Introduction to `git`
Part I

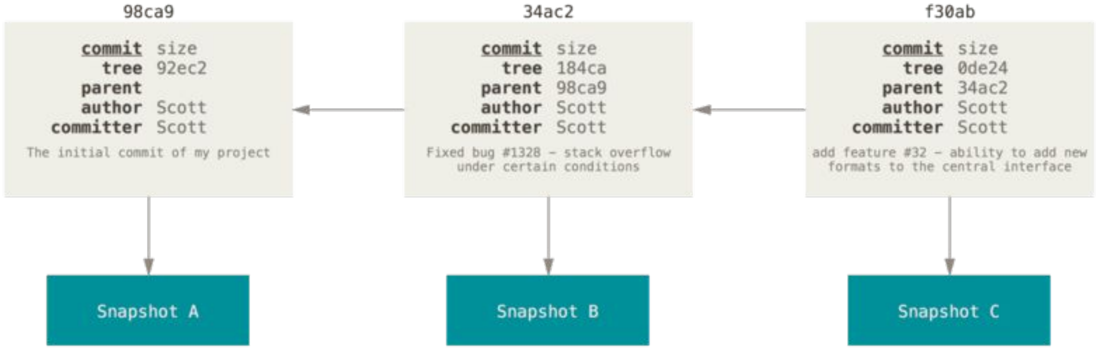
Childhood Cancer Data Lab x Alex's Lemonade Stand

git is a version control system

Provides a framework for keeping snapshots, known in git as ***commits***, of your project over time

We call a given project that git is tracking *a repository* (*repo* for short)

Repositories are usually used to track code, but they can track other files



98ca9

```
   commit  size
     tree  92ec2
   parent
   author  Scott
committer  Scott
The initial commit of my project
```

34ac2

```
   commit  size
     tree  184ca
   parent  98ca9
   author  Scott
committer  Scott
Fixed bug #1328 - stack overflow
under certain conditions
```

f30ab

```
   commit  size
     tree  0de24
   parent  34ac2
   author  Scott
committer  Scott
add feature #32 - ability to add new
formats to the central interface
```

Image from git-scm

git repositories hold a living record of your project

By storing project snapshots, you can safely* overwrite and/or remove files but still be able to recover them

*Unless you don't do it safely

Although git is not *technically* a backup, it's not not a backup!

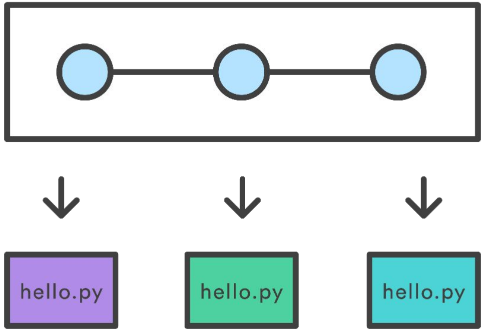


Image from Atlassian

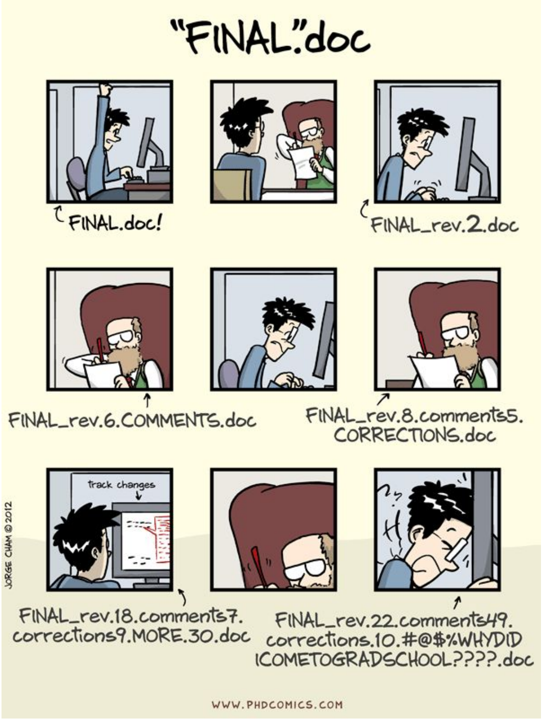


Image from PhD Comics

GitHub is a popular website for hosting and managing `git` repositories

Image modified from https://www.geekboots.com/story/what-is-the-difference-between-bitbucket-github-and-gitlab

`git` is both a powerful individual and collaborative tool

Working independently in a `git` repository and with a team can look a little different!

