Learn Git The Hard Way

An introduction to Git using 'The Hard Way' method.

Chapter 1. Core Git

This git course has been written to help git users get a clearer understanding of source control and git concepts. After following it they will be able to:

- use git to contribute to projects
- understand how to troubleshoot git when it gets confusing
- not be fazed when people talk about things like rebasing, bisecting, remotes, merges

It assumes:

- No prior knowledge of source control
- No prior knowledge of git

It aims to give users:

- A hands-on, practical understanding of git
- Enough information to understand what is going on as they go deeper into git
- A familiarity with advanced git usage

1.1. Introduction

This section covers:

- source control
- git vs trad SCs
- the four phases of the git lifecycle
- benefits of git
- git config

If you're not familiar with source control, it solves a simple problem: how do you keep track of changes in your codebase? It's a database of files and the histories of their states.

I'm old enough to remember a time when people complained about using source control at all!

Traditional source control tools such as CVS and SVN were centralised. You communicated with a server which maintained the state of the system. This could mean several things:

- The source control database could get very big
- The history could get very messy
- Managing your 'checkouts' of code could get complicated and painful

These code databases are known as 'repositories'.

In the old world, if you checked out source code, that was a copy of some code that was 'inferior' in

status to the centralised version.

As far as the user was concerned, code was in one of two states:

- Local changes ('dirty')
- Committed == pushed to server

My local changes could not be shared with anyone else until I committed and pushed them to the server.

Git, by contrast, is fundamentally distributed. Each git repository is a full copy of each other git repositories.

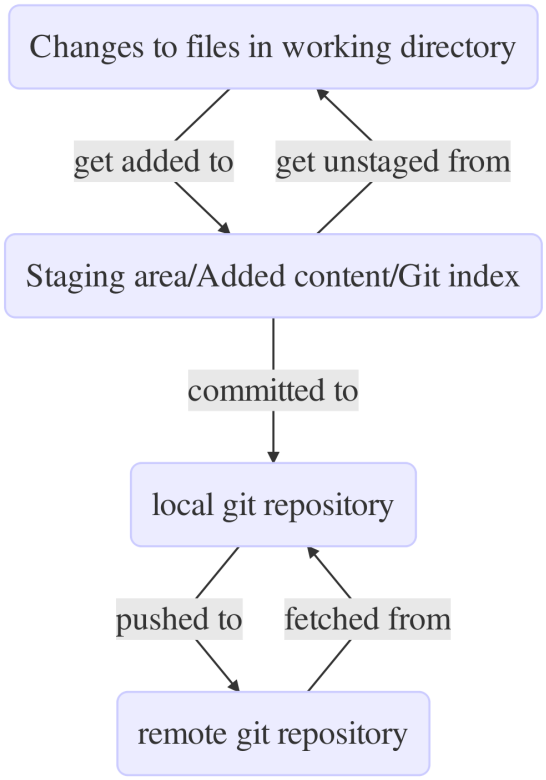
Remember this:

ALL GIT REPOSITORIES ARE EQUAL!

Remember, git was created so people could work on the linux kernel across the globe, and offline. So there is no concept of a central server that holds the golden source. Instead people maintain their own source code database and reconcile, copy from and integrate with others'.

1.1.1. The Four Phases of Git Content

In the git world you have four phases your code can go through:



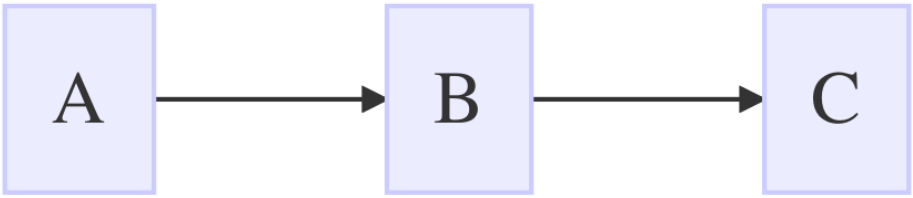
Understanding these 4 stages are key to understanding git.

If this seems over-complicated now, it won't as you grow to know and love git. If you've ever been confused by git, it's likely because these stages were not understood properly.

1.1.2. Branches

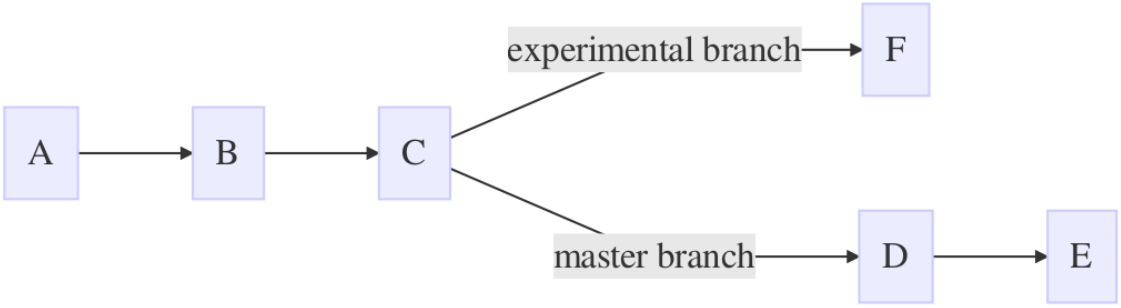
In case you've not looked at a SC tool before, a branch is a core concept.

A series of changes to a repository might look like this:



Change A is made, then B, then C. This might be informally called the 'main line'.

But let's say someone wants to make an experimental change but not affect the 'main line'. Then they might 'branch' the code at point C:



That way users can choose to get a view of the source on the 'main line' branch or the 'experimental' one.

That's all a branch is: a set of changes from a specific point in time.

1.1.3. But What About GitHub?

Earlier I said that:

ALL GIT REPOSITORIES ARE EQUAL!

In practice, some repositories are more equal than others (eg GitHub). This is a matter of

convention.

Most people use GitHub as their reference repository, but I could use a GitHub repo as a secondary repo for my workflow - it's up to me (indeed I do this for some of my private repos).

GitHub's de facto status as a centralised repository (and all the machinery that assumes its existence and continuous uptime) is the reason every GitHub outage causes a flurry of smart-alec comments about git being decentralised.

Being a distributed system makes Git more challenging to understand than traditional SCM tools.

Keeping your local repo sync'd with others is one of the challenges of git, but the first step to mastering git is understanding this equality of repos.

1.1.4. Other differences with git vs traditional VCSes

- History is more malleable.

You can change the history in your own copy of the repo and others' (if you have the appropriate permission to).

- Branching is cheap

In CVS it's very slow to branch a (O(n) to number of files). In git it's an O(1) step. This makes experimentation much easier. Branch deletion is a common and cheap operation.

- Commits are across the whole poject

In contrast to other source control tools, changes are made across the whole project, not per file. So moving files involves no loss of history for that file.

- No version numbers

Git does not automatically number versions of files/changes. It instead assigns a hash (effectively random) to the change.

- File renaming

You can rename files in git and the content will be tracked. This is a massive win compared to CVS.

1.1.5. Assumptions

At this point I assume you have git installed, and that you have set your details up as per the below. Replace with your email address and username:

```
$ git config --global user.email "you@example.com"
$ git config --global user.name "Your Name"
```

1.1.6. What you learned

- setting up git
- what git is - the four stages
- differences to other SC systems

1.1.7. Exercises

1) Install git and set up your config. Set up user.email and user.name using the --global flag. 2) Find out where the config is stored. 3) Research the other config items that are in the file and some of those that are not.

1.2. Git basics

This section covers:

- git init
- the .git folder
- git log
- git status
- git add
- git commit
- git diff

This section is important because these are the basic tools you will most often use with git.

To initialise a git repository, run 'git init' from within the root folder of the source you want to manage.

```
$ rm -rf 1.2.1
$ mkdir 1.2.1
$ cd 1.2.1
$ git init
```

This initialises a database in the folder '.git' locally. Your repository is entirely stored within this .git folder. There are no other files elsewhere on your filesystem you need to be concerned about. (There are config files for git, but these are global to the host. You can ignore them for now.)

```
$ cd .git
$ ls
config
description
HEAD
hooks
info
objects
refs
$ cd ..
```

It’s not part of the scope of this course to go into detail about the git internals files seen here.

What is worth being aware of here are:

- the 'HEAD' file
- config

1.2.1. HEAD

The HEAD is key - it points to the current branch you are 'on'.

If you look at the file, you will see it points to the refs/heads/master.

This is an internal representation of the default 'master' branch.

```
$ cat HEAD
ref: refs/heads/master
```

1.2.2. config

'config' stores information about your repository’s local configuration, eg what branches and remote repositories your repository is aware of. It’s a plain text file:

```
$ cat config
[core]
    repositoryformatversion = 0
    filemode = true
    bare = false
    logallrefupdates = true
    ignorecase = true
    precomposeunicode = true
```

1.2.3. git log

If you want to look at the history of this repository, you can run the git log command:

```
$ cd ..
$ git log
fatal: bad default revision 'HEAD'
```

You have a problem! This repository has no history to look at.

Git has followed the 'HEAD' pointer to the refs/heads/master entry and found nothing there! And indeed there is nothing there:

```
$ ls .git/refs/heads/master
ls: .git/refs/heads/master: No such file or directory
```

You need to create a history.

1.2.4. git status

As is often the case, git status is your friend:

```
$ git status
On branch master

Initial commit

nothing to commit (create/copy files and use "git add" to track)
```

It tells you where the HEAD is pointed at (the non-existent master branch), and that there is 'nothing to commit'.

Create a file and check status again:

```
$ touch mycode.py
$ git status
On branch master

Initial commit

Untracked files:
  (use "git add <file>..." to include in what will be committed)

    mycode.c
```

You are now advised that you have an 'untracked' file. Git has detected that it exists but the repository is not 'aware' of it.

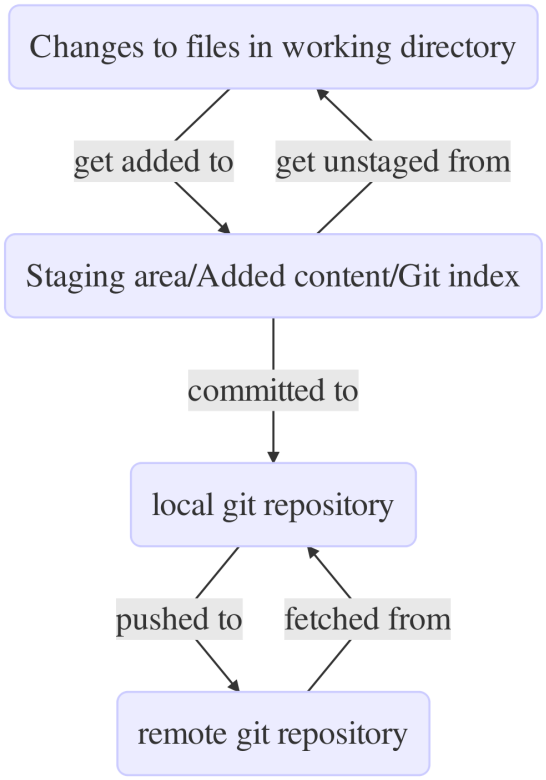
Make git aware of it by adding it to the repository.

1.2.5. git add

```
$ git add mycode.py
$ git status
On branch master

Initial commit

Changes to be committed:
  (use "git rm --cached <file>..." to unstage)

    new file:   mycode.py
```

You have added a file to the index ready to be committed to the repository.

Remember the four stages you talked about before:



You create your file (1- local changes), then added/staged it to the index (2) and then committed to the local repository.

