Thursday (September 20)

- First in-class exercise
- On using git (today is a prelude with useful info)
- Form 4-person teams
  - Use moodle to self-select a team; can do it before Thursday or on Thursday
- At least one person per team needs to bring a laptop

BRING A LAPTOP!

Our Goal

- Learn about different kinds of VCS
- Overview the basics of git
- Touch some intermediate git topics
- Clear up common points of confusion
  - Branch vs. Fork?
  - Merge vs. Pull Request?
  - Pull vs. Fetch?
  - Fork vs. Clone?

What are Version Control Systems

A Version Control System (VCS) records changes to a file set over time, making it easy to review or revert to specific versions later

What Is VCS?
Why Use Version Control?

- Easy to revert to previous versions
- Work on multiple features in parallel
- Makes collaboration easier
- Narrate the evolution of codebase with messages
- Nice tools such as GitHub (and GitLab (and BitBucket...)) with advanced features such as pipelines, issue tracking, wikis, etc...
- Can store a backup remotely and automatically - easy to keep this up to date!
- Helps keep your working space clean

Who Uses Version Control?

- Programmers
- Applications (Microsoft Word, Google Docs, …)
- Organizations
  - VCS can be used to sync data, not just code
Types of VCS

Centralized version control
- (old model)
- Examples: Concurrent Versions System (CVS)
  - Subversion (SVN)

Master Repository
Bob’s checkout
Alice’s checkout
Yuriy’s checkout
Yuriy’s laptop checkout
Yuriy’s desktop checkout
Bob’s checkout
Alice’s checkout

Types of VCS -- Centralized
- There exists a single "central" copy of the project
  - All developers commit to this single copy
- Each developer has local working copy(ies)
  - As soon as they commit, the central repo reflects the changes

Problems with centralized VC
- What if I don’t have a network connection?
- What if I am implementing a big change?
- What if I want to explore project history later?

Centralized version control

Types of VCS -- Distributed
- Each developer has their own repository.
  - Created by the developer, or
  - Cloned from an existing (remote) repository
- Developers work on their own repos
  - They can commit, branch, etc.
  - Activity is local unless it is pushed to remote repo
  - Remote activity is not seen until dev fetches from the remote repo
- Examples: Mercurial (hg), git

Distributed version control

Doing work
- I update my checkout (working copy)
- I edit
- I update my checkout again
- I merge changes if necessary
- I commit my changes to the Master
Distributed version control model

Doing work

- I pull from the Master
- I update my checkout
- I edit
- I commit
- I pull from the Master
- I merge tips if necessary and commit again
- I push my changes to the Master

History view (log)

- Bill and Melinda work at the same time
- At the end, all repositories have the same, rich history

Pros and Cons of Centralized VCS

A Motivating Example: What is this git command?
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NAME  

  git-add  -- Add file contents to the index

SYNOPSIS  


DESCRIPTION  

This command updates the index using the current content found in the working tree, to prepare the content staged for the next commit. It typically adds the current content of existing paths as a whole, but with some options it can also be used to add content with only part of the changes made in the working tree files applied, or remove paths that do not exist in the working tree anymore.

A Motivating Example: What is this git command?

NAME  

  git-commit  -- Commit changes and update the index

SYNOPSIS  


DESCRIPTION  

This command updates the index using the current content found in the working tree, to prepare the content staged for the next commit. It typically adds the current content of existing paths as a whole, but with some options it can also be used to add content with only part of the changes made in the working tree files applied, or remove paths that do not exist in the working tree anymore.

A Motivating Example: What is this git command?

NAME  

  git-checkout  -- switch branches or restore working tree files

SYNOPSIS  


DESCRIPTION  

Updates files in the working tree to match the version in the index or the specified tree. If no paths are given, git checkout will also update HEAD to set the specified branch as the current branch.

A Motivating Example: What is this git command?

NAME  

  git-fetch  -- Fetch remote branches

SYNOPSIS  

  git fetch [options] [remote-url] [branch]

DESCRIPTION  

Updates the index using the current content found in the working tree, to prepare the content staged for the next commit. It typically adds the current content of existing paths as a whole, but with some options it can also be used to add content with only part of the changes made in the working tree files applied, or remove paths that do not exist in the working tree anymore.

A Motivating Example: What is this git command?

NAME  

  git-rebase  -- Forward-port local commits to the updated upstream head

SYNOPSIS  

  git rebase [options] [remote-url] [branch]

DESCRIPTION  

Updates files in the working tree to match the version in the index or the specified tree. If no paths are given, git checkout will also update HEAD to set the specified branch as the current branch.

Our goal with git

Be able to understand the git man-pages
Git Basics

How Git Works

**Git Basics -- Tracked vs. Untracked**

- **untracked file**: a file not currently under version control
- **tracked file**: a file that is under version control

**Git Basics -- Three Main Stages**

1. **Committed**: Everything in the file is currently in the database
2. **Modified**: Changed the file but have not committed to the database
3. **Staged**: Marked the file for addition to the database in the next commit

Note that all of the above pertain to tracked files.

