Distributed version control with Git

Part 1:
Working locally

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https://gitlab.com/dmsussman/workingWithGit/

SYRACUSE SOFT MATTER PROGRAM

Common commands / outline of talk

Command	Description
git init	Initialize a git repository / this talk
git add ***files***	Add the files to the staging area
git status	View the status of files in working directory and staging area
git commit –m “***message***”	Record a snapshot of the staging area
git checkout	Switch branches or checkout a file / commit
git log, git diff	View a record of commits; see what is different between versions of a file
git help ***[verb]***	Get help on the specified command

What is version control?

A (systematic) way of managing multiple versions of programs, documents, databases, etc.

Theorem: Almost all real projects use some kind of version control.

Corollary: ....

Why use version control?

Team work:

* Makes working collaboratively much easier

Individual work:

* Scientific reproducibility of code
* Magical time machine for reverting to previous version of code

Git is a distributed system for version control

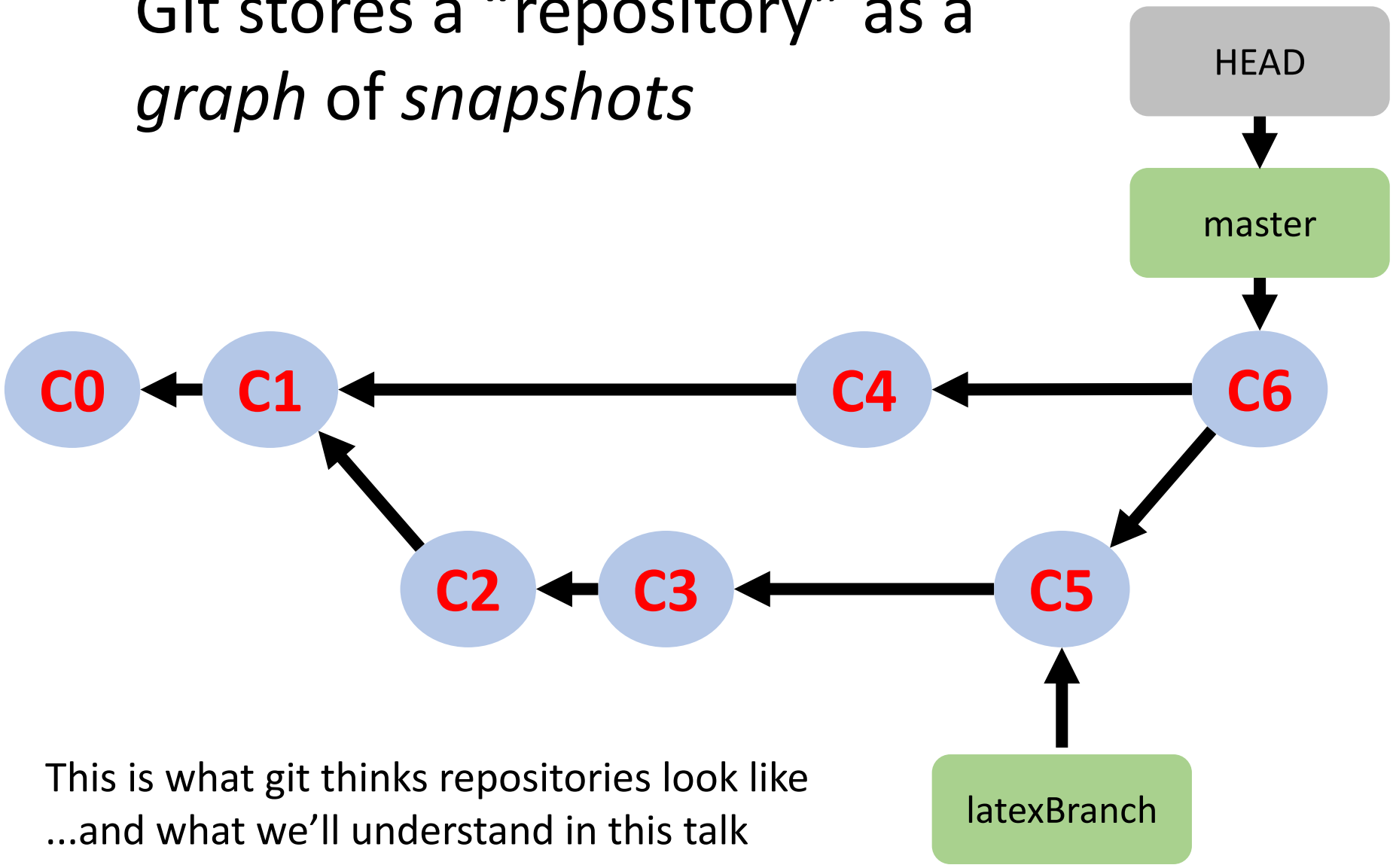
Distributed:

- No copy of a repository is more important than others (except by convention)
- Get version control even if offline

Git advantages:

- Very resilient (because it's distributed)
- Very fast
- Very compressed (favors frequent, small updates)
- Very widely used (every git question, ever, has been asked on Stack Overflow)

Git stores a “repository” as a *graph* of *snapshots*



This is what git thinks repositories look like
...and what we’ll understand in this talk

Step 0: install git

Is git already on your computer?

Type ”git –version” on the command line to find out

If not...

Windows: https://git-for-windows.github.io/

Mac: https://sourceforge.net/projects/git-osx-installer/files/

or “brew install git” or...

Linux: “sudo apt-get install git” or “sudo yum git” or ...

Set default user name and email

```
$ git config --global user.name ”My Name”
$ git config --global user.email ”myEmail@email.email"
```

Starting a new repository: the plan

Our basic workflow will be:

(start a repository)

Edit some files

Stage those changes

Review those changes

Commit those changes

... and repeat

Starting a new repository: *git init*

Let's navigate to a blank directory and begin...

```
$ git init
```

We've just initialized an empty repository!

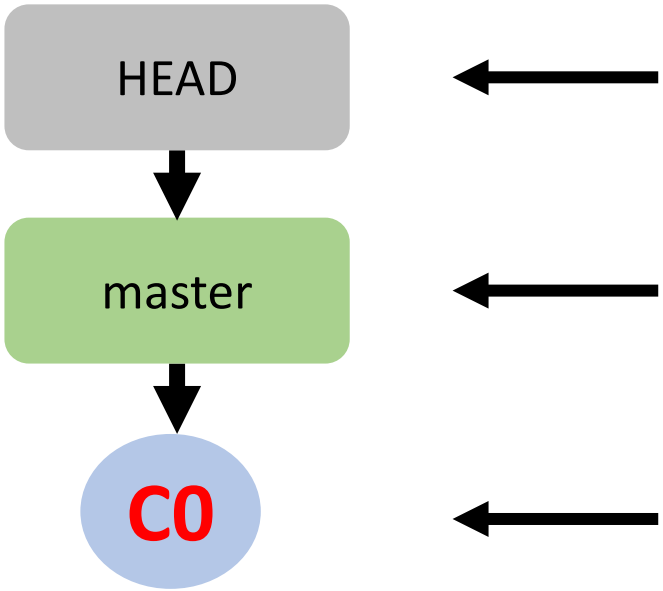
Starting a new repository: *git init*

Hey, it turns out I'm writing my Ph.D. thesis... in vim
...let's start with a few mystical commands

```
$ vim chapter1.rtf
$ git add chapter1.rtf
$ git commit -m "Chapter 1 finished"
```

Version control does not just have to be code!
We'll follow this pretend project for the rest of the talk

Git's thoughts about this repository



A special pointer referencing current commit

The *branch* that snapshot is on (will be clearer soon!)

A snapshot of the repository... (i.e., "chapter1.rtf")

The (local) trees of git

The "HEAD"

The last committed snapshot of the repository

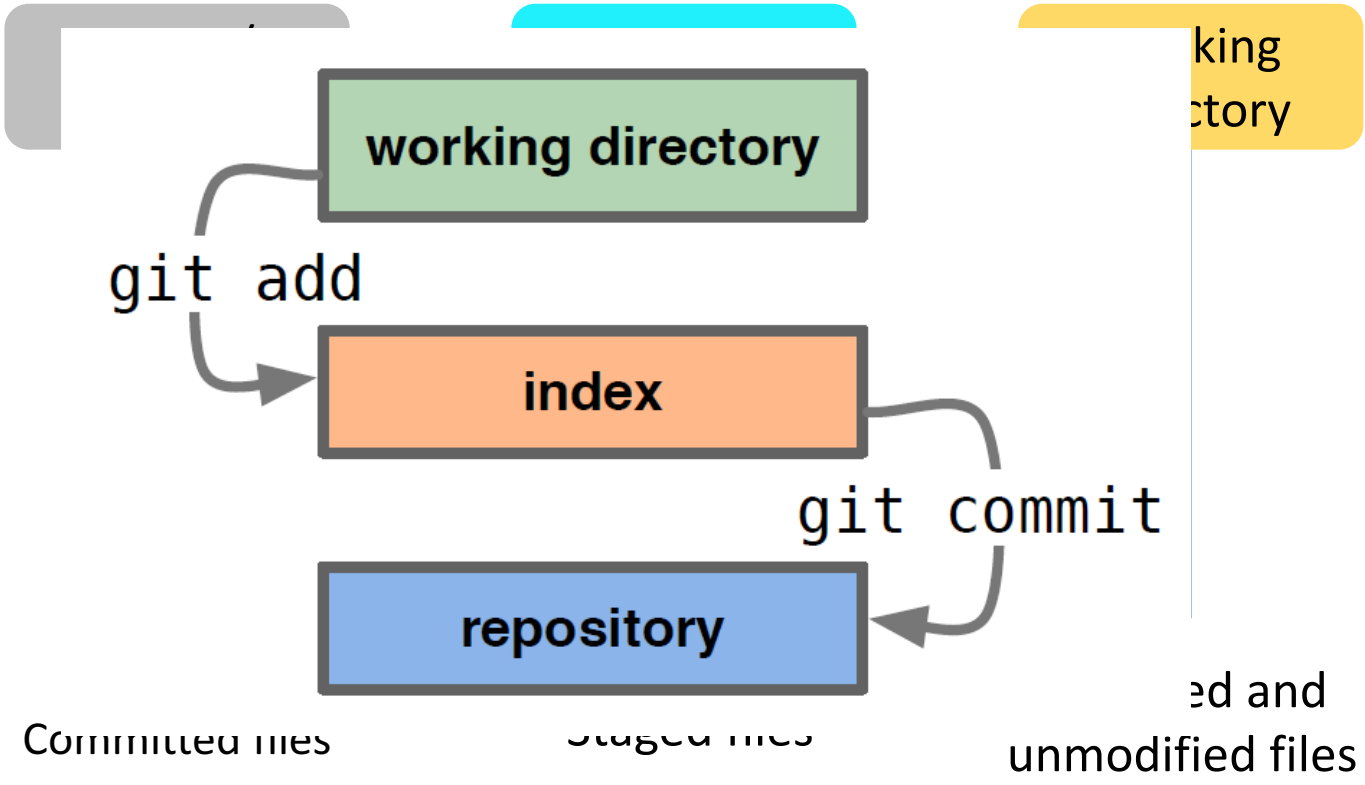
The "Staging area" (or "Index")

A proposed next snapshot

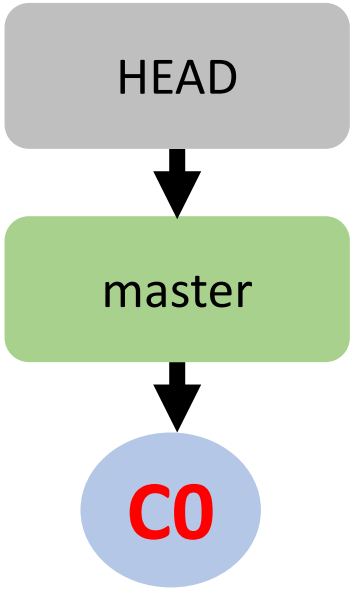
The "Working directory" (or "working tree")

Where you do work!

