GIT & GITHUB

Basics of Distributed Version Control

6.470

MIT WEB PROGRAMMING COMPETITION

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Overview

0. What is Git? Installation and setup
1. Introduction to version control; basic workflow in Git
2. Branching, merging, and rebasing
3. Working with remotes and Github

What is Git?

- A *distributed* version control system
- A few use cases:
  - Keep a history of previous versions
  - Develop simultaneously on different branches
    - Easily try out new features, integrate them into production or throw them out
  - Collaborate with other developers
    - “Push” and “pull” code from hosted repositories such as Github

Key improvements

- A ***distributed*** version control system
  - Everyone can act as the “server”
  - Everyone mirrors the entire repository instead of simply checking out the latest version of the code (unlike svn)
- Many local operations
  - Cheap to create new branches, merge, etc.
  - Speed increases over non-distributed systems like svn

Installation and setup

- Linux: apt-get install git-core
- Mac: http://code.google.com/p/git-osx-installer/
- Windows: http://msysgit.github.com/
  - Git bash
- Eclipse extensions such as eGit

First time setup

- git config --global user.name “Charles Liu”
- git config --global user.email “cliu2014@mit.edu”
- Line breaks (\r\n in Windows vs. \n in Mac/Linux)
  - Mac/Linux: git config --global core.autocrlf input
  - Windows: git config --global core.autocrlf true

Use case #1: history of versions

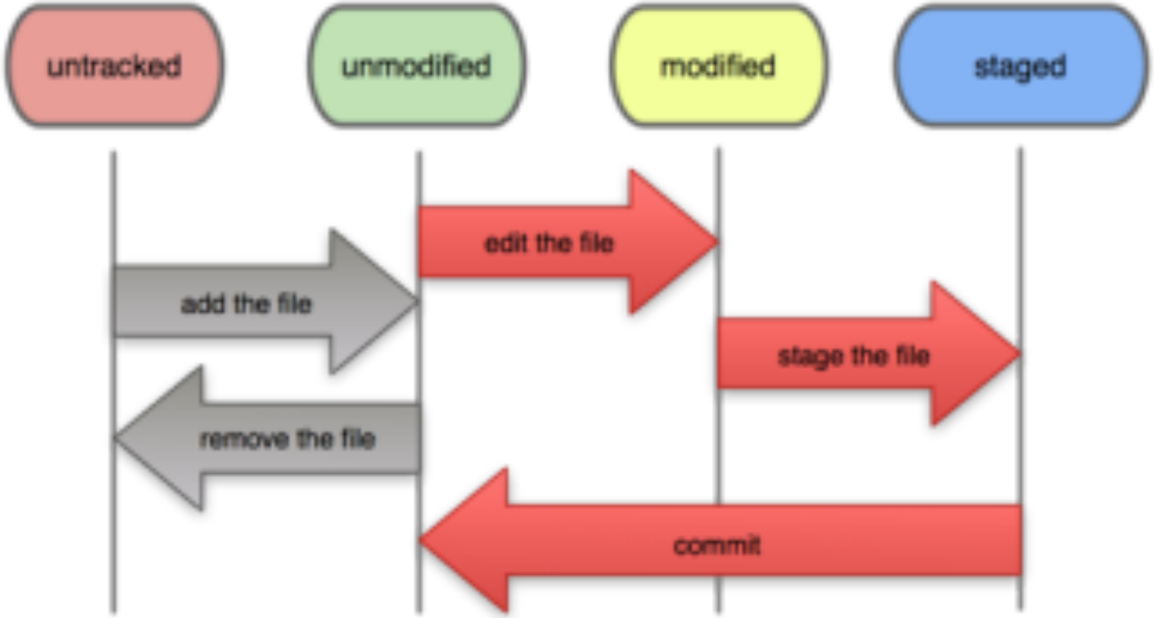
- Basic workflow
- Adding and committing files
- The git log
- The staging area
- Removing files
- Viewing diffs of files

Big ideas

- Snapshots, not deltas
- Everything is confined to the .git directory
- Most operations are safe – they only add data
  - We'll talk about two commands that are not safe today
- 3 possible states for a file
  - Changed
  - Staged
  - Committed

Basic workflow

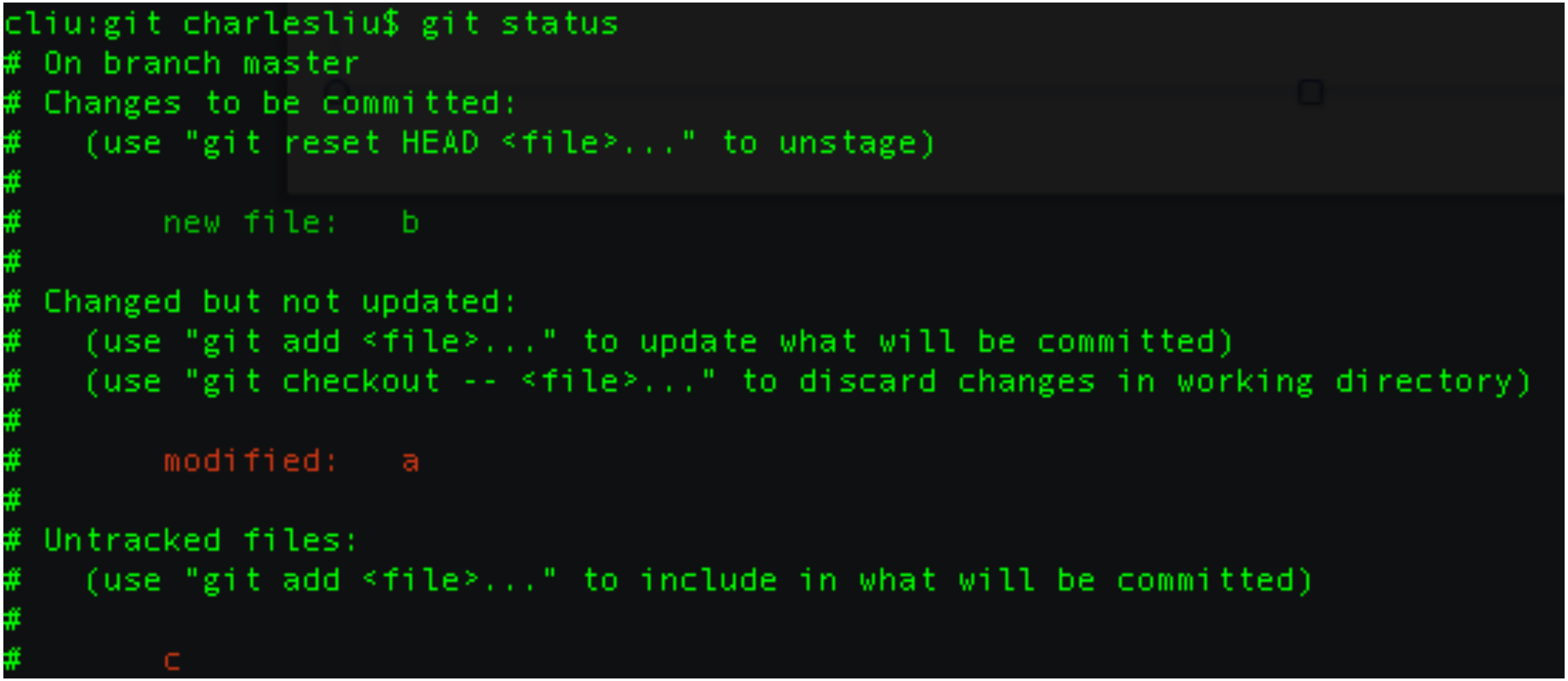
- **git init** – create git project in existing directory
  - Make Git start to “watch” for changes in the directory
- The basic workflow:



Basic workflow

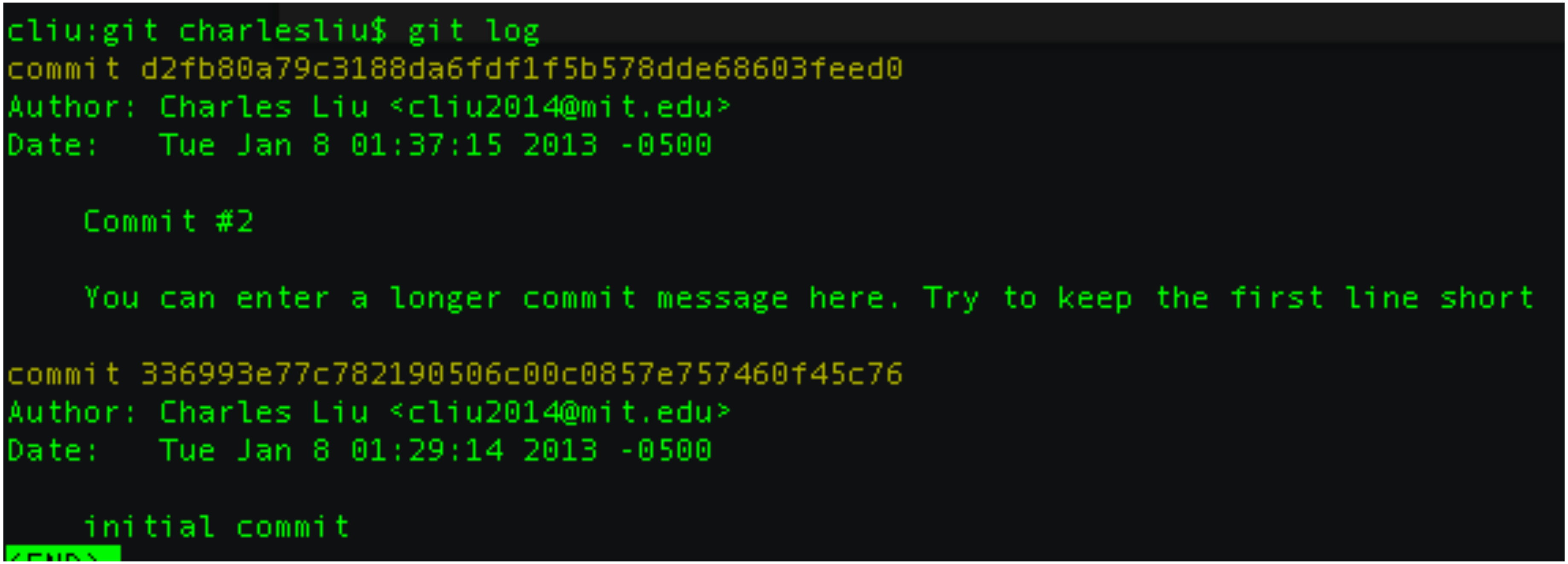
- Add files to be committed with **git add <filename>**
  - Puts the file in the "staging area"
- Create a commit (a "snapshot") of added files with **git commit**, followed by a commit message
- Use **git status** to see the current status of your working tree

The git status output



```
cliu:git charlesliu$ git status
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#       new file:   b
#
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified:   a
#
# Untracked files:
#   (use "git add <file>..." to include in what will be committed)
#
#       c
```

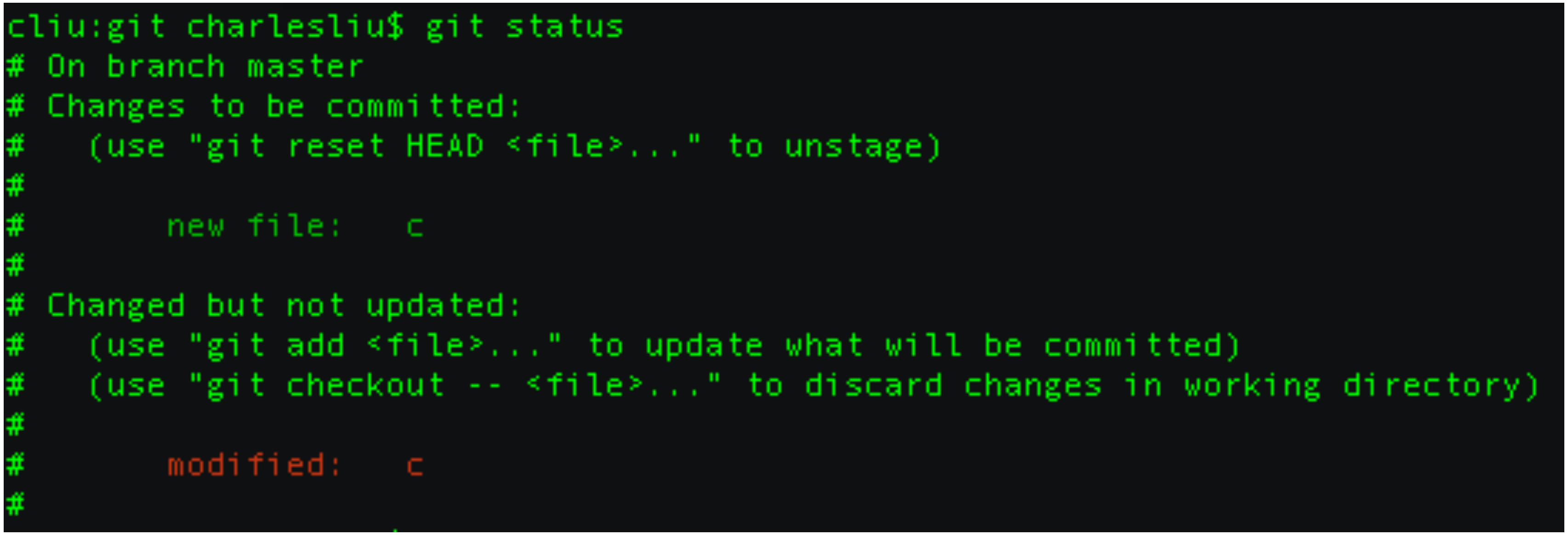
The git log output



```
cliu:git charlesliu$ git log
commit d2fb80a79c3188da6fdf1f5b578dde68603feed0
Author: Charles Liu <cliu2014@mit.edu>
Date:   Tue Jan 8 01:37:15 2013 -0500

    Commit #2

    You can enter a longer commit message here. Try to keep the first line short

commit 336993e77c782190506c00c0857e757460f45c76
Author: Charles Liu <cliu2014@mit.edu>
Date:   Tue Jan 8 01:29:14 2013 -0500

    initial commit
<END>
```

The staging area

- git add takes the snapshot of the file that will be committed → you can change the file after adding it



```
cliu:git charlesliu$ git status
# On branch master
# Changes to be committed:
#   (use "git reset HEAD <file>..." to unstage)
#
#       new file:   c
#
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#       modified:   c
#
```

