MPP-E1180 Lecture 3: Files, File Structures, Version Control, & Collaboration

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Objectives for the topic

- Class date change
- Introduce **Pair Assignment 1**
- **Importance** of (text) files and understanding files structures for reproducible research
- Understanding **files paths** (conventions, best practices)
- **Accessing** the file system from **R**
- Introduction to Git/GitHub for **version control**
- Git/GitHub for **collaboration**

Class change!

4 November class -> 18 November

Reversed order of Automatic Table/Plot Generation and Statistical Modelling Topics.

Pair Assignment 1

- **Due:** Friday 7 October
- Learning objectives: develop your understanding of
    - **file structures**,
    - **version control**,
    - **basic R data structures** and **descriptive statistics**.

Pair Assignment 1

Each pair will create a **new public GitHub repository**

- Must be **fully documented**, including with a **descriptive README.md** file. Your code must be **human readable** and **clearly commented**.
- Include **R source** code files that:
  - Access at least **two** core R data sets
  - Illustrate the data's distributions using a variety of **relevant descriptive statistics**
  - Two files must be **dynamically linked**
- **Another pair** makes a **pull request**. And this is discussed/merged.

Remember: Practical Tips for Reproducible Research

- Document Everything!
- Everything is a (text) file.
- All files should be human readable.
- Explicitly tie your files together.
- Have a plan to organise, store, and make your files available.

Importance of understanding files/file structures

- This topic may seem kind of . . . dry.
- Why not just click and drag files with the GUI (Graphical User Interface)?

Importance of understanding files/file structures

- **Reproducibility**: other researchers only have your files. If they are **well organised** and the **links** between the files are **explicitly stated** then they can better understand what you did.
    - Clearest way of explicitly stating links is **dynamically** using file paths in your source code.
- **The software tools of really reproducible research**: R, RMarkdown, LaTeX, etc. all require you to explicitly state file paths.
- **You**: well organised files will be easier for you to find/understand/use in the future.

Why text files?

(Almost) all files are ultimately text files.

- E.g. a website is typically just a series of connected `.html`, `.js`, and `.css` files.
- **These are text files!** Despite different file extensions.
    - To see this explore a webpage with Chrome Developer Tools

Why text files?

Text files are **versitile**.

- Store your data (`.csv`), store your analysis code (`.R`), store your presentation markup (`.Rmd`, `.tex`, `.bib`).
- They are **simple** and are **not dependent on particular software**.
    - Any text editor can open them.
- Helps **future-proof** research.
- Easy to **version control**.

CSV Example

CSV (Comma Separated Values)

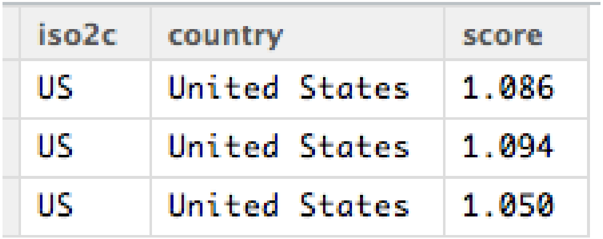
- All columns are separated by commas ,.
- All rows are separated by new lines.

CSV Example

In CSV this:

```
iso2c, country, score
US,United States,1.086
US,United States,1.094
US,United States,1.050
```

makes:



iso2c	country	score
US	United States	1.086
US	United States	1.094
US	United States	1.050

Figure 1:

Text files best practices

Use RStudio or some **text editor** (personal current favourite: atom.io) to edit text files.

- RStudio can open/edit/save any text file

Never open/edit/save using MS Word!

- Word will add a lot of hidden background text that is likely to cause problems with R and other software. R/etc doesn't understand Word's instructions.

Text files best practices

Document your text files, including **informative headers**.

