

Basic Git and GitHub

STSCI 4780 Lab
Tom Lored

Agenda

- Background technology
 - Markdown
 - Hashes/checksums
 - Diffs and patches
 - File systems
- Git
- GitHub
- Exercises & Assignment01

Markdown — A *markup* language

Plain text

Rendered text

Plain text	Rendered text
<pre># STSCI 4780 – Bayesian data analysis: principles and practice **Lectures:** Tuesdays & Thursdays, 1:25pm – 2:40pm, in Upson 109 **Labs:** Fridays, 2:55pm – 4:10pm, in Phillips 213 **Instructor:** Tom Loredo Center for Radiophysics & Space Research, and Field of Statistics 620 Space Sciences Building loredo@astro.cornell.edu Office hours: Wednesdays, 3pm – 4pm, and by appointment **Teaching Assistant:** Kerstin Frailey Dept. of Statistical Science Malott Hall kef73@cornell.edu Office hours TBD # Course goals Provide students: – A basic understanding of the principles and foundations underlying the Bayesian approach – Practical experience using basic/intermediate Bayesian methods – Experience with widely-used tools and software development practices for producing and sharing collaborative, reproducible statistical research – Exposure to the Bayesian academic research literature – An understanding of key differences between Bayesian and frequentist approaches # Grading Assignments (lecture + lab): 40% In-class quick quizzes: 30% Final project: 30% *Everyone has a rough week now and then.* The lowest-graded assignment and the two lowest-graded in-class quizzes will be dropped in everyone's final grade calculation. If you wish, you may skip an assignment and two quizzes without prejudice, but please do so cautiously. *Class participation is important.* As statisticians, clear communication of understanding and uncertainty is something that will be expected of you, and you need to be able to do this verbally as well as in documents. I will keep</pre>	<div>README.md 1287 Words</div> <h2>STSCI 4780 - Bayesian data analysis: principles and practice</h2> <p>Lectures: Tuesdays & Thursdays, 1:25pm - 2:40pm, in Upson 109 Labs: Fridays, 2:55pm - 4:10pm, in Phillips 213</p> <p>Instructor: Tom Loredo Center for Radiophysics & Space Research, and Field of Statistics 620 Space Sciences Building loredo@astro.cornell.edu Office hours: Wednesdays, 3pm - 4pm, and by appointment</p> <p>Teaching Assistant: Kerstin Frailey Dept. of Statistical Science Malott Hall kef73@cornell.edu Office hours TBD</p> <h2>Course goals</h2> <p>Provide students:</p> <ul style="list-style-type: none">• A basic understanding of the principles and foundations underlying the Bayesian approach• Practical experience using basic/intermediate Bayesian methods• Experience with widely-used tools and software development practices for producing and sharing collaborative, reproducible statistical research• Exposure to the Bayesian academic research literature• An understanding of key differences between Bayesian and frequentist approaches <h2>Grading</h2> <p>Assignments (lecture + lab): 40% In-class quick quizzes: 30% Final project: 30%</p> <p><i>Everyone has a rough week now and then.</i> The lowest-graded assignment and the two lowest-graded in-class quizzes will be dropped in everyone's final grade calculation. If you wish, you may skip an assignment and two quizzes without prejudice, but please do so cautiously.</p> <p><i>Class participation is important.</i> As statisticians, clear communication of understanding and uncertainty is something that will be expected of you, and you need to be able to do this verbally as well as in documents. I will keep</p>

See software setup web page for info on Markdown editors

Links and tables

in places (reflecting its history). Persi Diaconis, an influential mathematician and Bayesian statistician (and former Cornellian, and magician!), wrote a wonderful, frank, and very positive review that is worth reading:

[\["A Frequentist Does This, A Bayesian That" \(Diaconis's review of Jaynes's PTLOS\)\]\(http://www.siam.org/news/news.php?id=81\)](http://www.siam.org/news/news.php?id=81)

I've put several other useful books on reserve; I'll add comments about some of them here as we get to corresponding material in class.

Lecture plan

#	Date	Topic
1	Jan 22	Course intro; Motivation: Models, measurements, arguments
2	Jan 27	Assessing deductive arguments: Propositional logic, Boolean algebra
3	Jan 29	Assessing inductive arguments: Probability theory
4	Feb 3	Key theorems
5	Feb 5	Discrete data: Bernoulli, binomial, beta
6	Feb 10	More counting: Multinomial/Dirichlet, Poisson/gamma; nuisance parameters
7	Feb 12	Continuous data: Normal distribution, Student's t

After the Feb break, we'll synthesize what we've learned to a general prescription for inference with parametric models, and then continue with more sophisticated models---Bayesian counterparts to multi-parameter conventional regression models.

Next we'll focus on Bayesian computation, culminating with Markov chain Monte Carlo (MCMC).

With flexible computational tools in hand, we'll explore richer model structures---**hierarchical Bayesian models** (also known as multilevel models, or probabilistic graphical models).

At this point you will be defining your final projects. I have a large menu of further topics; we'll choose from them based in part on relevance to student projects.

Lab plan

For the first few weeks, the labs will operate somewhat separate from the lectures, aiming to build familiarity with the tools we'll use to implement nontrivial Bayesian computations later in the course.

#	Date	Topic
1	Jan 23	Markdown. Git. GitHub

computational implementation of Bayesian methods, but of course a deep understanding of foundations and fundamentals is a great help for practical use. The book is quite polemical in places (reflecting its history). Persi Diaconis, an influential mathematician and Bayesian statistician (and former Cornellian, and magician!), wrote a wonderful, frank, and very positive review that is worth reading:

["A Frequentist Does This, A Bayesian That" \(Diaconis's review of Jaynes's PTLOS\)](http://www.siam.org/news/news.php?id=81)

I've put several other useful books on reserve; I'll add comments about some of them here as we get to corresponding material in class.

Lecture plan

#	Date	Topic
1	Jan 22	Course intro; Motivation: Models, measurements, arguments
2	Jan 27	Assessing deductive arguments: Propositional logic, Boolean algebra
3	Jan 29	Assessing inductive arguments: Probability theory
4	Feb 3	Key theorems
5	Feb 5	Discrete data: Bernoulli, binomial, beta
6	Feb 10	More counting: Multinomial/Dirichlet, Poisson/gamma; nuisance parameters
7	Feb 12	Continuous data: Normal distribution, Student's t

After the Feb break, we'll synthesize what we've learned to a general prescription for inference with parametric models, and then continue with more sophisticated models---Bayesian counterparts to multi-parameter conventional regression models.

Next we'll focus on Bayesian computation, culminating with Markov chain Monte Carlo (MCMC).

With flexible computational tools in hand, we'll explore richer model structures---*hierarchical Bayesian models* (also known as multilevel models, or probabilistic graphical models).

At this point you will be defining your final projects. I have a large menu of further topics; we'll choose from them based in part on relevance to student projects.

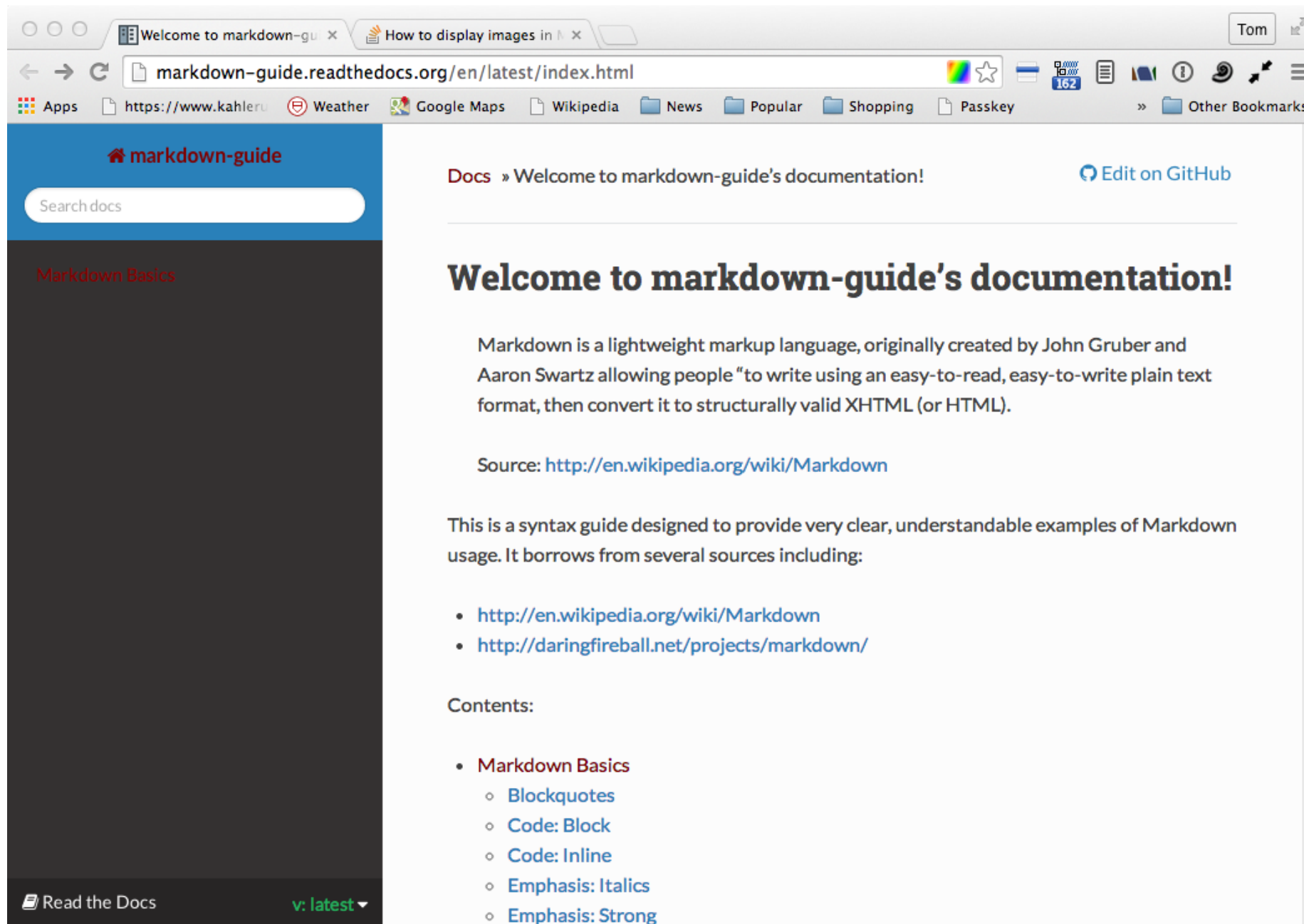
Lab plan

For the first few weeks, the labs will operate somewhat separate from the lectures, aiming to build familiarity with the tools we'll use to implement nontrivial Bayesian computations later in the course.

#	Date	Topic
---	------	-------

Markdown documentation

Markdown Guide at ReadTheDocs.org



Many, many other guides and cheatsheets online...

