Version control with git for Mathematicians

https://github.com/gabindu/git-intro

Gabriel Indurskis, based on slides by Max Joseph

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1 Discuss

What is your current version control system?

1. How do you manage different file versions?
2. How do you work with collaborators on the same files?
3. How much would your science/teaching/life suffer if your workstation exploded right now? (scale from 1-10)

2 What is git

Version control system (VCS)

- manage different versions of files
- collaborate with yourself
- collaborate with other people
- in principle a commandline tool, but can use convenient graphical interfaces and websites (GitHub/GitLab/BitBucket)
- many modern editors support it directly without the need of external software

3 Why use git

"Always remember your first collaborator is your future self, and your past self doesn't answer emails"

- Christie Bahlai

4 What is git good for?

- backup
- reproducibility
- collaboration
- organization
- transparency

5 Installation on Windows & Mac

1. - **On Mac OS**, git and ssh should already be available on the commandline. If not, install with Homebrew, using

     ```
     brew install git
     ```

   - **On Windows:** Git Bash & GUI:
     - includes Git Bash, a command-line terminal which simulates that of a Unix machine and includes the git commandline client & a SSH client

2. GitHub Desktop: a simple & very convenient GUI

   Optionally, create yourself an account on GitHub and log in on GitHub Desktop. (We will actually use GitLab for most things, but having access to GitHub directly is nice as well.)

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6 Installation on Linux

- usually nothing to do!
- if necessary, `apt-get install git`
- use your favourite editor (e.g. Emacs)
- use git on the commandline
- GUI alternatives:
  - if you use Emacs, install `magit` package.

7 Initial Git & SSH configuration

- Set your name and email in Git:
  - in GitHub Desktop: Options -> Git
  - or, on the commandline:
    ```
    git config --global user.name "Vlad Dracula"
    git config --global user.email "vlad@tran.sylvan.ia"
    git config --list
    ```
- Create yourself an SSH key pair:
  - On the commandline (Git Bash on Windows), do:
    ```
    ssh-keygen -t ed25519
    ```
- Upload your public SSH key to GitLab (and/or GitHub):
  - After logging on the website, click on your profile image, User Settings, SSH Keys
  - Copy & Paste your **public** key, usually found in `~/.ssh/id_ed25519.pub` (or maybe `id_rsa.pub` if you already had an older key)
  - in Git Bash, you can use the command
    ```
    cat ~/.ssh/id_ed25519.pub | clip
    ```
    to easily copy the relevant text.

8 Command line git

It's best to play around with git on the commandline at first, to better understand what it does. (Then it's ok to switch to a GUI.)

Somewhere on your computer, create a new directory with a (text) file, e.g. `test.tex` or `test.txt`, and fill it with some example content (at least a few lines). (You could also just copy an already existing document.)

You can do this with your usual methods, or on the commandline, for example with:

```
mkdir my-first-git-repo
cd my-first-git-repo
echo "This is a fancy test!" > test.txt
```

You can also create other files, of whatever type you want (LaTeX, Markdown, HTML, Python scripts, …) - binary files are ok as well!

9 Tell git to keep track of your files

9.1 Initializing a repository

On the commandline (Git Bash on Windows), make sure that you are inside the directory you created, then execute:

```
git init
```

If you call `ls -a`, you should now notice that a hidden `.git/` directory was created. This is where git does its magic, and you should therefore never touch this directory or its contents!

9.2 Checking repository status

```
git status
```

You should notice that there are “untracked” files. Right now, git does not actually do anything with your files yet, we first have to tell it to “track” them.

10 Adding your file to be tracked by git

To tell git that you want changes to the file `test.txt` to be “tracked”, execute:

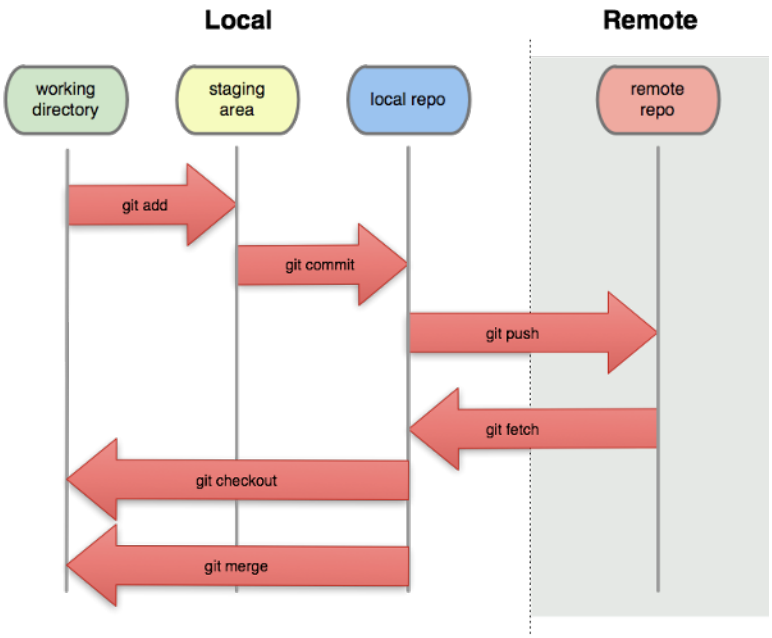
```
git add test.txt
```

or, to add all changed/new files (careful, this might add undesired temporary files):

```
git add --all
```

For future reference: If you want to avoid addingf temporary files (like LaTeX auxiliary files etc.), you can add a file `.gitignore` which tells git to *never* even propose to track these files. You can download an appropriate `.gitignore` file for whatever type of document you’re working on at https://www.gitignore.io/

11 Your changes are now “staged”



(Image from Software Carpentry)

12 Committing

12.1 Changes aren’t final until they’re committed

```
git status
```

12.2 Committing

Once you’re sure that your changes are worth saving

(THIS WILL GO ON YOUR PERMANENT RECORD)

```
git commit -m 'changed x, y, and z'
```

If you just use `git commit`, git will open an editor to ask you for a commit message. You can set the default editor by one of the following commands:

```
git config --global core.editor "atom --wait"
git config --global core.editor "emacs -nw"
git config --global core.editor "zile"
```

13 Commit messages

- Describe why and the what "in a nutshell"
- Note to your future self (and to anyone else who you're collaborating with)

14 Now make more changes and repeat!

1. Change/add files (using whatever editor you prefer) - for your first test, change at least 2 different lines.
2. See a quick overview of what changed, using one or all of the following:

   ```
   git status
   git diff
   git diff file
   ```

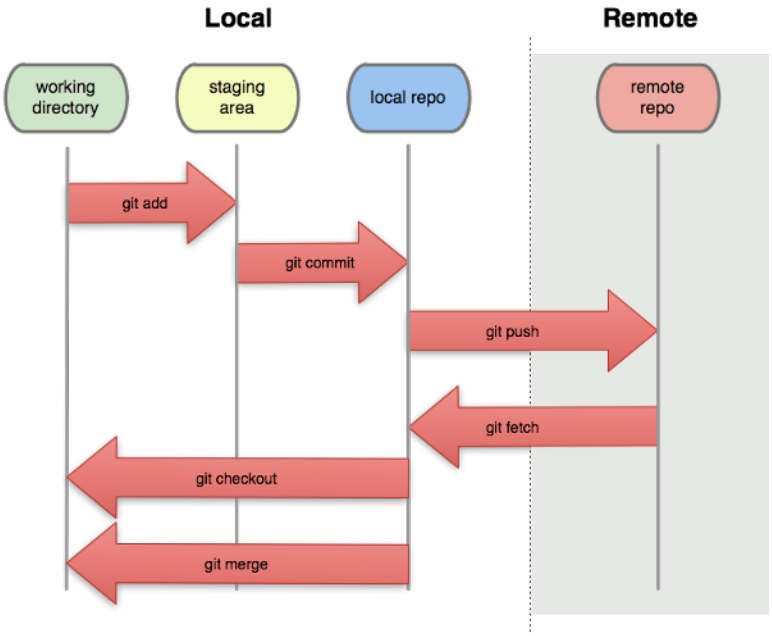
3. Add ("stage") changes with `git add file(s)`
4. Commit changes with `git commit -m commit-message`
5. View updated log with `git log`

