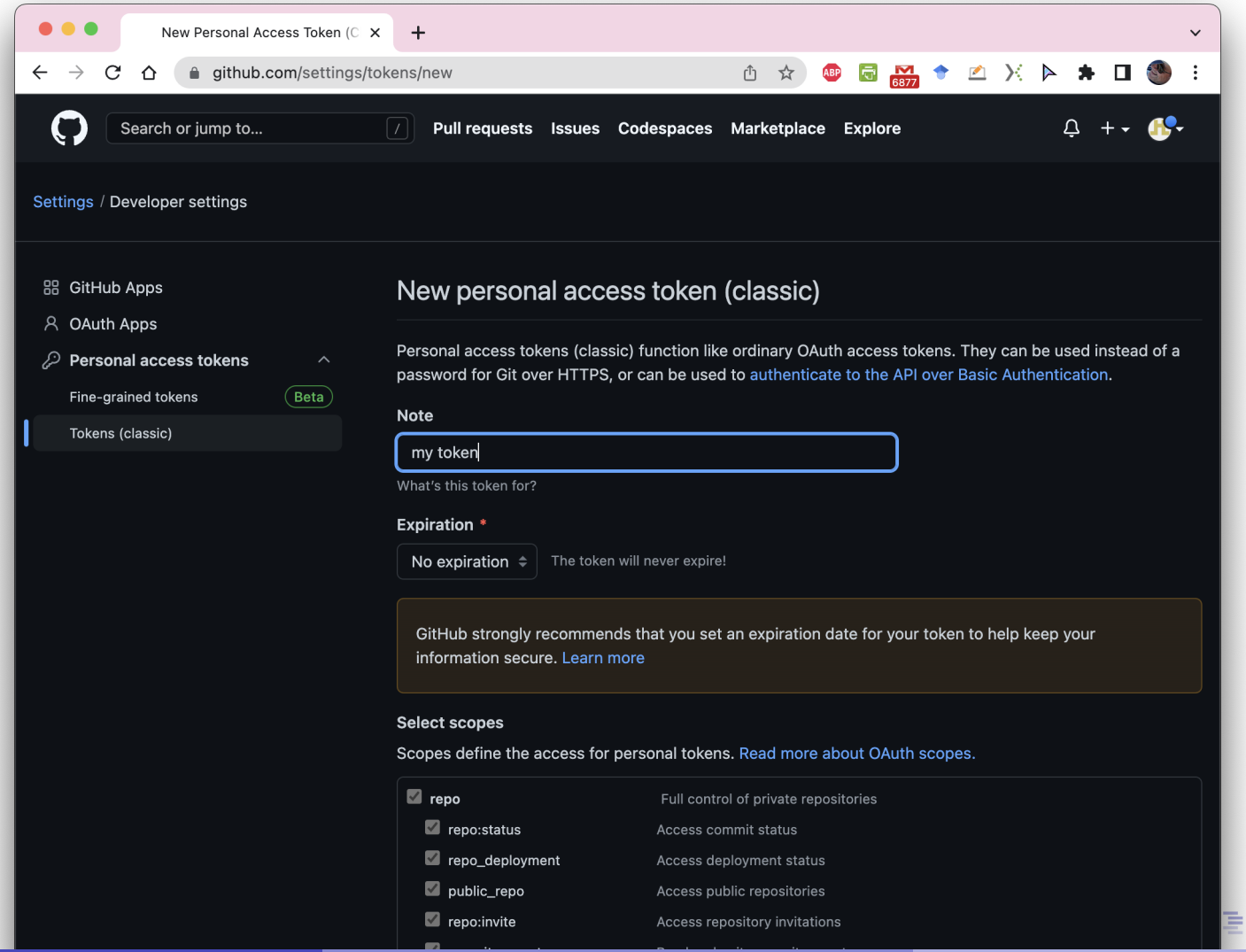
Accessing github

Select Personal access tokens, Tokens (classic) and Generate new token (classic)



