# Introduction to Git

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PUNCH Young Academy – PUNCH4NFDI

23 May 2024

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

AxelKrypton



PUNCH 4 NFDI

CRC-TR 211 Strong-interaction matter under extreme conditions

# Outline of the talk

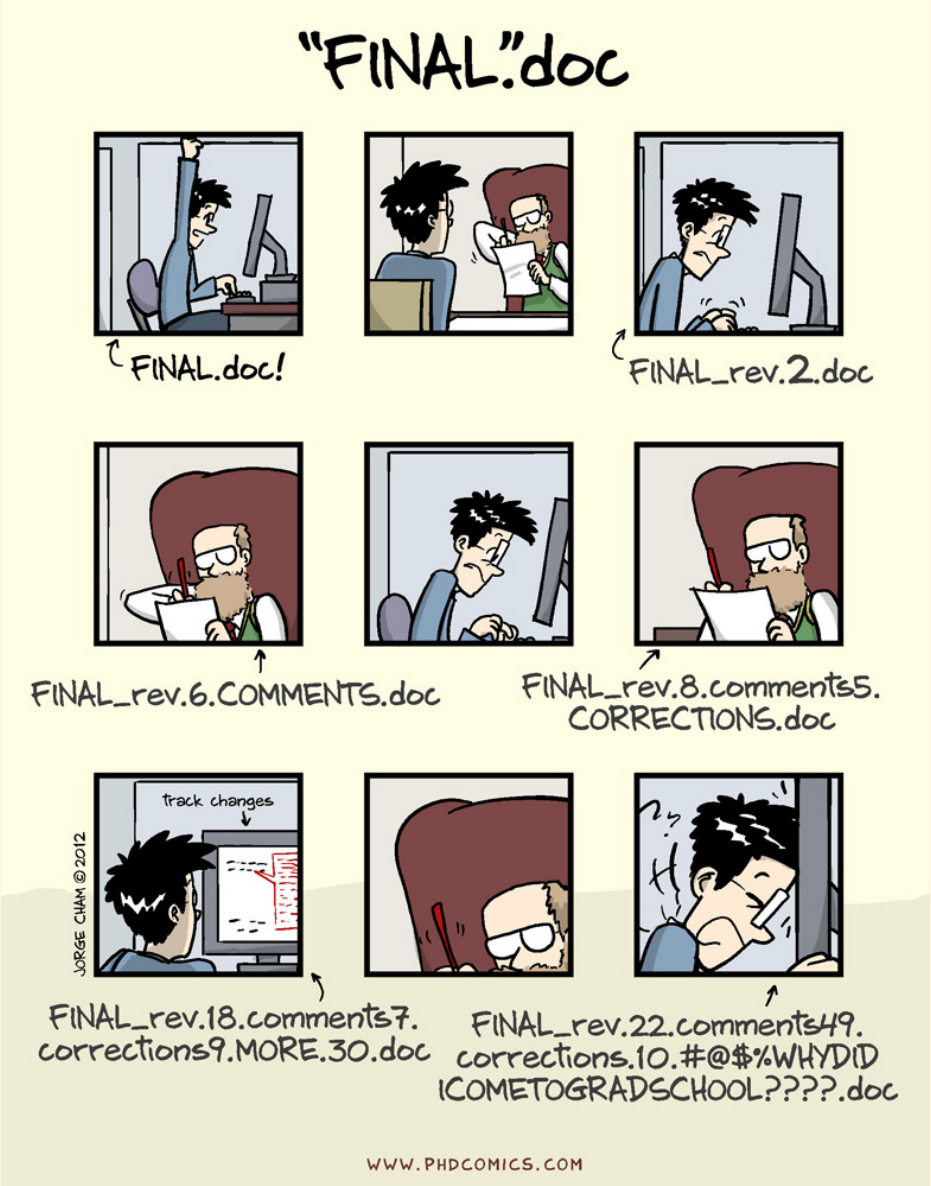
1. Why should you use it?
2. What is Git?
3. How to use Git locally?
4. Summary and conclusions

# Why should you use it?

OK, let’s do it without git

# A possible workflow

## Writing a review or a Ph.D. thesis



# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
  - You make a backup of your file
  - You comment out a block of text in your source
  - If the old version was better, you restore it by hand
  - If the new version is better, you clean up by hand

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?
  - Create a .tar or .zip file
  - Copy it somewhere and uncompress if needed

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?
- Which version did you send to your supervisor/colleagues?

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?
- Which version did you send to your supervisor/colleagues?
  - Put a copy of the PDF file or of the compressed folder somewhere
  - Keep the sent email for later use

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?
- Which version did you send to your supervisor/colleagues?
- How long did it take to write this section?
- When did I start writing this chapter?
- How much did I write on average per day?

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
- How do you create/view checkpoints?
- Which version did you send to your supervisor/colleagues?
- How long did it take to write this section?
- When did I start writing this chapter?
- How much did I write on average per day?

**Everything by hand, error-prone and big overhead!**

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
  - You work on separate parts at the same time
  - Only one person works at the same time

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
  - You send the changed files per email and put them in the folder by hand
  - Copy/Rsync in some shared place the new status of the project
  - If only one person works at once, a compressed archive can be exchanged

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
  - You don't, use `SSH`
  - Different machines are as different people, see above

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?
  - This information is not important
  - Sending work around per email allows to trace this...
  - Put comments into the source!

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?
- How do you give credit to authors?

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?
- How do you give credit to authors?
  - Detailed information is not important
  - A rough idea about who worked on what is enough
  - See comments into the source!

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?
- How do you give credit to authors?
- How do you go back in history e.g. in case of a bug?

# Another possible workflow

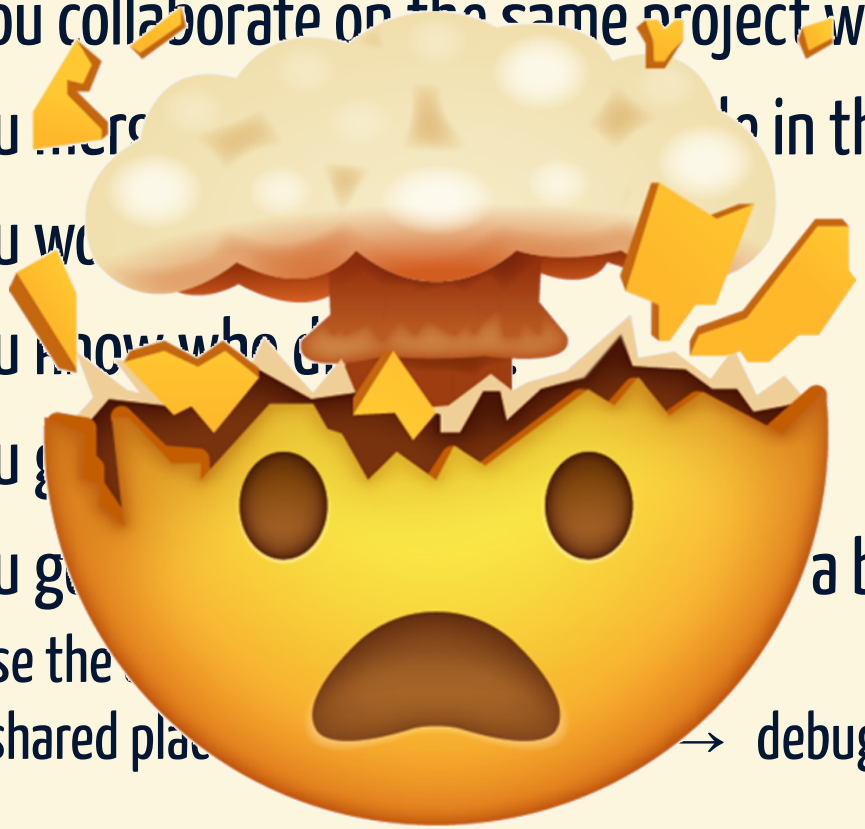
## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge work from other people in the team?
- How do you work on different machines?
- How do you know who did what?
- How do you give credit to authors?
- How do you go back in history e.g. in case of a bug?
  - Again, use the archives sent around per email
  - Using a shared place, this is not possible $\longrightarrow$ debug!

# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
- How do you merge [illegible] in the team?
- How do you wo[illegible]
- How do you know who d[illegible]
- How do you g[illegible]
- How do you g[illegible] a bug?
  - Again, use the [illegible]
  - Using a shared plac[illegible] → debug!



OK, and how would it be with Git?

# A possible workflow

## Writing a review or a Ph.D. thesis

- How do you make writing experiments?
  - Just do them (staging/stash area)
  - `git-branch`
- How do you create/view checkpoints?
  - `git-log` `git-tag` `git-checkout`
- Which version did you send to your supervisor/colleagues?
  - `git-log` `git-tag`
- How long did it take to write this section?
- When did I start writing this chapter?
- How much did I write on average per day?

