Getting Started
with Git and GitHub

Coffee, Cookie and Coding (C³) Workshop supported by the Public Health Data Science and Data Equity team

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- Worked 1.5 years as a Software Development Engineer on R packages and Shiny applications.

- Received a Masters in Biostatistics from the University of Washington in 2023.

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- Worked 7 years as a Molecular Biologist and Biochemist.

- Received a Masters in Applied Computational Mathematics from Johns Hopkins University in 2024.

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Special thanks to Justin for being here!

[Justin DeMayo](#)

System and Application Specialist

Yale's Harvey Cushing/John Hay Whitney Medical Library

Today's Learning Objectives

01 Understand why it is good to learn to use Git and GitHub. (~ 5 minutes)

02 Configure your local Git and personal GitHub accounts and set up security keys. (~ 25 minutes)

03 Learn how to share and contribute to projects with an example created in RStudio. (~ 20 minutes)

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Our Choice Resources

- Yale's Center for Research Computing workshop *Version Control by Git* by Kaylea Nelson

- Yale's Harvey Cushing/John Hay Whitney Medical Library workshop *Git & GitHub: An Introduction To Version Control* by Justin DeMayo

- *Getting Git Right* by Atlassian

- *Git and GitHub Tutorial* by W3 Schools

- *Introduction to GitHub* by GitHub

- *Happy Git and GitHub for user* by Jenny Bryan

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What is Git and GitHub?

How do they relate to one another?
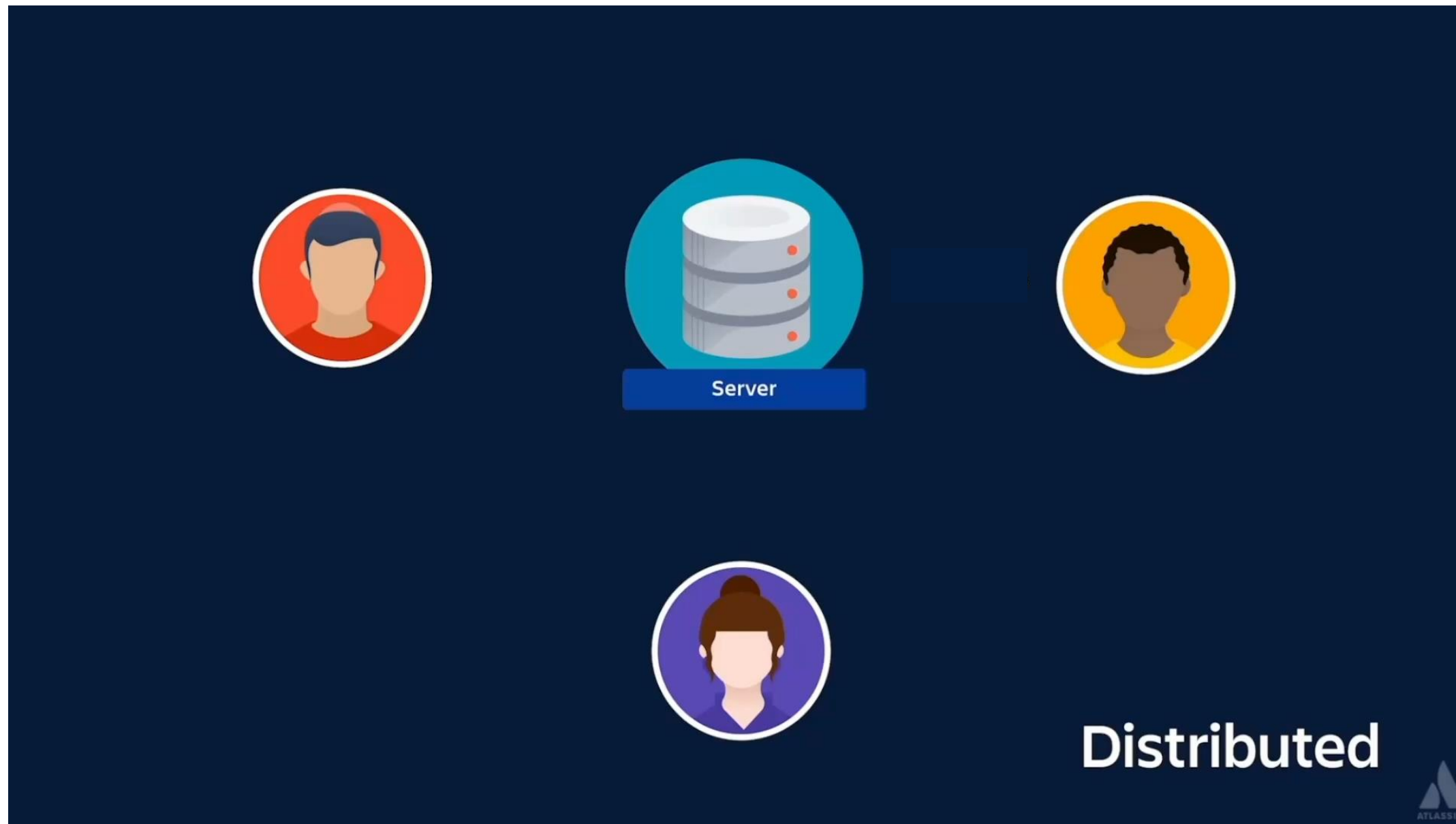
What is Version Control by Atlassian. Updated February 23rd, 2020.
Git logo. Downloaded October 10th, 2024.
GitHub logo. Downloaded October 10th, 2024.

