

Let's Git together

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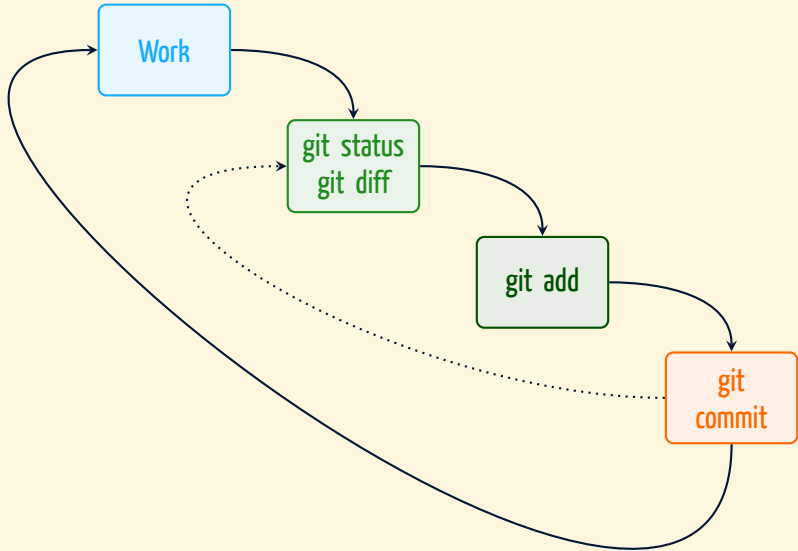
23 May 2024