} `git-shortlog`
`git-log`
`gitstats`*

* This is just one of the pletora of libraries to make statistics based on a git repository.

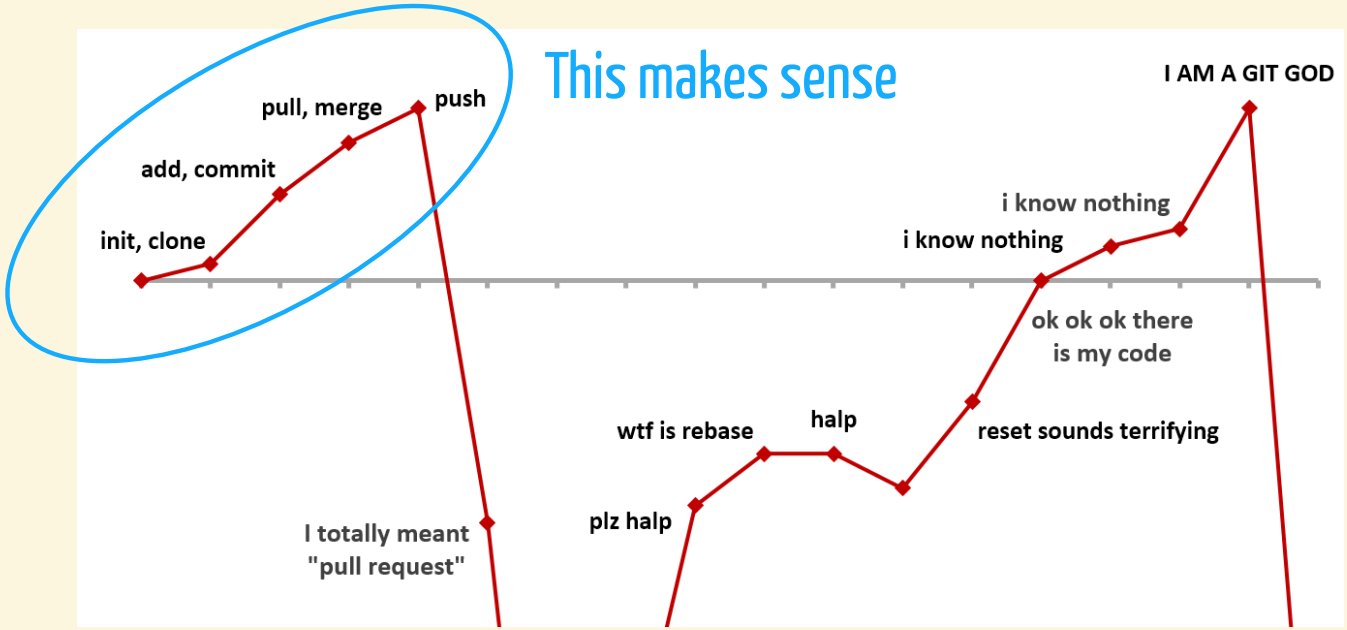
# Another possible workflow

## Collaborating on a project

- How can you collaborate on the same project with colleagues?
  - `git-pull` `git-push` `git-branch`
- How do you merge work from other people in the team?
  - `git-merge`
- How do you work on different machines?
  - `git-pull` `git-push`
- How do you know who did what?
  - `git-blame`
- How do you give credit to authors?
  - `git-shortlog`
- How do you go back in history e.g. in case of a bug?
  - `git-checkout` `git-bisect`

# Yes, but I have to learn all those commands!

There are many jokes on the web...




...but after all it is about having the correct mental set up!



Git was not designed to aim to user-friendliness, but it is by far the most used version control system in the world and hence in continuous evolution.

# Yes, but I have to learn all those commands!

- As any new tool, it needs some practice
- The short- to long-term payoff is worth the effort
- It is plenty of GUI clients
  - Sourcetree: A Free GIT Client For Windows And Mac
  - Guitar: Portable { Windows, Mac & Linux }
  - Git-Cola: Powerful GUI For GIT { Windows, Mac, Ubuntu & Linux }
  - [...]
- You can work in the terminal

  → after this course it will be possible and straightforward!



Git was not designed to aim to user-friendliness, but it is by far the most used version control system in the world and hence in continuous evolution.

# Last but not least

**Which large famous products are developed using Git?**

Linux, Homebrew, Windows, Tensorflow, Angular, Inkscape, ...

# Last but not least

git

## Which large famous products are developed using Git?

Linux, Homebrew, Windows, Tensorflow, Angular, Inkscape, ...

## And if I do not have so large projects?

It doesn't matter! There are too many advantages* having a project under a source code management tool. Even alone. **Simply use one (Git). Now.**

For collaborative projects like maintaining code in a group, handing it over from person to person and so on, Git is simply a must. **As project leader, you should think about requiring everybody to work in a Git repository.**

* Among many others, in a Git repository you can undo a `rm` command given by accident on a wrong file.

# What is Git?

# How does Git define itself?

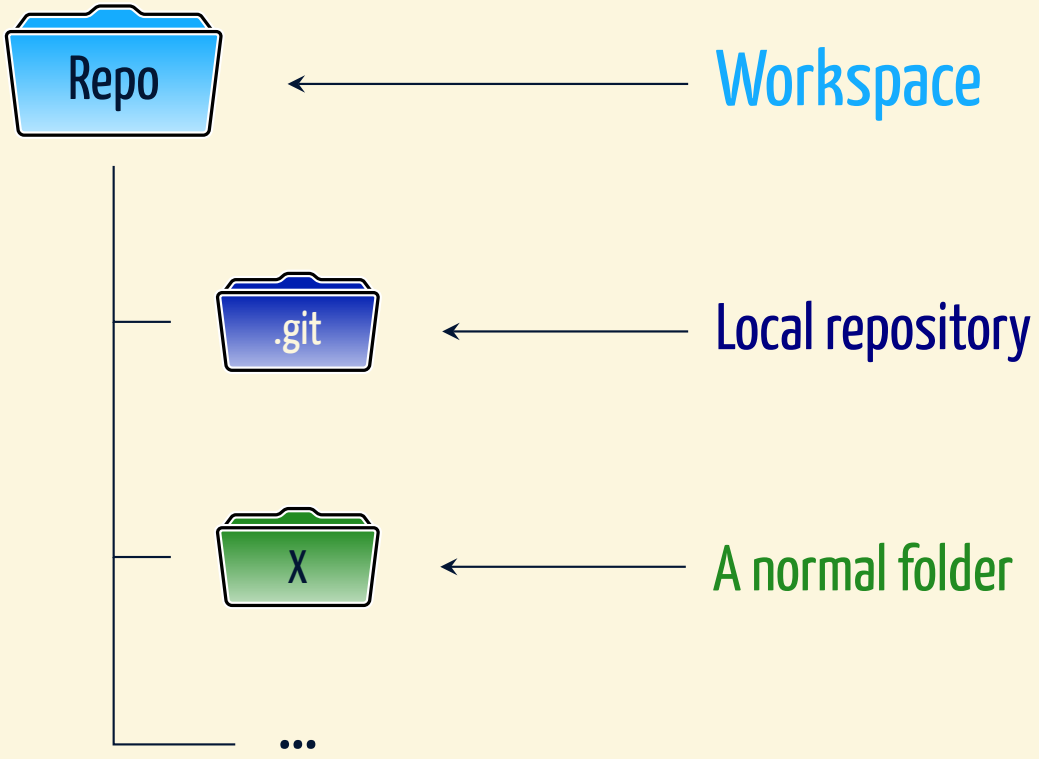
«Git is a free and open source distributed version control system designed to handle everything from small to very large projects with speed and efficiency. Git is easy to learn and has a tiny footprint with lightning fast performance.»