git

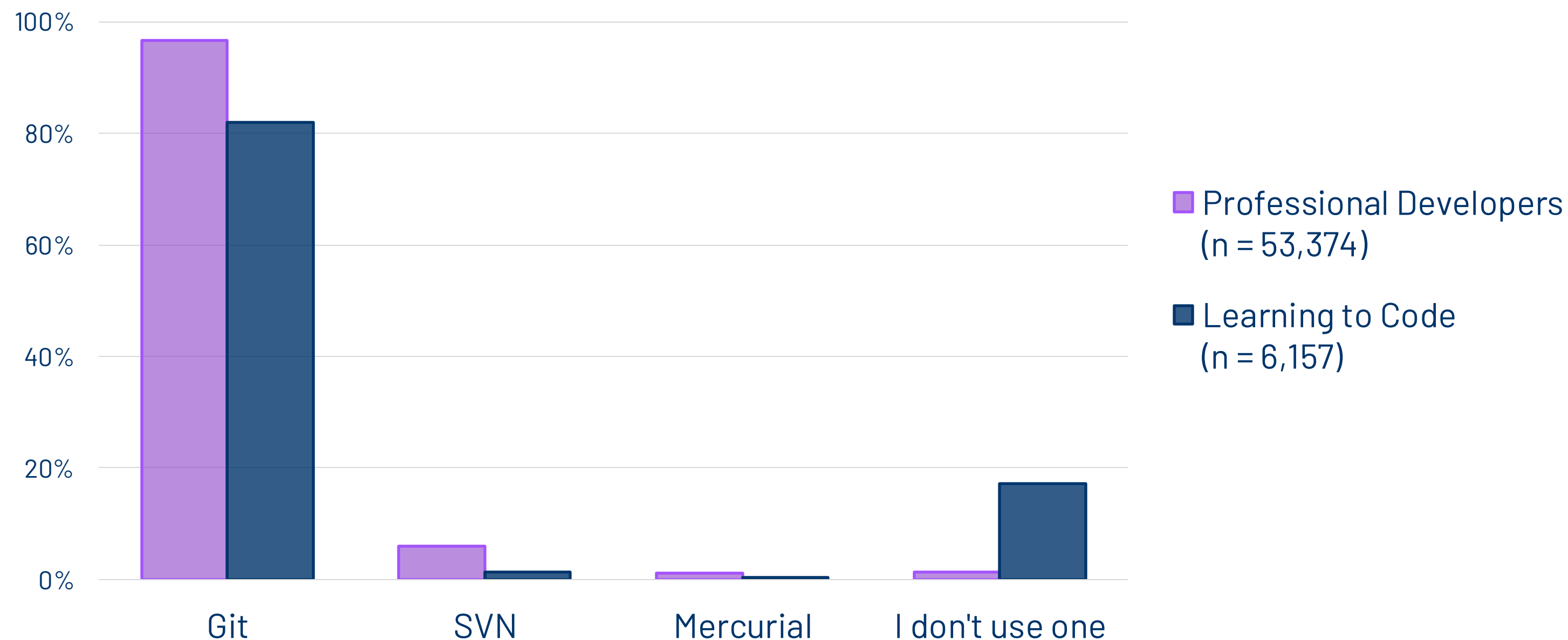System for project management by distributive version control (DVCS).
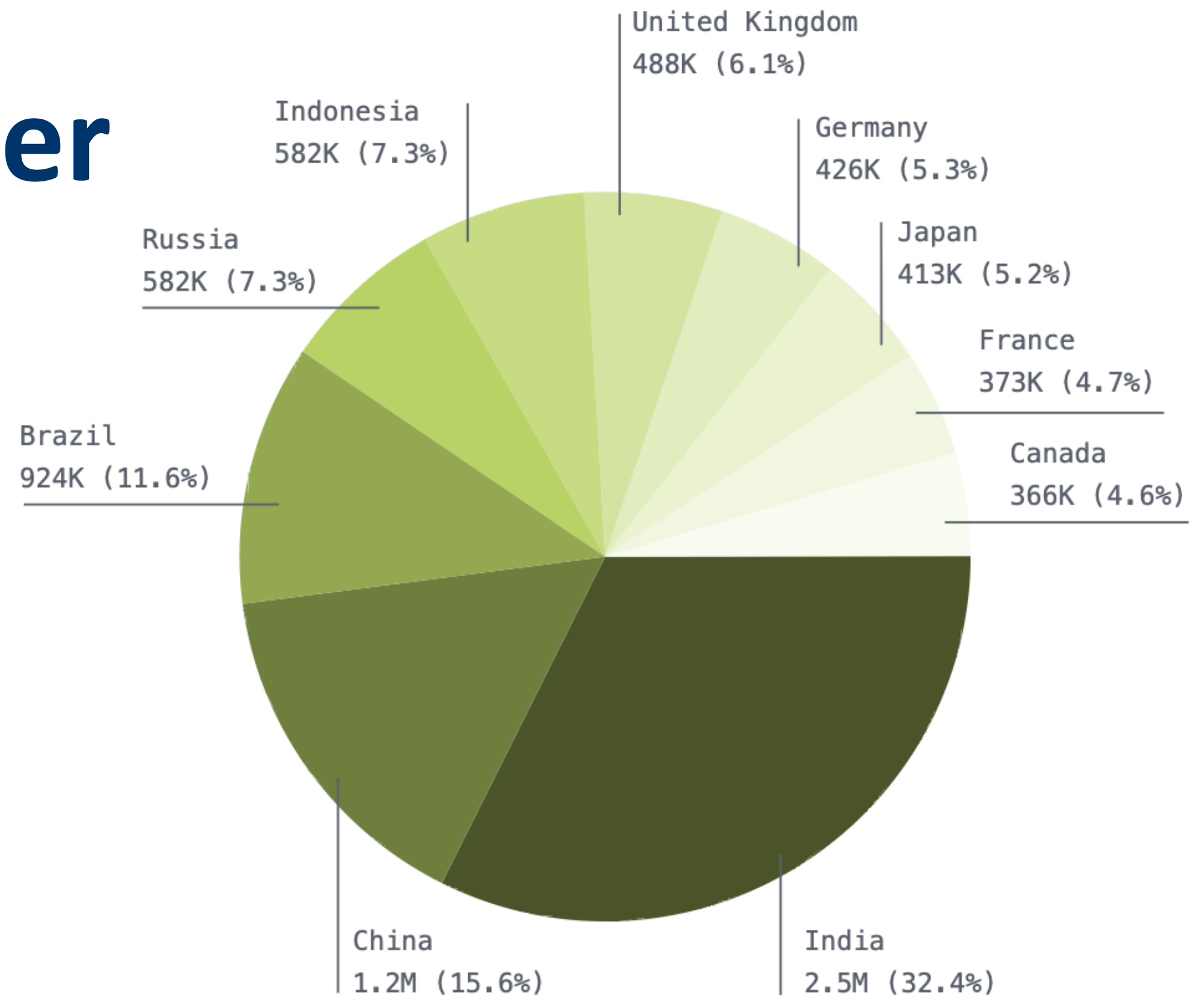
GitHub

Developer platform for housing and managing projects and acts as the DVCS server.

Git is the most widely used VCS but is underutilized by those learning to code.

Professional Developers
(n = 53,374)

Learning to Code
(n = 6,157)

2022 Developer Survey by StackOverflow. Published 2022.

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Total New Developers per Country

United Kingdom
488K (6.1%)

Indonesia
582K (7.3%)

Germany
426K (5.3%)

Russia
582K (7.3%)

Japan
413K (5.2%)

France
373K (4.7%)

Brazil
924K (11.6%)

Canada
366K (4.6%)

China
1.2M (15.6%)

India
2.5M (32.4%)

Install Git, create a GitHub account, and link them with security keys.

Install Git

Instructions follow *Getting Git Right* by Atlassian.

Windows

1. Navigate to Git-SCM.

2. Follow the prompts to install Git.

3. Confirm instillation using in Git Bash:

```
$ git --version
```

MacOS

If you have Xcode Git should be installed.

1. If you do not have Xcode:
   (using homebrew)

```
$ brew install git
```

(using MacPorts)

```
$ sudo port install git
```

2. Confirm instillation using:

```
$ git --version
```

Instructions for El Captain OS X 10.11.

