Git for Version Control

These slides are heavily based on slides created by Ruth Anderson for CSE 390a. Thanks, Ruth!

images taken from http://git-scm.com/book/en/

http://www.cs.washington.edu/403/

About Git

- Created by Linus Torvalds, creator of Linux, in 2005
  - Came out of Linux development community
  - Designed to do version control on Linux kernel

- Goals of Git:
  - Speed
  - Support for non-linear development (thousands of parallel branches)
  - Fully distributed
  - Able to handle large projects efficiently

  - *(A "git" is a cranky old man. Linus meant himself.)*

Installing/learning Git

- Git website: http://git-scm.com/
  - Free on-line book: http://git-scm.com/book
  - Reference page for Git: http://gitref.org/index.html
  - Git tutorial: http://schacon.github.com/git/gittutorial.html
  - Git for Computer Scientists:
    - http://eagain.net/articles/git-for-computer-scientists/

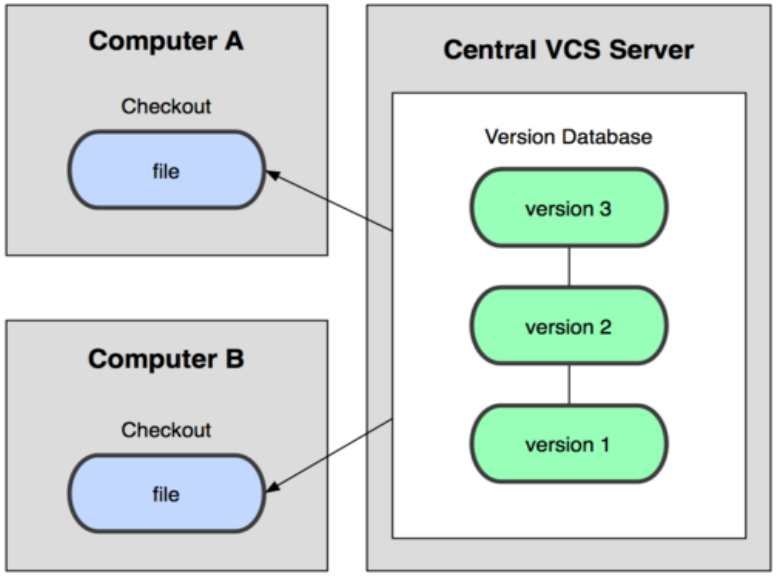
- At command line: *(where verb = config, add, commit, etc.)*
  - `git help verb`

Centralized VCS

- In Subversion, CVS, Perforce, etc.
  A central server repository (repo)
  holds the "official copy" of the code
  - the server maintains the sole
    version history of the repo

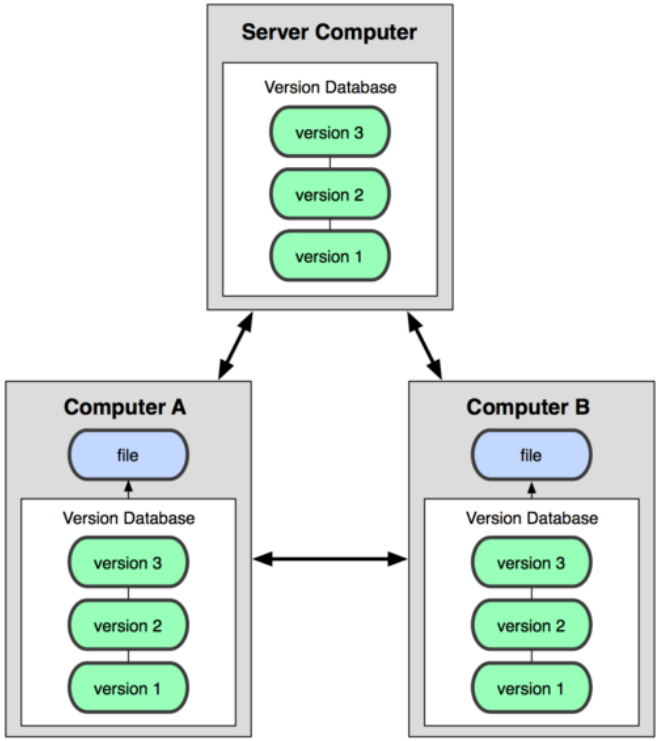
- You make "checkouts" of it
  to your local copy
  - you make local modifications
  - your changes are not versioned

