Version control

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CSE316: Fundamentals of Software Development

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http://www.cs.stonybrook.edu/~cse316

Never Lose Your Code Again

- Have you ever been working on a project and:
  - your computer died?
  - you made changes to something working and now it's not working?
  - you wanted to combine your work with a teammate's work?
- The solution?
  - Version Control (aka. revision control systems, source control, or source code management)

Software versioning and revision control systems

- Version control (also known as *revision control*, *source control*, and *source code management, VCS - version control system*) is the management of changes to documents, computer programs, large web sites, and other collections of information.
  - A system for **managing changes to files**
  - Used by individuals and teams to keep:
    - History of changes
    - Share and distribute common source code

Software versioning and revision control systems

- Large product development needs some capabilities to control development
  - Track changes to source including: Date changed, version #, developer, comments
  - Ability to 'revert' changes
  - Ability to mark all sources at a specific version to produce a release/distribution

There are many tools out there

CVS

SUBVERSION

git

Microsoft Visual Studio Team Foundation Server

PERFORCE

mercurial

beanstalk
Version control with a human face

Version Control System Services

- Backup and Restore
- Synchronization
- Short-term undo
- Long-term undo
- Track Changes
- Track Ownership
- Sandboxing
- Branching and merging

Backup and Restore

- Files are saved and committed at versioning steps
- One can jump to any moment in time
- Need that file as it was on August 23, 2020?
  - no problem, just ask the VCS for it

Synchronization

- Lets developers:
  - share files
  - stay up-to-date with the latest version
- Even while developers are working simultaneously.

Short-term Undo

- Editing a file and messed it up?
- Throw away your changes and go back to the “last known good” version in the database

Long-term Undo

- For particularly bad mistakes
- Suppose you made a change a year ago, and it had a bug
- Jump back to the old version, and see what change was made that day

Track Changes

- As files are updated, you can leave messages explaining why the change happened
  - stored in the VCS **log**, not the file
  - you can query it
- This makes it easy to see how a file is evolving over time, and why
- Developers should document every change

Track Ownership

- A VCS tags every change with:
  - the name of the person who made it
  - date/time of change
- Helpful for blamestorming

Sandboxing/branching

- Making a big change?
  - You need an insurance against yourself
- You can make temporary changes in an separate isolated area
  - test and work out the kinks before "checking in/merging" your changes to the main branch

Branching and Merging

- A larger sandbox
- You can branch a copy of your code into a separate area and modify it in isolation
  - tracking changes separately
- Later, you can merge your work back into the common area.

Terms

- Repository (repo): The database storing the files.
  - May also mean the Repository Server: The computer storing the repository
- Client: The computer connecting to the repository
- Working Set/Working Copy: Your local directory of files, where you make changes.
- Trunk/Main: The "primary" location for code in the repository

Terms

- Changelog/History: A list of changes made to files since it was created
- Revision: What version a file is on (v1, v2, etc.)
- Head: The latest revision in the repository

VCS Basic Actions

- init: initializes a new repository.
  - If you want to place a project under revision control, this is the first command you need to learn.
- Check out: Download the code from the repository server for the first time

VCS Basic Actions

- Add: Put a file into the repository for the first time, i.e. begin tracking it with Version Control
- Check in: Upload files to the repository (if they have changed).
  - the files get new revision numbers, and people can "check out" the latest one

Basic Actions

- Update/Sync: Synchronize your files with the latest from the repository
  - this lets you grab the latest revisions of all files
- Revert: Throw away your local changes and reload the latest version from the repository

Advanced Actions

- Branch: Create a separate copy of a file/folder for private use (bug fixing, testing, etc)
  - Branch is both a verb (”branch the code”) and a noun (”Which branch is it in?”)
- Diff/Change/Delta: Finding the differences between two files
  - useful for seeing what changed between revisions.

Advanced Actions

- Merge (or patch): Apply the changes from one file to another, to bring it up-to-date
  - For example, you can merge features from one branch into another
- Conflict: When pending changes to a file contradict each other
  - both changes cannot be applied
- Resolve: Fixing the changes that contradict each other and checking in the correct version

Advanced Actions

- Locking: "Taking control" of a file so nobody else can edit it until you unlock it.
  - some VCSs use this to avoid conflicts.
- Breaking the lock: Forcibly unlocking a file so you can edit it.
  - may be needed if someone locks a file and leaves
- Check out for edit: Checking out an "editable" version of a file
  - some VCSes have editable files by default, others require an explicit command.

