Git and GitHub In-depth

Research Computing
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Be Boulder.

Working with Git and GitHub

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Slides:
https://github.com/ResearchComputing/git_github_in_depth_short_course
Survey: http://tinyurl.com/curc-survey18

Goals

- Convince you that basic Git/GitHub fluency is:
  - Easy
  - Practical
  - An extremely important tool in your tool belt!

Learning Goals

- Know the differences between Git and GitHub
- Understand the basics of version control
- Learn basic Git and GitHub fluency
  - Creating a repo, add, commit, pull, clone, push
- Collaboration in GitHub

Outline

- What is version control?
- Brief overview of Git and GitHub
- When not to use GitHub
- Creating your own repository locally
- Pushing local changes to GitHub
- Documentation

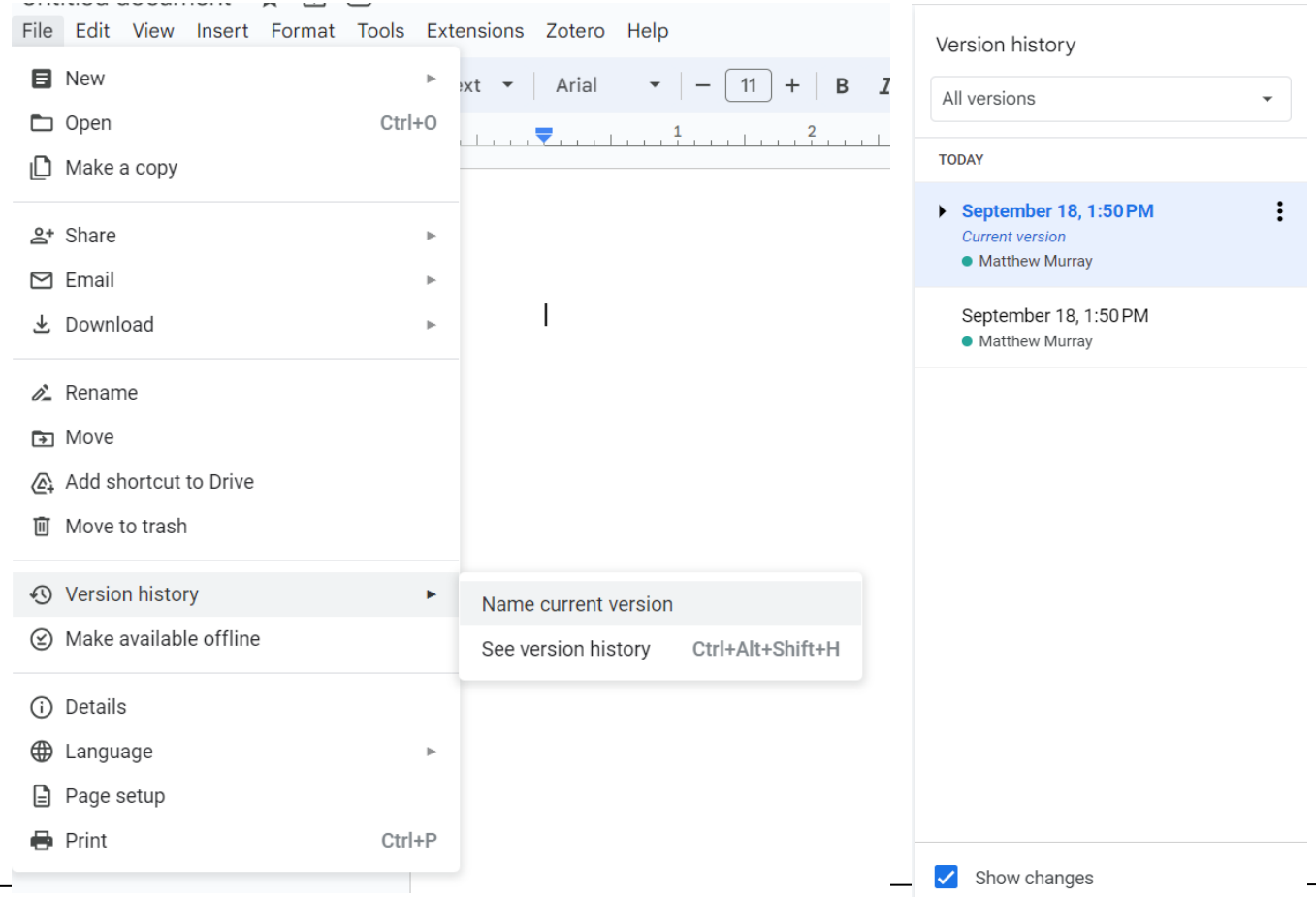
What is version control?

Version control is the practice of tracking and managing changes to files.

- Why do I need it?
  - Revert to various states of files
    - You can think of this as a backup
  - Allows you to modify items without harming the original copy
  - Not limited to code
    - Can be used for documents, images, etc.

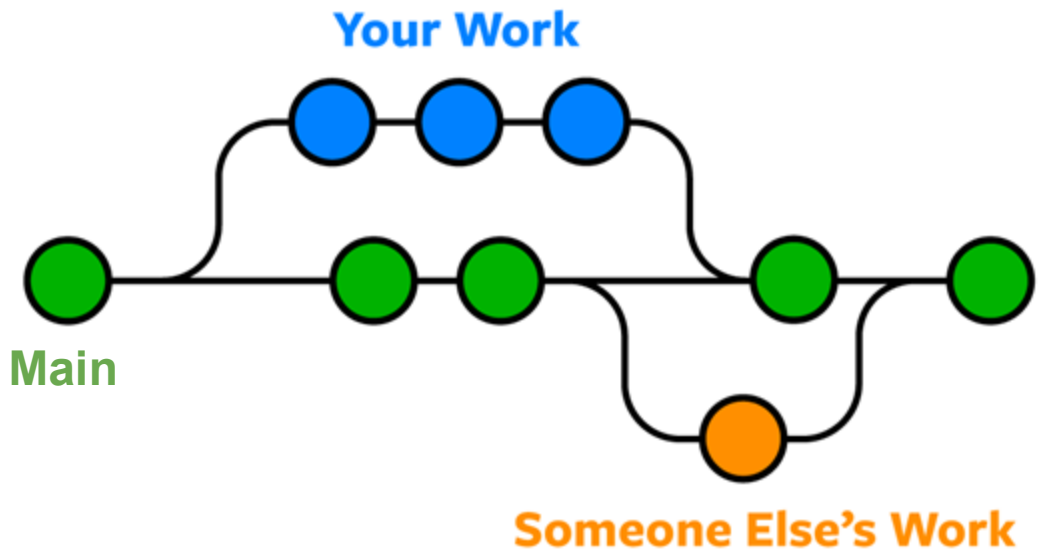
What is version control?

- Google Docs includes "Version History"
- This allows you to see what changes were made, when those changes happened, and who made them
- You can also revert to a previous version of your file



