E5883

MAYO CLINIC

CONTRIBUTING TO OPEN-SOURCE SOFTWARE

HOW TO BE PART OF A LARGE SOFTWARE PROJECT

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ISMRM & SMRT Annual Meeting & Exhibition
May 19, 2021

ISMRM & SMRT Annual Meeting & Exhibition
An Online Experience
15-20 May 2021

Declaration of Financial Interests or Relationships

Speaker Name: Eric A. Borisch

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

MAYO CLINIC

DOWNLOAD THESE SLIDES

https://github.com/eborisch/ISMRM

https://github.com/eborisch/ISMRM/blob/main/2021/Open-source.pdf

MAYO CLINIC

SOFTWARE ENGINEERING FOR MR SCIENTISTS

How to use version control:
#E5882 : Megan Poorman

How to be part of a large software project:
#E5883 : Eric Borisch

Wednesday, May 19
17:00 - 18:00 UTC

LEARNING OBJECTIVES

Who can contribute to Open-Source Software (OSS)?

Ways to contribute to OSS.

How to provide useful feedback / contributions to a project.

Using *git* to contribute to OSS projects.

AGENDA

1. Why you should contribute
2. Getting started – working with a project
3. Ways to contribute
4. Collaborating with *git*: key concepts
5. Contributing to a GitHub project
6. “Live” demonstration
7. Final thoughts, references & further reading

1 WHY YOU SHOULD CONTRIBUTE

CONTRIBUTING TO OPEN-SOURCE SOFTWARE

- Open-Source Software (OSS) is fundamentally a community endeavor
- You bring your own expertise and experiences to a project, which can be at any level:
  - as an end user
  - or as developer using a library
  - or as part of the project's team
- In the research context:
  - Helps support reproducible research
  - Visibility to future collaborators or employers

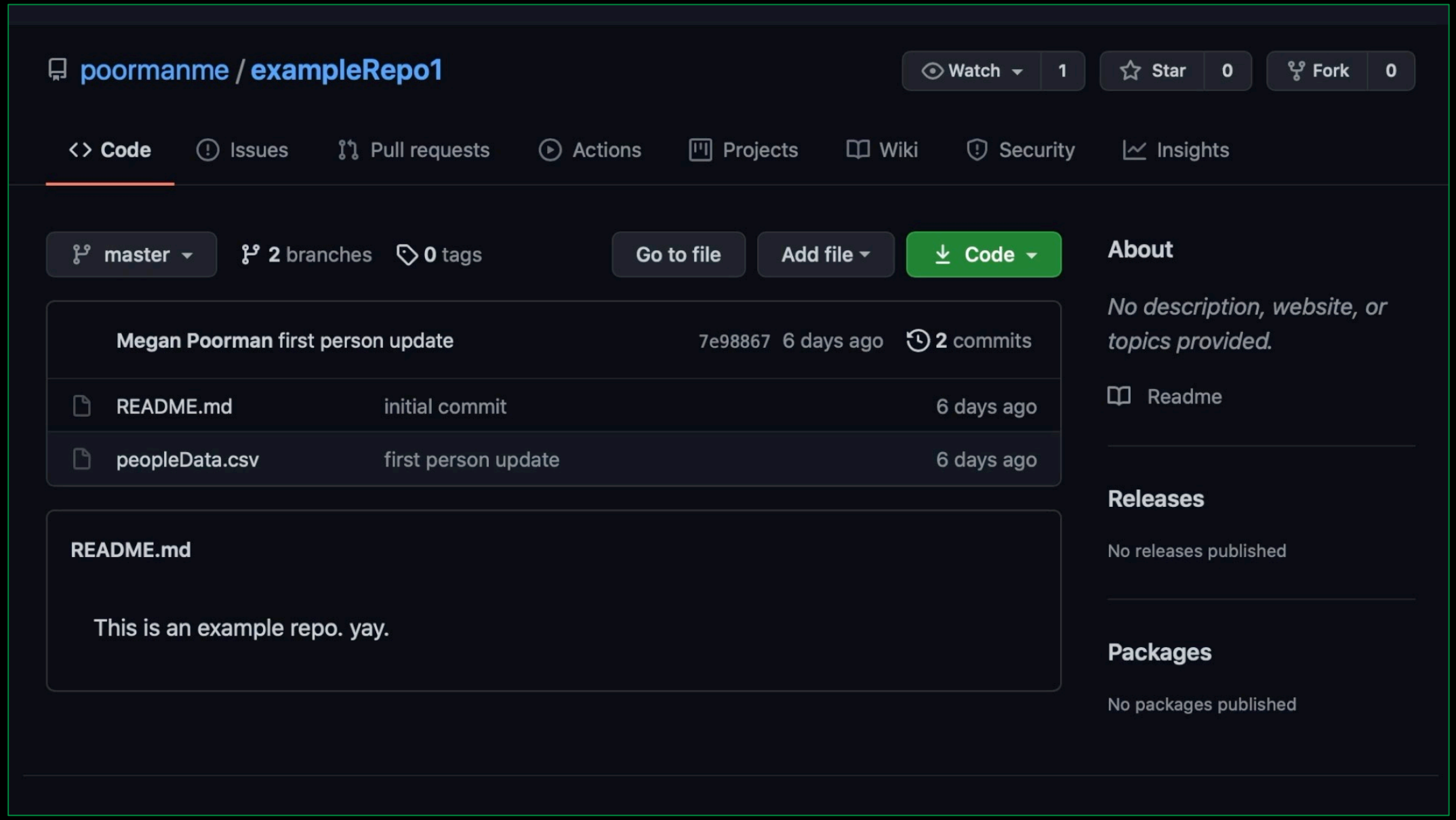
WHO CAN CONTRIBUTE TO OPEN-SOURCE SOFTWARE?

ANYONE

WHO CAN CONTRIBUTE TO OPEN-SOURCE SOFTWARE?

YOU

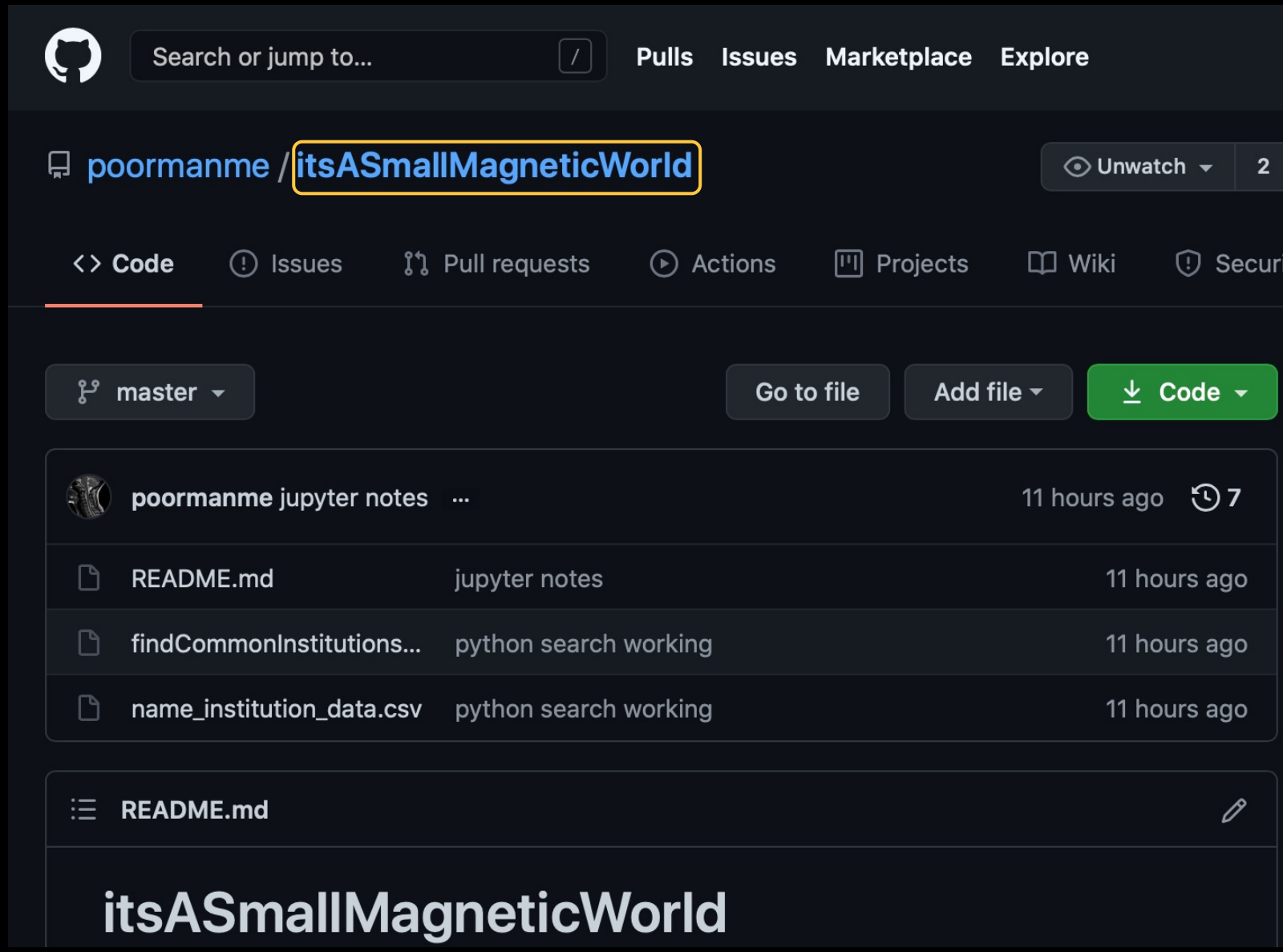
QUICK PREVIEW OF CONTRIBUTING A CHANGE



TIP: *.md : Markdown format, frequently used for formatted documentation on GitHub

ERRATA

- Collaborative repository location updated!
- Be sure to use the *itsASmallMagneticWorld* repository if you are following the video examples to contribute changes.



