Intro to Git/Github

Source control for research software development.

What I hope you take away.

- The value of Source control
- A github.com repo
- A basic understanding of the technology and tools
- Ability to update files in a repo
- Create and merge branches.

Topics

- General
  - What is source control?
  - Why source control?
  - What is git?
  - What is github?
- Working with Git
  - Tools
    - git command line
    - github website
- Demo and walkthrough

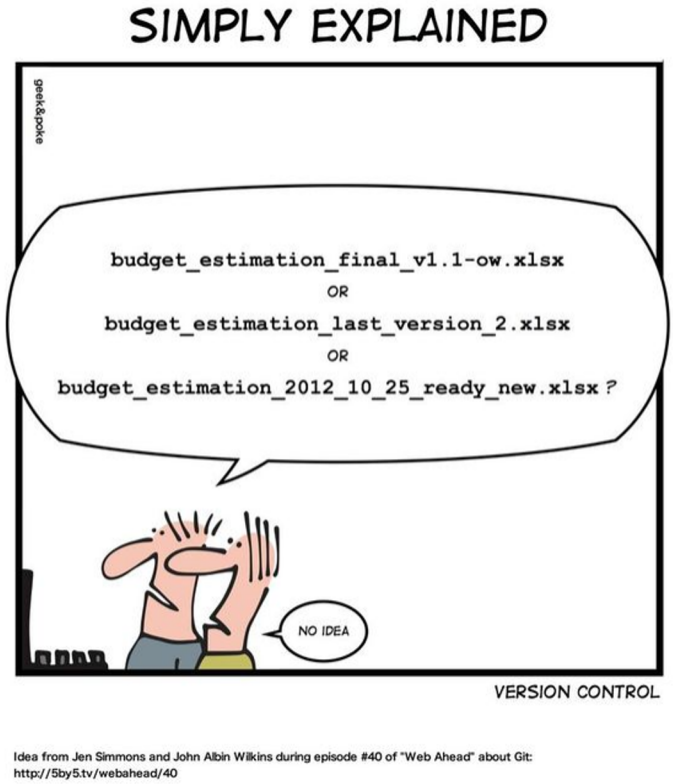
https://xkcd.com/1597/

What is source control?

“A component of software configuration management, version control, also known as revision control or source control, is the management of changes to documents,” - wikipedia (version control)

- track changes
- account for changes
- undo changes

Why source control?



Idea from Jen Simmons and John Albin Wilkins during episode #40 of "Web Ahead" about Git: http://5by5.tv/webahead/40

Versioning

What is the most current copy

History

The value of change over time

Accountability

Who made what changes when

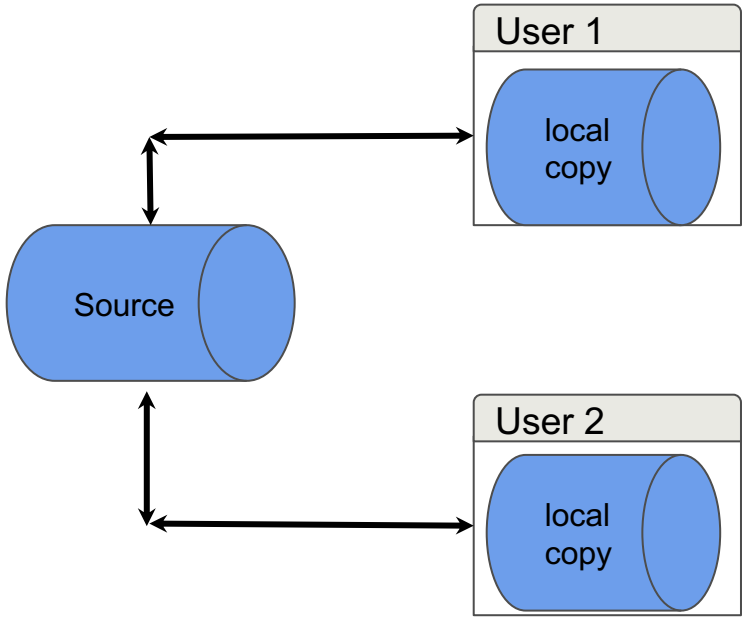
Context

Why was a change made

What is git?

Git is a distributed version control system.

- Central repository is not required
- Every user gets a full copy of the repo including history
- Changes can be branched and merged from any point
- Collaboration is built into the structure
- Originally created by Linus Torvalds to manage the Linux kernel code



What is github?

www.github.com

Repo management service

Free for individual users and educational groups

Additional tools for automation and collaboration

There are many alternatives to github including self hosted services but github is by far the most popular.
Github.com is currently owned by Microsoft.

The Zen of Git

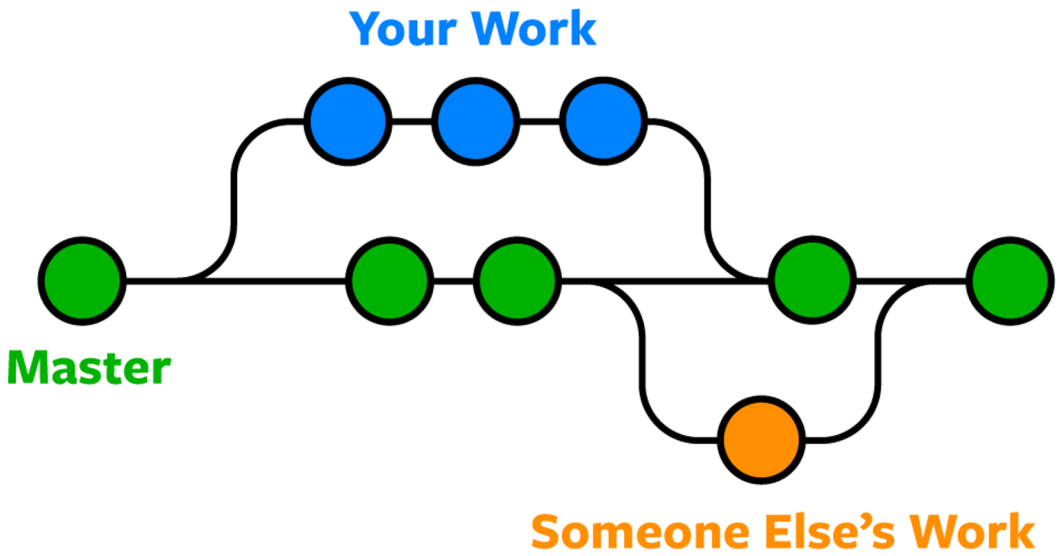
- Git uses a tree structure to visualize and organize states of code
  - Your main branch could be thought of as the “trunk”, and your other branches represent new features, code, etc.
- Git operates on a model of Push and Pull
  - Pull changes from your source to your local copy
  - Push changes from your local copy to your source

Collaboration

Collaboration in source control is the ability for multiple people to work on the same code at the once.

For this class we will use the git branch and merge model.

Rough depiction of this workflow.