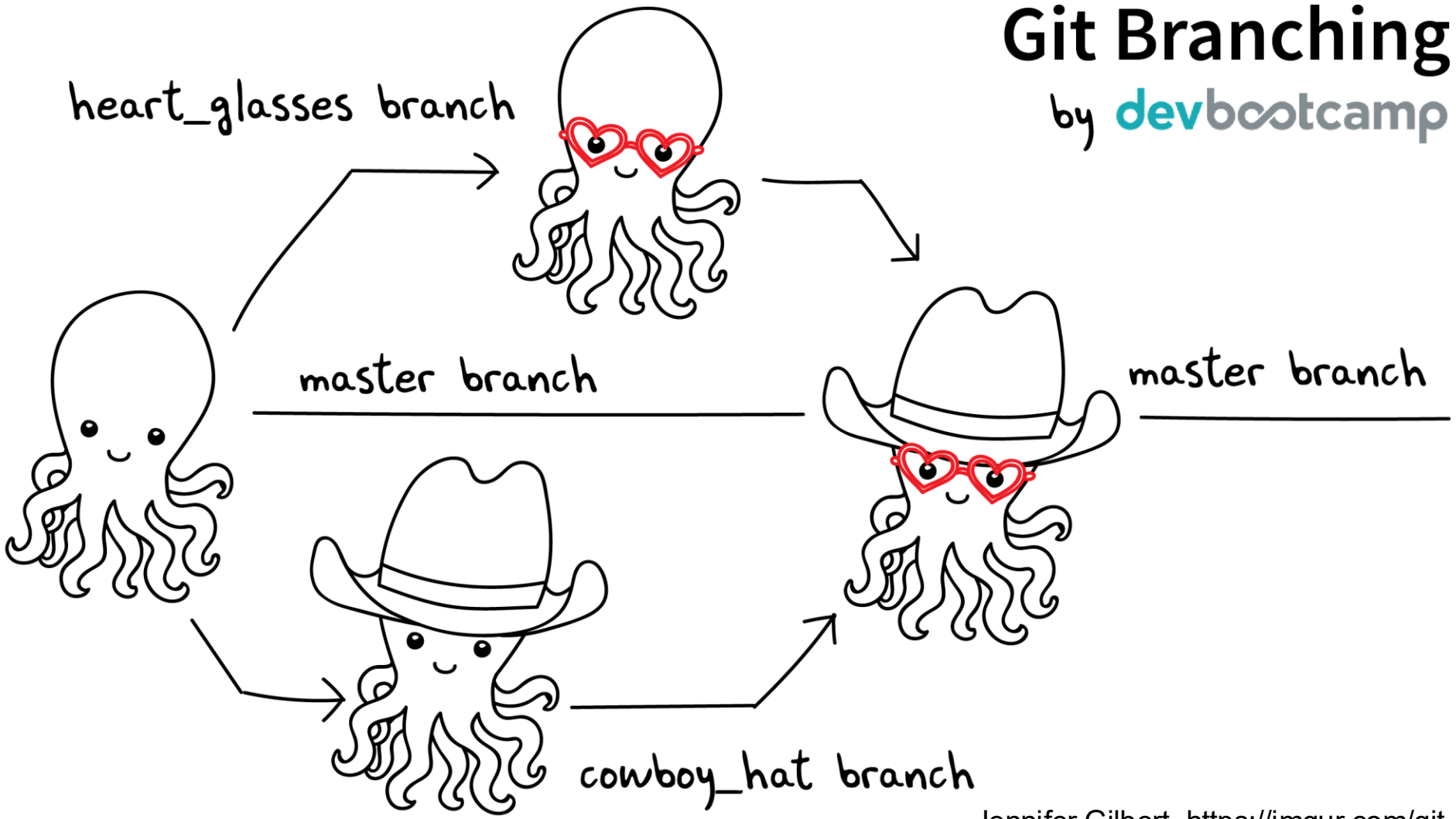
Additional benefits of version control

- Using version control provides
  - Clear tracking of the repo's history
  - Management and view of different branches (work)
  - Collaboration through merging of branches



Images: nobledesktop.com

Branching & Merging



Jennifer Gilbert. https://imgur.com/git-branching-YG8In8X

Git vs GitHub

- Git: version control system
  - the actual software

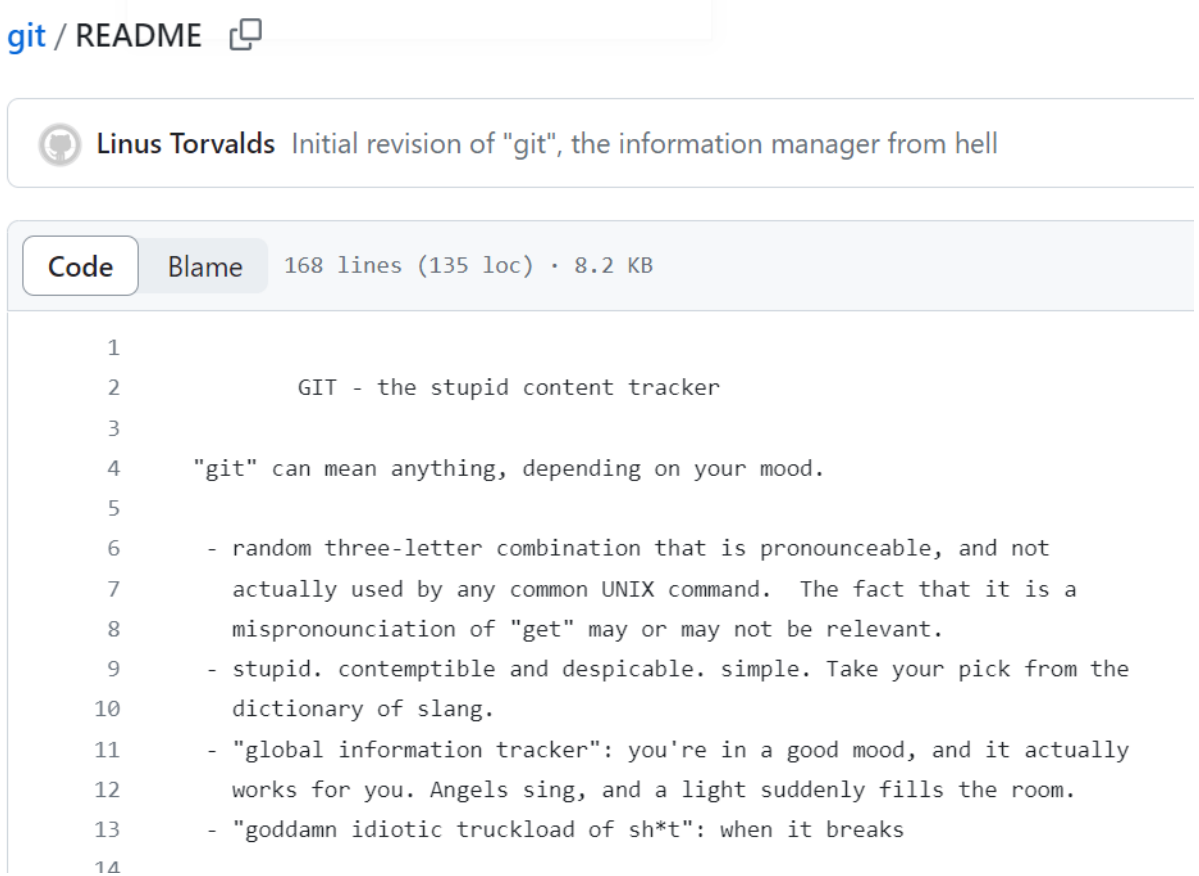
- GitHub
  - cloud-based storage website

What is Git?

- Git is version control software, created by Linus Torvalds, the same person who created the Linux operating system.
- Monitor files on your computer and tracks changes made to them over time
- Uses the command line

Why is it called “Git”?

- Linus Torvalds: "I'm an egotistical bastard, and I name all my projects after myself. First 'Linux', now 'Git’”.
- Git: “A silly, incompetent, stupid or annoying person (usually a man).” (Wikitionary)