Still you have no history!

```
$ git log
fatal: bad default revision 'HEAD'
```

So you need to commit it to the repository to get a history.

1.2.6. git commit

```
$ git commit
$ git log
commit e5fb099e952e8754b54f9b99be93d62e3fce0fca
Author: ianmiell <ian.miell@gmail.com>
Date:   Tue Apr 26 07:46:58 2016 +0100

    Some message
```

Now that git is aware of this file you can make a change to it and show how the local change looks using git diff.

1.2.7. git diff

```
$ vi mycode.py
$ git diff
```

Again, you can see what's going on by looking at the status. You can commit changes to files and add at the same time by doing 'commit -a'

```
$ git status
$ git commit -a
$ git status
```

git log now shows the history of the file:

```
$ git log
```

1.2.8. What you learned

- git init
- the .git folder
- HEAD - a pointer to where in the history you are
- git log
- git status
- git add
- git commit
- git diff

1.2.9. Exercises

1) Create a git repo

2) Add and commit a file to the repo

3) Commit a few more changes, and then run git log to view the history

1.3. Cloning a repo

- git clone
- git reset

1.3.1. Clone

In this section you're going to play with the contents of your repository by deleting the content and seeing what your options are to recover from the repository.

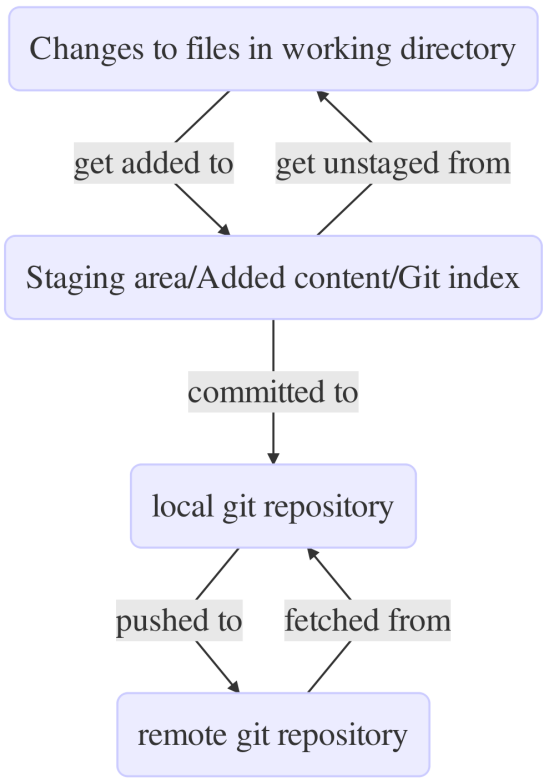
```
$ git clone https://github.com/ianmiell/shutit
$ cd shutit
$ ls .git
```

> **NOTE** If you have problems cloning from GitHub, you can replace the clone with any URL that you can access from within your network. Otherwise, check your proxy settings.

There's .git, just as before.

1.3.2. Accidental Deletion

Recall the 4 stages of data in a git repo:




```
$ git log                           # default history of this repo
$ git log --oneline                 # more concise history of this repo
$ git log --oneline --graph         # graphical view of the history of this repo
$ cd ..                             # exit this repo's root folder
$ git clone shutit cloned_shutit    # clone the repository
$ cd cloned_shutit                  # enter the repository
$ ls .git                           # you have a copy of the repository's history
$ rm -rf *                          # delete all the files!
$ ls .git                           # The .git folder is still there
```

You have cloned the repository, and 'accidentally' deleted all the files.

1.3.3. git reset

You can use 'git reset' to recover the state of the git repository in various ways.

By default, git will recover whatever has been added to the index/staging area and place it in your working directory.

By contrast a 'git reset --hard' will blitz all local and added changes, reverting your checkout to a just-cloned state.

```
$ git status        # reports that you have deleted files in working tree/directory
$ git add .         # added to staging/index area
$ git status        # reports that . Note there's a helpful message about resetting
now! Let's explore that.
$ git reset --mixed # --mixed is the default. out of staging/index area, but still
deleted in the working directory!
$ git status        # you are back to 'deleted in the working directory' with a
message about being ready to add
$ rm -rf *          # delete all the files again
$ git add .         # added to staging/index area ready to commit again
$ git reset --hard  # does a re-check out of the whole repository, discarding working
directory and changes to the index
$ git status        # you now have a consistent state between 1 (local changes) and 3
(committed)
```

1.3.4. What you learned

- git clone
- git reset

1.3.5. Exercises

1) Check out a git repo from either your company repository or github

2) Browse the git log for that repo

3) Look at the man page for git log and explore the options. Don’t worry about understanding everything in there, but play with the options and try to work out what is going on.

1.4. Git branching

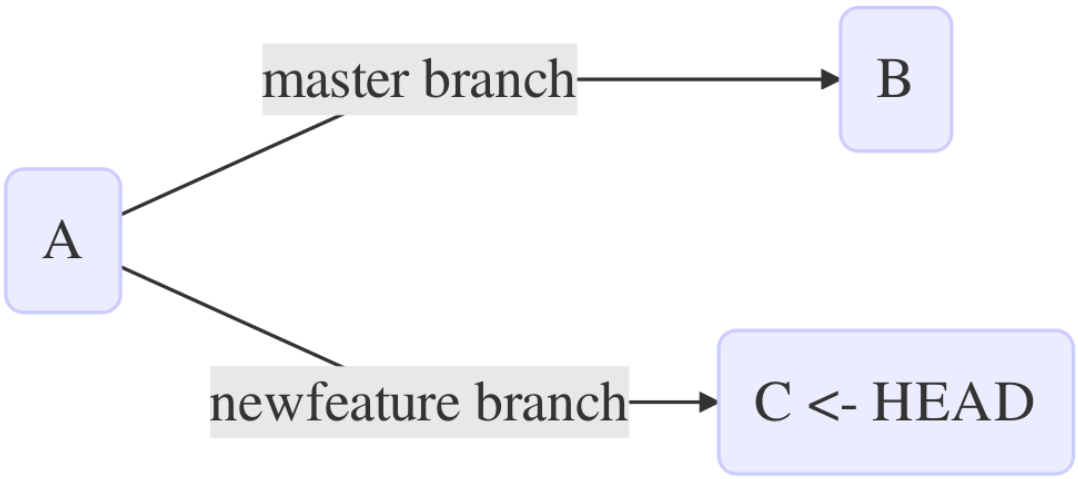
In this section you will learn about:

- git branch
- git checkout

In the next section of code you will create a git repository with a single file. This file will have separate changes made on two branches - master and newfeature.

```
$ rm -rf 1.4.1
$ mkdir 1.4.1
$ cd 1.4.1
$ git init
$ echo newfile > file1
$ git add file1
$ git commit -am 'new file1'
$ git status
$ git branch newfeature                      # Create the 'newfeature' branch
$ git status                                 # You are still on the master branch!
$ git branch                                 # git branch shows the branches in your
repository
$ echo Line_master1 >> file1                 # add Line_master1
$ git commit -am 'master change'             # add, commit and message
$ git log --decorate --graph --oneline       # graphical view of this branch
$ git log --decorate --graph --oneline --all # graphical view of all branches
$ git checkout newfeature                    # Check out the newfeature branch
$ cat file1                                  # This has been checked out at the
'branch point'
$ echo Line_feature1 >> file1                # add Line_feature1
$ git commit -am 'feature change'            # add, commit and message
$ git log --decorate --graph --oneline --all # graphical view of all branches
$ git checkout master                        # checkout the master branch
$ cat file1                                  # The feature change is not there
```

This is the final state of the commit tree.



which reflects the output of the last 'git log' command.

Note that the HEAD (and branch) moves forward with each commit.

The head is where git is pointed at right now, the branch is where that branch reference is pointed to.

Detached Heads

Sometimes when using git you might have seen this:

```
$ git status
HEAD detached at 76d43b6
```

The idea of 'detached heads' sounds scary, and often is to people. But it needn't be!

The HEAD pointer can be moved to an arbitrary point (git checkout does this).

The next set of commands will check out the repository this

```
$ mkdir lgthw
$ cd lgthw
$ git clone https://github.com/ianmiell/learn-git-the-hard-way.git
$ git log
$ git checkout 76d43b6b66f295c0a6c8fc738a3487cd31aea136
Note: checking out '76d43b6b66f295c0a6c8fc738a3487cd31aea136'.

You are in 'detached HEAD' state. You can look around, make experimental
changes and commit them, and you can discard any commits you make in this
state without impacting any branches by performing another checkout.

If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -b with the checkout command again. Example:

  git checkout -b <new-branch-name>

HEAD is now at 76d43b6... latest
$ git status
HEAD detached at 76d43b6
nothing to commit, working directory clean
$ cd -
$ rm -rf lgthw
```

'HEAD detached' means you are in a position associated with a branch.

It 'feels wrong' to be on a detached head because you have no pointer to a branch to reference.

A branch is just a pointer!

Remember these points:

- A 'branch' is just a pointer on a line of changes.
- HEAD is just 'where you are right now'.

- 'Detached head' means you are at a commit that has no branch associated with it

1.4.3. What about tags?

We can cover off tags real quick while we're here.

Tags are the same as branches except they have no history. They point to a particular commit, and don't change (unless you force a change).

You can tag something where you are:

```
$ git tag iwozere
```

or you can tag wherever a branch is right now in your checkout:

```
$ git tag remember_to_tell_bob_to_rewrite_this bobs_branch
```

The 'master' branch

It's worth also pointing out here that apart from its default status, there is nothing special about the 'master' branch. It's just a name. Your principal branch might be called 'live', 'alice', 'pristine', or whatever you like.

1.4.4. What you learned

- git branch
- git checkout
- Detached head
- git log decoration

1.4.5. Exercises

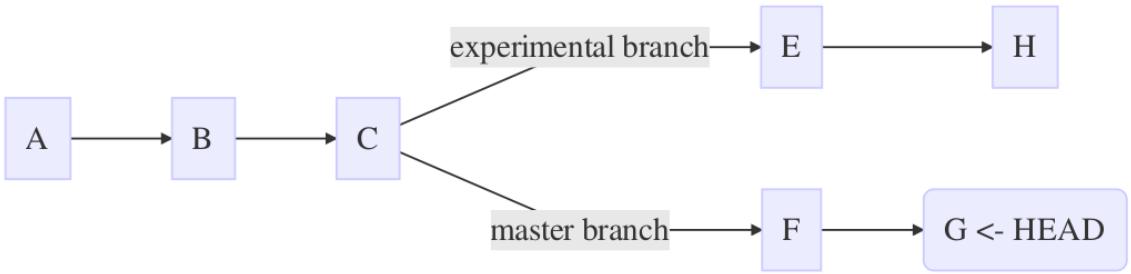
1) Clone a repository from GitHub and create a branch off the main branch (usually 'master') called 'mine'

2) Read up on 'git tag' and create a new commit on your branch and tag it

3) Create another commit from there, and return to your previous commit by doing 'git checkout <commit id>'. Does git status link to the tag as there's no commit?

1.5. Merging

You've already covered basic branching in previous sections. As you will recall, branching gives you the ability to work on parallel streams of development in the same codebase.