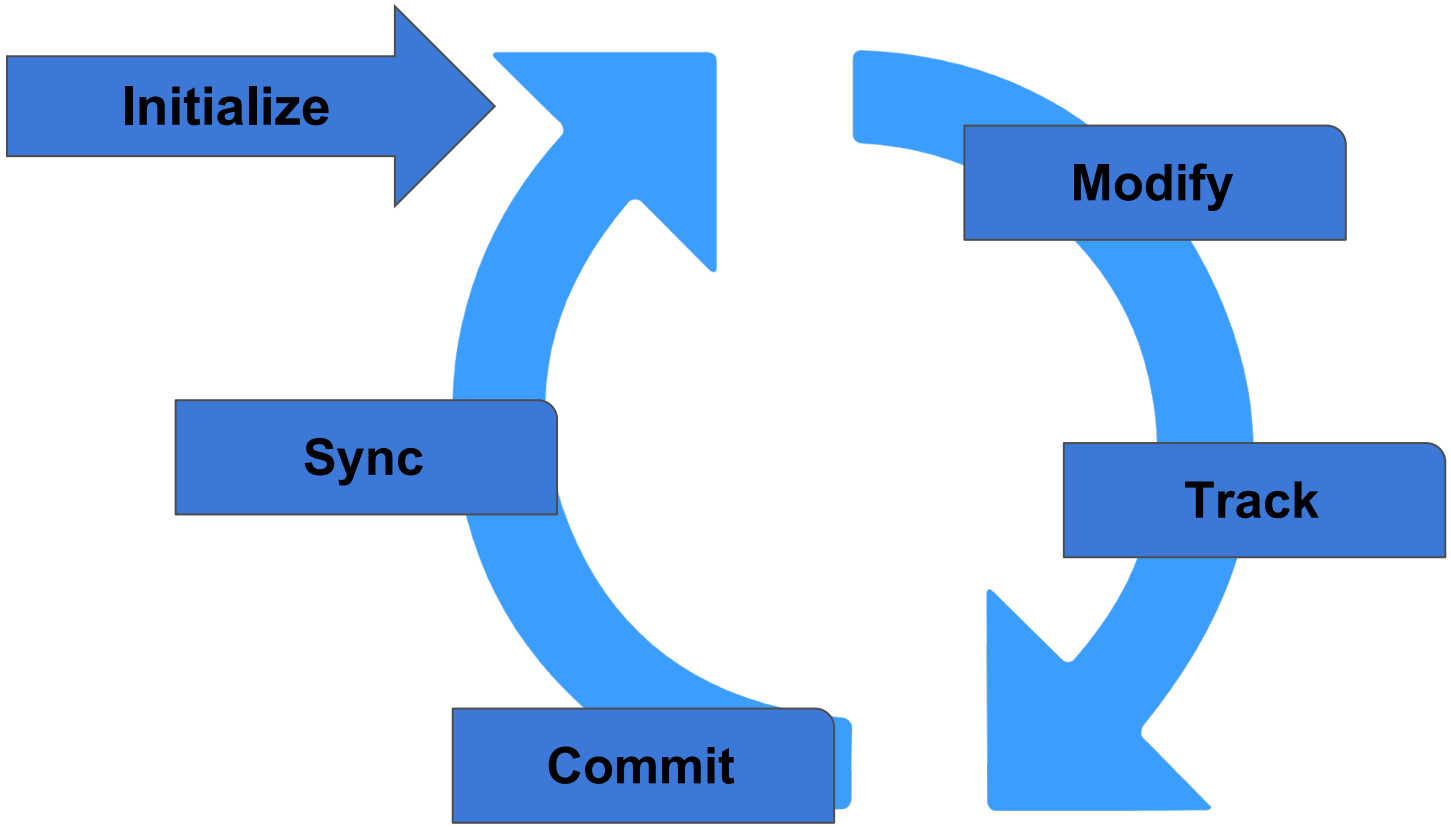


Git tools

Where to get git.

- https://git-scm.com/downloads
- `homebrew install git`
- `sudo yum install git`
- `sudo apt-get install git`
- Already available on all o2 nodes
- https://hub.github.com/ - command line enhancements
- https://git-scm.com/downloads/guis - graphical git

Version control lifecycle



Essential Git Commands

- `git clone`
- `git checkout`
- `git add`
- `git commit`
- `git pull`
- `git push`
- `git status`
- `git branch`

git clone – Cloning a repository

- clone is used to make a copy of an existing repository
- When you create a repository on GitHub, you'll need to clone it to your local machine to start developing with it
- Cloning a repository will download all the files in the most current state
  - But it will also pull the entire history of the repository:
    - changes, deleted files, commit history, etc.

https://git-scm.com/docs/git-clone

git checkout – Switching branches

- Branches are simply different states for your code to be in.
  - This can let you test out new code without affecting the ”main” branch
- `checkout` is how we will switch to other branches

Switch to ’new-feature’ branch

```
git checkout new-feature
```

Create a new branch

```
git checkout -b NEW_BRANCH
```

https://git-scm.com/docs/git-checkout

git add – Track Files in Git

- When you add a file to a git repository, it is not automatically tracked by git
  - This is to prevent unintentional changes to the repository, and prevent some kinds of files from being tracked (e.g. system-specific configuration files)
- You must add a file to git for git to begin tracking that file:

```
`git add new_file`
`git add -A`
```

https://git-scm.com/docs/git-add

git commit – Committing changes

- `commit` is the command used to add a change permanently to the git working tree + history
  - Almost like a checkpoint
- When you look through your git history (`git log`), you're looking through a history of *commits*
- A commit message is **ALWAYS** required!

```
`git commit -am "fixing syntax error"`
```

https://git-scm.com/docs/git-commit

git push – Pushing changes to a remote repo

- Changes to your local git repository are not automatically reflected in GitHub
  - We have to push our changes first
- Each branch in your repository has an “upstream” or “origin”, which identifies the remote repository (and branch) to push the changes to.
  - If you clone a repository, the source you cloned it from is automatically set as the upstream

```
`git push`
```

```
https://git-scm.com/docs/git-push
```

git push (Continued)

- If you create a new branch locally, that branch doesn't exist in GitHub yet. If you try to push a new branch, you'll be greeted with the following:

```
$ git push
fatal: The current branch test_branch has no upstream branch.
To push the current branch and set the remote as upstream, use

    git push --set-upstream origin test_branch
```

You can run the above to push the new branch and set it as the origin

git pull – Pulling changes from a remote repo

- Just like we have to push our changes, we have to pull changes made by others
- If someone pushes changes to your repository on GitHub, those changes are not automatically reflected on your local computer
- In order to get the latest state from a remote repo, you should use git pull

```
`git pull`
```

https://git-scm.com/docs/git-pull

git status – View the status of your local repo

- `status` is a very useful command to view information about the working state of your Git repo. It will show you:
  - The current branch you are on
  - Your branches status relative to the origin (e.g. ahead by *x* commits or behind by *y*)
  - Changes to the working tree
    - untracked files
    - changes to tracked files that are uncommitted

```
`git status`
```

https://git-scm.com/docs/git-status

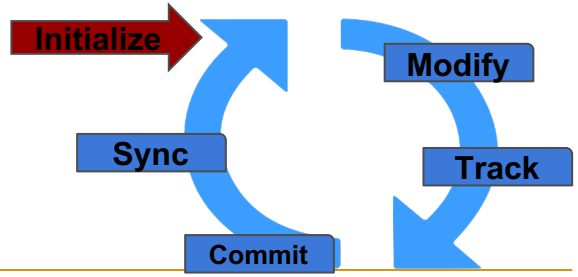
git branch – List and modify branches

- Running git branch will:
  - List the branches on your local machine
  - Show you which branch you're currently on
- You can also use git branch to:
  - Delete a branch
  - Create a new branch

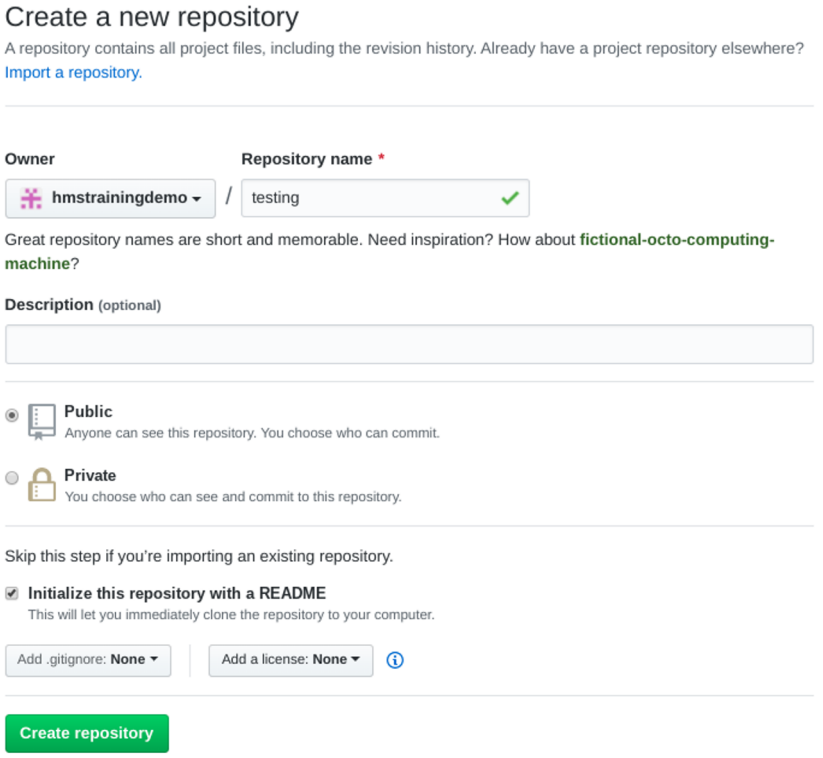
```
`git branch`
`git branch new_branch`
`git branch -D new_branch`
```

https://git-scm.com/docs/git-branch

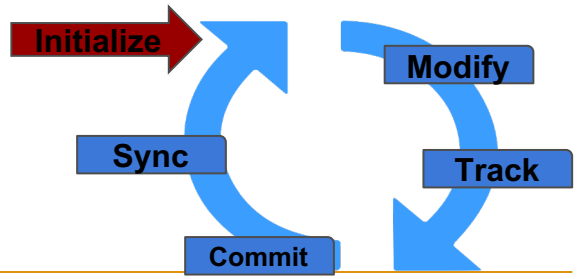
First repo!