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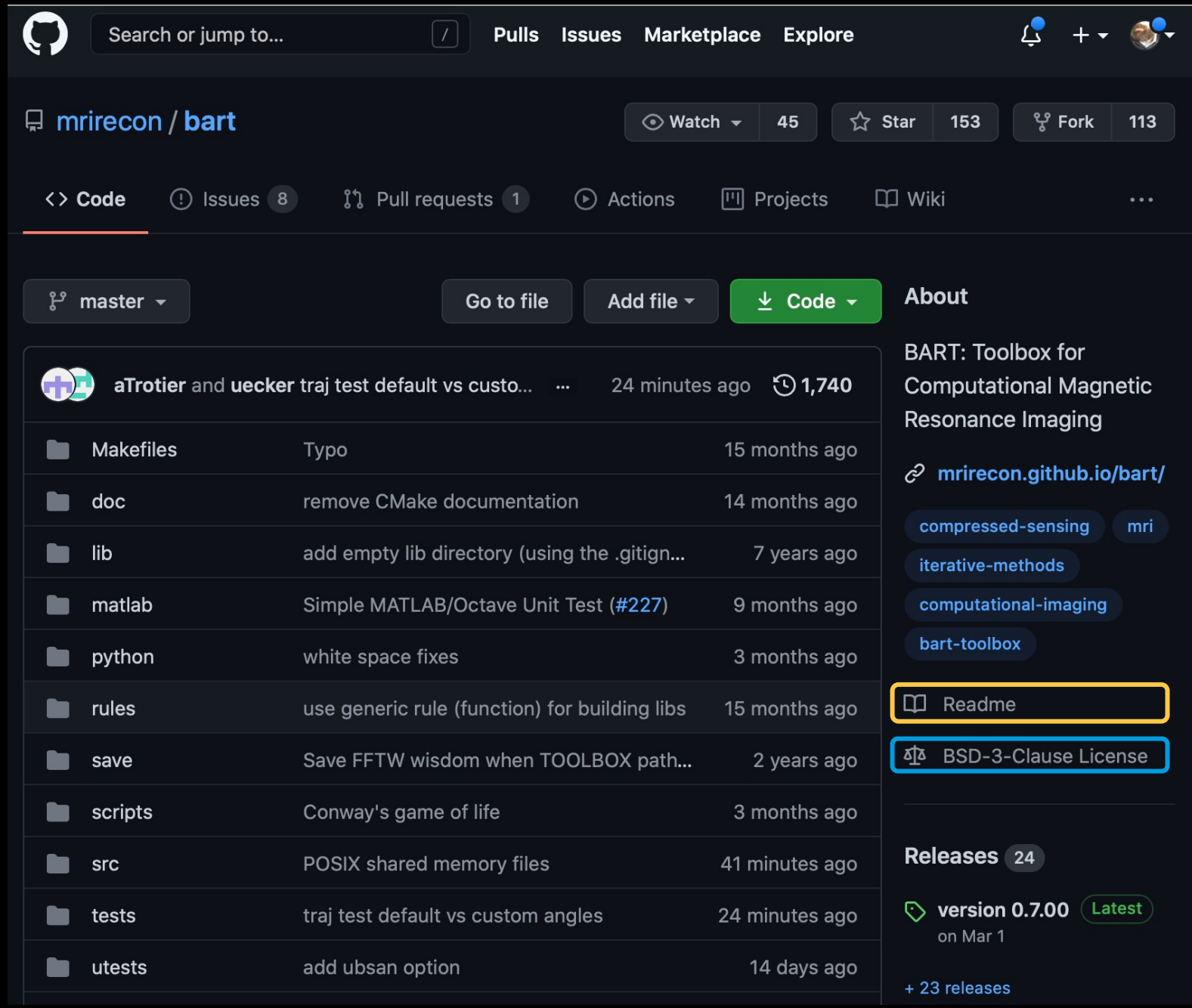
GETTING STARTED

Working with a project

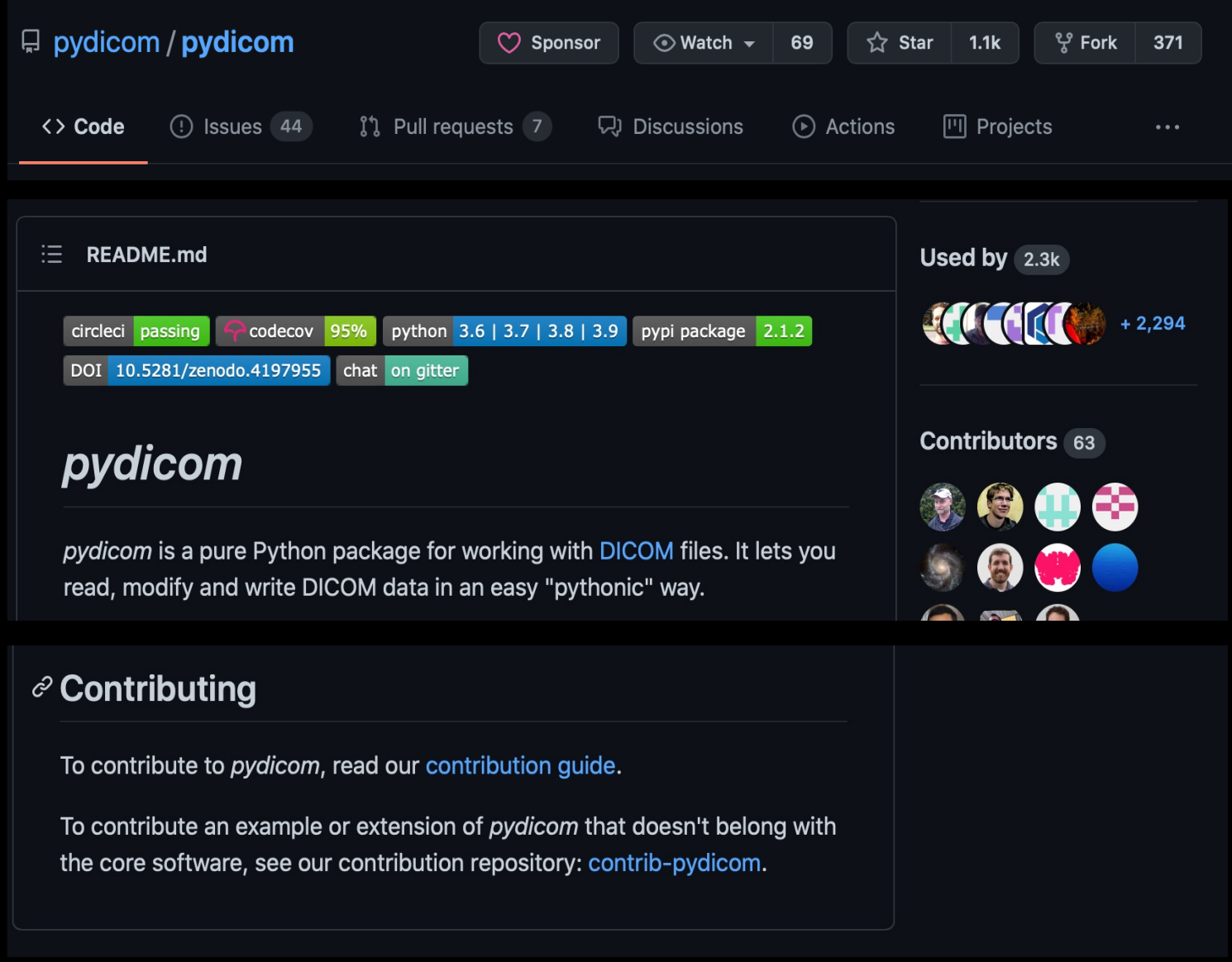
WORKING WITH A PROJECT

- A good place to start is the project's page on GitHub
- All code on GH is organized by *project/repository,* here *mrirecon/bart*
  - *project* is sometimes an individual *user*
- Check for two things right away:
  - Readme
  - License



WORKING WITH A PROJECT

- The *Readme* file will frequently have a section on contributing.
- Read and adhere to a project's contribution guidelines.
- Given a project, and knowing how/where they would like contributions, let's explore different types of contributions.



