

Reproducible research #2

R Projects

So far, you have run much of your analysis within a single R script or R Markdown file. Often, any associated data are within the same working directory as your script or R Markdown file, but the files for one project are not separated from files for other projects.

As you move to larger projects, this kind of set-up won't work as well. Instead, you'll want to start keeping all materials for a project in a single and exclusive directory.

Organization

Often, it helps to organize the files in a project directory into subdirectories. Common subdirectories include:

- `data-raw`: Raw data and R scripts to clean the raw data.
- `data`: Cleaned data, often saved as `.RData` after being generated by a script in `data-raw`.
- `R`: Code for any functions used in analysis.
- `reports`: Any final products rendered from R Markdown and their original R Markdown files (e.g., paper drafts, reports, presentations).

RStudio allows you to create “Projects” to organize code, data, and results within a directory. When you create a project, RStudio adds a file with the extension “.Rproj” to the directory.

Advantages of setting a directory to be an R Project are:

- Automatically uses the directory as your current working directory when you open the project.
- Coordinates well with git version control and GitHub repository system.
- Opens a “Files” window for navigating project files in an RStudio pane when you open the project.

You can create a new project from scratch or from an existing directory.

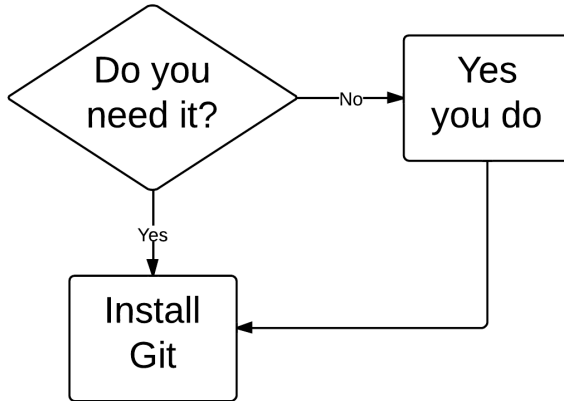
To create an R project from a working directory, in RStudio go to “File” -> “New Project” -> “New Directory”. You can then choose where you want to save the new project directory.

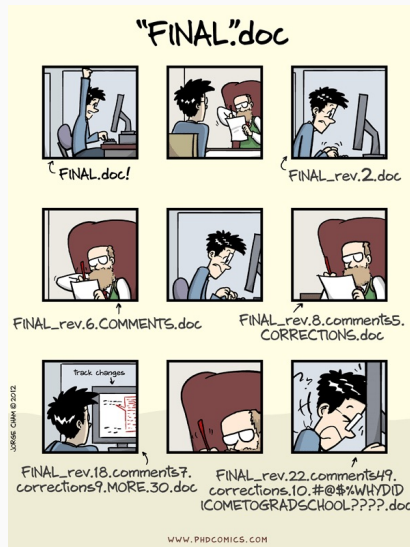
git

Git is a version control system.

It saves information about all changes you make on all files in a repository. This allows you to revert back to previous versions and search through the history for all files in the repository.

Version Control Flowchart





Source: PhDComics

Git is open source. You can download it for different operating systems here:

<https://git-scm.com/downloads>

You will need git on your computer to use git with RStudio and create local git repositories you can sync with GitHub repositories.

Sometimes, RStudio will automatically find git (once you've installed git) when you start RStudio.

However, in some cases, you may need to take some more steps to activate git in RStudio. To do this, go to "RStudio" -> "Preferences" -> "Git/SVN". Choose "Enable version control". If RStudio doesn't find your version of git in the "Git executable" box, browse for it.

Before you use git, you should configure it. For example, you should make sure it has your name and email address.

You can configure git with commands at the shell. For example, I would run the following code at a shell to configure git to have my proper user name and email:

```
git config --global user.name "Brooke Anderson"  
git config --global user.email "brooke.anderson@colostate.edu"
```

Initializing a git repository

You can initialize a git repository for a directory that is an R Project directory through R Studio.