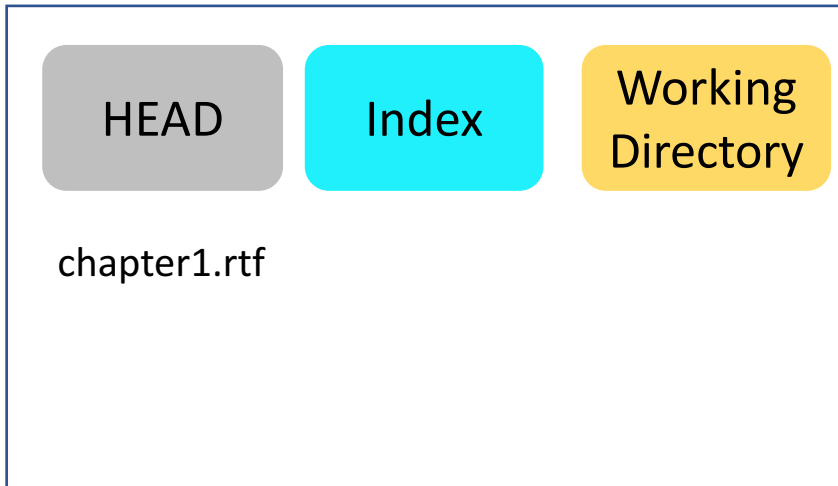
The (local) trees of git



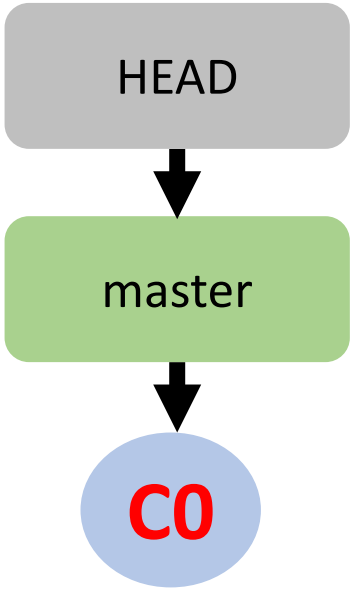
Looking at the current status: *git status*



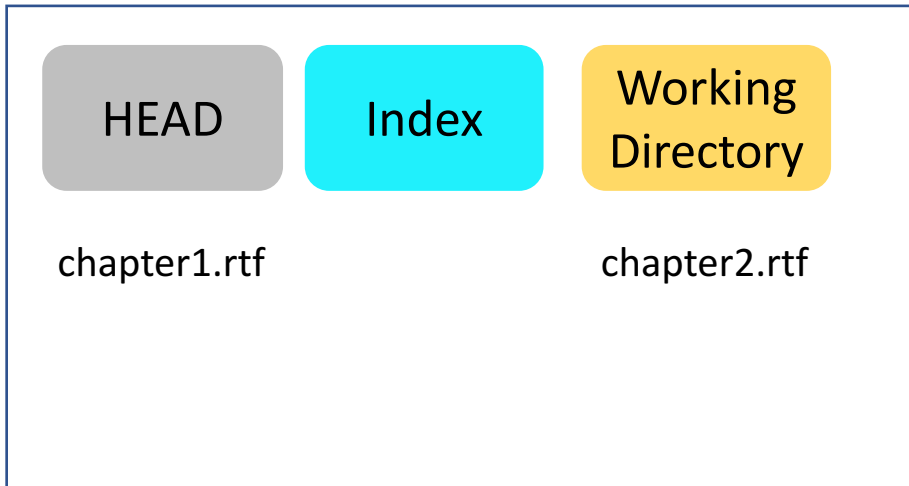

```
$ git status
On branch master
nothing to commit, working tree clean
```



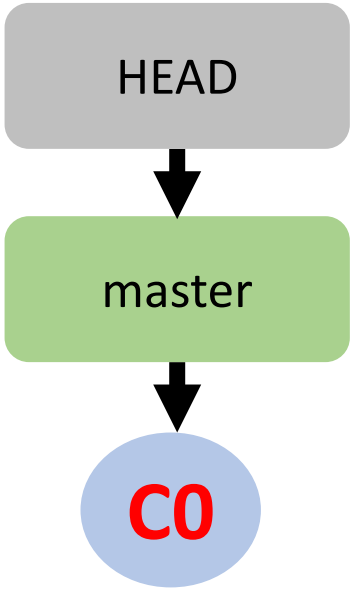
Life cycle of a commit: Editing files




```
$ vim chapter2.rtf
```

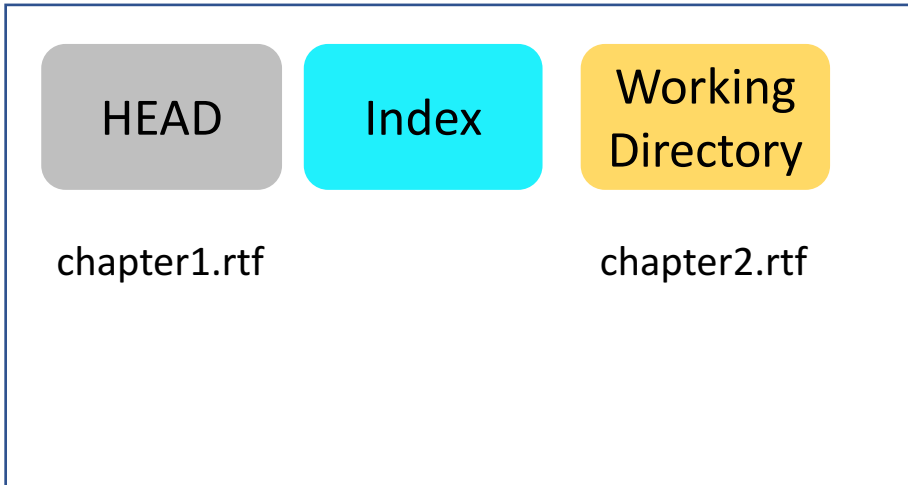


Life cycle of a commit: seeing changes

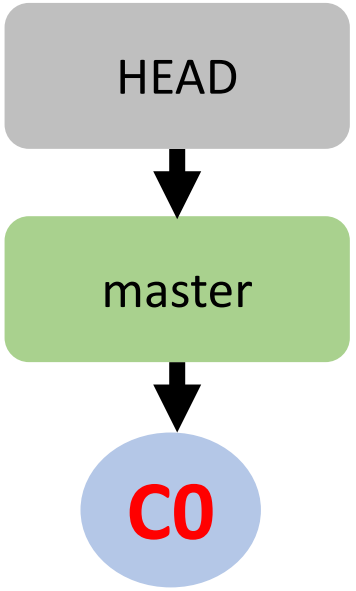



```
$ git status
On branch master
Untracked files: (use "git add <file>..." to
include in what will be committed)
chapter2.rtf
nothing added to commit but untracked files
present (use "git add" to track)
```

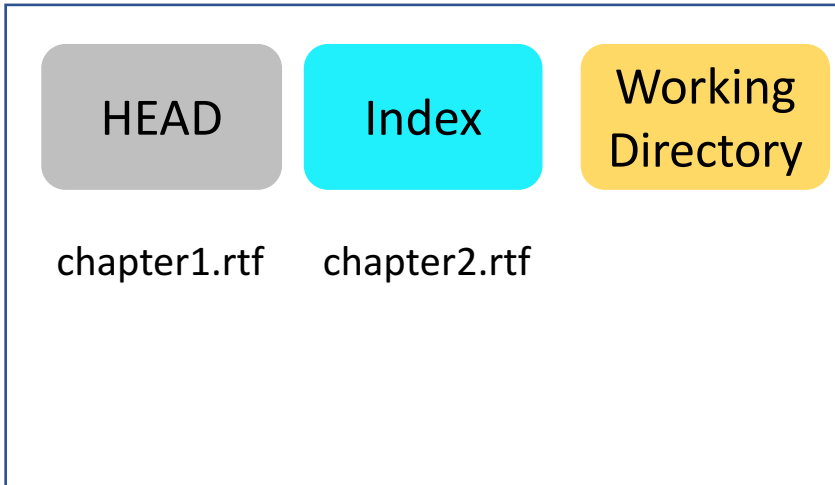
Look at all those helpful messages!



Life cycle of a commit: *git add*

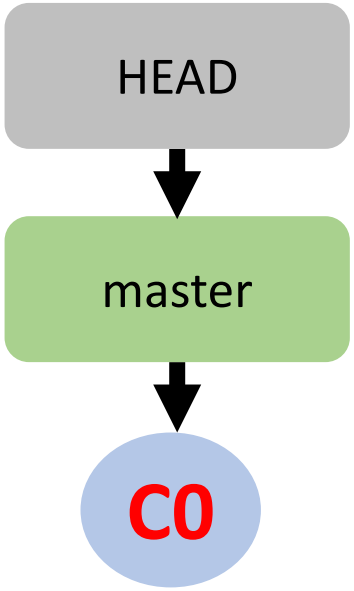



```
$ git add chapter2.rtf
$ git status
On branch master
Changes to be committed: (use "git reset
HEAD <file>..." to unstage)
new file:   chapter2.rtf
```

