



# BGGN 213

## Hands-on Lab Session

### Class 07

Barry Grant  
UC San Diego

<http://thegrantlab.org/bggn213>

Last class!

function()

# Last class revisited...

- Write a function `grade()` to determine an overall grade from a vector of student homework assignment scores dropping the lowest single assignment score.

```
# student 1
c(100, 100, 100, 100, 100, 100, 100, 90)

# student 2
c(100, NA, 90, 90, 90, 90, 97, 80)

# now grade all students in an example class
url <- "https://tinyurl.com/gradeinput"
```

# Last class revisited...

- Write a function `grade()` to determine an overall grade from a vector of student homework assignment scores dropping the lowest single assignment score.

```
grade <- function(x) {  
  x <- as.numeric(x)  
  x[ is.na(x) ] = 0  
  mean(x[ -which.min(x) ] )  
}
```

# Last class revisited...

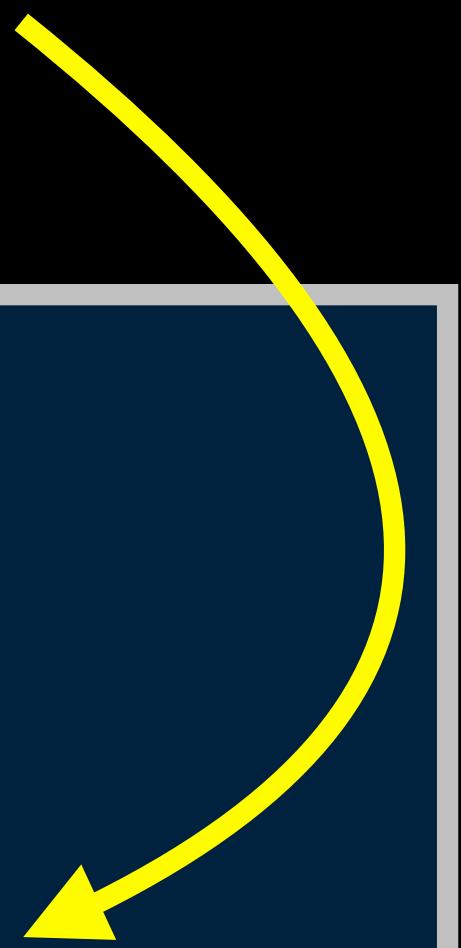
- Write a function `grade()` to determine an overall grade from a vector of student homework assignment scores dropping the lowest single assignment score.

```
grade <- function(x) {  
  x <- as.numeric(x)  
  x[ is.na(x) ] = 0  
  mean(x[ -which.min(x) ] )  
}
```

# Last class revisited...

- Write a function `grade()` to determine an overall grade from a vector of student homework assignment scores dropping the lowest single assignment score.

```
grade <- function(x) {  
  x <- as.numeric(x)  
  x[ is.na(x) ] = 0  
  mean(x[ -which.min(x) ])  
}
```



# Do this now...

- Write a function **grade2()** to determine an overall grade from a vector of student homework assignment scores **OPTIONALLY** dropping the lowest single assignment score.

```
grade <- function(x) {  
  x <- as.numeric(x)  
  x[ is.na(x) ] = 0  
  mean(x[ -which.min(x) ])  
}
```

# Last class revisited...

```
grade2 <- function(x, drop.lowest=TRUE) {  
  x <- as.numeric(x)  
  x[ is.na(x) ] = 0  
  if(drop.lowest) {  
    mean(x[ -which.min(x) ] )  
  } else {  
    mean(x)  
  }  
}
```

And some function homework....

**Complete Q6. In last days lab supplement**

```
library(bio3d)
s1 <- read.pdb("4AKE") # kinase with drug
s2 <- read.pdb("1AKE") # kinase no drug
s3 <- read.pdb("1E4Y") # kinase with drug

s1.chainA <- trim.pdb(s1, chain="A", elety="CA")
s2.chainA <- trim.pdb(s2, chain="A", elety="CA")
s3.chainA <- trim.pdb(s3, chain="A", elety="CA")

s1.b <- s1.chainA$atom$b
s2.b <- s2.chainA$atom$b
s3.b <- s3.chainA$atom$b

plotb3(s1.b, sse=s1.chainA, typ="l", ylab="Bfactor")
plotb3(s2.b, sse=s2.chainA, typ="l", ylab="Bfactor")
plotb3(s3.b, sse=s3.chainA, typ="l", ylab="Bfactor")
```

# Suggested steps for writing your functions

1. Start with a simple problem and get a working snippet of code
2. Rewrite to use temporary variables (e.g. x, y, df, m etc.)
3. Rewrite for clarity and to reduce calculation duplication
4. Turn into an initial function with clear useful names
5. Test on small well defined input and (subsets of) real input
6. Report on potential problem by failing early and loudly!
7. Refine and polish



# What is Git?

(1) An unpleasant or contemptible person. Often incompetent, annoying, senile, elderly or childish in character.



(2) A modern distributed version control system with an emphasis on speed and data integrity.



# What is Git?

(1) An unpleasant or contemptible person. Often incompetent, annoying, senile, elderly or childish in character.



(2) A modern distributed version control system with an emphasis on speed and data integrity.



# Version Control

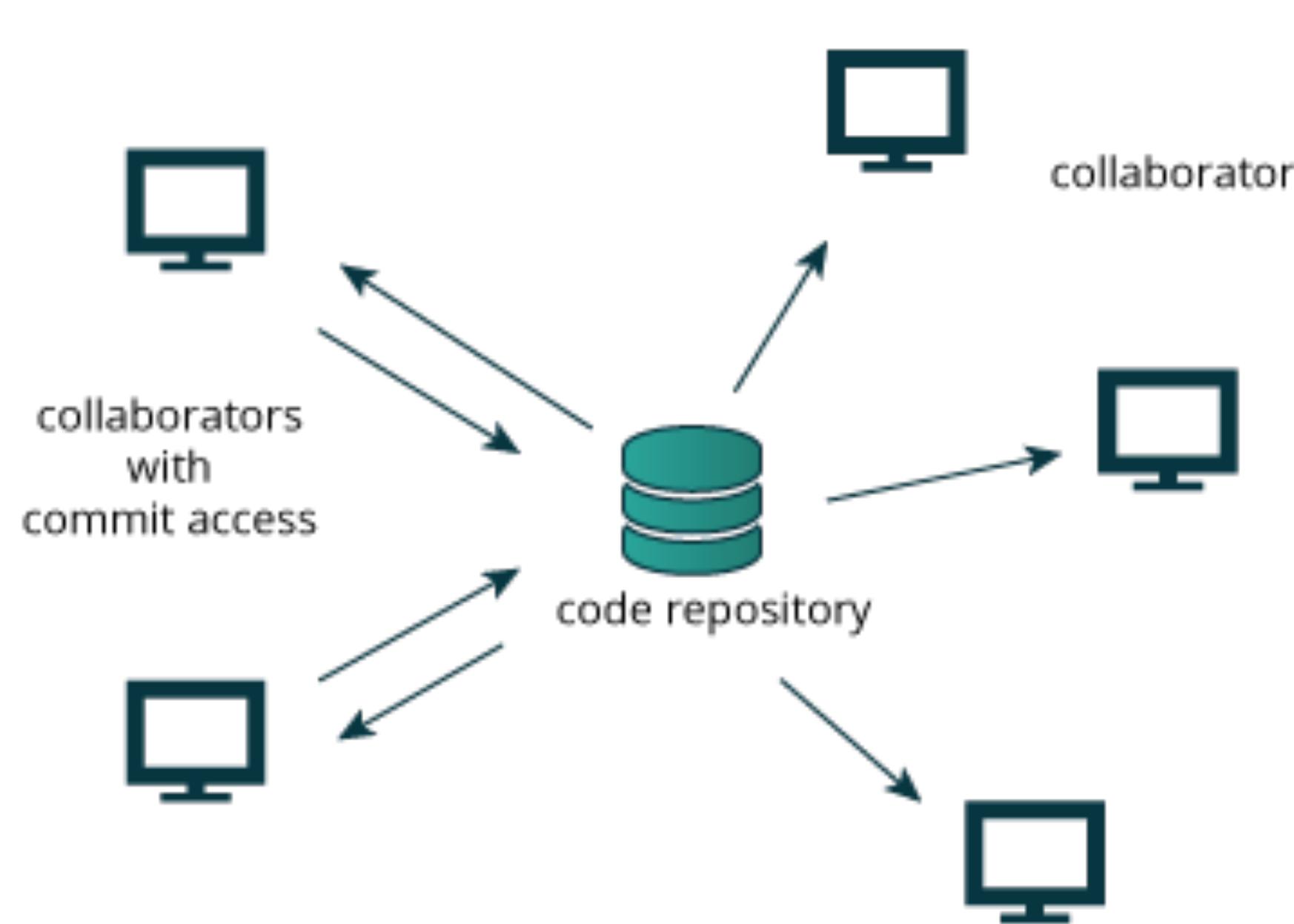
Version control systems (VCS) record changes to a file or set of files over time so that you can recall specific versions later.

Client-server	Free/open-source	<a href="#">CVS</a> (1986, 1990 in C) · <a href="#">CVSNT</a> (1998) · <a href="#">QVCS Enterprise</a> (1998) · <a href="#">Subversion</a> (2000)
	Proprietary	<a href="#">Software Change Manager</a> (1970s) · <a href="#">Panvalet</a> (1970s) · <a href="#">Endevor</a> (1980s) · <a href="#">Dimensions CM</a> (1980s) · <a href="#">DSEE</a> (1984) · <a href="#">Synergy</a> (1990) · <a href="#">ClearCase</a> (1992) · <a href="#">CMVC</a> (1994) · <a href="#">Visual SourceSafe</a> (1994) · <a href="#">Perforce</a> (1995) · <a href="#">StarTeam</a> (1995) · <a href="#">Integrity</a> (2001) · <a href="#">Surround SCM</a> (2002) · <a href="#">AccuRev SCM</a> (2002) · <a href="#">SourceAnywhere</a> (2003) · <a href="#">Vault</a> (2003) · <a href="#">Team Foundation Server</a> (2005) · <a href="#">Team Concert</a> (2008)
Distributed	Free/open-source	<a href="#">GNU arch</a> (2001) · <a href="#">Darcs</a> (2002) · <a href="#">DCVS</a> (2002) · <a href="#">ArX</a> (2003) · <a href="#">Monotone</a> (2003) · <a href="#">SVK</a> (2003) · <a href="#">Codeville</a> (2005) · <a href="#">Bazaar</a> (2005) · <a href="#">Git</a> (2005) · <a href="#">Mercurial</a> (2005) · <a href="#">Fossil</a> (2007) · <a href="#">Veracity</a> (2010)
	Proprietary	<a href="#">TeamWare</a> (1990s?) · <a href="#">Code Co-op</a> (1997) · <a href="#">BitKeeper</a> (1998) · <a href="#">Plastic SCM</a> (2006)

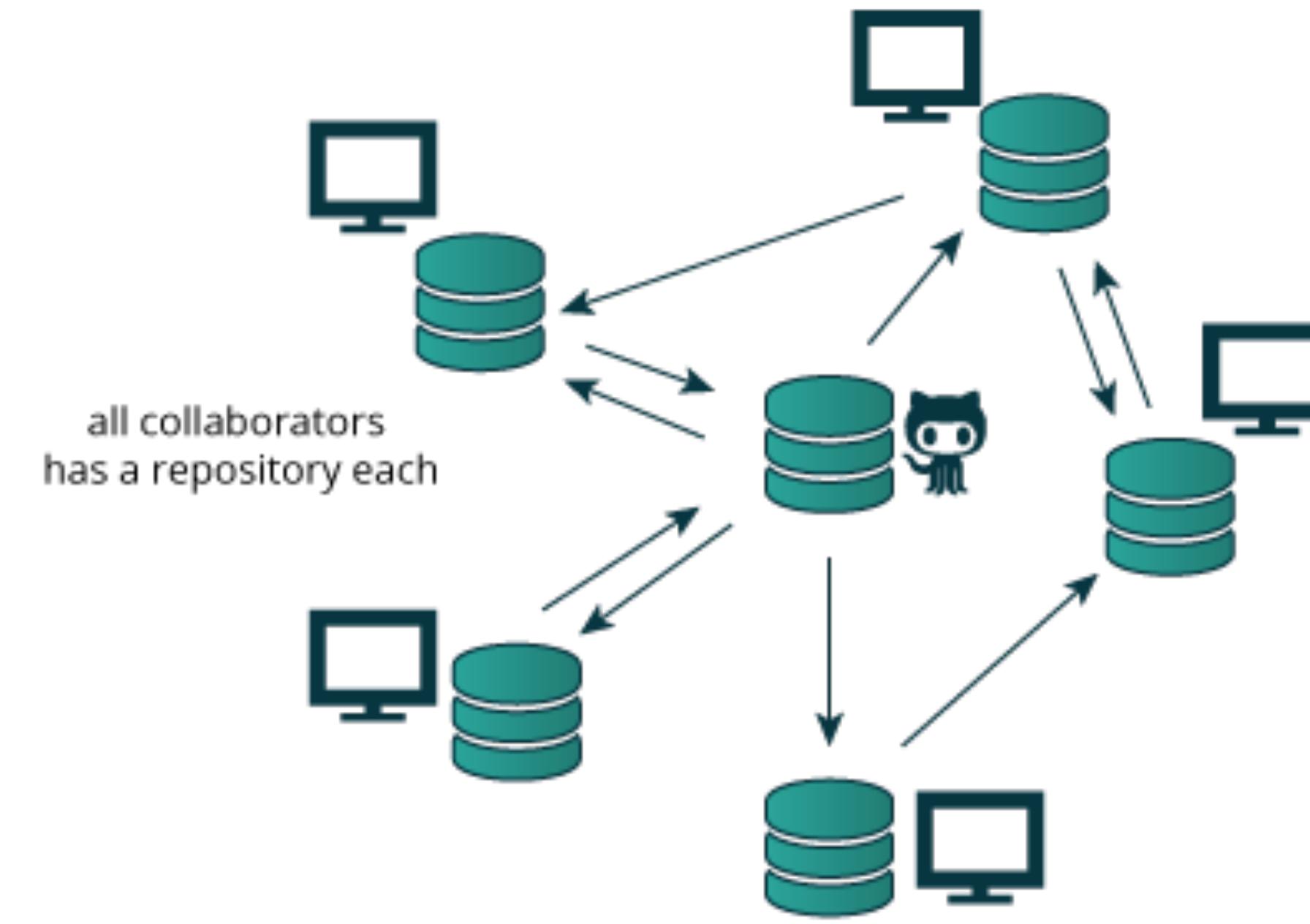
There are many VCS available, see:

[https://en.wikipedia.org/wiki/Revision\\_control](https://en.wikipedia.org/wiki/Revision_control)

# Client-Server vs Distributed VCS



Client-server approach



Distributed approach

**Distributed** version control systems (DCVS) allows multiple people to work on a given project without requiring them to share a common network.

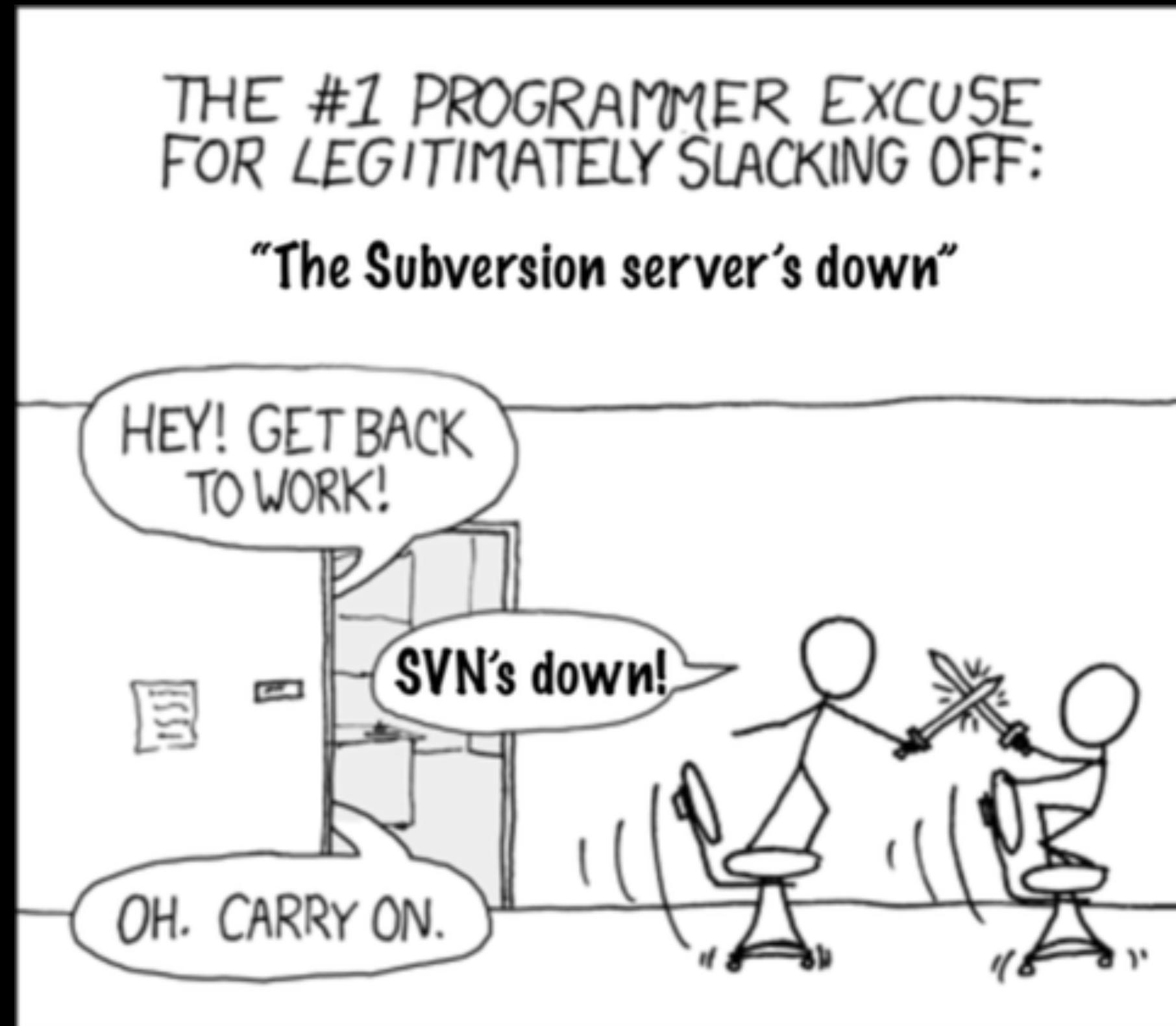
THE #1 PROGRAMMER EXCUSE  
FOR LEGITIMATELY SLACKING OFF:

