Introduction to version control with Git

Scientific workflows: Tools and Tips 

2023-06-15

What is this lecture series?

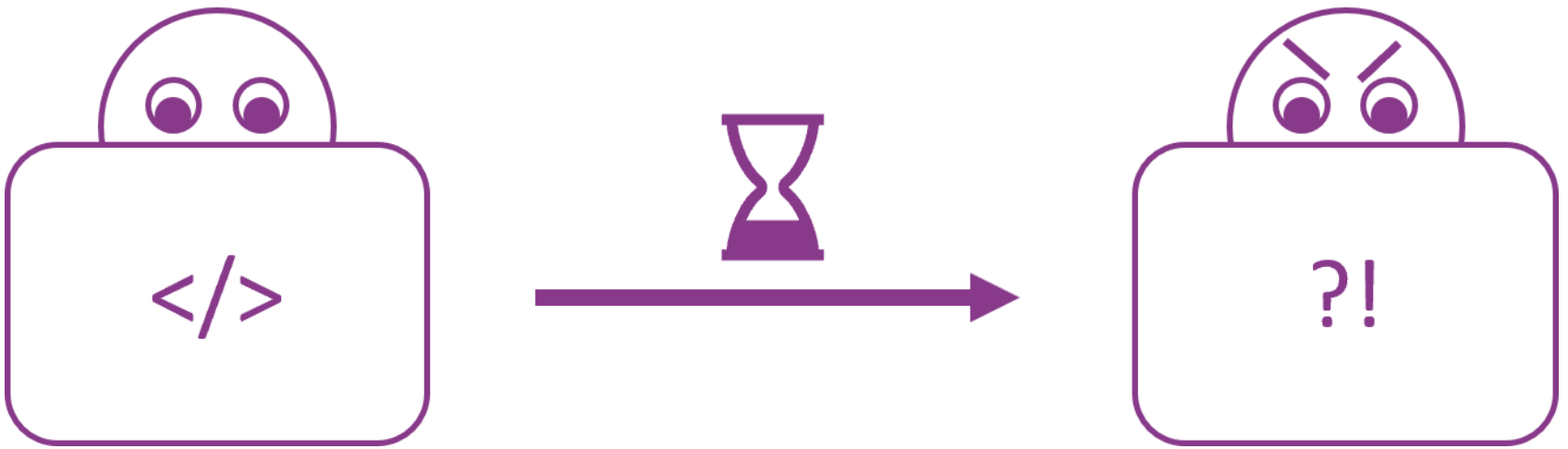
Scientific workflows: Tools and Tips 🛠️

🗓️ Every 3rd Thursday 🕐 4-5 p.m. 📍 Webex

- One topic from the world of scientific workflows
- For topic suggestions send me an email
- If you don't want to miss a lecture
  - Check out the lecture website
  - Subscribe to the mailing list
- Slides provided on Github

Motivation

Two examples in which proper version control can be a life/time saver



Requirements for good version control

- **Complete and long-term history** of every file in your project
- **Safe** (e.g. no accidental loss of versions)
- **Easy** to use
- **Overview and documentation** of all changes
- **Collaboration** should be possible

Version control with Git

- Open source and free to use version control software
- Quasi standard for software development
- A whole universe of other software and services around it

Today

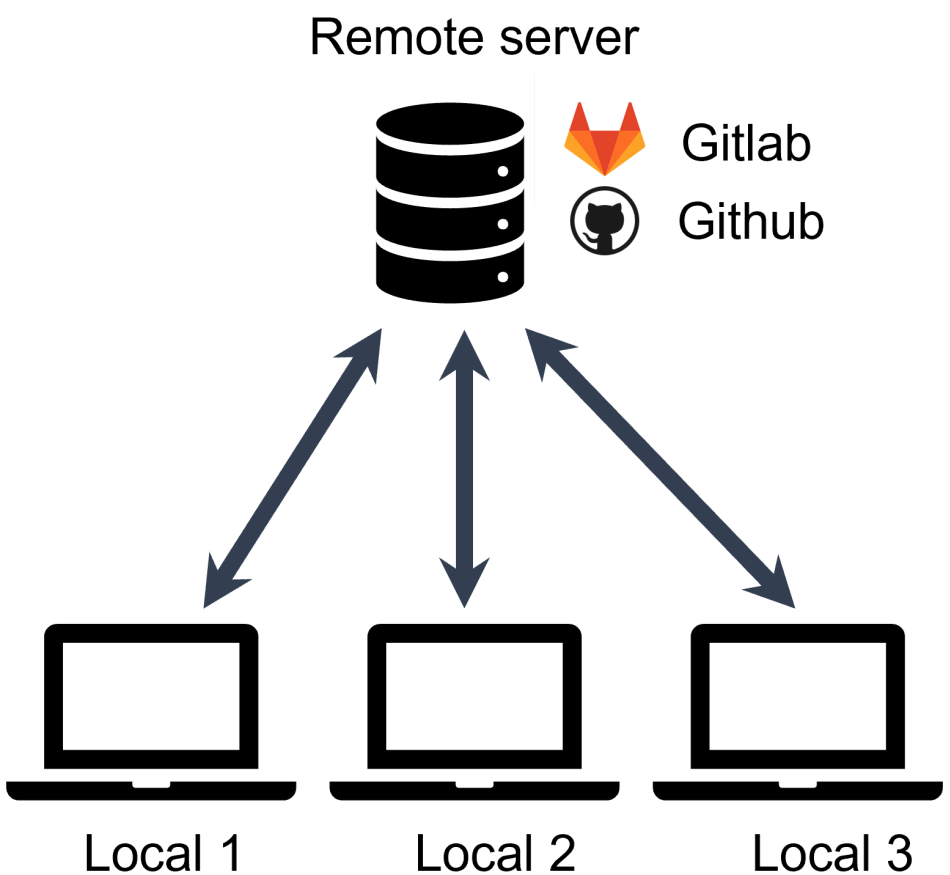
- Basic concepts of Git
- A simple workflow in theory and practice
- A small outlook on more advanced features