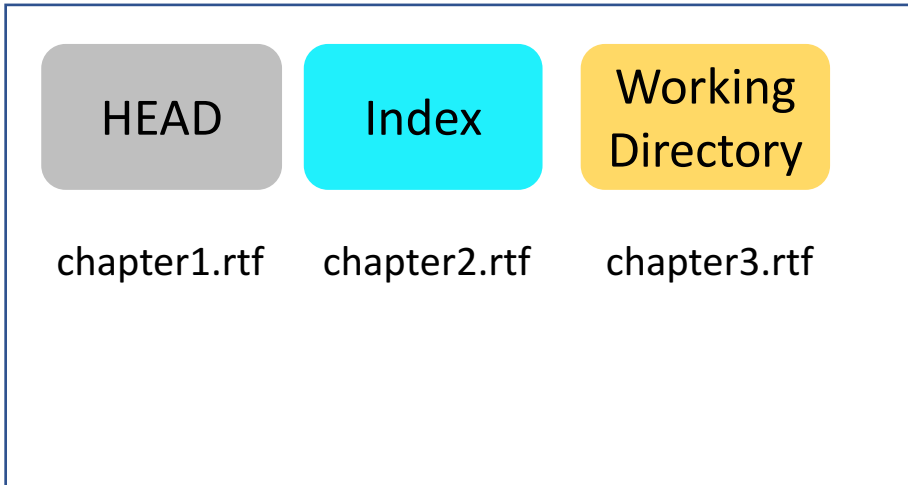


git add stages files to be committed

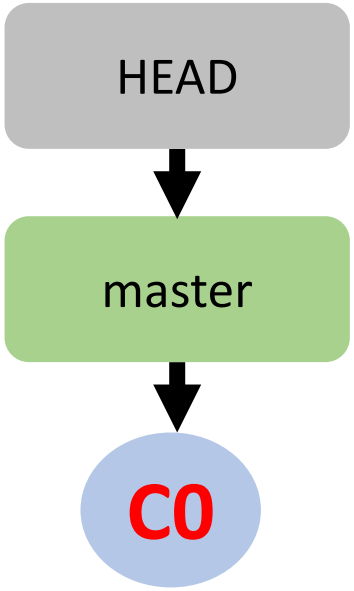
Life cycle of a commit: *git status*



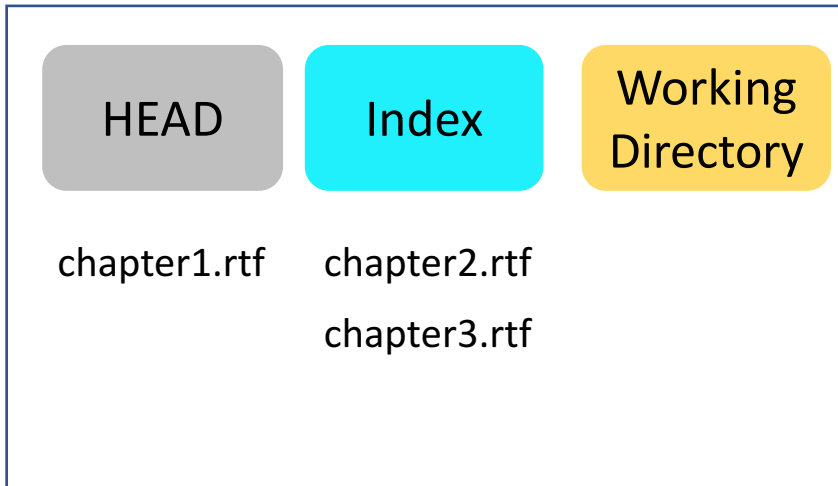

```
$ vim chapter3.rtf
$ git status
On branch master
Changes to be committed:
new file:   chapter2.rtf
Untracked files:
chapter3.rtf
```



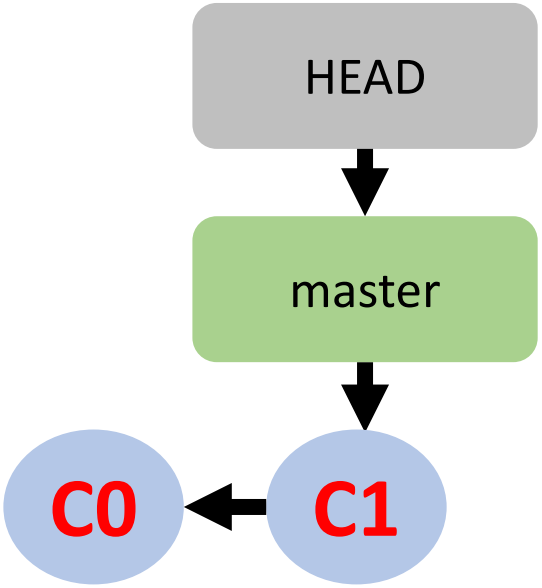
Life cycle of a commit: *git status*




```
$ git add chapter3.rtf
$ git status
On branch master
Changes to be committed:
new file:   chapter2.rtf
new file:   chapter3.rtf
```

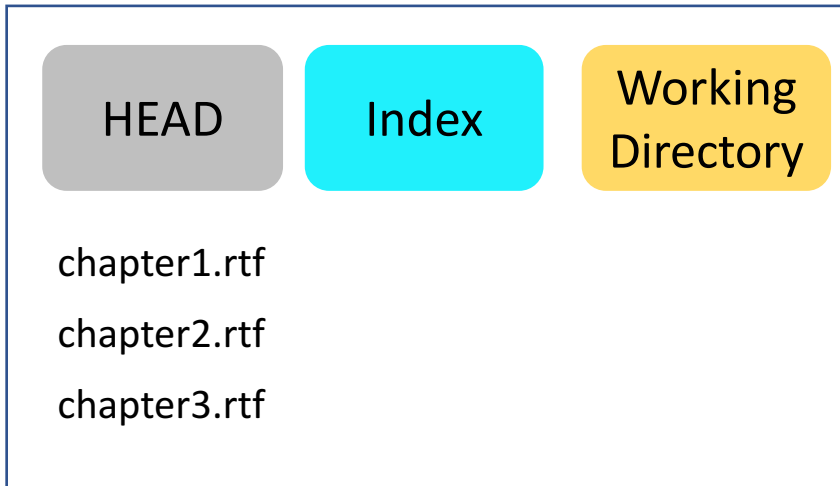


Looking at the current status: git status




```
$ git commit -m "Chapters 2 and 3 written"
$ git status
On branch master
nothing to commit, working tree clean
```

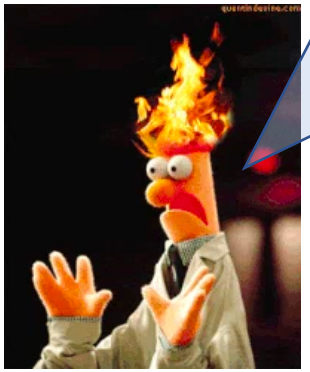
git commit takes a new snapshot
...commit messages are **mandatory**
(and useful!)



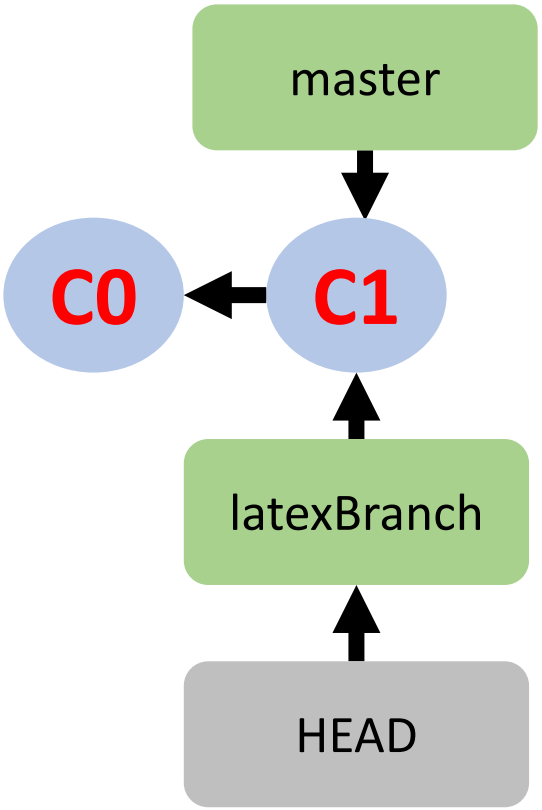
Branches!

After much thought, I've decided ".rtf" format is terrible for a thesis...

...if only I could experiment with an alternative

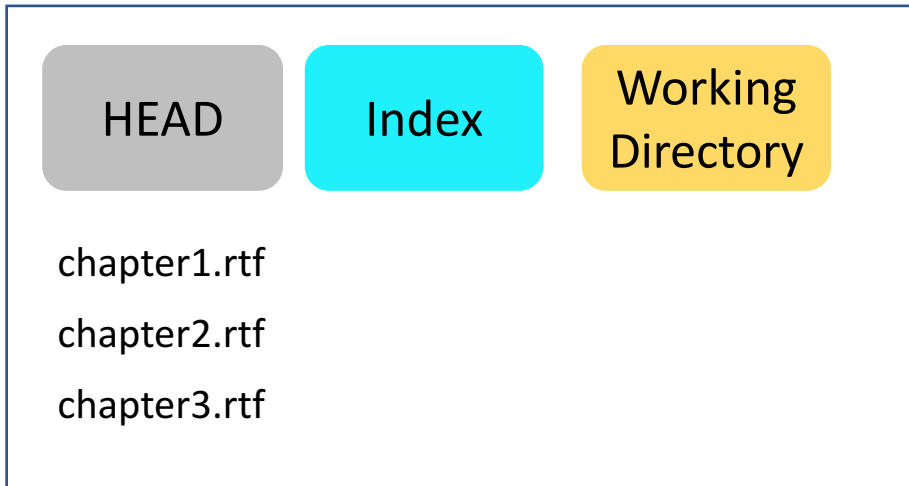


Making a new branch: *git checkout*

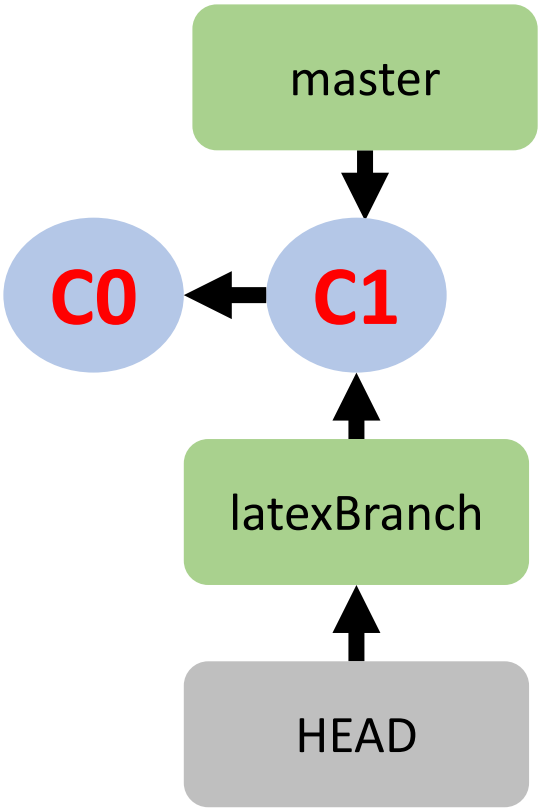



```
$ git checkout -b latexBranch
Switched to a new branch 'latexBranch'
```

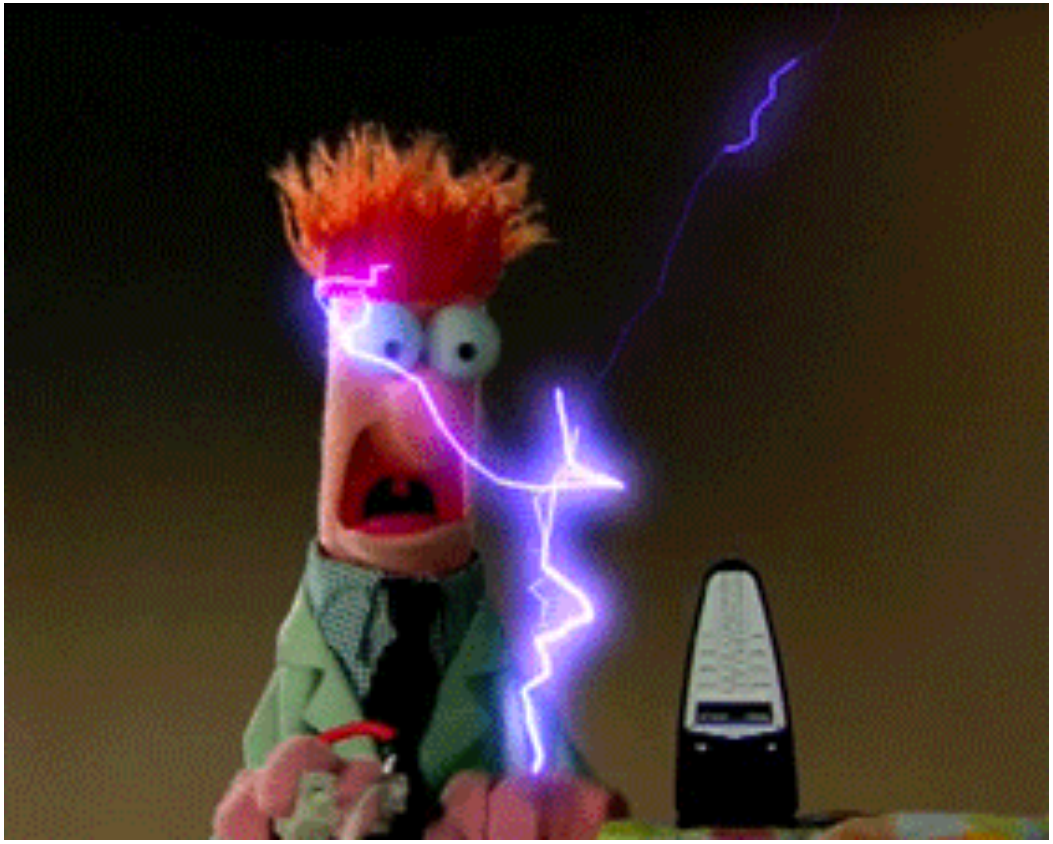
The “-b” option tells git to make a new branch...
we’ll see that checkout is quite powerful