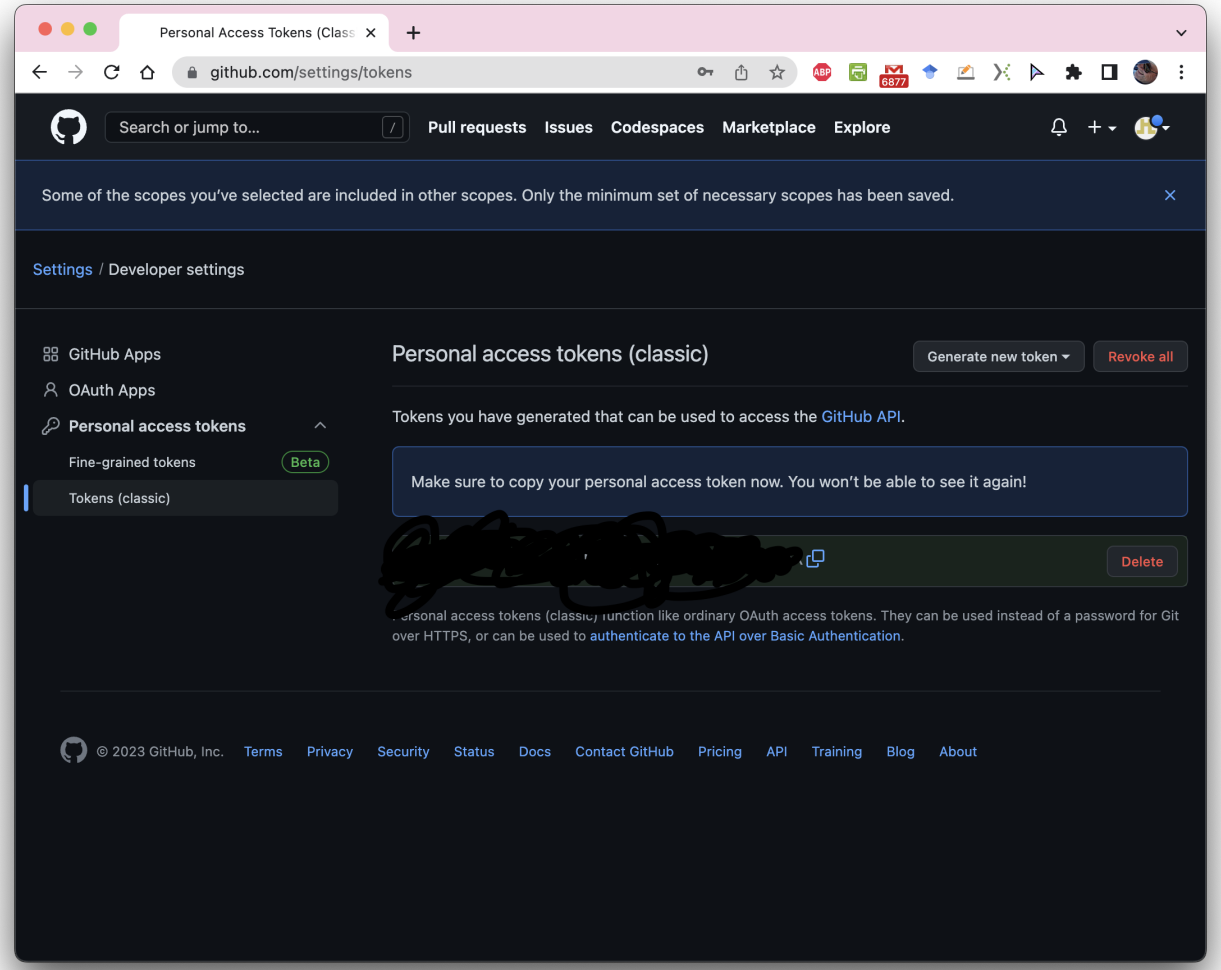
Accessing github

Choose a name for the token, select the expiration of the token, mark the appropriate access options (all if you are not sure), and generate it.



Accessing github

In the next screen, copy the token (a long string of characters) somewhere, since you will need it. The token is used instead of the github password



Sending commits (push)

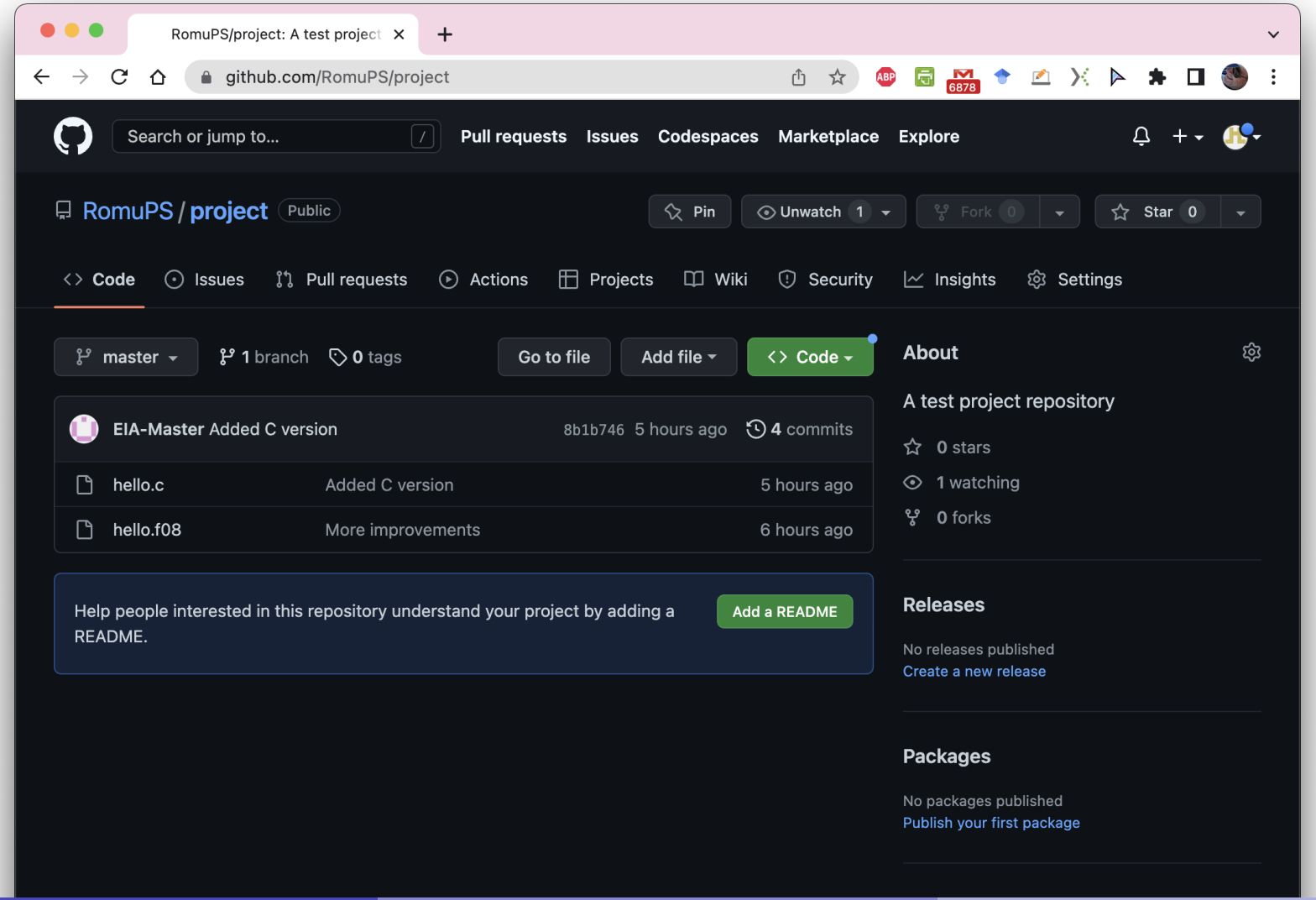
The git push command sends (pushes) commits from a branch of the local repository into the remote repository

```
# push commits
:project> git push origin master
Username for 'https://github.com': RomuPS
Password for 'https://RomuPS@github.com':   # Use your token!!
Enumerating objects: 12, done.
Counting objects: 100% (12/12), done.
Delta compression using up to 8 threads
Compressing objects: 100% (9/9), done.
Writing objects: 100% (12/12), 1.22 KiB | 1.22 MiB/s, done.
Total 12 (delta 0), reused 0 (delta 0), pack-reused 0
To https://github.com/RomuPS/project.git
 * [new branch]      master -> master
```