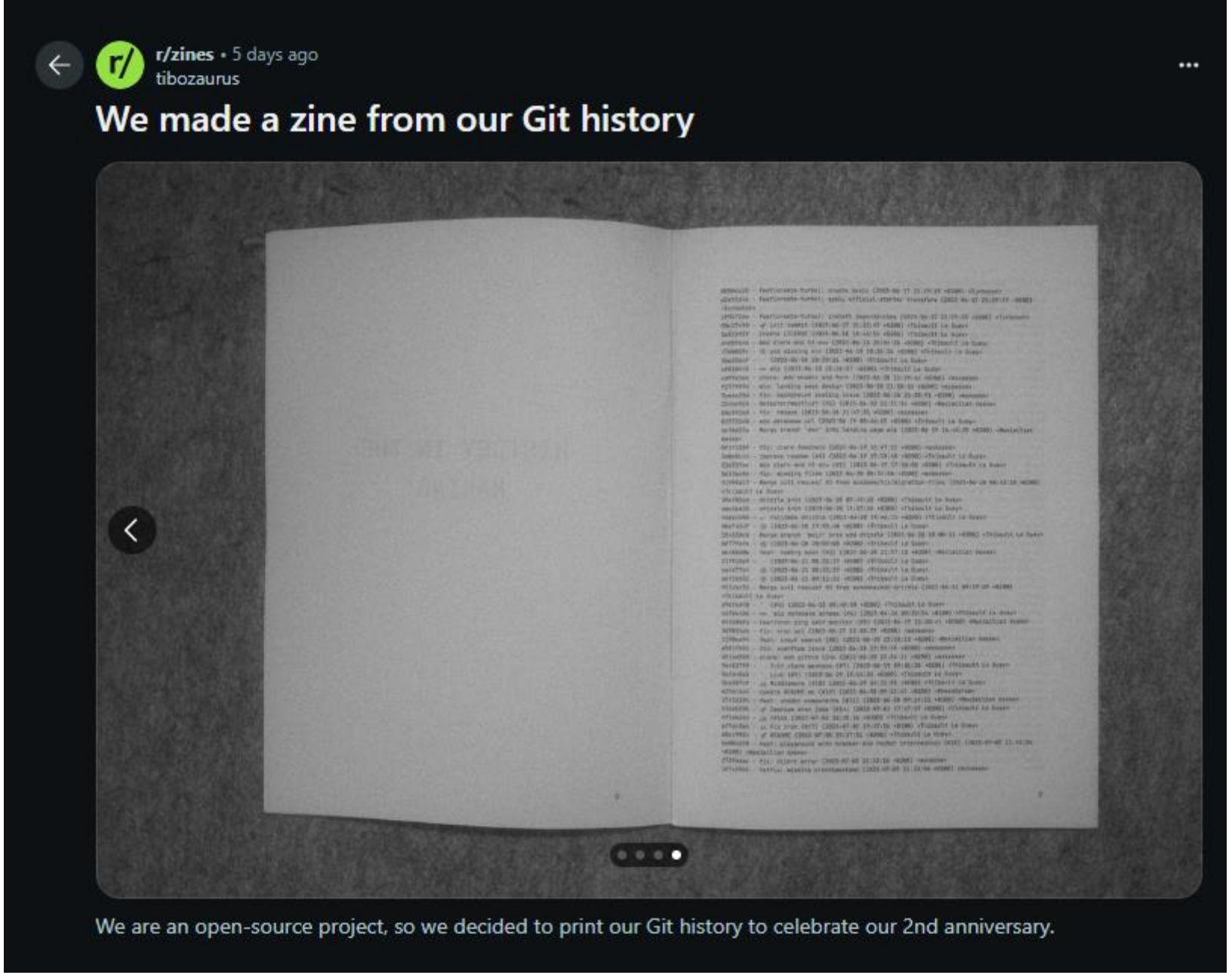


git / README

Linus Torvalds Initial revision of "git", the information manager from hell

Code Blame 168 lines (135 loc) · 8.2 KB

```
1
2           GIT - the stupid content tracker
3
4   "git" can mean anything, depending on your mood.
5
6    - random three-letter combination that is pronounceable, and not
7      actually used by any common UNIX command.  The fact that it is a
8      mispronounciation of "get" may or may not be relevant.
9    - stupid. contemptible and despicable. simple. Take your pick from the
10     dictionary of slang.
11   - "global information tracker": you're in a good mood, and it actually
12     works for you. Angels sing, and a light suddenly fills the room.
13   - "goddamn idiotic truckload of sh*t": when it breaks
14
```



https://www.reddit.com/r/zines/comments/1miy3bs/we_made_a_zine_from_our_git_history/

What is GitHub?

- GitHub is a Microsoft subsidiary that offers cloud hosting for Git repositories
- Provides a GUI (Graphical User Interface) for Git
  - Most (but not all) features are available in the GitHub Desktop client
- Allows for easy collaboration and sharing
  - Issue queues for bugs and features, pull requests, and more
- GitHub basic is free (up to 5GB of storage)
  - Hosts both open and private repositories
- GitHub Enterprise (free for CU affiliates)
  - Includes cloud-based development environments
  - https://oit.colorado.edu/services/business-services/github-enterprise

Alternatives to...

- Git (version control)
  - Apache Subversion (SVN)
  - Mercurial SCM
  - CVS (Concurrent Versions System)
- GitHub (hosting)
  - Codeberg
  - GitLab
  - Forgejo
  - Bitbucket

When NOT to use GitHub

- When you are looking for long-term preservation
  - There's no guarantee Microsoft will keep GitHub around forever
  - Lots of source-code-hosting platforms no longer exist
  - Thousands of URLs in research articles no longer work as they point to code hosted by defunct services
- When you want your code to be cited
  - Zenodo is an Open Access repository that can be linked to GitHub
  - Allows you to archive a specific release of public GitHub projects
  - Creates a DOI for the archive that you can use in citations

September 2, 2023

Software Open Access

PyGMT: A Python interface for the Generic Mapping Tools

Tian, Dongdong; Uieda, Leonardo; Leong, Wei Ji; Schlitzer, William; Fröhlich, Yvonne; Grund, Michael; Jones, Max; Toney, Liam; Yao, Jiayuan; Magen, Yohai; Jing-Hui, Tong; Materna, Kathryn; Belem, Andre; Newton, Tyler; Anant, Abhishek; Ziebarth, Malte; Quinn, Jamie; Wessel, Paul

PyGMT is a library for processing geospatial and geophysical data and making publication quality maps and figures. It provides a Pythonic interface for the Generic Mapping Tools (GMT), a command-line program widely used in the Earth Sciences.

The development of PyGMT has been supported by NSF grants OCE-1558403 and EAR-1948603.

Preview

baseline-images.zip

baseline-images

test_basemap.png	6.2 kB
test_basemap_compass.png	71.2 kB
test_basemap_loglog.png	24.5 kB
test_basemap_map_scale.png	31.0 kB
test_basemap_polar.png	31.9 kB

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Versions

Version v0.10.0 10.5281/zenodo.8303186	Sep 2, 2023
Version v0.9.0 10.5281/zenodo.7772533	Mar 31, 2023
Version v0.8.0 10.5281/zenodo.7481934	Dec 30, 2022
Version v0.7.0 10.5281/zenodo.6702566	Jul 1, 2022
Version v0.6.1 10.5281/zenodo.6426493	Apr 11, 2022

View all 17 versions

Cite all versions? You can cite all versions by using the DOI 10.5281/zenodo.3781524. This DOI represents all versions, and will always resolve to the latest one. Read more.

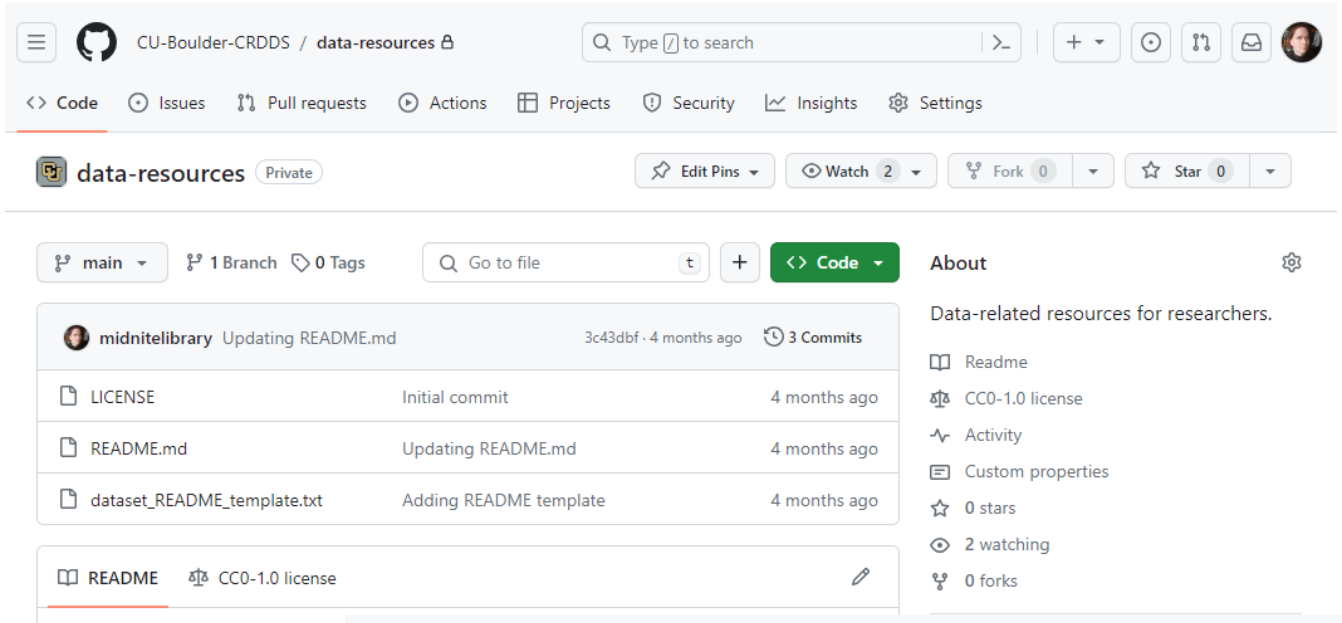
Publication date:

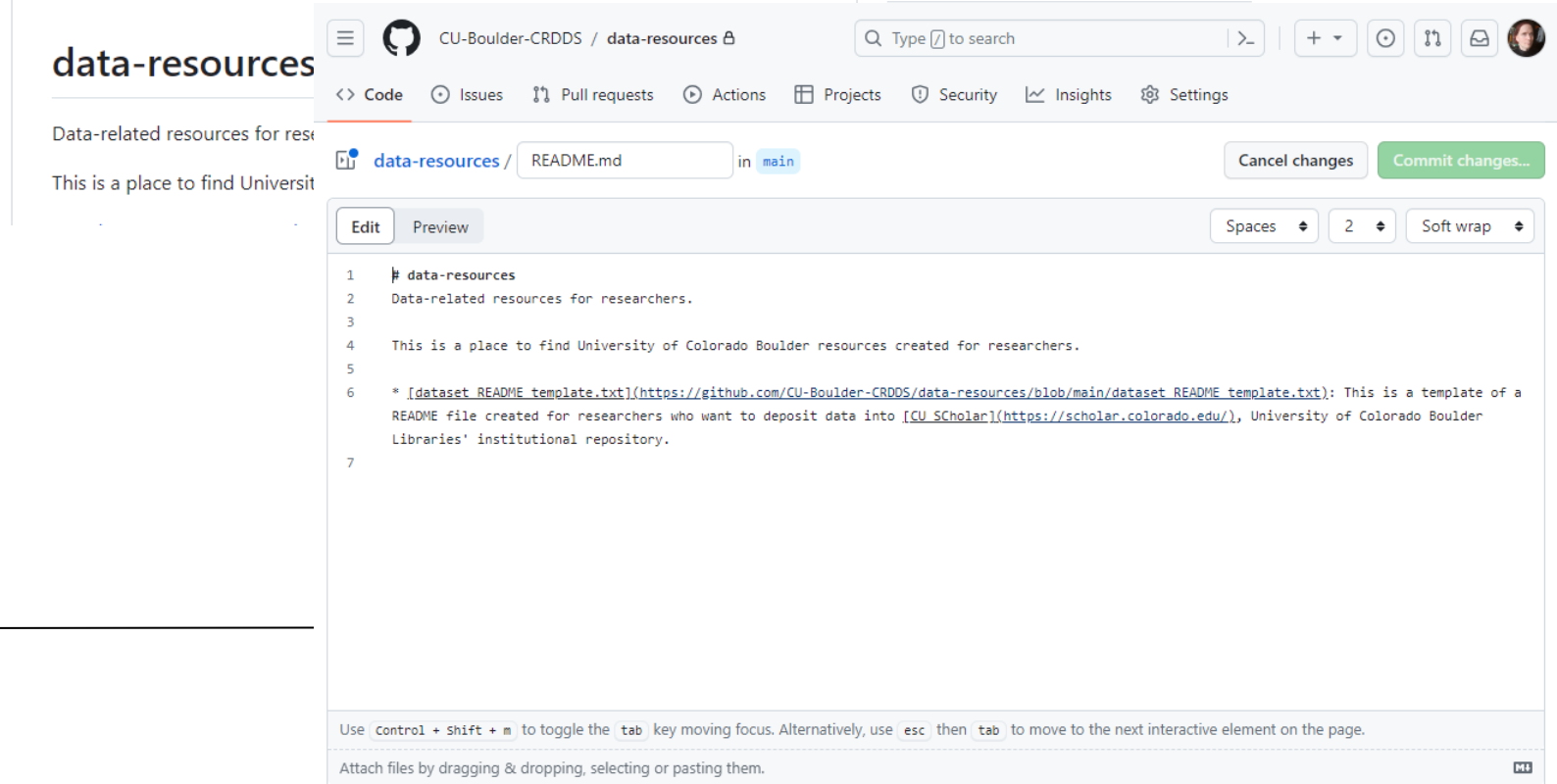
Ways to interact with GitHub

- The website
- GitHub Desktop
- Using Git and the command line

Website

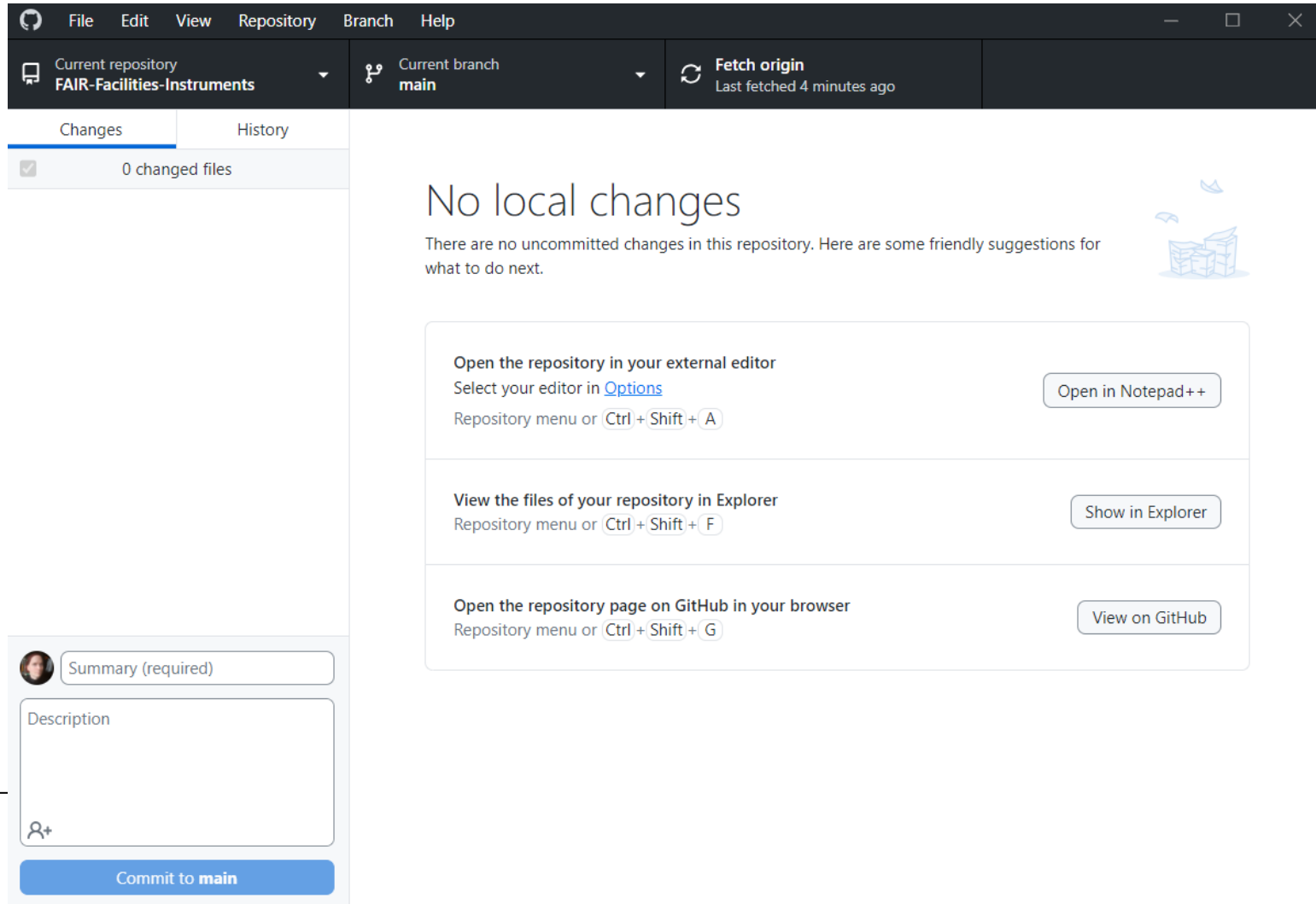
- Create and manage projects
- Upload and download files
- Write documentation



