

Introduction to Git and Version Control

2021-08-16

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

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Okinawa Institute of Science and Technology
August 16, 2021

Original Slides by James Schloss, 2016

Overview



1 Why Git?

- Traditional vs. Git Versioning

2 What is Git

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

3 How to Use Git

- The Terminal
- Create a repo
- Commits
- The Stage (Staging Area, or Index)
- Making Commits
- Checking Out Past Commits

4 Working Online

5 Wrap Up

6 Extra Credit

- Revert
- Rebase

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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?

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3 How to Use Git	
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• Create a repo	
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• Revert	
• Rebase	

- 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?



A photograph showing a massive, chaotic pile of discarded wooden chairs stacked against the side of a building. A small figure of a person stands at the bottom left, highlighting the enormous scale of the waste.



REPLAY

Introduction to Git and Version Control

└ Why Git?

└ Why Git?

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

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Why Git?



Christopher Buckley (OIST)

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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 -ltr
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 e393a47e257310df071ac8290cdefc04a60bb8944 (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 d918fbfe43cf474a34c6cde86ccf4845f63e9cb4 (HEAD -> new_versioning)
Author: Christopher Buckley <15166572+topherbuckley@users.noreply.github.com>
Date: Tue Nov 17 18:22:31 2020 +0900

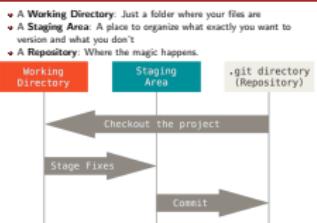
