Reproducible Research with R Markdown, Git, and Github

Kylie A. Bemis

Northeastern University
Khoury College of Computer Sciences

Northeastern University

Goals for this session

- R Markdown
- Git
- Github

R MARKDOWN

How to report reproducible analyses?

- Goal 1: Turn statistical analyses into reports
  - High-quality documents, presentations, dashboards, etc.
- Goal 2: Analyses should be *reproducible*
  - Update report results when analysis or data changes

R + Markdown

R

- R code chunks
- Inline results and plots
- Re-run to update report

Markdown

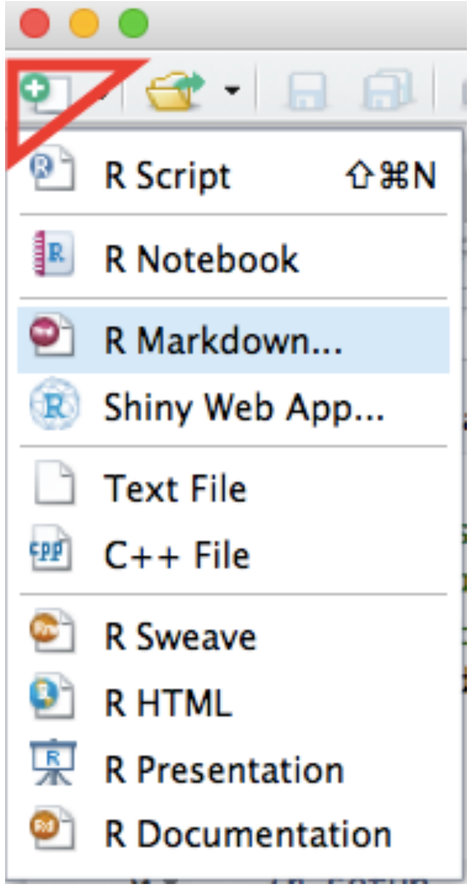
- Markup language
- Easily format text
- Create PDF, HTML, etc.

R Markdown

- Turn R code into high-quality reports
  - Markdown-formatted text
  - R code chunks with inline results
  - Compile a professional-quality document
- Recompile to produce updated report
  - All code is re-run to create new report
  - Reports are always up-to-date with newest data

