

Introduction to Git and Version Control

2021-08-17

Introduction to Git and Version Control
Lecture 1: Git ready!

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Overview



1 Why Git?

- Traditional vs. Git Versioning

2 What is Git

- Three Main Parts (Working Directory, Stage, Repository)

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- Commits
- The Stage (Staging Area, or Index)
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Introduction to Git and Version Control

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└ Overview

- Git is different from github
- Why Git? I'll tell you what my motivations are, but what are your motivations for being here?

- Version control
- Easily compare and merge changes between any version
- Organize your work items



Why Git?

- Version control
- Easily compare and merge changes between any version
- Organize your work items



Before

After

Introduction to Git and Version Control

└ Why Git?

└ Why Git?

Imagine I asked you to remove the red sharpie marker from the left hand side?

- Difficulty finding it
- Could dive right in, but might get poked by lot of sharp things on the way in
- Or you could dump everything out and start all over



Why Git?



Introduction to Git and Version Control

└ Why Git?

└ Why Git?

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Imagine I asked you to remove this chair. What difficulties would you face?

- How to access it safely
- Can't remove it without fearing everything will fall

Traditional vs. Git Versioning

- What changed when
- Not limited to file name length to inform user of changes

```
christopher@christopher-ThinkPad-W541:~/git/mythesis$ ls -gtr
total 4
-rw-rw-r-- 1 christopher 51 Nov 17 18:22 thesis
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_v1
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_v2
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_v3
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_v4
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_final
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_final1
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_final2
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_final3
-rw-rw-r-- 1 christopher 0 Nov 18 12:07 thesis_final4
christopher@christopher-ThinkPad-W541:~/git/mythesis$
```

```
christopher@christopher-ThinkPad-W541:~/git/mythesis$ git log --reverse
commit e393a47e257310df071ac8290cdcf0c4a60bb8944 (master)
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:14:52 2020 +0900

    Added empty thesis template

commit e017bf79743fa7724d4c35f430e1e78064823e1a
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:19:14 2020 +0900

    Added initial title

commit 750455880517cbdd5db25054e0e9815ed67da185
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:20:38 2020 +0900

    Added initial summary section

commit a83135a00c134372a7973a879e2431008b5a466
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:21:09 2020 +0900

    Added initial bulk of main body section

commit 98c17b7472ef14bd75804d4ddb990de92f211ba
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:21:31 2020 +0900

    Added initial conclusions

commit aa3034ff24084d3f95e37ae222f265da07d3590
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:22:03 2020 +0900

    Changed conclusions to reflect new findings on Mars

commit d918fbfe43cf474a34c6cd86ccf4845f63e9cb4 (HEAD -> new_versioning)
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:22:31 2020 +0900

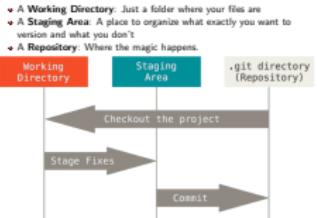
    Changed title after finding typo in teh the word
```

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└ Why Git?
 └ Traditional vs. Git Versioning
 └ Traditional vs. Git Versioning

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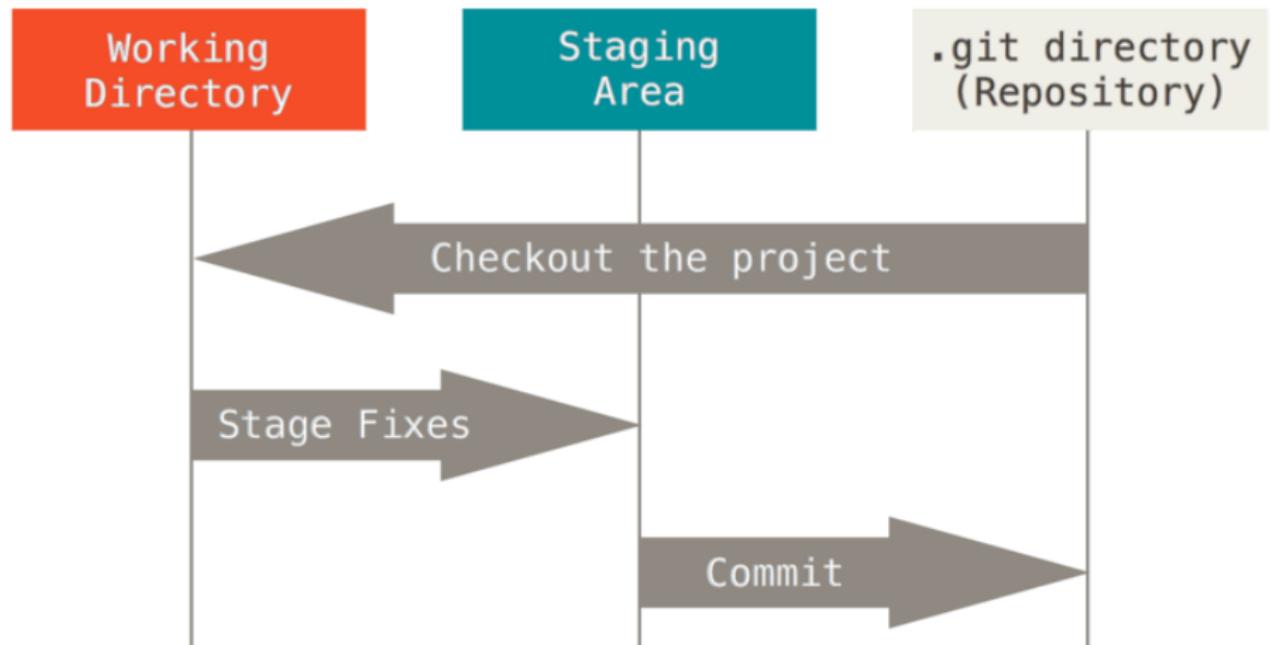


