

# Before we start today...

- Create a Github account
- Share your account name with me at tomoyas@mit.edu
- If possible (or necessary), install Git in your computer (check <https://happygitwithr.com/install-git.html>)

# Git for Social Scientists: Introduction to Version Control with Git

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<sup>1</sup>This slide deck is heavily inspired by the workshop materials by Suyeol Yun and Shiro Kuriwaki.

# Introduction



Companies using Git

[Airbnb](#)

[Allegro](#)

[Amazon Web Services - Labs](#)

[Amazon Web Services](#)

[Amazon](#)

[Ambientia Group Oy](#)

[Apple Inc.](#)

[arkency](#)

[AT&T Open Source](#)

Companies using Github

# Introduction

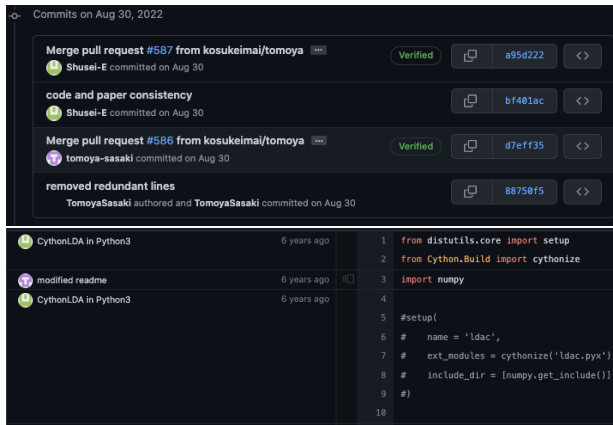
- Why Git? Why Github? Why version control?
- These are essential tools for programmers
- How about social scientists?
- My opinion: Social scientists also benefit from version control with Git
  - Increase in collaborative projects
  - Demand for clean replication materials
  - Complex data manipulation/preprocessing/analysis
- “Code and Data for the Social Sciences: A Practitioner’s Guide” by Gentzkow and Shapiro has a chapter dedicated for version control
- This workshop
  - Introduction to version control
  - Pros and cons of Git/Github
  - Brief introduction to these tools (how Git/Github works and how to use them)

# What is version control?

- Version control: tracking and managing changes to file content
- Git: (the most popular) software for version control
- Github: service to host your git on the Internet (alternatives include GitLab, Bitbucket ...)
- Repository: unit of a version control project, your project folder with a subfolder named `.git`
  - Often simply called “repo”
  - `.git` folder in a repository tracks and stores every single change you make in the corresponding repository
- I focus on Git/Github because they are extremely popular than their alternatives

# Benefit of Git/Github: Tracking who/how/when

- You can identify
  - who made changes
  - how they made the changes
  - when they made the changes
- You can check the entire history since you created a repository and move back to previous versions easily (undo changes)
- Github can visualize them nicely
- Useful when you
  - want to revert your (particular) changes
  - work on a collaborative project
- You don't need to keep
  - different versions of the same file:  
clean\_data\_1104.R, clean\_data\_1020.R
  - the same file edited by different people:  
clean\_data.tomoya.R, clean\_data.adam.R



The screenshot displays the GitHub interface for a repository. The top section, titled 'Commits on Aug 30, 2022', lists four commits:

- Merge pull request #587 from kosukeimai/tomoya** (Verified, a95d222) by Shusei-E committed on Aug 30.
- code and paper consistency** (bf401ac) by Shusei-E committed on Aug 30.
- Merge pull request #586 from kosukeimai/tomoya** (Verified, d7eff35) by tomoya-sasaki committed on Aug 30.
- removed redundant lines** (88750f5) by TomoyaSasaki authored and TomoyaSasaki committed on Aug 30.

Below the commit list, a table shows the commit history for three files:

File	Commit Hash	Author	When
CythonLDA in Python3	a95d222	Shusei-E	6 years ago
modified readme	bf401ac	Shusei-E	6 years ago
CythonLDA in Python3	d7eff35	tomoya-sasaki	6 years ago

On the right side of the table, a code diff for 'CythonLDA in Python3' is shown, highlighting changes to the setup.py file:

```
1 from distutils.core import setup
2 from Cython.Build import cythonize
3 import numpy
4
5 #setup(
6 #     name = 'ldac',
7 #     ext_modules = cythonize('ldac.pyx'),
8 #     include_dir = [numpy.get_include()]
9 #)
10
```

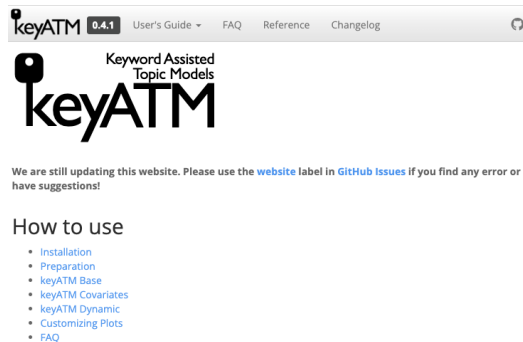
# Benefit of Git/Github: Tracking who/how/when