Use **comment characters** (R: `#`, Markdown/HTML: `<!-- -->`)

For example:

```r
#####################
# R source to gather World Bank data
# Christopher Gandrud
# 18 September 2018
# MIT License
####################

2 + 2 # Inline comment
```

Text files best practices

- Keep line length to about **80 characters**.
  - In Markdown/LaTeX paragraph breaks only exist if there are **two line breaks**.
  - Most text editors, including RStudio have a **margin ruler**.
  - Improves version control.

```
This is treated as
only one paragraph.

This is treated as

two paragraphs.
```

File paths

- Files are organised **hierarchically** into (upside down) trees.

```
Root
|_
    Parent
    |_
        Child1
        Child2
```

Root

Root directories are the **first level of a disk**.

They are the root out of which the file tree grows.

Naming Conventions:

Linux/Mac: `/`

- e.g. `/git_repos` means that the `git_repos` directory is a child of the root directory.

Windows: the disk is partitioned, e.g. the `C` partition is denoted `C:\`.

- `C:\git_repos` indicates that the `git_repos` directory is a child of the `C` partition.

Sub (child) directories

Sub (child) directories are denoted with a / in Linux/Mac and \ in Windows, e.g.:

```
# Linux/Mac
/git_repos/Project1

# Windows
C:\git_repos\Project1
```

R tip:

- In R for Windows you either use two backslashes \\ (\ is the R escape character)
- Or / in **relative paths** in R for Windows, it will know what you mean.

Working directories

A **working directory** is the directory where the program looks for files/other directories.

Always remember the working directory.

- Otherwise you may open/save files that you do not want to open/save.

Working directories

In R:

```r
# Find working directory
getwd()
```

```
## [1] "/git_repositories/SyllabusAndLectures/LectureSlides
```

```r
# List all files in the working directory
list.files()
```

```
## [1] "img"             "Lecture3.html" "Lecture3.Rmd"
```

```r
# Set root as working directory
setwd('/')
```

Extra: in the Terminal Shell

In the **Terminal Shell**:

```
# Find working directory
pwd
```

```
## /git_repositories/SyllabusAndLectures/LectureSlides/Lect
```

```
# Set root as working directory
cd /
```

Relative vs. Absolute file paths

Use **relative file paths** when possible.

- **Absolute file path**: the entire path on a particular system,
  - E.g. `/git_repos/Project1/Paper.Rmd`
- **Relative file path**: the path relative to the working directory.
  - E.g. if `/git_repos` is the working directory then the relative path for `Paper.Rmd` is `Project1/Paper.Rmd`.

Why?

- Your scripts will run easily on **other computers**. **Enhances reproducibility**. Easier for your collaborators. Easier for you when you use another computer.

File & directory name conventions

Don't use spaces in your file names.

They can create problems for programs that treat spaces as an indication that the path has ended.

Alternatives:

- `CamelCase` (ex. `DataAnalysis.R`)
- `file_underscore` (ex. `data_analysis.R`)

Load files into R–Dynamically Link

There are a number of R commands to load files, depending on the file type.

- Load Data: `read.table`, `read.csv` `read.dta` `xlsx::read.xlsx`, `rio::import`

```
read.csv('data/TestData.csv')
```

- Save Data: `write.csv`, `write.dta`
- Load and run R source code: `source`

```
source('source/Analysis1.R')
```

R Input/Output, including from URLs

URLs are also file paths for files on the internet.

You can use them the same way as local file paths.

The new rio package can import many different file types (including from URLS) with the same function: `import`.

```
library(rio)

Disproportionality <- import('http://bit.ly/Ss6zDO', format

names(Disproportionality)
```

```
## [1] "country"             "iso2c"                  "year"
## [4] "disproportionality"
```

Version Control with Git

Why version control?

- Detailed log of **all changes**.
- Easy to **revert back** to previous versions.
- Clear **attribution of work** (who contributed what).
    - Provides a **selective incentive**, helping to overcome the collaborative collective action problem!

Git vs. GitHub

What is Git?

- Git is an **open source** command line program for version control.

What is GitHub?