This is just a VERY limited toy example, but to just want to show how I versioned in my master's thesis compared to now using git. We'll get to the actual useful stuff later.



What is git?

- **A Working Directory**: Just a folder where your files are
- **A Staging Area**: A place to organize what exactly you want to version and what you don't
- **A Repository**: Where the magic happens.



Introduction to Git and Version Control

What is Git

- Three Main Parts (Working Directory, Stage, Repository)
- What is git?

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This chart might not make much sense now, but I hope it will before the end of these slides

Whether you realize it or not, you are already familiar with the "Working Directory". I'll save the staging area for a bit later, but first lets talk about what a repo is.

Repositories

- A **repository** is a container for both your project data and all the items that allow interactions with git commands.
 - There are many sites to host your repository on (github, bitbucket), including your own local machine.
 - All of the essential parts of your repository can be found in the `.git` directory
 - GitHub (a website hosting Git repositories) \neq Git (a set of tools for creating and managing those repositories).



Introduction to Git and Version Control

What is Git

- Three Main Parts (Working Directory, Stage, Repository)
 - Repositories

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Repositories

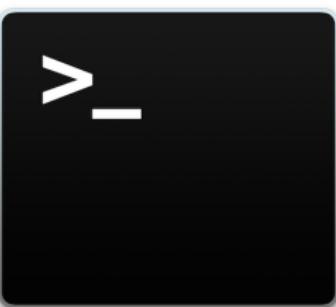
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 - There are many sites to host your repository on (github, bitbucket), including your own local machine.
 - All of the essential parts of your repository can be found in the `.git` directory
 - GitHub (a website hosting Git repositories) \neq Git (a set of tools for creating and managing those repositories).



Terminal Talk



- There are multiple GUIs available for Git, such as one from GitHub called the **GitHub Desktop**. We will not be using this for religious perfectly scientific reasons.
- These reasons primarily revolve around flexibility and improved understanding of the Git tools.
- Everything we do will be usable on Deigo.
- The **Pro Git** book is available online at git-scm.com/book
- There is a cheatsheet for Git available here: <https://www.git-tower.com/learn/cheatsheets/git>



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Introduction to Git and Version Control

- └ How to Use Git
 - └ The Terminal
 - └ Terminal Talk

- There are multiple GUIs available for Git, such as one from GitHub called the **GitHub Desktop**. We will not be using this for religious perfectly scientific reasons.
- These reasons primarily revolve around flexibility and improved understanding of the Git tools.
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- The **Pro Git** book is available online at git-scm.com/book
- There is a cheatsheet for Git available here: <https://www.git-tower.com/learn/cheatsheets/git>

- I personally struggled with the terminal interface at first because most of the man pages use so much vocab I don't know to explain terms I don't know. Hopefully by the end of this mini-course you'll have the basic vocab down so you can help yourselves more efficiently going forward.

Create a Repo(sitory)



Let's **git** started.

- To initialize a git repository, simply type **git init** in a directory (preferably empty for now)
- This creates a folder **.git/**, where all your repository information is held.



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└ How to Use Git
 └ Create a repo
 └ Create a Repo(sitory)

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Create a Repo(sitory)

Let's **git** started:

- To initialize a git repository, simply type **git init** in a directory (preferably empty for now)
- This creates a folder **.git/**, where all your repository information is held.





EXERCISE

- ① Open a terminal
- ② Create a new directory called **myFirstRepo** and enter it.
- ③ This is your Working Directory. Thats it!
- ④ Run **git init** in your Working Directory.
- ⑤ Take a peak in the newly created .git directory but don't touch anything quite yet.

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└ How to Use Git

└ Create a repo

└ Create an Empty Repo

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Create an Empty Repo

EXERCISE

- ① Open a terminal
- ② Create a new directory called **myFirstRepo** and enter it.
- ③ This is your Working Directory. Thats it!
- ④ Run **git init** in your Working Directory.
- ⑤ Take a peak in the newly created .git directory but don't touch anything quite yet.

Commits

- Conceptually similar to "versions"
- The more effort you put into crafting these the more helpful they are in the future.

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
AAAAAAA	3 HOURS AGO
ADKFJSLKDFJSOKLFJ	3 HOURS AGO
MY HANDS ARE TYPING WORDS	2 HOURS AGO
HAAAAAAAAANDS	2 HOURS AGO

AS A PROJECT DRAGS ON, MY GIT COMMIT MESSAGES GET LESS AND LESS INFORMATIVE.

