Introduction to version control with Git

Scientific workflows: Tools and Tips 🛠️
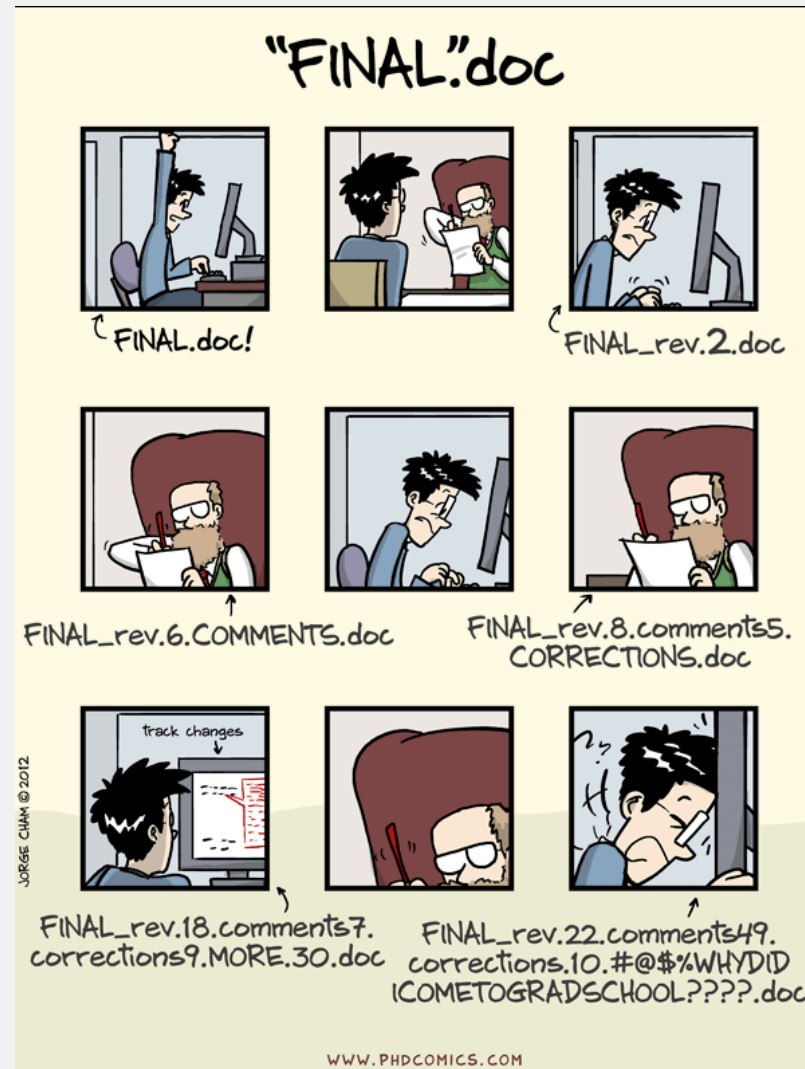
2026-01-15

Scientific workflows: Tools and Tips 🛠️

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

- Slides and material provided online
  - Subscribe to the mailing list
- **Credit points**: send me a private message/email with your name and email

It's never final

Jorge Cham (PhD comics)

Why version control?

Git is like a Lab Notebook for your scripts

- **Tracks** every change in your scripts

- Helps you **recover** older versions

- Enables safe and easy **collaboration**

- Makes it easy to **share** your work with others

Today

- Introduction to **Git**

- Simple Git workflow in **theory and practice**

- Publish your work on **GitHub**

- Find detailed how-to guides on the website

What is Git?

- **Open source and free** to use version control software

- Quasi **standard** for software development

- **Complete** and **long-term** history of every file in your project

- A whole universe of **other software and services** around it

What is Git?

- For projects with **mainly text files** (e.g. code, markdown files, ...)
- Basic idea: Take snapshots (**commits**) of your project over time
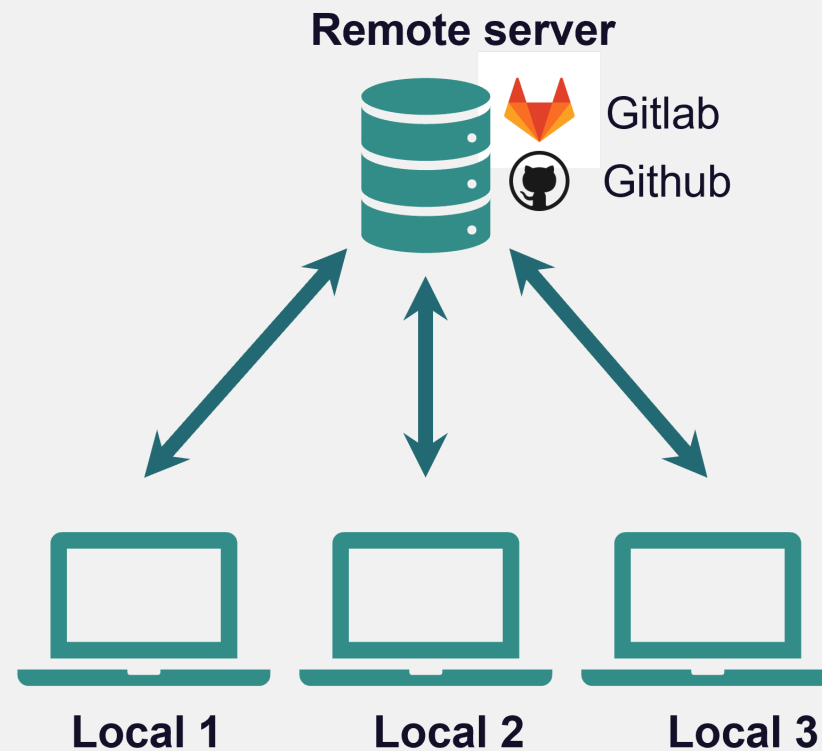
Development over time
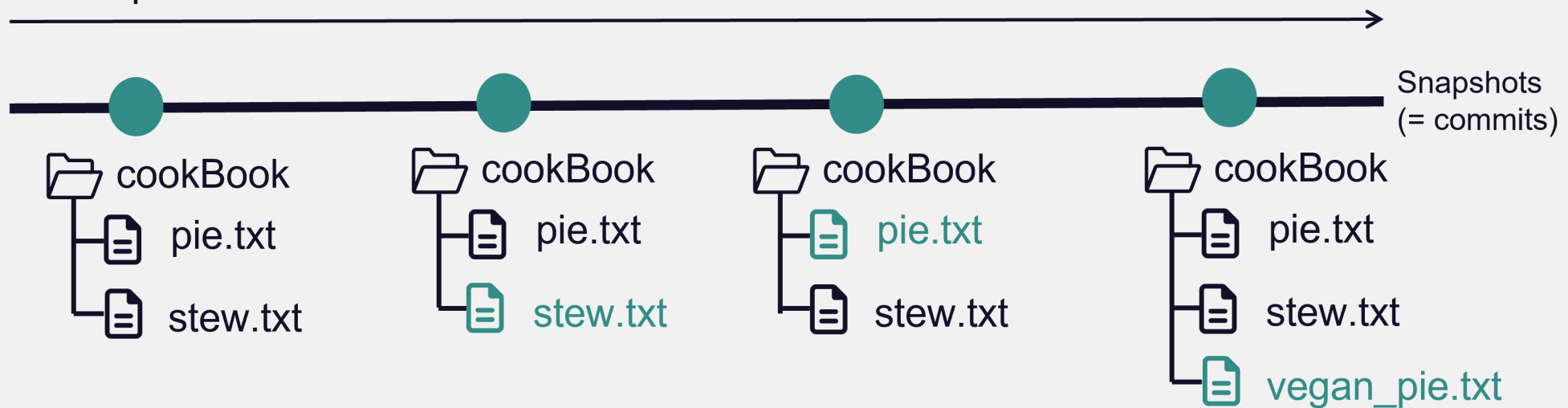
- A project version controlled with Git is a Git **repository** (**repo**)

Version control with Git

Git is a **distributed version control system**

Idea: many *local* repositories synced via one *remote* repo

Remote server

Gitlab

Github

Local 1   Local 2   Local 3

How to use Git

After you installed it there are different ways to interact with the software.

