# GITing Started

`git init; git status; git log; git add; git commit;`

## Overview

## Version control

- Keep track of changes of files over time, allowing you to roll back to previous versions
- Software to handle this are known as "version control systems" (VCS)

## Two paradigms

### Centralized (CVCS)

- Central server keeps track of all the changes and history
- Each developer has local copies of files they need, but need to check in with the server to do any versioning
- Server down? Good luck.
- Examples: CVS, SVN, Perforce

### Decentralized (DVCS)

- Each developer has a local copy of the entire codebase and its history
- Developers can perform versioning locally without needing to contact a server
- Server optional
- Examples: Git, Mercurial

## Why version control?

- Checkpointing your work
  - Have you ever made `main.c.backup1`, `main.c.backup2`,...?
- Keeping multiple parallel versions of your work
  - Have you implemented something one way, made another implementation but wanted to keep both around?
  - Have you ever emailed code or sent code in some messaging app?
  - Have you tried to coordinate people working on the same file?

## Enter...

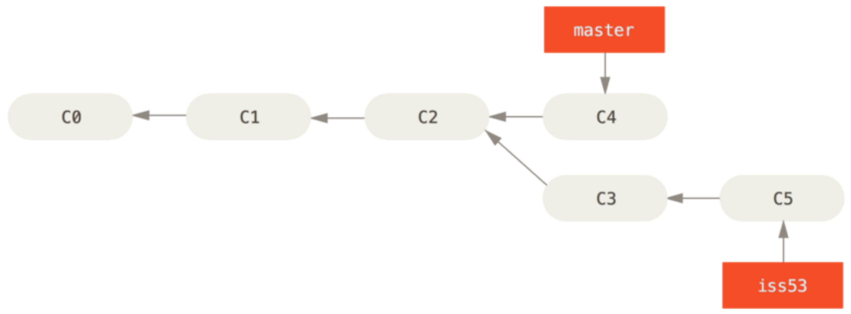
## Enter...Git!

- Distributed version control system (DVCS)
- Designed by Linus Torvalds to manage the Linux kernel
- No server needed, super easy to get started with
  - `git init`
  - `git add`
  - `git commit`

## That's it, lecture's over!

# Git Overview

- Repository: a directory of stuff that Git is versioning
  - `.git` is the directory that holds all this metadata
- Commit: a checkpoint for the files in the repository
  - Given a hash for identification
  - (Unlike other VCS, has actual snapshots of files rather than diffs)
- History is a linked list of commits pointing to their parent
  - Directed acyclic graph (DAG) may be a more accurate term



From *Pro Git*

## Basic commands

- `git init`
- `git status`
- `git log`
- `git add`
- `git reset`
- `git checkout`
- `git commit`

## Some neat resources

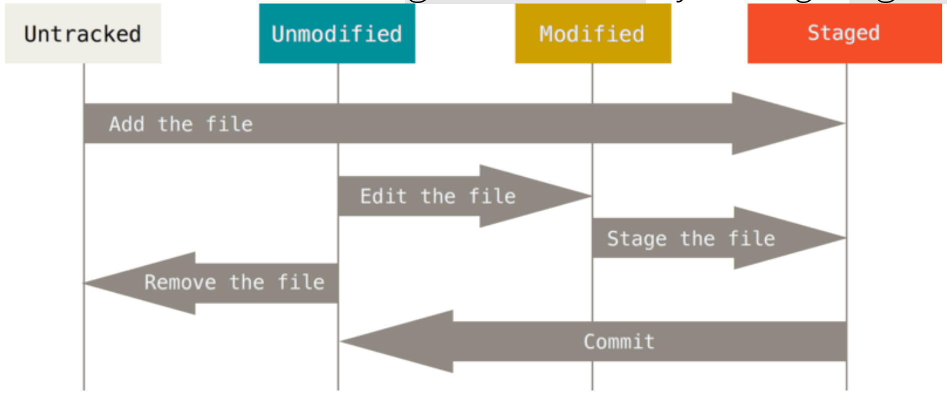
- `man git`
- `man git-<command>` or `git help <command>`
- Official Git documentation
- Official Git tutorial
    - `man gittutorial`
- Official Git minimal set of useful commands
    - `man giteveryday`
- *Pro Git* book
    - Free and comprehensive
    - Besides being on the web, has `.pdf`, `.epub`, and `.mobi` formats!
    - A really great read

