Version Control

IMPROVING REPRODUCIBILITY IN DATA SCIENCE

The Meaning of Reproducibility

Project structure

- Clear organization of analytic components

Version control

- **Controlled tracking of changes over time**
- **Ability to update & iterate while maintaining functioning code**

Coding standards

- Commenting
- Simplification
- Modularity

Documentation

- Providing context to code, both within code (e.g., commenting) and via external documents (e.g., README.md)

Virtual environments

- Enables reproducibility across multiple machines post-distribution

Code testing

- Small, modular testing of segments of code combined w/ large testing upon modification

The Importance of Version Control

Prevents programmer from losing track of what’s what

- Multiple versions of code
- Multiple “final” versions of code

Enables updates without breaking functioning code

- Enables reversion to older iterations, just in case

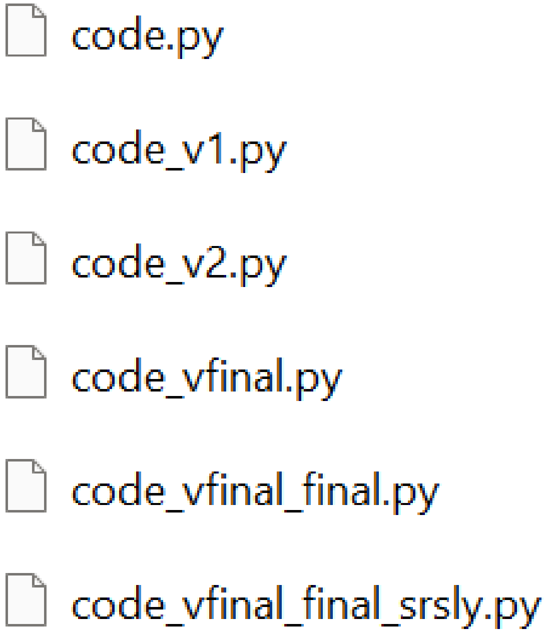
Documents the history of changes made for tracking purposes

Significantly improves collaboration amongst teams writing programs

- Though the workflow can be difficult to pick up

Enables simpler & more effective dissemination

- Point people to your GitHub to share code



code.py

code_v1.py

code_v2.py

code_vfinal.py

code_vfinal_final.py

code_vfinal_final_srsly.py

Introduction to Git

Most widely-used version control system

- Completely open-source system developed by Linus Torvalds (who also created Linux) in 2005

What does Git do?

- Manage coding projects using repositories
- Controls & tracks changing w/ staging & committing
- **Enables code revision & updates w/o the risk of breaking code by branching & merging**
- Provides a local working copy via cloning (not like working on a Google doc, for example)

Sources: https://git-scm.com/, https://www.w3schools.com/git/git_intro.asp?remote=github

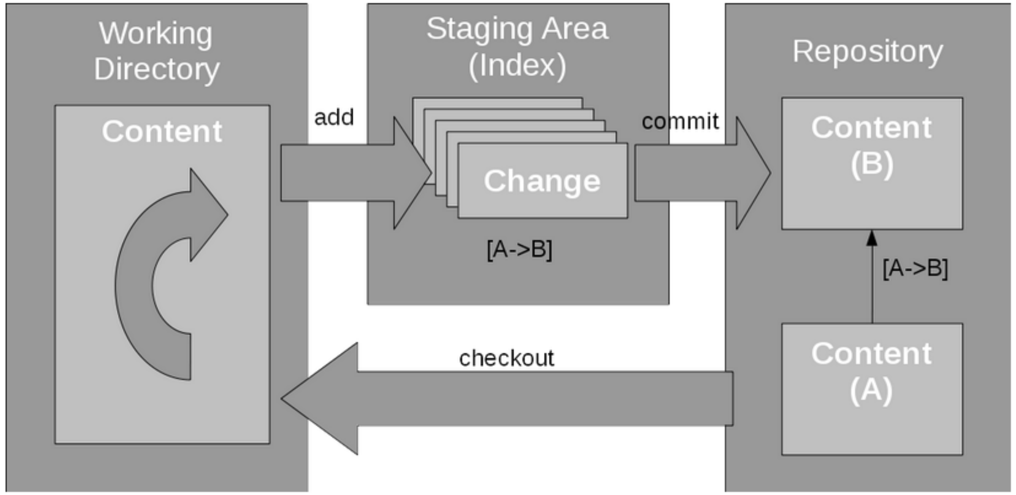
…but how does Git work?

Three primary components:

- **Working directory** – Where changes are made
- **Staging area** – Where changes are indexed (accounted for) & prepared for application
- **Repository** – Where changes are applied

It's all hidden in the .git directory…

- objects/ stores snapshot ("commit") metadata
- refs/ points to commits
- /index stores pointers to commits (e.g., branches)
- /HEAD points to current branch