Markdown is not standardized—there are many Markdown "flavors"

Hashes/checksums

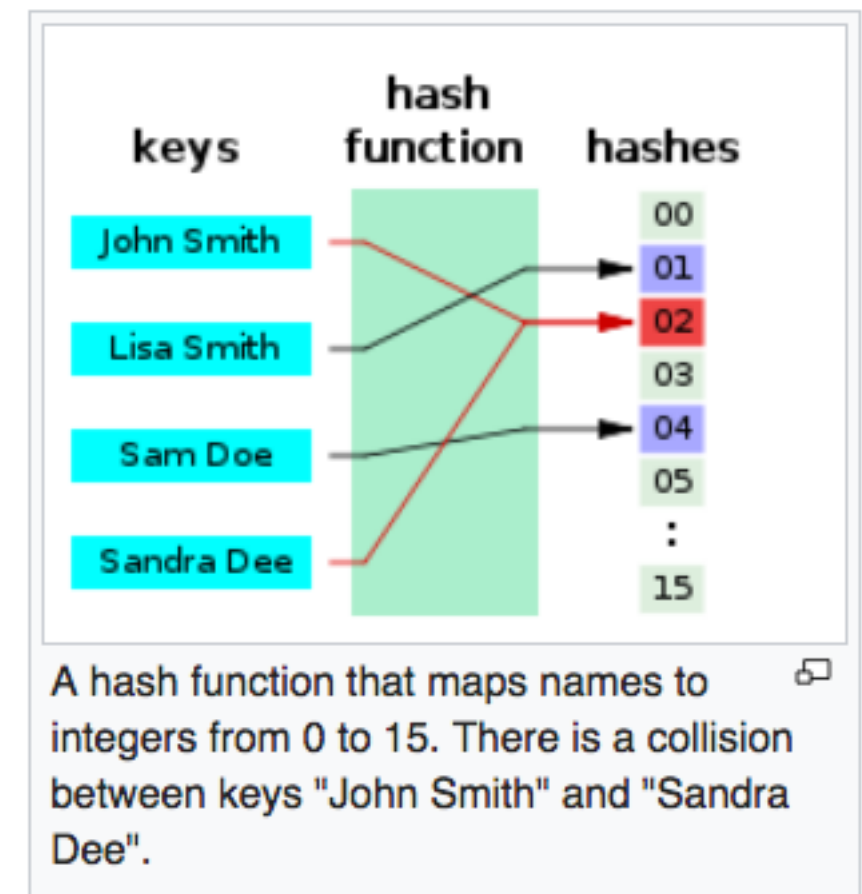
Hash = A "fingerprint" for a sequence of bits/bytes, such as the contents of a file

Hash function

From Wikipedia, the free encyclopedia

A **hash function** is any **function** that can be used to map **data** of arbitrary size to data of fixed size. The values returned by a hash function are called **hash values**, **hash codes**, **digests**, or simply **hashes**. One use is a data structure called a **hash table**, widely used in computer software for rapid data lookup. Hash functions accelerate table or database lookup by detecting duplicated records in a large file. An example is finding similar stretches in DNA sequences. They are also useful in **cryptography**. A **cryptographic hash function** allows one to easily verify that some input data maps to a given hash value, but if the input data is unknown, it is deliberately difficult to reconstruct it (or equivalent alternatives) by knowing the stored hash value. This is used for assuring **integrity** of transmitted data, and is the building block for **HMACs**, which provide **message authentication**.

Hash functions are related to (and often confused with) **checksums**, **check digits**, **fingerprints**, **lossy compression**, **randomization functions**, error-correcting codes, and ciphers. Although



SHA-1 hash

SHA-1

From Wikipedia, the free encyclopedia

In [cryptography](#), **SHA-1** (**Secure Hash Algorithm 1**) is a [cryptographic hash function](#) which takes an input and produces a 160-bit (20-byte) hash value known as a [message digest](#) - typically rendered as a [hexadecimal](#) number, 40 digits long. It was designed by the United States [National Security Agency](#), and is a U.S. [Federal Information Processing Standard](#).^[3]

Linux/macOS:

```
CourseInfo:106$ shasum README.md
4c05239ff718ea4dfc22d1794be17db3cb33d614  README.md
```

Windows:

```
$ certutil.exe -hashfile console.xml SHA1
SHA1 has of file console.xml:
26 e2 16 34 [...]
```

Diffs and patches

diff = A line-based summary of the differences between two files

patch = A diff in a format that can be used to transform one file to another

```
$ cat > HelloWorld1.txt
Hello, world!
$ cat > HelloWorld2.txt
Hello world!
```

```
$ diff HelloWorld1.txt HelloWorld2.txt
1c1
< Hello, world!
---
> Hello world!
```

Longer example on Wikipedia

Make a "unified diff" comparing 1 to 2:

```
$ diff -u HelloWorld1.txt HelloWorld2.txt > patchfile.txt
$ cat patchfile.txt
--- HelloWorld1.txt2018-01-26 12:44:34.000000000 -0500
+++ HelloWorld2.txt2018-01-26 12:44:48.000000000 -0500
@@ -1,1 @@
-Hello, world!
+Hello world!
```

Patch file 1 to make it match file 2:

```
$ patch < patchfile.txt
patching file HelloWorld1.txt

$ cat HelloWorld1.txt
Hello world!
```

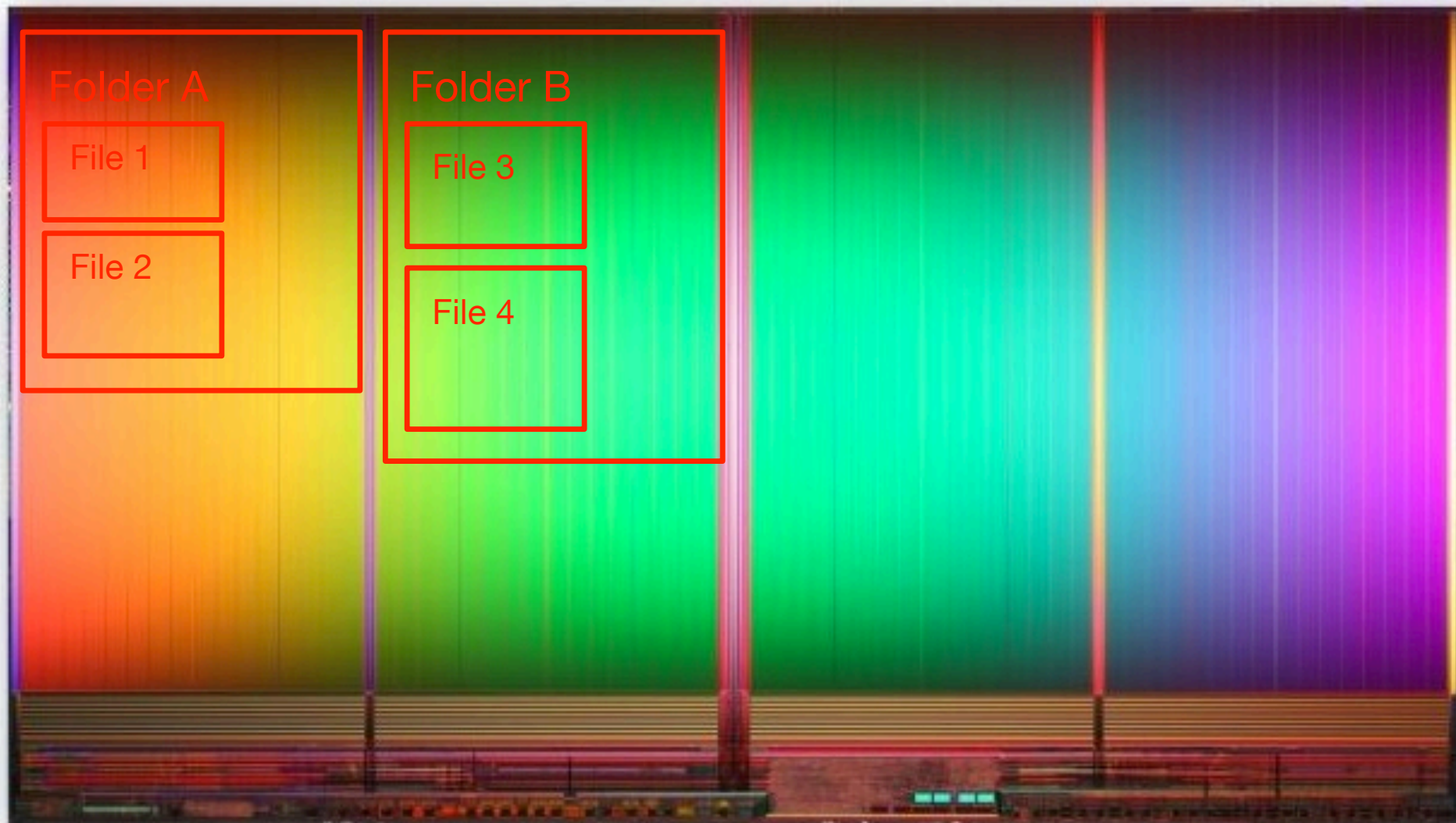
File systems

Your operating system maintains a *file system* for each volume or partition of persistent storage (hard drive, SSD, USB drive...), managing storage and retrieval of data.

The desktop GUI provides an interface to the file system using the metaphor of a file cabinet, containing (nested) folders and documents.

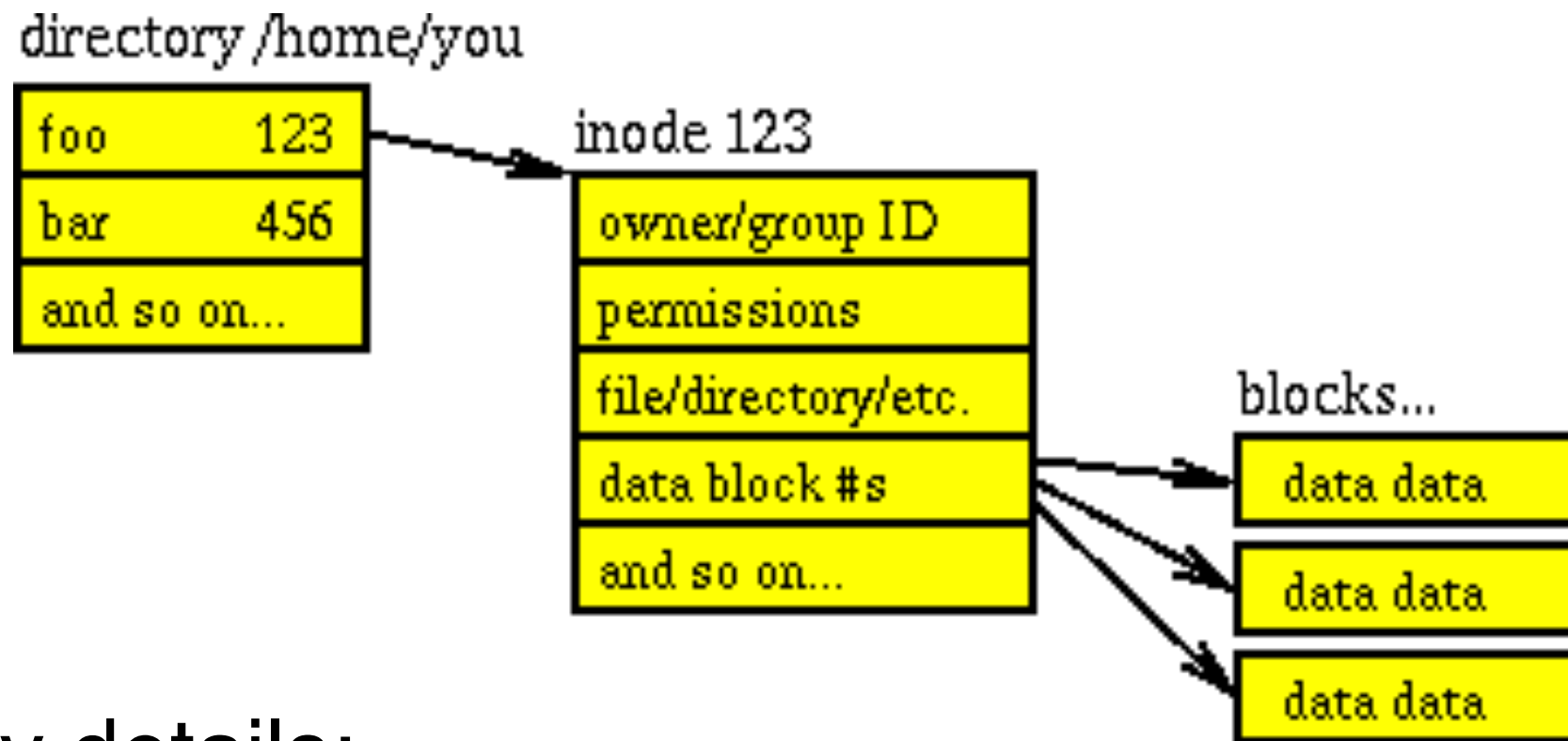
A file system is really a sophisticated and complex database, with little resemblance to a file cabinet!