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Configure Git

There are three levels that can be configured:

1. **System level:** every user on the computer and all their repositories.

    ```
    $ git config --list --show-origin
    ```

2. **Global level:** one user's profile and all their repositories.

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

3. **Local level:** one specific repository.

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

Configure Git

```
$ git config --list  # --show-origin

$ git config --global user.name "Your Name Here"
$ git config --global user.email "your@email.com"
```

Variations:

1. Changing `--global` to `--local` within an initialized repository will override the global settings.

2. Multiple global credentials can be set using Conditional Includes (available since Git 2.13). More details can be found on Free Code Camp or Tomáš Janoušek's StackExchange response.

Sign-up for a GitHub Account

If you do not have an account:

Navigate to GitHub and follow the prompts.

Select tips for username conventions (from *Happy Git with R*).

- o   Incorporate your name.

- o   Short, lower case, and something you would share with an employer.

- o   Don't highlight temporary affiliations, like your current university.

Other Resources:

GitHub Command-Line Interphase (CLI), *GitHub Skills*, and *Repositories documentation* by GitHub

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Differences between SSH and HTTPS

SSH	HTTPS
1. SSH (Secure Shell) key pairs: matching a locally stored "private key" and the remotely stored "public key".	1. HTTPS (Hypertext Transfer Protocol Secure) access with a username and personal access token (PAT).
2. More secure than HTTPS.	2. Easier to set-up and recommended for beginners.
3. Commit signiture verification (sign commits and tags).	3. Requires re-entering credentials.
4. *Switching remote URLs from SSH to HTTPS* by GitHub.	4. *Switching remote URLs from HTTPS to SSH* by GitHub.

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SSH

Variations:

1. Global SSH private/public key pair for the GitHub repository.

2. Fine-grained SSH private/public key pair for individual GitHub repositories that are individually deployed (Managing deploy keys).

3. SSH public/private key authentication with a hardware security key for an added layer of security.

Other Resources:

- *Cloning with SSH URL's* and *Troubleshooting SSH* by GitHub.

- *SSH agent forwarding* and *Adding your SSH key to the ssh-agent* by GitHub.

- *Setting up multiple SSH keys on one computer* by Kat Connolly.

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SSH

1. Check for existing private/public key pairs.

   ```
   $ ls -al ~/.ssh
   ```

2. Look for file names that include: "id_ed25519/id_ed25519.pub", "id_rsa/id_rsa.pub", or "id_ecdsa/id_ecdsa.pub".

   NOTE: DSA (ssh-dss) are no longer supported since March 2022.
   NOTE: RSA keys (ssh-rsa) with "valid after" dating after November 2, 2021 require the SHA-2 signature algorithm.

3. Test the SSH key connection with GitHub.

   ```
   $ ssh -T git@github.com
   > Hi USERNAME! You've successfully authenticated,
     but GitHub does not provide shell access.
   ```

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SSH

1. Choose one algorithm and generate an SSH private/public key pair.

```
# Ed25519 algorithm (fast algorithm)
$ ssh-keygen -t ed25519 -C "your@email.com"

# RSA algorithm (for legacy systems)
$ ssh-keygen -t rsa -b 4096 -C "your@email.com"
```

2. Set the file location where the key is saved. Use the default location and key name by hitting **Enter**. Change the file path (not recommended!) or key name by copying the modifying the path: i.e. `~/id_ed25519_school`.

```
> Enter a file in which to save the key
  (/Users/YOU/.ssh/id_ALGORITHM): [File path or Enter]
```

continued …

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SSH

3. Enter in a passphrase for accessing the SSH keys. Additional guidelines can be found: *Working with SSH key passphrases* by GitHub.

```
> Enter passphrase (empty for no passphrase): [Type
  a passphrase]
> Enter same passphrase again: [Type passphrase]
```

4. Now we will add the public SSH key to GitHub. Copy it to your clipboard.

```
$ pbcopy < ~/.ssh/id_ALGORITHM_name.pub
```

continued …

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SSH

5. Go to your GitHub account [settings page](#).

6. In the "Access" section on the left, go to the "[SSH and GPG Keys](#)" page.

7. Click the "New SSH Key" button in the top right.

8. A a title explaining the use of the key (i.e. Personal laptop).

9. Select "Authentication key" as the key type. More details about the differences can be found in [bk2204 StackExchange](#) response.

10. In the "Key" field, paste your public key.

11. Click "Add SSH key" and follow the prompts.

continued ...

SSH

12. Final step is to test the SSH key connection with GitHub.

```
$ ssh -T git@github.com
> Hi USERNAME! You've successfully authenticated,
  but GitHub does not provide shell access.
```

NOTE: GitHub's SSH key fingerprints validate a connection. Copy the keys in this link to the "~/.ssh/known_hosts" file to avoid manually verifying GitHub hosts.

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HTTPS

Cloning from a Public repository:

No username or personal access token (PAT) is required.

Cloning from a Private repository:

Must authenticate access using your GitHub username and PAT.

Other Resources:

- *Cloning with HTTPS URL's* and *Managing your PATs* by GitHub.

- *Git Cridential Manager* by various contributors.

- *Install the git-credential-osxkeychain helper* by Atlassian.

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HTTPS

1. Go to your GitHub account settings page.

2. In the last section on the left, select "Developer Settings".

3. Under the "Personal access tokens" drop-down menu, open the tokens (classic) page.

4. In the drop-down select "Generate new token (classic)".

5. Add a PAT note and set its expiration time-frame.

6. Under "Select scopes" section check "Repo" for full control of private repositories. Find more about managing scopes: OAuth scopes.

7. Click "Generate token".

8. Copy the generated PAT and save it somewhere secure.

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Worked Through Example in RStudio

Personal Repository

START LOCALLY

Initialize Git in a local project folder.

Push "Hello World" in a README.md file to an empty GitHub repository.

START REMOTELY

Clone a clean-break copy of the JHU-CRC-Vaccinations repository.