- We'll come back to different approaches for collaborative `git` workflows later

For the individual, `git` provides a record of your work, allows you to make changes without losing past work (reversion is possible!)

For the team, `git` provides a common framework and structure for collaborating without conflicts (if properly coordinated!)

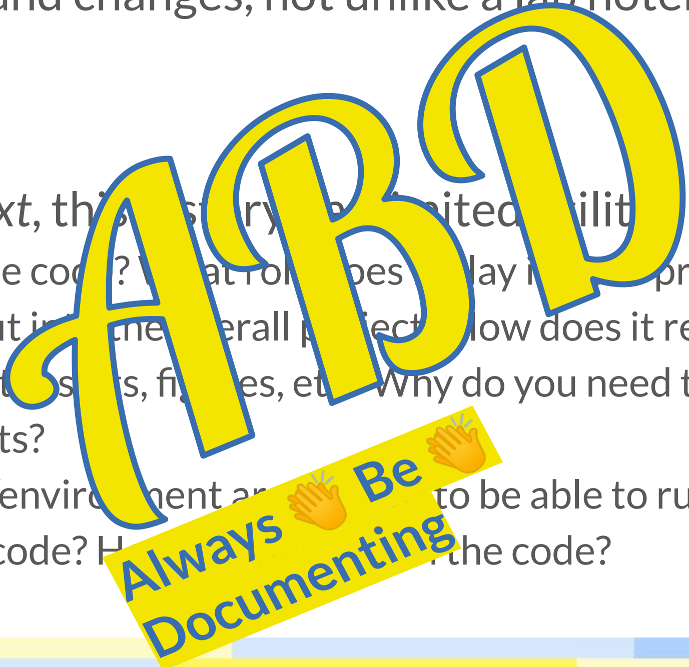
- Some project management is baked into `git` and/or GitHub, but other aspects you'll need to bring to the table yourself

git repositories are similar to lab notebooks

If used well, git (along with certain GitHub features!) can store a precise history of project development and changes, not unlike a lab notebook

But without any *context*, this history has limited utility

- Why did you write the code? What role does it play in the project?
- How does this code fit into the overall project? How does it relate to other pieces of code?
- Does the code output results, figures, etc? Why do you need those results? How do you interpret those results?
- What dependencies/environment are needed to be able to run the code?
- How do you run the code? H[illegible] the code?



Documentation is critical for **you**, your **team**, and the broader **research community.**

What should you add to a repository?

Code, *sometimes* results, and *sometimes* data

- In particular for scientific analyses, you may have figures and tables that code creates
- Depending on the scope & size of results/data files, they may or may not be suitable for a repository

A `LICENSE` file

- Protects both the rights of you (the authors) and the code itself
- If you are writing software, make sure that your `LICENSE` is compatible with your dependencies
- https://choosealicense.com/

That's right you guessed it - documentation

- What are the contents of your repository? How do you navigate the repository?
- What is the relationship among pieces of code? What is the relationship between code and other types of files?
- Are there any specific contribution guidelines folks need to follow?

What shouldn't you add to a repository?

Large files: GitHub cannot accommodate files >= 100 MB without extra (less reproducible) steps

- If your colleague has stored large files but you haven't taken the extra steps, you're going to have a bad time.

Unreleased/private data or results files, including PPI/PHI data or results

- Although it is possible to delete sensitive data from a repository's history, you really don't want to find yourself in that position

Any items that you don't have the permission to distribute

- Always check the `LICENSE` details of your dependencies, third-party datasets, etc.