- A **company/web service** that hosts Git repositories and enables ‘social coding’.
- Other services are available, e.g. BitBucket
- Note: ultimately your locally stored repositories are yours separate from GitHub.

GUI GitHub

What is GitHub for Mac/Windows?

- A GUI for Git.
- Makes it easier to use.
- Ultimately just does command line Git.

Note: Explaining using the command line

The following example uses command line Git, even though you are free to use GUI GitHub.

Why?

- **Easier to document** (not just a bunch of screen shots).
- The command line Git is the '**real Git**'. GUI Git's are a facade, and more likely to change/be different across implementations.
- Understanding command line Git will help you **understand problems and concepts that arise later**.

Getting started with Git

Key terms (local):

- **Repository** (repo): a directory where Git looks for changes
- **Initialize** (init): have Git begin watching a directory
- `add`: stage a file so that Git starts watching it
- `commit`: record changes to the repo
- `branch`: continuous history of the repository. You can have multiple branches
- **master**: the main branch. By convention this should be the most stable version.

Getting started with Git

Key terms (local):

- `checkout`: revert to a previous version or a branch
- `merge`: combine one branch into another
- `tag`: a human readable name given to a particular commit
- `blame`: attribution of who changed what

Getting started with Git

Key terms (remote):

- *Collaborator*: someone with read/write permission on a repo
- `clone`: copy a remotely hosted repository onto your computer
- `push`: commit changes to a remotely hosted repository
- `pull`: merge changes from a remotely hosted repository
  - In GUI GitHub `push` and `pull` are combined into **sync**
- **fork**: copy a repository that you do not own
- **pull request**: after forking a repo, changes can be made and suggested to the original repo's owner.

Getting started with Git

Note: using command line (Terminal Shell), but all of these things can be done with the GUI file system (point and click) + GitHub GUI.

First lets create a directory (`FirstRepo`) that will become our **Git repository** (i.e. parent directory)

```
# Make repository directory
mkdir /git_repositories/FirstRepo

# Change working directory
cd /git_repositories/FirstRepo

# Begin version control by initialising as a Git repo
git init
```

Getting started with Git

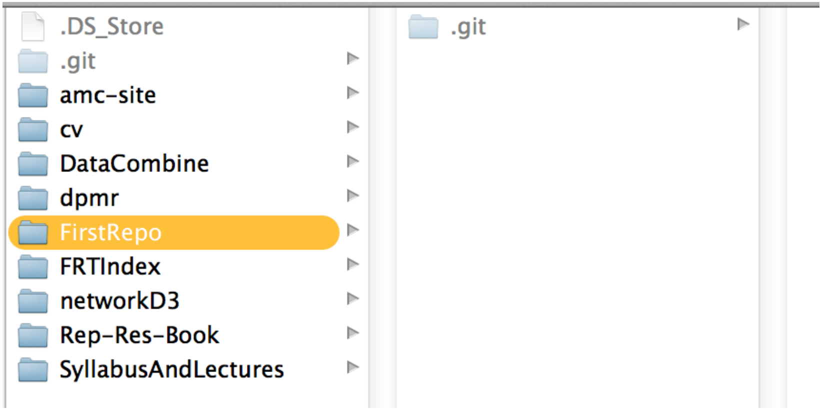


Figure 2: Git Invisible

Getting started with Git

Add a text file to the repo.

```
# Create a new file called README.md
echo "# My first repo" > README.md

# Check Git status
git status
```

```
# On branch master
#
# Initial commit
#
# Untracked files:
#   (use "git add <file>..." to include in what will be co
#
#    README.md
```

Getting started with Git

Note: All repos should have an informative `README.md` file.

- `.md` is for Markdown

Bonus: They are **rendered on GitHub**. For example, the Syllabus on SyllabusAndLectures.

Getting started with Git

Begin tracking changes, by **staging** the repo's files.

```
git add .
```

Make some changes to `README.md`. Save the changes.

These changes will not be logged by Git until they are **committed**

```
git commit -am 'author name added to README'
```

- `a`: all changes are committed
- `m`: add a Git commit message. Try to be **informative**.

