Practical Git (and GitHub)

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Introductions

- Me
- You
  - Any experience with version control?
  - Any experience with Git?
  - What are your goals for this class?

Class details

- We'll move between
  - Lecture
  - Hands-on in my console, working together
  - Labs, where you'll work on your own
- Ask questions at any time
- Use the docs (aka google)
- And a few requests from me
  - Please be on time
  - Please let me know if you need to duck out early
  - No cell-phones (take it outside)

Slide conventions

- I format code a little
  - `Like so`
- A parameter or variable will be wrapped in <>
  - `git checkout <branch>`
  - Would be used like so
  - `git checkout my-branch-name`

Resources

- The slides are available here:
  - https://www.dropbox.com/s/umcx80imv9wsk2j/git-introduction-slides.pdf?dl=0
  - http://bit.ly/1LqMq0M
- Grab a cheat sheet
  - https://training.github.com/kit/
- Some of the repositories we'll be using

- Some of the repositories we'll be doing
  - https://github.com/rm-training

Class outline (day 1 and 2)

- Day 1
  - ~~Introductions~~
  - Git basics (A local repo)
  - Remotes
  - GitHub intro
  - Collaborating
- Day 2
  - Collaborating with git, continued
  - Git tools
  - Rebasing & advanced merging
  - Debugging (log, bisect)
  - Fixing (reset, revert)
  - Getting more out of git

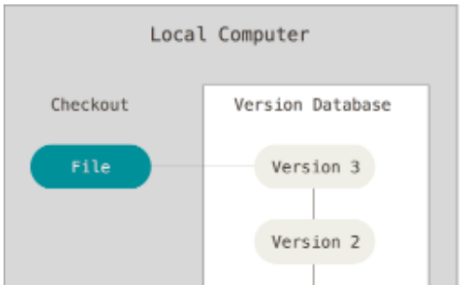
Why Version Control?

Why Version Control?

- Because I want to…
  - keep track of file changes over time
  - be able to go back to older versions of files
  - view the history of changes to my files
- Rudimentary version control!
  - `/my-files/myfile.v1`
    `/my-files/myfile.v2`
    `/my-files/myfile.v3.draft`
- But…
  - Error prone
  - Single point of failure

Centralized Version Control Systems

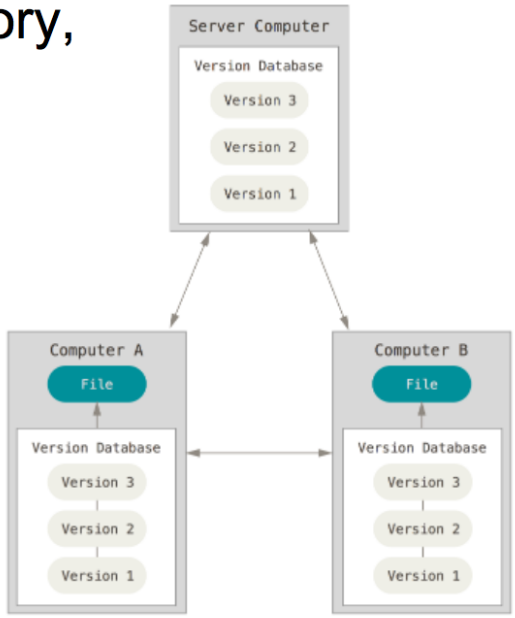
- CVS, Subversion, Perforce
- A single, primary server manages all versions
- Gives fine-grained control and it is easy to see who is doing what
- But…
  - Still a single point of failure!
  - Branching + merging is a pain
  - Checkout locks are frustrating



- Entire history is not available locally

Distributed VCS

- Git, Mercurial, Bazaar
- All clients mirror the repository, *including* the entire history
- All clients act as backups
- No single point of failure
- Supports many workflows



Enter Git!

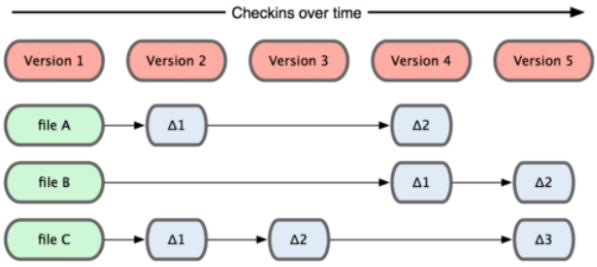
- Born out of necessity from Linux kernel
- Focuses on **speed**, **efficiency**, supporting **non-linear development** and very **large projects**
- At its core it is just a simple key-value data store
  - You can insert any content and it will give you a key you can use to retrieve the content

What makes Git different

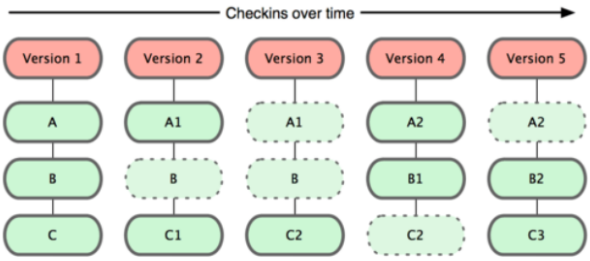
- **Snapshots**, not differences
- Nearly every operation is **local**
- Data **integrity**
  - Every file is checksummed
  - Data is never removed, always added
- **Branching** is easy

Git: Snapshots vs Diffs

- Git stores data as “full” snapshots of your repository files in each commit, versus a diff
  - A picture of what your files look like at that moment.
- Why is this a big deal?
  - It makes git more like a mini-filesystem with some powerful tools rather than simply a VCS



Diffs



Snapshots

Git: Local operations

- Entire repo history is local so you don’t need to wait for network to check logs, etc

wait for network to check logs, etc.

- No dependency on a server to perform work, branch, commit

Git: Data integrity

- Every file is checksummed before it is stored
- All files are referred to by their checksum
  - Impossible to change a file
  - Can't lose a file in transit
- SHA-1 hash for checksumming
  - 40 char string, hexadecimal, based on contents of the file or directory structure
  - `0fa9a37657c9feca1d99e37cd8c4fb34be47c15e`
- Commits are also referenced by their hash

Git: Branching is easy

- It's fast
- Branches are lightweight
- Can easily switch between branches
- (Unlike old VCS)

Module: Git Basics

- We'll cover…
  - How to install git
  - Creating a *local* repository

- The difference between staging and committing
- How to stage and commit files and changes
- Viewing a commit and your history
- Moving and removing files

Install Git

- Install
  - http://git-scm.com/download/
  - Or… use a package manager like homebrew
  - Or… install github's gui
    - https://mac.github.com/
    - https://windows.github.com/
- `git --version`
  - Make sure you're on 2.0 or above

Configure Git

- Use "`git config`" to set configuration vars
  - `git config <key> <val>`
  - `git config --global user.name "Ryan Morris"`
- Configs are stored in plaintext at one of three levels
  - System (all users) `--system`
    - `/etc/gitconfig`
  - Global (your user) `--global`
    - `~/.gitconfig or ~/.config/git/config`
    - Windows: `C:\Users\$User\$Home\.gitconfig`
  - Local (in a repo) `--local`
    - `.git/config`
- List configs
  - `git config --list`

Mind the whitespace

- Windows uses CRLF, Mac/Linux use LF
  - Cross-platform work can be a pain
- `git config --global core.autocrlf <type>`
  - `input` (OSX/Linux)
    - Convert CRLF to LF on commit only

- Convert CRLF to LF on commit only
- `true` (Windows)
  - Convert LF to CRLF when checking out a file
- `false`
  - Do not perform any conversions
  - Use this if all collaborators are on the same system

Lab: Setup

- Make sure git is installed
  - `git --version`
- Set up your identity
  - `git config --global user.name “Ryan Morris”`
  - `git config --global user.email me@gmail.com`
- And your CRLF setting
  - `git config --global core.autocrlf <val>`
- And *maybe* your text editor
  - defaults to vi or $EDITOR
  - `git config --global core.editor emacs`
    - Or…
      - `“sublime --n --w”`
      - `“atom --wait”`
- Check your configurations
  - `git config --list`
  - `git config <key>`

Creating a repository

- Make a root directory for the repo
  - `mkdir basic-repo`
  - `cd basic-repo`
- Initialize a new repository
  - `git init`
- Check the status and the log
  - `git status`
  - `git log`
- Check what git has initialized
  - `ls -la`
  - `ls -la .git`

Directory structure

- When you initialize your git repo you'll get:
  - `./`
    - Your working directory
    - Files in the current commit's snapshot
    - A single checkout of one version of the repository
  - `./.git/`

- The git database
- All your repository information is here
- `./.git/index`
  - Your staging area

Our first commit

- Create a file, *stage* it, *commit* it
  - `touch README`
  - `git add .`
  - `git commit -m 'Initial README'`
- Check the status and the log
  - `git status`
  - `git log`

Three areas of concern

- The **working directory**
  - What you see in your filesystem
  - All files from your current commit/snapshot
  - *Along with modifications not yet staged*
- The **staging area** (aka the **index**)
  - Where you prepare your next commit
- The **repository**
  - All version data, every commit
  - A special pointer, **HEAD**, keeps track of your last commit