Types of VCSs

- Major models used in various products
  - Centralized server based version control
    - File Locking
    - Version merging
  - Distributed Vesion Control
    - When you check out the code from a repository, you create a local repository
      - Allows many developers to work on a given project without requiring that they maintain a connection to a common network.

VCSs

- Revision Control System (RCS)
  - dead as a stand-alone system
- Concurrent Versioning System (CVS)
  - dying
- Subversion (SVN)
  - killing CVS
  - open source under the Apache license
  - http://subversion.apache.org
- Distributed/decentralized revision control:
  - Git
  - Mercurial
- GNU Bazaar
- BitKeeper

Apache Subversion (SVN)

- Developed by the Apache Software Foundation
- Distributed under Apache License (an open source license)
- Used by:
  - Apache Software Foundation
  - FreeBSD
  - GCC
  - Mono
  - SourceForge
- Server-client model: Native SVN server or Apache HTTP Server.

SVN Common operations

- Import: is the act of copying a local directory tree (that is not currently a working copy) into the repository for the first time.
- Checkout: is to create a local working copy from the repository. A user may specify a specific revision or obtain the latest.
- Commit (check in or ci): is to write or merge the changes made in the working copy back to the repository.
- Update (or sync): merges changes made in the repository (by other people or by the same person on another machine) into the local working copy.
- Merge: is an operation in which two sets of changes are applied to a file or set of files: updates or syncs the user working copy with changes made and checked into the repository by other users + check in files + incorporate branches into a unified trunk.

Apache Subversion

- How to run SVN?
  - Command line: `svn` executable

    ```
    svn commit a.txt
    svn update
    ```
  - SVN Clients: TortoiseSVN, Netbeans SVN plugin, Eclipse Subclipse, etc.

Distributed Version Control

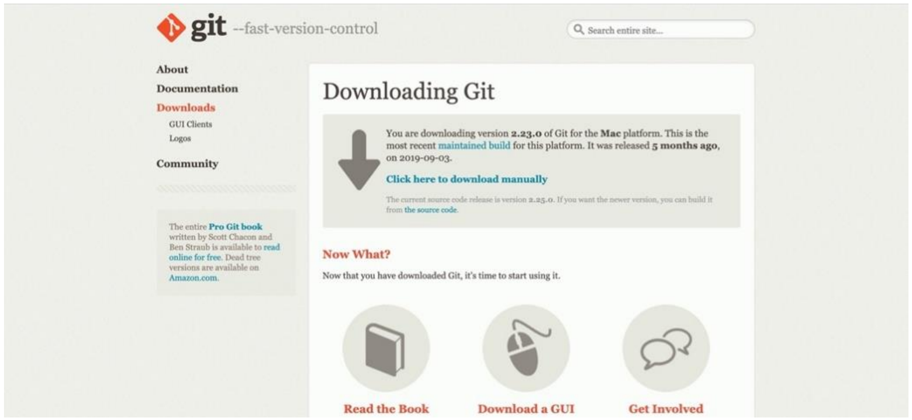
- There are multiple copies of the repository
  - Not one 'cannonical' reference copy of the repository
  - Multiple repos are each a 'working copy' on some peer system
  - Advantages
    - Common Operations (commit, view history, revert changes, etc) are fast since they happen on a local 'owned' repo.
    - Each peer repo acts as a 'remote backup' of other repos (protects against data loss)
  - Drawbacks
    - Comples merge operations (usually can be entirely automated)
    - Merges with conflicts must be resolved by hand

git

- Git:
  - Distributed (Decentralized) Version Control System
    - Has a local repository but can also 'push' the repo to a remote server.
    - Each developer works on their own copy of the repository
    - Can continue to work even if offline
  - GNU license
  - Released in 2005 (original author Linus Torvalds - also created Linux)
  - Used by Linux kernel
  - Free download: http://git-scm.com
  - Clients: http://www.sourcetreeapp.com, https://desktop.github.com, http://www.syntevo.com/smartgit, https://www.gitkraken.com (Linux), https://git-fork.com (Mac OsX, Windows)
  - Repositorie servers: https://github.com, https://bitbucket.org (private repos., Multi-factor authentication), GitLab

Installing Git

- Navigate to: http://git-scm.com/download/



The entire **Pro Git book** written by Scott Chacon and Ben Straub is available to read online for free. Dead tree versions are available on Amazon.com.

