

git gud

"Boy I sure do love creating a merge commit every time I pull!"

# Overview

- Review
- Rewriting history
  - Fixing mistakes
  - Cleaning up
- Stashing
- Understanding remotes
- Workflows
  - Overview
  - Centralized workflow
  - Merge conflicts

# Review

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

# Review

- `git remote`
- `git push`
- `git pull`

# Review

- Creating a local repository
- Staging files
- Making commits
- Making branches
- Merging branches
- Interacting with remotes

# Rewriting history

- This section involves changing up commit history
- Use with caution if you have already pushed them to a branch that's shared with other people
- If you force the remote branch to take on the rewritten history, it'll cause the other peoples' local branches to be incoherent

# Fixing mistakes

Scenario: made a commit by accident and want to "uncommit"

- `git reset` to the rescue!
- `git reset HEAD~1` is a common internet answer given without explanation

Dissecting it:

- `git reset` sets the HEAD to a specified state (bringing the current branch along for the ride)
- `HEAD~1` specifies that we want the HEAD to take on the state of the commit that is 1 before the HEAD
  - We could provide the commit's hash or some reference/pointer to a commit instead (e.g. branch or tag name)

# Fixing mistakes

Scenario: made a commit by accident and want to "uncommit"

- `git reset` has three major modes in this application:
  - `--soft`: undoes the commit, leaves the Working Directory untouched, and leaves the changed files **staged**
  - `--mixed`: default, undoes the commit, leaves the Working Directory untouched, and leaves the changed files **unstaged**
  - `--hard`: undoes the commit and brings the Working Directory to the state of the commit, discarding the changes



# Fixing mistakes

## Scenario: forgot to add a file

- `git add <file>`
- `git commit --amend`
- `git commit --amend` will bring the currently staged changes into the current commit and allow you to edit the commit message
  - If you forgot to *delete* a file, just `git rm <file>` to remove and stage the removal, the `git commit --amend`
  - `git commit --amend --no-edit` won't ask you to edit the commit message

## Scenario: typo in commit message

- `git commit --amend` with no staged files will just have you edit the commit message

# Cleaning up

- `git rebase` is an incredible powerful command that allows you to rewrite history
- `git rebase -i <base tip>` is the form you most likely will use
  - `<base tip>` is either a commit hash or branch that you want to replay commits onto

## Common use-cases include:

- "Squashing" commits
  - This allows you to put multiple minor commits into a single more substantial one
- Reordering commits
- Rewording commits
- Playing back commits on top of another branch (more on this later)

# Caveats of rewriting commits

- `rebase` and `commit --amend` *rewrite* commits if you make changes
- A commit's hash depends on the files' data, the commit message, commit info, **and the parent**

## What does this mean?

- A reworded commit is technically a *new* commit
- Adding a file to a commit turns it into a *new* commit
- **Child commits will technically become new commits**
- Don't believe me? Check the hashes
- **Be wary if you have rewritten commits that have already made it to a remote branch that other people access**
- If you force the remote branch to take on your rewritten history, people who have previously pulled to their local repositories will no longer have coherent histories

# Stashing

- `git stash` allows you to save the state of your Index **and Working Directory** into the "stash" (acts like a stack) and rolls you back to a clean Working Directory
- This is particularly useful if you need to jump around different branches while you have some modified files hanging about that would be changed by the other branches
  - `git checkout <branch>` won't let you switch branches if the target branch modifies files that are currently already modified
- `git stash` will implicitly perform a `git stash push` and putting your current Index and Working Directory's state onto the stash's stack
- `git stash pop` will bring the top entry of the stash's stack into your Index and Working Directory, deleting that entry from the stash
- Note how `pop` will delete automatically delete that entry
- `git stash apply` will do the same thing as `pop` but without the automatic entry deletion: useful in case the `pop` fails/has issues
- `git stash drop` will then delete the item at the top of the stash's stack

# Understanding remotes

- Recall that a **remote** is repository hosted on some server
- Recall that remote names have no special meaning: **origin** is just the default when you clone
- A remote has its own set of branches and commits, being another copy of the repository in this distributed system
- When working locally, note that **master** is not the same as **origin/master**
  - **master** is an arbitrary local branch with that name that may or may not be "tracking" **origin/master** (we'll elaborate later)
  - **origin/master** is a branch named **master** on the remote **origin**, which could for example have a URL of **git@gitlab.umich.edu:eeecs201/somerepo.git**

# Understanding remotes

- This is where we get the legendary command `git reset --hard origin/master` to undo everything locally
  - Maybe we have totally borked our local branch `master`: maybe its history has been destroyed by a rebase and we just want to go back to something sane
  - This does a hard reset for `master` using `origin/master`'s commit as the target state

# Tracking branches

- They may have the similar names, but **master** is a local branch that is *tracking* **origin/master**
- What this means is that **master** looks at **origin/master** as the place to push/pull commits to/from
  - **origin/master** is known as its **upstream branch**
- If you checkout a branch that exists on *one* remote but not locally, Git will automatically create a local branch of the same name and have it track that remote branch.
  - This only works if there is only a single remote with that branch name.
- We can arbitrarily create tracking branches of arbitrary names that track remote branches
  - **git checkout -b top-of-tree origin/dev** will create a local branch **top-of-tree** that tracks **origin/dev** (and switch the current branch to **top-of-tree**)
  - **git branch -u origin/issue149** will cause the current local branch to track **origin/issue149** (i.e. setting the upstream)

# Tracking branches

- This is what `git push`'s `-u/--set-upstream` flag is for
  - It will set the upstream of the given branch
  - `git push -u origin main` will push a local branch `main` to `origin/main`, setting `origin/main` as the upstream
  - `git push -u origin main:dev` will push a local branch `main` to `origin/dev`, setting `origin/dev` as the upstream
- Your local repo does keep a cached copy of `origin/master`, which gets updated whenever you `git fetch`: it doesn't automatically keep in touch with the server
- `git pull` performs `git fetch` then merges `origin/master` into `master`
  - Many a Git beginner has been victim to this automatic merging (me included)...
  - There's also rebase mode where it rebases `master` onto `origin/master` instead



# Workflows

Maybe you have run into this scenario...

