

METHODS 3: MULTILEVEL STATISTICAL MODELLING AND MACHINE LEARNING



BACHELOR OF COGNITIVE SCIENCE

AARHUS UNIVERSITY

1 SEPTEMBER 2021

EMIL TRENCKNER JESSEN

METHODS 3: MULTILEVEL STATISTICAL MODELING AND MACHINE
LEARNING



COURSE OVERVIEW (FIRST HALF)

W1: Introduction

Setting up R and Python and recollection of the general linear model

W2: Linear Mixed Effects Models

Modelling random effects - and how do they differ from fixed effects?

W3: Generalized Linear Mixed Effects Models

What to do when the response variable is not continuous?

W4: Explanation and prediction

Why are good explanations sometimes bad?

W5: Evaluating and comparing models

How do we assess how models compare to one another?

Fall break:

Machine Learning and Python programming follows

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W3: Generalized Linear Mixed Effects Models

What to do when the response variable is not continuous?

W4: Explanation and prediction

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W5: Evaluating and comparing models

How do we assess how models compare to one another?

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TODAYS PLAN

- ... About last week
- Terminal
- Git & GitHub
- Work on assignment

TERMINAL



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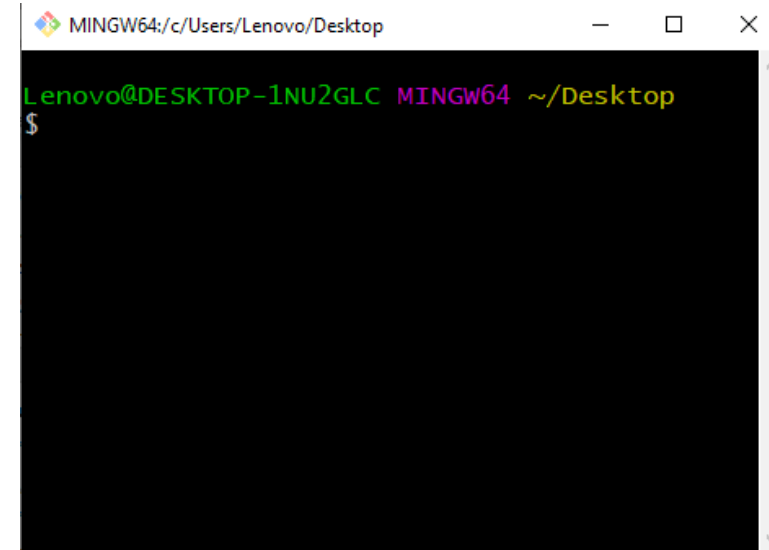


TERMINAL

- A way of accessing computer structure and functions without the use of visual representation



=

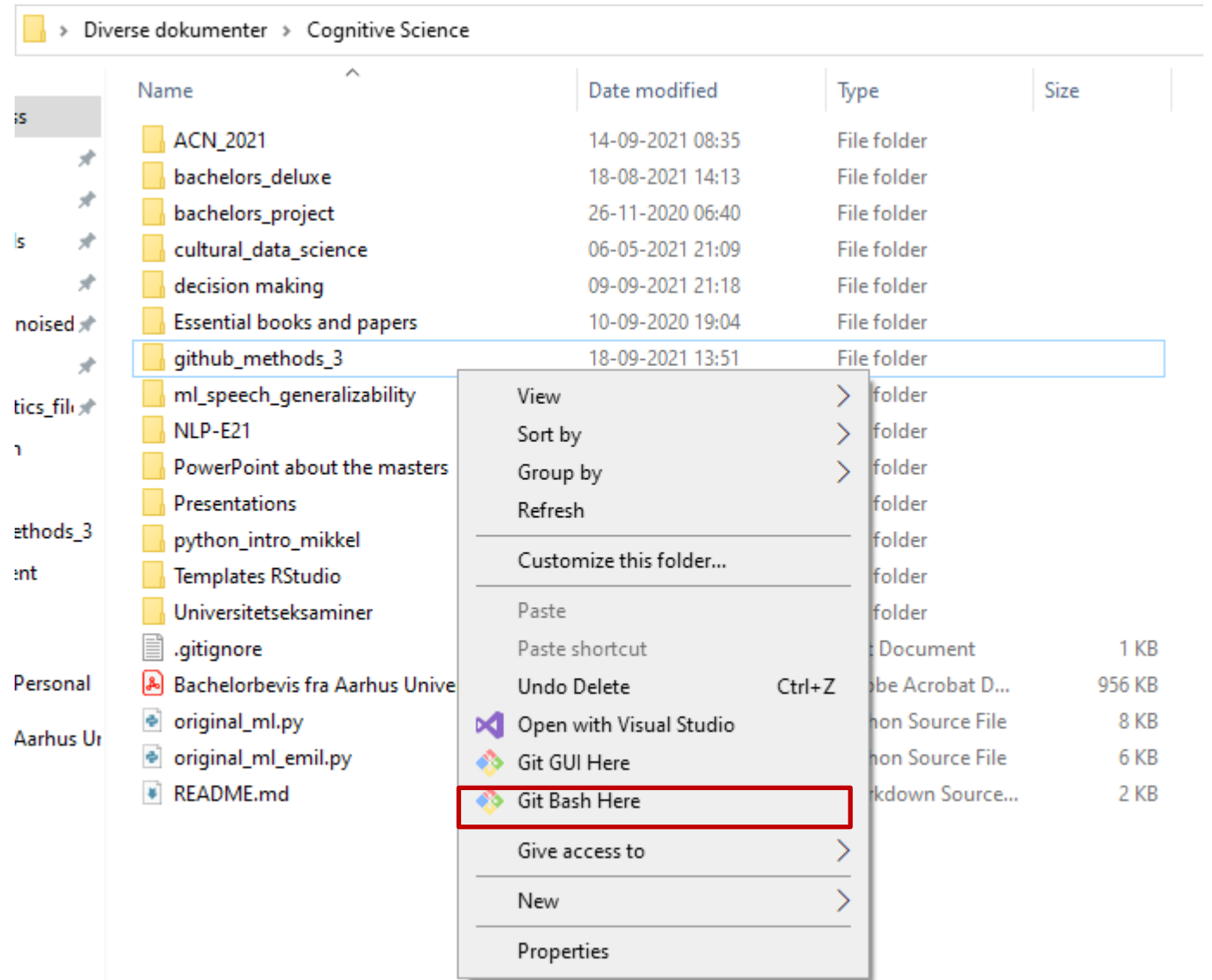


TERMINAL

- Opening terminal in folder?

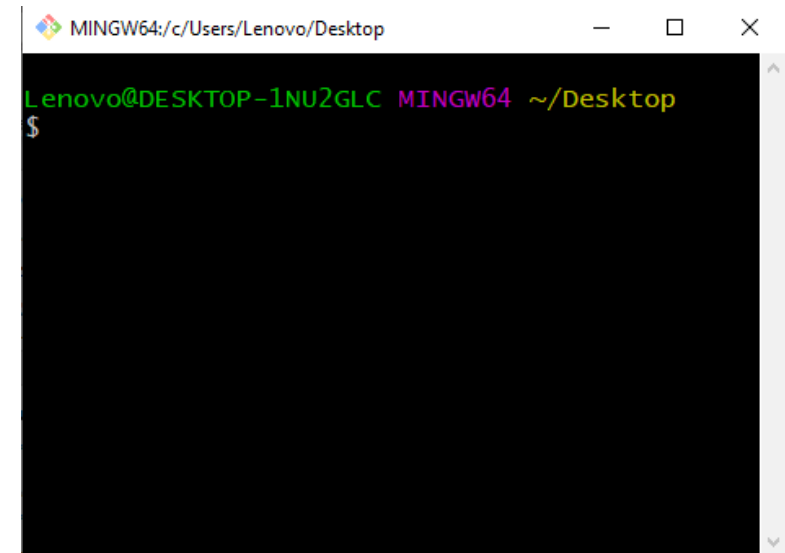
TERMINAL

- Opening terminal in folder?