`git` repositories are not a replacement for project management tools

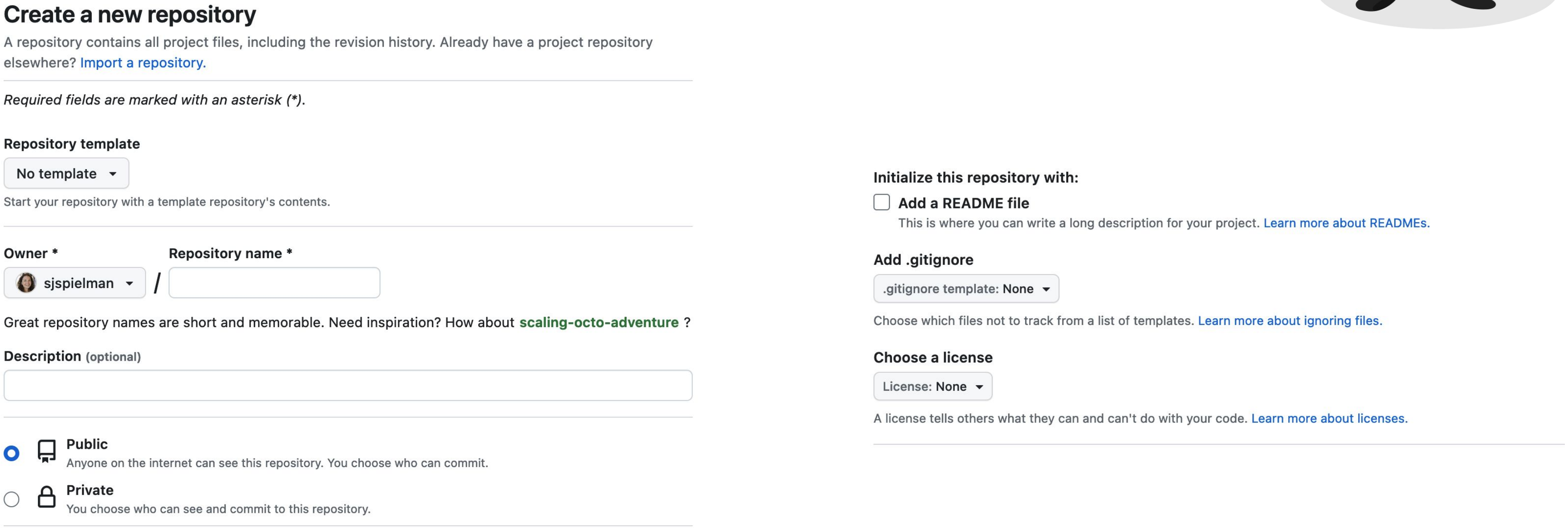
Think of `git` & GitHub as providing *complementary frameworks* to your overall project management strategy

You'll also need to develop *(and document!)* external processes that help your team work together in `git` & GitHub

The fundamental `git` flow

Creating a repository

You can create repositories locally, but it's usually easier to make them on GitHub (github.com/new) and then ***clone them*** to your computer.



Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? Import a repository.

Required fields are marked with an asterisk (*).

Repository template

No template ▾

Start your repository with a template repository's contents.

Owner * sjspielman ▾ / **Repository name ***

Great repository names are short and memorable. Need inspiration? How about **scaling-octo-adventure** ?

Description (optional)

● **Public**
Anyone on the internet can see this repository. You choose who can commit.

○ **Private**
You choose who can see and commit to this repository.

Initialize this repository with:

□ **Add a README file**
This is where you can write a long description for your project. Learn more about READMEs.

Add .gitignore

.gitignore template: None ▾

Choose which files not to track from a list of templates. Learn more about ignoring files.

Choose a license

License: None ▾

A license tells others what they can and can't do with your code. Learn more about licenses.

Set up your credentials with SSH keys

Reference:
https://docs.github.com/en/authentication/connecting-to-github-with-ssh/about-ssh

