



BGGN 213

Find a Gene Assignment

Lecture 10

Barry Grant

UC San Diego

<http://thegrantlab.org/bggn213>

Find-a-Gene Project Assignment

- A total of 20% of the course grade will be assigned based on the [“find-a-gene project assignment”](#)
- The objective with this assignment is for you to demonstrate your grasp of database searching, sequence analysis, structure analysis and the R environment that we have covered to date in class.
- You may wish to consult the scoring rubric (in the linked project description) and the [example report](#) for format and content guidance.
 - ➔ Your responses to questions **Q1-Q4** are due at the beginning of class Friday **May 17th** (05/17/19).
 - ➔ The complete assignment, including responses to **all questions**, is due at the beginning of class Wed **June 5th** (06/06/19).

Questions:

[Q1] Tell me the name of a protein you are interested in. Include the species and the accession number. This can be a human protein or a protein from any other species as long as its function is known.

If you do not have a favorite protein, select human RBP4 or KIF11. Do not use beta globin as this is in the worked example report that I provide you with online.

[Q2] Perform a BLAST search against a DNA database, such as a database consisting of genomic DNA or ESTs. The BLAST server can be at NCBI or elsewhere. Include details of the BLAST method used, database searched and any limits applied (e.g. Organism).

Also include the output of that BLAST search in your document. If appropriate, change the font to Courier size 10 so that the results are displayed neatly. You can also screen capture a BLAST output (e.g. alt print screen on a PC or on a MAC press ⌘-shift-4. The pointer becomes a bulls eye. Select the area you wish to capture and release. The image is saved as a file called Screen Shot [] .png in your Desktop directory). It is **not** necessary to print out all of the blast results if there are many pages.

On the BLAST results, clearly indicate a match that represents a protein sequence, encoded from some DNA sequence, that is homologous to your query protein. I need to be able to inspect the pairwise alignment you have selected, including the E value and score. It should be labeled a "genomic clone" or "mRNA sequence", etc. - but include no functional annotation.

In general, [Q2] is the most difficult for students because it requires you to have a "feel" for how to interpret BLAST results. You need to distinguish between a perfect match to your query (i.e. a sequence that is not "novel"), a near match (something that might be "novel", depending on the results of [Q4]), and a non-homologous result.

If you are having trouble finding a novel gene try restricting your search to an organism that is poorly annotated.

[Q3] Gather information about this "novel" **protein**. At a minimum, show me the protein sequence of the "novel" protein as displayed in your BLAST results from [Q2] as FASTA format (you can copy and paste the aligned sequence subject lines from your BLAST result page if necessary) or translate your novel DNA sequence using a tool called EMBOSS Transeq at the EBI. Don't forget to translate all six reading frames; the ORF (open reading frame) is likely to be the longest sequence without a stop codon. It may not start with a methionine if you don't have the complete coding region. Make sure the sequence you provide includes a header/subject line and is in traditional FASTA format.

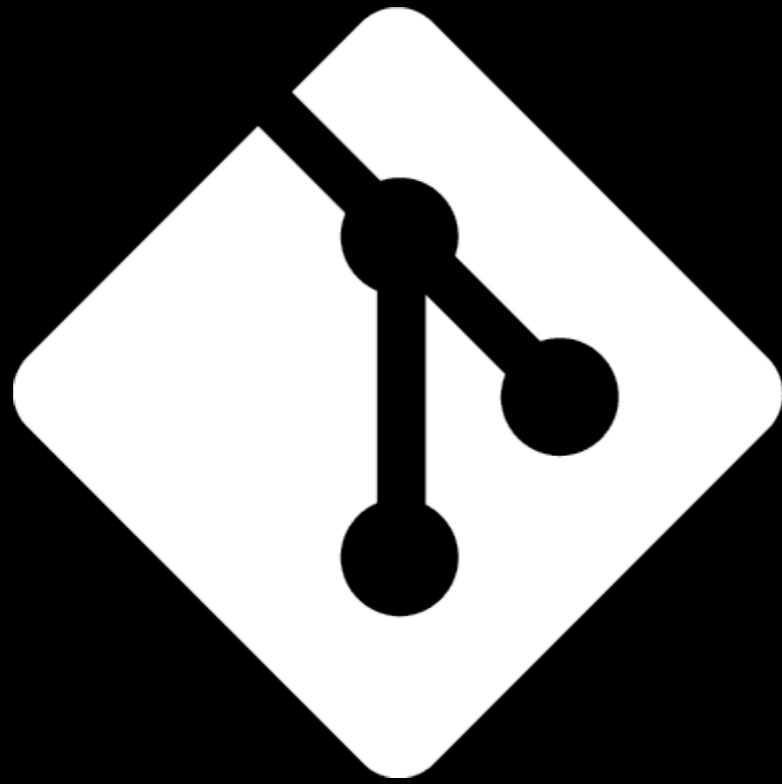
Here, tell me the name of the novel protein, and the species from which it derives. It is very unlikely (but still definitely possible) that you will find a novel gene from an organism such as *S. cerevisiae*, human or mouse, because those genomes have already been thoroughly annotated. It is more likely that you will discover a new gene in a genome that is currently being sequenced, such as bacteria or plants or protozoa.

[Q4] Prove that this gene, and its corresponding protein, are novel. For the purposes of this project, "novel" is defined as follows. Take the protein sequence (your answer to [Q3]), and use it as a query in a blastp search of the nr database at NCBI.

- If there is a match with 100% amino acid identity to a protein in the database, from the same species, then your protein is NOT novel (even if the match is to a protein with a name such as "unknown"). Someone has already found and annotated this sequence, and assigned it an accession number.
- If the top match reported has less than 100% identity, then it is likely that your protein is novel, and you have succeeded.
- If there is a match with 100% identity, but to a different species than the one you started with, then you have likely succeeded in finding a novel gene.
- If there are no database matches to the original query from [Q1], this indicates that you have partially succeeded: yes, you may have found a new gene, but no, it is not actually homologous to the original query. You should probably start over.

[Q5] Generate a multiple sequence alignment with your novel protein, your original query protein, and a group of other members of this family from different species. A typical number of proteins to use in a multiple sequence alignment for this assignment purpose is a minimum of 5 and a maximum of 20 - although the exact number is up to you. Include the multiple sequence alignment in your report. Use Courier font with a size appropriate to fit page width.

Side-note: Indicate your sequence in the alignment by choosing an appropriate name for each sequence in the input unaligned sequence file (i.e. edit the sequence file so that the species, or short common, names (rather than accession numbers) display in the output alignment and in the subsequent answers below). The goal in this step is to create an interesting alignment for building a phylogenetic tree that illustrates species divergence.



git

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

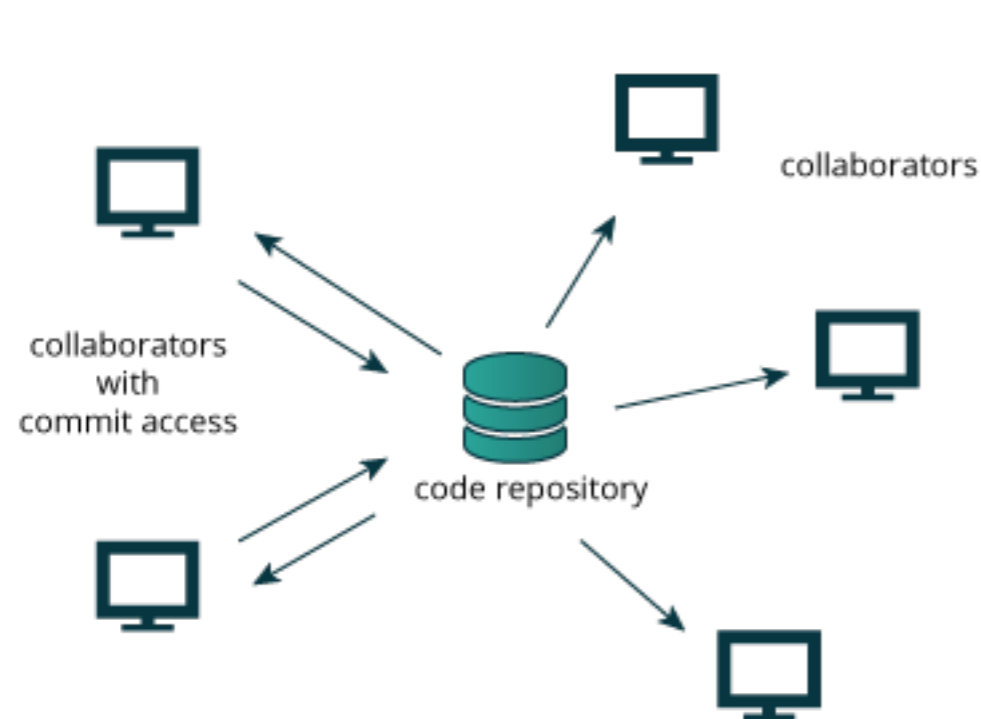
Version control systems (VCS) record changes to a file or set of files over time so that you can recall specific versions later.

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

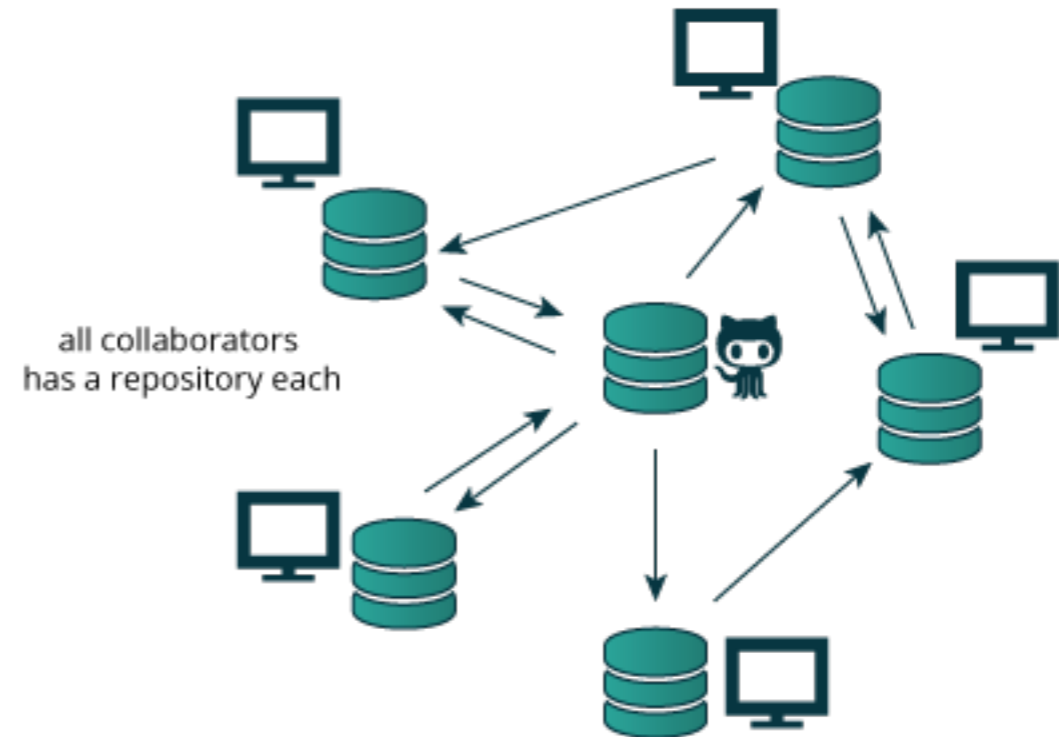
There are many VCS available, see:

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.