15 Now, do something really stupid

- "Accidentally" introduce some errors to your file (or even delete a file!)
- Whoops! *If only we had access to a time machine…*
- Hang on, we do!

  ```
  git diff
  git checkout HEAD test.txt
  ```

16 What happened?



(Image from Software Carpentry)

17 Wait, what does HEAD refer to?

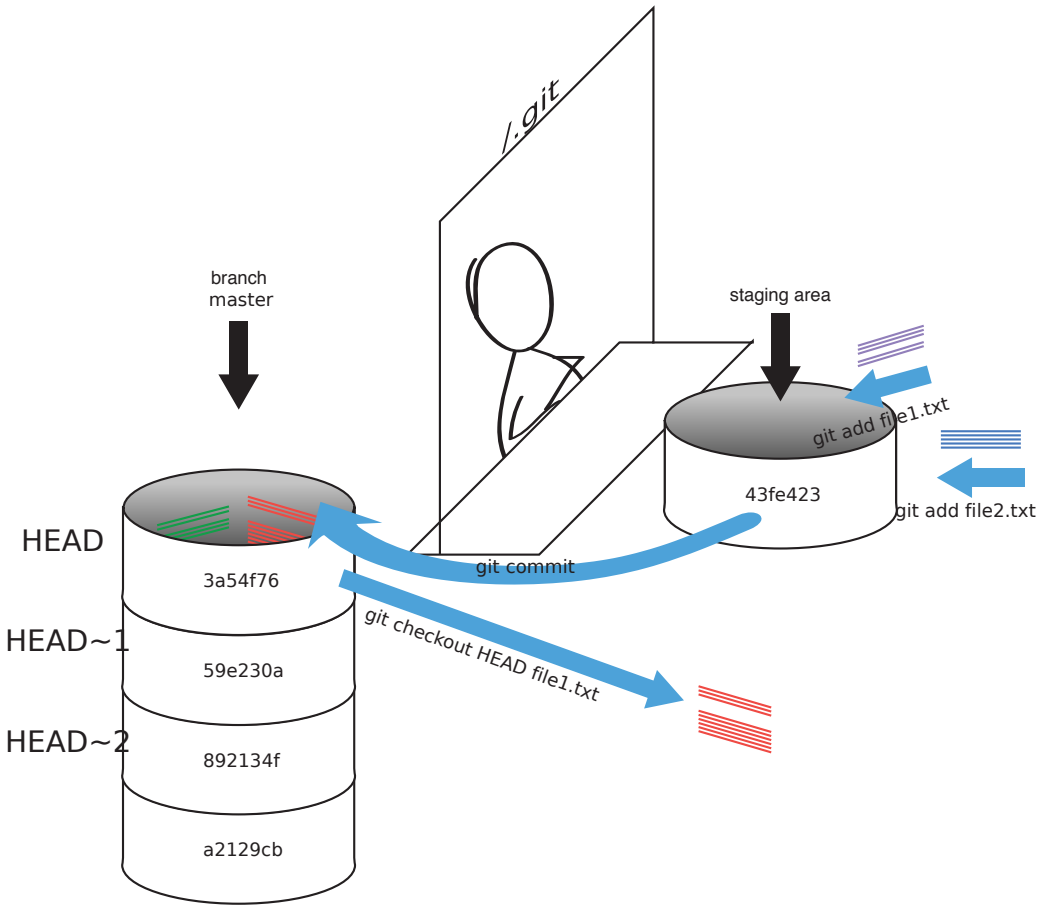


Figure 1: Commits ≈ a stack of heads

(Image from Software Carpentry)

18 Mirroring your repository on the internet

Up until now, everything has happened solely on your computer (and in fact, only in the directory you worked in). To have a backup and to synchronize between different computers (and possibly collaborators), you should link your repository to a "remote repository". There are several popular websites for this:

18.1 GitHub vs. GitLab vs. BitBucket

Private repos (only accessible by yourself or others you share it with):

- (only very recently) free on GitHub, but only < 4 collaborators.
- free on BitBucket (w/ < 6 collaborators)
- free on GitLab (**unlimited** collaborators)

- all very similar, but differences include:
  - feature set included in free vs. paid plan
  - open source vs. closed source
  - popularity & user base
- *I personally find GitLab the best free offer at the moment - but you can use all three if you want (and you can always switch)!*