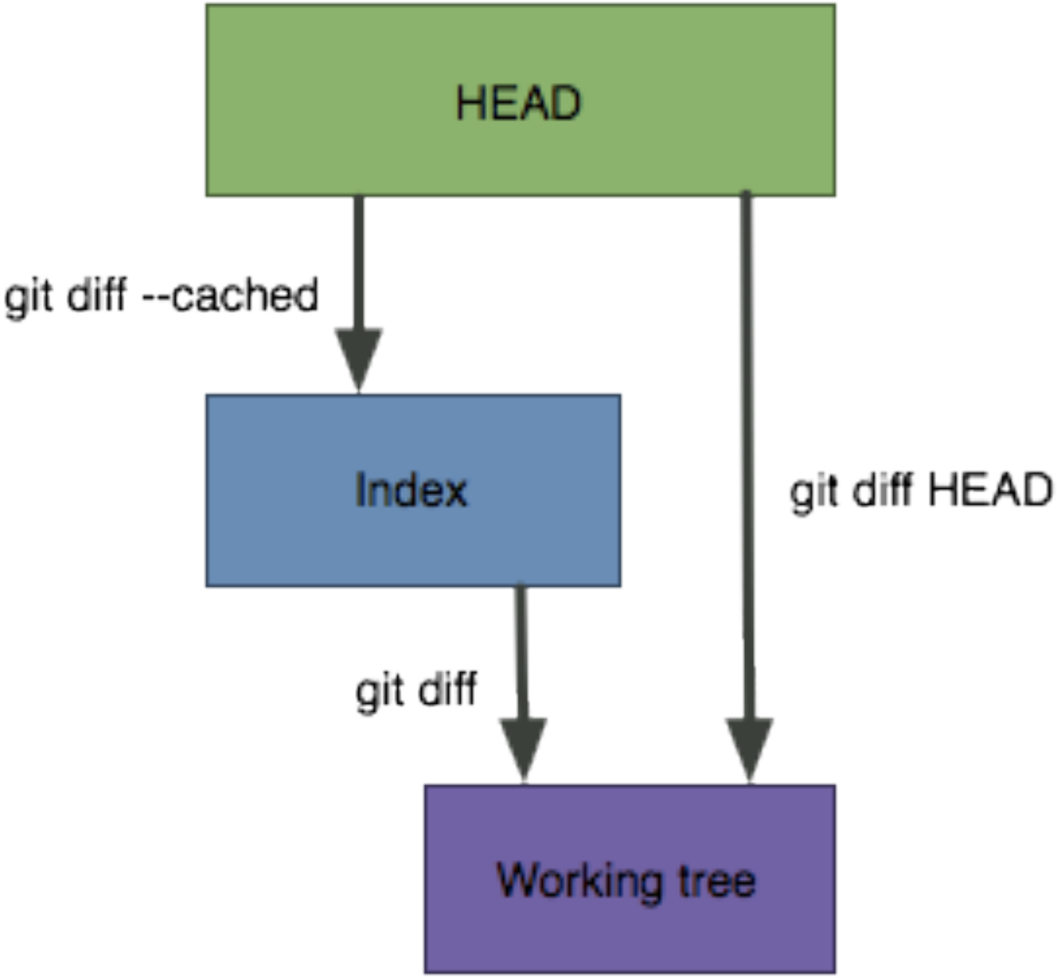
The staging area

- To unstage a file, but retain your changes in the working tree:
  - git reset HEAD <filename>
- To discard current changes in the working tree, and make it look like the last commit:
  - git checkout -- <filename>
  - **Be careful! You will lose your changes and not get them back!**

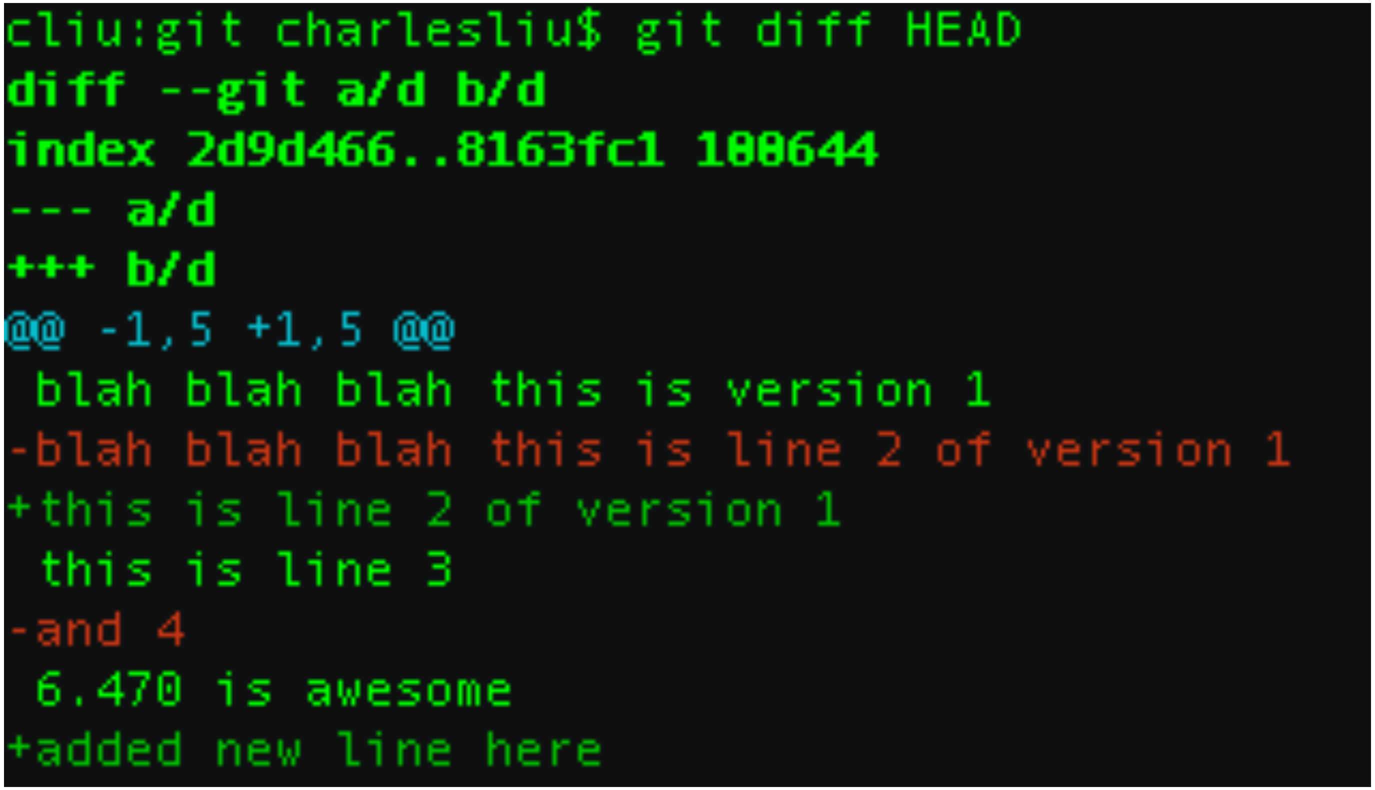
Removing a file

- To remove a file from the working tree and in the next commit, simply **git rm <filename>**
- To remove it from the next commit, but keep the file in the working tree, do **git rm --cached <filename>**

Viewing diffs of files



Viewing diffs of files



```
cliu:git charlesliu$ git diff HEAD
diff --git a/d b/d
index 2d9d466..8163fc1 100644
--- a/d
+++ b/d
@@ -1,5 +1,5 @@
 blah blah blah this is version 1
-blah blah blah this is line 2 of version 1
+this is line 2 of version 1
 this is line 3
-and 4
 6.470 is awesome
+added new line here
```

Use case #2: branching

- What is a branch?
- Branching commands
- The HEAD pointer
- Basics of merging
- Basics of rebasing
- Aside: the git reset command

What is a branch?