## Initializing a Git repository

- `git init`
  - That's pretty much it
- Initializes a Git repository inside the current directory
  - Creates the `.git` directory that contains all this Git data
- There will be an initial "branch" that you will be on with a default name
  - Currently it is `master`, subject to change
  - There is no special meaning ascribed to this by Git, it's just a default
  - (In newer versions of Git) You can specify the `-b` and `--initial-branch` arguments to change what the initial branch is
- FYI, initializing Git repos inside of Git repos might not work the way you expect them to
  - These sub-repos, or "sub-modules" follow their own versioning
  - The "parent" repo just keeps track of what version the sub-module is at, doesn't keep track of the files inside of it

# Files have multiple states

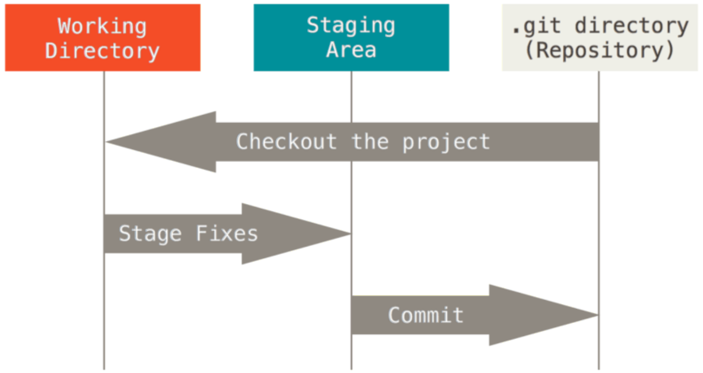
- **Unmodified**: Nothing has happened to this file; no changes as of the current commit
- **Modified**: This file differs from the version as of the current commit. Can be `git added` to be **Staged**
- **Staged**: This file differs, and is set to be in the next commit
- **Untracked**: This file does not exist as of the current commit
  - It's pretty similar to **Modified**; it "differs" by existing when it shouldn't
  - You can hide these from `git status` by adding a `.gitignore` file



From *Pro Git*

# Ties into the "areas"

- **Working Directory**: the directory as your filesystem sees it, a mess of files which may or may not be changed, or may be even untracked
- **Staging Area/Index**: list of files whose snapshots will be part of the next commit
    - You'll see it referred to as either: I'm going to say "**Index**" for brevity and to distinguish it from the file state of **Staged**
- **Repository**: What commits Git now has saved
- Files and their snapshots will work their way through these three areas



From *Pro Git*

## Scenario 1: Untracked file

1. An untracked file chills in the **Working Directory**
2. You decide to start versioning it, so you `git add` it, making it **Staged** and putting it into the **Index**
3. You commit the file in the **Index**, landing it in **Repository**

## Scenario 2: Modified file

1. The file is now **Unchanged** as of the current commit, and is still chilling in the **Working Directory**
2. You make some changes, so now the file is **Modified**
   - Oops, maybe I don't like what I did and want to change it back to the old commited version, let's `git checkout` it
3. You `git add` it, making it **Staged** and putting it into the **Index**
   - Oops, maybe I added an extra file I didn't want to stage, let's `git reset` it back to **Modified**
4. You commit the file's snapshot, getting that snapshot into the **Repository**

## Putting it together, locally (1)

### Initialization

1. Initialize the repository
   - `git init`
2. Add the initial files you want to track to the **Index**
   - `git add`
3. Commit those initial files to the **Repository**
   - `git commit`

## Putting it together, locally (2)

### Loop

1. Modify some files
   - Don't like a modification and want to make the file **Unmodified** again? `git checkout <filename>`
   - `git restore` is a new command that performs this behavior
2. Add **Modified/Untracked** files to the **Index**
   - `git add`
   - Accidentally added a file? `git reset <filename>` to take it out of the **Index**
3. Commit those files to the **Repository**
   - `git commit`
   - Didn't like your commit message or forgot to include some files? Add them to the **Index**, and `git commit --amend`
4. Goto 1, rinse and repeat

## Commits

- `git commit -m <message>` is a quick and dirty way to make a commit
  - You see it a lot in tutorials because it's a one-liner, not because it's "good"
- Not super ideal when it's a project that you're going to collaborate with others on
- `git commit` will open the configured editor and allow you to more easily fully fill out a commit message

## Commit message style

### Title

- Limit to 50 characters
- Capitalize the first letter
- Imperative ("Fix xyz", "Remove abc")
- Summarize the commit