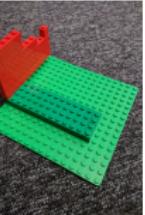


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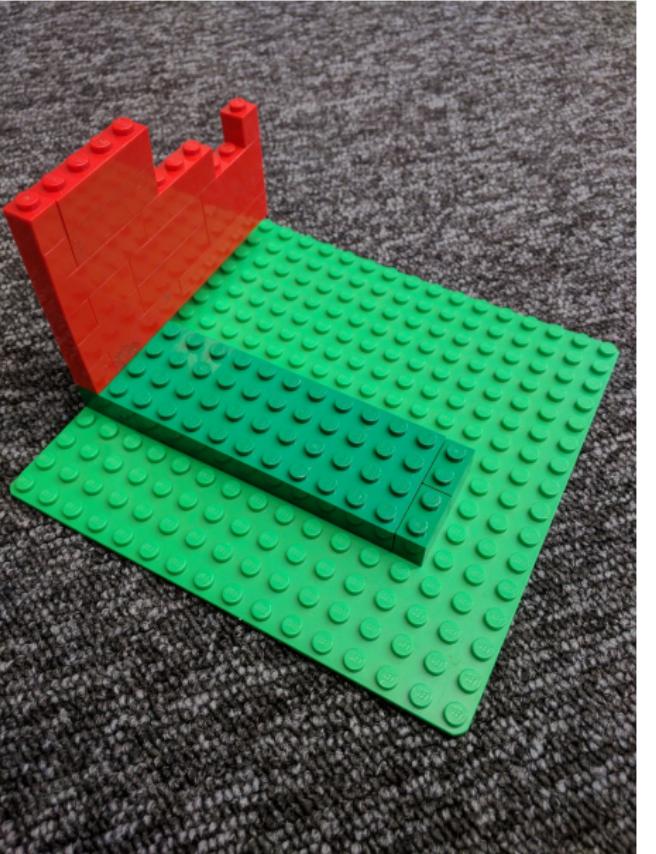
- How to Use Git
- Commits
- Commits

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Commits



Introduction to Git and Version Control

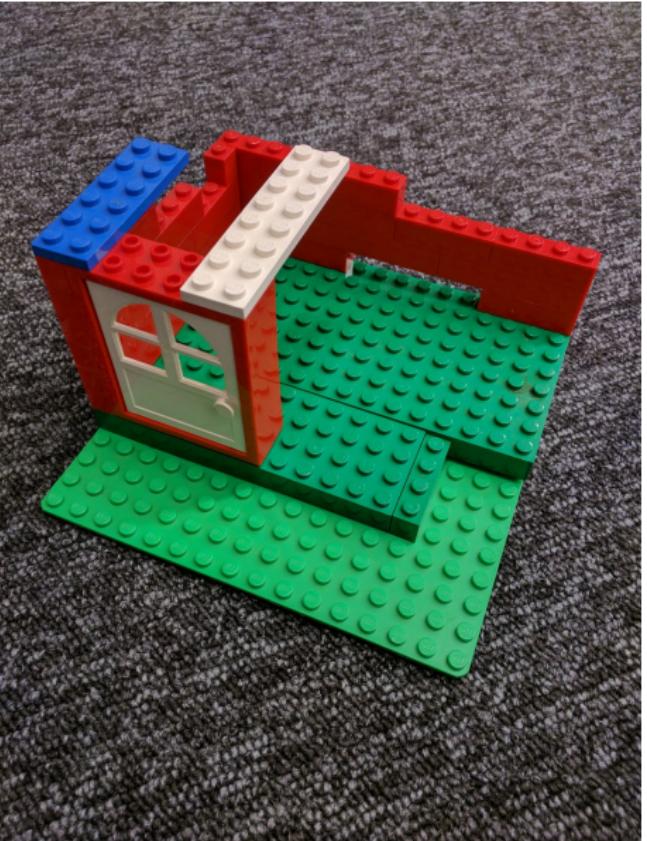
- └ How to Use Git
 - └ Commits
 - └ Commits

Added some stuff

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Commits



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Introduction to Git and Version Control

- └ How to Use Git
 - └ Commits
 - └ Commits

Added some more stuff



Commits

Introduction to Git and Version Control

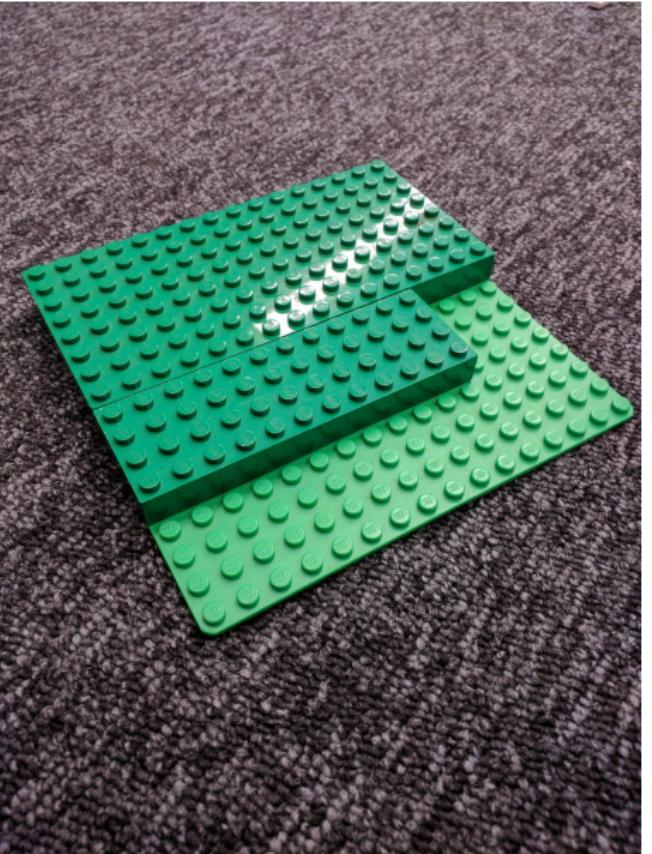
- └ How to Use Git
- └ Commits
- └ Commits