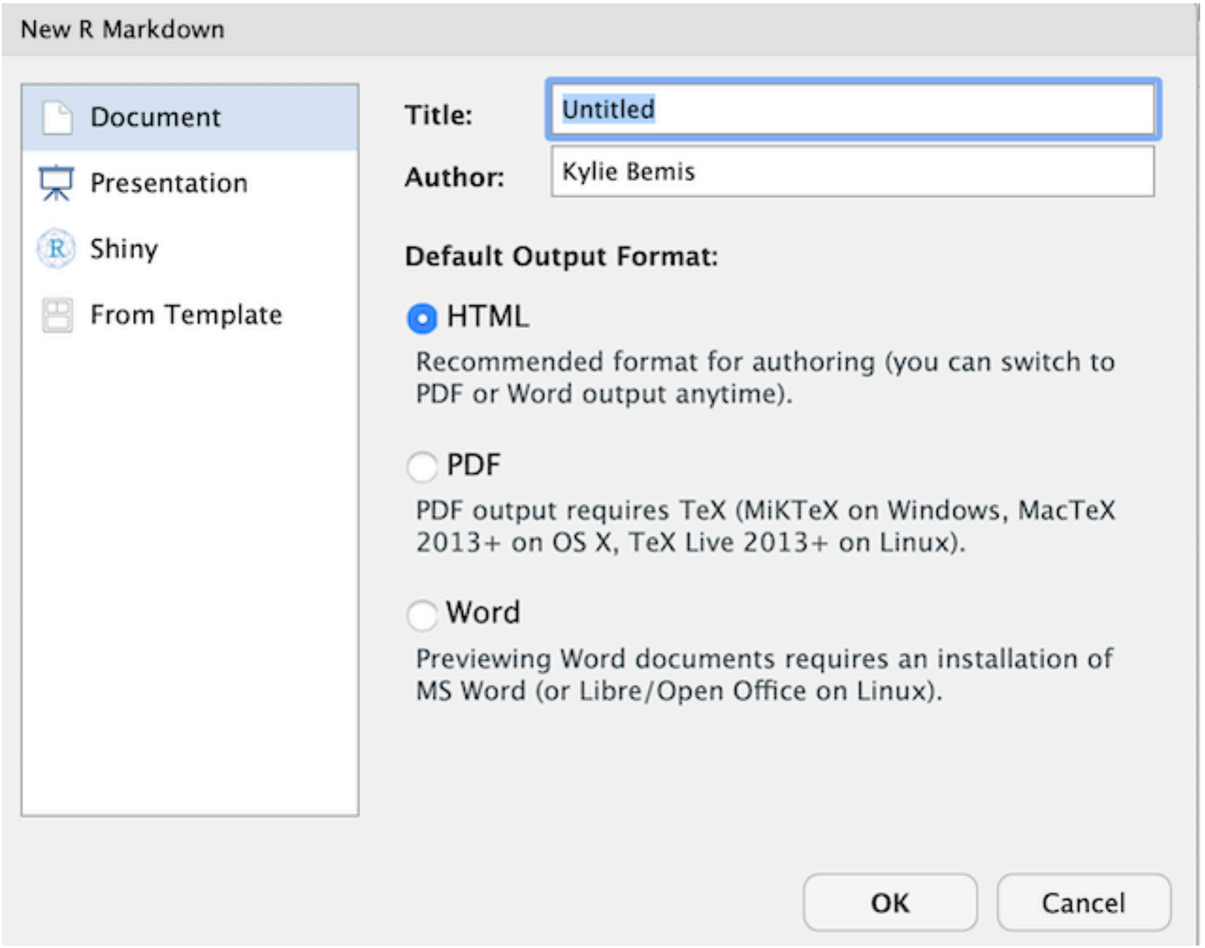
Create an R Markdown source file

Easy to create and author R Markdown from RStudio



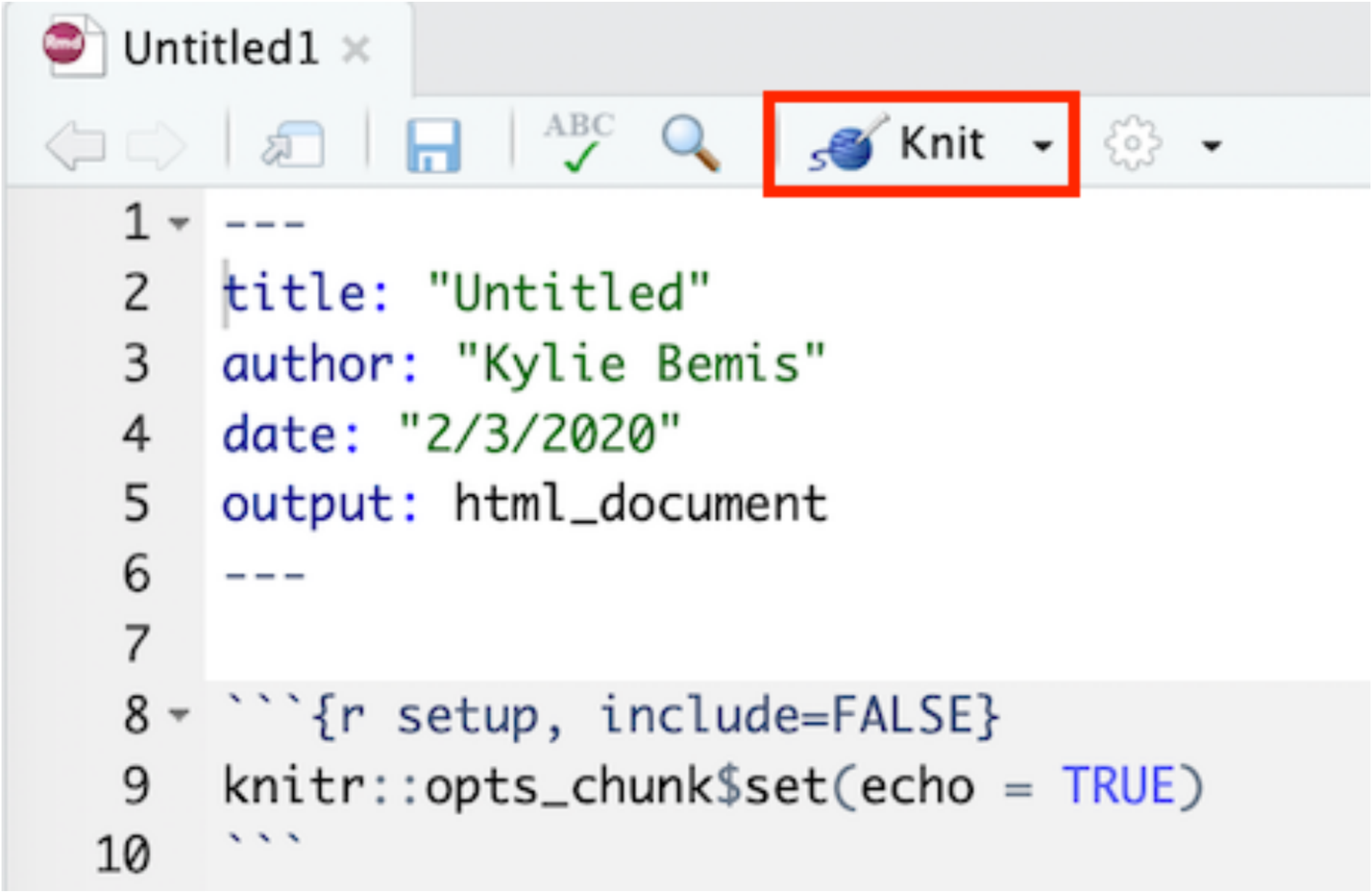
Choose an R Markdown format

Select an output format and title (and author)



Compile an R Markdown document

Click the "Knit" button to compile into a finished document



Markdown formatting

```
Text formatting
-------------------------------------------------------------

*italic*  or _italic_
**bold**   __bold__
`code`
superscript^2^ and subscript~2~

Headings
-------------------------------------------------------------