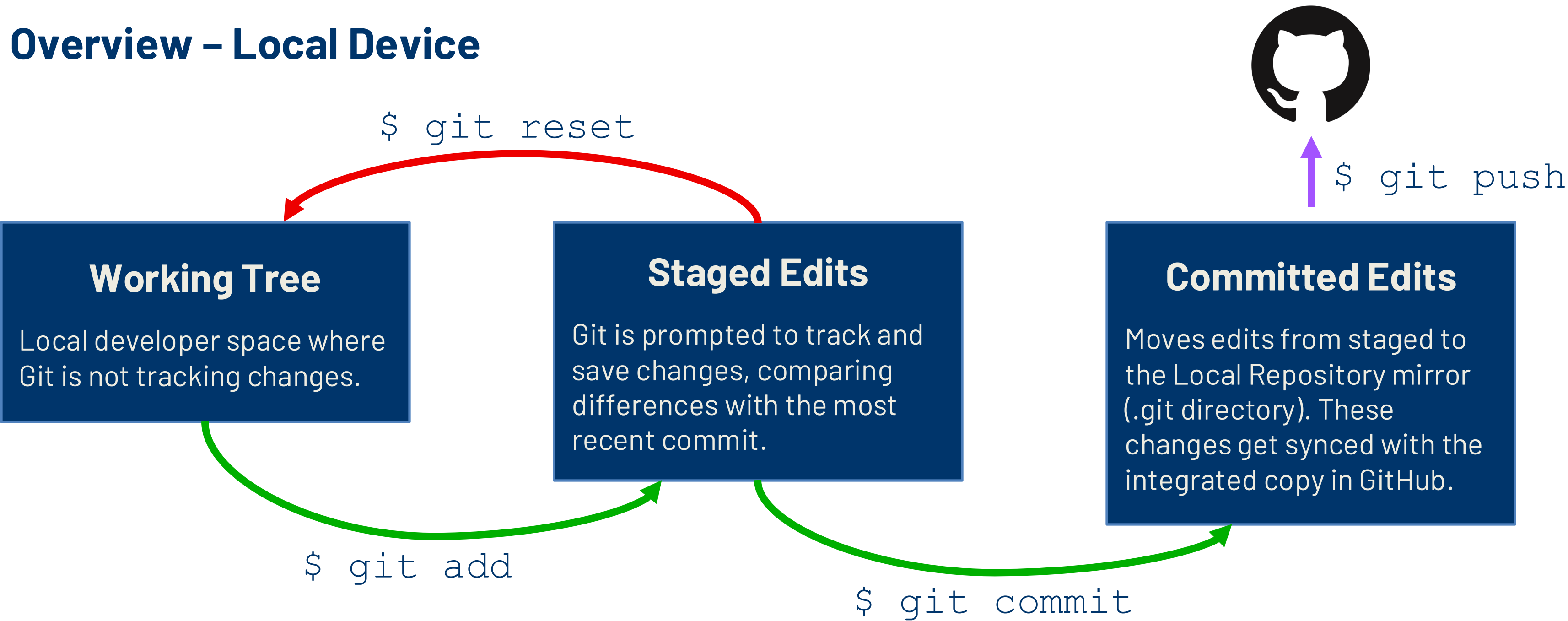Make a bar plot and push to the remote repository.

REAL-WORLD EXAMPLE

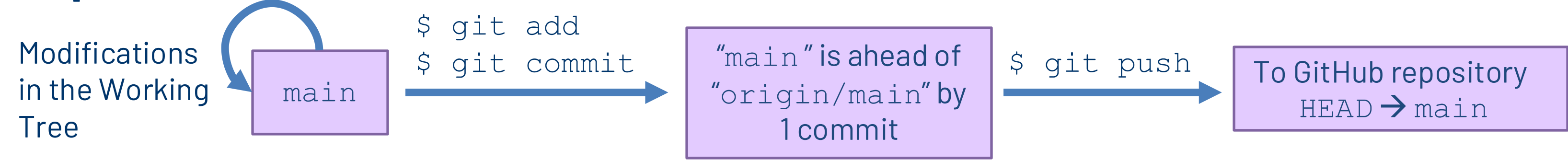Generate a new plot and run through the status through push commands.

Going Beyond Basic Git

- Yale's Center for Research Computing workshop *Version Control by Git* by Kaylea Nelson

- *Getting Git Right* by Atlassian

- *What is git commit, push, pull, log, aliases, fetch, config & clone* by Amit Prajapati

- *Git Guides* by various Graphite contributors

- *How to Write a Git Commit Message* by cbeams

- *Git GUI Clients* by various contributors

Overview – Local Device

$ git reset

Working Tree
Local developer space where Git is not tracking changes.

Staged Edits
Git is prompted to track and save changes, comparing differences with the most recent commit.

Committed Edits
Moves edits from staged to the Local Repository mirror (.git directory). These changes get synced with the integrated copy in GitHub.

$ git add

$ git commit

$ git push

Example

Modifications in the Working Tree

main

$ git add
$ git commit

"main" is ahead of "origin/main" by 1 commit

$ git push

To GitHub repository HEAD → main

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`$ git …`

CLONE

- A one-time operation that creates a local working copy of the remote repository.

- Used when first creating a mirror from a remote repository.

`$ git clone <repo>`

FETCH/MERGE

- "`fetch`" copies commits, files, and references in the remote repository.

- "`merge`" integrates independent lines of development into one branch.

PULL

- Combines the action of "`fetch`" and "`merge`".

- Merges upstream changes not reflected in the local repository.

- Sometimes, this needs to be run before a push.

`$ git pull <repo>`

Start Locally

1. Open Terminal and navigate to your destined directory.

```
$ cd "/file location"          # Project location
$ mkdir "First Repo"           # Make a project folder
$ cd "First Repo"              # Enter the project
```

2. Initialize Git in the project folder with a branch called "main".

```
$ git init -b main
```

3. Create a new README.md file.

```
$ touch "README.md"
```

continued …

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Start Locally

4. Edit the newly created README.md file

```
$ vim README.md    # Opens the file for editing
```

5. In file edit mode hit "**a**" and type in "Hello World!!". Hit **Esc** to exit file edit mode and type ":wq" to quit viewing the README.md contents in Terminal.

6. Stage our file for version control and commit changes.

```
$ git status                     # Show branch status
$ git add .                      # Stage all files
$ git status                     # Show status changed
$ git commit -m "First push"     # Commit the changes
```

continued …

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Start Locally

7. In GitHub, create a new repository. Change the name, owner (as needed), add a description, and switch sharing permissions to Private.

   NOTE: Do not add a README, .gitignore, or license.

8. Designate the remote location, transfer protocol (SSH/HTTPS), and associate both with the "`origin`" repository alias.