- Push "master" into "origin"
- Requires GitHub username and token

Sending commits (push)

Now out GitHub project is populated with the files from the local repository



Sending commits (push)

Now we can make more commits in the local repository and push them on the remote using the same steps

```
# Add a new file
:project> vim hello.py
:project> cat hello.py
print("Hello World!")
:project> git add hello.py
# commit the changes
:project> git commit -m "Added python version"
[master 19a5b0e] Added python version
 1 file changed, 2 insertions(+)
 create mode 100644 hello.py
# push the changes
:project> git push origin master  # no password/token needed
Enumerating objects: 4, done.
Counting objects: 100% (4/4), done.
Delta compression using up to 8 threads
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 327 bytes | 327.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
To https://github.com/RomuPS/project.git
   8b1b746..19a5b0e  master -> master
```

The changes have been pushed to the remote GitHub (check!)

Pushing branches

```
:project> git branch experiment
:project> git branch
  experiment
* master
:project> git checkout experiment
Switched to branch 'experiment'
:project> vim hello.jl
:project> git add hello.jl
:project> git commit -m "Added Julia version"
:project> git push origin master
Everything up-to-date
# oops! We must push the branch explicitly
:project> git push origin experiment
Enumerating objects: 4, done.
Counting objects: 100% (4/4), done.
Delta compression using up to 8 threads
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 354 bytes | 354.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
remote:
remote: Create a pull request for 'experiment' on GitHub by visiting:
remote:      https://github.com/RomuPS/project/pull/new/experiment
remote:
To https://github.com/RomuPS/project.git
 * [new branch]      experiment -> experiment
```

We can check in the GitHub page that now two branches appear, "master" and "experiment"

Cloning a Github repository

Github allows to *clone* an entire repository of another person into our local machine (that is, if the repository is public)

We will have the complete repository, with all its contents, at our disposition, to edit and play with it

Example: Let us clone a nice repository of emacs configurations for people trying to escape from vim: **Emacs for the stubborn martian vimmer** `https://github.com/hlissner/doom-emacs`,

```
:> git clone https://github.com/hlissner/doom-emacs ./.emacs.d
Cloning into './.emacs.d'...
remote: Enumerating objects: 118647, done.
remote: Counting objects: 100% (20/20), done.
remote: Compressing objects: 100% (17/17), done.
remote: Total 118647 (delta 4), reused 6 (delta 3), pack-reused 118627
Receiving objects: 100% (118647/118647), 29.34 MiB | 21.90 MiB/s, done.
Resolving deltas: 100% (82909/82909), done.
```

The contents is in our emacs configuration folder `.emacs.d`

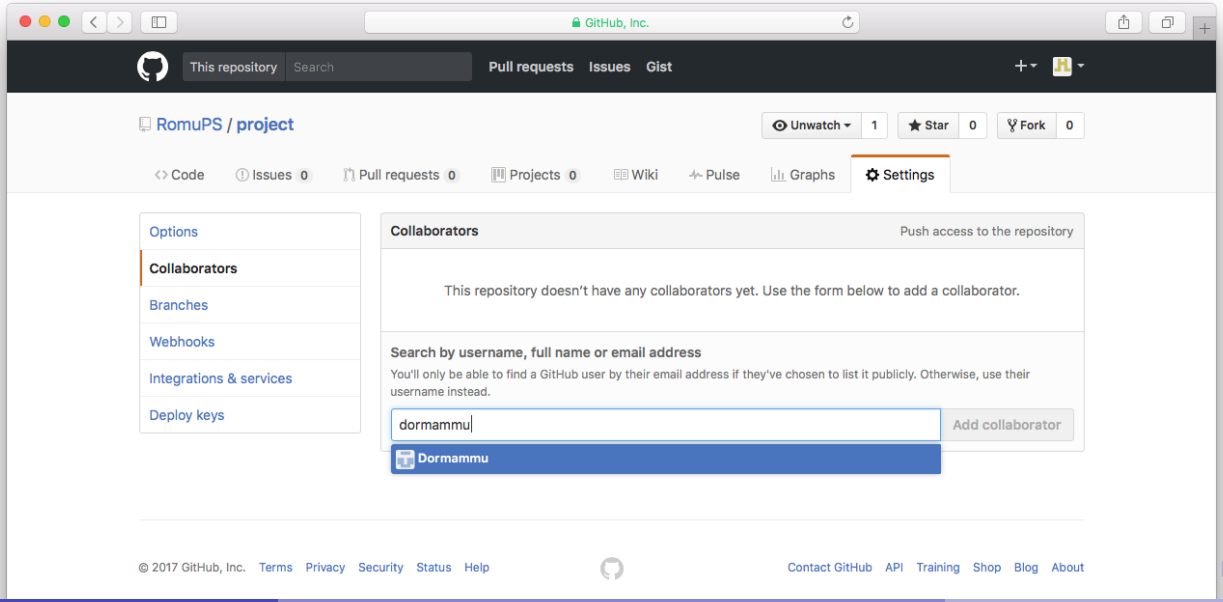
We can now start messing and playing with it.

