Let's Git together

Alessandro Sciarra

CRC-TR 211 – Software Development Center

6 July 2023

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

AxelKrypton

PUNCH 4NFDI

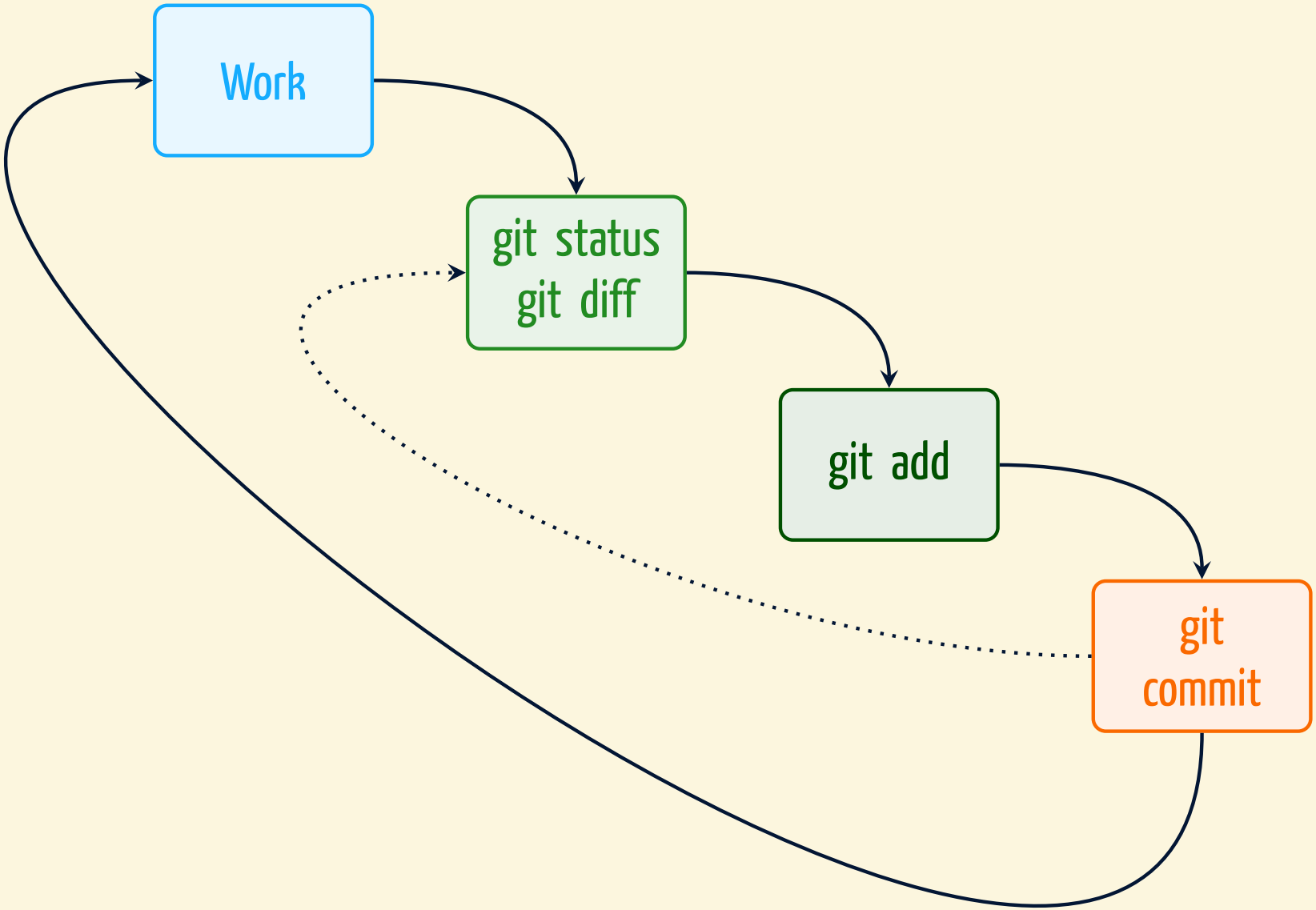
CRC-TR 211 Strong-interaction matter under extreme conditions

Outline of the talk

1. A short recap from last time
2. Using branches
3. Working with remote repositories
4. The stashing area
5. Bare repositories
6. The remaining git commands
7. Conclusions