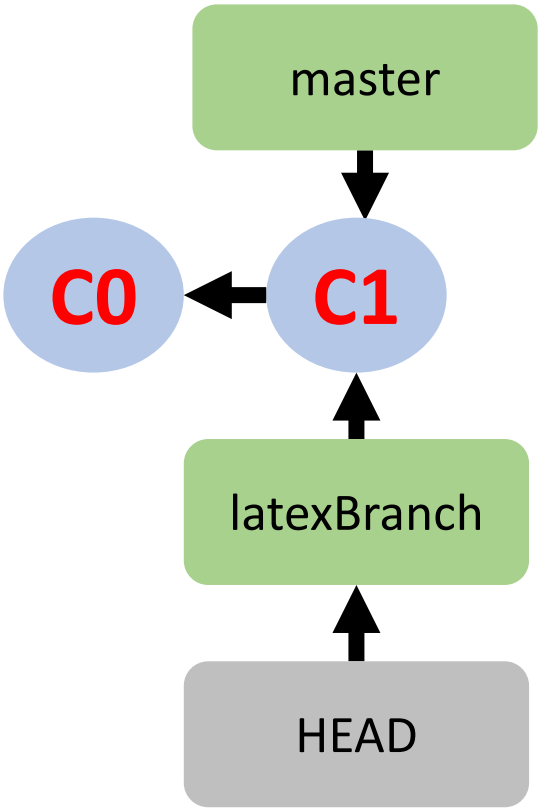
Rescuing me from myself: *git checkout*




```
$ rm chapter1.rtf
```



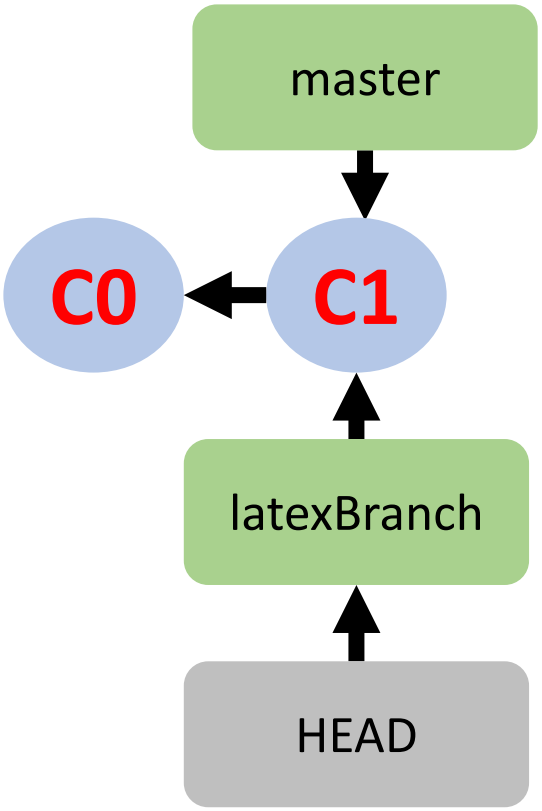
Rescuing me from myself: *git checkout*



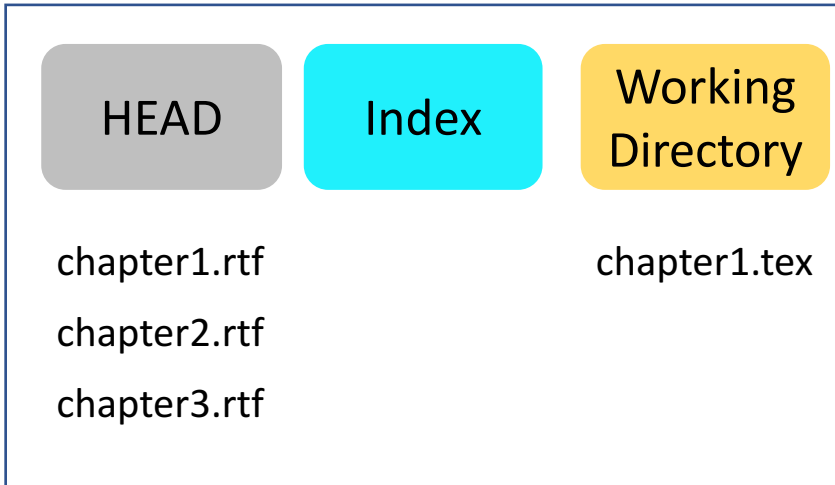

```
$ git status
On branch latexBranch
Changes not staged for commit: (use "git
checkout -- <file>..." to discard changes in
working directory)
deleted:    chapter1.rtf
no changes added to commit
```

HEAD	Index	Working Directory
chapter1.rtf		~~chapter1.rtf~~
chapter2.rtf		
chapter3.rtf		

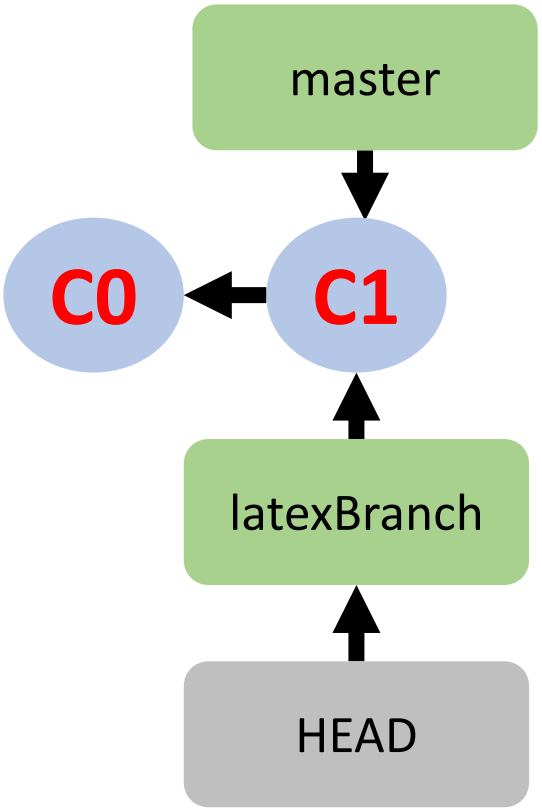
Rescuing me from myself: *git checkout*



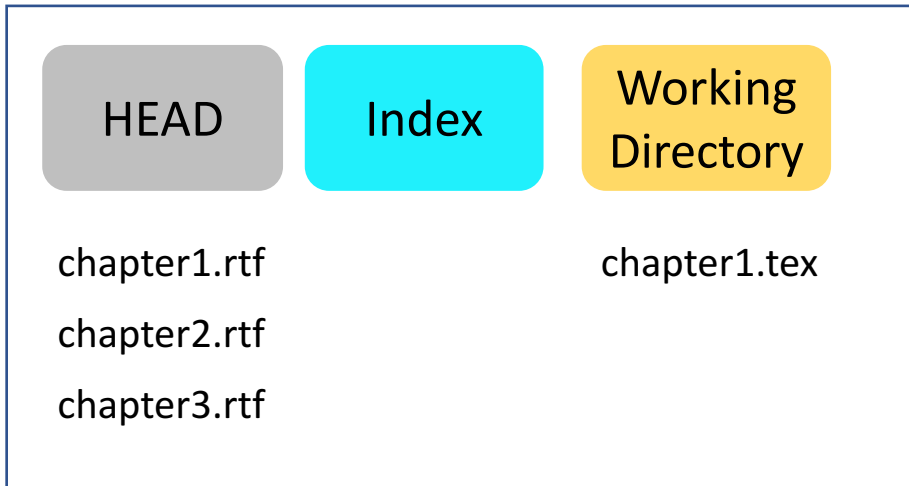

```
$ git checkout -- chapter1.rtf
$ mv chapter1.rtf chapter1.tex
$ vim chapter1.tex
```



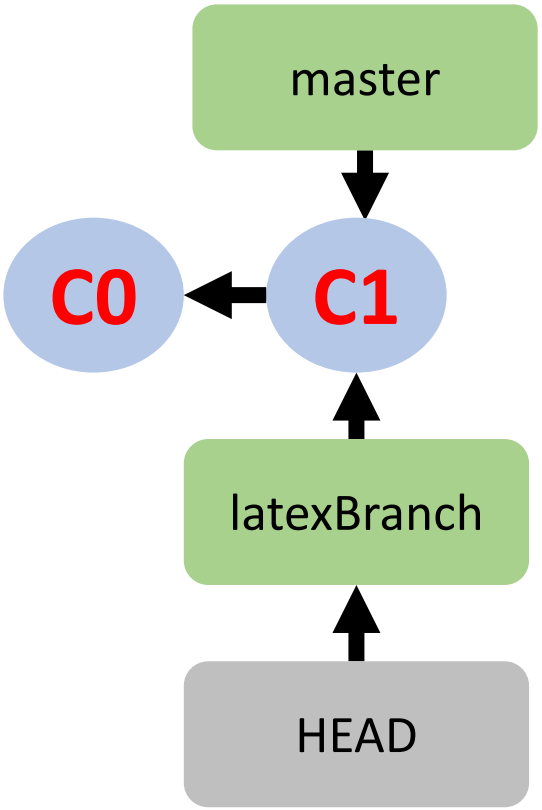
Preparing for a new commit...




```
$ git status
On branch latexBranch
Changes not staged for commit:
deleted:    chapter1.rtf
Untracked files:
chapter1.tex
```



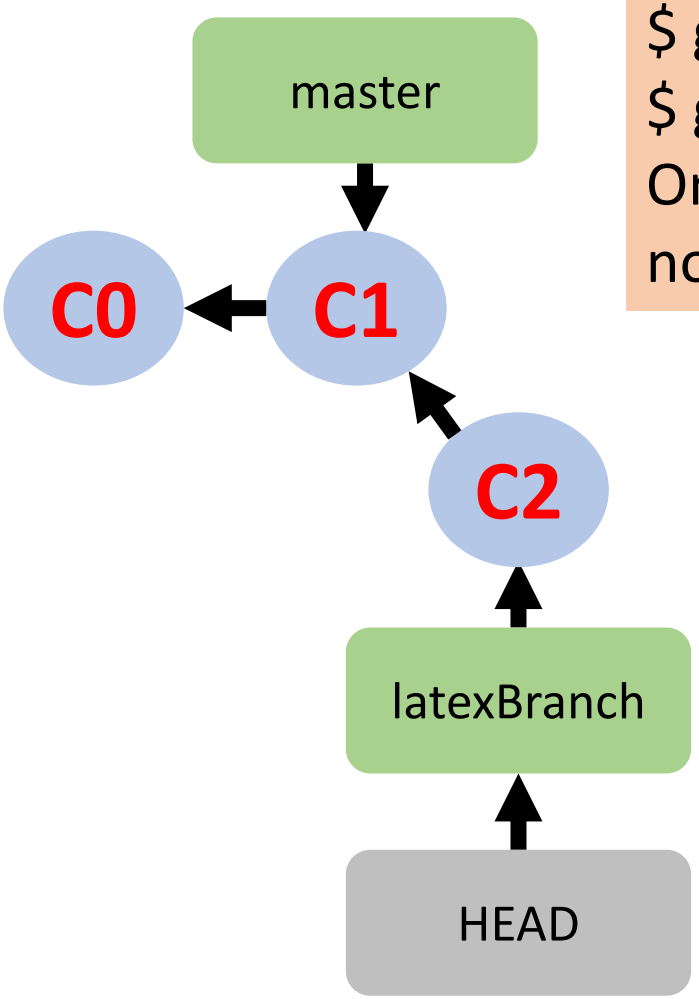
Preparing for a new commit...