- Visualize a project's development as a "linked list" of commits.
- When a development track splits, a new branch is created.
- In Git, branches are actually just a pointer to these commits

Branching commands

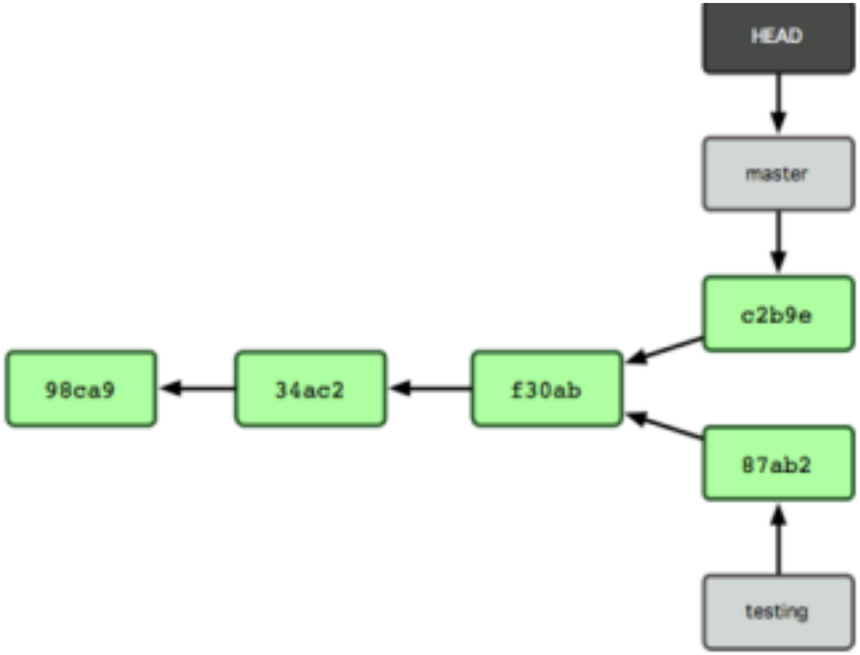
- List all branches in the project – **git branch**
- Create a new branch – **git branch <branchname>**
- Switch to a branch – **git checkout <branchname>**
- Create and immediately switch – **git checkout –b <branchname>**
- Delete a branch – **git branch –d <branchname>**

Stashing

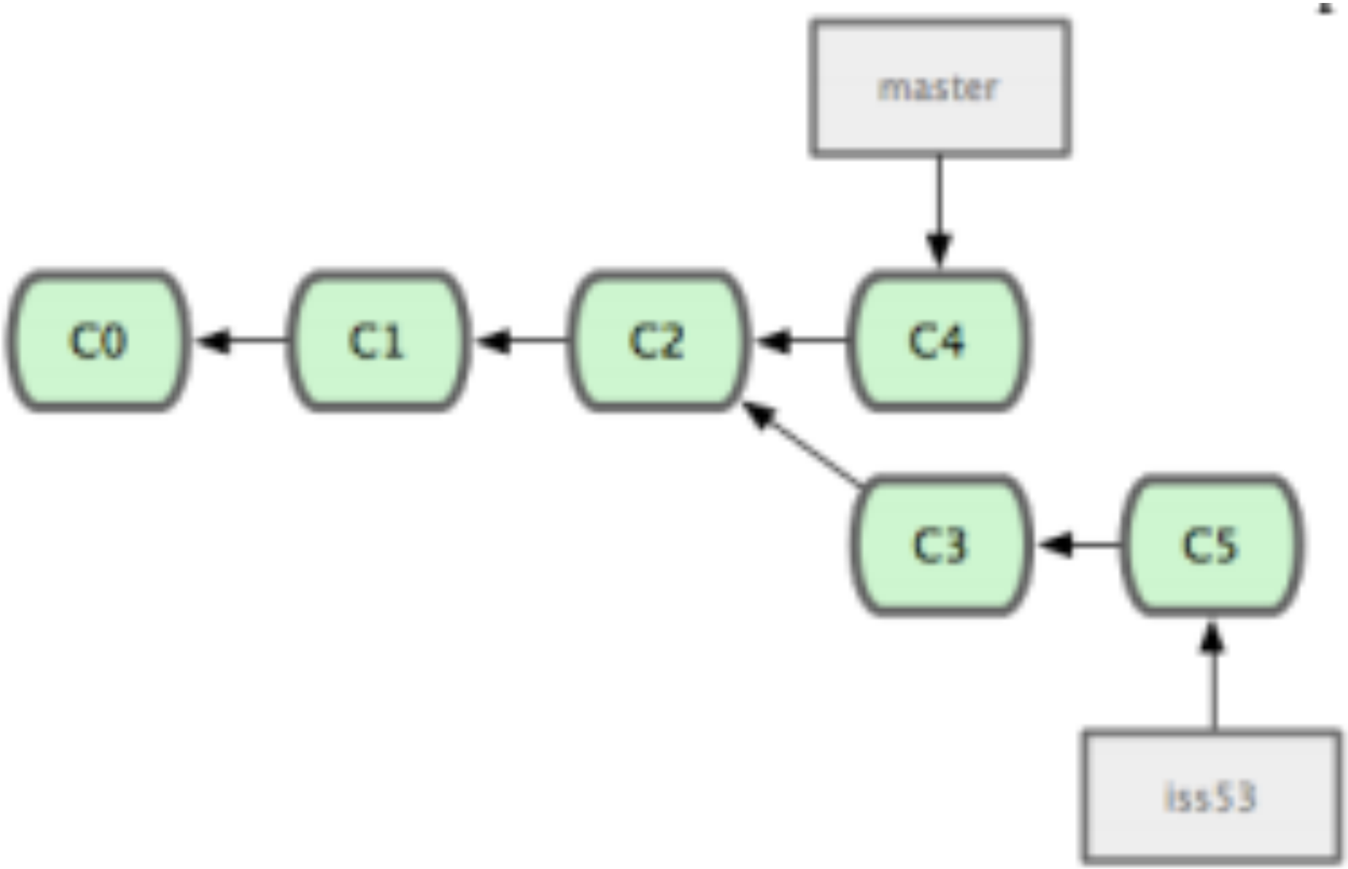
- Working tree must be clean when switching branches
- Stash changes that you don't want to commit at that time – **git stash**
  - Puts a stash onto the stack
- Later, apply the most recent stashed changes and remove that stash – **git stash pop**
- Also, **git stash apply** to apply changes but not remove the stash from the stack