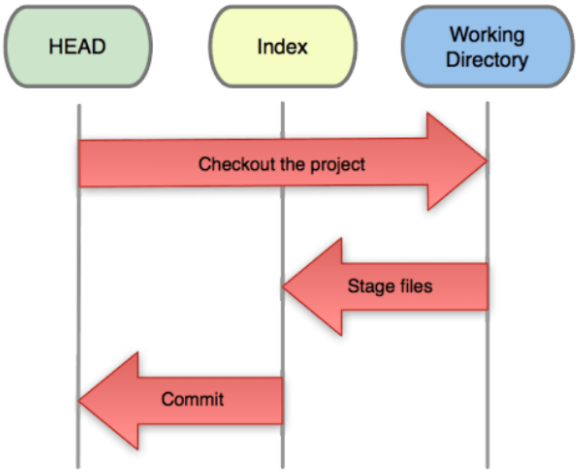
Tracked vs untracked

- Files are considered **tracked** or **untracked**
- Tracked
  - Unmodified
  - Modified
  - Staged (added to the index)
- Untracked
  - A file that is not in the previous commit

- And everything else

The basic commit workflow

1. You **modify** files in your working directory
2. You **stage** files and changes that you want to be included in the next commit in the index
3. You **commit** the index as the next snapshot



Git status

- `git status`
  - Shows information about your **current branch**
  - Changes added to the **staging area (index)**
  - *Untracked* files and *tracked* file modifications in the **working directory**
  - Some helpful tips for undoing things

Staging files

- `git add <filename>`
  - To prepare a snapshot to commit, you'll add modifications and untracked files to the staging area with "git add"
- Track a new file:
  - `touch NEWFILE`
  - `git status`
  - `git add NEWFILE`
  - `git status`
- Track a modification:
  - `echo 'Read Me' > README`

- `git status`
- `git add README`
- `git status`

Staging files, cont…

- You can also add directories
  - `git add <dirname>`
  - `git add <dir>/<subdir>`
- Use a wildcard
  - `git add *.html`
- Or… just add everything
  - `git add .`

View your changes

- `git diff`

- `git diff`
  - Shows diff output of what is in your working directory
  - Does not include untracked files, however
- `git diff --staged`
  - Shows diff output of what you have staged

Committing

- Once files are staged, you can commit those changes as the next snapshot
- `git commit`
  - Prompts for a commit message, which serves as the description
- Commit with a message
  - `git commit -m “My commit message”`
  - A commit (as with many things) will abort if no message given
- Include file diff in the message meta
  - `git commit -v`
- Skip staging (auto-stage tracked file changes)

- Skip staging (auto stage tracked file changes)
  - `git commit -a`

Your commit(s)

- `git show <commit or branch>`
  - View commit info + diff
- Commits are referenced by their sha1 hash
  - ex: 42d484c401f0a19cc8a954c16240821329acefac
  - aka commit id, hash, sha
  - `git show 42d484c401f0a19cc8a954c16240821329acefac`
- Can also reference in abbreviated form
  - `git show 42d4`

Your history

- `git log`
  - View the history of commits

- Defaults to from the current branch tip (HEAD)

- Plenty of options! We'll pick them up as we go… a few helpful ones
  - `--oneline`
  - `-<n>`
  - `--abbrev-commit`
  - `-p`
  - `--stat`

Removing files

- `git rm <filename>`
  - Removes the file and auto-stages the removal
  - `-r` for recursive, like removing a directory
- If you simply **rm** the file, you must then **stage** the removal
  - `rm <filename>`
  - `git add <filename>`
- May only want to remove from staging w/out affecting WD (ie: to keep and ignore it)
  - `git rm --cached <filename>`