# 1st Level Header

## 2nd Level Header

### 3rd Level Header

Lists
-------------------------------------------------------------

*   Bulleted list item 1

*   Item 2

    * Item 2a

    * Item 2b

1.  Numbered list item 1

1.  Item 2. The numbers are incremented automatically in the
output.
```

Text formatting

italic or *italic* **bold bold** `code` superscript^2 and subscript$_2$

Headings

1st Level Header

2nd Level Header

3rd Level Header

Lists

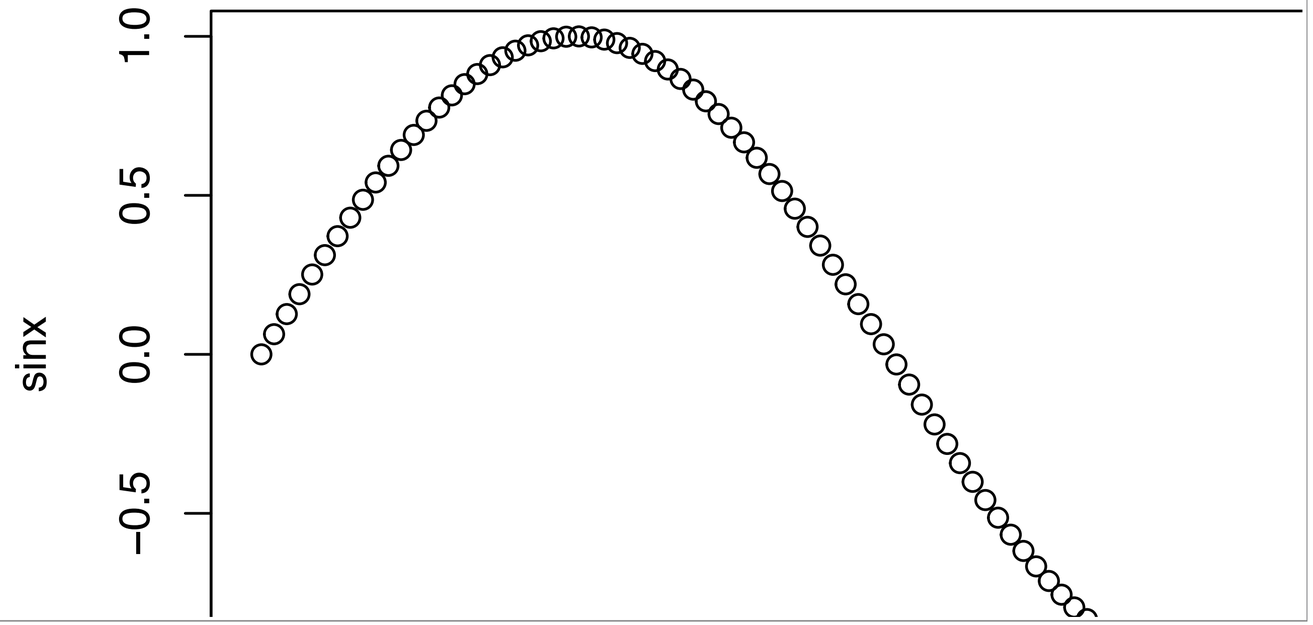
- Bulleted list item 1
- Item 2
  - Item 2a
  - Item 2b