- You can check how the results change when we try different specification
- Easy to track which part of the results changed

699	+	log(HHI)	& 0.02	& 0.02	& 0.07	& 0.07	\\
700	-		& (0.02)	& (0.08)	& (0.06)	& (0.09)	\\
701	-	Presidential	& -0.48^{**}	& -0.48	& 0.57	& 0.57	\\
702	-		& (0.22)	& (0.83)	& (0.79)	& (1.00)	\\
703	-	log(HHI) * Presidential	& -0.03	& -0.03	& 0.10	& 0.10	\\
704	-		& (0.03)	& (0.11)	& (0.12)	& (0.14)	\\
679	+	log(HHI) * Presidential	& 0.03	& -0.03	& 0.09	& 0.09	\\
680	+		& (0.04)	& (0.04)	& (0.07)	& (0.08)	\\
681	+	log(HHI)	& -0.05	& -0.05	& -0.13	& -0.13	\\
682	+		& (0.04)	& (0.04)	& (0.08)	& (0.08)	\\
683	+	Presidential	& 0.40	& 0.40	& 0.76	& 0.76	\\
684	+		& (0.34)	& (0.34)	& (0.59)	& (0.66)	\\

# Other side benefits of Git/Github

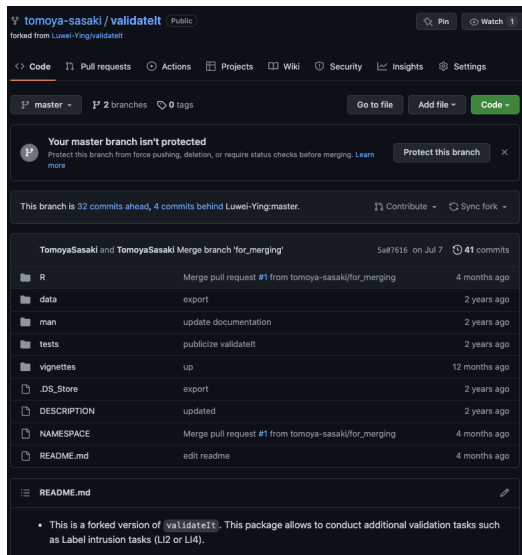
- Hosting a customizable website (free, no ads, tons of templates)
- Contribute to software packages hosting on Github
- Tweak a package developed by someone else for your own purposes
- Send a request to package developer (often happens at “Issue”)
- Nice integration with popular apps/websites such as RStudio and Overleaf





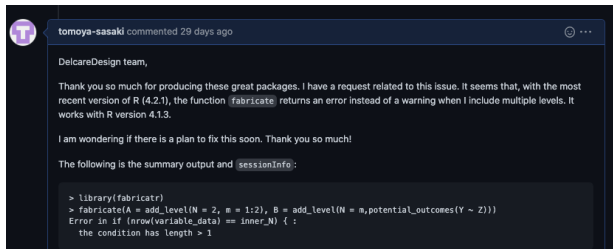
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## Download



Source



PDF

## Actions



Copy Project



Word Count

## Sync



Dropbox



Git



GitHub

# Limitations: not suitable for tracking large files

- Github imposes file size limit:
  - 25 MB per file limit (you can change this limit up to 100MB by changing setup)
  - 1GB per repository limit
- Remember that `.git` tracks and stores all the change you make in a repository  
~> if you store a huge file in the repository and let `.git` tracks its changes, the `.git` folder can grow quite huge
- Use `.gitignore` to specify files that Git should not track “ignore”

```
*.csv # ignore csv files  
/data/ # ignore any file in data folder
```
- Include huge files as well as sensitive files that contain password, API key etc in `.gitignore`

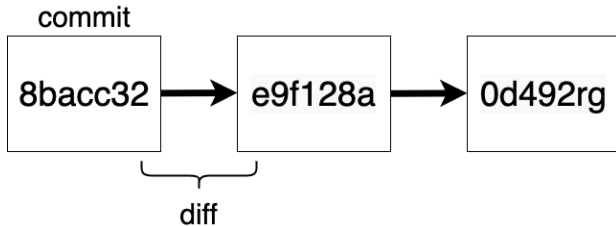
# Limitations: not great if you want to track non-text files

- Git cannot track line by line changes for non-text files such as PDF, Microsoft Word/Excel/Powerpoint, JPG, ...
- Note that Git still tracks changes
- The value of Git/Github is limited
- In the right example, Git/Github recognizes the changes as the changes in file sizes  
→ even though you update a figure in PDF or PNG format, Git/Github might not recognize it unless the file size changes...