### Body

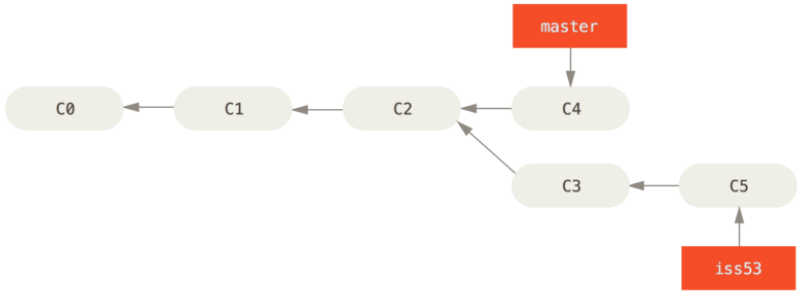
- Limit to 72 characters per line
- Explain what changed and why, not how
    - Your code (ideally) is the "how"
- Depending on your team/workplace: references to bug/issue number e.g. "Issue #22772", "Bug #1337"

## Commit message style

- No, I'm not making this up, it's straight from the horse's mouth
- Ultimately these are just guidelines, not rules
    - Do what your team does, but try to keep good habits when you start something yourself

# Branching

- Making a linked list of commits is cool, but what can we do with it? Can we go back? Can we split off?
- `HEAD` is a pointer pointing to the current commit that's being looked at
- A **branch** in Git is a pointer to a commit
  - Super lightweight compared to other VCS, go wild
  - `HEAD` will follow along with the branch you are on



From *Pro Git*

## Branching

- Lots of applications:
    - Make a "backup" of branch: easy to refer to a particular commit
    - Manage a feature ("topic"/"feature" branches)
    - Have a separate line of development (e.g. taking two different approaches)
    - Represent release schedules (e.g. a development branch and a release branch)

# Branching

- The default branch is `master`
  - Typically used for production/release
- `git branch` lists your local branches
- `git branch <branch-name>` creates a new branch
  - `<branch-name>` will point to wherever `HEAD` is pointing to
- `git checkout <branch-name>` checks out the branch, making your `HEAD` point to where `<branch-name>` is pointing to
  - `git switch` also switches to a branch; added in Git 2.23.0
  - `git checkout -b <branch-name>` creates **and checks out** the branch
- `git merge <branch-name>` will try to move the current branch to where `<branch-name>` is; this is called **fast-forwarding**
  - If the branches diverged (`<branch-name>` and the current branch both got new commits before merging), a special "merge commit" will be produced linking the two branches (we'll look at this later)

# Remotes

- So far everything we've been looking at has been local
- What if you want to share it?
- A **remote** is a repository is hosted by some server on the Internet or internal network
- `git clone <URL> [directory]` will copy the repository from the server to your local machine
    - `origin` is the default name of the **remote** whose URL you cloned from
- `git remote -v` will list your **remotes**
- Confusingly, "remote" can refer to a particular server as well as the local repository's name for it
    - In one local repo, **remote** `origin` can point to `git@gitlab.umich.edu:eecs201/content/website.git`
    - In another repo, `origin` can point to `git@gitlab.umich.edu:brng/eecs201-basic-git.git`
    - These remote names are on a per-local repo basis

## Remotes

- The **remote** has its own branches
  - Your local **Repository**'s branches might be *"tracking"* this a corresponding remote branch (more on this in the future)
  - e.g. local `dev` tracks `origin/dev`
- `git fetch` will get the latest commits from the **remote** into the **Repository**
  - These commits are more for the **Repository** to go "Oh hey, the remote branch has new commits on it!"
  - Effectively, the **Repository** has a local cached version of `origin/dev`
- `git pull` will do a `git fetch` and additionally `git merge`, potentially modifying your **Working Directory**
  - Under the hood, it's `merge`ing the locally cached version of remote branch into the local branch
  - e.g. it's `merge`ing `origin/dev` into `dev`
- As you work on your locally, you can make commits to your local **Repository**
- `git push` will send commits to the **remote**

## Remote hosting services
(a.k.a. Git != GitHub)

- GitHub
- BitBucket
- GitLab
  - GitLab is also a Git host server software that you can use to host your own repos
  - gitlab.umich.edu is the GitLab server that the University of Michigan runs
  - gitlab.eecs.umich.edu is the GitLab server that the EECS runs

## Communicating with remotes

- HTTP will use a username and password to authenticate
  - URL format: `https://somedomain.tld/path/to/repo.git`
  - Gets annoying having to type login info all the time
- SSH requires key setup
  - URL format: `git@somedomain.tld:path/to/repo.git`
  - No need to enter username and password though!
- These are the two most common for day to day use

Questions?

## Addenda

## Core commands

- `git init`
- `git status`
- `git log`
- `git add`
- `git reset`
- `git commit`
- `git branch`
- `git checkout`
  - (`git switch`)
  - (`git restore`)
- `git merge`

## Remote and Collaboration commands

- `git clone`
- `git fetch`
- `git pull`
- `git push`
- `git remote`

## Additional Commands

- `git help`
- `git stash`
- `git show`
- `git diff`
- `git rebase`
- `git blame`