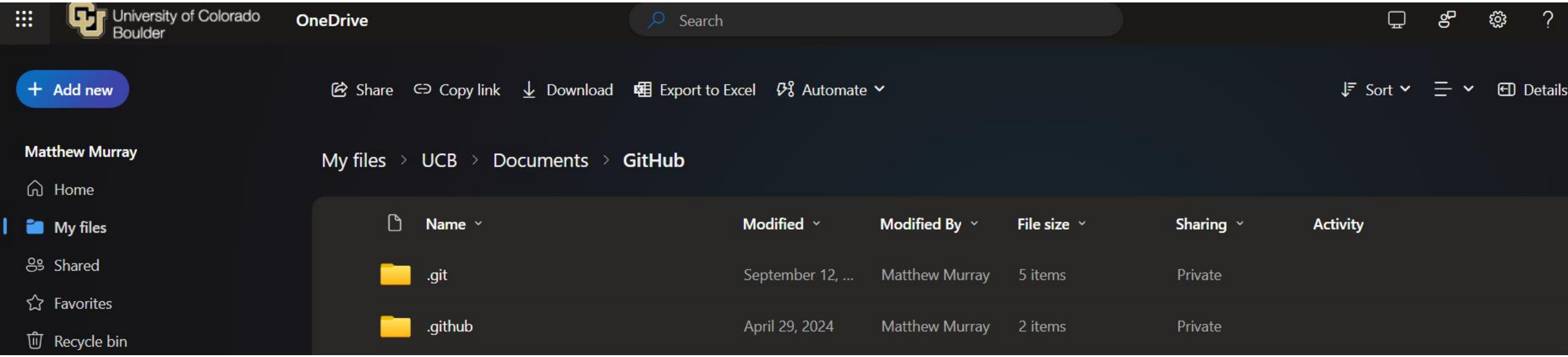


GitHub Desktop

- Create, clone, and fork projects
- Commit changes and submit contributions
- Many people who use Git frequently prefer to use the command line
- Other graphical Git interfaces exist



Be careful where you put your GitHub directory



- Microsoft OneDrive uploads a lot of stuff to the cloud, which you don’t always want

Getting Started with Git

Getting Started

- A GitHub account set up.
  - If you don't have one, sign up at GitHub.com.

- Many systems have Git installed; however, you may need to download it on your local machine:
  - See https://git-scm.com/book/en/v2/Getting-Started-Installing-Git for more information on installing Git
  - To check if Git is installed, run:

```
$ git –version
```

Linking Git to GitHub

- Once downloaded, we can then configure Git with our GitHub username and email via the command line. This allows us to interact with our GitHub more easily.
  - First, set your username. For example, if my GitHub username is gh-user, then I would do the following:

    ```
    $ git config --global user.name “gh-user”
    ```

  - Now, set your email. For example, if my email for GitHub is gh-user@gmail.com, then I would do the following:

    ```
    $ git config --global user.email “gh-user@gmail.com”
    ```

- Confirm Git has been configured (should show your entered info)

```
$ git config --list
```

Personal Access Token

- Allows you to verify your identity with GitHub
  - For more information, see https://docs.github.com/en/authentication/keeping-your-account-and-data-secure/managing-your-personal-access-tokens
- Downside is that you need to enter your username and then the Personal Access Token as your password for events such as:
  - Any interaction with a private repo
  - Pushing to a public repo
- There are ways to store your username and token, but these require third-party software

SSH Keys

- Alternative way to verify your identity with GitHub
  - For more information see: https://docs.github.com/en/authentication/connecting-to-github-with-ssh/generating-a-new-ssh-key-and-adding-it-to-the-ssh-agent
  - Be sure to select the proper Operating System when using the link
- Setup is more involved, but makes it so that you never have to enter your username and token when interacting with a private repo or pushing to a public repo

Getting Started with Git (local)

Hands on tutorial

Goal: Create a simple project that contains a markdown file

First let's create a new directory for our project:

```
$ mkdir git_work
$ cd git_work
$ mkdir git-tutorial
$ cd git-tutotial
```

Git Repository (Repo)

- A Git repository tracks and saves the history of all changes made.
  - All this information is stored in ".git", which is the repository folder

- We can make a directory (folder) a Git repo using "git init"

Git Init

- In your “git-tutorial” directory run

```
$ git init
```

- Git creates the "hidden" directory called “.git”

```
$ ls -la
```

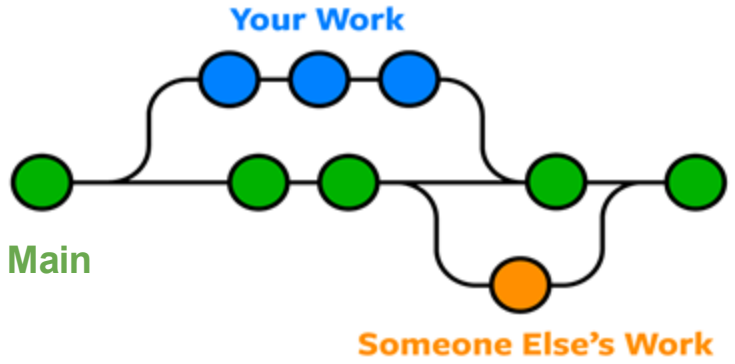
- Your directory is now a repo!
  - Git is now ready to to be used
  - Allows us to tell Git what items to watch

Create the main branch

Now that we have a repo, we can create branches. Branches are a version of the repository.

- It is customary to name the primary branch “main”
- This can be done as follows (after an init)

```
$ git checkout –b main
```



- You can switch between branches

```
$ git checkout <branch-name>
```

Let's add a file!

- It is customary to add a README.md
  - Description of repo and any helpful information
- To add a README.md, in "git-tutorial" create and edit the file using nano (or an editor of your choice)

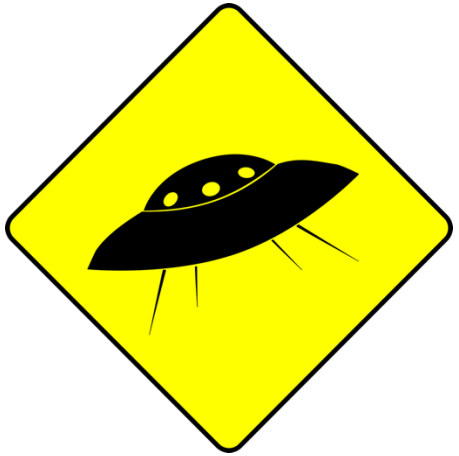
```
$ nano README.md
```

  - Add anything you would like!
  - Be sure to save the file when you exit.

Best Practices: Documentation

- Include documentation with your project in GitHub so that others (and you) know what your project is and how it should be used.
- A README.md (markdown) file can be included in your GitHub project and will display on the front page
- What to include in a README:
  - What your project does
  - How people can use it
  - Who you are and how to contact you
  - License information
- Lots of examples and templates available
- We can provide feedback on documentation

Git does not know about README.md yet!!



Areas of Git Workflow

Working Area

- Items that you are currently working on
- Are not tracked by Git!
- Exists locally
- Created by using “git init”

Staging Area

- When Git starts tracking and saving your work
- Exists locally
- Items are added to this area by using “git add”

Snapshot Area

- All staged items are captured
- Version of the repo
- Exists locally
- Items are added to this area by using “git commit”

GitHub

- Exists locally and on GitHub!
- Items are added to this area using “git push”

Git Status

- The git status command displays the state of the working and staging area.

- Let's see what area README.md is in

```
$ git status
```

  - We see it is an untracked file, so it is in the working area

What if you don’t want Git to track something?

.gitignore

We can add a file named “.gitignore” to our repo

- Specifies what items (files, directories, etc.) should never be tracked
- Let’s create a file to ignore!

```
$ echo "Super secret stuff" > confidential_data.txt
```

- Add “.gitignore” to “git-tutorial” and put “confidential_data.txt” in it

```
$ echo confidential_data.txt > .gitignore
```

Let’s add our files to the staging area now!

