now you *git* it! (day i of ii)

wintersession winter 2022, january 13 @ 10:00
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me (@DbCrWk, ddabke)

- he/him/his
- education
  - applied math phd @ Princeton
  - math/cs undergrad @ Duke
- industry
  - Facebook, NASA, BlackRock, Airtable
- started with svn, then realized how git works and why it’s awesome
shoutout to @jiaweizhang

- engineer
- electrical engineering undergrad @ Duke
- wrote part of this talk with me four years ago
1. introduction
This is Git. It tracks collaborative work on projects through a beautiful distributed graph theory tree model.

Cool. How do we use it?

No idea. Just memorize these shell commands and type them to sync up. If you get errors, save your work elsewhere, delete the project, and download a fresh copy.

As a project drags on, my Git commit messages get less and less informative.

In case of fire

1. git commit
2. git push
3. leave building

citation: xkcd, https://github.com/qw3rt man/git-fire
workshop structure

1. overall style
   a. feel free to jump in with questions at any time (don’t be afraid!)
   b. i will poll the audience a lot

2. start with basic concepts and theory; then practical exercises
   a. discuss basic ideas; play with a few
   b. learn git for working with ourselves and other people

3. high-level
   a. day 1: basics, toy examples, theory
   b. day 2: exercises; personal and team workflows

main points

1. use version control
2. be fearless
3. perfect is the enemy of the good
4. git is designed (see https://github.com/git/git)
what is version control (vcs)?
why version control?
why version control?

1. tracking changes over time
why version control?

1. tracking changes over time
2. working with other people
key vcs dichotomies

1. **source** vs. generated
2. **code** vs. **binary**
3. immutable vs. **mutable**
4. **distributed** vs. centralized
do we want everything under version control?
do we want everything under version control?

no!

- sometimes call `git` “source control”
- general rule: track the least info you can to generate everything else
source vs. binaries

- what is this file type?
  - "code": direct human-readable text that can be edited
  - "binary": data and content made for some computer program

- how is this file being used?
  - "source": ground-truth information, data, or files
  - "generated": secondary information, data, or files that can be wholly constructed from "source"
source vs. binaries, e.g.

<table>
<thead>
<tr>
<th>code</th>
<th>source</th>
<th>generated</th>
</tr>
</thead>
<tbody>
<tr>
<td>SomeClass.c</td>
<td>SomeClass.o</td>
<td></td>
</tr>
<tr>
<td>binary</td>
<td>figure in a paper</td>
<td>pdf file from latex</td>
</tr>
</tbody>
</table>
centralized vs. decentralized

**centralized**
- one “master” repo
- central server or machine hosts the “canonical code”
- checkout / checkin to one place
- checkout only parts of a repo
- easy to manage permissions

**decentralized**
- everyone has the entire repo (yes, submodules exist in git, etc., but c’mon)
- checkout / checkin from anywhere
- “canonical code” is *established by convention*
immutable vs. mutable

**immutable**
- cannot rewrite the “history” or “record” of what has happened
- history reflects what actually happened
- safer

**mutable**
- possible to change history
- history can be beautified, changed to be easier to read for the future
- more flexible
- can be more dangerous
- **must establish convention**
isn’t github a centralized system, though? wait . . . what is github?
what is a convention in code and why do they matter?
assumptions & conventions at 3 levels

1. **application-level (git)**
   - we progress forward in time; collaborative coding

2. **user-level**
   - commit messages and branch names are meaningful

3. **system-level**
   - code needs to be tracked on different computers with multiple copies of code on each computer
demo 1: goals

1. commits: units of change
2. branches: connecting these units of change
   a. support decentralization
   b. support mutability
commits and branches; go to: https://learngitbranching.js.org/?NODEMO
demo 1: takeaways

1. how decentralized, mutable VCS has to work
2. how to manipulate git assuming files are tracked
unanswered questions