Moving files

- `git mv <from> <to>`
  - Moves the file and stages the move
- But git doesn't track file movement, really… So this is basically equivalent to
  - ```
    mv <from> <to>
    git rm <from>
    git add <to>
    ```

Recap

- We initialized a repository with **git init**
- Kept track of staging and working directory changes with **git status**
    ```

- Added changes to staging with **git add**
- Commited with **git commit -m "Message"**
- Checked diffs with **git diff**
- And then viewed our history with **git log**
- We also were able to move and delete files through git

Lab: Basics

- First, **create** a new repository, "about-me"
- Then create a txt file named with your name
  - `Touch <yourname>.txt`
  - Check the status, check the diff
- Then **stage** and **commit** the file
  - Check the log
  - Use "`git show`" on the commit id you just created
- Then **edit** the file to add a short profile about you:
  - `<Your Name>`
    `* Born in: <where you were born>`
  - Check the status, check the diff
- Then **stage** those changes
  - Check the status, check the diff
- Then **commit**
- All done?
  - Try creating a new file, "junk", add then commit it
  - Try moving the "junk" to "junk.txt", add then commit that change
  - Check out the `git log`

Module: Basic undoing

- We'll learn about undoing some things like
  - Un-staging a file
  - Un-modifying a file in your working directory
  - And changing your last commit

Undoing things

- First, some prep
  - Make a change to a file, add it
  - Make another change to the file
  - `git status`
- `git status` tells us how to undo things in

staging and our working directory

Undoing things

- Remove modifications from your working directory
  - `git checkout -- <file>`
- Remove something from your staging area
  - `git reset <file>`
  - Which is equivalent to: `git reset HEAD <file>`
- Can remove untracked stuff with
  - `git clean -f`

Undoing things

- Change the last commit
  - `git commit --amend`
  - To add forgotten changes
    - add them to your staging area then amend
  - To modify the commit message
    - just keep your staging area clean and amend
- To completely undo a commit
  - `git reset HEAD^`
  - We'll revisit this…

Recap

- You can un-stage things with
  - `git reset <file>`
- You can ditch changes from your working directory with
  - `git checkout -- <file>`
- You can change your last commit and commit message with

- `git commit --amend`
- Remove untracked files with
  - `git clean -f`
- And undo the last commit with
  - `git reset HEAD^`

Lab: Undoing things

- Take some time to practice editing files then ditching the changes with "git checkout" and un-staging them with "git reset"
  - Create a new file
  - Edit an existing file
  - Stage them
  - Un-stage one at a time
  - Ditch the WD changes one at a time
  - Clean up any untracked files
- Can an untracked file be "undone" with "git checkout"?

Module: Branches

- We'll learn about
  - Branching in git
  - Moving between branches with git checkout
  - What the HEAD is all about
  - Merging branches
  - Deleting branches

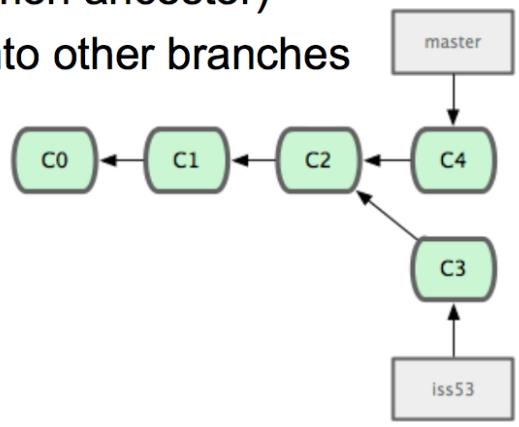
Branches

- Up until now we've been working on a single branch, **master**
- We can use branches to keep separate tracks of work in parallel
- Why branch?
  - Experimentation
  - Stability
  - Many work tracks in parallel

- Many work tracks in parallel

Branches in git

- For now… think of a branch as a copy of the repository at a given point in time
  - It's cheap! Don't worry about adding branches
  - You can extend the branch with new commits
  - The branch shares a history with the branch you branched from (And a common ancestor)
  - Branches can be merged into other branches



Git branch

- List all your branches
  - `git branch`
    - `--list`
- Create a branch
  - `git branch <branch-name>`
- Switch to the the branch out (moves HEAD)
  - `git checkout <branch-name>`
- Create a branch and immediately check it out
  - `git checkout -b <branch-name>`

Git checkout

- Updates your *working directory* in a non-destructive way
- Can be used to
  - Undo changes in the WD
    - `git checkout -- <file>`
  - Switch branches
    - `git checkout <branch-name>`
  - And checkout a specific commit
    - `git checkout <commit-id>`
    - This puts HEAD in a "detached state", which just means it

- This puts HEAD in a "detached state", which just means it is not pointing to a branch reference and commits can't be made

HEAD

- HEAD is a special pointer git uses to keep track of what branch you're currently on
  - And what the parent of the next commit will be…
- We've been working on one branch so far, "master"
  - `cat .git/HEAD`
    - "ref: refs/heads/master"
    - This is a pointer to the master branch reference
- `git checkout` updates where HEAD points to

Log, revisited

- Visualize the history through the log

- `--graph` to show the tree
- `--decorate` to show branch refs
- `--all` to see all commits, including non-reachable
- `git log --oneline --decorate --graph --all`

Lab: Branching

- View your branches
- Create a new branch off of master, “add-readme”, to do some work
  - This is sometimes referred to as a “topic branch”
- On “add-readme”
  - Create a new file, “README”, stage and commit it
- Then back on “master”
  - Create a second branch, “add-fav-color”
- On “add-fav-color”
  - Edit your `<name>.txt` file to add your favorite color to the list
  - Stage the change, commit it
- View the log `--graph --oneline` as you create new branches and switch between them

Merging

- Merging is how you get work from one branch into another
  - `git checkout <target-branch>`
  - `git merge <source-branch>`
- Commits from source-branch will be combined in to the target-branch history
  - How this is done depends on the state of the history at the time of the merge
- A merge does not affect the source branch

Basic merge strategies

- Fast-forward
  - When the branch ancestor is the same as the tip of the target branch

target branch

- Results in a streamlined history
- Can avoid this with `--no-ff` option
  - `git merge --no-ff <source-branch>`

- Three-way merge
  - If the commit on the branch you're merging is NOT a direct ancestor of the branch's tip you're merging into
  - Results in a new "merge" commit
  - Prompts for a commit message

Branch Management

- You can see which branches have been merged
  - `git branch --merged`
- And see which branches are not yet merged
  - `git branch --no-merged`
- Also, don't forget to remove branches you're done with
  - `git branch -d testing`
- To remove an un-merged branch
  - `git branch -D testing`

Basic branching workflow

- You're working on **master** and get a ticket to make a change
  - Instead of working directly on master…
- Create a new branch, based off master
- Do your work in the new branch
- Merge it back into master when ready

Recap: Branching and Merging

- We saw how to view, create and delete branches with `git branch`
- Then switching between branches (and even commits) with `git checkout`

commits) with `git checkout`

- `git merge` is how we'll merging the work from one branch into another
- And we briefly covered a branching workflow, in which new work is done in topic branches off of the stable master branch

Lab: Merging

- Continuing from the branching lab…
- On master
  - Merge your "add-readme" branch
    - Review your log, `--oneline --graph --all`
    - What kind of merge did it perform?
  - View which branches are merged (--merged) and not merged (--no-merged)
  - Merge your "add-fav-color" branch
    - Review your log
    - What kind of merge did it perform?
- Then create a new branch, "add-license"
- On "add-license"
  - Add a "LICENSE" file, commit this.
  - Then edit the LICENSE file: "copyright 2015". Add, commit.
- On "master"
  - Merge "add-license" as a non fast-forward merge with `--no-ff`
- Review the log, `--oneline --graph --all`
  - Notice the difference between the merges?
- Delete your merged branches

Module: Merge issues

- We'll cover
  - Undoing a merge
  - Fixing conflicts from a merge

Undoing a merge

- If you've just completed the merge and decided you didn't want to do that…
  - `git reset --hard ORIG_HEAD`
- A less destructive option
  - `git reset --merge ORIG_HEAD`

- Resets staging but attempts to leave WD changes in tact
- But if a merge has happened and it's already "out there"… you will have to revert instead
  - `git revert -m 1 <merge-commit>`
  - Creates a new commit to undo the merged branch

Merge conflicts

- When a merge doesn't go smoothly, you've got a conflict
  - Like when the same part of a file has changed in two branches being merged together
- When a conflict happens
  - The merge is not committed
  - Git will ask you to resolve the conflict
  - You have to manually fix the conflict and commit the fixes
  - Then the conflict is resolved and the merge is considered complete

Abort a merge during a conflict

- You can simply abort the merge in conflict
  - `git merge --abort`
- In older versions of git (still works)
  - `git reset --merge`
  - `git reset --hard HEAD`

Resolving conflicts

- Git adds standard conflict-resolution markers to the files that have conflicts
  -
```
<<<<<<<< HEAD
   original title
========
   new title
>>>>>>>> new-branch
```
- To resolve the conflict
  - Check for conflicted files with git status

- Check for conflicted files with `git status`
  - Go fix the conflicts by hand (or a tool)
  - `git add` the resolved files
  - `git commit` to wrap it all up once all conflicts are resolved
- Or…
  - `git mergetool`

Recap: Merge issues

- We saw how to undo a merge either by using `git reset` if the merge was just performed
- Or by using `git revert`, when the merge has been done some time in the past.
- We also got to see what a merge conflict is like and how to resolve it

Lab: Resolving a conflict

Lab: Resolving a conflict

- Let's create a conflict!
  - Create two branches off of master
  - In one branch, let's call it "red", edit your favorite color (in your <name>.txt file) to be "Red!"
  - In the other branch, call it "blue", edit your favorite color to be "No, Blue!"
- On "master"
  - Merge "red"
  - Then merge "blue" -- you should get a conflict
- Undo the merge! Just to get a feel for it
  - Then merge "blue" again
- Resolve the conflict

Module: Tagging

- We'll learn about one of the last "objects" in git (along with branches and commits), **tags**!
- And how you can bookmark commits with a tag.

Tags

- In git, a tag is like a commit bookmark
  - release points
  - special commits
- It can be annotated (signed) or lightweight
- Adding a tag is simple
  - `git tag <name> <optional-commit>`
  - `git tag -a <name> <optional-commit>`
  - `git tag -a <name> -m “Message”`
- List your tags
  - `git tag`
- View a specific tag
  - `git show <tag-name>`
- Or check it out
  - `git checkout <tag-name>`

Lab: Tagging

- Tag your commit commit with a lightweight tag
  - `git tag current`
- List off your tags
  - `git tag`
- View info about your tag
  - `git show current`
- Try an annotated tag
  - `git tag -a v1.0`

Module: Stashing, aliases, ignores

- We'll learn how to store work in progress by stashing through `git stash`
- As well as looking at two helpful repository utilities
  - We'll see how git aliases can help us simplify our workflow
  - And how we can tell our repository to ignore certain files

Stashing

- If you're working on something and you want to save it for later without creating a commit, you can stash it
- Stashing will
  - Save all staged & working directory changes
  - Reset the staging area
  - Reset the working directory
- Helpful for…
  - Quickly storing work you want to revisit
  - Moving work you didn't want on branch A to branch B
- But usually a commit is fine, too

Stashing

- To stash, just
  - `git stash`

- `git stash`
- To re-apply the last stashed changes
  - `git stash pop`
- To see what is in the “stash”
  - `git stash list`
- To work from the list
  - `git stash apply <name>`
  - `git stash drop <name>`
  - `git stash pop <name>`
- Clear your stash
  - `git stash clear`

Stashing (continued)