   ```
   $  git remote add origin <SSH/HTTPS link>
   ```

9. Push the project file to the empty remote repository.

   ```
   $  git push -u origin main
   ```

10. Refresh the GitHub page to see the changes reflected.

Start Remotely

1. Open the JHU-CRC-Vaccinations GitHub remote repository URL.

2. Follow Method #1 or #2 to create a clean-break copy of the remote repository in your personal GitHub account.

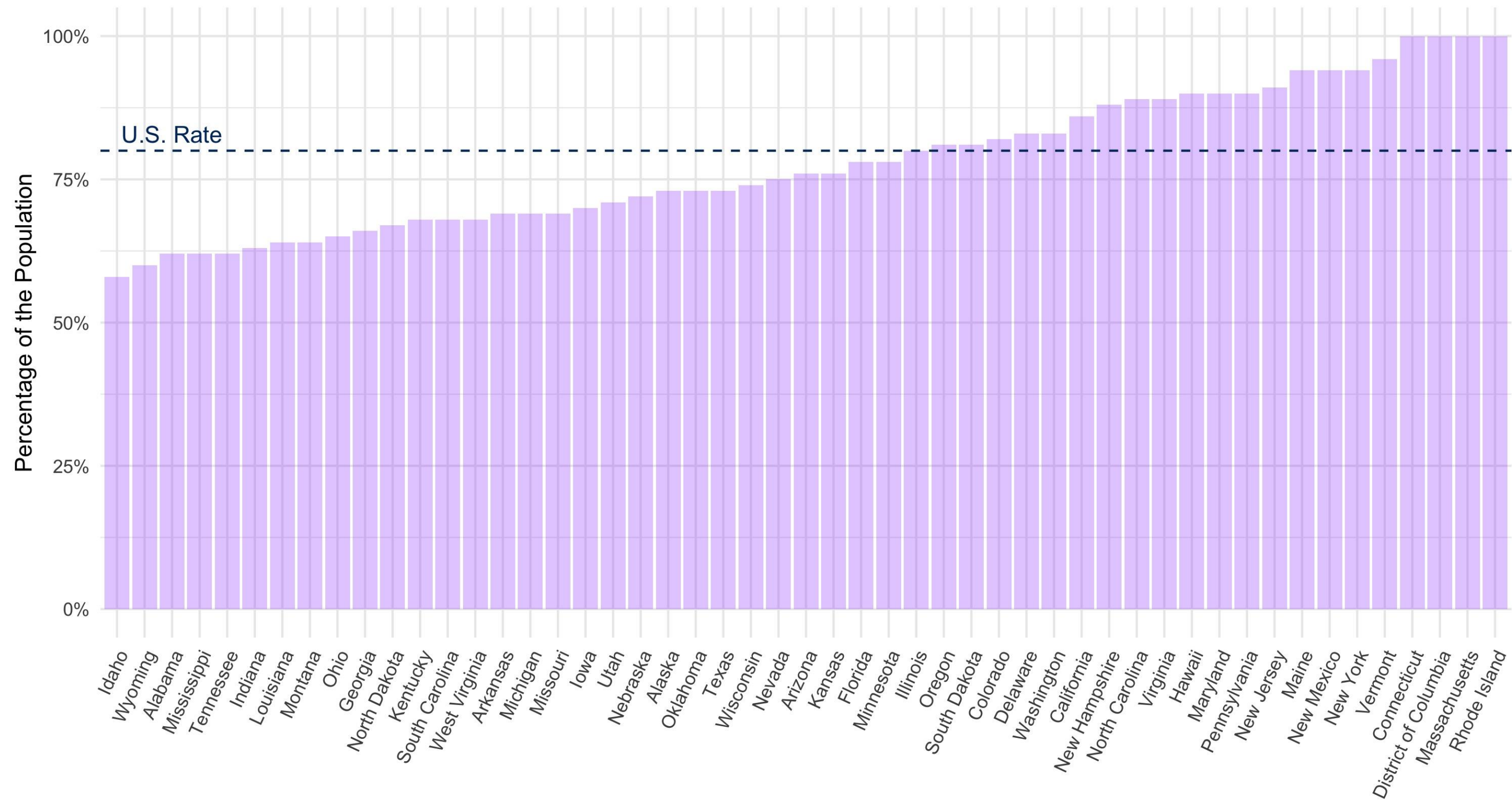3. Navigate to the file location you want to store the repository copy.

   ```
   $ cd "/file location"        # Project location
   ```

4. Clone the repository that was copied into your personal GitHub.

   ```
   $ git clone <SSH/HTTPS link>
   ```

continued …

Percentage of Population With At Least One Dose by March 2023 Across U.S. States

Start Remotely

5. Enter the cloned project file.

```
$ cd "repo name"                # Enter the project
```

6. Open the R project environment.

```
$ open JHU-CRC-Vaccinations.Rproj
```

7. Generate the vaccinations bar graph and save a JPEG to the project folder.
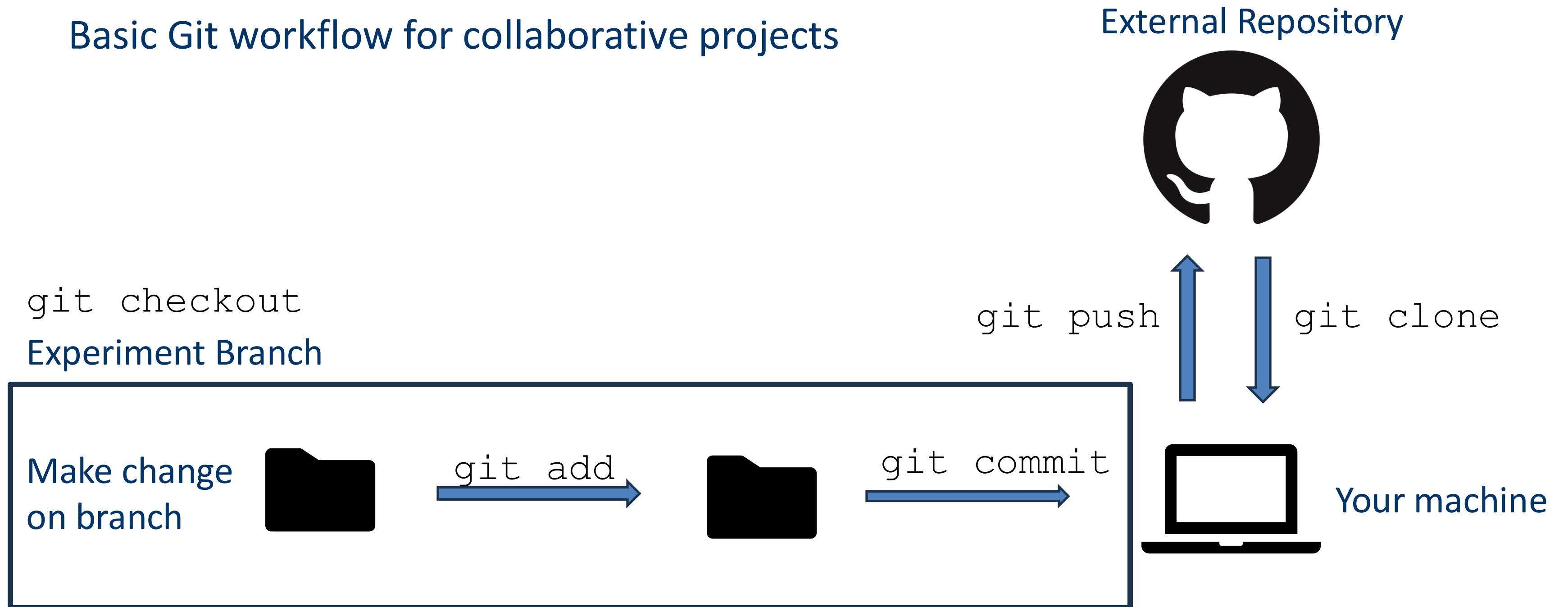
8. Stage and commit the changes.

```
$ git add .                     # Stage all files
$ git commit -m "New plot"      # Commit the changes
$ git push                      # Merge with remote
```

9. Refresh the GitHub page to see the changes reflected.

Accessing Repositories

Basic Git workflow for collaborative projects

External Repository

`git push`   `git clone`

`git checkout`
Experiment Branch

Make change on branch   `git add`   `git commit`

Your machine

Collaborating with Branches

Think of your work as a tree, with a branch representing a separate path where changes won't impact the main body of work.

