Beginner's Guide to Git and GitHub

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1 Introduction

This guide offers a beginner-friendly overview of Git and GitHub, essential tools for version control and collaboration in data science and software development. It focuses on core concepts, commands, and workflows—especially using RStudio.

1.1 Understanding Git and GitHub

1.1.1 What is Git?

Git is a distributed version control system used to track changes in files and coordinate work across teams. It is especially valuable in software and data science projects where collaboration and version tracking are essential. Git allows you to:

✅ Track changes to code, data, or documentation over time

🔙 Revert to previous versions if something breaks

🌿 Create branches to work on features or experiments independently

👥 Collaborate with others without overwriting each other's work

Each Git repository contains a full history of changes, allowing users to explore, compare, or restore past versions of a project at any time.

1.1.2 What is GitHub?

GitHub is a cloud-based platform that hosts Git repositories online. It makes it easier to collaborate, share, and manage your code with others. GitHub builds on Git by providing:

☁️ Remote storage for Git repositories, making them accessible from anywhere

🔁 Pull requests, which allow contributors to suggest changes and collaborate through code review

🐛 Issue tracking to manage bugs, feature requests, and tasks

📜 Visual tools to browse commit history, diffs, branches, and contributions

GitHub also integrates with tools like RStudio, making it ideal for data science workflows.

1.1.3 Local vs Remote Repositories

In a Git project, you typically work with two types of repositories:

Local repository:

Stored on your own computer

Where you write code, commit changes, and test new features

Offers full version history without needing an internet connection

Remote repository:

Hosted online, usually on platforms like GitHub, GitLab, or Bitbucket.

Used for collaboration, backup, and sharing your project

Requires git push to upload local changes and git pull to download updates from others

Working with both local and remote repositories allows for flexible development, secure backups, and seamless teamwork.

1.1.4 Setting Up Git in RStudio

Open RStudio and go to Tools > Global Options > Git/SVN.

Ensure Git is installed and RStudio can detect it.

Create a new project with version control: File > New Project > Version Control > Git.

Clone from GitHub or initialize a new repository.

1.1.5 Git Basics and Core Commands

.gitignore

The .gitignore file tells Git which files or directories to ignore. Common entries include:

.Rhistory .RData .DS_Store *.log* .tmp

Key Git Commands

Git Command	Meaning	Why It's Useful
`git init`	Start tracking the project with Git	Begin version control
`git status`	Check the status of changes	See staged, unstaged, or untracked files
`git add filename`	Stage a specific file	Prepare a file for committing

Git Command	Meaning	Why It's Useful
`git add .`	Stage all changes in the working directory	Quickly add everything for commit
`git commit -m "message"`	Save a snapshot of changes	Record work into Git history
`git log`	Show commit history	View detailed list of commits
`git log --oneline`	Condensed commit history	View a brief summary of commits
`git branch`	List all branches	Manage and view project branches
`git branch branch_name`	Create a new branch	Work separately without affecting the main
`git switch branch_name`	Switch to another branch	Move between versions
`git switch -c branch_name`	Create and switch to a new branch	Shortcut to save time
`git merge branch_name`	Merge another branch into current	Combine features safely
`git push`	Upload commits to GitHub	Share work online
`git push -u origin main`	Push and track a new branch	Set up branch tracking
`git pull`	Download and merge remote changes	Stay updated with remote
`git tag -a v1.0 -m "message"`	Create an annotated tag	Mark important project points
`git reset --soft HEAD~1`	Undo last commit but keep changes staged	Correct mistakes without losing work
`git remote add origin url`	Connect local repo to GitHub	Set up a remote repository
`git remote -v`	View remote connections	Confirm remote links
`git remote remove origin`	Remove a GitHub link	Disconnect remote repository
`git branch -d branch_name`	Delete a local branch	Clean up after merging
`git stash`	Temporarily save uncommitted work	Save work without committing
`git stash pop`	Reapply stashed work	Restore work and continue

Git Command	Meaning	Why It's Useful
`git revert commit_id`	Undo a specific commit safely	Safe undo for public history
`git rebase branch_name`	Move branch commits onto another branch	Simplify commit history
`git rebase -i HEAD~n`	Interactive rebase to squash commits	Combine multiple commits into one

1.1.6 Git Workflow Example (RStudio)

Step-by-Step:

Create a new RStudio Project using Git.