Also, compare to previous commits with `git diff`

Git Log

You can view all previous commits with `git log`

```
git log
```

```
commit 3c49e3f1d2f03513c1554bb36d034562312b5bed
Author: christophergandrud <christopher.gandrud@gmail.co>
Date:   Tue Sep 9 15:54:44 2014 +0200

    author name added to README
```

Git Checkout

Each commit is given a **unique SHA-1 hash**.

The hash in the previous example was: `3c49e3f1d2f03513c1554bb36d034562312b5bed`.

You can switch back to any previous commit with `git checkout` and the commit hash.

Use `--` for the last commit.

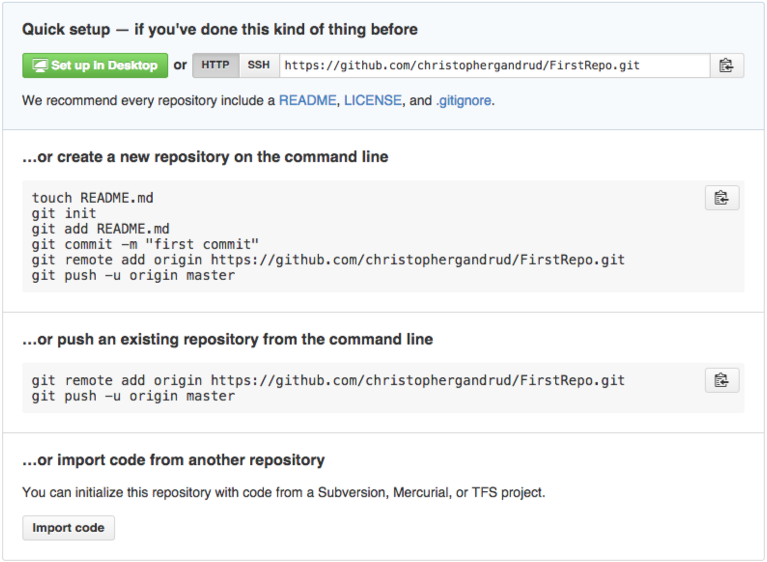
```
git checkout --
```

Add to GitHub

So far the repo is only on your own computer.

To add it to GitHub:

1. Create a new repository on GitHub. Give it the same name as you local repo (i.e. `FirstRepo`). Do not initialise with any files.
2. Follow the instructions:



Quick setup — if you've done this kind of thing before

```
https://github.com/christophergandrud/FirstRepo.git
```

We recommend every repository include a README, LICENSE, and .gitignore.

...or create a new repository on the command line

```
touch README.md
git init
git add README.md
git commit -m "first commit"
git remote add origin https://github.com/christophergandrud/FirstRepo.git
git push -u origin master
```

...or push an existing repository from the command line

```
git remote add origin https://github.com/christophergandrud/FirstRepo.git
git push -u origin master
```

...or import code from another repository

You can initialize this repository with code from a Subversion, Mercurial, or TFS project.

Figure 3: New GitHub Repo

Updating From Remote Repositories

After you commit a change to the **local** repository you need to **push** the changes to GitHub:

```
git push origin master
```

- `origin`: the remote repo on GitHub
- `master` is the master branch (we'll get to this in a second)

Updating From Remote Repositories

If there are changes on the remote repo, then you will need to **pull** and **merge** them.

```
git pull origin master
```

```
Unpacking objects: 100% (3/3), done.
From https://github.com/christophergandrud/FirstRepo
 * branch            master     -> FETCH_HEAD
   3c49e3f..fe3cc0a  master     -> origin/master
Updating 3c49e3f..fe3cc0a
Fast-forward
 README.md | 4 +++-
 1 file changed, 3 insertions(+), 1 deletion(-)
```

Git will tell you if there are any **merge confilcts**. You will need to sort these out.

Comparing Commits on GitHub

View a file's `History`.