About branches by GitHub Docs
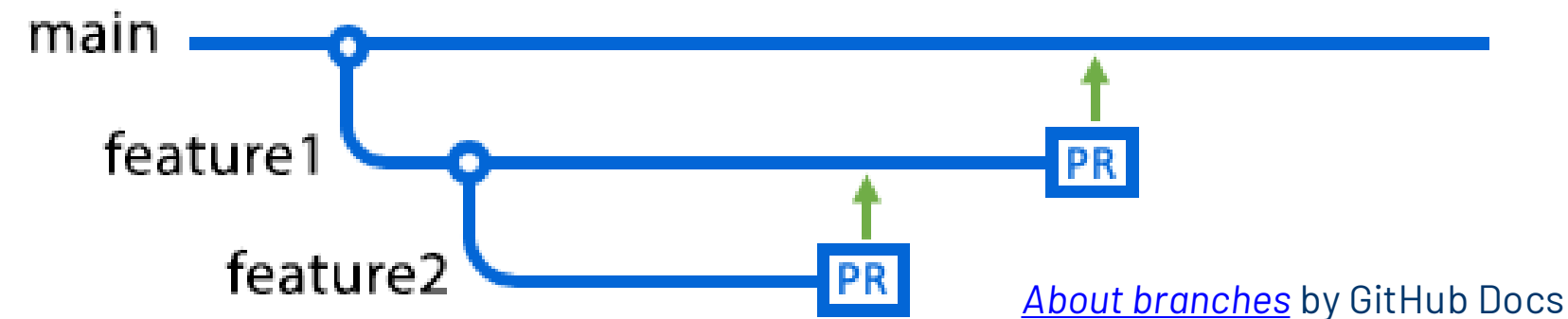
- Branches allow you to develop features, fix bugs, or safely experiment with new ideas in a contained area of your repository.

- You always create a branch from an existing branch.

- Once satisfied, you open a pull request (PR) to merge the changes you made.

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Branch Git Commands

Create a copy of the repository to local machine:

```
$ git clone https://github.com/howardbaik/test-branches.git
```

Move into the repository folder:

```
$ cd test-branches
```

Check which branch we are on:

```
$ git branch
```

Create a new branch and move into it:

```
$ git checkout -b experiment-branch
```

Check that we are on the experiment branch:

```
$ git branch
```

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Making changes and merging branches

After making changes to our files on the experiment branch,

See files not staged for commit:

```
$ git status
```

Stage the change:

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

Commit the change with message:

```
$ git commit -m "Update README.md"
```

Merging branches

Move back to the main branch:

```
$ git checkout main
```

Merge experiment branch:

```
$ git merge experiment-branch
```

Check status, one last time:

```
$ git status
```

Collaborating with Pull Requests

- Pull Request: A proposal to merge a set of changes from one branch into the main branch.

- Collaborators can review and discuss the proposed set of changes before they integrate the changes into the main branch.

- After initializing a pull request, you'll see a review page that shows a high-level overview of the changes between your branch and the repository's main branch.
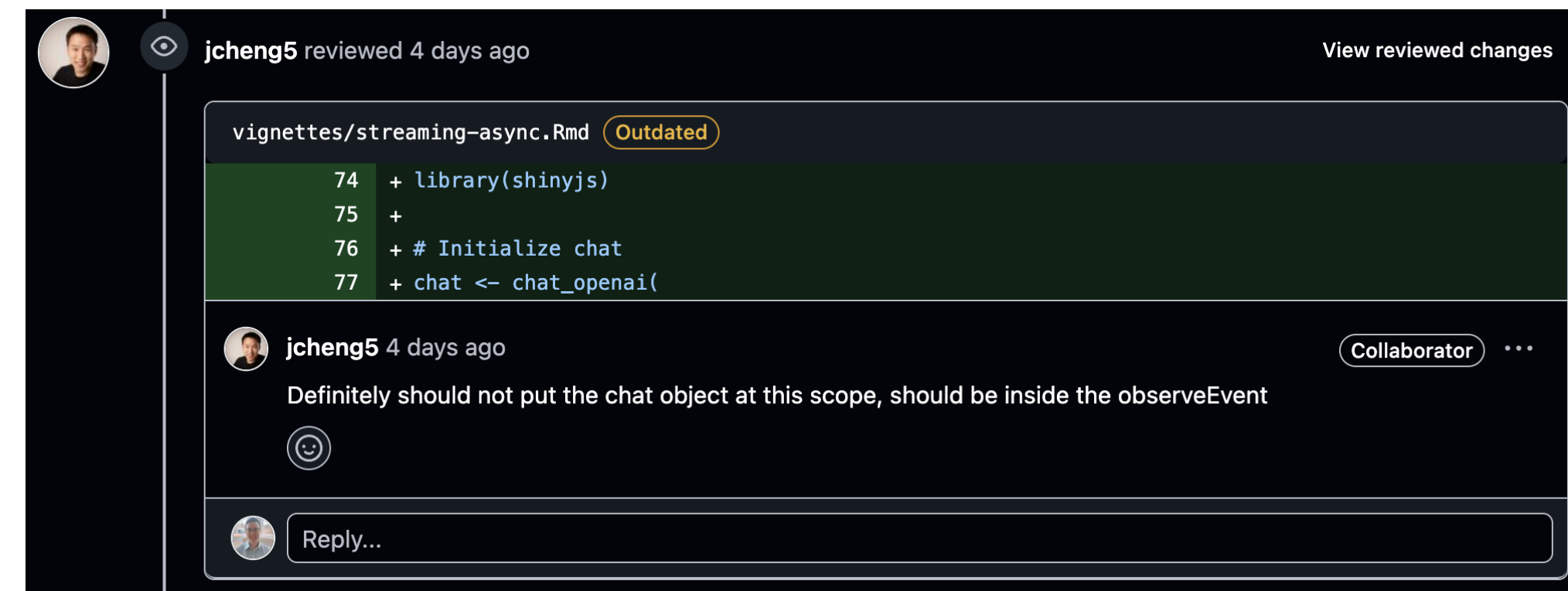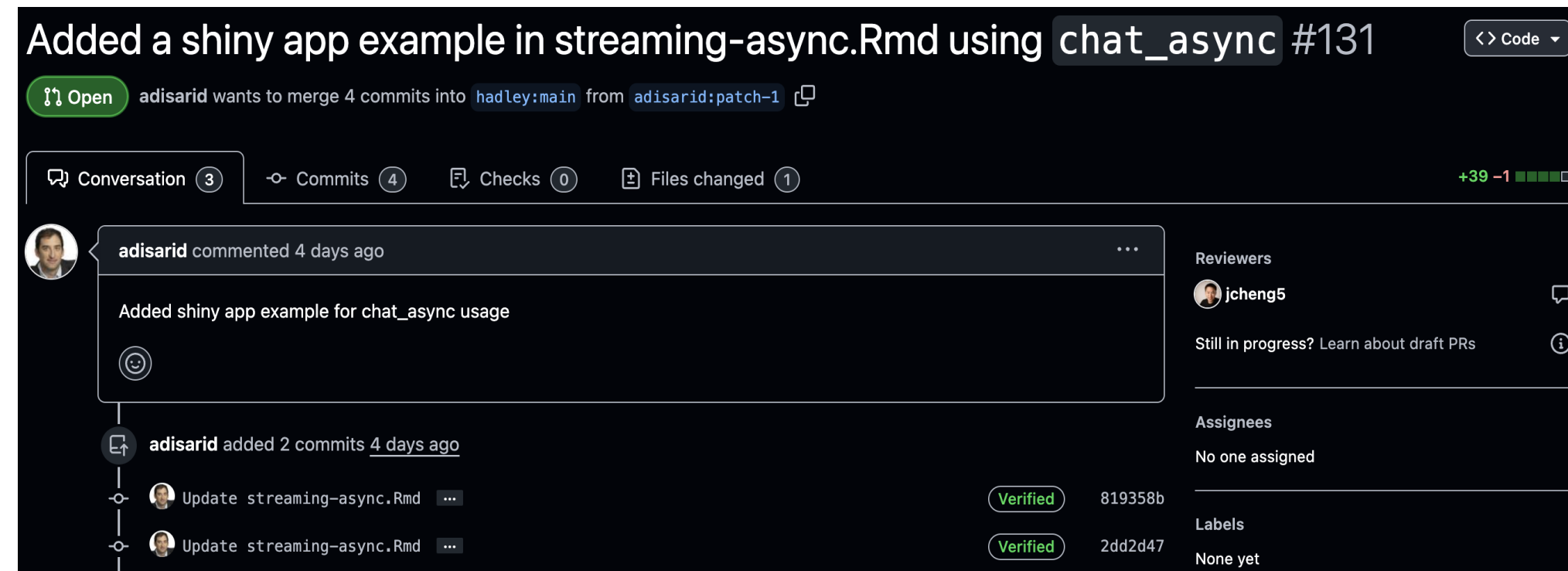
Back to Worked Through Example (in R)