- Repo name
- Private repo
- Create Readme
- Click Create repository

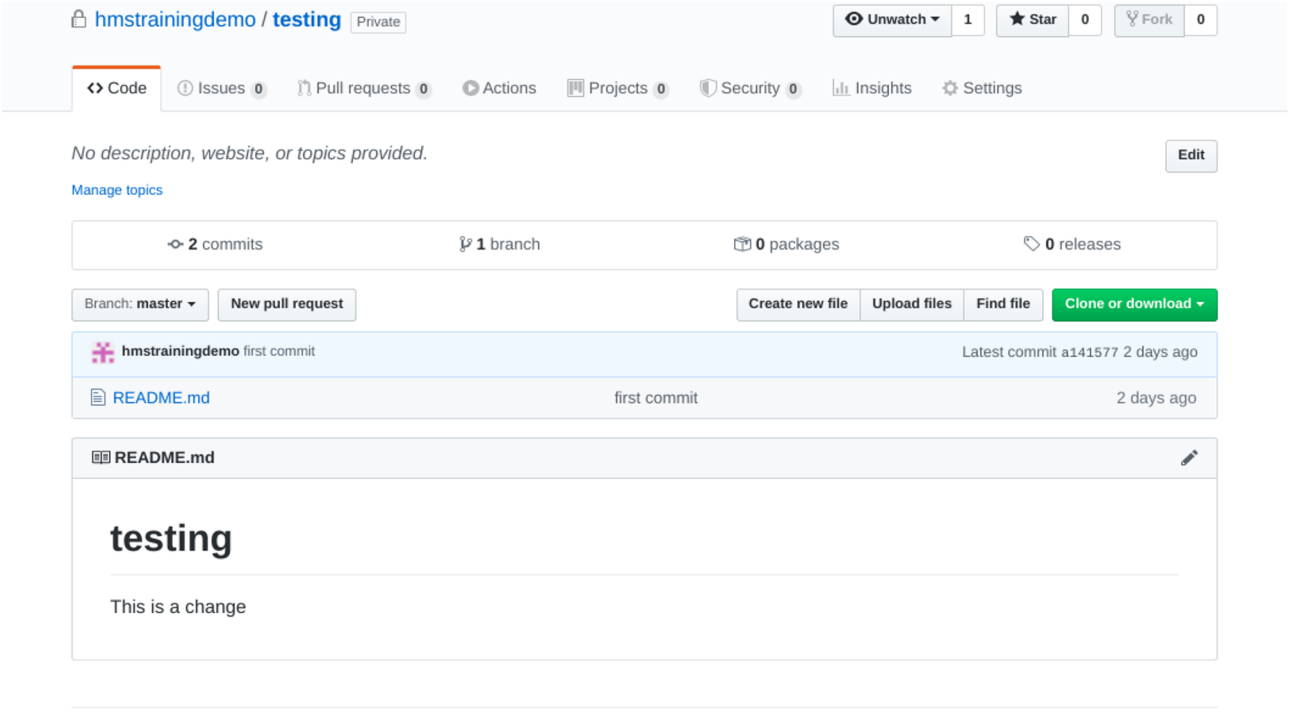


The repository interface



- Tour!

- Edit the Readme file
- Commit changes
- View history



Git config

Get config with `` `git config --list` ``

Setting a user

```
`git config --global user.name "hms training"`
`git config --global user.email hmstrainingdemo@gmail.com`
```

Sets user info for your changes

The `.gitconfig` file in your home directory stores this info

Git config (continued)

Tired of entering your git credentials every time? We can set a credential helper to save us this step.

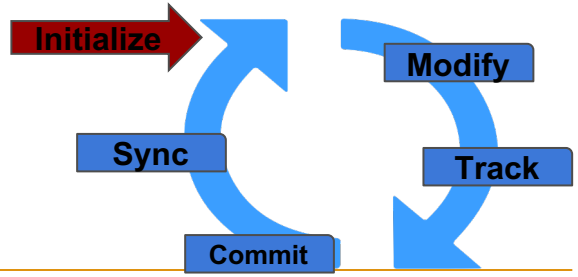
Git includes two credential helpers by default

- cache – caches credentials in memory (recommended)
- store – stores credentials on disk (less secure, not recommended)

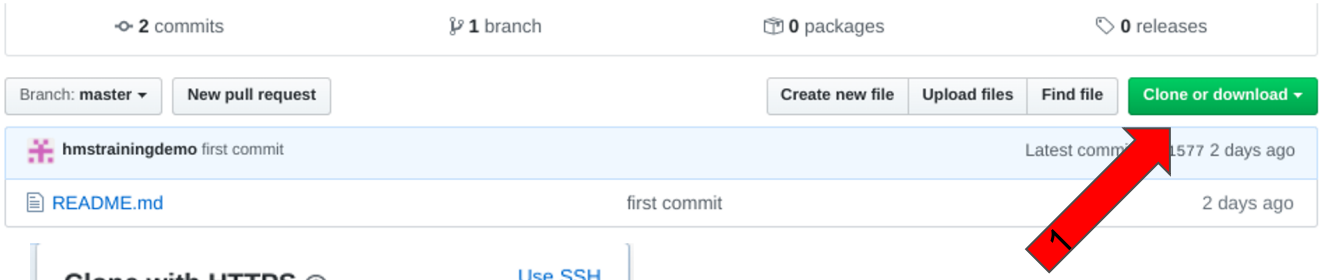
```
`git config –global credential.helper cache`
```

https://docs.github.com/en/github/using-git/updating-credentials-from-the-macos-keychain

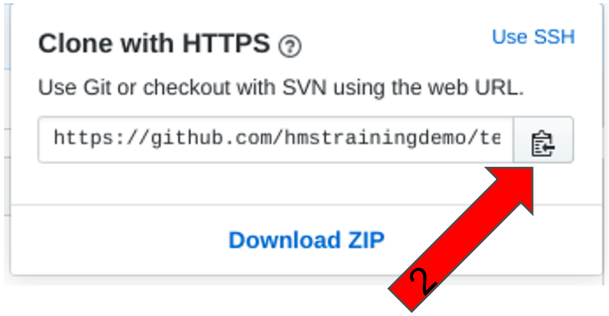
Cloning your repo



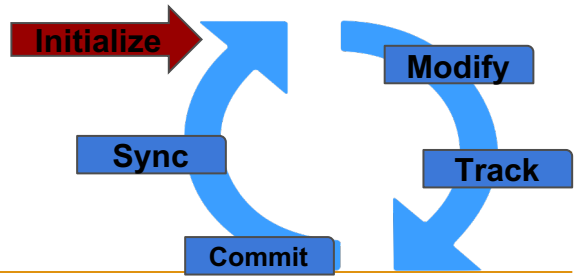
Click “Clone or download”



Click the clipboard icon 



Switch to your terminal and type `` `git clone ` `` and paste in your url (ctrl+v)

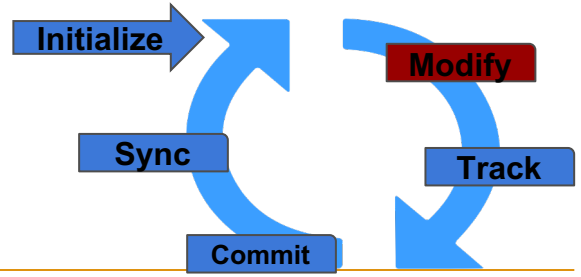


Cloning your repo (cont)

You should see something like this…

```
[gester@project-dev ~]$ git clone https://github.com/hmstrainingdemo
Cloning into 'testing'...
Username for 'https://github.com': hmstrainingdemo
Password for 'https://hmstrainingdemo@github.com':
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 0), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (6/6), done.
[gester@project-dev ~]$ ls
node_modules  testing
[gester@project-dev ~]$ cd testing/
[gester@project-dev testing]$ ls
README.md
```

you can see your new directory, in this case “testing”.
You should also be able to see your `README.md` file inside it.