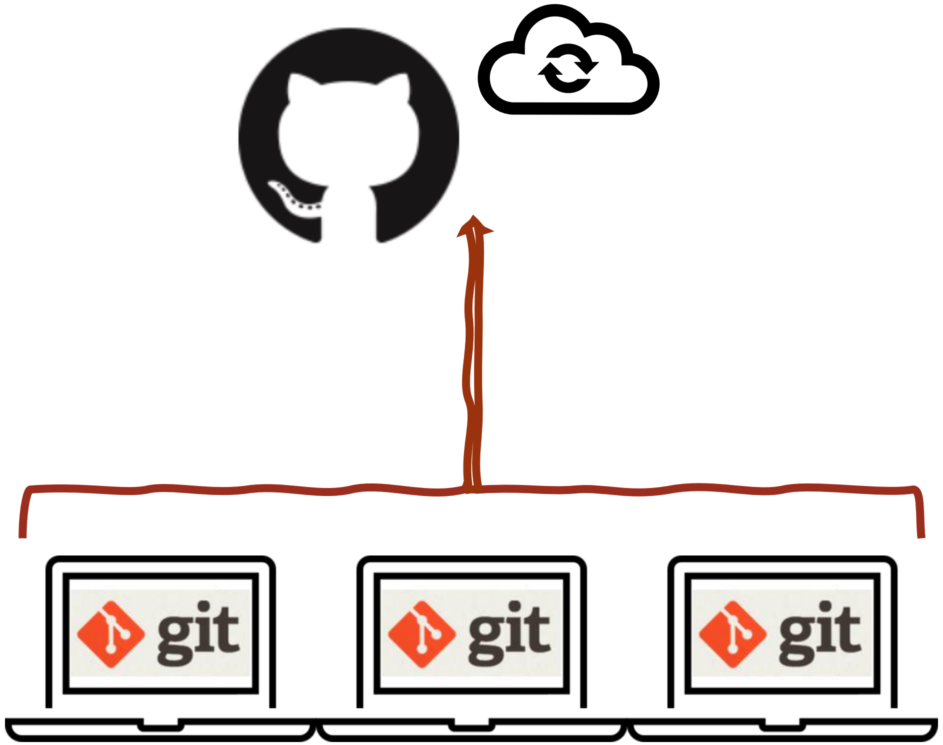


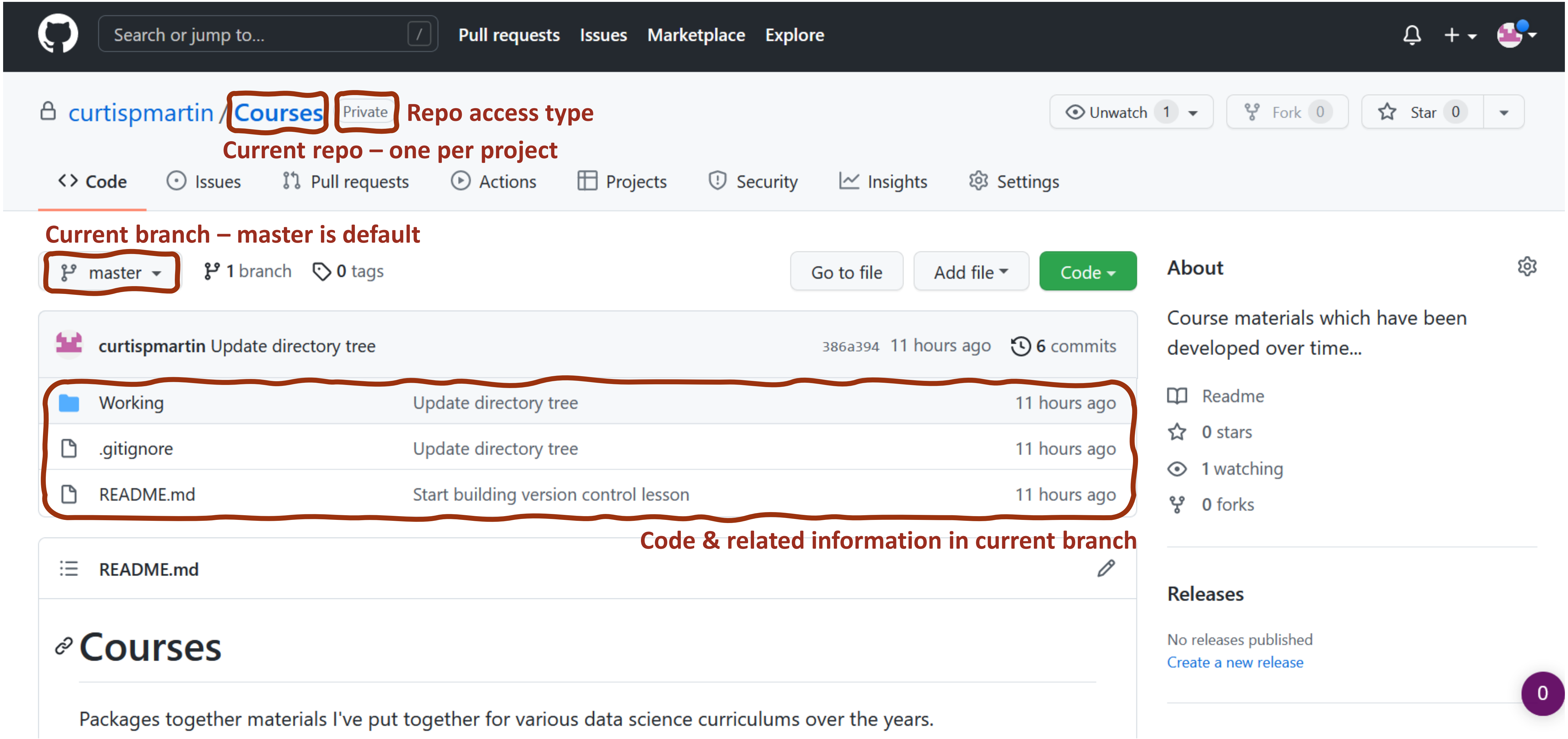
Sources: https://developer.ibm.com/tutorials/d-learn-workings-git/

Git or GitHub?

GitHub is a centralized, online hub for hosting & managing projects using Git

- In a sense, provides a visual representation of what Git does, which enables simpler hosting, collaborating, & sharing





Repo access type

Current repo – one per project

Current branch – master is default

curtispmartin Update directory tree 386a394 11 hours ago 6 commits

Working	Update directory tree	11 hours ago
.gitignore	Update directory tree	11 hours ago
README.md	Start building version control lesson	11 hours ago

Code & related information in current branch

README.md

Courses

Packages together materials I've put together for various data science curriculums over the years.

About

Course materials which have been developed over time...

