R4DS - Unit 3: Git & Github or: How I Learned to Stop Worrying and Love Version Control

Andrea Gilardi
March 27, 2023

Outline and main concepts

- The objective of this unit is to introduce a Version Control System (VCS) named Git and its basic functionalities.
- After installing the software, we will explore a simple but powerful workflow considering a local repository. Then, we will connect our PC to a remote repository on Github.
- Finally, I will show you how to replicate (most of) the same steps using the Rstudio IDE.

About Version Control

- Version Control is a system that records changes of a set of files over time so that you can recall specific versions later.
- For example, if you are developing an algorithm for a new statistical procedure, Version Control Systems (VCS) allow you to revert files back to a previous state in case of bugs.
- You can also compare files over times, see which changes introduced the bug and revert back to a working state.
- **If you screw up, you can "easily" recover!**.

What is Git?

- Git[1] is a Distributed VCS, which means that you always have the entire history of the project at your disposal.
- It is a particularly efficient tool for large projects and it has a branching system that allows for non-linear development.
- At the beginning, we will work with the Git Shell. Then, I will show you how to integrate Git and Rstudio.

[1] Why is it named like that? See the last paragraph here!

Install git

First, you need to check if you've already installed git! Run the following from your shell: `git --version`.

If you see `git command not found`, keep reading!

Windows: Download installer from here. A few notes:

- You should install git under `C:/Program Files`.
- When asked about `Adjusting your PATH environment`, make sure to select `Git from the command line and also from 3rd-party software`.

  Let's do it together!

macOS: The shell should prompt you to install it after running the previous command. See also here.

First time git setup

First, we can slightly customize the Git environment.

Setup identity: Run the following commands

- `git config --global user.name "Andrea Gilardi"`
- `git config --global user.email andrea.gilardi@unimib.it`

Please use the same email as the github account.

Setup editor: See here for instructions.