Git status and making changes

Shows the current state of your copy of a git repo

```
[gester@project-dev testing]$ git status
# On branch master
nothing to commit, working directory clean
[gester@project-dev testing]$
```

Lets update the `README.md` file with;

```
echo >> README.md
echo "This is an update" >> README.md
```

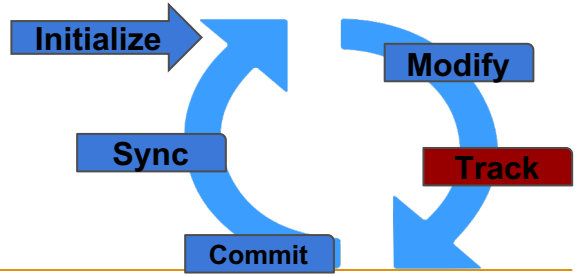
```
[gester@project-dev testing]$ echo >> README.md
[gester@project-dev testing]$ echo "This is an update" >> README.md
```

We can see our updates with `cat`

```
[gester@project-dev testing]$ cat README.md
# testing
This is an update
```

We can now see our `git status` command has changed

```
[gester@project-dev testing]$ git status
# On branch master
# Changes not staged for commit:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified:   README.md
#
no changes added to commit (use "git add" and/or "git commit -a")
[gester@project-dev testing]$
```



Tracking a change

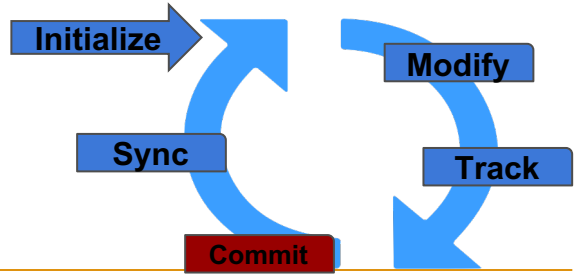
Now we need to let git know we want to keep this change.

First we add it to the list of files we want to commit, this is also called staging.

`` `git add README.md` ``

This produces no output but our `` `git status` `` will change.

```
[gester@project-dev testing]$ git add README.md
[gester@project-dev testing]$ git status
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#       modified:   README.md
#
[gester@project-dev testing]$
```



Commiting the change

Now we need to tell git to save this change in the file history.

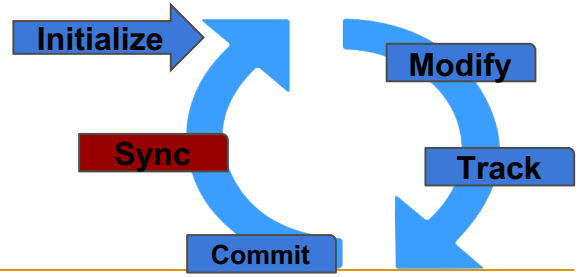
`git commit` allows us to do this.

Commits require a commit message, this allows you to give context to your changes. We will do this with the `-m` flag.

`git commit -m "my first commit"`

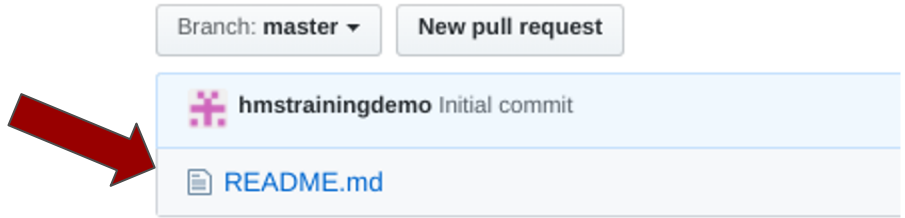
As we should expect now this changes `git status` again.

```
[gester@project-dev testing]$ git commit -m "my first commit"
[master f67ebea] my first commit
 1 file changed, 1 insertion(+)
[gester@project-dev testing]$ git status
# On branch master
# Your branch is ahead of 'origin/master' by 1 commit.
#   (use "git push" to publish your local commits)
#
nothing to commit, working directory clean
[gester@project-dev testing]$
```



Git push

Switching to Github we can click on our file but we don't see our changes

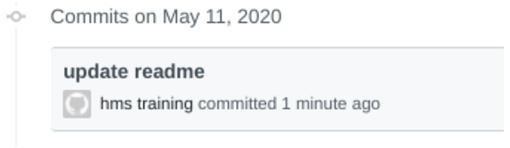


We have to send our changes to to the remote repo with `git push`

```
[gester@project-dev testing]$ git push
Username for 'https://github.com': hmstrainingdemo
Password for 'https://hmstrainingdemo@github.com':
Counting objects: 5, done.
Writing objects: 100% (3/3), 272 bytes | 0 bytes/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To https://github.com/hmstrainingdemo/testing.git
   8fb42ee..0e0a126  master -> master
[gester@project-dev testing]$
```

Now if we check the history we will see our new commit

And if we click on the file we will see our changes.



Review so far

So what just happened here?

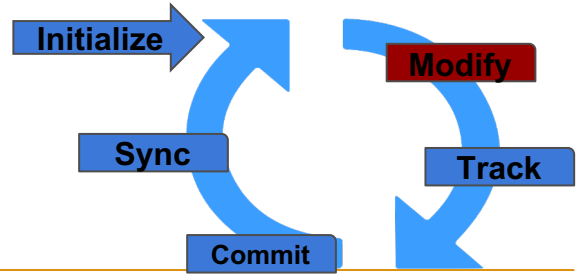
- We changed a file
- Told git to track the change
- Saved that change to the history

Things to note:

`[master f67ebea]` Is showing a hash.

A git hash is a unique identifier for a given commit. This is just the beginning of the hash.

```
[gester@project-dev testing]$ git status
# On branch master
# Changes not staged for commit:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified:   README.md
#
no changes added to commit (use "git add" and/or "git commit -a")
[gester@project-dev testing]$ git add README.md
[gester@project-dev testing]$ git status
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#       modified:   README.md
#
[gester@project-dev testing]$ git commit -m "my first commit"
[master f67ebea] my first commit
 1 file changed, 1 insertion(+)
[gester@project-dev testing]$ git status
# On branch master
# Your branch is ahead of 'origin/master' by 1 commit.
#   (use "git push" to publish your local commits)
#
nothing to commit, working directory clean
[gester@project-dev testing]$
```



git time travel

`git log` - show a list of all previous commits to the current branch

Notice that the first 8 characters of the commit hash match what was returned on when you committed the change

```
[gester@project-dev testing]$ git log
commit f67ebeaeb61f5bfa8c6fc19548662279bd0b43cb
Author: hms training <hmstrainingdemo@gmail.com>
Date:   Sat May 9 17:40:23 2020 +0000

    my first commit
```

`git revert` - go back in time

Use `--no-edit` for the demo.
revert needs a hash to revert to. Notice you don't need the entire hash, just enough to be unique (usually the first 8 chars)

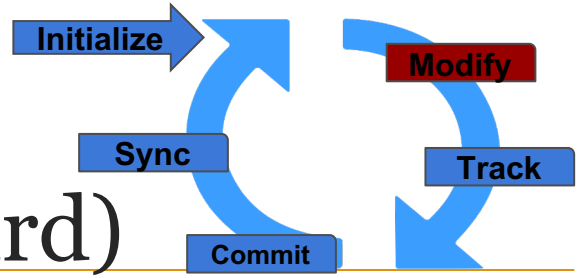
```
[gester@project-dev testing]$ git revert --no-edit e158fea1
[master d96fc00] Revert "Revert "my first commit""
 1 file changed, 1 insertion(+)
```