# How Git tracks files

- Git tracks changes in files with “**commit**”
- Changes between commits are called “**diff**”
- Each commit is a snapshot of your repository at specific times
- Commit has a human-readable message and an (first few characters of) commit ID
- Commit is not automatic and you actively make a “commit” with a message
- Ideally commit should be atomic units of change that represent a specific idea
- You need to “**stage**” the files you want to add to commit (more later)



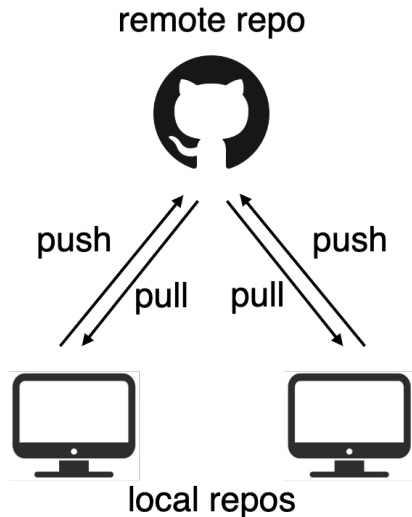
- 8bacc32: “test commit”
- e9f128a: “edit analysis code”
- 0d492rg: “add new analysis”

# Github and more on repos

- If you just work on your local repos (and only on one computer), you don't need Github
- Repos: unit of a version control project, contains a folder with a subfolder named `.git`
  - Local repos: repos (folder) in your own computer, ordinary project folder with subfolder named `.git`
  - Remote repos: repos (folder) in a web hosting services such as Github
- Remote repos such as Github...
  - come with unique URL (`https://github.com/username/reponame.git`)
  - are basically a copy of your local repos
  - nicely visualize your commits and also serve as a backup of your codes (remember, not for data)
  - useful when you work on the same project with multiple computers
- You can choose remote repo to be public or private
- Github accounts let you create unlimited number of private repos with upto 3 collaborators  
unlimited number of public repos with unlimited number of collaborators

# How to interact with remote repos on Github

- Interaction with remote repos: **pull** and **push**
- You **push** the commits you made to remote repos
- You **pull** new commits on remote repos
- Technically “pull” does **fetch** and **merge**





# How to use Git/Github

- So far, we have covered some fundamental concepts around Git/Github
- But how do we initialize a repo and commit/pull/push in practice?
- Command line, Github desktop app etc
- This workshop focuses on RStudio
- I personally use command line

# General (suggestive) initialization

- ❶ Establish a connection between your computer and Github
  - ❷ Create a repo on Github (create a public one for now)
  - ❸ **Clone** your remote repo on Github to your computer (can be any location). This is your local repo.
  - ❹ Edit `.gitignore` to make sure that Git won't track any sensitive or huge file
- If you have any existing project that you want to track with Git, create a remote repo on Github, clone it to your computer (i.e., local repo), and move codes and folders into the local repo

# General (suggestive) daily workflow

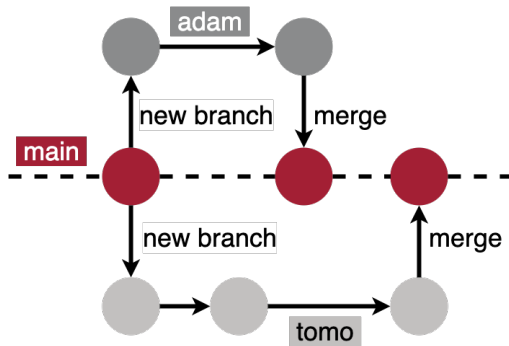
- ❶ Edit, add, or delete files in your repo
- ❷ Stage files you want to add to commit and make a commit when you make some changes that represent a specific idea or solve particular issues
  - Add lines to clean data
  - Add lines to visualize regression results
  - Delete lines that are irrelevant anymore
- ❸ Push when you make a set of commits or when you call it a day
- ❹ Pull any new commits in the remote repo if there are commits and pushes to the remote repo from other computers
- ❺ Repeat the process above
  - Push at least once a day if you make any edit
  - Let's try out with Github and RStudio

# Setup authentication

- When we interact with a remote Git server, such as GitHub, we need to provide credentials
- Github provides two authentication methods, HTTPS and SSH
- I recommend HTTPS and will use HTTPS in this workshop
- Procedure
  - ➊ Go to <https://github.com/settings/tokens> and click “Generate token”
  - ➋ Decide the scope. Choose (at least) “repo”, “user”, and “workflow”.
  - ➌ Click “Generate token”. This is the same as the password to interact with Git. You shouldn’t show this to anyone.
  - ➍ Copy the generated strings (PAT, personal access token)
  - ➎ Open RStudio and run `gitcreds::gitcreds_set()` (Install the `gitcreds` package beforehand)
  - ➏ Paste your PAT
  - ➐ RStudio stores and remembers PAT for you