3 WAYS TO CONTRIBUTE

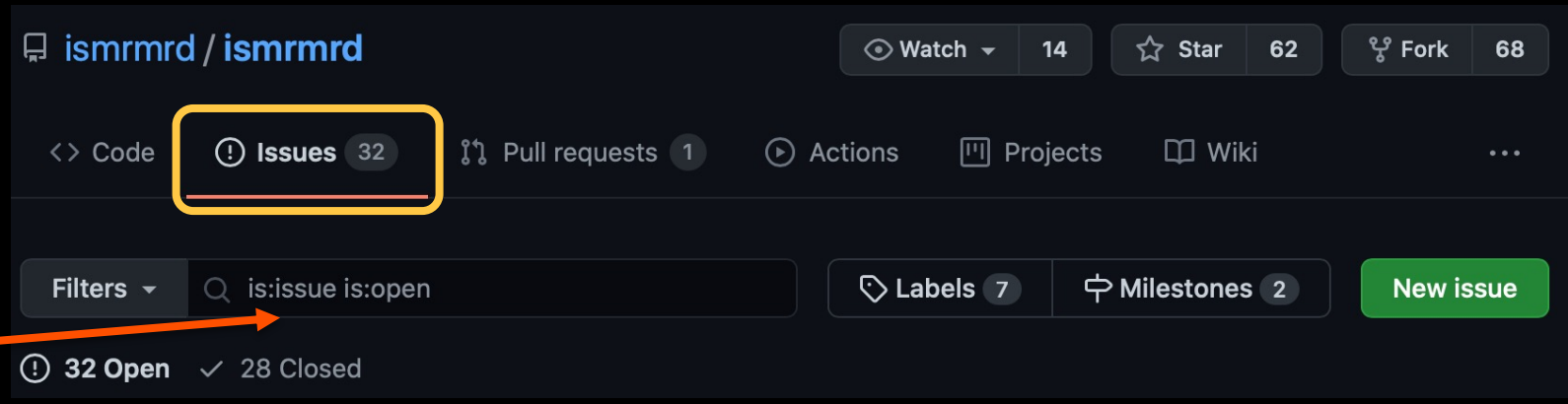
CONTRIBUTING

- Any level of user can meaningfully contribute to an open-source project.

- End users (not necessarily programmers)
  - Documentation improvements or additions [Pull requests]
  - Report issues, or provide feature requests [Issues or Discussions]
- Developers (users of a software library, for example)
  - Provide bug fixes [Pull requests]
  - Implement new features [Pull requests]
- Team members (Originators or collaborators on the project)
  - Review and address bug reports / feature requests [Issues & Pull requests]
  - Discuss and plan future developments [Discussions / Wiki]

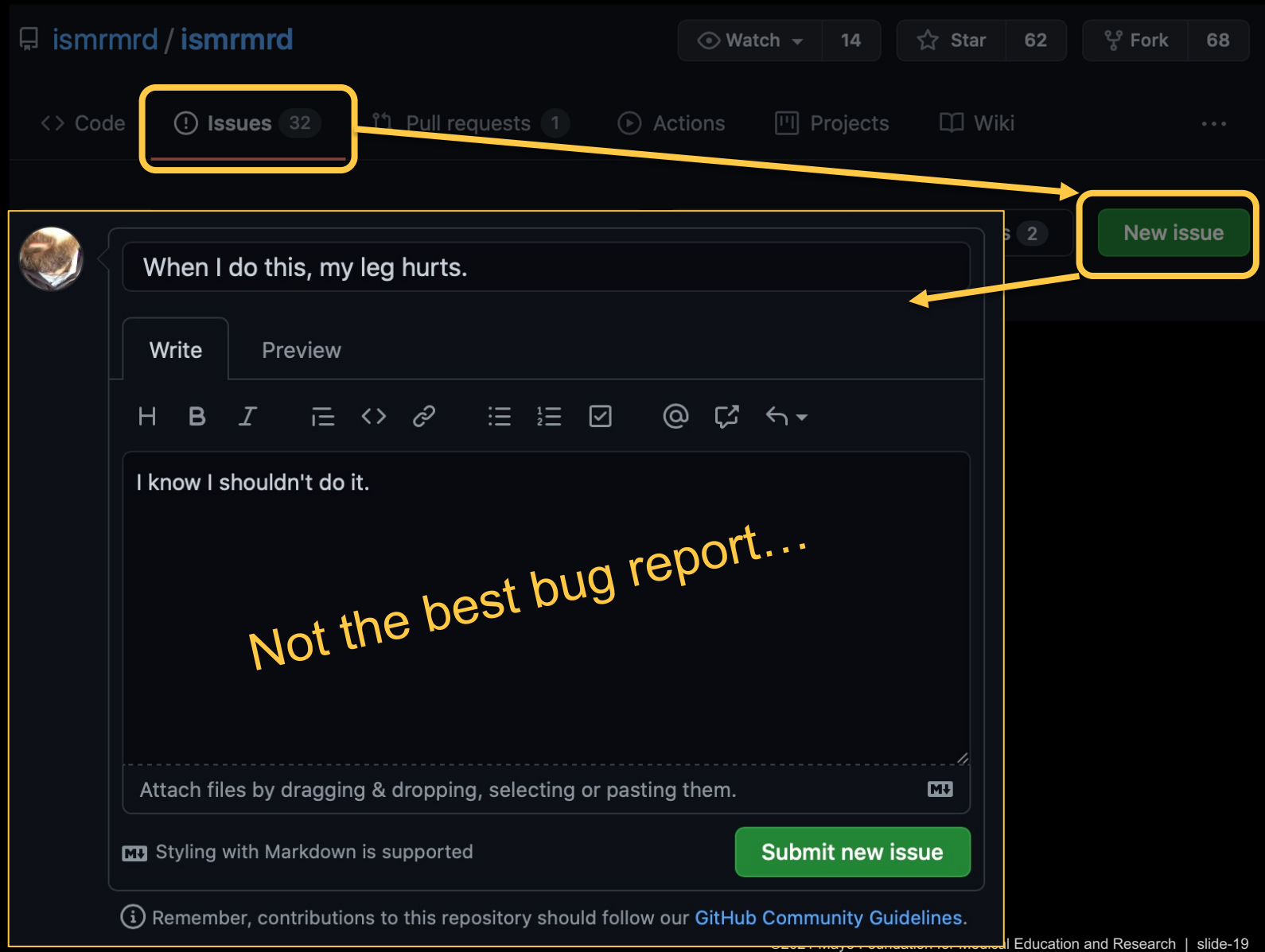
SUBMITTING ISSUES OR ENHANCEMENTS

- *Issues* are typically used both for *bug reports* and *enhancements* (feature requests)
- Always search for *existing* issues or suggestions that are similar or duplicates of your own.
  - Even adding a “me too” note to an existing issue helps inform the project that multiple users are impacted
  - Avoiding duplicates makes prioritizing and addressing issues easier