Make changes to a file (e.g., analysis.R).

Use the Git tab in RStudio or run in terminal:

git status git add analysis.R git commit -m "Initial analysis script" git push

Modify file again and repeat add, commit, and push.

Branching

git branch new-feature: Create a new branch

git checkout new-feature: Switch to the branch

git merge new-feature: Merge into main branch

1.1.7 GitHub-Specific Features

Forking

Fork a repository to your GitHub account to work on a copy independently.

Pull Requests

Used to propose changes from a fork or branch into the main repository. Allows for code review and discussion.

GitHub Issues

Used to track bugs, enhancements, and tasks.

README.md and LICENSE

README.md: Overview of the project, setup instructions

LICENSE: Declares the terms under which others can use the code

1.1.8 Best Practices

Write clear, descriptive commit messages (e.g., "Add user authentication logic")

Add constantly, Commit frequently, and push rarely

Use .gitignore to prevent clutter

Never force push unless absolutely necessary

Use branches for new features or fixes

Document your repository with a README and meaningful comments

2 Assigment 2

2.1 Initialize New RStudio Project

Start by creating a new RStudio project, then add a simple Quarto file (e.g., example.qmd). Knit the file to HTML to ensure everything works correctly. You should see the output rendered in the Viewer pane or in your browser. Something like:

Beginner's Guide to Git and GitHub

</> Code

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1 Introduction

This guide introduces Git and GitHub for users with no prior experience. It walks you through key concepts, workflows, and best practices using real terminal commands, practical examples, and helpful diagrams where relevant.

2 1. Git: The Mental Model

Git works across **three main layers**:

- **Working Directory**: Your actual files.
- **Index (Staging Area)**: What will be included in the next commit.
- **HEAD (Repository)**: The last committed snapshot.

Key transitions:

```bash
git add # Moves changes → index (staging)
git commit # Moves index →
```

2.2 Initialize Git

To start tracking your project with Git in a local (unconnected) environment, use git init in the terminal to initialize a new Git repository.

```
jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigme
nt2/Aasigment2
$ git init
Initialized empty Git repository in C:/Users/jesus/Do
cuments/ETC 5513/Assigment2/Aasigment2/.git/

jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigme
nt2/Aasigment2 (master)
$ git add .
```

Image

This command initializes a new Git repository locally. It's the first step in tracking changes, making commits, and later syncing your project with GitHub.

2.3 Stage, and Push to GitHub

As shown in the image, we use git add, git commit, and git push to stage and upload our local changes to the remote repository.

git add . — Stages all new and modified files. You can also stage specific files (e.g., git add example.qmd).

git commit -m "message" — Records the staged changes with a short, descriptive message.

To connect to

```
jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigme
nt2/Aasigment2 (master)
$ git commit -m "Initial commit with example.qmd and
image"
```

GitHub, the user adds a remote:

git remote add origin git branch -M main

This will connect us to the remote repository and rename the master branch to main, this last part is not neccesary but is easier to track it this way.

And then we push all commited changes. This will update our remote repository in Git:

git push -u origin main -u establishes an upstream link, so future git push commands don't need to specify the branch.