Git Add

- The git add command adds a change in the **working area to the staging area.**

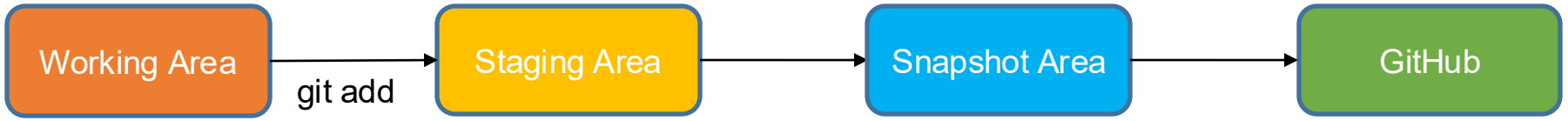
- Let's add our README.md to the staging area

```
$ git add README.md
```

or add everything in the current directory

```
$ git add .
```

- Anytime a change is made, you need to do a git add (to track them)



Git Reset

- If you've already staged files using git add and you want to move them back to the working directory, you can use the following command:

```
$ git reset <file>
```

- To unstage the README.md file:

```
$ git reset README.md
```

Git Commit

- The git commit command captures a snapshot of all staged items
  - Commits can be thought of as a version of the repo
  - Commits should be accompanied with a brief message

- Let's commit our staged item!

  $ git commit -m "Create repo, add README.md, add .gitignore"

  $ git status

Common practice – add, commit

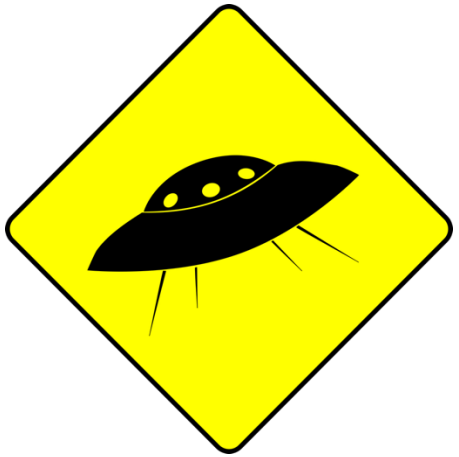
- git add
  - Can be performed as much as you want
  - Doesn’t need to be done after every change
- git commit
  - Always include a comment!!
  - Bundle common staged items together
  - Try not to put too many things in a commit

Git Log

- The command git log **lists the commits made in that repository**
- Lists the most recent commits first

  $ git log

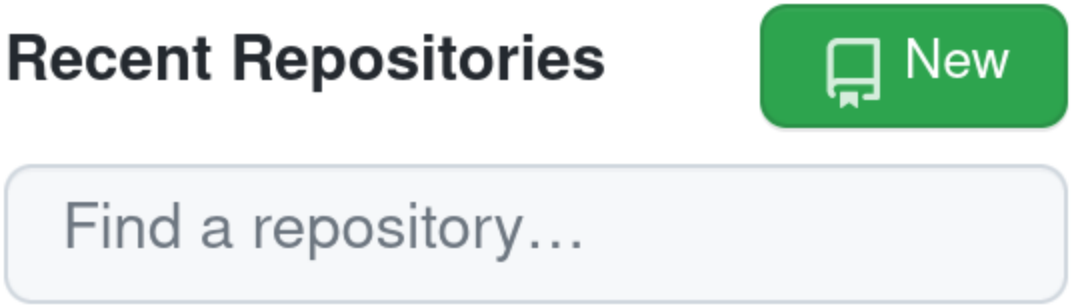
All changes and files are only locally stored right now!



To GitHub we go!

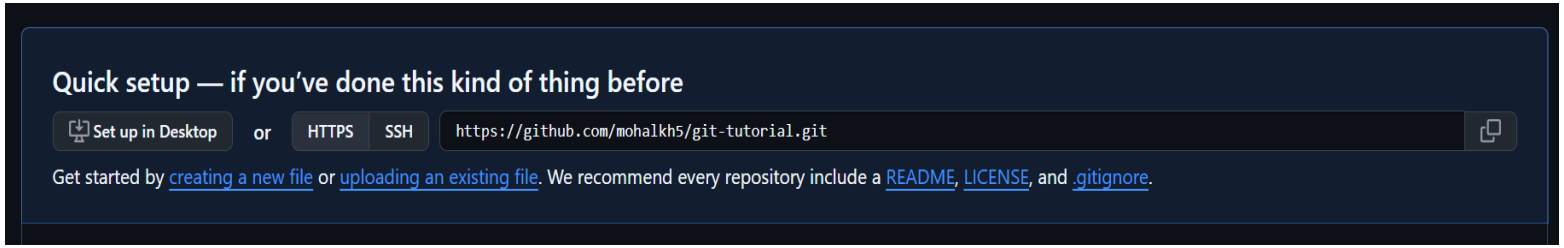
GitHub

- When you first create a repo locally, you will need to setup a new repository on GitHub too
  - Go to https://github.com
  - Sign in
  - Click on “Create New Repository” or just “New”



Create Repo in GitHub

- Name your repo, I chose “git-tutorial”
- Don’t add a README or a .gitignore
- Click “Create repository”
- We have set everything up in the previous slides, we only need to copy the ssh link!



Linking local repo to GitHub repo

Git Remote

- Used to identify the remote (e.g. GitHub) repos are linked to your local repo
- Used to link remote repos to your local repo
- To view currently linked remote repos:

```
$ git remote -v
```

- To link our remote repository:
  - When using an SSH key do:

```
$ git remote add origin git@github.com:<user>/git-tutorial.git
```

  - When using a Personal Access Token do:

```
$ git remote add origin https://github.com/<user>/git-tutorial.git
```

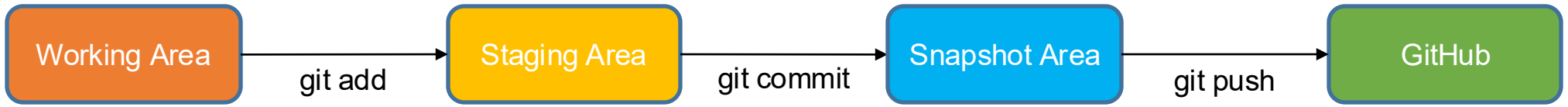
Sending local changes to GitHub

Git Push

Uploads local repository content to a remote repository

- Pushing is how you transfer commits from your local repo to a remote repo

```
$ git push <name of remote repo> <branch>
$ git push origin main
```



GitHub

- Go back to GitHub and refresh your page
  - should see the files we have added (and not the ones we've ignored)
- Some cool features!
  - look at our commits
  - directly edit/commit in the browser
- Let's do that! Let's something and commit it on GitHub
  - But now our remote repo is one commit ahead of our local one…

Git Fetch & Merge

- Git fetch retrieves the changes from the remote repo

```
$ git fetch
```

- Git merge combines two branches

```
$ git merge origin/main
```

There's an easier way!

Git Pull

- Git pull combines the fetch and merge commands

```
$ git pull <name of remote repo> <branch>
$ git pull origin main
```

IMPORTANT!

- Make sure no commits have been done on local branch
- It is fine to have staged items (git add)
- ALWAYS do git pull before any commits!