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)
$
```
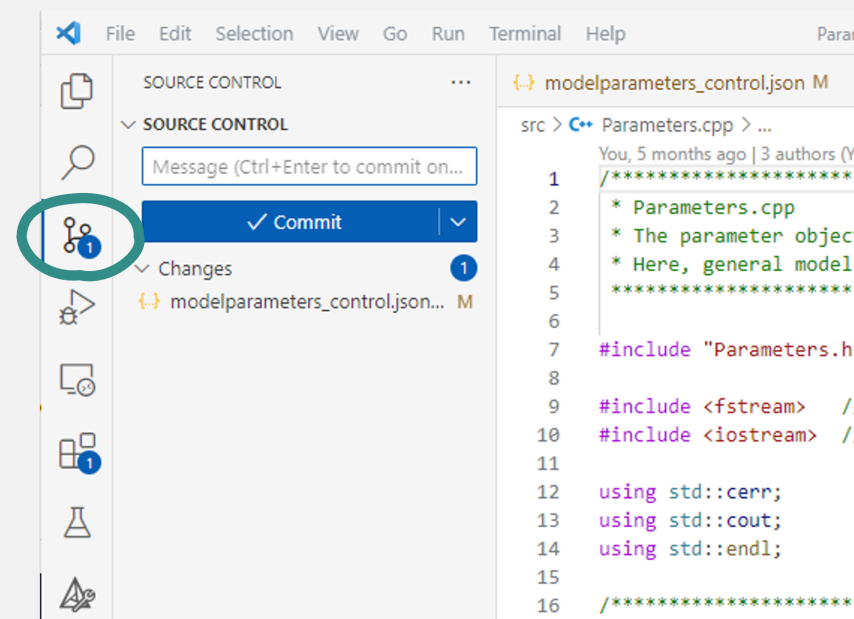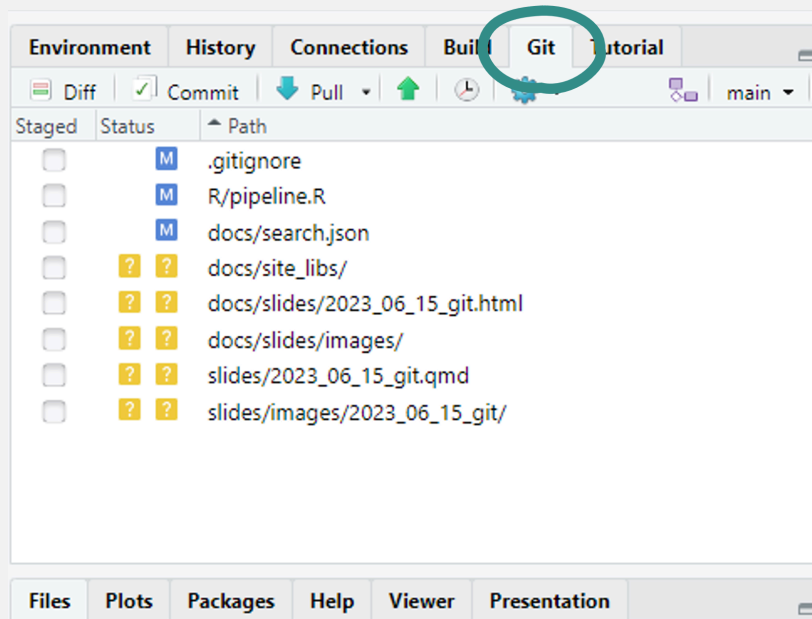
✚ Most control   ━ You need to use terminal 😱

✚ A lot of help/answers online

How to use Git - Integrated GUIs

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

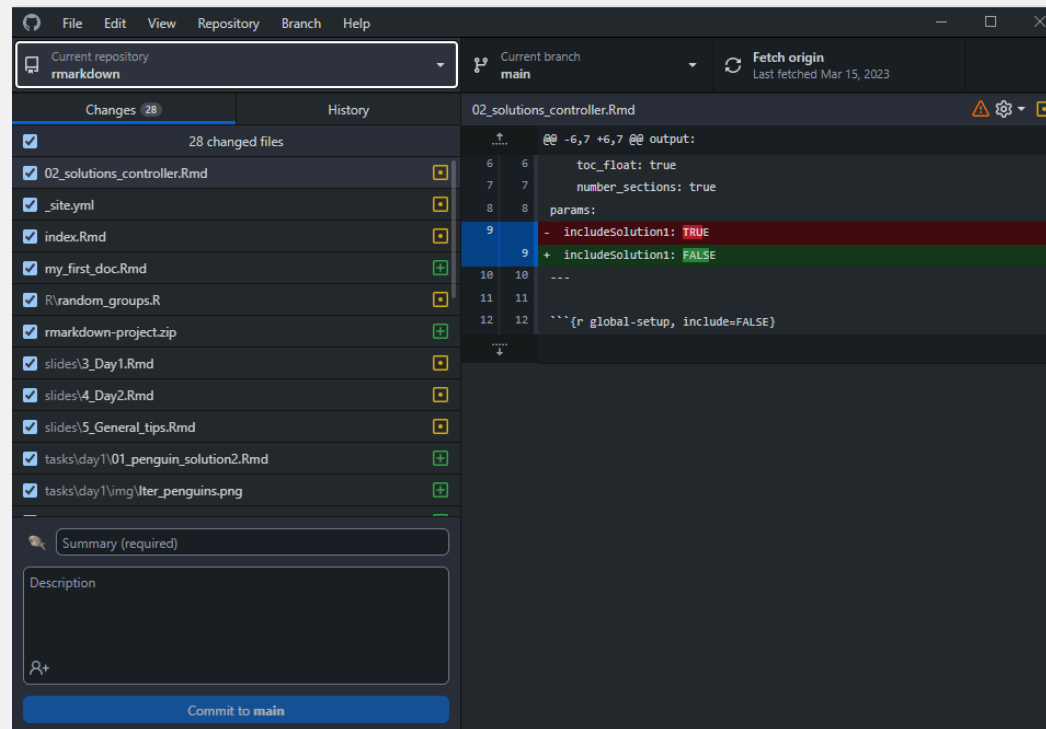➕ Easy and intuitive

➖ Different for every program

➕ Stay inside IDE

How to use Git - Standalone GUIs

Standalone Git GUI software, e.g. GitHub Desktop, Source Tree, ...

➕ Easy and intuitive

➖ Switch programs to use Git

➕ Use for all projects

How to use Git

Which one to choose?

- Depends on experience and taste

- You can mix methods because they are all interfaces to the same Git

- We will use GitHub Desktop

  - Beginner-friendly, intuitive and convenient

  - Nice integration with GitHub

> 💡 Tip
>
> Have a look here to find **How-To guides for the other methods** as well.
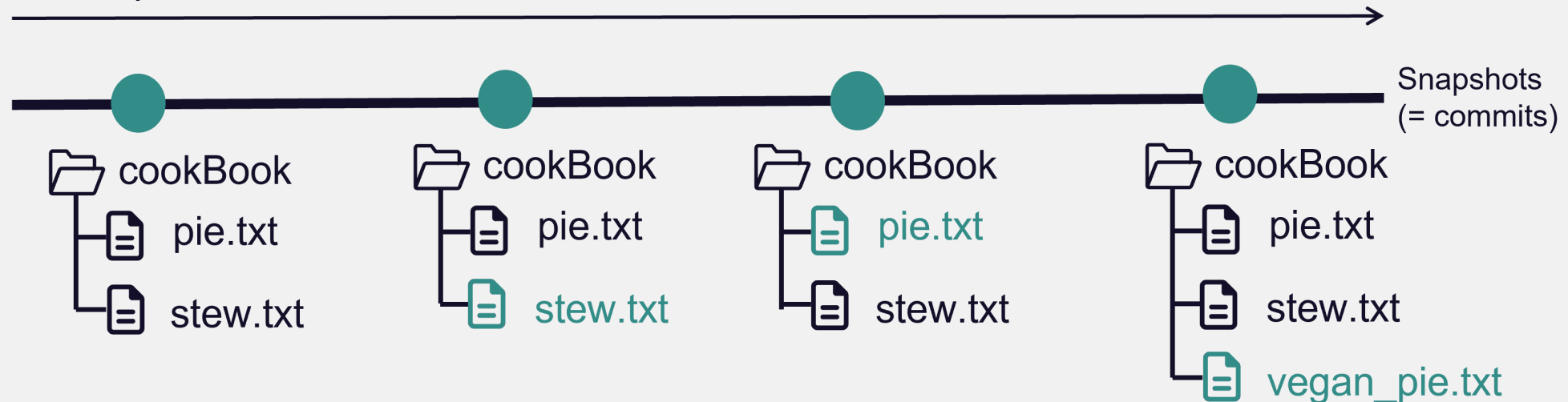
The basic Git workflow

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

Example

A cook book project to collect all my favorite recipes.

Development over time

Snapshots
(= commits)

cookBook
- pie.txt
- stew.txt

cookBook
- pie.txt
- stew.txt

cookBook
- pie.txt
- stew.txt

cookBook
- pie.txt
- stew.txt
- vegan_pie.txt

In real life this would be e.g. a data analysis project, your thesis in LaTex, a software project, …