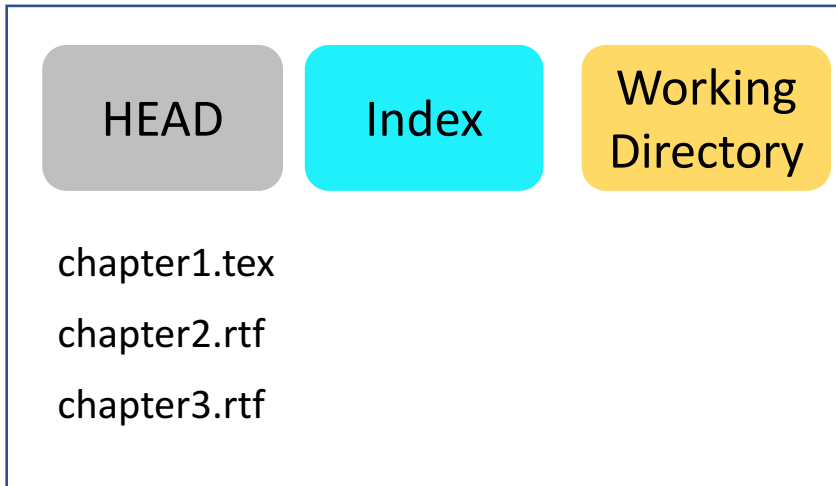

```
$ git add --all
```

HEAD	Index	Working Directory
chapter1.rtf	chapter1.tex	
chapter2.rtf		
chapter3.rtf		

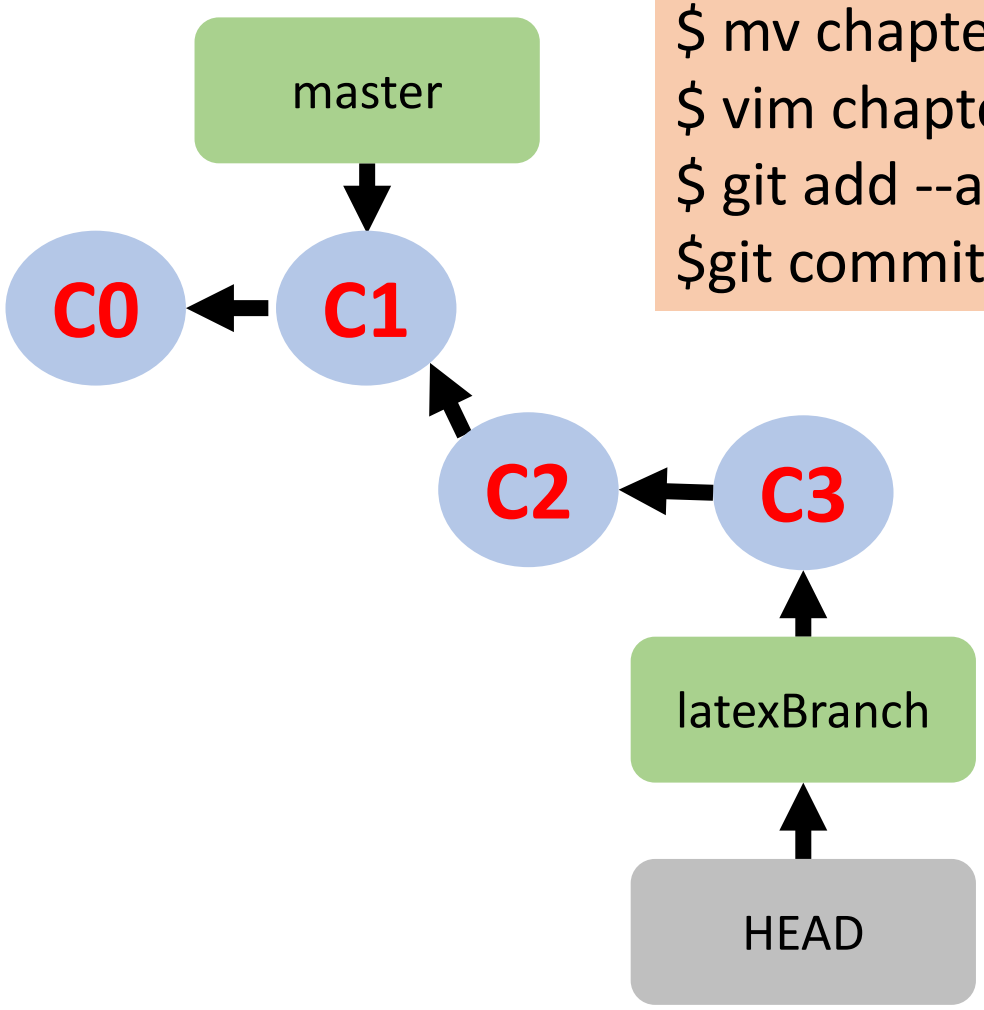
Committing the new branch



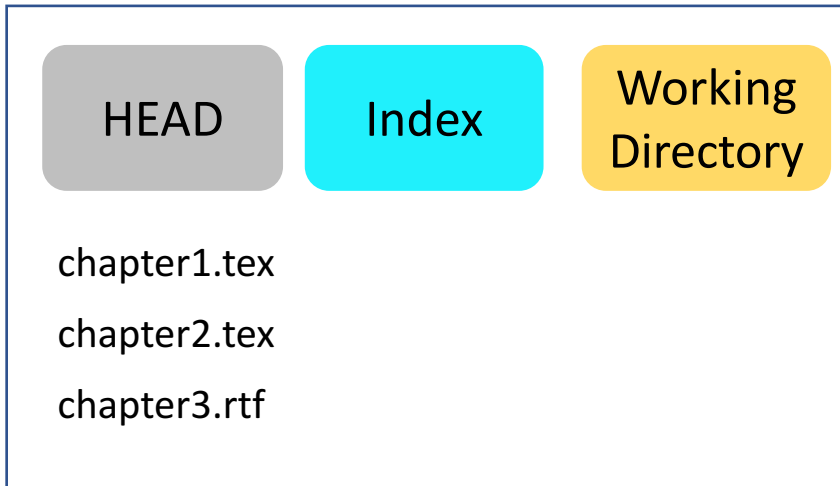

```
$ git commit -m "re-wrote chapter 1 in tex”
$ git status
On branch latexBranch
nothing to commit, working tree clean
```



Extending the branch



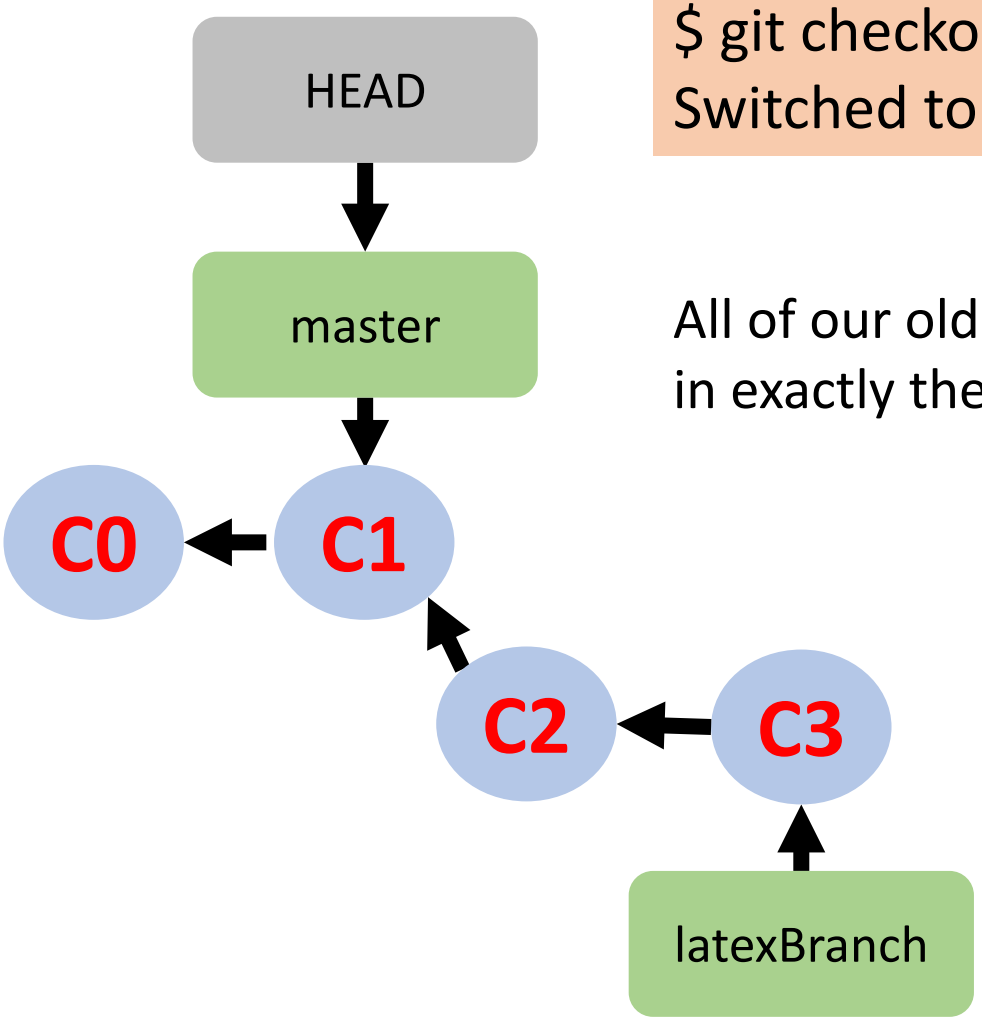

```
$ mv chapter2.rtf chapter2.tex
$ vim chapter2.tex
$ git add --all
$git commit -m ”converted chapter 2 to tex”
```