2.3.1 Story Time (Skip to next step to continue with the guide)

Because I was trying to push onto the class repository instead of a repository I had access to I had a bit of a problem as shown:

```
jesus@SlothGodHP MINGW64 ~/Document
s/ETC 5513/Assigment2/Aasigment2 (t
estbranch)
$ git push --set-upstream origin te
stbranch
The authenticity of host '[ssh.gith
ub.com]:443 ([4.237.22.40]:443)' ca
n't be established.
ED25519 key fingerprint is SHA256:+
DiY3wvvV6TuJJhbpZisF/zLDA0zPMSvHdkr
4UvCOqU.
This host key is known by the follo
wing other names/addresses:
    ~/.ssh/known_hosts:1: github.co
m
Are you sure you want to continue c
onnecting (yes/no/[fingerprint])? y
es
Warning: Permanently added '[ssh.gi
thub.com]:443' (ED25519) to the lis
t of known hosts.
ERROR: Permission to numbats/rcp.gi
t denied to SlothGodCh.
fatal: Could not read from remote repository.

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

Since I don't have ownership of the repository, no matter how much I tried to cheat Git, neither of us will succeed. But you'll still get a good laugh watching me run around like a headless chicken (see git_history.txt). To fix all the 'fixing'—which included, but wasn't limited to, modifying my SSH—I created a new repository on GitHub, got the new SSH key, and did the following:

When I first tried to push my local repository to GitHub with the command:

git push –set-upstream origin main

I ran into the following error:

no such identity: /c/Users/jesus/.ssh/id_ed25519: No such file or directory git@ssh.github.com: Permission denied (publickey). fatal: Could not read from remote repository.

This error meant that Git couldn't find my SSH key at the expected location, so it couldn't authenticate with GitHub.

To fix this, I removed the existing remote configuration:

git remote remove origin

I did this because the remote configuration might have been incorrect or pointed to the wrong repository.

2.3.2 Configured SSH settings:

If Git can't authenticate with GitHub due to SSH issues (like "Permission denied (publickey)"), follow these steps:

1. Check SSH key setup: Open the SSH config file with:

nano ~/.ssh/config

2. Update SSH config: Change the public key to id_rsa like this:

Host github.com

HostName github.com User git IdentityFile ~/.ssh/id_rsa

3.Test connection:

ssh -T git@github.com You should see: Hi SlothGodCh! You've successfully authenticated, but GitHub does not provide shell access.

4. Fix the remote: Since the previous remote was incorrect, I ran into this issue when pushing:

git push –set-upstream origin main fatal: 'origin' does not appear to be a git repository

This happened because I had removed the remote origin earlier, so Git didn't know where to push my code.

To fix this, I added the correct remote repository:

git remote add origin git@github.com:SlothGodCh/assigment2.git

This command re-established the connection to my GitHub repository using the SSH protocol.

5. Push the code: After adding the correct remote, I pushed my code with:

git push -u origin main

The output showed all my files being uploaded and confirmed that the 'main' branch was set up correctly:

- [new branch] main -> main branch 'main' set up to track 'origin/main'.

6. Verify the successful push: To check everything was synced, I ran:

git status

It showed:

On branch main Your branch is up to date with 'origin/main'. nothing to commit, working tree clean

And:

git branch

Which displayed:

- main testbranch This confirmed that my local 'main' branch was properly connected to the remote repository.

7. The Easy Way: Instead of going through all the issues, you could do it the easy way by running:

git init git add . git commit -m "Initial commit: added example.qmd and knitted HTML file" git remote add origin git branch -M main git push -u origin main

This setup would connect your local repository to GitHub without the hassle.

2.3.3 Create and Push a New Branch

To do this step I eliminated the previously created (if you followed the part 1 you can skip this section) testbranch and restarted the process

2.3.4 Deleting a Local Git Branch

To permanently delete the local testbranch, I used the force deletion command:

git branch -D testbranch

This successfully removed the branch with the confirmation:

Deleted branch testbranch (was 56e63ab).

The -D flag forces deletion (equivalent to –delete –force)

This only affects the local repository - the remote branch remains unchanged

The hash 56e63ab shows the last commit on the deleted branch

Note: Always ensure you've merged or saved needed changes before deletion, especially since this action cannot be undone - all commits exclusive to this branch will be permanently lost unless they exist in another branch or were pushed to a remote.

2.4 Git Branching Workflow Demonstration

Step 1: To safely develop new features without affecting the main codebase, the user creates a new branch:

```
jesus@SlothGodHP MINGW64 ~/Docum
ents/ETC 5513/Assigment2/Assigme
nt2 (main)
$ git checkout -b testbranch
Switched to a new branch 'testbr
anch'

jesus@SlothGodHP MINGW64 ~/Docum
ents/ETC 5513/Assigment2/Assigme
nt2 (testbranch)
$ git add example.qmd

jesus@SlothGodHP MINGW64 ~/Docum
ents/ETC 5513/Assigment2/Assigme
nt2 (testbranch)
$ git commit -m "Update example.
qmd in testbranch"
[testbranch aca824d] Update exam
ple.qmd in testbranch
 1 file changed, 93 insertions(+
), 1 deletion(-)

jesus@SlothGodHP MINGW64 ~/Docum
ents/ETC 5513/Assigment2/Assigme
nt2 (testbranch)
$ git push -u origin testbranch
Enumerating objects: 30, done.
Counting objects: 100% (30/30),
done.
```

Image

git checkout -b testbranch

The terminal responded:

Switched to a new branch 'testbranch'

This command both creates and switches to the new branch in one go, making it simpler than using git branch testbranch followed by git switch testbranch.

Step 2: Making and Staging Changes

After editing example.qmd, the user stages and commits:

git add example.qmd

This prepared my changes to be recorded in the version history.

Then, I committed the changes with:

git commit -m "Update example.qmd in testbranch"

Next, I pushed the branch to GitHub:

git push -u origin testbranch

This command does two things: it syncs the branch with GitHub and sets up tracking between my local and remote branches.

The output showed the progress and ended with:

- [new branch] testbranch -> testbranch branch 'testbranch' set up to track 'origin/testbranch'

This meant:

The testbranch was created on the remote repository.

My committed changes were uploaded.

Tracking was set up between the local and remote branches.

Step 3: Checking Status and Adding More Changes

To check work or stage additional changes:

git status

Alternatively, you can check the Git tab in the upper right corner of RStudio, which shows the same information visually.

The output showed two things:

A modified RStudio project file

A new untracked image file (Fig6.png)

To stage everything, I used::

git add . git commit -m "Commit before pushing branch"

And pushed the updates to the remote branch:

git push -u origin testbranch

The output confirmed that all my latest changes were successfully synchronized with GitHub.

Step 4: Switching Back to Main Branch

Once I was done working on testbranch, I switched back to the main branch with:

git switch main

The message: Your branch is ahead of 'origin/main' by 1 commit.

This means I have local changes on the main branch that haven't been pushed to the remote repository yet.

2.5 Add a data Folder and Amend the Previous Commit

The user adds a data folder with relevant files: mkdir data #Copy your Assignment 1 data files into the data folder ls data # Verify files are present Stage the new files

git add data

Amend the previous commit To include these files in the previous commit (instead of creating a new one):

git commit –amend –no-edit This keeps the commit history clean by updating the last commit without changing its message.

Because this rewrites history, a force-push is needed:

Force push to update remote

git push –force Required because we rewrote commit history

Only safe for personal branches (like testbranch)

Important Notes:

This replaces the previous commit entirely

Never force-push to shared branches (main, dev, etc.)

If collaborating, inform teammates after force-pushing

The amended commit will now include both your original changes and the new data folder.

2.6 Create a Merge Conflict and push fix

Switch to Main Branch git switch main Switches from testbranch back to the main development branch. The terminal indicates this in blue (NAME OF CURRENT BRANCH). The user modifies the same section of example.qmd that was changed on testbranch. These conflicting edits are committed and pushed:

About this Project This text is DIFFERENT on main!

Commit and Push Main Changes

git add . git commit -m "Conflicting edit on main branch" git push

Records and shares the conflicting changes with the remote repository.

Attempt Merge bash git merge testbranch

The git merge command combines changes from one branch into another. Checks for new commits in the source branch (testbranch) that are not in the target branch (main).

Determines if changes can be merged automatically (fast-forward) or if manual conflict resolution is needed. Automatic Merge (If Possible)

If changes affect different files/lines, Git merges them without conflicts.

If the branches diverged (modified the same part of a file), Git pauses and reports a merge conflict.

Conflict Detection (If Changes Overlap)

When the same part of a file is modified differently in both branches, Git marks the conflict:

Auto-merging example.qmd CONFLICT (content): Merge conflict in example.qmd Automatic merge failed; fix conflicts and then commit the result.

```

<<<<<<< HEAD (Current Branch: main)
Changes from main branch
=======
Changes from testbranch
>>>>>>> testbranch
Requires manual editing to resolve.

```

Resolve Conflict Manually The user manually edits the file to resolve the conflict, eliminating all <>HEAD and testbranch section, then finishes the merge:

git add example.qmd git commit -m "Resolve merge conflict between main and testbranch" git push

2.7 Tag the Merged Commit

To create a version tag:

git tag -a v1.0 -m "First stable version after merge" git push origin v1.0

Tags mark release points. Annotated tags (-a) store metadata (author, date, message) and are preferred over lightweight tags.