- You can give it a description
  - `git stash save “<description>”`
- Stash only working directory
  - `git stash --keep-index`
  - Don’t stash staged things… only WD changes
- Stash untracked files as well
  - `git stash --include-untracked`
- Apply previously staged stuff
  - `git stash apply <name> --index`

Aliases

- Aliases are a way for us to create command shortcuts within git
- We just add them to the config
  - Expects a git command, or external command prefixed by "!"
    - `git config --global alias.visual '!gitk'`
- *Lab:* Let's set up a few
  - `git config --global alias.co checkout`
  - `git config --global alias.unstage 'reset HEAD --'`
  - `git config --global alias.undo-merge 'reset --hard ORIG_HEAD'`
  - `git config --global alias.graph 'log --oneline --graph --decorate'`

Ignoring files

- You can tell git to ignore certain files and folders
  - Set up a `.gitignore` file in the root of your project
    - `*.tmp`

- `*.log`
- `tmp/`
- `/.build # only ".build" in current directory`
- `logs/*.log`
- Can use some basic glob patterns

- And, to stop tracking a file that is currently tracked
  - `git rm --cached <file>`
- Github has a lot of prefab gitignores
  - https://github.com/github/gitignore

Recap: Stashing, aliases, ignores

- **Stashing** is helpful for quickly saving work in progress without having to affect history through a commit
- **Git aliases** are great for making command shortcuts
- You can easily avoid having junk/utility/config files and folders tracked in your repository by using **.gitignore**

Lab: Stashing

- Let's imagine you need to work on the README file
- On "master"
  - Create a new branch, "readme-edits"
- On "readme-edits"
  - Add a line to the README file, "Read Me Introduction"
  - Add and commit this change
- Let's imagine you've walked away for lunch then came back and saw a ticket to update the LICENSE file…
  - Add a line to LICENSE, "Copyright 2015"
  - Add this change.. ***Oh wait***!
  - It's unrelated to this branch's work effort
  - Stash it instead of committing… we should put it in its own branch
- On "master"
  - Create a new branch, "license-edits"
- On "license-edits"
  - Un-stash your edit
  - Add and commit it

Pretty command line output

- At this point you may be lusting after my colors…
- "Sexy bash prompt"
  - https://github.com/gf3/dotfiles/blob/v1.0.0/.bash_prompt
  - Add this into your `~/.bash_profile`

- There are alternatives out there…
- And my colors
  - Add these to your .gitconfig
  - http://bit.ly/1SPPaXR

Let's regroup!

- You have the tools for basic git stuff on your local
- You can create a history of commits
- You can create branches and merge them
- You can view diffs
- You can deal with undoing basic changes
- You can deal with basic conflicts
- You can stash your work in progress

Module: Remote basics

- We'll learn
  - About what a remote is and what it is for
  - How to set up a basic repository on GitHub
  - Connecting your local repository to a hosted repository through a "remote"
  - Sharing your work by pushing your branches to the hosted repository

Collaboration!

- We've been dealing with our little local git repository, which is nice, but what about collaborating with others?
- We probably want to..
  - Contribute to public projects
  - Have others contribute to our projects

- Have others contribute to our projects
- Have a team work together on a project
- Simply share our code
- Keep our repository safe in case our HD dies

- First we will just get ourselves a hosted repo

Remotes

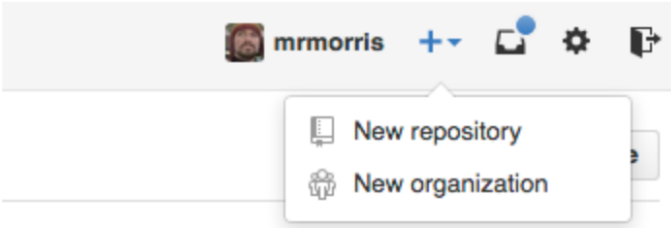
- Remotes are local references to other versions of the repository hosted elsewhere
- They are just copies of the repository!
  - Though their history may have diverged from yours by now…
- We'll be using **github** to host our repositories

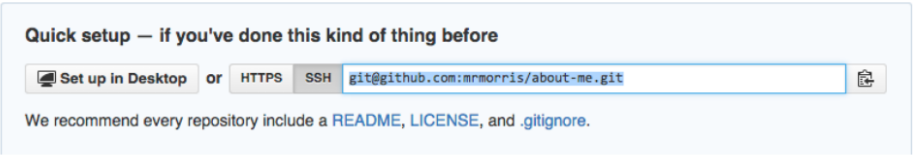
GitHub

- Hosted Git repository service
  - Free for public repositories
  - Paid for private tiers
- And more project tools…
  - Web UI
  - GH Pages
  - Issues
  - Wiki
  - Integrations w/ services and hooks
- Alternatives…
  - Bitbucket
  - GitLab

GitHub – Hosting our repository

- Go to github.com
  - (got an account?)
- Add a new repository
  - Name it “about-me”
    - *don’t initialize it*
- Copy the remote (HTTPS) URL





- Add a **remote** to our local git repository
  - `git remote add origin <remote-url>`
  - `git push --set-upstream origin master`
- You will be prompted for your github credentials
- Now check out the repository on GitHub

What just happened there?

- We created an empty repository on GitHub
- Locally, we added a remote reference to this repository and labeled it “origin”
  - `git remote add <name> <url>`
- We then pushed our local repository data to the remote repository
  - `git push <remote-name> <branch-name>`
- The `--set-upstream` (-u) flag set the remote as the permanent tracking remote for the branch
- Our local repo <-> A GitHub remote

Git protocols

- Or… how I learned to stop typing in my credentials every time I touched a remote
- HTTPS
  - Git will prompt you for your github creds
  - We can tell git to store our credentials (15 min)
    - `git config --global credential.helper cache`
  - Not working?
    - If you have two-factor authentication you'll need to use a GitHub "Personal Access Token" :p
- SSH…
  - Requires SSH keys to be set up
    - Generate your SSH key (Instructions coming)
    - Add it to your GitHub account

Lab: SSH Keys + GitHub

- Check for keys you have already
  - `ls -al ~/.ssh`
  - Looking for id_dsa.pub, id_ecdsa.pub, id_rsa.pub
- Not there? Generate a new one
  - `ssh-keygen -t rsa -b 4096 -C "your@email.com"`
  - [use defaults]
  - [enter a passphrase]
- Turn on ssh-agent
  - Osx has it by default via keychain
  - Linux has it already
  - `eval "$(ssh-agent -s)" # start it in the bg`
  - `ssh-add ~/.ssh/id_rsa`
- Add your SSH key to your GitHub account
  - Copy the *.pub file you generated
    - `pbcopy < ~/.ssh/id_rsa.pub`
  - Github.com > Settings > Add SSH Key > Paste > Add Key
    - https://github.com/settings/ssh

- Test it!
  - `ssh -T git@github.com`
- GitHub has a very nice guide for all of this:
  - https://help.github.com/articles/generating-ssh-keys/

Working with remotes

- You'll be **fetching** remote updates to your local
  - `git fetch <remote-name>`
  - `git fetch --all`
  - `git remote update`
- You'll be **merging** updates from remotes
  - `git merge <remote-name>/<branch-name>`
  - `git pull <remote-name> <branch-name>`
    - A shortcut; fetch & merge in one
- And **pushing** your local branch updates to remote branches
  - `git push <remote-name> <branch-name>`

Fetch, pull and push

- Fetch updates remote references

- **Fetch** updates remote references
  - Updated remote branch info + data is pulled down
  - Will NOT automatically merge updates.
  - **Pull** updates remote references and merges data
    - It is a fetch and then a merge
- **Push** sends your updated reference (branch) to the remote, along with all necessary data
  - Will fail when the remote branch is ahead of your local branch and a fast-forward merge is not possible
- This is how you **keep up to date** and **share changes**

Sending tags

- To share **tags** you've added you need to push them to the remote as well
  - `git push <remote-name> <tag-name>`
  - `git push <remote-name> --tags`

A workflow incorporating remotes

- You have a “stable” master branch
  - All new work is branched off master
- Before beginning a new branch off master, you check for updates from the remote and incorporate them into master
- You then branch off an updated master
  - You work in your branch
- When done with your work
  - You once again update master from the remote
  - Then you merge your branch to master
  - Then you push an updated master to the remote

Remote management

- Adding remotes
  - `git remote add <name>`

- Removing remotes
  - `git remote rm <name>`
- Renaming
  - `git remote rename <orig-name> <new-name>`
- More info
  - `git remote show <name>`
- Listing
  - `git remote`
  - `git remote --verbose`

Remote *branch* management

- View a list of branches on your remotes
  - `git branch --remote`
  - `git branch --all`
- You can check these out
  - `git checkout origin/master`
  - This will be in a detached HEAD state
- You can branch from them
  - `git checkout -b origin-master origin/master`
  - This sets up auto-tracking
- You can push new remote branches
  - `git push origin origin-master`

Tracking branches

- You can tie a local branch to a remote branch so that it is “tracking” the remote
  - Fetch, Push, Pull, Merge, Rebase will automatically use the tracking branch
- Set up a local branch to track to a remote branch
  - `git branch --track <branch> <remote>/<branch>`
  - `git push --set-upstream <remote> <branch>`
  - `git branch --set-upstream-to <remote>/<branch>`
- You can view tracking branch info
  - `git branch -vv`

Pruning remote (branches)

- There are potentially 3 versions of every remote branch
  - The actual branch on the remote repo

- Your snapshot of that branch locally (in refs/remotes)
- And a local branch that may be tracking the remote

- `git prune`
  - Removes references to remote branches that do not exist on the remote anymore
  - `git remote prune <remote>`
    - or
  - `git fetch --prune`

Wait, what about collaborating?

- We'll begin to collaborate as we link team members up via our remotes and one (or many) hosted repositories

Recap

- We just covered
  - Creating a hosted repository on GitHub
  - Linking to it from a local repo through `git remote`
  - Pushing changes on the master branch to the remote repository's master branch with `git push`
  - And we introduced the basics of a collaboration workflow in git using `git fetch` (to get updates) and `git push` (to share updates)

Lab: Remote basics

- Add a new remote with the same repo url as your about-me repository. Call it "github"
  - Check the branches that are on "github" -- you should at least see "master". Forget to fetch?
- Create a new branch off master, call it "develop"
- Push this new branch to the "github" remote and set

- Push this new branch to the "github" remote and set it up to be tracked
  - How do you confirm it is tracked?
- Check the decorated log.
  - `git log --decorate --oneline`
  - What's different?
- Fetch updates to your "origin" repo

Module: GitHub Intro

- We'll get to know GitHub and learn about
  - Your account settings
  - Exploring & managing repositories
  - Introduction to issues and how they can be used in combination with pull requests

What can we do within GitHub?

- We can do a lot directly in GH
  - Create repositories (of course)
  - Create branches (oh?)
  - Create/edit files and create commits (neat!)
  - Submit pull requests (essential)
- Along with project stuff…
  - Wiki, for documentation
  - Issues, bug/issue tracker
  - Analytics

Let's browse GitHub

- My Account…
  - Add multiple emails and your SSH keys here
  - Manage notifications
  - Two-factor authentication?
- A repository
  - https://github.com/twbs/bootstrap
  - You can watch, star it
  - Fork it (clones it - you'll own the copy)
  - Review the project README, issues, pull requests, etc

- Review the project README, issues, pull requests, etc
- Adding a repository
  - Make it public or private
  - Initialize a few things, if you want
    - README
      - (any format, favor .md)
      - Will render as the landing page for your project
    - Pre-packaged .gitignore and license

Let's browse: GitHub Repo Mgmt

- Set the default (master) branch
- Set repository features on/off
- Manage collaborators
- Set up service integrations
  - Integrate with external services like CI servers, bug tracking, chat systems, etc
- Set up hooks
  - Set up client-side git hooks
- Add deploy keys
  - For a single repository; typically an SSH key from your server that is deploying

Let's Browse: GitHub Issues

- Built-in, per-project (repository) issue/bug tracker
- Ties into the pull-request workflow
- Use a GitHub flavored version of MarkDown

GitHub MarkDown in Issues

- https://guides.github.com/features/mastering-markdown/
- Can set up task lists