The Data Lab has started using 1Password to manage creds and it's 🔥🔥

https://developer.1password.com/docs/ssh/

Clone the repository to "download" it

You only do this *one time.*

```
cd directory/to/store/your/repo
```

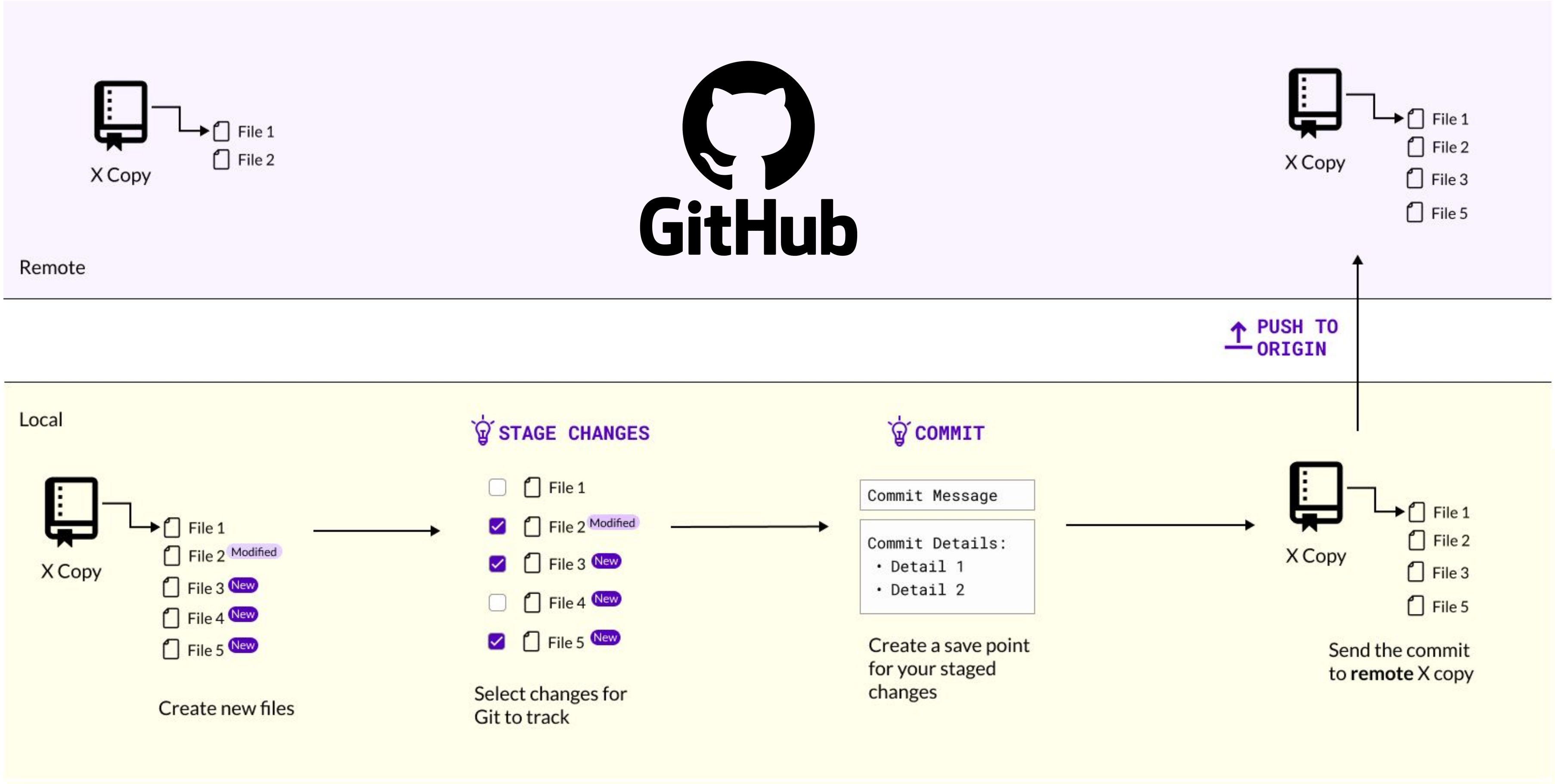
```
git clone git@github.com/ACCOUNT-NAME/REPO-NAME
```

Future interaction between your *remote and local* repositories is done with…

- `git push`: Send changes from local repo to remote repo
- `git pull`: Get changes from remote repo into your local repo