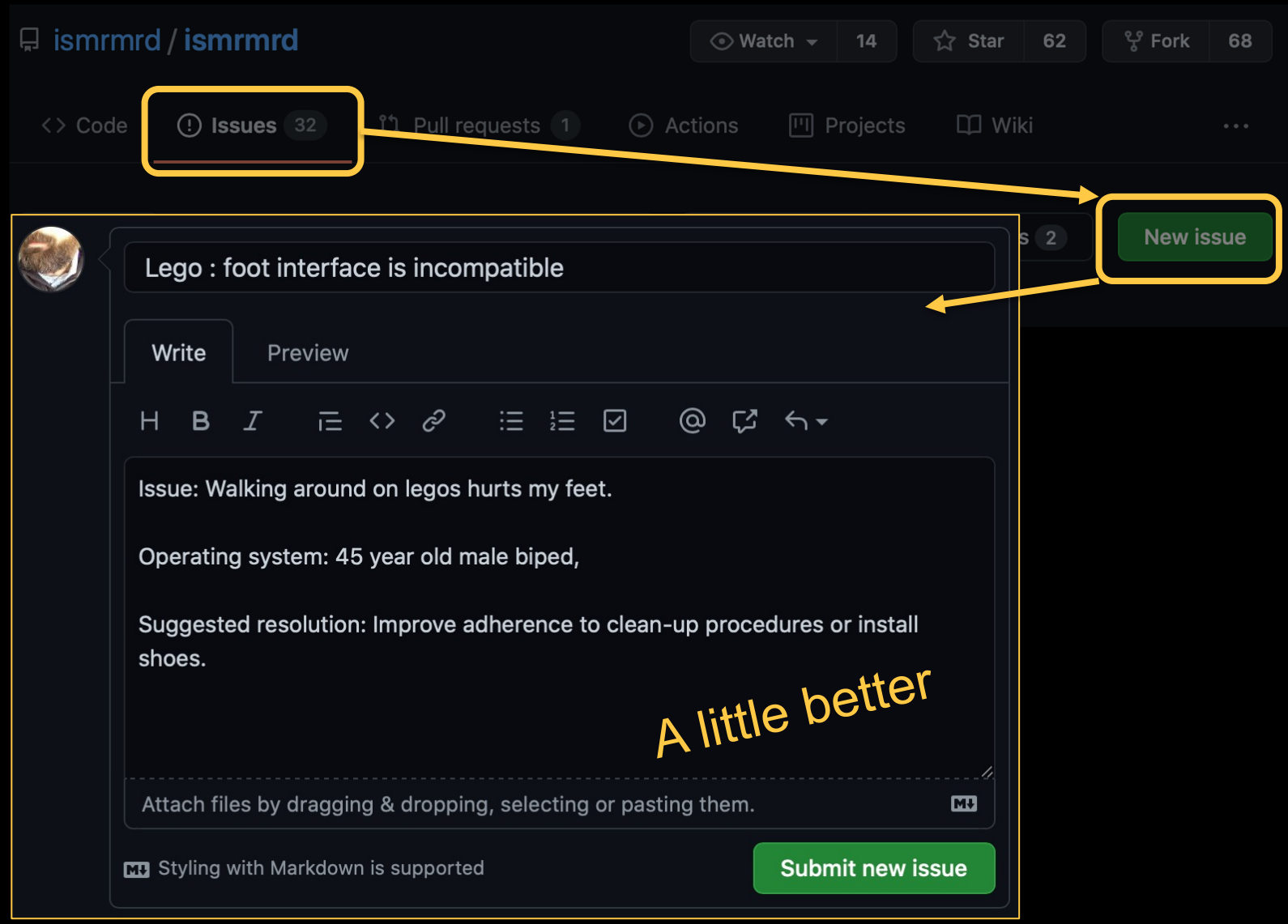
SUBMITTING ISSUES OR ENHANCEMENTS

- When you are satisfied this is a new issue or enhancement, create a new issue.
- Make your subject line as descriptive as possible (while keeping it short)



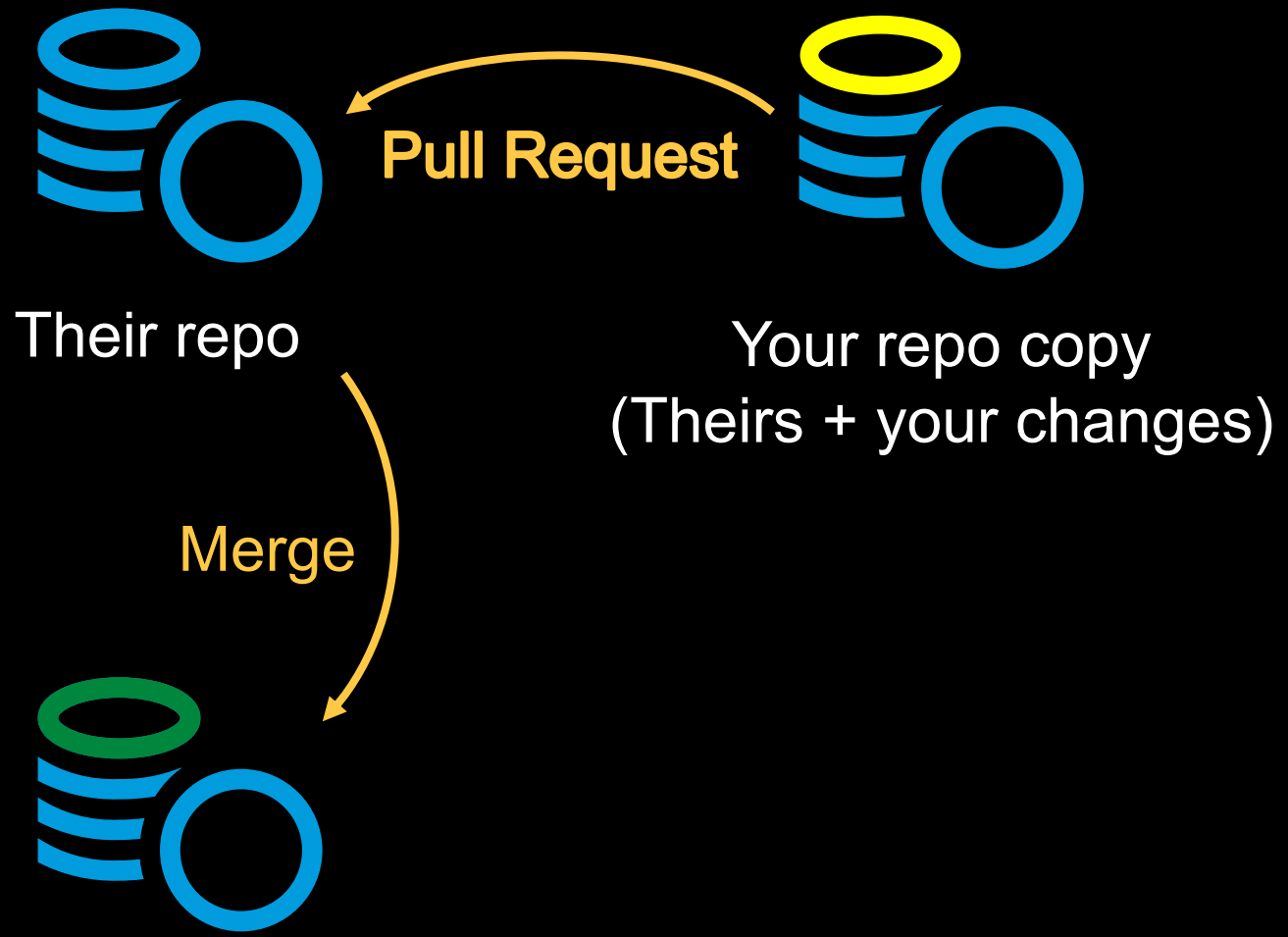
SUBMITTING ISSUES OR ENHANCEMENTS

- When you are satisfied this is a new issue or enhancement, create a new issue.
- Make your subject line as descriptive as possible (while keeping it short)
- For bug reports:
  - try to include a *reproducer*
  - Include the specifics of how you are using the software. Operating system (and version), software version, etc.
  - If you have thoughts on how the bug can be resolved, include those, too!
  - Many projects will have an issue template to fill out



PULL REQUEST : PREVIEW

- We will come back to this…



4 COLLABORATING WITH GIT: KEY CONCEPTS & PRACTICES

KEY GIT TERMS AND RELATED COMMANDS

Repository : `git clone <remote>`

A set of files with a recorded history of states; stored in a `.git/` directory at the top-level of the on-disk directory tree.

[A] commit : `git log` shows history

An atomic record (snapshot*) of file state / contents at a point in time.

[To] commit : `git commit –m <msg>`

The act of creating a commit from a (typically staged via *git add*) selected state.

remote : `git remote –v` lists remotes

A repository hosted somewhere other than the current directory tree; frequently on github or gitlab. Common names: *origin* or *upstream*. Using `git clone <remote>` to initialize a repository automatically sets *origin* to the source URL.

A repository can have multiple remotes set via: `git remote add <name> <URL>`

A *remote* can be updated to match the latest version via `git fetch <name>`

branch : `git branch –v` lists branches

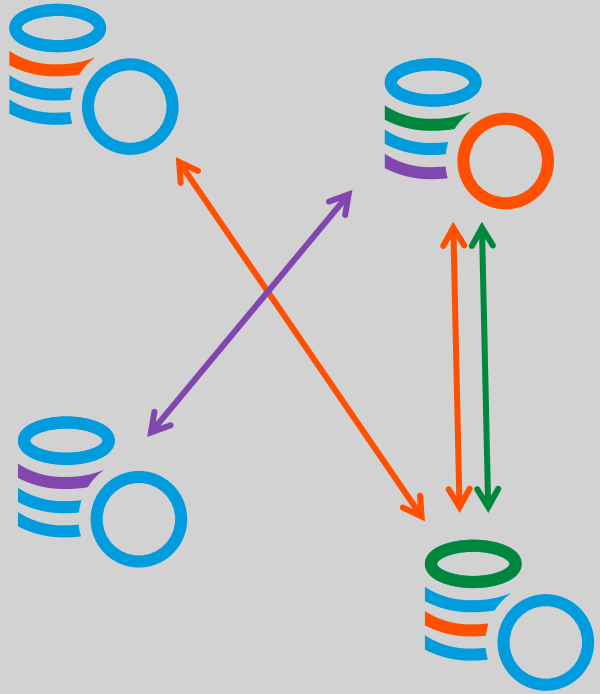
One of potentially multiple views of a repository state. The primary branch is typically named either *main* or *master*, and you can switch branches with `git checkout <name>`

A new branch with can be created with `git checkout -b <new_name> <origin>`, where *origin* can be a *remote/branch*, or omitted to refer to the current (HEAD) state.