The HEAD pointer

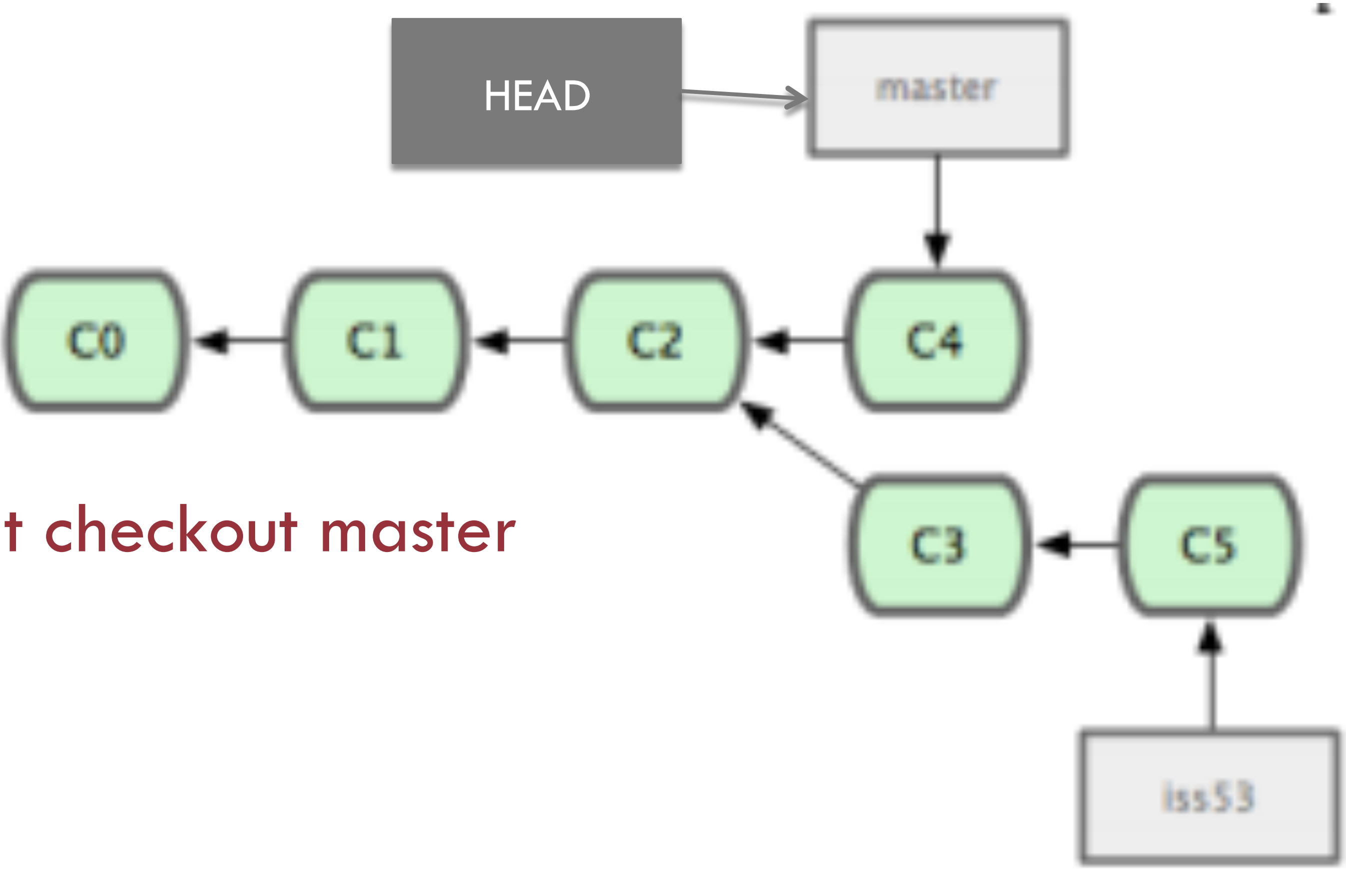
- Recall: all branches simply a pointer to a commit
- HEAD: special pointer to the current branch, moves around as you switch branches