`git log` now shows a new entry labeled revert

```
[gester@project-dev testing]$ git log
commit d96fc00b994f12252869f638e34acedd35ab53b2
Author: hms training <hmstrainingdemo@gmail.com>
Date:   Sat May 9 22:01:25 2020 +0000

    Revert "Revert "my first commit""

    This reverts commit e158fea16f1c95b6551e6a3db21871ab72453250.
```



Git time travel (cont, time travel is hard)

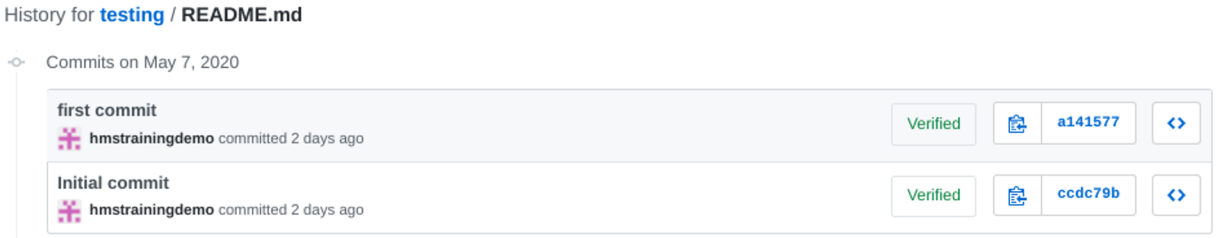
If we look at our `README.md` file now we will see that the last thing we added is gone.

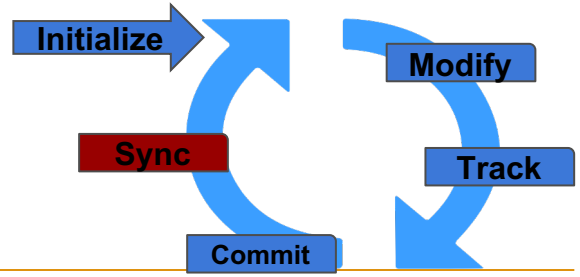
```
[gester@project-dev testing]$ cat README.md
# testing[gester@project-dev testing]$
```

Wibbily Wobbaly Timey Wimey

`` `Git checkout [hash]` `` - travel to any point in the history of a git repo
You can use the log to find any point in your repo and instantly move to that point in time.
There you can either inspect all the files at that state, run the code, or make a new branch.
Time travel is confusing and can be dangerous, be careful!

History is also available in the github web interface.





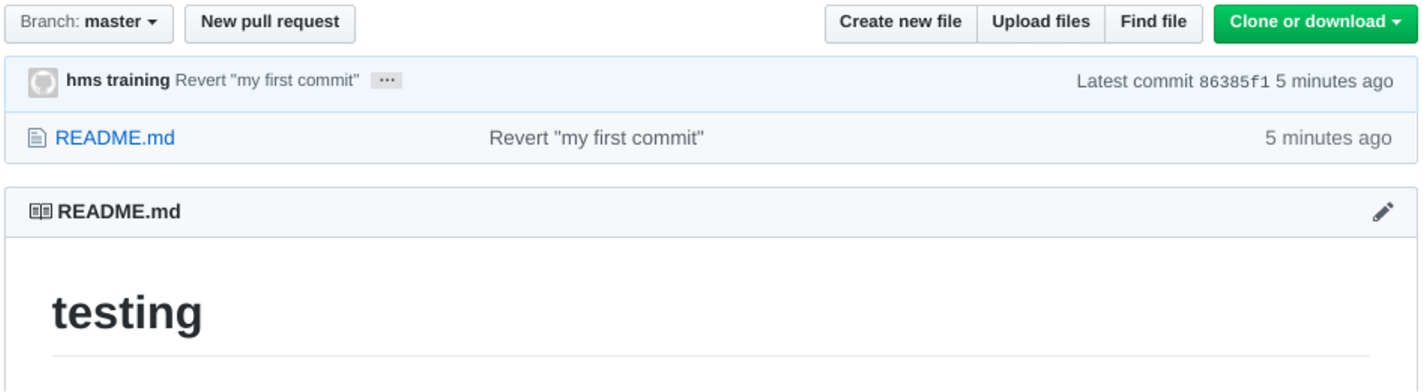
Push the revert to remote

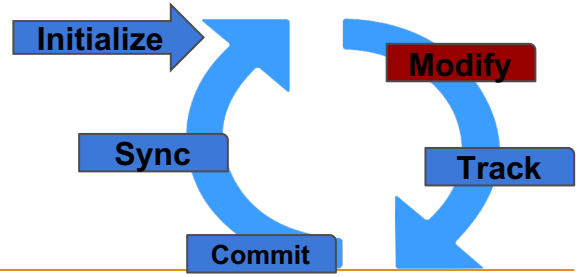
Note: `git revert` gets you the track and commit steps for free

To make sure the remote repo has the change removed, we'll need to run `git push` again

```
[gester@project-dev testing]$ git push
Username for 'https://github.com': hmstrainingdemo
Password for 'https://hmstrainingdemo@github.com':
Counting objects: 5, done.
Writing objects: 100% (3/3), 283 bytes | 0 bytes/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To https://github.com/hmstrainingdemo/testing.git
   0e0a126..86385f1  master -> master
[gester@project-dev testing]$
```

Now we will see those changes reflected on github





Undoing a change

How to quickly revert a file before committing it.

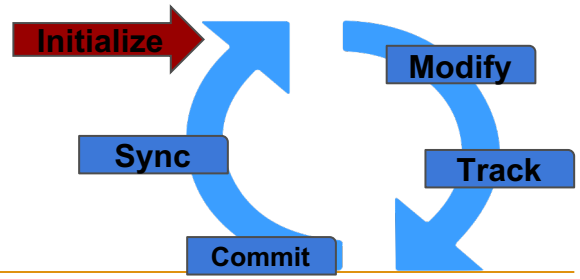
Let's make a quick change to our file

`` `echo "bunch of bad code" >> README.md` ``

```
[gester@project-dev testing]$ echo "bunch of bad code" >> README.md
[gester@project-dev testing]$ cat README.md
# testing"bunch of bad code"
[gester@project-dev testing]$
```

We can then use `` `git checkout -- README.md` `` to roll back to the last committed state of a file

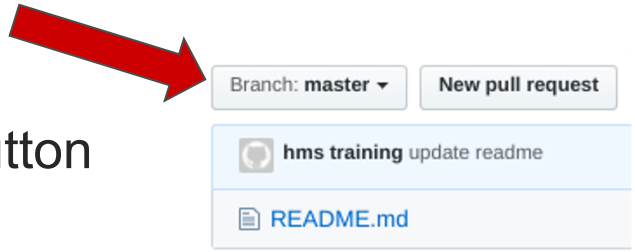
```
[gester@project-dev testing]$ git checkout -- README.md
[gester@project-dev testing]$ cat README.md
# testing[gester@project-dev testing]$
```



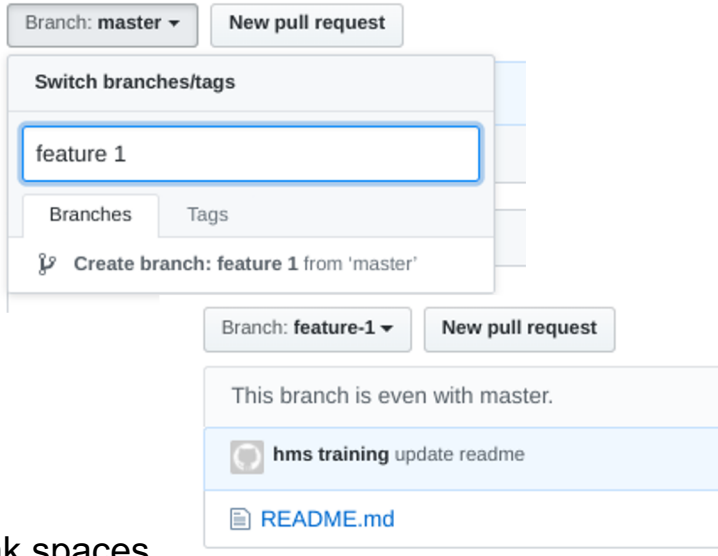
Creating a new branch

On github.com:

Click the “Branch: Master” button

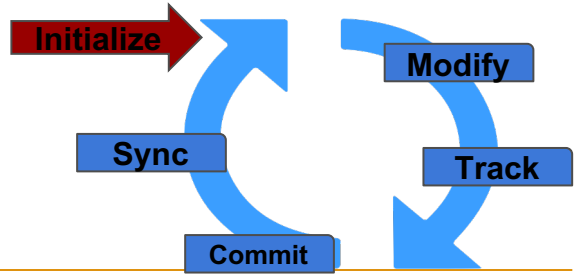


Enter a new branch name in the box and hit enter



We are now on the new branch

Note: the addition of a “-” in our branch name. Git doesn’t like blank spaces.