- Readme
- 0 stars
- 1 watching
- 0 forks

Releases

No releases published

Create a new release

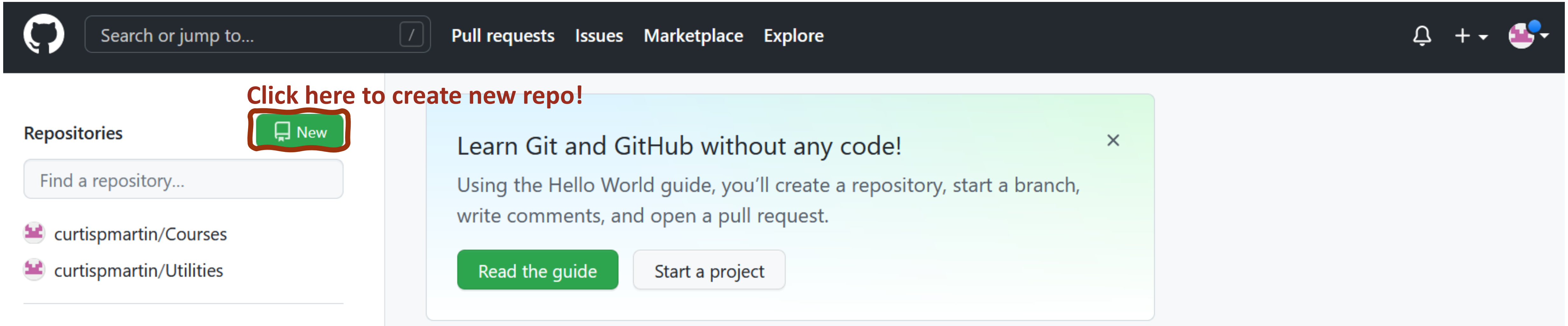
Setting up Git/Hub

First things first: Download necessary software & create accounts

- Git: Download Git for Windows here; download Git for Mac here?
- GitHub: Create an account here

Create your first repo on GitHub

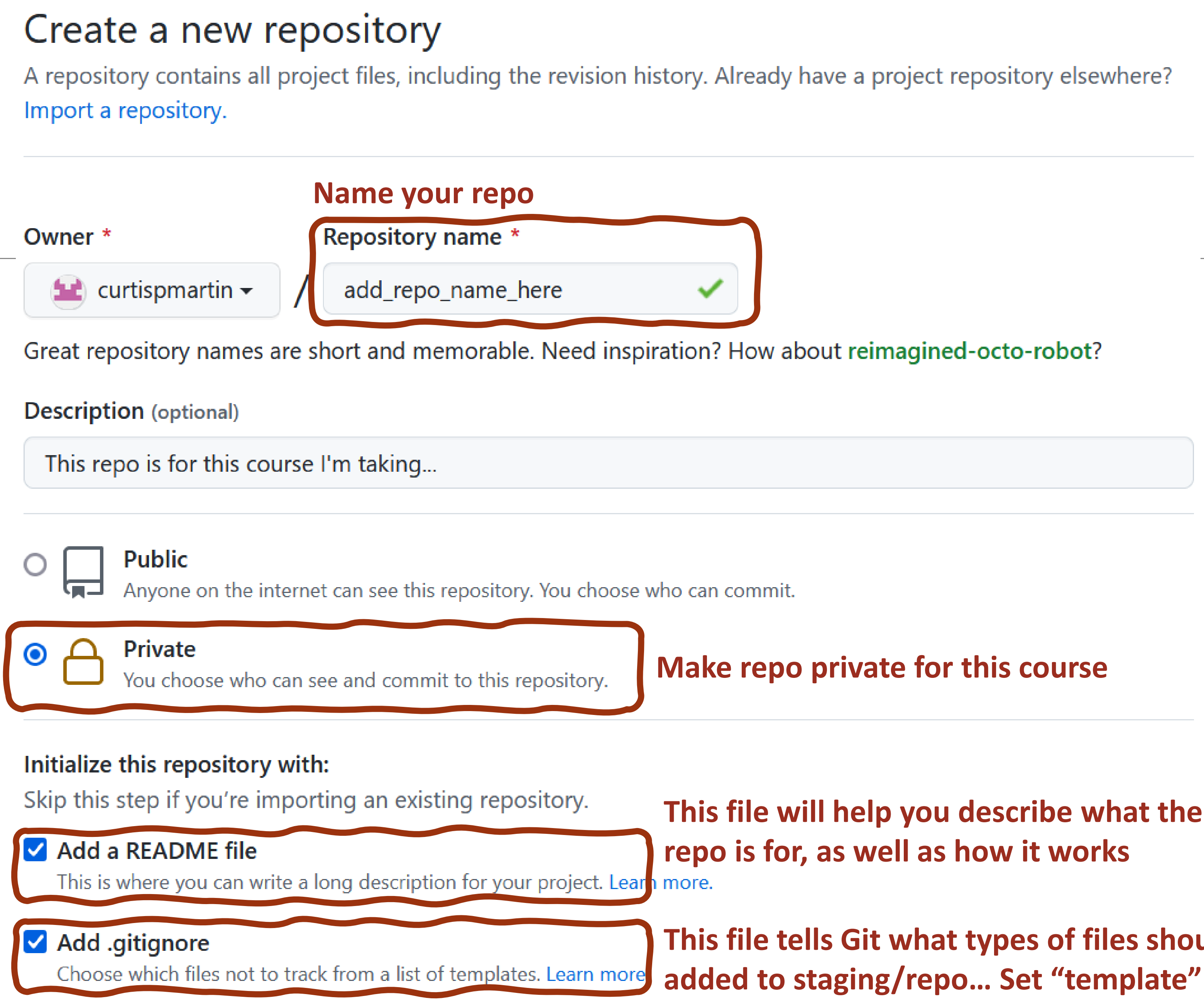
- Call it "XXX XXX"



Click here to create new repo!

Learn Git and GitHub without any code!

Using the Hello World guide, you'll create a repository, start a branch, write comments, and open a pull request.



Create a new repository

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

Name your repo

Owner * curtispmartin / Repository name * add_repo_name_here ✓

Great repository names are short and memorable. Need inspiration? How about reimagined-octo-robot?

Description (optional)

This repo is for this course I'm taking...

○ **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.