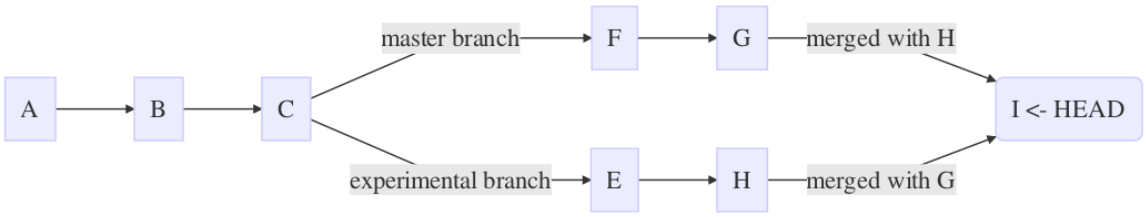


In a sense, merging is the opposite of branching. When you merge, you take two separate points in your development tree and fuse them together.

It's important to understand merging as it's a routine job of a repository maintainer to merge branches together.

In the above diagram, the repository is positioned at the tip of master (G).You know this because the HEAD is pointed at it.

If you merge the experimental branch into master with a 'git merge experimental', you end up with a tree that looks like this:

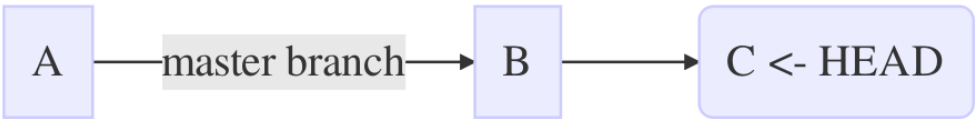


A new change has been made (I). This change merges together the changes made on experimental with the changes made on master.

You can run through the above scenario step-by-step by following these commands:

```
$ rm -rf 1.5.1
$ mkdir -p 1.5.1
$ cd 1.5.1
$ git init
$ echo A > file1
$ git add file1
$ git commit -am 'A'
$ echo B >> file1
$ git commit -am 'B'
$ echo C >> file1
$ git commit -am 'C'
```

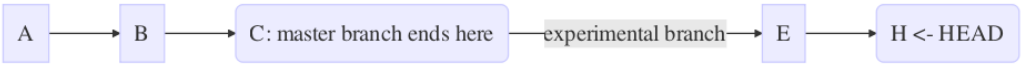
Now you are at this point:



you can branch to experimental and make your changes:

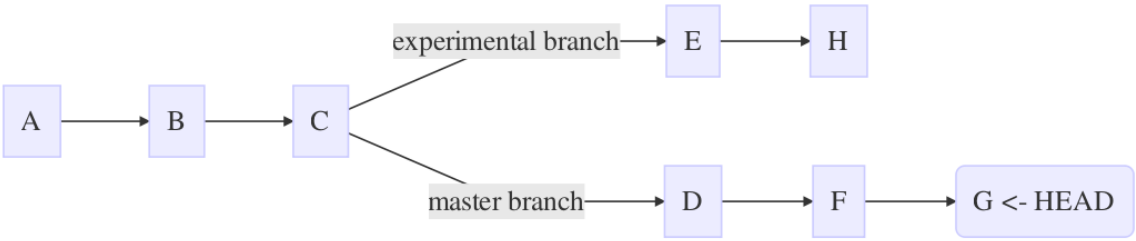
```
$ git branch experimental
$ git checkout experimental
$ git branch
$ echo E >> file1
$ git commit -am 'E'
$ echo H >> file1
$ git commit -am 'H'
```

and the repository is now in this state:



Return to master and make changes D, F and G:

```
$ git checkout master
$ git branch
$ echo D >> file1
$ git commit -am 'D'
$ echo F >> file1
$ git commit -am 'F'
$ echo G >> file1
$ git commit -am 'G'
```



and you are ready to merge!

```
$ git merge experimental
Auto-merging file1
CONFLICT (content): Merge conflict in file1
Automatic merge failed; fix conflicts and then commit the result.
```

Oh dear, that does not look good. The merge failed with a CONFLICT.

1.5.1. What's going on?

So what exactly happens when you perform a merge?

When you run a merge, git looks at the branch you are on (here it is master), and the branch you are merging in, and works out what the first common ancestor is. In this case, it's point C, as that's where you branched experimental.

It then takes the changes on the branch you are merging in from that point and applies them to the branch you are on in one go.

These changes create a new commit, and the git log graph shows the branches joined back up.

Sometimes though, the changes made on the branches conflict with one another. In this case, the D, F and G of the master changed the same lines as the E and H of experimental.

Git doesn't know what to do with these lines. Should it put the E and H in instead of the D, F and G, or put them all in? If it should put them all in, then what order should they go in?

Changing lines around the same area in code can have disastrous effects, so git does not make a decision when this happens. Instead it tells you that there was a conflict, and asks you to 'fix conflicts and then commit the result'.

If you look at file1 now:

```
A
B
C
<<<<<<< HEAD
D
F
G
=======
E
H
>>>>>>> experimental
```

all the lines from both branches are in the file. There are three sections here. The file up to line C is untouched, as there was no conflict. Then we see a line with arrows indicating the start of a conflicting section, followed by the point in the repo that those changes were made on (in this case, HEAD) '<<<<<<< HEAD'. Then a line of just equals signs indicates the end of a conflicting set of

changes, followed by the changes on the other conflicting branch (the E and H on experimental).

What you choose to do here is up to you as maintainers of this repository. You could add or remove lines as you wish until you were happy the merge has been completed. At that point you can commit your change, and the merge has taken place.

You could even leave the file as is (including the '<<<<<<<','=======', and '>>>>>>>' lines, though this is unlikely to be what you want! It's surprising how easily you can forget to resolve all the conflicting sections in your codebase when doing a merge.

When you are done you can commit the change, and view the history with the git log command.

```
$ git commit -am 'merged experimental in'
$ git log --all --oneline --graph --decorate
*   69441b0 (HEAD, master) merged
|\
| * b3d54fe (experimental) H
| * 4a013db E
* | d9d3722 G
* | bf0fc3e F
* | ccedaee D
|/
* 8835191 C
* f9e5b4f B
* 38471fe A
```

Reading this from bottom to top, you can read commit C and commit H as being merged into the HEAD of master.

NOTE	git prefers to show the history from most recent to oldest, which is the opposite of the diagrams in this section. The git man pages like to show time from left to right, like this:

```
             A'--B'--C' topic
            /
D---E---F---G master
```

If you think this is confusing, I won't disagree. However, for git log it makes some sense: if you are looking at a repository with a long history, you are more likely to be interested in recent changes than older ones.

1.5.2. What you learned

- What a merge is
- What a merge conflict is
- How to resolve a merge conflict

- How to read a merged log history

1.5.3. Exercises

1) Initialise a repository, commit a file, make changes on two branches and merge

2) Read over git merge's man page, and research what you don't understand

3) Create a merge knowing there will be a conflict and understand what you need to do to resolve

Chapter 2. Advanced local repository management

Part 1 dealt with core git concepts, and setting up and managing code within a local git repository.

Part 2 deals with advanced local repository management and techniques, before moving onto to Part 3, which looks at working with other git repositories.

In Part 2 you will cover:

- git stash
- git cherry-pick
- git rebase
- git bisect

2.1. Git Stash

Next I introduce a concept that you may end up using a lot!

Often when you are working you want to return to a pristine state, but not lose the work you have done so far.

Traditionally with other source control tools you've copied files that have changed locally aside, then updated your repo, and diffed and re-applied the changed files.

However, git has a concept of the stash to store all local changes ready to reapply at will.

You can get very sophisticated with the stash, but 99% of the time I use it like this:

```
[do some work]

[get interupted]

git stash

[deal with interruption]

git stash pop
```

Here is a basic example of a change I want to 'stash':

```
$ rm -rf 2.1.1
$ mkdir 2.1.1
$ cd 2.1.1
$ git init
$ echo 'Some content' > file1
$ git add file1
$ git commit -am initial
$ echo 'Some changes I am not sure about' >> file1
```

Let's imagine I'm in the middle of some work, and Alice lets me know that there's an important update to the code I need to pull from BitBucket.

First you can see what changes you have made locally with 'git diff':

```
$ git diff
diff --git a/file1 b/file1
index 0ee3895..5554e0f 100644
--- a/file1
+++ b/file1
@@ -1 +1,2 @@
 Some content
+Some changes I'm not sure about...
```

To store away these changes locally you run 'git stash':

```
$ git stash
Saved working directory and index state WIP on master: 34509a0 initial
HEAD is now at 34509a0 initial
```

A quick 'git status' confirms that your working directory is 'clean':

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

What happened to your change?

The really keen can look at

```
$ git log --graph --all --decorate
*   commit 6a2fda32eaf55fedf90c3aa237a528cf7cf50a95 (refs/stash)
|\  Merge: 34509a0 9ff137c
| | Author: Ian Miell <ian.miell@gmail.com>
| | Date:   Tue Jun 28 12:02:45 2016 +0100
| |
| |     WIP on master: 34509a0 initial
| |
| * commit 9ff137cd51373afe6db37cbac4f1011b0db78ace
|/  Author: Ian Miell <ian.miell@gmail.com>
|   Date:   Tue Jun 28 12:02:45 2016 +0100
|
|       index on master: 34509a0 initial
|
* commit 34509a0afaf3eb9b7ff31dee3ab804903c8d36b0 (HEAD, master)
  Author: Ian Miell <ian.miell@gmail.com>
  Date:   Tue Jun 28 12:01:49 2016 +0100

      initial
```

As you can see, it’s committed the state of the index (9ff...) and then committed the local change to the refs/stash branch, and merged them as a child of the HEAD on a new 'refs/stash' branch.

Don’t worry too much about the details: it’s basically stored all the changes you’ve made (but not *committed*) ready to be re-applied.

'stash' is a special branch which is kept local to your repository. The message 'WIP on master' and 'index on master' is added automatically for you.

The master branch is still where it was and the HEAD pointer is pointed at it (that is where your repo now is).

I can now do my other work (in this case, pulling the latest changes from a remote) without concern for whether it conflicts with those changes.

```
$ git stash list
stash@{0}: WIP on master: 34509a0 initial
```

Once I’m ready, I can reapply those changes by running 'git stash pop':

```
$ git stash pop
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:   file1

no changes added to commit (use "git add" and/or "git commit -a")
Dropped refs/stash@{0} (279ee87c68798caaf2ea3d45fcfa0ac42df6ba4b)
```

which 'pops' the zero-numbered change off the stash stack and restores the changes I stashed, applied to wherever I've ended up.

2.1.1. Choosing your stash

You may be wondering at this point how you manage multiple stashes.

Type this sequence out. It will stash two similar-looking changes.

```
$ rm -rf 2.1.2
$ mkdir 2.1.2
$ cd 2.1.2
$ git init
$ echo 'Some content' > file1
$ git add file1
$ git commit -am initial
$ echo 'First changes I am not sure about' >> file1
$ git stash
$ echo 'Second change I am also not sure about' >> file1
$ git stash
$ git stash list
stash@{0}: WIP on master: d3f21d2 initial
stash@{1}: WIP on master: d3f21d2 initial
```

You can see you now have two changes in your stash. But which is which?

Some minimal information is available with 'git stash show <ID>'

```
$ git stash show stash@{0}
 file1 | 1 +
 1 file changed, 1 insertion(+)
$ git stash show stash@{1}
 file1 | 1 +
 1 file changed, 1 insertion(+)
```

but this is not sufficient for you to tell what is going on.

'git stash show --patch <ID>' gives you diff information also:

```
$ git stash show --patch stash@{0}
diff --git a/file1 b/file1
index 0ee3895..c8f5c78 100644
--- a/file1
+++ b/file1
@@ -1 +1,2 @@
 Some content
+Second change I am also not sure about

$ git stash show --patch stash@{1}
diff --git a/file1 b/file1
index 0ee3895..aa51db4 100644
--- a/file1
+++ b/file1
@@ -1 +1,2 @@
 Some content
+First changes I am not sure about
```

From this you can infer that stash pushes to a stack at number zero, and then pops from zero if you use git stash pop.