Downloading Git

You are downloading version **2.23.0** of Git for the **Mac** platform. This is the most recent maintained build for this platform. It was released **5 months ago**, on 2019-09-03.

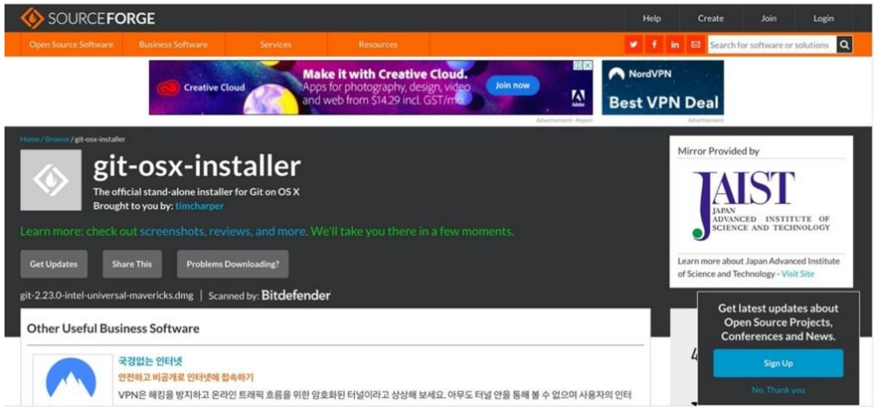
Click here to download manually

The current source code release is version **2.25.0**. If you want the newer version, you can build it from the source code.

Now What?

Now that you have downloaded Git, it's time to start using it.

- Click the link 'Click here to download manually'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git-osx-installer

The official stand-alone installer for Git on OS X
Brought to you by: timcharper

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git-2.23.0-intel-universal-mavericks.dmg | Scanned by: Bitdefender

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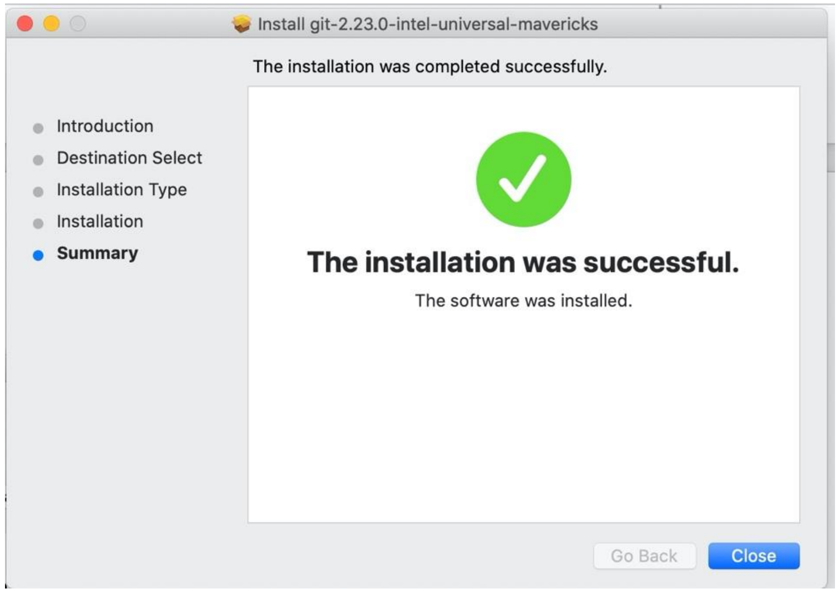
Installing Git on Mac OSX

- Double click on the package (.exe, .pkg) file


Install git-2.23.0-intel-universal-mavericks

The installation was completed successfully.

- Introduction
- Destination Select
- Installation Type
- Installation
- **Summary**

The installation was successful.

The software was installed.