Git homepage

1. Free and open
2. **Distributed version control system**
3. From small to very large projects
4. With speed and efficiency
5. Easy to learn

# How does it work?

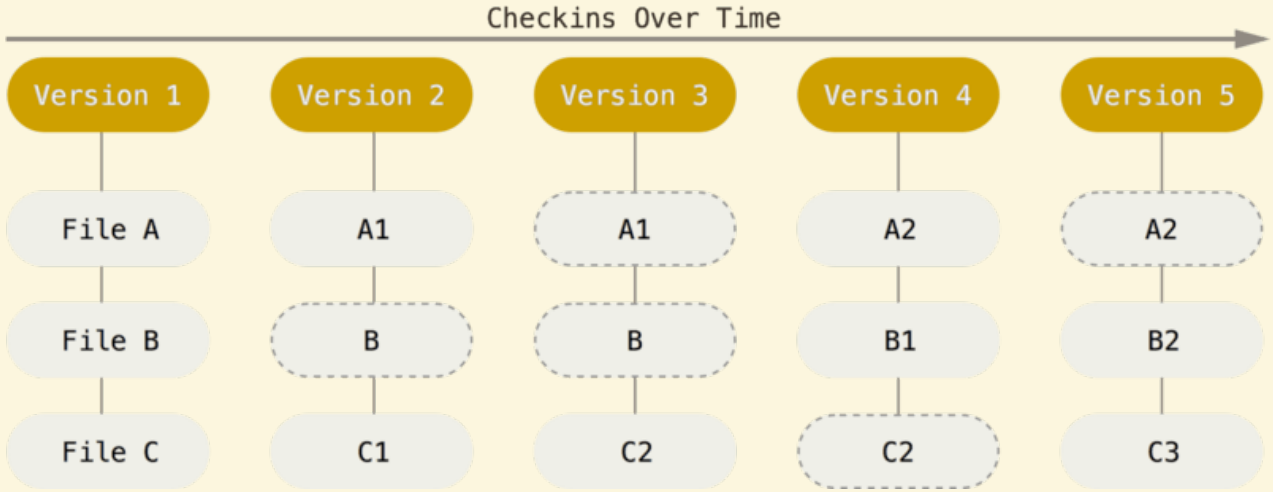
- **Repository:** a database containing all versions of the files



# How does it work?

- **Repository:** a database containing all versions of the files
- Snapshot-based system
  - Snapshots are called commits
  - Commits are named by checksums (also used to ensure data integrity)

{ It's impossible to change the contents of any file or directory without Git knowing about it }




🔗From the Git-Book

# How does it work?

- **Repository:** a database containing all versions of the files
- Snapshot-based system
  - Snapshots are called commits
  - Commits are named by checksums (also used to ensure data integrity)

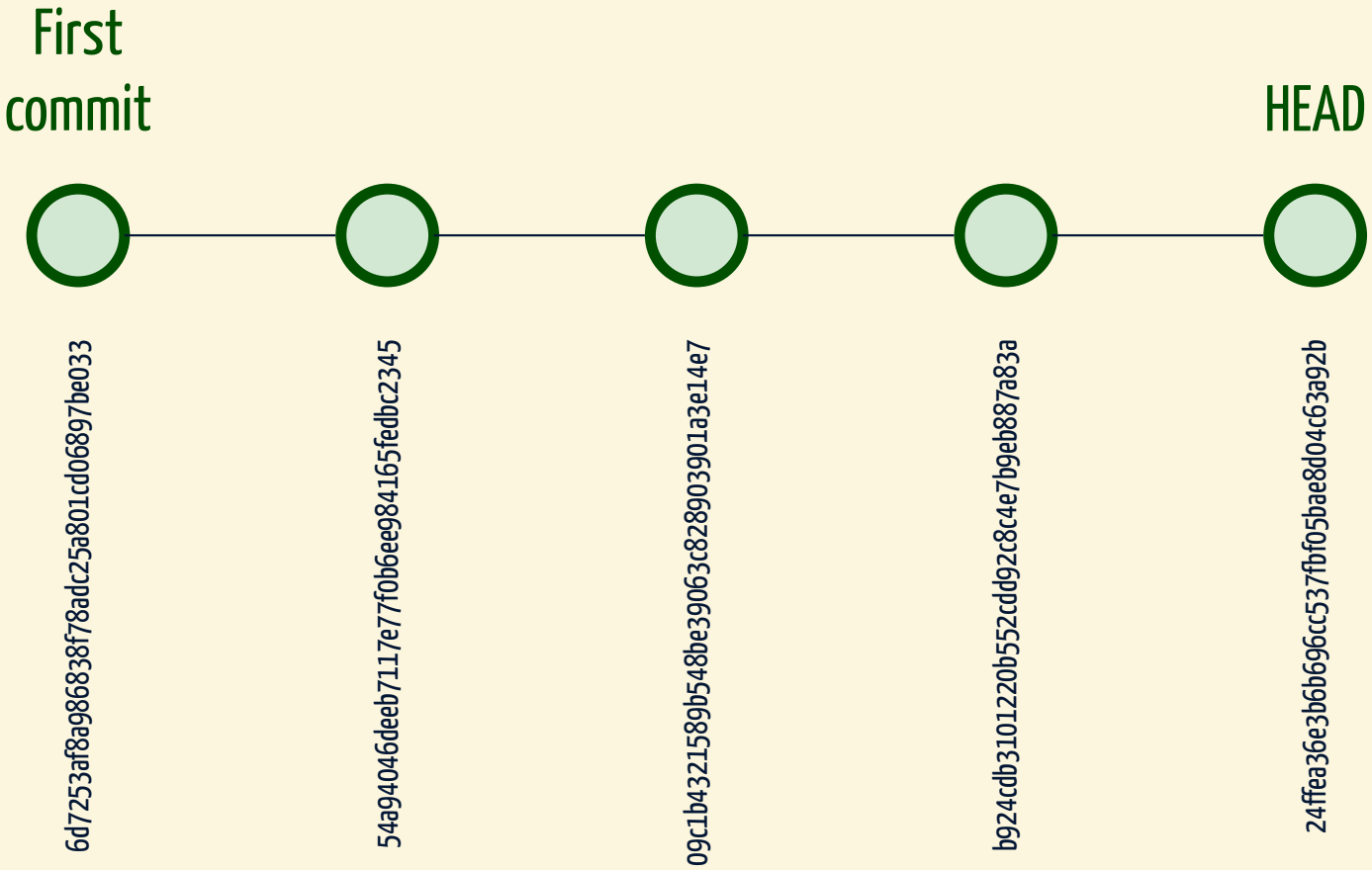
    { It's impossible to change the contents of any file or directory without Git knowing about it }
- Almost every operation is local
  - Working without network connecting
  - Distributed system $\longrightarrow$ everyone carries a backup!

**Are you curious to know how Git works bottom-up?**

Refer to 🔗 this 31-pages document , well written, but not needed at start.

# An example of Git history

Every commit is a snapshot of the state of the repository at that point



# The correct abstract mental setup

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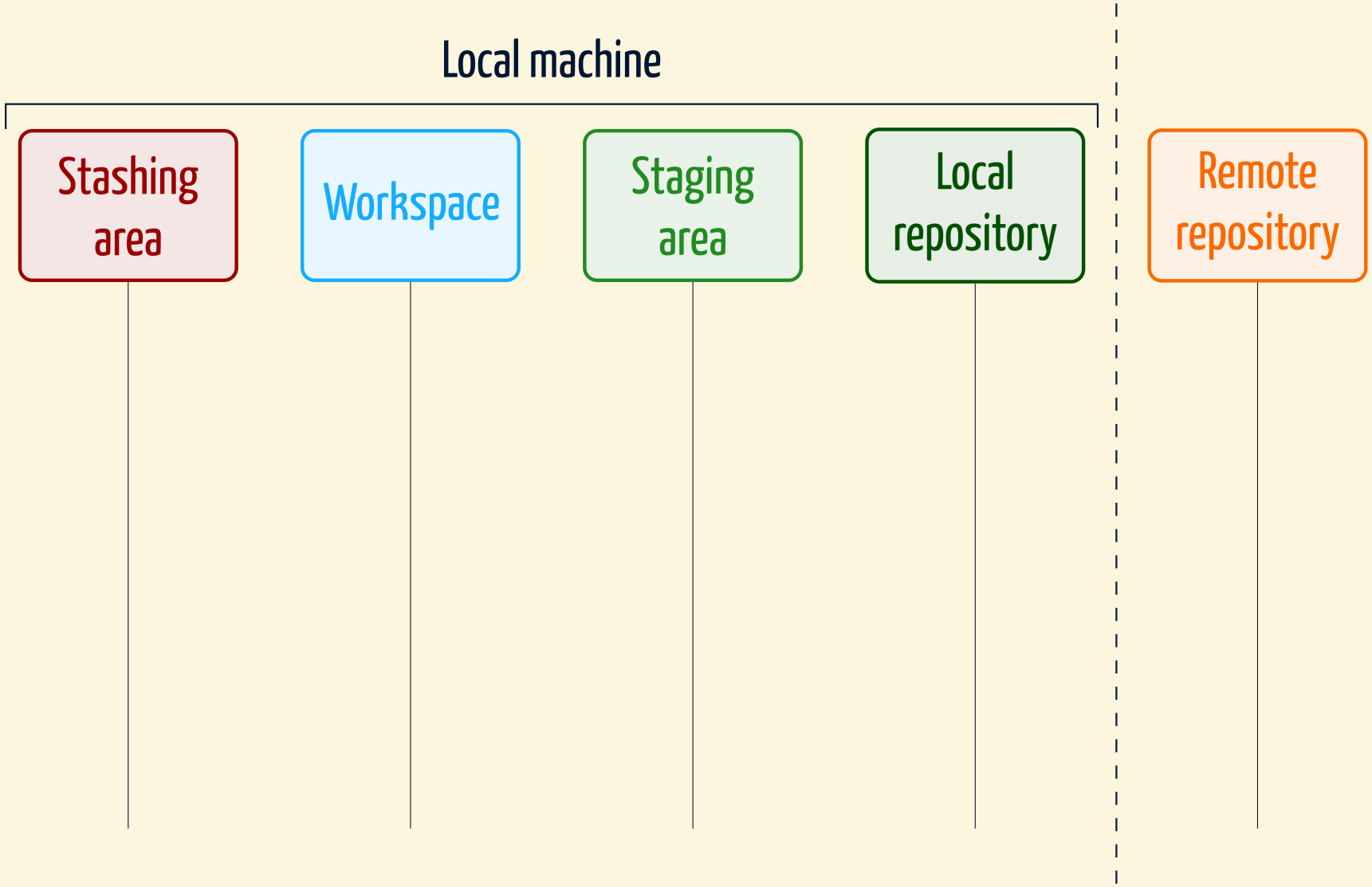