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Done! Now lets say we found an error in the western wall. Which commit was that added in?



Commits



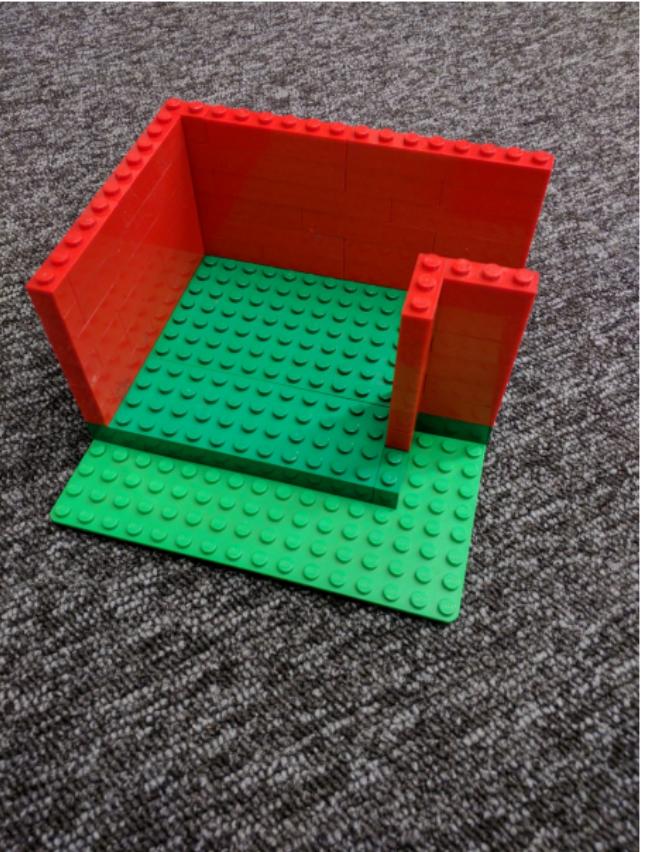
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Introduction to Git and Version Control
└ How to Use Git
 └ Commits
 └ Commits

Added the foundation



Commits



Introduction to Git and Version Control

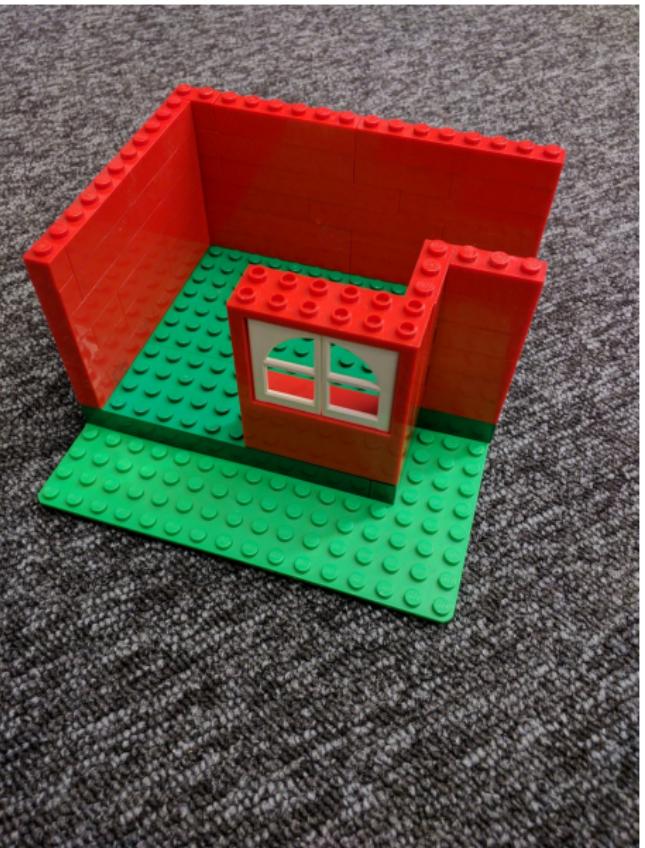
- └ How to Use Git
- └ Commits
- └ Commits

Added the walls

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Commits



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- └ How to Use Git
- └ Commits
- └ Commits

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Added the window



Commits



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- └ How to Use Git
- └ Commits
- └ Commits