```
- [x] First task, complete
- [ ] Second task, incomplete…
```

- Code style with fences

```
```javascript
    var rad = function() {
```
```

- Reference and notify collaborators with `@username` mentions
- Reference issues and pull requests with `#<num>`
  - Issues and pull requests will not conflict
- Reference repositories and issues

  - `username#<num>`
  - `username/repo#<num>`
- Reference a commit by full sha1 hash (40 chars in full)
- Emoticons! `:<meta>:`
- Supports images (drag & drop)

Recap so far

- GitHub is a place for us to **host our repository** and to **maintain project collaboration**
- We can browse lots of information about our repo
- **Issues** are great for tracking bugs/updates (though you are not tied to them)
- **Pull requests** are essential for bringing changes into your project
- You can use pull requests to **submit patches** to other projects, too

Lab: Issues

- We're going to use issues to begin collaborating as a team
- Visit my "about-us" repo
  - https://github.com/rm-training/about-us
- Create an issue requesting that I add you to the team
  - Mention me, **@mrmorris**
  - I will add you to the team (*and while I do that…*)
- Create a second issue
  - Ask your neighbor (left of you) for their git username
  - Add an issue for your neighbor requesting they add an **html** page about themselves.
  - Include a checklist in the issue with two items to make sure they don't forget:
    - 1) include your name as the header
    - 2) list your three favorite cities in the world
  - Experiment with MarkDown

Module: Pull requests

- We'll see how we can
  - create branches
  - make file edits
  - and submit pull requests
  - …all from within GitHub

Pull Requests

- GitHub term
- You can make a “merge request” to bring your work into another branch or project
  - “Please merge my branch into your branch”
- Works well with many different workflows
- Encourages early collaboration
- *Will ALWAYS do a non-fast-forward merge

I’ll resolve my issue first

- https://github.com/rm-training/about-us/issues

- To do:
  - Create the branch
  - Add the index.html file
  - ~~Push it to the remote~~ (we're working directly in gh)
  - Create a pull request from the branch
    - Mention the issue #
  - Get it reviewed
  - Merge it
  - Delete the branch

Lab: Resolving the issue with a pr

- This is all to be done within GitHub (no local work)
- As developers: Resolve your newly assigned issue
  - Create a branch for your work off master
  - Add a file (`your-name.html`)
  - Edit the file with the information required
  - Commit to your branch
  - Now create a pull request for your branch to be merged into `master`
    - Mention the issue you're fixing with `#<issue-number>`
- As an issue opener: Review the issue you submitted for your neighbor (you are the owner, after all)
  - Check the "Files Changed" tab
  - Let's assume you forgot to ask them to include their favorite color. Drop in the new requirement in the pull request discussion.
- As developers: Handle the new requirement in your branch
  - Edit the file, commit
- As an issue opener: Re-review the pull request
  - Good now? Give them a thumbs up to indicate it's OK to merge.
- As developers: You got the thumbs up!
  - Merge your branch via the pull request
  - Delete your branch in github

Recap so far

- So far we've been working as a team within a single repository, entirely within GitHub
- We're using **issues** as our ticket tracker
- And creating **new branches for new work**
- We then created **pull requests** to initiate a merge review to get our changes back into the main repository branch
- We kept our review discussion around our issue/ pull-request in GitHub
- Ultimately, upon **approval**, our work was **merged**

Module: Repository workflows

- We'll get a feel for the different ways you can organize your team's workflow

- We'll use git clone to copy down our hosted repo
- And we'll look at how you can keep up to date locally in your clone
- Along with your fork

Remotes and branches => workflow

- How you structure your remotes and branches determine your workflow
- A project can be public or private
- Remote approaches
  - Single remote, all contributing
  - Many remotes (through forking), contributing up to single repo
- Branching approaches
  - `master or main or production`
  - `master (stable) + develop (new work)`
  - `master + develop + hotfixes`
  - `master + integration + staging`

GitHub Flow

- GitHub supports a particular workflow
  - `master` is always stable
  - Branch any new work off master
  - Submit a pull request (early)
  - Discuss work in the pull request
  - Merge pull request to master when ready
- https://guides.github.com/introduction/flow/

Taking it local

- It's all well and good to be able to do a lot of basic work directly in GitHub, but what about getting a local copy of that repository we've been working in?

- We can do that!

Cloning

- Copy an existing repository to a new local
  - `git clone <remote-url> <otional-dir>`
- `git clone` will
  - Initialize a local git repo in the directory
  - Pull all data and remote branches down
  - Set up an initial remote, called “origin”
  - Set up the initial tracking branch for “master”
- If you are going to work on a repository that already exists then you will likely start by cloning
- *Forking* in GitHub is like cloning (but you own it)

Staying up to date

- If we have a remote, we can stay up to date with
  - `git fetch <remote>`
- And bring updates from remote branches into our local branches
  - `git checkout <branch>`
    `git merge <remote>/<branch>`
- We can push our own updates to the remote
  - `git push <remote> <branch>`

Lab: Cloning

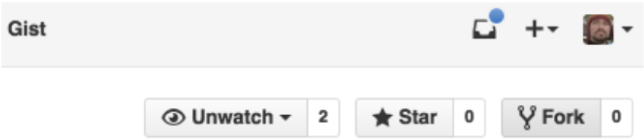
- Clone my repository!
  - **Clone** the repository locally
  - Get the clone url from my repo page:
    - https://github.com/rm-training/about-us
- Create a new **topic branch** to do some work
  - The task: Edit your profile page to add a paragraph about your pet preference (cat, dog, nothing?) and why.
  - Share your branch by **pushing** it to the remote repository

- Share your branch by **pushing** it to the remote repository
- On GitHub, open a **pull request** to have your new branch merged into the master branch

- We'll review & merge together
- After we have merged them…
  - Update your local master branch using `git fetch`, then `git merge`
- What would happen if you didn't keep up to date and decided to branch off master?

GitHub Forks

- You can Fork any public project in GitHub
  - It's a copy you own



- Why fork?
  - To submit work to a public project
  - Organizational safety net for larger teams
  - To enforce a subset of project owner(s)
- Forking workflow
  - You fork a project (the **upstream**)
  - You branch off of (and push branches to) your fork
  - You submit pull requests into the main, **upstream**, project
  - Project owner can review and merge

Lab: Forking

- Now we're going to work within our own forks…
  - Each of us, as developers, will have our own fork and will push our work to that fork then submit Pull Requests to the main repository.
- Fork my repository via GitHub
  - https://github.com/rm-training/about-us
- Clone **your fork** to your local via git
  - Clone your fork into a new directory ("about-us-fork"?)
    - `git clone <your-fork-url-from-github> ./`
  - Look at the branches that are set up and the remotes
- Create a new branch off of master to make an edit
  - Edit the index.html file to add a link to your profile page
    - `<a href="your-name.html">Your Name</a>`
  - Push your new branch to your fork
  - From GitHub, submit a pull request into my repository
- We will review and merge
- How do we keep our local (and our fork) up to date with the main repository?
- How do we deal with these… *conflicts*?

Staying up to date (pt 2)

- When working on one remote, just fetch and merge from the "origin"
- When working on a **fork**, you will want to fetch updates from the "**upstream**"
  - Add an "**upstream**" remote (the main repository)
    - `git remote add upstream <main-repo-url>`
  - Fetch and merge updates from there

- Fetch and merge updates from there
  - `git fetch upstream`
  - `git merge upstream/<branch>`
- Push them to your fork as needed
  - `git push origin master`

Lab: Staying up to date w/ forks

- Add a new "upstream" remote for the main repository
- **Fetch** the updates from upstream
- To keep master up to date:
  - Merge updates from upstream master to your local master
  - Push the updated local master to your fork's master
- Then to deal with the conflicts:
  - Merge the updates from master into our topic branches
  - Re-push our topic branches to GitHub
  - Merge it from GitHub

GitHub wrap up

GitHub… wrap up

- There are GitHub UI's for working with git locally
- Integrations to take GitHub further
- And of course, a pretty meaty API

Module: Collaboration Workflows

- We'll put together what we know and review some collaboration workflows
- As well as branch strategies

Distributed Workflows

- Centralized workflow
  - One central repo, everyone works from it, everyone updates it
- Integration-manager workflow
  - Several clones with one being the official project
  - Pull requests are submitted to merge changes into the official project
  - Maintainer reviews and merges
- Dictator and lieutenants workflow
  - Clusters of workers around clones, being merged up by higher ups

Collaborator roles

- Private, small team
  - One repo, everyone has push/pull, everyone merges to master
  - Topic branches are used for work; merged to master; pushed to origin. Other collaborators must fetch & merge updates before merging and pushing updates.
- Private, managed team
- Forked public project
  - You fork the repository and work within your clone
  - You create a branch and use that to submit a patch or pull request to the official project
  - You add the upstream/official remote so you can pull updates from there, too

Branch workflows

- Continuous Integration
  - Master is the primary working branch (stable)
  - **Topic branches** come off master and are merged back in when done
- GitHub Flow
  - Continuous Integration with Pull Requests
- Stable vs development
  - Master vs development branches

Branching Strategies

- Long-running branches
  - easy to maintain in git due to easy of merging
  - Typically will see
    - master (stable)
    - develop, integration or next
- Topic Branches
  - Short-lived branch for a single feature/bug/piece of work
- Hot-fix branches
  - Branch off “stable” (instead of development tracks)
  - Merge into stable
  - Merge stable back into development tracks

Tag Strategies

- Tag versions

- V1.0
- V1.0.1 (hotfixes)

- Keep versions in “active development” in a branch
- Otherwise, just use the tag

Recap: Workflows

- How you structure your **team**, your **repositories** and your **branches** is up to you (and your team)
  - Pick a strategy and have everyone stick to it
- One main repo? Many forks?
- One primary branch, or several tracks of development?
- Public or private?

Day 1 Homework

- Read the Git Parable
  - http://tom.preston-werner.com/2009/05/19/the-git-parable.html

Module: Git Tools

- We'll learn about the graphical tools git makes available to stage files and view your log
- As well as how you can go further with merging

- As well as how you can go further with merging and diffing by using external visual tools

GitK

- GitK for a graphical display of the log and search
  - `gitk`
- Accepts most params that "`git log`" accepts
  - `gitk --all --decorate`
- Can also see what changes are in your staging and working directory

Git GUI

- A full UI for most Git functionality, but really boils down to…
- A tool for crafting commits
  - `git gui`
- You can stage and commit
  - Including patching (partials)

Mergetool

- Perform merges using a visual tool by setting up "mergetool"
  - `git config --global merge.tool <toolname>`
- Then during a merge conflict
  - `git mergetool`

- `git mergetool`
- `git mergetool -t <toolname>`

- To see some options you may have already
  - `git mergetool --tool-help`
- Additional config
  - `git config --global mergetool.<toolname>.cmd “bla”`
  - `git config --global mergetool.trustExitCode false`
    - Whether the exit code indicates a successful merge
  - `git config --global mergetool.keepBackup false`

Difftool

- You can use a similar visual tool for viewing diffs, too
  - `git config --global diff.tool <toolname>`
- Then just use it
  - `git difftool`
  - `git difftool -t <toolname>`
- To see some options you may have already
  - `git difftool --tool-help`
- More configs
  - `git config --global difftool.prompt false`

Example: Kaleidoscope

- Grab it
  - http://www.kaleidoscopeapp.com/
- Can automatically tie it into git, or manually enter:
  - ```
    [difftool "Kaleidoscope”]
     cmd = ksdiff --partial-changeset --relative-path \"$MERGED\" -- \"$LOCAL\" \"$REMOTE\”