Version control with Git

- For projects with mainly text files (e.g. code, markdown files, …)
- Basic idea: Take snapshots of your project over time
  - Snapshots are called **commits** in Git
- A project that is version controlled with Git is called **Git repository** (or **Git repo**)

Version control with Git

Git is a **distributed version control system**



- Idea: many local repositories synced via one remote repo
- Every machine has full-fledged version of repository with entire history

How to use Git

After you installed it there are different ways to use the software for your projects

How to use Git - Terminal

Using Git from the terminal

```
Selina_User@DESKTOP-G0RM7MS MINGW64 ~/Files_Selina
$ cd Repos/02_workshops/first_git_project/

Selina_User@DESKTOP-G0RM7MS MINGW64 ~/Files_Selina/Repos/02_workshops/first_git_
project
$ git init
Initialized empty Git repository in C:/Users/Selina_User/Files_Selina/Repos/02_w
orkshops/first_git_project/.git/

Selina_User@DESKTOP-G0RM7MS MINGW64 ~/Files_Selina/Repos/02_workshops/first_git_
project (master)
$
```

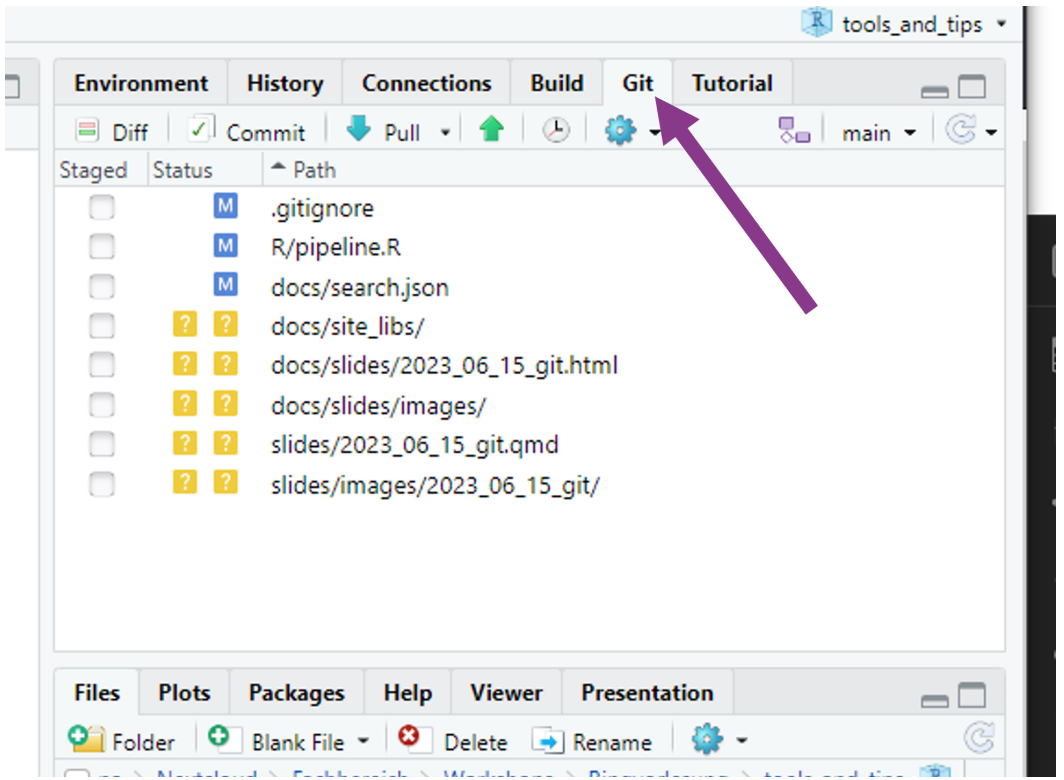
`r fontawesome::fa(name = "plus", fill = "green")` Gives you most control

`r fontawesome::fa(name = "plus", fill = "green")` You find a lot of help online

`r fontawesome::fa(name = "minus", fill = "red")` You need to use the terminal

How to use Git - GUIs

A Git GUI is integrated in most (all?) IDEs, e.g. R Studio



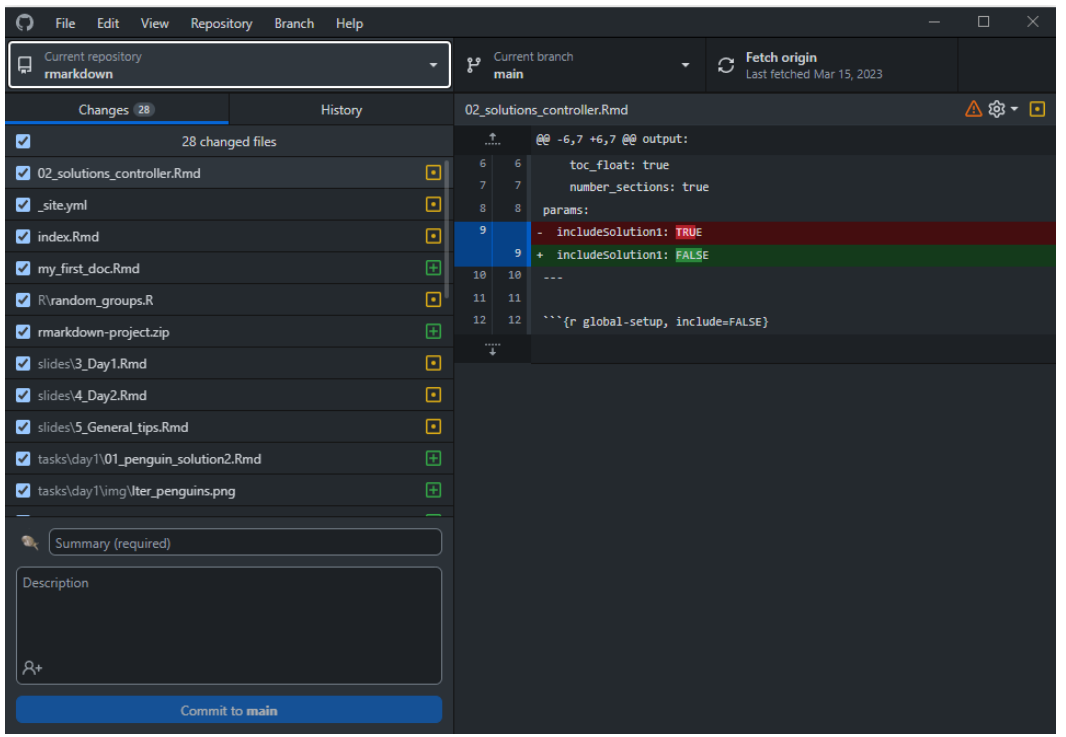
`r fontawesome::fa(name = "plus", fill = "green")` (Often) Easy and intuitive