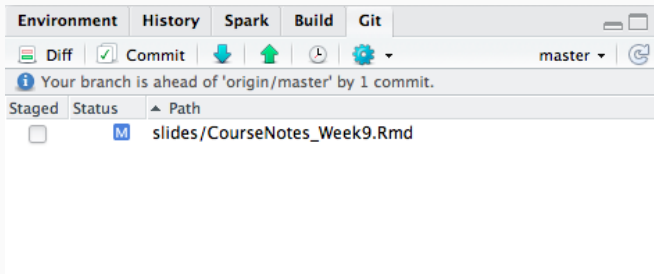
1. Open the Project.
2. Go to “Tools” -> “Version Control” -> “Project Setup”.
3. In the box for “Version control system”, choose “Git”.

Note: If you have just installed git, and have not restarted RStudio, you'll need to do that before RStudio will recognize git. If you do not see “Git” in the box for “Version control system”, it means either that you do not have git installed on your computer or that RStudio was unable to find it.

Initializing a git repository

Once you initialize the project as a git repository, you should have a “Git” window in one of your RStudio panes (top right pane by default).

As you make and save changes to files, they will show up in this window for you to commit. For example, this is what the Git window for our coursebook looks like when I have changes to the slides for week 9 that I need to commit:



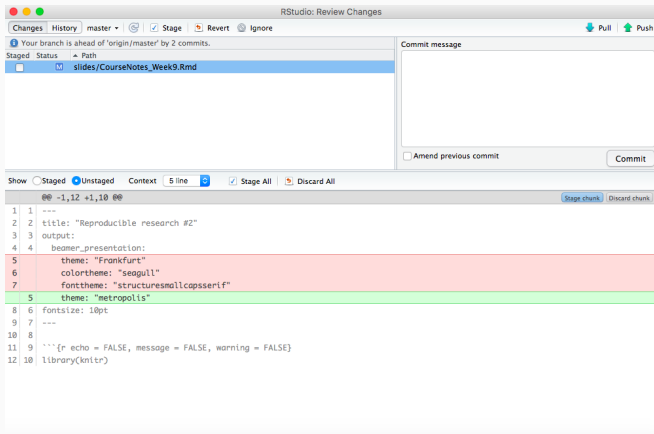
Committing

When you want git to record changes, you *commit* the files with the changes. Each time you commit, you have to include a short commit message with some information about the changes.

You can make commits from a shell. However, in this course we'll just make commits from the RStudio environment. Each time you commit, you are saving a record of the change **locally** (i.e., on your computer). To send this change to other remote repositories, you'll need to link with **remote** repositories and then **push** and **pull** your commits.

Committing

To make a commit from RStudio, click on the “Commit” button in the Git window. That will open a separate commit window that looks like this:



Committing

In this window, to commit changes:

1. Click on the files you want to commit to select them.
2. If you'd like, you can use the bottom part of the window to look through the changes you are committing in each file.
3. Write a message in the "Commit message" box. Keep the message to one line in this box if you can. If you need to explain more, write a short one-line message, skip a line, and then write a longer explanation. (Think of this like an email, where the first line is the subject line and then the rest is the body of the email.) Write the message in the imperative voice ("Add Rmarkdown file", "Change code for cleaning data").
4. Click on the "Commit" button on the right.

Once you commit changes to files, they will disappear from the Git window until you make and save more changes in them.

Committing



	COMMENT	DATE
○	CREATED MAIN LOOP & TIMING CONTROL	14 HOURS AGO
○	ENABLED CONFIG FILE PARSING	9 HOURS AGO
○	MISC BUGFIXES	5 HOURS AGO
○	CODE ADDITIONS/EDITS	4 HOURS AGO
○	MORE CODE	4 HOURS AGO
○	HERE HAVE CODE	4 HOURS AGO
○	AAAAA	3 HOURS AGO
○	ADKFJSLKDFJSDKLFJ	3 HOURS AGO
○	MY HANDS ARE TYPING WORDS	2 HOURS AGO
○	HAAAAAAAAAANDS	2 HOURS AGO

AS A PROJECT DRAGS ON, MY GIT COMMIT MESSAGES GET LESS AND LESS INFORMATIVE.