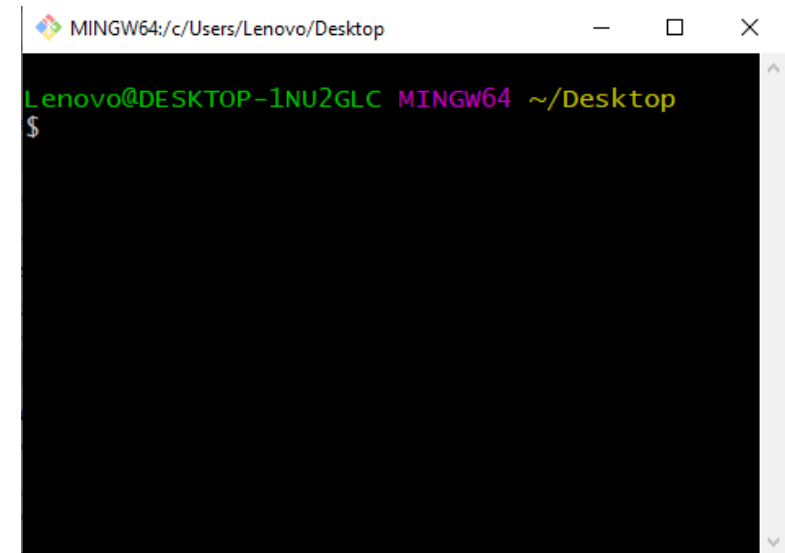
TERMINAL TERMINOLOGY

- Terminal/Console



TERMINAL TERMINOLOGY

- Terminal/Console
- Shell
 - Bash (MacOS, Linux)
 - Cmd (Win)
 - PowerShell (Win)



COMMANDS

- pwd
- ls
- cd <dir_name>
- mkdir, rm -r, etc.

COMMANDS

- pwd
- ls
- cd <dir_name>
- mkdir, rm -r, etc.

```
MINGW64:/c/Users/Lenovo/Desktop/Film
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ pwd
/c/Users/Lenovo/Desktop

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ ls
'Diverse dokumenter'/
DnD/
Film/
'Løgumkloster højskole'/
Zoltan-Dienes-Chap-3.pdf
bookmarks.html
'class 1, list.txt'
desktop.ini
'methods 3 week 1 followups.txt'
wd/

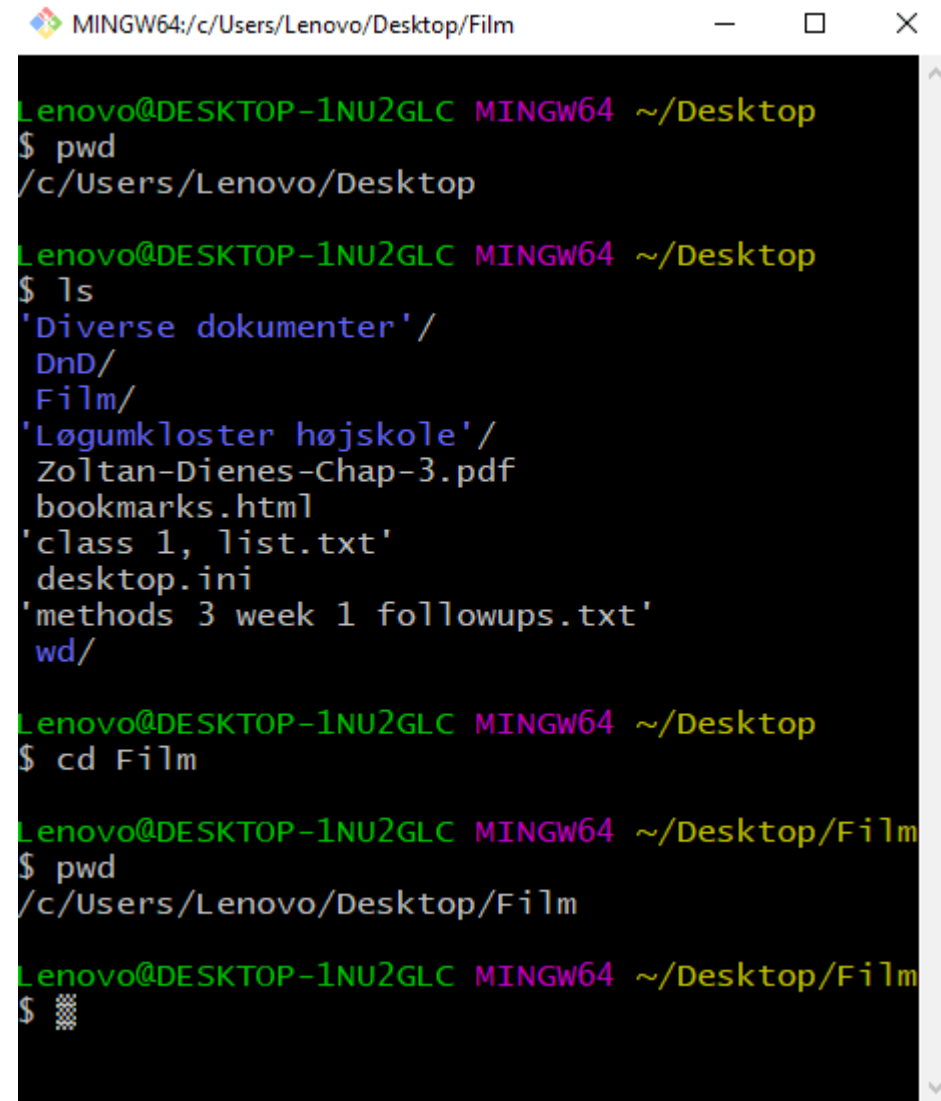
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ cd Film

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Film
$ pwd
/c/Users/Lenovo/Desktop/Film

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Film
$
```

TERMINAL

- Questions?



```
MINGW64:/c/Users/Lenovo/Desktop/Film
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ pwd
/c/Users/Lenovo/Desktop

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ ls
'Diverse dokumenter'/
DnD/
Film/
'Løgumkloster højskole'/
Zoltan-Dienes-Chap-3.pdf
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Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop
$ cd Film

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Film
$ pwd
/c/Users/Lenovo/Desktop/Film

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Film
$
```