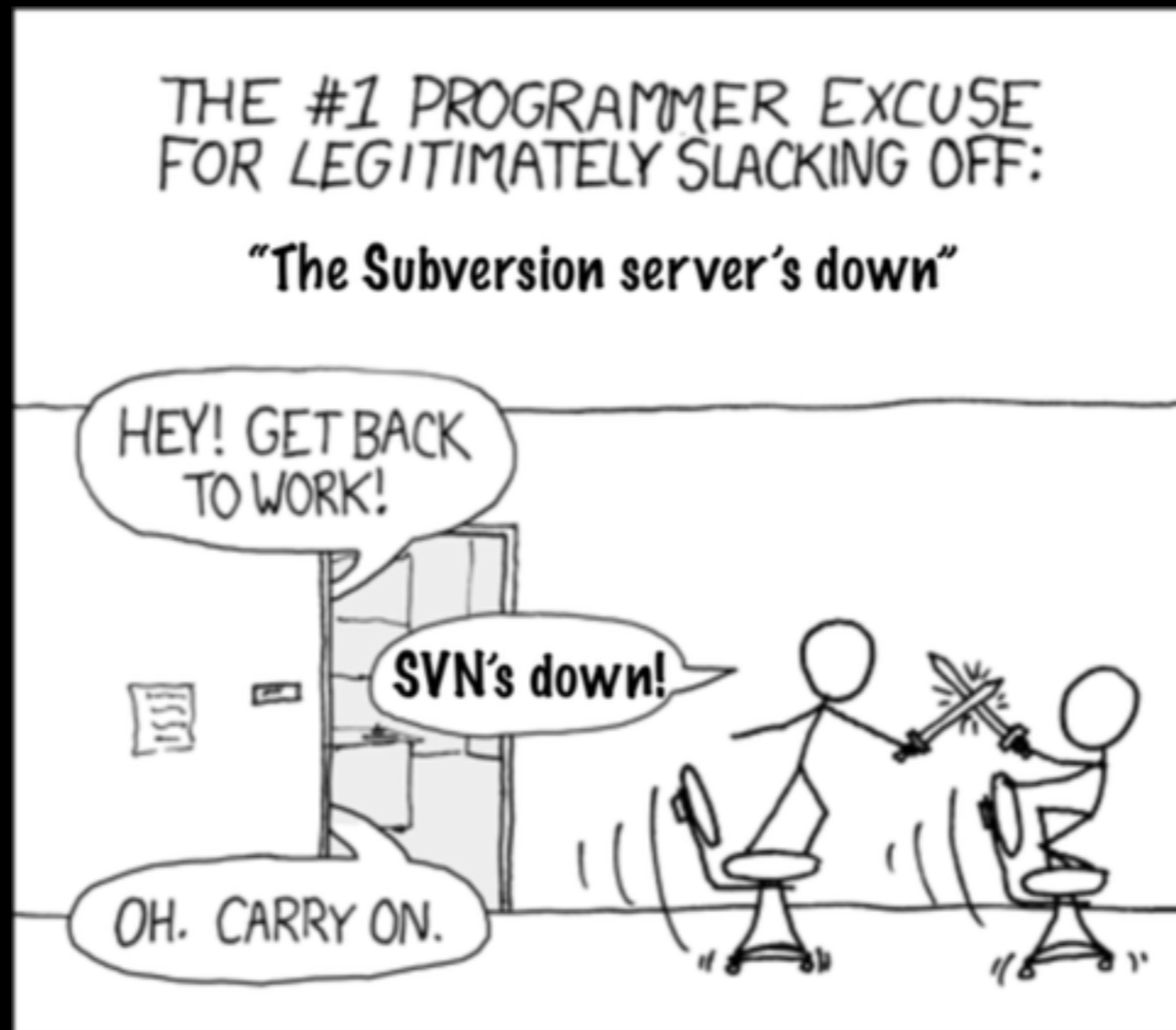
THE #1 PROGRAMMER EXCUSE
FOR LEGITIMATELY SLACKING OFF:

"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>

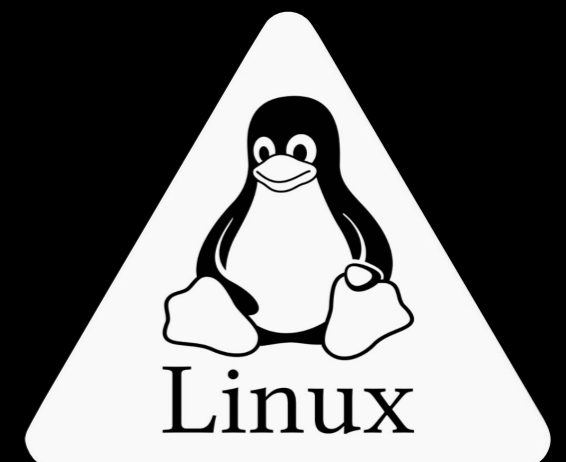
Where did Git come from?

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

① **which git**

② **git --version**

Obtaining Git

Do it Yourself!

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

Follow the GitBash instructions here:

https://bioboot.github.io/bgggn213_S19/setup/

Mac & Linux

Download git directly from here:

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

Configuring Git

Do it Yourself!

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"

Using Git

Using Git

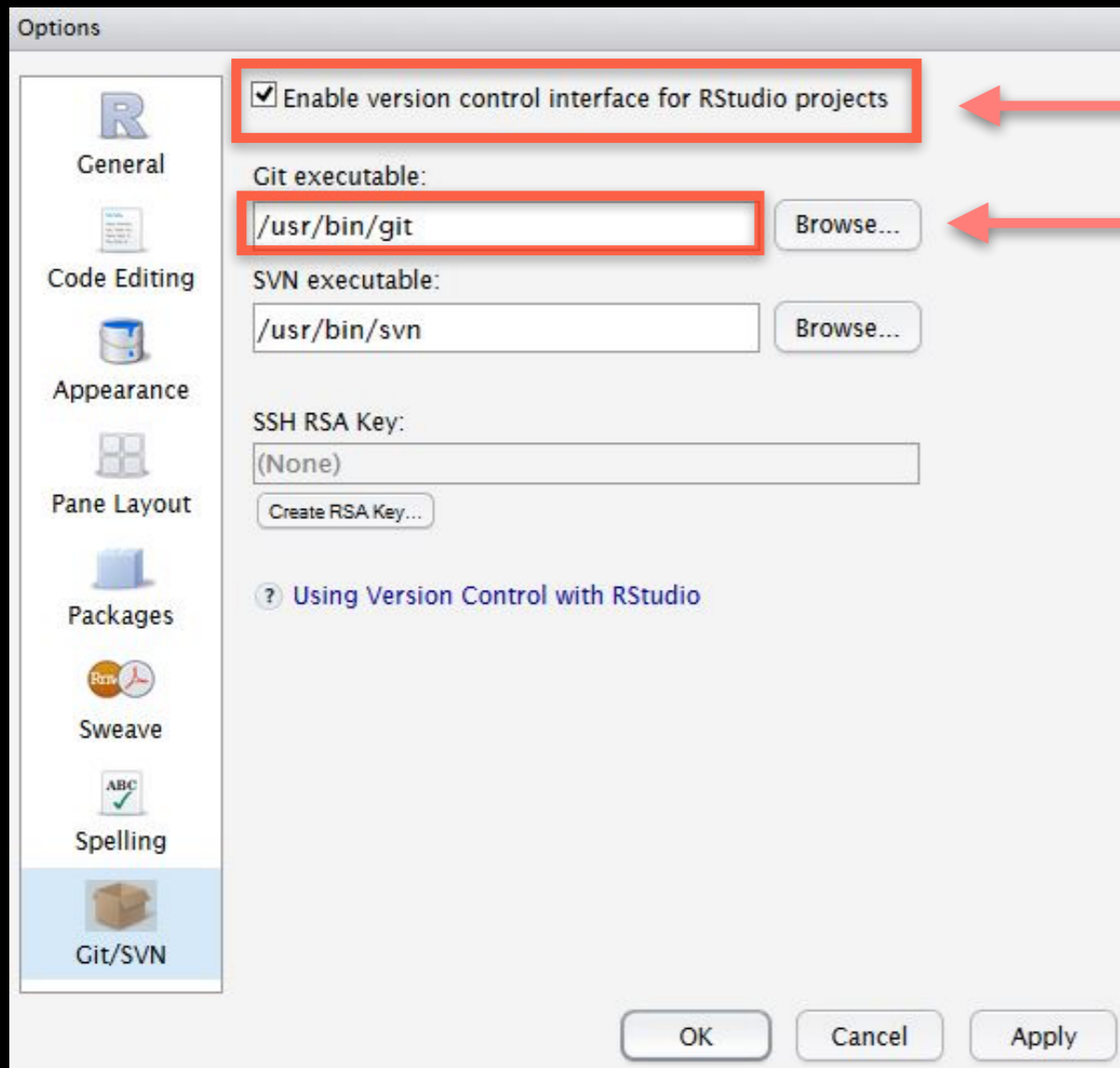
1. Initiate a Git repository.
2. Edit content (i.e. change some files).
3. Store a 'snapshot' of the current file state.*

For Mac & Linux

(PC on next slide)

Do it Yourself!

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



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

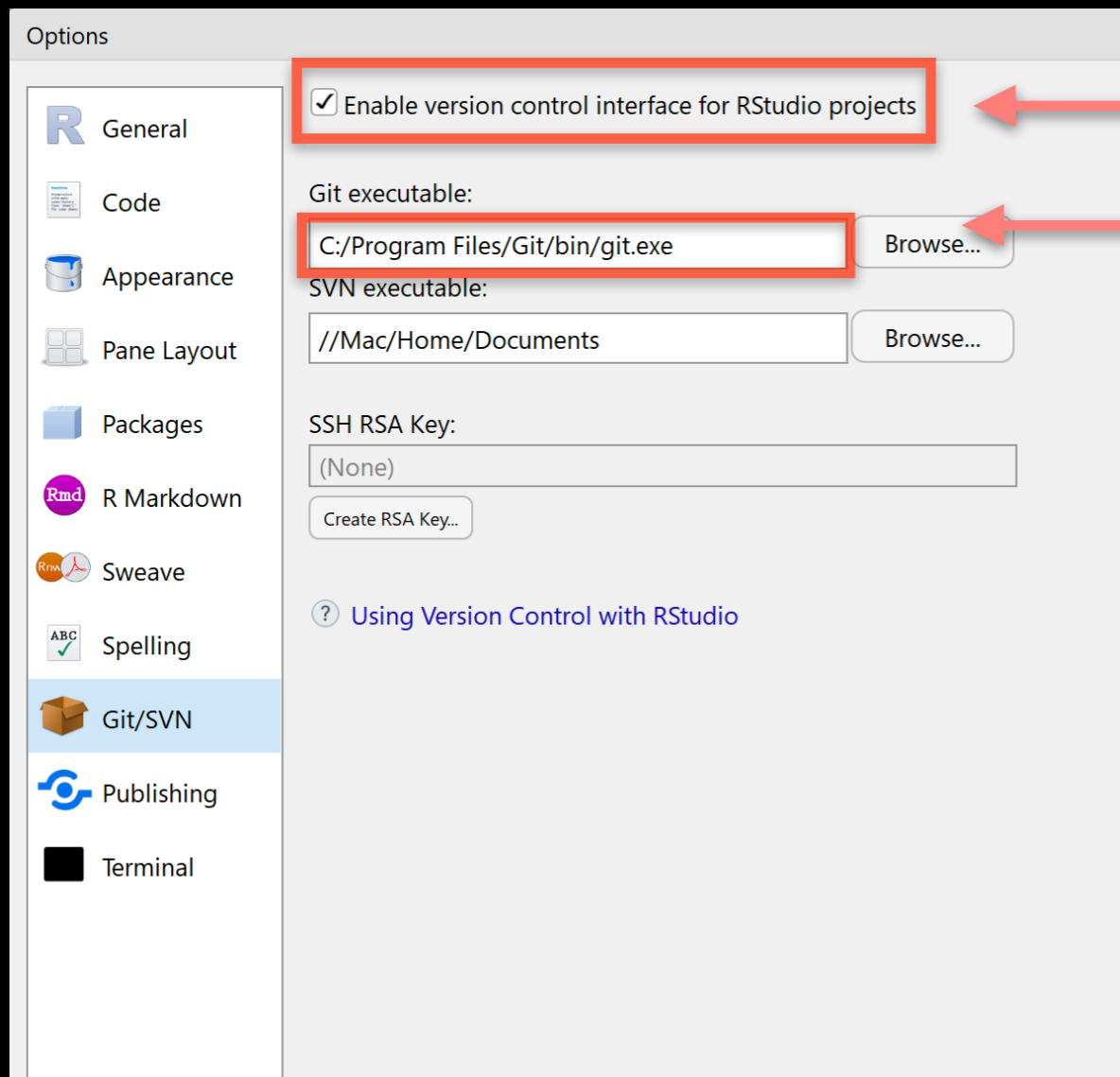
Check in your RStudio "Terminal" tab:

```
blitz:another> which git
/usr/local/bin/git
blitz:another>
```

On a PC!