* Internally, a git commit describes the state of files at a point in time (a snapshot); diffs (changes) can be calculated between different snapshots with related content.

GIT: *DISTRIBUTED* VERSION CONTROL

- Built from the ground-up for distributed version control
- *git* helps you manage and distribute your changes, but doesn't impose many restrictions
- Some best practices when collaborating with others:
  - Perform development on a local branch rather than *main (master)*
  - Rebase your development branch against *upstream* frequently
  - Stage commits to upstream in a *feature branch* (the first step to a *pull request*)



GIT COLLABORATION BEST PRACTICES: WORK IN A LOCAL DEVELOPMENT BRANCH

- Avoid working directly in the *main* (*master*) branch
  - The *main* branch should be updated on GitHub via *pull requests,* which *merge* in *commits* from a *feature branch*
- After cloning the remote repository, immediately checkout a local development branch with `git checkout –b <branch name> <starting point>`
  - -b: Checkout the requested starting point (*origin/master* below) as a local branch with the provided name (*lcl_dev*)
  - Note that the branch will be set to *track* the provided starting point (here origin/master)

```
~/s/external $ git clone https://github.com/ismrmrd/ismrmrd.git
Cloning into 'ismrmrd'...
<snip>
~/s/external $ cd ismrmrd/
~/s/e/ismrmrd (master|✓) $ git checkout -b lcl_dev origin/master
Branch 'lcl_dev' set up to track remote branch 'master' from 'origin'.
Switched to a new branch 'lcl_dev'
```

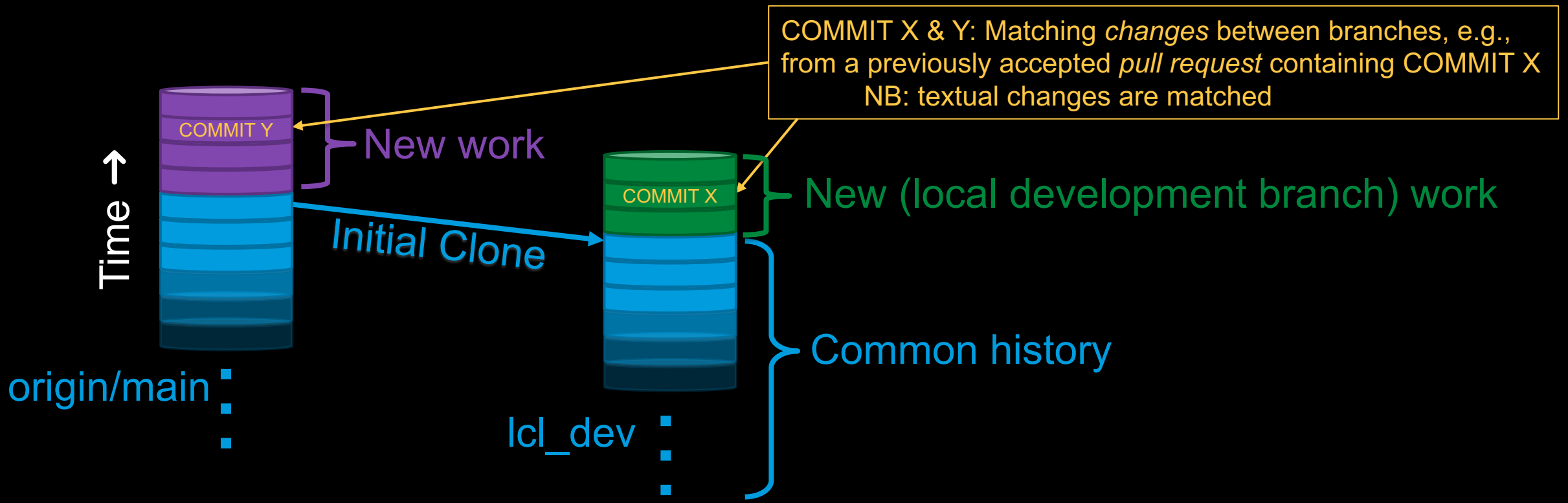
TIP: While my examples use the command line, there are excellent GUIs available!

GIT COLLABORATION EXAMPLE: WORK IN A LOCAL DEVELOPMENT BRANCH

```
~/s/e/ismrmrd (lcl_dev|✓) $ echo 'THIS IS A CHANGE' >> README.md
~/s/e/ismrmrd (lcl_dev|+1) $ git add README.md
~/s/e/ismrmrd (lcl_dev|●1) $ git commit -m "Testing a change"
[lcl_dev 515b6f4] Testing a change
 1 file changed, 1 insertion(+)

~/s/e/ismrmrd (lcl_dev↑1|✓) $ git log
commit 515b6f43a5a700630f6cec7bc7c0b7382bfa83b2 (HEAD -> lcl_dev)
Author: Eric A. Borisch <borisch.eric@mayo.edu>
Date:   Mon Apr 12 11:39:19 2021 -0500

    Testing a change

commit c86c89cfcee43e4ce1c146f6e4817dc2e06b2e63 (origin/master, origin/HEAD, master)
Author: Michael Hansen <mihansen@microsoft.com>
Date:   Sat Feb 20 09:54:28 2021 -0800

    Fixed all warnings and treating warnings as errors on Windows (#171)
```