GIT



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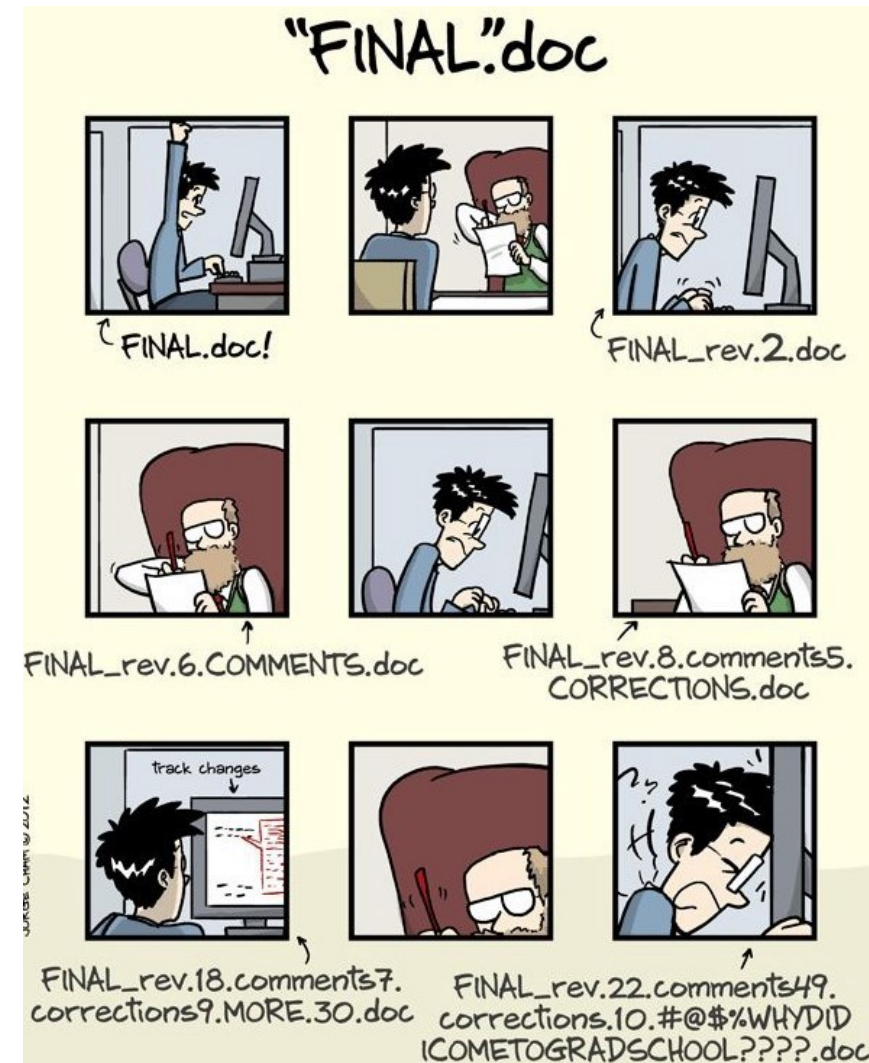
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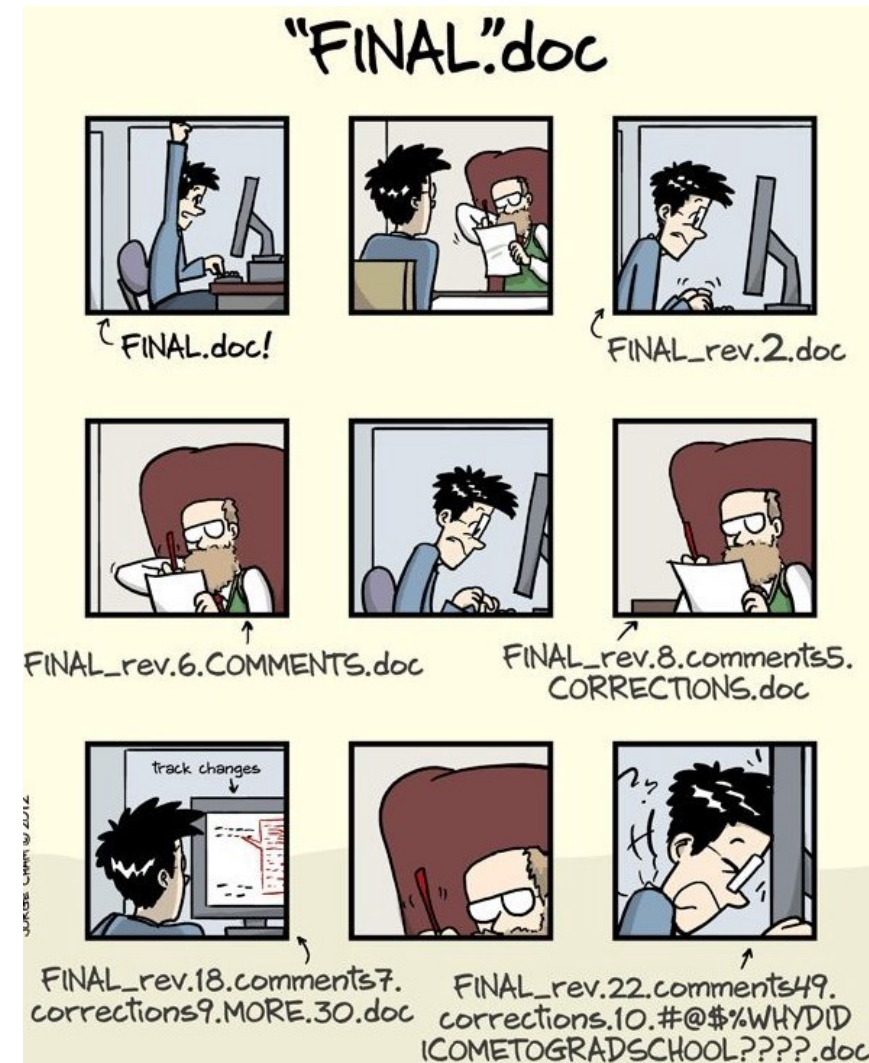
GIT

- Version control system



GIT

- Version control system
- Allows for going back in time

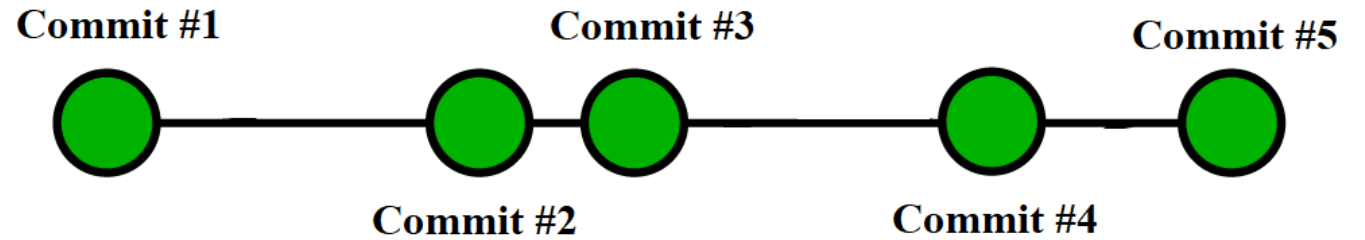


GIT

- Version control system
- Allows for going back in time
- Commit -> creating checkpoint

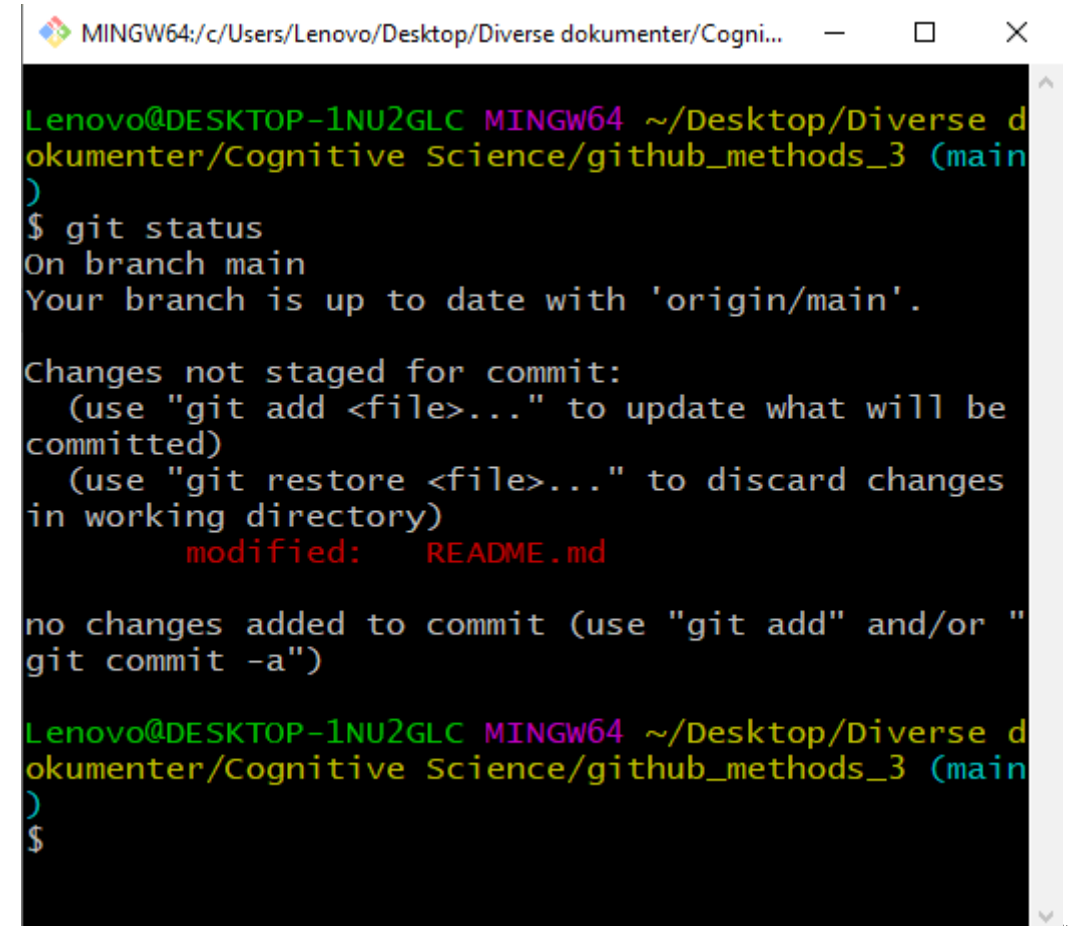
GIT

- Version control system
- Allows for going back in time
- Commit -> creating checkpoint