If you want to apply the first change only from here, run:

```
$ git stash apply stash@{1}
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:   file1

no changes added to commit (use "git add" and/or "git commit -a")

$ git diff
diff --git a/file1 b/file1
index 0ee3895..aa51db4 100644
--- a/file1
+++ b/file1
@@ -1 +1,2 @@
 Some content
+First changes I am not sure about
```

Be aware of a little gotcha here - if you 'apply' a git stash, then it remains in the list. 'git stash pop' will remove the stash item for you.

```
$ git stash list
stash@{0}: WIP on master: d3f21d2 initial
stash@{1}: WIP on master: d3f21d2 initial
```

How to manually remove a stash entry is left as an exercise for the reader.

In general, use of the stash is limited to simple pushes/pops.

2.1.2. What you learned

- What the stash is
- How it works
- How to re-apply changes

2.1.3. Exercises

- Stash several changes and then re-apply them in a different order, ending up with an empty stash list

2.2. Cherry Picking

Next we look at 'cherry-picking'.

Since every commit in git is a change set with a reference id, you can easily port changes from one branch to another.

To demonstrate this, create a simple repository with two changes:

```
$ rm -rf 2.4.1
$ mkdir 2.4.1
$ cd 2.4.1
$ git init
$ echo change1 > file1
$ git add file1
$ git commit -am change1
$ echo change2 >> file1
$ git commit -am change2
$ git log
```

At this point you branch off into two branches, master and experimental.

```
$ git branch experimental
$ git checkout experimental
$ ex -sc '1i|crazy change' -cx file1  # Magic to insert before the first line
$ cat file1
$ git commit -am crazy
$ echo more sensible change >> file1
$ cat file1
$ git commit -am sensible
```

You decide that the sensible change is the one you want to keep.

First get the reference id with a git log:

```
$ git log
```

then checkout the master and run a cherry-pick command:

```
$ git checkout master
$ git cherry-pick ID
$ git log
```

NOTE	while researching this I came across complex scenarios where the diff was not easily applied (hence the insertion of the 'crazy change' at the top).

Sometimes the cherry-pick might fail because the diff cannot easily be applied, as in this case:

```
$ rm -rf 2.4.3
$ mkdir 2.4.3
$ cd 2.4.3
$ git init
$ echo change1 > file1
$ git add file1
$ git commit -am change1
$ echo change2 >> file1
$ git commit -am change2
$ git log
$ git branch experimental
$ git checkout experimental
$ echo crazy change >> file1
$ cat file1
$ git commit -am crazy
$ echo more sensible change >> file1
$ cat file1
$ git commit -am sensible
$ git log
$ git checkout master
$ git cherry-pick ID
```

When cherry-picking you will get a message like this:

```
error: could not apply 743d18e... sensible
hint: after resolving the conflicts, mark the corrected paths
hint: with 'git add <paths>' or 'git rm <paths>'
hint: and commit the result with 'git commit'
```

in which case you need to follow the instructions above.

As ever, a git status helps you see what's going on.

```
$ git status
On branch master
You are currently cherry-picking commit 743d18e.
  (fix conflicts and run "git cherry-pick --continue")
  (use "git cherry-pick --abort" to cancel the cherry-pick operation)

Unmerged paths:
  (use "git add <file>..." to mark resolution)

    both modified:   file1

no changes added to commit (use "git add" and/or "git commit -a")
```

Cherry-picking is often a simple and easy to follow way to move changes between different

branches, which can be very useful.

2.2.1. What you learned

- what git cherry pick does

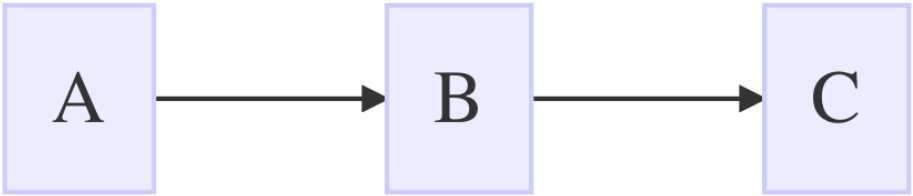
2.3. Git Rebase

Rebasing is one of the most commonly-discussed advanced git topics.

In essence it’s quite simple, but it can get very confusing.

Following this you’re going to learn about rebasing and fast-forwarding with a simple example, so pay attention!

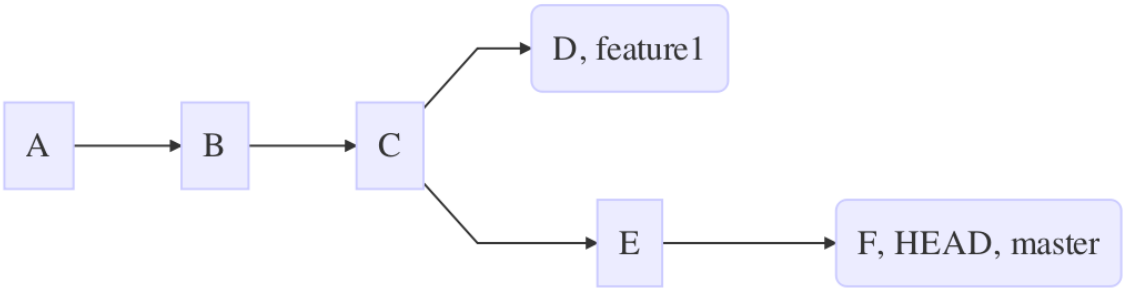
Let’s say you have a set of changes on a master branch:



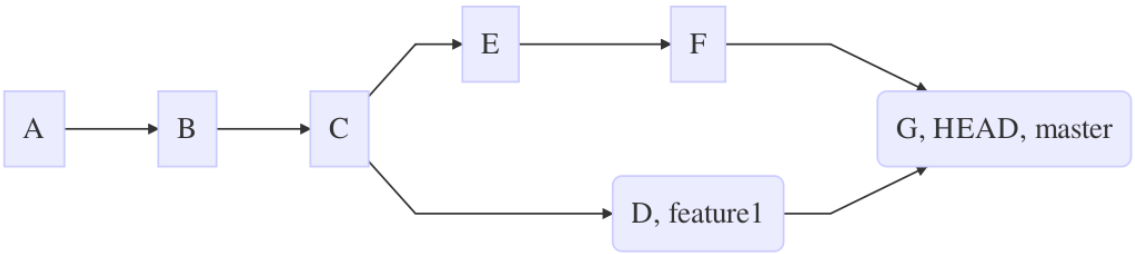
NOTE	The diagrams in this book are left-right in time order, whereas the 'git log' is bottom-up in time order.

and at this point you branch off to 'feature1' and make another change:

Now you go back to master and make a couple more changes:



Now think about this from the point of view of the developer of feature1. She has made a change from point C on the master branch, but the situation has moved on. Now if master wants to merge in the change on feature1, it could merge it in, and the tree would look like this:



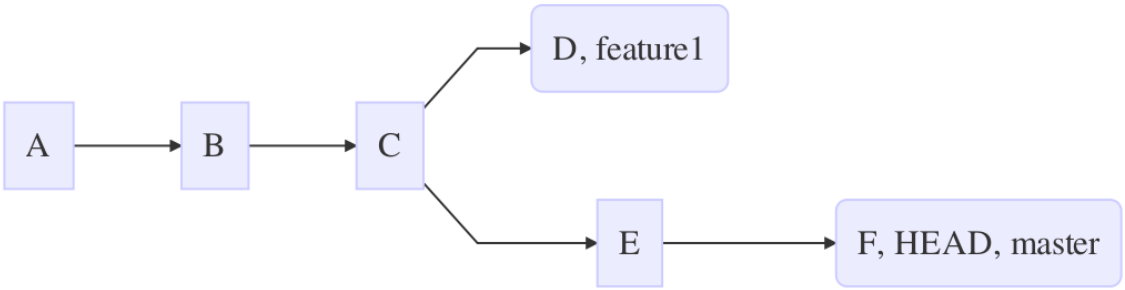
That is OK, but not entirely desirable for two reasons:

- The history has just got more complicated
- You have introduced an extra new change (G), which is the merge of D and F

Wouldn't it be better if the history looked like this?

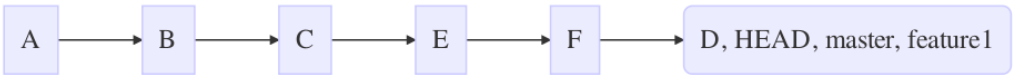
This is much cleaner and easier to follow. If, for example, a bug was introduced in D, it's easier to find (eg using bisect, which you will come onto). Also, the feature1 branch can be safely deleted without any significant information being lost, making the history tidier and simpler.

If you remind yourselves of the situation pre-merge (above) then you can visualise 'picking up' the changes on the feature1 branch and moving them to the HEAD. So from this:




```
A
|
B
|
C
|\
E D (feature1)
|
F (HEAD, master)
```

To this:




```
A
|
B
|
C
|
E
|
F (HEAD, master)
 \
  D (feature1)
```

This is what a rebase is: you take a set of changes from a particular point and apply them from a different point - re-base!

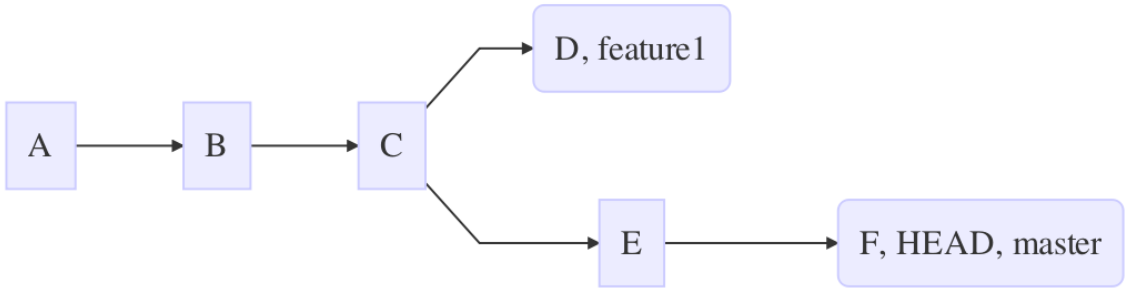
NOTE	be aware that people also talk about rebasing to 'squash' commits. This is a slightly different scneario that uses the same rebase command.