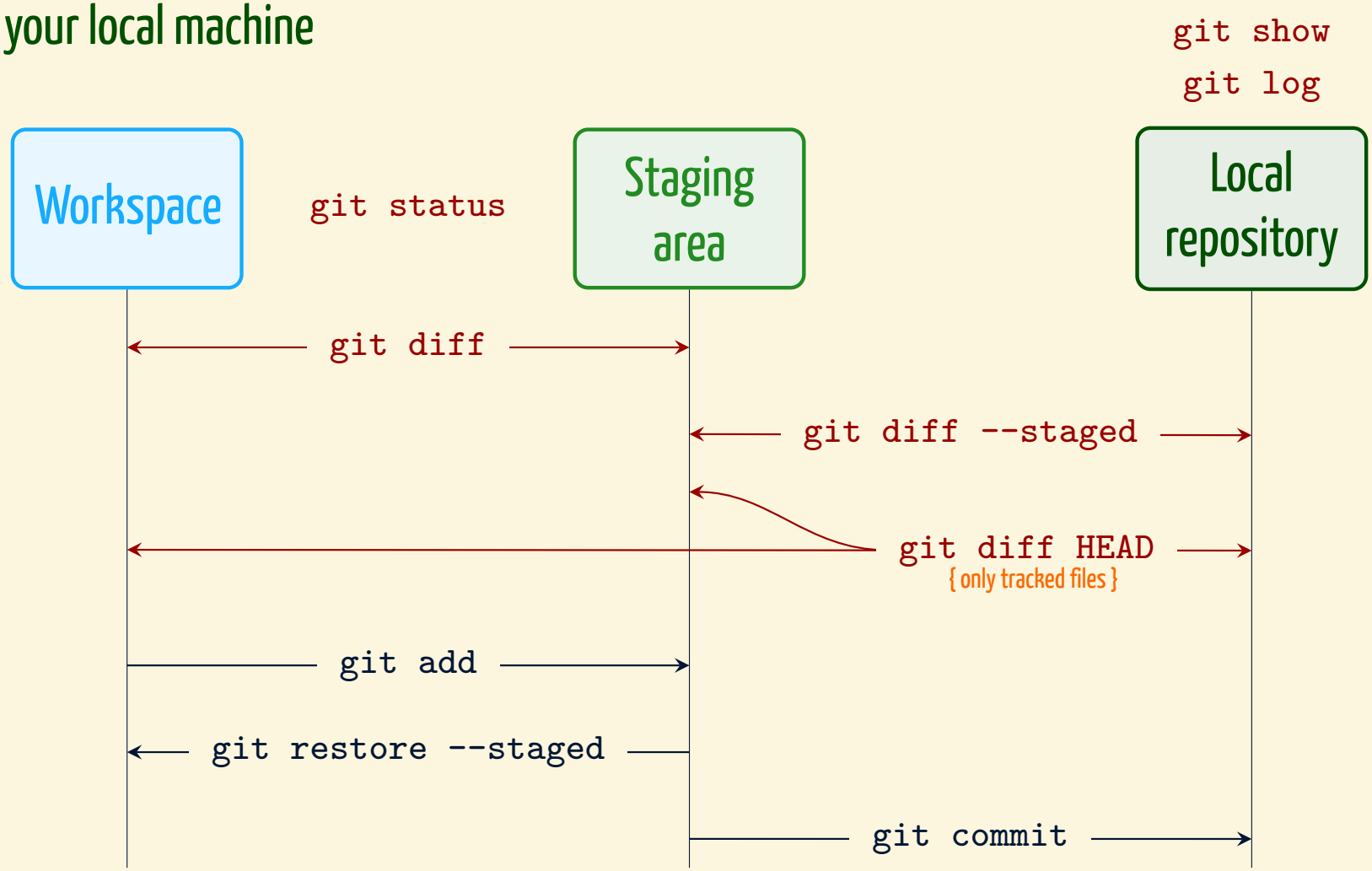
A short recap from last time

By now, this is how your workflow looks like



Our mental picture, so far

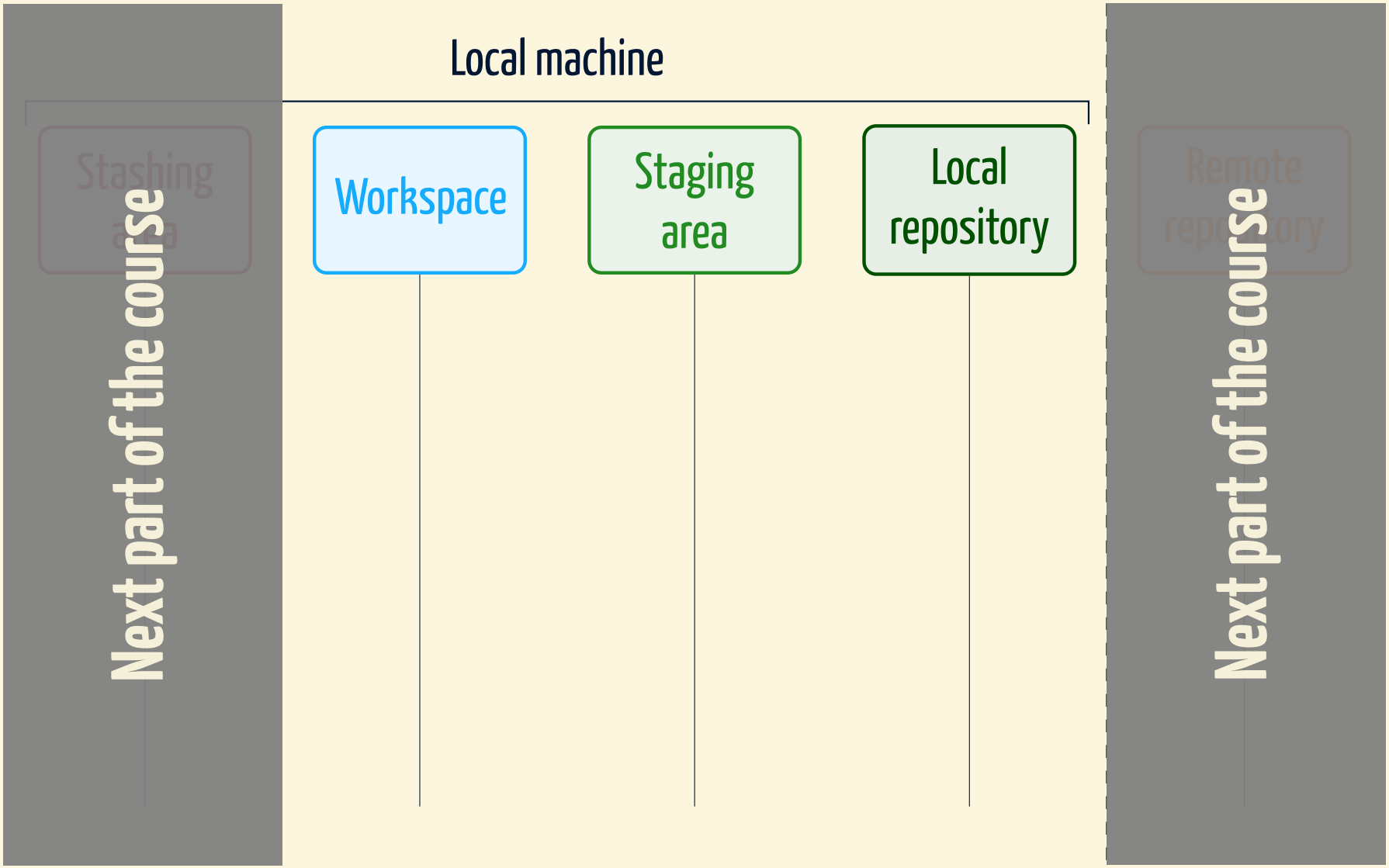
On your local machine



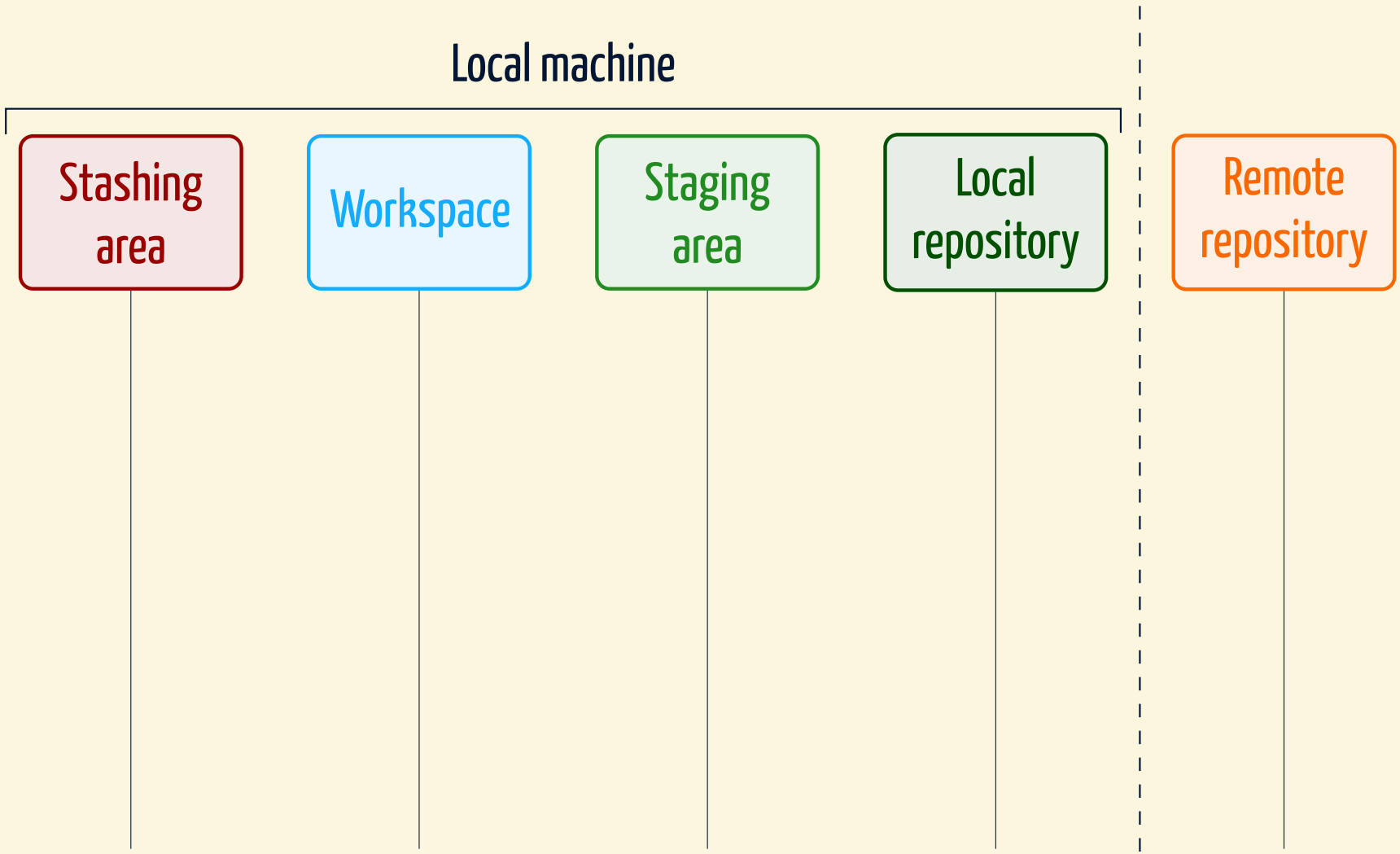
Commands marked in dark red do not change anything in the repository!