Moving around the git tree: *git checkout*

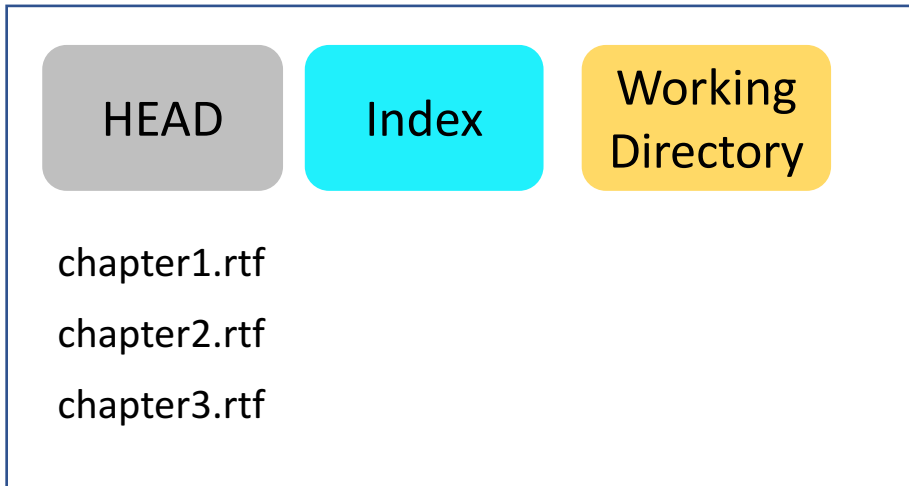
*My advisor just asked for **another** chapter, and I haven't finished converting everything to TeX yet!*

Moving around the git tree: *git checkout*

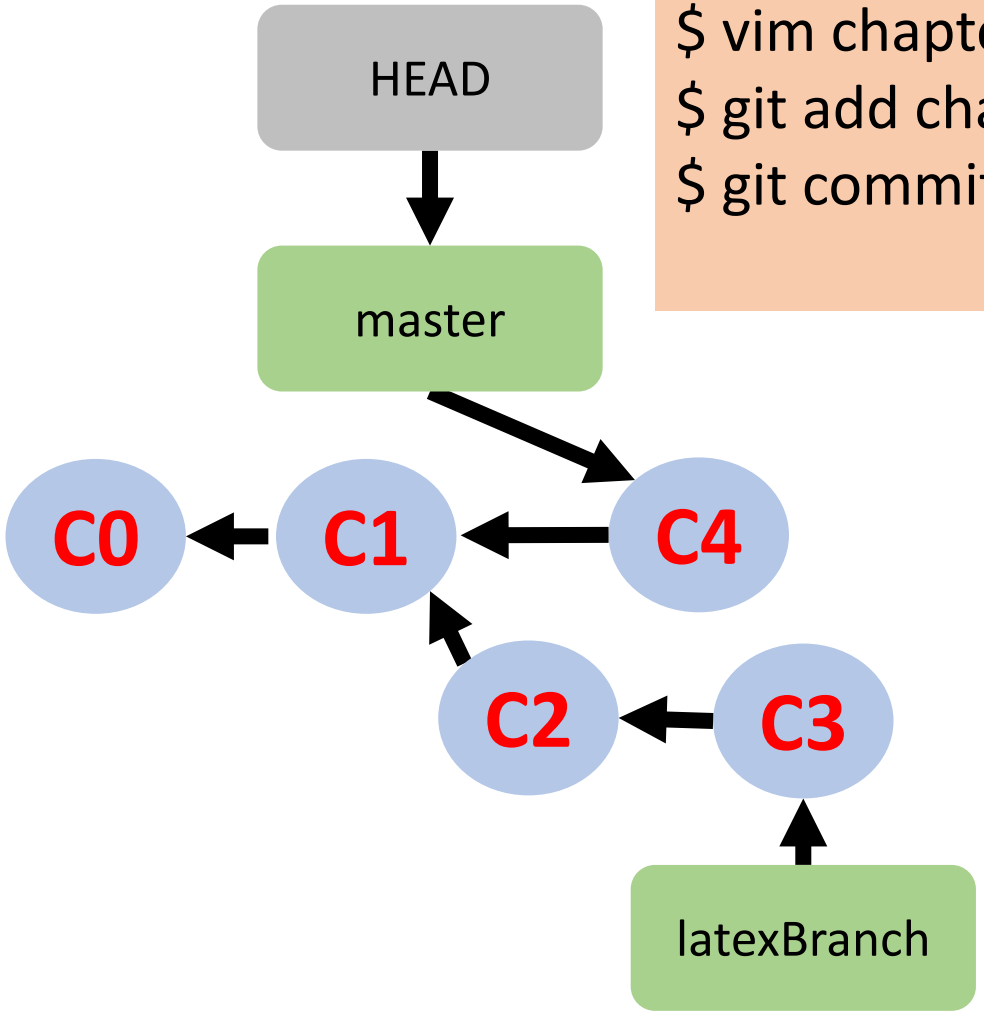



```
$ git checkout master
Switched to branch 'master'
```

All of our old .rtf files are still there,
in exactly the state we left them in!



Moving around the git tree: *git checkout*




```
$ vim chapter4.rtf
$ git add chapter4.rtf
$ git commit -m “Chapter 4 written in garbage
                                format”
```

HEAD | Index | Working Directory

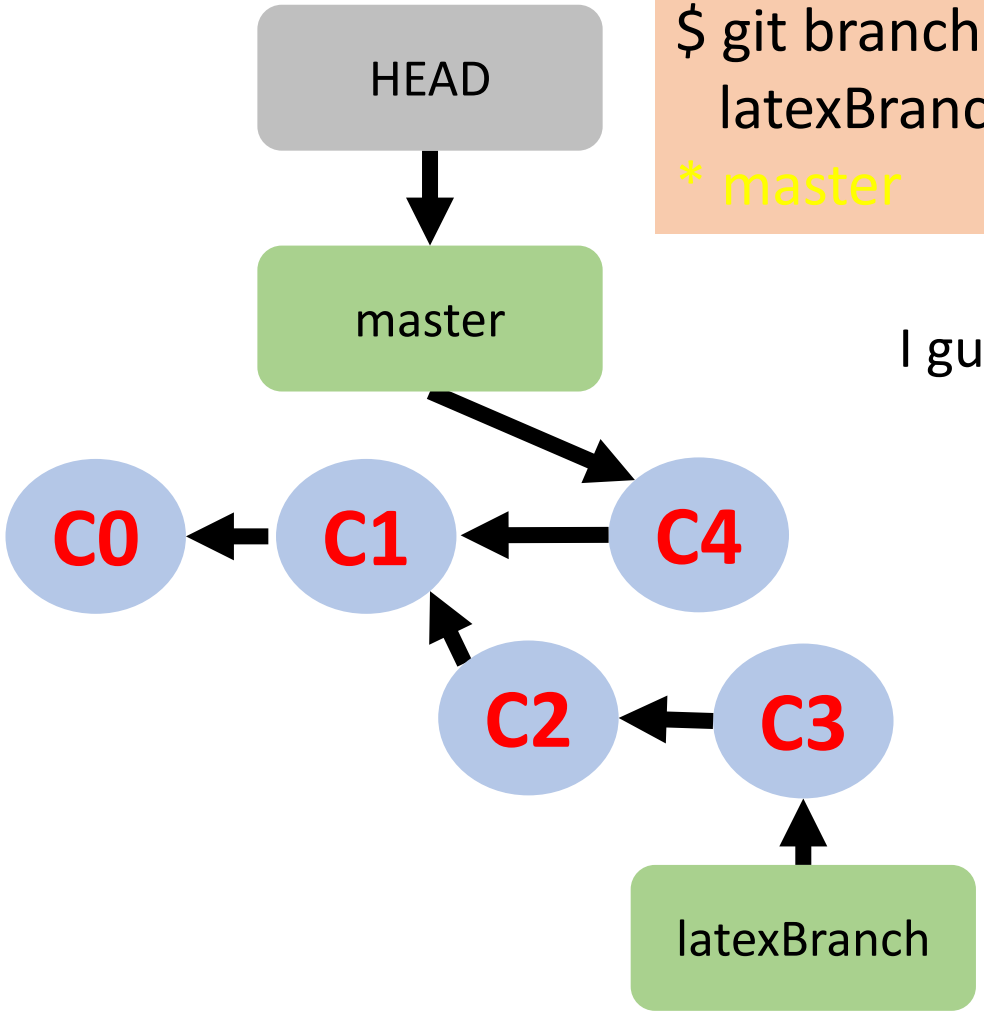
chapter1.rtf

chapter2.rtf

chapter3.rtf

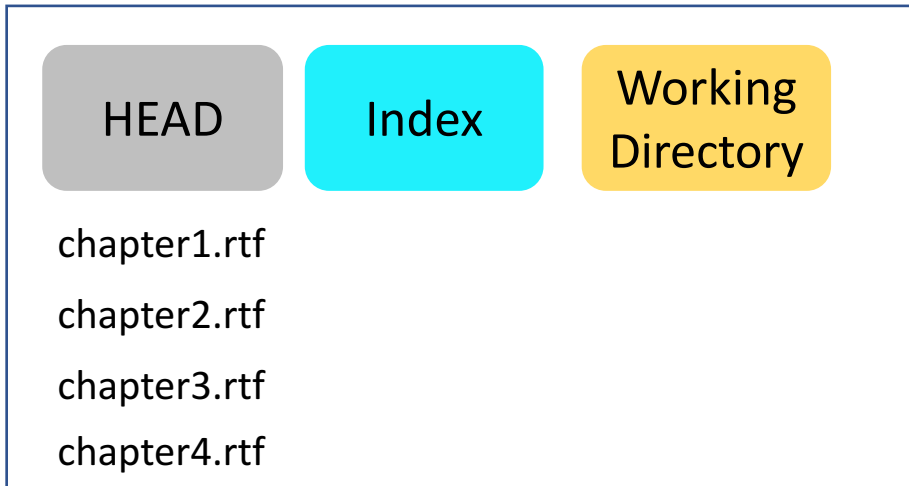
chapter4.rtf

“Where am I?”: *git branch*



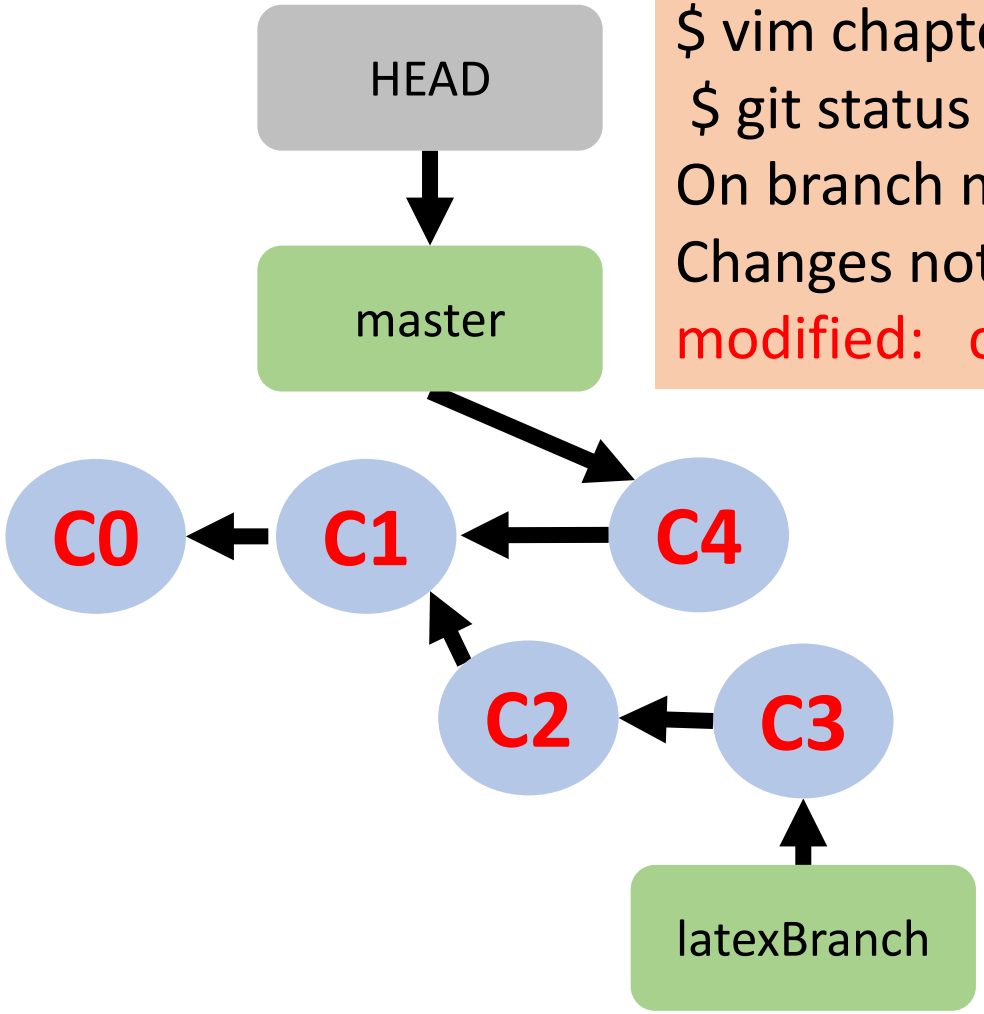

```
$ git branch
  latexBranch
* master
```