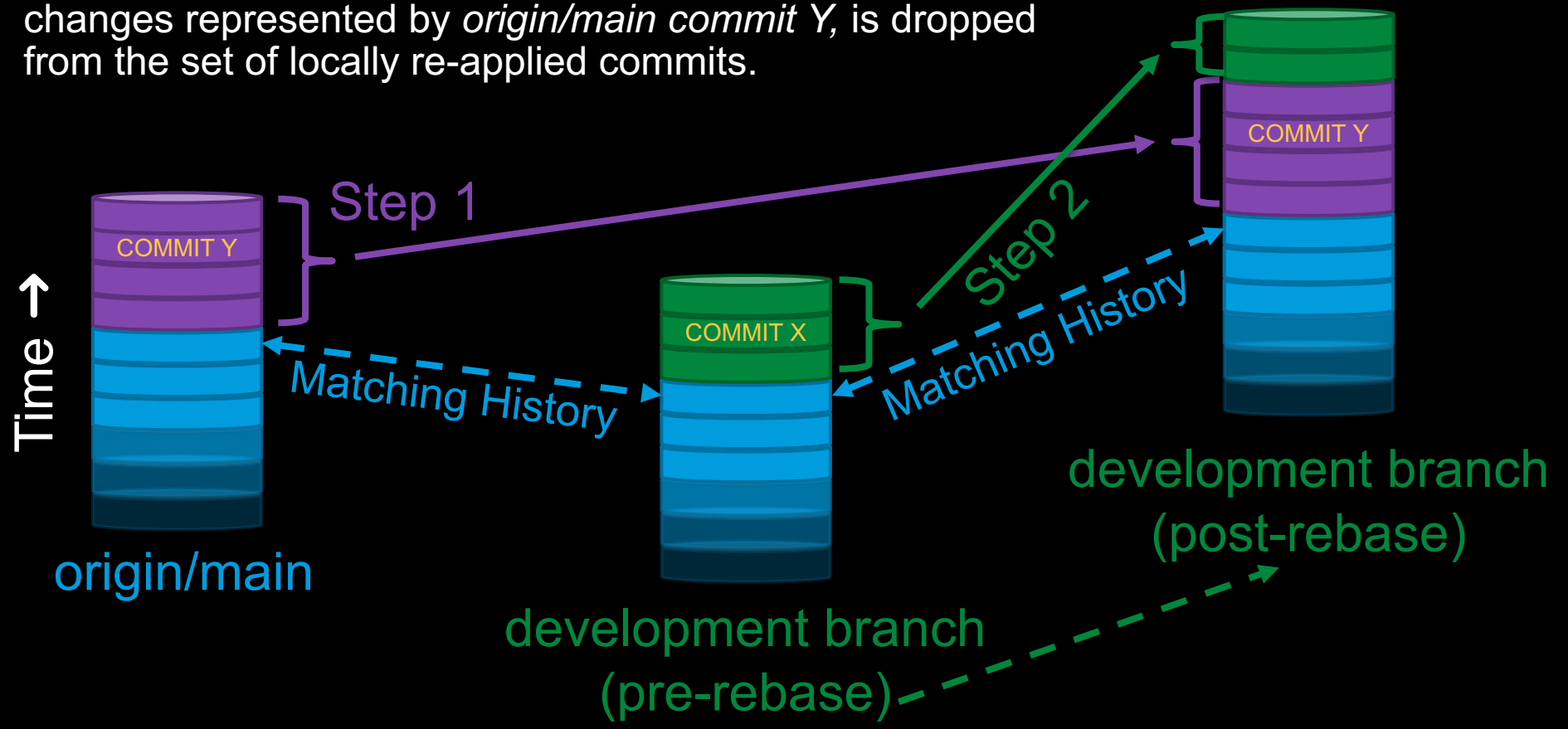

GIT COLLABORATION BEST PRACTICES: REBASE DEVELOPMENT BRANCH FREQUENTLY

- Rebasing pulls new changes from the upstream repository, and replays local changes *on top of* them, in order.
- Matching sets of textual changes that exist in the upstream branch are skipped during replay



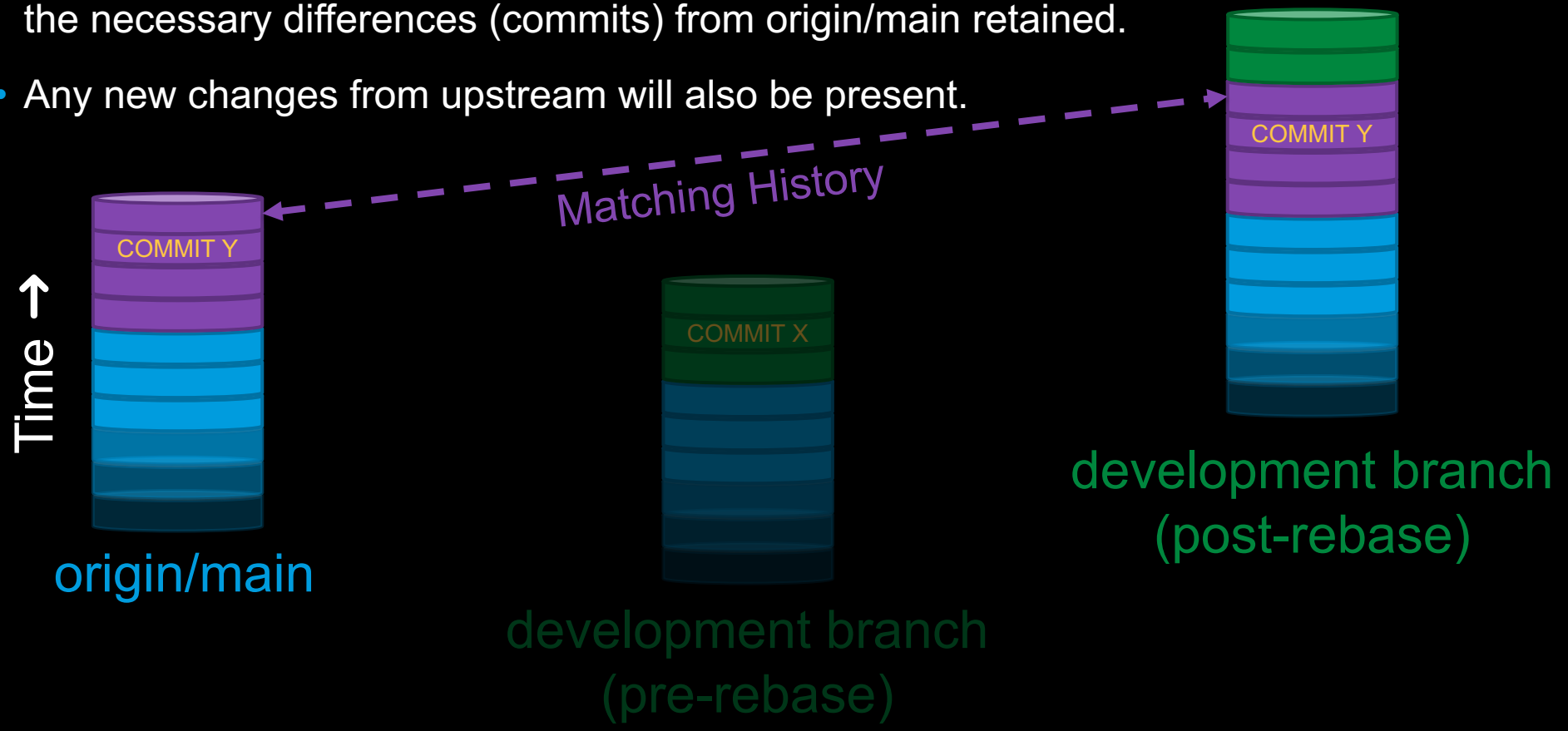
GIT COLLABORATION BEST PRACTICES: REBASE DEVELOPMENT BRANCH FREQUENTLY

- `git fetch origin && git rebase origin/main` or `git pull --rebase origin main`
- During *step 2*, the *local commit* X, which matches the changes represented by *origin/main commit Y,* is dropped from the set of locally re-applied commits.



GIT COLLABORATION BEST PRACTICES: REBASE DEVELOPMENT BRANCH FREQUENTLY

- `git fetch origin && git rebase origin/main` or
  `git pull --rebase origin main`
- After completion, your local changes are still present, but with only the necessary differences (commits) from origin/main retained.
- Any new changes from upstream will also be present.



GIT COLLABORATION BEST PRACTICES: STAGE COMMITS IN A FEATURE BRANCH

- When preparing to submit a set of local changes related to a common feature, create a new branch named for the feature, and stage commits within the branch.
  - You will *push* this branch to GitHub and create a *pull request* (into *main*, for example) on GitHub when it is ready.

- There are multiple ways to do this, the simplest is to create a new branch based on origin/master and implement the feature directly in a set of commits.

- If you've already implemented the changes as a set of commits in *lcl_dev*, either:
  - Create a new branch based on origin/master, and *git cherry-pick* desired commits into it. [Shown on next slide.]
  - Create a new branch based on the *lcl_dev* and perform an *interactive rebase* onto origin/master, retaining only those commits related to the feature.

GIT COLLABORATION EXAMPLE: STAGE COMMITS IN A FEATURE BRANCH

```
~/s/e/ismrmrd (lcl_dev↑2|✓) $ git log --pretty=oneline --abbrev-commit
0287081 (HEAD -> lcl_dev) Unrelated change
515b6f4 Testing a change
c86c89c (origin/master, origin/HEAD, master) Fixed all warnings and treating warnings as
errors on Windows (#171)
1d042ab Added windows workflow (#170)

~/s/e/ismrmrd (lcl_dev↑1|✓) $ git fetch origin
<snip>
~/s/e/ismrmrd (lcl_dev↑2|✓) $ git checkout -b new_feature origin/master
Branch 'new_feature' set up to track remote branch 'master' from 'origin'.
Switched to a new branch 'feature'

~/s/e/ismrmrd (new_feature|✓) $ git cherry-pick 515b6f4
[new_feature 27249af] Testing a change
 Date: Mon Apr 12 11:39:19 2021 -0500
 1 file changed, 1 insertion(+)

~/s/e/ismrmrd (new_feature↑1|✓) $ git log --pretty=oneline --abbrev-commit
27249af (HEAD -> new_feature) Testing a change
c86c89c (origin/master, origin/HEAD, master) Fixed all warnings and treating warnings as
errors on Windows (#171)
1d042ab Added windows workflow (#170)
```

GIT COLLABORATION EXAMPLE: STAGE COMMITS IN A FEATURE BRANCH [+PUSH?]

- We've done our work in a development branch
- We've rebased onto (latest; after a `git fetch origin`) origin/master
- We've created a feature branch with just the commits we want.
- Time to push now, RIGHT?