Let's Try: Pull and Checkout

Back on the command line:

We will run a `git pull` to get the latest data from our github repo

```
[gester@project-dev testing]$ git pull
Username for 'https://github.com': hmstrainingdemo
Password for 'https://hmstrainingdemo@github.com':
From https://github.com/hmstrainingdemo/testing
 * [new branch]      feature-1  -> origin/feature-1
Already up-to-date.
[gester@project-dev testing]$
```

Git helpfully tells us there is a new branch but `git status` still shows us on the master

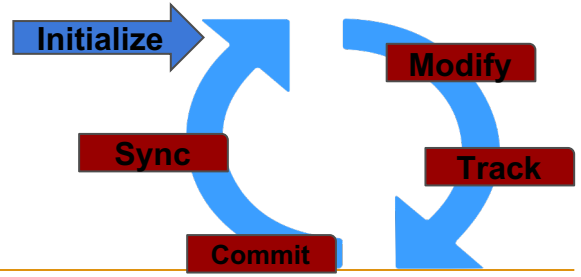
```
[gester@project-dev testing]$ git status
# On branch master
nothing to commit, working directory clean
[gester@project-dev testing]$
```

We can change to our new branch with `git checkout`

```
[gester@project-dev testing]$ git checkout feature-1
Branch feature-1 set up to track remote branch feature-1 from origin.
Switched to a new branch 'feature-1'
[gester@project-dev testing]$
```

Now `git status` shows what we want

```
[gester@project-dev testing]$ git status
# On branch feature-1
nothing to commit, working directory clean
[gester@project-dev testing]$
```



Updating a branch

A branch is your working copy of the state of the code at the time the branch was made.

Let's make an update, we'll create a new file with `` `echo "Now for something different" >> newfile.md` ``

We can also add and commit this file as well

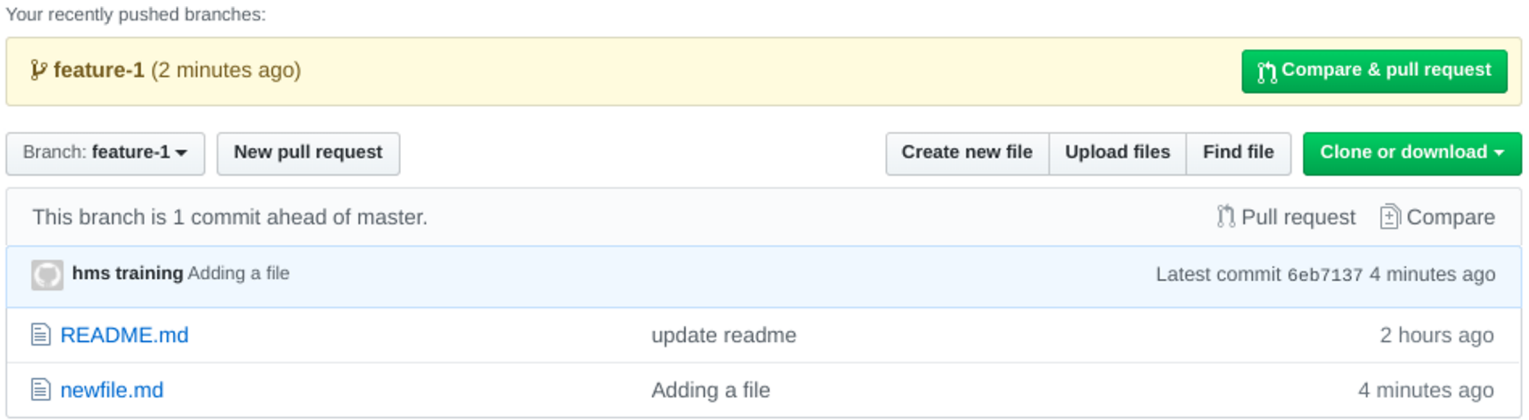
```
[gester@project-dev testing]$ echo "Now for something different" >> newfile.md
[gester@project-dev testing]$ git add newfile.md
[gester@project-dev testing]$ git commit -m "Adding a file"
[feature-1 6eb7137] Adding a file
 1 file changed, 1 insertion(+)
 create mode 100644 newfile.md
[gester@project-dev testing]$
```

And push this up to github with `` `git push` ``

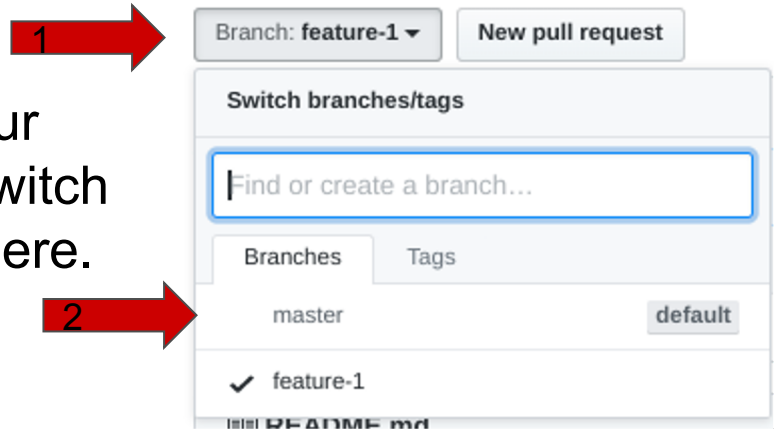
```
[gester@project-dev testing]$ git push
Counting objects: 4, done.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 312 bytes | 0 bytes/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To https://github.com/hmstrainingdemo/testing.git
   2a1b2ef..6eb7137  feature-1 -> feature-1
[gester@project-dev testing]$
```

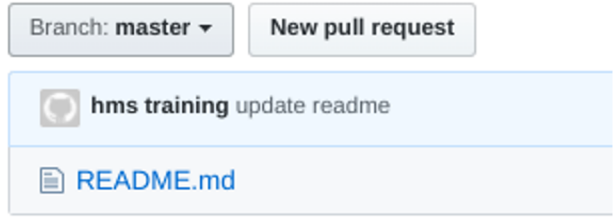
Updating a branch (cont)

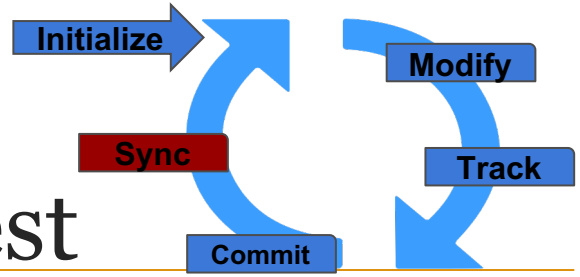
We should now see our new file on github



This file only exists on our branch however. If we switch back to master it's not there.

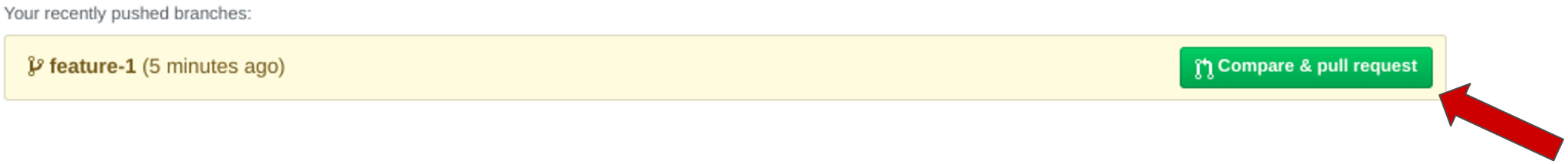




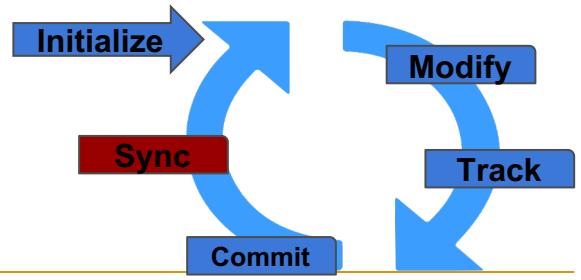


Merging branches with a pull request

To get our file onto the master branch we will create a pull request. Github already gives you a hand with this.