`r fontawesome::fa(name = "plus", fill = "green")` Stay inside your IDE

`r fontawesome::fa(name = "minus", fill = "red")` Not universal

How to use Git - GUIs

Standalone Git GUI software, e.g. Github Desktop



`r fontawesome::fa(name = "plus", fill = "green")` Easy and intuitive

`r fontawesome::fa(name = "plus", fill = "green")` Helps with initial setup of Git

`r fontawesome::fa(name = "plus", fill = "green")` Nice integration with Github

`r fontawesome::fa(name = "minus", fill = "red")` Switch program to use Git

How to use Git

Which one to choose?

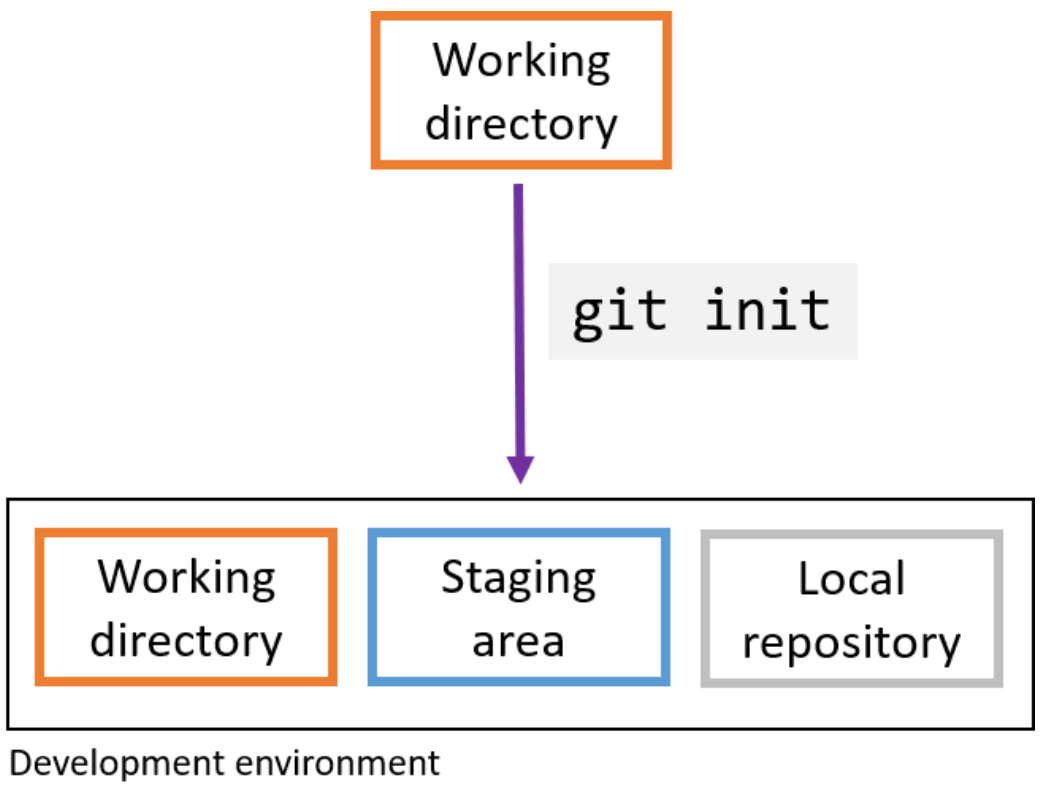
- Depends on your prior experience and taste
- If you never used the terminal before, I recommend to start with Github Desktop
  - But in the long run, it's definitely worth it looking into the terminal
- You can also mix methods and freely switch between them

The basic Git workflow

> `git init`, `git add`, `git commit`, `git push`

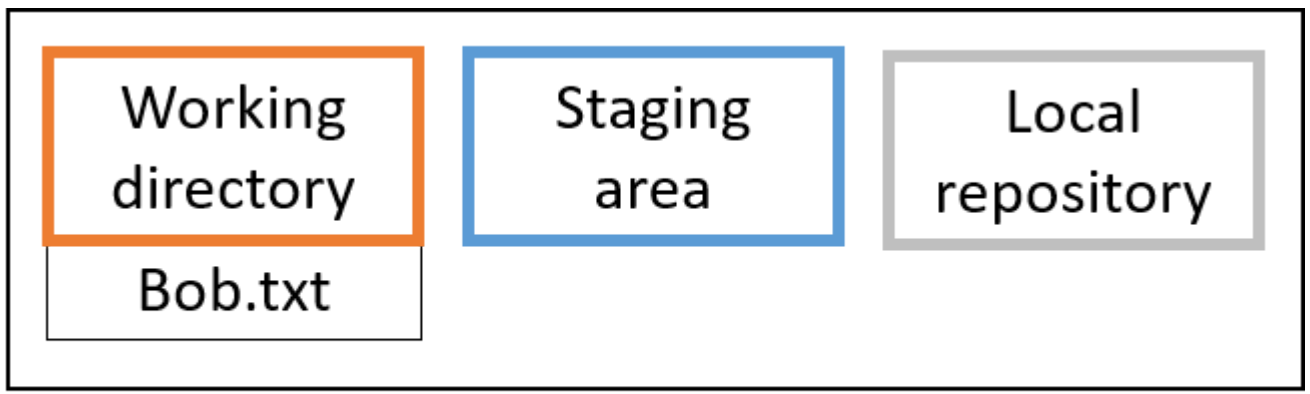
Step 1: Initialize a git repository

- Adds a (hidden) `.git` folder to your project that will contain the Git repository
- You don't have to touch anything that is in this folder