"The Subversion server's down"



<http://tinyurl.com/distributed-advantages>

# Git is now the most popular free VCS!



## Git offers:

- Speed
- Backups
- Off-line access
- Small footprint
- Simplicity\*
- Social coding

<http://tinyurl.com/distributed-advantages>

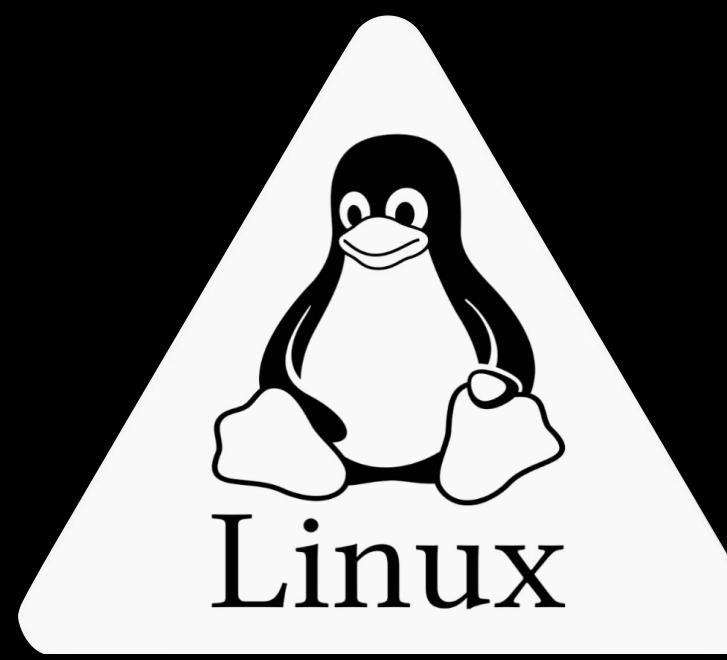
# Where did Git come from?

Written initially by Linus Torvalds to support Linux kernel and OS development.

Meant to be distributed, fast and more natural.

Capable of handling large projects.

Now the most popular free VCS!





# Why use Git?

Q. Would you write your lab book in pencil, then erase and overwrite it every day with new content?

Q. Would you write your lab book in pencil, then erase and overwrite it every day with new content?

Version control is the lab notebook of the digital world: it's what professionals use to keep track of what they've done and to collaborate with others.

# Why use Git?

- Provides ‘snapshots’ of your project during development and provides a full record of project history.
- Allows you to easily reproduce and rollback to past versions of analysis and compare differences. (N.B. Helps fix software regression bugs!)
- Keeps track of changes to code you use from others such as fixed bugs & new features
- Provides a mechanism for sharing, updating and collaborating (like a social network)
- Helps keep your work and software organized and available

# Obtaining Git

**Note:** You hopefully already have git installed!

To check open the “**Terminal**” tab in RStudio and type:

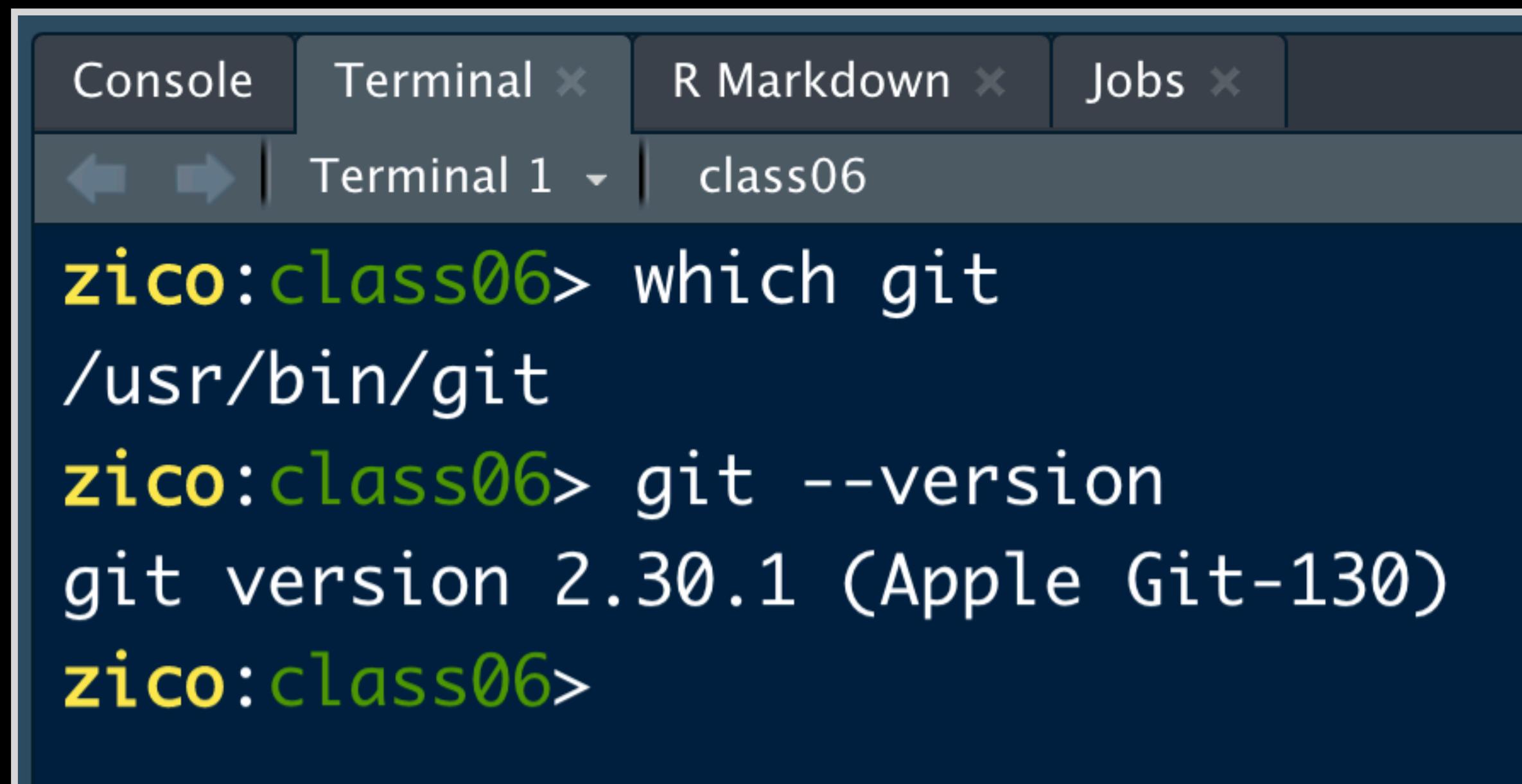
- 1 **which git**
- 2 **git --version**

# Obtaining Git

**Note:** You might already have git installed  
To check open the “**Terminal**” tab in RStudio and type:

- 1 **which git**
- 2 **git --version**

# Obtaining Git



The screenshot shows the RStudio interface with the Terminal tab active. The terminal window title is "Terminal 1 - class06". The terminal output shows the results of running the "which git" and "git --version" commands.

```
zico:class06> which git
/usr/bin/git
zico:class06> git --version
git version 2.30.1 (Apple Git-130)
zico:class06>
```

**Note:** You might already have git installed  
To check open the “**Terminal**” tab in RStudio and type:

- 1 **which git**
- 2 **git --version**

# Obtaining Git

## Windows Only (if you have problems)

If the “**which git**” command did not work, try:

**where git**

If this works see next slide. If not then you need to install **GitBash**, instructions here:

Class Computer Setup Page

## Mac Only (if you have problems)

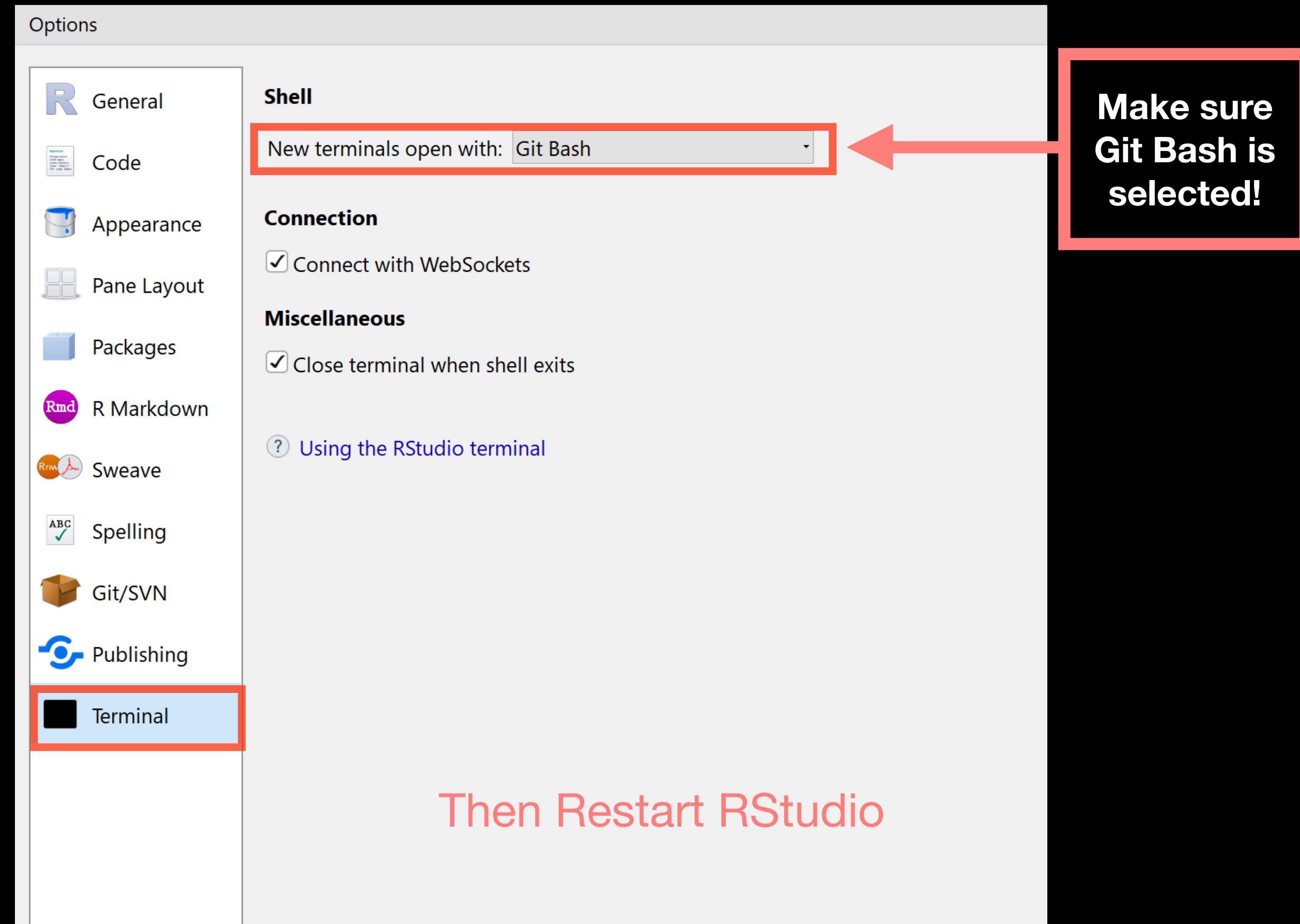
If the “**which git**” command did not work, you may need to install select developer tools.

In your Terminal type:

**xcode-select --install**

# On a PC Only!

***Go to: RStudio > Tools > Global Options > Terminal***



**Note:** You might already have git installed  
To check open the “**Terminal**” tab in RStudio and type:

- 1 **which git**
- 2 **git --version**

# Installing Git

**Windows (if you have problems)**

Follow the GitBash instructions here:

Class [Computer Setup Page](#)

**Mac (if you have problems)**

In the **Terminal** instal select developer tools

**xcode-select --install**

# Configuring Git

# Configuring Git

(RStudio **Terminal** Tab)  
(...or *RStudio > Tools > Shell*)

# First tell Git who you are

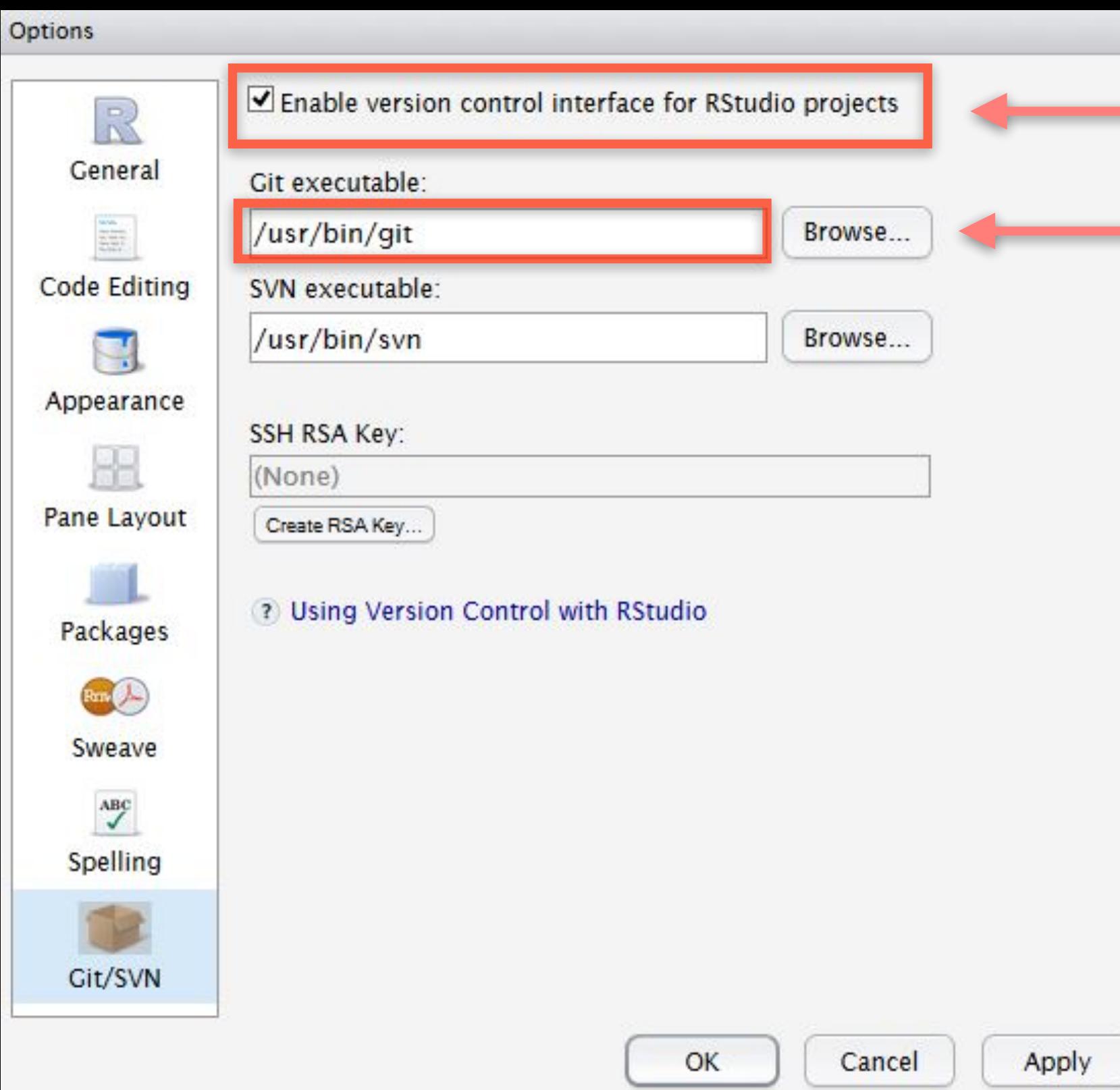
- > git config --global user.name "Barry Grant"
- > git config --global user.email "bjgrant@ucsd.edu"