The "stage/commit/push" flow

1. **Pull** changes from GitHub to make sure your local repo is up-to-date, and ensure you're in the right branch *(stay tuned!)*
2. Make code changes, in small bites!
3. **Stage** the changes you want to be part of the next commit
   a. Stage with `git add`, `git rm`, etc.
   b. Best practice to stage *one new/modified/removed file at a time* to avoid problems
4. **Commit** your code changes with an informative message
   a. Commit with `git commit -m "informative message"`*
   (*we know there are lots of choices here!)
5. **Push** your local commit(s) to the **remote repository** you cloned from GitHub
   a. Push with `git push`



Remote

X Copy

File 1

File 2

GitHub

X Copy

File 1

File 2

File 3

File 5

PUSH TO ORIGIN

Local

X Copy

File 1

File 2 Modified

File 3 New

File 4 New

File 5 New

Create new files

STAGE CHANGES

□ File 1

☑ File 2 Modified

☑ File 3 New

□ File 4 New

☑ File 5 New

Select changes for Git to track

COMMIT

```
Commit Message
```

```
Commit Details:
 • Detail 1
 • Detail 2
```

Create a save point for your staged changes

X Copy

File 1

File 2

File 3

File 5

Send the commit to **remote** X copy

When it comes to commits, less is more

Smaller units of work are better for…

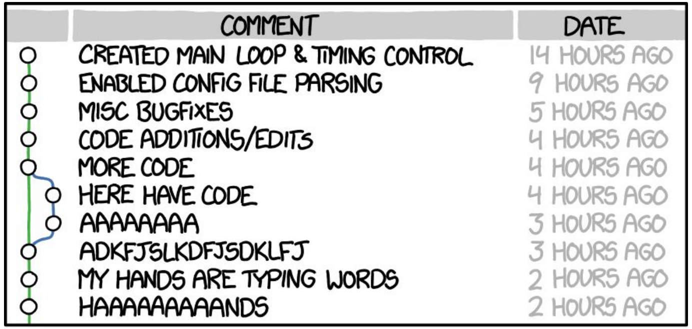
- You, when writing your code
- You, when reviewing someone else's code
- Your teammate, when reviewing your code

If you are reviewing someone's work, which commit message is most helpful?

- `All the work I did on Tuesday`
- `Update notebook`
- `Modified notebook to change plot size`

Which scenario is easier to look through?

- 1-3 changed files in a commit, or 25 changed files
- 400 lines of new code, or 4000 lines of new code



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.

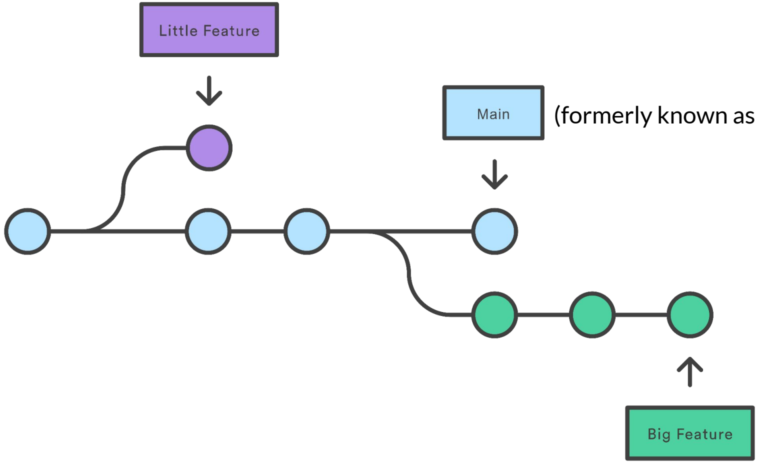
https://xkcd.com/1296/

We often like to work in **feature branches**

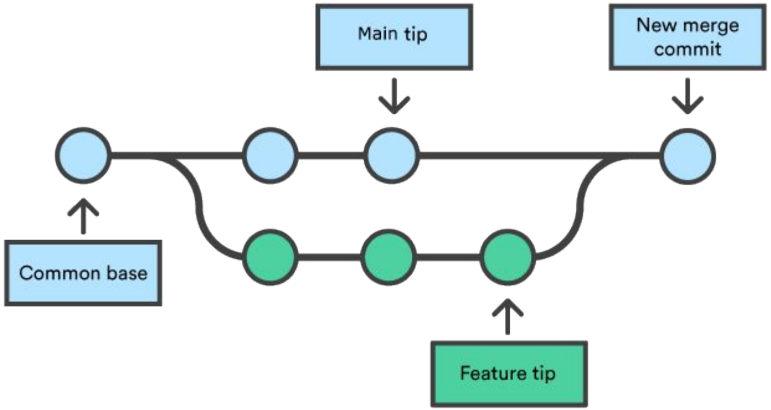
Collaborative work in different branches is a key feature* of `git` version control

*Pun intended, with apologies.