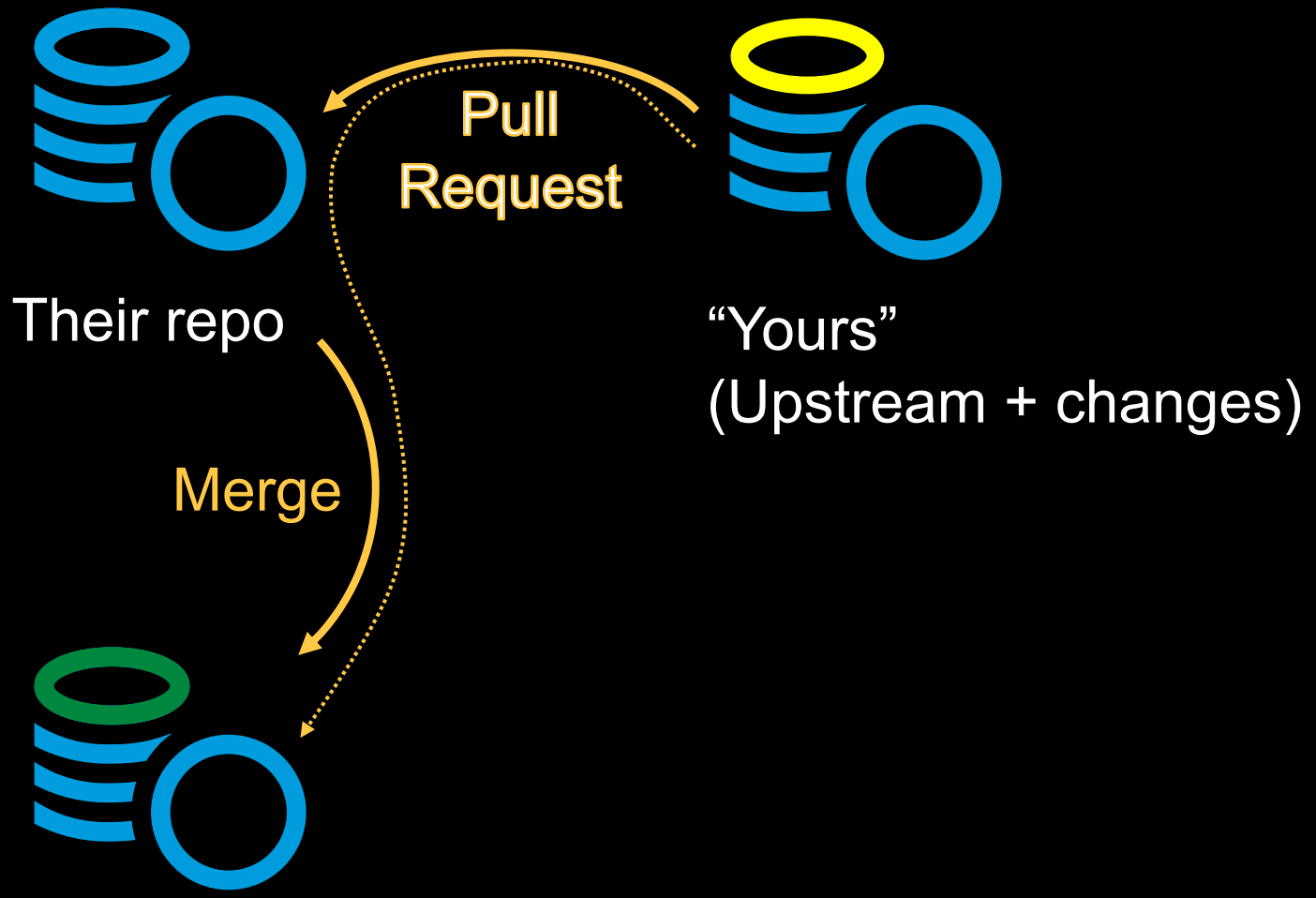
```
~/s/e/ismrmrd (new_feature↑1|✓) $ git log --pretty=oneline --abbrev-commit
27249af (HEAD -> new_feature) Testing a change
c86c89c (origin/master, origin/HEAD, master) Fixed all warnings and treating warnings as
errors on Windows (#171)
1d042ab Added windows workflow (#170)

~/s/e/ismrmrd (new_feature↑1|✓) $ git push origin new_feature
ERROR: Permission to ismrmrd/ismrmrd.git denied to eborisch.
fatal: Could not read from remote repository.


Please make sure you have the correct access rights
and the repository exists.
```


5 CONTRIBUTING TO A GITHUB PROJECT

PULL REQUEST : OVERVIEW

- *Pull requests* are the fundamental unit of collaboration for code modifications on GitHub.
- Encapsulates a set of changes (*commits*) that you have made to *your copy* of the repository along with a *request* to *pull* those changes into the *upstream* (the project's) repository, all with an online location to:
  - track the request
  - discuss the changes
  - modify the requested changes

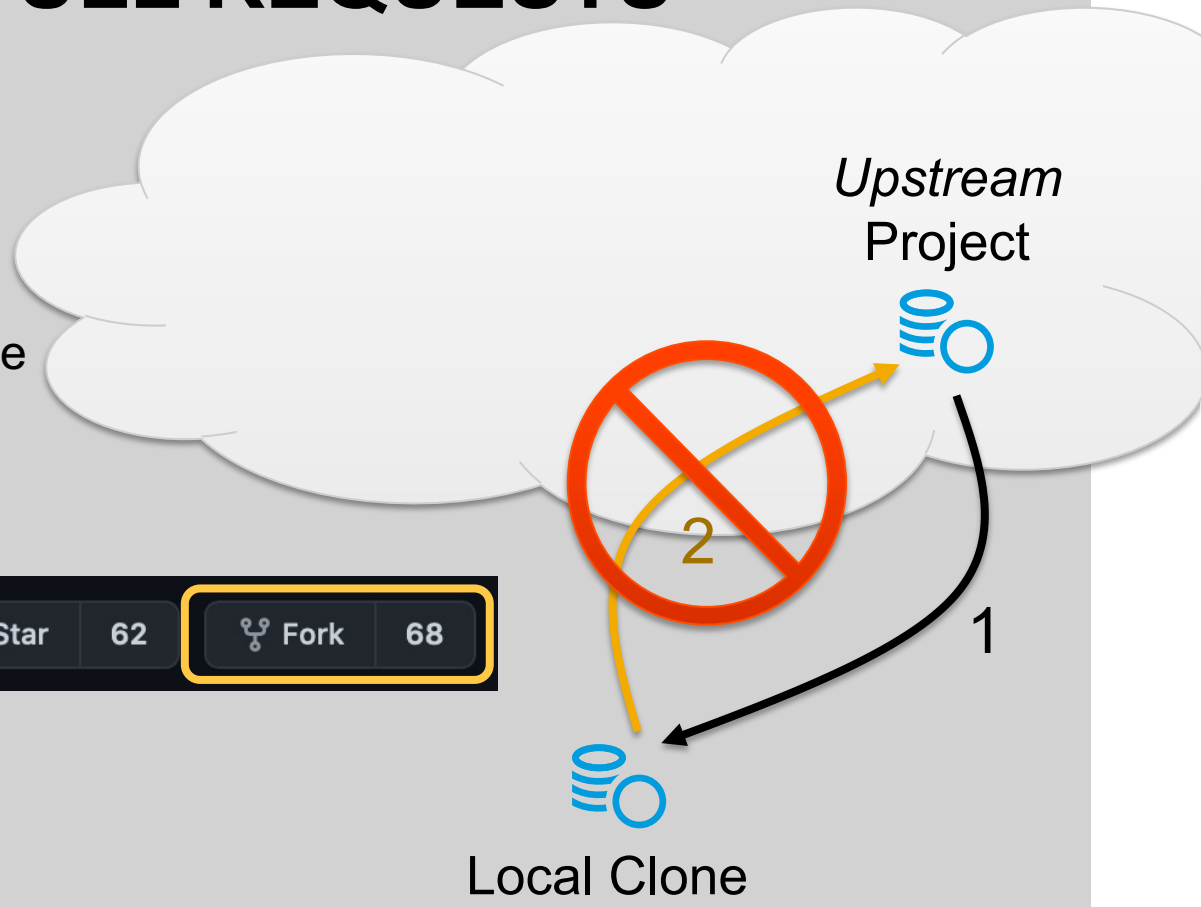
  etc.
- If the project accepts your changes, a *merge* is performed to apply your changes to the project's repository.



GITHUB CONTRIBUTIONS: PULL REQUESTS

1. We've started with a clone of a GitHub project
2. We prepared our local *feature branch* and tried to push it back to the project, but that was rejected due to permissions. (We don't have write access.)

   Solution? A "Fork".