Step 1: Initialize a Git repository

cookBook

Working
directory

📂 cookBook

Step 1: Initialize a Git repository

cookBook

Working directory

git init

cookBook

cookBook

.git

Working directory

Staging area

Local repository
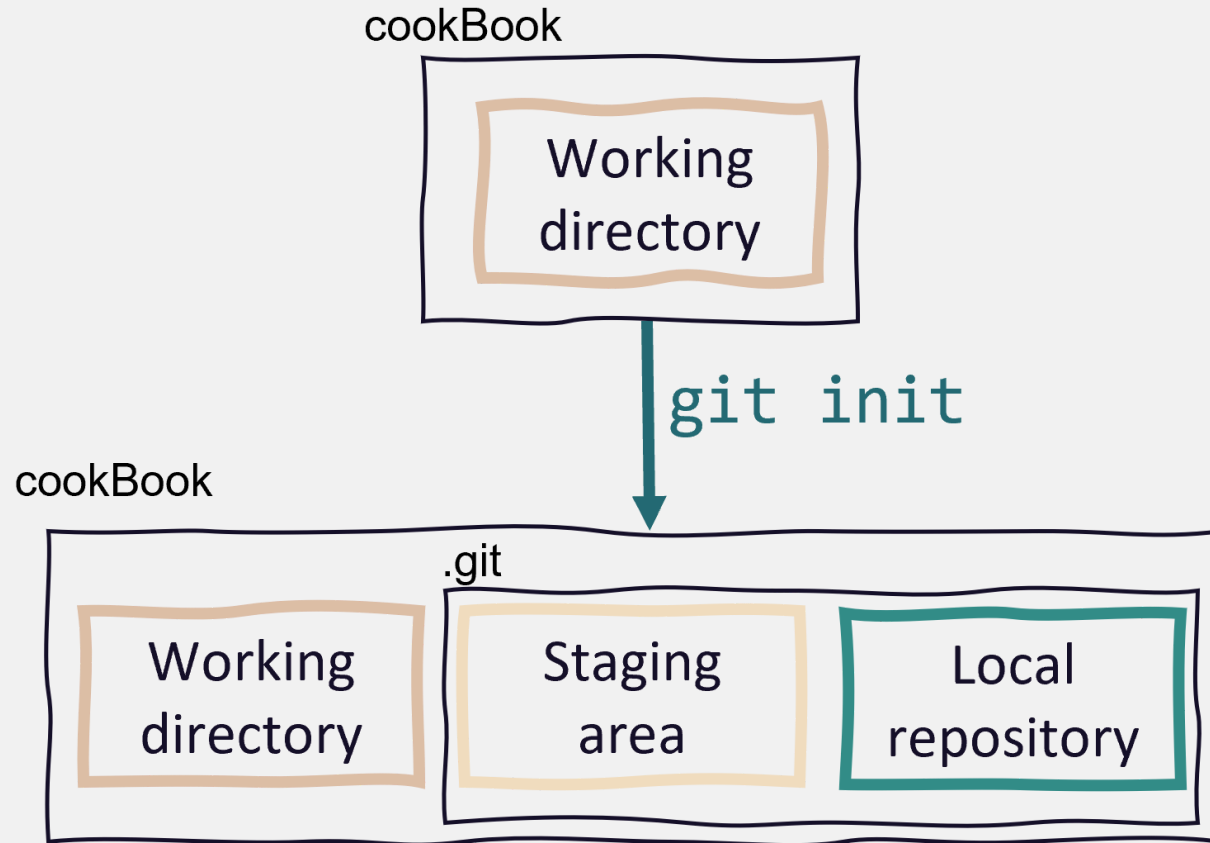
cookBook

git init

cookBook

.git

Step 1: Initialize a Git repository

cookBook

Working directory

git init

cookBook

.git

Working directory | Staging area | Local repository

cookBook

git init

cookBook

.git

Place for **files**

A **list of changes** that go into the next snapshot (commit)

The **heart of your project**: This is where the **commit history** lives
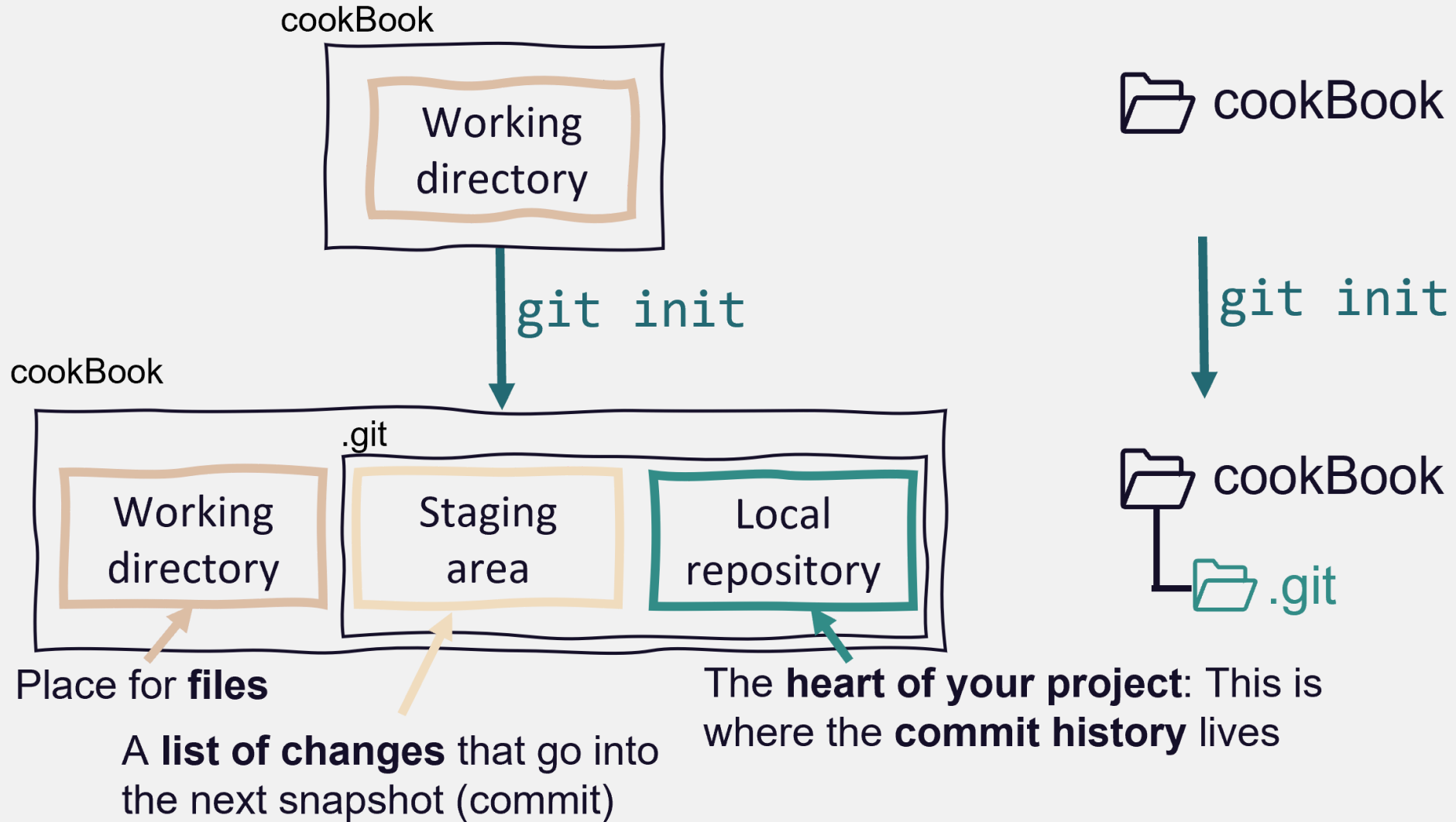
Step 2: Add and modify files

Git detects any changes in the working directory
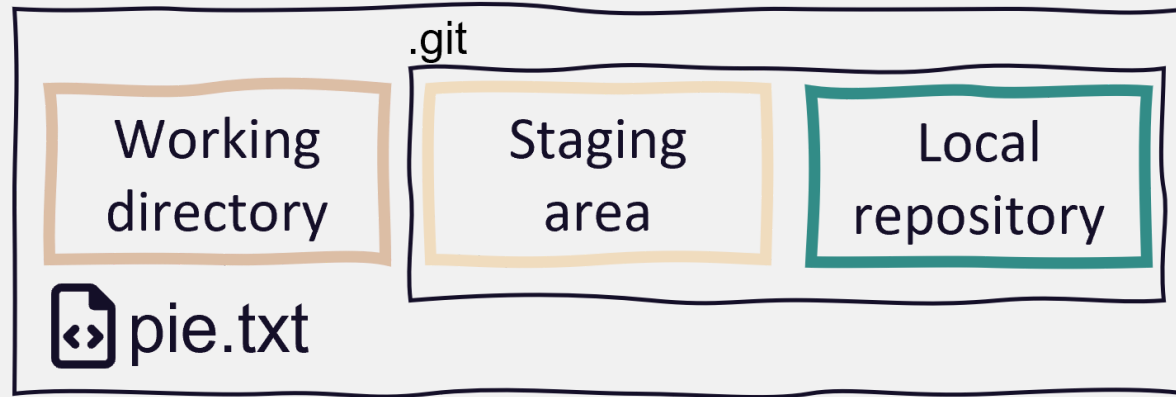
Step 2: Stage changes

Staging a file means to **list it for the next commit**.
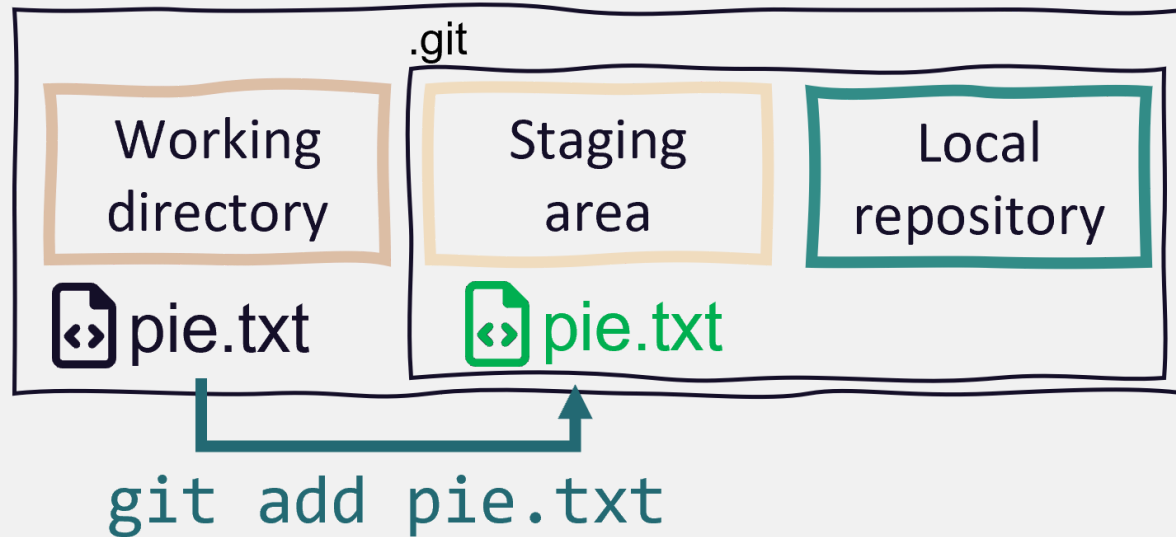
Step 2: Stage changes

Staging a file means to **list it for the next commit**.

git add pie.txt
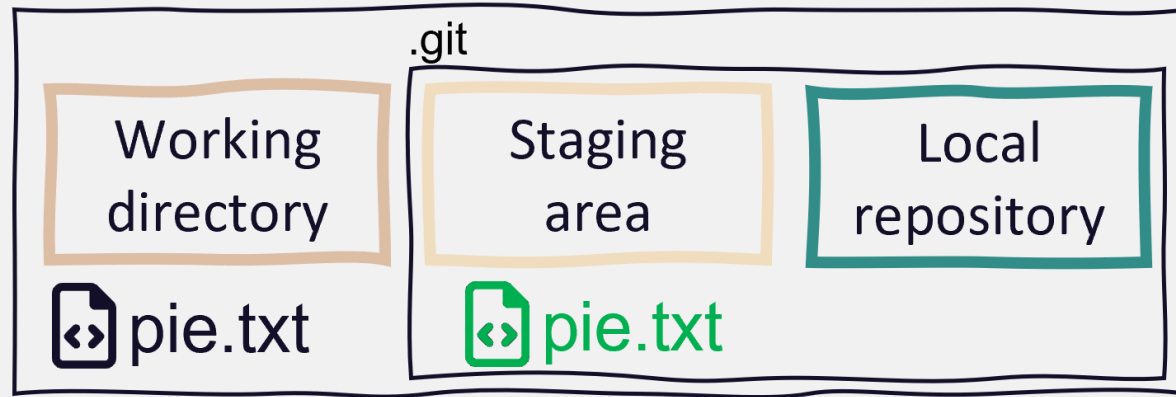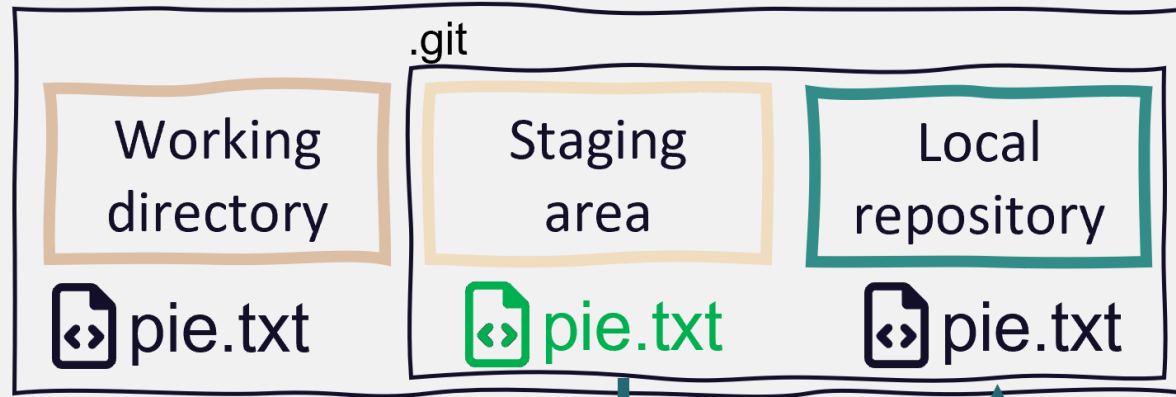
Step 3: Commit changes

Commits are the snapshots of your project state

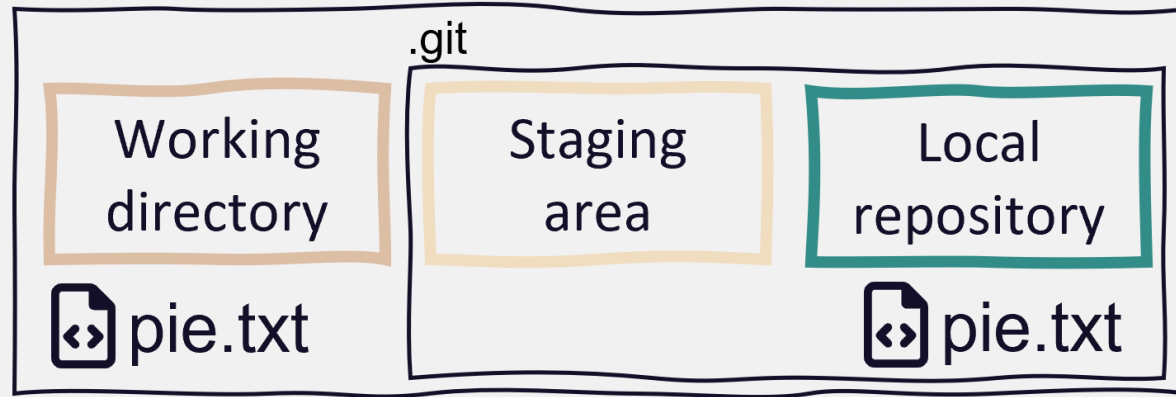# Step 3: Commit changes

Commits are the snapshots of your project state

git commit -m „Add pie recipe"

Step 3: Commit changes
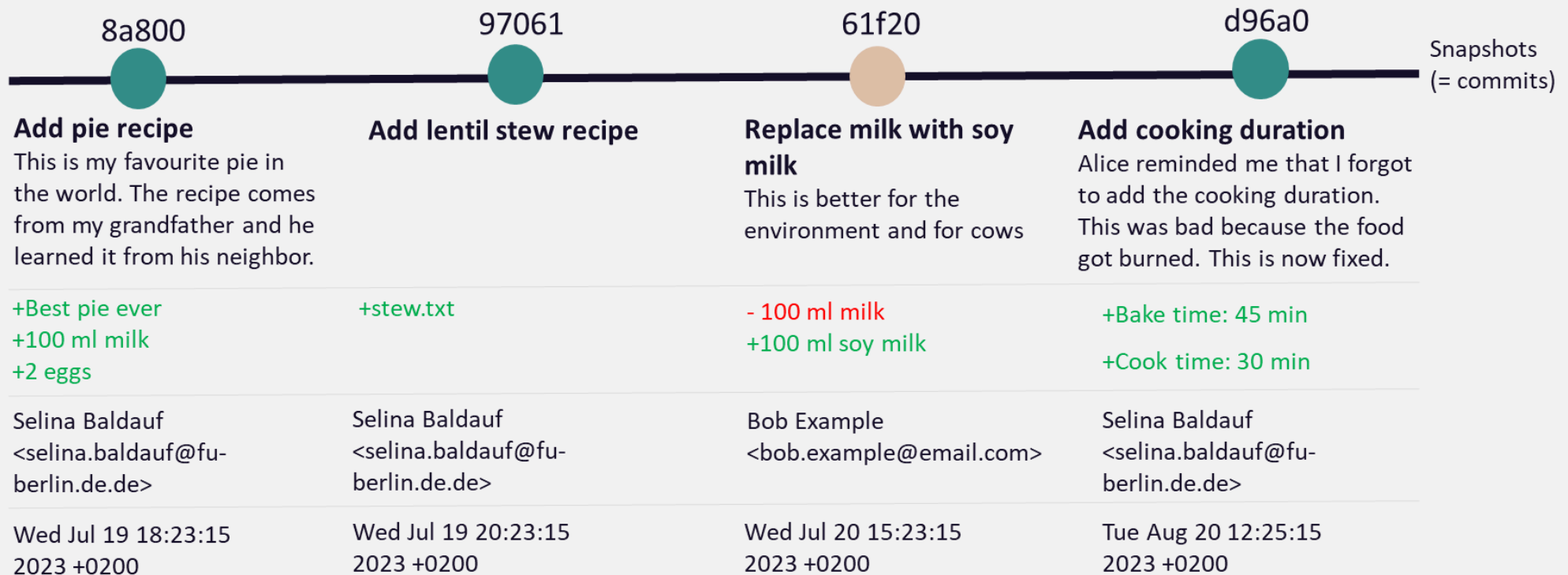
Changes are part of Git history and staging area is clear again