Make repo private for this course

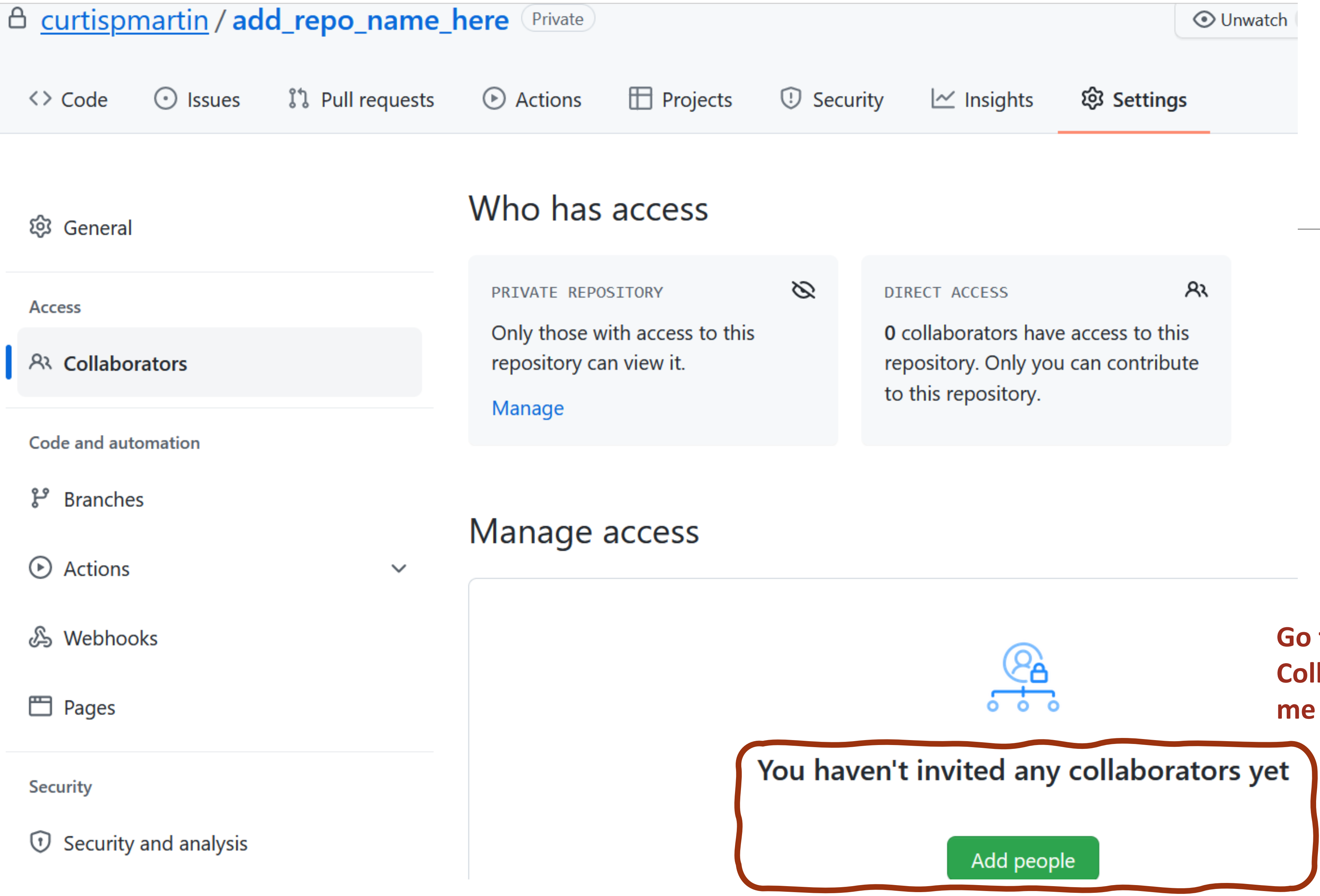
Initialize this repository with:
Skip this step if you're importing an existing repository.

☑ **Add a README file**
This is where you can write a long description for your project. Learn more.

This file will help you describe what the repo is for, as well as how it works

☑ **Add .gitignore**
Choose which files not to track from a list of templates. Learn more

This file tells Git what types of files should not be added to staging/repo… Set "template" to Python



Who has access

PRIVATE REPOSITORY

Only those with access to this repository can view it.

DIRECT ACCESS

0 collaborators have access to this repository. Only you can contribute to this repository.

Manage access

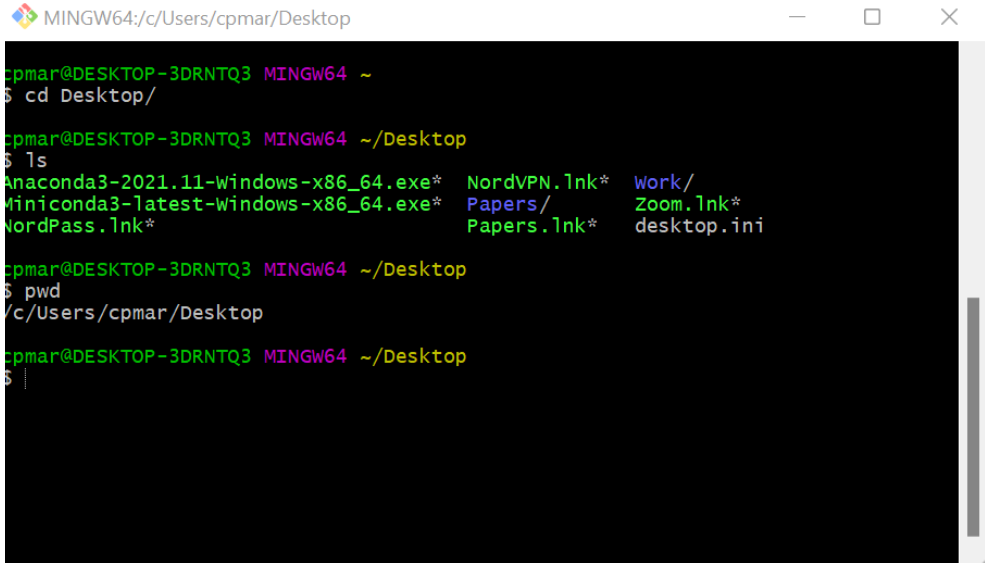
You haven't invited any collaborators yet

Go to Settings --> Collaborators & add me as a Collaborator

Setting up Git/Hub

Navigate to your Git bash… A few important commands are needed!