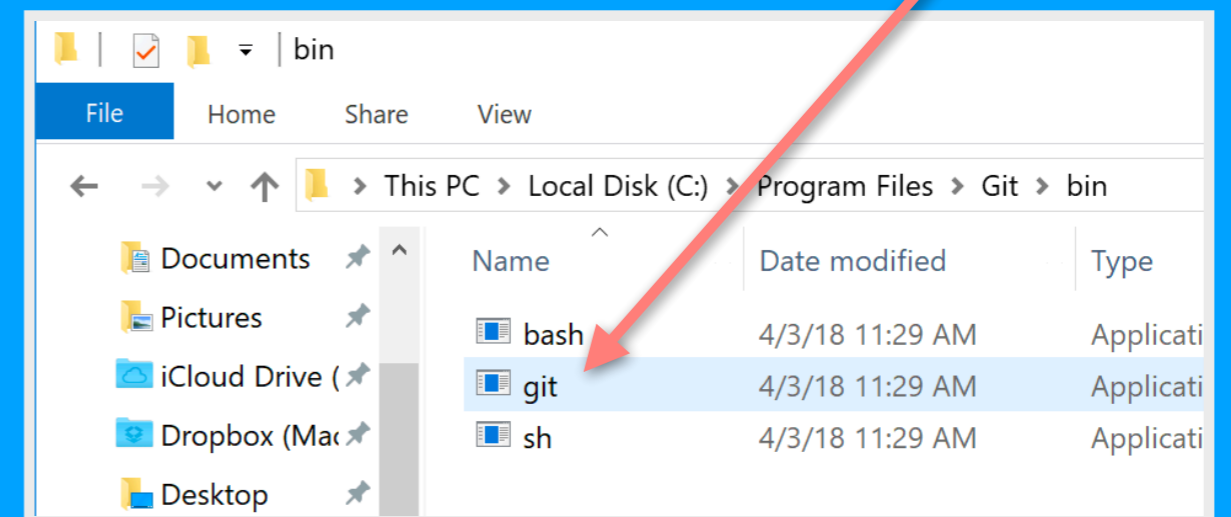
Do it Yourself!

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



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

Check in your Windows File Explorer:

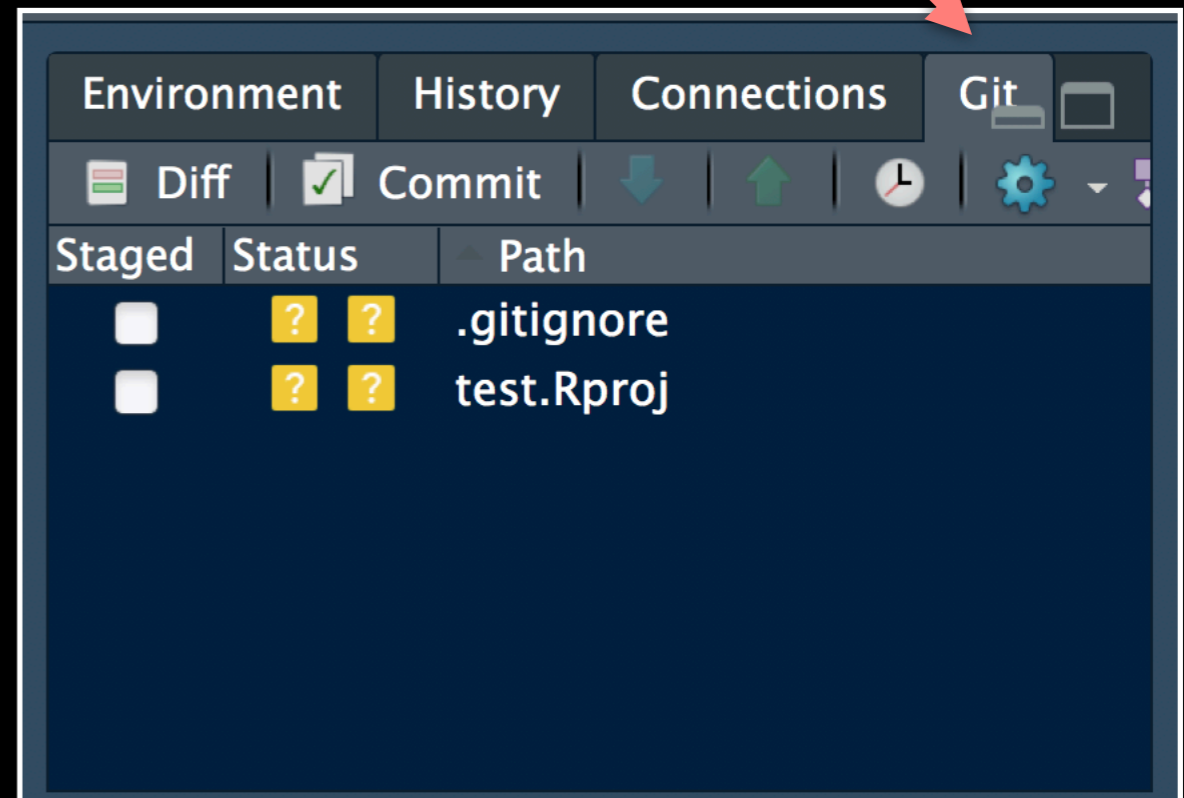
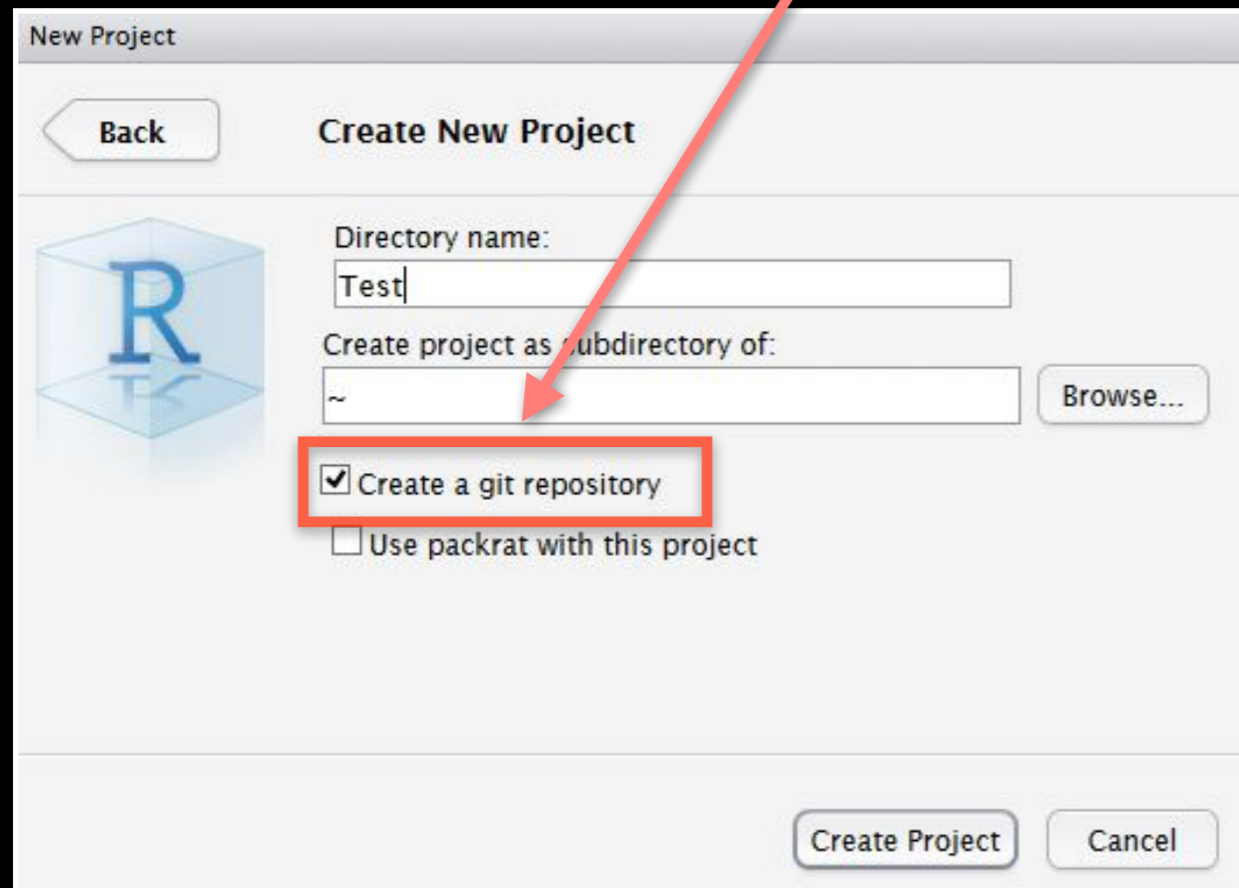


Create a new RStudio project

Do it Yourself!

1 New option to create a Git repository...

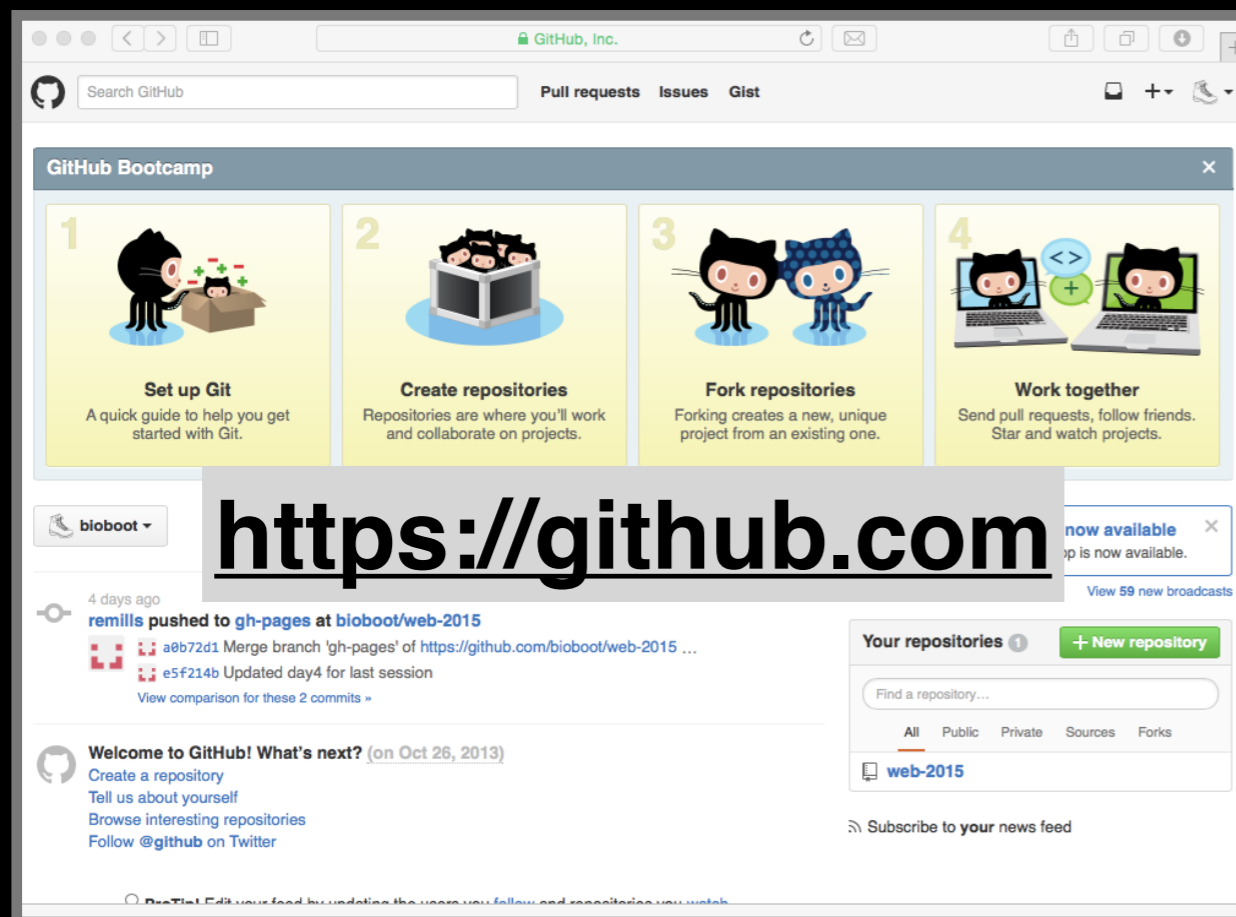
2 New Git tab...