Step 2: Modify files and stage changes

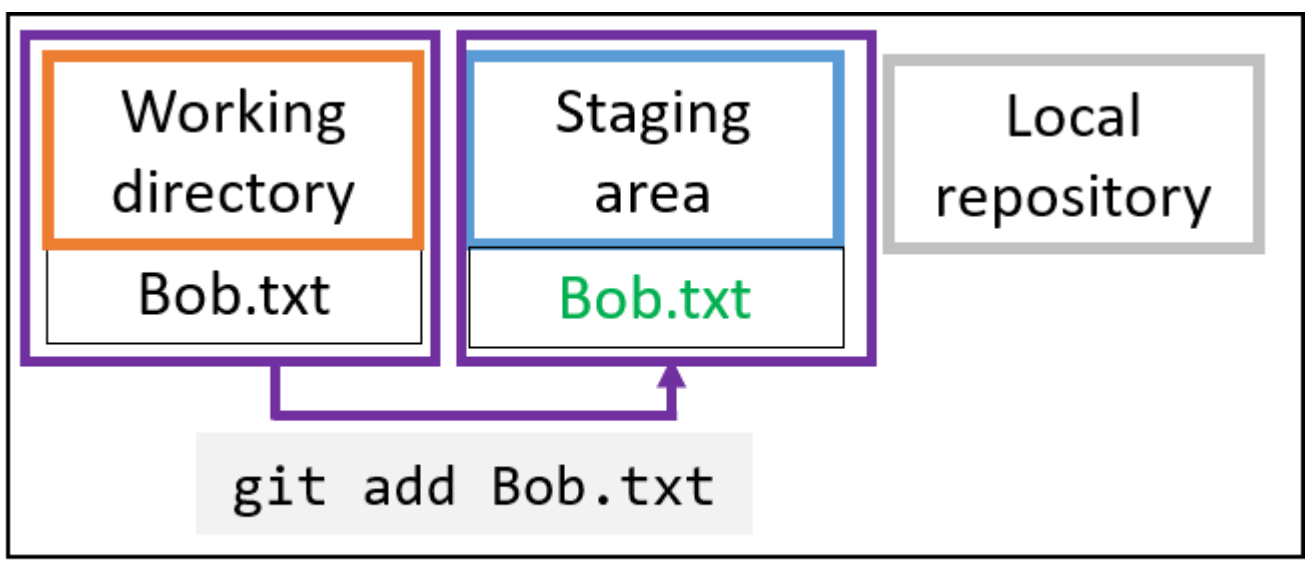
Git detects any changes in the working directory



Step 2: Modify files and stage changes

When you want a file to be part of the next commit (i.e. snapshot), you have to stage the file

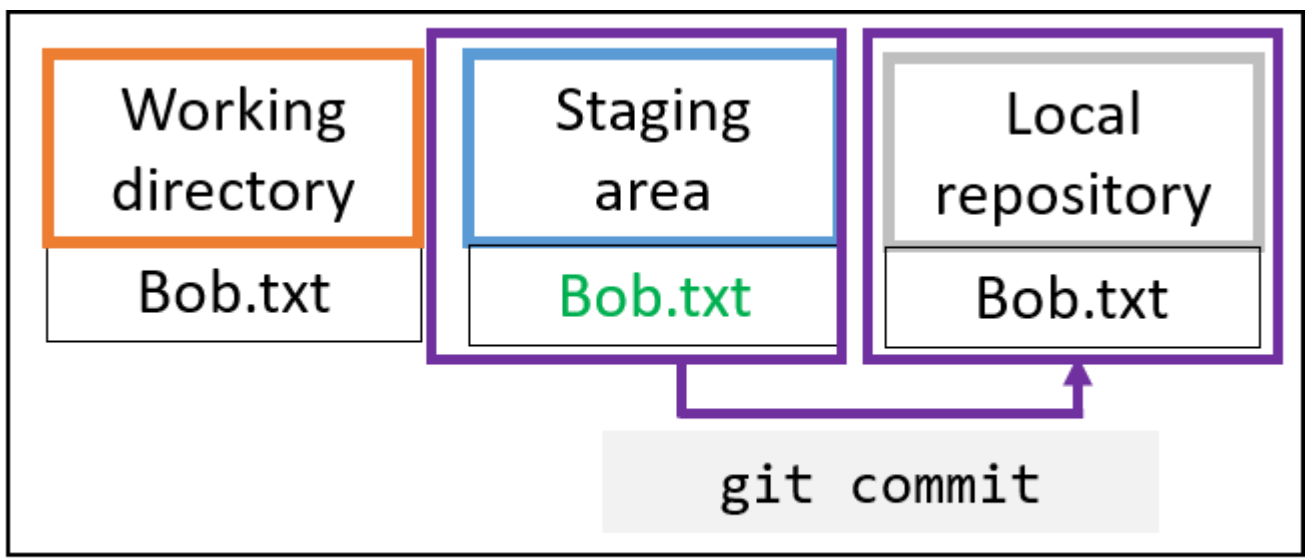
- In the terminal use `git add`
- Usually in Git GUIs this is just a check mark next to the file name



Development environment

Step 3: Commit changes

- Commits are the snapshots of your project states
- Commit work from staging area to local repository
  - Collect meaningful chunks of work in the staging area, then commit