Merging

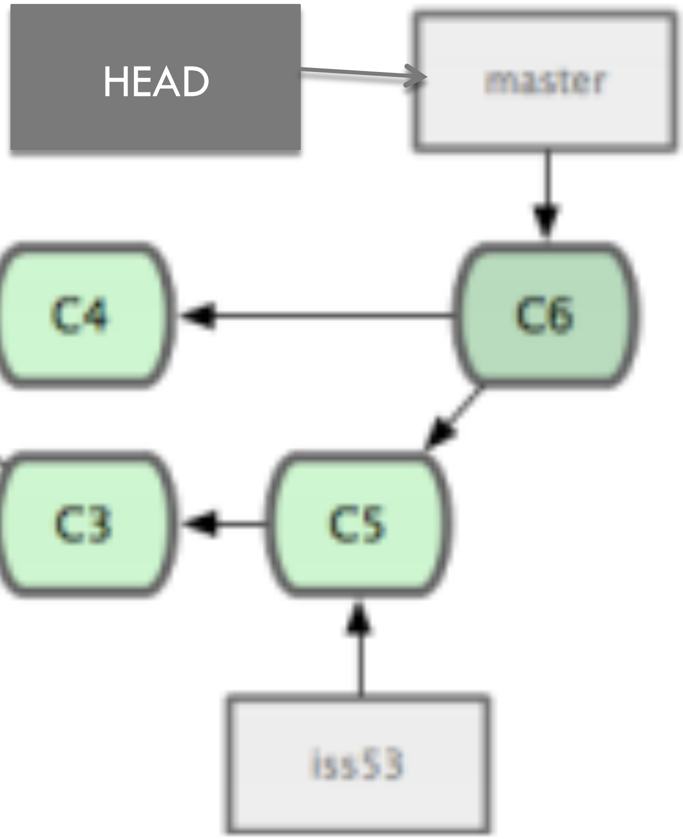


Merging



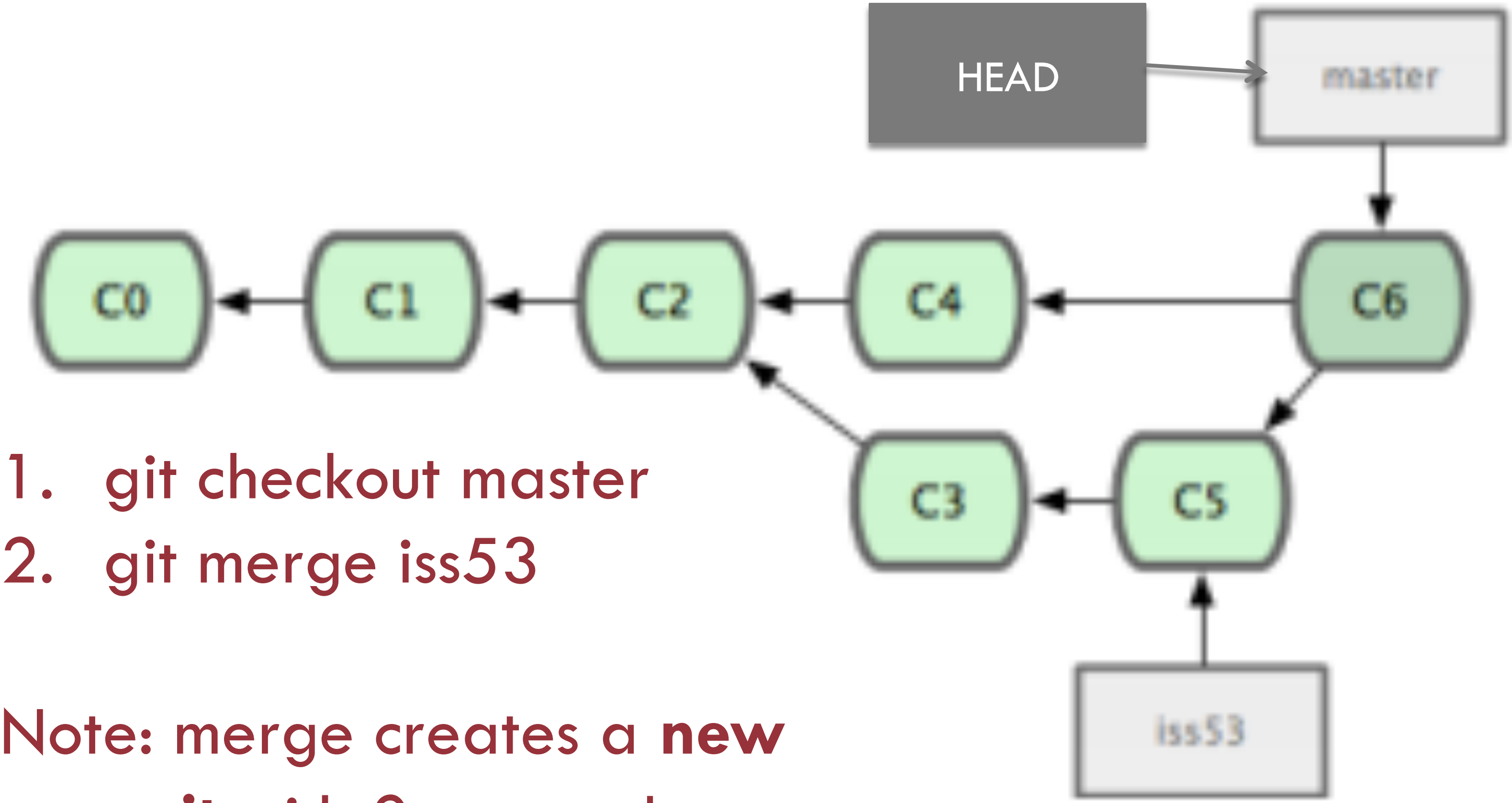
1. git checkout master

Merging



1. git checkout master
2. git merge iss53

Merging



1. git checkout master
2. git merge iss53

Note: merge creates a **new commit** with 2 parents!

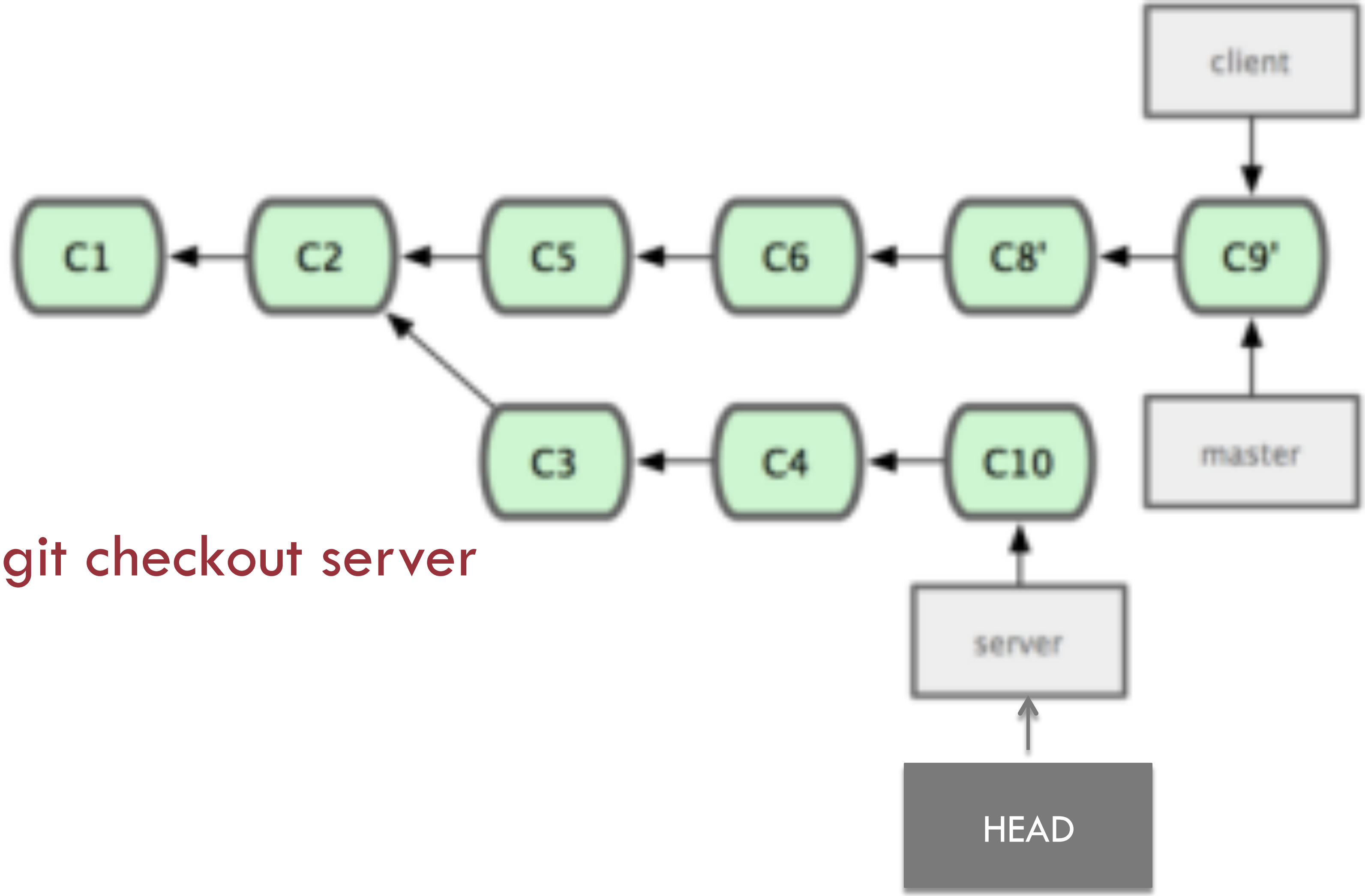
Merge conflicts

- Sometimes, two branches will edit the same piece of code in different ways.
- Must resolve the conflict manually, then add the conflicting files and explicitly commit.
- Demo