Installing Git on Mac OSX

- Set name and email in global config

  git config --global user.name 'John Public'

  git config --global user.email 'john.q.public@mymail.com'

- Verify settings are correct

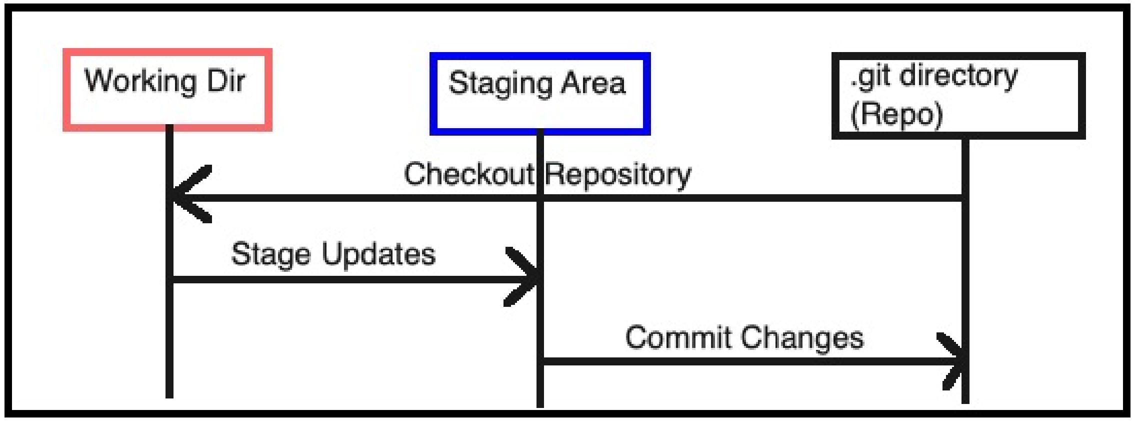
  git config –global –l

git Common operations

- Setting Up a Git Repository:
  - git init: initializes a new Git repository.
    - If you want to place a project under revision control, this is the first command you need to learn.
  - git clone ?location: creates a copy of an existing Git repository.
    - Cloning is the most common way for developers to obtain a working copy of a central repository.
    - Example: git clone git://git.kernel.org/pub/scm/linux/kernel/git/torvalds/
  - git add ?file: moves changes from the working directory to the staging area.
  - git commit: takes the staged snapshot and commits it to the project history.
  - git pull: downloads a branch from a remote repository, then immediately merges it into the current branch.
  - git push: move a local branch to another repository.

Architecture

- Three areas:
  - Working area
  - Staging Area
  - Repository



Workflow

- Typical workflow
  - Pull updates from remote repository
  - Edit files
  - Add files to staging area (git add)
  - Commit changes to local repo.
  - Push committed changes to remote repository
- If you create a branch:
  - Merge branch back to master
  - Delete branch (optional)
  - Push changes

git status

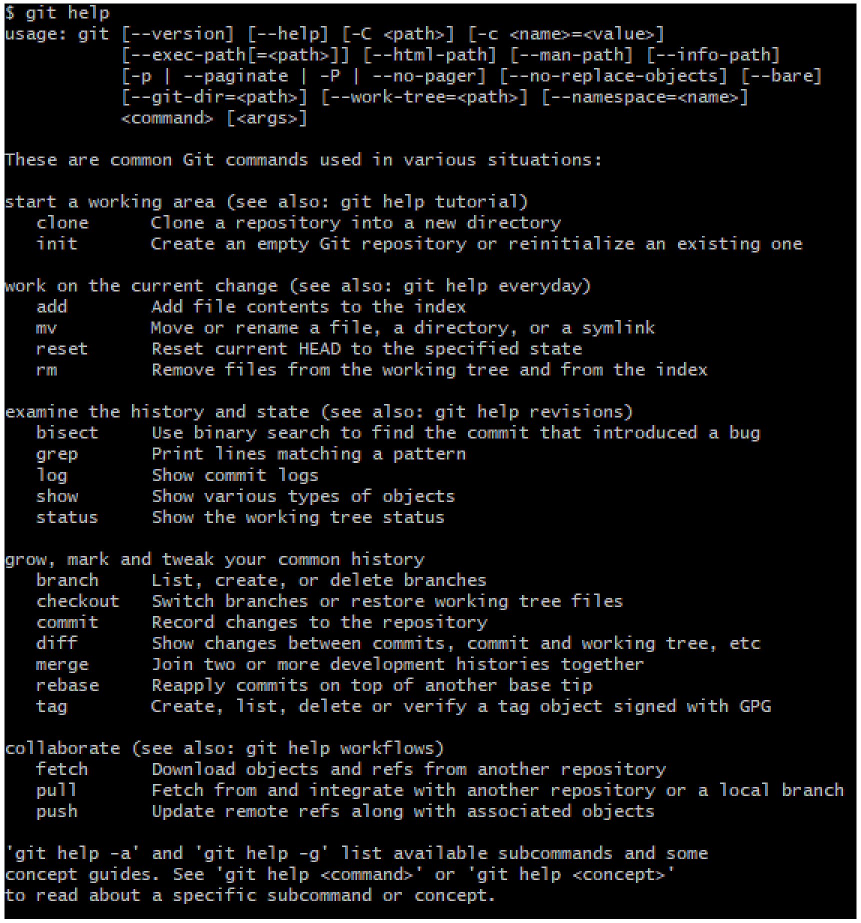
- This command will show status of a repo
  - Changes files
  - Untracked files