GIT COMMANDS

- git status



```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumenter/Cogni...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$ git status
On branch main
Your branch is up to date with 'origin/main'.

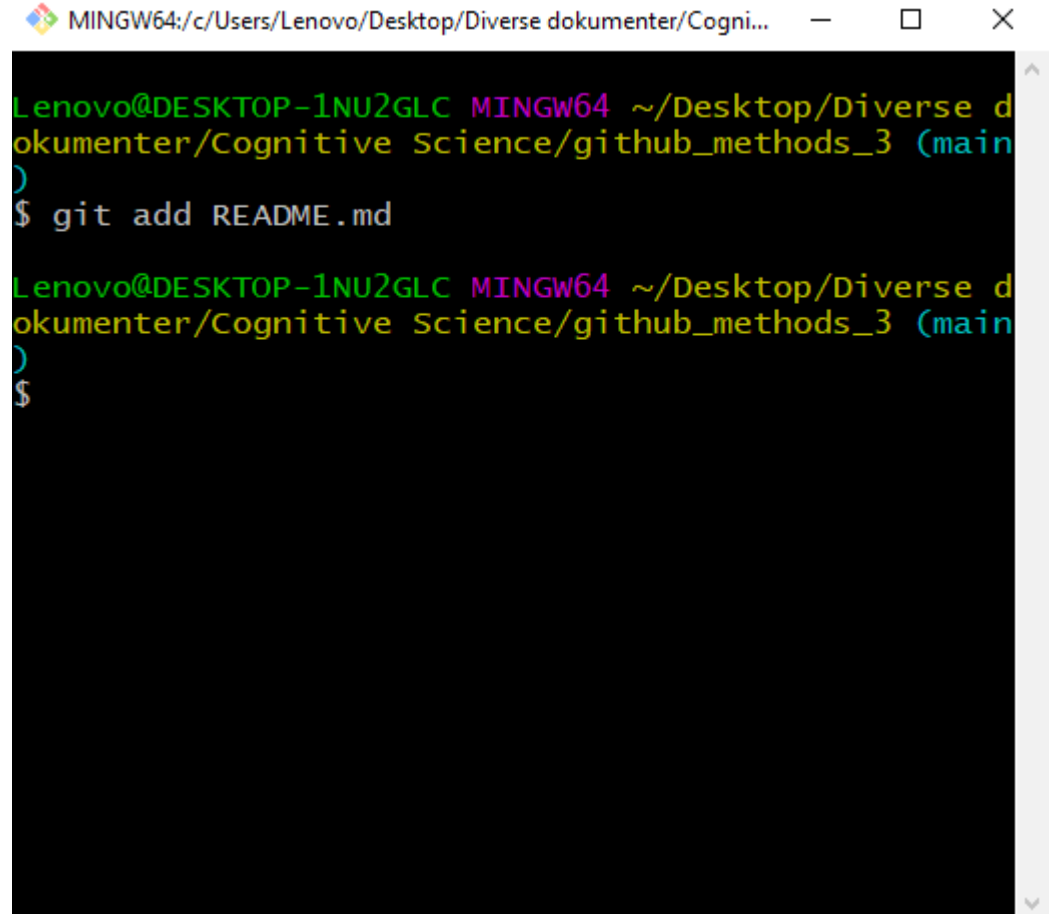
Changes not staged for commit:
  (use "git add <file>..." to update what will be
  committed)
  (use "git restore <file>..." to discard changes
  in working directory)
        modified:   README.md

no changes added to commit (use "git add" and/or "
git commit -a")

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$
```

GIT COMMANDS

- git status
- git add <file_to_track>

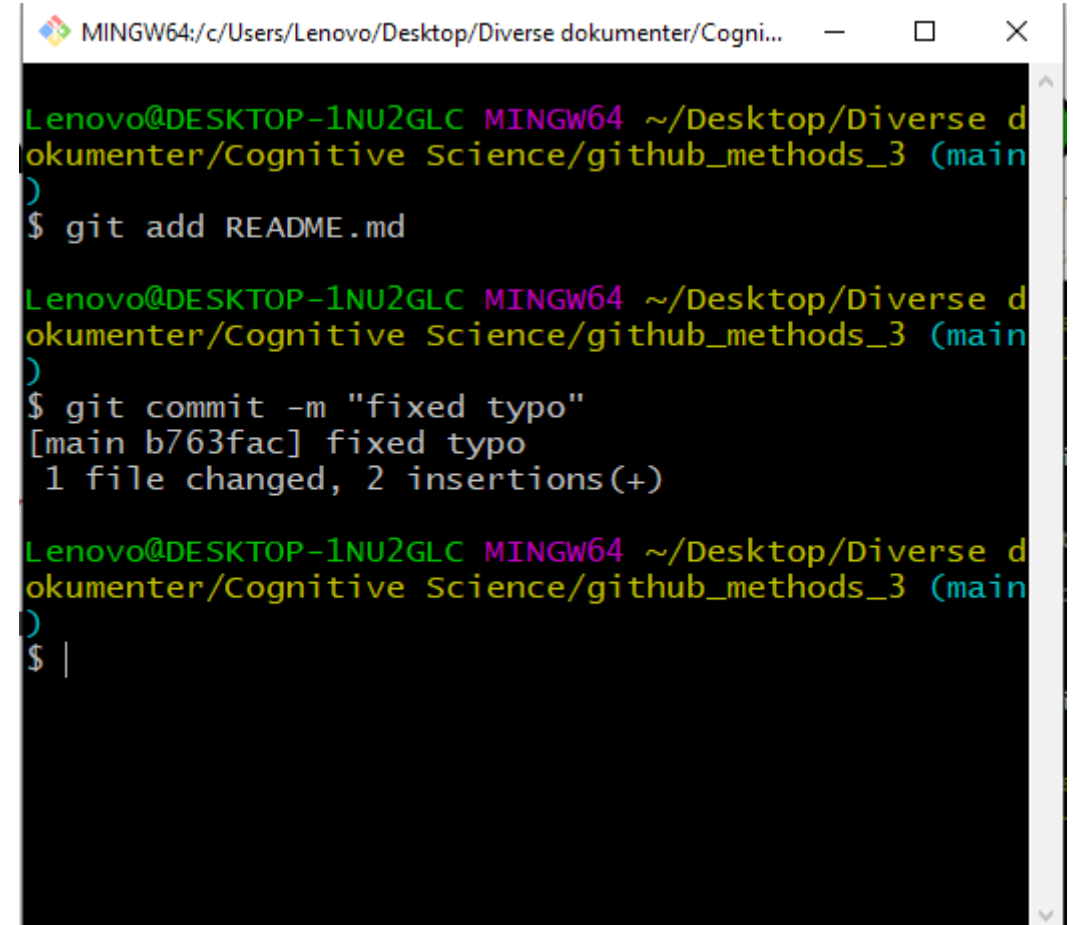
A screenshot of a terminal window titled 'MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumenter/Cogni...'. The terminal shows a user at 'Lenovo@DESKTOP-1NU2GLC' in a 'MINGW64' environment, located at '~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3' on the 'main' branch. The user enters the command '\$ git add README.md'.

```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumenter/Cogni...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$ git add README.md

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$
```

GIT COMMANDS

- git status
- git add <file_to_track>
- git commit -m "fixed typo"



```
MINGW64:/c:/Users/Lenovo/Desktop/Diverse dokumenter/Cogni...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$ git add README.md

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$ git commit -m "fixed typo"
[main b763fac] fixed typo
1 file changed, 2 insertions(+)

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse d
okumenter/Cognitive Science/github_methods_3 (main
)
$ |
```

GIT

- Questions?