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Added the door



Commits



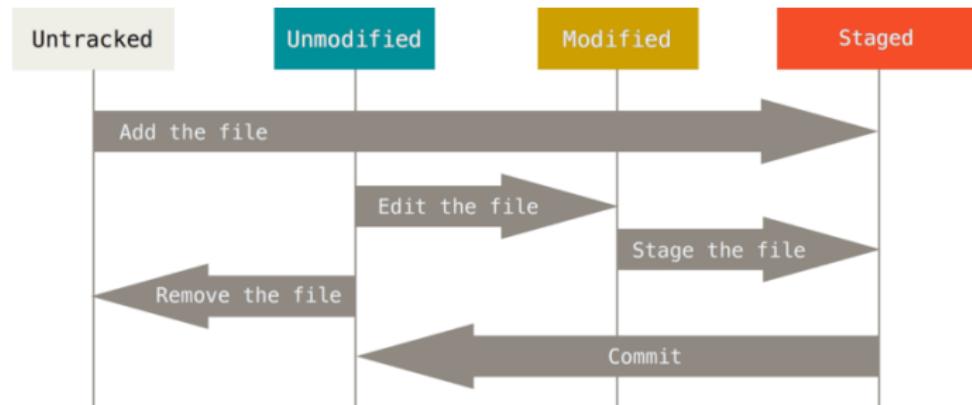
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- └ How to Use Git
 - └ Commits
 - └ Commits

Added the roof

Staging Changes



- A new file is initially **untracked**
- When you use **git add**, it moves to the staging area and becomes **staged**
- After being committed (using **git commit**), a file is up-to-date and considered **unmodified**
- Changing a file makes it modified, but doesn't add it to the staging area

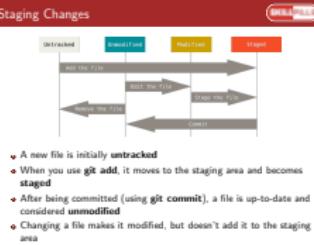
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How to Use Git

The Stage (Staging Area, or Index)

Staging Changes

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So how do we construct or make these GOOD commits? By using the Staging Area or Index. Next we'll discuss what this is and how to use it to make GOOD commits.

Currying the Stage before Committing



- Check what is on the stage with **git status**. Anything in **green** is staged.
- If you wish to unstage all changes, simply type **git reset**. This will remove everything from the stage, but keep your working directory untouched.
- **git reset** will work for individual files as well

```
git reset <file>
```



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- └ How to Use Git
 - └ The Stage (Staging Area, or Index)
 - └ Currying the Stage before Committing

Currying the Stage before Committing

- Check what is on the stage with **git status**. Anything in **green** is staged.
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- **git reset** will work for individual files as well
`git reset <file>`





EXERCISE

- ① Create a new empty file **myfile.txt**
- ② Check the status of everything with **git status**
- ③ Add **myfile.txt** to the stage via **git add myfile.txt**
- ④ Check the status of everything again with **git status**. What changed?
- ⑤ Unstage the changes with **git reset myfile.txt**
- ⑥ Check the status of everything again with **git status**. What changed?

Introduction to Git and Version Control

└ How to Use Git

└ The Stage (Staging Area, or Index)

└ Try out the Stage

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EXERCISE

- ① Create a new empty file **myfile.txt**
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- ③ Add **myfile.txt** to the stage via **git add myfile.txt**
- ④ Check the status of everything again with **git status**. What changed?
- ⑤ Unstage the changes with **git reset myfile.txt**
- ⑥ Check the status of everything again with **git status**. What changed?



- Git keeps track of **commits**. Check these commits with **git log**.
There's plenty of options to show only what you want or everything under the sun.
- **git status** checks any changes since the last commit.
- **git commit** commits everything in the *staging area* - git status shows these files in **green** by default.

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└ How to Use Git

└ The Stage (Staging Area, or Index)

└ Committing from the Stage

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- Git keeps track of **commits**. Check these commits with **git log**. There's plenty of options to show only what you want or everything under the sun.
- **git status** checks any changes since the last commit.
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EXERCISE

- ① Reopen your **myFirstRepo** from before
- ② Add the **myFile.txt** back to the stage with **git add myFile.txt**
- ③ Check the status of the stage with **git status**
- ④ Once satisfied with what is in the stage and you're ready to commit, go ahead and do so with **git commit** to add your new file to the git repository. Be sure to add a meaningful commit message!
- ⑤ Check the **git log**.
- ⑥ Check the **git status**
- ⑦ Add a line of text to **myFile.txt** and save it.
- ⑧ Check the status of the stage with **git status**
- ⑨ Check the differences in the file with **git diff**
- ⑩ Once satisfied with your changes, add it back to the stage and commit.

Introduction to Git and Version Control

How to Use Git

Making Commits

Making Commits

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- ➊ Reopen your **myFirstRepo** from before
- ➋ Add the **myFile.txt** back to the stage with **git add myFile.txt**
- ➌ Check the status of the stage with **git status**
- ➍ Once satisfied with what is in the stage and you're ready to commit, go ahead and do so with **git commit** to add your new file to the git repository. Be sure to add a meaningful commit message!
- ➎ Check the **git log**.
- ➏ Check the **git status**
- ➐ Add a line of text to **myFile.txt** and save it.
- ➑ Check the status of the stage with **git status**
- ➒ Check the differences in the file with **git diff**
- ➓ Once satisfied with your changes, add it back to the stage and commit.