    Changed title after finding typo in teh the word
```

Introduction to Git and Version Control
└ 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.

The diagram illustrates the three main components of Git:

- Working Directory**
- Staging Area**
- .git directory (Repository)**

Arrows indicate the flow between these components:

- A large arrow points from the Working Directory to the Staging Area, labeled "Checkout the project".
- A large arrow points from the Staging Area to the .git directory, labeled "Stage Fixes".
- A large arrow points from the .git directory back to the Working Directory, labeled "Commit".

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

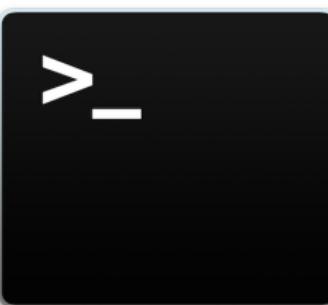
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 - There are many sites to host your repository on (github, bitbucket), including your own local machine.
 - All of the essential parts of your repository can be found in the `.git` directory
 - GitHub (a website hosting Git repositories) \neq Git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

- 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.

- 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.
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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.



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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.

Introduction to Git and Version Control

└ 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.

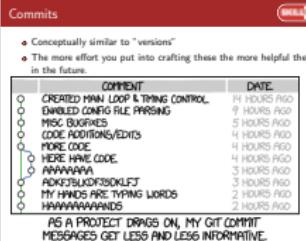
COMMENT	DATE
CREATED MAIN LOOP & TIMING CONTROL	14 HOURS AGO
ENABLED CONFIG FILE PARSING	9 HOURS AGO
MISC BUGFIXES	5 HOURS AGO
CODE ADDITIONS/EDITS	4 HOURS AGO
MORE CODE	4 HOURS AGO
HERE HAVE CODE	4 HOURS AGO
AAAAAAA	3 HOURS AGO
ADKFJSLKDFJSOKLFJ	3 HOURS AGO
MY HANDS ARE TYPING WORDS	2 HOURS AGO
HAAAAAAAAANDS	2 HOURS AGO