GITHUB



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LEARNING



GITHUB

- Online host for Git
- Enables:
 - Collaboration across computers
 - Script/project sharing
- Used in increasingly many workplaces



GITHUB COMMANDS

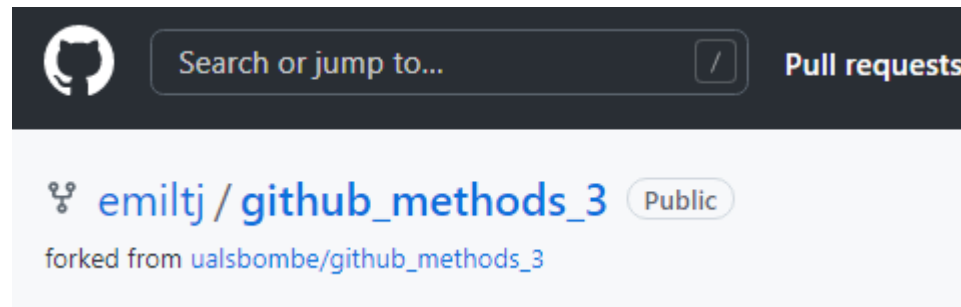
- Forking
- Cloning repo
- Navigate remote(s)
- Push to GitHub
- Pull from GitHub

GITHUB FORKING

- Forking
- “Gafle”

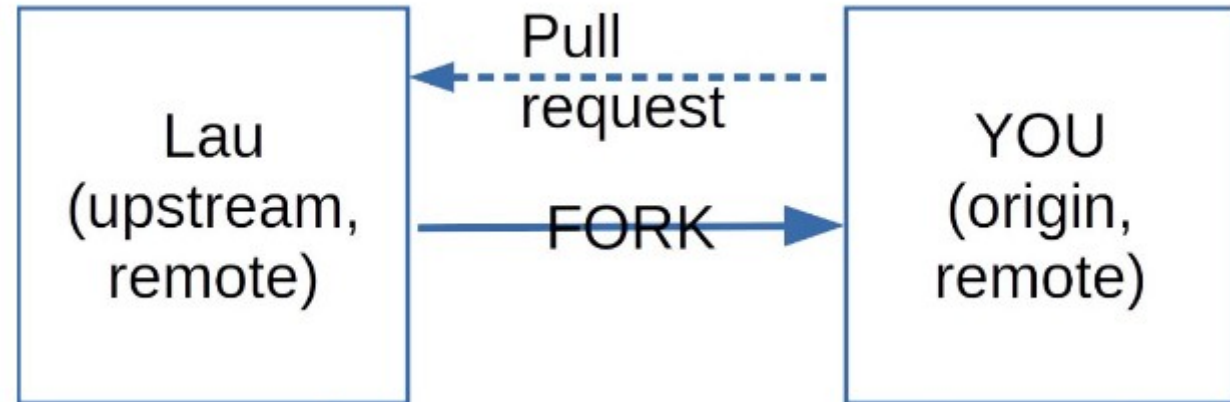
GITHUB FORKING

- Forking
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GITHUB FORKING

- Forking
- “Gafle”

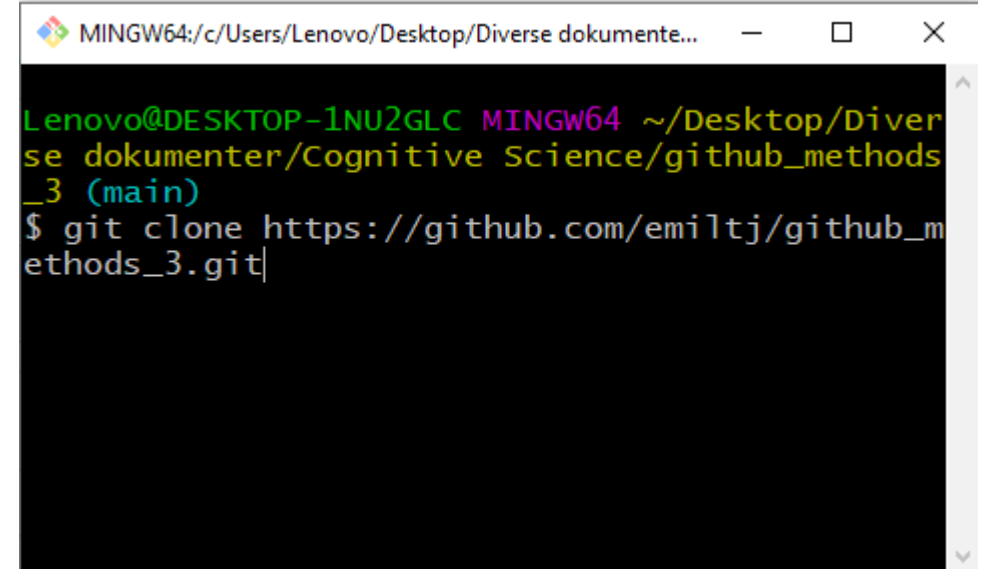


GITHUB CLONING

- `$ git clone <url>`
- Creates copy on local machine

GITHUB CLONING

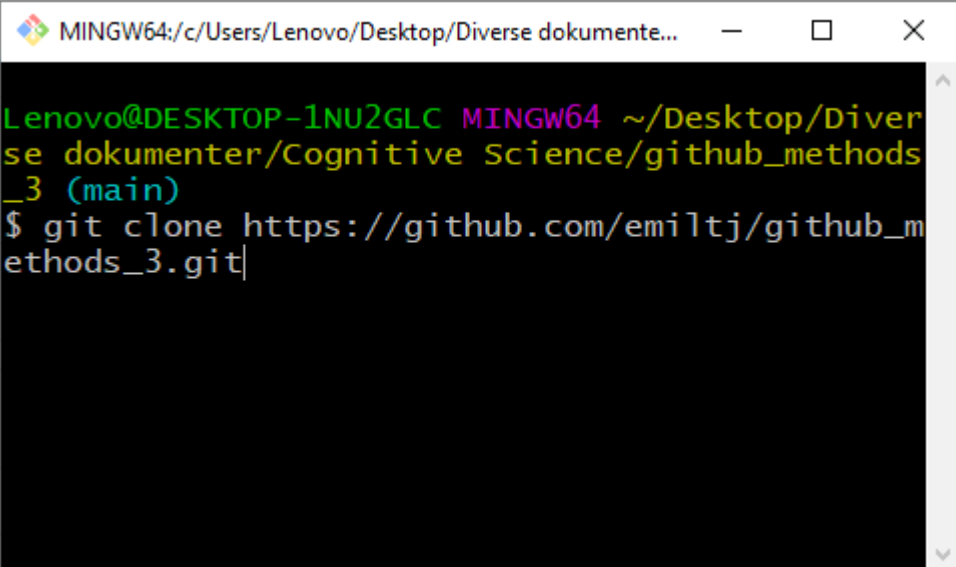
- \$ git clone <url>
- Creates copy on local machine

A screenshot of a Windows terminal window titled 'MINGW64: c:/Users/Lenovo/Desktop/Diverse dokumente...'. The terminal shows the prompt 'Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)' followed by the command '\$ git clone https://github.com/emiltj/github_methods_3.git' which is partially typed.