Checking out your past commits

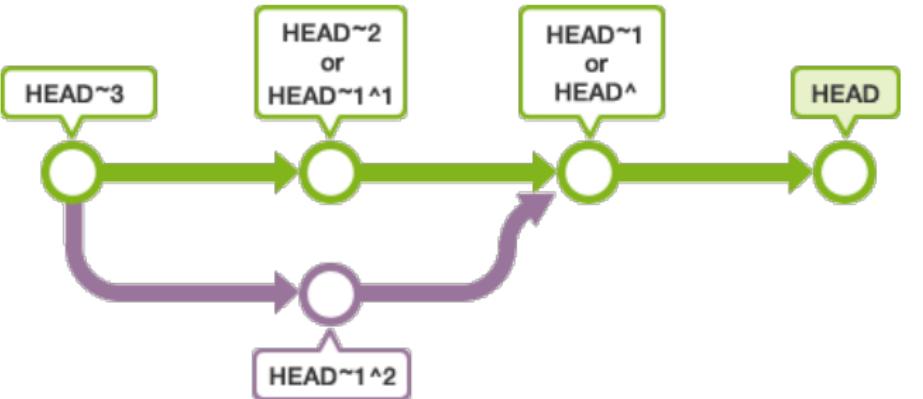


- **git checkout** allows you to view the repository at any commit (found with **git log**).

- You may also checkout specific files like so:

```
git checkout a1e8fb5 hello.py
```

- Note that the most recent commit is **HEAD** and the one just before that is **HEAD~1**



Introduction to Git and Version Control

└ How to Use Git

└ Checking Out Past Commits

└ Checking out your past commits

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Checking out your past commits

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- You may also checkout specific files like so:

```
git checkout a1e8fb5 hello.py
```

- Note that the most recent commit is **HEAD** and the one just before that is **HEAD~1**



Checkout Your History



EXERCISE

- ① Add a second line of text to **myFile.txt** and save it.
- ② Add these changes to the stage with **git add myFile.txt** and check the status with **git status**
- ③ Once satisfied with what is in the stage and you're ready to commit, use **git commit** to add your new file to the git repository.
- ④ Check the **git log**. You should have three commits by now.
- ⑤ Go checkout each of the commits with **git checkout <HASH>**, **git checkout HEAD~1**, or **git checkout HEAD~2**
- ⑥ See whats different with **ls -al** or **git status** or just open **myfile.txt** in your favorite text editor
- ⑦ When you are satisfied that your commit history is as expected you can return to the most recent commit with **git checkout master** (Note this could be **git checkout main** depending on your version of git.)

Introduction to Git and Version Control

└ How to Use Git

└ Checking Out Past Commits

└ Checkout Your History

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Checkout Your History

EXERCISE

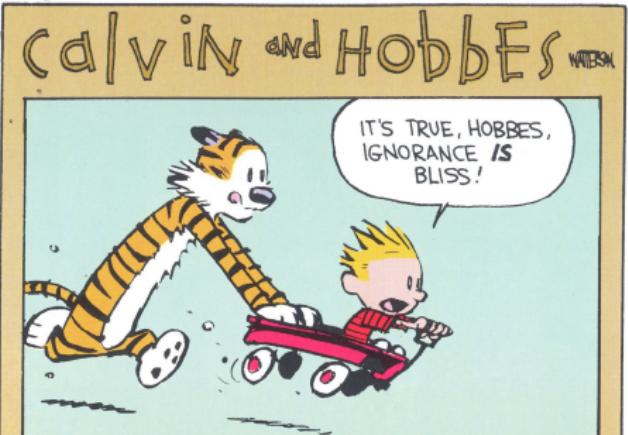
- ➊ Add a second line of text to **myFile.txt** and save it.
- ➋ Add these changes to the stage with **git add myFile.txt** and check the status with **git status**
- ➌ Once satisfied with what is in the stage and you're ready to commit, use **git commit** to add your new file to the git repository.
- ➍ Check the **git log**. You should have three commits by now.
- ➎ Go checkout each of the commits with **git checkout <HASH>**, **git checkout HEAD~1**, or **git checkout HEAD~2**
- ➏ See whats different with **ls -al** or **git status** or just open **myfile.txt** in your favorite text editor
- ➐ When you are satisfied that your commit history is as expected you can return to the most recent commit with **git checkout master** (Note this could be **git checkout main** depending on your version of git.)