This will let you open a new pull request. There is a lot here so well take a detailed look.



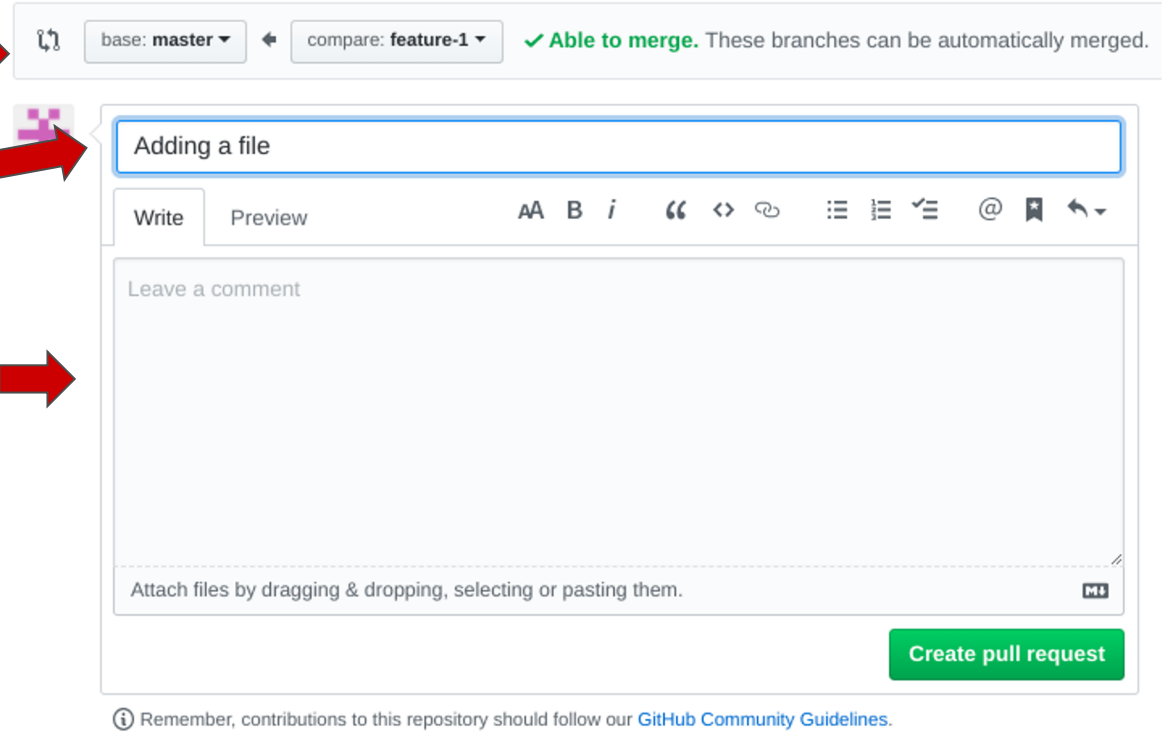
The pull request screen.

This is telling us that we are merging “feature-1” into “master”

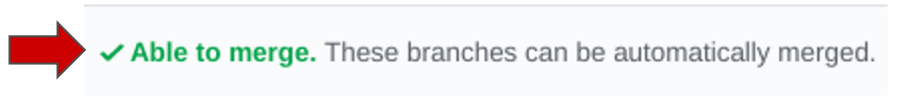
A title for your pull request

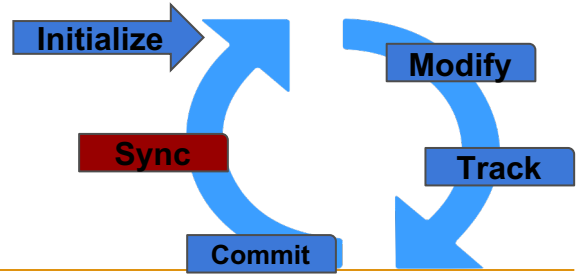
You can add a comment about what your merge is to provide context to your teammates. This can include any information you need.

We can this click the **Create pull request** Button



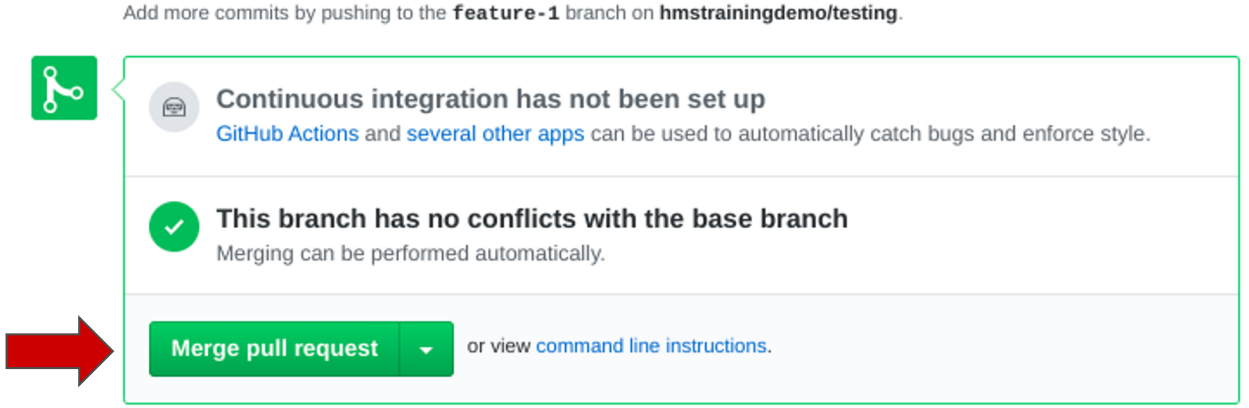
Note: This message is about merge conflicts. If you see this you are good to go. Resolving merge conflicts is more than we have time for in this class.



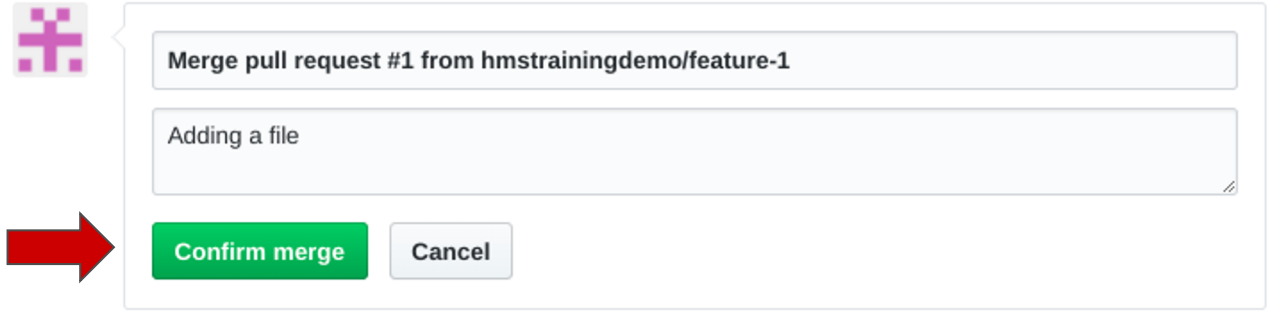


The merge screen

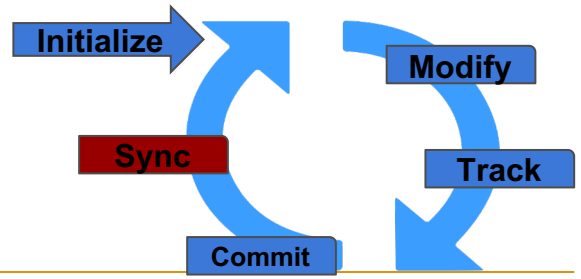
After a few seconds we should get something like this