What a file system is *not*



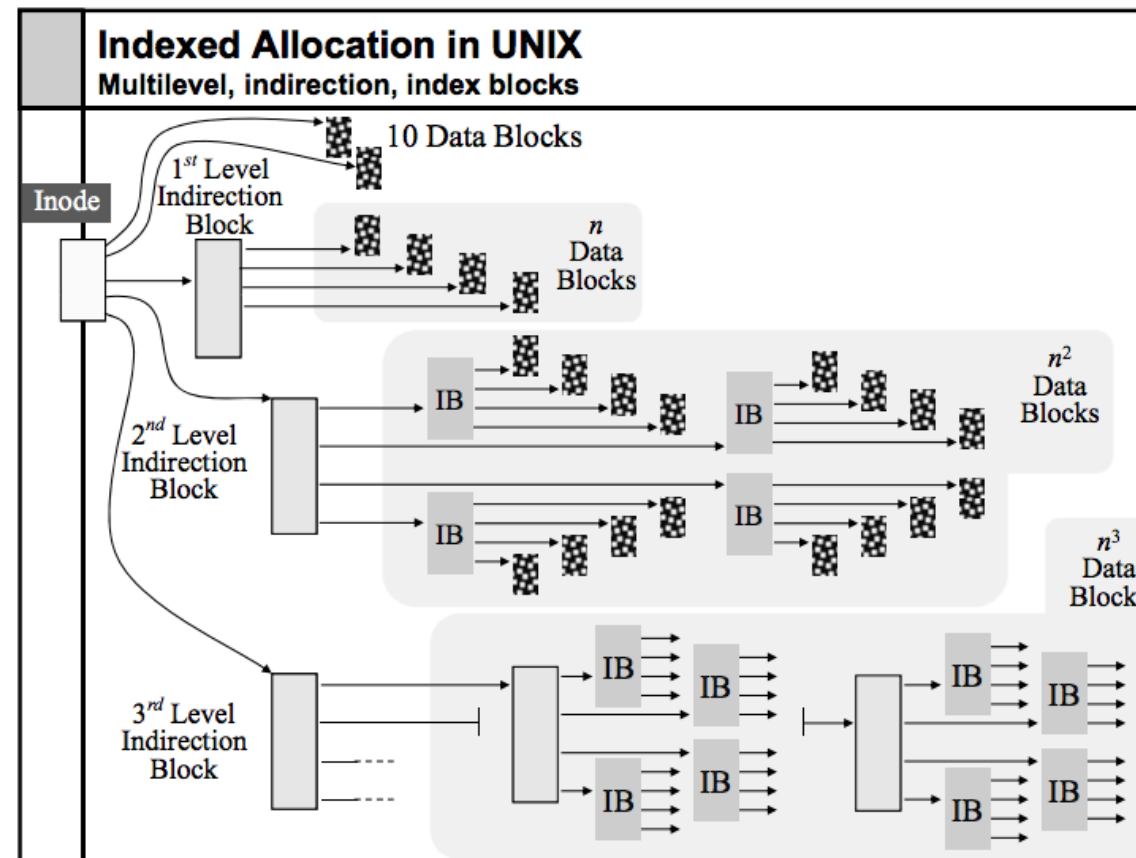
Intel 32 GB NAND flash chip

Outline of a Linux file system:



inode gory details:

SuperUser.com



UTexas OS class notes

Takeaways

- Files are not monolithic pieces of content with names attached.
- The name is separate from the content (e.g., *hard links* assign separate names to the same content). A directory is a special type of file that associates names with content.
- The content is stored in many chunks (blocks) that may be strewn across the media.
- A file system is a complex database, not an electronic file cabinet.

What is Git?

Git is a ***distributed version control system***

- **Version control:** Git lets you have a single, visible working copy of a directory (folder), but maintain a history of snapshots that you can move between.
- **Distributed:** Git enables multiple users to work on a collection of files independently, sharing changes in a collaborative fashion, including a record of changes.
- **System:** Git is a collection of dozens of command-line programs, most of them accessed via the master program, "git".

What's different about Git?

- **Distributed:** Most earlier VCSs required complicated locked checking in and out of files to support collaboration. Git lets users work independently on the same files, providing tools for handling conflicts when merging work.
- **Blobs vs. diffs:** Other VCSs maintain a *history of diffs*, changing the repo from one state to another. Git maintains a *history of "blobs,"* chunks of file content associated with a file name. It is essentially a ***virtual file system***.

Two ways to use Git

Command line

```
git add README.md
```

```
git status
```

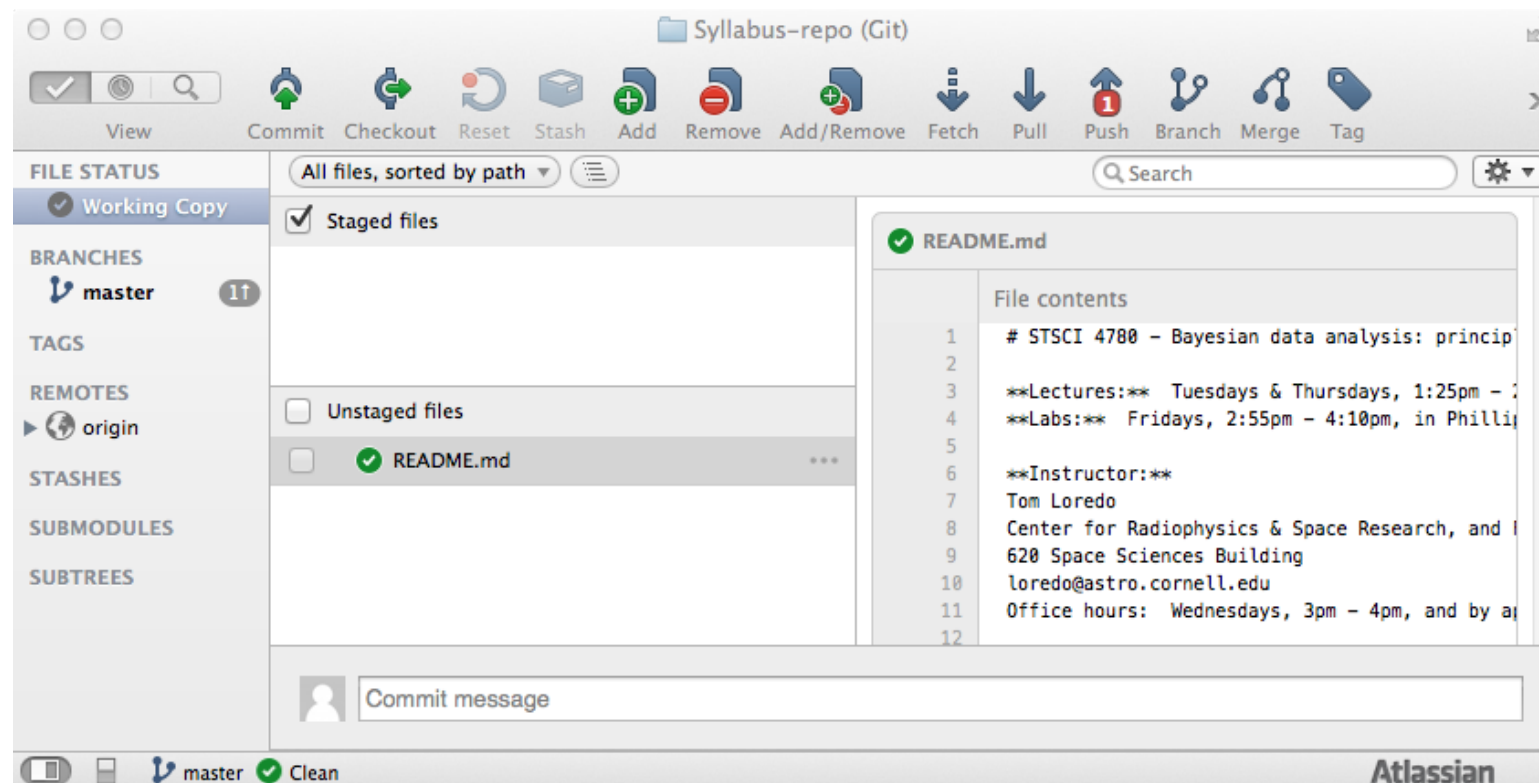
```
git help commit
```

```
git commit -m "First draft of README file"
```

*prints useful info, including instructions;
use often!*

*prints documentation for the
command; use it!*

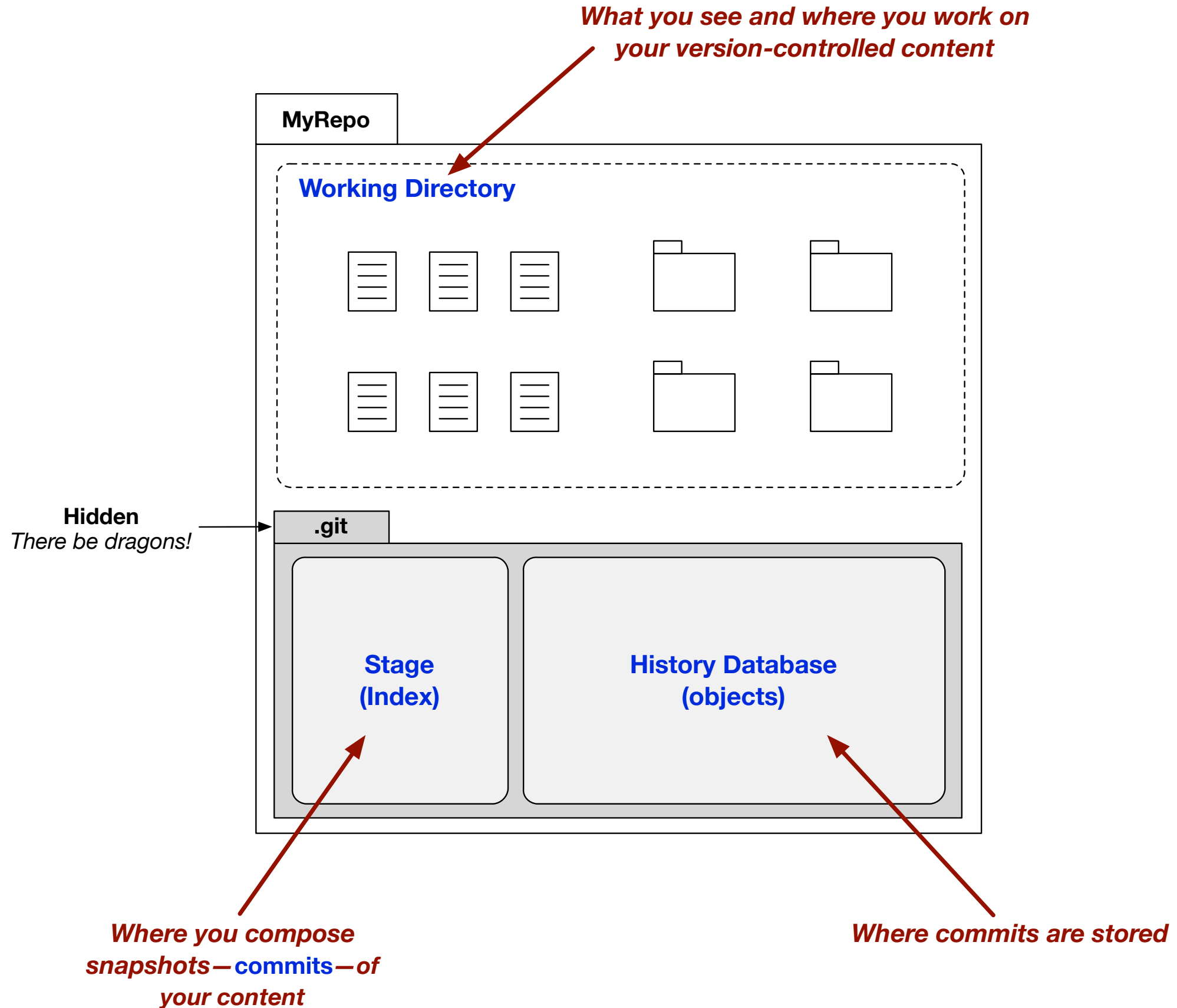
Graphical user interface (GUI)