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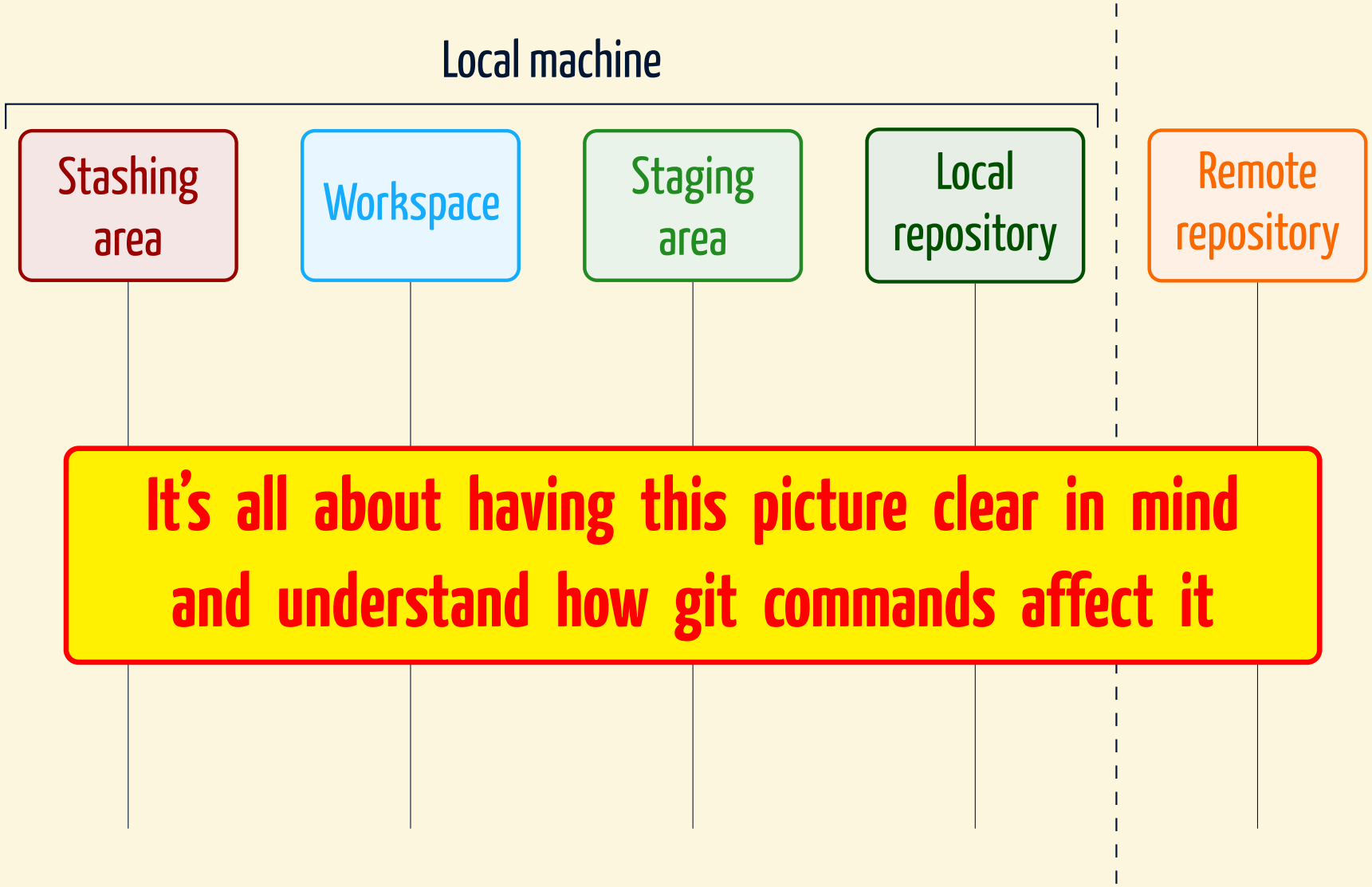
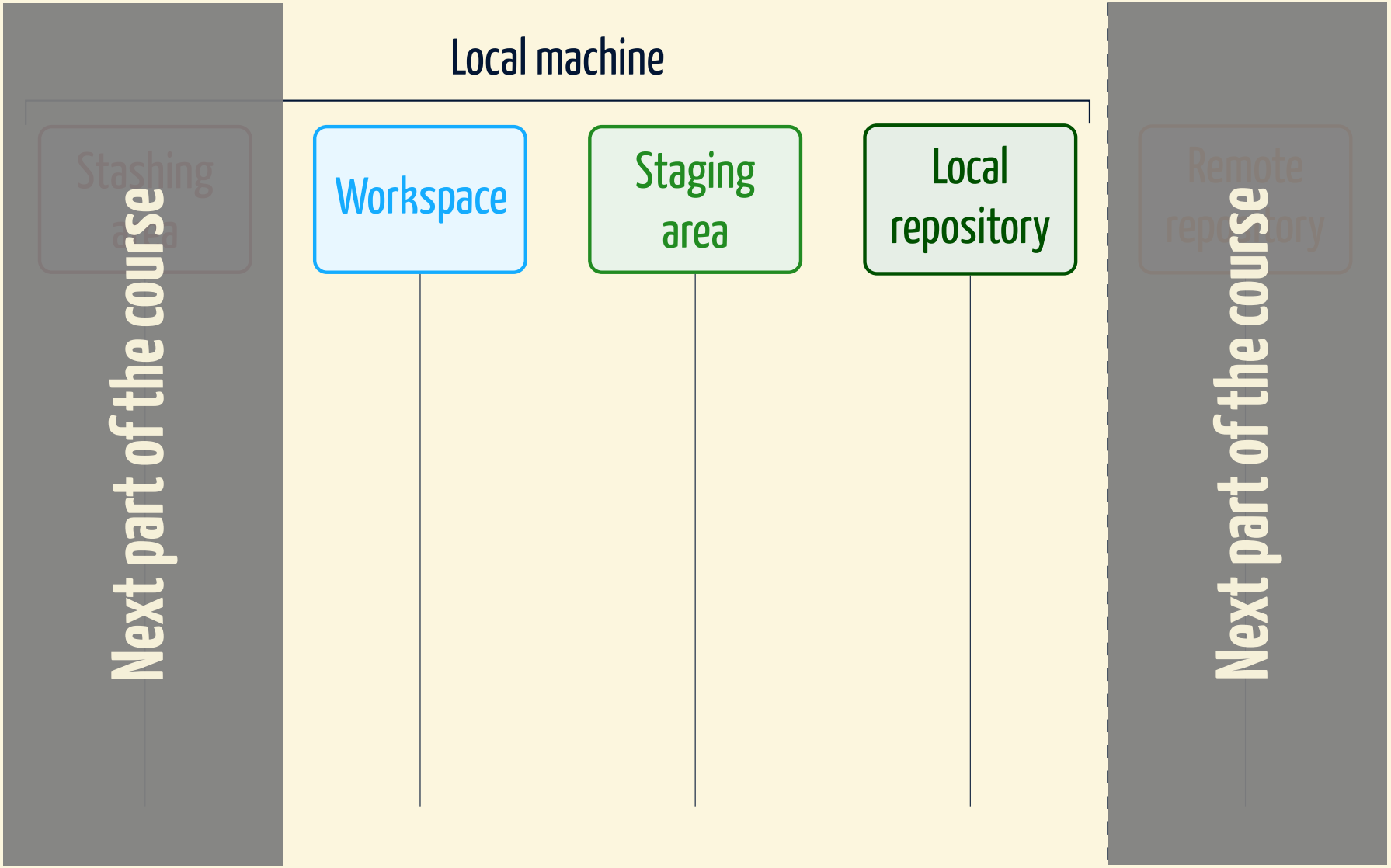



**It's all about having this picture clear in mind and understand how git commands affect it**

# The correct abstract mental setup



# How to use Git locally?

# Preliminary steps

## Be sure to introduce yourself to Git on **each** machine from which you work

1. It is likely that Git is installed on your machine.
   - Check it in a terminal e.g. via `git version`
   - If needed, 🔗 install it
2. Optionally, 🔗 get/enable autocompletion in the terminal
3. Tell Git who you are and your email address

   → this information will be used to sign your work in history

```
$ git config --global user.name 'Alessandro Sciarra'
$ git config --global user.email 'sciarra@itp.uni-frankfurt.de'
```

4. Set your favourite editor e.g. to write commit messages

```
$ git config --global core.editor 'emacs -nw'
```

The dollar symbol `$` denotes the end of the prompt in the terminal. It will be from now on to denote commands to be used in the terminal.