Clicking this button will bring up a confirm



And this will finalize the merge

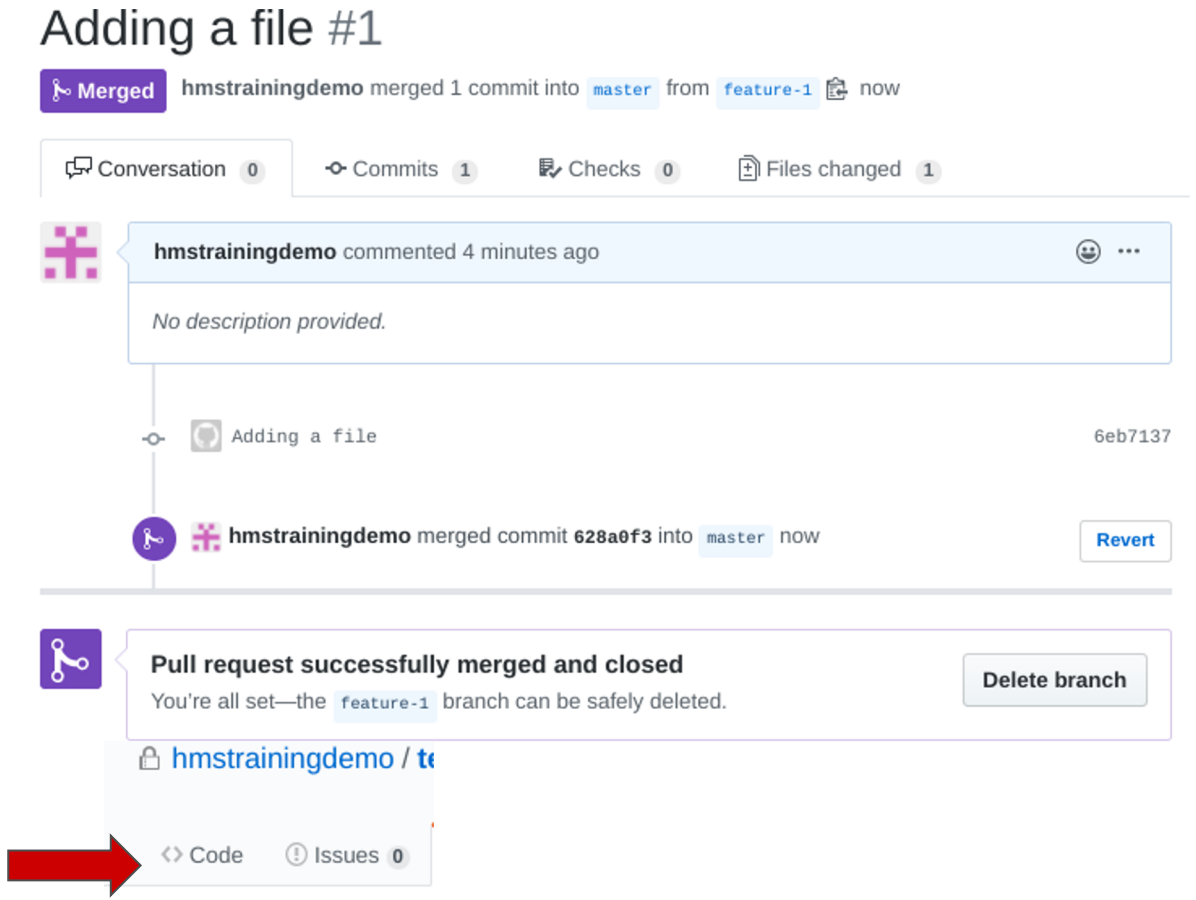


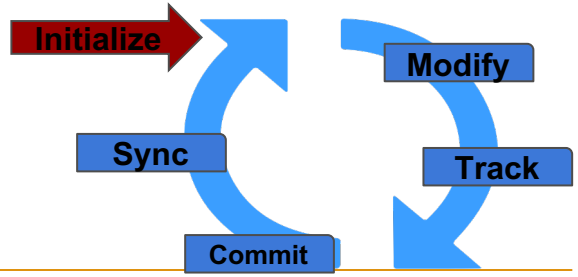
The merge screen (cont)

We have completed the merge.

- There is a description of what was done.
- Revert the merge if we made a mistake.
- The option to delete the branch if we are done with it.

clicking on the “code” link will bring us back to the main repo screen where we can see our file on the master branch





Let's Try: Streamlined branching

Adding a second "feature" via the command line.

`git checkout master` - make sure we are on the master branch

`git branch feature-2` - create a new branch

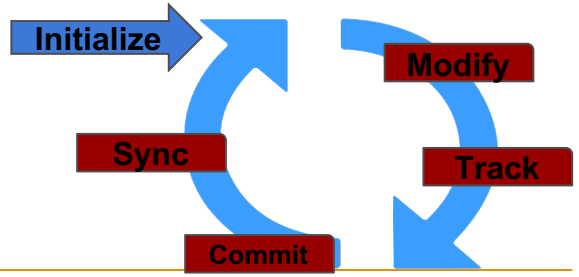
`git checkout feature-2` - change to the new branch

```
[gester@project-dev testing]$ git branch
  feature-1
* master
[gester@project-dev testing]$ git branch feature-2
[gester@project-dev testing]$ git branch
  feature-1
  feature-2
* master
[gester@project-dev testing]$ git checkout feature-2
Switched to branch 'feature-2'
[gester@project-dev testing]$
```

We can do this in a single line as well

`git checkout -b feature-2`

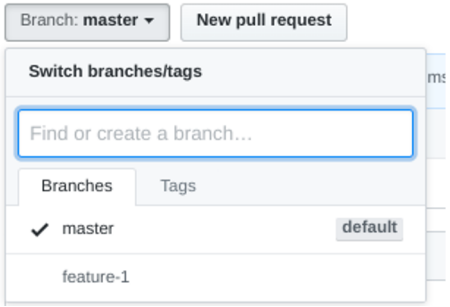
```
[gester@project-dev testing]$ git branch
  feature-1
* master
[gester@project-dev testing]$ git checkout -b feature-2
Switched to a new branch 'feature-2'
[gester@project-dev testing]$ git branch
  feature-1
* feature-2
  master
[gester@project-dev testing]$
```



Streamlined branching (cont)

Notice that our new branch does not exist in github yet

We need to push our new branch up first, but we can't push an empty branch. So let's create some new data.




```
`echo "new feature" >> feature2.md`
`git add feature2.md`
`git commit -m "add new feature"`
```

```
[gester@project-dev testing]$ echo "new feature" >> feature2.md
[gester@project-dev testing]$ git add feature2.md
[gester@project-dev testing]$ git commit -m "add new feature"
[feature-2 455c88d] add new feature
 1 file changed, 1 insertion(+)
 create mode 100644 feature2.md
[gester@project-dev testing]$
```

Now we can push our new branch and see it on github

`git push -u origin feature-2` - push our new branch data to remote. We need to tell it what to call the new branch and where to put it.

```
[gester@project-dev testing]$ git push -u origin feature-2
Username for 'https://github.com': hmstrainingdemo
Password for 'https://hmstrainingdemo@github.com':
Counting objects: 4, done.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 322 bytes | 0 bytes/s, done.
Total 3 (delta 0), reused 0 (delta 0)
remote:
remote: Create a pull request for 'feature-2' on GitHub by visiting:
remote:      https://github.com/hmstrainingdemo/testing/pull/new/feature-2
remote:
To https://github.com/hmstrainingdemo/testing.git
 * [new branch]      feature-2 -> feature-2
Branch feature-2 set up to track remote branch feature-2 from origin.
[gester@project-dev testing]$
```

Questions?

What we have covered:

- repo creation
- cloning a repo
- updating files - with undo
- syncing with a remote
- branching
- merging

Further reading

The git book https://git-scm.com/book/en/v2

Git cheat sheet https://education.github.com/git-cheat-sheet-education.pdf

Atlassian git tutorials https://www.atlassian.com/git/tutorials

These slides can be found at https://github.com/hmsrc/user-training/intro-to-git-2020.pdf

Alex Cullen alex_cullen@hms.harvard.edu
github: https://github.com/acullenhms

Jason McDonald jason_mcdonald@hms.harvard.edu
github https://github.com/jfmcdonald