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

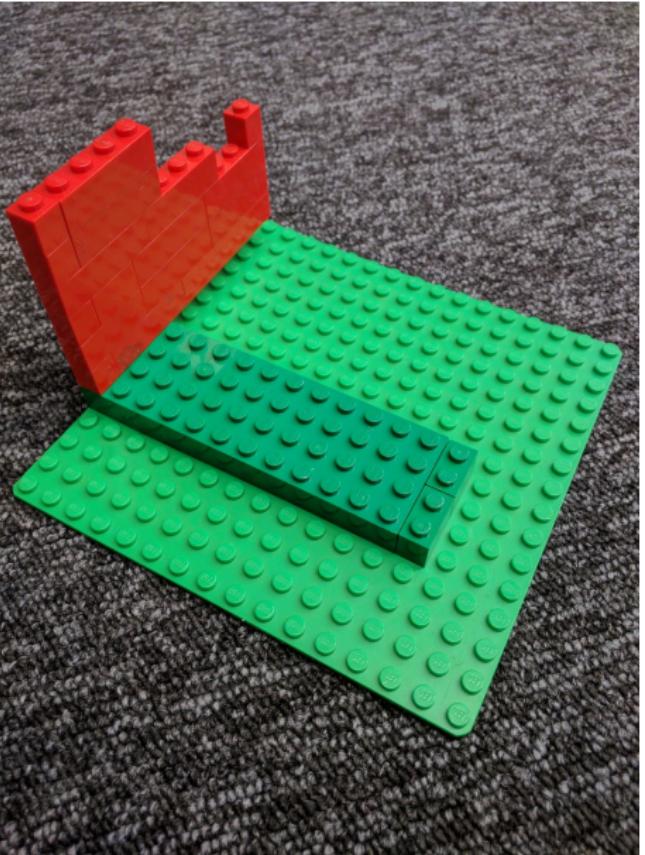
Introduction to Git and Version Control

- How to Use Git
- Commits
- Commits

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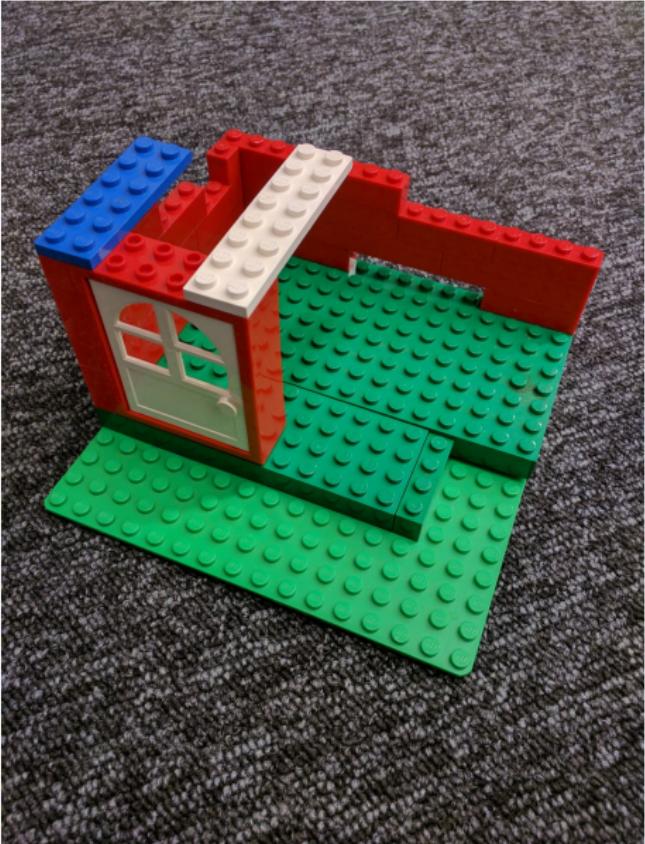
- Using git in and of itself does not mean you will have better versioning.
- We need to make GOOD commits for git to have any significant benefit.
- By "versions" I mean what you may be used to seeing in dropbox or similar backup schemes.
- Git at its worst acts quite similar to this, but if used properly can add so much more.
- To clarify with a more visual example, I made a house using legos. (Lego photos on next slides).



Added some stuff



Commits



Introduction to Git and Version Control

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

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Added some more stuff



Commits



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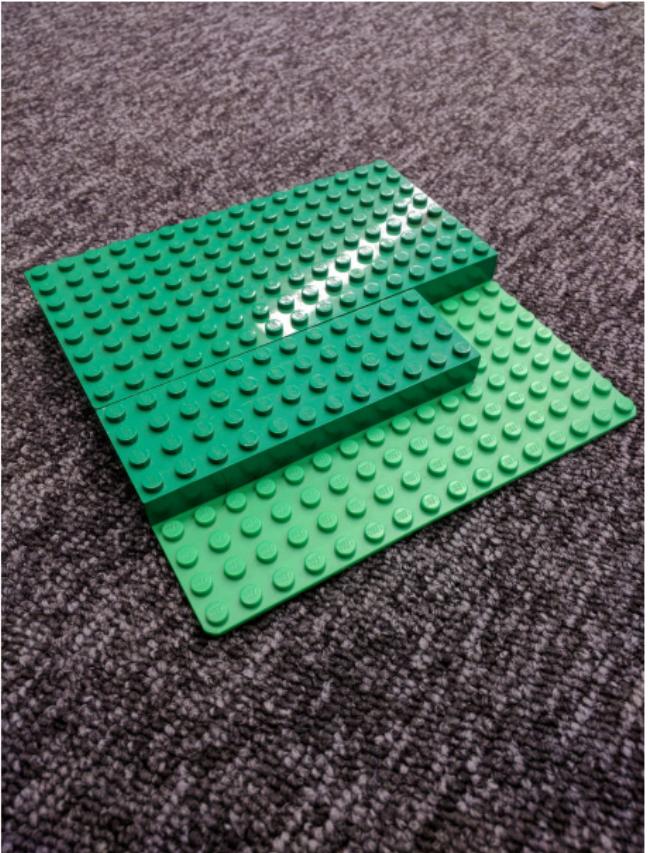
- └ How to Use Git
- └ Commits
- └ Commits

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



Commits

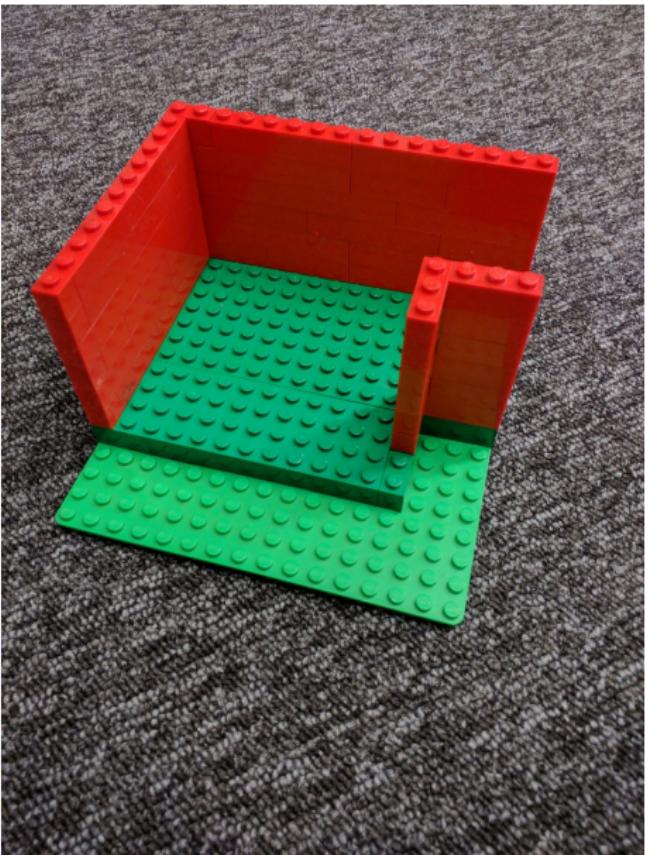


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Introduction to Git and Version Control

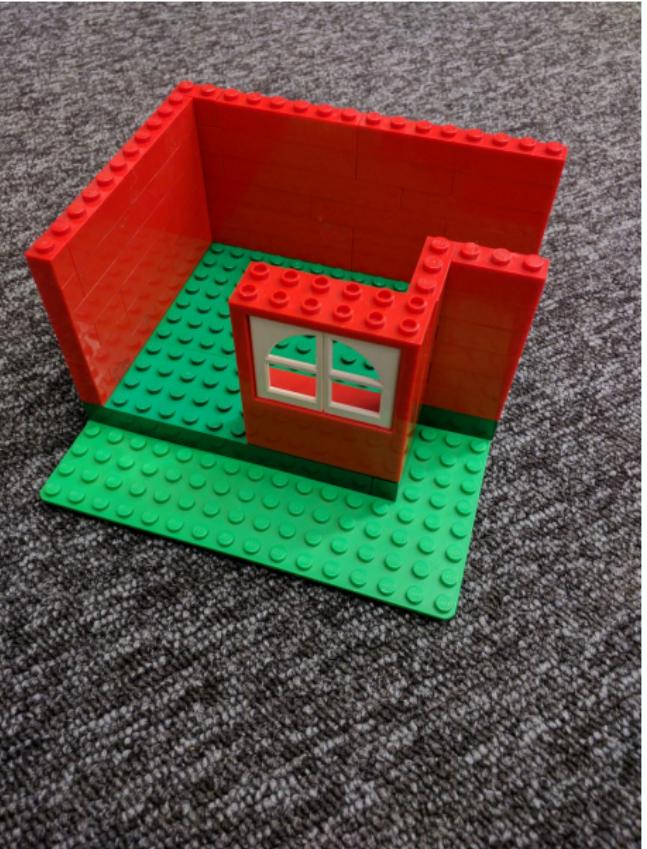
- └ How to Use Git
 - └ Commits
 - └ Commits

Added the foundation





Commits



Introduction to Git and Version Control

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

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Added the window



Commits



Introduction to Git and Version Control

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

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Added the door



Commits



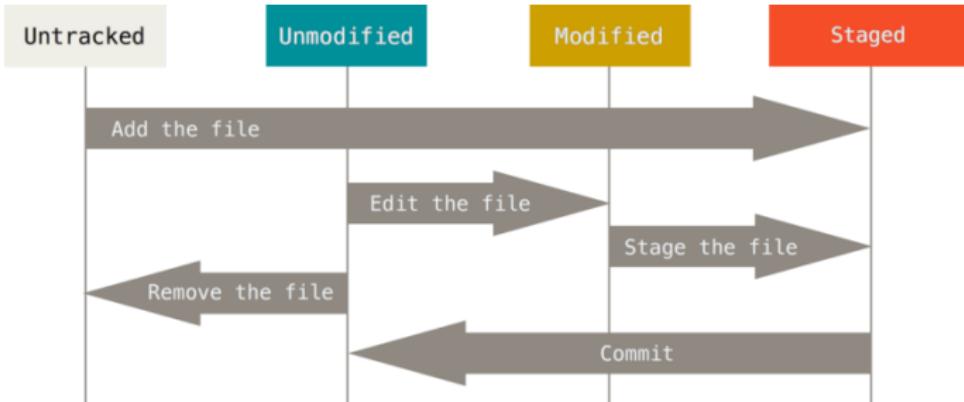
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- └ How to Use Git
- └ Commits
- └ Commits

Added the roof