    [mergetool "Kaleidoscope”]
     cmd = ksdiff --merge --output \"$MERGED\" --base \"$BASE\" -- \"$LOCAL\" --snapshot \"$REMOTE\" –snapshot
     trustexitcode = true
    ```
- Usage:
  - `git mergetool -y -t Kaleidoscope`
  - `git difftool -y -t Kaleidoscope`

Recap: Git tools

- **GitK** is extremely usual for viewing and searching through your commit history
- Git **GUI** is *sort* of helpful, at least for visually patching files to staging
- Avoid painful merge/diff issues in the command line, set up a mergetool and difftool of choice
    ```

line, set up a **mergetool** and **difftool** of choice.

Lab: Set up our merge/diff tools

- Check what you have available
  - `git mergetool --tool-help`
- Then pick one and configure it
  - `git config --global merge.tool <toolname>`
  - `git config --global diff.tool <toolname>`
- Then test it by creating a conflict
  - Create a new repository (locally)
  - Add a new file, commit it (your first commit)
  - Create two branches off master
  - In both, edit the same line in the same file
  - Now: `difftool`
  - In both: add, commit
  - Merge one
  - Then attempt to merge the other
  - Now: `mergetool`

Module: Altering history

- We'll look at an alternative to merging, **rebase**, which allows us to integrate changes with a modified history
- Through **rebase** we can avoid merge-commits as well as squash commits down into a single commit
- Finally, we'll use **cherry-pick** to grab a single commit from a branch and integrate it onto another

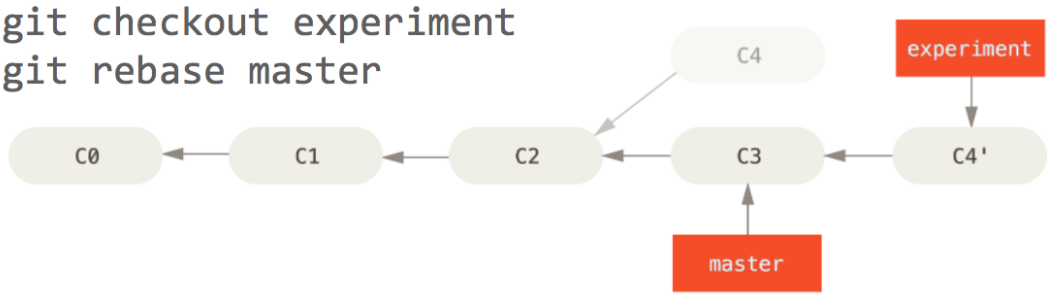
Common merge types

- When merging, git will attempt to use the most appropriate method of merge
- Fast-forward
  - If both branches share the **same parent**
  - Is like a non-destructive **rebase**
  - Can avoid: `git merge --no-ff <branch>`
- Recursive (3-way)

- If the branches have diverged
- Results in a new merge commit

Rebase as a third option

- We can also “rebase” changes from one branch to another
- This takes the unique commits from the branch you are on and re-applies them as though the target branch is the new parent
- For example:
  - `git checkout experiment`
    `git rebase master`



Rebasing

- `git rebase <new-base>`
  - Sets **current branch** to point to **new base as its tip** then **re-applies** the unique commits on top of that
- Like a transplant, or grafting
  - Snip off the commits in current branch,
  - Re-apply one at a time to target branch
  - Current branch ref is set as the new tip
- It affects the current branch only
- It re-applies only the unique diffs on current
  - `git log <new-base>..`
- It is history-altering!

Rebase to keep up to date

- When pulling changes from another branch (incl. remotes)
  - `git fetch origin`
  - `git rebase origin/master`
- But remember, this regenerates every *unique* commit in your current branch
  - Pushing to your remote will fail because it can't fast forward (indeed, the original parent has changed)
  - So you have to force it

- So you have to force it
  - `git push origin <branch> --force`
- But! Don't rebase (or force push) shared commits

Rebase to squash

- Using rebase "interactive" you can *squash* and modify commits
  - `git rebase -i origin/master`
  - Give you the option to "s" squash or "e" edit commits as it replays them
- Merge also has a squash option
  - `git merge <branch> --squash`
    `#still need to commit`
    `git commit`
  - Will squash all commits on other branch into one and stage it on the current branch

Rebase conflicts

- Sometimes rebase will conflict, fix it and continue

- Sometimes there's a conflict while it rebases…
- Resolve the conflict and
  - `git rebase --continue`
- Otherwise just abort the whole operation
  - `git rebase --abort`

Rebase vs Merge

- Merge
  - Safe, easy, non-destructive
  - Easier to see branching activity
  - Easier to revert a merge (commit)
  - Noisy, lots of extra merge commits
  - Hard to follow the history
- Rebase
  - Clean, linear history
  - Can clean up lots of in-progress commits
  - Easier to navigate w/ log, bisect and gitk
  - Flexibility, can squash and edit commits
  - Unsafe, destructive
  - No traceability (ex: when was this feature merged?)
- So when should I use them?
  - **Merge** (--no-ff) completed work into master
  - **Rebase** to fetch updates into topic branches and into local master

- **Rebase** to fetch updates into topic branches and into local master
- Ultimately it is up to you and your team

Cherry-pick

- You can select one commit at a time to rebase it into your current branch
  - `git cherry-pick r32fs32`
  - "Apply X commit as a new commit on my current branch"
- This does alter history
- Like rebase, you can continue/abort
  - `git cherry-pick --continue`
  - `git cherry-pick --abort`

Workflow: Merge/History Strategies

- Always merge (never rebase)
- Always rebase (never merge)

- Always rebase (never merge)
- A mix
  - Merge branches to master (never fast-forward)
  - Rebase to update branches from the upstream
- To squash or not to squash?

Recap: Altering History

- **Rebase** is a powerful (and dangerous) alternative to merging
- Keep a clean history by avoiding merge commits, and **squashing** messy work
- But **merge** still has a place to maintain a meaningful history
- **Cherry-picking** is good at grabbing one (or a couple) commits from one branch into another
- But in all history-altering operations be careful not to affect shared commits

Lab: Changing history

- Clone my repository:
  - https://github.com/rm-training/history-changer
- Check the graph (`--all`)
- 1) Using rebase to bring in updates
  - Update the topic-behind-1 and topic-behind-2 branches with changes from master by using `rebase`
  - Resolve conflicts as needed
- 2) Using rebase to squash commits
  - Check out the messy-branch and view the log
  - Use `rebase -i` to squash it into one commit
  - Give it a more meaningful commit message
- 3) Cherry pick a commit
  - Check out diamond branch
  - Find the commit with the "super important patch"
  - Create a new branch, diamond-only, off master and use `git cherry-pick` to bring that important commit into the new branch
- 4) How would you push a branch you rebased back to the remote?