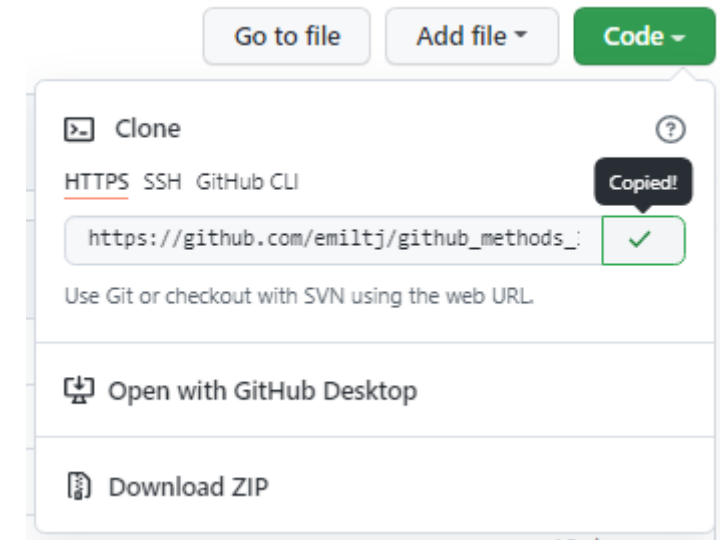
```
MINGW64: c:/Users/Lenovo/Desktop/Diverse dokumente...  
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)  
$ git clone https://github.com/emiltj/github_methods_3.git
```

GITHUB CLONING

- \$ git clone <url>
- Creates copy on local machine

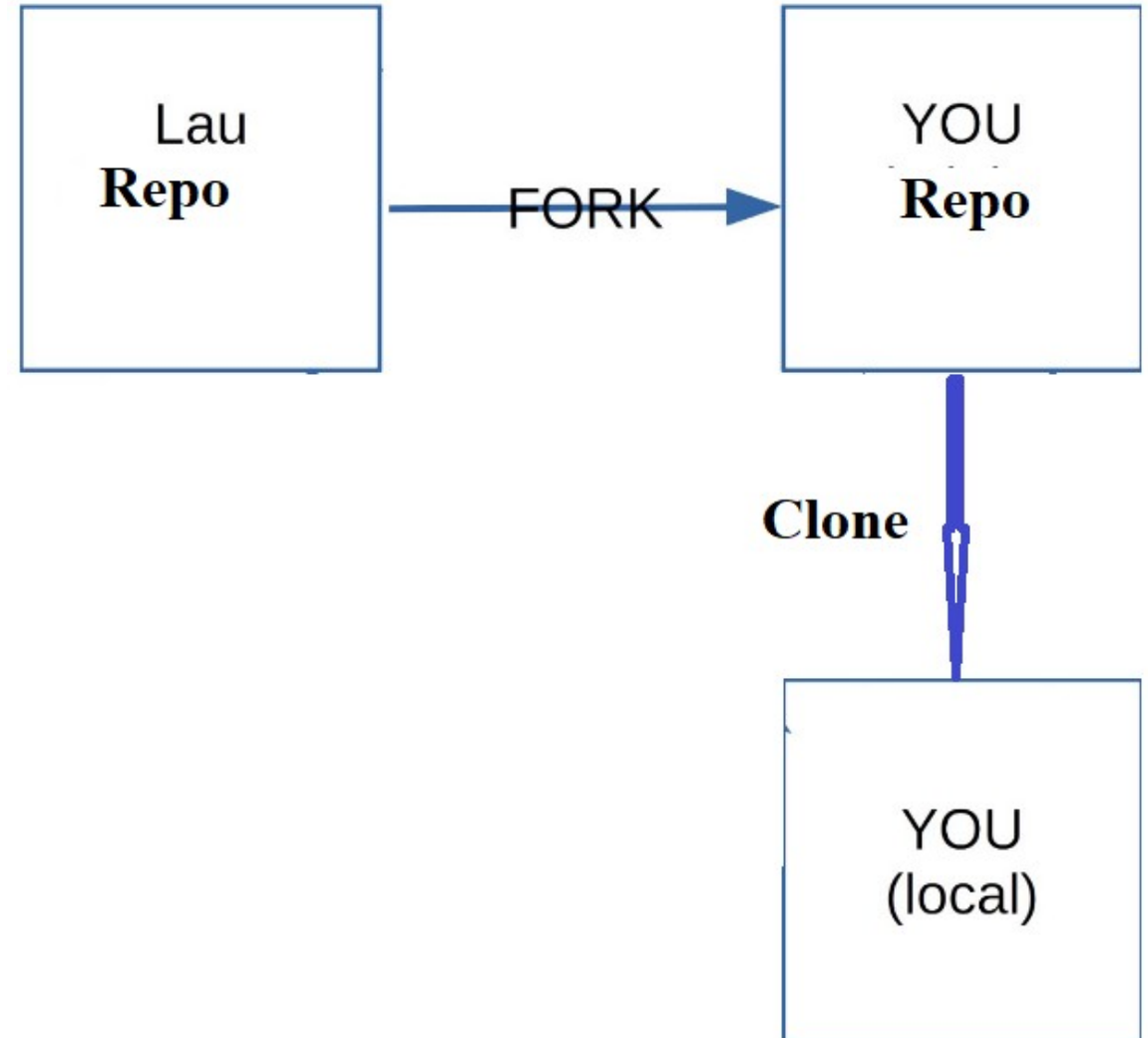


```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumente...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)
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```



GITHUB CLONING

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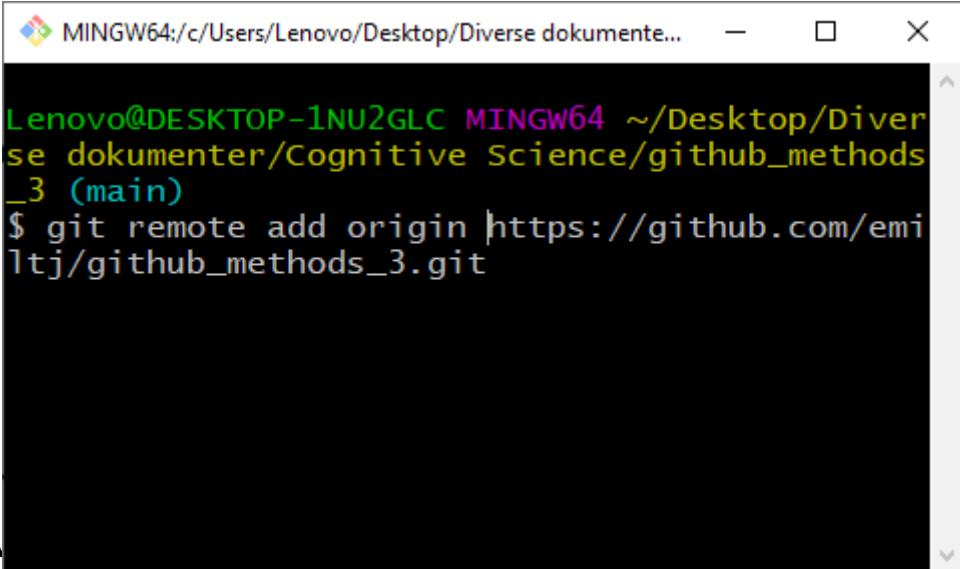


GITHUB REMOTE

- Remote = path to GitHub repo

GITHUB REMOTE

- Remote = path to GitHub repo
- `$ git remote add <short_for_url> <url>`

A screenshot of a terminal window with a black background and colored text. The window title is 'MINGW64:/c:/Users/Lenovo/Desktop/Diverse dokumente...'. The prompt is 'Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)'. The command entered is '\$ git remote add origin https://github.com/emiltj/github_methods_3.git'.