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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

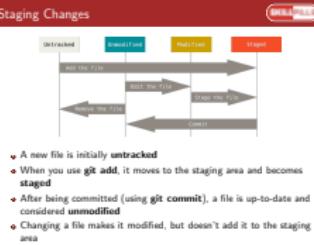
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How to Use Git

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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Introduction to Git and Version Control

- └ 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.
- 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



Try out the Stage



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.

Introduction to Git and Version Control

└ 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.
- **git commit** commits everything in the *staging area* - git status shows these files in **green** by default.



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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Making Commits

EXERCISE

- 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

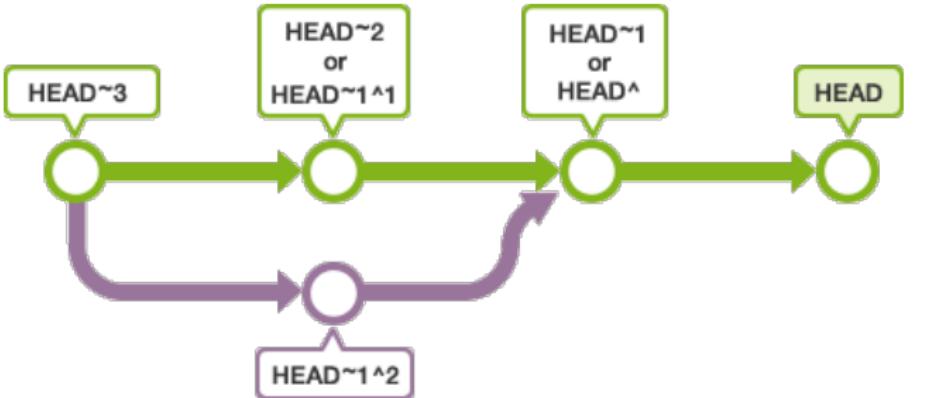


- **git checkout** allows you to view the repository at any commit (found with **git log**).

- 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**



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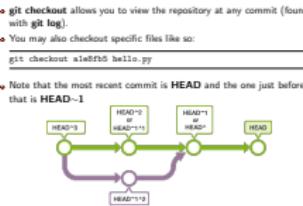
How to Use Git

Checking Out Past Commits

Checking out your past commits

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Checking out your past commits



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

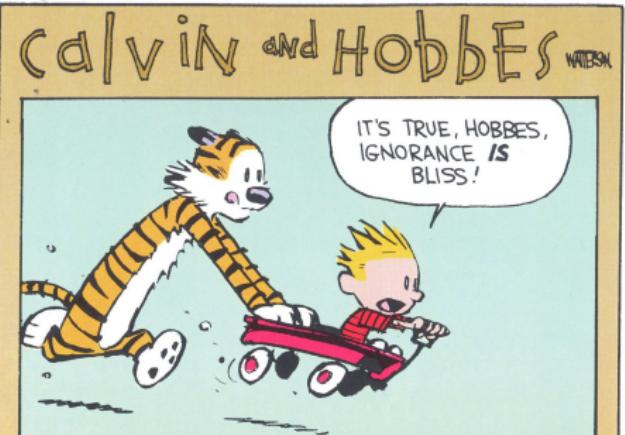
- ① Add a second line of text to **myFile.txt** and save it.
- ② Add these changes to the stage with **git add myFile.txt** and check the status with **git status**
- ③ Once satisfied with what is in the stage and you're ready to commit, use **git commit** to add your new file to the git repository.
- 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.)

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
```



