Reproducible Workflow: Software [35mins]

Quick Overviews of Version Control (Github) and Dynamic Documents (RMarkdown)

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Slides at https://goo.gl/aBQ3LR

Inter-American Development Bank Workshop, March 2018

Version Control

Version Control Problem to avoid

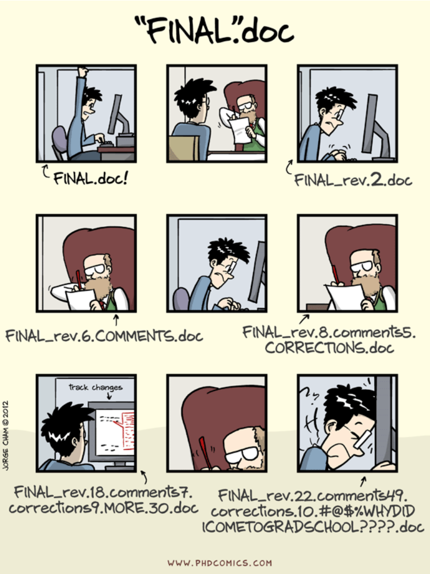


Figure 1: http://www.phdcomics.com/comics/archive/phd101212s.gif

Managing expectations

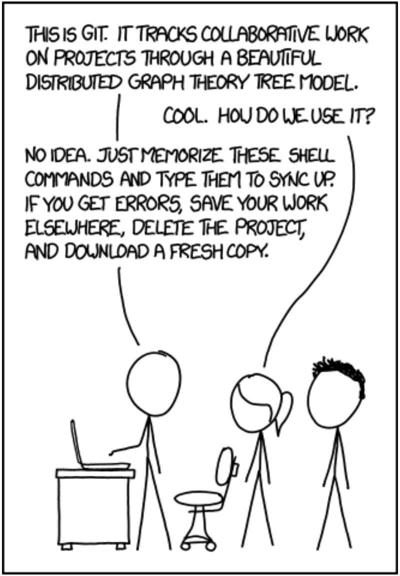

THIS IS GIT. IT TRACKS COLLABORATIVE WORK ON PROJECTS THROUGH A BEAUTIFUL DISTRIBUTED GRAPH THEORY TREE MODEL.
COOL. HOW DO WE USE IT?
NO IDEA. JUST MEMORIZE THESE SHELL COMMANDS AND TYPE THEM TO SYNC UP. IF YOU GET ERRORS, SAVE YOUR WORK ELSEWHERE, DELETE THE PROJECT, AND DOWNLOAD A FRESH COPY.

Figure 2: Git xkcd comic

The Primary Goal of Version Control (for us)

The Goal: keep track of any potentially meaningfull modification to your code. (Git is also great for collaboration and exploring the work of others).

Strategy 1:

1 - Agree on a naming convention with you co-authors (eg: YYYYMMDDfilename_INITALS).
2 - Begin working from the last saved version (eg: `20180325demo_FH.do`).
3 - At the end of the day, save on a new version (eg: `20180327demo_FH.do`).

Pros: Easy adoption.

Cons: Error prone, hard to document, lots of files for each document.

Strategy 2:

1 - Name your file `filename` (ideally `01_filename`)
2 - Take a snapshot of your work (`Commit`) every time you complete relevant change (day, hour or minutes).
3 - Update your entire working folder to the cloud ('push').

Pros: Error proof, seemless documentation, one file per document, track differences over all versions, meant to work with the cloud.

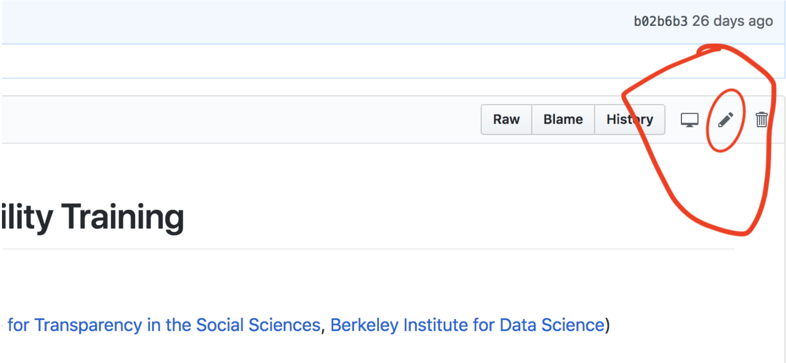
Cons: Harder adoption.

Tips to ease the adoption: concepts.

- **Git** is the software that does all the magic. **Github** is an implementation of Git that is easier to use, provides free (public) cloud service, and tools for collaboration.
- A repository (**repo**) is a master folder that contains all your work.
- Whenever you take a snapshot of your *saved* work, you **commit**
- When you make changes to your files in your computer, you are working **locally**, whenever you make changes to the files in the cloud you are working **remotelly**.
- Whenever you want to update your *remote repo*, you **push**. If you want to update you *local repo*, you **pull**.
- When you copy a repo from another person into your online github account, you **fork** it.
- When you start a repo from github.com (just created or forked), and want to download it for the first time to your local computer, you **clone** it.

Tips to ease the adoption: 4 min tutorial.

1- Create github.com account and sign in. [1 min]
2- Search `BITSS IDB` 3- Fork it.[1min]
4- (You have left the BITSS account, and are now in your account)
5- Click on `README.md`, then click on the pencil icon [1min]



ility Training

for Transparency in the Social Sciences, Berkeley Institute for Data Science)

Tips to ease the adoption: 4 min tutorial.

6- Modify the title (`# IDB Reproducibility Training`) and click `Commit changes`
7- Go back to the root folder of the repo (`IDBMarch2018`), and click `Clone or download`. And download as a zip.