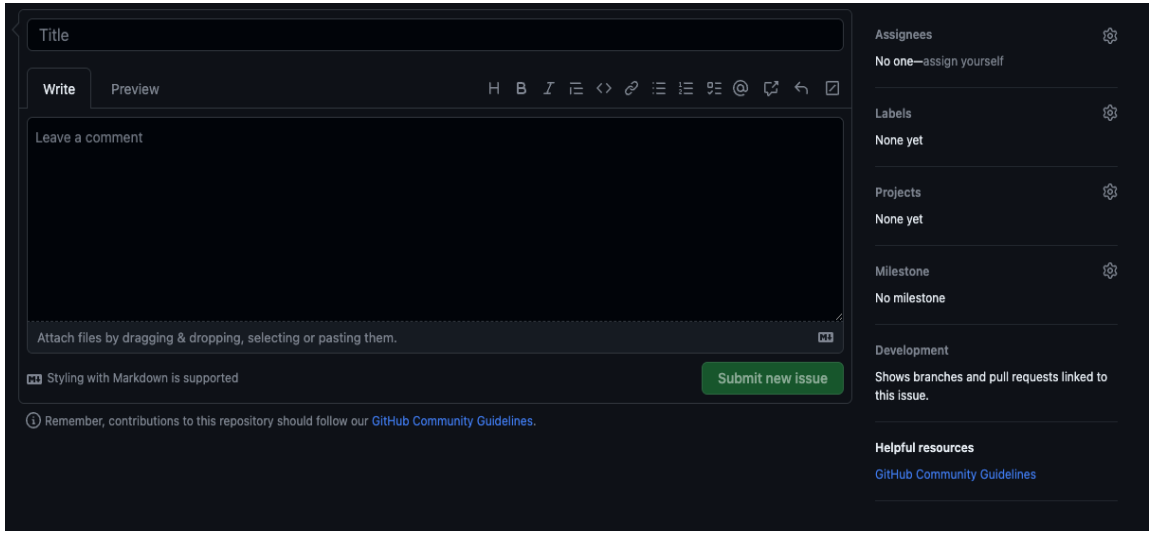
Advanced topic: Collaboration

GitHub Issues

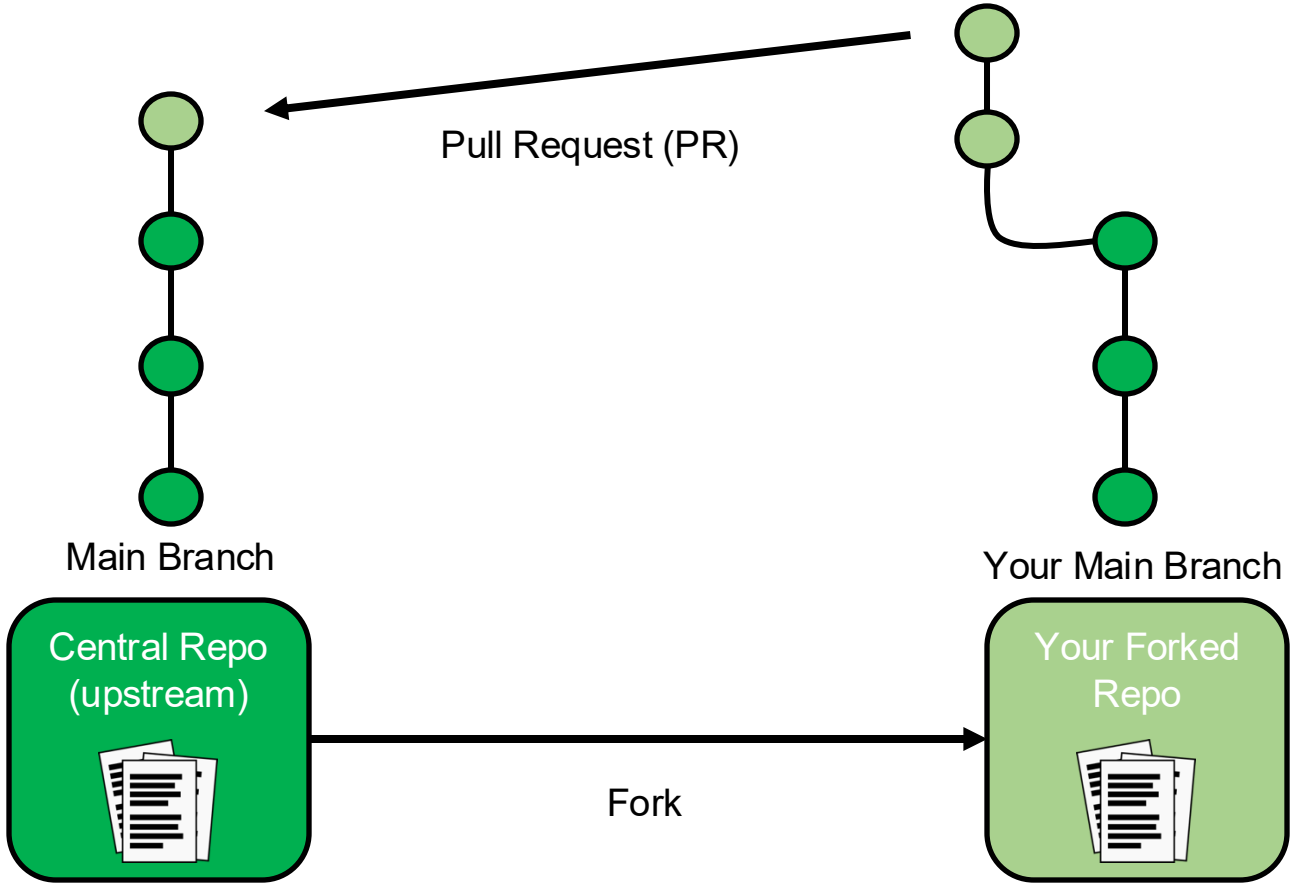
- Allows you to discuss the project
- Point out issues, request features, ask for help
- Useful place to see past user discussion

GitHub Issues

- Include as much detail as possible
  - Version of software
  - Operating system
- Provide a simple minimal example, if possible
- If a feature request
  - Outline possible implementation
  - Highlight its value

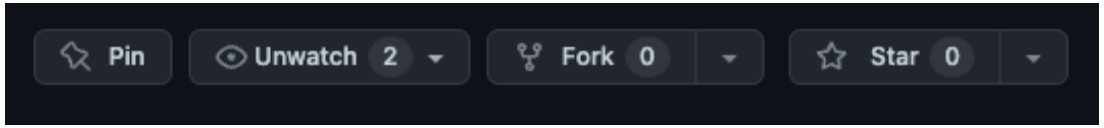


GitHub Forks



GitHub Forks

- Improves collaboration
  - Don’t have to worry about disturbing the upstream repo
  - Improves transparency through pull requests
- Go ahead and Fork my repo:
  - Go to https://github.com/rctutorial/hello-world
  - Click “Fork” button
  - Click “Create fork”
- Creates your own version of my repo under your GitHub



Git Clone

- Git clone **makes a clone (or copy) of a remote repo in a new directory, at another location**.

```
$ git clone <url> <optional new name>
```

- Easy way to grab third-party code, or pre-existing code you might need to work on
- Cloning when you have SSH keys (be sure to make “git_work_cloned”):

```
$ git clone git@github.com:rctutorial/hello-world.git
```

Pull Requests (PRs)

- A request that an upstream repo pull your branch into their branch
- Starting a PR does not automatically merge changes
  - Notifies maintainers of upstream repo
  - Allows maintainers to review your changes
    - Discussion of changes
    - Requested additional changes
- Maintainers of upstream repo merge in the changes

PR steps

1. Fork upstream repo
2. Clone the forked repo
3. Connect forked and cloned repo to upstream repo. Ex. using SSH keys:

```
$ git remote add upstream git@github.com:rctutorial/hello-world.git
```

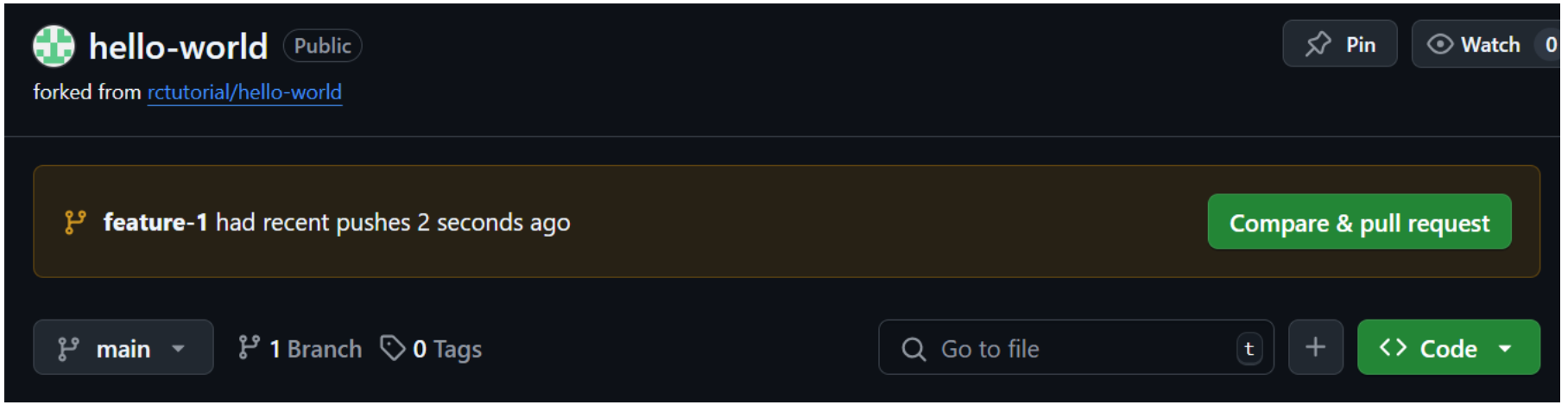
4. Create a new branch specific to your change

```
$ git checkout –b <new-branch> <branch-to-copy>
```