The commit history

8a800	**97061**	**61f20**	**d96a0**
Add pie recipe	**Add lentil stew recipe**	**Replace milk with soy milk**	**Add cooking duration**
This is my favourite pie in the world. The recipe comes from my grandfather and he learned it from his neighbor.		This is better for the environment and for cows	Alice reminded me that I forgot to add the cooking duration. This was bad because the food got burned. This is now fixed.
+Best pie ever +100 ml milk +2 eggs	+stew.txt	- 100 ml milk +100 ml soy milk	+Bake time: 45 min +Cook time: 30 min
Selina Baldauf <selina.baldauf@fu-berlin.de.de>	Selina Baldauf <selina.baldauf@fu-berlin.de.de>	Bob Example <bob.example@email.com>	Selina Baldauf <selina.baldauf@fu-berlin.de.de>
Wed Jul 19 18:23:15 2023 +0200	Wed Jul 19 20:23:15 2023 +0200	Wed Jul 20 15:23:15 2023 +0200	Tue Aug 20 12:25:15 2023 +0200

Snapshots (= commits)

Good commit messages

COMMENT	DATE
CREATED MAIN LOOP & TIMING CONTROL	14 HOURS AGO
ENABLED CONFIG FILE PARSING	9 HOURS AGO
MISC BUGFIXES	5 HOURS AGO
CODE ADDITIONS/EDITS	4 HOURS AGO
MORE CODE	4 HOURS AGO
HERE HAVE CODE	4 HOURS AGO
AAAAAAAA	3 HOURS AGO
ADKFJSLKDFJSDKLFJ	3 HOURS AGO
MY HANDS ARE TYPING WORDS	2 HOURS AGO
HAAAAAAAANDS	2 HOURS AGO

AS A PROJECT DRAGS ON, MY GIT COMMIT MESSAGES GET LESS AND LESS INFORMATIVE.

xkcd on commit messages

Good commit messages

Good commit messages are descriptive and helpful.

✔️