- When you're done, you
  "check in" back to the server
  - your checkin increments the repo's version



Distributed VCS (Git)

- In git, mercurial, etc., you don't "checkout" from a central repo
  - you "clone" it and "pull" changes from it
- Your local repo is a complete copy of everything on the remote server
  - yours is "just as good" as theirs
- Many operations are local:
  - check in/out from *local* repo
  - commit changes to *local* repo
  - local repo keeps version history

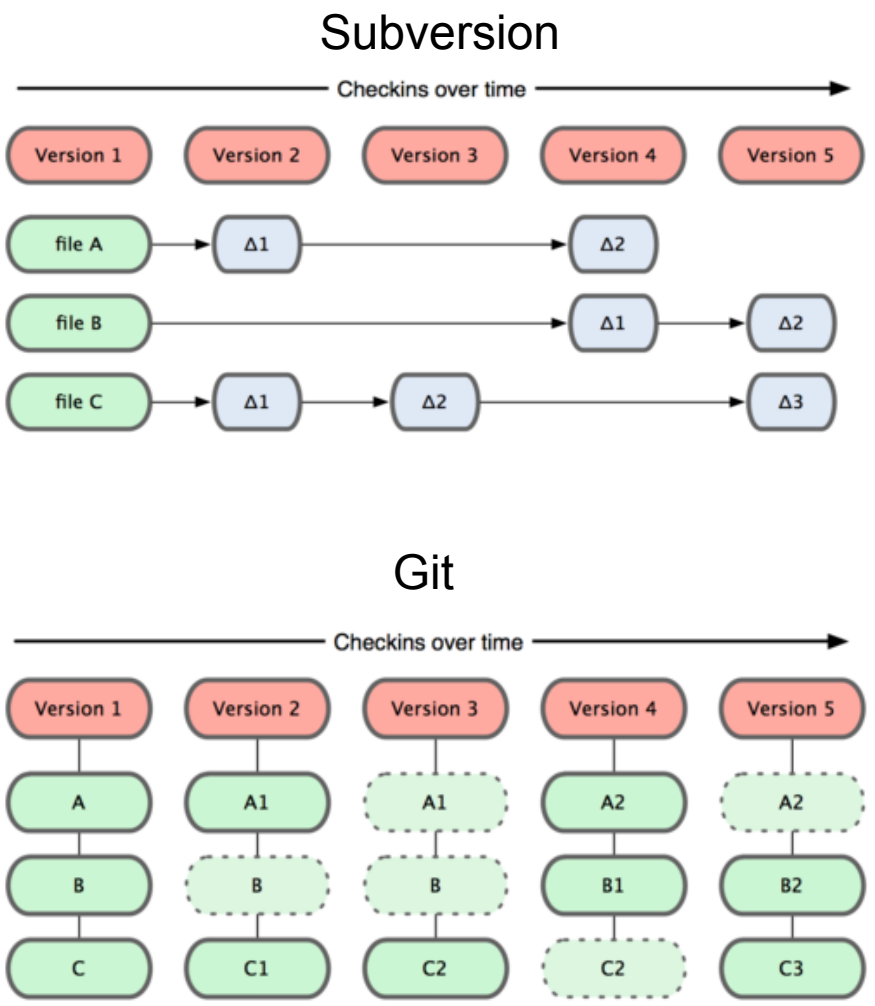


- When you're ready, you can "push" changes back to server

Git snapshots

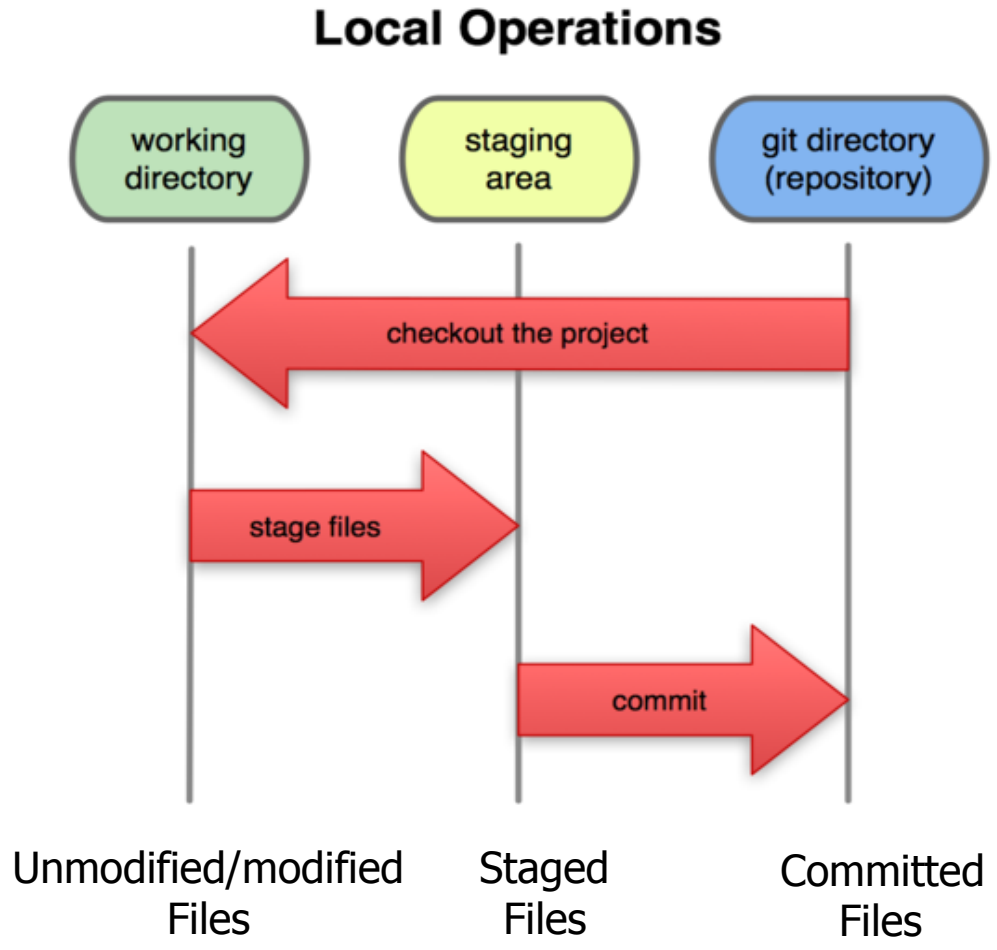
- Centralized VCS like Subversion track version data on each individual file.

- Git keeps "snapshots" of the entire state of the project.
  - Each checkin version of the overall code has a copy of each file in it.
  - Some files change on a given checkin, some do not.
  - More redundancy, but faster.