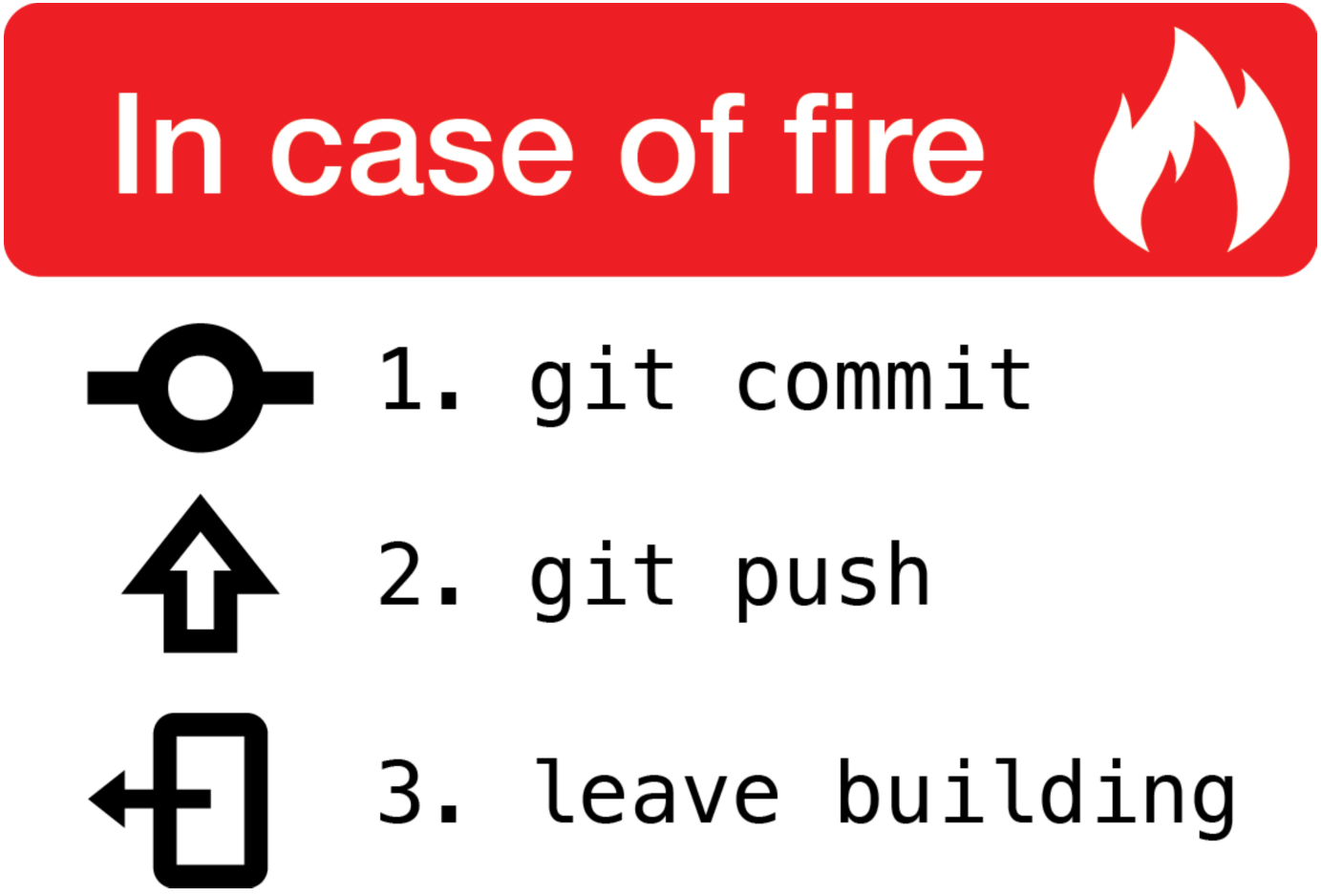
Default branch name: You can run

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

The default name for the initial branch is `master`.

Check settings: Run `git config --list`

Git Basics 😅...



Source. Don't worry, now we are going to review many many more details!

My first Git repo!

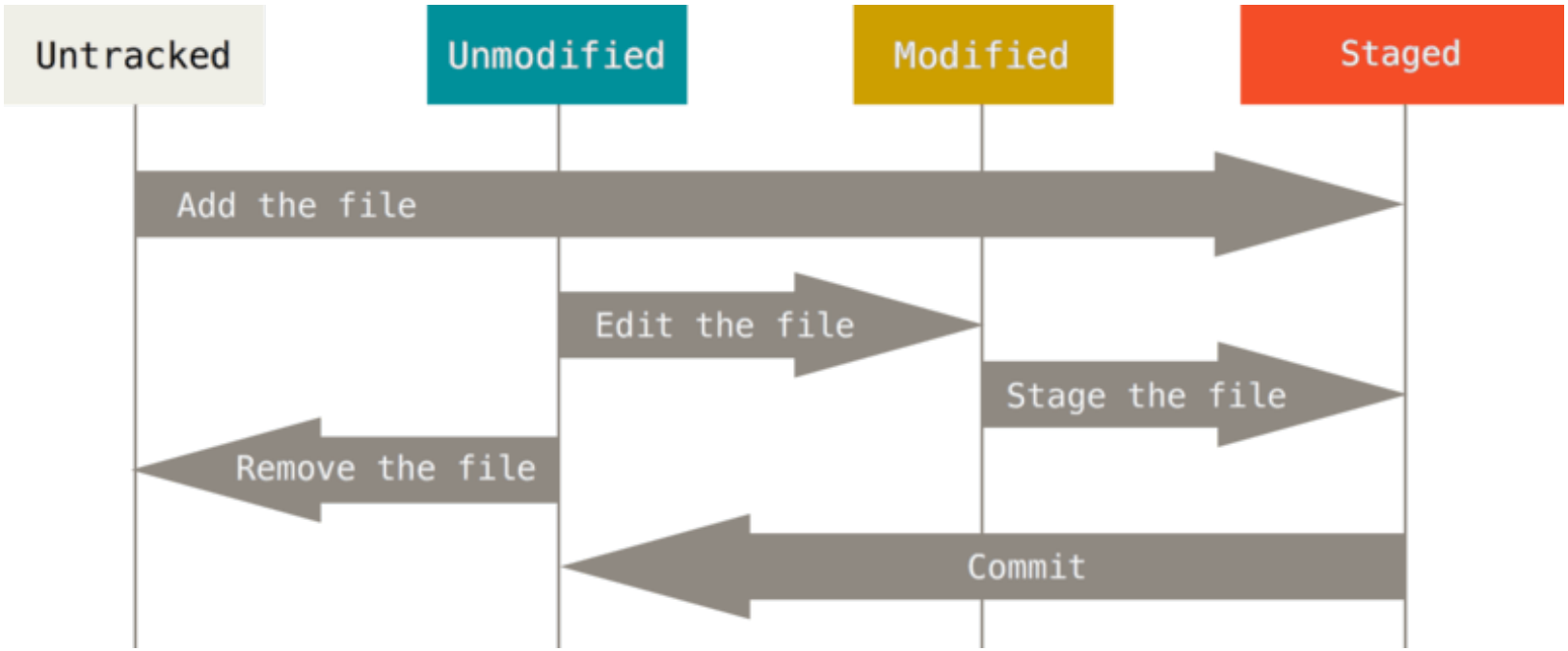
We can create a Git repository in two ways:

1. Take a local directory and initialise a Git structure.
   - Create an empty directory where you will store your files;
   - Open the shell inside the new repo and run `git init`.
2. Clone an existing repository stored online.
   - Open the shell into the parent repository;
   - Run `git clone <url>`. For example, run `git clone https://github.com/agila5/R4DS-PhD-Unimib.git`.