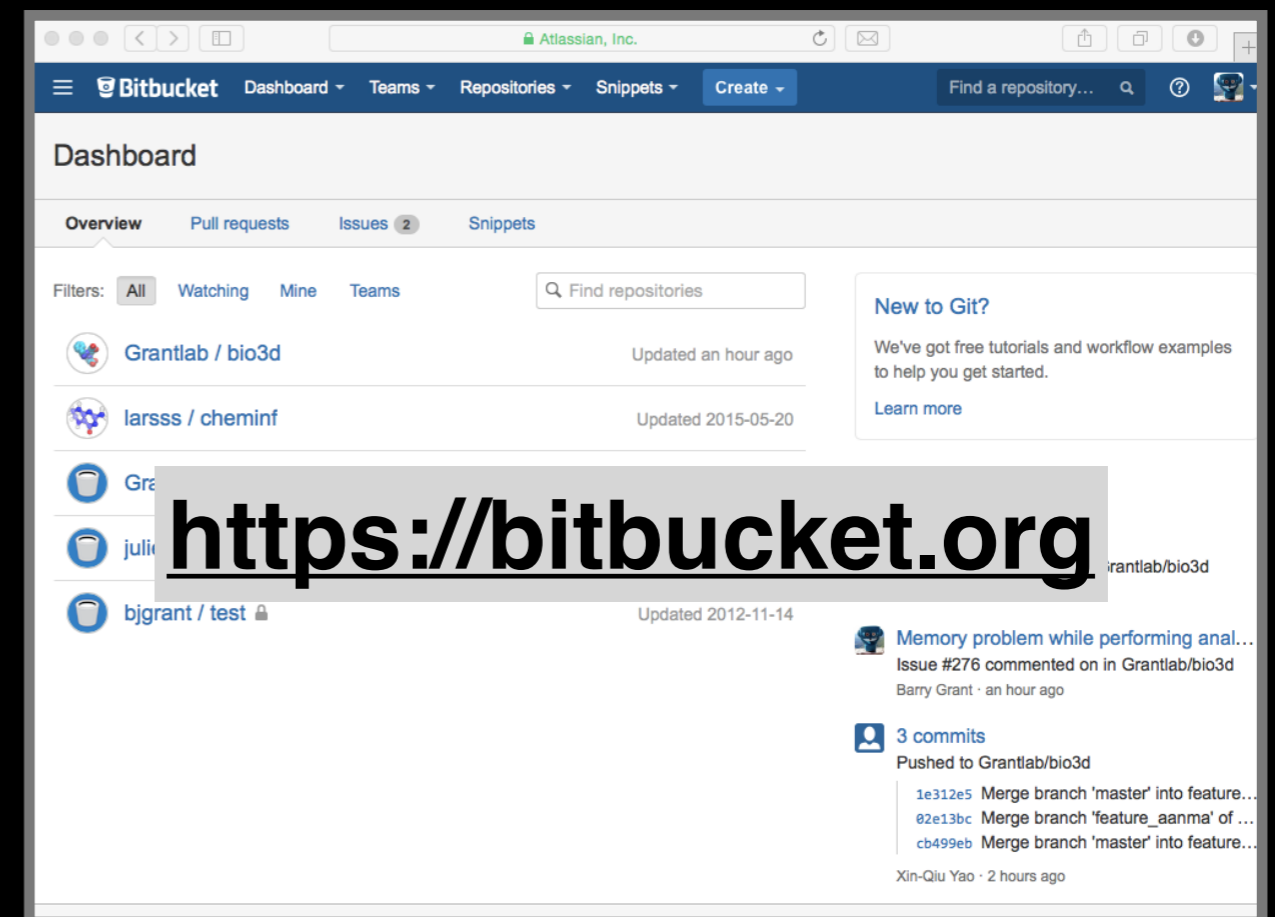
Check if new Git options appear in RStudio?

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*.



The screenshot shows the GitHub homepage. At the top, there is a search bar and navigation links for Pull requests, Issues, and Gist. Below this is the 'GitHub Bootcamp' section with four numbered steps: 1. Set up Git, 2. Create repositories, 3. Fork repositories, and 4. Work together. A large URL <https://github.com> is overlaid in the center. The bottom section features a 'Your repositories' widget showing a repository named 'web-2015' and a 'Welcome to GitHub!' message.



The screenshot shows the Bitbucket dashboard. At the top, there is a navigation bar with links for Dashboard, Teams, Repositories, Snippets, and Create. Below this is the 'Dashboard' section with tabs for Overview, Pull requests, Issues (2), and Snippets. A list of repositories is shown, including 'Grantlab / bio3d' and 'larsss / cheminf'. A large URL <https://bitbucket.org> is overlaid in the center. The bottom right section shows a commit history for the 'Grantlab/bio3d' repository.

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

THE WALL STREET JOURNAL.

Subscribe Now | Sign In
\$12 FOR 12 WEEKS

Home World U.S. Politics Economy Business **Tech** Markets Opinion Arts Life Real Estate



Workers Get New Tools for Airing Their Gripes



Cell Carriers Battle for Wi-Fi Airwaves



Snapchat Names ex-Mattel Exec Voller to Its Finance Chief



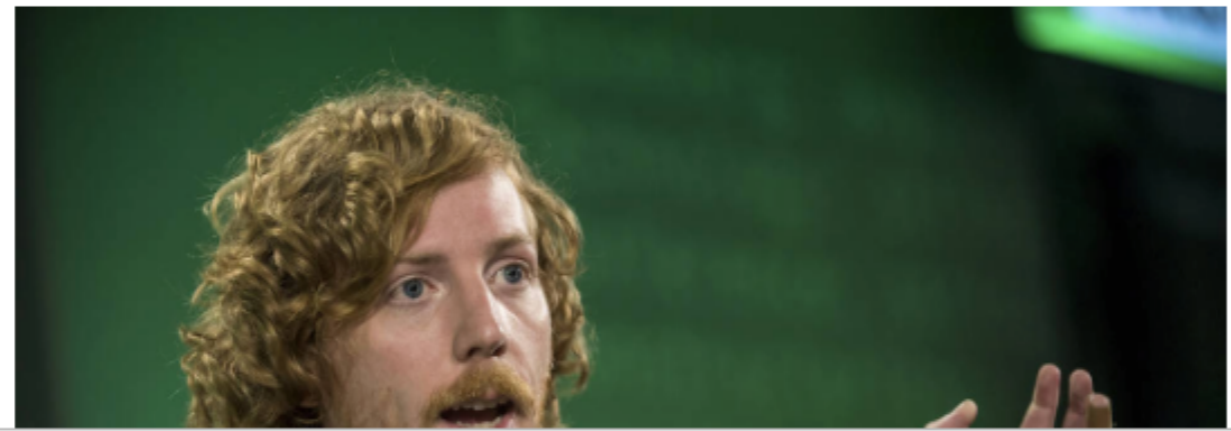
YOU ARE READING A PREVIEW OF A PAID ARTICLE. [SUBSCRIBE NOW](#) TO GET MORE GREAT CONTENT.

- 3234
- 433
-
-
-
-
-

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](#)



Sign in

- News
- Sport
- Weather
- Shop
- Reel
- Travel
- More

Search

NEWS

- Home
- Video
- World
- US & Canada
- UK
- Business
- Tech
- Science
- Stories
- Entertainment & Arts
- Health

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



Dave Lee
North America technology reporter

4 June 2018

Share



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?