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

The complete correct abstract mental setup

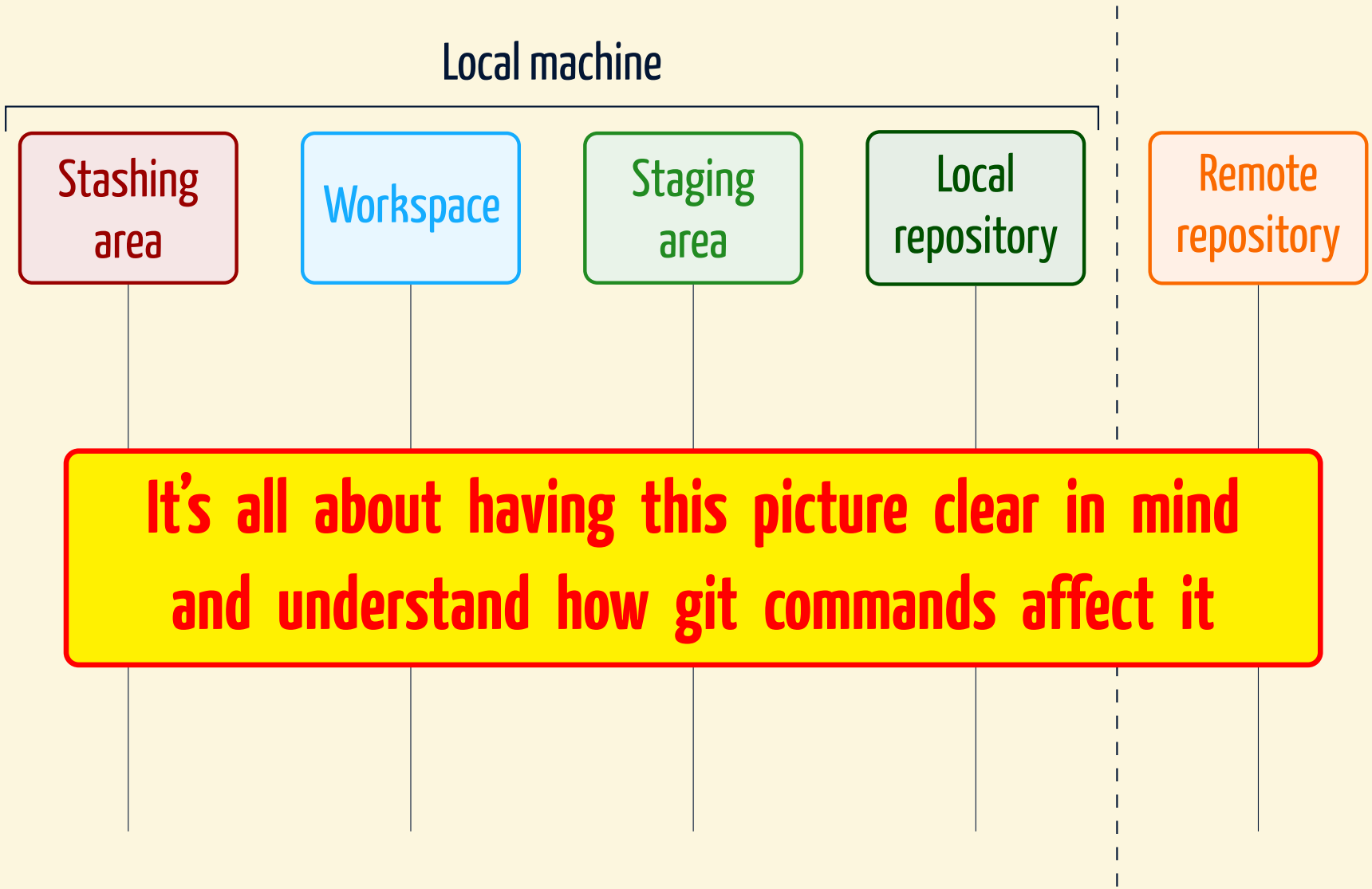


The complete correct abstract mental setup



Now we'll complete the picture

The complete correct abstract mental setup

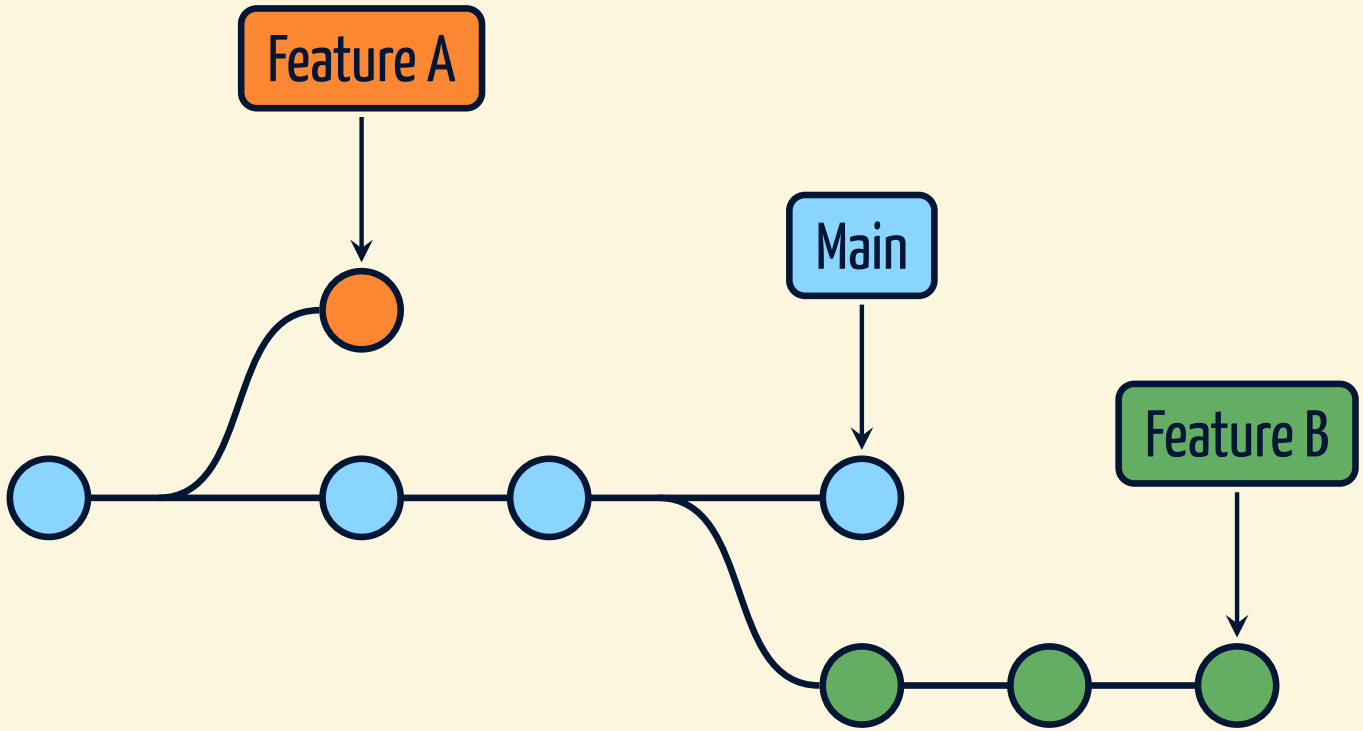


Now we'll complete the picture

Using branches

A key feature of Git

- Branches store **different versions of your project**
- Technically just pointers to a commit



A key feature of Git

- Branches store **different versions of your project**
- Technically just pointers to a commit
- They enable parallel development
  - Implement new features
  - Fix bugs
  - Try out something
  - […]
- The always existing `main` branch:
  - By default created at initialization
  - Development should be done on other branches
  - Till ~2020 it was called `master`

Git branch

```
# List all existing local branches
$ git branch
* main
```

```
# Create a new branch
$ git branch new-branch
$ git branch
* main
  new-branch
```

```
# Delete a branch
$ git branch -d new-branch
Deleted branch new-branch (was a45b032).
$ git branch
* main
```

Git is safe

If a modifications would be lost, Git does not allow you to delete the branch using the `-d` option. Use the `-D` option, instead, to force the deletion.

Git switch

This will in general change your workspace!

```
# Switching to another branch
$ git branch
* main
  new-branch
$ git switch new-branch
Switched to branch 'new-branch'
$ git branch
  main
* new-branch
```

Git is safe

You may switch branches with uncommitted changes in the work-tree if and only if said switching does not require clobbering those changes.

Before v2.23 of Git (August 2019), the command `git checkout` needed to be used to switch branch.

Git switch

This will in general change your workspace!

```
# Switching to another branch
$ git branch
* main
  new-branch
$ git switch new-branch
Switched to branch 'new-branch'
$ git branch
  main
* new-branch
```

```
# Creating and switching to a new branch at once
$ git switch -c another-branch
Switched to a new branch 'another-branch'
$ git branch
* another-branch
  main                    # Pay attention from which
  new-branch              # branch you create a new one!
```

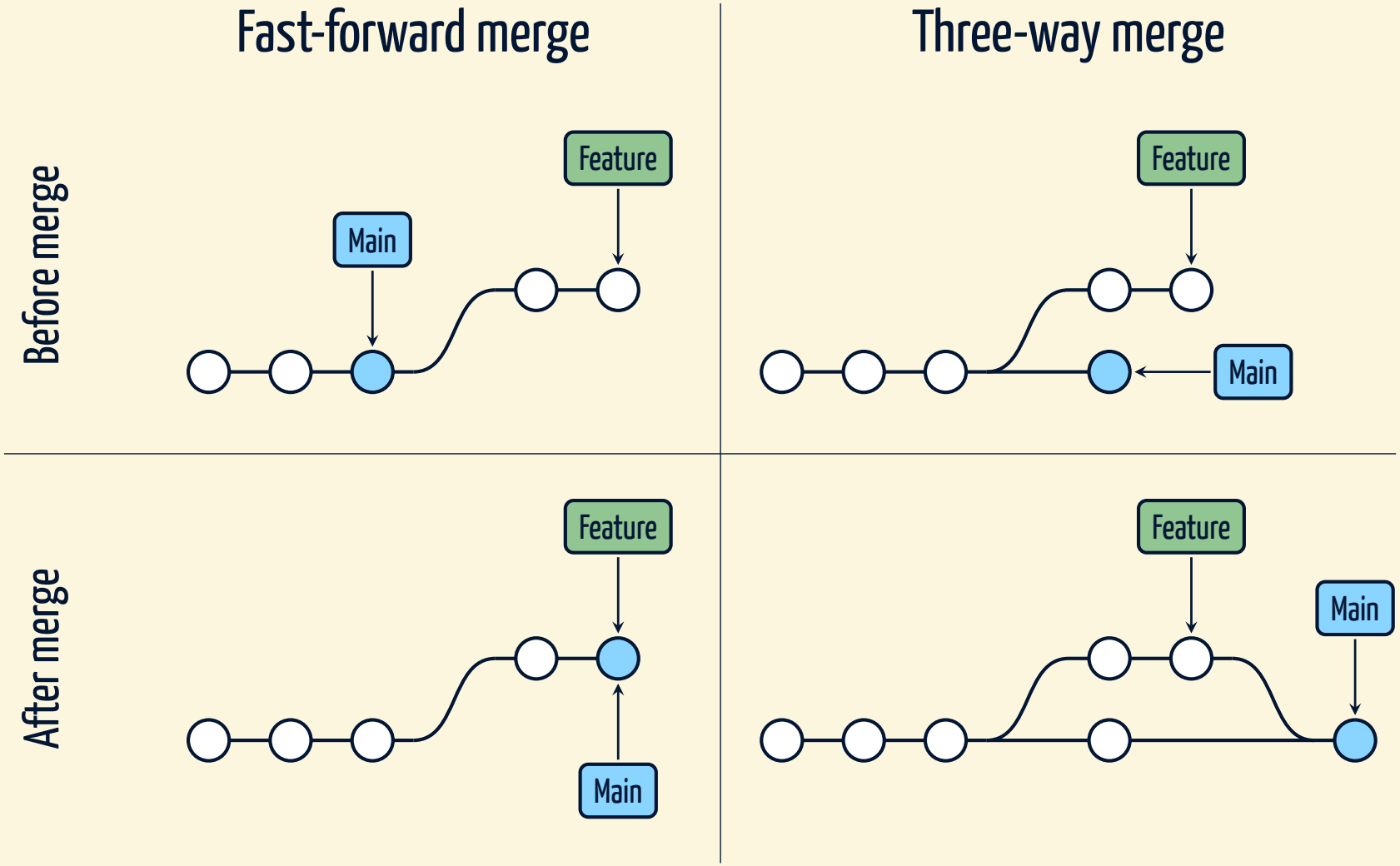

Before v2.23 of Git (August 2019), the command `git checkout` needed to be used to switch branch.