```
Add pie recipe

This is my favorite pie in the world.
The recipe comes from my grandfather and
he learned it from his neighbor.
```
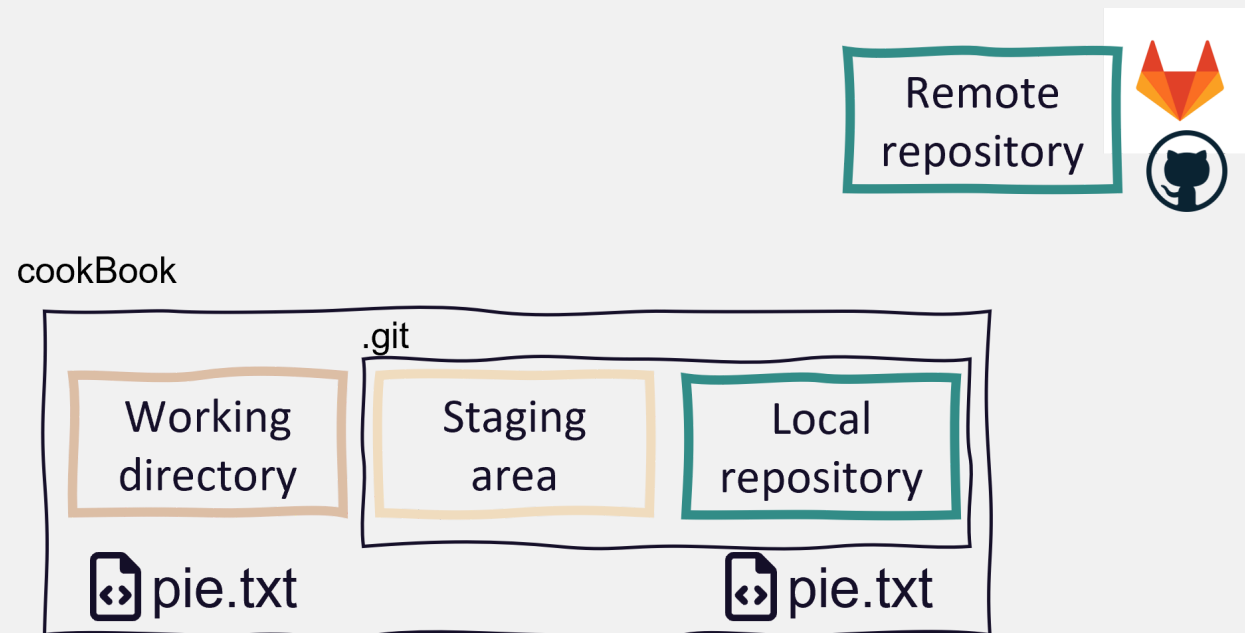
❌

```
added a file.