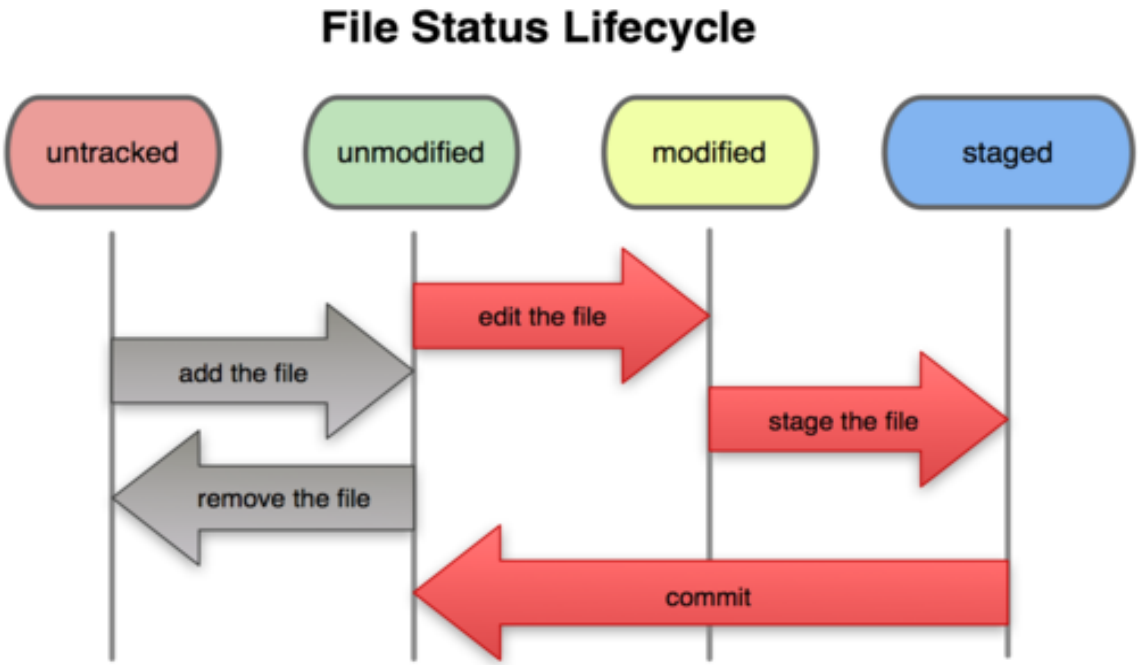
Local git areas

- In your local copy on git, files can be:
  - In your local repo
    - (committed)
  - Checked out and modified, but not yet committed
    - (working copy)
  - Or, in-between, in a **"staging" area**
    - Staged files are ready to be committed.
    - A commit saves a snapshot of all staged state.



Basic Git workflow

- **Modify** files in your working directory.
- **Stage** files, adding snapshots of them to your staging area.
- **Commit**, which takes the files in the staging area and stores that snapshot permanently to your Git directory.



Git commit checksums

- In Subversion each modification to the central repo increments the version # of the overall repo.
  - In Git, each user has their own copy of the repo, and commits changes to their local copy of the repo before pushing to the central server.
  - So Git generates a unique **SHA-1 hash** (40 character string of hex digits) for every commit.
  - Refers to commits by this ID rather than a version number.
  - Often we only see the first 7 characters:
    - `1677b2d Edited first line of readme`
    - `258efa7 Added line to readme`
    - `0e52da7 Initial commit`

Initial Git configuration

- Set the name and email for Git to use when you commit:
  - `git config --global user.name "Bugs Bunny"`
  - `git config --global user.email bugs@gmail.com`
  - You can call `git config -list` to verify these are set.

- Set the editor that is used for writing commit messages:
  - `git config --global core.editor nano`
    - (it is vim by default)

Creating a Git repo

Two common scenarios: (only do one of these)

- To create a new **local Git repo** in your current directory:
  - `git init`
    - This will create a `.git` directory in your current directory.
    - Then you can commit files in that directory into the repo.
  - `git add` *`filename`*
  - `git commit -m "`*`commit message`*`"`

- To **clone a remote repo** to your current directory:
  - `git clone` *`url localDirectoryName`*
    - This will create the given local directory, containing a working copy of the files from the repo, and a `.git` directory (used to hold the staging area and your actual local repo)