# Configuring RStudio

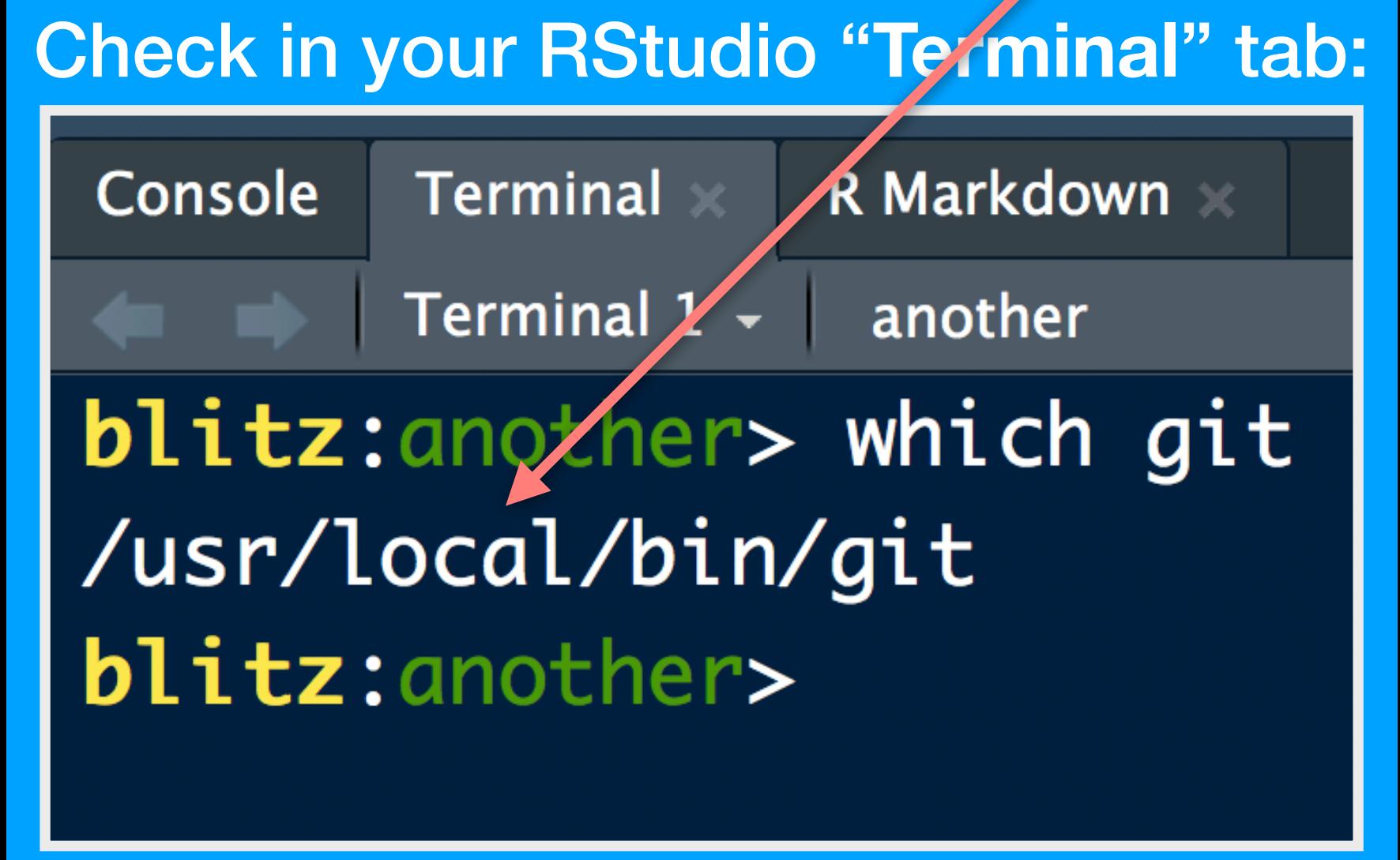
# For Mac & Linux

(PC on next slide)

**Go to: RStudio > Tools > Global Options > Git/SVN**

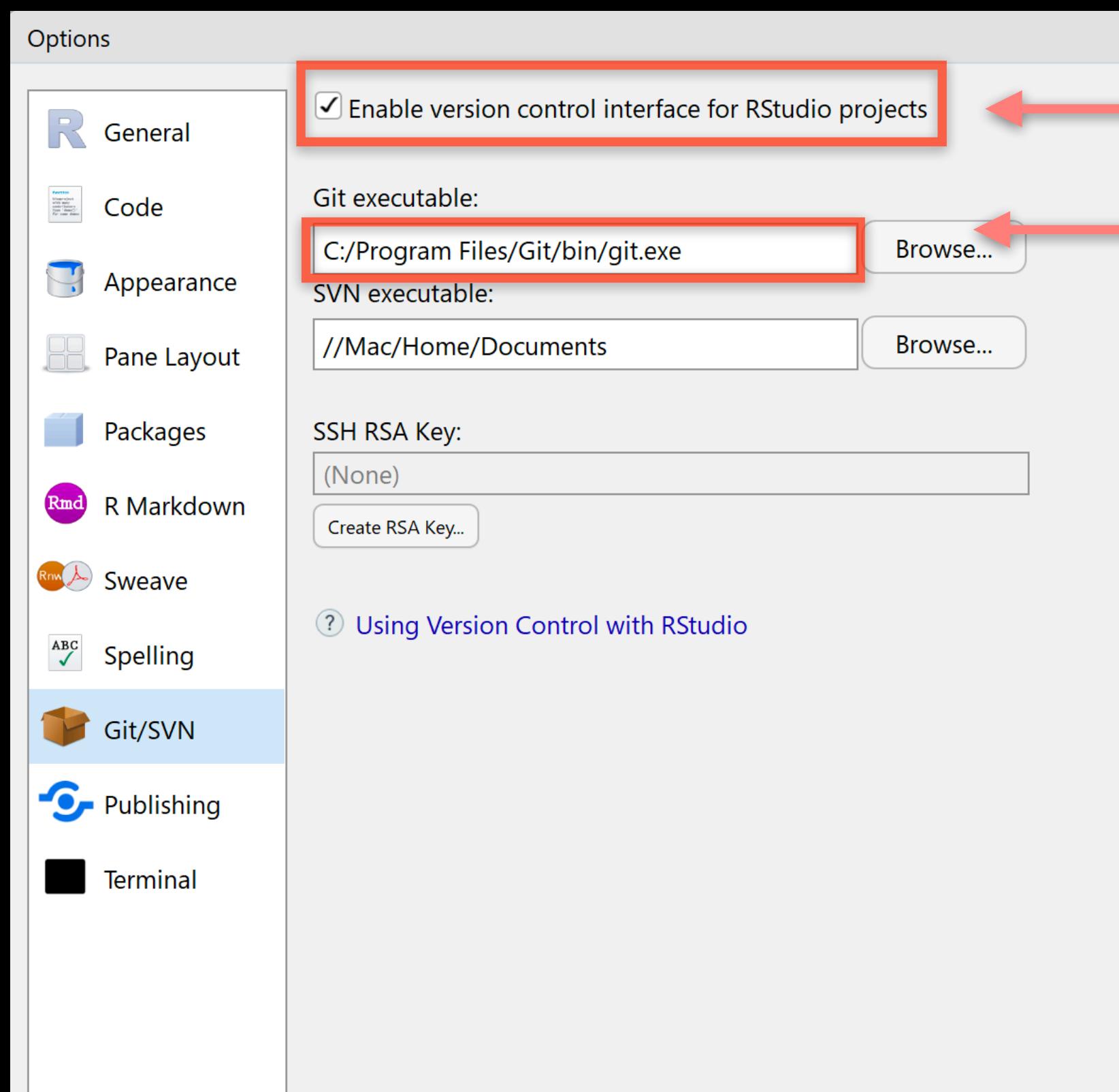


- 1 *Make sure this is **ticked!***
- 2 *Make sure this is **correct!***

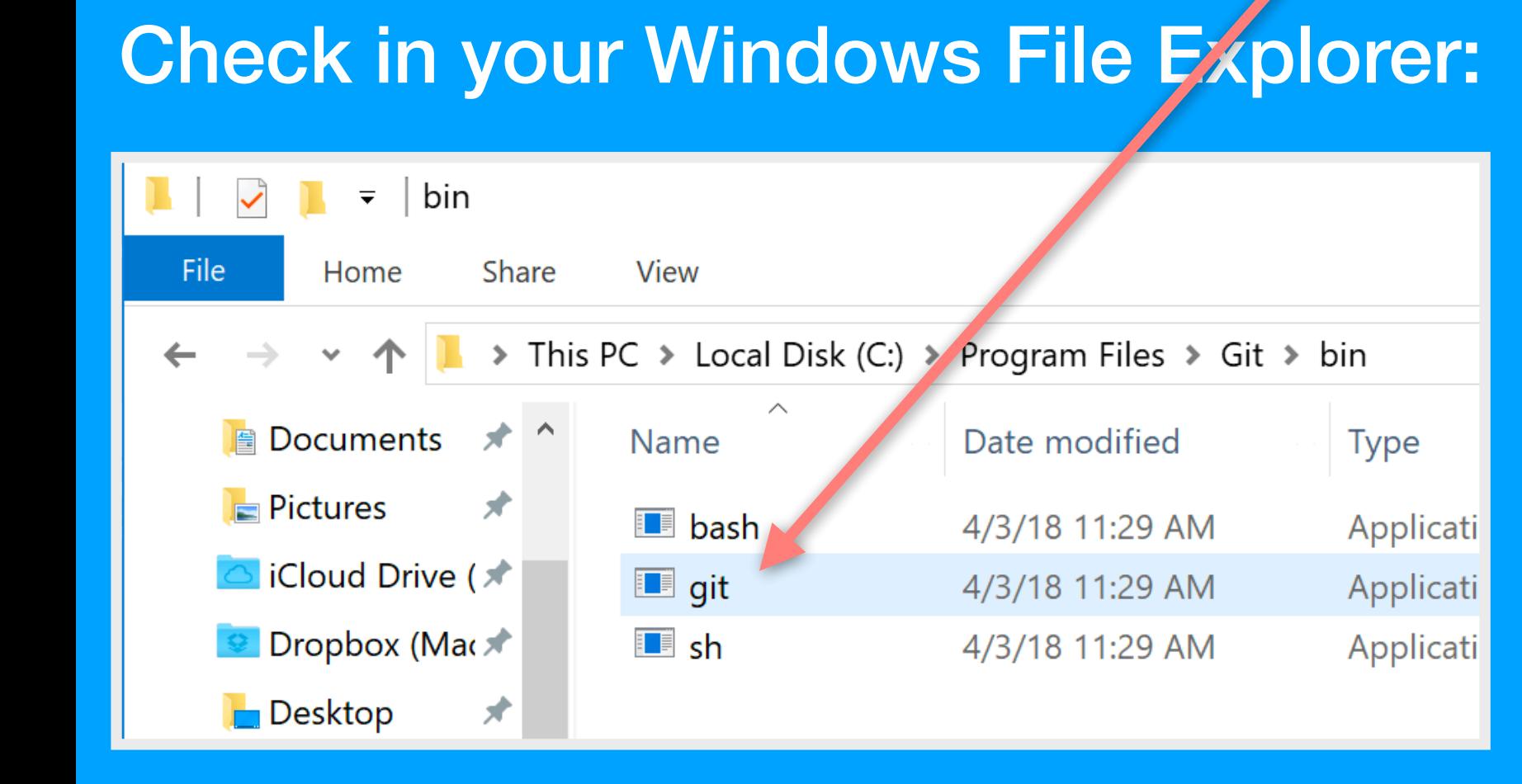


# On a PC!

**Go to: RStudio > Tools > Global Options > Git/SVN**



- 1 *Make sure this is **ticked**!*
- 2 This is the PATH for PC!



# Restart RStudio!

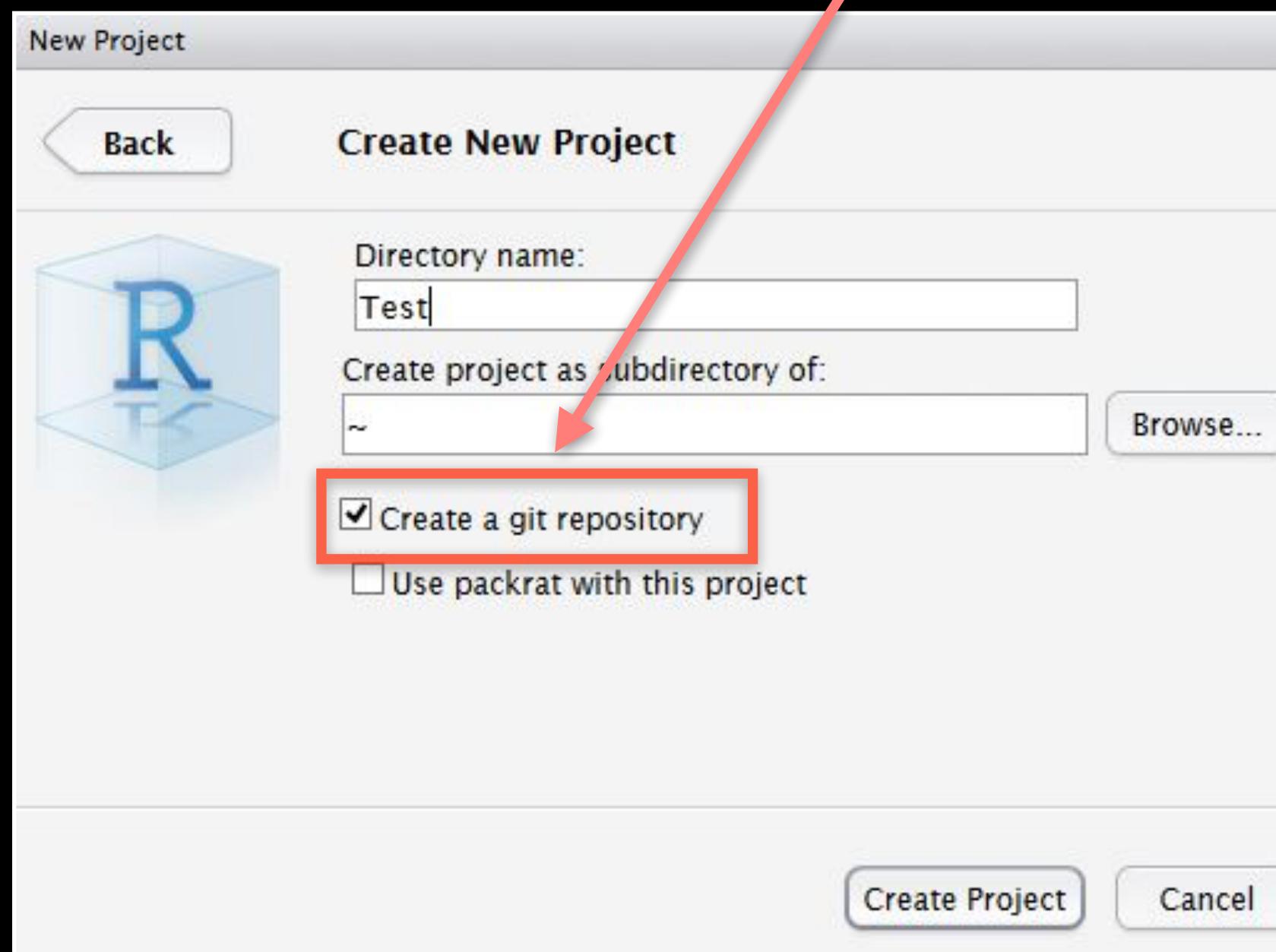
# Using Git

# Using Git

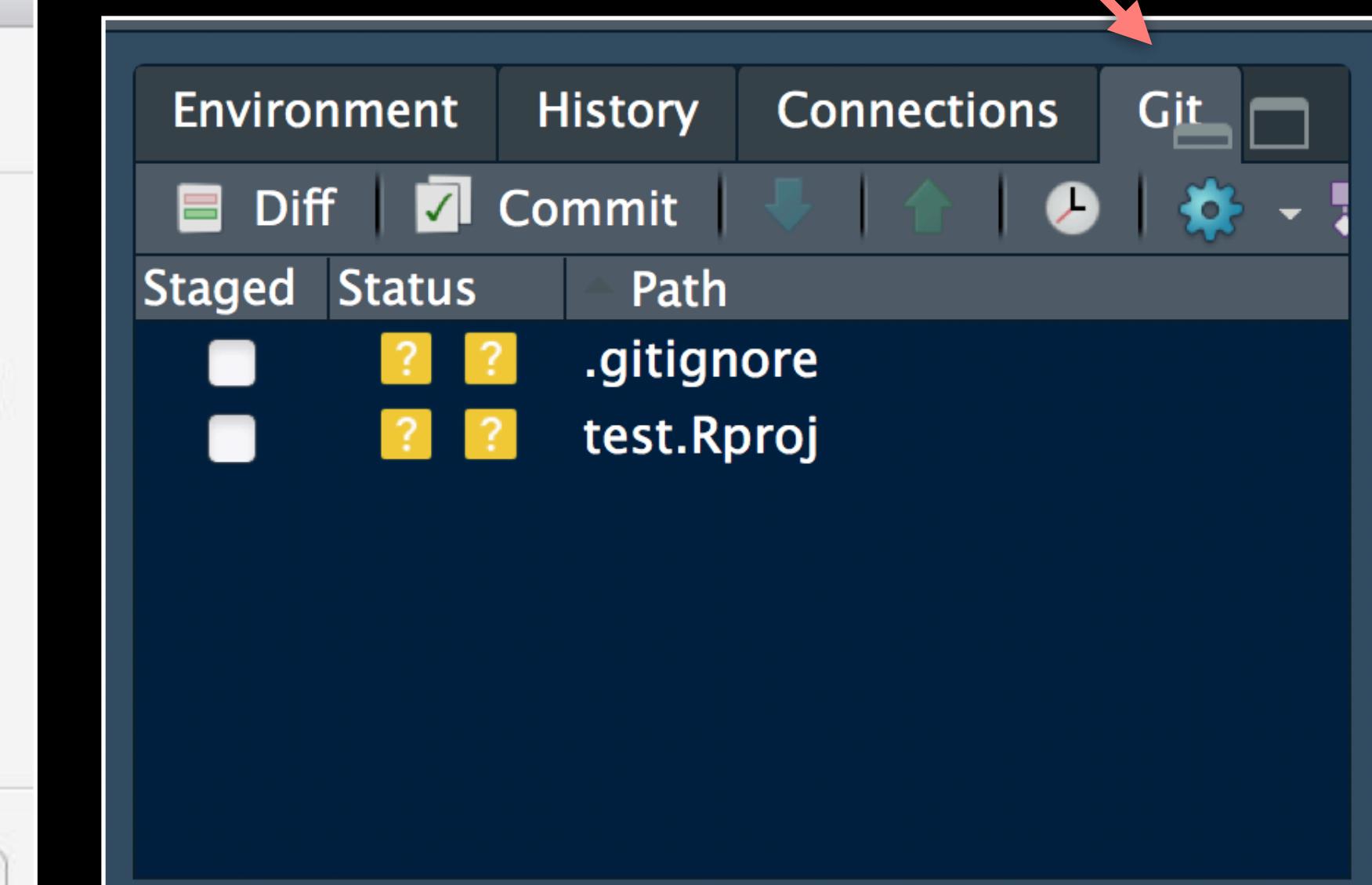
1. Initiate a Git repository.
2. Edit content (i.e. change some files).
3. Store a 'snapshot' of the current file state.\*

# Create a new **Test** RStudio project

**1** New option to create a Git repository...



**2** New Git tab...



Check if new Git options appear in RStudio?