# Asking for help about Git

1. There are 3 ways in terminal
   - `git help <command>` e.g. `git help config`
   - `git <command> --help` e.g. `git config --help`
   - `man git-<command>` e.g. `man git-config`
2. List of commands on the official reference
3. Ask Google

There is plenty of cheat-sheets online:

GitHub education GitLab Bitbucket

Every `git <command>` can be referred to as `git-command`, although the first notation has to be used to run the command.

# Creating a repository

## It is as simple as running one command

```
$ git config --get user.name
Alessandro Sciarra
$ git config --get user.email
sciarra@itp.uni-frankfurt.de
# Suppose to be in a folder you want to turn into a repository
$ pwd
/home/asciarra/Documents/first-repo
$ ls -a
.  ..  Paper.aux  Paper.log  Paper.out  Paper.pdf  Paper.tex
```

# Creating a repository

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```

```
$ git init  # <--- Here you go!
Initialised empty Git repository in ~/Documents/first-repo/.git/
$ ls -a
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# Creating a repository

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Initialised empty Git repository in ~/Documents/first-repo/.git/
$ ls -a
.  ..  .git  Paper.aux  Paper.log  Paper.out  Paper.pdf  Paper.tex
```

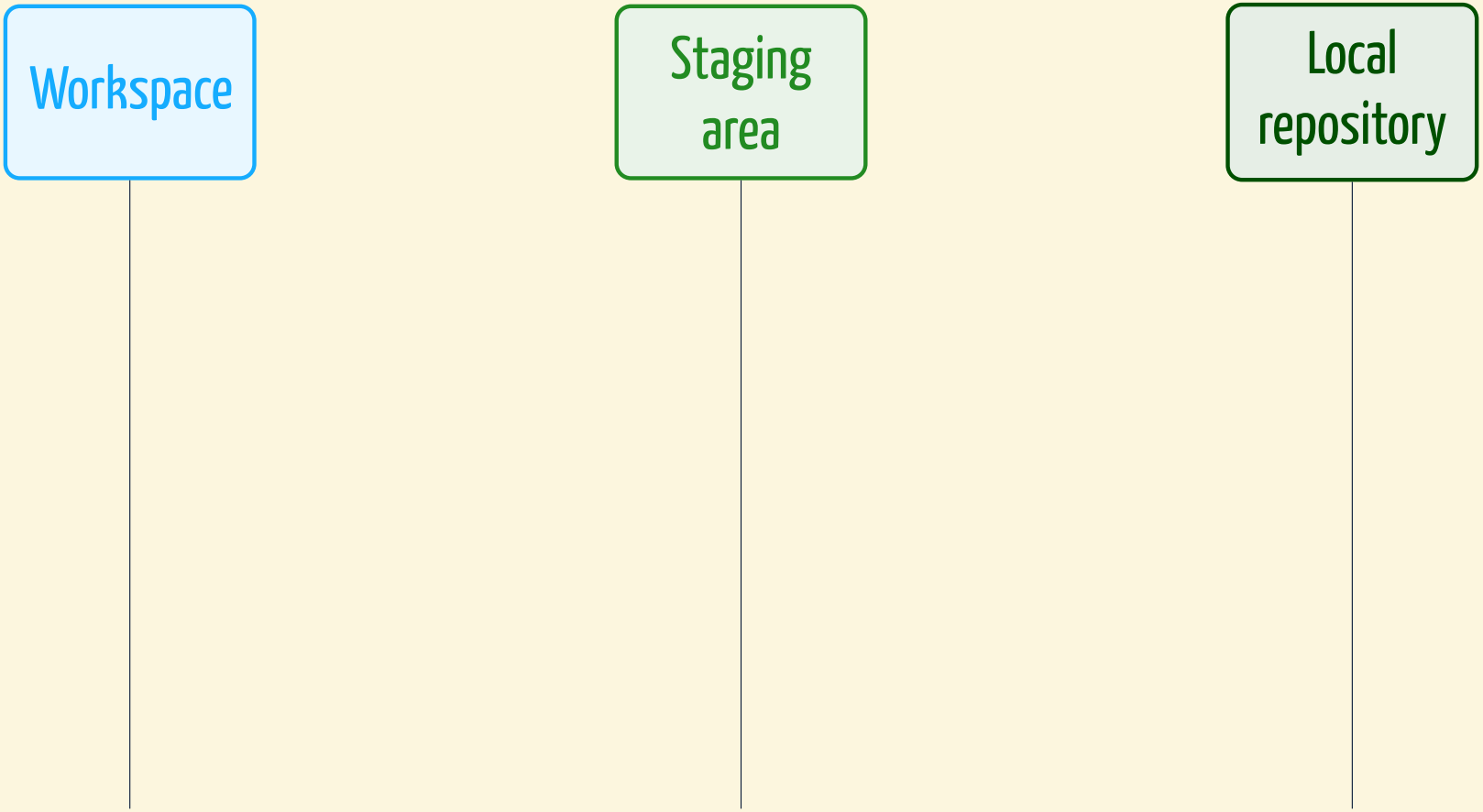
**Do not shoot yourself!**

Never ever touch by hand the content of the `.git` folder.