Let’s walk through the above scenario with git commands.

```
rm -rf 2.5.1
mkdir 2.5.1
cd 2.5.1
git init
echo A > file1
git add file1
git commit -am A
echo B >> file1
git commit -am B
echo C >> file1
git commit -am C

git checkout -b feature1
echo D >> file1
git commit -am D

git checkout master
echo E >> file1
git commit -am E
echo F >> file1
git commit -am F

git log --all --decorate --graph
# * commit baacf6fb432967a9d404858268928278df40c7a3 (feature1)
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     D
# |
# | * commit cb548ab427a50028f2dbd721f4c285cbd6ad595d (HEAD, master)
# | | Author: Ian Miell <ian.miell@gmail.com>
# | | Date:   Wed Jun 29 19:02:09 2016 +0100
# | |
# | |     F
# | |
# | * commit 9a9a81060dd74ded8306e7c1a49400529188df70
# |/  Author: Ian Miell <ian.miell@gmail.com>
# |   Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |       E
# |
# * commit 44954ddfb91d96aaa3bbedab3ae7bcb47aa833be
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     C
# |
# * commit a63e4ff9ba95ab478a5755ed4e3c9c9bc3ddbc37
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
```

```
# |
# |     B
# |
# * commit b1fd27851324ed88caa958e2da9d7a36e24277dc
#   Author: Ian Miell <ian.miell@gmail.com>
#   Date:   Wed Jun 29 19:02:09 2016 +0100
#
#       A
```

You are now in this state:



You go to feature1 and rebase:

```
git checkout feature1
git rebase master
# First, rewinding head to replay your work on top of it...
# Applying: D
# Using index info to reconstruct a base tree...
# M file1
# Falling back to patching base and 3-way merge...
# Auto-merging file1
# CONFLICT (content): Merge conflict in file1
# Failed to merge in the changes.
# Patch failed at 0001 D
# The copy of the patch that failed is found in:
#    /Users/imiell/gitcourse/tmprebase/.git/rebase-apply/patch
#
# When you have resolved this problem, run "git rebase --continue".
# If you prefer to skip this patch, run "git rebase --skip" instead.
# To check out the original branch and stop rebasing, run "git rebase --abort".
vi file1
git add file1
git rebase --continue
# Applying: D
git log --all --decorate --graph
* commit eff7c3a62c8a2ce74302207db014b0db82c22d4e (HEAD, feature1)
| Author: Ian Miell <ian.miell@gmail.com>
| Date:   Wed Jun 29 19:02:09 2016 +0100
```

```
 |
 |     D
 |
 * commit cb548ab427a50028f2dbd721f4c285cbd6ad595d (master)
 | Author: Ian Miell <ian.miell@gmail.com>
 | Date:   Wed Jun 29 19:02:09 2016 +0100
 |
 |     F
 |
 * commit 9a9a81060dd74ded8306e7c1a49400529188df70
 | Author: Ian Miell <ian.miell@gmail.com>
 | Date:   Wed Jun 29 19:02:09 2016 +0100
 |
 |     E
 |
 * commit 44954ddfb91d96aaa3bbedab3ae7bcb47aa833be
 | Author: Ian Miell <ian.miell@gmail.com>
 | Date:   Wed Jun 29 19:02:09 2016 +0100
 |
 |     C
 |
 * commit a63e4ff9ba95ab478a5755ed4e3c9c9bc3ddbc37
 | Author: Ian Miell <ian.miell@gmail.com>
 | Date:   Wed Jun 29 19:02:09 2016 +0100
 |
 |     B
 |
 * commit b1fd27851324ed88caa958e2da9d7a36e24277dc
   Author: Ian Miell <ian.miell@gmail.com>
   Date:   Wed Jun 29 19:02:09 2016 +0100

       A
```

Now the changes are in one line you can merge the feature1 master branch.

```
git checkout master
git merge feature1
# Updating cb548ab..eff7c3a
# Fast-forward
#  file1 | 1 +
#  1 file changed, 1 insertion(+)
git log --all --decorate --graph
# * commit eff7c3a62c8a2ce74302207db014b0db82c22d4e (HEAD, master, feature1)
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     D
# |
# * commit cb548ab427a50028f2dbd721f4c285cbd6ad595d
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     F
# |
# * commit 9a9a81060dd74ded8306e7c1a49400529188df70
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     E
# |
# * commit 44954ddfb91d96aaa3bbedab3ae7bcb47aa833be
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     C
# |
# * commit a63e4ff9ba95ab478a5755ed4e3c9c9bc3ddbc37
# | Author: Ian Miell <ian.miell@gmail.com>
# | Date:   Wed Jun 29 19:02:09 2016 +0100
# |
# |     B
# |
# * commit b1fd27851324ed88caa958e2da9d7a36e24277dc
#   Author: Ian Miell <ian.miell@gmail.com>
#   Date:   Wed Jun 29 19:02:09 2016 +0100
#
#       A
```

2.3.1. Fast-forwarding

What's interesting about the above is this:

```
git merge feature1
# Updating cb548ab..eff7c3a
# Fast-forward
#  file1 | 1 +
#  1 file changed, 1 insertion(+)
```

Because the changes are in a line, no new changes need to be made - the master branch pointer merely needs to be 'fast-forwarded' to the same point as feature1! The HEAD pointer, naturally, moves with the branch you're on (master).

2.3.2. What you learned

- What a rebase is
- What fast-forward means

2.4. Git Bisect

Bisecting is a very powerful tool for finding bugs.

Let's say you have a set of changes on a master branch:

You discover a previously-unseen bug at point A100 and want to debug it. One way to do this is to read over the code, add logging etc.. This can be time-consuming, and there is another simpler way to gather information about what change caused the bug.

Git bisect is a very useful tool for finding out where a bug was introduced. If you know where a bug was introduced, you can look at the diff of the commit that caused it and

It works by picking a start point where the bug definitely did not exist (the 'good' point). In this case you'll choose point A1. Then you pick a point where the bug definitely did exist (the 'bad' point). In this case, that's A100.

Once the git bisect session has that information, it can hand you a version at the hafway point between the 'good' and 'bad' points and asks you to run whatever you need to run to determine whether it's good or bad. If you tell it it's 'good' it will mark all version at that point and before as 'good'.

It then repeats the process, giving you a version at the halfway point between 'good' and 'bad', asking you for its status. In this sequence, you are given A75:

If you determine that this version was 'bad', then all the versions after it are marked as bad:

This binary search process repeats until you know which versions were good and bad. One outcome might be:

Once you know that the first 'bad' commit was A63, you can examine the difference between A62 and A63, and this gives you a clue.

2.4.1. A 'real' git bisect session

Let’s make this more realistic with an actual git bisect session.

What you’re going to do is create a git repo with one file (projectfile). In this file you are going to add a line for each commit. The first line will be 1, the second 2, and so on until the hundredth commit which adds the line '100'.

In this scenario the 'bug' is the line '63', but you don’t know that yet. All you know is that you can tell if the bug is in the code with the shell script:

```
rm -rf git-bisect && mkdir -p git-bisect && cd git-bisect
git init
touch projectfile
git add projectfile
for ((i=1;i<=100;i++)); do echo $i >> projectfile; git commit -am "A$i"; done
git log
git bisect start
git bisect bad
git status
git checkout HEAD~99   # Check out the first checkout
git log
git status
git bisect good
git log                # Now at A50
git status
git bisect good
git log                # Now at A75
git bisect bad
git log                # Now at A62
git bisect good
git log                # Now at A68
git bisect bad
git log                # Now at A65
git bisect bad
git log                # Now at A64
git bisect bad
git log                # Now at A63
git bisect bad
# 79583459dc6061bd91d55cfcf8c34fae845f836b is the first bad commit
# commit 79583459dc6061bd91d55cfcf8c34fae845f836b
# Author: Ian Miell <ian.miell@gmail.com>
# Date:   Sun Jul 10 11:53:47 2016 +0100
#
#     A63
#
# :100644 100644 aea6bd8ad6845cca3804a87230fee1b69651643d
55200b3d5d7c0e515eaccaf8465a295017e88249 M    projectfile
```

The bisect is complete, and has reported 79583459dc6061bd91d55cfcf8c34fae845f836b as the first bad commit (this may differ for you).

You can get the diff between this commit and its parent by using the '^' operator with diff:

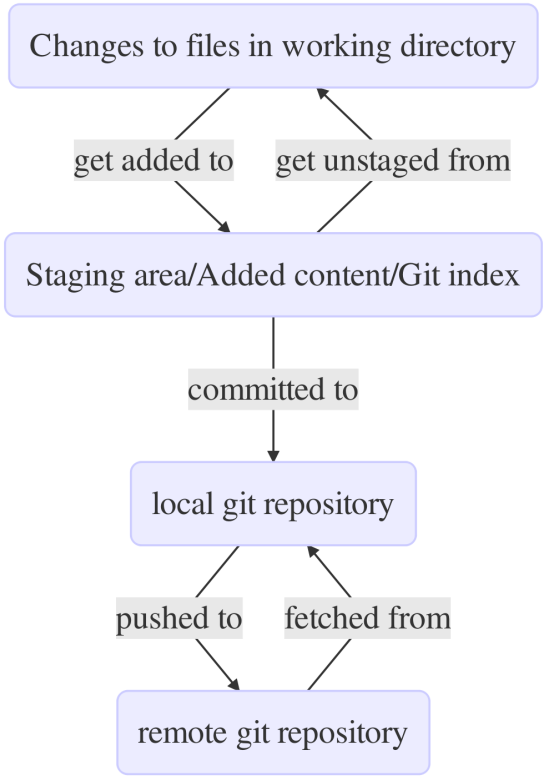
```
git diff 79583459dc6061bd91d55cfcf8c34fae845f836b^
79583459dc6061bd91d55cfcf8c34fae845f836b
# diff --git a/projectfile b/projectfile
# index aea6bd8..55200b3 100644
# --- a/projectfile
# +++ b/projectfile
# @@ -60,3 +60,4 @@
#  60
#  61
#  62
# +63
```

2.4.2. What you learned

- How to bisect a git repo

2.5. Git add interactive

Previously you've learned about the four stages of working in Git:



So far you've shown a difference between adding (staging) and committing, but this still causes confusion for people - what's the point of this?

Let's demonstrate how you might want to use this with a simple example:

```
$ mkdir 2.2.1
$ cd 2.2.1
$ git init
$ echo 'This is file1' > file1
$ echo 'This is file2' > file2
$ git add file1 file2
$ git commit -am 'files added'
$ cat > file1 << END
Good change
This is file1
Experimental change
END
$ cat > file2 << END
All good
This is file2
END
```

```
$ git add -i
```

Then tap in:

```
p
1

s
y
n
q
```

Now run:

```
$ git add -i
           staged     unstaged path
  1:    unchanged        +2/-0 file1

*** Commands ***
  1: status   2: update   3: revert   4: add untracked
  5: patch    6: diff     7: quit     8: help
What now> p
           staged     unstaged path
  1:    unchanged        +2/-0 file1
Patch update>> 1
           staged     unstaged path
* 1:    unchanged        +2/-0 file1
Patch update>>
diff --git a/file1 b/file1
index 6a00e12..014f6e4 100644
--- a/file1
+++ b/file1
@@ -1 +1,3 @@
+Good change
 This is file 1
+Experimental change
Stage this hunk [y,n,q,a,d,/,s,e,?]? s
Split into 2 hunks.
@@ -1 +1,2 @@
+Good change
 This is file 1
Stage this hunk [y,n,q,a,d,/,j,J,g,e,?]? y
@@ -1 +2,2 @@
 This is file 1
+Experimental change
Stage this hunk [y,n,q,a,d,/,K,g,e,?]? n

*** Commands ***
  1: status   2: update   3: revert   4: add untracked
  5: patch    6: diff     7: quit     8: help
What now> q
Bye.
$ git status # There are both staged and unstaged changes
$ git diff   # One change has been added (but not committed), and the other is still a
change only in section 1
```

Now you have staged the good change, but not lost the other changes you have made. This gives you more granular control over the changes committed.

If you are happy with the changes you can go ahead and commit all the changes you have made.

NOTE	Committing will still commit all the changes you have made. What is the point of staging then? It is to confirm that you want to commit some changes made locally, but not others.

These changes are added to the 'index' (as opposed to the repository). Remember: index==staging==adding Committing: goes to the repository, which can then be pushed to remote repositories

2.5.1. What you learned

- Difference between staging and committing
- Why the distinction exists
- How to stage specific 'hunks' of code to the index

2.6. Reflog

In this section we're going to look at the reflog.