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

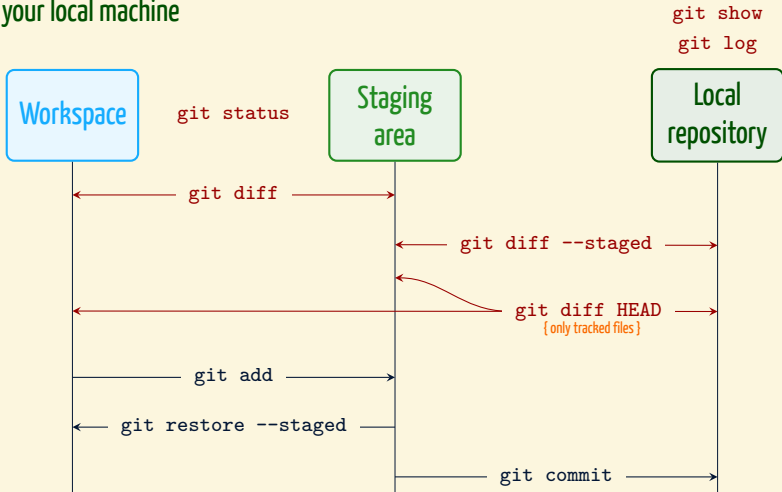
A short recap from last time

By now, this is how your workflow looks like



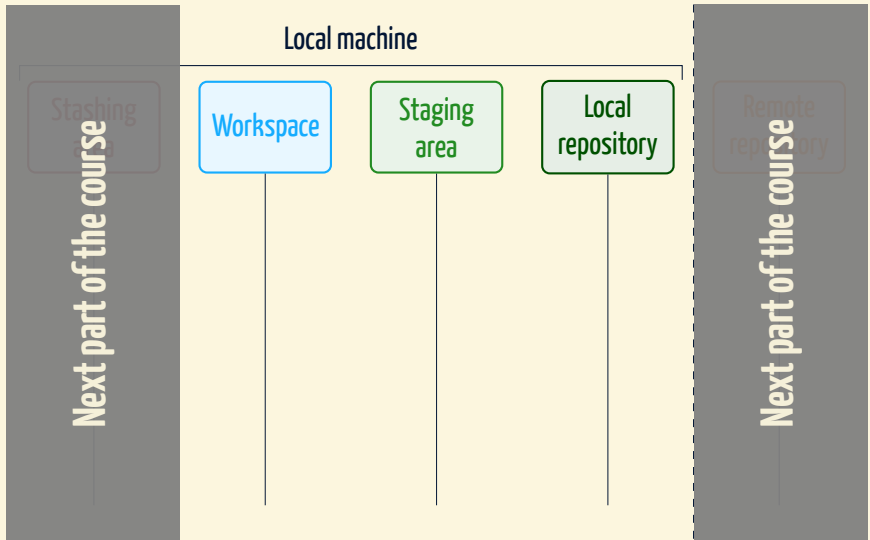
Our mental picture, so far

On your local machine



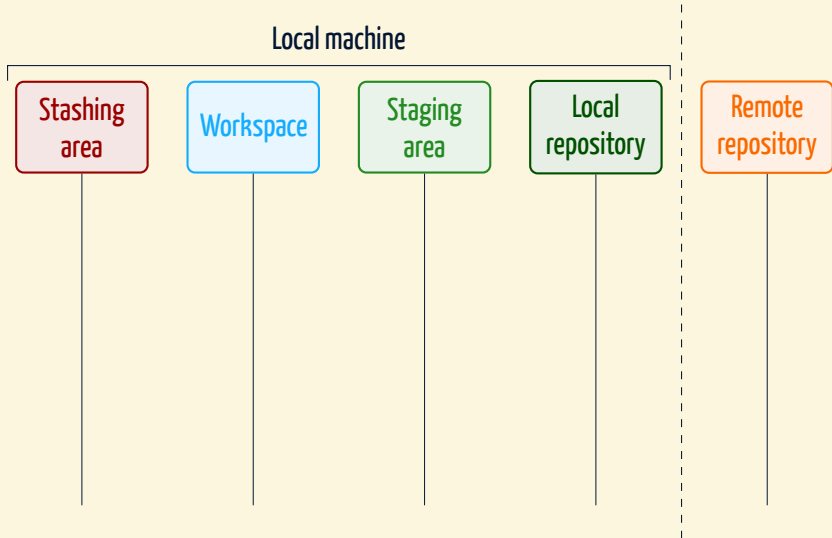
Commands marked in **dark red** do not change anything in the repository!

The complete correct abstract mental setup



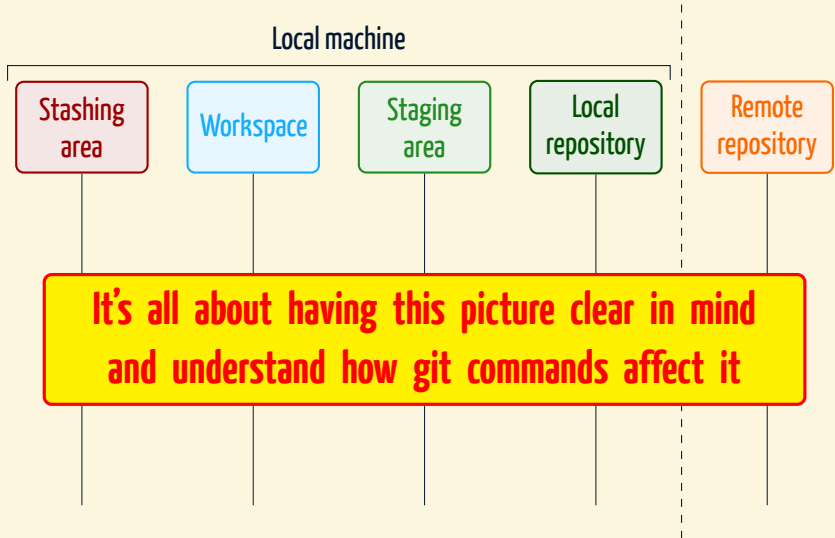
What we explored last time

The complete correct abstract mental setup



Now we'll complete the picture

The complete correct abstract mental setup



Now we'll complete the picture

Git User Interface philosophy

Git is your friend!

What happens if I ask Git something not possible?

In many case, when Git fails, it reports to you a detailed error message that is likely to make you understand what has happened. **Make sure you read it!** Sometimes you need to figure out what should be done, but you never get a silent failure.