Development environment

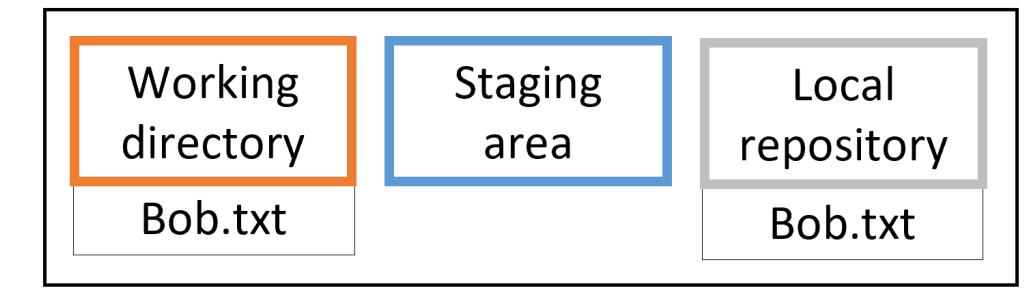
Step 3: Commit changes

- Every commit has a unique identifier (so-called hash)
  - You can use this hash to come back to the version
- Every commit has a commit message that describes what the changes are about

Read here for a nice and detailed explanation on good commit messages how to write them.

Step 4: Create and connect a remote repo

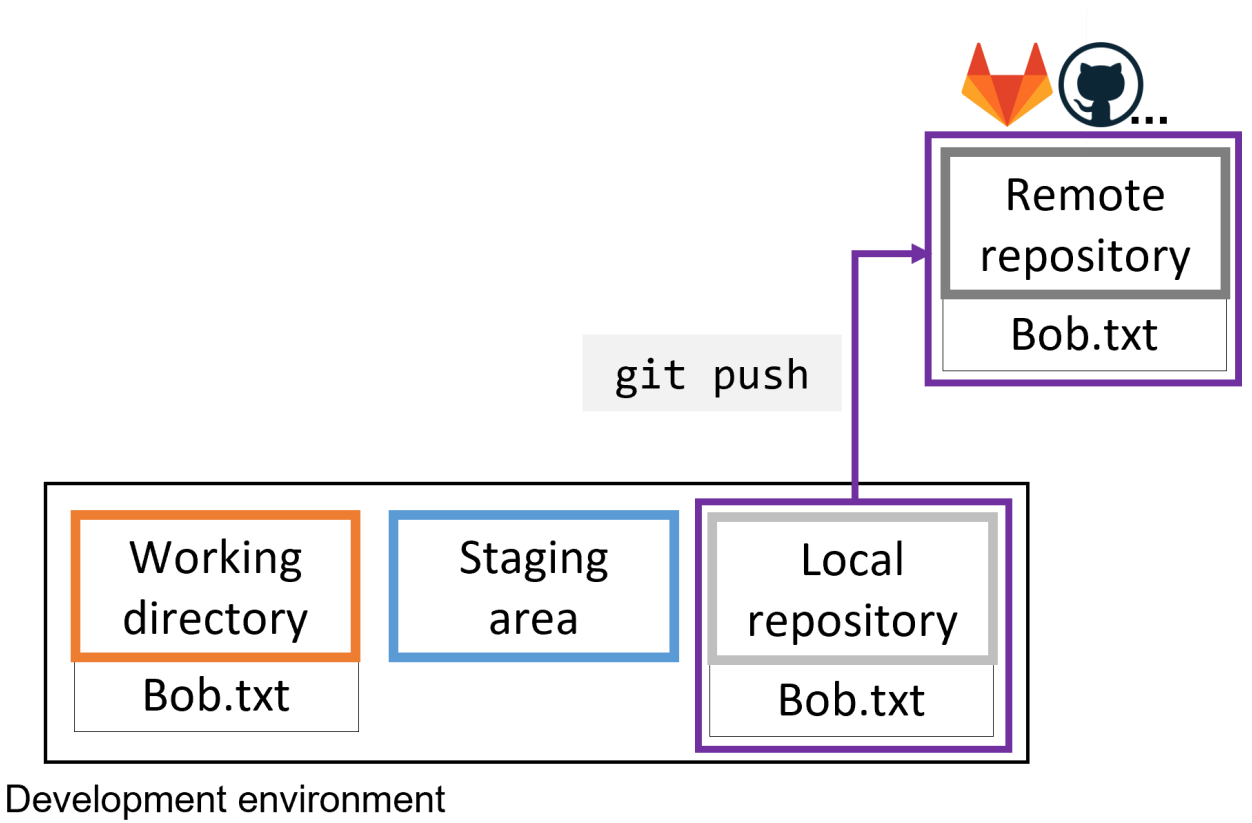
- Remote repositories are on a server and can be used to *synchronize*, *share* and *collaborate*
- Remote repositories can be private (only for you and selected collaborators) or public (visible to anyone online)


Working directory
Bob.txt
Staging area
Local repository
Bob.txt
Development environment