# How Git/Github handle collaborative projects

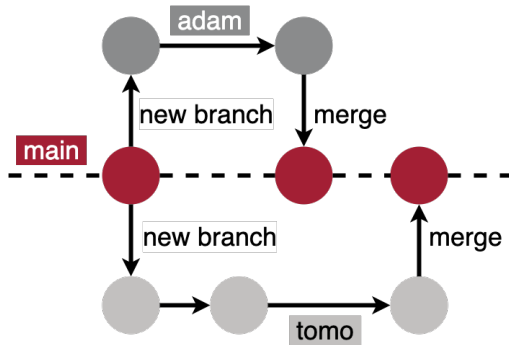
- Easy collaboration is a distinct feature of Git
- Key concepts: **branch** and **fork**
- Branches are parallel universe of a repository
- Main branch is the default branch and should contain stable version
- You contribute to a repo by creating a new branch in isolation from changes that other people are making to the repo
- Whenever you work on a collaborative project, you should always create a new branch



- Each circle represents “commit”
- In this example, Adam and Tomo work on the same project and each of them creates a branch

# How Git/Github handle collaborative projects

- Once your work is done, open **pull request**, and **merge** your branch into the default branch
- Pull request is an opportunity to discuss or check (**review**) if the changes you make in your branch won't break the default branch
- By merging your branch into the default branch, any edit you make in your branch will be reflected in the default branch
- When both of them finish their work, they open a pull request and merge their branch into the main branch



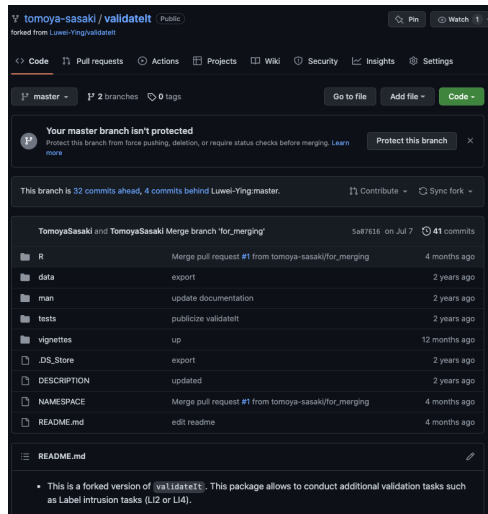
- Each circle represents “commit”
- In this example, Adam and Tomo work on the same project and each of them creates a branch

# General (suggestive) daily workflow with multiple branches

- ❶ Create a new branch (usually from the default branch)
- ❷ In your branch...
  - ❶ Edit, add, or delete files in your repo
  - ❷ Stage files you want to add to commit and make a commit when you make some changes that represent a specific idea or solve particular issues
  - ❸ Push when you make a set of commits or when you call it a day
  - ❹ Repeat the process above
- ❸ Create a pull request when you finish your project
- ❹ Merge your branch into the default branch
  - Let's try out with Github and RStudio

# Working on someone else's repo

- Even if you have a public repository on Github, only those who have permission can directory push and merge to your repo
- What to do if you want to contribute to someone else's repo or borrow their idea and tailor for your own project?
- **Fork** their project to your Github account
  - Original: <https://github.com/xxx/reponame.git>
  - Forked repo:  
<https://github.com/yourusername/reponame.git>





# Comparison and relationship to alternatives (Dropbox, Google Drive)

- Unlike Dropbox or Google Drive, Git/Github does not automatically track changes  
    ~> you need to take (small) action (mostly) when you
- However, you can make your project folder clean with commits and branches
- You can revert your changes easily and flexibly if you make frequent commits  
    ~> Dropbox and Google Drive only preserve once-in-a-day snapshots
- Putting Git local repos in Dropbox or Google Drive can be very tricky when your Dropbox/Google Drive account is synced to multiple computers
- Git does not like autosync (autoupdate) by Dropbox/Google Drive
- But you probably want to rely on these other services to store huge data that Git does not track
- In my setup, I put Git repos in Dropbox but sync them only with my main computer and the same Git repos in my other computers are located in non-Dropbox folders

# What's next?

- Working with private repos
- (Gradually) Learning how to use git in command lines
- Probably you mess up once in a while. I still make mistakes sometimes
- You can fix them easily by reverting

# Useful resources

- Happy Git and GitHub for the useR: <https://happygitwithr.com/index.html>
- Git Guide: <https://github.com/git-guides>
- git-vs-dropbox: <https://michaelstepner.com/blog/git-vs-dropbox/>