*SourceTree for Mac/Win;
many other options:
<http://git-scm.com/downloads/guis>*

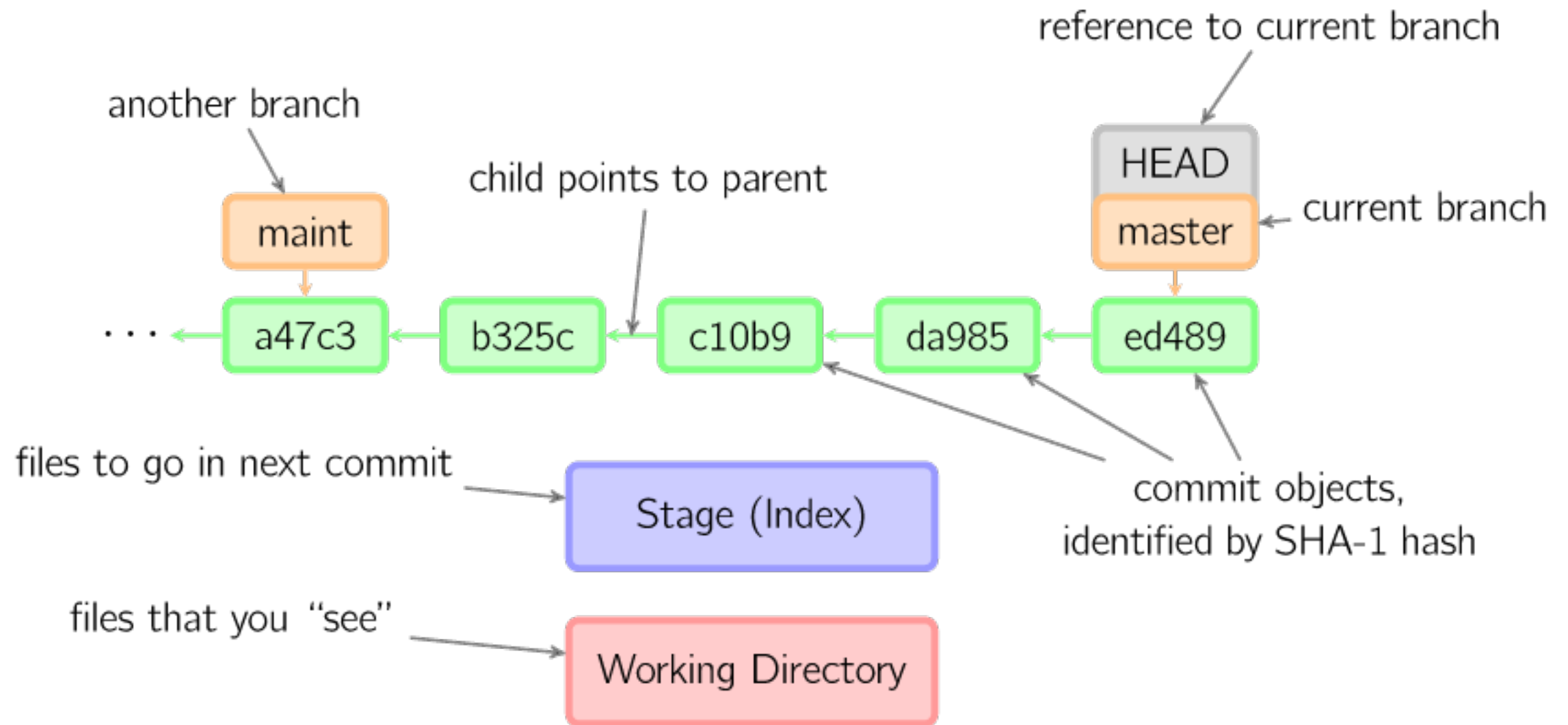
No GUI does everything
the Git command line can
do; *you need to be familiar
with command-line Git*

A Git repository



Commits (snapshots)

- A commit stores a tree data structure associating directory and file names with blobs of content—a snapshot of the WD file system
- Each is assigned a **unique ID** via SHA-1 hash → 40 hex digits
Looks like: 09fac8dbfd27bd9b4d23a00eb648aa751789536d
- Each is associated with a **log message** the user writes that should *briefly* describe the content or reason for the commit
- History: Except for 1st commit, each commit keeps a pointer to the previous commit → a **commit graph**
- Access:
 - *By ID* — Usually 1st few digits suffice
 - *By **branch*** — A named pointer to a point in the history
 - *By **tag*** — Special name you assign to bookmark important points in the history
 - ***"HEAD"*** — Fixed name for the current commit on the current branch



From "A Visual Git Reference"
<http://marklodato.github.io/visual-git-guide/index-en.html>

Why the Stage?

- Staging helps you split up one large change into multiple commits

Example: You are working on several changes (in your working directory), but a colleague needs one of them *right now*. Add/commit the needed files, while you continue working on the others.

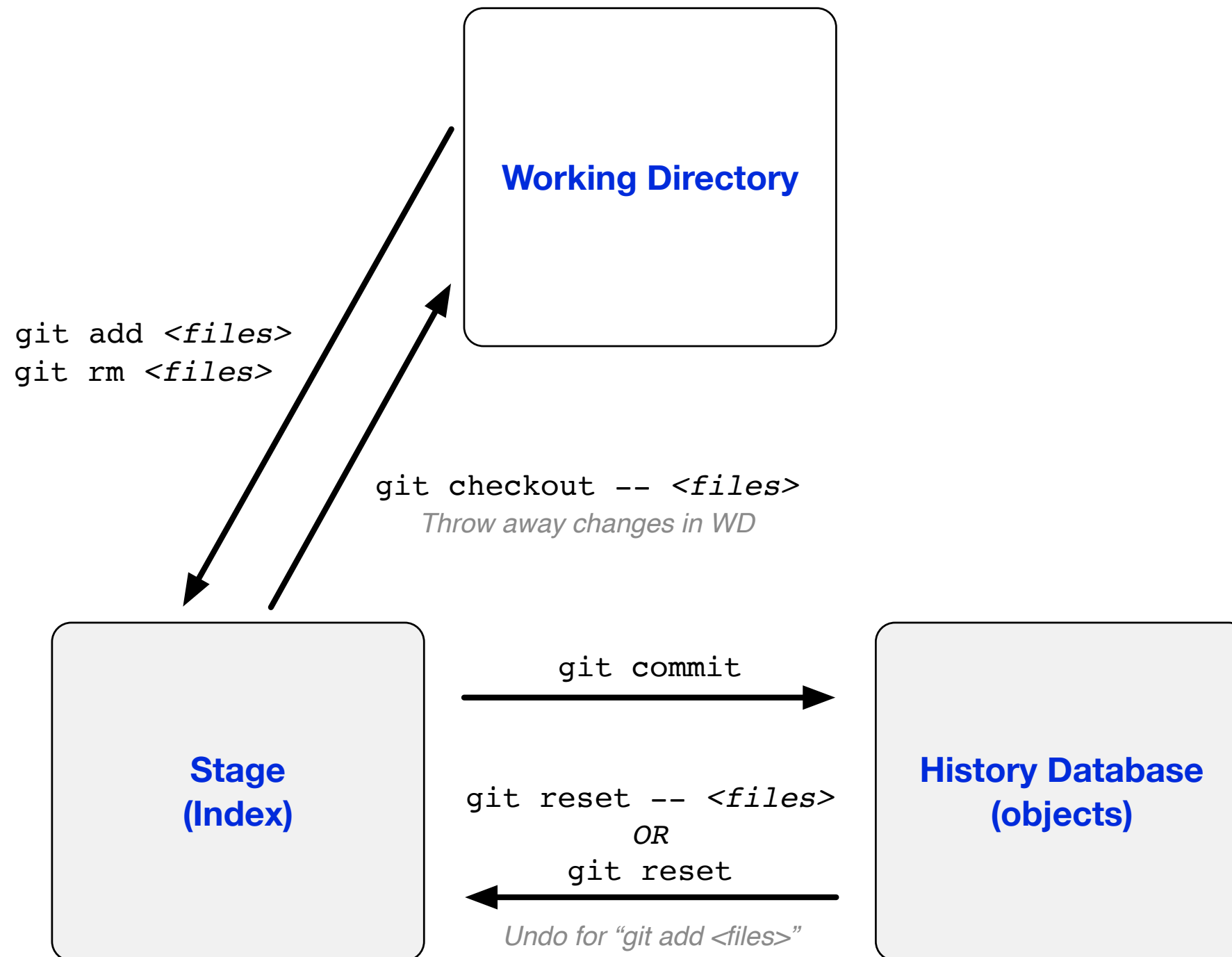
- Staging helps in reviewing changes
- Staging helps when a merge between branches has conflicts

See:

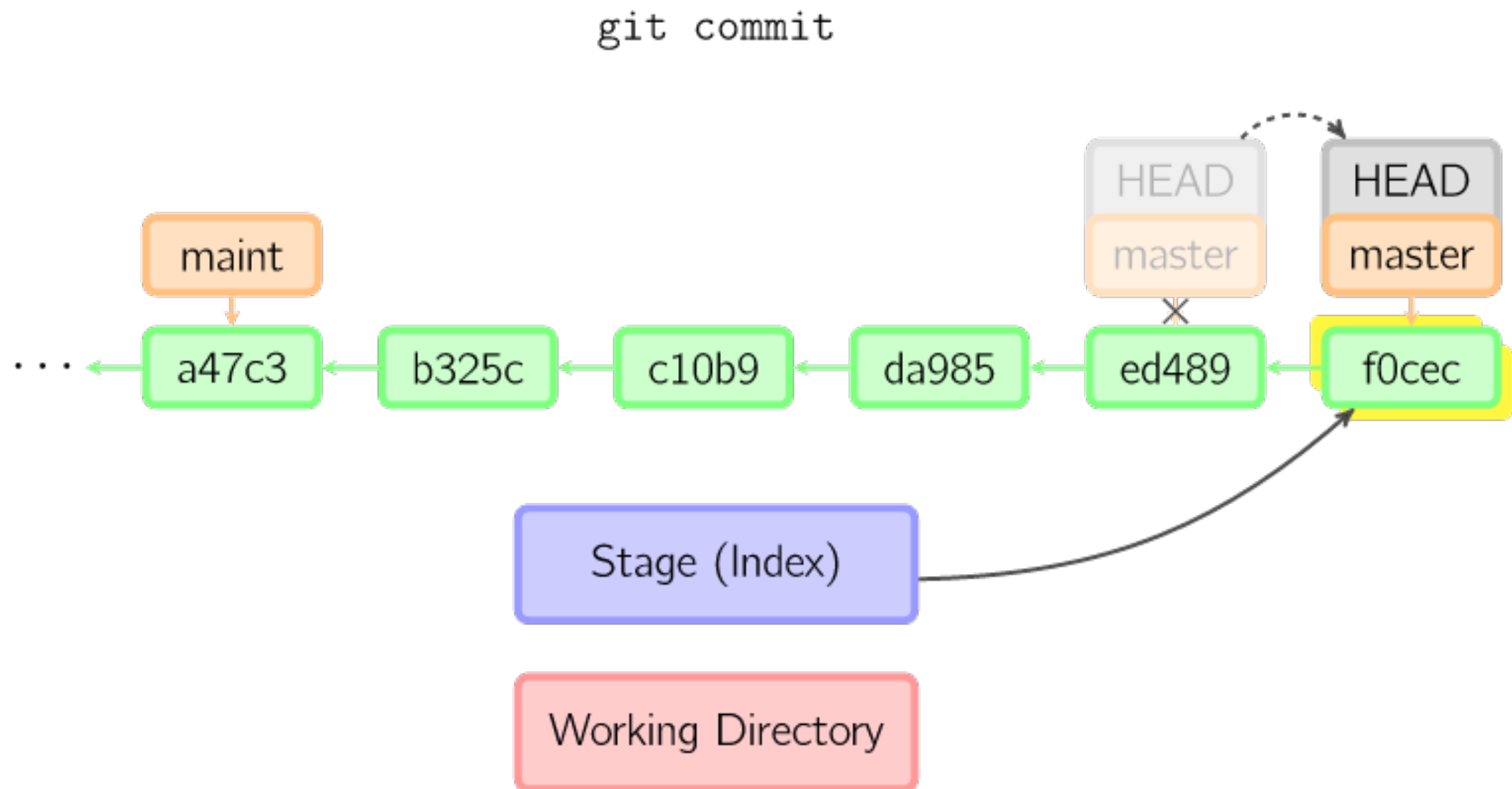
<http://gitolite.com/uses-of-index.html>

<http://programmers.stackexchange.com/questions/69178/what-is-the-benefit-of-gits-two-stage-commit-process-staging>

Basic usage



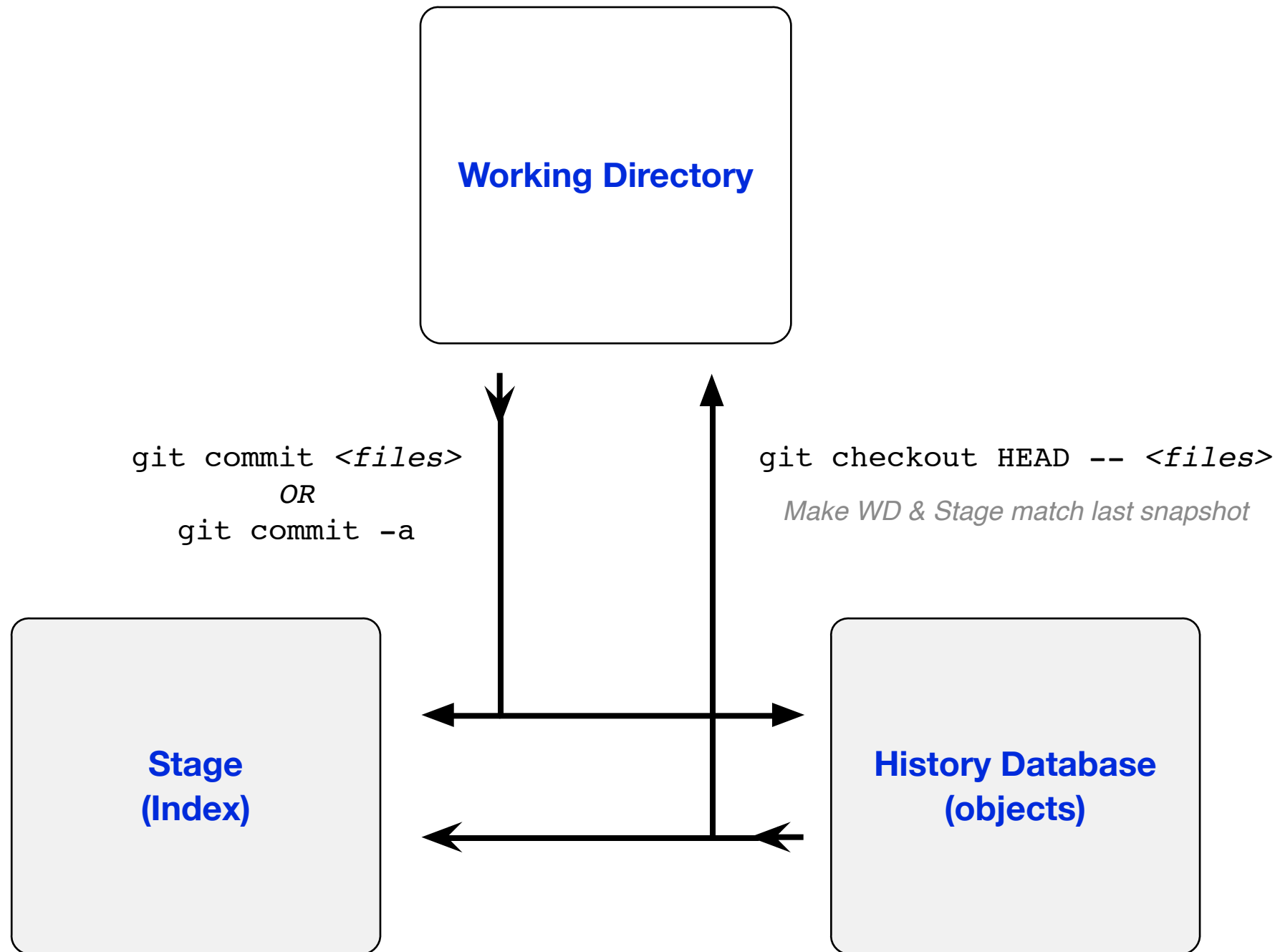
Effect of `commit` on the history



The commit message

- `git commit` will start a text editor in your console/terminal window, allowing you to enter a commit message. By default it may use an unfamiliar editor; the choice is customizable. When you save the message and quit the editor, Git completes the commit.
- Most commonly, a short, single-line message suffices, and you can ***use a shortcut*** to avoid invoking an editor:
`git commit -m "commit message string in quotes"`