...
Remote repository

Step 5: Share your changes with the remote repo

- Push your local changes to the remote with `git push`

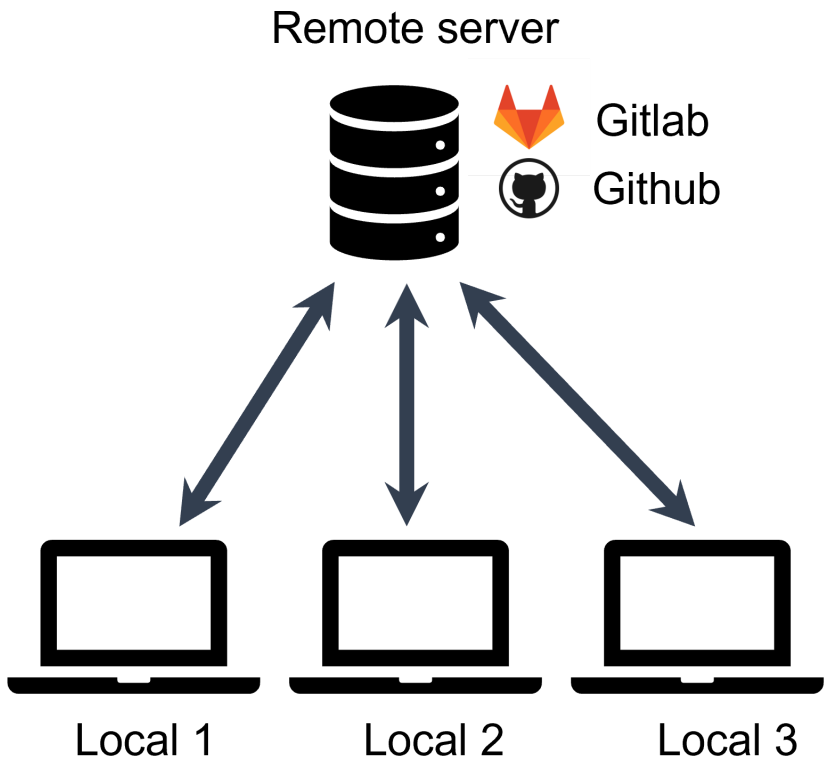


Summary of the basic steps

- `git init`: Initialize a git repository
  - adds a `.git` folder to your working directory
- `git add`: Add files to the staging area
  - This marks the files as being part of the next commit
- `git commit`: Take a snapshot of your current project version
  - Includes a timestamp, a meaningful commit message and information on the person who did the commit
- `git push`: Push your newest commits to the remote repository
  - Sync your local project version with the remote e.g. on Github

Synchronize, share and collaborate

Get a repo from a remote

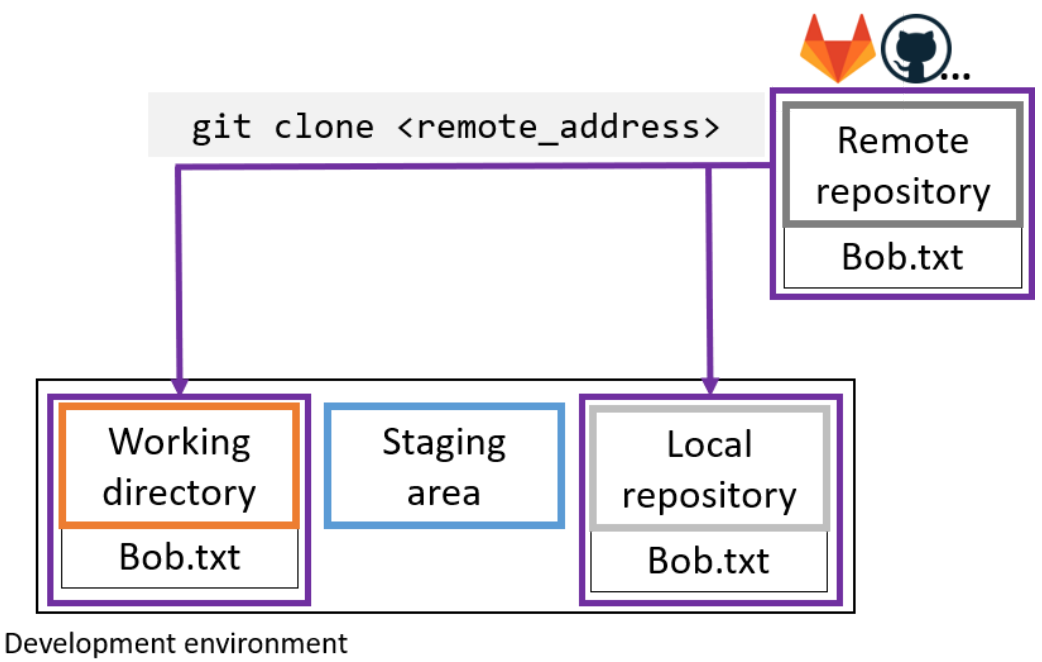


- In Git language, this is called **cloning**
- Get a copy of your own repository on a different machine
- Get the repository from somebody else

Get a repo from a remote

By cloning, you get a full copy of the repository and the working directory with all files on your machine.

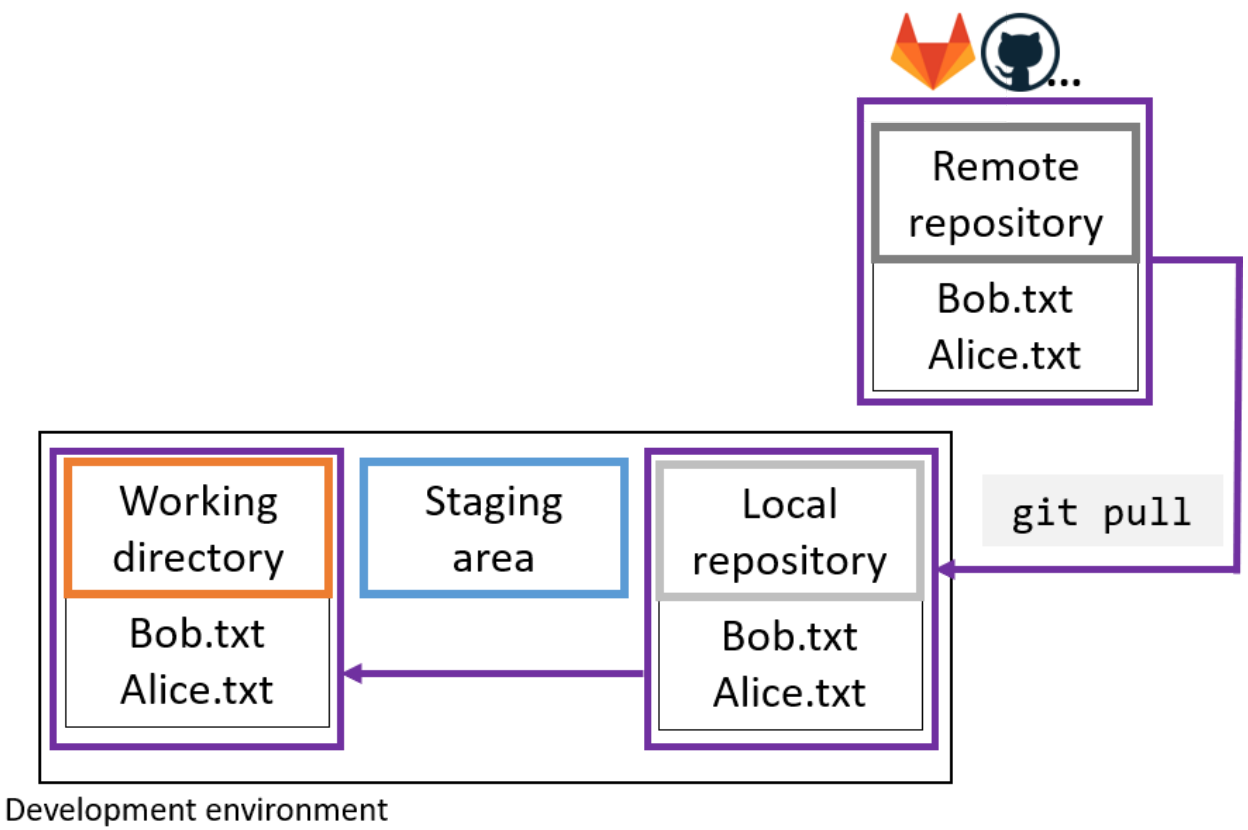
- Clone a remote repository with `git clone <remote_address>`