- **ls** – List what’s in your current working directory (“CWD”)
- **cd** <filepath> – Change CWD to that specified by filepath
- **mkdir** <newdirectory> – Make new directory (folder) in CWD
- pwd – Print path to CWD
- mv <filename> <newfilepath> – Move file in CWD to new location
- cp <filename> <newfilepath> – Copy file in CWD to new location
- cat <filename> – Print out file contents in bash
- touch <filename> – Create empty file w/ file name in CWD



```
cpmar@DESKTOP-3DRNTQ3 MINGW64 ~
$ cd Desktop/

cpmar@DESKTOP-3DRNTQ3 MINGW64 ~/Desktop
$ ls
Anaconda3-2021.11-Windows-x86_64.exe*  NordVPN.lnk*  Work/
Miniconda3-latest-Windows-x86_64.exe*  Papers/       Zoom.lnk*
NordPass.lnk*                          Papers.lnk*   desktop.ini

cpmar@DESKTOP-3DRNTQ3 MINGW64 ~/Desktop
$ pwd
/c/Users/cpmar/Desktop

cpmar@DESKTOP-3DRNTQ3 MINGW64 ~/Desktop
$
```

You can find more commands here

Note: In this course, angle brackets (<>) indicate user input required

Connect Git to GitHub

Must authenticate Git client w/ your GitHub

- SSH (recommended) – [More on SSH here]
- HTTPS

Step 1: Create SSH key using Git bash

- `ssh-keygen -t ed25519 -C <your_email_address>`
- Accept default location for key
- Enter & re-enter key passphrase for enhanced security

Step 2: Add SSH key to ssh-agent

- `eval $(ssh-agent -s)`
- `ssh-add ~/.ssh/id_ed25519`

Step 3: Add SSH key to Github account

- `clip < ~/.ssh/id_ed25519.pub`
- Log into Github
- Go to settings > SSH and GPG keys
- Click New SSH key
- Paste into "Key" text box
- Add "Title" (name of computer you're using)
- Click "Add SSH key"

Note: In general, backticks (`) indicate commands or lines of code

Cloning your Git Repo

Last thing before we start using Git: You need to clone your repo onto your computer

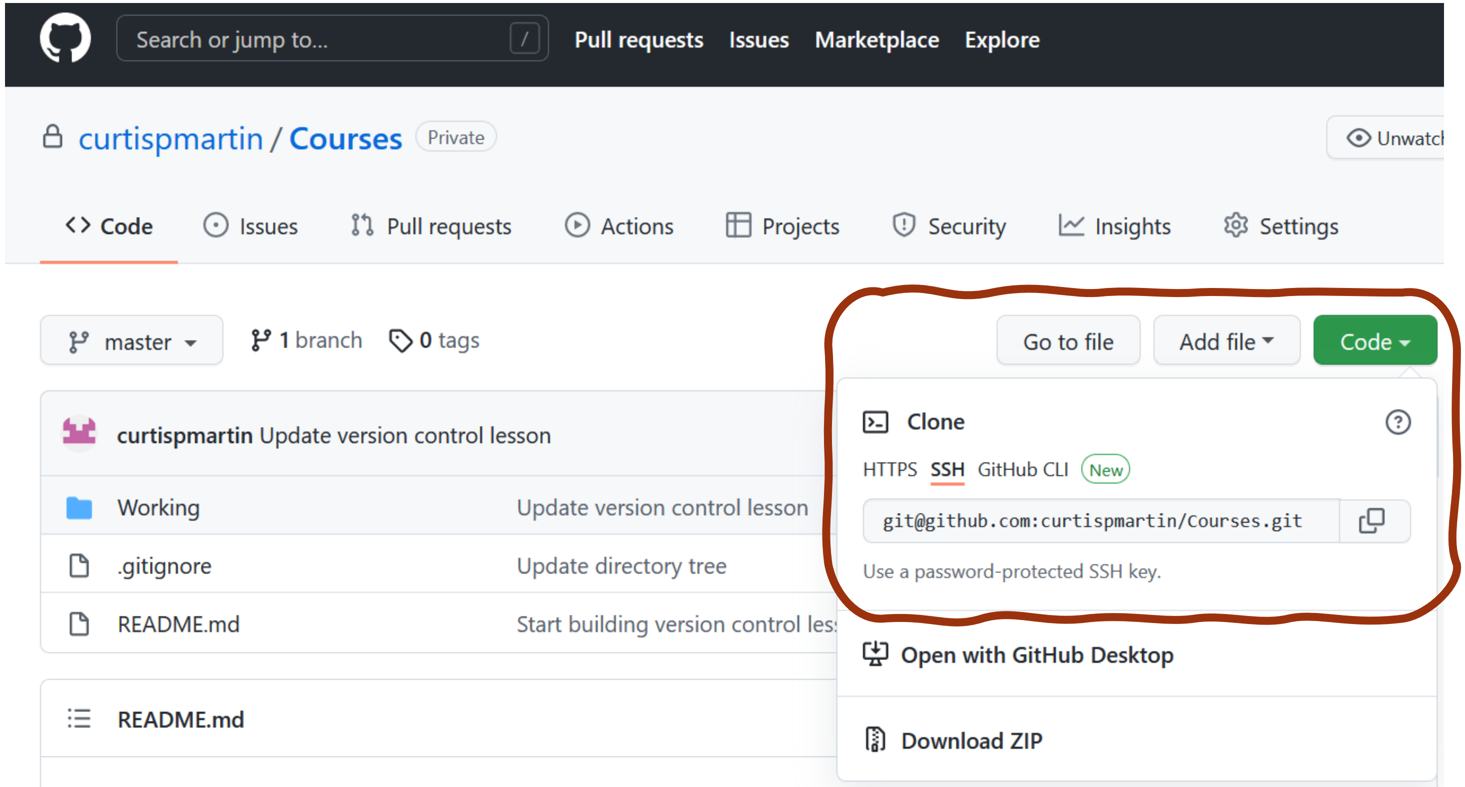
- Makes a local copy of your repo so you can write/update/manage code

Step 1: Copy SSH link

- In repo, go to Code > SSH

Step 2: Clone to location of choice

- `cd <path_to_location>`
- `git clone <SSH link>`



curtispmartin Update version control lesson

Working	Update version control lesson
.gitignore	Update directory tree
README.md	Start building version control les