Source: xkcd

Browsing history

On the top left of the Commit window, you can toggle to “History”. This window allows you to explore the history of commits for the repository.

The screenshot shows the RStudio 'Review Changes' window. At the top, there's a tab labeled 'History' with a dropdown menu showing 'master' and '(all commits)'. Below this is a table of commit history. The table has columns for Subject, Author, Date, and SHA. The commit 'origin/master origin/HEAD Make a small change to in-course exercise' is selected, highlighted in blue. Below the table, there's a section for the selected commit, showing the file '09-reproduciblesearch2.Rmd' and a diff view. The diff view shows changes to the file, with line numbers 399, 400, 401, 402, 403, 404, and 405. The diff shows a mix of additions and deletions, with some lines highlighted in green and others in red. The commit message for the selected commit is 'Make a small change to in-course exercise'.

Subject	Author	Date	SHA
Move some figure files	Brooke Anderson <brooke.anderson@colo	2017-10-16	20e32e94
Add in some figures for slides	Brooke Anderson <brooke.anderson@colo	2017-10-16	58f43de6
origin/master origin/HEAD Make a small change to in-course exercise	Brooke Anderson <brooke.anderson@colo	2017-10-16	2293e8f8
Try adding coursebook material for week 9	Brooke Anderson <brooke.anderson@colo	2017-10-16	e4201f2
Some final changes	Brooke Anderson <brooke.anderson@colo	2017-10-11	5f633f71
Try adding back in choroplethr code	Brooke Anderson <brooke.anderson@colo	2017-10-11	d8cf0aaa
A bit more work on in-course exercise	Brooke Anderson <brooke.anderson@colo	2017-10-11	546016b

Commits 1-100 of 584

09-reproduciblesearch2.Rmd

09-reproduciblesearch2.Rmd View file @ 2293e8f8

```
@@ -399,7 +399,7 @@ In this part of the group exercise, you will set up an R Project to use for the
399 399 - The "data-raw" directory will ultimately have your raw data as well as some R scripts with code for cleaning up the raw
data. The homework requires you to pull FARS data from several years. Create a subdirectory in "data-raw" that will just
have that data. In the "Files" pane in RStudio, navigate into the "data-raw" subdirectory. Use the "New Folder" button to
create a new subdirectory within the "data-raw" subdirectory. Name it "yearly_person_data".
400 400 - Download FARS data from the years 1999 to 2010. From each year, pull out the "person" file. Save these yearly "person"
files in the "yearly_person_data" subdirectory you created. As a file name, use "person_" and then the year. For example, if
you are saving this file for 1999 in the form of a csv, you would name the file "person_1999.csv".
401 401 - The "writing" subdirectory will have your R Markdown file and its output. Create a new R Markdown file ("File" -> "New
File" -> "R Markdown") and save it to this subdirectory. You can change the name and date for the file if you'd like. Delete
all the text that comes as a default. Write a piece of code that lists the files you saved in "data-raw/yearly_person_data".
Remember that the working directory for an R Markdown file is the directory in which it's saved, so you'll need to use a
relative pathname that goes up one directory ("..") and then goes into "data-raw" and "yearly_person_data".
402 - If you have time, go to the [FARS documentation](https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812316) and
find out more about which variables are included in this data set and which values they can have.
402 - If you have time, go to the FARS documentation that you found in an earlier in-course exercise.
403 403 ### Linking your project with a GitHub repository
404 404
405 405
```

In-course exercise

We'll take a break now to do the in-course exercise, through all the local set-up for putting an R Project under git version control on your own computer.