# Using Git in RStudio

1. **Initiate** a git repository for an RStudio Project
2. Do your work and edit content as normal
3. Store a ‘snapshot’ of the current file state
  - (a) Periodically **add** important files to git “Staging Area”
  - (b) **Commit** changes to your “git repository”

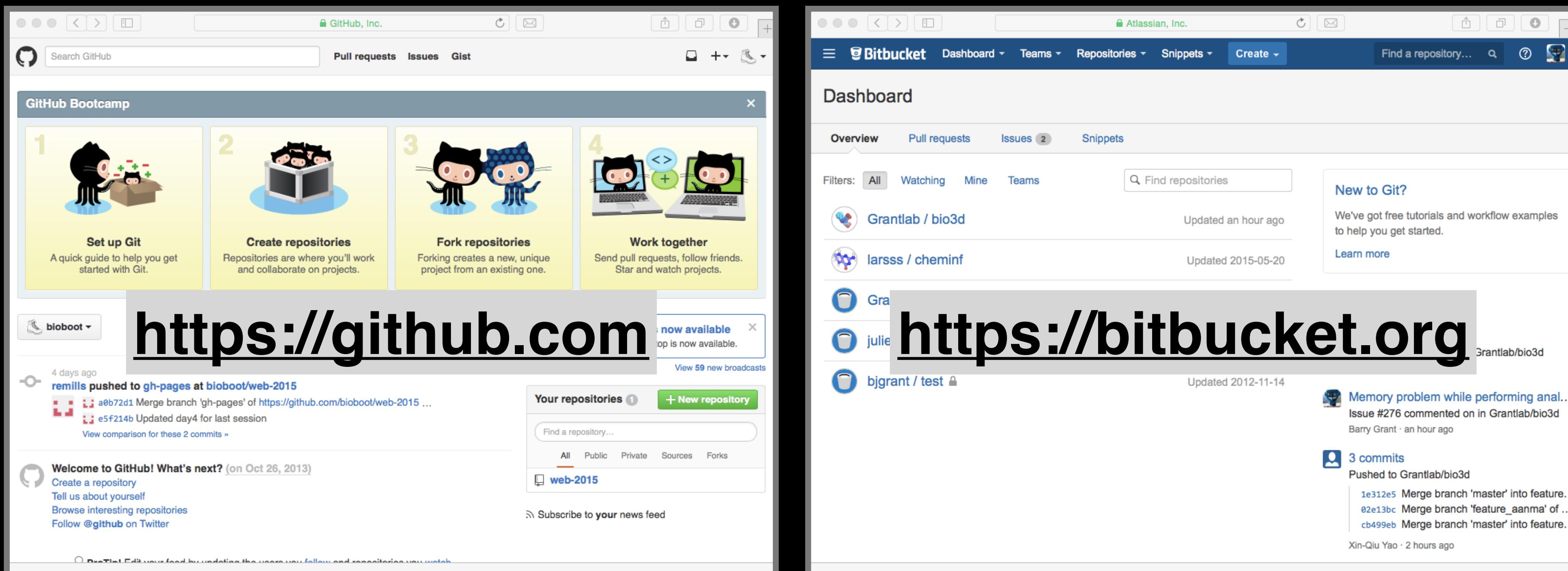
Rinse and repeat....

Follow along!

# Demo:

# GitHub & Bitbucket

**GitHub** and **Bitbucket** are two popular hosting services for Git repositories. These services allow you to share your projects and collaborate with others using both '**public**' and '**private**' repositories\*.



wsj.com

Nikkei  
17893.73 0.49% Hang Seng  
21404.96 0.72% U.S. 10 Yr  
-0/32 Yield 2.074% Crude Oil  
39.17 -0.36% Yen  
119.16 0.26% EXPAND

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TECH

## GitHub Raises \$250 Million at \$2 Billion Valuation

Capital raise puts company's total funding at \$350 million





**Analytics**  
How does your organization's talent measure up to its technology?  
[Read the MIT Sloan report](#) 

www.bbc.com/news/technology-44351214

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# NEWS

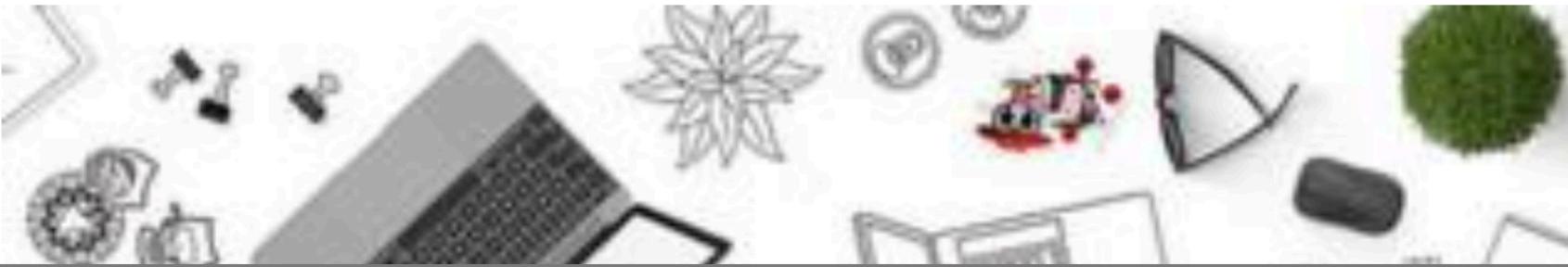
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## Microsoft buys Github code-sharing site for \$7.5bn

 **Dave Lee**  
North America technology reporter

4 June 2018 | [Comment](#)

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**Top Stories**

**Gangster 'Whitey' Bulger killed in prison**  
Bulger was severely beaten by one or more inmates shortly after arriving at the prison, sources say.  
30 October 2018

**Synagogue shooting victims' funerals start**  
30 October 2018

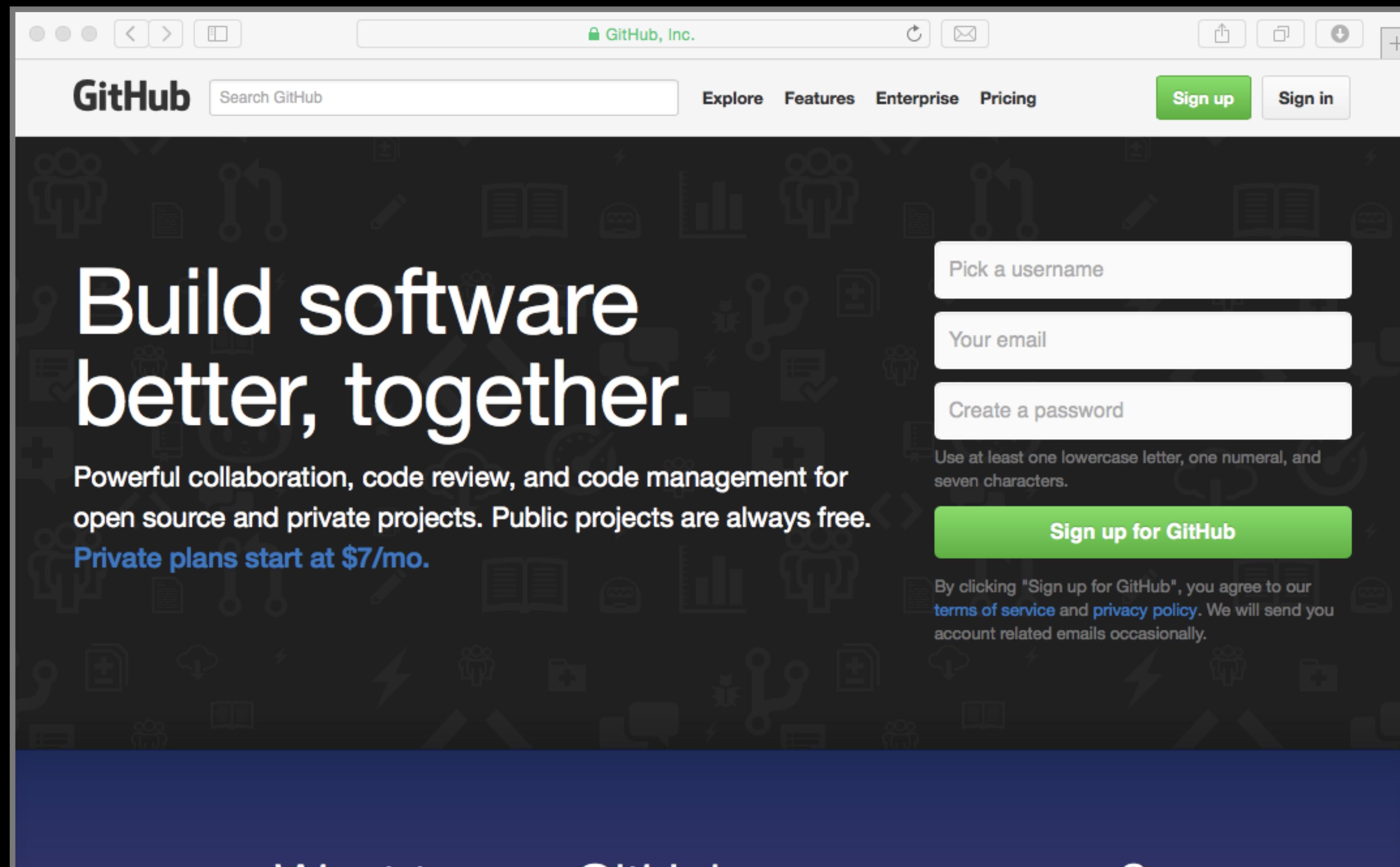
**What do American voters care about?**  
30 October 2018

# What is the big deal?

- At the simplest level GitHub and Bitbucket offer **backup** of your projects history and a centralized mechanism for **sharing** with others by putting **your Git repo online**.
  - GitHub in particular is often referred to as the “nerds FaceBook and LinkedIn combined”.
- At their core both services **offer a new paradigm for open collaborative project development**, particularly for software.
  - In essence they allow anybody to contribute to any public project and get acknowledgment.

# First sign up for a GitHub account

<https://github.com>



# Pick the FREE plan!

The screenshot shows the GitHub account setup process. At the top, there are three steps: 'Completed' (Set up a personal account), 'Step 2: Choose your plan' (which is highlighted in blue), and 'Step 3: Go to your dashboard'. The main area is titled 'Choose your personal plan' and lists five plans: Large (\$50/month, 50 repos), Medium (\$22/month, 20 repos), Small (\$12/month, 10 repos), Micro (\$7/month, 5 repos), and Free (\$0/month, 0 repos). The 'Free' plan is circled in red and has a 'Chosen' button next to it. To the right, a box lists 'Each plan includes:' with items like Unlimited collaborators, Unlimited public repositories, Free setup, HTTPS Protection, Email support, and Wikis, Issues, Pages, & more.

Plan	Cost	Private repositories	Action
Large	\$50/month	50	Choose
Medium	\$22/month	20	Choose
Small	\$12/month	10	Choose
Micro	\$7/month	5	Choose
Free	\$0/month	0	Chosen

Each plan includes:

- Unlimited collaborators
- Unlimited public repositories
- ✓ Free setup
- ✓ HTTPS Protection
- ✓ Email support
- ✓ Wikis, Issues, Pages, & more

Charges to your account will be made in **US Dollars**. Converted prices are provided as a convenience and are only an *estimate* based on current exchange rates. Local prices will change as the exchange rate fluctuates.  
Don't worry, you can cancel or upgrade at any time.

# Your GitHub homepage

## Check your email for verification request

The screenshot shows a GitHub profile page for a user named `biobootStudent`. The profile picture is a green pixelated version of the Minecraft Creeper. The user joined on August 26, 2015, and has 0 followers, 0 starred repositories, and 0 repositories they are following. A 'Pro tip' message encourages updating the profile with name, location, and a picture. The contributions graph shows a grid where each cell represents a day's worth of activity. A legend indicates that darker green squares represent more commits. Below the graph, text explains what a contribution graph is and how it works, mentioning a guide to creating a first repository.

Pro tip: updating your profile with your name, location, and a profile picture helps other GitHub users get to know you. [Edit profile](#)

Contributions

Summary of pull requests, issues opened, and commits. [Learn how we count contributions.](#)

This is your **contribution graph**. When you make a commit to a repository, you'll get a  for that day. Make more contributions and you'll get a darker green square. Over time, your chart might start looking [something like this](#).

We have a quick guide that will show you how to create your first repository. You'll also make a commit and [earn your first green square!](#)

[Read the Hello World guide](#)