1. Numbered list item 1
2. Item 2. The numbers are incremented automatically in the out

R code chunks

```{r}
x <- seq(from=0, to=2*pi, length.out=100)
sinx <- sin(x)
plot(sinx ~ x)
```

```r
x <- seq(from=0, to=2*pi, length.out=100)
sinx <- sin(x)
plot(sinx ~ x)
```

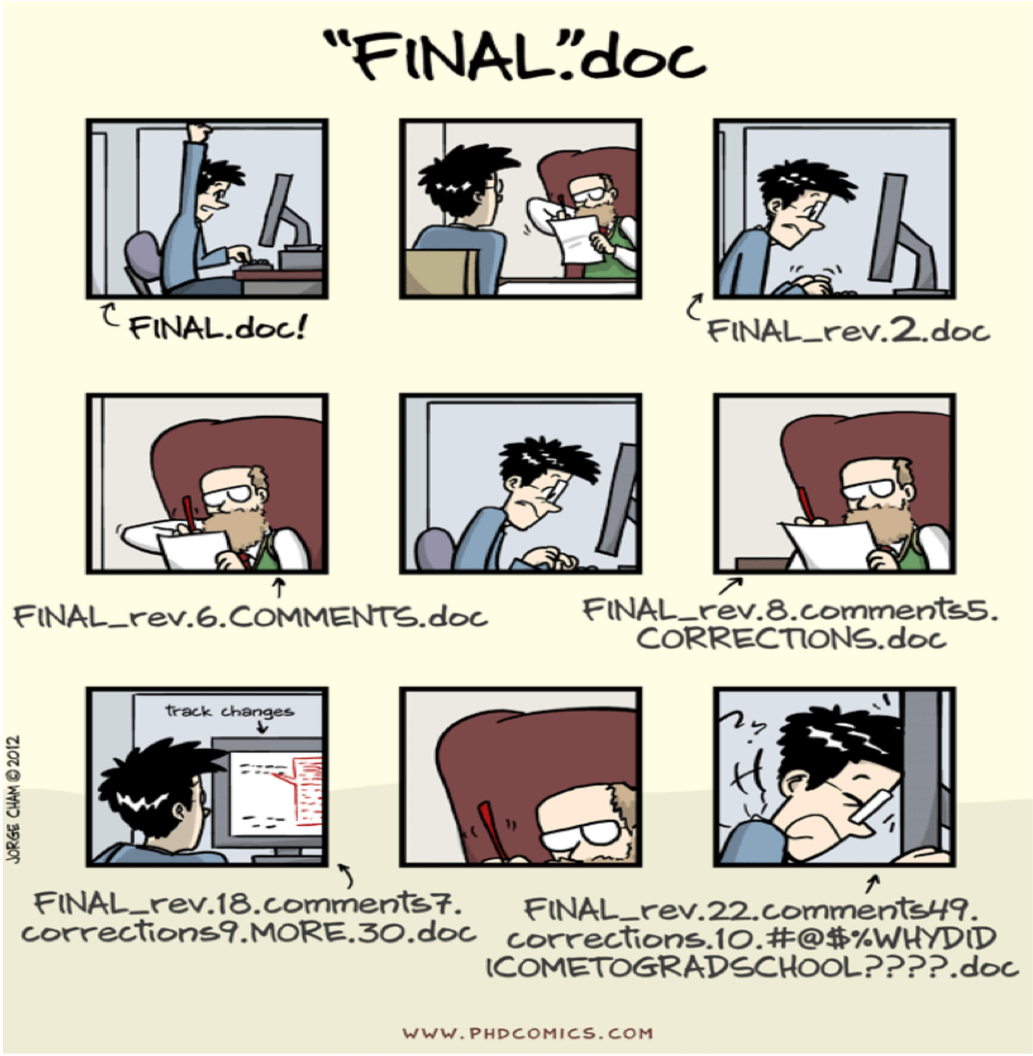


Advanced R Markdown

- Customize code chunks
  - Hide echoed code or results
  - Set dimensions of plots
  - And much, much more…
- R Markdown cheat sheet:
  - https://www.rstudio.com/wp-content/uploads/2016/03/rmarkdown-cheatsheet-2.0.pdf