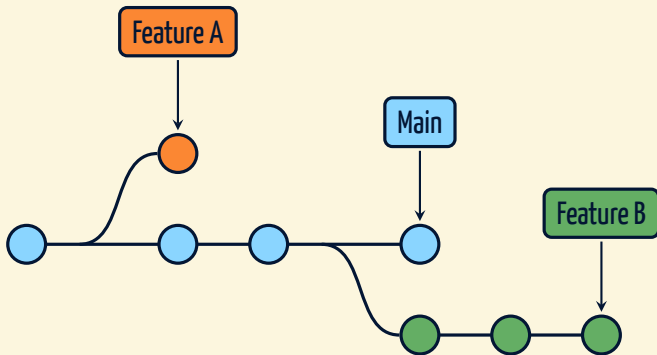
Git will hardly make you loose changes

There are only few commands that potentially make you loose changes and usually these require you to force the operation with a command line option. This together with the verbose reporting system allows you to be pretty confident in using and experimenting with Git.

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.

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
  new-branch

# Pay attention from which
# branch you create a new one!
```

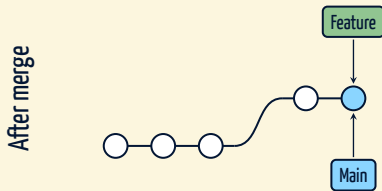
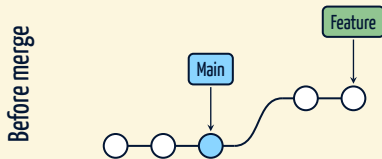

Merging branches

- 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

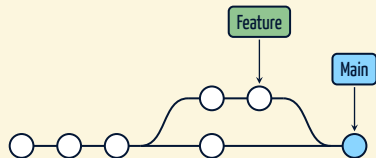
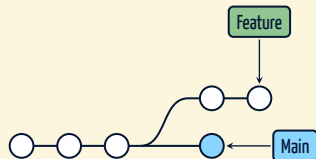
Git is safe, conflicts are not a bad thing!

Different types of merge

Fast-forward merge



Three-way merge



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!



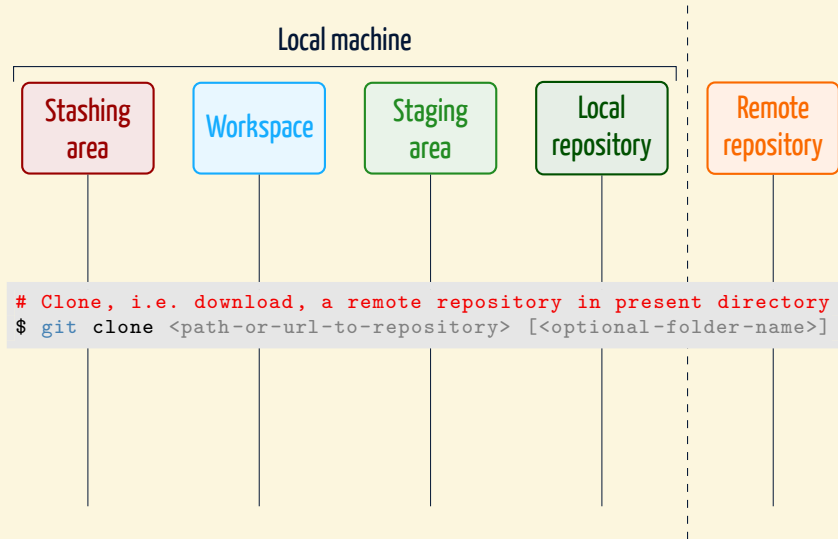
The Git prompt I use in my **Bash** terminal is a customization of [🔗this one!](#)

Working with remote repositories

Cloning a remote repository



Cloning a remote repository



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

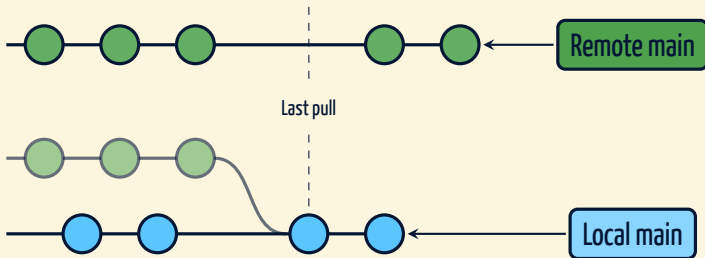
Fetching and pulling: Examples