Merging branches

- To merge means to unify the snapshots of two different branches
- This is automatically done by Git in a clever way
- When Git does not know how to merge the content of some file, it will create a conflict
- If conflicts occur, the merge will not automatically finish
- A merge can be aborted in case of conflicts with the `--abort` option { The content of the repository will be restored to the state before issuing the merge command }
- To fix conflicts, open and manually adjust files where Git failed

Git is safe, conflicts are not a bad thing!

Different types of merge



The three-way nomenclature comes from the fact that Git uses three commits to generate the merge commit: the two branch tips and their common ancestor.

Git merge: How does it work?

1. If possible, Git performs a fast-forward merge
2. Otherwise a three-way merge is done and a new commit created

Be sure to be on the correct branch!

```
git merge <source-branch>
```

It incorporates changes from the specified branch into the present branch!

```
# It is possible to force a three-way merge:
$ git merge --no-ff <source-branch>
```

Merge conflicts: Fixing procedure

```
# A general example
$ git merge <branch_name>
Auto-merging <file>
CONFLICT (content): Merge conflict in <file>
Automatic merge failed; fix conflicts and then commit the result.
```

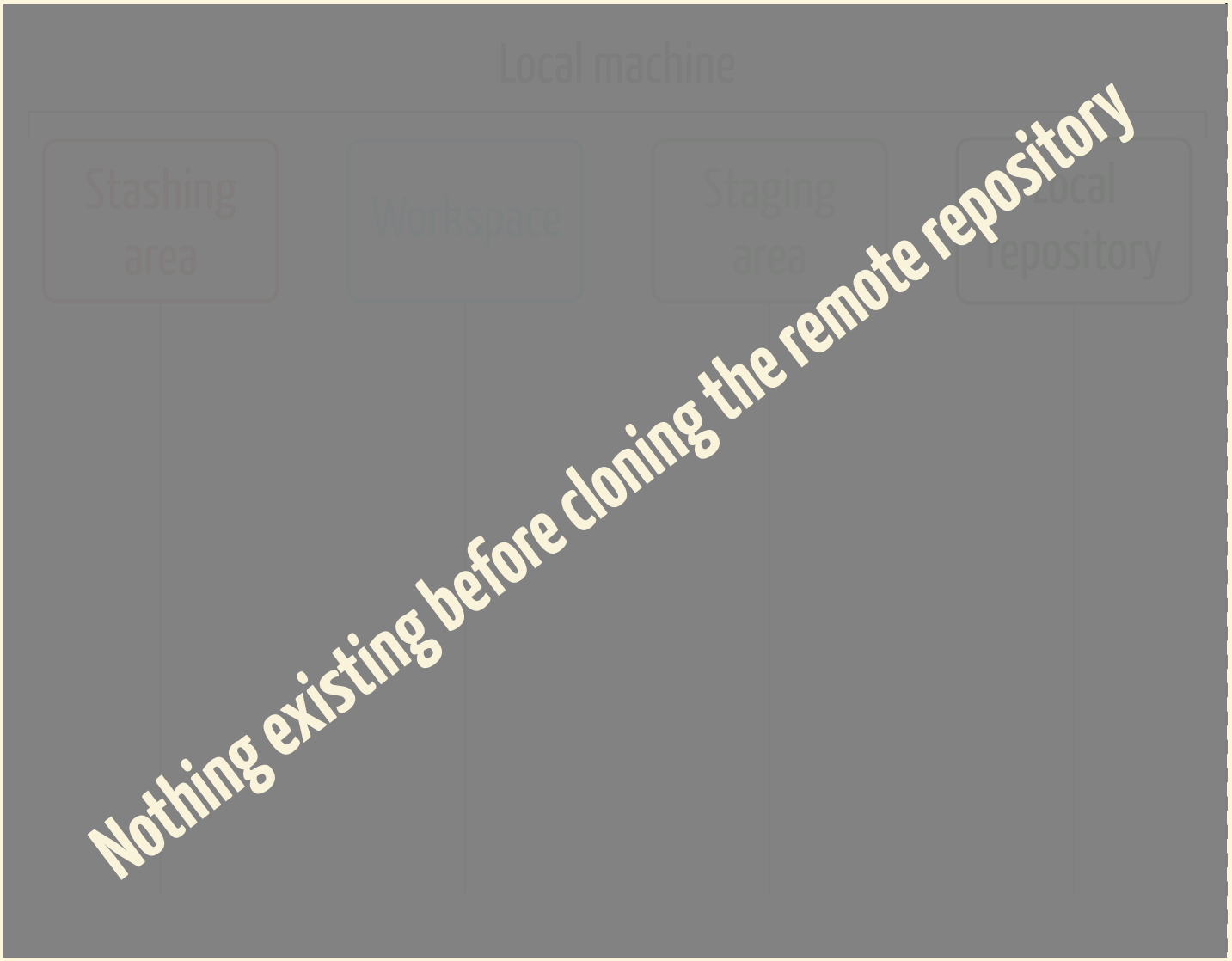
1. Run `git status` to see unmerged paths
2. Find problematic hunks in files that contain conflicts
   ↳ Look for delimiters in the files: `<<<<<<<`, `=======`, `>>>>>>>`
3. Remove delimiters and adjust content
4. Check the project works (e.g. compile, run tests)
5. `git add` the files with fixed conflicts
6. Commit added files
   ↳ Git propose you an auto-generated commit message

Live example!

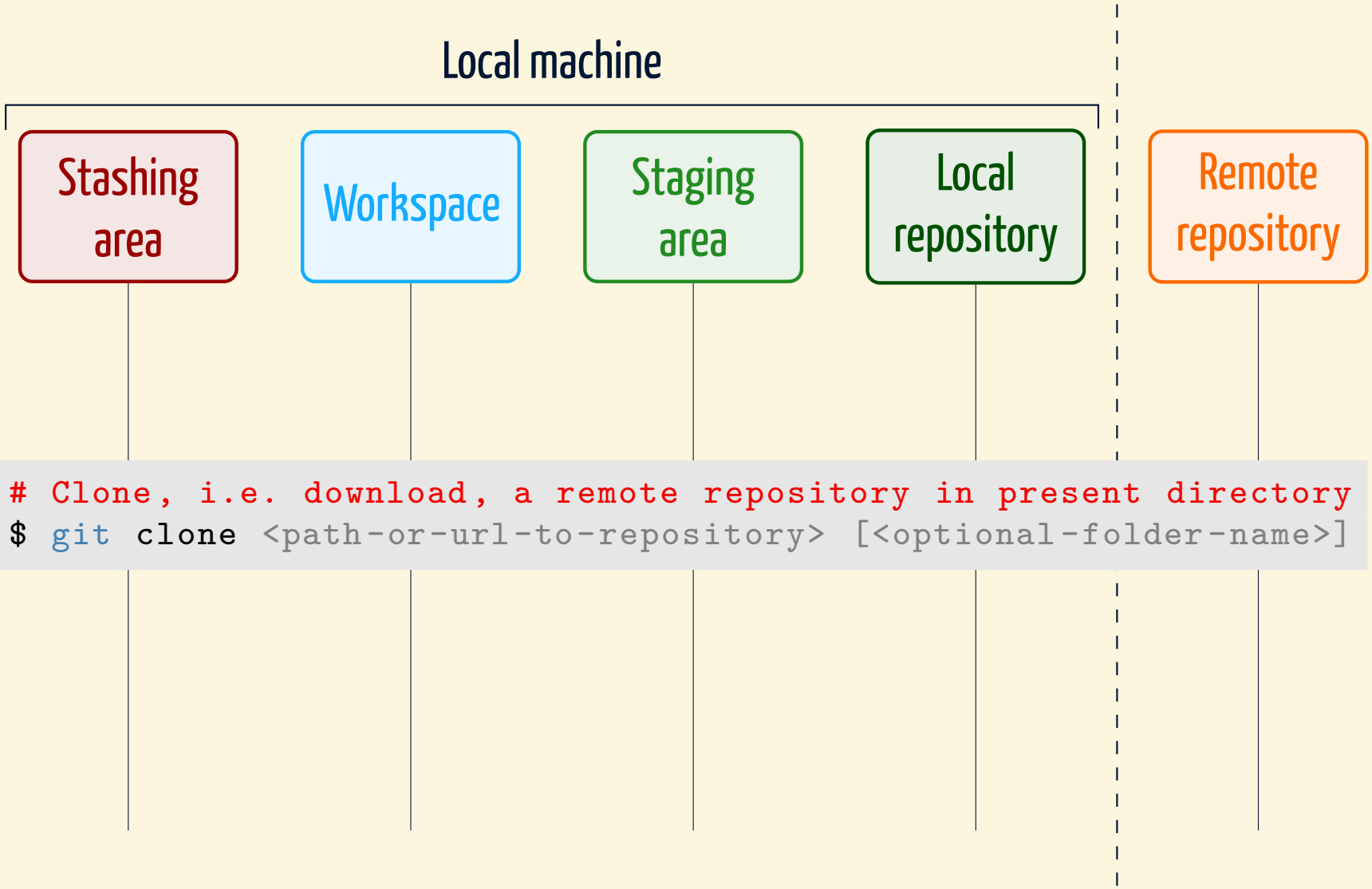
The Git prompt I use in my **bash** terminal is a customization of this one !