GIT AND GITHUB

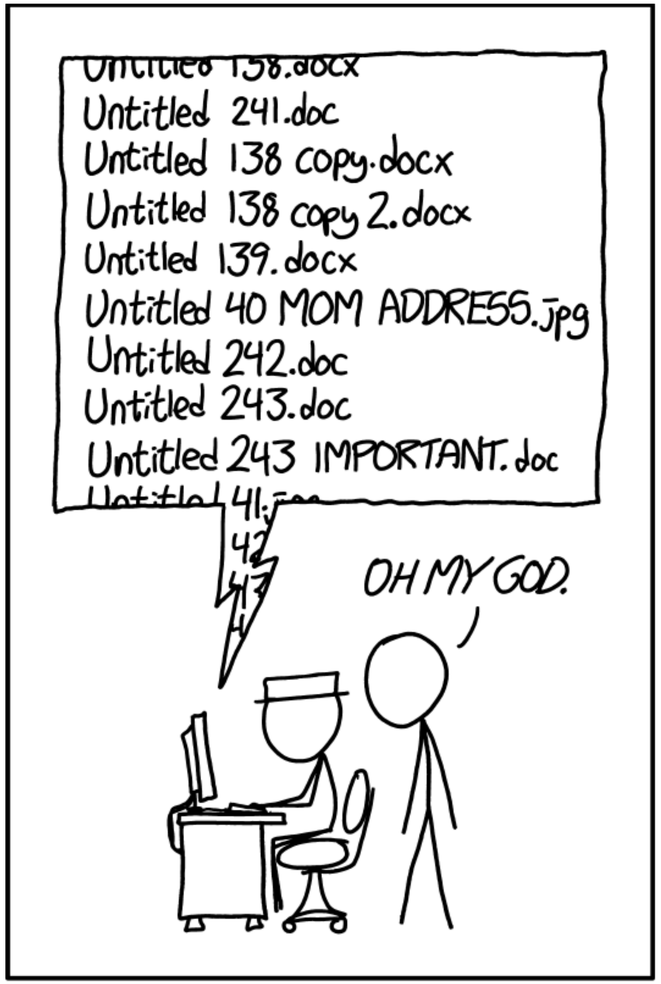
How do you manage files in a project?



title: "notFinal.doc" - originally published 10/12/2012

Version control

- Complex projects produce many files
- Need to **track changes** and **versions**
- Need to **share with collaborators**



PROTIP: NEVER LOOK IN SOMEONE ELSE'S DOCUMENTS FOLDER.

Goals of version control

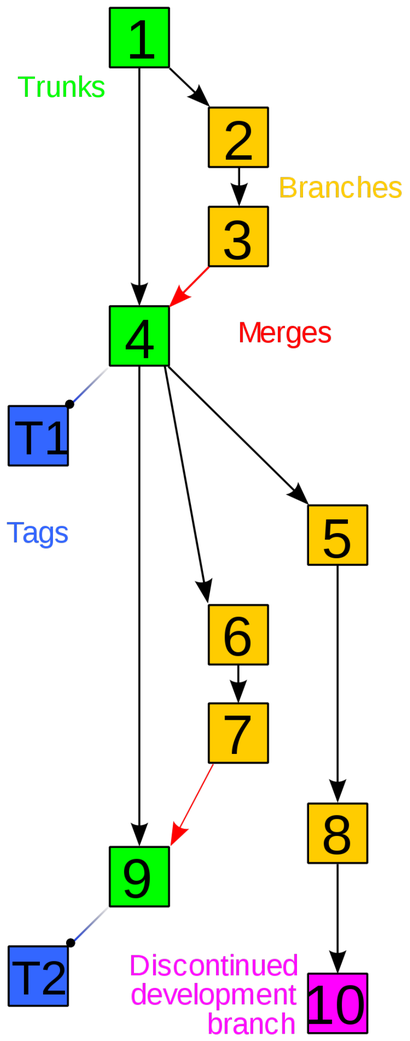
- Track changes made to a project
  - Track **changes across multiple files**
  - Track **creation** and **deletion** of files
  - **Revert** and **merge** changes as necessary
- Allow multiple **branches** of progress
- **Synchronize work** with collaborators

Vocabulary

- A **repository** ("repo") stores a project tracked by version control and its history
- A **commit** is a snapshot of a set of ***changes***
- The project ***head*** is the most recent commit
- Changes can be **pushed** and **pulled** from one repository to another

History and branches

- Revisions depend on earlier revisions
  - Each revision is linked to the revisions it depends on
- Progress may *fork* into separate **branches**
  - Develop new features or prepare bug patches
  - **Merge changes** back to the ***trunk*** or "main" branch
- Project history forms a ***graph***