```
# 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.**



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 main
[...]
```

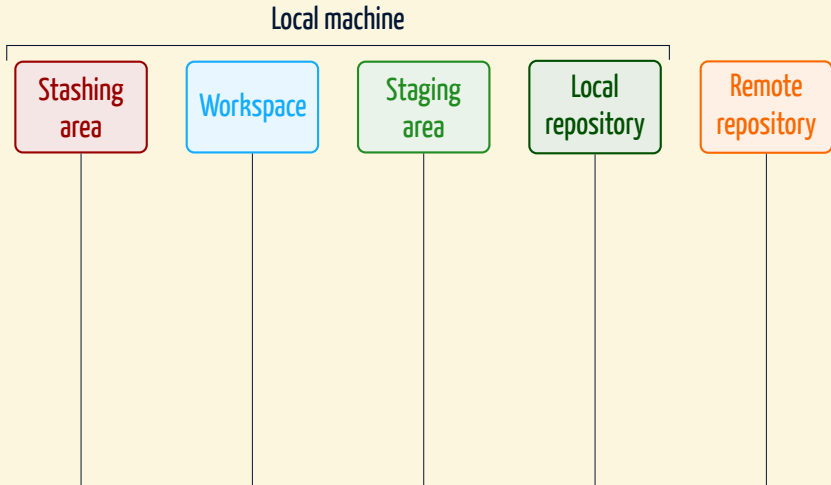
Pushing your own work

- 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

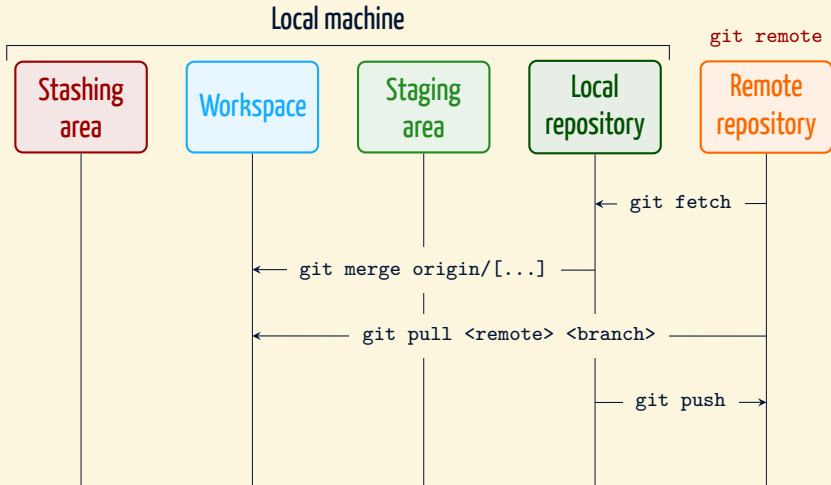
Push before saying to your collaborators you did some changes!

```
$ 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

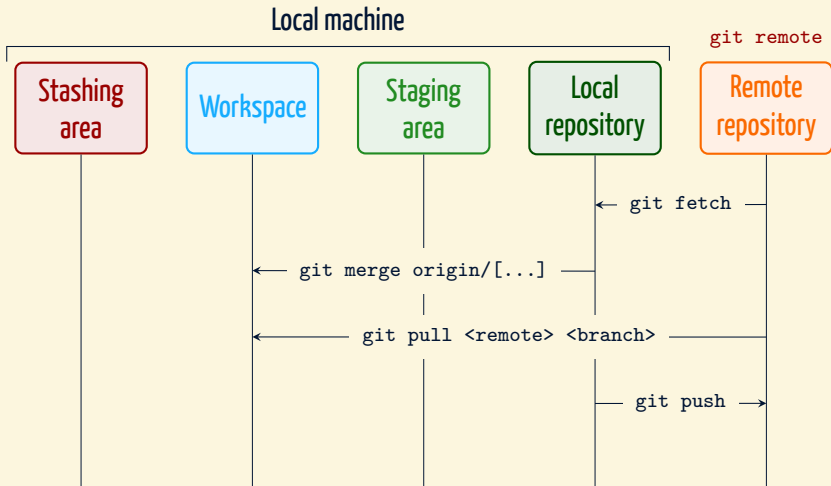
What if I want neither to commit nor to restore?