Rebasing

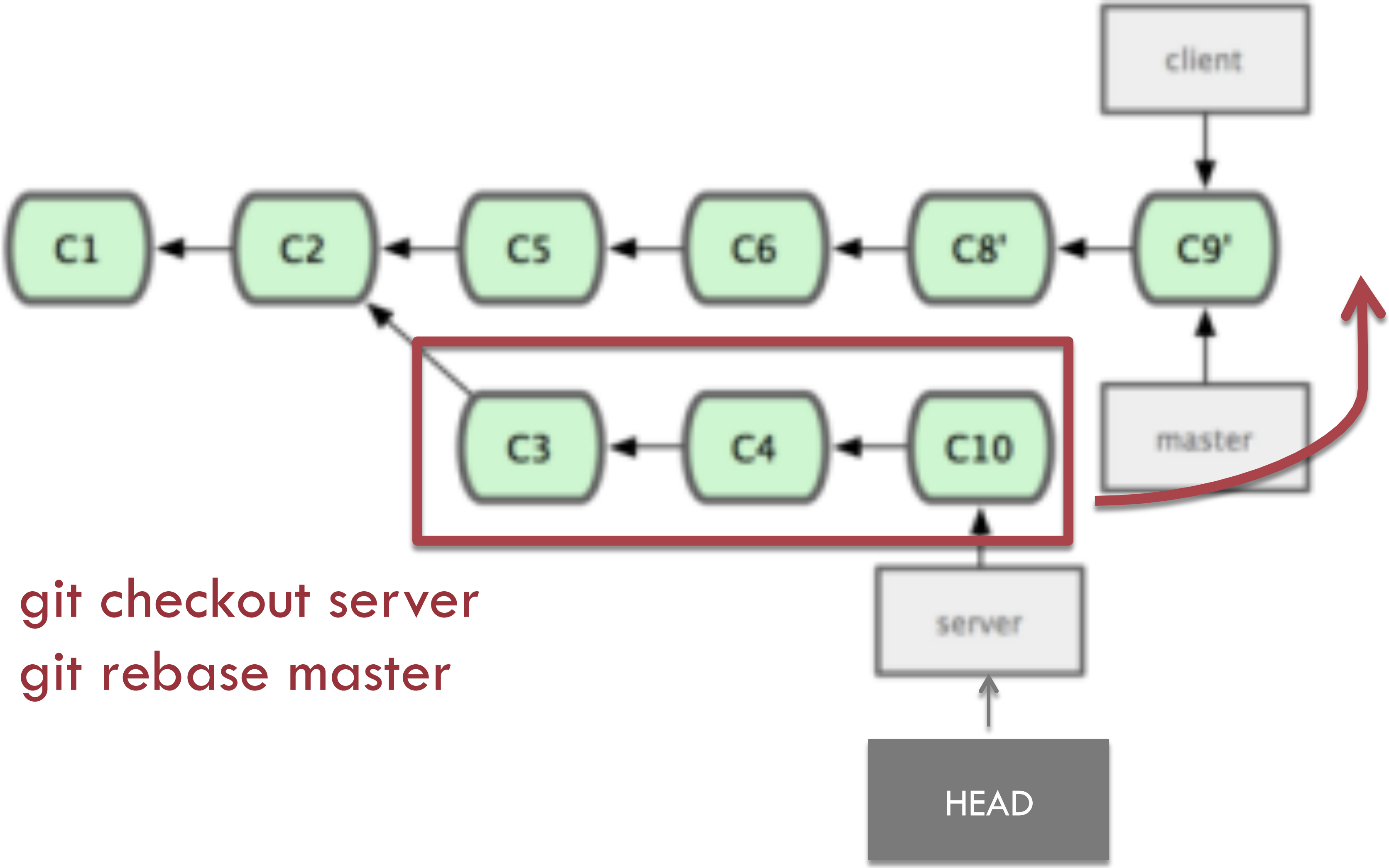
- Instead of a merge, which creates a **new commit** originating from both branches, a **rebase** takes the contents of one branch after the “split” and moves them to the end of the other branch.
- The command **git rebase <basebranch>** takes your currently checked out branch and **replays the diffs** on top of basebranch.

Rebasing



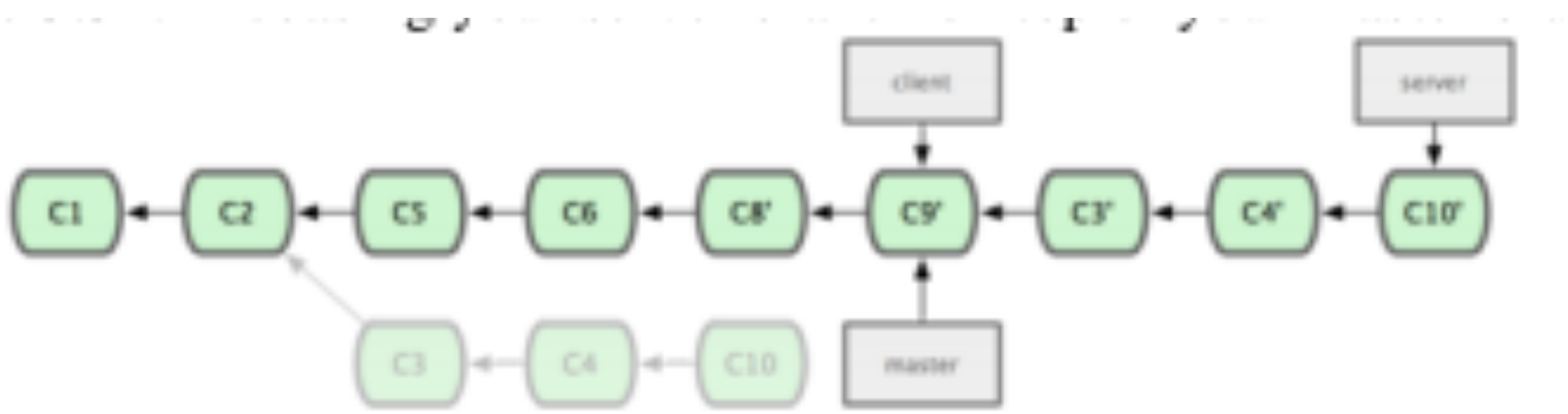
1. git checkout server

Rebasing



1. git checkout server
2. git rebase master

Rebasing



1. git checkout server
2. git rebase master

Why rebase?

- Creates a linear history; often cleaner and easier to read.
- But…**DO. NOT. EVER.** rebase anything that has already been pushed to a repo someone else has access to
  - Rebasing removes commits and writes new ones; but someone else might have already based their work off your old commits!

An aside…the git reset command

- 3 versions…and often the source of much confusion!
  - git reset --soft <commit / pointer to commit>
  - git reset --mixed <commit / pointer to commit> (or simply git reset)
  - git reset --hard <commit / pointer to commit>
- Reset proceeds in 3 steps:
  1. Move the HEAD pointer
  2. Update the index/staging area to the new contents of HEAD
  3. Update the working directory

3 steps to reset

1. Move the HEAD pointer – soft stops here.
2. Update the index/staging area to the new contents of HEAD – mixed stops here.
3. Update the working directory – hard stops here

Note: reset --hard overwrites the working directory. This is another command that can potentially cause loss of data!

Use case #3: collaboration

- Creating a repo on Github
- Remotes
- Remote-tracking branches
- Push, fetch, and pull
- The git clone command

Remotes

- A target computer that has Git repos that you can access
  - Via http(s), ssh, or git protocols
- **git remote add <remotename> <remoteaddress>**
- **git remote –v (view remotes)**
- **git remote rm <remotename>**
- Often, with one remote, we name it “origin”