README.md

Clone

HTTPS SSH GitHub CLI New

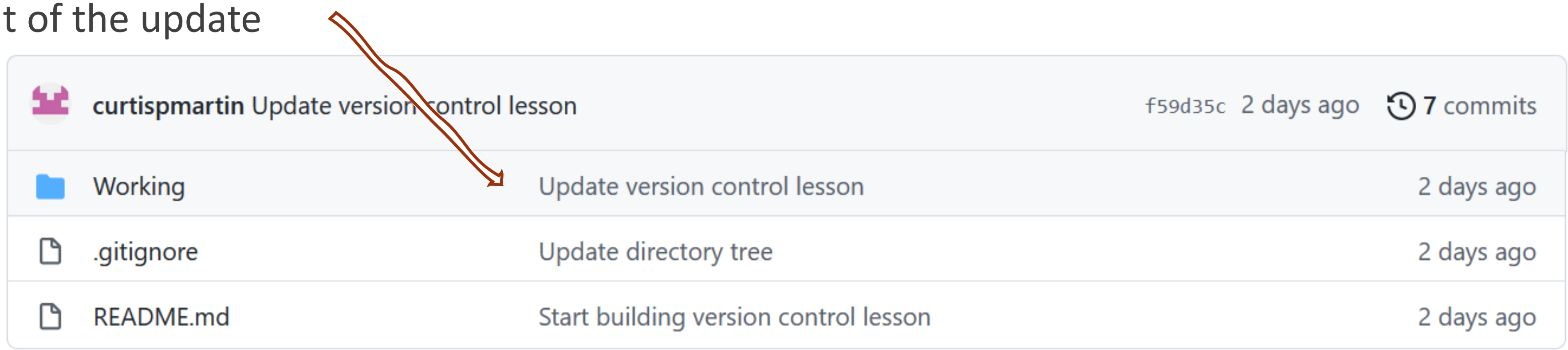
```
git@github.com:curtispmartin/Courses.git
```

Use a password-protected SSH key.

Git: Basic Workflow

Five basic commands to start:

- `git **status**` – Gives you a status report for each file
- `git **add** <filename>` – Adds file to staging… use `*` to add all files
- `git **commit** -m <message>` – Commits changes in staging area; message should briefly summarize the point of the update



curtispmartin Update version control lesson f59d35c 2 days ago **7** commits

Working	Update version control lesson	2 days ago
.gitignore	Update directory tree	2 days ago
README.md	Start building version control lesson	2 days ago

- `git **push**` – Send commit to repo
- `git **pull**` – Pull most recent commit from repo (only necessary for collaborative work)

Git: Branching

What is a branch?

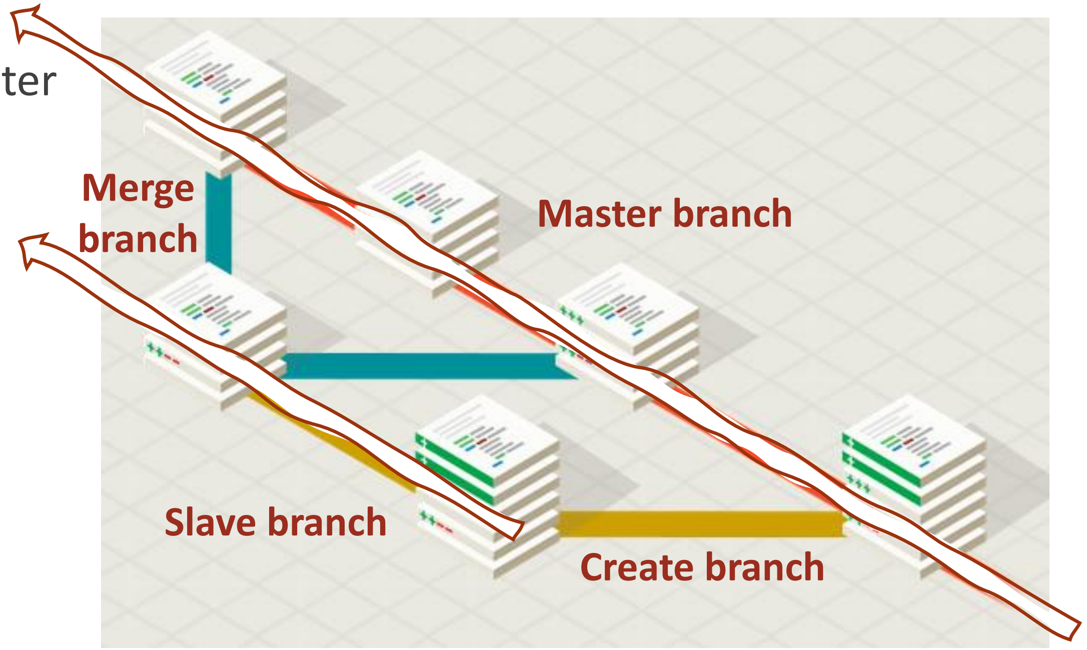
- Branches are essentially tracked copies of the master
- Modifications in a branch aren't incorporated into the master until explicitly merged

Why branching?

- Allows you to modify code w/o the risk of breaking it
- Simplifies (kinda) collaboration on projects

When to create a branch?

- Developing a new feature
- Making significant updates to current code



Merge branch

Master branch

Slave branch

Create branch

Sources: https://git-scm.com/book/en/v2/Git-Branching-Basic-Branching-and-Merging

Git: Branching

Step 1: Create the branch

- Create new branch: `git **checkout** -b <branchname>`
- Push branch to repo: `git push **origin** -u <branchname>`

Step 2: Do work in branch

- Switch to branch: `git checkout <branchname>`
- Make your updates; add, commit, push to repo as if nothing has changed

Step 3: Merge branch

- Once feature/update is complete, checkout master: `git checkout master`
- Then merge branch w/ master: `git **merge** <branchname>`
- Delete branch using: `git branch -d <branchname>`
- Push deletion to repo: `git push origin –d <branchname>`

Sources: https://git-scm.com/book/en/v2/Git-Branching-Basic-Branching-and-Merging

Preparing for Success

Directory structure

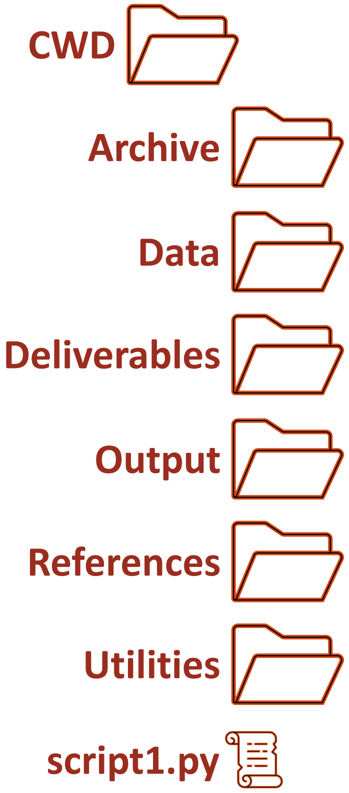
- Create a system for organizing code & related files
- Stick to it (but don't be afraid to adapt)!
- Highly dependent on the type of work you do