**Git Basics -- Creating Repositories**

**Initializing a repository**

- `git init` - Create an empty repository or reinitialize an existing one
- `--bare` - create a bare repository
- `-- [directory]` - `git init` is run inside the provided directory

`git init` creates a `.git` folder in the directory chosen

**Cloning a Repository**

- `git clone` - Clone a repository into a new directory
  - `--depth <depth>` - Create a shallow clone with a history truncated to `<depth>` commits
  - `--branch <name>` - Point local HEAD to specific branch (more on HEAD in a bit)
  - `--reference <name>` - Use `<name>` to keep track of remote repo instead of "origin"

**.git/**

- **What's in it?**
  - `branches/`:
  - `CONFLICT_EDITMSG`: most recent commit message
  - `config`: configures your git repository
  - `description`: only used by the GitWeb program (source)
  - `hooks/`: This contains client or server-side hook scripts (more info)
  - `info/`: The "staging area"
  - `info`: keeps a global exclude file for your project
  - `objects/`: keeps track of history of HEAD and refs
  - `objects`: where the actual content is stored
  - `refs/`: keeps track of refs and tags

- `index`: The "staging area"
.git/
- What’s in it?
  - branches/:
    - COMMIT_EDITMSG: most recent commit message
    - fetch: configure your git repository
    - hooks/: only used by the GitWeb program
    - index: The "staging area"
    - info/: keeps a global exclude file for your project
    - logs/: keeps track of history of HEAD and refs
    - objects/: where the actual content is stored in a database
    - refs/: keeps track of refs and tags

Git Vocabulary
- index: staging area (located .git/index)
- content
- tree
- working tree
- staged
- commit
- ref
- branch
- HEAD
- upstream

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- branch: basically just a (special) ref. Semantically: represents a line of dev
- HEAD: a ref pointing to branch/commit being worked on (i.e., Working Tree)
- upstream

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- HEAD: a ref pointing to branch/commit being worked on (i.e., Working Tree)
- upstream: complicated, basically “backwards in time” (but not quiet)
Git Basics

Working Locally

Git Basics: Changing Content -- git add

git add does two things:

1. given an untracked file it will
   a. start tracking it
   b. update /.git/index using the current content found in the working tree to prep the content for the next commit (i.e., the content is staged)
2. given a modified unstaged file it will
   a. stage its contents to commit

--patch, -p: start an interactive staging session that lets you choose portions of a file to add to the next commit.

Git Basics: Changing Content -- git commit

git commit updates the Git database with staged content in /.git/index

- Note that staged files can have unstaged changes
- By default this will open an editor for you to enter a commit message

--message=<msg>, -m <msg>: Add <msg> as the commit message. If multiple messages are given, concatenate as separate paragraphs
--patch, -p: Use the interactive patch selection interface to choose which changes to commit (similar to git add -p)

Git Basics: Making Queries -- git status

git status shows the working tree status. This command displays:

- paths that have differences between the index file and the current HEAD
- paths that have differences between the working tree and the index file
- paths in the working tree that are not tracked by git

--short, -s: Give the output in the short-format
--ignored: Show ignored files

Git Basics: Making Queries -- git log

git log inspects commit history with multiple display options

- git log is basically a wrapper around git rev-list and git diff-* (don’t worry about these - I sure don’t!)

Some Examples

git log
git log --graph
git log --graph --all
git log --graph --all --oneline
**Git Basics: Making Queries -- git log**

...Some Examples

```
git log --graph --abbrev-commit --decorate --format=format:'
%C(bold blue)%h%C(reset) - %C(bold cyan)%d%C(reset) %C(auto)%rD%C(reset) %C(bold cyan)(%cD) %C(reset)
%C(dim white) - %an <%ae>
%C(reset) %C(dim white)(committer: %cn <%ce>)%C(reset)'
git log --graph --abbrev-commit --decorate --format=format:'
%C(bold blue)%h%C(reset) - %C(bold cyan)%d%C(reset) %C(auto)%rD%C(reset) %C(bold cyan)(%cD) %C(reset)
%C(dim white) - %an <%ae>
%C(reset) %C(dim white)(committer: %cn <%ce>)%C(reset)'
```

**Git Merge**

**Git Rebase**

**Changing Commit History with Rebase**

- Git rebase lets us change our commit history
- rebase is a powerful tool, but we will only scratch the surface
Changing Commit History with Rebase

- Git rebase --onto gives us a bit more power
Why use Git Rebase?

Fork vs. Clone

Points of Confusion
Fork vs. Clone

Fork
- Fork is NOT A GIT CONCEPT
  - It was invented by GitHub
  - Fork stores extra information and makes pull requests possible

Clone
- Clone IS A GIT CONCEPT
  - clone extends init
  - exists independent of github

Branch vs. Clone

Branch
Branch creates a ref

Clone
Clone creates a new repository

Pull vs. Fetch

Fetch
- Take target branch from a remote repository and store it in .git/refs/remotes/
- NOT integrated/merged with local branches!!!

Pull
- Fetches remote branch and merges with local branch or repository

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