This is really good.
```

See here for more details on good commit messages.

Step 4: Share changes with the remote repo

Use remote repos (on a server) to **backup**, **synchronize**, **share** and **collaborate**
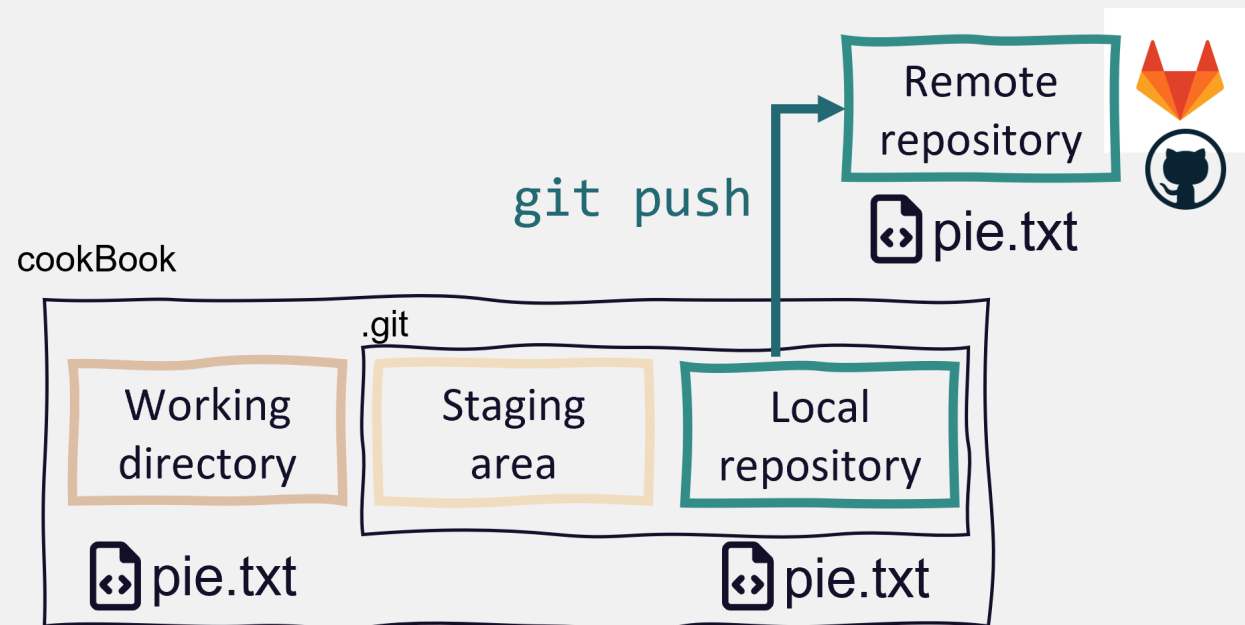
- can be **private** (you + collaborators) or **public** (visible to anyone)

Step 4: Share changes with the remote repo

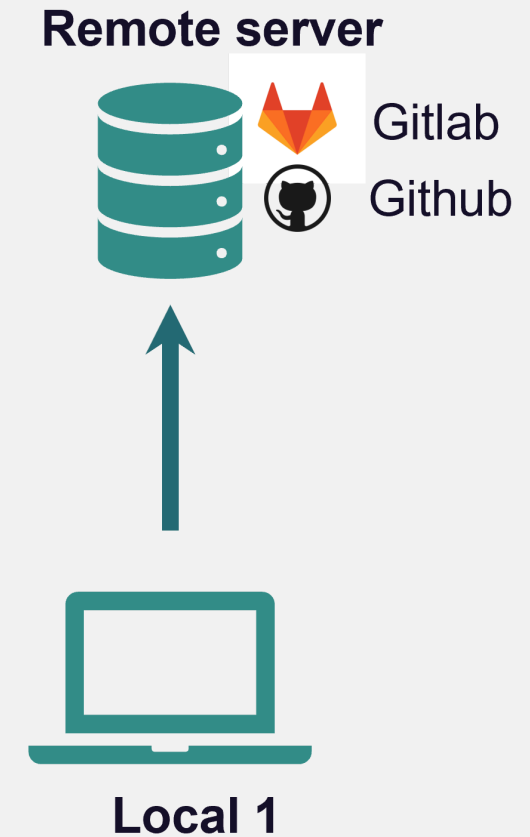Use remote repos (on a server) to **backup**, **synchronize**, **share** and **collaborate**

- can be **private** (you + collaborators) or **public** (visible to anyone)

Recap

Basic Git workflow:

1. **Initialize** a Git repository

2. **Work** on the project

3. **Stage** and **commit** changes to the local repository

4. **Push** to the remote repository

Remote server

Gitlab

Github

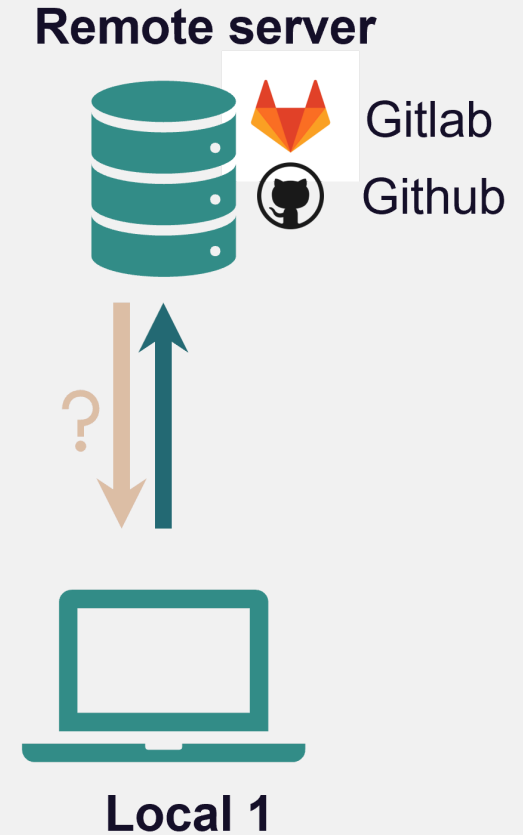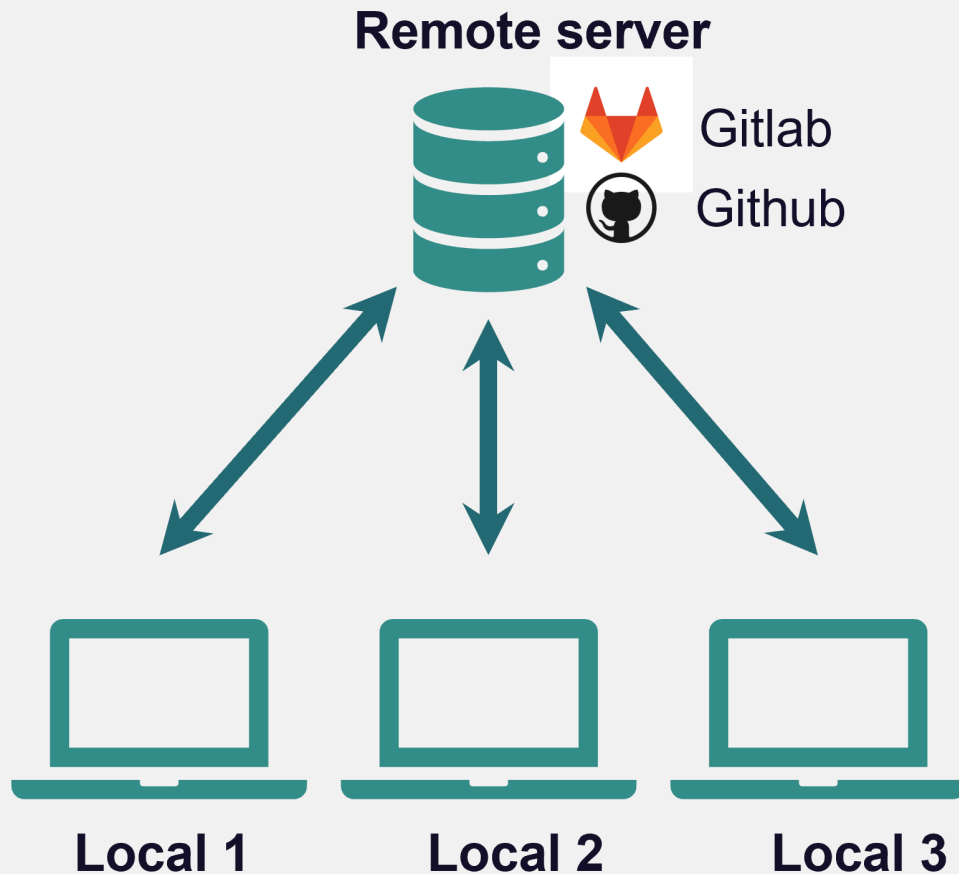**Local 1**

Recap

Basic Git workflow:

1. **Initialize** a Git repository

2. **Work** on the project

3. **Stage** and **commit** changes to the local repository

4. **Push** to the remote repository

Remote server

Gitlab

Github

?

Local 1

Recap

Git is a **distributed version control system**

Remote server

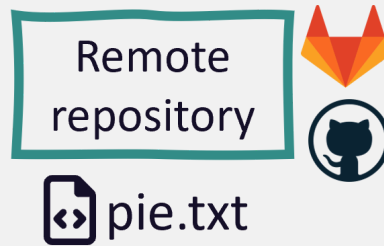Gitlab

Github

Local 1   Local 2   Local 3

- Idea: many *local* repositories synced via one *remote* repo

- Collaborate with

  - **yourself** on different machines

  - your **colleagues** and friends

  - **strangers** on open source projects

Get a repo from a remote

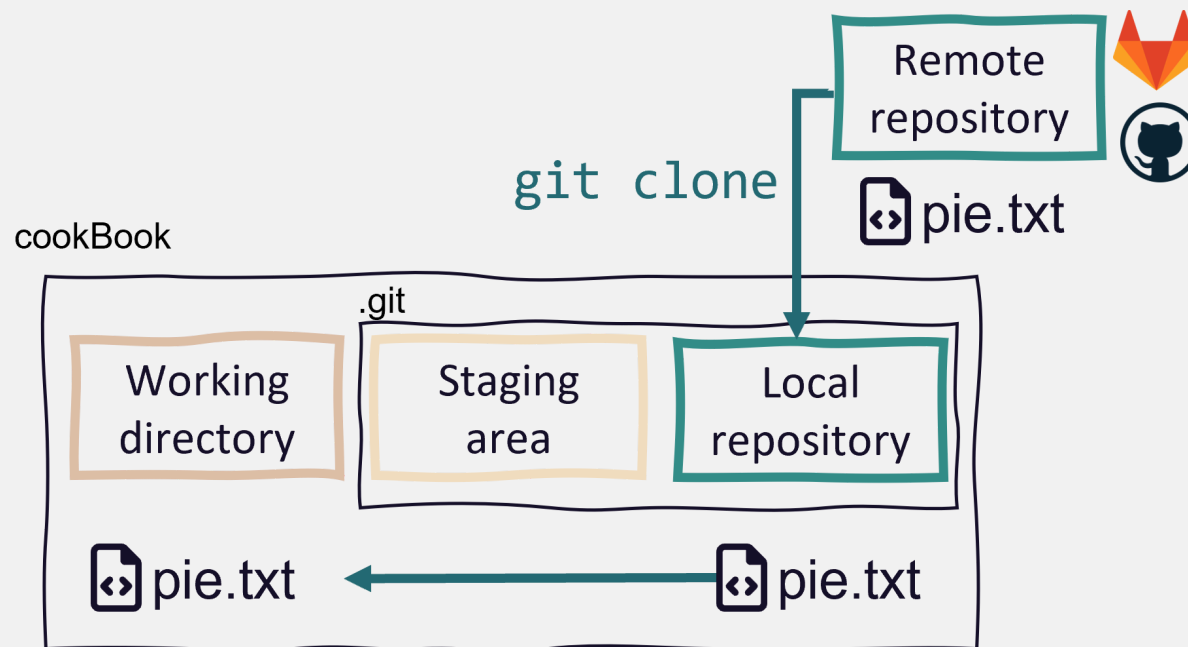In Git language, this is called **cloning**

You can clone all public repositories and private repositories if you are a owner/collaborator

Get a repo from a remote

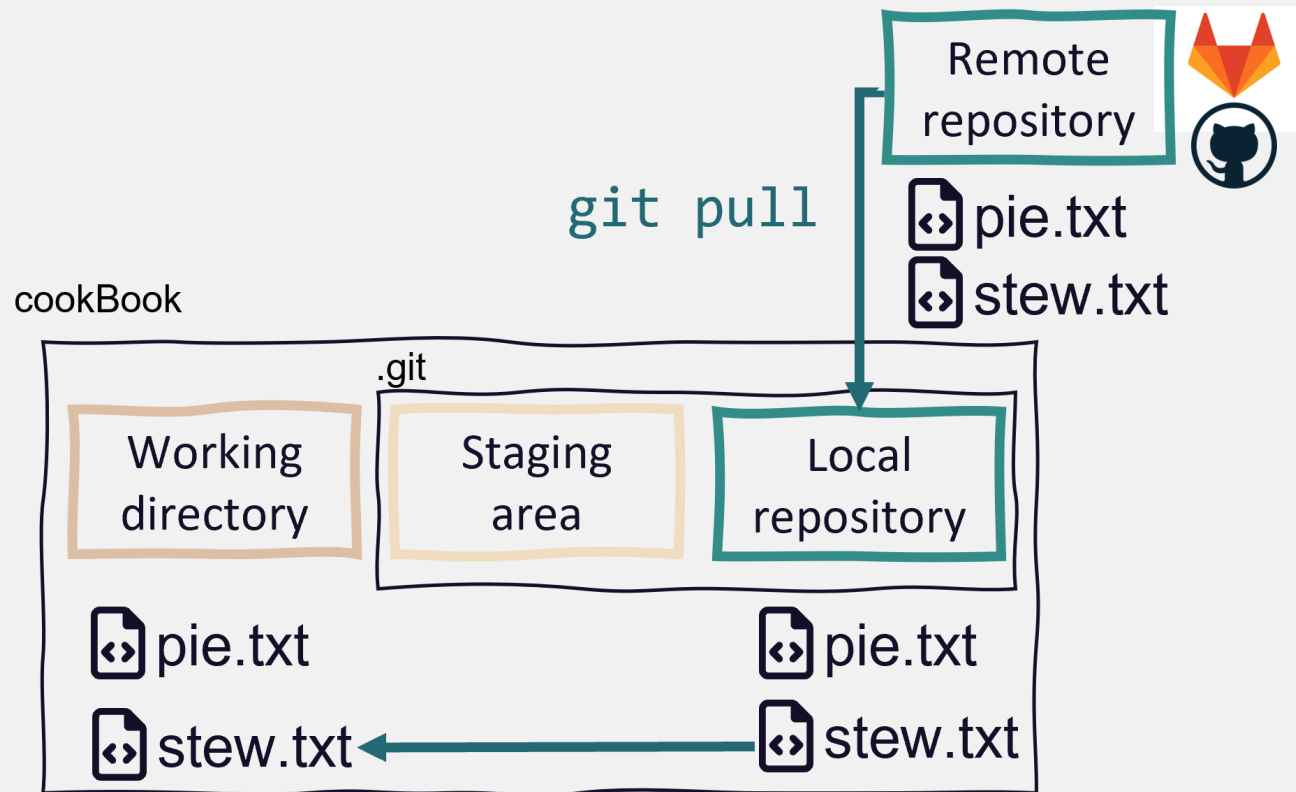In Git language, this is called **cloning**

You can clone all public repositories and private repositories if you are a owner/collaborator