ToDo: try to use GitHub

- Owned by Microsoft
- Make an account
- Download Git
  - https://git-scm.com/downloads
- We'll use GitBash

The GitBash Command Line

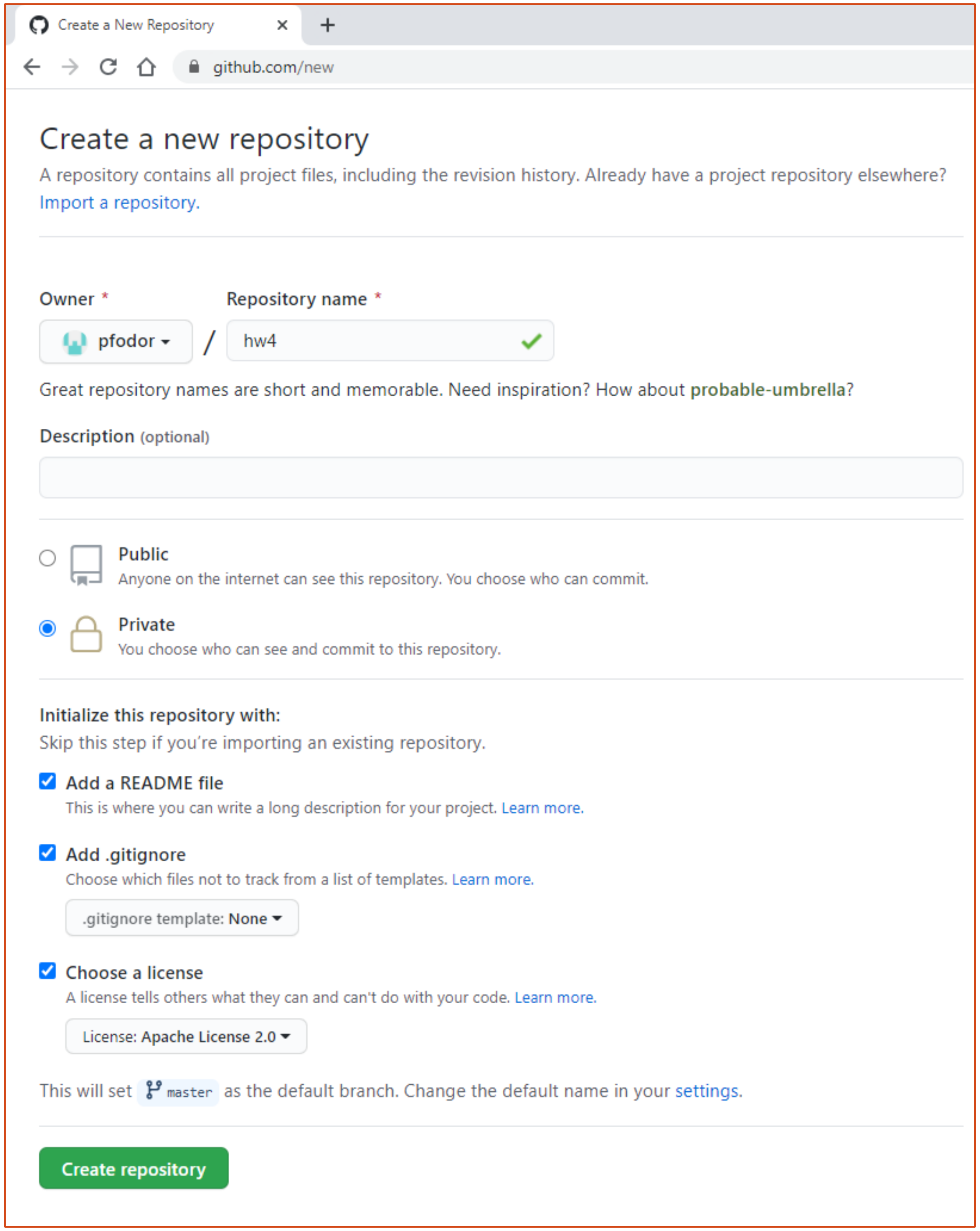
- Try these things:
  - pwd
  - ls
  - ls -l
  - mkdir hw4
  - cd hw4



```
$ git help
usage: git [--version] [--help] [-C <path>] [-c <name>=<value>]
           [--exec-path[=<path>]] [--html-path] [--man-path] [--info-path]
           [-p | --paginate | -P | --no-pager] [--no-replace-objects] [--bare]
           [--git-dir=<path>] [--work-tree=<path>] [--namespace=<name>]
           <command> [<args>]

These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
   clone      Clone a repository into a new directory
   init       Create an empty Git repository or reinitialize an existing one

work on the current change (see also: git help everyday)
   add        Add file contents to the index
   mv         Move or rename a file, a directory, or a symlink
   reset      Reset current HEAD to the specified state
   rm         Remove files from the working tree and from the index

examine the history and state (see also: git help revisions)
   bisect     Use binary search to find the commit that introduced a bug
   grep       Print lines matching a pattern
   log        Show commit logs
   show       Show various types of objects
   status     Show the working tree status

grow, mark and tweak your common history
   branch     List, create, or delete branches
   checkout   Switch branches or restore working tree files
   commit     Record changes to the repository
   diff       Show changes between commits, commit and working tree, etc
   merge      Join two or more development histories together
   rebase     Reapply commits on top of another base tip
   tag        Create, list, delete or verify a tag object signed with GPG

collaborate (see also: git help workflows)
   fetch      Download objects and refs from another repository
   pull       Fetch from and integrate with another repository or a local branch
   push       Update remote refs along with associated objects

'git help -a' and 'git help -g' list available subcommands and some
concept guides. See 'git help <command>' or 'git help <concept>'
to read about a specific subcommand or concept.
```