```
MINGW64:/c:/Users/Lenovo/Desktop/Diverse dokumente...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)
$ git remote add origin https://github.com/emiltj/github_methods_3.git
```

GITHUB REMOTE

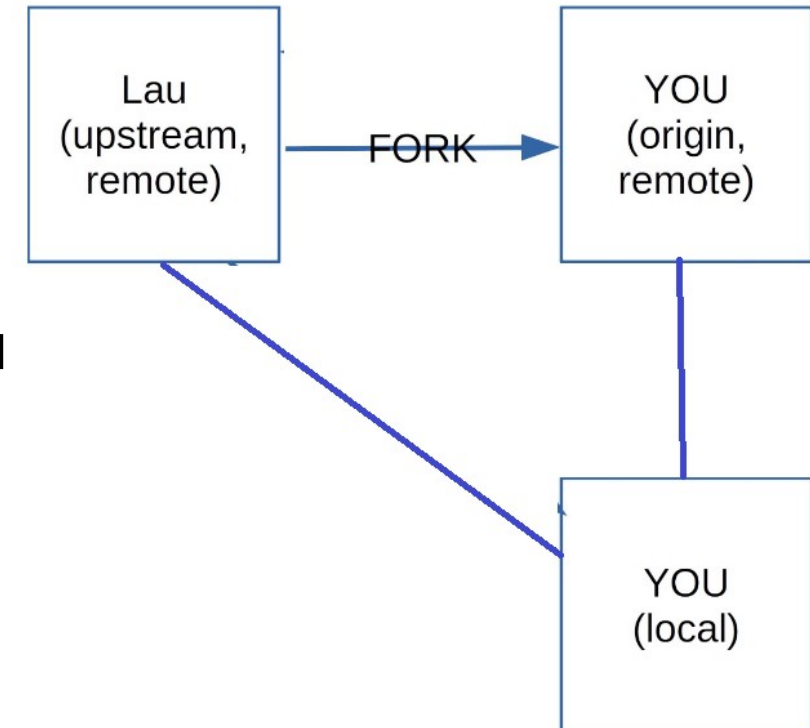
- Remote = path to GitHub repo
- `$ git remote add <short_for_url> <url>`
- adding upstream

```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumente...  
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)  
$ git remote add origin https://github.com/emil-tj/github_methods_3.git
```

```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumente...  
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)  
$ git remote add upstream https://github.com/ualsbombe/github_methods_3.git
```

GITHUB REMOTE

- Remote = path to GitHub repo
- `$ git remote add <short_for_url> <u`
- adding upstream



GITHUB REMOTE

- Which remotes do I have?

GITHUB REMOTE

- Which remotes do I have?
- `$ git remote -v`

GITHUB REMOTE

- Which remotes do I have?
- \$ git remote -v

```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive
b_methods_3 (main)
$ git remote -v
origin https://github.com/emiltj/github_methods_3.git (fetch)
origin https://github.com/emiltj/github_methods_3.git (push)
upstream https://github.com/ualsbombe/github_methods_3 (fetch)
upstream https://github.com/ualsbombe/github_methods_3 (push)

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive
b_methods_3 (main)
$
```

GITHUB PUSH/PULL

- `$ git push origin main`

GITHUB PUSH/PULL

- \$ git push origin main

```
MINGW64:/c/Users/Lenovo/Desktop/Diverse dokumente...
Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)
$ git push origin main
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Delta compression using up to 4 threads
Compressing objects: 100% (3/3), done.
Writing objects: 100% (3/3), 295 bytes | 295.00 KiB/s, done.
Total 3 (delta 2), reused 0 (delta 0), pack-reused 0
remote: Resolving deltas: 100% (2/2), completed with 2 local objects.
To https://github.com/emiltj/github_methods_3.git
   b85fbb4..b763fac  main -> main