From Git documentation

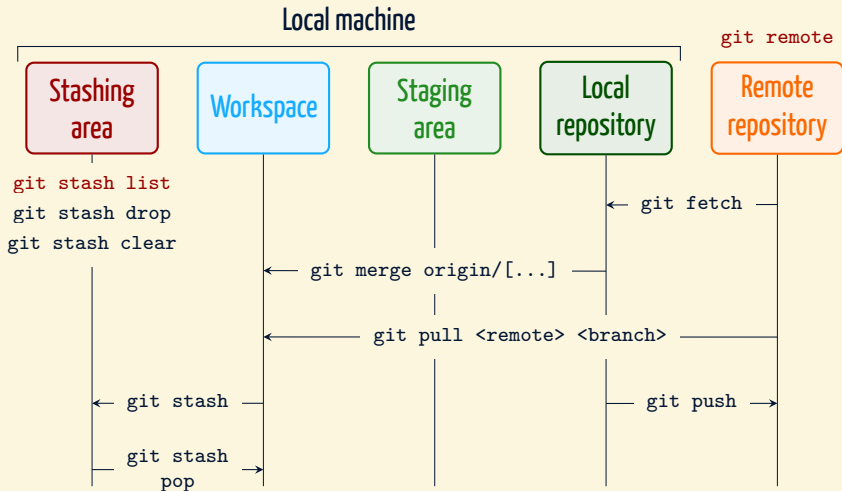
Often, when you've been working on part of your project, things are in a messy state and you want to switch branches for a bit to work on something else. The problem is, you don't want to do a commit of half-done work just so you can get back to this point later. The answer to this issue is the **git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

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
```

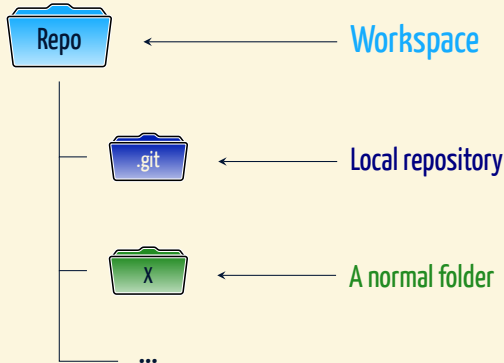
Using apply instead of pop the entry in the stash list remains untouched.

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

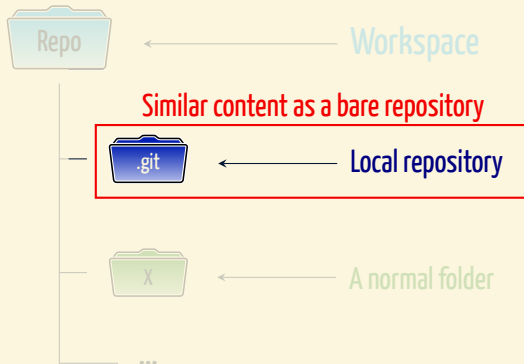
1 Non-bare repositories: Meant for working



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.
```


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
```

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

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 '<bare-repository>.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.

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 |
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| 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!
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- 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»



git rebase
git tag
Semantic versioning
Gitflow

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

Live exercise

Let's collaborate!

1 Clone the exercise repository from Redmine

↳ `https://<USERNAME>@git.physik.uni-bielefeld.de/git-together`

2 Create and switch to a new branch

3 Create a new file, e.g. via

```
$ echo "$(whoami): $(date)" > "$(whoami).txt"
```

and add your name to the AUTHORS file

4 Commit your changes to the repository and push your branch

5 Let your local branch track the remote one

6 Check your work in the browser

7 Be sure the main branch is up-to-date and merge your branch into it*

8 Pull and push it to the remote

9 Check that your changes appear as expected on `master` in the browser and, if so, remove your branch locally and remotely