Git commands

command	description
`git clone` ***`url [dir]`***	copy a Git repository so you can add to it
`git add` ***`file`***	adds file contents to the staging area
`git commit`	records a snapshot of the staging area
`git status`	view the status of your files in the working directory and staging area
`git diff`	shows diff of what is staged and what is modified but unstaged
`git help` ***`[command]`***	get help info about a particular command
`git pull`	fetch from a remote repo and try to merge into the current branch
`git push`	push your new branches and data to a remote repository
others: `init, reset, branch, checkout, merge, log, tag`	

Add and commit a file

- The first time we ask a file to be tracked, *and every time before we commit a file*, we must add it to the staging area:
  - `git add Hello.java Goodbye.java`
    - Takes a snapshot of these files, adds them to the staging area.
    - In older VCS, "add" means "start tracking this file." In Git, "add" means "add to staging area" so it will be part of the next commit.
- To move staged changes into the repo, we commit:
  - `git commit –m "Fixing bug #22"`
- To undo changes on a file before you have committed it:
  - `git reset HEAD -- filename` (unstages the file)
  - `git checkout -- filename` (undoes your changes)
  - All these commands are acting on your local version of repo.

Viewing/undoing changes

- To view status of files in working directory and staging area:
  - `git status` or `git status -s` (short version)
- To see what is modified but unstaged:
  - `git diff`
- To see a list of staged changes:
  - `git diff --cached`
- To see a log of all changes in your local repo:
  - `git log` or `git log --oneline` (shorter version)

```
1677b2d Edited first line of readme
258efa7 Added line to readme
0e52da7 Initial commit
```

  - `git log -5` (to show only the 5 most recent updates), etc.

An example workflow

```
[rea@attu1 superstar]$ emacs rea.txt
[rea@attu1 superstar]$ git status
  no changes added to commit
  (use "git add" and/or "git commit -a")
[rea@attu1 superstar]$ git status -s
  M rea.txt
[rea@attu1 superstar]$ git diff
  diff --git a/rea.txt b/rea.txt
[rea@attu1 superstar]$ git add rea.txt
[rea@attu1 superstar]$ git status
  #       modified:   rea.txt
[rea@attu1 superstar]$ git diff --cached
  diff --git a/rea.txt b/rea.txt
[rea@attu1 superstar]$ git commit -m "Created new text file"
```

Branching and merging

Git uses branching heavily to switch between multiple tasks.

- To create a new local branch:
  - `git branch` *`name`*
- To list all local branches: (* = current branch)
  - `git branch`
- To switch to a given local branch:
  - `git checkout` *`branchname`*
- To merge changes from a branch into the local master:
  - `git checkout master`
  - `git merge` *`branchname`*

Merge conflicts

- The conflicting file will contain <<< and >>> sections to indicate where Git was unable to resolve a conflict:

```
<<<<<<< HEAD:index.html
<div id="footer">todo: message here</div>
=======
<div id="footer">
  thanks for visiting our site
</div>
>>>>>>> SpecialBranch:index.html
```

branch 1's version

branch 2's version

- Find all such sections, and edit them to the proper state (whichever of the two versions is newer / better / more correct).

Interaction w/ remote repo

- **Push** your local changes to the remote repo.
- **Pull** from remote repo to get most recent changes.
  - (fix conflicts if necessary, add/commit them to your local repo)

- To fetch the most recent updates from the remote repo into your local repo, and put them into your working directory:
  - `git pull origin master`

- To put your changes from your local repo in the remote repo:
  - `git push origin master`

GitHub

- GitHub.com is a site for online storage of Git repositories.
  - You can create a **remote repo** there and push code to it.
  - Many open source projects use it, such as the Linux kernel.
  - You can get free space for open source projects, or you can pay for private projects.
    - Free private repos for educational use: github.com/edu

- *Question:* Do I always have to use GitHub to use Git?
  - *Answer:* No! You can use Git locally for your own purposes.
  - Or you or someone else could set up a server to share files.
  - Or you could share a repo with users on the same file system, as long everyone has the needed file permissions).