I guess we’re on the “master” branch



“What have I done?”: *git diff*

Let’s edit one of our files

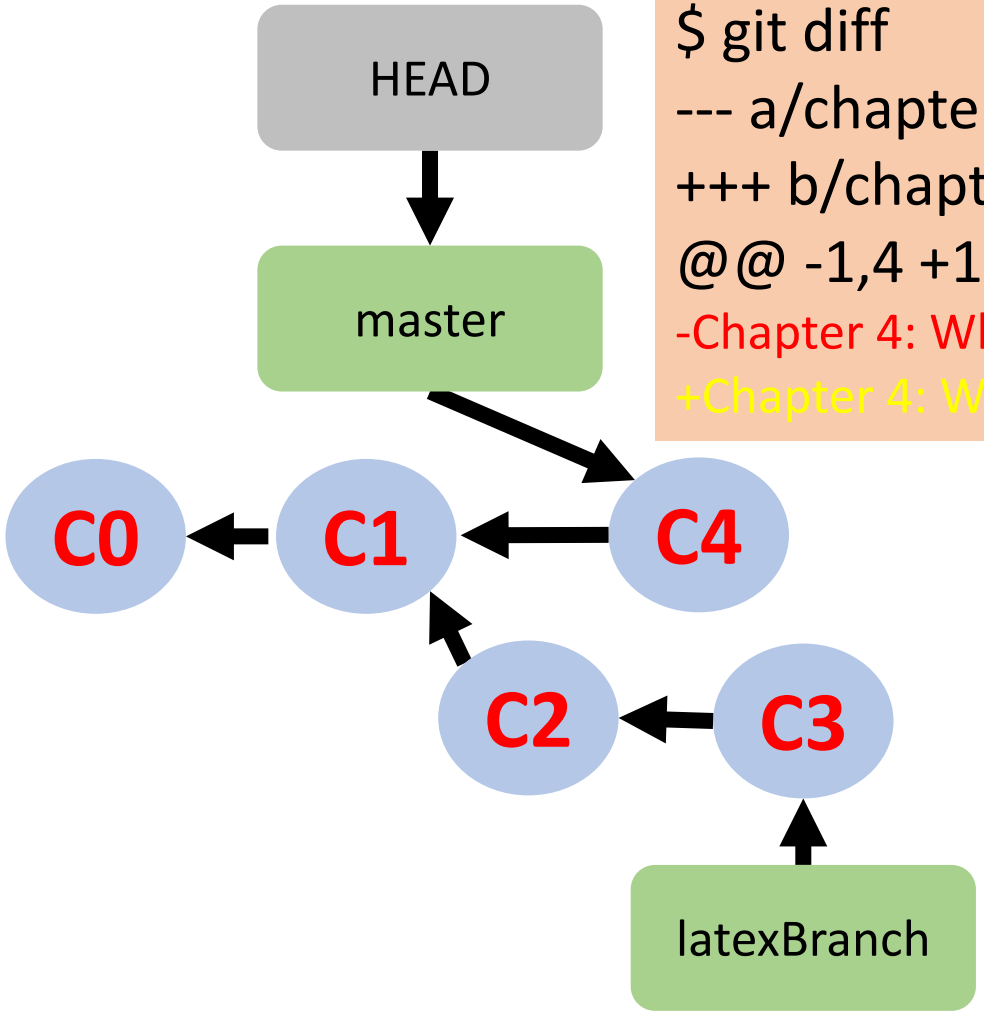



```
$ vim chapter4.rtf
 $ git status
On branch master
Changes not staged for commit:
modified:   chapter4.rtf
```

HEAD	Index	Working Directory
chapter1.rtf		chapter4.rtf
chapter2.rtf		
chapter3.rtf		
chapter4.rtf		

“What have I done?”: *git diff*

Let’s edit one of our files



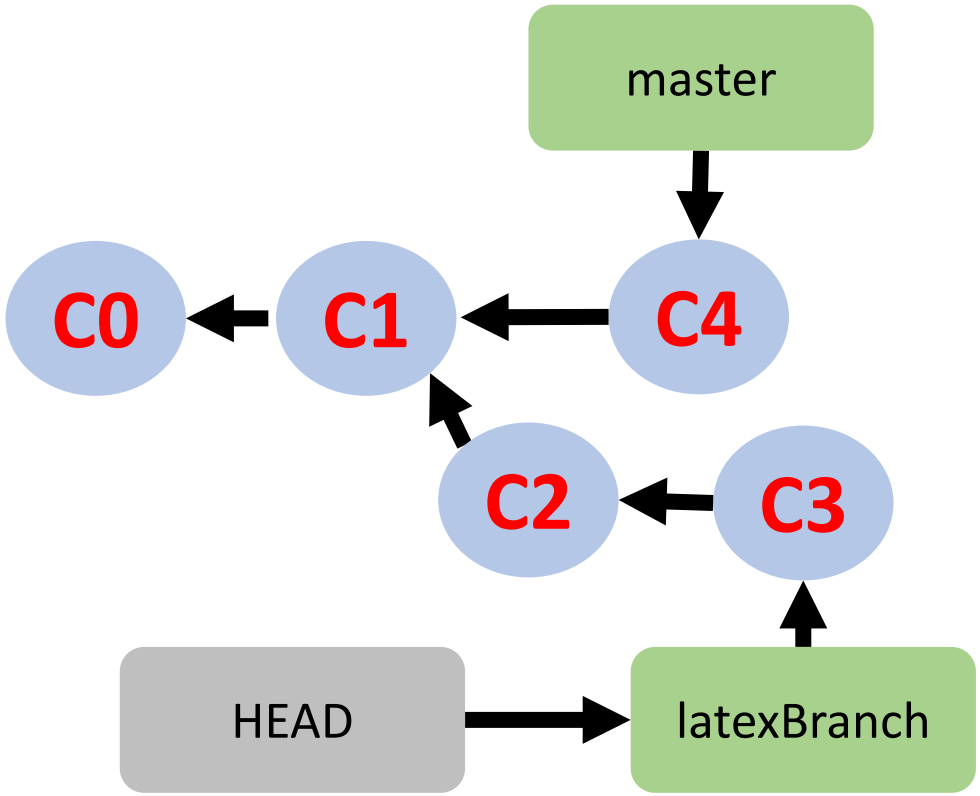

```
$ git diff
--- a/chapter4.rtf
+++ b/chapter4.rtf
@@ -1,4 +1,4 @@
-Chapter 4: When the going gets tough
+Chapter 4: When the going gets tough...really tough
```

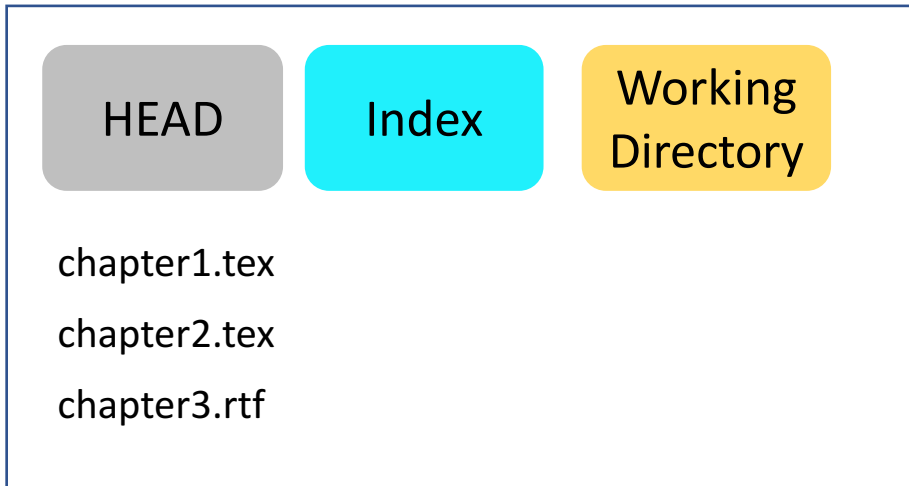
HEAD	Index	Working Directory
chapter1.rtf		chapter4.rtf
chapter2.rtf		
chapter3.rtf		
chapter4.rtf		

Undoing changes: *git checkout*

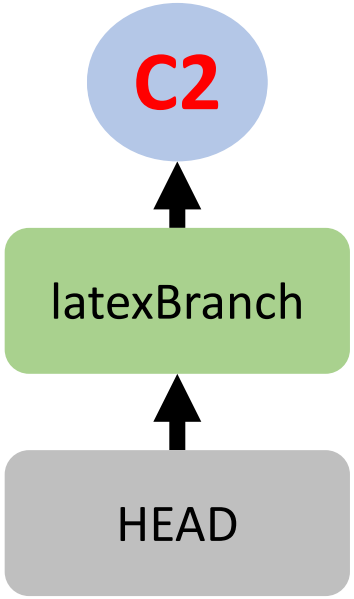
That edit wasn't so edifying.... let's undo it and switch back to the latexBranch

```
$ git checkout -- chapter4.rtf
$ git checkout latexBranch
```





“What have I done?”: *git log*



This would put you in a “detached head” state...