- You are working with a group of people on a project and decide to use Git to collaborate, and host your repo on the campus GitLab
- Perhaps none of you are particularly versed in Git (with one member even opting to use the GitLab webpage to upload/edit files!)
- So each of you do your work, **push**ing and **pull**ing to **master**

# Workflows

Maybe you have run into this scenario...

- Almost immediately you're going to run into a situation where two (or more) people race to push their commits
  - Person A pushes their commit first
  - Person B tries to **push**, but the server refuses and tells them that their local branch is behind
  - Person B **pulls**, causing a superfluous merge commit between **origin/master** and Person B's **master** branch
  - Person B then **pushes** their original commit and a merge commit that has the amazing default message that says **master** got merged with **origin/master...**
- As the project continues, each person is pushing tiny incremental commits.

# Workflows

- Workflows give a structure to how we should perform our versioning work
- Git does not explicitly lay out workflows for us to follow
- This lecture we'll be focusing on what Atlassian would call a "Centralized Workflow"
  - I've chosen this as it's fairly standard and is manageable and suitable for school life, while giving you the fundamentals
  - Read more about Workflows in the [Atlassian tutorials](#)

# (Basic) Centralized Workflow

- In this we have a main branch that code is being contributed to (e.g. `master`, `dev`)
- For brevity, let's refer to the remote as `origin` and the main branch as `dev`
- Locally each user tracks `origin/dev` on some local tracking branch (e.g. `dev`)
- Each user works on this local tracking branch on their feature/fix
- The user makes the commits they want
- The user uses `git rebase` to squash, reorder, and reword commits to package up their feature/fix more nicely
  - Probably a good idea to squash two commits where one has a sizeable change and the other fixes a typo in the first
- The user then pushes their change

# (Basic) Centralized Workflow

- If it fails due to the local branch being behind, then the new commits need to be pulled
  - `git pull --rebase origin dev` will perform a rebase of your new commit on top of the commits fetched from `origin` instead of a merge, avoiding the merge commit
  - Local branch `dev` will be fast forwarded to `origin/dev`, and your new commits will be put on top of `dev`'s new up to date spot
- Now the user should be able to `push` (if they can't due to some other speedy user, they simply just have to do another `pull`)
- As a result, we now have a relatively clean history with meaningful commits free of "*superfluous*" merge commits

# +Feature Branching

- The idea behind this is to have a main branch (e.g. **dev**) represent a stable, passing codebase
- Feature branches are spawned off, have their features completed and committed, and have their commits *brought back* into the main branch
- Feature/topic branches could range from actual remote branches with multiple contributors to a single person handling their issue locally
- The flow is very similar, with feature/topic branches that have multiple contributors having something like a miniature Centralized Workflow
  - When the feature is complete (and tested), it can be locally **merge**-ed into **dev** and pushed to **origin/dev**
  - This merge commit will capture this branching and merging behavior in the history
  - Alternatively if you want to have a linear history, you can use **rebase** instead of **merge**
  - One option at this point is to have a person responsible for bringing feature commits into the main branch

# +Feature Branching

- You can also do this locally
- Say you were assigned bugs 1, 2, and 3
- You have a local tracking branch `dev` that tracks `origin/dev`
- You then have three local feature/topic branches `bug1`, `bug2`, and `bug3`
- You can perform your fixes for each of them, switching between them when you get stuck, etc.
- When you finish up bug 2, you can get the latest changes for `dev` and then rebase/merge `bug2` onto/into the newly updated `dev` and perform the appropriate push
- You then repeat this process for bugs 1 and 3

# Merge conflicts

- Sometimes when you perform a **merge** or **rebase** the commits of one branch conflict with the commits of another
- This is called a "merge conflict"
- The **merge** or **rebase** process stops, allowing for you to edit the files that have conflicts to get the file to have the correct contents
  - This conflict resolution stage will insert some special strings into your code saying that one branch/commit had these particular contents and another branch/commit had these certain other contents.
  - You might've seen `<<<<<<<`, `=====`, and `>>>>>>` at some point
- When you finish up with the conflict resolution, stage the necessary files and finish the **merge/rebase** procedure
  - **git status** will tell you the appropriate command to run to continue



# Workflows

- This was only a *taste* of workflows
- There are different kinds
- You may develop your own style of local workflow as you get more used to Git
  - The Centralized Workflow and its kind are more of remote collaboration workflows
  - You don't have to go *strictly* by the local workflows described here
  - Git is very flexible by nature, so workflows themselves aren't really built into the tool

Now go forth!

You are officially dangerous with Git :)

(There's more stuff, like `git cherry-pick`, `git blame`, and `git bisect`!)

Questions?