# What comes next?

# What comes next?

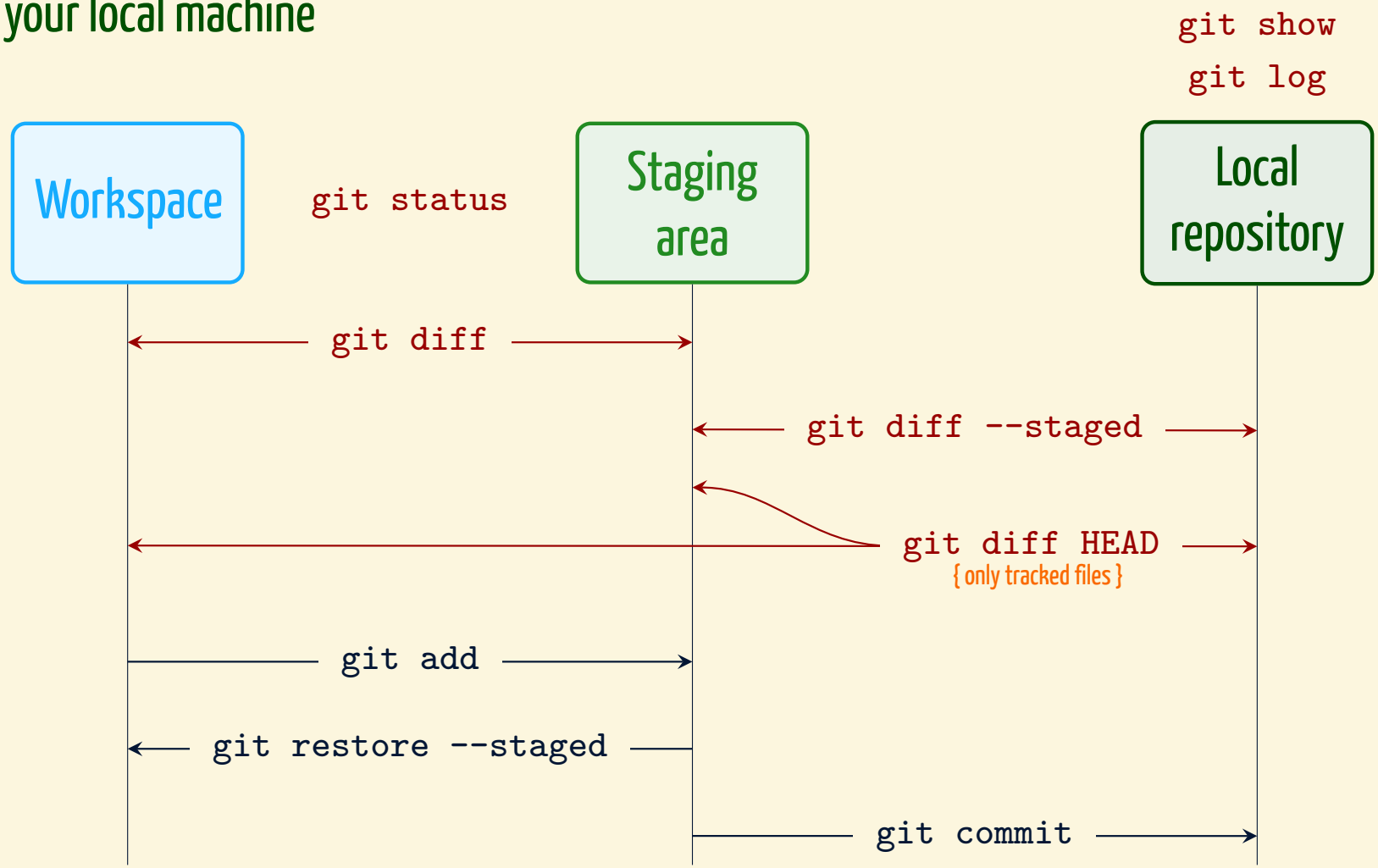
## On your local machine




Commands marked in dark red do not change anything in the repository!

# What comes next?

## On your local machine




Commands marked in dark red do not change anything in the repository!



Git introduced `git restore` in v2.23 but this stayed buggy for a while. Use it from v2.27 on, otherwise use `git reset`.

# Git status

```
$ git status
On branch main

No commits yet

Untracked files:
  (use "git add <file>..." to include in what will be committed)
    Paper.aux
    Paper.log
    Paper.out
    Paper.pdf
    Paper.tex

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

**You do not want to put everything in a repository!**

It is possible to tell git to ignore some files, like temporary ones

# Letting Git ignore some files

```
$ printf '*.%s\n' aux log out pdf > .gitignore
$ cat .gitignore
*.aux
*.log
*.out
*.pdf
$ git status
On branch main

No commits yet

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

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

github/gitignore

for LaTeX projects

# Our first commit

## In your terminal

```
$ git log
fatal: your current branch 'main' does not have any commits yet
$ git add .gitignore
$ git status
On branch main

No commits yet

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

Untracked files:
  (use "git add <file>..." to include in what will be committed)
    Paper.tex
$ git commit
```

# Our first commit

## In your favourite editor

```
# Please enter the commit message for your changes. Lines starting
# with '#' will be ignored, and an empty message aborts the commit.
#
# On branch main
#
# Initial commit
#
# Changes to be committed:
#       new file:   .gitignore
#
# Untracked files:
#       Paper.tex
#
```

# Our first commit

## In your favourite editor

```
Add .gitignore file for TeX project

# Please enter the commit message for your changes. Lines starting
# with '#' will be ignored, and an empty message aborts the commit.
#
# On branch main
#
# Initial commit
#
# Changes to be committed:
#       new file:   .gitignore
#
# Untracked files:
#       Paper.tex
#
```

# Our first commit

## In your terminal

```
$ git log
fatal: your current branch 'main' does not have any commits yet
$ git add .gitignore
$ git status
On branch main

No commits yet

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

Untracked files:
  (use "git add <file>..." to include in what will be committed)
    Paper.tex
$ git commit
# Your editor opens -> type commit message, save and exit
[main (root-commit) bb8c78b] Add .gitignore file for TeX project
 1 file changed, 4 insertions(+)
 create mode 100644 .gitignore
```

# Inspecting history

```
$ git log
commit bb8c78b68075dacf8467420bc00867c73ef5ba8c (HEAD -> main)
Author: Alessandro Sciarra <asciarra@fias.uni-frankfurt.de>
Date:   Thu Dec 23 10:13:05 2021 +0100

    Add .gitignore file for TeX project
$ git log --oneline
bb8c78b (HEAD -> main) Add .gitignore file for LaTeX project
```

Use a pager to avoid polluting terminal

```
$ git config --global core.pager 'less -+$LESS -R'
```

Use `git show` or `git show <SHA1>` to inspect what has been done in last or given commit

# Our second commit

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

nothing added to commit but untracked files present
(use "git add" to track)
$ git add Paper.tex # Always add to the staging
                    # area before committing!
$ git status
On branch main
Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        new file: Paper.tex
$ git commit -m 'Add paper main document'
[main 9c6154d] Add paper main document
 1 file changed, 147 insertions(+)
 create mode 100644 Paper.tex
```

# Use good commit messages

```
$ git log --oneline
9c6154d (HEAD -> main) Add paper main document
bb8c78b Add .gitignore file for LaTeX project
```

- Write them like an email to yourself (or to the other developers)
  → Subject line + body, follow the 50/72 rule
- Subject: Summarize what has been done
  → **Use present tense and no period at the end!**
- Body: After empty line, document why you made the changes
  ↳ { add one only if needed }

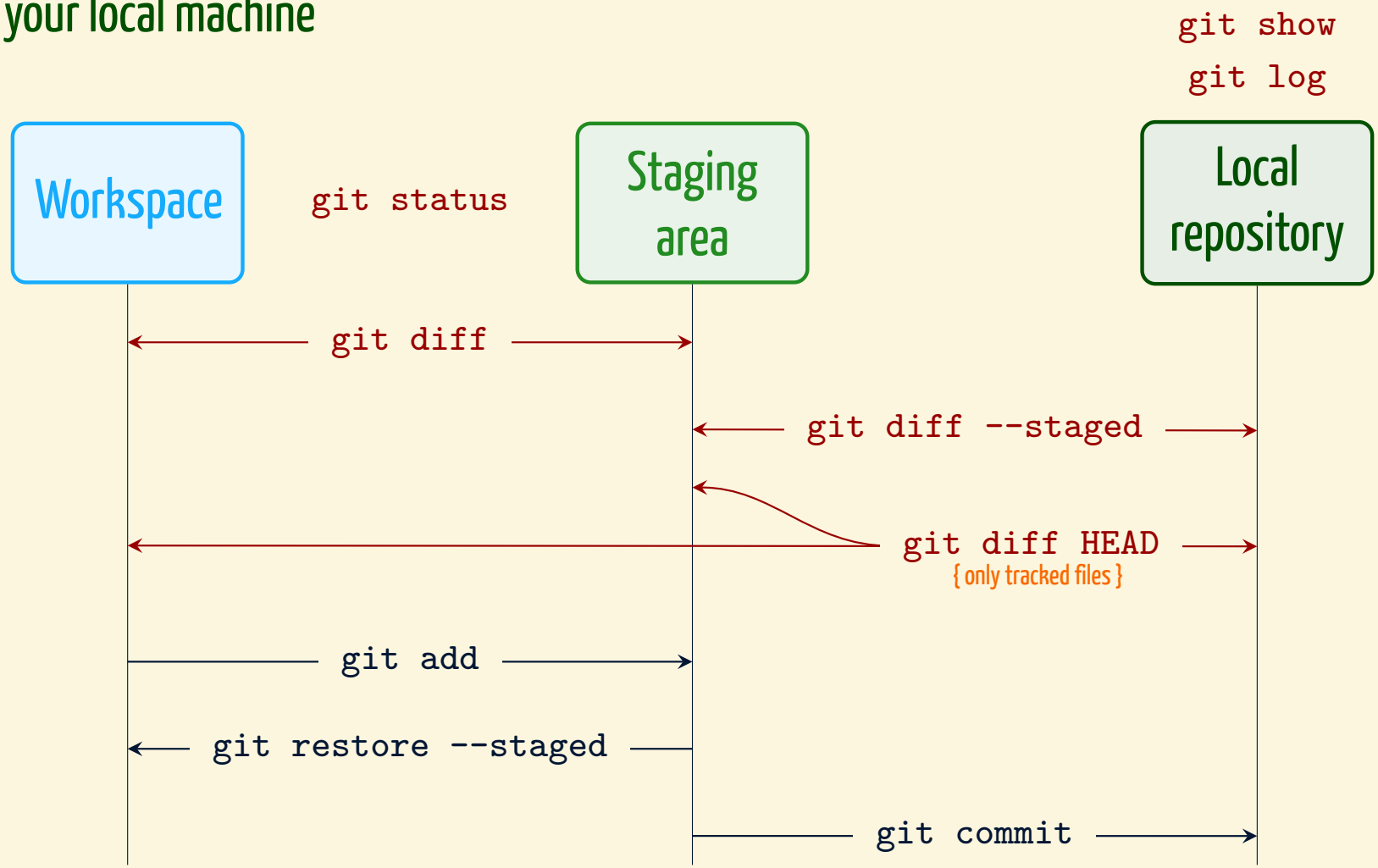
**Good commits**

Commit small and conceptually separated changes, commit often and do not add binary files to your repository.

In coding projects, although not always possible/trivial, try to commit working/compiling code.

# Back to our mental picture

## On your local machine




Commands marked in dark red do not change anything in the repository!



Git introduced `git restore` in v2.23 but this stayed buggy for a while. Use it from v2.27 on, otherwise use `git reset`.

# Working and displaying changes

## In your terminal