Get changes from the remote

- Local changes, publish to remote: `git push`

- Remote changes, pull to local: `git pull`

Remote repository

git pull

pie.txt
stew.txt

cookBook

.git

Working directory

Staging area

Local repository

pie.txt
stew.txt

pie.txt
stew.txt

A simple collaboration workflow

my commits   Bob's commits   main
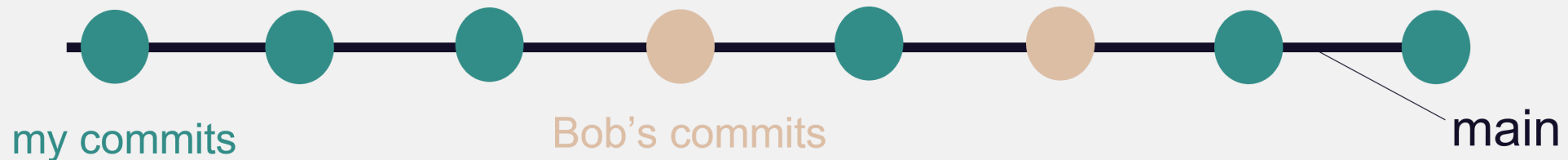
- One remote repo on GitHub, multiple local repos

- Idea: Everyone works on the same branch
  - **Pull before** you start **working**
  - **Push after** you finished **working**

A branching-merging workflow
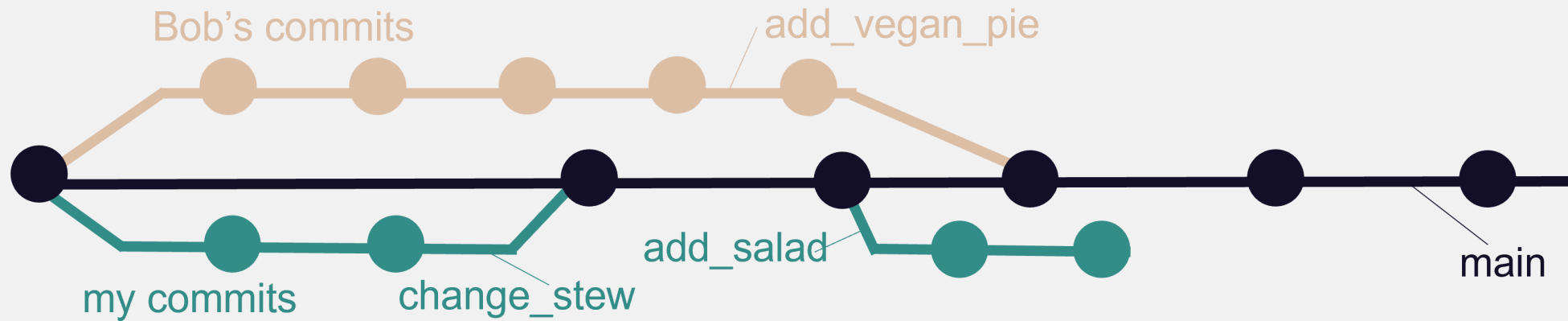
- One remote repo on GitHub, multiple local repos

- Idea: Everyone works on the their **separate branch**

  - **Merge** branch with the main when work is done

- Check out the How-To guide for details

Publishing your work

Remote repositories

- There are **commercial** and **self-hosted** options for your remote repositories

  - Commercial: GitHub, Gitlab, Bitbucket, …

  - Self-hosted: Gitlab (maybe at your institution?)

- Please be aware of your institutional guidelines

  - Servers outside EU

  - Privacy rules might apply depending on type of data

Public repositories

- Making a repository public is a good way to publish and share your work

- Always add a README.md file

- Always add a LICENSE file

    - This is important to clarify how others can use your work

- Connect your repo with Zenodo to get a DOI

If you are interested, browse some nice GitHub repositories for inspiration (e.g. Git training repository, Computational notebooks, Repo to publish code from a manuscript)

Outlook

- Git can do much more than we covered today

  - Complex collaboration workflows with code review steps

  - Rolling back to previous versions

  - Ignoring files from the repository