19 Mirroring your repository on the internet

19.1 Setting up a "remote"

1. Create repository (or "project") on the GitLab/GitHub/BitBucket website (for now: no .gitignore, no README, and no license)
2. The website should show you instructions on what to do next, but if you already have the files and a git repository on your computer, it is simply:

   ```
   git remote add origin URL
   ```

   (use the URL shown on the website for your project, best the one using SSH, to avoid having to type in passwords all the time.)
3. Verify the path of the remote:

   ```
   git remote -v
   ```

20 Synchronizing with the remote

Once your repository has been linked to a remote, you can:

20.1 Push (or "publish") your changes:

```
git push -u origin master
```

(after the first time, you can simply use `git push`)

You can then check the remote website to see new changes. (Click on "Repository -> commits".)

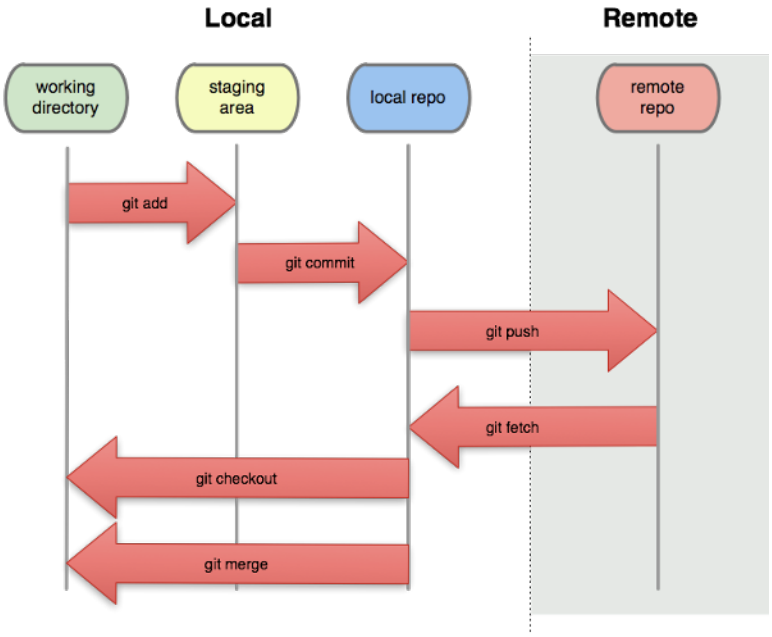
20.2 Pulling from the remote

To get the latest changes (made by yourself or possibly collaborators) from the remote, do:

```
git pull
```

Technical detail: `git fetch` only checks the status of the remote, while `git pull` actually applies those changes in your working directory.

21 Overview



(Image from Software Carpentry)

22 Things you can do with a remote repository

22.1 Use the fancy website interface

- examine your code, the commit log, keep track of issues, etc.!
- Interface with other services (e.g. Slack.com) to get notifications on commits, discuss changes with team members…
- Collaborate with others!

22.2 Synchronize and continue work on a different computer

- If necessary, start from scratch by cloning your remote repo:

  ```
  git clone URL
  ```

- Update the local repo from the remote with: `git pull`
- Important rule to remember: Always `git pull` before starting to edit your local files!

23 Clone an already existing repository

Find the URL of a repository you want to work on.

- For example, log into GitLab and go to the main page of our CourseOutlines-Math-ChamplainStLambert repository.
- Click on “Clone” and select the URL shown under “clone with SSH” (this avoids having to type in passwords all the time).
- Now get the files onto your computer:
  - In GitHub Desktop: “Clone repository”, then enter the URL (if the SSH URL does not work, try again with the https URL)
  - or, on the commandline:

    ```
    cd folder-where-you-want-it
    git clone URL
    ```

- This automatically connects your new local repo with the remote, so you can directly use `git push` and `git pull`.