But... we don't have permissions to push anything into the github repository

Collaborating with GitHub

GitHub allows the collaboration of different users on the same repository
There are two possibilities for collaboration:

- In the tab Settings, define a collaborator, by searching his/her username or email address. This gives the collaborator(s) full access to push data to the remote repository
- While this is simple, it can lead to problems
  - Two people trying to push the same file, with different versions
  - Can lead to conflicts, which are difficult to observe and fix, since everybody has the same privileges



Cloning and forking

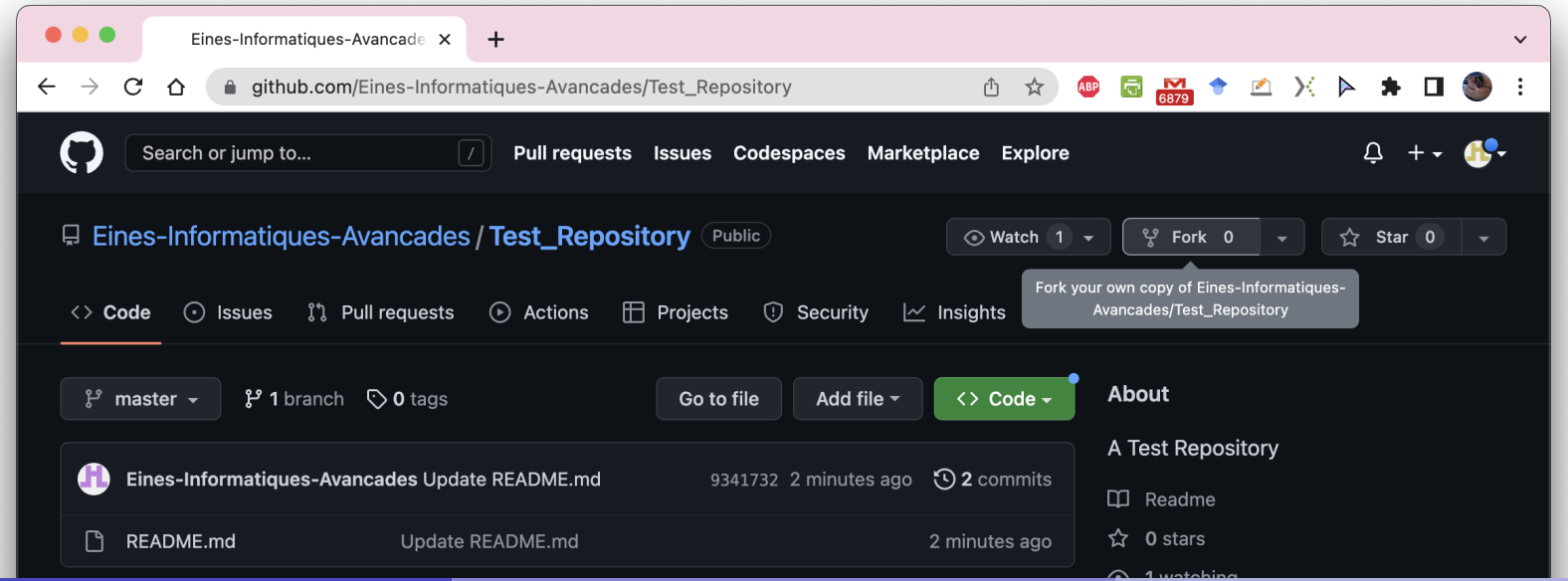
Another approach to collaborating on GitHub consists in **forking** an already existing project

To start the collaboration, some manager creates a main repository, where the main version of the code base will be maintained

Collaborators, on their GitHub page, locate the page of the manager, and the main repository.

On this page, collaborators click on the button `Fork`

This creates in your own GitHub account a full copy of the main repository



Cloning a remote repository

To have access to the forked repository we just created, we have to clone it, from our GitHub space, into our local machine (user your own github username!!)

```
:> git clone https://github.com/RomuPS/Test_Repository
Cloning into 'Test_Repository'...
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 6 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (6/6), done.
:> cd Test_Repository/
:Test_Repository> ls -l
total 8
-rw-r--r--@ 1 romu  staff  66 Feb 11 20:50 README.md
:Test_Repository> git remote -v
origin        https://github.com/RomuPS/Test_Repository (fetch)
origin        https://github.com/RomuPS/Test_Repository (push)
```

The cloning operation directly links our local to our remote copy of the main repository, with the alias "origin"

In this way, we can start making changes and updating our own version of the main repository

Updating a cloned remote repository

But in the mean time, the main repository may have been changed.