Working with remote repositories

Cloning a remote repository



Cloning a remote repository




```
# Clone, i.e. download, a remote repository in present directory
$ git clone <path-or-url-to-repository> [<optional-folder-name>]
```

Cloning a remote repository

```
# Clone the repository of this course
$ ls
$ git clone git@github.com:AxelKrypton/Git-crash-course.git
Cloning into 'Git-crash-course'...
remote: Enumerating objects: 82, done.
remote: Counting objects: 100% (66/66), done.
remote: Compressing objects: 100% (47/47), done.
remote: Total 82 (delta 26), reused 52 (delta 18), pack-reused 16
Receiving objects: 100% (82/82), 4.47 MiB | 4.49 MiB/s, done.
Resolving deltas: 100% (29/29), done.
$ ls
Git-crash-course
```

The local repository is aware of the remote one!

Git remote

In the local repository, the remote one is (by default) referred as **origin**

```
# Check out the remote information
$ cd Git-crash-course
$ git remote
origin
$ git remote -v
origin    git@github.com:AxelKrypton/Git-crash-course.git (fetch)
origin    git@github.com:AxelKrypton/Git-crash-course.git (push)
$ git remote rename origin GitHub
$ git remote
GitHub
# A repository can have multiple remote locations
$ git remote add MyServer <url-to-new-remote>
$ git remote
GitHub
MyServer
```

First interactions with the remote repository

```
$ git branch -r
  origin/HEAD -> origin/main
  origin/main
  origin/experiment
$ git branch -a
* main
  remotes/origin/HEAD -> origin/main
  remotes/origin/main
  remotes/origin/experiment
```

```
# Switch to a new branch that mirrors the state of a remote one
$ git switch experiment
Branch 'experiment' set up to track remote branch 'experiment'
    from 'origin'.
Switched to a new branch 'experiment'
$ git branch -vv
* experiment    a1d62e63 [origin/experiment] last-commit-message
  main          a1d62e63 [origin/main] last-commit-message
```

We'll come back to the idea of tracking in a moment!

Fetching and pulling

When collaborating in a project, the remote repository will in general change because of other people's work

```
$ git fetch <remote-name>
```

- Information about the remote repository (e.g. branches) can be updated by fetching from a remote
- Fetching does not change the local workspace!

Fetching and pulling

When collaborating in a project, the remote repository will in general change because of other people's work

```
$ git pull <remote-name> <remote-branch-name>
```

- Pulling instead is updating both the information about the remote repository and the local workspace
- Git pull is actual a shortcut to do a fetch followed by a merge with a remote branch

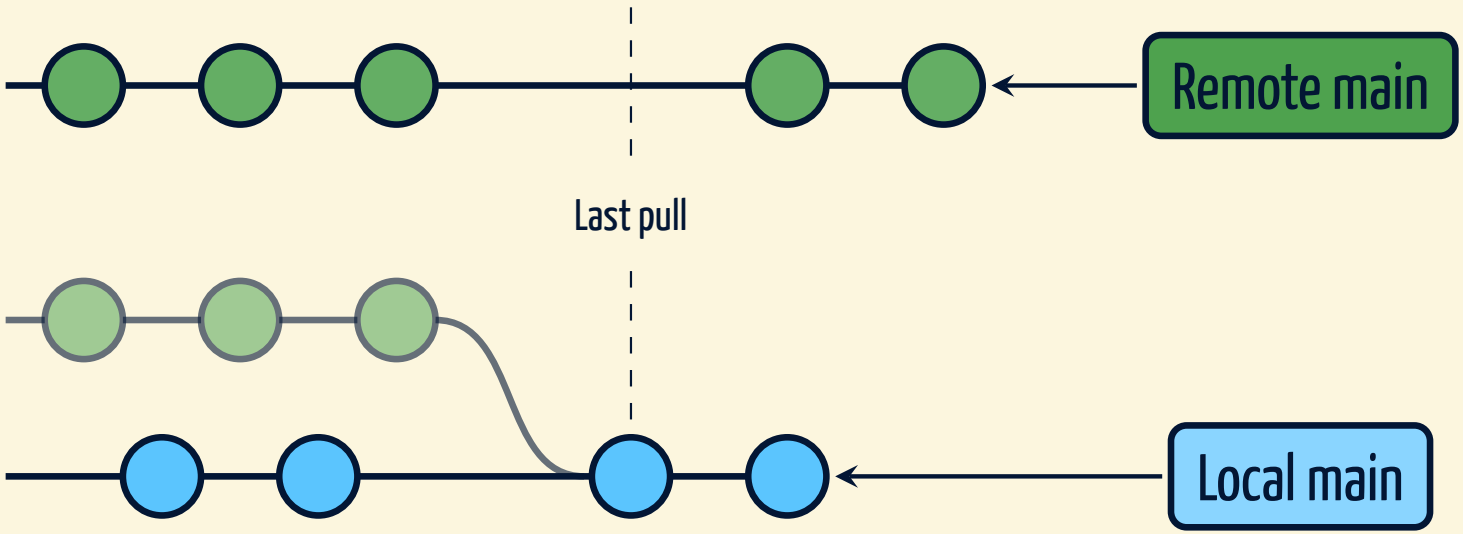
Fetching and pulling: Examples

```
# If there is only one remote, you can omit it
$ git fetch origin
a1e8fb5..45e66a4 main -> origin/main
a1e8fb5..9e8ab1c develop -> origin/develop
* [new branch] some-feature -> origin/some-feature
# To remove locally references to remote deleted branches:
$ git fetch --prune
From github.com:AxelKrypton/Git-crash-course
- [deleted]           (none)     -> origin/experiment
```

```
# Be sure to be on the correct branch before pulling
$ git branch
* main
$ git pull origin main
From github.com:AxelKrypton/Git-crash-course
* branch            main       -> FETCH_HEAD
Already up to date.
```

Fetching and pulling: Examples

If you created commits on the present branch, pulling it from remote will perform a merge and, if this is not a fast-forward merge, the editor to make a commit with an auto-generated message will be displayed to you. Conflicts might occur as well.



These 3-way merge commits because of pulling operations are not ideal and next time we'll learn how to avoid them.

Fetching and pulling: Examples

If you created commits on the present branch, pulling it from remote will perform a merge and, if this is not a fast-forward merge, the editor to make a commit with an auto-generated message will be displayed to you. Conflicts might occur as well.

```
$ git log --oneline
a45b032 (HEAD -> main) Some work done locally on main
6e5ea4b (origin/main, origin/HEAD) Last commit pulled
236d4af Previous history
# If I now pull and some new commit exists remotely after
# 6e5ea4b, a 3-way merge occurs and the editor will open
$ git pull origin master
[...]
```


These 3-way merge commits because of pulling operations are not ideal and next time we'll learn how to avoid them.