The reflog gives you references to a sequential history of what you have done to the repo. This can come in very handy when you play with your local repo's history, as you will see here.

First set up a repo with two commits:

```
$ rm -rf 2.3.1
$ mkdir 2.3.1
$ cd 2.3.1
$ git init
$ echo first commit > file1
$ git add file1
$ git commit -am file1
$ echo second commit >> file1
$ git commit -am file1.1
$ git log
```

Then do some magic to effectively remove the last commit:

```
$ git checkout HEAD^    # Use the caret character as a parent
$ git branch -f master
$ git checkout master
$ git log
```

NOTE	don't worry about what you just did - it's a more advanced set of commands that mess with git's history.

The last commit has disappeared! You have fully reverted the master branch to where it was before.

Don’t worry about what you did there, the point here is: what you do if you get ourselves into a mess, and what do you do to get out of it?

This is where git reflog can help.

Git reflog records all *movements* of branches in the repo. Like stashes, it is local to your repo.

```
$ git reflog
66cdcd2 HEAD@{0}: checkout: moving from 66cdcd23c5c005edecd7cd7b162d7b42b7a02ab4 to
master
66cdcd2 HEAD@{1}: checkout: moving from master to HEAD^
40e99f7 HEAD@{2}: commit: file1.1
66cdcd2 HEAD@{3}: commit (initial): file1
```

Git reflog is a history of the changes made to the HEAD (remember the head is a pointer to the current location of the repository).

If you 'reset --hard' the repository to the reference given:

```
$ git reset --hard 40e99f7
HEAD is now at 40e99f7 file1.1
$ git log
```

you are returned to where you were.

The --hard updates both the index (staging/added) and the working tree, as you saw previously.

The refog contains refernces to the state of the repository at various points even if those points are no longer apparently reachable within the repo.

2.6.1. What you have learned

- git reflog
- git reset (--mixed)
- git reset --hard

Chapter 3. Remote Repositories

Part 2 dealt with advanced local repository management and techniques

Part 3 is where it gets interesting! In this part you will start to interact

Now that you understand what a git repository is, how branches work, and how they are all fundamentally equivalent, you are in a great position to understand how to work with others using git.

In Part 3 you will cover:

- git push
- git fetch
- git pull
- git submodule
- pull requests

3.1. Fetching and Pulling Content

In part one I emphasized the point that all git repositories are equal.

This section covers how git repositories communicate with each other and manage their differences.

We have already covered git clone, but let's create a simple git repo and then clone it:

```
$ rm -rf git_origin git_cloned
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin git_cloned
```

These two repositories (the folders 'git_origin' and 'git_cloned') now contain identical content:

```
$ diff git_origin/file1 git_cloned/file1
```

However, their .git/config files differ in instructive ways.

The git_origin folder has this in its .git/config file:

```
$ cat git_origin/.git/config
[core]
    repositoryformatversion = 0
    filemode = true
    bare = false
    logallrefupdates = true
    ignorecase = true
    precomposeunicode = true
```

while the git_cloned folder has this in its .git/config file:

```
$ cat git_cloned/.git/config
[core]
    repositoryformatversion = 0
    filemode = true
    bare = false
    logallrefupdates = true
    ignorecase = true
    precomposeunicode = true
[remote "origin"]
    url = /Users/imiell/gitcourse/git_origin
    fetch = +refs/heads/*:refs/remotes/origin/*
[branch "master"]
    remote = origin
    merge = refs/heads/master
```

While the git_origin has no visibility of any 'remotes', the cloned one does. It has an origin remote.

Its url is (in this case) pointed at the file. URLs can also be http/https, ssh, or git.

If I go to the cloned repo and ask it for information about remotes:

```
$ cd git_cloned
$ git remote
origin
```

I get the name 'origin' back.

The name 'origin' is the default name for a remote, but it has no special meaning. It could be renamed to 'bitbucket', or 'gitlab' for example.

To get more defailed about remotes, run with -v:

```
$ git remote -v
origin  /Users/imiell/gitcourse/git_origin (fetch)
origin  /Users/imiell/gitcourse/git_origin (push)
```

which gives you the information about the URLs you saw in the config file.

3.1.1. fetch

The above remotes are divided into "(fetch)" and "(push)" actions. These relate to two different actions on remotes, ie getting changes from a remote, or pushing changes to a remote.

These actions can work against different remotes. For example, the output of git remote might be:

```
$ git remote -v
origin  /Users/imiell/gitcourse/one_origin (fetch)
origin  /Users/imiell/gitcourse/another_origin (push)
```

but I've never seen an example of this in the wild.

First you look at 'fetch'ing from the remote.

'git fetch' gets the latest changes from the remote repository and copies them into the local repository.

Crucially, these changes are not 'mixed' with your repository, but are kept in a separate place.

You can see this if you use the 'git branch -a' command.

First make a change to the origin's repo:

```
$ cd git_origin
$ echo 'fetchable change' >> file1
$ git commit -am fetchable
```

Then go to the cloned repository and fetch the changes on the master branch on the origin remote (git_origin):

```
$ cd ../git_cloned
$ git fetch origin master
remote: Counting objects: 3, done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From /Users/imiell/gitcourse/git_origin
 * branch            master     -> FETCH_HEAD
   ceed883..056dd2c  master     -> origin/master
```

What the above output means is that the origin's master has been brought into this repo's references. This branch is now referred to locally as: origin/master.

This has not affected the local master branch at all!

```
$ git log
```

You can see this repository's view of all the branches by running a git branch command with '--all':

```
$ git branch --all
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
```

Here you see the local 'master' branch, followed by the remotes/origin/HEAD pointer (remember HEAD is a pointer to a location in the repository), which is linked to remotes/origin/master.

If you want to dig into the internals at this point, you can peek at the .git folder again:

```
$ ls .git/refs/
heads   remotes tags
```

which has 'heads' which contains references to local branch:

```
$ cat .git/refs/heads/master
ceed883eec5a797471cd1c62365d9f2899b857c7
```

and similarly for remote branches:

```
$ cat .git/refs/remotes/origin/master
056dd2ce64da1e746214107b74866c375a85ffc2
```

So you've 'fetch'ed the remote branch and have it locally.

To apply the remote master's changes to the local one you merge it just as you would for any other reference:

```
$ git merge origin/master
Updating ceed883..056dd2c
Fast-forward
 file1 | 1 +
 1 file changed, 1 insertion(+)
$ git log
commit 056dd2ce64da1e746214107b74866c375a85ffc2
Author: Ian Miell <ian.miell@gmail.com>
Date:   Tue Jun 28 18:41:41 2016 +0100

    fetchable

commit ceed883eec5a797471cd1c62365d9f2899b857c7
Author: Ian Miell <ian.miell@gmail.com>
Date:   Tue Jun 28 17:30:44 2016 +0100

    file1
```

3.1.2. What you've learned

You have learned what a 'git pull' actually does.

A 'git pull' does a

- fetch, followed by a
- merge

A pull fetches the mapped branch, and then merges it into the local branch.

In general I prefer that rather than using 'git pull' you do fetch and merge separately and keep reminding yourself of what's going with respect to 'remotes' in your git repository. Once you've internalised that workflow, start using 'git pull' as a convenience. If you use 'git pull' too early there is a danger of seeing it as magical, or at least not feeling entirely sure about what's going on!

We will cover what your branch locally is mapped to remotely in the next section, where you will cover remote repository management in more depth.

3.1.3. Exercises

1) Look up the man page for git pull and try and follow the description at the top. Make sure you try to understand every part.

2) Clone a git repository from GitHub, and fetch and merge a particular branch from it into a new branch you have created locally. Draw a diagram of what you have done. If the repository doesn't have a branch, find one that does.

3.2. Working with multiple repos

Now you are going to work with multiple repos.

Let's do the same as you did before, but create two clones of the origin: alice_cloned and bob_cloned.

```
$ rm -rf git_origin alice_cloned bob_cloned
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin alice_cloned
$ git clone git_origin bob_cloned
```

Now alice_cloned and bob_cloned have git_origin as the origin remote:

```
$ cd alice_cloned
$ git remote -v
origin  /Users/imiell/gitcourse/git_origin (fetch)
origin  /Users/imiell/gitcourse/git_origin (push)
$ cd ../bob_cloned
$ git remote -v
origin  /Users/imiell/gitcourse/git_origin (fetch)
origin  /Users/imiell/gitcourse/git_origin (push)
```

Now alice makes a change in her master branch:

```
$ echo alice_change >> file1
imiell@Ians-MacBook-Air:~/gitcourse/alice_cloned$ git commit -am 'alice change'
[master 9077a48] alice change
 1 file changed, 1 insertion(+)
```

Alice <→ Origin <→ Bob

The question is: how does Bob get Alice's change into his master branch without going to origin?

This is a common scenario in distributed teams. If you consider that git was created for managing the codebase of the Linux operating system, it's easy to imagine the git_origin as Linus Torvalds' repository, Alice as a contributor and Bob as a so-called lieutenant.

So here is how:

1) ADD alice's repository as a remote to Bob's

2) FETCH alice’s updated master branch

3) MERGE alice’s master branch into Bob’s local one

As you have already seen, steps 2) and 3) can be collapsed into a 'git pull', but it is more instructive to keep these separate.

1) ADD alice’s repository as a remote to Bob’s

First, Bob needs to add alice’s repository as a remote.

```
$ git remote add alice ../alice_cloned
$ git remote -v
alice   ../alice_cloned/ (fetch)
alice   ../alice_cloned/ (push)
origin  /Users/imiell/gitcourse/git_origin (fetch)
origin  /Users/imiell/gitcourse/git_origin (push)
```

You have now linked up your repository to alice’s, and given it the name 'alice'.

2) FETCH alice’s updated master branch

```
$ git fetch alice master
remote: Counting objects: 3, done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From ../alice_cloned
 * branch            master     -> FETCH_HEAD
 * [new branch]      master     -> alice/master
```

Alice’s master branch is now fetched to your local repository.

```
$ git branch -vv -a
* master                fdc7132 [origin/master] file1
  remotes/alice/master  9077a48 alice change
  remotes/origin/HEAD   -> origin/master
  remotes/origin/master fdc7132 file1
```

3) MERGE alice’s master branch into Bob’s local one

```
$ git merge alice/master
Updating fdc7132..9077a48
Fast-forward
 file1 | 1 +
 1 file changed, 1 insertion(+)
$ cat file1
first commit
alice_change
```

You may be wondering why you use alice/master and not remotes/alice/master, as the output of 'git branch -vv -a' tells you. You can run:

```
$ git merge remotes/alice/master
```

which will do the same. Git assumes that the branch is a remote (presumably from seeing the '/' in the branch) and adds the 'remotes' for you.

This 'Lieutenants' model is one example of a git workflow. Although it was the one git was originally created for, it is still common for developers to use a traditional centralised model around a repository such as GitLab or BitBucket.

This is why people make jokes when GitHub is down. Git is designed to be a distributed source control tool, but the simplicity of depending on a central server is also powerful. In any case, git can support both models.

3.2.1. What you learned

- How to add a remote repo
- How to fetch changes from the remote repo
- How to merge changes from the remote repo
- There are different git workflows for different organisation structures

You now understand what a remote repository is, how it fits in with the 'all git repositories are equal' mantra, and are ready to look at working with remotes and branches.

This is where git repositories' relationships become very intertwined, and your hard work thus far will pay off as you get to doing a pull request and fully grasping what’s happening!

3.2.2. Exercises

1) Create a git repo and clone it to a second one. Make a change on the first repo’s master branch, and fetch and merge it into the second one.