Add a collaborator to your repository

1. Ask for the username of the person you're inviting as a collaborator.

2. Click **Settings.**

3. In the "Access" section of the sidebar, click **Collaborators**.

4. Click **Add people**.

5. In the search field, start typing the name of person you want to invite, then click a name in the list of matches.

6. Click **Add NAME to REPOSITORY**.

Create a copy of the repo to local machine

Create a copy of the repository to local machine:

```
$ git clone REPOSITORY_URL
```

Move into the repository folder:

```
$ cd JHU-CRC-Cases-and-Deaths
```

Create a new branch and move into it:

Check which branch we are on:

```
$ git branch
```
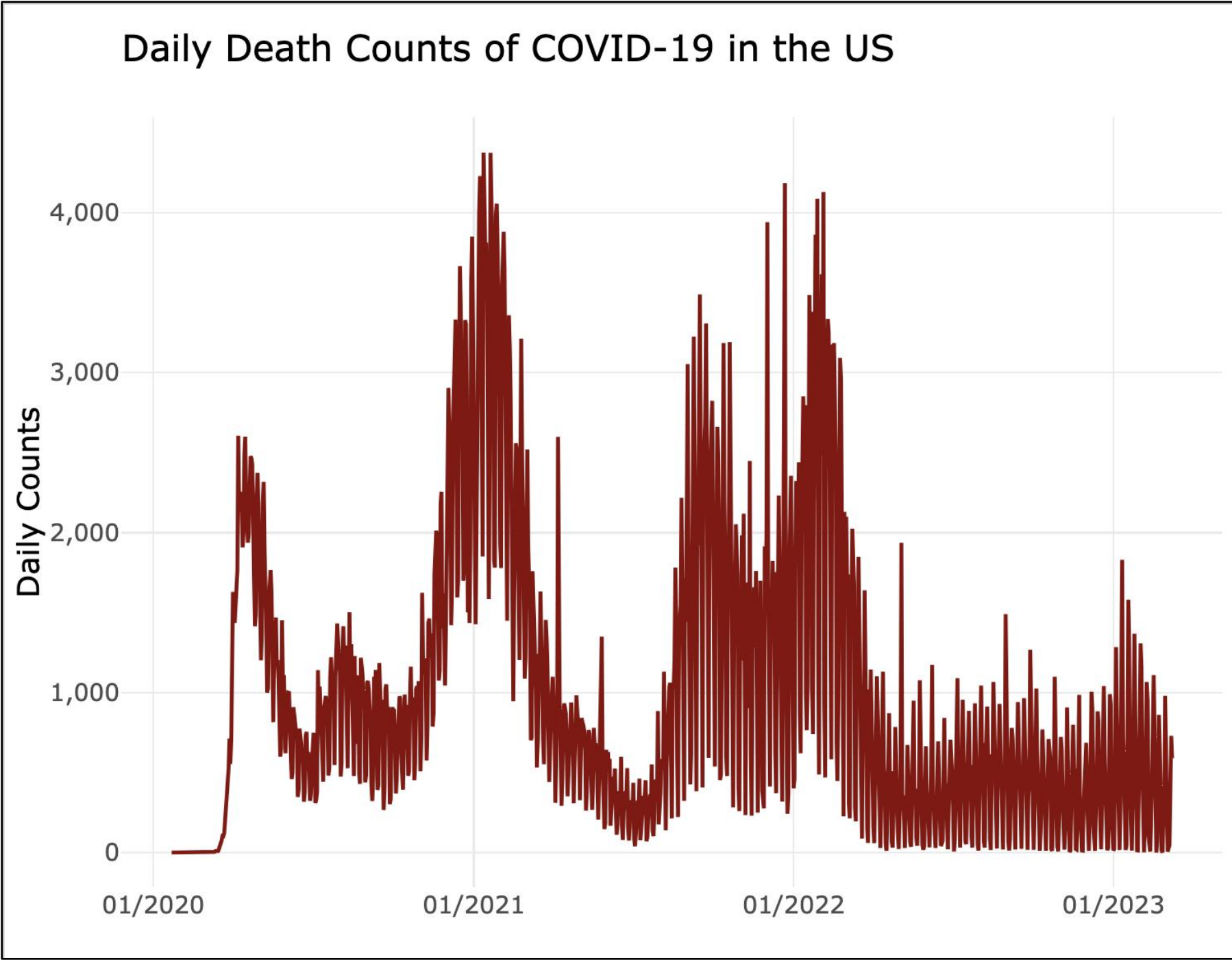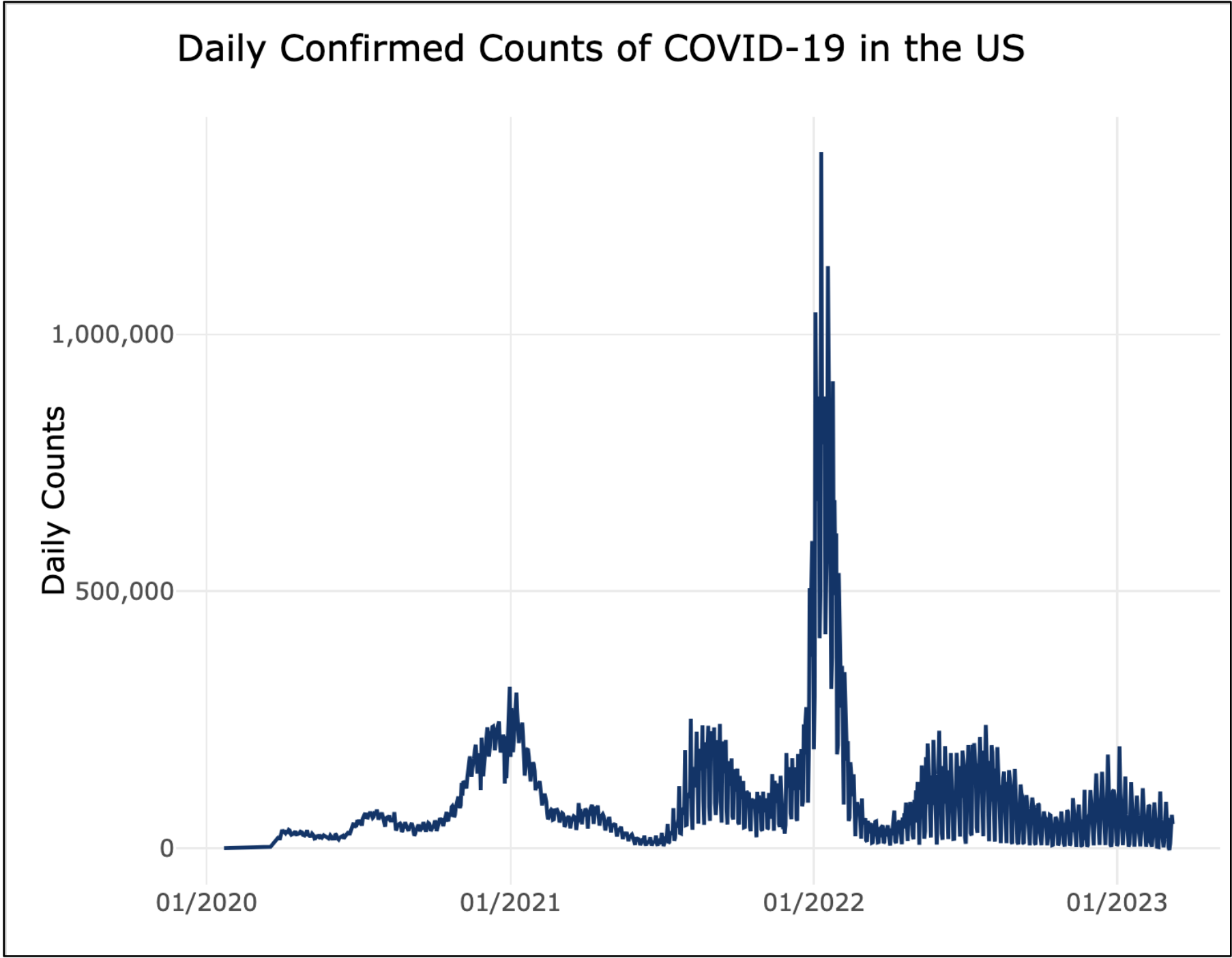
Create a new branch and move into it:

```
$ git checkout -b experiment-branch
```

Check that we are on the experiment branch:

```
$ git branch
```

Open repository in RStudio:

```
$ open JHU-CRC-Cases-and-Deaths.Rproj
```

After making changes on the experiment branch,

Stage the change:

```
$ git add .
```

Commit the change with message:

```
$ git commit -m "Update analysis file"
```

Push the changes (set remote as upstream):

```
$ git push --set-upstream origin experiment-branch
```

Submit a Pull Request

1. In the yellow banner, click **Compare & pull request** to create a pull request.

2. Type a title and description for your pull request.

3. To create a pull request that is ready for review, click **Create Pull Request.**

Evaluation

Next Workshop

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Presents the Second

Coffee, Cookie and Coding (C³) Session

A Journey into the World of tidyverse

Hybrid Workshop

Upon completing the workshop, you will be able to:
- Read, clean and wrangle data using tidyverse.
- Learn how to apply dplyr, tidyr and stringr.
- Make an interpretable plot using ggplot2.

When	Where	RSVP Required
2 Dec, 2024 (Mon) 3:00 PM – 4:00 PM	LEPH 115, 60 College Street Zoom link will be sent upon RSVP	Register by Nov 29 https://tinyurl.com/dsdeworkshop2