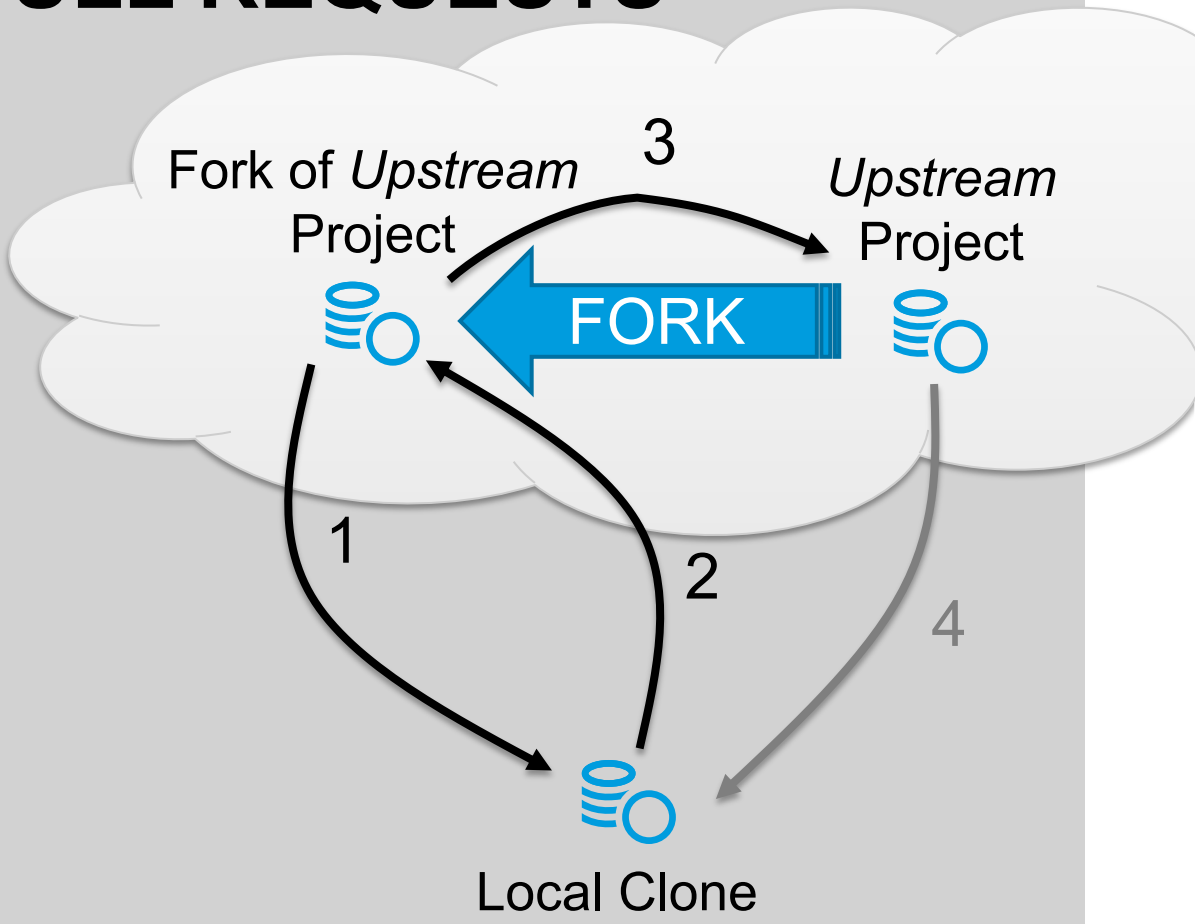


GITHUB CONTRIBUTIONS: PULL REQUESTS

"Fork" the project to your account on GitHub, then start with the same steps ...

1. Clone (the fork) to your local system
   - Create *feature* branch; modify; commit. (repeat modify/commit as needed)
2. Push *feature* branch to our fork
3. Create a *pull request* to *merge* your *feature branch* into the *upstream* project
   - Will become part of *upstream* when they choose to *merge* it
4. Add *upstream* remote to facilitate future *pulls* of the latest changes :

```
git remote add upstream <URL>
```

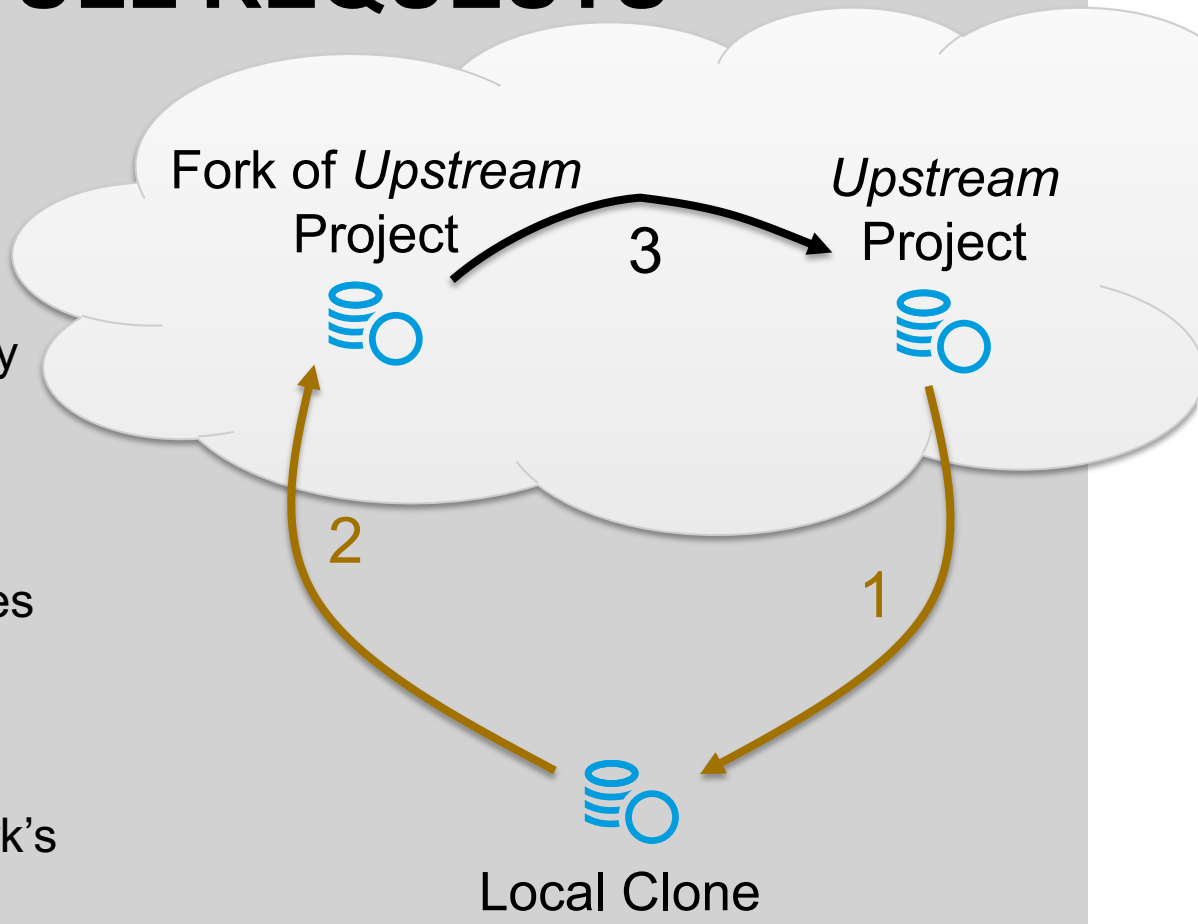


GITHUB CONTRIBUTIONS: PULL REQUESTS

Once this is established, new work is more direct:

Create a new local *feature branch*; modify; commit. (Repeat modify/commit as needed.) When you're ready to generate a pull request:

1. Perform:
   `git pull --rebase upstream master`
   within the *feature branch* to *pull* in the latest changes
2. Push the *feature branch* to your fork with:
   `git push origin feature`
3. Create (on GitHub) a *pull request* to *merge* your fork's *feature branch* into the *upstream* project



6 “LIVE” DEMONSTRATION

7 FINAL THOUGHTS & FURTHER READING

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SOFTWARE ENGINEERING FOR MR SCIENTISTS

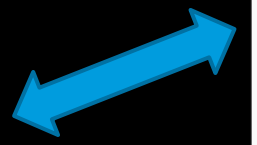
How to use version control:
#E5882 : Megan Poorman

How to be part of a large software project:
#E5883 : Eric Borisch

Wednesday, May 19
17:00 - 18:00 UTC

FURTHER READING

- These slides:
  https://github.com/eborisch/ISMRM/blob/main/2021/Open-source.pdf
- Configuring SSH keys for working with GitHub
  https://docs.github.com/en/github/authenticating-to-github/connecting-to-github-with-ssh
- Online git reference documentation:
  https://git-scm.com/docs
- A nice overview on different ways to contribute to OSS:
  https://opensource.guide/how-to-contribute/
- The git “choose your own adventure” or “oops I did X, how do I fix it?”:
  http://sethrobertson.github.io/GitFixUm/fixup.html
- One of many “cheat-sheets” out there:
  https://www.atlassian.com/git/tutorials/atlassian-git-cheatsheet
- Markdown format:
  https://guides.github.com/features/mastering-markdown/
- GUI interfaces to git:
  https://git-scm.com/downloads/guis



Questions?

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