$ git log

```
commit 2b72641b21f9873470d2b2493e4030f92fb0625d (HEAD -> latexBranch)
Author: Daniel Sussman <dmsussma@syr.edu>
Date:   Tue Sep 12 12:20:49 2017 -0400

    converted chapter 2 to tex

commit e69f620b9064b3c58e0b5df7fae80b956aa6ef4d
Author: Daniel Sussman <dmsussma@syr.edu>
Date:   Tue Sep 12 12:15:36 2017 -0400

    re-wrote chapter 1 in tex

commit 0173951
Author: Daniel
Date:   Tue Se

    Chapters 2

commit 07c5f4403e2ef9f3ba34194c1ddc49955174786b
Author: Daniel Sussman <dmsussma@syr.edu>
Date:   Tue Sep 12 10:39:24 2017 -0400

    Chapter 1 finished
```

Just like files and branches, specific commits can also be checked out by their *commit hash:*
$ git checkout e69f620
(typically just the first 7 characters needed)

“What have I done?”: *git log*

```
$ git lg2
```

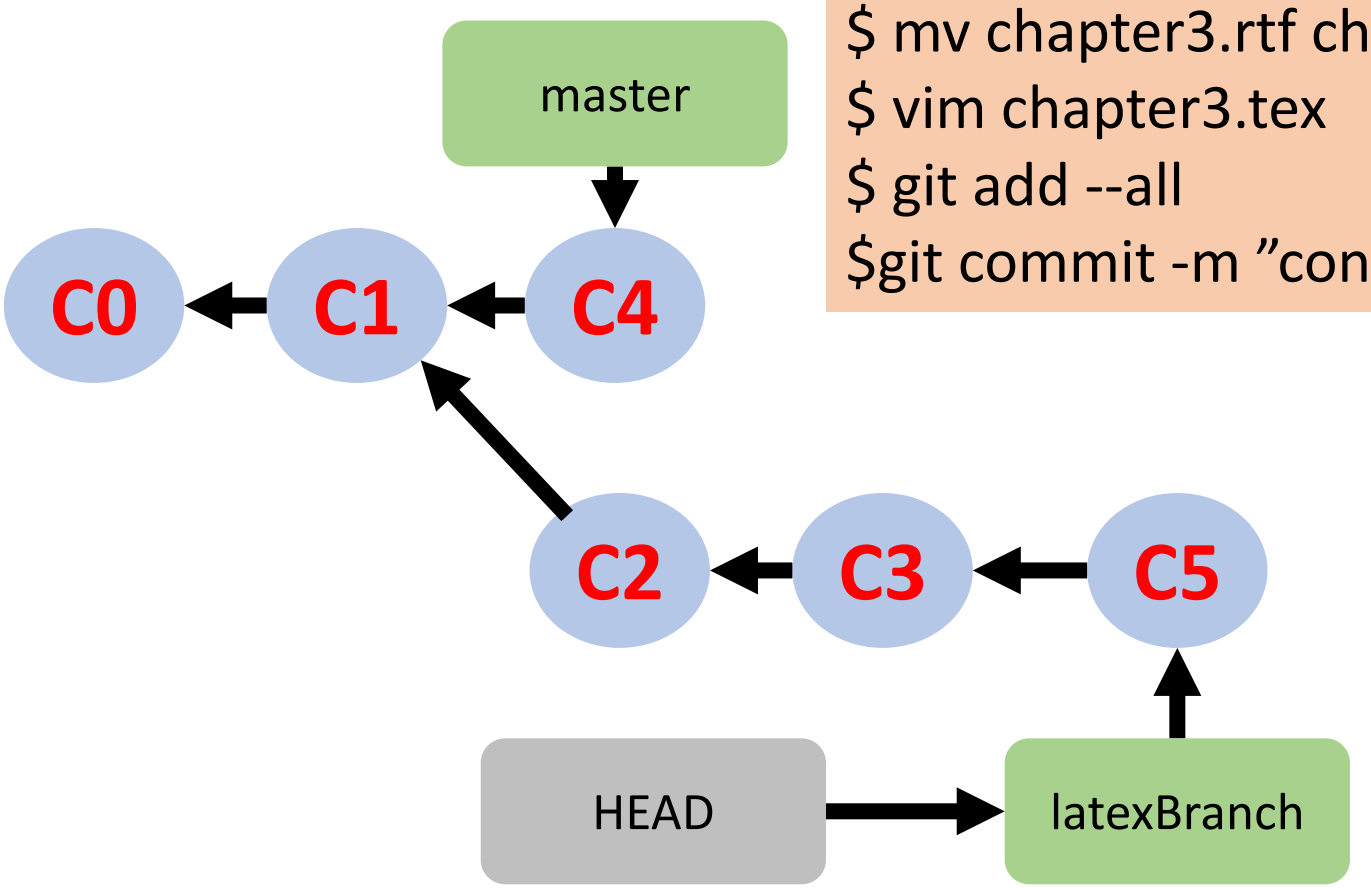
```
lg2 = log --graph --abbrev-commit --decorate --format=format:'%C(bold blue)%h%C(reset) - %C(bold cyan)%aD%C(reset)
%C(bold green)(%ar)%C(reset)%C(bold yellow)%d%C(reset)%n'' %C(white)%s%C(reset) %C(dim white)- %an%C(reset)' --all
```

```
* bcb0fdb - Tue, 12 Sep 2017 12:40:31 -0400 (9 minutes ago) (master)
|          Chapter 4 written in garbage format - Daniel Sussman
| * 2b72641 - Tue, 12 Sep 2017 12:20:49 -0400 (29 minutes ago) (HEAD -> latexBranch)
| |           converted chapter 2 to tex - Daniel Sussman
| * e69f620 - Tue, 12 Sep 2017 12:15:36 -0400 (34 minutes ago)
|/            re-wrote chapter 1 in tex - Daniel Sussman
* 0173951 - Tue, 12 Sep 2017 11:31:42 -0400 (78 minutes ago)
|          Chapters 2 and 3 written - Daniel Sussman
* 07c5f44 - Tue, 12 Sep 2017 10:39:24 -0400 (2 hours ago)
           Chapter 1 finished - Daniel Sussman
```

...git is extraordinarily feature-rich, and can take a very long time to learn. The most essential features, though, are straightforward

Let’s finish this thesis...

```
$ git checkout latexBranch
$ mv chapter3.rtf chapter3.tex
$ vim chapter3.tex
$ git add --all
$git commit -m ”converted chapter 3”
```



HEAD

chapter1.tex

chapter2.tex

chapter3.tex

Bringing branches back together: *git merge*

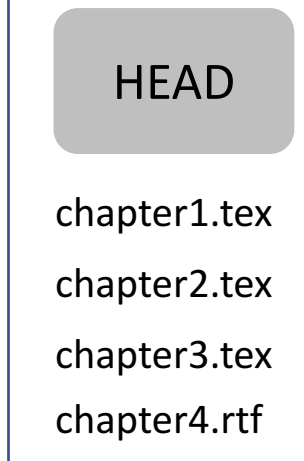
Okay, I think it's time to merge the experimental laTeX branch with the rest of my thesis!

Bringing branches back together: *git merge*

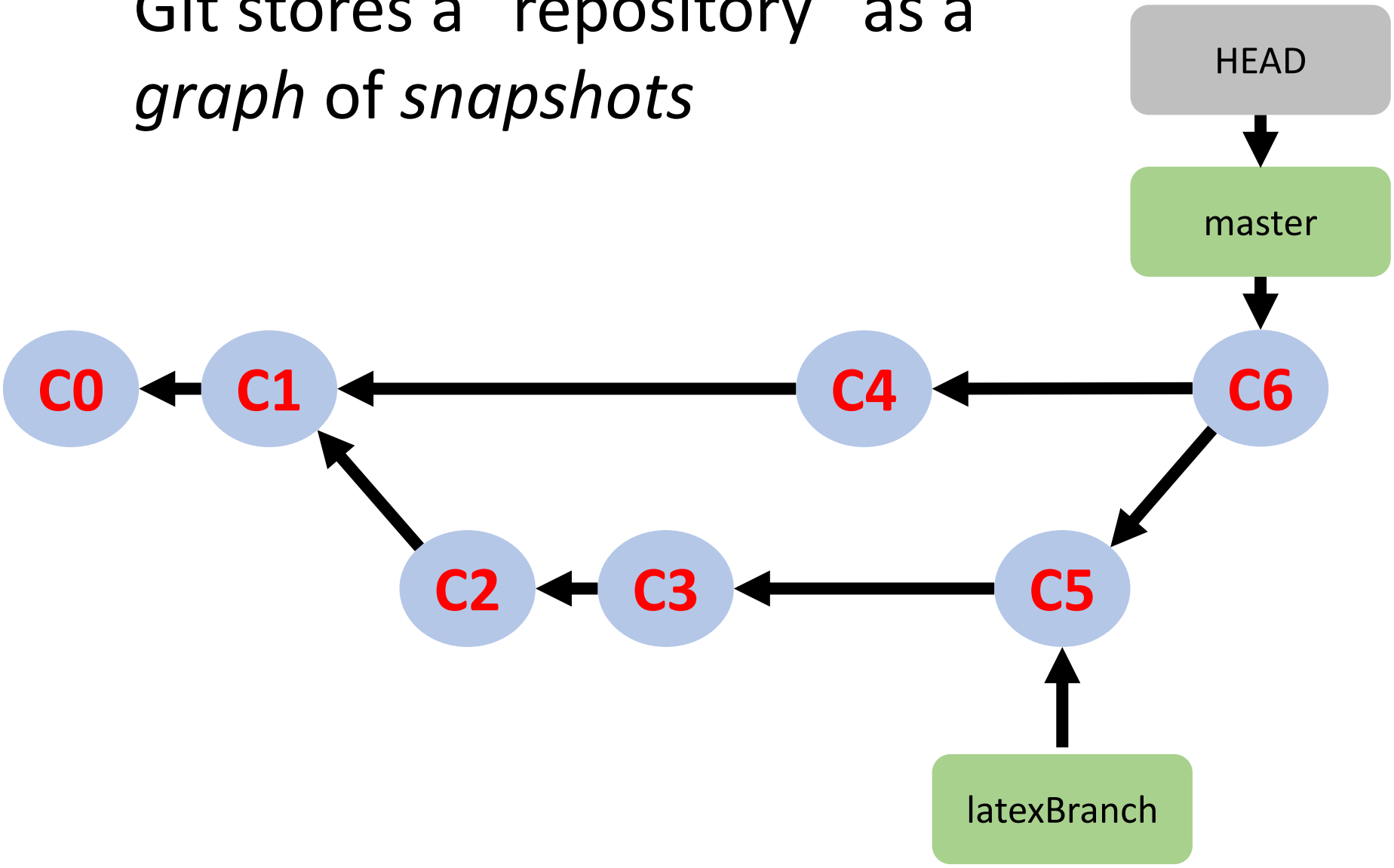
```
$ git checkout master
$ git merge latexBranch
```

```
dmsussma@~/repos/introToGitManningGroup$git merge latexBranch
Auto-merging chapter3.tex
Auto-merging chapter2.tex
Auto-merging chapter1.tex
Merge made by the 'recursive' strategy.
 chapter1.rtf => chapter1.tex | 2 +-
 chapter2.rtf => chapter2.tex | 2 +-
 chapter3.rtf => chapter3.tex | 2 +-
 3 files changed, 3 insertions(+), 3 deletions(-)
 rename chapter1.rtf => chapter1.tex (93%)
 rename chapter2.rtf => chapter2.tex (94%)
 rename chapter3.rtf => chapter3.tex (95%)
```

This creates a new snapshot that points to the last commits on both branches



Git stores a “repository” as a *graph* of *snapshots*



This is just scratching the surface!
More git resources:

Git's own documentation!

Just type "git help" or "git help [command]"

The "Pro Git" book

https://git-scm.com/book/en/v2

TryGit for an interactive walkthrough of basic commands

https://try.github.io/

Atlassian has some nice tutorials for learning git

https://www.atlassian.com/git/tutorials/learn-git-with-bitbucket-cloud

In addition to the above references, I drew inspiration and/or stole slide ideas from:

Zachary Ling, “Fundamentals of Git”
http://slideplayer.com/slide/6171599/

Ruth Anderson’s CSE 390a lecture:
https://courses.cs.washington.edu/courses/cse390a/
https://github.com/ldfaiztt/CSE390A/blob/master/Week%2011/390aGitIntro_12au.pdf