Lenovo@DESKTOP-1NU2GLC MINGW64 ~/Desktop/Diverse dokumenter/Cognitive Science/github_methods_3 (main)
$
```

GITHUB PUSH/PULL

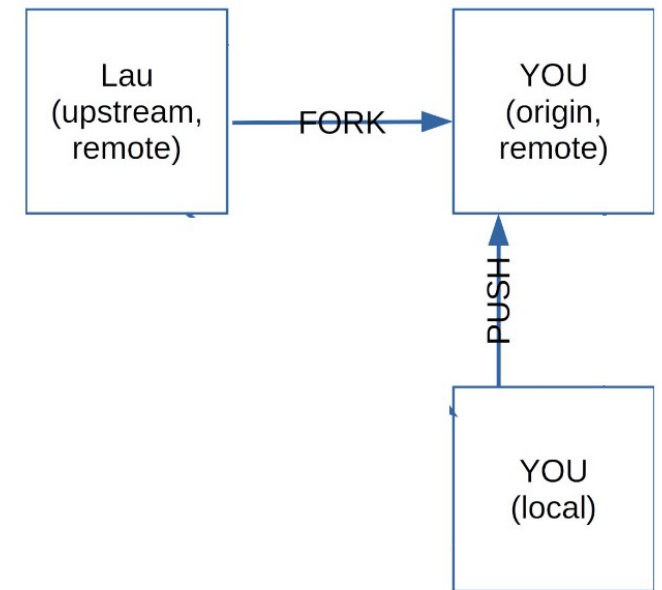
- \$ git push origin main
 - “git push https://github.com/emiltj/github_methods_3.git main”

GITHUB PUSH/PULL

- \$ git push origin main

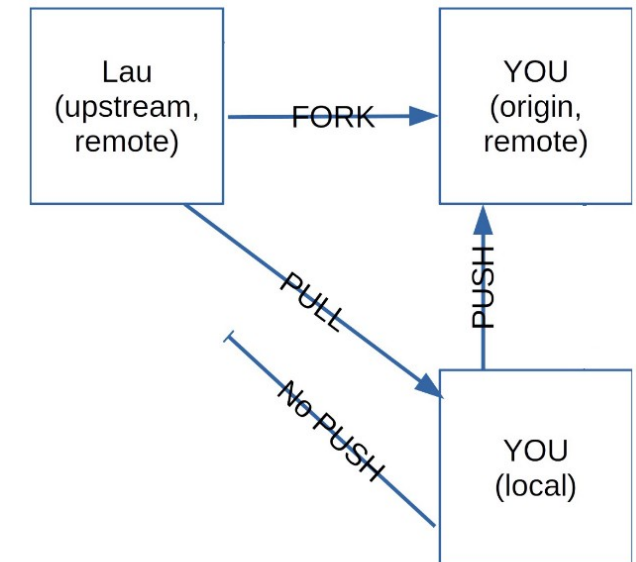
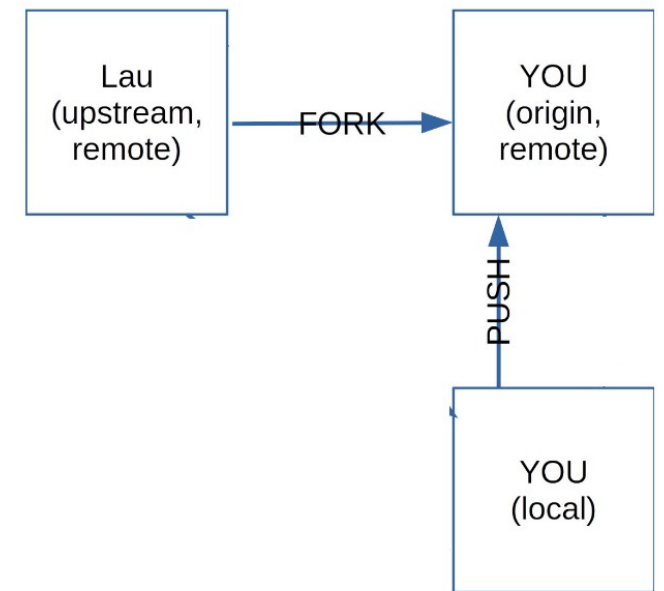
- “git push

https://github.com/emiltj/github_methods_3.git
main”

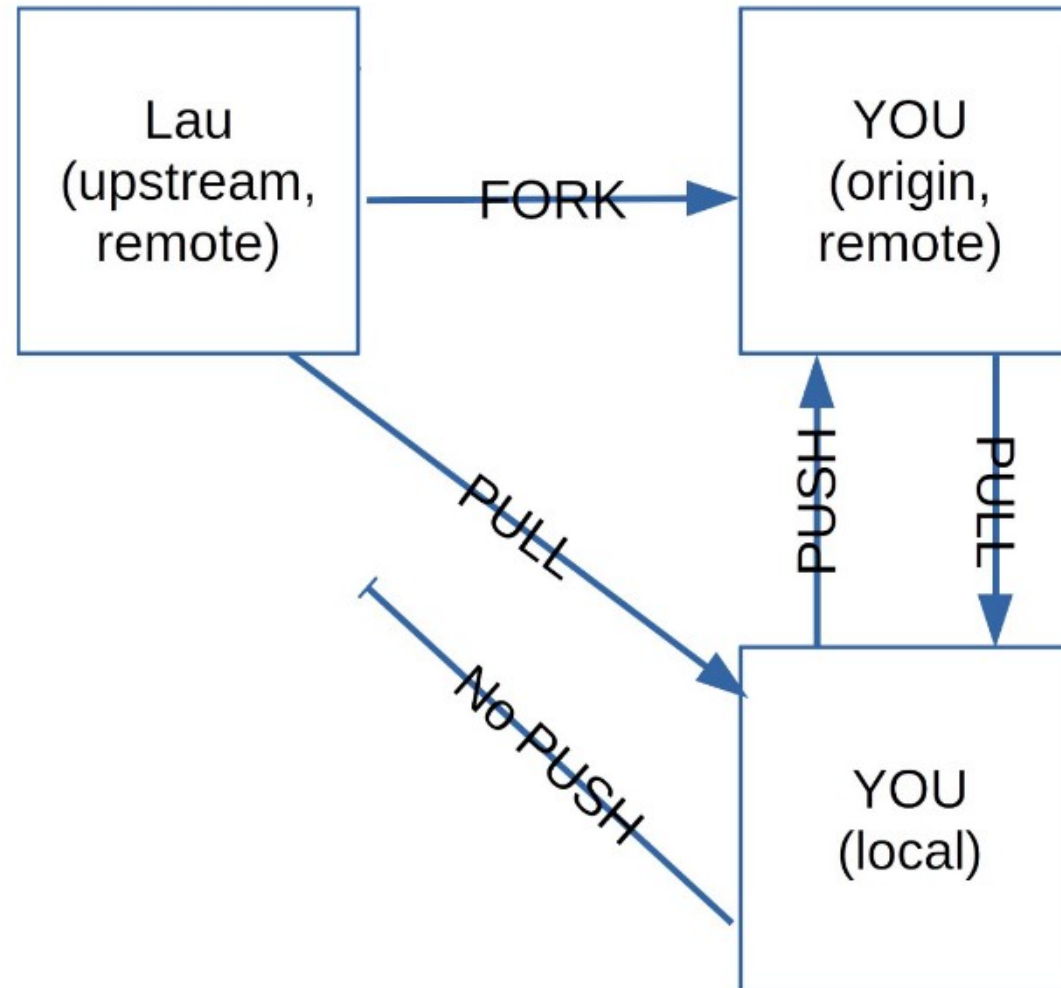


GITHUB PUSH/PULL

- \$ git push origin main
 - “git push https://github.com/emiltj/github_methods_3.git main”
- \$ git pull upstream main
 - “git pull https://github.com/ualsbombe/github_methods_3.git main”

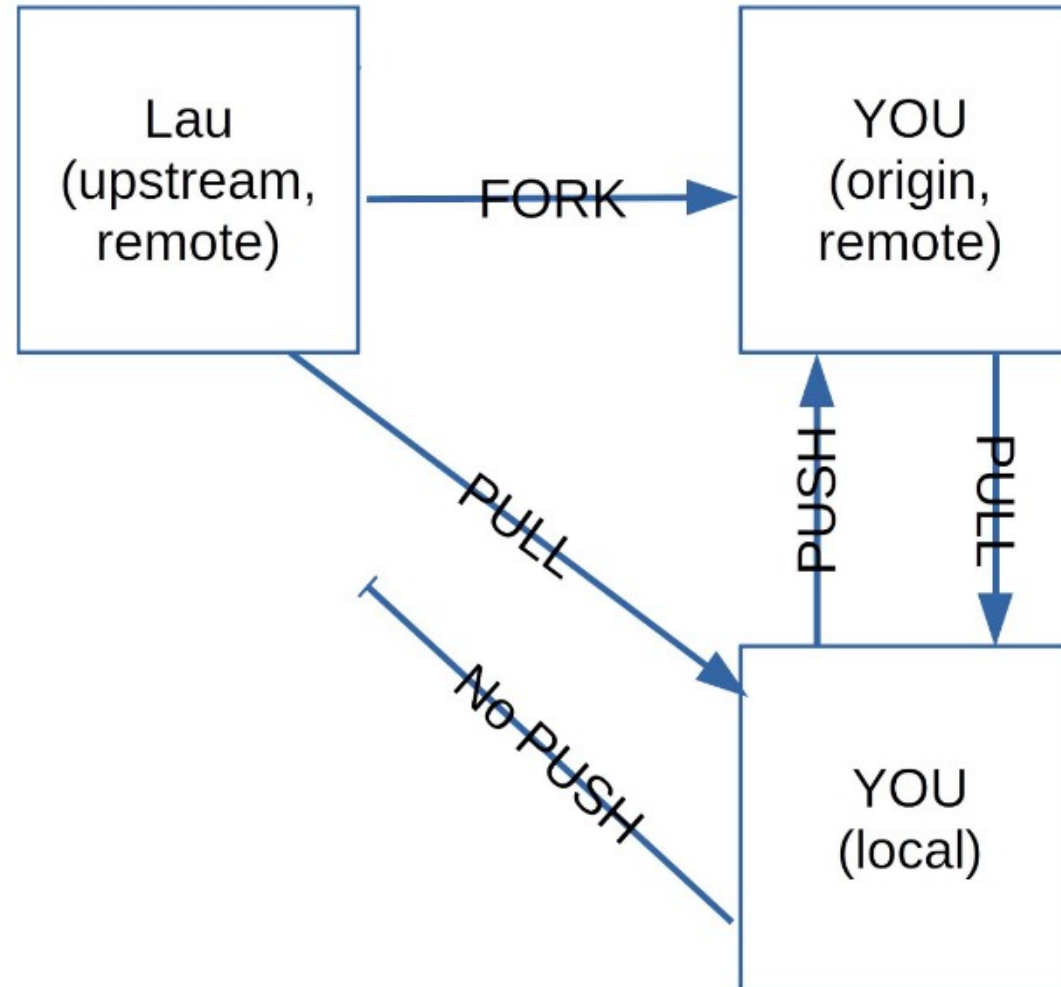


GITHUB



GITHUB

- Questions?



EXERCISES

1. Check if your bash recognizes conda (\$ conda --version) If not, come ask.
2. Using Laus “*pushing_your_solutions.pdf* ”
 1. Push your most recent changes
 2. Pull Lau’s new assignment
3. Add your name + repo to cryptpad if you haven’t already
4. New assignment
 - a) Create copy of “practical_exercise_2”, give unique filename ending
 - b) Work on new copied version of assignment
5. Break at 11:00 – 11:15

BREAK TIME

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.



FEEDBACK

EXERCISES

1. Check if your bash recognizes conda (\$ conda --version) If not, come ask.
2. Using Laus “*pushing_your_solutions.pdf* ”
 1. Push your most recent changes
 2. Pull Lau’s new assignment
3. Add your name + repo to cryptpad if you haven’t already
4. New assignment
 - a) Create copy of “practical_exercise_2”, give unique filename ending
 - b) Work on new copied version of assignment
5. At 11:55 push most recent changes