2) Create a change on both master branches from 1) that will conflict and commit them. Resolve the conflicts and make both repositories consistent.

3) Do the same as in 2) but on three copies of the same repo (ie two clones).

4) Try setting up two independent copies of the same repo (ie do not clone) and bring changes in and out on multiple branches.

3.3. Pushing Code

You're familiar now with git branches and remote git repositories.

In this section you're going to familiarise yourself with how branches are managed between the two, and what goes on in a push.

First, set up a simple origin git repository and clone it, just as you did before.

```
$ rm -rf git_origin git_clone
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin git_clone
```

As it stands you have no branches on either the origin or the clone other than the default (master):

```
$ cd git_origin
$ git branch -a -v
* master bedca8c file1
$ cd ../git_clone
$ git branch -a -v
* master                bedca8c file1
  remotes/origin/HEAD   -> origin/master
  remotes/origin/master bedca8c file1
$ cd ..
```

Make sure you understand why there are three lines in the second 'git branch' output! If you don't, start the chapter again!

3.3.1. Create branch and push to remote

Now you're going to create a branch on the clone, do some work on it, and then push it to the remote repository.

This is a common use case, as users may experiment with different branches locally, then decide they want to share their work with others by pushing it to a commonly-accessible remote repository, eg on GitHub.

```
$ cd git_clone
$ git checkout -b abranch
$ echo 'cloned abranch commit' >> file1
$ git commit -am 'cloned abranch commit'
$ git push origin abranch:abranch
```

The key bit there was at the end, with the git push command. The colon separates the local branch name from the branch name you are pushing to on the remote (which here happen to have the same name).

3.3.2. Pushing to branch repositories with different content?

You might be asking yourself at this point: what happens if both repositories have a branch with different content?

Let's see! Type this out.

```
$ rm -rf git_origin git_clone
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin git_clone
$ cd git_clone
$ git checkout -b abranch
$ echo 'cloned abranch commit' >> file1
$ git commit -am 'cloned abranch commit'
$ cd ../git_origin
$ git checkout -b abranch
$ echo 'origin abranch commit' >> file1
$ git commit -am 'origin abranch commit'
$ cd ../git_clone
$ git push origin abranch:abranch
```

The output of the last command will look something like this:

```
To /Users/imiell/tmp/git_origin
 ! [rejected]        abranch -> abranch (fetch first)
error: failed to push some refs to '/Users/imiell/tmp/git_origin'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: to the same ref. You may want to first integrate the remote changes
hint: (e.g., 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for details.
```

Read the output carefully. It tells you exactly what's going on. Breaking it down:

```
Updates were rejected because the remote contains work that you do not have locally.
```

The remote (the origin) has a commit (with the content: 'origin abranch commit') that you have no record of locally in your branch with the same name.

```
This is usually caused by another repository pushing to the same ref.
```

It's correctly diagnosed the problem as another repository (git_remote) pushing to the same name on the receiving remote. Finally, it offers some advice.

```
You may want to first integrate the remote changes (e.g., 'git pull ...') before
pushing again.
```

But you know better than to 'git pull'! Do a fetch and merge:

```
$ git fetch origin
remote: Counting objects: 3, done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From /Users/imiell/tmp/git_origin
 * [new branch]      abranch    -> origin/abranch
```

Now check the branches you have locally:

```
$ git branch -v -a
* abranch                d99581a cloned abranch commit
  master                 9917bcd file1
  remotes/origin/HEAD    -> origin/master
  remotes/origin/abranch f2be4e0 origin abranch commit
  remotes/origin/master  9917bcd file1
```

Observe that the 'remotes/origin/abranch' branch you now have locally ('f2be4e0 origin branch commit') is different from the local 'abranch' branch ('d99581a cloned abranch commit').

To complete your manual pull, merge the remote branch into the local:

```
For bonus points, do a rebase here rather than a merge for a cleaner history!
```

```
$ git merge remotes/origin/abranch
Auto-merging file1
CONFLICT (content): Merge conflict in file1
Automatic merge failed; fix conflicts and then commit the result.
```

Follow the instructions to resolve the conflict and commit the result.

3.3.3. The branch exists on the remote, but not locally

It is common to have a branch that exists on a remote repository, but not in your local repository. Maybe someone else pushed a branch up, or has made a pull request from a branch in that repository.

Type the following out to simulate that state of affairs:

```
$ rm -rf git_origin git_clone
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin git_clone
$ cd git_origin
$ git checkout -b abranch
$ echo 'origin abranch commit' >> file1
$ git commit -am 'cloned abranch commit'
$ git branch -a
* abranch
  master
$ cd ../git_clone
$ git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
$ git remote -v
origin  /tmp/git_origin (fetch)
origin  /tmp/git_origin (push)
```

You will observe that the cloned repository has no knowledge of the 'abranch' branch on the 'origin' repository, even though the 'origin' is known to the cloned repo. There’s no magic about the tracking of a remote repository, you have to trigger your repository to read the remote’s state.

To get the branch into your repository you will need to fetch it.

```
$ git fetch origin
remote: Counting objects: 3, done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From /Users/imiell/tmp/git_origin
 * [new branch]      abranch    -> origin/abranch
```

Note that you didn't need to specify a branch to get from the origin. By default it will get all branches that may be of interest.

```
$ git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/abranch
  remotes/origin/master
```

Now your cloned repository has knowledge that a branch called abranch exists on the origin remote. But there is no branch in your local repository:

```
$ git branch
* master
```

Now if you check out an abranch branch in your local repository, git is smart enough to match the name and uses this branch to 'track' the remote branch from the origin:

```
$ git checkout abranch
Branch abranch set up to track remote branch abranch from origin.
Switched to a new branch 'abranch'
$ git branch -a -vv
* abranch                19a1fe0 [origin/abranch] cloned abranch commit
  master                 05d6bd2 [origin/master] file1
  remotes/origin/HEAD    -> origin/master
  remotes/origin/abranch 19a1fe0 cloned abranch commit
  remotes/origin/master  05d6bd2 file1
```

Pay close attention to branch tracking, as it can be very confusing to git newcomers!

Now if you 'git push' any changes on this branch, git will attempt to push those changes to the tracked branch, ie the abranch branch on the remote repository.

3.3.4. Tracking a remote branch with a different name

More rarely, you may want to track a branch on the remote repository that has a different name. Or, you may want to manually mark the local branch as tracking a remote one.

In these situations, you might see this kind of error when you push:

```
$ git push
fatal: The current branch abranch has no upstream branch.
To push the current branch and set the remote as upstream, use

    git push --set-upstream origin abranch
```

As is often the case, careful reading of the error will tell you what you need to know. It's just the jargon that can be difficult to follow!

In this case, the error is telling you that your branch is not tracking any remote branch, so it doesn't know what to push to.

Type in these commands to reproduce this situation:

```
$ rm -rf git_origin git_clone
$ mkdir git_origin
$ cd git_origin
$ git init
$ echo 'first commit' > file1
$ git add file1
$ git commit -am file1
$ cd ..
$ git clone git_origin git_clone
$ cd git_clone
$ git checkout -b abranch
$ echo 'origin abranch commit' >> file1
$ git commit -am 'cloned abranch commit'
$ git push
fatal: The current branch abranch has no upstream branch.
To push the current branch and set the remote as upstream, use

    git push --set-upstream origin abranch
```

Now, let's have a look at the branches you have locally when you try to push:

```
$ git branch -vv
* abranch 179b22a cloned abranch commit
  master  41ffa8a [origin/master] file1
```

While the master branch is tracking the 'origin/master' branch (ie the master branch on the origin remote), the branch 'abranch' is not tracking any remote branch.

At this point you could run either:

```
git push --set-upstream origin abranch
```

or

```
git push -u origin abranch
```

and that would set up the tracking for you while pushing.

Before that though, you’re going to type:

```
$ git push origin abranch
Counting objects: 3, done.
Writing objects: 100% (3/3), 273 bytes | 0 bytes/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /Users/imiell/tmp/git_origin
 * [new branch]      abranch -> abranch
```

That successfully pushed the change to the remote branch, which was created as it did not already exist. However, if you re-run the branch command again:

```
$ git branch -vv
* abranch 179b22a cloned abranch commit
  master  41ffa8a [origin/master] file1
```

it is still not tracking the origin’s master branch. If you add the --set-upstream / -u flag on a push, the branch will track the remote’s branch:

```
$ git push -u origin abranch
Branch abranch set up to track remote branch abranch from origin.
Everything up-to-date
$ git branch -vv
* abranch 179b22a [origin/abranch] cloned abranch commit
  master  41ffa8a [origin/master] file1
```

3.3.5. What you learned

3.3.6. Exercises

3.4. Git Submodules

Submodules are a useful concept, and often seen in real projects.

Git submodules can be very confusing if you stumble into them without much preparation or experience. Following this tutorial, you should have a good understanding for a simple submodule workflow and what is going on when you run the core submodule commands.

Sometimes you want to 'include' one repository in another, but not simply copy it over. Submodules

allow you to manage the separate codebase with your repository without changing the other repository.

Let's look at a concrete example.

Let's say Alice maintains a library:

```
$ rm -rf alicelib && mkdir alicelib && cd alicelib
$ git init
$ echo 'A' > file1
$ git add file1
$ git commit -am 'A'
$ git checkout -b experimental      # Branch to experimental
$ echo 'C - EXPERIMENTAL' >> file1
$ git commit -am EXPERIMENTAL
$ git checkout master
$ echo 'B' >> file1
$ git commit -am 'B'
```

Alice's library's history looks like this:

```
A
|\
| C (experimental)
|
B (master)
```

Now Bob wants to use Alice's library for his own code, but specifically wants to use what's on the experimental branch.

One option is to copy the code over directly, but that seems to be against the spirit of git.

If an improvement is made on the experimental branch, or Bob wants to move later to follow what's on the master branch, then he must copy over the code he wants. For one file it might be manageable, but for a more realistic and large project, managing this will be completely impractical.

Another option is to check out the code in another folder and link to it in some predictable way in the code (eg your code might run 'source ../alice_experimental). Again, this causes management problems, as the user checking out the source must remember to keep code outside this git repository in a certain place for it all to work.

3.4.1. git submodule

Git submodules solve these 'external repository' dependency issues, with a little overhead. Now that you understand local and remote repositories, it will be easier to grasp how submodules work.

They use git commands to track copies of other repositories within your repository. The tracking is

under your control (so you decide when it gets 'updated', regardless of how the other repository moves on), and the tracking is done within a file that is stored with your git repository.

WARNING	git submodules can be confusing if you don't follow a few basic patterns or understand how they work, so it's worth paying attention to this.

Let's make this clearer with a walkthrough.

You are going to assume you have the 'alicelib' repository created as above.

Now create Bob's repository:

```
$ rm -rf bob_repo && mkdir bob_repo && cd bob_repo
$ git init
$ echo 'source alicelib' > file1
$ git add file1
$ git commit -am 'sourcing alicelib'
$ echo 'do something with alicelib experimental' >> file1
$ git commit -am 'using alicelib experimental'
$ cat file1
source alicelib
do something with alicelib
```

Now you have alice's repo referenced in bob_repo's code, but bob_repo has no link to alice_repo's code.