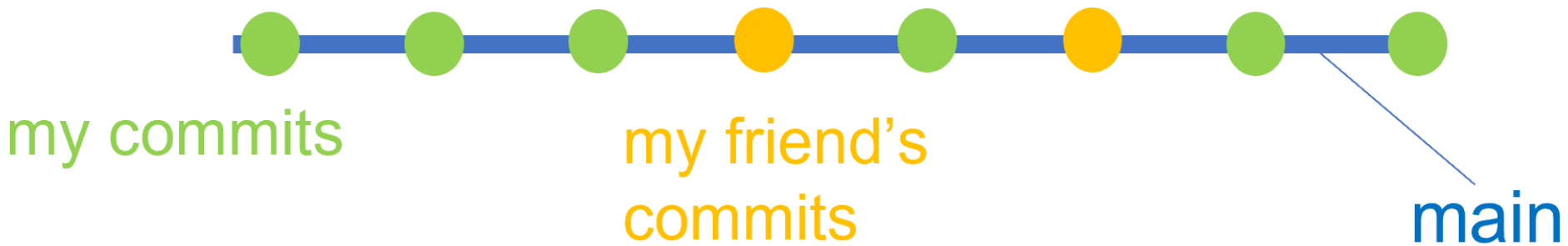
- If the clone is authorized it can also commit and push

Get changes from the remote

- Local changes, publish to remote: `git push`
- Remote changes, pull to local: `git pull`



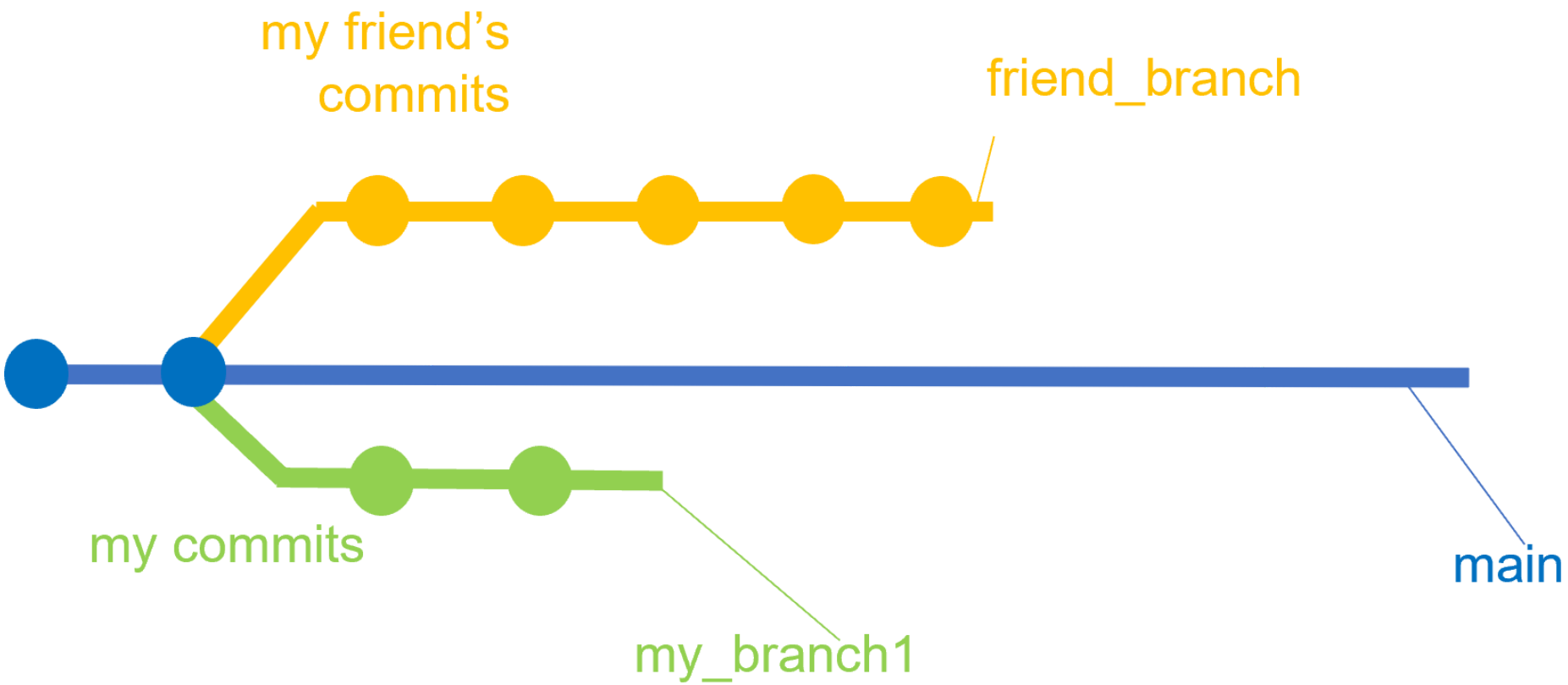
A simple collaboration workflow



- By default: Everything on one branch (main)
  - Branches are connections between specific commits
- Basic idea: **Pull** newest version before you start working, **push** new version after you are done