GitHub

GitHub allows you to host git repositories online. This allows you to:

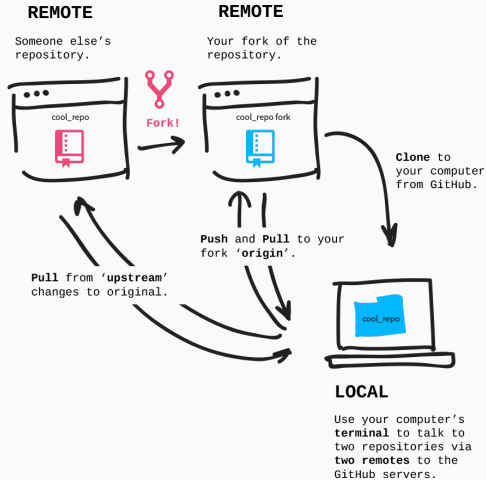
- Work collaboratively on a shared repository
- Fork someone else's repository to create your own copy that you can use and change as you want
- Suggest changes to other people's repositories through pull requests

To push local repositories to GitHub and fork other people's repositories, you will need a GitHub account.

You can sign up at <https://github.com>. A free account is fine.

The basic unit for working in GitHub is the repository. You can think of a repository as very similar to an R Project— it's a directory of files with some supplemental files saving some additional information about the directory.

While R Projects have this additional information saved as an “.RProj” file, git repositories have this information in a directory called “.git”. Because this pathname starts with a dot, it won't show up in many of the ways you list files in a directory. From a shell, you can see files that start with . by running `ls -a` from within that directory.



Source: GitHub

Linking local repo to GitHub repo

If you have a local directory that you would like to push to GitHub, these are the steps to do it.

First, you need to make sure that the directory is under git version control. See the notes on initializing a repository.

Linking local repo to GitHub repo

Next, you need to create an empty repository on GitHub to sync with your local repository. Do that by:

1. In GitHub, click on the “+” in the upper right corner (“Create new”).
2. Choose “Create new repository”.
3. Give your repository the same name as the local directory you’d like to connect it to. For example, if you want to connect it to a directory called “fars_analysis” on your computer, name the repository “fars_analysis”.
4. Leave everything else as-is (unless you’d like to add a short description in the “Description” box). Click on “Create repository” at the bottom of the page.

Linking local repo to GitHub repo

Now you are ready to connect the two repositories.

First, you'll want to change some settings in RStudio so GitHub will recognize that your local repository belongs to you, rather than asking for you password every time.

- In RStudio, go to “RStudio” -> “Preferences” -> “Git / svn”. Choose to “Create RSA key”.
- Click on “View public key”. Copy what shows up.
- Go to your GitHub account and navigate to “Settings”. Click on “SSH and GPG keys”.
- Click on “New SSH key”. Name the key something like “RStudio” (you might want to include the device name if you'll have SSH keys from RStudio on several computers). Past in your public key in the “Key box”.

Syncing RStudio and GitHub

Now you're ready to push your local repository to the empty GitHub repository you created.

1. Open a shell and navigate to the directory you want to push. (You can open a shell from RStudio using the gear button in the Git window.)
2. Add the GitHub repository as a remote branch with the following command (this gives an example for adding a GitHub repository named "ex_repo" in my GitHub account, "geanders"):

```
git remote add origin git@github.com:geanders/ex_repo.git
```

3. Push the contents of the local repository to the GitHub repository.

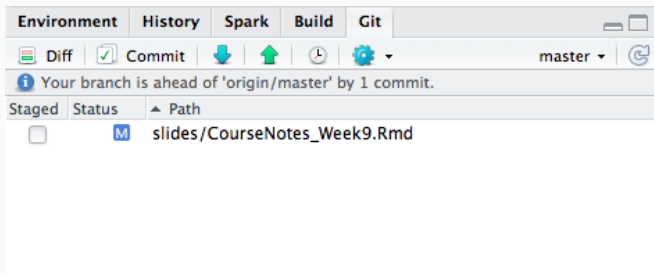
```
git push -u origin master
```

To pull a repository that already exists on GitHub and to which you have access (or that you've forked), first use `cd` to change a shell into the directory where you want to put the repository then run `git clone` to clone the repository locally. For example, if I wanted to clone a GitHub repository called “ex_repo” in my GitHub account, I would run:

```
git clone git@github.com:geanders/ex_repo.git
```


Syncing RStudio and GitHub

Once you have linked a local R project with a GitHub repository, you can push and pull commits using the blue down arrow (pull from GitHub) and green up arrow (push to GitHub) in the Git window in RStudio.