  - …

- GitHub et al. offer many more features

  - Issues, pull requests, code review, project management, …

  - Host websites, wikis, …

- Start with the basic workflow and build on that

Next lecture

Semester break in February/March!

Topic of next lecture t.b.a.

📅 16th April 🕐 4-5 p.m. 📍 Webex

🔔 Subscribe to the mailing list

📧 For topic suggestions and/or feedback send me an email

Thanks for your attention

Questions?

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 time stamp, commit message and information on the person who did the commit

- `git push`: Push new commits to the remote repository

  - Sync your local project version with the remote e.g. on GitHub

Undo things

git revert

Revert changes

- Use `git revert` to revert specific commits

- This does not delete the commit, it creates a **new commit that undoes a previous commit**
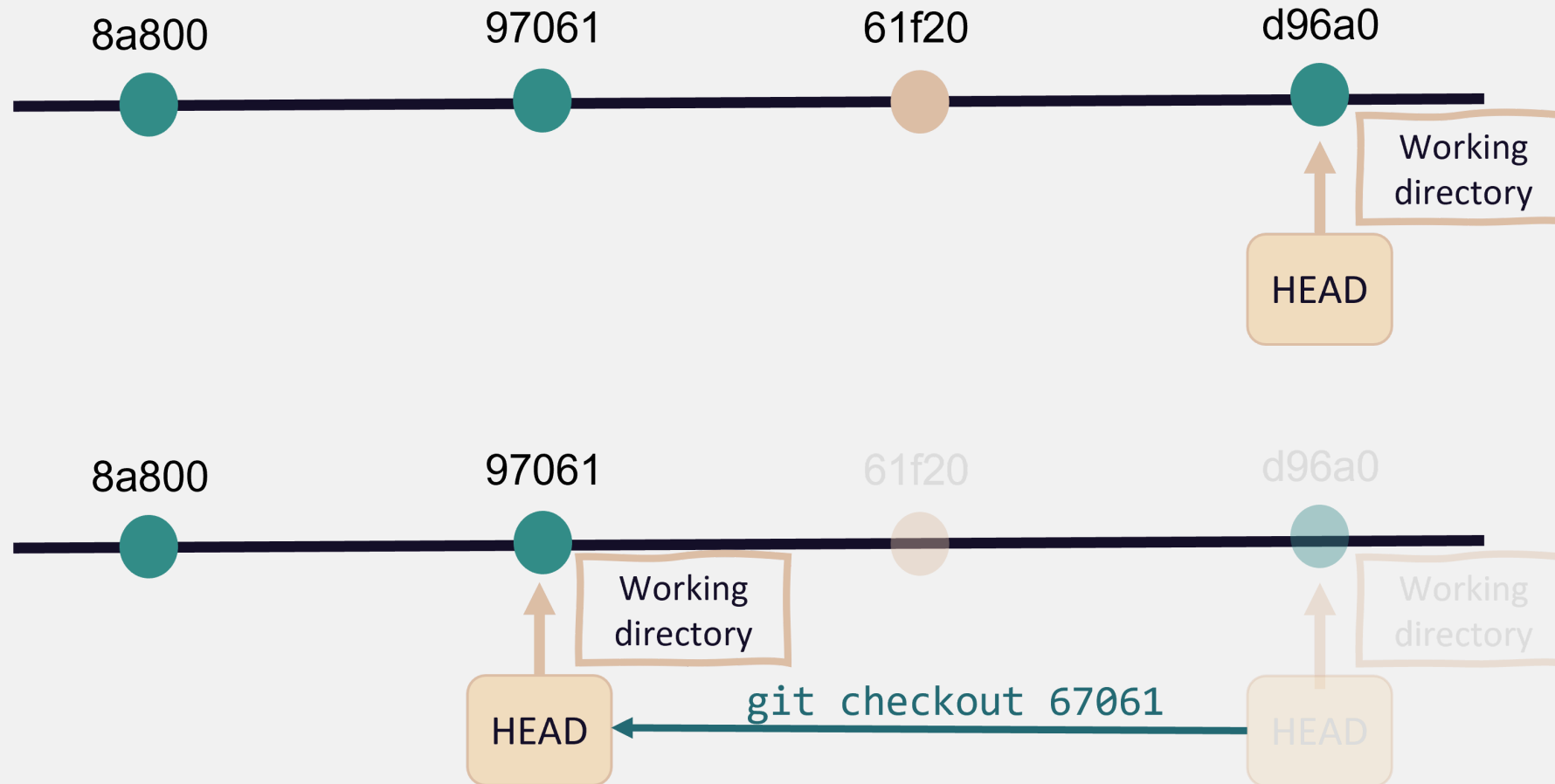
  - It's a safe way to undo commited changes

8a800   97061   61f20   d96a0

Replace milk with soy milk

git revert 61f20

8a800   97061   61f20   d96a0   a876b

Replace milk with soy milk

Revert "Replace milk with soy milk"

Go back in time

git checkout

Checkout a previous commit

Take your work space back in time temporarily with `git checkout`

Ignoring files with

.gitignore

Ignore files with `.gitignore`

- Useful to ignore e.g.

  - Compiled code and build directories

  - Log files

  - Hidden system files

  - Personal IDE config files

  - …

Ignore files with .gitignore

- Create a file with the name .gitignore in working directory

- Add all files and directories you want to ignore to the .gitignore file

Example

```
*.html     # ignore all .html files
*.pdf      # ignore all .pdf files

debug.log # ignore the file debug.log

build/     # ignore all files in subdirectory build
```

See here for more ignore patterns that you can use.