```
# Make some changes
$ git status
On branch main
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: Paper.tex

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

# Working and displaying changes

## In your pager, e.g. `less`

```
diff --git a/Paper.tex b/Paper.tex
index 3c408e5..3669114 100644
--- a/Paper.tex
+++ b/Paper.tex
@@ -42,7 +42,7 @@ pdftitle={LaTeX Seminar for PhD students}
     {Sprecher \& Seminarleiter}%
 }

-\date{\May 16, 2024}
+\date{23. Dezember 2021}

 \newcommand{\etc}{etc.}
 \newcommand{\zB}{z.B.}
```

# Working and displaying changes

## In your terminal

```
# Make some changes
$ git status
On branch main
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: Paper.tex

no changes added to commit (use "git add" and/or "git commit -a")
$ git diff
$ git diff --staged  # Nothing in the staging area!
$ git add Paper.tex
$ git diff           # No changes anymore in the workspace!
$ git diff --staged  # Our changes are now staged
$ git commit -m 'Fix date for main document'
# ...
```

# What else can I easily explore?

- Stage all tracked modified files at once

```
git add -u
```

- Stage partial modification in a file

```
git add -p
```

- Define your aliases

```
git config --global alias.unstage 'restore --staged --'
# From now on, you can use 'git unstage'
```

- Let git correct you when you mistype*

```
git config --global help.autocorrect 1
```

- Change/correct your last commit message

```
git commit --amend
```

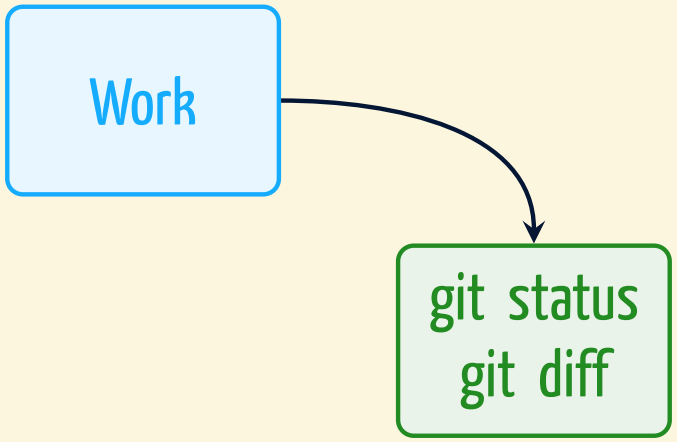
* If you want a friend to correct your mistyped last command **in general** in the terminal, check-out this hilarious project .

# Summary and conclusions

# Your workflow from now on, right?

Work

# Your workflow from now on, right?



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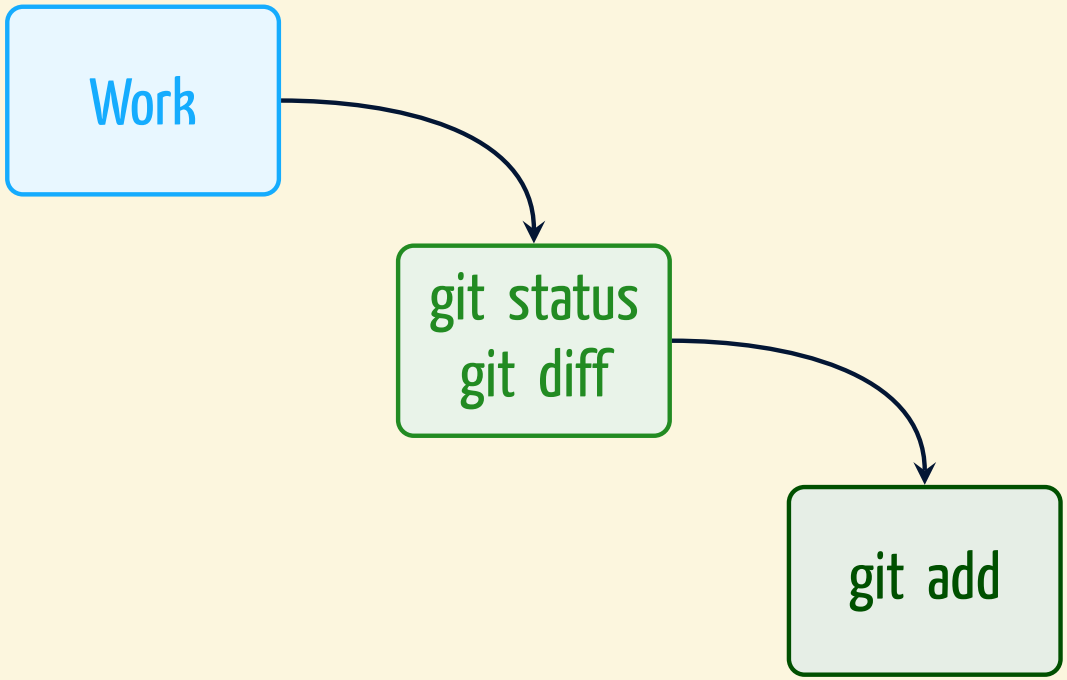
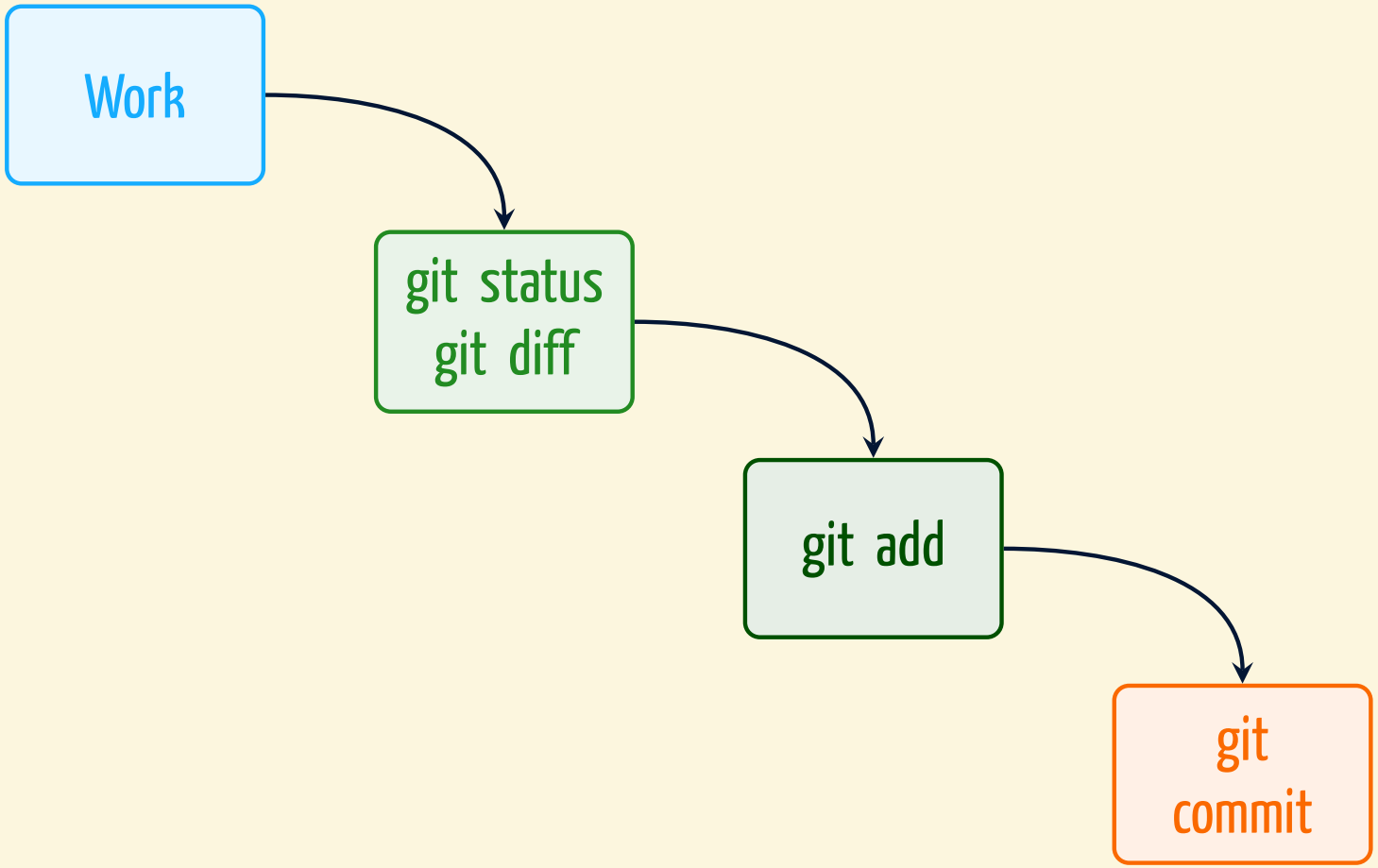