We'll take a break now to do the rest of the in-course exercise.

GitHub helps you work with others on code. There are two main ways you can do this:

- **Collaborating:** Different people have the ability to push and pull directly to and from the same repository. When one person pushes a change to the repository, other collaborators can immediately get the changes by pulling the latest GitHub commits to their local repository.
- **Forking:** Different people have their own GitHub repositories, with each linked to their own local repository. When a person pushes changes to GitHub, it only makes changes to his own repository. The person must issue a pull request to another person's fork of the repository to share the changes.

Each original GitHub repository (i.e., not a fork of another repository) has a tab for “Issues”. This page works like a Discussion Forum.

You can create new “Issue” threads to describe and discuss things that you want to change about the repository.

Issues can be closed once the problem has been resolved. You can close issues on the “Issue” page with the “Close issue” button.

If a commit you make in RStudio closes an issue, you can automatically close the issue on GitHub by including “Close #[issue number]” in your commit message and then pushing to GitHub.

For example, if issue #5 is “Fix typo in section 3”, and you make a change to fix that typo, you could make and save the change locally, commit that change with the commit message “Close #5”, and then push to GitHub, and issue #5 in “Issues” for that GitHub repository will automatically be closed, with a link to the commit that fixed the issue.

Pull request

You can use a *pull request* to suggest changes to a repository that you do not own or otherwise have the permission to directly change.

You can also use pull requests within your own repositories. Some people will create a pull request every time they have a big issue they want to fix in one of their repositories.

In GitHub, each repository has a “Pull requests” tab where you can manage pull requests (submit a pull request to another fork or merge in someone else’s pull request for your fork).

Pull request

Take the following steps to suggest changes to someone else's repository:

1. Fork the repository
2. Make changes (locally or on GitHub)
3. Save your changes and commit them
4. Submit a pull request to the original repository
5. If there are not any conflicts and the owner of the original repository likes your changes, he or she can merge them directly into the original repository. If there are conflicts, these need to be resolved before the pull request can be merged.

Merge conflicts

At some point, you will get *merge conflicts*. These happen when two people have changed the same piece of code in two different ways at the same time.

For example, say Rachel and I are both working on local versions of the same repository, and I change a line to `mtcars[1,]` while Rachel changes the same line to `head(mtcars, 1)`. Rachel pushes to the GitHub version of the repository before I do.

When I pull the latest commits to the GitHub repository, I will have a merge conflict for this line. To be able to commit a final version, I'll need to decide which version of the code to use and commit a version of the file with that code.

Merge conflicts

Merge conflicts can come up in a few situations:

- You pull in commits from the GitHub branch of a repository you've been working on locally.
- Someone sends a pull request for one of your repositories.

Merge conflicts

If there are merge conflicts, they'll show up like this in the file:

```
<<<<<< HEAD
mtcars[1, ]
=====
head(mtcars, 1)
>>>>>> remote-branch
```

To fix them, search for all these spots in files with conflicts, pick the code you want to use, and delete everything else.

Merge conflicts

For the example conflict, I might change the file from this:

```
<<<<<< HEAD
mtcars[1, ]
=====
head(mtcars, 1)
>>>>>> remote-branch
```

To this:

```
head(mtcars, 1)
```

Then you can save and commit the file.

Find out more

If you'd like to find out more, Hadley Wickham has a great chapter on using git and GitHub with RStudio in his *R Packages* book:

<http://r-pkgs.had.co.nz/git.html>

Final note on git



Source: xkcd