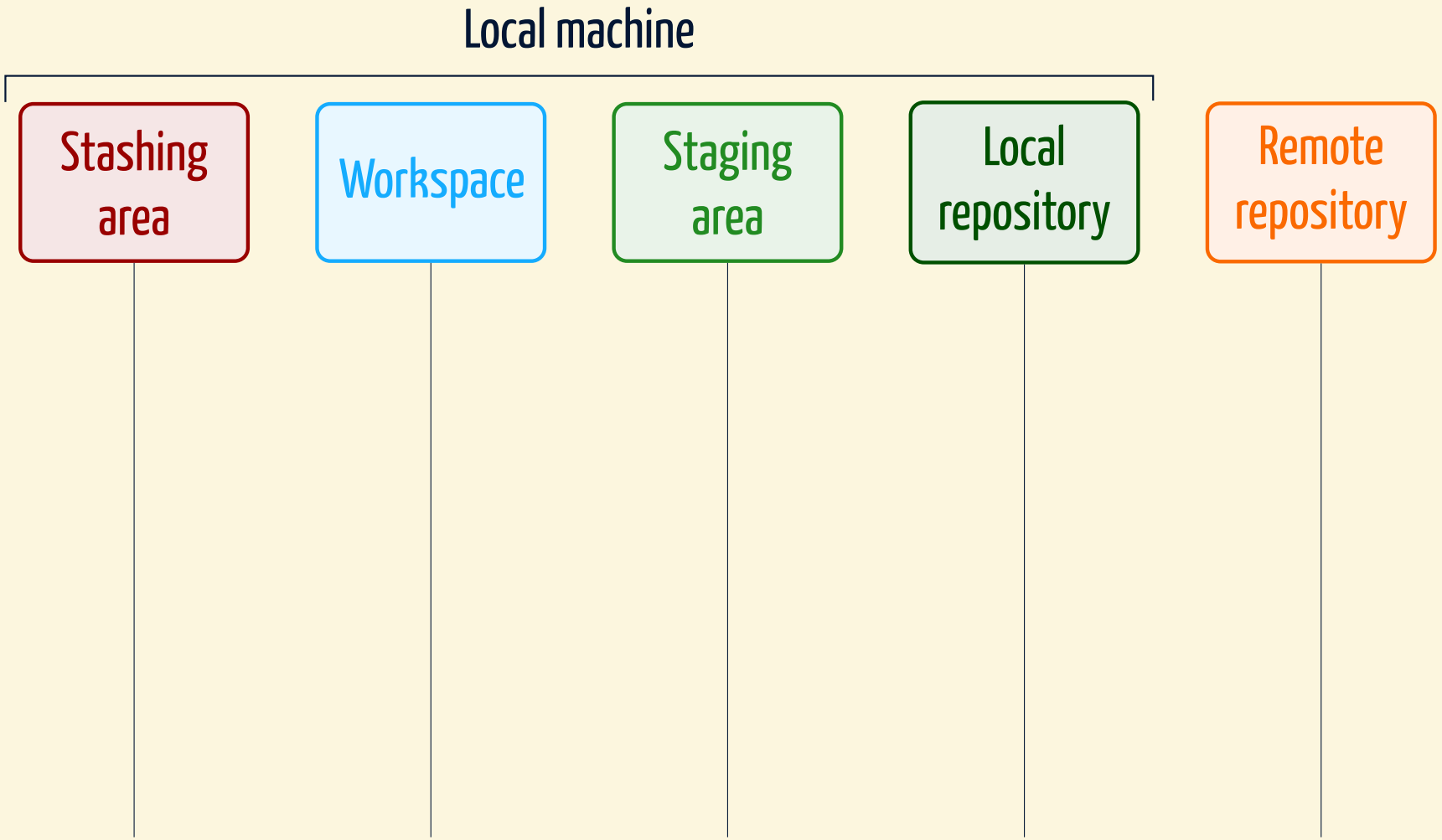
Pushing your own work

- To push means to make the changes done in the local repository available in the remote one, i.e. to update a remote branch with a local one
- Only changes that are committed are pushed
- If the remote and the local history diverge (i.e. you forgot to pull before committing), the push operation will be rejected

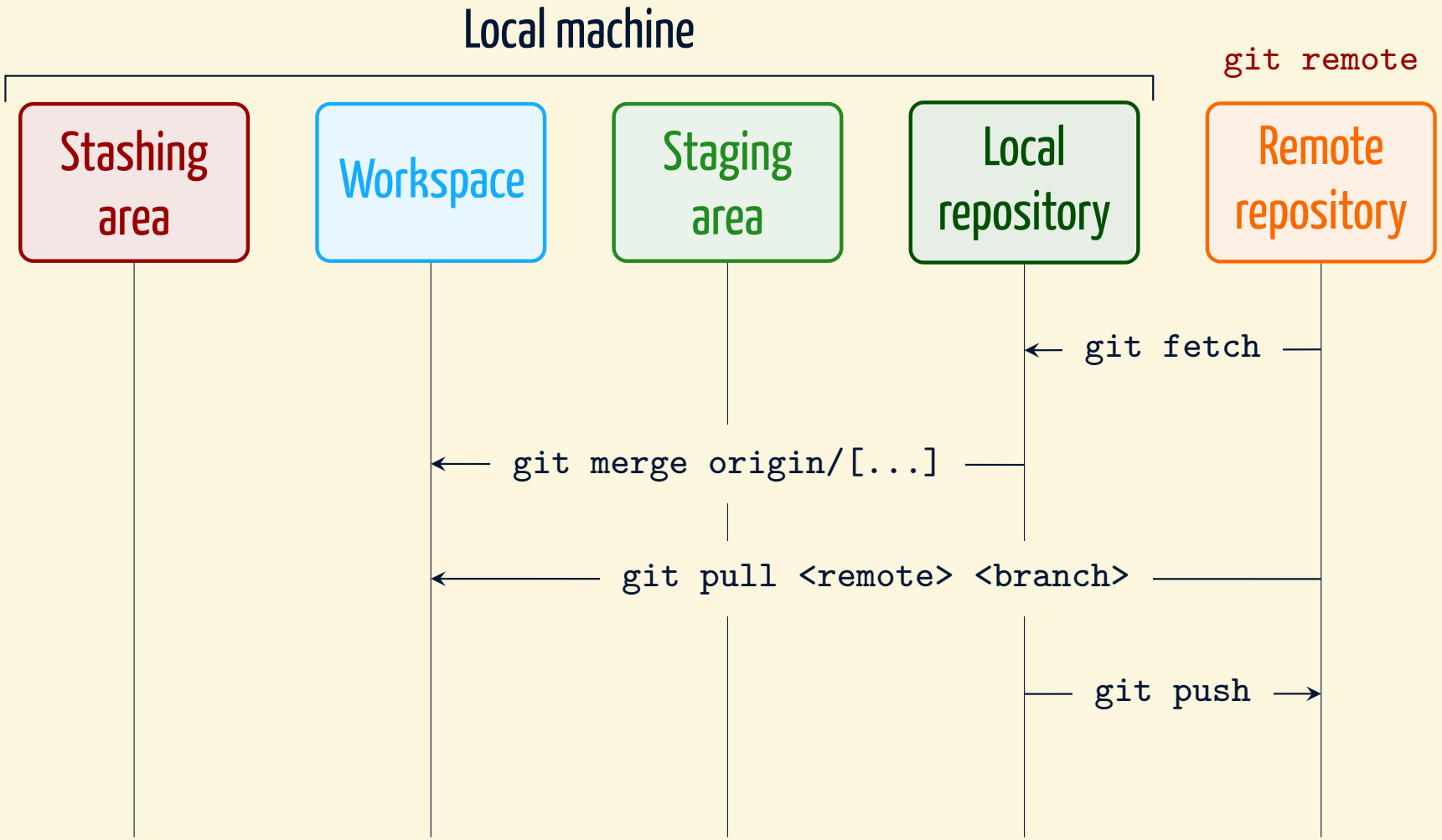
Push before saying to your collaborators you did some changes!

```
$ git push origin main
[...]
# To delete remote branches 'git push' is also used:
$ git push <remote-name> --delete <branch_name>
```

How does this fit into our mental picture?



How does this fit into our mental picture?



Keep in mind that it is very tough (if not impossible) to undo these commands.

Few words about tracking branches

A convenient feature

It is possible to make a default association between a local and a remote branch which is used for pull and push operations!

```
# Show all existing branches in verbose mode
$ git branch -a -vv
  exp1                  6e5ea4b Commit msg
  exp2                  6e5ea4b Commit msg
* main                  6e5ea4b [origin/main] Commit msg
  remotes/origin/HEAD -> origin/main
  remotes/origin/main  6e5ea4b Commit msg
  remotes/origin/exp1  6e5ea4b Commit msg
```

```
# First possibility (when remote branch already exists)
$ git switch exp1
Switched to branch 'exp1'
$ git branch --set-upstream-to=origin/exp1
Branch 'exp1' set up to track remote branch 'exp1' from 'origin'.
```

Few words about tracking branches

A convenient feature

It is possible to make a default association between a local and a remote branch which is used for pull and push operations!

```
# Second possibility (even without remote branch, yet)
$ git switch exp2
Switched to branch 'exp2'
$ git push -u origin exp2
[...]
To github.com:AxelKrypton/Git-crash-course.git
* [new branch]      exp2 -> exp2
Branch 'exp2' set up to track remote branch 'exp2' from 'origin'.
```

```
# Check branch tracking associations
$ git branch -vv
  exp1              6e5ea4b [origin/exp1] Commit msg
* exp2              6e5ea4b [origin/exp2] Commit msg
  main              6e5ea4b [origin/main] Commit msg
```

Few words about tracking branches

A convenient feature

It is possible to make a default association between a local and a remote branch which is used for pull and push operations!

Between tracking branches

It is then possible to simply use **git pull** and **git push** commands!

```
# Check branch tracking associations
$ git branch -vv
  exp1              6e5ea4b [origin/exp1] Commit msg
* exp2              6e5ea4b [origin/exp2] Commit msg
  main              6e5ea4b [origin/main] Commit msg
```

The stashing area

What if I want neither to commit nor to restore?