To update the changes in the main repository into our local version, we have to link it to the main, for which we choose the alias "main"

```
:Test_Repository> git remote add main https://github.com/Eines-Informatiques-Avancades/Test_Repository
:Test_Repository> git remote -v
main        https://github.com/Eines-Informatiques-Avancades/Test_Repository (fetch)
main        https://github.com/Eines-Informatiques-Avancades/Test_Repository (push)
origin        https://github.com/RomuPS/Test_Repository (fetch)
origin        https://github.com/RomuPS/Test_Repository (push)
```

Now we can fetch changes in main

```
:Test_Repository> git fetch main
From https://github.com/Eines-Informatiques-Avancades/Test_Repository
 * [new branch]      master     -> main/master

:Test_Repository> git pull main master
From https://github.com/Eines-Informatiques-Avancades/Test_Repository
 * branch            master     -> FETCH_HEAD
Already up to date.
```

Working in a cloned remote repository

We now work on our cloned repository, adding a file

```
:Test_Repository> vim stuff.txt
:Test_Repository> cat stuff.txt
This is a file with really unimportant stuff

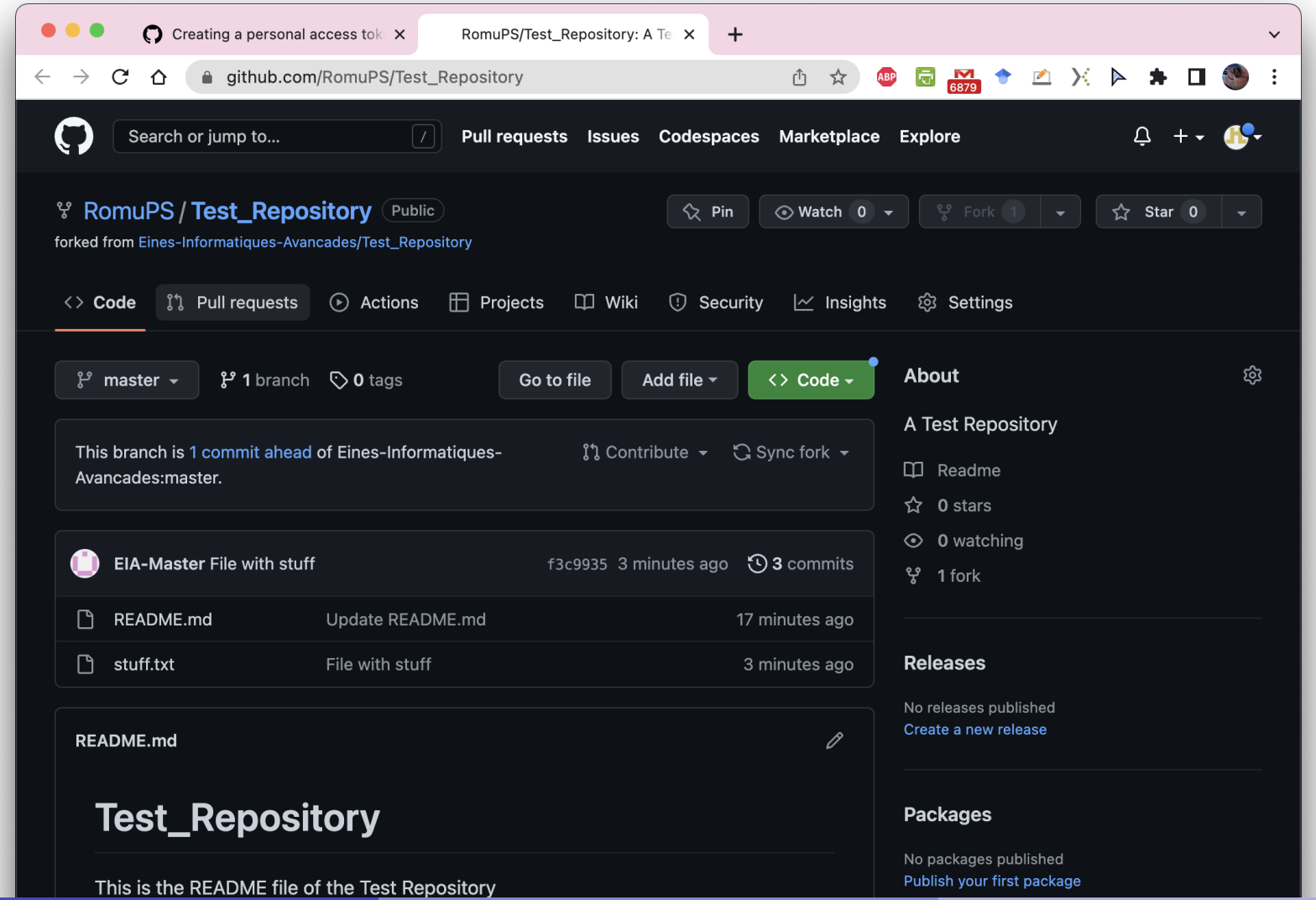
:Test_Repository> git add stuff.txt
:Test_Repository> git commit -m "File with stuff"
[master f3c9935] File with stuff
 1 file changed, 2 insertions(+)
 create mode 100644 stuff.txt
# push to our cloned remote "origin"
:Test_Repository> git push origin master
Enumerating objects: 4, done.
Counting objects: 100% (4/4), done.
Delta compression using up to 8 threads
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 328 bytes | 328.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
To https://github.com/RomuPS/Test_Repository
   9341732..f3c9935  master -> master
```

But since we do not have access to the main repository "main", we cannot directly push there our changes

```
:Test_Repository> git push main master
remote: Permission to Eines-Informatiques-Avancades/Test_Repository.git denied to RomuPS.
fatal: unable to access 'https://github.com/Eines-Informatiques-Avancades/Test_Repository/': The requested URL
```