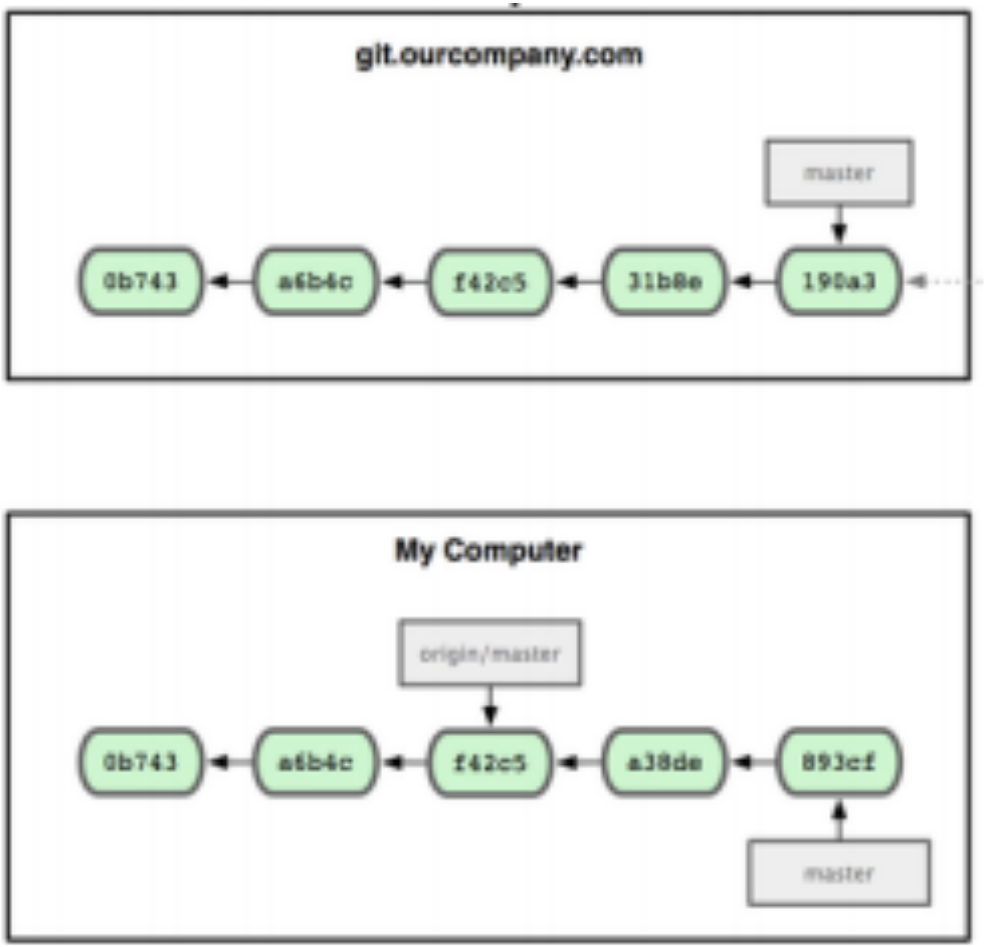
Pushing and fetching

- **git push <remotename> <branchname>** sends your code in the branch up to the remote
  - Often just git push: depends on settings but often equivalent to git push origin master
- **git fetch <remotename>**

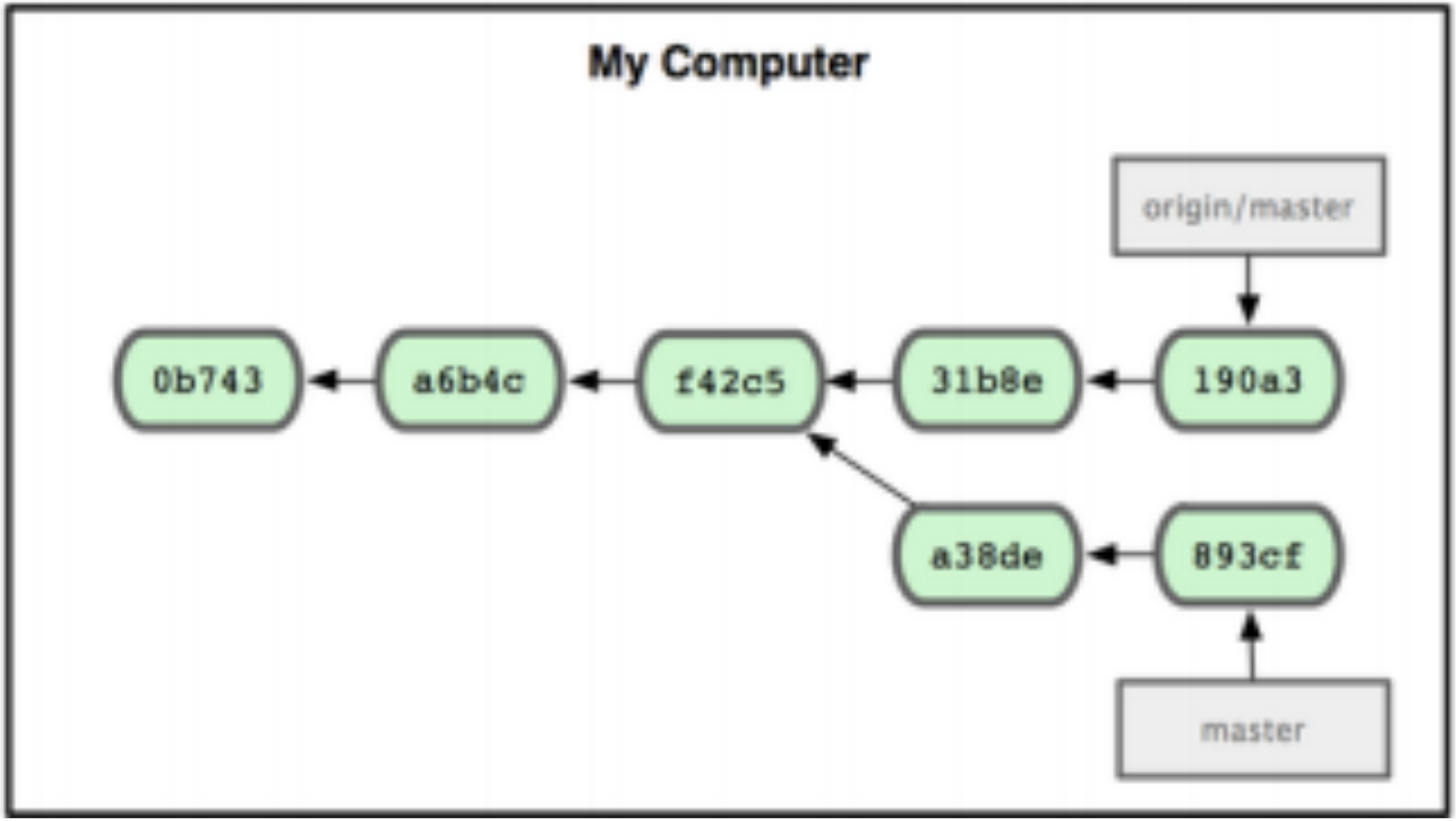
Remote tracking branches

- When you do git fetch, you don’t immediately see the changes. Why?
- Changes are fetched to a “**remote tracking branch**”
  - Branches associated with a remote, but treat them like a local branch
  - Can merge with your current master (git checkout master; git merge origin/master)
  - Even better…rebase

Remote tracking branches



Remote tracking branches



Github demo

In summary…

- Basic workflow in git
  - Adding, committing, viewing diffs
- Branches
  - The HEAD pointer, merging, and rebasing
- Remotes
  - Pushing and fetching; quick introduction to Github

Lots of other topics

- Tags and version numbers
- Interactive rebase: squashing and amending commits
- Relative pointers from HEAD (e.g. HEAD^^, HEAD~3)
- Submodules
- Using your own server as a git server (bare repos)
- Git as a filesystem (git grep, git ls-files, etc.)
- GUIs to view trees and graphical merge tools
- …more!

For more information

- The book *Pro Git* (which I based much of this presentation on), available for free!
  - https://github.s3.amazonaws.com/media/progit.en.pdf
  - Covered Chapters 1-3 in detail, very simple ideas from Chapters 4-6
- Git documentation: do **git help <commandname>**
- Google, StackOverflow, etc.