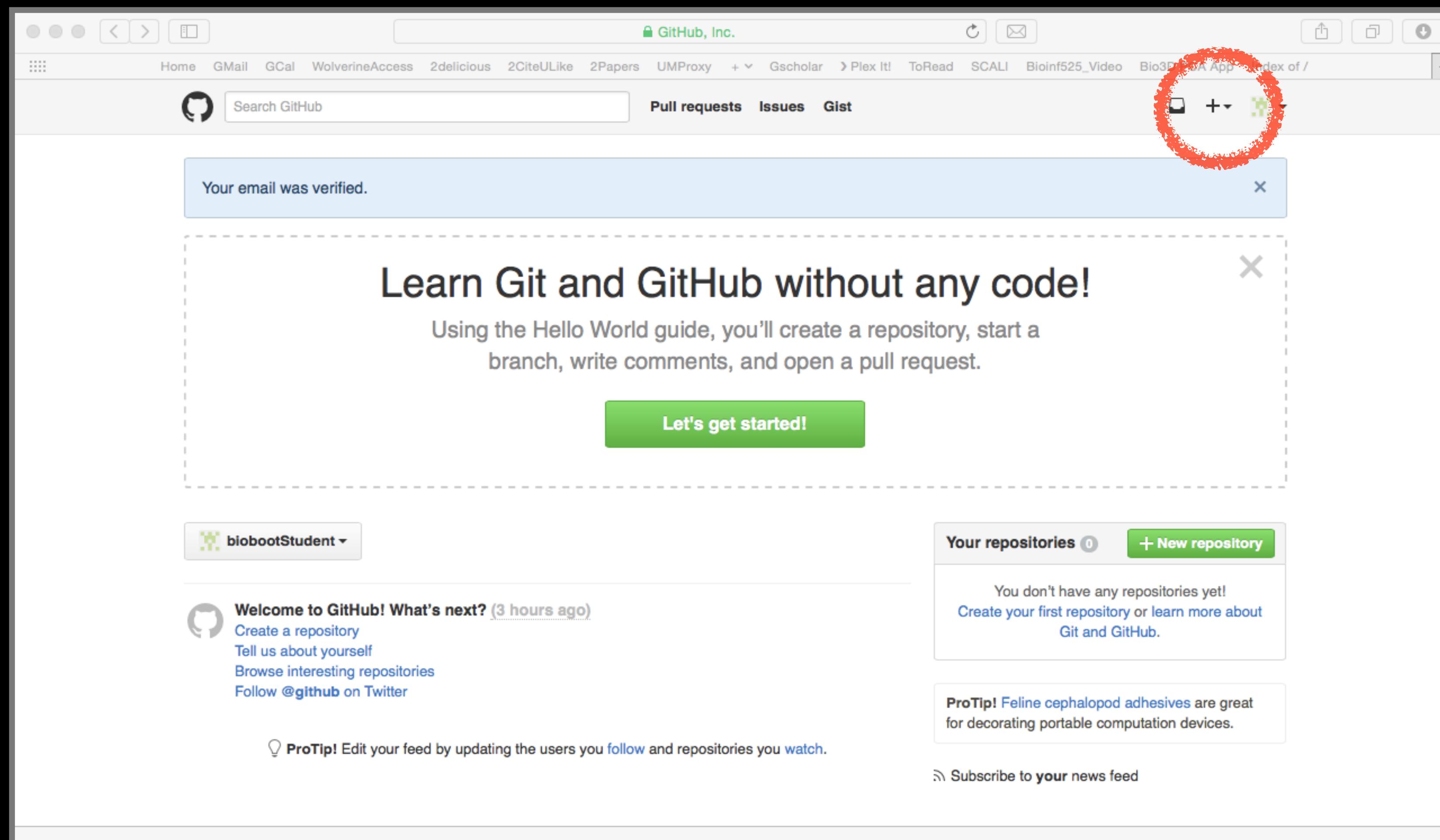
# Connecting RStudio to GitHub

Create a **Personal Access Token** (PAT) on GitHub

See **section 4** of lab worksheet

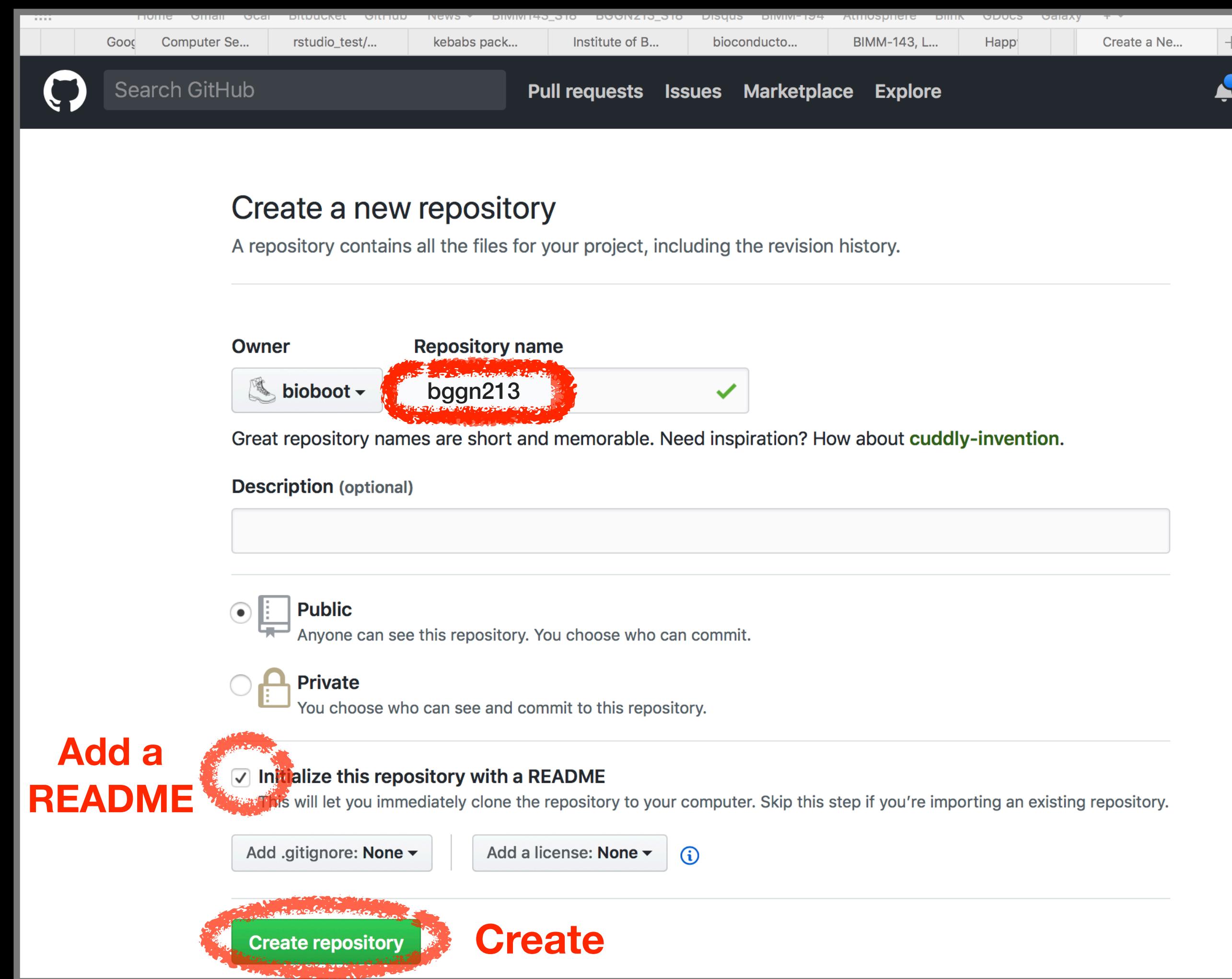
# Skip the hello-world tutorial

<https://guides.github.com/activities/hello-world/>

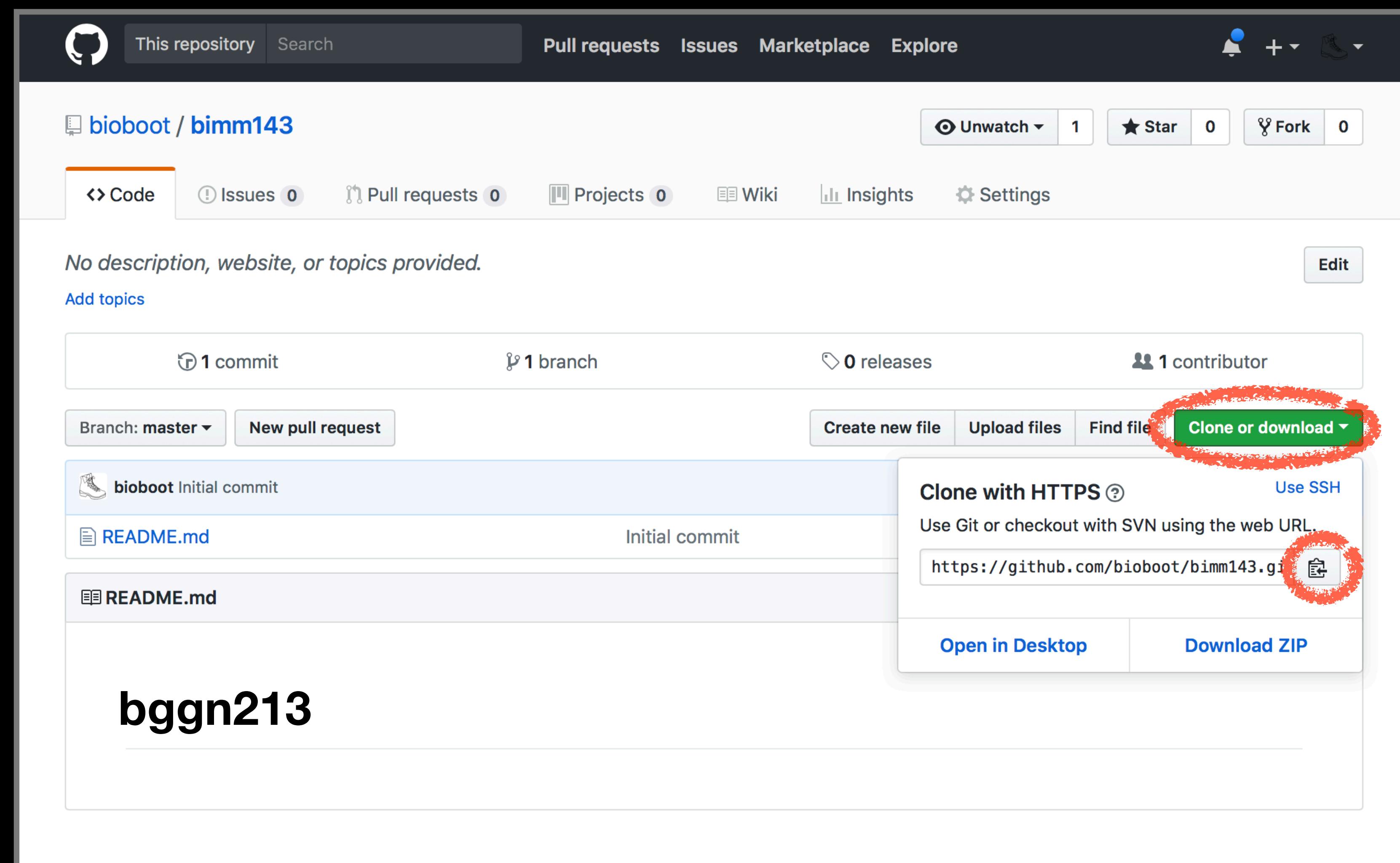


# Name your repo

## bggn213



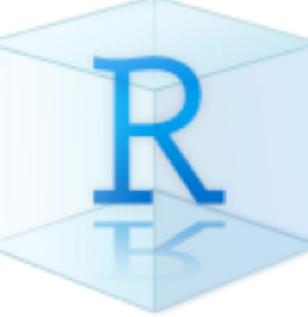
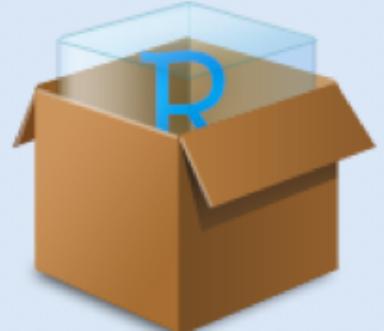
# Copy the “Clone” HTTPS link



# RStudio > New Project > Version Control

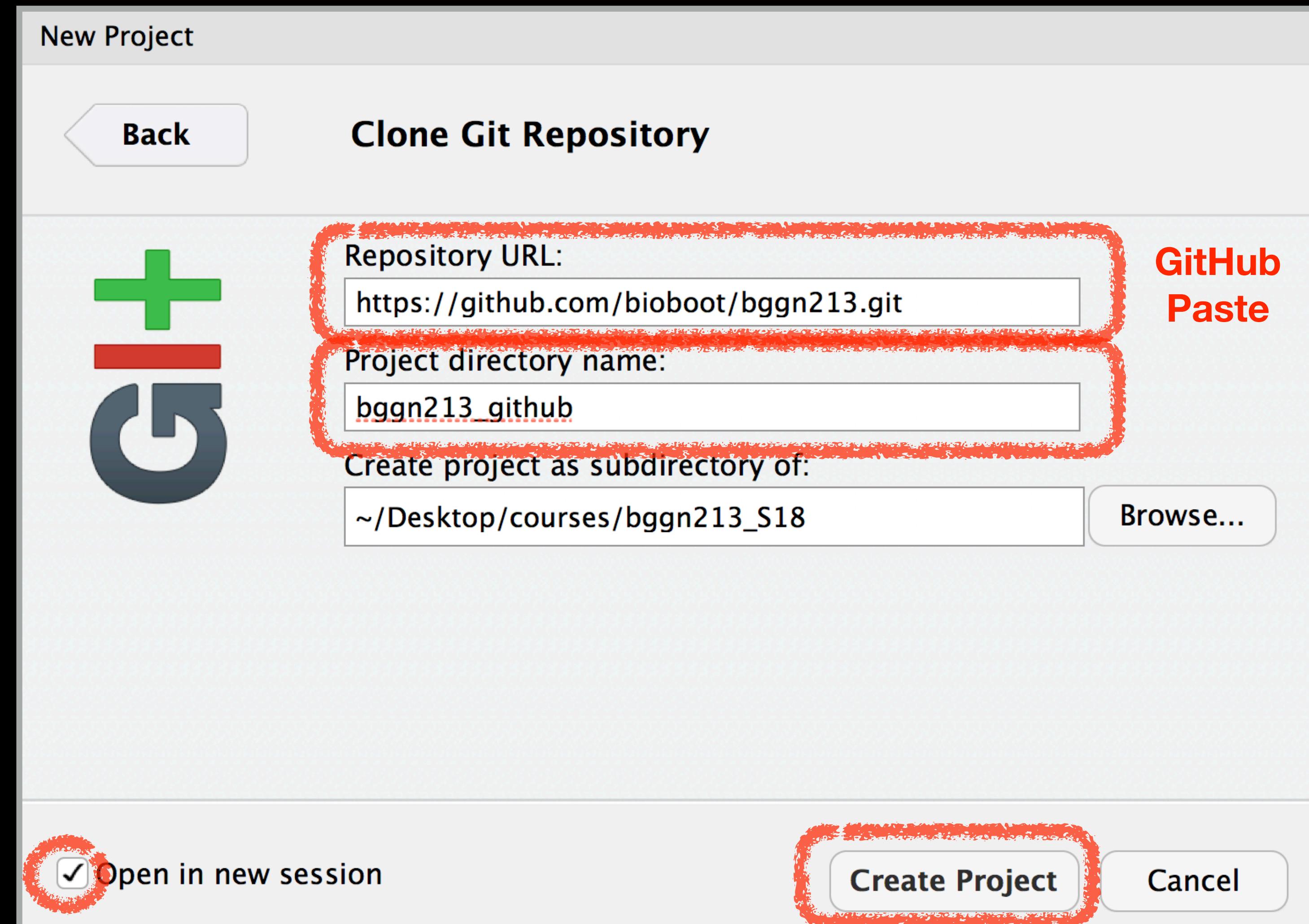
New Project

## Create Project

- **New Directory**  
Start a project in a brand new working directory >
- **Existing Directory**  
Associate a project with an existing working directory >
- **Version Control**  
Checkout a project from a version control repository >