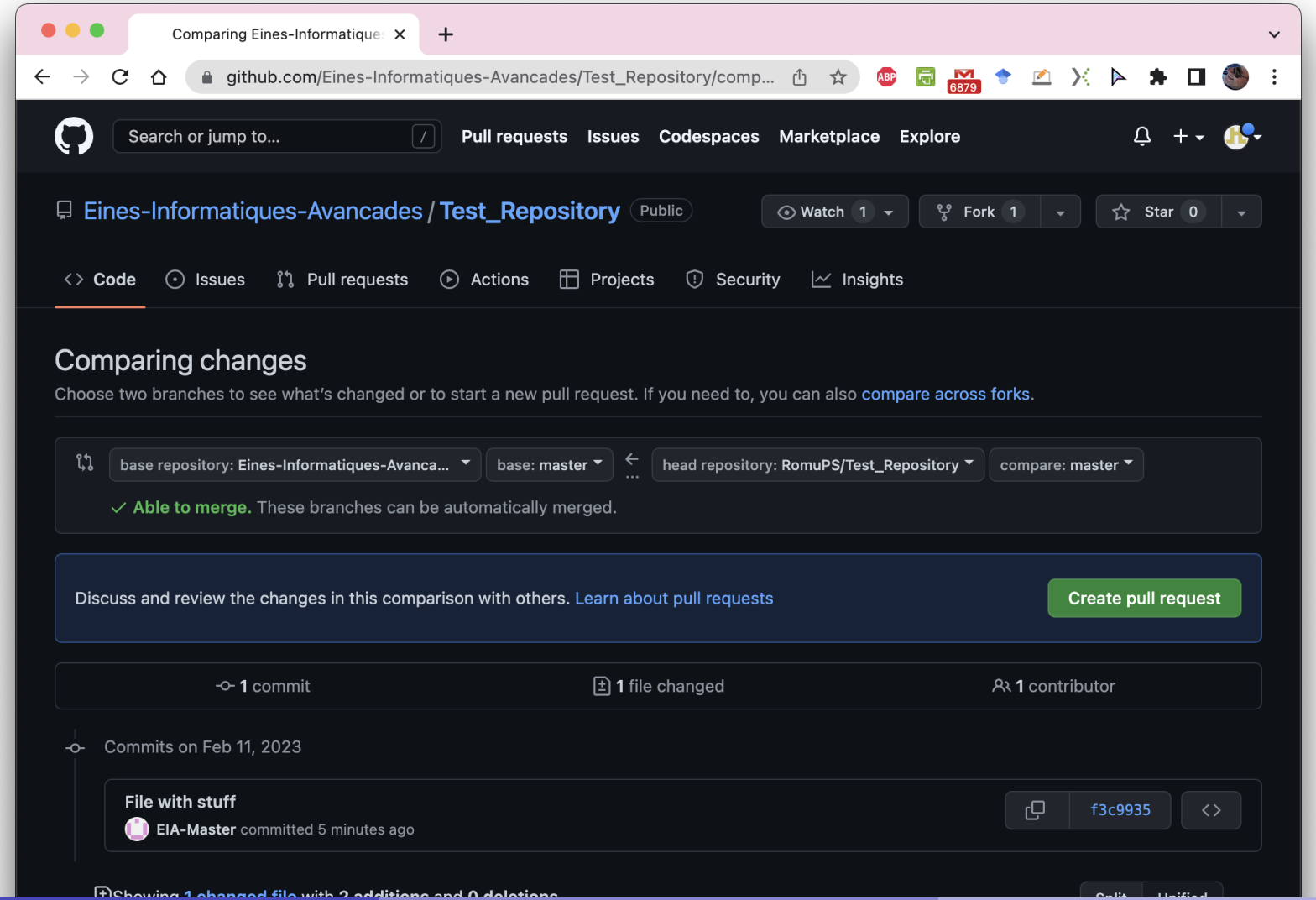
Pulling to the main remote repository

To pull changes to the main, we have to open a "New pull request" in our GitHub web page, in the Pull requests section



Pulling to the main remote repository

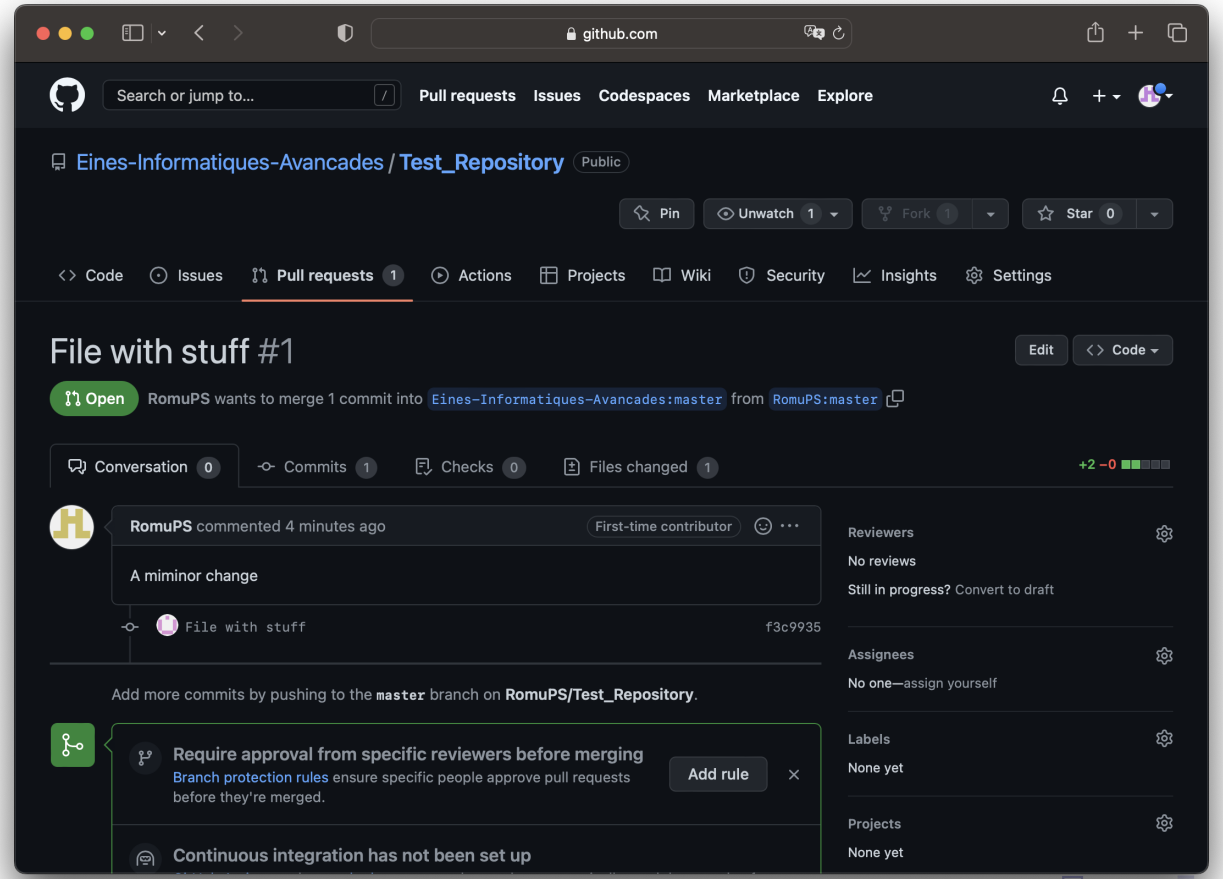
We have to choose the base fork (the main) and our fork, choose the branches we want to pull, add a comment, and submit