Git and Github

- **Git** is a popular version control system
  - Distributed version control system
  - Repo is mirrored on each developer's machine
  - No need to rely on a central server
- **Github** hosts online Git repositories
  - Free hosting of open-source projects
  - Share work with collaborators

Installing Git

- First check if Git is already installed
- **macOS** download:
  - https://git-scm.com/download/mac
- **Windows** download:
  - https://gitforwindows.org

Setting up Git

- Git needs to know who is making changes
- Configure your credentials:
  - `git config --global user.name <your name>`
  - `git config --global user.email <your email>`
  - `git config --global --list`

Using Git

- Any directory with a git history is a repo
- Initialize a git repo in a directory:
  - Navigate to a directory
  - `git init`
- Any files in the repo can now be tracked

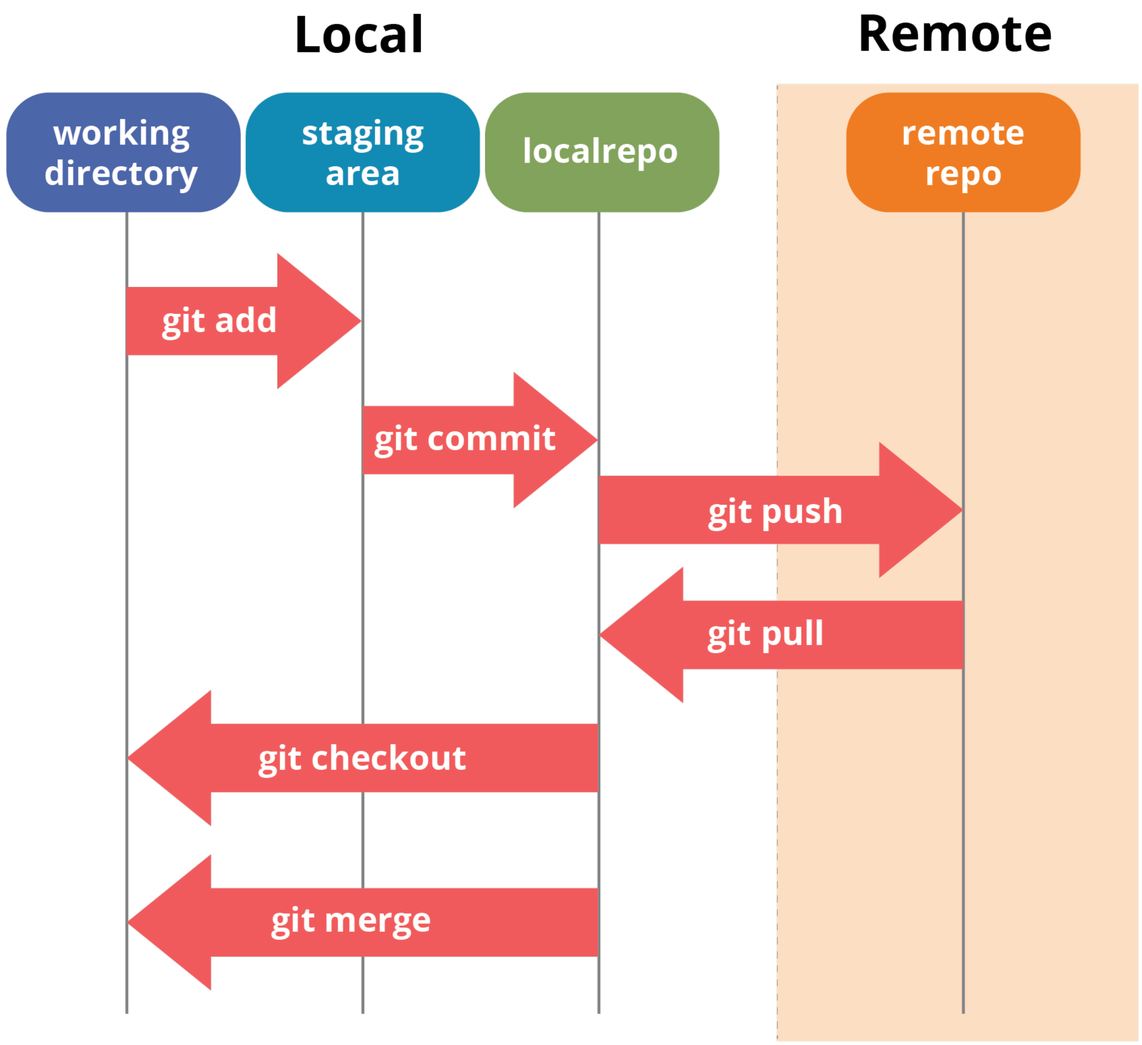
Using Git and Github

- Share work on a remote repository
- Create a new repo on Github
- Clone the repo locally
  - Copy the web URL from the Github repo page
  - `git clone <URL>`
- Work locally and push to Github