git init

- Creates a local git repository
- Puts empty repo in .git
- Don’t ever touch anything in .git



Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? Import a repository.

Owner * pfodor / Repository name * hw4

Great repository names are short and memorable. Need inspiration? How about probable-umbrella?

Description (optional)

Public
Anyone on the internet can see this repository. You choose who can commit.

[✓ Private]
You choose who can see and commit to this repository.

Initialize this repository with:
Skip this step if you're importing an existing repository.

[✓] Add a README file
This is where you can write a long description for your project. Learn more.

[✓] Add .gitignore
Choose which files not to track from a list of templates. Learn more.

.gitignore template: None

[✓] Choose a license
A license tells others what they can and can't do with your code. Learn more.

License: Apache License 2.0

This will set `master` as the default branch. Change the default name in your settings.

Once your Online Repo is Created

- Make sure you are logged into GitHub (like in Chrome)
- Connect your local repo to your remote one:

```
git remote add origin https://github.com/pfodor/hw4
```

- remote add – tells git to specify the remote repository
  - origin – name you are giving to the remote repository
  - Now your local repo can push and pull to and from your GitHub repo

First, pull

- You will want all the files in the repository

git pull origin master

- master? What's that?
  - a branch
- What's the branch?
  - i.e. a version
  - a repo can have multiple branches

Add any new files

- Easiest way, just add everything

```
git add .
```

- Adds files to the repo
- Their changes can now be tracked
- Some files you don't want in your repo
  - .gitignore

Commit Changes

```
git commit -m "this is my first commit"
```

- Don’t forget the comments

Push your changes to the remote repo

git push origin master

- If you are working alone, no problem
- If not, be careful, you may have to pull others' changes first

Merge & Revert

- merge – approve all changes in VSC
- revert – to previous version or date

Summary

- Git is one of the most popular source control systems
- It is a distributed system rather than a centralized source control system
- Git contains a working directory, staging area, and repository to help manage committing changes in a very controlled manner