Branches

You can create multiple **branches** in your repo.

These allow you to:

- Make changes to a project without affecting the **master** branch
- A branch called **gh-pages** pushed to GitHub will become a hosted website.

Branches Example

Create a new branch called `TestBranch`

```
git checkout -B TestBranch
```

You can `add` files and `commit` changes.

When you think that the changes are ready to be merged with the `master` branch:

```
git commit -am 'last changes to TestBranch, ready for maste

git checkout master

git merge TestBranch

# Delete the branch if you want to
git branch -D TestBranch
```

Tags

You can **tag** a particular commit so that it is easy to find.

You need to tag your assignments when you turn them in.

```
git tag -a v0.1 -m 'First tag'

git push --tags
```

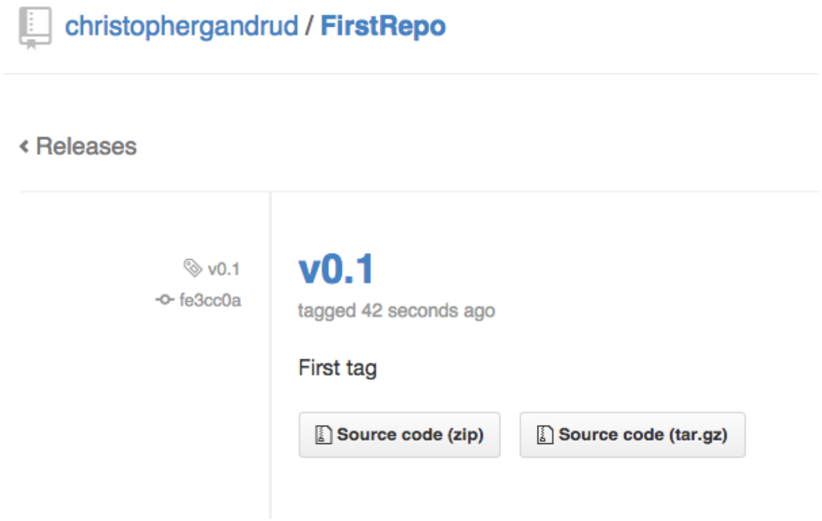


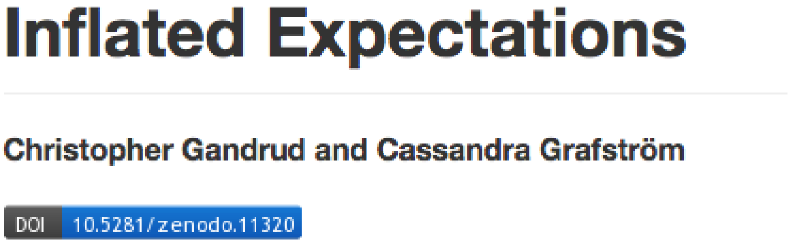
Figure 4: Git tag example

Tags and DOI

You can use GitHub tags to create Digital Object Identifiers (DOI).

- Use for **citing** (particular version of) research.
- For **How-To** see `https://guides.github.com/activities/citable-code/`

DOI Badges in README files on GitHub:



Inflated Expectations

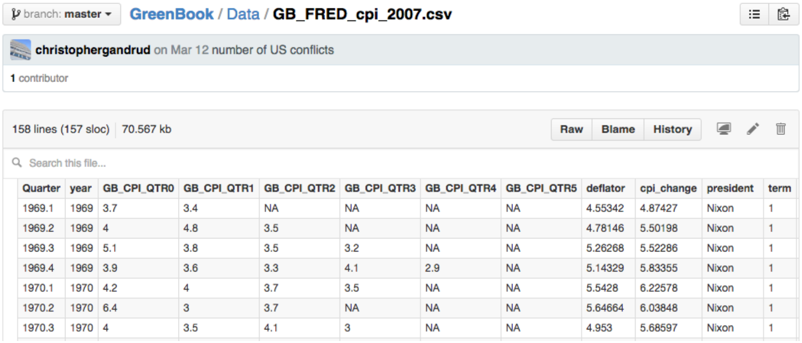
Christopher Gandrud and Cassandra Grafström