# Your workflow from now on, right?



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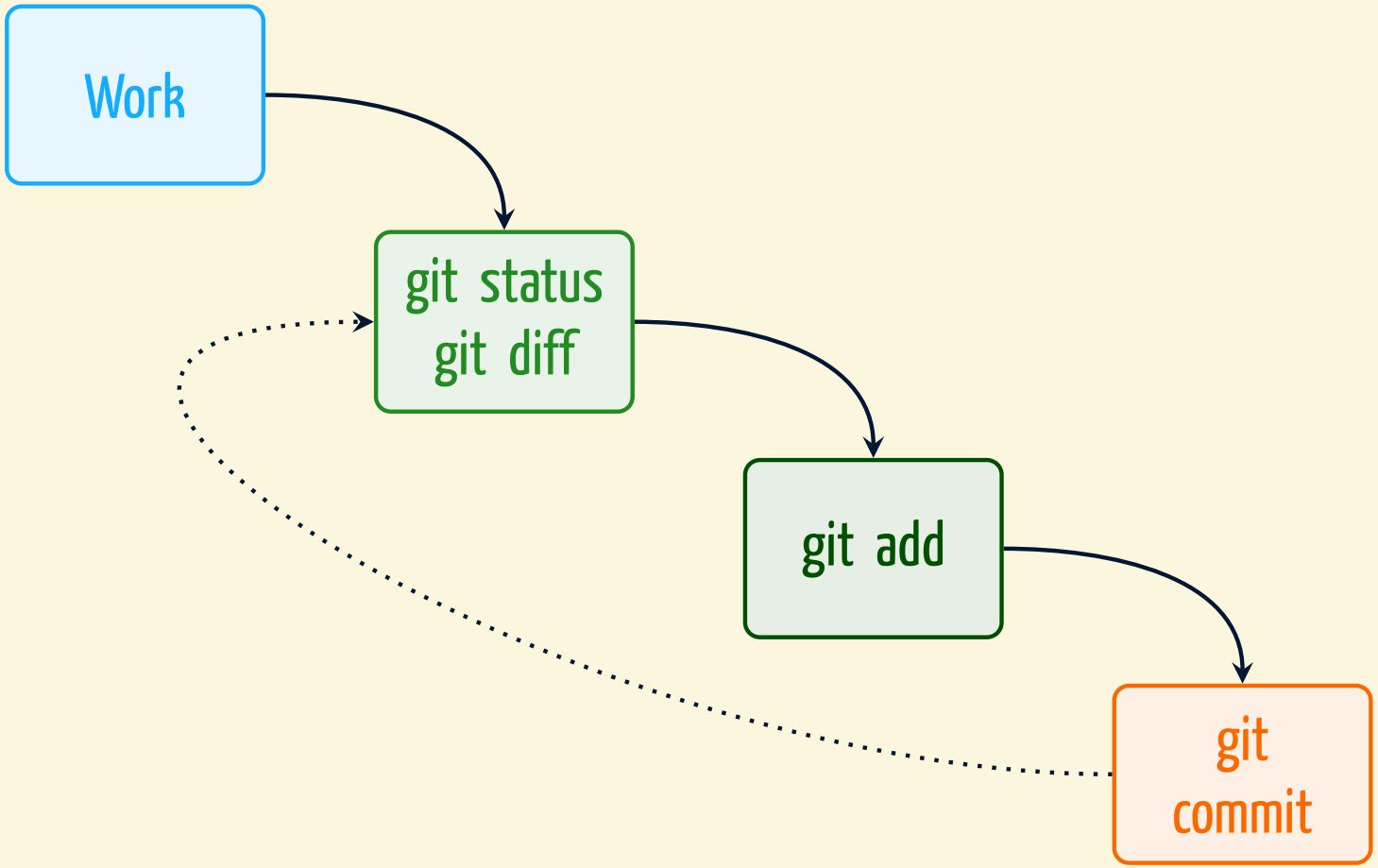

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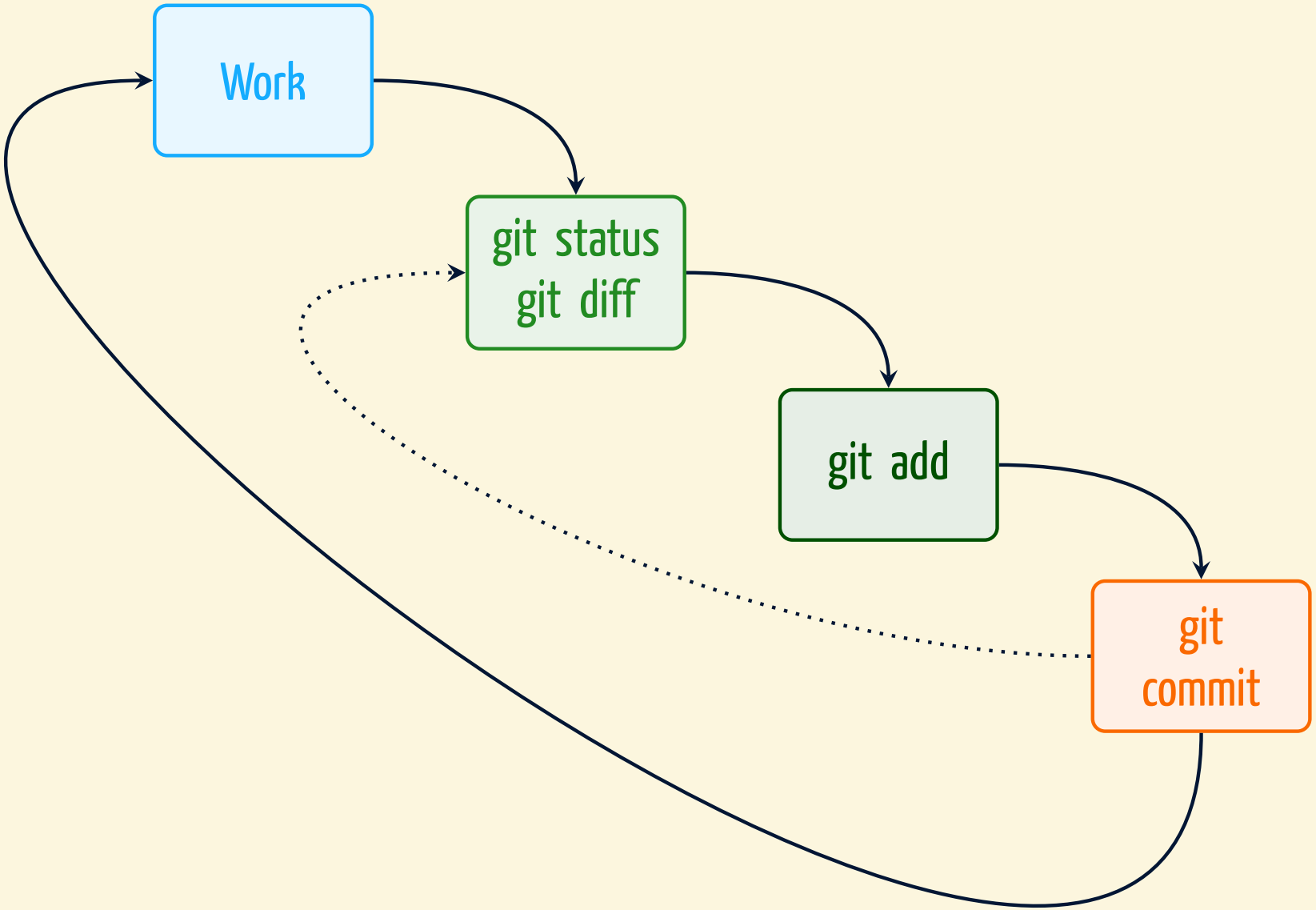

# That's **NOT** all folks

1. Start using Git. **Now.** Not tomorrow or next week, today!
   $\longrightarrow$ Repeat what done on these slides

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3. Git is much more than this!
   → Attend next part: «Let's git **together**»

```
git clone
git branch
git switch
git checkout
git merge
git pull
git push
```

# That's **NOT** all folks

Thank you!

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**Believe me, it's worth it!**