Git Generally Only Adds

- After you commit something it is fairly difficult to remove it.
- This is a double edged sword. Low risk of losing anything permanently. High risk of creating a **HUGE** repo.
- Keep your repository clean! Do your best to commit as few images and data files as possible!
- You can do this by ignoring certain file extensions in a **.gitignore** file.
- Great templates for projects of many types found at
<https://github.com/github/gitignore>

```
# Example gitignore configuration
```

```
*.log  
*.tar  
*.gz  
*.exe  
*.dat  
*.lvp
```



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How to Use Git

Checking Out Past Commits

Git Generally Only Adds

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Git Generally Only Adds

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```
# Example gitignore configuration
*.log
*.tar
*.gz
*.exe
*.dat
*.lvp
```





EXERCISE

- ① Touch multiple files with various extensions, one of which should be **.dat**.
- ② Ignore the **.dat** file, but commit all the others.
- ③ Be sure to write a clear message describing what you did.
- ④ Check the **git log**

Introduction to Git and Version Control

└ How to Use Git

└ Checking Out Past Commits

└ Quick Exercise

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EXERCISE

- Touch multiple files with various extensions, one of which should be **.dat**.
- Ignore the **.dat** file, but commit all the others.
- Be sure to write a clear message describing what you did.
- Check the **git log**

Modifying Previous Commits



- If you commit something that turns out to be a mistake, don't worry! There are plenty of tools to rework commits.
- Some are more powerful (and potentially destructive than others)
- Non-destructive: (Leaves history intact)
 - **revert**
- Potentially destructive: (Changes history)
 - **reset**
 - **rebase**
- Danger Zone: (Can erase history)
 - **reflog**
- Note: These tools may take some time to conceptualize, so I encourage you to play around with them in your toy environments (e.g. `myFirstRepo`) a fair bit before trying them out on your actual code base.

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└ How to Use Git

└ Checking Out Past Commits

└ Modifying Previous Commits

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Modifying Previous Commits

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Using Revert



- **git revert <HASH>** makes a new commit showing what you reverted.
- Pro: This is very useful for public repos where you want to show exactly what you've undone to others.
- Con: Can make your commit history messy if used too often.

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- └ How to Use Git
 - └ Revert
 - └ Using Revert

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Using Revert



EXERCISE

- ① Make a few commits to your **myFirstRepo** if you don't have any already. Make sure they are simple for now (just single line additions). Use **git log** to understand your current git history and **cat myfile.txt** to understand the contents of your file before reverting.
- ② Find a commit you want to revert using **git log** and **git show** or **git diff**. Ensure the commit you choose is just the addition of a single line.
- ③ Revert that commit with **git revert <HASH>** or **git revert HEAD~<#>** Use **git log** to understand your current git history. Use **cat myfile.txt** to again understand the contents of your file after reverting.

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- └ How to Use Git
 - └ Revert
 - └ Using Revert

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Using Revert

EXERCISE

- ① Make a few commits to your **myFirstRepo** if you don't have any already. Make sure they are simple for now (just single line additions). Use **git log** to understand your current git history and **cat myfile.txt** to understand the contents of your file before reverting.
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- ③ Revert that commit with **git revert <HASH>** or **git revert HEAD~<#>** Use **git log** to understand your current git history. Use **cat myfile.txt** to again understand the contents of your file after reverting.



- You may remember the **git reset** command to remove things from the Staging Area (undoing staging)
- We can also use **git reset** to undo commits.
- This is a great way to undo fairly recent commits (one or two before), but not the ideal tool for doing anything further than that.
- When you use **git reset HEAD^1** you undo your most recent commit but retain all the changes the commit made. This is useful if you accidentally included a file in a commit and want to go back, and remake the commit.

└ How to Use Git

└ Reset

└ Using Reset

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- We can also use **git reset** to undo commits.
- This is a great way to undo fairly recent commits (one or two before), but not the ideal tool for doing anything further than that.
- When you use **git reset HEAD^1** you undo your most recent commit but retain all the changes the commit made. This is useful if you accidentally included a file in a commit and want to go back, and remake the commit.

Using Reset

EXERCISE

- ① Make a new commit with a single line addition to myfile.txt and add a new file called "BIGBINARY".
- ② Make sure you have a clean working directory (no local changes compared to most recent commit) with **git status**
- ③ Use **git show** to show the changes made by your most recent commit. Hopefully this should show the single line addition to myfile.txt and the newly added BIGBINARY file.
- ④ Use **git reset HEAD^1** to undo this commit but keep the single line addition and BIGBINARY in the working directory (Your work is not undone, just the commit).
- ⑤ Use **git status** to see that this line addition is still in your text file, but **git log** no longer shows the commit
- ⑥ Make a new GOOD commit by adding only myfile.txt to the stage and not BIGBINARY.



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- └ How to Use Git
 - └ Reset
 - └ Using Reset

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Using Reset

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Using Rebase



- **git rebase** rewrites the commit history by starting from specified base commit and choosing what to do with each commit all the way to the current HEAD.
- Pro: Great for removing WIP commits or otherwise meaningless commits. Use it to clean up your local history before pushing to a public repo.
- Con: This has the possibility to create a lot of conflicts if used in a shared repo (as one person's history will differ from another). Generally rebase should not be used to modify any commits you have pushed to a public repo.
- Generally I recommend using **git rebase -i** for beginners as this shows you what is going on each step of the way.

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Using Rebase

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Using Rebase



EXERCISE

- ① Make sure you have at least 5 commits to your **myFirstRepo**.
- ② Making at least one of these a meaningless WIP commit.
- ③ Use **git log** to find the earliest commit that was bad (first WIP commit). Copy the HASH from the commit **just prior** to this WIP commit. We want to rebase our current HEAD not on the WIP commit, but just before it so we can remove or fix the WIP commit.
- ④ Use **git rebase -i <HASH>** and follow the instructions

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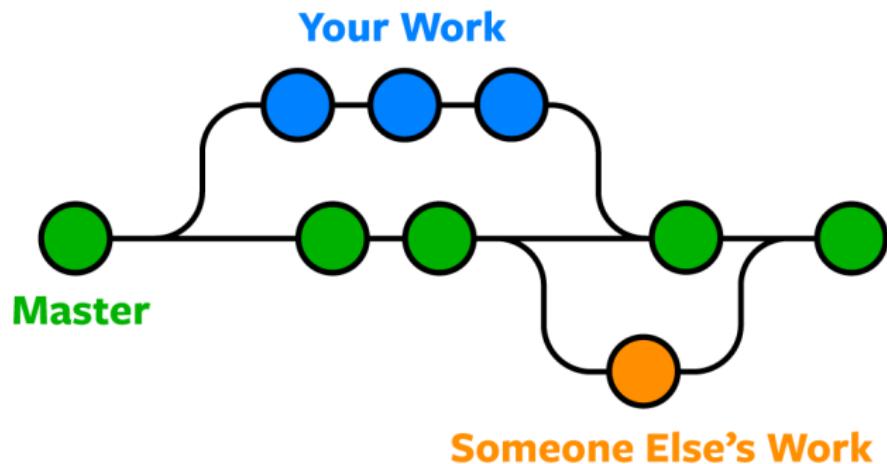
Using Rebase

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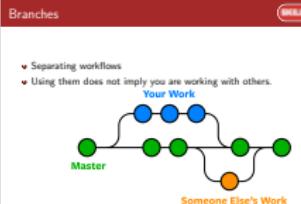
- Separating workflows
- Using them does not imply you are working with others.



Introduction to Git and Version Control

- How to Use Git
 - Rebase
 - Branches

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- When you want to develop something separately (New features, refactoring, hacking away) but don't want to affect your main workflow.
- Make a new branch before doing something you think will break the code, or do something you think will be nontrivial (more than one commit).
- With the house example, think separation of the development of garage or porch. Or think about remodeling the interior while someone else works on the exterior.



- **git branch { new-branch }** Create a new branch at HEAD
 - **git branch -av**: List all existing branches
 - **git branch -d {branch}**: Delete a branch
 - **git checkout {branch}**: Checkout a branch
 - Shortcut: **git checkout -b {branch}**: Create a new branch @ HEAD and then check it out.

- Introduction to Git and Version Control
 - How to Use Git
 - Rebase
 - Branches: Creating Them

Lets take a look at how to create, delete and play around with branches

- `git branch | new-branch`: Create a new branch at HEAD
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git with it!

Now we move to the fun* stuff: working with **online repositories**.

- For this, we will be using **github**.
- We'll begin by creating a GitHub repository using the website.
 - If we're working on a project that's already hosted on a remote Git server, we can skip this step.
- Next, we use **git clone** to download a copy.
- From here, you can do the following:
 - **git push** to push any changes you may have to the online repository.
 - **git pull** to take any changes from the repository.

*Here, the word *fun* is subject to interpretation.



Introduction to Git and Version Control

└ Working Online

└ git with it!

It may be better (especially for beginners) to use `git fetch` or `git remote update` rather than `pull`

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git with it!

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Quick Exercise



EXERCISE

- ① Fork the <https://github.com/oist/skillpill-git> repository using a browser.
- ② Clone the forked repository* to your local disk:

```
git clone git@github.com:<git_user_name>/skillpill-git.git
```

or

```
git clone  
https://github.com/<git_user_name>/skillpill-git.git
```

- ③ Make some simple commits and test the process of **pushing** and **pulling** stuff from that repo.

*The examples here show cloning the SkillPill Git repository - replace the links as appropriate!

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Working Online

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What it will feel like...

- git is not intuitive to start with, but it's a powerful tool for storing and restoring history, and working collaboratively with other people.
- The more you use it, the more you will like it. Think Stockholm syndrome.
- Operations that you use frequently will become easy.
- Operations you use infrequently, you can Google!



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└ Wrap Up

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└ What it will feel like...

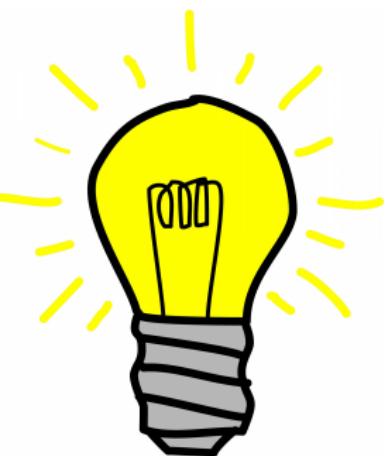
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Final Comments



- git is weird. It's not intuitive, but it's the best way to collaborate with people on open projects.
- It's also great even if you don't collaborate!
- Whenever you are using git, think about other people and how they will perceive your comments. **Would you be able to understand your own cryptic commit messages?**
- You will make mistakes. Don't worry about it. Your entire history is backed up already. Learn from your mistakes and don't make them again!
- Read error messages carefully - they can be useful/informative/instructive.



Introduction to Git and Version Control

└ Wrap Up

└ Final Comments

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