At the end of the class, we will see how to create a Git repo on Github and clone it on your local computer.

Git basics - A graphical abstract

The following figure nicely summarises the algorithm used by Git to record changes in a repository.



Source: https://git-scm.com/book/en/v2/Git-Basics-Recording-Changes-to-the-Repository

Git Status

- Let's create a local Git repo (e.g. `myFirstGitRepo`)!
- Open a (Git) shell inside the repo and run `git status`. You should see the following output:

```
On branch main

No commits yet

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

- Now we need to create a new file (say `README.md`) and add some content (e.g. `"Hello World :)"`).

Git Status (cont)

- Now you should see

```
On branch main

No commits yet

Untracked files:
(use "git add <file>..." to include in what will be committed)
      README.md

nothing added to commit but untracked files present (use "git
add" to track)
```

- Untracked basically means that Git sees a file you didn't have in the previous snapshot, and which hasn't yet been staged. Let's start tracking the file!

Tracking New Files

- We can run `git add README.md` to start tracking the new file. Then, if we run `git status` again we see

```
On branch main

No commits yet

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

- Now `README.md` file is staged[2] and we can commit[3] by running `git commit -m "Some text"`.

[2] Staged means "ready to go into the next commit snapshot".
[3] Committed means "saved in the local database".

Committing Your Changes

- You should see something like

```
$ git commit  -m "first commit - add README.md"
[main (root-commit) 3b94fbf] first commit - add README.md
1 file changed, 1 insertion(+)
create mode 100644 README.md
```

  We can see that the message describes some details about the commit (the branch, how many files were changed ...)

- If we check the status again...

```
$ git status
On branch main
nothing to commit, working tree clean
```

Let's do it again!

- Let's create a new file (say `CONTRIBUTING.md`) and add some text to it. Now, if we ran `git status`, we would see the same output as before (just with a different file name).
- Let's modify also `README.md` adding some text. Now we see

```
[truncated...]
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: README.md

Untracked files:
(use "git add <file>..." to include in what will be committed)
      CONTRIBUTING.md

[truncated...]
```

Let's do it again! (cont)

- The output says that the **tracked** file `README.md` has been modified in the directory but is not **staged** yet. We can stage both files running `git add .` and now we see

```
$ git status
On branch main
Changes to be committed:
(use "git restore --staged <file>..." to unstage)
      new file: CONTRIBUTING.md
      modified: README.md
```

- Now we could run `git commit -m "..."` as before. But what happens if we modified a staged file? Let's add even more text to `README.md`.

Let's do it again! (cont)

- We see the following

```
$ git status
On branch main
Changes to be committed:
(use "git restore --staged <file>..." to unstage)
      new file: CONTRIBUTING.md
      modified: README.md

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: README.md
```

- If you commit now, you will preserve the currently staged version of `README.md`. You can run `git add README.md` again in case you need to update the file version.

Let's do it again! (cont)

- The `git diff` command can be used to see what we changed but not yet staged:

```
$ git diff
diff --git a/README.md b/README.md
index dd577f0..3d6d21b 100644
--- a/README.md
+++ b/README.md
@@ -1,2 +1,3 @@
Hallo World :)
-Hallo World 2 :)
\ No newline at end of file
+Hallo World 2 :)
+Hallo World 3 :)
\ No newline at end of file
```

- And if we want to compare the currently staged file with the previous commit? Then, use `git diff --staged`.

Let's do it again! (cont)

- Now you should see

```
$ git diff --staged
diff --git a/CONTRIBUTING.md b/CONTRIBUTING.md
new file mode 100644
index 0000000..b3da348
--- /dev/null
+++ b/CONTRIBUTING.md
@@ -0,0 +1 @@
+You are welcome to contribute to my repo :)
\ No newline at end of file
diff --git a/README.md b/README.md
index bf231b1..dd577f0 100644
--- a/README.md
+++ b/README.md
@@ -1 +1,2 @@
-Hallo World :)
\ No newline at end of file
+Hallo World :)
+Hallo World 2 :)
\ No newline at end of file
```

Let's do it again! (cont)

- Now, after staging all files and committing, we should see

```
$ git status
On branch main
nothing to commit, working tree clean
```

- **NB:** If you add the `-a` flag to `git commit`, then Git automatically stage every file **that is already tracked** before doing the commit.

Ignoring files

- A `.gitignore` file can be used to tell Git not to track certain types of files (e.g. log files).
- Let's create an `example.log` file inside our repo. We see

```
$ git status
On branch main
Untracked files:
(use "git add <file>..." to include in what will be committed)
      example.log

nothing added to commit but untracked files present (use "git
add" to track)
```

Ignoring files (cont)

- If we create a `.gitignore` file that includes the path of the new file (i.e. `example.log`), then we see

```
$ git status
On branch main
Untracked files:
(use "git add <file>..." to include in what will be committed)
      .gitignore

nothing added to commit but untracked files present (use "git
add" to track)
```

- More details: https://git-scm.com/book/en/v2/Git-Basics-Recording-Changes-to-the-Repository

I f*ucked up 😭 `--amend`!