Internal documentation

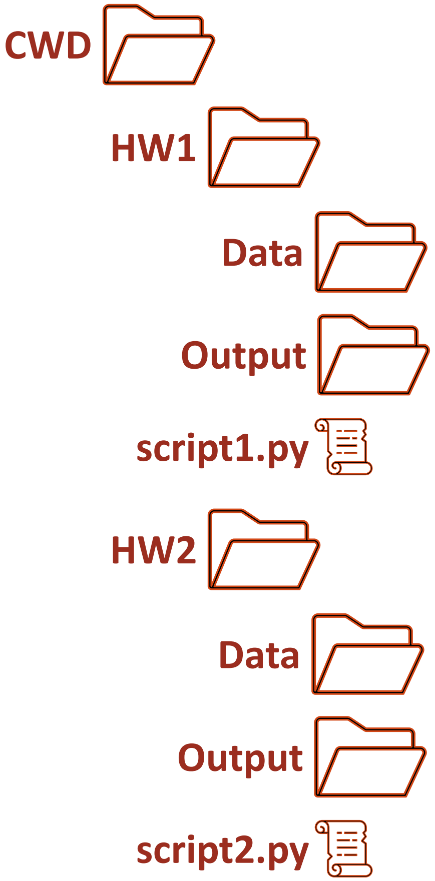
- Header detailing what the code does, inputs/outputs (I/O), etc.
- Comments describing what blocks of code do

External documentation

- **"README.md" in Git repo – What is intent? How do files relate?**
- User manual – Not relevant here, but could be in future



CWD
Archive
Data
Deliverables
Output
References
Utilities
script1.py



CWD
HW1
Data
Output
script1.py
HW2
Data
Output
script2.py

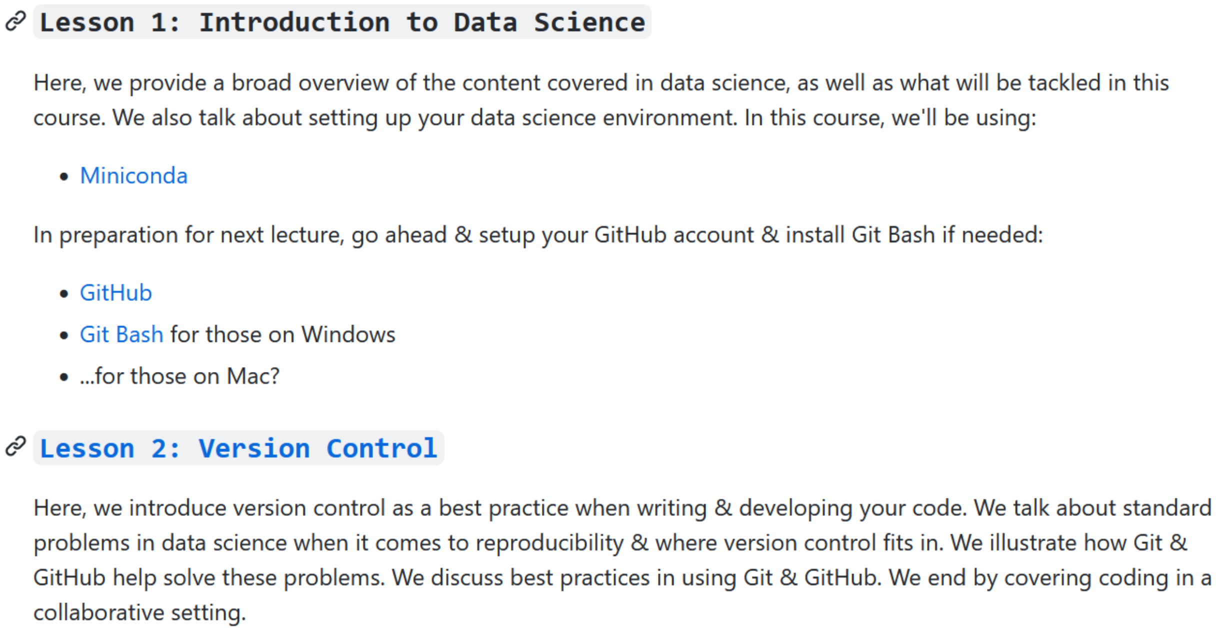
“README.md”

README files are found at top level of repo and inside each analysis folder

- Markdown is used to create documentation

The simple things

- Title headers are created at three levels using # (largest), ## (second largest), & ### (smallest)
- Text not preceded by # will become body text
- Asterisks or dashes to create bulleted lists
- Inline code: `this will show up as code`



`Lesson 1: Introduction to Data Science`

Here, we provide a broad overview of the content covered in data science, as well as what will be tackled in this course. We also talk about setting up your data science environment. In this course, we'll be using:

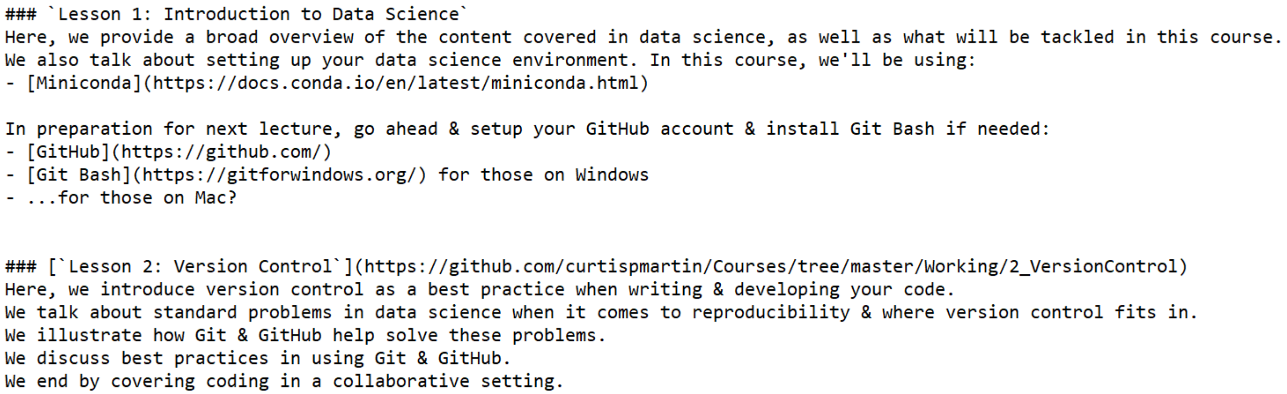
- Miniconda

In preparation for next lecture, go ahead & setup your GitHub account & install Git Bash if needed:

- GitHub
- Git Bash for those on Windows
- ...for those on Mac?