```
jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigment2/Assigment2 (main)
$ git tag -a v1.0 -m "First stable version after merge"

jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigment2/Assigment2 (main)
$ git push origin v1.0
Enumerating objects: 1, done.
Counting objects: 100% (1/1), done.
Writing objects: 100% (1/1), 186 bytes | 186.00 KiB/s, done.
Total 1 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
To github.com:SlothGodCh/assigment2.git
 * [new tag]         v1.0 -> v1.0
```

2.8 Delete branch `testbranch` locally and on the remote.

To clean up after merging:

git branch -d testbranch # Local deletion git push origin –delete testbranch # Remote deletion

We use -d to safely deletes the branch only if merged. Use -D to force-delete if necessary (e.g., unmerged changes).

```
jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigment2/Assigment2 (main)
$ git branch -D testbranch
Deleted branch testbranch (was 9cf0546).
jesus@SlothGodHP MINGW64 ~/Documents/ETC 5513/Assigment2/Assigment2 (main)
$ git push origin --delete testbranch
To github.com:SlothGodCh/assigment2.git
 - [deleted]         testbranch
```

2.9 Show the commit log in condensed form in the terminal.

To inspect commit history:

git log –oneline –graph –decorate –all

This provides a visual and concise overview of commits and branches.

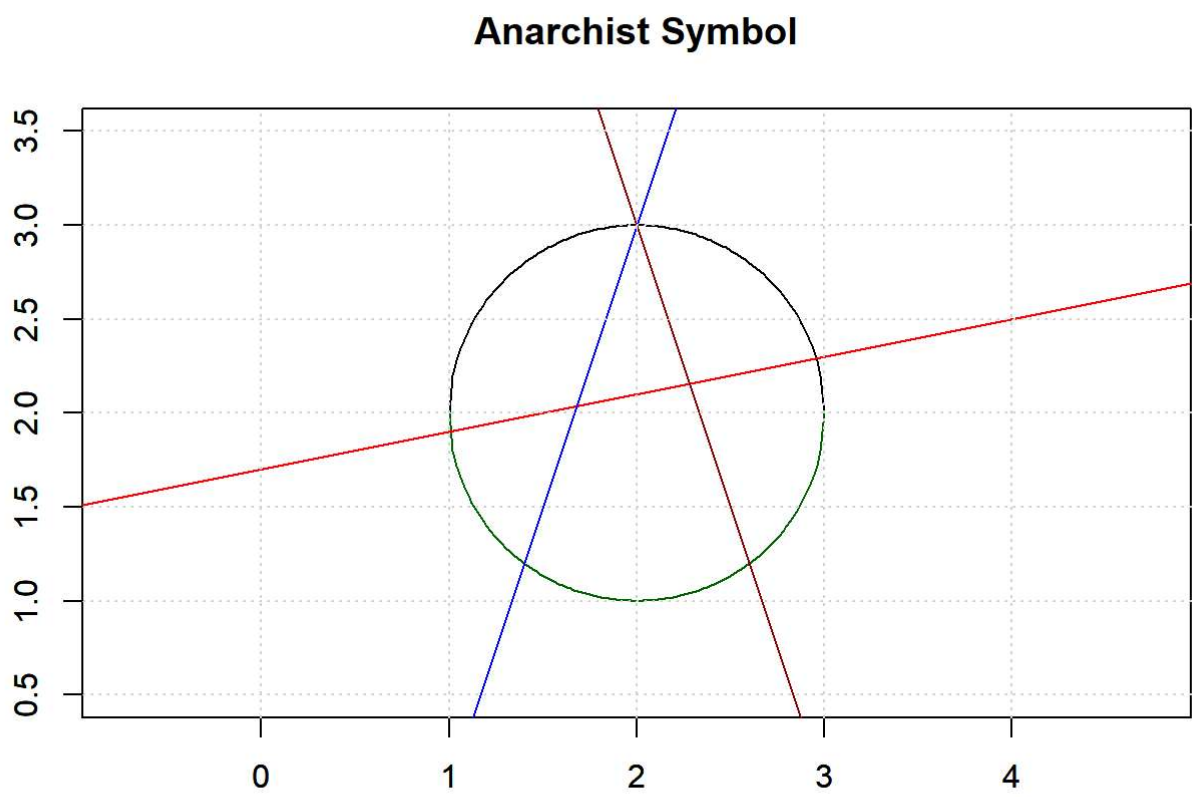
```
jesus@SlothGodHP MINGW64 ~/Docum
ents/ETC 5513/Assigment2/Assigme
nt2 (main)
$ git log --oneline --graph --de
corate --all
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge confl
ict between main and testbranch
|\
| * 262f993 Updated text
* | 363e5a6 Conflicting edit
|/
* 2924eb4 Changes to cause conflict
* 9a179b7 Commit before pushing branch
* aca824d Update example.qmd in testbranch
:
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge confl
ic
t between main and testbranch
|\
| * 262f993 Updated text
* | 363e5a6 Conflicting edit
|/
* 2924eb4 Changes to cause conflict
* 9a179b7 Commit before pushing branch
* aca824d Update example.qmd in testbranch
| * a1faf7e (refs/stash) WIP on main: 56a6a6a Deleted previous testbra
nc
h
|/|
| * db69ec9 index on main: 56a6a6a Deleted previous testbranch
|/
| * db69ec9 index on main: 56a6a6a Deleted previous testbranch
|/
:...skipping...
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge confl
ic
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge conflict
|\
| * 262f993 Updated text
* | 363e5a6 Conflicting edit
|/
* 2924eb4 Changes to cause conflict
* 9a179b7 Commit before pushing branch
* aca824d Update example.qmd in testbranch
| * a1faf7e (refs/stash) WIP on main: 56a6a6a Deleted previous testbranch
|/|
| * db69ec9 index on main: 56a6a6a Deleted previous testbranch
|/
* 56a6a6a Deleted previous testbranch
* db54e4a Added ss to the images folding
* eaf5033 Corrected broken english
* 6e60e46 Initial commit to move origin
* 2da8fde Initial commit with example.qmd and image
```