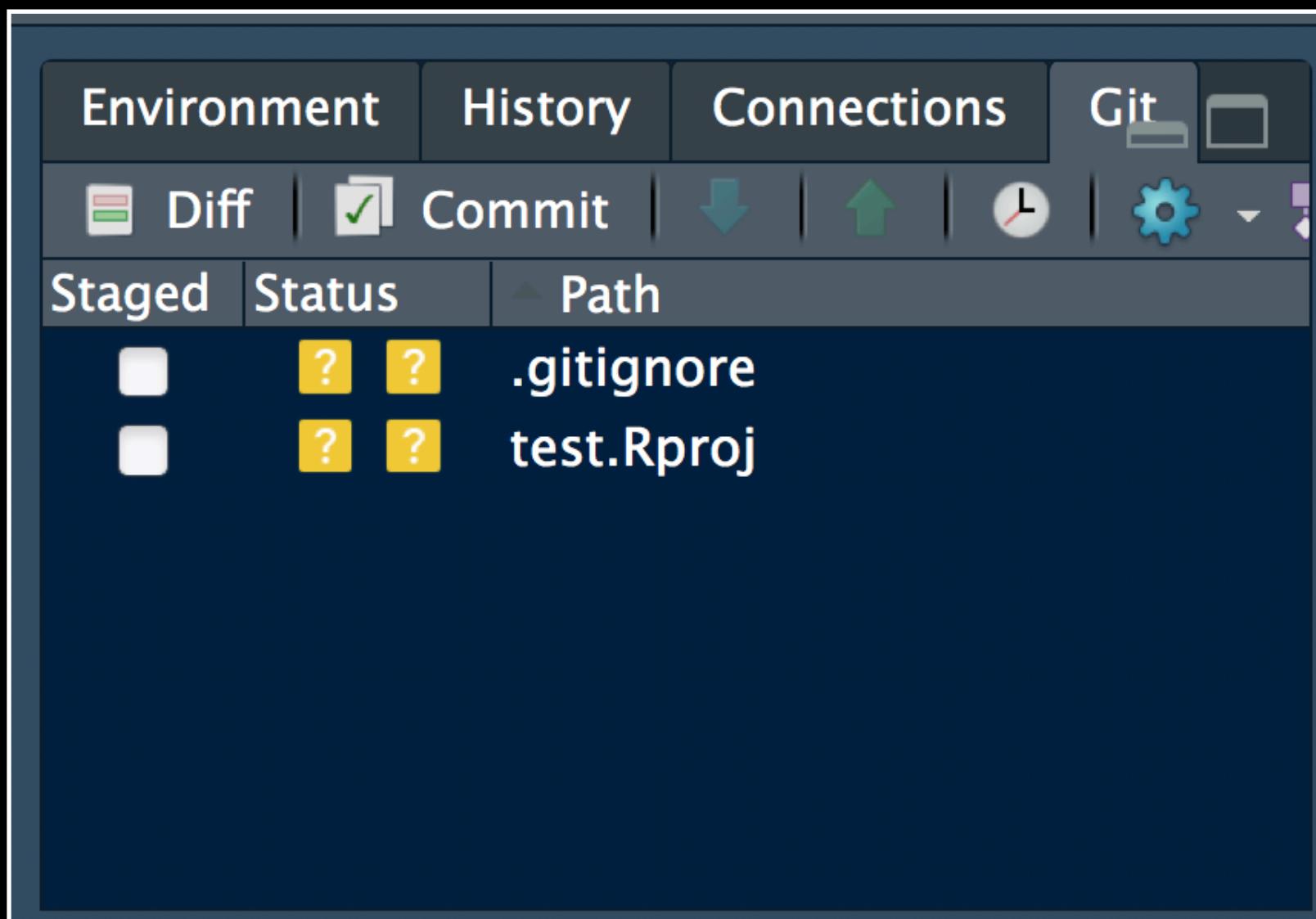
Cancel

# RStudio > New Project > Version Control



# Demo of editing, adding committing and pushing

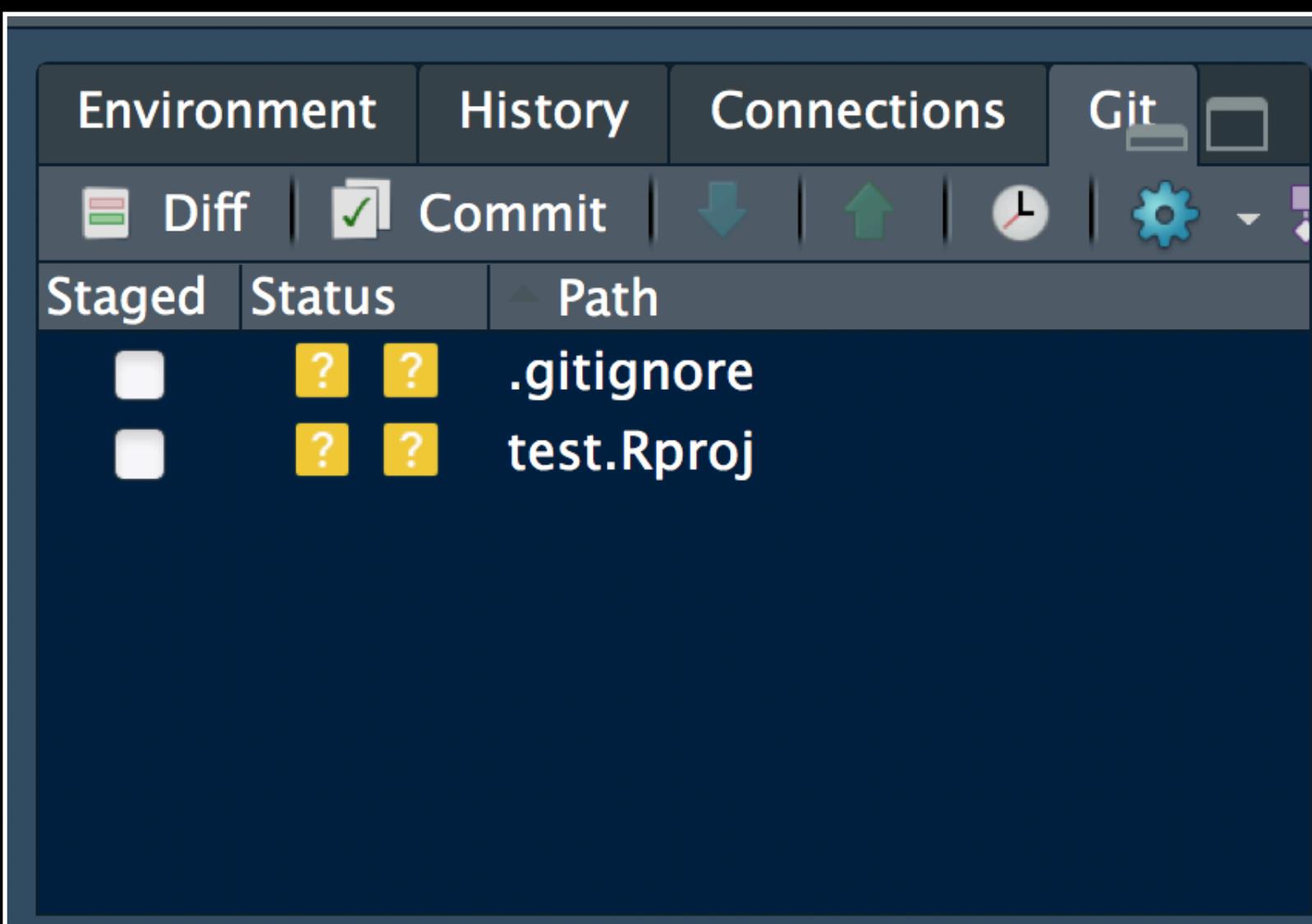
**Check if new Git tab  
Appears in RStudio?**



Now experiment editing the README.md file in RStudio and adding, committing and pushing changes to GitHub via this tab

# Demo of *editing, adding committing and pushing*

**Check if new Git tab  
Appears in RStudio?**

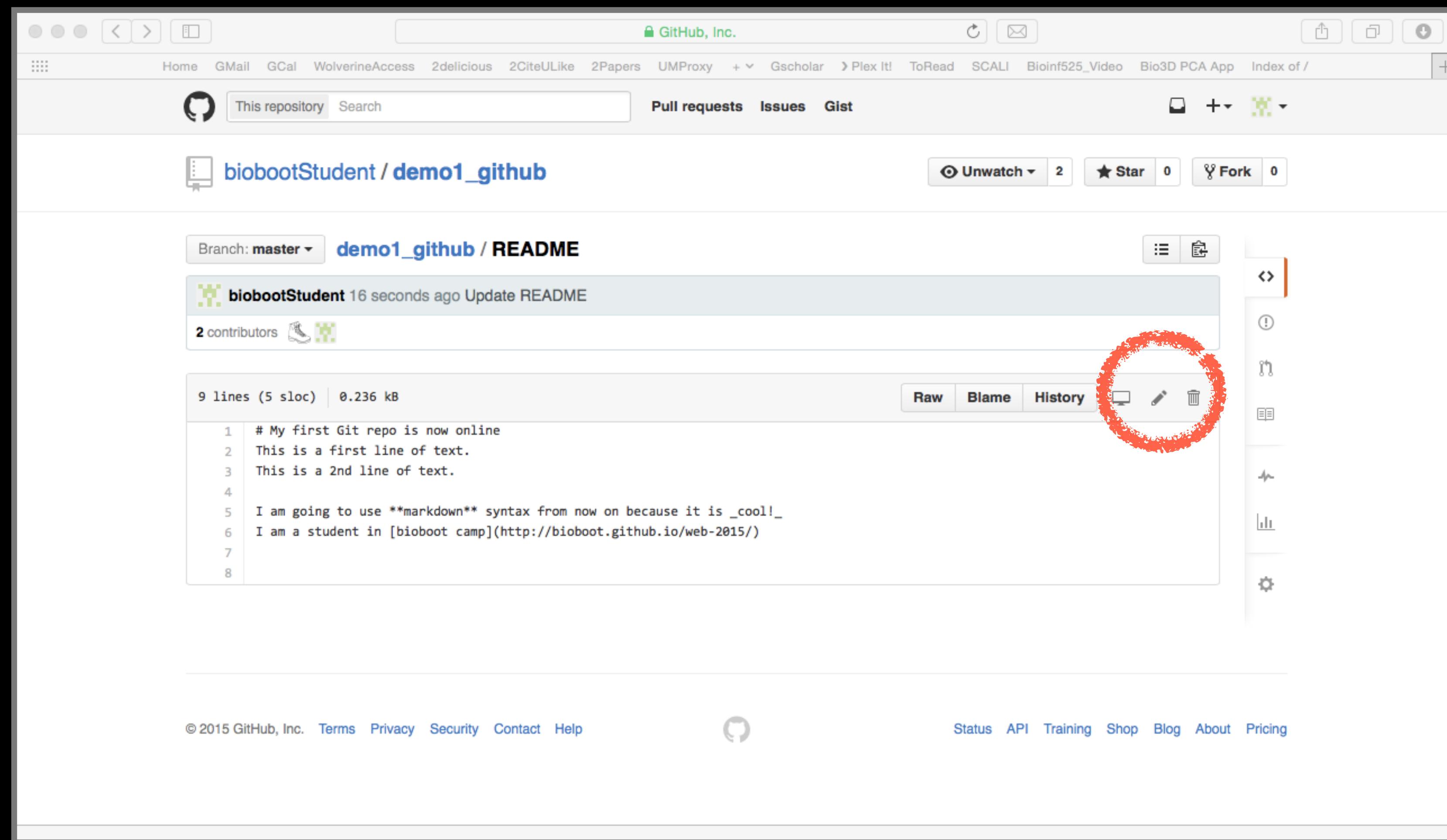


**Now experiment editing the README.md file in RStudio and adding, committing and pushing changes to GitHub via this tab**

**When you are ready copy your different class directories/projects to this new GitHub tracked folder**

# Side-note: How to edit online

Specifically lets add some Markdown content



# Summary

- Git is a popular ‘distributed’ version control system that is lightweight and free
- GitHub and BitBucket are popular hosting services for git repositories that have changed the way people contribute to open source projects
- Introduced basic git and GitHub usage within RStudio and encouraged you to adopt these ‘best practices’ for your future projects.

# Learning Resources

- **Set up Git.** If you will be using Git mostly or entirely via **GitHub**, look at these how-tos.  
*< <https://help.github.com/categories/bootcamp/> >*
- **Getting Git Right.** Excellent **Bitbucket** git tutorials  
*< <https://www.atlassian.com/git/> >*
- **Pro Git.** A complete, book-length guide and reference to Git, by Scott Chacon and Ben Straub.  
*< <http://git-scm.com/book/en/v2> >*
- **StackOverflow.** Excellent programming and developer Q&A.  
*< <http://stackoverflow.com/questions/tagged/git> >*

# Learning git can be painful!

However in practice it is not nearly as crazy-making as the alternatives:

- Documents as email attachments
- Hair-raising ZIP archives containing file salad
- Am I working with the most recent data?
- Archaeological “digs” on old email threads and uncertainty about how/if certain changes have been made or issues solved

Finally Please remember that **GitHub** and **BitBucket** are **PUBLIC** and that you should cultivate your professional and scholarly profile with intention!



# BGGN 213

## Hands-on Lab Session

### Class 07

Barry Grant  
UC San Diego

<http://thegrantlab.org/bggn213>

# Reference Slides

# Using Command Line Git

1. Initiate a Git repository.
2. Edit content (i.e. change some files).
3. Store a 'snapshot' of the current file state.\*

# Initiate a Git repository

# Initiate a Git repository

```
> cd ~/Desktop  
> mkdir git_class # Make a new directory  
> cd git_class    # Change to this directory  
> git init      # Our first Git command!  
> ls -a          # what happened?
```

# Side-Note: The `.git` directory

- Git created a ‘hidden’ `.git` directory inside your current working directory.
- You can use the ‘`ls -a`’ command to list (*i.e.* see) this directory and its contents.
- This is where Git stores all its goodies - **this is Git!**
- You should not need to edit the contents of the `.git` directory for now but do feel free to poke around.

# Important Git commands

```
> git status      # report on content changes
```

```
> git add <filename>    # stage/track a file  
> git commit -m "message"  # snapshot
```

# Important Git commands

```
> git status      # report on content changes
```

```
> git add <filename>    # stage/track a file  
> git commit -m "message"  # snapshot
```

You will use these three commands again and again in your Git workflow!

# Git TRACKS your directory content

- To get a report of changes (since last commit) use:  
**> git status**

- You tell Git which files to track with:  
**> git add <filename>**

This adds files to a so called **STAGING AREA** (akin to a “shopping cart” before purchasing).

- You tell Git when to take an historical **SNAPSHOT** of your staged files (*i.e.* record their current state) with:  
**> git commit -m ‘Your message about changes’**

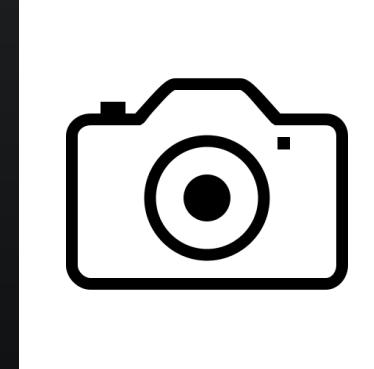
# Example Git workflow



Eva creates a README text file  
(this starts as untracked)



Adds file to STAGING AREA\*  
(tracked and ready to take a snapshot)



Commit changes\*  
(records snapshot of staged files!)

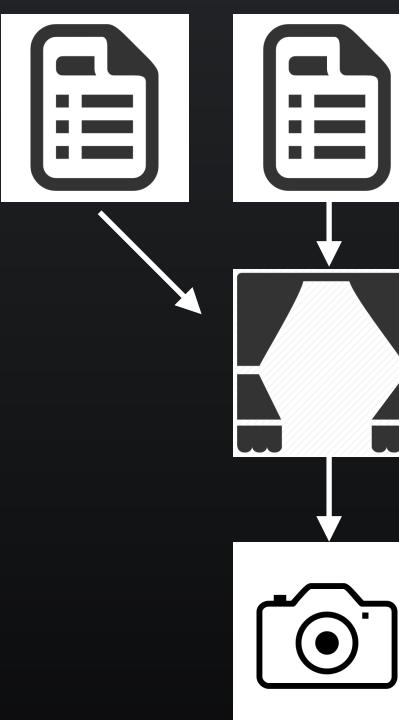
# Example Git workflow



Eva creates a README text file

Adds file to STAGING AREA\*

Commit changes\*



Eva modifies README and adds a ToDo text file

Adds both to STAGING AREA\*

Commit changes\*

# 1. Eva creates a README file

```
> # cd ~/Desktop/git_class  
> # git init  
  
> echo "This is a first line of text." > README  
> git status      # Report on changes  
# On branch master  
#  
# Initial commit  
#  
# Untracked files:  
# (use "git add <file>..." to include in what will be committed)  
#  
# README  
#  
# nothing added to commit but untracked files present (use "git add" to track)
```

## 2. Adds to ‘staging area’

```
> git add README      # Add README file to staging area  
> git status          # Report on changes  
  
# On branch master  
#  
# Initial commit  
#  
# Changes to be committed:  
#   (use "git rm --cached <file>..." to unstage)  
#  
#       new file: README  
#
```

### 3. Commit changes

```
> git commit -m "Create a README file" # Take snapshot
```

```
# [master (root-commit) 8676840] Create a README file  
# 1 file changed, 1 insertion(+)  
# create mode 100644 README
```

```
> git status # Report on changes
```

```
# On branch master  
# nothing to commit, working directory clean
```

## 4. Eva modifies README file and adds a ToDo file

```
> echo "This is a 2nd line of text." >> README
> echo "Learn git basics" >> ToDo

> git status      # Report on changes
# On branch master
#
# Changes not staged for commit:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified: README
#
# Untracked files:
#   (use "git add <file>..." to include in what will be committed)
#
#       ToDo
#
# no changes added to commit (use "git add" and/or "git commit -a")
```

## 5. Adds both files to ‘staging area’

```
> git add README ToDo      # Add both files to 'staging area'  
> git status                 # Report on changes  
  
# On branch master  
# Changes to be committed:  
#   (use "git reset HEAD <file>..." to unstage)  
#  
#       modified: README  
#       new file: ToDo  
#
```

## 6. Commits changes

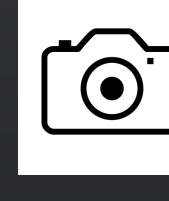
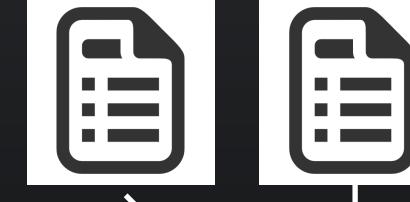
```
> git commit -m "Add ToDo and modify README"
```

```
# [master 7b679fa] Add ToDo and modify README
# 2 files changed, 2 insertions(+)
# create mode 100644 ToDo
```

```
> git status
```

```
# On branch master
# nothing to commit, working directory clean
```

# Example Git workflow

1.  Eva creates a README text file
2.  Adds file to STAGING AREA\*
3.  Commit changes\*
  
4.  Eva modifies README and adds a ToDo text file
5.  Adds both to STAGING AREA\*
6.  Commit changes\*

...But, how do we see the history of our project changes?

# git log: Timeline history of snapshots (*i.e.* commits)

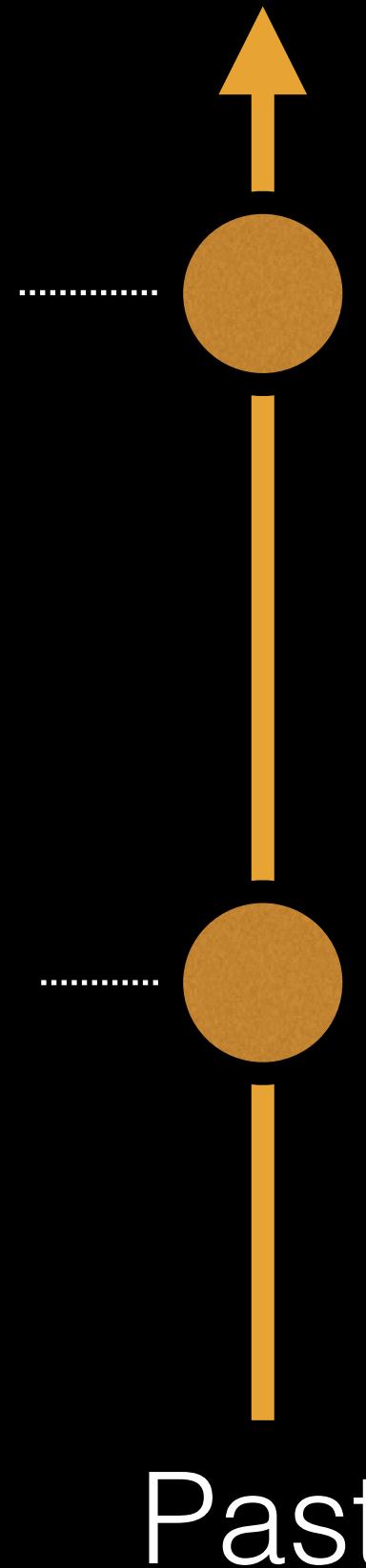
> **git log**

```
# commit 7b679fa747e8640918fcaad7e4c3f9c70c87b170
# Author: Barry Grant <bjgrant@umich.edu>
# Date:  Thu Jul 30 11:43:40 2015 -0400
#
#   Add ToDo and finished README
#
# commit 86768401610770ae32e2fd4faee07d1d5c68619c
# Author: Barry Grant <bjgrant@umich.edu>
# Date:  Thu Jul 30 11:26:40 2015 -0400
#
#   Create a README file
#
```