Shortcutting the stage

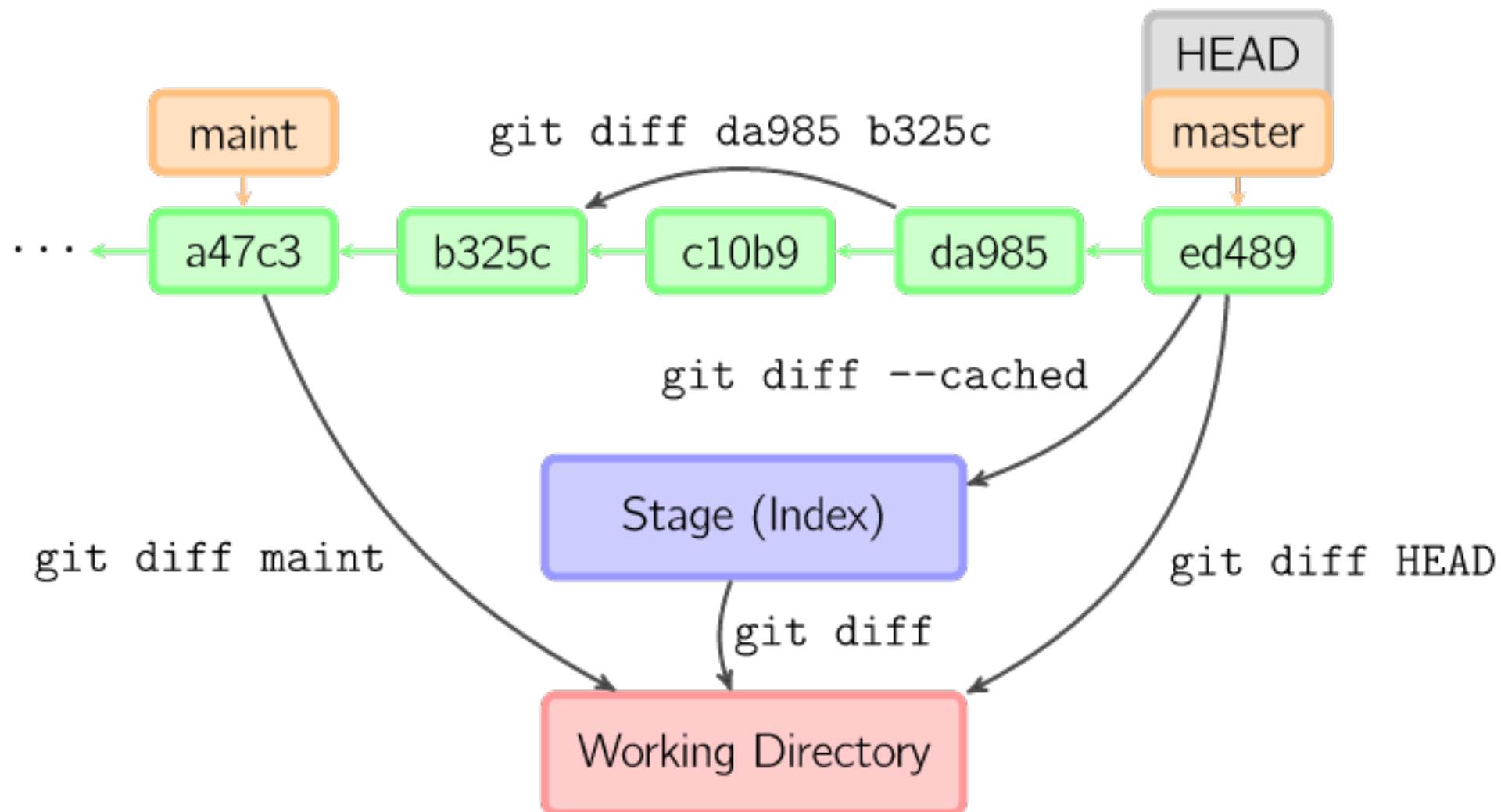


Checking state

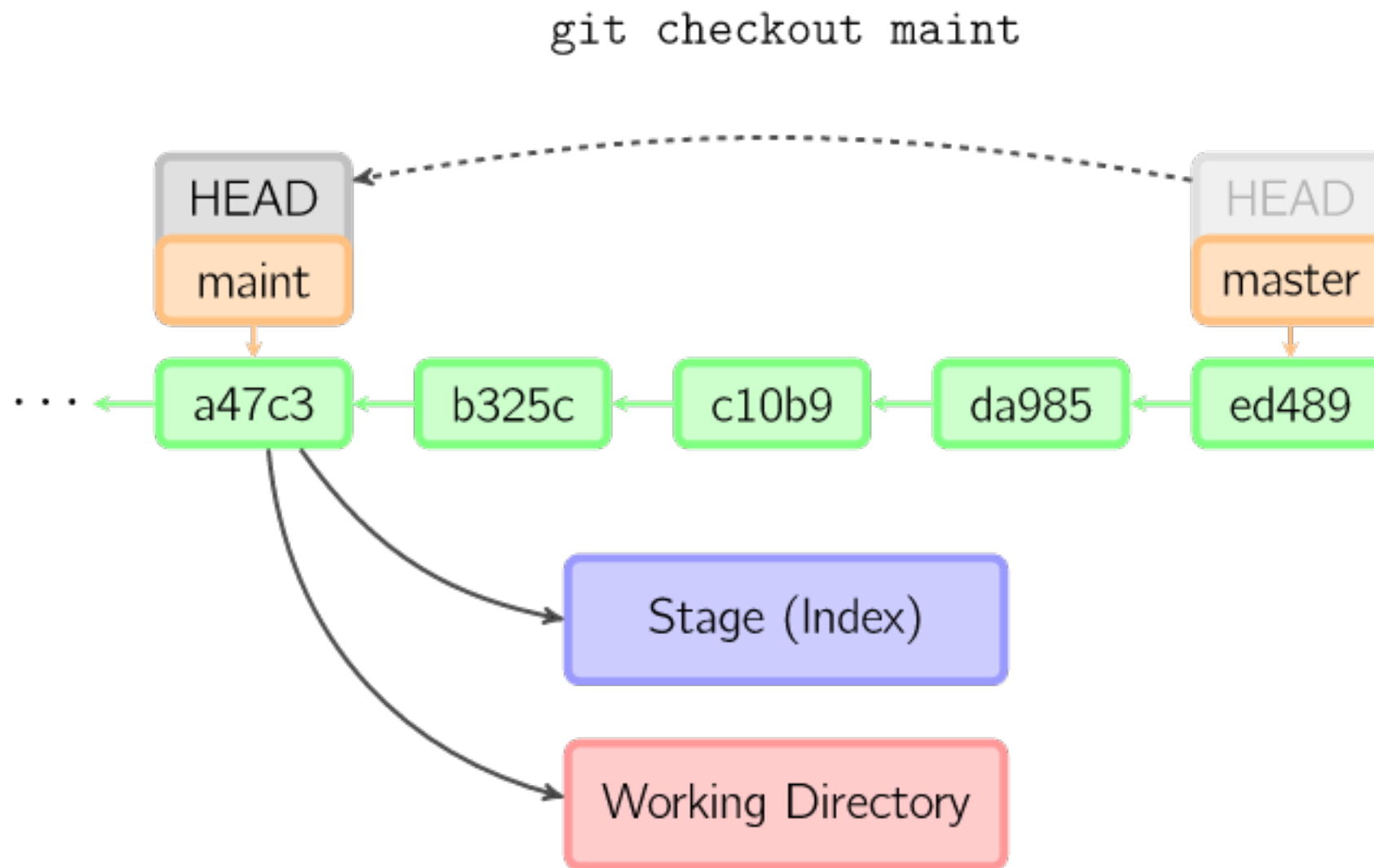
git status

Generates a status report — *use often!*

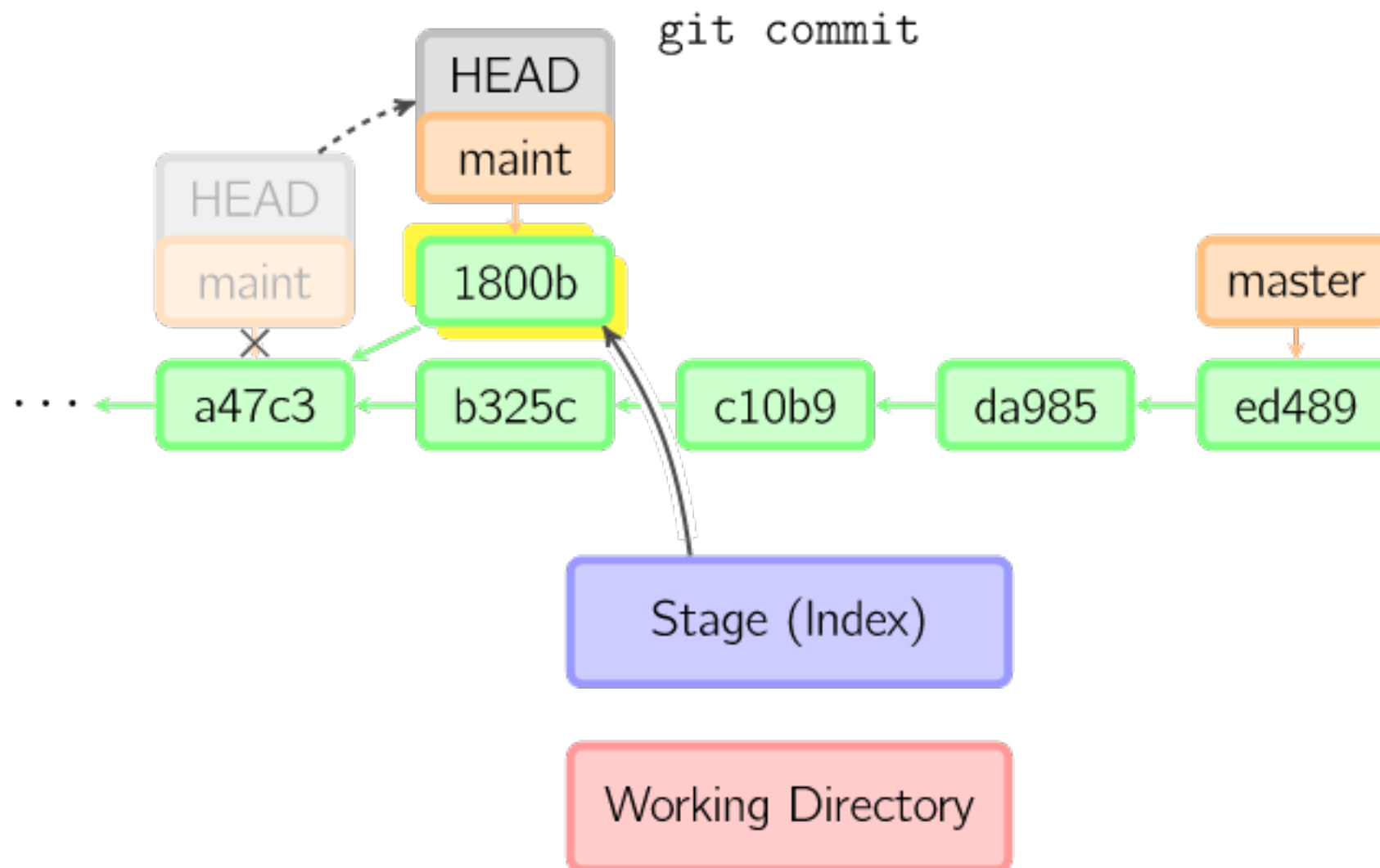
git diff ...



**Switching to another branch moves
HEAD and updates Stage & WD**



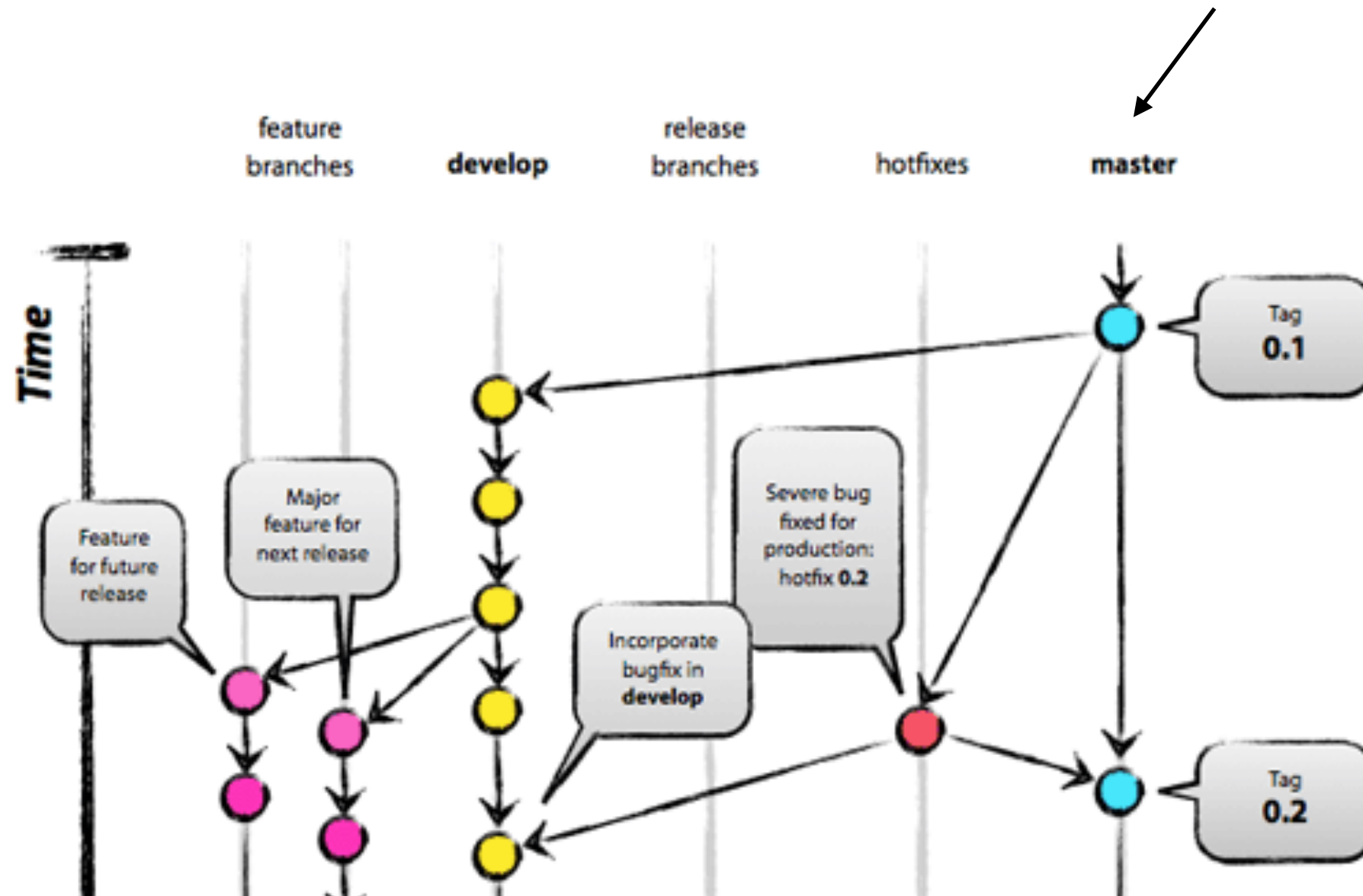
Committing on a branch creates a parallel history



Easily switch between branches (with `git checkout`);
merge verified new content with `git merge`

Branching strategy

master is the (default) deployable branch—what you want non-developers/ non-collaborators to see



From <http://betterexplained.com/articles/aha-moments-when-learning-git/>

.gitignore

The (optional) `.gitignore` file tells Git what files to ignore when it checks the repo status to advise you on what to add & commit. E.g.:

- Large data files that won't be edited/changed, or that you don't want copied when your repo is cloned or pushed to another location
- Binary executables (large but easy to re-create)
- Interpreter/compiler output (.o, .pyc...)
- IDE or editor metadata files (.Rproj.user/...)
- Images?