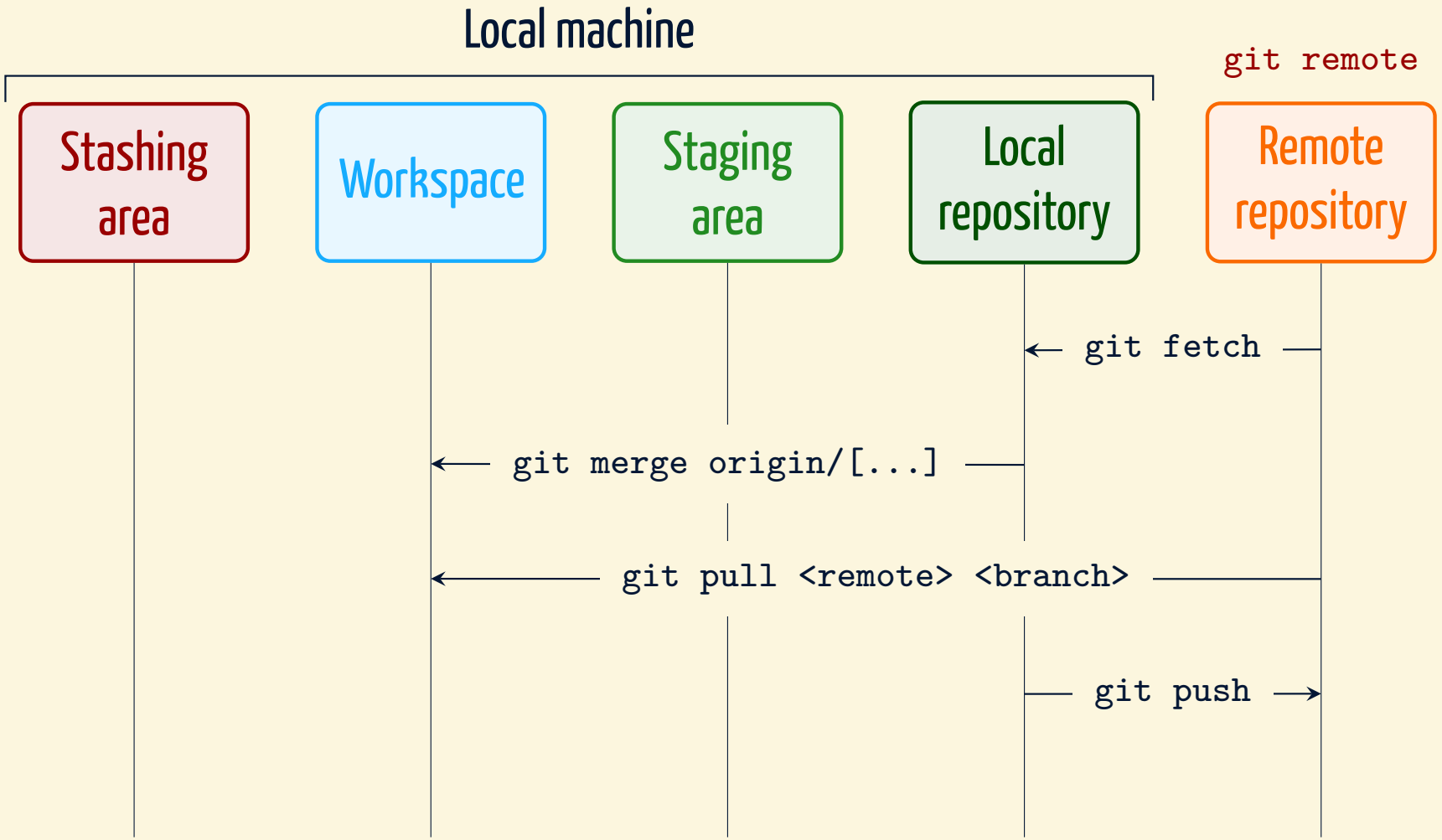
From Git documentation

Often, when you've been working on part of your project, things are in a messy state and you want to switch branches for a bit to work on something else. The problem is, you don't want to do a commit of half-done work just so you can get back to this point later. The answer to this issue is the **git stash** command.

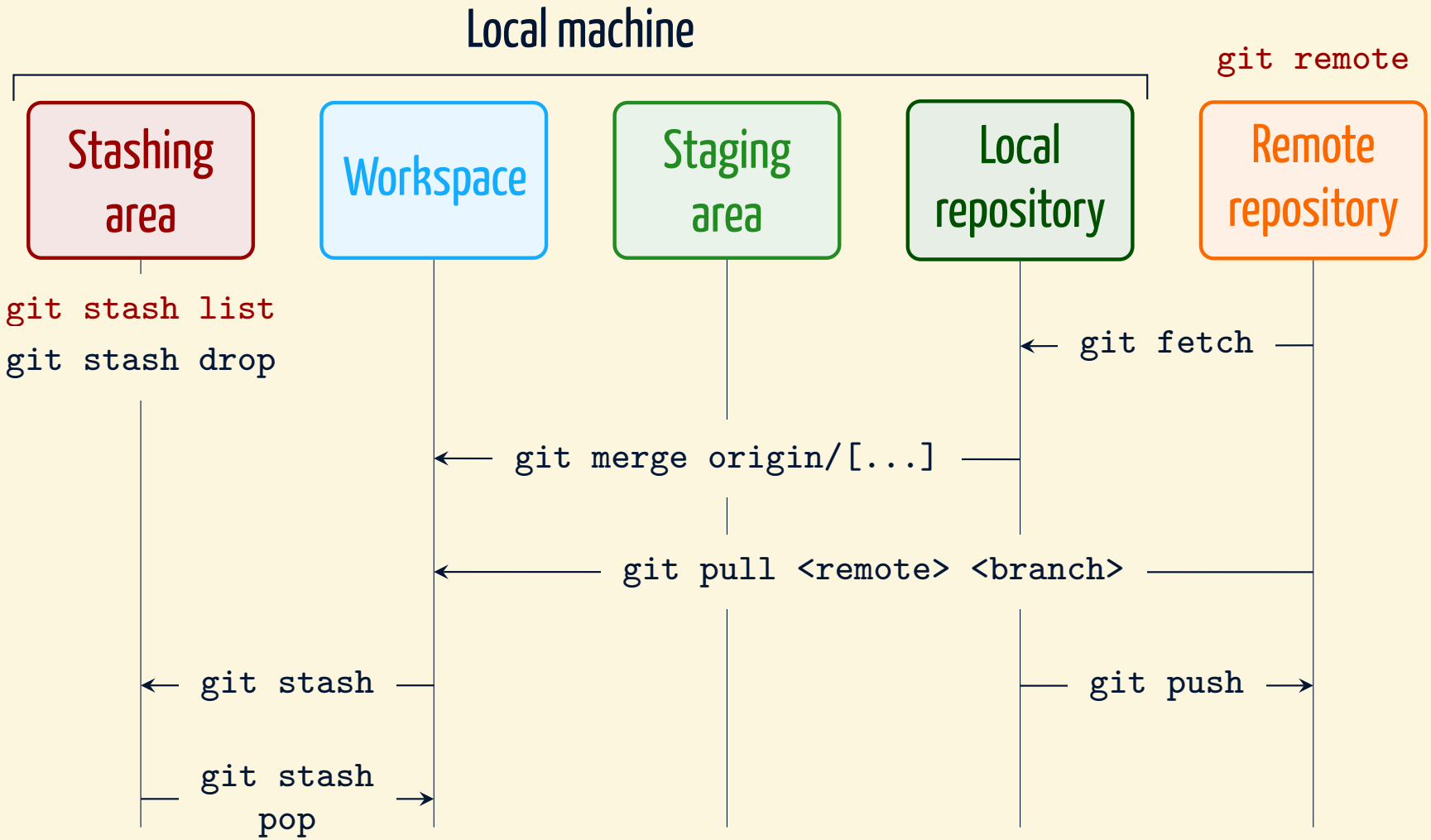
- Tracked files and staged changes can be moved to the **stashing area**
- The stashing area is a stack* of unfinished changes to be used later (or discarded) even on different branches
- From 2018 on it is possible to stash only some files/changes

* Although people still refer to the stashing area as a stack, the last-in-first-out principle is not anymore a must and item in the middle of the stack can be used.

Let's complete our mental picture



Let's complete our mental picture



This sketch together with that of last time will help you daily!

A taste about stashing

```
$ git log -n1 --oneline
b3092cc (HEAD -> main, origin/main, origin/HEAD) Last commit
$ git status -s
M  Part_2/Git-together.pdf # Staged for commit
 M Part_2/Git-together.tex # Modified but not staged
```

```
$ git stash list
stash@{0}: WIP on exp1: a3edd5f Epic fail
# Stash present work, 'git stash' defaults to 'git stash push'
$ git stash
Saved working directory and index state WIP on main: b3092cc [...]
$ git stash list
stash@{0}: WIP on main: b3092cc Last commit
stash@{1}: WIP on exp1: a3edd5f Epic fail
```