My robot repo is now 500GB due to huge Solidworks CAD files.



How to Use Git

- └ Checking Out Past Commits
 - └ Quick Exercise

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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**

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**

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!

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

git with it!

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



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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Quick Exercise

EXERCISE

- ➊ Fork <https://github.com/oist/skillpill-git> repository using a browser.
- ➋ 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`
- ➌ 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!

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!



Introduction to Git and Version Control

└ Wrap Up

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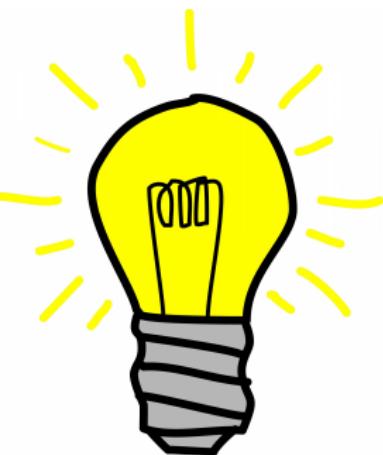
└ What it will feel like...

- 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!





- 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.



└ Wrap Up

└ Final Comments

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(If Time Allows) 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)
 - **rebase**
- Danger Zone: (Can erase history)
 - **reflog**

Introduction to Git and Version Control

└ Extra Credit

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Using Revert



- Revert makes a new commit showing that you reverted a previous commit.
- Pro: This is very useful for public repos (next session) where you want to show exactly what you've undone to others.
- Con: This can make your commit history quite messy if used too often.

EXERCISE

- Make a few commits to your **myFirstRepo** or just use the existing history of your skill-pill fork
- Find a commit you want to revert using **git log** and **git show** or **git diff**
- Revert that commit with **git revert <HASH>** or **git revert HEAD~<#>**

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Using Rebase



- 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 on any commits you have pushed to a public repo.

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