See <https://github.com/github/gitignore/> for a collection of example `.gitignore` files

GitHub

- A web-based Git repository hosting service
 - *Usually just host commits there*
 - *Collaborate with other developers*
 - *Share work with the public*
- Sync GitHub repo with local repo via `push` and `pull`
- Other features: GitHub Pages, Wikis, issue tracking...
- GitHub organizations: A collection of separate repos associated with teams; provides membership/access control

CU-BDA-2015/Syllabus

GitHub, Inc. [US] <https://github.com/CU-BDA-2015/Syllabus>

Apps <https://www.kahleru> Weather Google Maps Wikipedia News Popular Shopping Passkey Other Bookmarks

This repository Search Explore Gist Blog Help tloredo + -

CU-BDA-2015 / Syllabus Unwatch 1 Star 0 Fork 0

Syllabus for STSCI 4780 - Bayesian data analysis: Principles and practice — Edit

5 commits 1 branch 0 releases 1 contributor

branch: master Syllabus / +

Add software info files generated by OmniOutliner, to test before lin... latest commit 9028c5b162

tloredo authored 20 hours ago

SoftwareInfo	Add software info files generated by OmniOutliner, to test before lin...	20 hours ago
README.md	Added textbook pub link	21 hours ago

README.md

STSCI 4780 - Bayesian data analysis: principles and practice

Lectures: Tuesdays & Thursdays, 1:25pm - 2:40pm, in Upson 109
Labs: Fridays, 2:55pm - 4:10pm, in Phillips 213

Instructor:
Tom Loredo
Center for Radiophysics & Space Research, and Field of Statistics
620 Space Sciences Building
loredo@astro.cornell.edu
Office hours: Wednesdays, 3pm - 4pm, and by appointment

Teaching Assistant:
Kerstin Frailey
Dept. of Statistical Science

Code

Issues 0

Pull Requests 0

Wiki

Pulse

Graphs

Settings

HTTPS clone URL

<https://github.com/loredo/STSCI4780>

You can clone with [HTTPS](#), [SSH](#), or [Subversion](#).

Clone in Desktop

Download ZIP

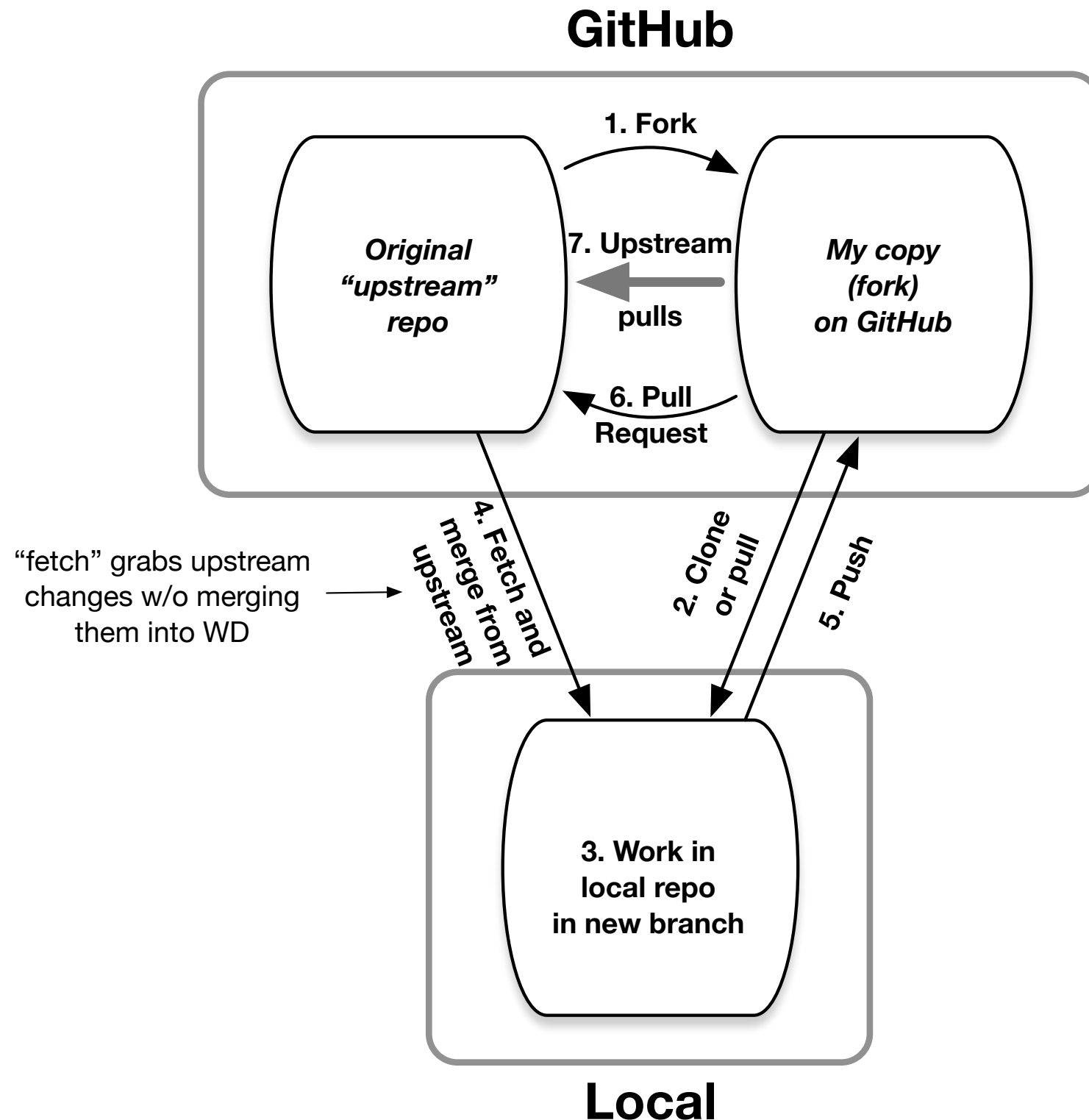
README handled
specially →

Rendered README
Markdown →

GitHub workflows

Fork-based

← The workflow used for open-source projects

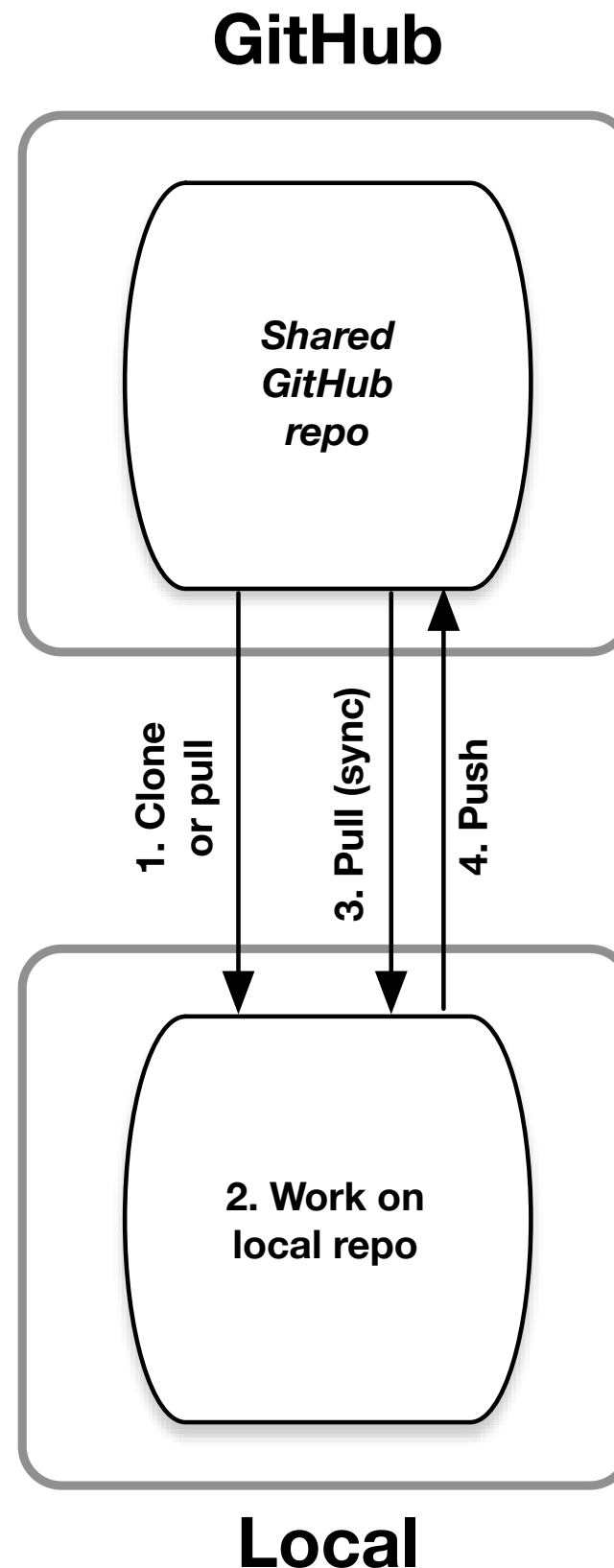


For details see:

- [Git/GitHub Walkthrough \(CU CS5152\)](#)
- [Forking workflow tutorial \(Atlassian\)](#)
- [GitHub forking workflow](#)

Centralized ←

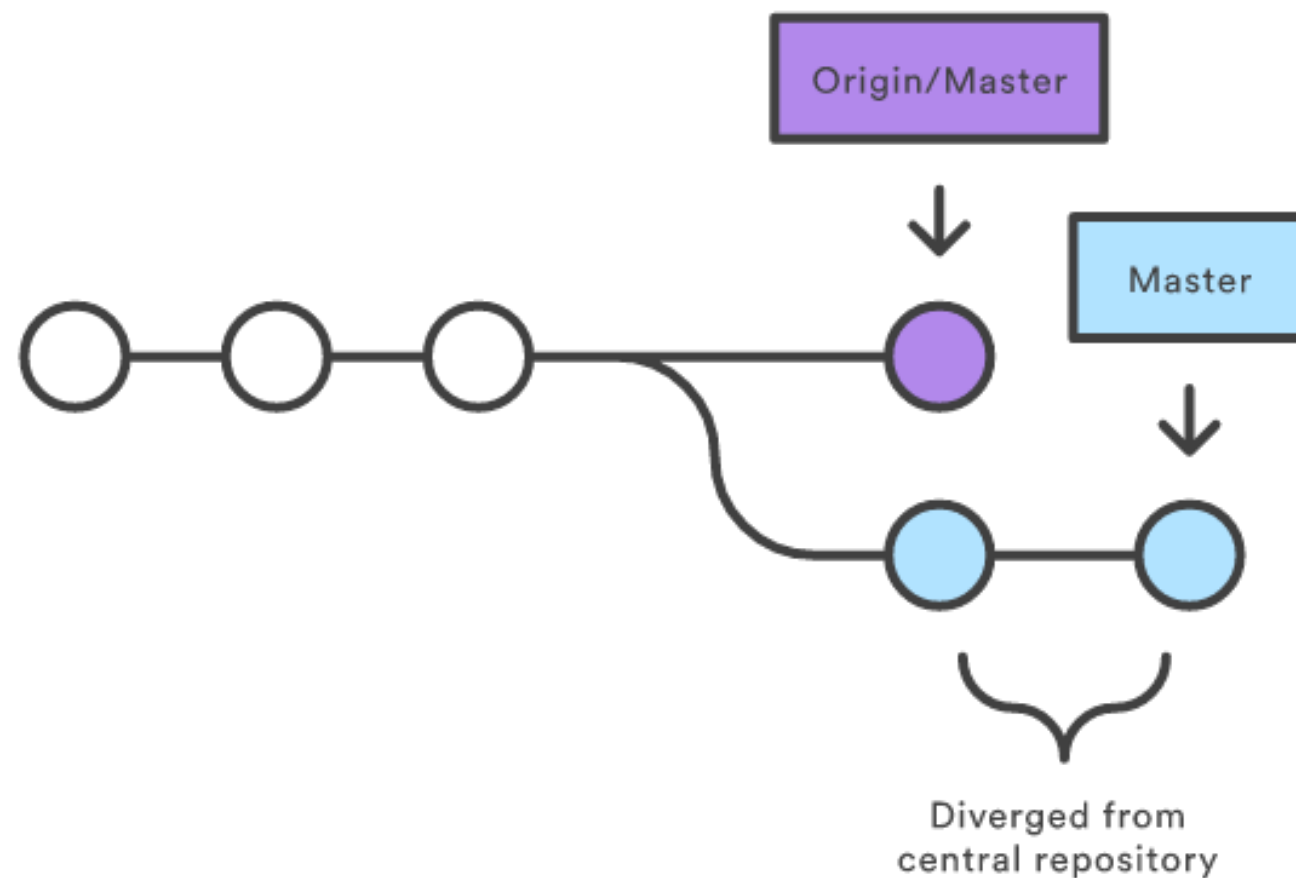
**The workflow we'll
use for assignments**