Email: admin.dsdeysph@yale.edu

Thank you!

sph.yale.edu/dsde

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Appendix

Glossary

Version Control   Manage, organize, and track different versions of files. These systems identify differences between versions and allows reverting to older versions. Examples: Google docs.

Distributive Version Control System   The project codebase is copied as a mirror to each contributor's local computer. Local changes get synched via patches sent peer-to-peer through the server.

Mirror   An exact copy of a project from a server, including a full-change history.

Glossary

Server Computer or system that provides resources (i.e. data or programs) to other computers, known as clients, over a network.

Patch Snippets of code or data used to update existing software.

Peer-to-peer Participants in a network act as both client and server by trading resources and services with one another.

git add Prompt git to track changes that have been made to specific files and compare those differences to previously saved version in the .git directory.

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Glossary

git commit — Save your changes as a snapshot in your project's history, present in the .git directory.

git push — Upload your committed work to a shared online location, so others can see it.

git clone — Make a copy of a project from the internet to your own computer.

git branch — Create different "versions" or "paths" of a project that you can work on separately.

Glossary

git checkout Flip between different "path" of your project.

git merge Combine two versions of a project into one.

Helpful Cheat Sheets:

1. *Git Cheat Sheet* by Atlassian

2. *Git Bash Shortcuts* by Mohan Balasundaram

3. *Terminal Shortcuts* by Apple

4. *Vim Cheat Sheet* by Richard Torruellas

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Slide 5

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