1. how does git know what is a “unit of change?”
2. how does git connect to other computers?
2. how does **git** track changes?
starting a git project

1. pick a folder (called a “directory”) on your computer
2. run `git init`
   a. tells git to track the directory
   b. for efficiency: tracks changes
Git takes “snapshots” of your repositories (repos)
Working Directory  
Staging Area  
.git directory (Repository)

Checkout the project  
Stage Fixes  
Commit

storing a unit of changes

1. commits: units of changes, based on convention
   a. you decide what changes are “meaningful” to package into a commit

2. simple git operations:
   a. git add
   b. git commit
3. technical details: clarifying conventions
okay, but how does git actually track these files?
everything is an object

Object

- pointer
  - hash, sha-1

content
- patches, trees, urls
what is a hash again?
okay, but how do i remember hashes?
hashes are labelled

- humans cannot remember complicated hash values
- by convention: hashes use shortened value
- git allows us to label objects
  - commits: labelled by branches, tags, etc.
  - other computers: labelled by remotes
commit: the most important object

- **pointer**: some hash value
- **content**
  - author*
  - timestamp*
  - previous commit
  - patch
    - changes made from last commit
  - cryptographic signature (optional)

*git is non-adversarial and trusts the given information; these are not verified and be very easily faked
citation: https://buddy.works/blog/5-types-of-git-workflows
what is special about master?
nothing!
4. forming commits
preamble: using a command line

- unforgiving, but don’t panic!
  - case-sensitive
  - not optimized for readability
  - order of commands matters
preamble: git

- let’s make sure *git* is installed
- by operating system
  - linux: you probably already know what to do
  - mac: you are secretly running linux
  - windows: `¯\_(ツ)_/¯` (ssh into adroit and use linux)
- there is an “activation energy” to using *git*
So you want to do something with git

Google frantically

Type some command you find on StackOverflow

Burst into tears

citation: somewhere on google
demo

on your computer this time
configure git

$git config --global user.name "git fan"

$git config --global user.email gitfan@git.git

use email you will use for “most” of your projects (and that you will link to github)

*reminder: git trusts whatever you tell is and does not verify; github verifies
git init

- pick a directory (a folder) to track
- once initialized: directory is called repository
git add

add file(s) to staging area
git commit

commit files in the staging area; mark these changes as one “unit”
git status

figure out what is happening in your repository
git log

see the history of git
5. connecting commits
git checkout -b

checkout a new branch
pop quiz: what is special about master?
git merge

merge a branch (or object) into another branch (or object)
merge conflicts

- what is a merge conflict?
- what does it represent?
git reset

remove stuff from your staging area that you added
git revert

safe “undo” by adding a new commit with old code, rather than modifying history
git show

shows an object
git diff

see the difference between two objects
6. advanced git stuff
rebase vs. merge

- **rebase**: opposite of merge
- **case study**: take commits of feature and place them on top of master
  - merge: git checkout master; git merge feature
  - rebase: git checkout feature; git rebase master; git checkout master; git merge feature
git add -p

more granular way to add content to the “staging area”
git clean

remove untracked changes that are not in the staging area

git clean -n # shows changes

git clean -f # deletes changes

git clean -fd # deletes changes that include directories
reflog

git magic that let’s you see where your refs have been pointing

what does this mean?

you can see all code/objects that you’ve seen on your computer
stash

- don’t really use this
- in case you need to quickly store your code without committing it
- don’t rely on this! it’s not real version control
gitconfig

- shoutout to @codebytere (she works at github)
- configure your git and aliases
- protip: put your gitconfig under git so you can easily set up a new environment
gitignore

tl;dr: tell git to **not** put something in version control

Samples

- generated_binary_file.bin (**a specific file**)
- generated/binaries (**a directory**)
- *.pdf (**any pdf file**)
- !this_one_pdf.pdf (**an exception to a more generic rule**)
references

now you git it!