DOI 10.5281/zenodo.11320

Figure 5: DOI Readme

Data on GitHub

CSV files are rendered in the browser:



christophergandrud on Mar 12 number of US conflicts

1 contributor

158 lines (157 sloc) | 70.567 kb

Quarter	year	GB_CPI_QTR0	GB_CPI_QTR1	GB_CPI_QTR2	GB_CPI_QTR3	GB_CPI_QTR4	GB_CPI_QTR5	deflator	cpi_change	president	term
1969.1	1969	3.7	3.4	NA	NA	NA	NA	4.55342	4.87427	Nixon	1
1969.2	1969	4	4.8	3.5	NA	NA	NA	4.78146	5.50198	Nixon	1
1969.3	1969	5.1	3.8	3.5	3.2	NA	NA	5.26268	5.52286	Nixon	1
1969.4	1969	3.9	3.6	3.3	4.1	2.9	NA	5.14329	5.83355	Nixon	1
1970.1	1970	4.2	4	3.7	3.5	NA	NA	5.5428	6.22578	Nixon	1
1970.2	1970	6.4	3	3.7	NA	NA	NA	5.64664	6.03848	Nixon	1
1970.3	1970	4	3.5	4.1	3	NA	NA	4.953	5.68597	Nixon	1

Figure 6: CSV rendered

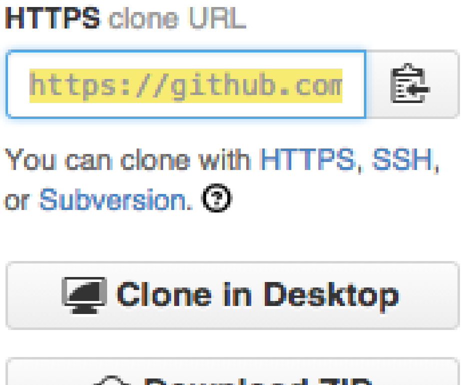
Collaborating on GitHub: Official Collaborators

You can add **official collaborators** to the repo on GitHub:

Settings > Collaborators > Enter collaborator's GitHub username

Now the will have read/write privileges (they can **push** as well as **pull**)

They should **clone** the repo.



GitHub Issues

A good way to communicate is to use GitHub Issues.

Creates an open and public record of thoughts/issues that anyone can contribute to.

Forking/Pull Requests

Fork: You can copy a repo and then build on it by **forking** it.

- This maintains entire version history, contributors, etc,

Pull: Anyone (non-official contributors) can make a **pull request**.

Simplest way is to click edit () on someone else's repo. Begin editing.

Note:

- Need approval from a repo owner
- Once the request is accepted, the change is **automatically merged** into master.

GitHub Caveats

Cannot store large files ($>$ 50 mb).

Public repos are public! So **never put a password** or other sensitive information in them.

- If you want Git/GitHub to **ignore** a file in your local repo, place its file path in a file called `.gitignore`.
- For efficiency can use regular expressions
  - For example to ignore all PDF files use:

```
*.pdf
```

Seminar: Files/File Paths

Play around with the file system from R (and if you want to) the Shell

- Find the working directory, change the working directory, explore the files in the working directory.

If you have any data files, try to load them into R.

- If not load `Analysis/Data/MainData.csv` into R from `https://github.com/christophergandrud/Rep-Res-ExampleProject1`.

Seminar: Git/GitHub

- Create a new **remote repository** on GitHub and **clone** it to your computer.
- Add and commit you your *.R* file from the previous seminar and a README.md file.
- Add your neighbour as a **collaborator** to the repo.
- Make, push, and pull commits from each other.
- Open and close issues.
- Fork a neighbour's repo.
- Make a pull request to another neighbour's repo (or the SyllabusAndLectures). Justify why it is an important request.
- Accept (or reject) a pull request.