Always do (1) before you start working on anything that others may have contributed to. If you have work you haven't pushed back yet, commit first.

Pulling: merge or rebase?

If others have pushed changes upstream in the time since your previous pull or clone, then your commits effectively have created a branch (your branch is the local *master* branch, the new content on GitHub is on an *origin/master* branch from your perspective):



Two ways to handle this — *merge policy* vs. *rebase policy*; see:

<https://www.atlassian.com/git/articles/git-team-workflows-merge-or-rebase/>

<https://www.atlassian.com/git/tutorials/comparing-workflows/centralized-workflow>

Merge policy

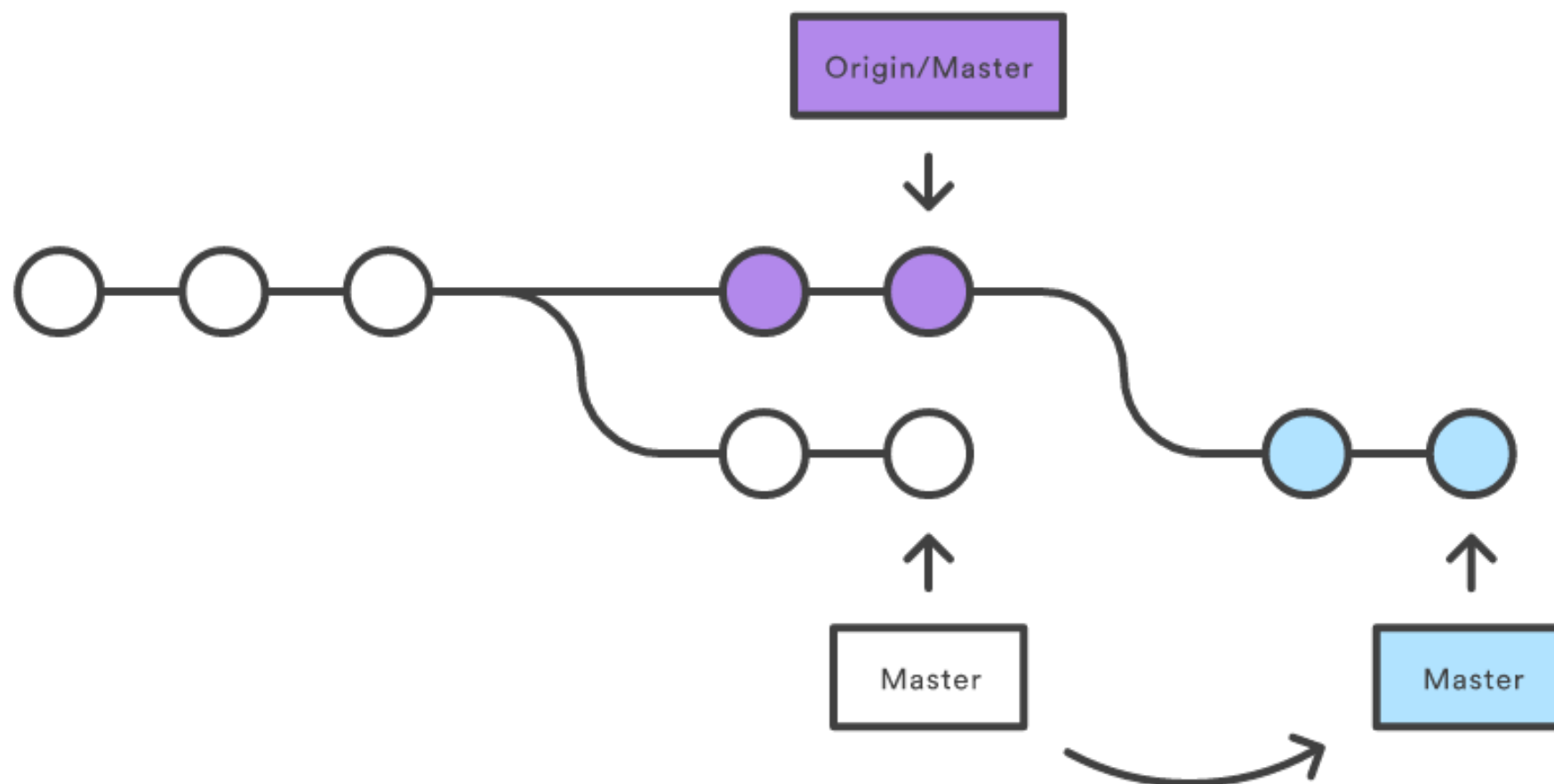
Treat the upstream commits like a genuine branch and **merge** them into *master*; this is what `git pull` offers to do by default.* This is the simpler option. This records merges in the repo history, making the history look complicated even if there are no conflicts between changes. But this can be useful for tracing changes. ***This is safest for non-experts.***

* As long as there are no conflicting edits in the pulled content, git pull will merge the pulled content into your history, and launch an editor asking you for a message explaining the merge. *You can safely ignore the request and quit the editor.* Some Git GUIs do this by default.

Rebase policy

Rebase your master branch (alter the history of the master branch), pulling the changes from *origin/master*, and shifting your new commits **after** the pulled commits in the local *master* history. This makes it harder to trace the commit history, but keeps the history linear. *Rebasing will cause problems if origin/master has some of your post-branch changes!* Only do it if none of your changes have been shared with anyone.

```
git pull --rebase origin master
```



See <https://www.atlassian.com/git/tutorials/comparing-workflows/centralized-workflow>

Getting started with Git

Identify yourself

```
git config --global user.name "YOUR NAME HERE"  
git config --global user.email "me@mydomain"
```

Suppress an annoying warning (may not be necessary)

```
git config --global push.default simple
```

To create a repo—two options

- New (empty) repo in the current directory:

```
git init
```

E.g., use this to make a repo for experimenting with Git commands.

- Clone an existing repo in the current directory (e.g., CourseInfo):

```
git clone https://github.com/CU-BDA-2018/CourseInfo.git
```

URL grabbed from GitHub page

Git/GitHub Exercise

- **Command-line practice** (in a folder where you'll do your project coding)
 - On GitHub, create a new repo in your account, with the default README.md
 - Clone the GitHub repo onto your computer, in your practice folder, using:
`git clone URL-to-repo`
 - Inside your practice folder, use a text editor to edit the README.md plain text file, changing its Markdown content, and save it
 - Using git, add and commit the new content to your local repo
 - Push your changes back to GitHub (remember to *pull first* to sync with any changes made in the meantime); check on GitHub to verify the push worked
- **GUI practice** (e.g., with SourceTree)
 - Connect your GUI with your local copy of your project's GitHub repo
 - Pull any pending changes
 - Make some changes to your README.md file, and save it
 - Use the GUI to add and commit your changes
 - Push the changes back to GitHub (pull first to sync!)

Assignment

Due: Thursday, 30 Jan, 11:59pm (i.e., end of Thursday)

- Create a new, empty repo in our GitHub org; name it **me-BDAOrg** where "me" is your GitHub username. *This will be your repo for all of your BDA course assignments*, with each future assignment in its own directory.
- Create a directory on your computer where you'll maintain a local copy of your repo; start a command-line session and make this your working directory (e.g., "cd" into it).
- Clone the GitHub repo onto your computer by grabbing its URL from the GitHub page and using it like this:
`git clone URL-HERE`
You may get a warning that the repo is empty; it's a warning, not an error, so you can ignore it.
Note that cloning *creates a new directory* in your current directory for the repo; you will work inside that directory. Feel free to move it after cloning; that doesn't affect its connection to GitHub.
- Create a README.md file in the clone's working directory using the text or Markdown editor of your choice, or edit the default README.md if you asked GitHub to create one.
- Write a **short** (about 1/2 to 1 page if printed) description of yourself and your motivation for taking this course, including:
 - Your name, major, and student status (year)
 - A brief description of a data analysis problem or class of problems that interests you. This could be a problem from a lab course, a thesis project, academic literature in your field, or from the public media.
 - Include one image that shows an example of data pertaining to the identified problem. Copy the image itself into your repo, and use it in your Markdown text. See the [GitHub Markdown Guide](#) for quick instructions, or the [GitHub Markdown Specification](#) for gory details (the "PythonForBDA.md" file in the LabResources repo provides an example).
 - As you work, commit your work into your local repo multiple times, when you reach natural stopping points (see note on next slide).

- **Note:** Once you've made your first commit in the initially empty local repo, git automatically creates the default **master** branch. It does not yet exist back on GitHub. If you run `git status` (as you should, often!), you'll get a message that "the upstream is gone." Ignore it; it's just cryptically stating the obvious that what you just created locally is not yet back on GitHub. Once you push your revised repo back to GitHub, `master` will exist there and the message won't reappear.
- If you are using a plain text editor, you won't be able to see the rendered README.md file until you commit it and send it back to GitHub. To do so, you need to **push** your repo back to GitHub (you'll be prompted for your GitHub login):
`git push`
 If you are using a Markdown editor, you won't have to push until you're finished.
- When you are finished, after your final commit, "bookmark" that commit with an **annotated tag**:
`git tag -a Submitted -m "Submitted assignment"`
- Push your final tagged state back up to GitHub. By default, git does not push tags, so you have to tell it to do so; this is to make sure you really want to share the tag with *everyone* (vs. just using it for your own bookkeeping):
`git push --follow-tags`
- Verify the project on GitHub:
 - Go to your repo and make sure the README.md file appears as it should.
 - Make sure the tag was pushed: Near the top of the GitHub repo page there will be a line reporting the number of commits and branches. It should also say there is 1 "**release**" —GitHub treats tags specially, as a version of your project you want to release to users. If you click on "release" you'll find GitHub has created an easy-to-download compressed archive of your project's tagged working directory.

Grading: This assignment is worth 3 points
 3=All requirements met; 2=One or two notable shortcomings;
 1=Appears to be half-hearted attempt; 0=Not handed in