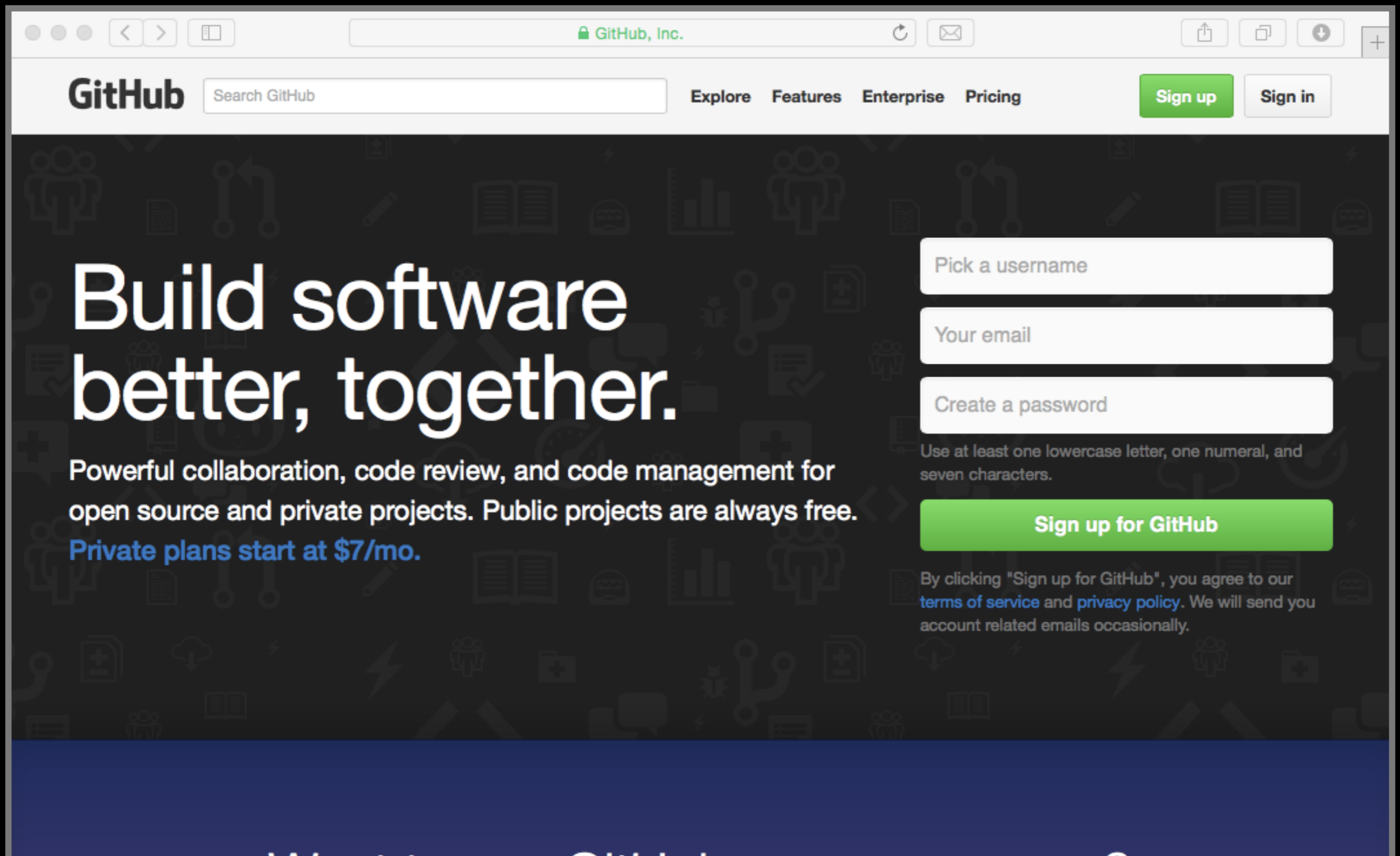
30 October 2018

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>

A screenshot of the GitHub website's sign-up page. The browser's address bar shows "GitHub, Inc." and the URL "https://github.com". The page features a navigation bar with the GitHub logo, a search bar, and links for "Explore", "Features", "Enterprise", and "Pricing". On the right side of the navigation bar are "Sign up" and "Sign in" buttons. The main content area has a dark background with a pattern of small icons. On the left, the text reads "Build software better, together." followed by "Powerful collaboration, code review, and code management for open source and private projects. Public projects are always free. Private plans start at \$7/mo." On the right, there is a sign-up form with three input fields: "Pick a username", "Your email", and "Create a password". Below the password field is a note: "Use at least one lowercase letter, one numeral, and seven characters." At the bottom of the form is a green "Sign up for GitHub" button. Below the button is a disclaimer: "By clicking 'Sign up for GitHub', you agree to our terms of service and privacy policy. We will send you account related emails occasionally." The footer of the page is a solid blue bar with the GitHub logo and the text "© 2015 GitHub, Inc." partially visible.

Pick the **FREE** plan!

The screenshot shows the GitHub account setup page. At the top, there's a navigation bar with the GitHub logo, a search bar, and links for 'Pull requests', 'Issues', and 'Gist'. Below this, a large heading says 'Welcome to GitHub' followed by a personalized message: 'You've taken your first step into a larger world, @biobootStudent.' A progress bar indicates three steps: 'Step 1: Completed Set up a personal account', 'Step 2: Choose your plan', and 'Step 3: Go to your dashboard'. The main content area is titled 'Choose your personal plan' and features a table of plans. The 'Free' plan is highlighted in blue and its 'Chosen' button is circled in red. To the right of the table, a box titled 'Each plan includes:' lists benefits such as 'Unlimited collaborators', 'Unlimited public repositories', 'Free setup', 'HTTPS Protection', 'Email support', and 'Wikis, Issues, Pages, & more'. At the bottom, a disclaimer states that charges are in US Dollars and prices are estimates based on current exchange rates.

Plan	Cost	Private repositories	
Large	\$50/month	50	<input type="button" value="Choose"/>
Medium	\$22/month	20	<input type="button" value="Choose"/>
Small	\$12/month	10	<input type="button" value="Choose"/>
Micro	\$7/month	5	<input type="button" value="Choose"/>
Free	\$0/month	0	<input type="button" value="Chosen"/>

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 web browser window displaying the GitHub homepage for a user named 'biobootStudent'. The browser's address bar shows 'GitHub, Inc.'. The page header includes a search bar, navigation links for 'Pull requests', 'Issues', and 'Gist', and utility icons. The main content area is divided into two columns. The left column features a profile picture (a green and white grid), the username 'biobootStudent', and statistics: '0 Followers', '0 Starred', and '0 Following'. The right column contains a 'Pro tip' about updating a profile, navigation tabs for 'Contributions', 'Repositories', and 'Public activity', and a 'Contributions' section. The 'Contributions' section includes a calendar grid for months from Sep to Aug, with a legend for 'Less' and 'More' contributions. Below the grid, there is explanatory text about the contribution graph and a link to 'Read the Hello World guide'.

GitHub, Inc.

Search GitHub

Pull requests Issues Gist

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

Contributions Repositories Public activity

Contributions

Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug

M

W

F

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

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](#)

Skip the hello-world tutorial

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

The screenshot shows the GitHub homepage for the user 'biobootStudent'. At the top, there is a navigation bar with a search bar and links for 'Pull requests', 'Issues', and 'Gist'. A red circle highlights the '+ New repository' button in the top right corner. Below the navigation bar, a blue message box states 'Your email was verified.'. A large green call-to-action box in the center reads 'Learn Git and GitHub without any code!' and includes a 'Let's get started!' button. To the right, the 'Your repositories' section shows '0' repositories and a '+ New repository' button. Below this, a message says 'You don't have any repositories yet! Create your first repository or learn more about Git and GitHub.' A 'ProTip!' section at the bottom right suggests 'Feline cephalopod adhesives' for decorating portable computation devices. The bottom of the page includes a 'Subscribe to your news feed' link.

Name your repo

bggn213

Search GitHub Pull requests Issues Marketplace Explore

Create a new repository

A repository contains all the files for your project, including the revision history.

Owner: bioboot

Repository name: **bggn213** ✓

Great repository names are short and memorable. Need inspiration? How about [cuddly-invention](#).

Description (optional)

Public
Anyone can see this repository. You choose who can commit.

Private
You choose who can see and commit to this repository.

Add a README **Initialize this repository with a README**
This will let you immediately clone the repository to your computer. Skip this step if you're importing an existing repository.

Add .gitignore: **None** | Add a license: **None** ⓘ

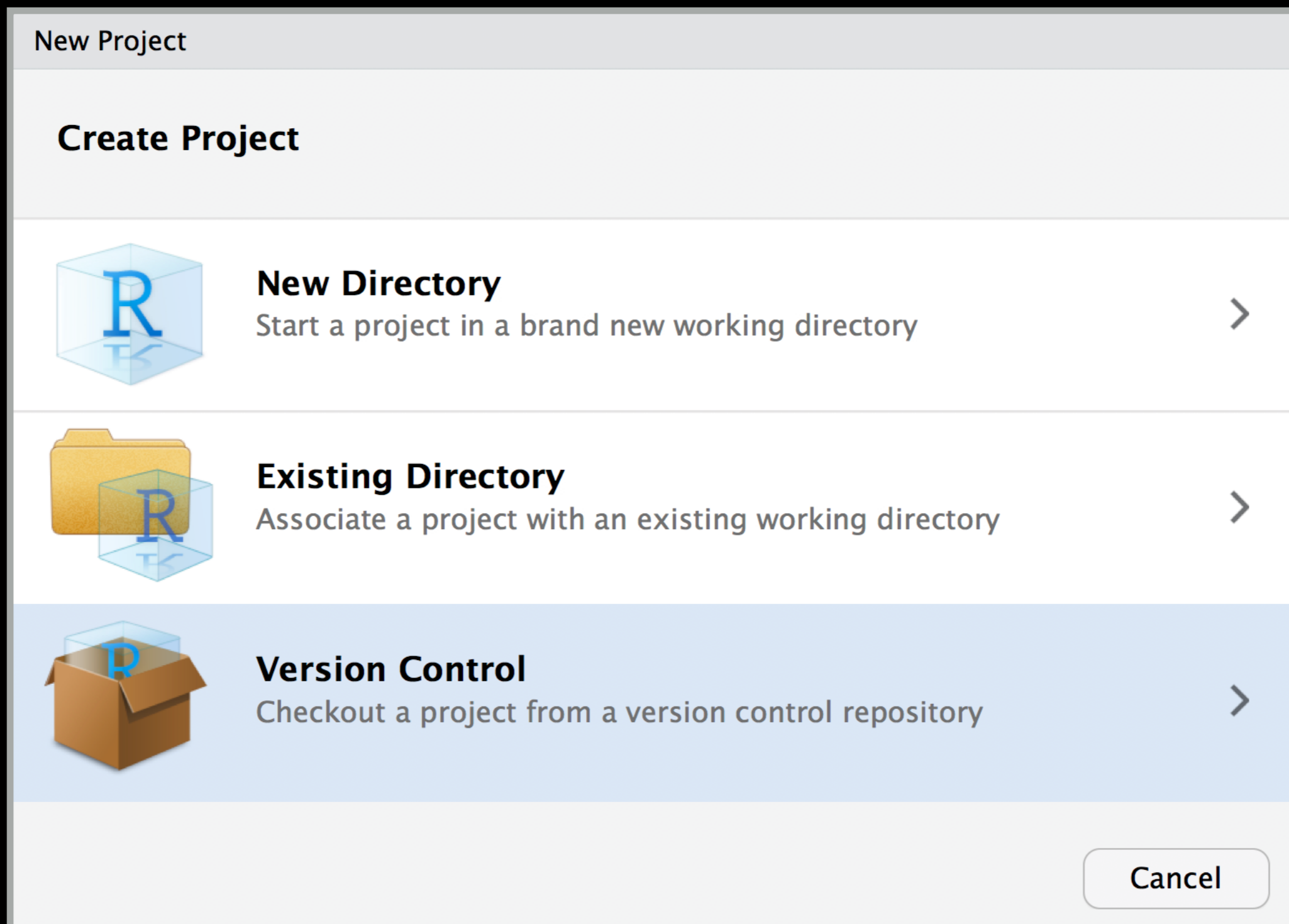
Create repository **Create**

Copy the “Clone” HTTPS link

This screenshot shows the GitHub interface for the repository `bioboot / bimm143`. The repository has 1 commit, 1 branch, 0 releases, and 1 contributor. The `Clone or download` button is highlighted in green. A dropdown menu is open, showing the `Clone with HTTPS` option, which is highlighted in red. The resulting URL `https://github.com/bioboot/bimm143.git` is also highlighted in red. The repository name `bimm143` is highlighted in red in the main content area.

GitHub repository page for `bioboot / bimm143`. The repository has 1 commit, 1 branch, 0 releases, and 1 contributor. The `Clone or download` button is highlighted in green. A dropdown menu is open, showing the `Clone with HTTPS` option, which is highlighted in red. The resulting URL `https://github.com/bioboot/bimm143.git` is also highlighted in red. The repository name `bimm143` is highlighted in red in the main content area.