```
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge conflict between main and testbranch
|\
| * 262f993 Updated text
* | 363e5a6 Conflicting edit
|/
* 2924eb4 Changes to cause conflict
* 9a179b7 Commit before pushing branch
* aca824d Update example.qmd in testbranch
| * a1faf7e (refs/stash) WIP on main: 56a6a6a Deleted previous testbranch
|/|
| * db69ec9 index on main: 56a6a6a Deleted previous testbranch
|/
* 56a6a6a Deleted previous testbranch
* db54e4a Added ss to the images folding
* eaf5033 Corrected broken english
* 6e60e46 Initial commit to move origin
* 2da8fde Initial commit with example.qmd and image
~
(END)
```


```
*   9cf0546 (HEAD -> main, tag: v1.0, origin/main) Resolve merge conflict between main and testbranch
|\
| * 262f993 Updated text
* | 363e5a6 Conflicting edit
|/
* 2924eb4 Changes to cause conflict
* 9a179b7 Commit before pushing branch
* aca824d Update example.qmd in testbranch
| * a1faf7e (refs/stash) WIP on main: 56a6a6a Deleted previous testbranch
|/|
| * db69ec9 index on main: 56a6a6a Deleted previous testbranch
|/
* 56a6a6a Deleted previous testbranch
* db54e4a Added ss to the images folding
* eaf5033 Corrected broken english
* 6e60e46 Initial commit to move origin
* 2da8fde Initial commit with example.qmd and image
~
~
```


2.10 Undo a Commit (Without Losing Changes)

Simple Semicircle Plot



After adding a new section to example.qmd and committing it:

git add . git commit -m “Add new section 9”

The user realizes they want to undo the commit but keep the changes. They run:

git reset –soft HEAD~1

–soft undoes the commit but preserves staged changes, allowing edits or re-commits.

Alternatives:

–mixed: Unstages changes but keeps them.

–hard: Deletes changes — irreversible without backups.