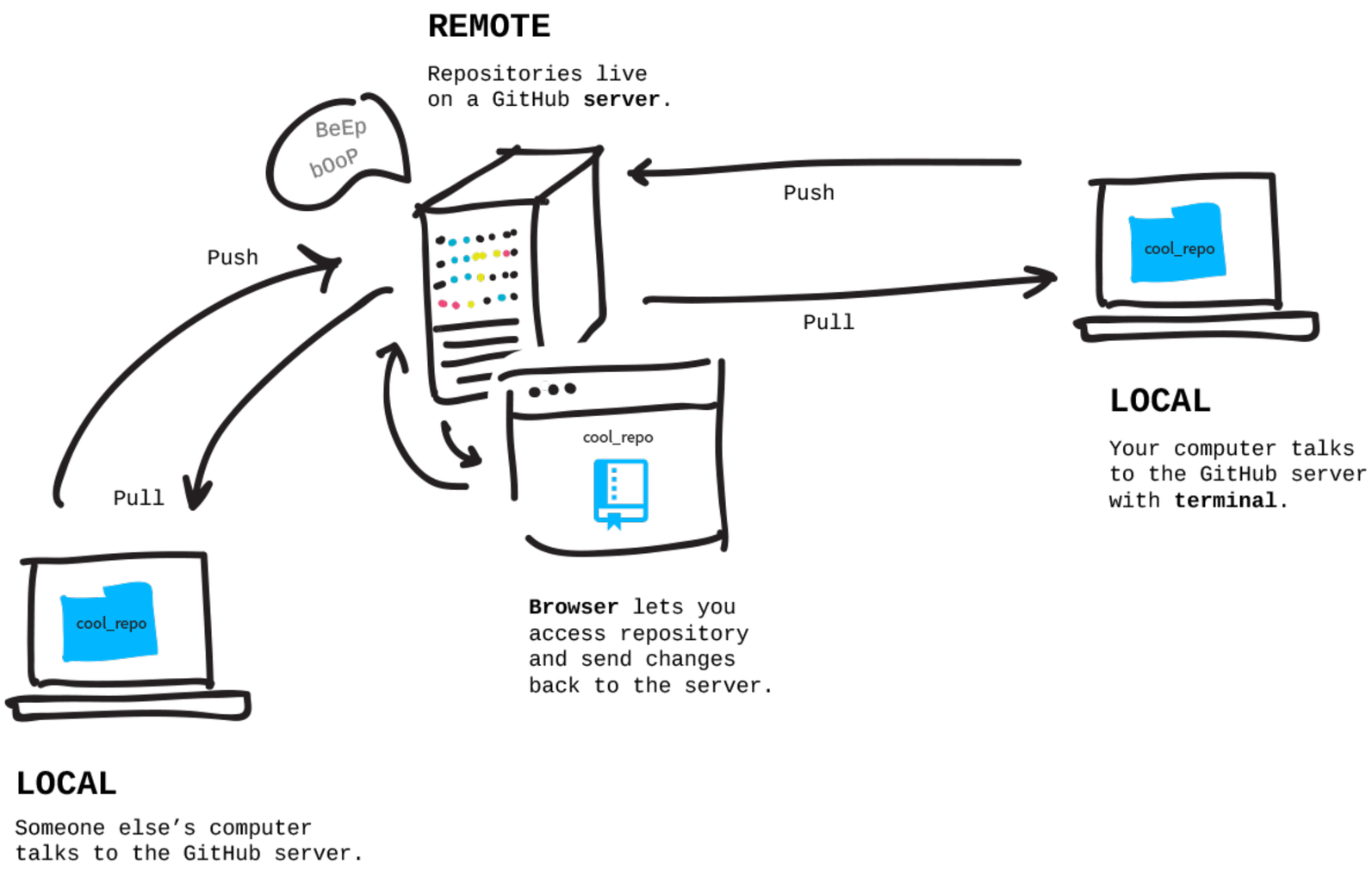
Understanding Git

- **Working directory** is the directory on your machine where the repo lives
- **Staging area** is the set of files that has changed since your last ***commit***
- The **local repository** is the repo on your machine (including its complete history)
- A **remote repository** is a version of the repo on a remote site such as Github