We'll talk much more about branches soon!



(formerly known as `master`)



Images from Atlassian (L) (R)

The unsung heroes `git diff` and `git status`

`git diff` should be run for each change before you stage it

- *You think you know what code you've written, but you have no idea.*
- `git diff` alone will show you changes for all modified files
- `git diff <modified file>` will show just your file of interest

`git status` should be run ~as often as possible, and then maybe more. It tells you...

- Which branch you are on
- Which files are modified/added/removed but unstaged
- Which changes are staged but not committed
- How many local (unpushed) commits you have
- 🚨 *Protip!* I have this alias on every machine I use, and I type it *constantly*: `alias gst="git status"`

The improved "stage/commit/push" flow

1. Run `git status`
2. Make code changes
3. Run `git status`
4. **Stage** the changes you want to be part of the next commit
    a. `git diff` first, make any necessary changes, and then stage
5. Run `git status`
6. **Commit** your code changes with an informative message
7. Run `git status`
8. **Push** your local commit(s) to the **remote repository** you cloned from GitHub
9. Run `git status`

Safely undoing changes: A non-comprehensive introduction

Woops! I modified a file that I didn't mean to modify, *and I know this because I ran `git status`*

- `git checkout <filename>`
- `git restore <filename>` (git >= 2.23)

Woops! I committed a file that I didn't mean to modify, *and I know this because I ran `git status`*

- `git restore --staged <filename>`

Woops! I staged files that I wasn't ready to stage yet, *which I know because I ran `git status`*; can I undo the staging?

- `git reset`
- See here for more ways to use `git reset`, some of which are ⚠️ *destructive* (will undo previous commits!)

Safely undoing changes: A non-comprehensive introduction

Woops! My commit message should have been different!

- `git commit --amend`

Woops! I want to undo the changes in a previous commit, but still preserve the project history and avoid destructive actions!

- `git revert <commit hash>`

For more inspiration and/or commiseration, may I suggest https://dangitgit.com/

Using `.gitkeep` files

`git`, in general, does not store empty directories, but sometimes we need them

By *convention* (*not* a formal `git` feature!), we add empty hidden files called `.gitkeep` into empty directories we want to retain. For example….

- A `data/` directory that stores data locally and that code expects, but data itself is far too big to actually keep under version control
- Directories that you create for future use when setting up your project, but don't yet have contents, e.g. `plots/`

Using `.gitignore` files

`.gitignore` files are hidden files that tell `git` to ignore certain files. They can stay in your repository folder, but won't be part of the repository itself.

Telling `git` to ignore certain files will....

- Make `git` stop telling you about untracked changes when you run `git status`

- Prevent you from staging/committing these files by accident, and running `git status` liberally will help key you into which files need to be ignored

Using `.gitignore` files

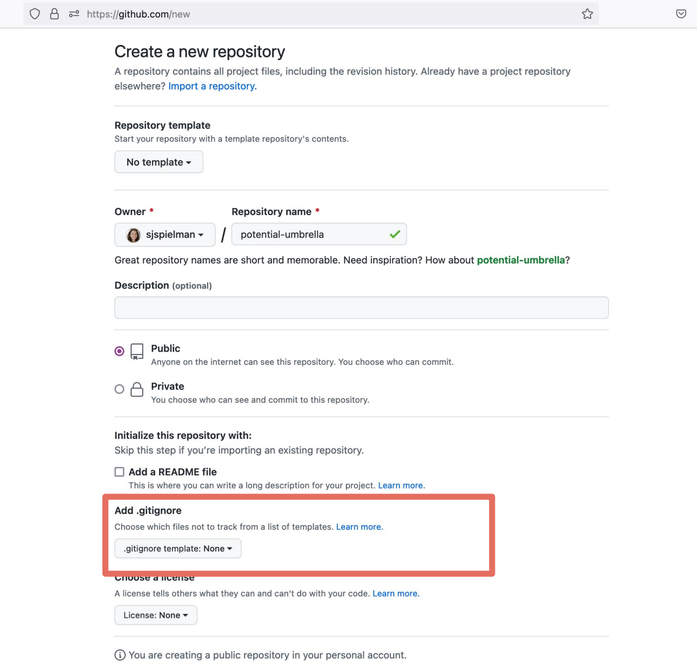
You can have many `.gitignore` files in a repo (in different directories) and/or a single `.gitignore` at the top of your repo that all subdirectories "inherit"