RStudio > New Project > **Version Control**





RStudio > New Project > Version Control

New Project

[Back](#)

Clone Git Repository



Repository URL:

Project directory name:

Create project as subdirectory of:
 [Browse...](#)

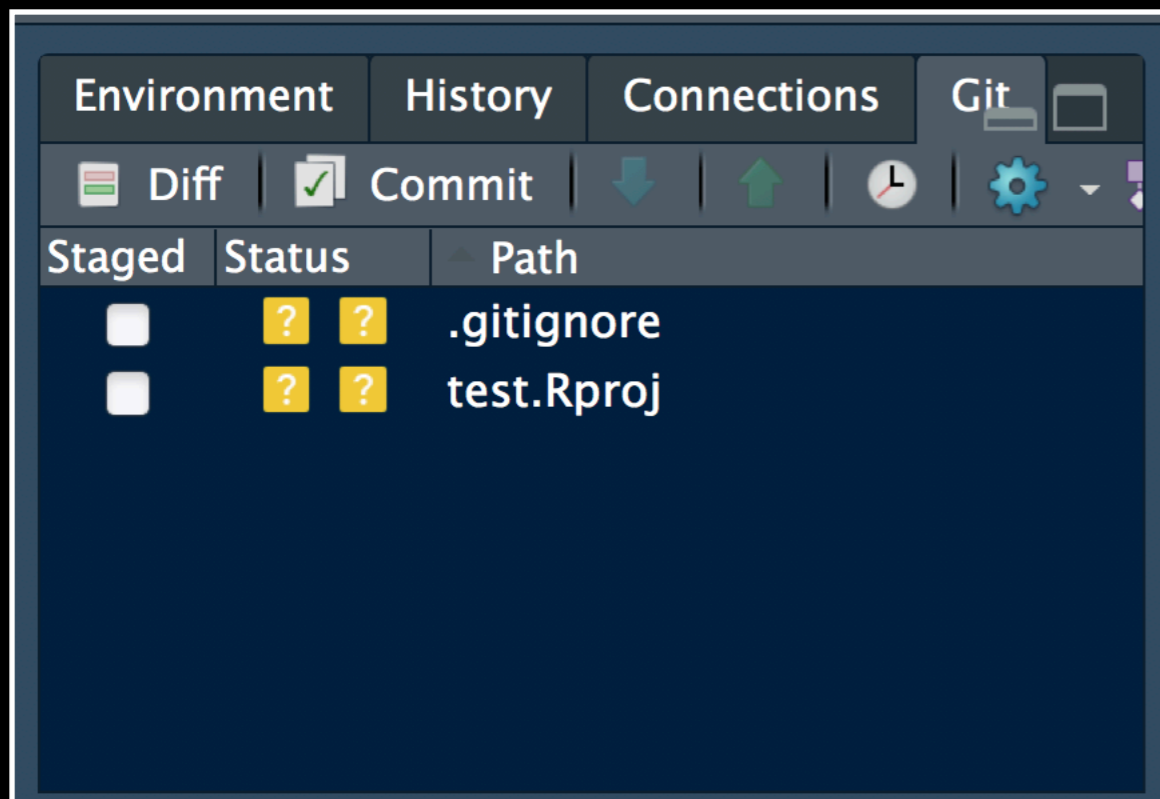
[GitHub Paste](#)

Open in new session

[Create Project](#) [Cancel](#)

Demo of *editing, adding committing and pushing*

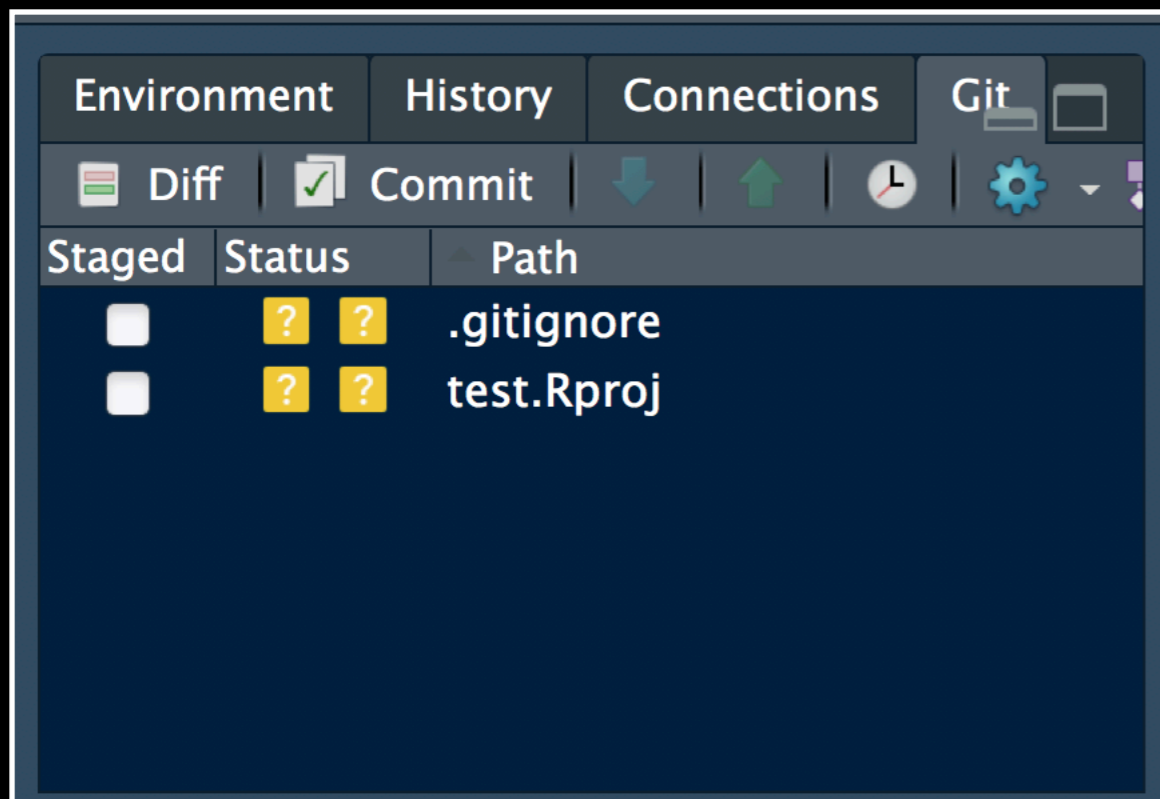
**Check if new Git tab
Appears in RStudio?**



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?**

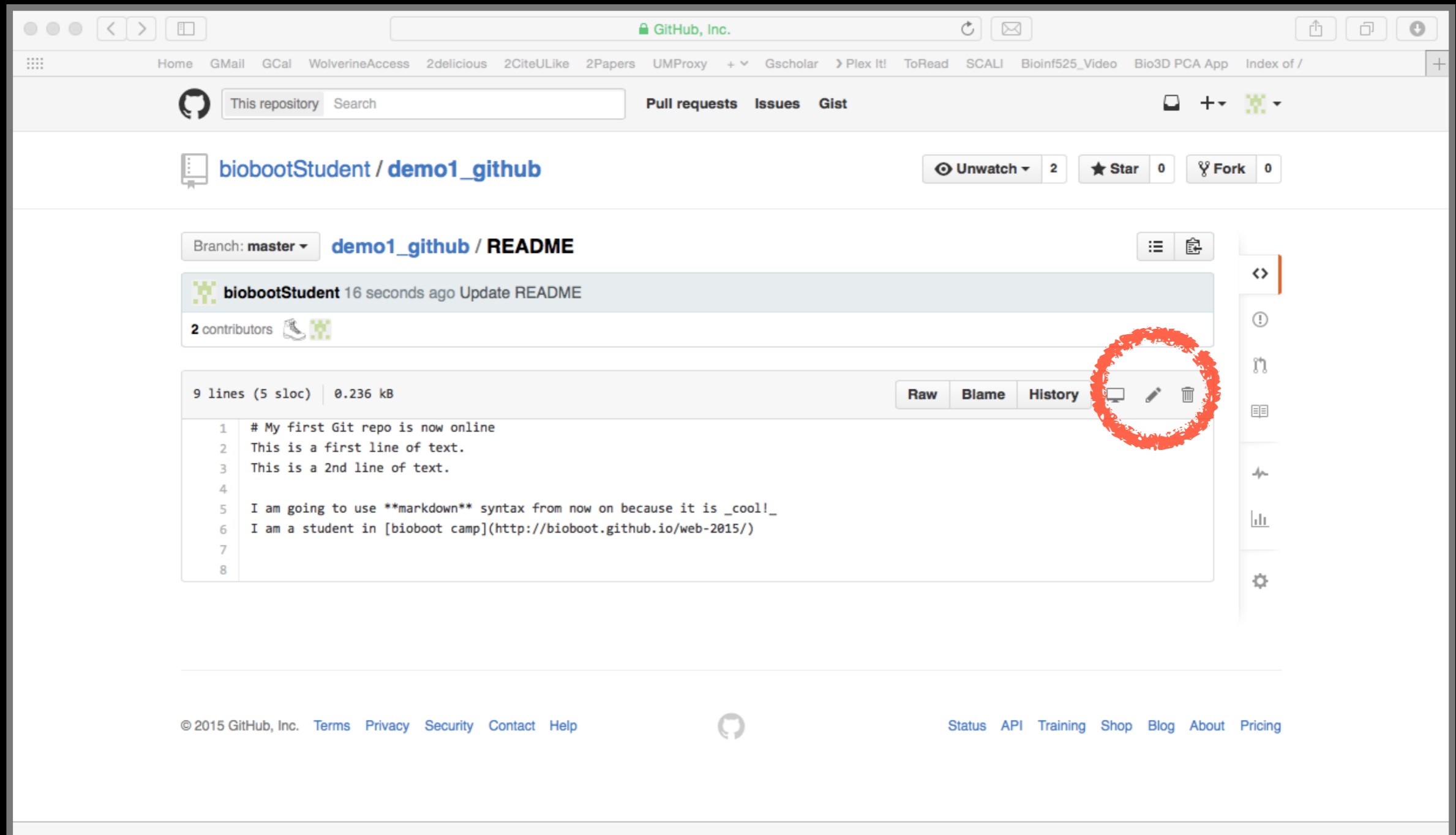


**Now experiment editing the
README.md file in RStudio
and adding, committing and
pushing changes to GitHub
via this tab**

**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



The screenshot shows a web browser window displaying a GitHub repository page for 'biobootStudent / demo1_github'. The page is on the 'master' branch and shows the 'README' file. The file content is as follows:

```
1 # My first Git repo is now online
2 This is a first line of text.
3 This is a 2nd line of text.
4
5 I am going to use markdown syntax from now on because it is _cool!
6 I am a student in [bioboot camp](http://bioboot.github.io/web-2015/)
7
8
```

The 'README' file is 9 lines long (5 sloc) and 0.236 kB in size. The page includes navigation links for 'Raw', 'Blame', and 'History'. A red circle highlights the 'Edit' icon (a pencil) in the top right corner of the file viewer area. The footer of the page contains copyright information for GitHub, Inc. (© 2015) and various links including Terms, Privacy, Security, Contact, Help, Status, API, Training, Shop, Blog, About, and Pricing.

Enable passwd-less push and pull to GitHub:

<http://tinyurl.com/rclass-github>

Step 1B only please!

(We have already done steps 1A and 2 to 5)

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!

[Muddy Point Assessment]

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’**

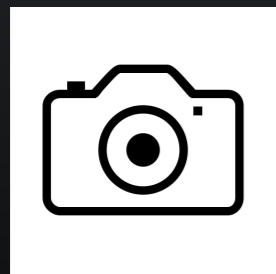
Example Git workflow



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!)

Hands on example!