Git workflow



Visualizing local and remote repos



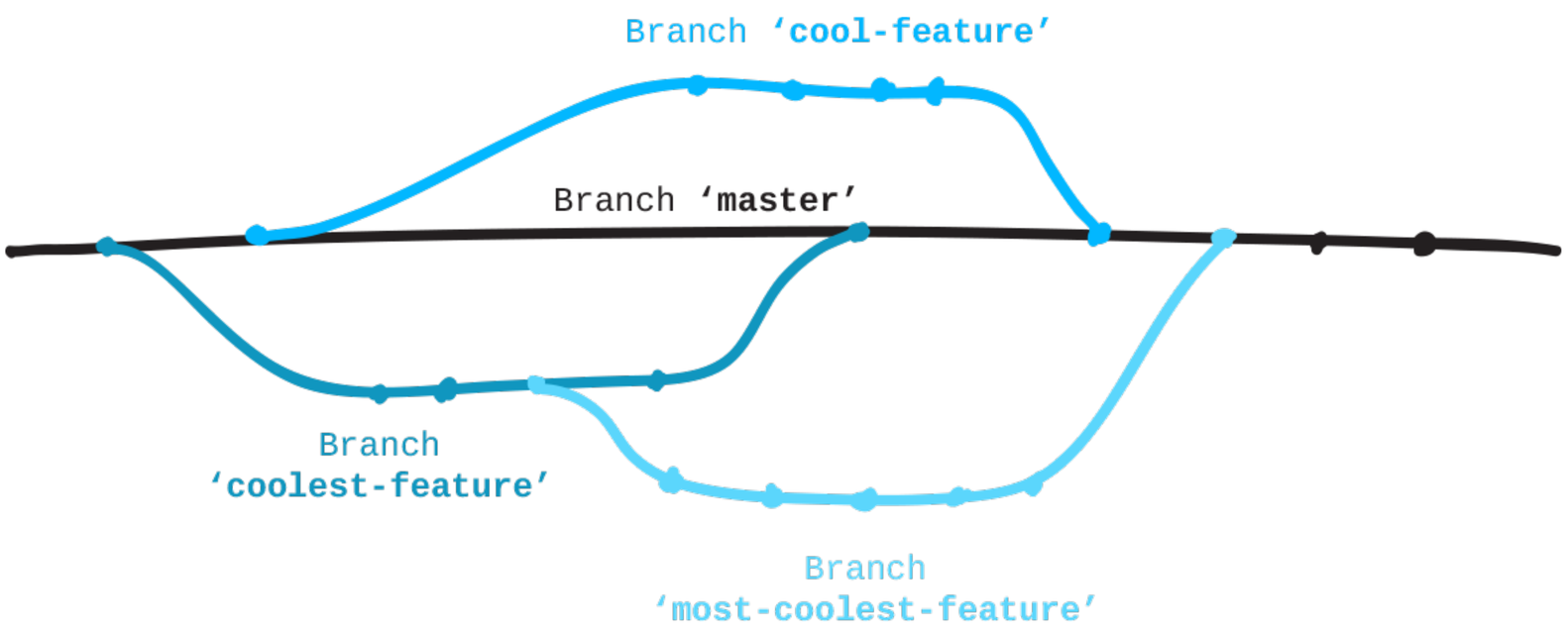
Basic Git commands

- `git add` will add new or changed files to the staging area
  - `git add --all` to add all new or changed files
- `git commit` creates a commit out of the staged changes
  - `git commit -m “notes here”` to commit with a short message
- `git push/pull <remote> <branch>` pushes or pulls commits from your local repo to a remote repo
  - E.g., `git push origin main`

A typical workflow

1. Fetch your teammates' changes from Github with `git pull`
2. Make changes to your local repo
3. Stage changes for commit with `git add`
4. Commit staged changes to your local repo with `git commit`
5. Push your changes to Github with `git push`
6. Repeat steps 1-5 and always `pull` before `push`ing!

Use branches to organize development



Basic branch commands

- `git branch` lists available branches
- `git checkout -b <name>` will create a new branch
- `git checkout <name>` switches to a different branch
- `git merge <name>` merges a branch into the current one
  - Commits from the other branch are copied into the current one
  - You may need to manually fix merge conflicts

BREAK