If you had Github Desktop (an app from the Github company) installed, you could clone the repo and play more.

But I just wanted to give you a quick intro to: - Find code of interest, fork it, edit it, make your first commit, and download.

Want to learn more:

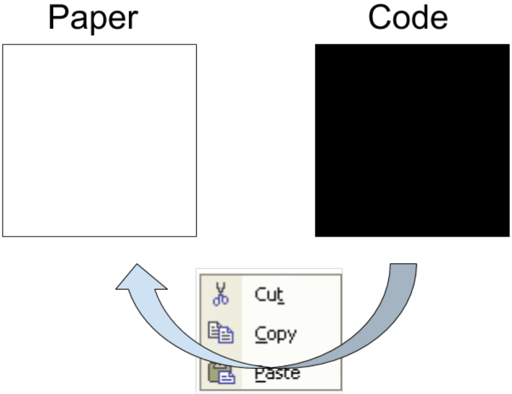
- Great 20 min intro to Git by Alice Bartlett
- Great 2hr tutorial to Github by Jenny Bryan (git ninja)
- Documentation from Matthew Gentzkow Jesse Shapiro

Dynamic Documents

Dynamic Documents For Computational Reproducibility

- Based on principles of *literate programming* aims at combining code and paper in one single document
- Best framework to achieve the holy grail of **one-click reproducible workflow**
- Best two current implementations: `RMarkdown (R)` & `Jupyter (Python)`. `Stata` is catching up (dyndocs release here and reviews here and here)

Currently code and narrative components live in separate universes



Paper

Code

Dynamic Documents: integrate the two universes!

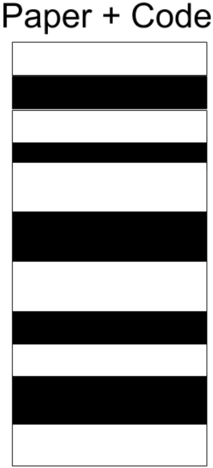


Figure 4:

Dynamic Documents: A Recipe

- 1 simple language that can combine text and code: `Markdown`
- 1 statistical package to do the analysis (`R`, `Python`, `3S's?`)
- 1 machinery to combine analysis and text to create a single output: `Pandoc`
- [Optional-but-not-really] 1 program to bring all the elements together: RStudio/RMarkdown, Jupyter

Hands-on excercise: the birthday problem!

As an illustration lets write a report using the participants in this workshop to illustrate the famous birthday problem.

> *What is the probability that at least two people this room share the same birthday?*
>
> *Is it something like* $\frac{1}{365} \times N = 0.11$*?*

Create a new RMarkdown File

1 - In RStudio: `File-> New File -> RMarkdown...`

2 - Name it, and save it.

3 - Review/edit the header, and delete all the default body of text except for one code chunk.

4 - Define a seed (`set.seed(1234)` and number of people in the room (`n.pers = ?`)

The birthday problem: the math

Actually the math says otherwise:

$$\begin{aligned}1-\bar{p}(n) &= 1 \times \left(1-\frac{1}{365}\right) \times \left(1-\frac{2}{365}\right) \times \cdots \times \left(1-\frac{n-1}{365}\right)\\ &= \frac{365 \times 364 \times \cdots \times (365-n+1)}{365^n}\\ &= \frac{365!}{365^n(365-n)!} = \frac{n! \cdot \binom{365}{n}}{365^n} \qquad (1)\\ p(n=40) &= 0.891\end{aligned}$$

Code for the math (https://goo.gl/ZFQvba)

Don't look at this: just copy and paste into your report

```
\begin{align}
 1 - \bar p(n) &= 1 \times \left(1-\frac{1}{365}\right)
 \times \left(1-\frac{2}{365}\right) \times \cdots \times
 \left(1-\frac{n-1}{365}\right) \nonumber  \\
 &= \frac{ 365 \times 364 \times \cdots \times
   (365-n+1) }{ 365^n } \nonumber \\
 &= \frac{ 365! }{ 365^n (365-n)!} =
   \frac{n!\cdot\binom{365}{n}}{365^n}\\
p(n= `r n.pers`) &= `r
 round(1 - factorial(n.pers) *
         choose(365,n.pers)/ 365^n.pers, 3)`\nonumber
\end{align}
```

Don't like math? Let's run a simple simulation!

1 - Simulate 10,000 rooms with $n = 40$ random birthdays, and store the results in matrix where each row represents a room.
2 - For each room (row) compute the number of unique birthdays.
3 - Compute the average number of times a room has 40 unique birthdays, across 10,000 simulations, and report the complement.

Code for the simulation (https://goo.gl/ZFQvba)

```
birthday.prob = function(n.pers, n.sims) {
  # simulate birthdays
  birthdays = matrix(round(runif(n.pers * n.sims, 1, 365)),
                      nrow = n.sims, ncol = n.pers)
  # for each room (row) get unique birthdays
  unique.birthdays = apply(birthdays, 1, unique)
  # Indicator with 1 if all are unique birthdays
  all.different = (lapply(unique.birthdays, length) == n.pe
  # Compute average time all have different birthdays
  result = 1 - mean(all.different)
return(result)
}
n.pers.param = 43
n.sims.param = 1e4
birthday.prob(n.pers.param,n.sims.param)
```

```
## [1] 0.9268
```

Results

- Many people originally think of a prob $\sim \frac{1}{365} \times N = 0.118$
- However the true probability is of $p(n = 43) = 0.924$
- And the simulated probability is of 0.9265

Final Remarks & More Resources

- With DD with can achieve a one-click reproducible workflow.
- This is particularly helpful to understand/present results that are hard to digest.
- Stata just develop an internal version of DD for v15. Review Here
- More great examples here
- Want to learn more: great free books (can you guess how they were written?)