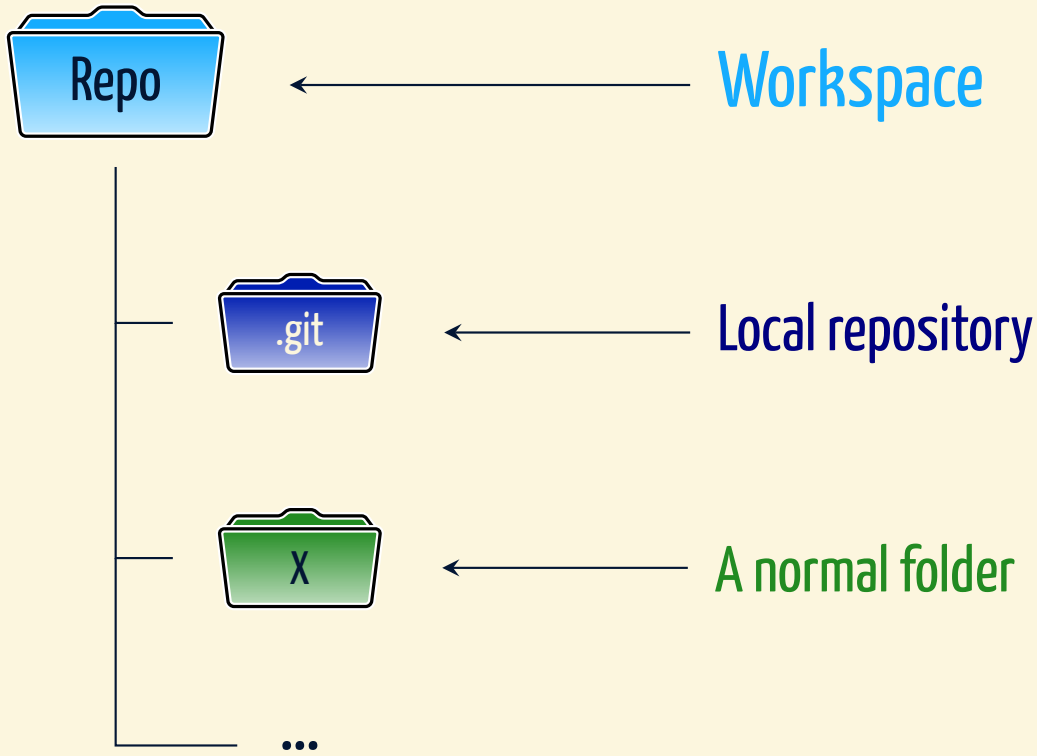
```
# Let's get back our work (in general conflicts are possible)
$ git stash pop
[...] # <- new status of the repository
Dropped refs/stash@{0} (25d8510240cdb562be3d3a7bd22be28ffa5a29e3)
# If conflicts occur, no stash is dropped
#  => use 'git stash drop' after having resolved them
```

Using `apply` instead of `pop` the entry in the stash list remains untouched.
You can also `apply`, `pop`, `drop`, etc. any stash in the list referring it as `"stash@{n}"` or simply as `n` (from Git v2.11).

Bare repositories

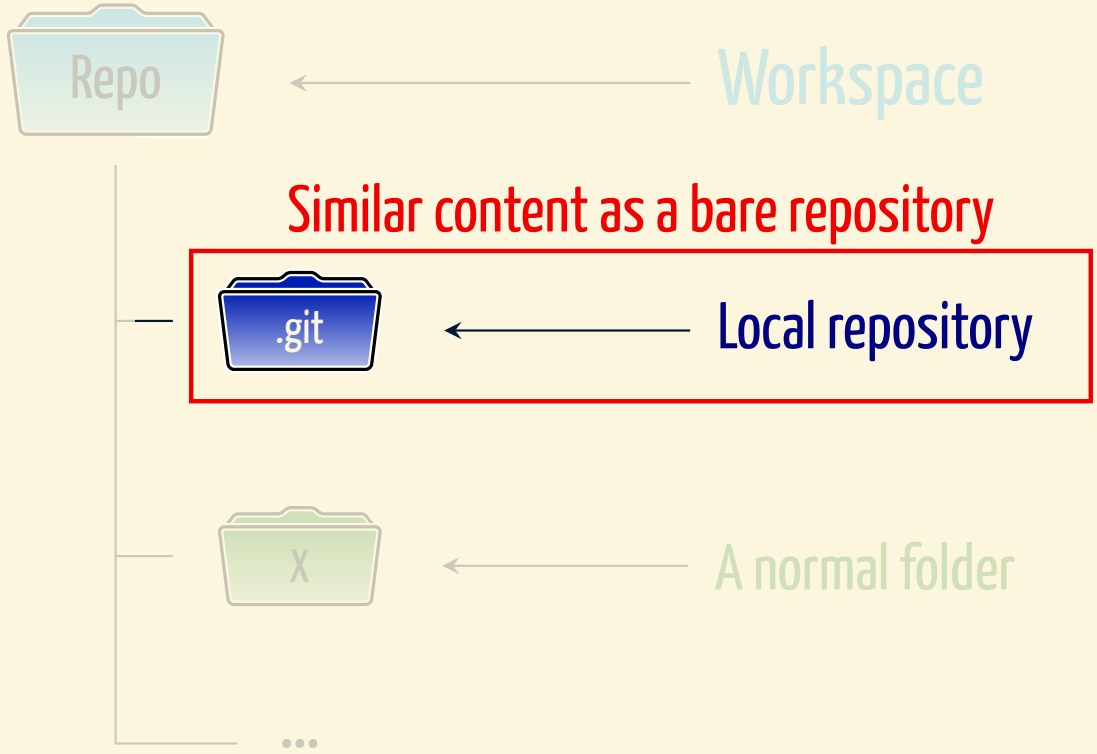
There are two types of repositories

1. **Non-bare repositories:** Meant for working



There are two types of repositories

1. **Non-bare repositories:** Meant for working
2. **Bare repositories:** Meant for sharing
   - ↳ a repository that doesn't contain a working directory



How to create and use bare repositories?

- By default it is not possible to push to a non-bare repository
- If you create a new repository in the browser on a platform like e.g. GitHub, you will not notice it, but a bare one will be created
- Bare repositories are meant to serve as remote
  ↳ i.e. to pull from and push to

1. Initialize a bare empty repository, clone it, work and push to it

```
$ mkdir <bare-repository>.git # .git is often used as suffix
$ git init --bare <bare-repository>.git
Initialised empty Git repository <bare-repository>.git
$ git clone <bare-repository>.git <non-bare-repo>
Cloning into '<non-bare-repo>'...
warning: You appear to have cloned an empty repository.
done.
$ cd <non-bare-repo>
# Work as usual and push when needed.
```


You can put your bare repository e.g. on a server or an external HDD (to clone on different machine without network).

How to create and use bare repositories?

2 Initialize a bare empty repository and push an existing one to it

```
$ mkdir <bare-repository>.git
$ git init --bare <bare-repository>.git
Initialised empty Git repository <bare-repository>.git
$ cd <existent-non-bare-repository>
$ git remote add origin /path/to/<bare-repository>.git
$ git push -u origin main # <- From local desired branch
```


You can put your bare repository e.g. on a server or an external HDD (to clone on different machine without network).

How to create and use bare repositories?

2 Initialize a bare empty repository and push an existing one to it

```
$ mkdir <bare-repository>.git
$ git init --bare <bare-repository>.git
Initialised empty Git repository <bare-repository>.git
$ cd <existent-non-bare-repository>
$ git remote add origin /path/to/<bare-repository>.git
$ git push -u origin main # <- From local desired branch
```

3 Create a bare version of an existing non-bare one

```
$ git clone --bare <non-bare-repository> <bare-repository>.git
Cloning into bare repository 'QCD.git'...
done.
$ cd <non-bare-repository>
$ git remote add origin /path/to/<bare-repository>.git
```


You can put your bare repository e.g. on a server or an external HDD (to clone on different machine without network).

How to create and use bare repositories?

2 Initialize a bare empty repository and push an existing one to it

```
$ mkdir <bare-repository>.git
$ git init --bare <bare-repository>.git
Initialised empty Git repository <bare-repository>.git
$ cd <existent-non-bare-repository>
$ git remote add origin /path/to/<bare-repository>.git
$ git push -u origin main # <- From local desired branch
```

3 Create a bare version of an existing non-bare one

```
$ git clone --bare <non-bare-repository> <bare-repository>.git
Cloning into bare repository 'QCD.git'...
done.
$ cd <non-bare-repository>
$ git remote add origin /path/to/<bare-repository>.git
```

Pick your favourite way

Probably options 2 and 3 are handier.

You can put your bare repository e.g. on a server or an external HDD (to clone on different machine without network).

The remaining git commands

You can now explore the rest alone!

git mv	Move or rename a file, a directory, or a symlink
git restore	Restore working tree files { we mentioned it already }
git rm	Remove files from the working tree and from the index
git bisect	Use binary search to find the commit that introduced a bug
git grep	Print lines matching a pattern
git rebase	Reapply commits on top of another base tip
git reset	Reset current HEAD to the specified state
git tag	Create, list, delete or verify a tag object signed with GPG
git [...]	Few more technical commands

You can now explore the rest alone!

git mv	Move or rename a file, a directory, or a symlink
git restore	Restore working tree files { we mentioned it already }
git rm	Remove files from the working tree and from the index
git bisect	Use binary search to find the commit that introduced a bug
git grep	Print lines matching a pattern
git rebase	Reapply commits on top of another base tip
git reset	Reset current HEAD to the specified state
git tag	Create, list, delete or verify a tag object signed with GPG
git [...]	Few more technical commands

Wait for it!

In the next and last part of the course we'll learn to rebase and tag

Conclusions

That's **ALMOST** all folks

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

That's **ALMOST** all folks

1. Start using Git. **Now.** Not tomorrow or next week, today!
   → Repeat what done on these slides
2. Was anything unclear? Did you get stuck at some point?
   → Drop me ✉ an email

That's **ALMOST** all folks

1. Start using Git. **Now.** Not tomorrow or next week, today!
   → Repeat what done on these slides
2. Was anything unclear? Did you get stuck at some point?
   → Drop me ✉ an email
3. You can use Git to work in a very professional way!
   → Attend next part: «Git in real life»

That's **ALMOST** all folks

Thank you!

1. Start using Git. **Now.** Not tomorrow or next week, today!
   → Repeat what done on these slides
2. Was anything unclear? Did you get stuck at some point?
   → Drop me an email
3. You can use Git to work in a very professional way!
   → Attend next part: «Git in real life»

Believe me, it's worth it!

git rebase
git tag
Semantic versioning
Gitflow