The first step to including alicelib in bob_repo is to initialise submodules:

```
$ git submodule init
```

Once a git submodule init has been performed, you can 'add' the submodule you want:

```
$ git submodule add ../alicelib
Cloning into 'alicelib'...
done.
```

A new file has been created (.gitmodules), and the folder alicelib has been created:

```
$ ls -a
.       ..      .git        .gitmodules alicelib    file1
```

alicelib has been clone just as any other git repository would be anywhere else:

```
$ ls -a alicelib/
.   ..  .git    file1
```

but the .gitmodules file tracks where the submodule comes from:

```
$ cat .gitmodules
[submodule "alicelib"]
    path = alicelib
    url = ../alicelib
```

If you get confused, git provides a useful 'status' command for gitmodules:

```
$ git submodule status
ff75b7fc52c3a7d52d89a47fd27d7d22ed280b6f alicelib (heads/master)
```

Now, you may have some questions at this point, such as:

- How do you get to the experimental branch?
- What happens if alice's branch changes? Does my code automatically update?
- What if I make a change to alicelib within my repository submodule checkout? Can I push those to alice's? Can I keep those private to my repository?
- What if there are conflicts between these repositories?
  i. and so on. I certainly had these questions when I came to git submodules, and with some trial and error it took me some time to understand what was going on, so I really recommend playing with these simple examples to get the relationships clear in your mind.

3.4.2. Get the experimental branch

Since your 'alicelib' submodule is a straightforward clone of the remote 'alicelib' origin, you have the master branch and the origin's experimental branch:

```
$ git branch -a -vv
* master                      ff75b7f [origin/master] B
  remotes/origin/HEAD         -> origin/master
  remotes/origin/experimental 969b840 C EXPERIMENTAL
  remotes/origin/master       ff75b7f B
```

You are on the master branch (indicated with a *), which is mapped to remotes/origin/master.

NOTE the refs (eg ff75b7f) may be different in your output

You do not have an experimental branch locally. However, if you checkout a branch that does not exist locally but does exist remotely, git will assume you want to track that remote branch.

```
$ git checkout experimental
Branch experimental set up to track remote branch experimental from origin.
Switched to a new branch 'experimental'
$ git branch -a -vv
* experimental                969b840 [origin/experimental] C EXPERIMENTAL
  remotes/origin/HEAD         -> origin/master
  remotes/origin/experimental 969b840 C EXPERIMENTAL
  remotes/origin/master       ff75b7f B
```

NOTE If more than one remote has the same name, git will not perform this matching. In that case you would have to run the full command:

```
$ git checkout -b experimental --track origin/master
```

assuming it's the origin's master branch you want to track.

3.4.3. Git tracks the submodule's state

Now that you've checked out and tracked the remote experimental branch in your submodule, a change has taken place in bob_repo. If you return to bob_repo's root folder and run 'git diff' you will see that the subproject commit of 'alicelib' has changed:

```
$ cd ..
$ git diff
diff --git a/alicelib b/alicelib
index ff75b7f..969b840 160000
--- a/alicelib
+++ b/alicelib
@@ -1 +1 @@
-Subproject commit ff75b7fc52c3a7d52d89a47fd27d7d22ed280b6f
+Subproject commit 969b840142f389de55357350a6f26f0825e02393
```

The commit identifier now matches the experimental.

Note that bob_repo tracks the *specific commit* and not the remote branch. This means that changes to alicelib in the origin repository are not automatically tracked within bob_repo's submodule.

You want to commit this change to the submodule:

```
$ git commit -am 'alicelib moved to experimental'
[master 1f67953] alicelib moved to experimental
 2 files changed, 4 insertions(+)
 create mode 100644 .gitmodules
 create mode 160000 alicelib
```

3.4.4. Alice makes a change

Alice now spots a bug in her experimental branch that she wants to fix:

```
$ cd ../alicelib
$ git checkout experimental
$ echo 'D' >> file1
$ git commit -am 'D - a fix added'
```

Now there is a mismatch between alicelib's experimental branch and bob_repo's experimental branch.

```
$ cd ../bob_repo/alicelib
$ git status
On branch experimental
Your branch is up-to-date with 'origin/experimental'.
nothing to commit, working directory clean
```

git status reports that bob_repo's alicelib is up-to-date with origin/experimental. Remember that origin/experimental is the locally stored representation of alicelib's experimental branch. Since you have not contacted alicelib to see if there are any updates, this is still the case.

To get the latest changes you can perform a fetch and merge, or save time by running a 'pull', which does both:

```
$ git pull
remote: Counting objects: 3, done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From /Users/imiell/gitcourse/alicelib
   969b840..1a725f6  experimental -> origin/experimental
Updating 969b840..1a725f6
Fast-forward
 file1 | 1 +
 1 file changed, 1 insertion(+)
```

> GOTCHAS: Generally I would advise not editing repositories that are checked out as submodules until you are more experienced with git. You quickly may find yourself in a 'detached HEAD' state and confused about what you've done.

3.4.5. Checking out a project with submodules

Submodules have a special status within git repositories. Since they are both included within a repository and at the same time referencing a remote repository, a simple clone will not check out the included submodule:

```
$ cd ../..
$ rm -rf bob_repo_cloned
$ git clone bob_repo bob_repo_cloned
$ cd bob_repo_cloned
$ ls -1
alicelib
file1
$ cd alicelib
$ ls ## No output
```

Alicelib is not there. Confusingly, 'git submodule status' gives you little clue what's going on here.

```
$ git submodule status
-969b840142f389de55357350a6f26f0825e02393 alicelib
```

The dash (or minus sign) at the front indicates the submodule is not cheked out. Only by running a 'git submodule init' and a 'git submodule update' can you retrieve the appropriate submodule repository:

```
$ git submodule init
Submodule 'alicelib' (/Users/imiell/gitcourse/alicelib) registered for path 'alicelib'
$ git submodule update
Submodule path 'alicelib': checked out '969b840142f389de55357350a6f26f0825e02393'
$ git submodule status
969b840142f389de55357350a6f26f0825e02393 alicelib (969b840)
```

Now the submodule status has no dash, and a commit ID has been added to the output (969b840).

3.4.6. git clone --recursive

Fortunately there is an easier way. You can clone the repository with a --recursive flag to automatically init and update any submodules (and submodules of those submodules ad infinitum) within the cloned repo:

```
$ cd ..
$ git clone --recursive bob_repo bob_repo_cloned_recursive
Cloning into 'bob_repo_cloned'...
done.
Submodule 'alicelib' (/Users/imiell/gitcourse/alicelib) registered for path 'alicelib'
Cloning into 'alicelib'...
done.
Submodule path 'alicelib': checked out '969b840142f389de55357350a6f26f0825e02393'
```

3.4.7. You have learned

- How to set up git submodules
- How to add a submodule to a repo
- How to track remote branches
- How to checkout submodules with init and update
- How to checkout submodules with recursive

3.5. Pull Requests

In essence pull requests are very simple, but they can get confusing to newbies because of all the other concepts that are related and can complicate discussion about them.

Fortunately you've covered them, so you are ready!

- remotes
- branches
- repository relationships
- reconciling remote branches

A pull request is a request from a user for another user

This request can come in any form at all that makes sense. You can send an email with the diffs to the maintainer, fork and branch, then send a reference to the branch, branch on the maintainer's repo and mail them the branch name, put a request in plain English on a post-it - whatever works!

I'm going to focus here on the standard GitHub pull request model.

3.5.1. GitHub pull requests

For this section

The standard GitHub model is to:

- Fork the repository
- Make a branch on the forked repository
- Make changes on this branch
- Make a pull request to the original repository to merge this branch's changes

Your task now is to do this on the GitHub repository!

There is a file called 'records/trained_users.txt' in the repository of this course. You're going to add your name to it and raise that change as a Pull Request.

Remember that this is just one model of pull request! I will talk about other models later.

If you haven't created a GitHub account, please do so now. It's free. Go to https://github.com and sign up.

Fork the Repository

Next you need to fork the repository. To do this, go to the 'learn-git-the-hard-way' repository on GitHub:

https://github.com/ianmiell/learn-git-the-hard-way

and click on the 'Fork' button near the top.

You will now have created a fork of the repository in your own account. Replace YOURUSERNAME with your username in the below URL and you should see the same repository homepage:

https://github.com/YOURUSERNAME/learn-git-the-hard-way

Branch on the Forked Repository

To make a branch on your forked repository, type in these commands:

```
$ git clone https://github.com/YOURUSERNAME/learn-git-the-hard-way
$ cd learn-git-the-hard-way
$ git checkout -b myfirstbranch
$ git status
```

You just cloned your forked version of the repository, and created a branch called 'myfirstbranch'. As ever, running git status gives you a quick view of which branch you're on.

3.5.2. Make Change on the Branch

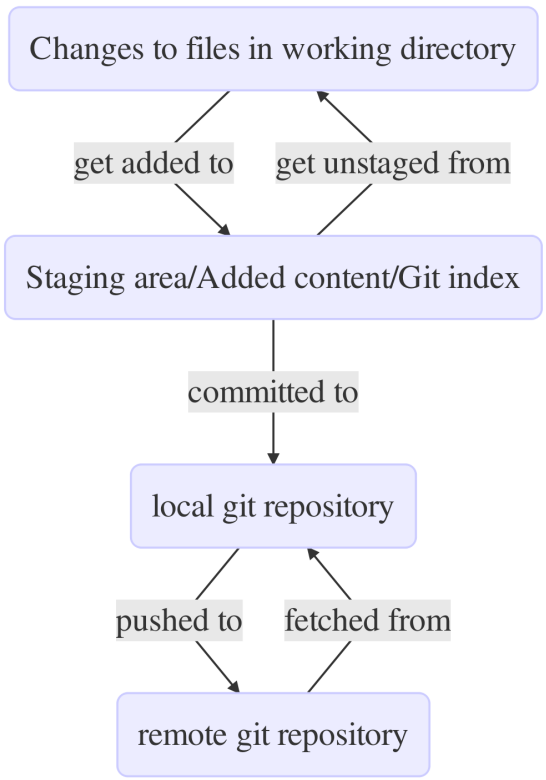
Now type in these commands to make a change and push it to GitHub:

```
$ echo 'my change to the README' >> README.md
$ git commit -am 'my change to the README'
$ git push -u origin myfirstbranch
```

The first command adds a line to the README.md file. The second commits the change you made to this new branch.

3.5.3. Understand the relationships

Make sure these relationships are clear in your mind! Here is a diagram that may help:



TODO: commit TODO: what you have done

3.5.4. Make Pull Request

Now you have a branch on the forked repository on GitHub, you want to get that branch's changes into the maintainer's repository. This is where you raise the pull request.

Go to GitHub in a browser and view your repository:

https://github.com/YOURUSERNAME/learn-git-the-hard-way

TODO: Go to the branch TODO: Click make pull request (?). Fill out the form TODO: What to do next

3.6. Pull Requests in Practice - Rebasing

Maintainers will often ask that you rebase your branch to the main branch before making a pull request.

You will remember rebases from section [TODO - 2.5]. If you don't remember, go back and read over it again!

Maintainers will want you to rebase, so that the work of merging any changes made since you forked from the origin is done by you, the submitter, rather than them. This also makes the history of the main line easier.

If you didn't understand the above paragraph, then definitely work through the rebase section

again!

The goal is that all the messy work is done on the branch (which in git is a more disposable thing) and the good stuff makes its way into the main line. Many projects will delete branches once they have served their purpose, and git supports this.

```
$ git branch -d mybranch
```

It will even warn you if the branch has not been merged into the branch you are currently on!

```
$ git branch -d abranch
error: The branch 'abranch' is not fully merged.
If you are sure you want to delete it, run 'git branch -D abranch'.
```

3.6.1. What you have learned

TODO

3.6.2. Exercises

1) Submit a pull request to this repository (https://github.com/ianmiell/learn-git-the-hard-way) and see what happens!

TODO