24 Branches

- Any repository has a default "branch" in which all files are stored, usually called "master". This branch is usually reserved for the current most up-to-date, well-working production version (good example to keep in mind: the live files for a website, e.g. http://math.mychamplain.ca)
- But when working on new "features", it's usually not a good idea to immediately put those into the master branch!
- So, instead, you create a new branch, work in there without danger of destroying anything for others, and finally ask for the changes to be **merged** into the master branch:

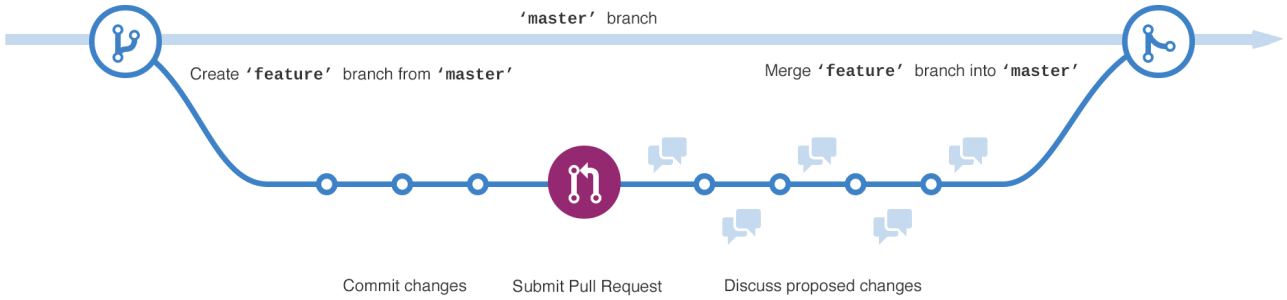


Figure 2: Branching

25 Working in a branch

25.1 Create a local branch

- Create & checkout a new branch (for now, use your first name as the name for the branch): `git checkout -b branchname`
- Work on the files as before, stage, commit, and push to the remote server.
- Inspect the log to see what happened (`git log`)

25.2 Ask for your changes to be merged into `master`

When you're satisfied with your work (and you pushed to the remote), it's time to "merge" it into the master branch. Usually, only the maintainer of the repository is allowed to do that, so you need to **create a "Pull Request"**, which is done on the website:

On GitLab:

- go to "Repository -> Branches", it should list all branches
- click on "merge request" next to your branch
- fill in some details in the form to explain what you did

26 General Best Practice Rules of Thumb

- **Commit often, perfect later, publish once!**
- Use meaningful commit messages.
- Do *not* commit anything that can be regenerated from other things that were committed. For example, pdf-files which are created from a LaTeX source, binary files which were compiled from a C++ source file, etc.
- Note: The case of pdf-files is arguable - it's sometimes nice to have the latest compiled document version archived as well, but it is technically an unnecessary waste of harddrive space and causes the repository to grow much faster than it usually would. Use your own judgment.
- *Always* use `git pull` before you start editing. This pulls in any changes made by others (or yourself on another computer!) from the remote repository.

27 Using a graphical user interface (GUI) to git

Now that you're comfortable with the principles behind git, you are ready to do everything with a few clicks (instead of typing `git add`, `git commit`, etc. all the time)!

27.1 On Windows or Mac OS:

Install Github Desktop (if not done yet), then add "an already existing repository" from your computer. It's quite self-explicatory!

27.2 On Linux:

- If you use Emacs, I recommend installing the `magit` package (ask me for help configuring it if necessary).
- Otherwise, there are many other GUIs for git available (and which might already be installed on your system, e.g. `gitk`). There is also an unofficial version of Github Desktop for Linux (which I haven't tested myself).

28 What else?

28.1 Slack.com

- A website with private "chat rooms" or "channels"
- enables convenient on-topic discussions (avoiding email chains and hard to find information),
- with integration to GitLab/GitHub:
  - show notifications about commits
  - create/inspect issues directly from the chat
- I've created a Slack group "CCSL Math Dept" for us, simply let me know if you'd like me to (re-)send an invitation.

29 Additional ressources

29.1 References

- Git it: Interactive Tutorial to learn some more details about git
- Pro Git: free book by Scott Chacon and Ben Straub with everything you might ever want to know about git
- Git Cheat Sheet
- On undoing, fixing, or removing commits in git: A git choose your own adventure
- https://www.gitignore.io/: Create appropriate `.gitignore` files for your projects
- Git Best Practices

29.2 Specific for us: Champlain St-Lambert Math Department

- CCSL GitLab repositories: currently for Generic Course Plans and math.mychamplain.ca
- CCSL Slack Group