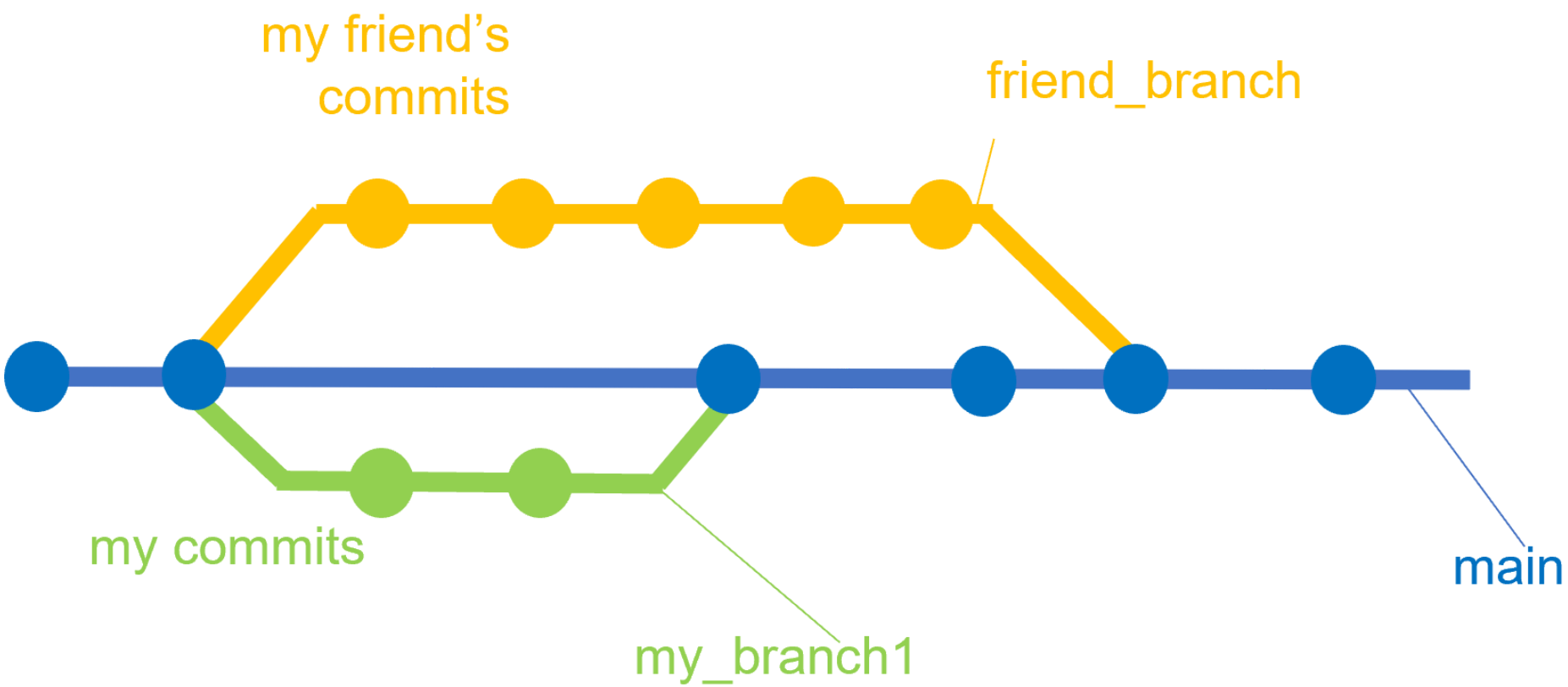
A more complex collaboration workflow

- You can also have multiple branches of the same project



A more complex collaboration workflow

- Branches can be merged using `git merge`



Remote repository platforms

The combination of Git and a remote repository platform unlocks a lot of possibilities!

- Advanced workflow features for collaboration and open-source development
  - Issues and pull requests
- Publishing and sharing of projects
  - Easily connect with Zenodo to get a DOI
  - Accepted by many journals
- Additional features
  - Project wikis
  - Project websites

Take home

- Git (+ Github) is very powerful for coding projects
  - Keep track of your changes and go back if you need to
  - Collaborate and share
- Can be confusing in the beginning, but Git GUIs make it intuitive
- Valuable addition to your toolbox that's also relevant outside academia

Tips for getting started

Start using it for small projects and discover features as you go along.

Don't get frustrated by the complexity - it will get better.

Use a GUI if you don't like the terminal.

Get started

Command line

Follow this Git training for learning the Git concepts in the command line.

. . .

R and R Studio

There is a whole book on using Git with R that explains the setup in detail but also goes into more advanced topics.

Follow this step by step guide to set up Git and a Github connection in R and R Studio

. . .

Github Desktop

Next lecture

Research compendia with R

A research compendium is a **collection of all the digital parts of your research projects** (data, code, documents) with the goal of your results being reproducible. You can do this in R by building an R  which makes it easy to publish a fully reproducible version of your project.

. . .

 20th July  1-2 p.m.  Webex

 Subscribe to the mailing list

 For topic suggestions and/or feedback send me an email

Thank you for your attention :)

Questions?

References

Learn git concepts, not commands: Blogpost that explains really well the concepts of git, also more advanced ones like `rebase` or `cherry-pick`.

How to write good commit messages: Blogpost that explains why good commit messages are important and gives 7 rules for writing them.

Git cheat sheet: Always handy if you don't remember the basic commands

Book on how to use Git wih R