- The `--amend` option can be used to rectify a `git commit` message. For example, if we run

```
$ git add .
$ git commit -m "a typo here :("
```

  then we can adjust the text with

```
$ git commit --amend -m "the right text now!"
```

- Check the commit history with `git log`!
- The `--amend` option works analogously if we add more files to the staged area.

I f*cked up 😭 `git restore`!

- As we saw from the previous messages, `git restore --staged <file>` can be used to unstage a file. We can test it by modifying the `.gitignore file` explicitly forcing Git to ignore `.Rdata` files (see Unit 1!).
- Similarly, `git restore <file>` can be used to discard unstaged changes so that a file looks like when we last committed it! Let's remove the `.Rdata` string from `.gitignore`.

Other commands

As you can imagine, there are several more useful Git commands but we are not going to review all of them. A (not-comprehensive) list:

- `git rm`: remove a file from Git (see also previous messages);
- `git mv`: record a file movement;
- `git log`: explore the commits' history.

During the next units, we will explore `git blame` and `git bisect` (which are useful for debugging Git projects).

Github!

- **Github** is an hosting service that provides home for Git-based projects. Github allows other people to see your work! It is a also good idea to save your (solo) projects on Github (as a backup in case you screw up badly).
- The first thing to do is to create an account. Signup.
- See here if you need a few suggestions for choosing your github name. See also this Chapter (and the whole book) for a more complete description of Git/Github.
- Now we need to complete the most difficult step: synch (local) Git with (remote) Github...

Can you hear me now?

- When you interact with a remote Git server, you need to include your credentials into the request (otherwise everybody can add files to your repo, which is bad...).
- Git can adopt two different protocols: HTTPS and SSH. Here we focus on HTTPS. Check the references of this course if you want to explore the other protocol.
- An HTTPS protocol uses a Personal Access Token (PAT) to add private credentials into your request.

Can you hear me now? (cont)

- For us, the easiest way to generate a PAT is running the following R commands:

```
install.packages(c("usethis", "gitcreds"))
usethis::create_github_token()
```

- Then, store the PAT explicitly by running

```
gitcreds::gitcreds_set()
```

  to get a prompt where you can paste your PAT.

- See here for many more details and troubleshooting. Also remember to restart Rstudio after installing Git!

- Now we can finally create our first Github repo and clone it.

Git and Github

Let's recap the whole process:

1. Create a (possibly empty) repository on Github;
2. Clone the repository on your computer (i.e. `git clone`);
3. Add a `README.md` file or some other content;
4. Stage the new file and create a new commit;
5. Push the new commit on Github (i.e. `git push`);
6. Check the result and celebrate 

Git, Github and Rstudio

Now, let's delete the Git repo (after pushing the new commit) and repeat the same process from Rstudio.

1. Open Rstudio and Click on "Create a Project";
2. Select Version Control -> Git and copy the URL from Github. Then click on Create Project.

The output is a Git folder with the same file(s) as before. Now, it includes also an `.Rproj` (and extra) files. Finally

1. explore the new (automatically-defined) `.gitignore` file;
2. create a new `.R` file and commit with the Git control panel.

More details on remotes

- As you can imagine, there is nothing special with Github and we can use a similar process to connect a local Git repo with other hosting service (e.g. Gitlab) and other remotes.
- The command `git remote` can list the remotes:

```
$ git remote -v
origin  https://github.com/agila5/R4DS-PhD-Unimib.git (fetch)
origin  https://github.com/agila5/R4DS-PhD-Unimib.git (push)
```

- See https://git-scm.com/book/en/v2/Git-Basics-Working-with-Remotes for more details. We will also re-examine this topic when we talk about branches.

Homework!

1. Create an (empty) repository on Github named `GithubHomework`;
2. Clone it on your computer using the Rstudio IDE;
3. Create a `README.md` file that contains a minimal description of the repository. Push the new file on Github including an informative commit message and check the output locally and online. **NB:** Run `git status` frequently.
4. Add a new directory named `R` and, into the new directory, create two new files named `GithubHomework.log` and `script.R`, respectively.
5. Ignore the `.log` file and commit the `.R` file using the following message: `"BLABLABLA"`.

Homework! (cont)

6. Amend the previous commit message adopting a more informative one (your choice!).
7. Push the new changes to the remote (i.e. Github).
8. How can you modify the message for a commit that you've already pushed? **Google is your friend** 😄.
9. Check that you completed the previous task by exploring the history of the project both from Git (i.e. `git log`) and from Github (again, ask to Google!).