5. Make your changes on this branch
6. Perform a git add, commit, and push to origin
7. Create a PR from GitHub

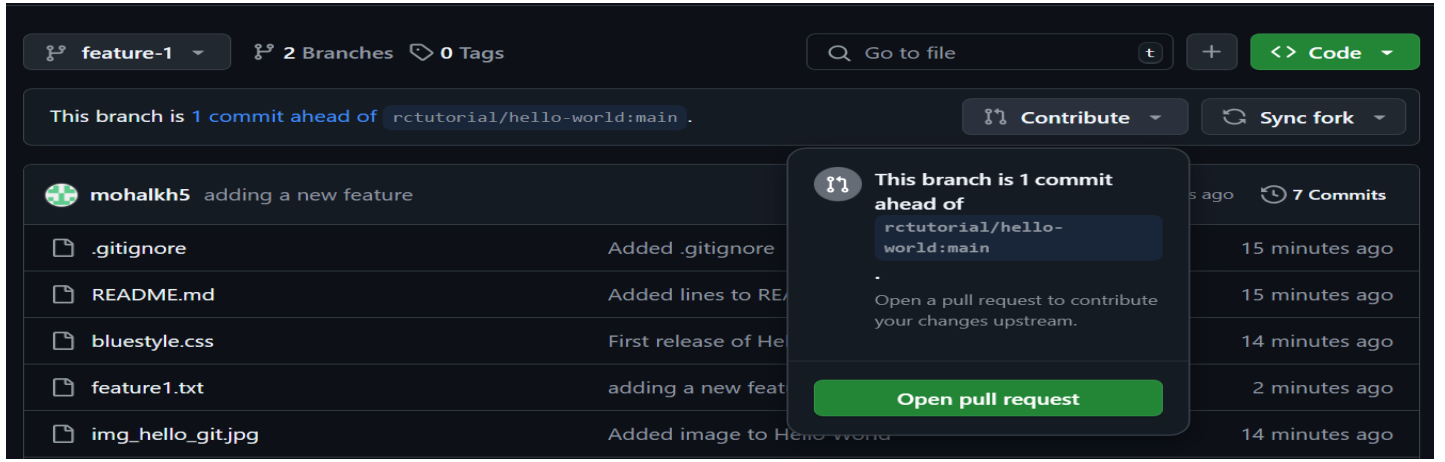
Creating a PR

- After you push your changes to the forked repo, you can click the pop-up “Compare & pull request” on GitHub
  - Will disappear after some time



Creating a PR

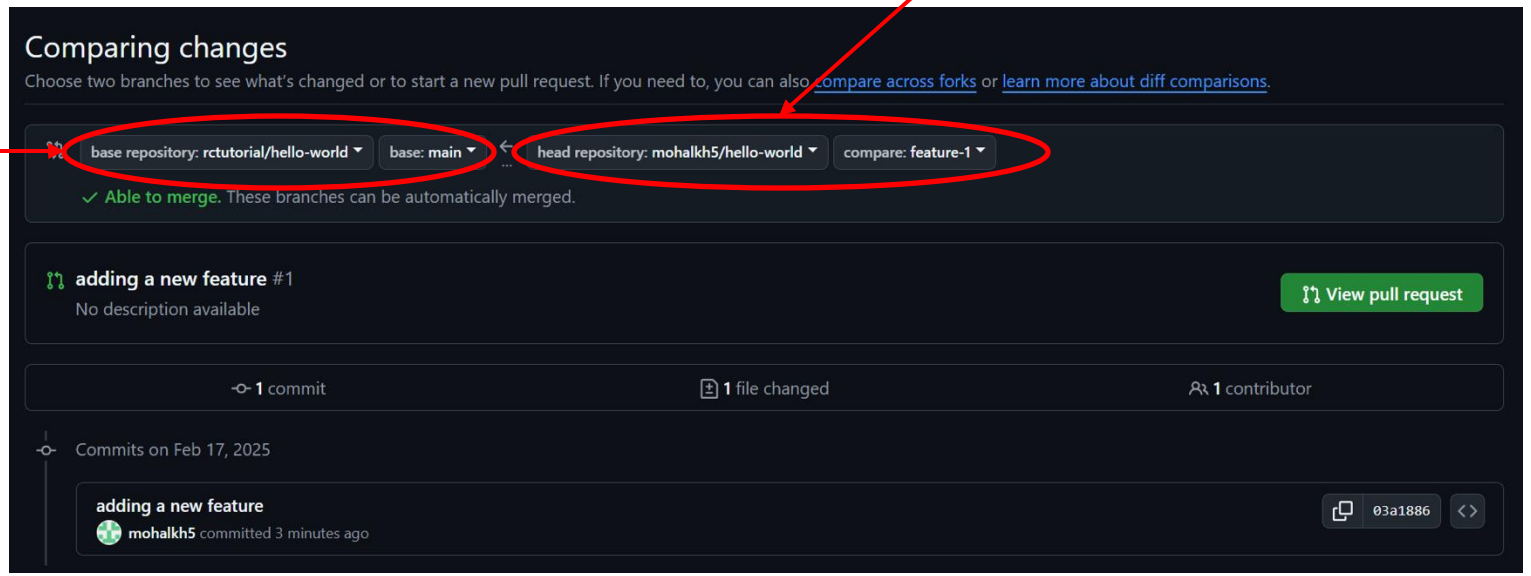
- After you push your changes to the forked repo
  1. Switch to your new branch
  2. Click the drop-down arrow next to “Contribute”
  3. Click “Open pull request”
- Will NOT disappear!



Creating a PR

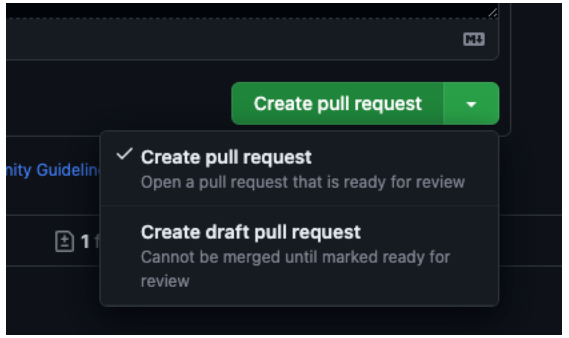
Our forked repo and branch with our changes

Upstream repo and branch we want to merge into



Pull Requests – Best Practice

- Create a new feature branch of forked repo
- When submitting a PR
  - Provide a short descriptive title
  - In comment section
    - Link to any current issue
    - Describe what the PR does and reasons for it
- Draft pull requests
  - PR is a work in progress
  - Can be used for discussion



Merging

- When doing a “git pull” you are merging in changes
- This process can be done manually
- When collaborating, multiple individuals can be working on the same item
  - Conflicts can happen!
- One needs to manually resolve conflicts
- Fantastic tutorial on merging:

https://www.atlassian.com/git/tutorials/using-branches/git-merge

Help! I'm stuck, where do I go?

- **Trainings with Center for Research Data and Digital Scholarship (CRDDS)**: https://www.colorado.edu/crdds/
- **Software Carpentries tutorial:** https://swcarpentry.github.io/git-novice/index.html
- **GitHub Student Developer Pack:** https://education.github.com/pack
- **Helpdesk**: rc-help@colorado.edu

Survey and feedback

Survey: http://tinyurl.com/curc-survey18

Slides: https://github.com/ResearchComputing/git_github_in_depth_short_course