Pulling to the main remote repository

In the GitHub page of the owner of main, appears a pull request, in the corresponding tab. The owner of main can check it, see if there are no conflicts, and accept (merge) it.

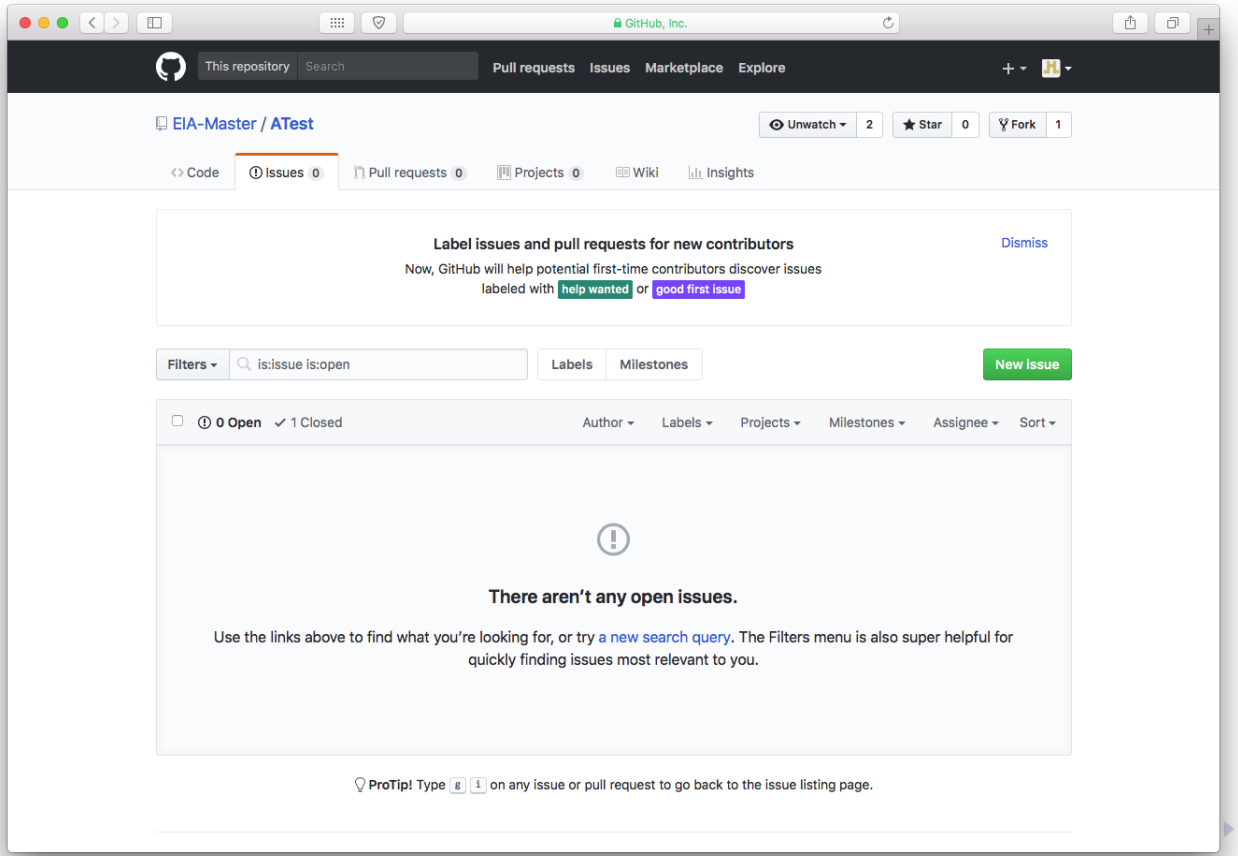
Both remotes (origin and main) will be now synchronized