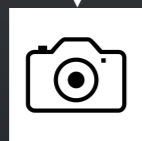
Example Git workflow



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

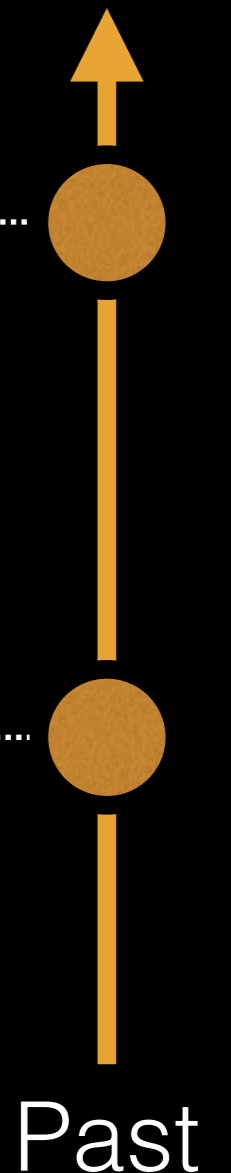
Author: Barry Grant <bjgrant@umich.edu>

Date: Thu Jul 30 11:26:40 2015 -0400

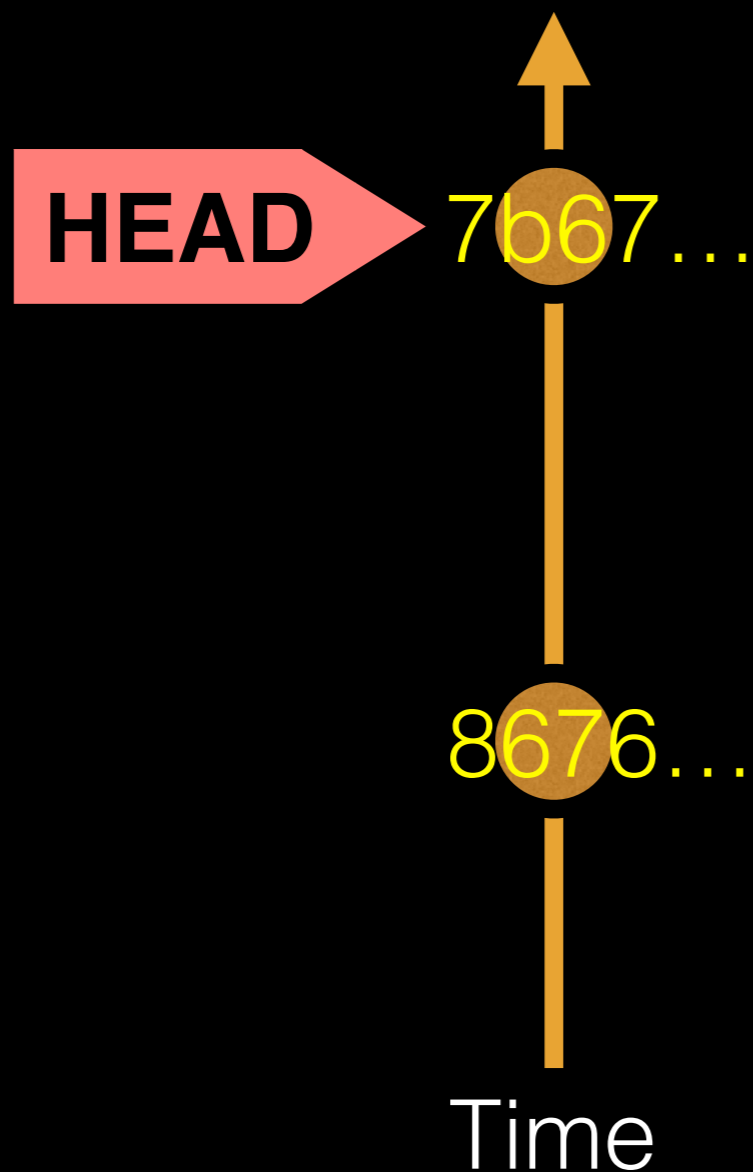
#

Create a README file

#



Side-Note: Git history is akin to a graph

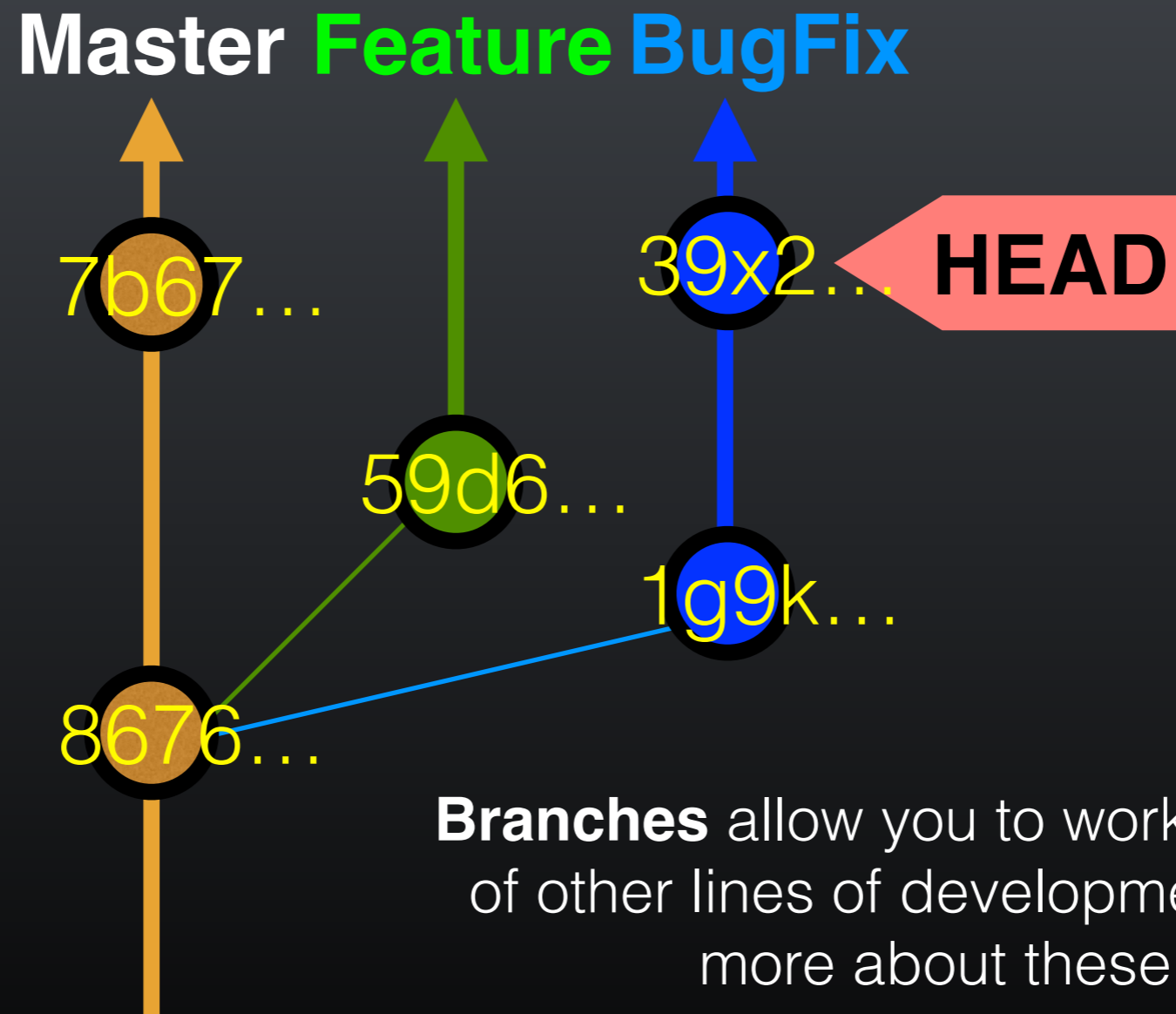


Nodes are **commits** labeled by their unique '**commit ID**'.

(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

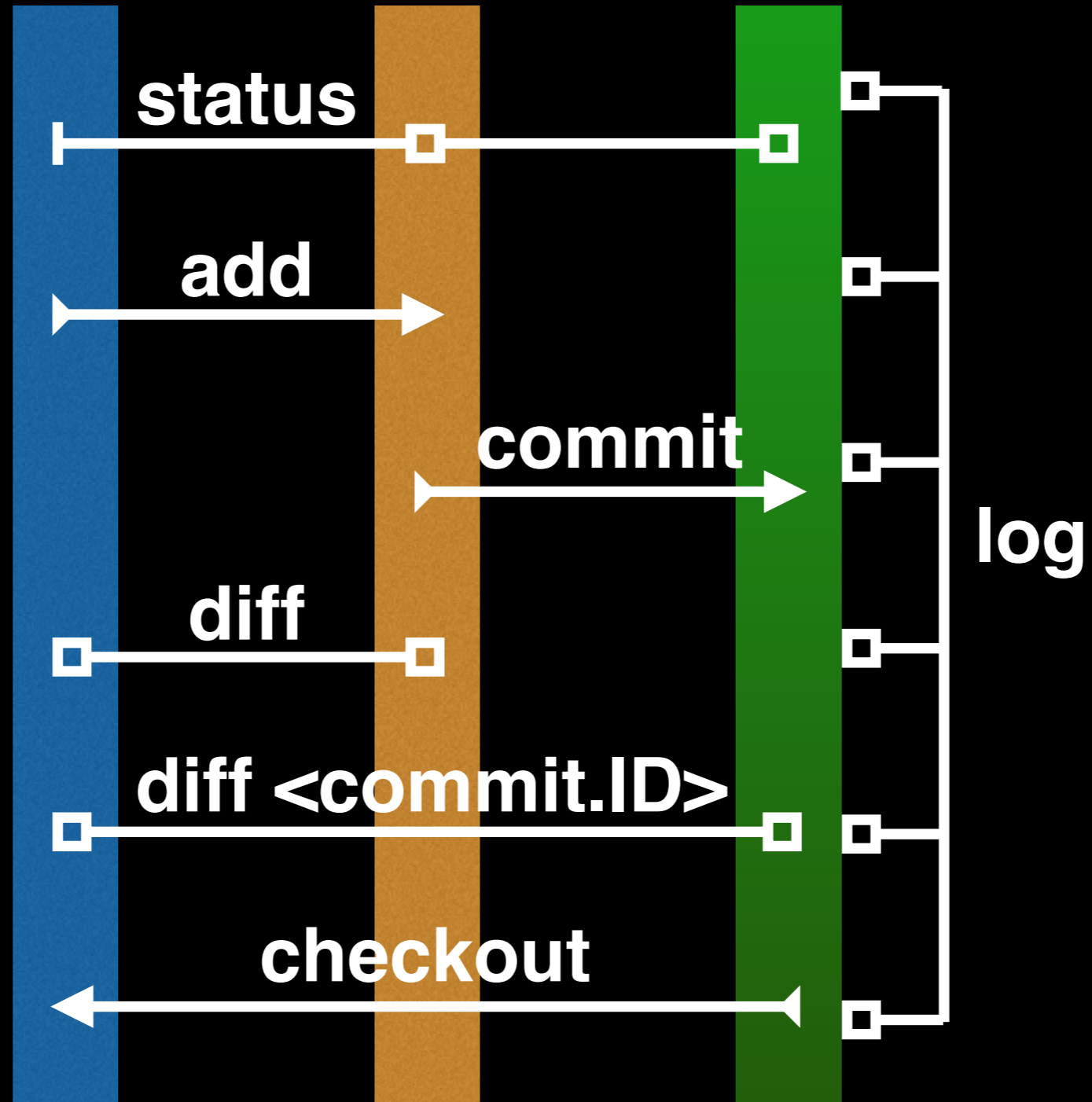
> **git commit -m 'Your message'** # Take a content snapshot!