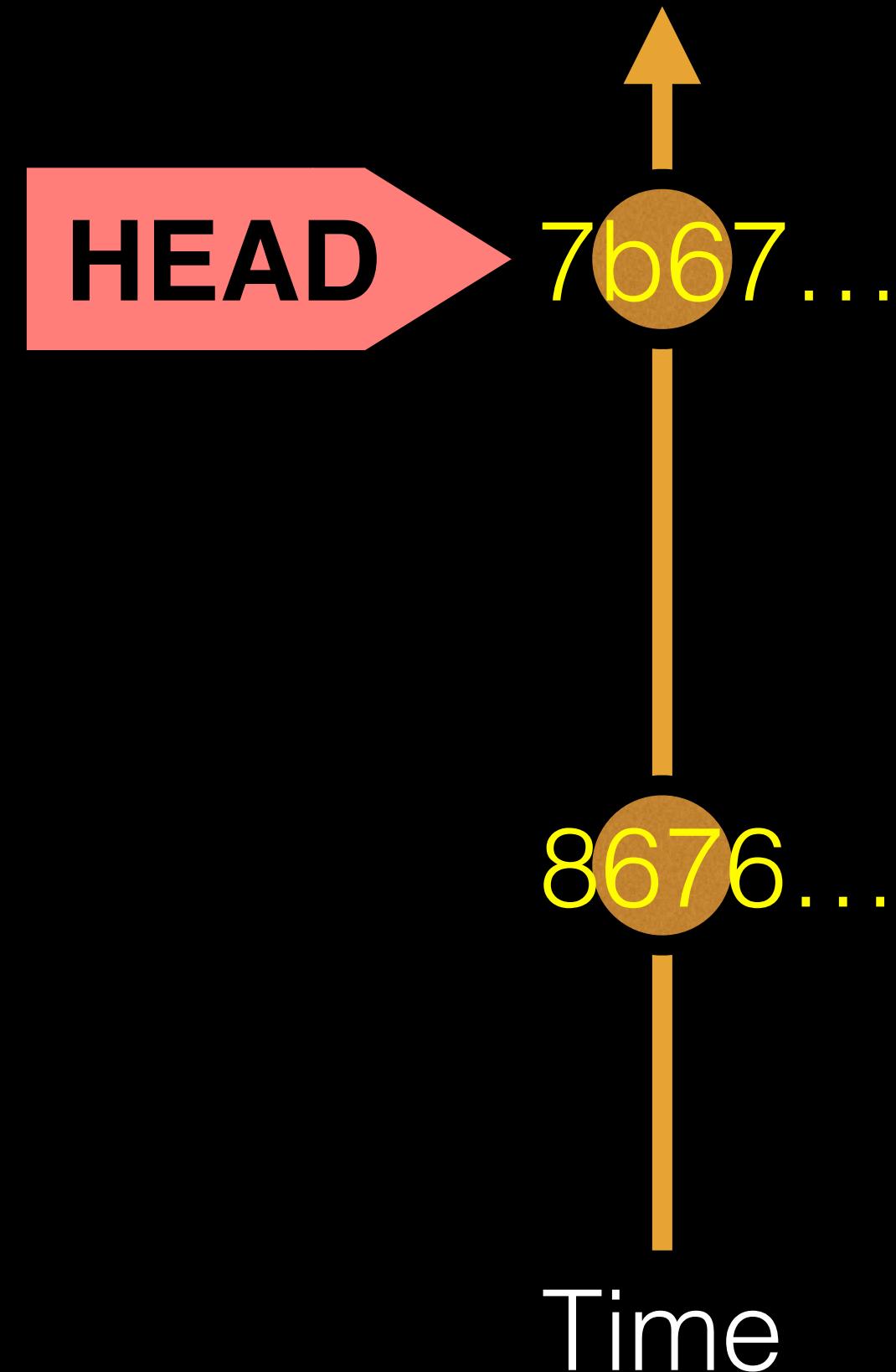
# git log: Timeline history of snapshots (*i.e.* commits)

```
> git log
```

```
# commit 7b679fa747e8640918fcaad7e4c3f9c70c87b170
# Author: Barry Grant <bjgrant@umich.edu>
# Date:  Thu Jul 30 11:43:40 2015 -0400
#
#   Add ToDo and finished README
#
# commit 86768401610770ae32e2fd4faee07d1d5c68619c
# Author: Barry Grant <bjgrant@umich.edu>
# Date:  Thu Jul 30 11:26:40 2015 -0400
#
#   Create a README file
#
```



# Side-Note: Git history is akin to a graph

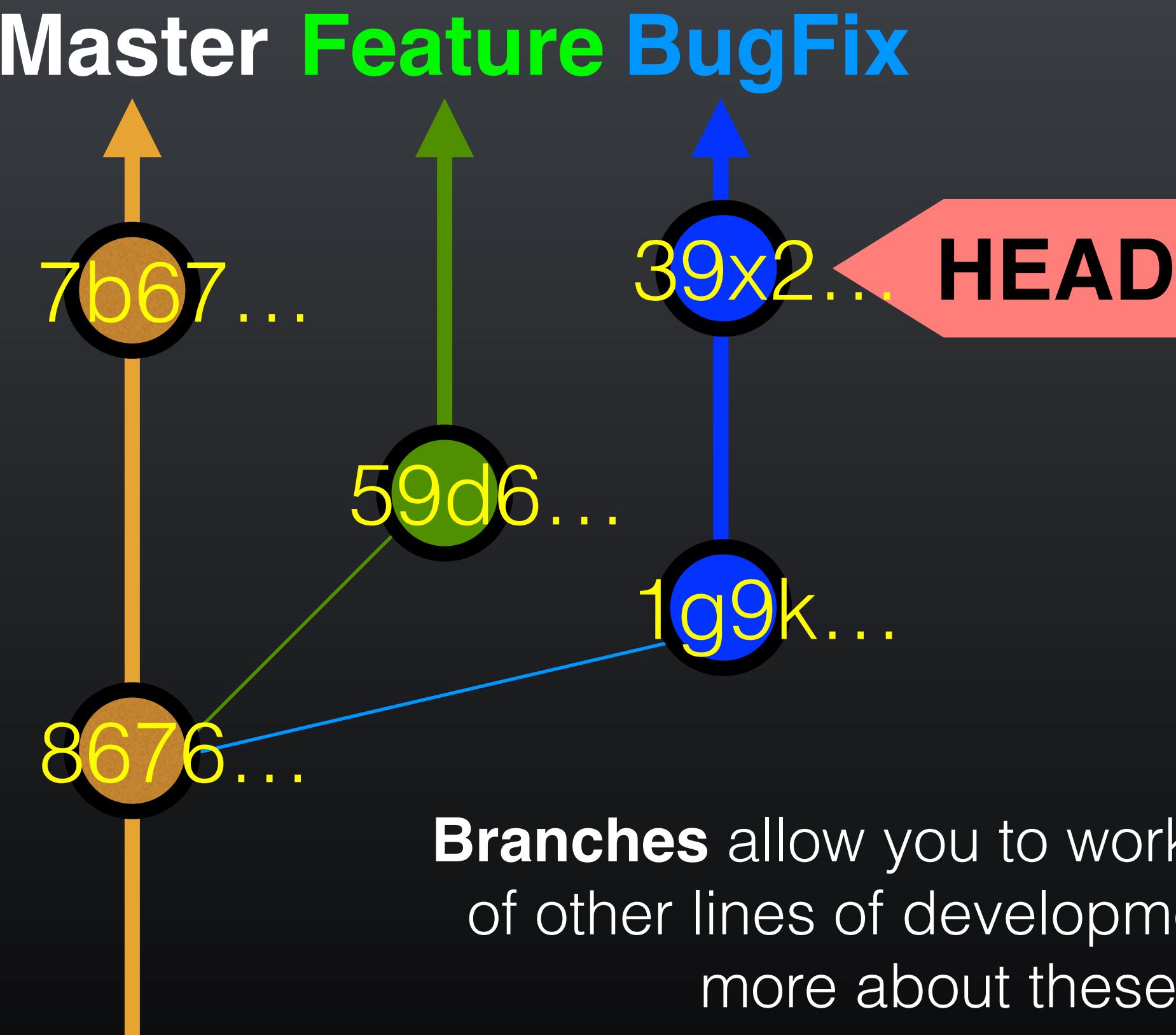


Nodes are **commits** labeled by their unique '**commit ID**'.

(This is a **CHECKSUM** of the commits author, time, commit msg, commit content and previous commit ID).

**HEAD** is a reference (or '**pointer**') to the currently checked out commit (typically the most recent commit).

# Projects can have complicated graphs due to **branching**



## Key Points:

You explicitly and iteratively tell git what files to track (“**git add**”) and snapshot (“**git commit**”).

Git keeps an historical log “(**git log**)” of the content changes (and your comments on these changes) at each past commit.

It is good practice to regularly check the status of your working directory, staging arena repo (“**git status**”)

# Break

# Summary of key Git commands:

```
> git status      # Get a status report of changes since last commit
```

```
> git add <filename>      # Tell Git which files to track/stage
```

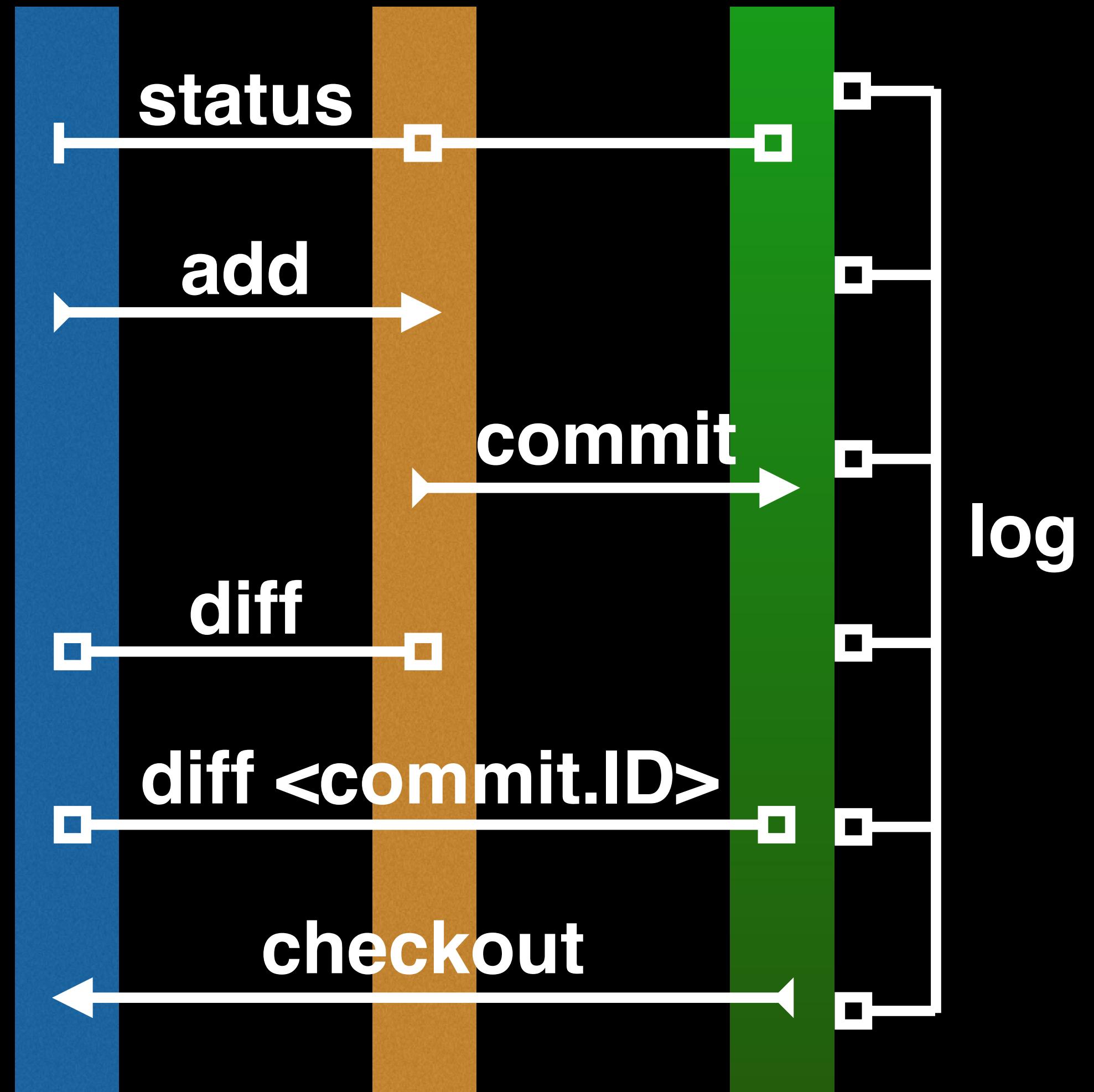
```
> git commit -m 'Your message'    # Take a content snapshot!
```

```
> git log          # Review your commit history
```

```
> git diff <commit.ID> <commit.ID> # Inspect content differences
```

```
> git checkout <commit.ID> # Navigate through the commit history
```

Your 'Staging Local  
Directory Area' Repository



# git diff: Show changes between commits

```
> git diff 8676 7b67
```

```
# diff --git a/README b/README
# index 73bc85a..67bd82c 100644
# --- a/README
# +++ b/README
# @@ -1 +1,2 @@
# This is a first line of text.
# +This is a 2nd line of text.

# diff --git a/ToDo b/ToDo
# new file mode 100644
# index 0000000..14fb56
# --- /dev/null
# +++ b/ToDo
# @@ -0,0 +1 @@
# +Learn git basics
```



# git diff: Show changes between commits

```
> git diff 7b67 8676
```

```
# diff --git a/README b/README
# index 67bd82c..73bc85a 100644
# --- a/README
# +++ b/README
# @@ -1,2 +1 @@
# This is a first line of text.
# -This is a 2nd line of text.

# diff --git a/ToDo b/ToDo
# deleted file mode 100644
# index 14fb5d6..0000000
# --- a/ToDo
# +++ /dev/null
# @@ 1 +0,0 @@
# -Learn git basics
```



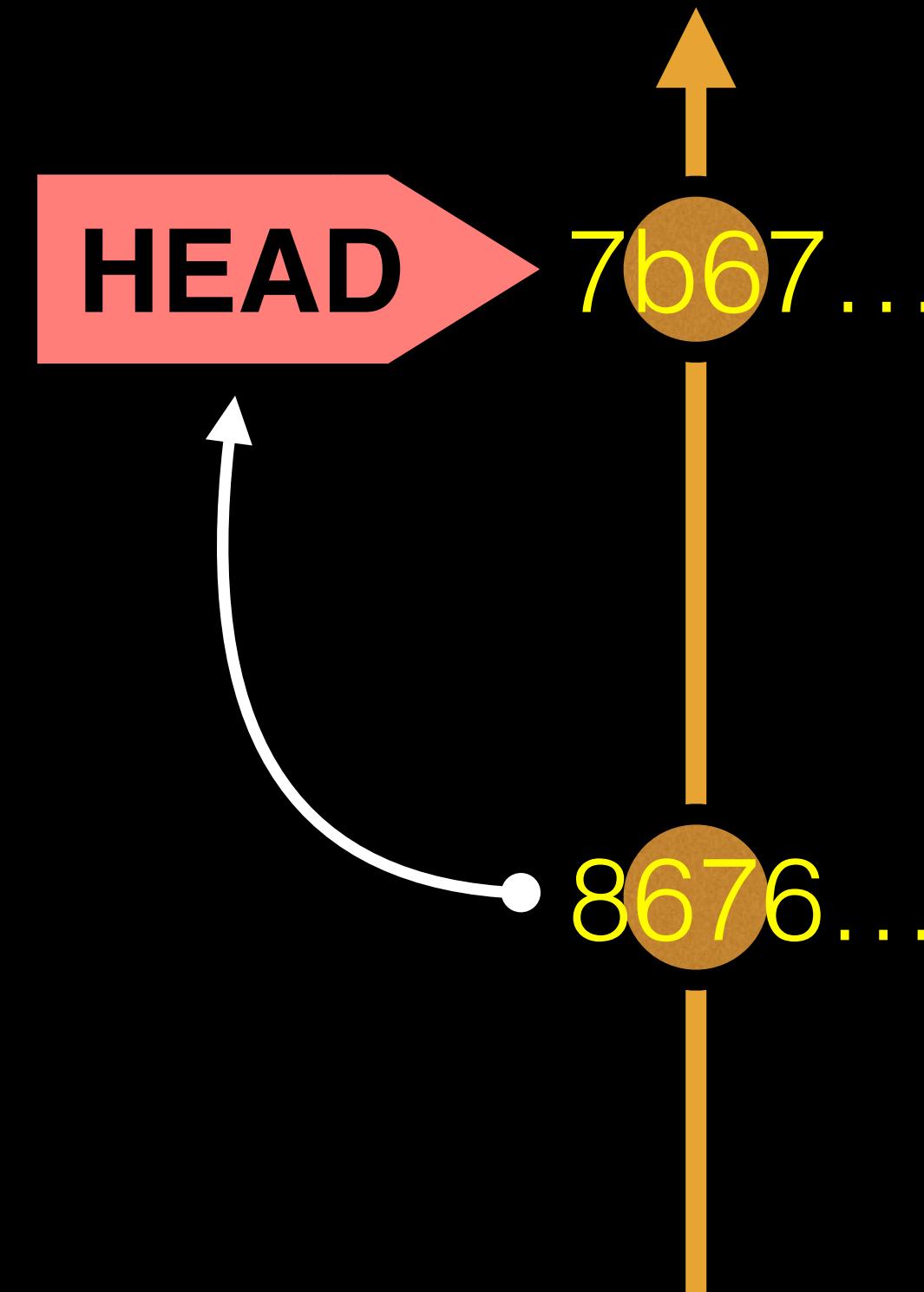
# git diff: Show changes between commits

```
> git diff 8676
```