Module: More with merge

- We'll check out a few more advanced options when merging
- As well as some additional approaches for

dealing with conflicts

Merging options

- Merge and ignore whitespace
  - `git merge -Xignore-all-space <branch>`
    - Ignore all whitespace when comparing lines
  - `git merge -Xignore-space-change <branch>`
    - Ignore changes in amount of whitespace
- Avoid auto-committing the merge
  - `git merge --no-commit <branch>`

Merge preference

- When merging, we can tell git to prefer a specific branch
- Expecting a conflict?
  - `git merge -Xours <branch>`
    - Prefer the current branch for conflicts
  - `git merge -Xtheirs <branch>`
    - Prefer the branch you are merging in
- Or just opt for one entirely
  - `git merge -s ours <branch>`
    - Defer to current branch for *any* diffs
  - There used to be a "`theirs`" but it has been abandoned due to uselessness
  - Still results in a (dummy) merge commit

When in conflict

- View a "merge" diff
  - `git diff --merge`
- Reset a *conflicted* file to the *conflicted* state
  - In case you screwed things up while resolving it
  - `git checkout -m <filename>`

- `git checkout -m <filename>`

- Opt for one version or another
  - Skips having to manually resolve the conflict
  - `git checkout --ours <filename>`
    - Defer to *current* branch version
  - `git checkout --theirs <filename>`
    - Defer to *merged* branch version

ReReRe

- Reuse recorded resolution
- Tell git to track merge resolutions for re-use
  - `git config --global rerere.enabled true`
- It will remember how you resolved identical conflicted hunks and use that solution in the future

Recap: More merging

- We saw a few merge options like
  - Ignoring whitespace
  - Conflict hints with `-Xours` and -`Xtheirs`
  - And having merge use one branch over another entirely with the `(-s) ours` strategy
- When in conflict you can pick between versions with `checkout --ours` and `--theirs`
- ReReRe is a neat helper to keep track of conflict resolutions
- Many other options and strategies

Module: Comparing

- We'll check out the "`..`" and "…" operators for comparing commits and branches
- This is good for being able to see a collective diff output, or see the set of commits being introduced by a branch

Comparing branches with log

- What is in <B> that is not in <A>
  - `git log <A>..<B>`
  - Same as:
    - `git log <B> --not <A>`
    - `git log ^<A> <B>`
  - `git log ..<A>`
    - Commits that are on <A> and not in current
- What is different in both <A> and <B> but not shared?
  - `git log <A>…<B>`
  - To see which branch a commit comes from in the output
    - `git log <A>…<B> --left-right`

Comparing branches with diff

- See the diffs between two branches
  - `git diff <A>..<B>`
  - Will show all changes across <A> and <B>, including changes that <A> would introduce to <B>. Which isn't what we want if comparing before a merge
- See the diff that <B> introduces to <A>
  - `git diff <A>…<B>`

It's about the common ancestor

- Given this lovely commit tree…

```
O-O-X-O-O-O-A
      \
       O-O-O-B
```

- `git diff A..B`
  - Is like "`git diff A B`"
- `git diff A…B`

- Is like "`git diff X B`"
- See it in action by cloning
  - https://github.com/rm-training/comparing

Recap: Comparing

- Easy enough!
- We can use log (with ..) to determine what commits are being introduced by a branch
- And diff (with …) to see what changes a branch is introducing

Lab: Comparing

- Clone my repo
  - https://github.com/rm-training/comparing
- View the log graph
- From master, how can you check which commits the “add-introduction” branch would introduce to master?
- How can you check the difference in all commits between “add-introduction” and “add-profile”
  - Does it matter which order you check in?
- How can you check the difference “add-profile” would introduce to “master”?

Module: Debugging through Git

- We’ll see how we can use git log to get lots of information about our repository history
- And how we can annotate a file with git blame to see who changed what.
- We’ll also try out git bisect for finding where a bad change was introduced

Debugging with log

- Use `git log` to find a commit you need
- Lots of options…
  - Just one liners please
    - `--oneline`
  - View the diff
    - `-p`
  - Abbreviated commit stats
    - `--stat`
  - Custom format
    - `--pretty`
    - `git log --pretty=format:”%an committed %h %ar: %s”`
  - Only show file names
    - `--name-only`
  - Include references
    - `--decorate`
  - Shortened commit id
    - `--abbrev-commit`
- http://git-scm.com/docs/git-log

Limiting the Log

- Number of commits

- `-<n>`
- By date
  - `--since 2.days`
  - `--until “2012-01-01”`
  - `--before “yesterday”`
  - `--after “yesterday”`
- Avoid merge commits
  - `--no-merges`
- Give a range
  - `git log <since>..<until>`
  - When given branches, it outputs the difference from <until> not in <since>

Searching the Log

- Search by author
  - `--author “Ryan”`
- Search commit messages
  - `git log --grep “Added”`
- Search content (commits that add or remove a line matching the string) (use -G for regex version)
  - `git log -S ”myString”`
  - `git log -G “[0-9]+Rad”`
- A path or file

- `git log -- file1 file2 path1 etc`

Git Bisect

- Binary search through commits and changes
- Start it up
  - `git bisect`
- Then tell bisect the bad commit and last good commit
  - `git bisect bad <commit or defaults to current>`
  - `git bisect good <commit or tag when it was good>`
- Halves commits and switches to mid-point. Tell git if this commit is good/bad
  - `git bisect good`
  - `git bisect bad`
- It will output the hash of the first bad commit
  - `git bisect reset`

Git blame

- Annotates file with commit information for each line

- `git blame <filename>`
- Limit the output
  - `git blame -L 12,22 <filename>`
- Track code movement
  - `git blame -C <filename>`

Recap: Debugging in git

- The git log is a very powerful tool for parsing the repository history, and also debugging
- When in doubt, git bisect can help you search for where a change was introduced
- And finally, we saw how we can view who changed lines in a file with git blame

Lab: Bisect and blame

- Use `git bisect` to find where a change was introduced (and then determine who did it)
- Clone my repository
  - https://github.com/rm-training/long-history
- Using `git bisect`, determine in which commit the "Long walks on the beach" line was added to index.html
- Using `git blame`, determine who originally added that line.
- All done?
  - Experiment with git log
  - Search the log for the line using "`git log -S`"

Module: Fixing issues with git

- We'll learn how we can search the history of what we've done in git using the reflog
- And come away with a better understanding of git's HEAD pointer

git's HEAD pointer

- We'll learn about navigating through your repository's commits
- Finally, we'll see how we can undo changes or make things right using git reset and git revert

HEAD

- Head is a symbolic reference to the branch you're on (or commit)
  - Actually a pointer to another reference
- For example…
  - `git checkout master`
  - `cat .git/HEAD`
    - Outputs: `Ref: refs/heads/master`
- HEAD is used
  - For new commits
    - A commit is given a parent id from HEAD
    - The branch ref is updated to point to the new commit
    - HEAD still points to the branch
  - When you checkout a commit or branch
    - HEAD is updated to point to that commit or branch

The reflog

- Git keeps a log of where **HEAD** and **branch refs** have been over the past few months
  - `git reflog`

```
$ git reflog -5
975df88 HEAD@{0}: commit (merge): Merge branch 'new-branch-3' into new-branch-2
b4be984 HEAD@{1}: commit: borp
c42aec6 HEAD@{2}: checkout: moving from master to new-branch-2
8b004ca HEAD@{3}: reset: moving to 8b004ca
9def1c4 HEAD@{4}: commit (merge): Merge branch 'new-branch-3'
```

- You can use these references
  - `git show HEAD@{3}`
  - "Where HEAD was three moves ago"
- Branches also have ref logs
  - `git reflog master`
- And you can reference by date
  - `git show master@{yesterday}`
  - `git show master@{one.week.ago}`

Ancestral references

- For any commit, branch or tag, you can trace up through its heritage
- Direct parent
  - `git show HEAD^`
  - If it was a merge commit it has two parents, show second
    - `git show <merge_commit_hash>^2`
- Parent

- Parent
  - `git show HEAD~`
    - 1st parent of HEAD
    - same as `HEAD^`
  - `git show HEAD~2`
    - 1st parent of the 1st parent of HEAD
    - Same as `HEAD^^`
  - `git show HEAD~n`
    - nth parent of HEAD

Git reset

- `git reset` manipulates the three trees of git (HEAD, staging and the working directory)
- It has three basic operations
  - Moving HEAD (`--soft`)
    - Changes the commit the current branch ref points to (via HEAD)
      - `git reset --soft HEAD~`
    - ie: udno the last commit without losing staging changes
  - Moving HEAD and updating staging (`--mixed`)
    - Changes current branch ref *and* updates index to match that commit
      - `git reset --mixed HEAD~`
  - Moving HEAD, update staging and update WD (`--hard`)
    - Changes current branch ref, updates the index *and* updates the working directory to match as well
      - `git reset --hard HEAD~`
    - This is destructive in that it will wipe out changes in your WD

Git reset (continued)

- If you use a filename/path, however…
  - `git reset <filename>`
- It will behave like a `--mixed` reset
  - It can't move HEAD to a file, so it skips --soft
- Will put whatever <filename> looks like in the HEAD commit and put that in the Index
  - ie: unstage the file changes
- You can specify the commit version
  - `git reset <commit> <filename>`

Checkout (in terms of reset)

- `git checkout` will change what reference HEAD points to
  - Unlike reset, it does not affect the reference itself
  - Updates index and WD to match, but it will not overwrite changes you have made
- `git checkout <filename>`
  - Will update the WD and index file from what HEAD

points to

Commit recovery (and undoing)

- Using log, reflog, reset and checkout, we can fix a lot of problems we may find ourselves in.
- Find a lost commit
- Find a lost branch
- Undo a merge
- Undo a rebase

Git revert

Git revert

- Apply an inverse of changes from a commit or set of commits
- If I want to undo commit `ab3r230`
  - `git revert ab3r230`
    - This will create a new commit applying changes that effectively reverse the changes in `ab3r230`
  - `git revert ab3r230 --no-commit`
    - Will create the revert changes but will not commit them
- Once reverted, I can't re-merge that commit
  - I can, however, revert a revert
- Good for undoing ***public*** commits

Reverting a merge

- To revert a merged branch just revert the "merge commit"
  - `git revert 352e23 -m 1`
    - `--mainline`
    - You tell it (1 or 2) which brain is the mainline to revert
    - 1 is right-most, 2 is next to the left

```
$ git log --oneline --graph
* b83f729 Added third file
*   f757139 Merge branch 'newbranch'
```

```
|\
| * e66afed New file in branch
|/
* 8f80b81 New file added
* 1b08cb2 Added readme
```

Fixing some common issues

- Branch won't merge cleanly
  - Rebase your branch
  - Or merge the target into your branch and resolve
- Accidentally rebased
  - Reset to the commit before the rebase
    - Use the ORIG_HEAD
      - `git reset --hard ORIG_HEAD`
    - Or, use reflog to find the original HEAD
      - `git reflog <branch> -10`
- Broke the master
  - Just check out the remote version again

Whitespace got you down?