> **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 Directory 'Staging Area' Local 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
# @@ -1,2 @@
# 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..14fbd56
# --- /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 14fbd56..0000000
# --- a/ToDo
# +++ /dev/null
# @@ 1 +0,0 @@
# -Learn git basics
```

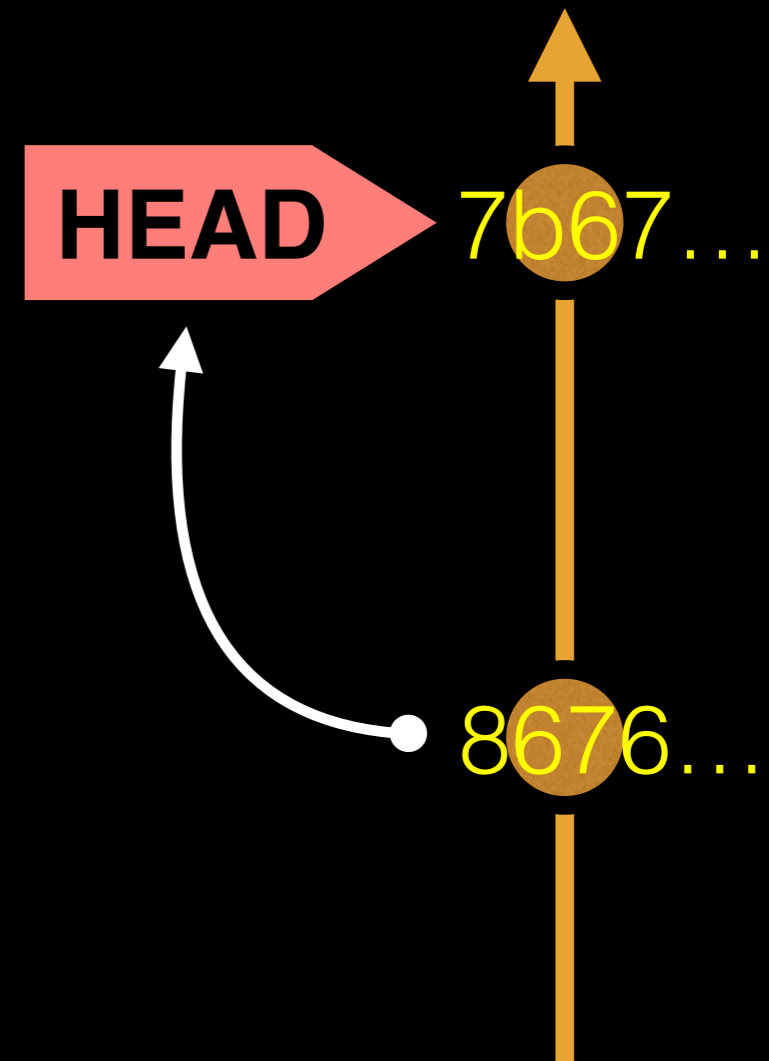


git diff: Show changes between commits

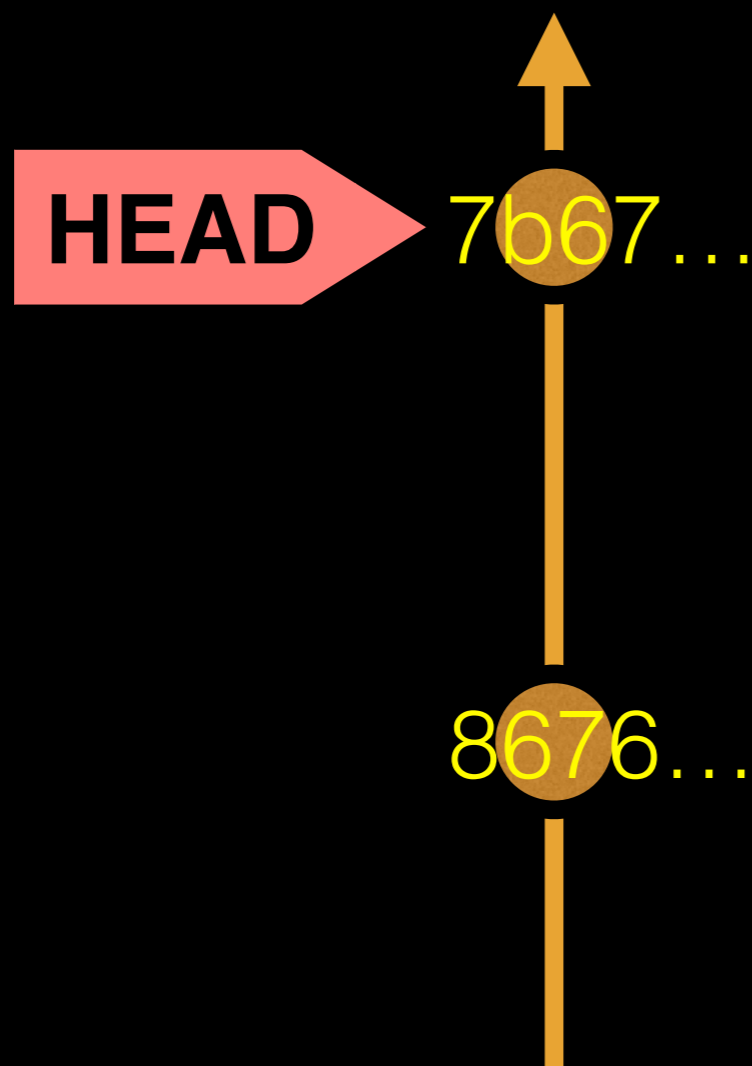
```
> git diff 8676      ## Difference to current HEAD position!
```

```
# diff --git a/README b/README
# index 73bc85a..67bd82c 100644
# --- a/README
# +++ b/README
# @@ -1,2 @@
# 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..14fbd56
# --- /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**

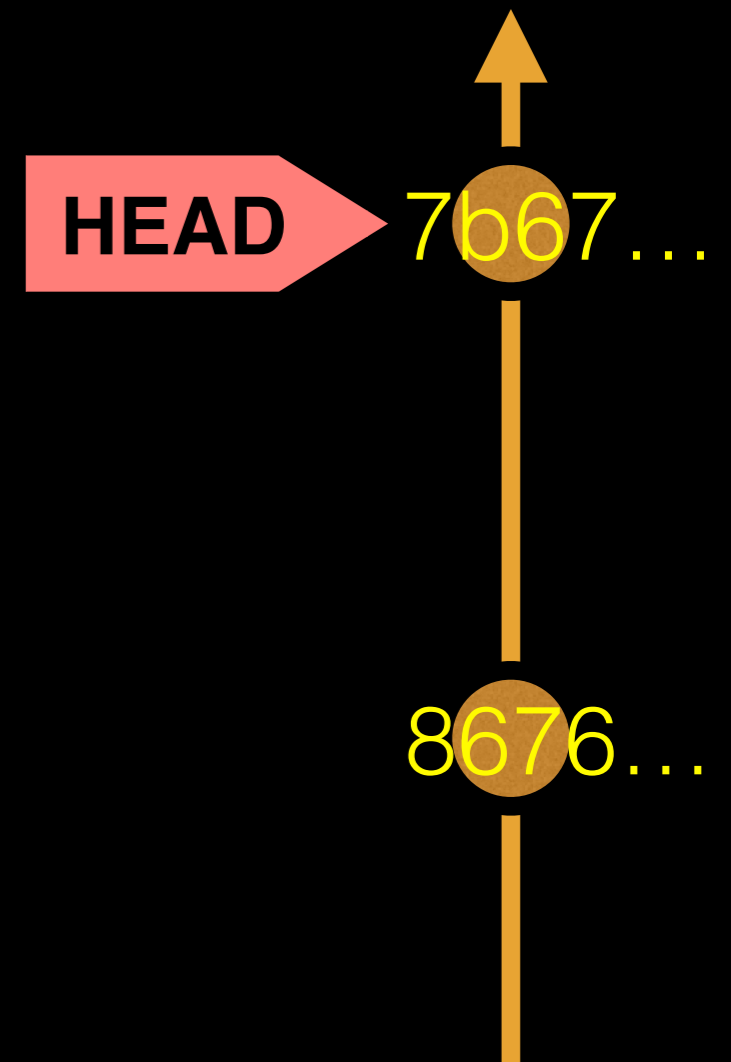
This is a first line of text.

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)

Do it Yourself!

> 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 86768

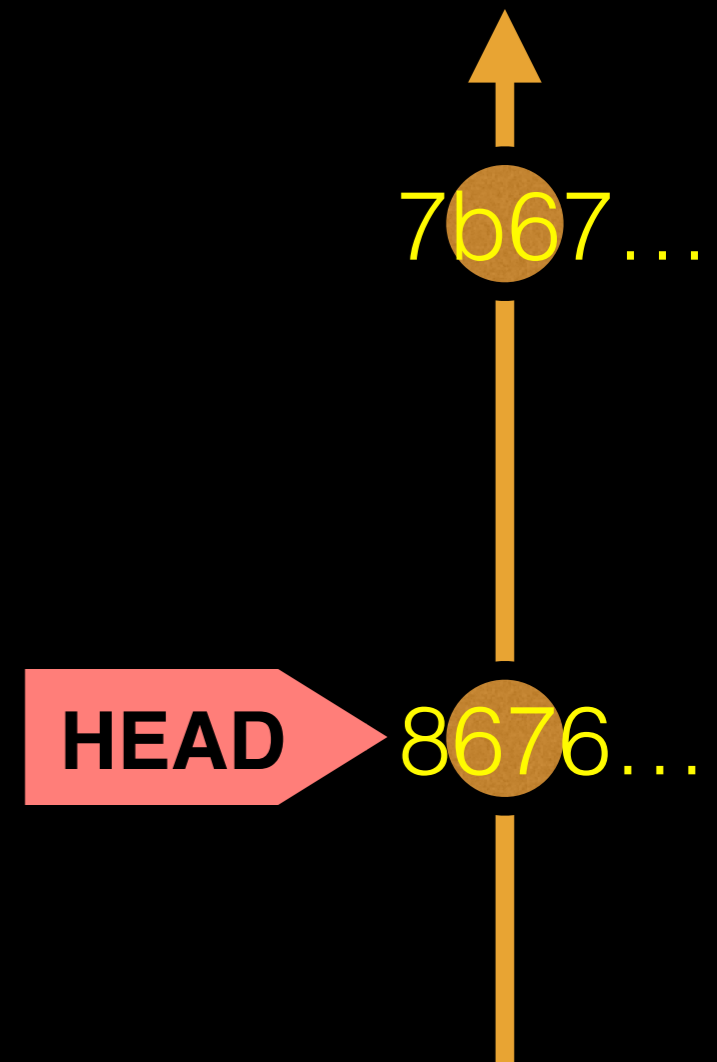
```
# You are in 'detached HEAD' state...<cut>...  
# HEAD is now at 8676840... Create a README file
```

> 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

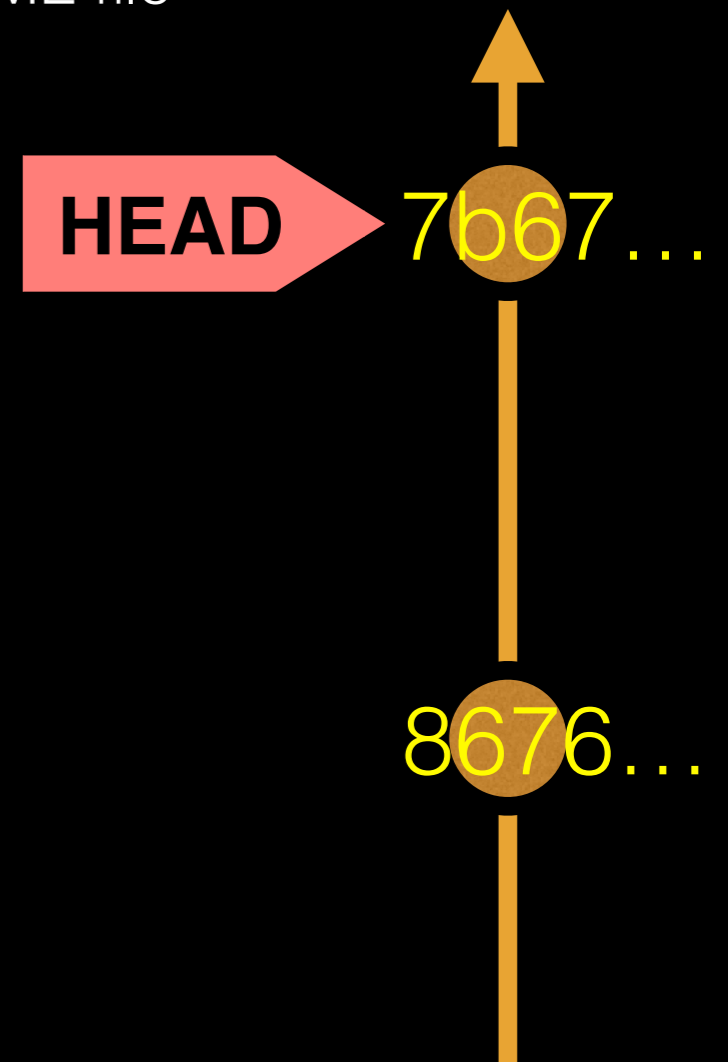
```
# Previous HEAD position was 8676840... Create a README file  
# Switched to branch 'master'
```

> 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>