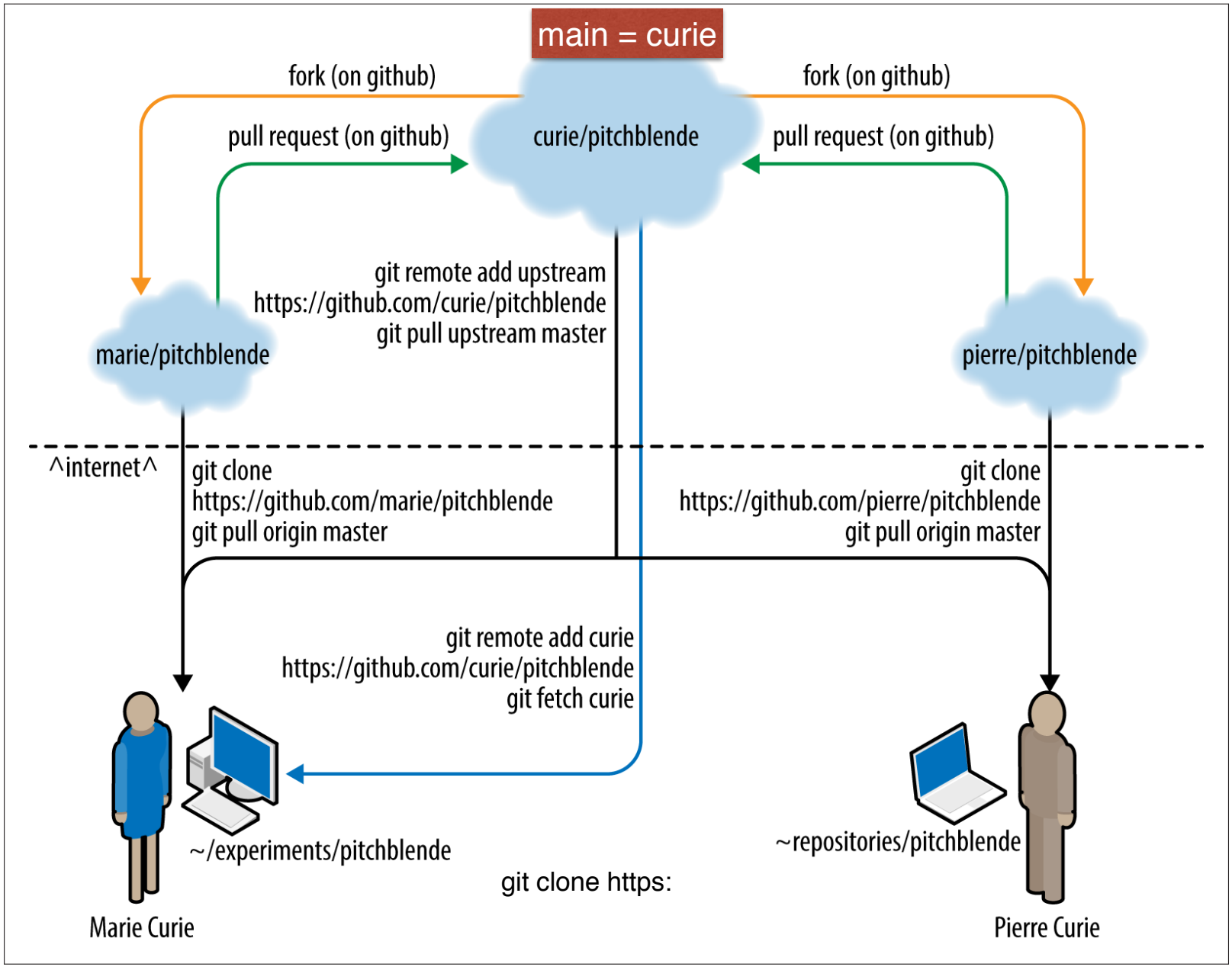
Managing collaboration

Apart from adding new pieces of code, GitHub allows discussion on problems (issues) in the codebase. To start a discussion, we have to open a new issue in the Issues tab of the main repository.

The discussion can be continued by the members of the collaboration, and closed when the problem raised has been solved.



Forking and cloning sum up



Final Remark: README best practices

Objective of the README is to provide information about:

- What is the purpose of the project?
- What are the prerequisites?
- How to install it?
- How to run it?
- Contributors

Best practices:

- Make it to the point
- Make it clear
- Provide examples of installation and running

You can find examples of good README files in the course repository

https://github.com/Eines-Informatiques-Avancades/awesome-readme

Final Remark: README best practices

You can write the README using the markdown markup language to organize the structure of the document in sections, add enumerations, figures, references, equations, emphasize, insert snippets of code, etc

Quadratic formula

```
## Quadratic formula

In [elementary algebra][r1], the
**quadratic formula** is the solution of
the [quadratic equation][r2]. With the
above parameterization, the quadratic
formula is:

$$ x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}
$$

_Math is hard, let's write some code:_

```swift
lazy var propertyName: NSDateFormatter =
{
    let formatter = NSDateFormatter()
    formatter.dateStyle = .long
    return formatter
}()
```

Inspirational Quote
```

Quadratic formula

In elementary algebra, the **quadratic formula** is the solution of the quadratic equation. With the above parameterization, the quadratic formula is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Math is hard, let's write some code:

```swift
lazy var propertyName: NSDateFormatter =
{
    let formatter = NSDateFormatter()
    formatter.dateStyle = .long
    return formatter
}()
```

Inspirational Quote

> Those who dare to fail miserably can achieve

Collaboration exercise

We are going to develop a fake project in which I will play the role of boss.

- Go to the course GitHub page (Eines-Informatiques-Avancades user) and fork and clone the repository `Test_Repository`
- Link your own copy to repository folder as main
- Open a branch of the project in your own local folder, add some source code for something simple and merge it into your master
- Make a pull request
- Let us see what happens ...