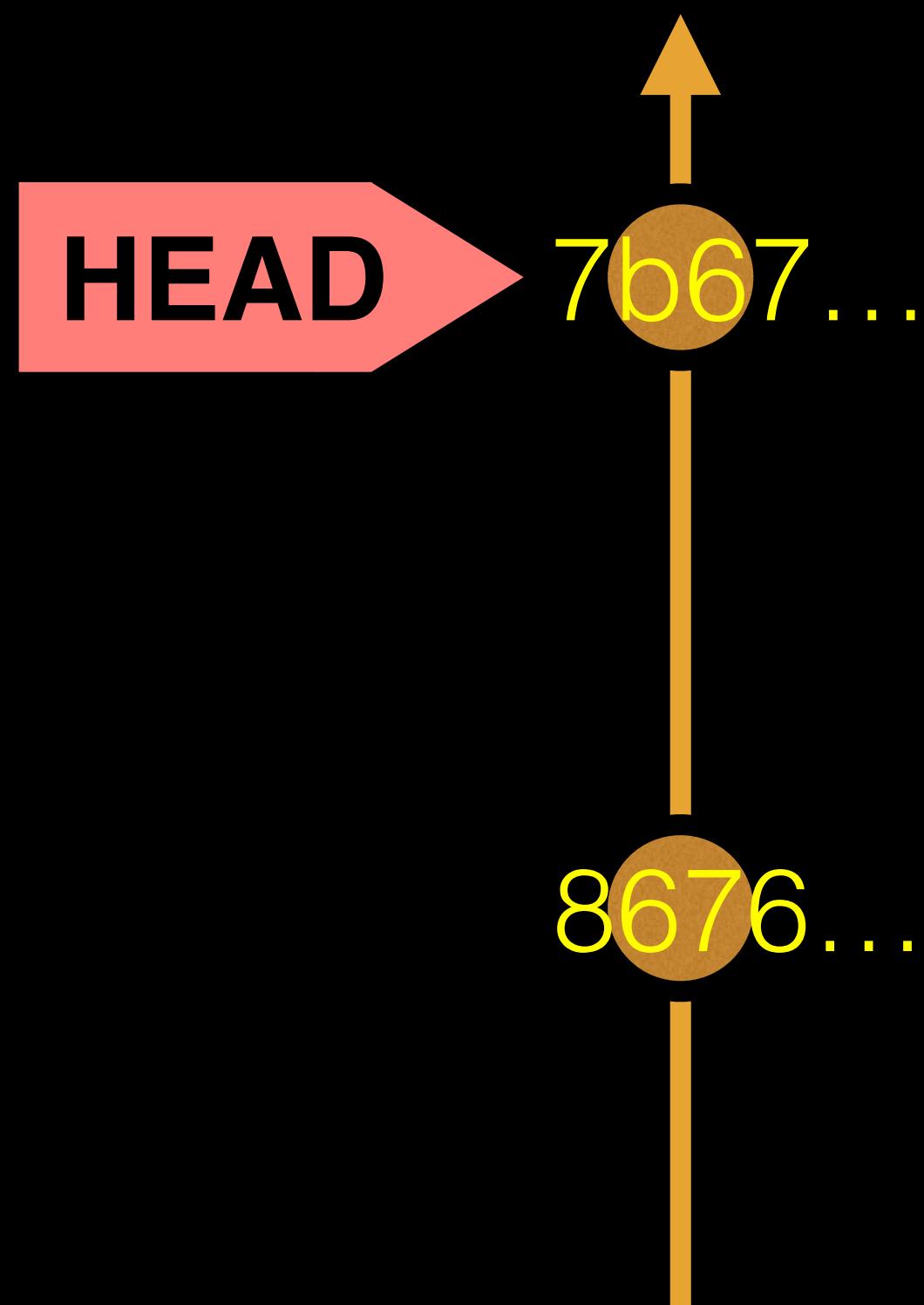
## Difference to current HEAD position!

```
# diff --git a/README b/README
# index 73bc85a..67bd82c 100644
# --- a/README
# +++ b/README
# @@ -1 +1,2 @@
# This is a first line of text.
# +This is a 2nd line of text.

# diff --git a/ToDo b/ToDo
# new file mode 100644
# index 0000000..14fb56
# --- /dev/null
# +++ b/ToDo
# @@ -0,0 +1 @@
# +Learn git basics
```



# **HEAD** advances automatically with each new commit



To move **HEAD** (back or forward) on the Git graph (and retrieve the associated snapshot content) we can use the command:

> `git checkout <commit.ID>`

# git checkout: Moves HEAD

> **more README**

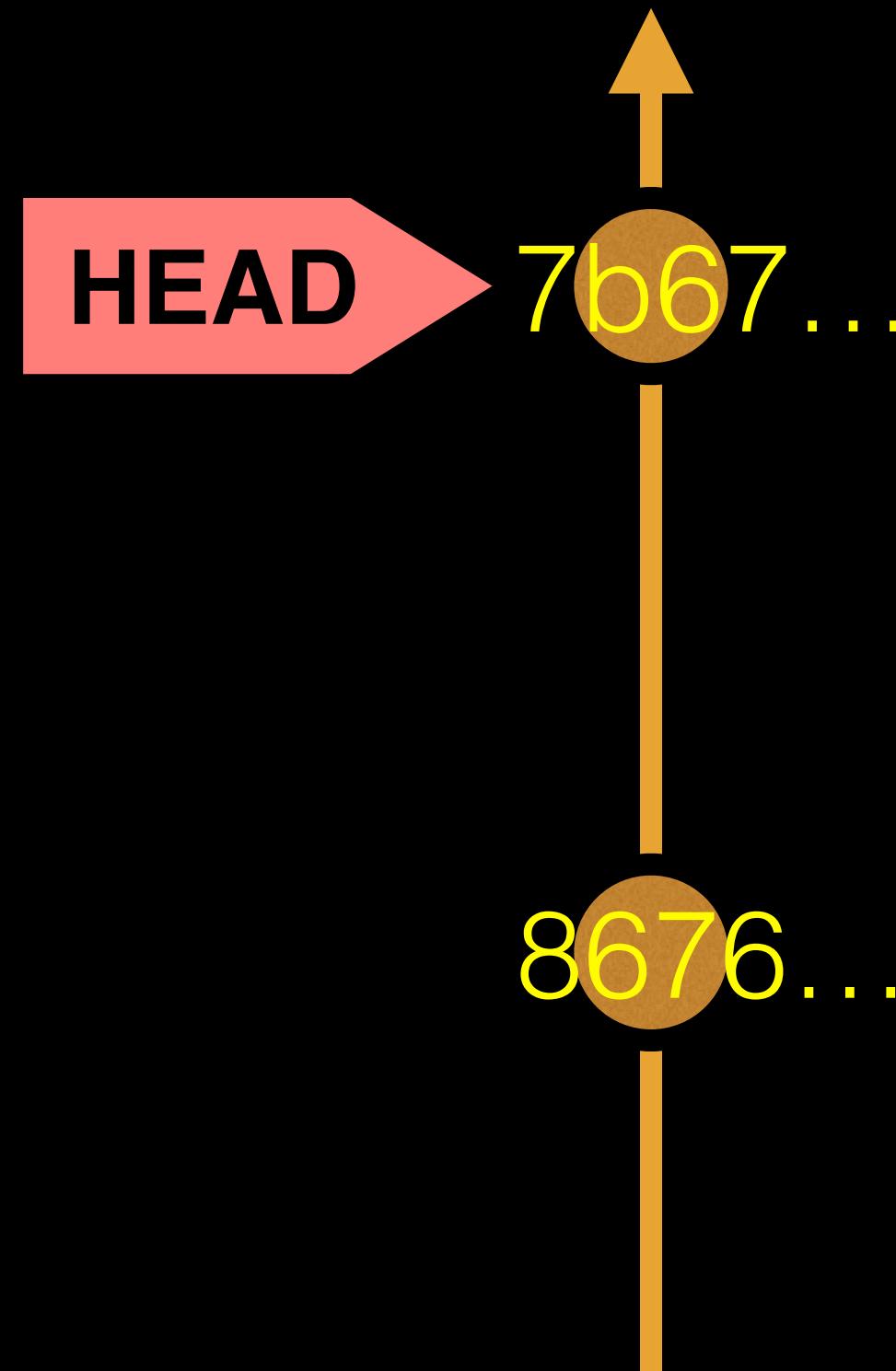
This is a first line of text.

This is a 2nd line of text.

> **git log --oneline**

# 7b679fa Add ToDo and finished README

# 8676840 Create a README file



# git checkout: Moves HEAD (e.g. back in time)

> **more README**

This is a first line of text.

This is a 2nd line of text.

> **git log --oneline**

# 7b679fa Add ToDo and finished README

# 8676840 Create a README file

> **git checkout 8676840**

# You are in 'detached HEAD' state...<cut>...

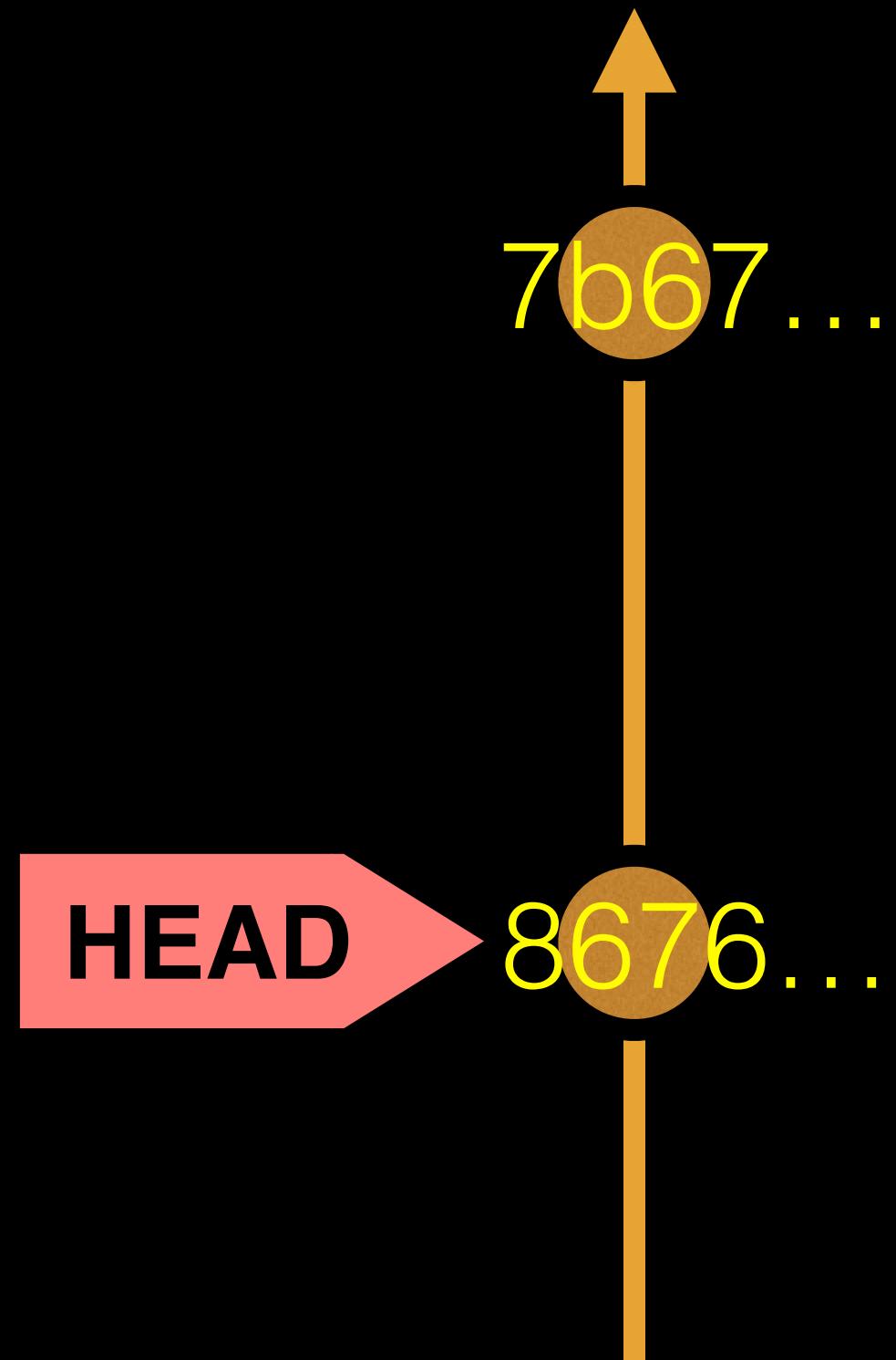
# HEAD is now at 8676840... Create a README file

> **more README**

This is a first line of text.

> **git log --oneline**

# 8676840 Create a README file



# git checkout: Moves HEAD (e.g. back to the future!)

> **git checkout master**

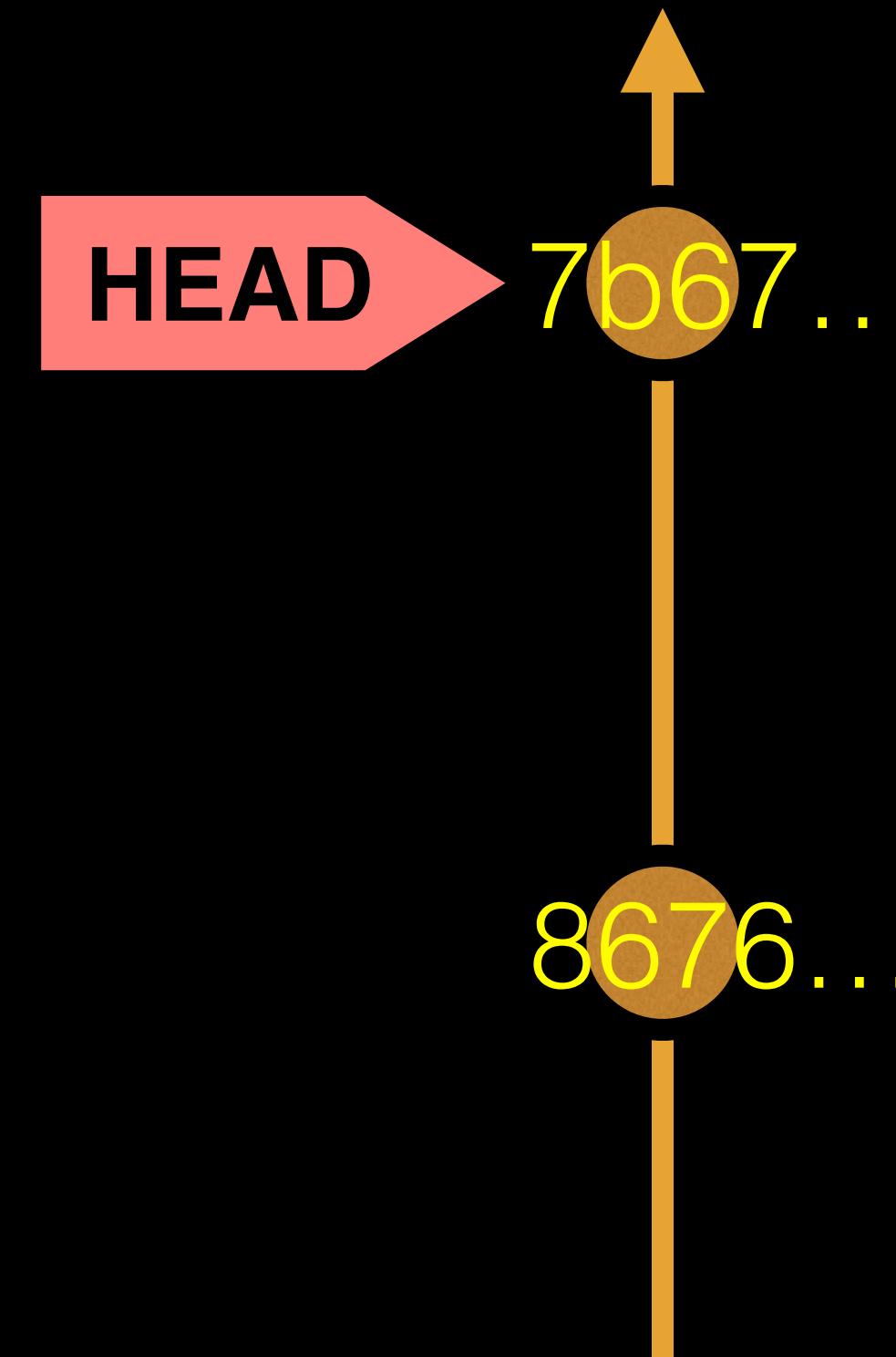
```
# Previous HEAD position was 8676840... Create a README file
# Switched to branch 'master'
```

> **git log --oneline**

```
# 7b679fa Add ToDo and finished README
# 8676840 Create a README file
```

> **more README**

```
This is a first line of text.
This is a 2nd line of text.
```



# Side-Note: There are two\* main ways to use **git checkout**

- Checking out a **commit** makes the entire working directory match that commit. This can be used to view an old state of your project.

> `git checkout <commit.ID>`

- Checking out a **specific file** lets you see an old version of that particular file, leaving the rest of your working directory untouched.

> `git checkout <commit.ID> <filename>`

# You can discard revisions with **git revert**

- The **git revert** command undoes a committed snapshot.
- But, instead of removing the commit from the project history, it figures out how to **undo the changes** introduced by the commit and **appends a new commit** with the resulting content.

> `git revert <commit.ID>`

- This prevents Git from losing history!

# Removing untracked files with **git clean**

- The **git clean** command removes untracked files from your working directory.
- Like an ordinary **rm** command, **git clean** is not undoable, so make sure you really want to delete the untracked files before you run it.

> `git clean -n # dry run display of files to be 'cleaned'`

> `git clean -f # remove untracked files`

# GUIs

**Tower** (Mac only)

**GitHub\_Desktop** (Mac, Windows)

**SourceTree** (Mac, Windows)

**SmartGit** (Linux)

**RStudio**

<https://git-scm.com/downloads/guis>