- Noticing “changed” files in working directory that you can’t reset with “`git reset --hard HEAD`”?
- It may be whitespace issues
  - ```
    git rm --cached -r .
    # reset isn’t enough on its own
    git reset --hard
    ```
- Then set your appropriate autocrlf
  - And have your team do the same

Recap: Fixing issues in git

- We witnessed the power of the reflog, which allows us to track our local history of actions and branch changes
- Using the reflog (and log) we can take control of our branches, and fix a lot of snafus, with git reset and git revert
- Hopefully we have a good understanding of what HEAD is
- And we know how to navigate through commit
    ```

ancestry using ~ and ^

Lab: Reflog and reset

- In the “about-us” repository
- On master
  - Add two commits with arbitrary changes
- Ack!
  - We should have branched.
  - Use `git reflog` and `reset` to undo those commits w/out losing the changes
- Create a new branch off master
  - Commit your changes
  - Create one more commit
- Merge the branch into master
  - Oops! Didn’t mean to merge…
  - Use `git reflog` and `reset` to undo the merge
- Now merge with --no-ff
  - Ack, we didn’t want to do that, either
  - But what if this was already public?
  - Use `git revert` to undo the merge
- We have a messy master (compared to the upstream)
  - How would you fix it?

Git hooks

- A way to fire off custom scripts when certain actions occur

- Stored in `.git/hooks`
- To enable one, just put the appropriate named file in the hooks subdirectory
  - Check out the samples
    - `ls .git/hooks`
- Client-side (committer)
  - pre-commit, prepare-commit-msg, commit-msg, post-commit, pre-rebase, post-rewrite, post-checkout, post-merge, pre-push, pre-auto-gc, plus some email ones
- Server-side (on the remote)
  - pre-receive, update, post-receive
- They are local to a repo

A sample pre-commit hook

- Add “prepare-commit-msg” file to .git/hooks
  - ```
    #!/bin/sh
    echo "# Please include a useful commit message!" > $1
    ```
- Don’t forget to make it executable
  - `chmod +x prepare-commit-msg`
- Then try a commit!
    ```

A sample server-side hook

- create a bare repository
  - `git init --bare remote-sim`
  - This will be our virtual remote
- Let's set up a post-receive on the "remote"
  - Create and edit "post-receive" in .git/hooks/
  - Add this content…
  - https://gist.github.com/mrmorris/3e1c5087ed52303a9ea6

Now to set up a local repo

- Create another repository and add the bare repo as origin
  - `cd ~/ && git init local-repo && cd local-repo`

- `git remote add origin ../path/to/remote-sim`
- This repo is our local, while the remote-sim repo is our remote server
- Create a commit then push master to the origin
- Check the result on the remote-sim repo

Module: Getting more out of git

- We'll revisit some commands and expand on their options, to get more out of what git has to offer

Patching

- Some git tools give the option of doing things as a patch
  - `add`, `reset`, `stash`
- Commit only partial changes with “--patch”
  - `git add --patch`
  - Or use `git gui`
  - Or use *interactive*
    - `git add -i`

What else is there?

- Submodules
  - Have repositories inside your repository
- .gitattributes
  - Ability to set (and track) directory-specific file rules

- Git and SVN
  - There is a bridge available
  - GitHub has an importer

Advanced branch management

- Tired of all those local branches?
  - Alias:
    - `git config --global alias.clean-branches = !sh -c 'git checkout master && git branch --merged master | grep -v master | xargs -n 1 git branch -d'`
  - Or a script
    - http://rob.by/2013/remove-merged-branches-from-git

Git in your IDE

- Manage branches, checkouts, see annotations, built-in diffing, etc…
- Eclipse
  - Ships with a plugin, egit
  - Switch to the “git perspective”
    - Window > open perspective > other… select Git
- *Storm
  - Enable “Git Integration” plugin
  - Make sure path to git is correct

Git and Jenkins (or other CI systems)

- Install the Git plugin
- Create an SSH keypair for your jenkins user and add it to your git repo (on github)
- Set up a git user and email
- Connect to your git repo to test

- Create a new job in Jenkins
  - Use “git” for Source Code Management
  - Enter repo URL
  - Select the branch; jenkins will pull from here when a build is started
- Set up the post-receive hook in your repo (github)

Best Practices in Git

- Commit early and often
- Useful commit messages
- Branch new work (don’t work on master)
- Use remotes for people (not branches)
- Don’t change published history
- Keep up to date
- Establish a branching and team workflow
- Tag your releases
- Don’t commit configuration/secure stuff
- In an emergency, use the reflog

Module: Git internals

- We'll look behind the curtains of git and how it stores the repository data
- You'll get a better sense of how git works and how commits, branches and tags come together
- These commands may not have practical use, but they can be helpful to firm up the concepts

The .git directory

- `ls -la .git`
  - Refs contains our tags, branch and remote branch references
  - `cat .git/refs/heads/master`
    - Shows it as just a commit id!
  - `cat .git/HEAD`
    - Shows it as a reference to a branch
    - Unlike branches, it is not a direct link to a commit

- Unlike branches, it is not a direct link to a commit
- If you checkout a commit, HEAD will contain the commit id and will be considered a “detached HEAD”; it does not coincide with a local branch

Git’s object database

- Git stores four main objects
  - Trees
  - Blobs
  - Commits
  - And Tags
- **Tree** objects are representations of the snapshots, recording the state of a directory at a given point
  - Git ties trees together by wrapping each in a commit object and specifying a parent (another commit)
  - Trees combine blobs and other trees together
- **Commit** object specifies the top-level tree for a snapshot of the project at that point (author + committer + message)
- **Blobs** represent file data
- **Tags** are objects that represent a commit; they can be annotated (and therefore objects in their own right) or just reference a commit (lightweight)

Branch references

- While commits are objects that track a tree
  - And parent commit + meta
- Branches (incl. remote branches) are references to commits.
- `.git/refs` includes
  - Branches
  - Remote tracking branches
  - and Tag *references* (which point to tag *objects*)

Cat-file a commit

- `git cat-file <type> <object>`
  - Will output an object's info
- `git cat-file commit HEAD`
  - Commit info, like tree id, parent(s), author and committer information, commit message

Git ls-tree a tree

- Trees contain binary data, so we can't use `cat-file`
- `git ls-tree 61d35fb`
  - Displays what looks like a directory listing

Cat-file a blob

- From our tree listing, pick a blob
  - `git cat-file blob bef7f4ae`
  - Displays the entire file content
- Since all these objects are identified by their SHA-1 checksum, identical blobs are not duplicated (but are shared)
  - But, yes, a one-liner change results in two blobs

Cat-file a tag

- `git cat-file tag v1.0`
  - Contains the commit id associated with it
  - Along with author, message information
- Only annotated tags are “objects”

So what is a branch?

- `git cat-file -t master`
  - `-t` gets us the type of the object
  - “commit”!
- A branch is just a reference to a commit
  - `git cat-file commit master`

gc & packfiles

- If you add one big file then edit one line and commit, git will store 2 blobs… effectively doubling the disk space in use
- Git can and does clean up duplicate data like this by packing it

- Git can and does clean up duplicate data like this by packing it into “packfiles”
  - Initially, the data is called “loose” object format
- Tell git to run its garbage collection & packing
  - `git gc`
  - And packs up objects into .git/objects/pack
- Dangling files (not referenced by any commit) are not packed
- Packfiles compress down by looking for files that are named and sized similarly and store their deltas from one version to the next
- Newer versions of files are stored in full, while over versions in the pack are deltas (to optimize accessing the newer files)

GitHub Pages

- An easy way to get a static (+js) page up via a repository
- Create “`username.github.io`” repository
  - Ex: mrmorris.github.io
  - Add an index.html file to your clone and push it up
  - Or use their layout bootstrapper to start
- Visit http://username.github.io
- Supports Jekyll installations
- Can set CNAME to use your own domain
- Has a nice layout bootstrapper

Lab: GitHub Page Teams

- Group up into teams of 3-4. Each of you will be acting as a “Repo owner” of your own repo and “Team member” across your team’s repositories.
- As Repository Owners:
  - Add your team as collaborators
  - Create an initial issue: Add initial index page with a small profile about you (Assign to you)
  - Create an additional issue (at least one) per team member and assign to each team member. Need ideas?
    - Add a simple page about yourself and link to it from the index
    - Add an awesome animated gif to the index
    - Edit my index and bold all mentions of my name
    - Keep it light and simple
  - You are responsible for providing feedback on the issues in YOUR repository. You are providing approval to merge (or merging them yourself).
- Repository Team Members:
  - Beside that repo you own and manage…
  - You'll get a couple issues assigned to you. You are expected to:
    - Locally clone each repository that you are working on
    - Branch off master to submit your work to the repo
    - Create a pull request to resolve your issue
    - Get PR approval before merging
  - It would be nice of you to also review code changes across all repos you are involved in.
- Check out your progress at http://<username>.github.io