- You can also have a global file in `~/.gitignore` that will apply to all repos on your computer
- ⚠️*But caution*: Your collaborators probably don't have that file.
- ⚠️⚠️*But caution again*: You probably don't have that file synced up among machines (e.g., your computer and your lab server)

🚨 *Protip!* Working on a Mac? `.DS_Store` does not spark joy. Ignore it!

GitHub has some useful `.gitignore` templates

This is one example of a GitHub feature that helps you organize your projects!



https://github.com/new

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? Import a repository.

Repository template

Start your repository with a template repository's contents.

No template ▾

Owner * / **Repository name** *

sjspielman ▾ / potential-umbrella ✓

Great repository names are short and memorable. Need inspiration? How about **potential-umbrella**?

Description (optional)

● **Public**
Anyone on the internet can see this repository. You choose who can commit.

○ **Private**
You choose who can see and commit to this repository.

Initialize this repository with:

Skip this step if you're importing an existing repository.

□ **Add a README file**
This is where you can write a long description for your project. Learn more.

Add .gitignore

Choose which files not to track from a list of templates. Learn more.

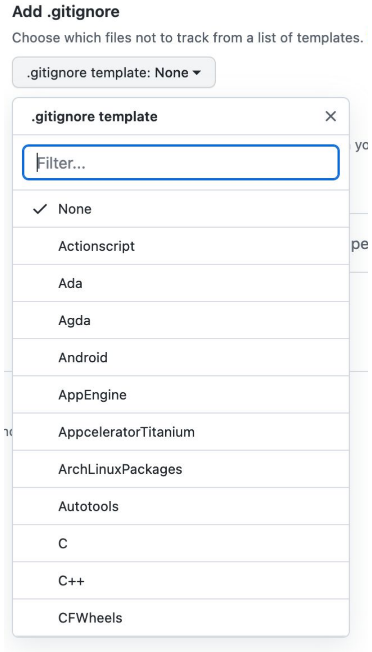
.gitignore template: None ▾

Choose a license

A license tells others what they can and can't do with your code. Learn more.

License: None ▾

ⓘ You are creating a public repository in your personal account.



Add .gitignore

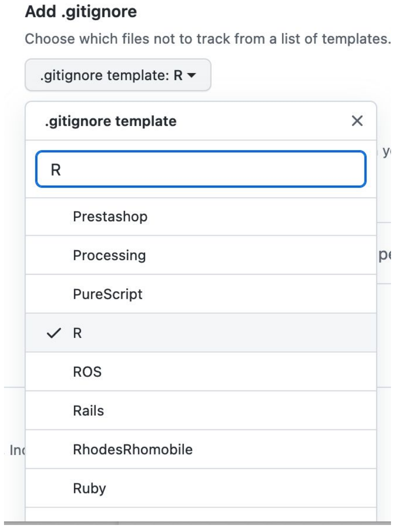
Choose which files not to track from a list of templates.

.gitignore template: None ▾

.gitignore template ✕

Filter...

- ✓ None
- Actionscript
- Ada
- Agda
- Android
- AppEngine
- AppceleratorTitanium
- ArchLinuxPackages
- Autotools
- C
- C++
- CFWheels



Add .gitignore

Choose which files not to track from a list of templates.

.gitignore template: R ▾

.gitignore template ✕

R

- Prestashop
- Processing
- PureScript
- ✓ R
- ROS
- Rails
- RhodesRhomobile
- Ruby

Let's see some `git` in action