`Lesson 2: Version Control`

Here, we introduce version control as a best practice when writing & developing your code. We talk about standard problems in data science when it comes to reproducibility & where version control fits in. We illustrate how Git & GitHub help solve these problems. We discuss best practices in using Git & GitHub. We end by covering coding in a collaborative setting.



```
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- [Miniconda](https://docs.conda.io/en/latest/miniconda.html)

In preparation for next lecture, go ahead & setup your GitHub account & install Git Bash if needed:
- [GitHub](https://github.com/)
- [Git Bash](https://gitforwindows.org/) for those on Windows
- ...for those on Mac?

### [`Lesson 2: Version Control`](https://github.com/curtispmartin/Courses/tree/master/Working/2_VersionControl)
Here, we introduce version control as a best practice when writing & developing your code.
We talk about standard problems in data science when it comes to reproducibility & where version control fits in.
We illustrate how Git & GitHub help solve these problems.
We discuss best practices in using Git & GitHub.
We end by covering coding in a collaborative setting.
```

“.gitignore”

“.gitignore” file is how you tell repo what not to track

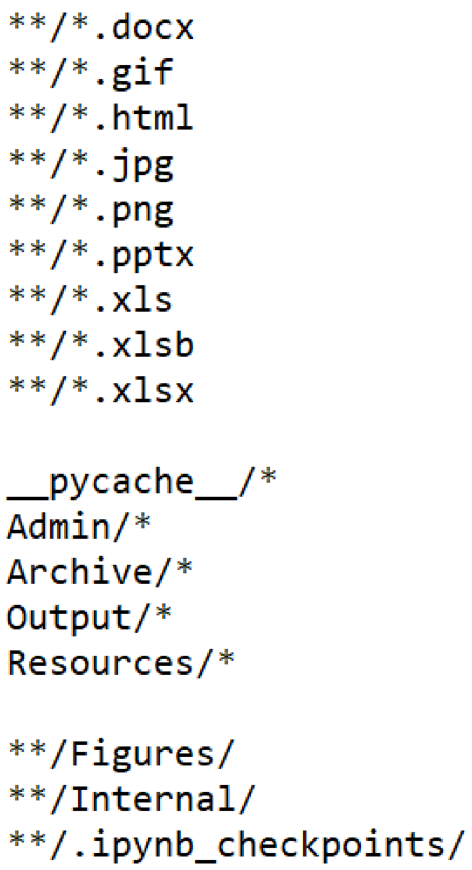
- By default, repos track all files

Tend to want to ignore either specific file types… (**/*.<filetype>)

- Data – .csv, .xlsx, .pkl, .Rdata, etc.
- Output – .png, .jpg, .gif, .tif
- Other – .docx, .pdf, .pptx (unless you’re teaching a class…)

…or we want to ignore specific directories (directory/* or **/directory/)

- Want to put administrative stuff on GitHub?
- Want to put sandboxes up?
- What about old stuff which is no longer relevant?



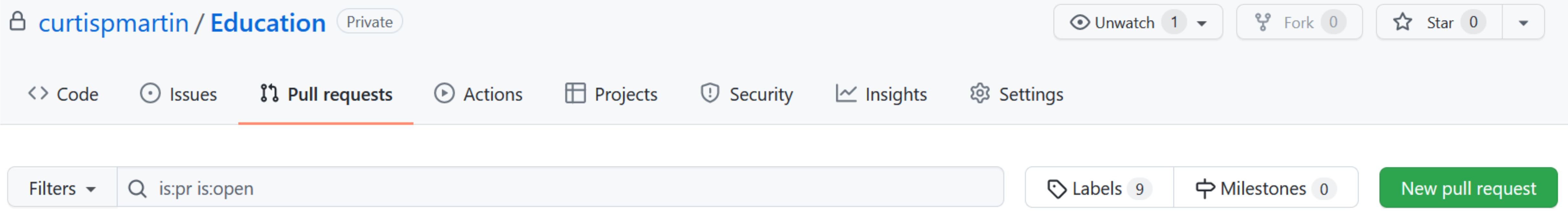
```
**/*.docx
**/*.gif
**/*.html
**/*.jpg
**/*.png
**/*.pptx
**/*.xls
**/*.xlsb
**/*.xlsx

__pycache__/*
Admin/*
Archive/*
Output/*
Resources/*

**/Figures/
**/Internal/
**/.ipynb_checkpoints/
```

Git: Collaborative Coding

The process for using Git/Hub is largely the same, w/ (at least) one big exception: Pull requests

The workflow:

- You create a new branch to start building out some new functionality
- You write & finish the new functionality
- You stage & commit the new code to the repo
- **You then submit a pull request which tells your collaborators the code is ready for merging**
- **This prompts your teammates (or at least the owner of the repo) to review new code before merging**
- **Once agreeable, you or a teammate can then accept the request, merge the branches, then `git pull`**



In-Class Activity…

Set up Git/Hub on your environment

- Download & install Git
- Set up GitHub account
- Create SSH key on local machine
- Link Git to GitHub using SSH key
- Make your repo private

Create your own repo for this course called "XXX XXX"

- Add me & TAs as collaborators
- Confirm local copy & connection to GitHub

Create a subdirectory in repo called "2_VersionControl"

- In it, create a Jupyter notebook ("inclass.ipynb") & copy over code from "inclass.html" file

Stage & commit your repo

Create new branch called "newname"

- Open "inclass.ipynb" using Jupyter
- Change 'myname' to your name
- Push new branch to GitHub

Once functional, merge "newname" w/ "master" branch, then stage & commit

Til next time…

HOMEWORK?