Git Tutorial

Let's git to work

- Version control overview
- Michael's Git cheat sheet
- Examples
- Michael's config tips
- Pedantic details

What problem do we want to solve with version ctrl?

Basic development coordination between people (Diff & Merge)

Preserve progress (separate bugs from master)

Track bug origins (blame)

What problem do ***WE*** want to solve with version ctrl?

Multiple scientists, NOT software engineers

Typically easier to rewrite code than read it

Focus on rapid prototyping and experiments

What problem do ***WE*** want to solve with version ctrl?

Basic development coordination between people (Diff & Merge)

~~Preserve progress (separate bugs from master)~~

~~Track bug origins (blame)~~

FOR SCIENCE!

"Proper" Software Engineering Version Ctrl.

Branching strategy

- A `master` branch is "production" or closest thing to it
  - Never add bugs intentionally
  - Typically source of continuous build cycles and QA testing on pipeline to production
- Side branches are where all development occurs
  - Buggy development code is ok
  - Merge into `master` when feature and testing is complete
  - Can isolate different developer efforts from each other, or not

"Proper" Software Engineering Version Ctrl.

Commit strategies

Verbose

- Document and preserve EVERYTHING!
- Constant checkpointing
- Know exactly where something went wrong
- Not easy to read

```
* d0276e4 - Wed, 9 Mar 2016 18:56:59 -0800 (17 hours ago) (HEAD -> master)
|         fixed a typo "hello wrold" - Michael Stewart
* b5eac1e - Wed, 9 Mar 2016 18:51:59 -0800 (17 hours ago)
|         named a class - Michael Stewart
* cbd35a0 - Wed, 9 Mar 2016 18:50:45 -0800 (17 hours ago)
|         started to write a comment - Michael Stewart
* 9bd3568 - Wed, 9 Mar 2016 17:40:30 -0800 (18 hours ago)
|         fixed indentation - Michael Stewart
* 6520c75 - Wed, 9 Mar 2016 17:36:29 -0800 (18 hours ago)
|         took a 5 minute walk - Michael Stewart
* 4fb0f58 - Wed, 9 Mar 2016 17:32:59 -0800 (18 hours ago)
|         wrote import statements - Michael Stewart
* 54ca0fc - Wed, 9 Mar 2016 17:30:16 -0800 (18 hours ago)
          initial commit - Michael Stewart
```

"Proper" Software Engineering Version Ctrl.

Commit strategies

Commit for readability

- Fewer checkpoints
- Fast comparison and branching
- Easy to read

```
* b5eac1e - Sun, 7 Feb 2016 17:15:47 -0800 (5 weeks ago)
|         refactoring to use object classes - Michael Stewart
* cbd35a0 - Sat, 6 Feb 2016 18:10:35 -0800 (5 weeks ago)
|         fixed various bugs - Michael Stewart
* acf472c - Fri, 5 Feb 2016 16:27:57 -0800 (5 weeks ago)
|         begun tests - Michael Stewart
* bf45d26 - Thu, 4 Feb 2016 11:33:14 -0800 (5 weeks ago)
|         feature: log printing - Michael Stewart
* 4c0de2c - Wed, 3 Feb 2016 13:15:26 -0700 (5 weeks ago)
|         simplified structure for testing and serialization - Michael Stewart
* 4fb0f58 - Tue, 2 Feb 2016 20:15:35 -0700 (6 weeks ago)
|         initial script format works - Michael Stewart
* 54ca0fc - Mon, 1 Feb 2016 17:01:44 -0700 (6 weeks ago)
          initial commit - Michael Stewart
```

Git can do more

Classic version ctrl principles:

- Immutable recording
- Central control

Git!

- Git rewrites history!
- Git is decentralized!

~~"Proper"~~ Software Engineering Version Ctrl.

Commit strategies

Rewrite History

- Constant checkpointing
- Readable in detail during development
- At the end of the day, **`git rebase!`**
- Easy to read long-term

```
* d0276e4 - Wed, 9 Mar 2016 18:56:59 -0800 (17 hours ago)
|         fixed a typo "hello wrold" - Michael Stewart
* b5eac1e - Wed, 9 Mar 2016 18:51:59 -0800 (17 hours ago)
|         named a class - Michael Stewart
* cbd35a0 - Wed, 9 Mar 2016 18:50:45 -0800 (17 hours ago)
|         started to write a comment - Michael Stewart
* 9bd3568 - Wed, 9 Mar 2016 17:40:30 -0800 (18 hours ago)
|         fixed indentation - Michael Stewart
* 6520c75 - Wed, 9 Mar 2016 17:36:29 -0800 (18 hours ago)
|         took a 5 minute walk - Michael Stewart
* 4fb0f58 - Wed, 9 Mar 2016 17:32:59 -0800 (18 hours ago)
|         wrote import statements - Michael Stewart
* 54ca0fc - Wed, 9 Mar 2016 17:30:16 -0800 (18 hours ago)
          initial commit - Michael Stewart
```

`git rebase!`

```
* 4fb0f58 - Thu, 10 Mar 2016 11:25:35 -0800 (5 minutes ago)
|         initial script format works - Michael Stewart
* 54ca0fc - Wed, 9 Mar 2016 17:30:16 -0800 (18 hours ago)
          initial commit - Michael Stewart
```

~~"Proper"~~ Software Engineering Version Ctrl.

Branching strategies

Lazy method

Work directly on **`master`** if there's ~0% chance of a merge conflict

- you are adding entirely new code
- not changing any existing code or refactoring

Works OK with just 2 people

…on different hemispheres

…who only add new files

Frequently run into conflicts on fetch/pull

:(

Recommended Software Engineering Version Ctrl.

Branching strategies

Personal branches

- Make a branch for your work
- Make a branch for different "features"
- Try to merge/rebase frequently to integrate master changes into your branch.
  Stay in-touch!

Merge or rebase to master when complete.

You should always be working in a branch.

It's easier to merge conflicts between branches than within the same branch.

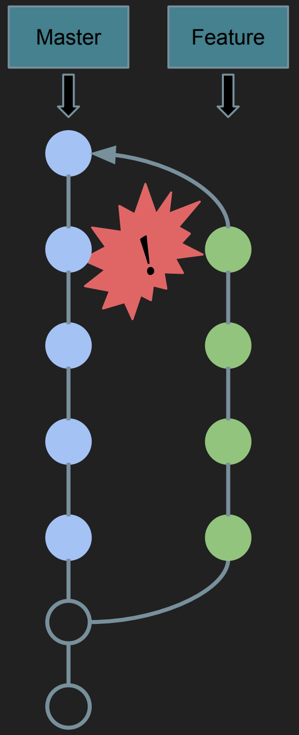
Recommended Software Engineering Version Ctrl.

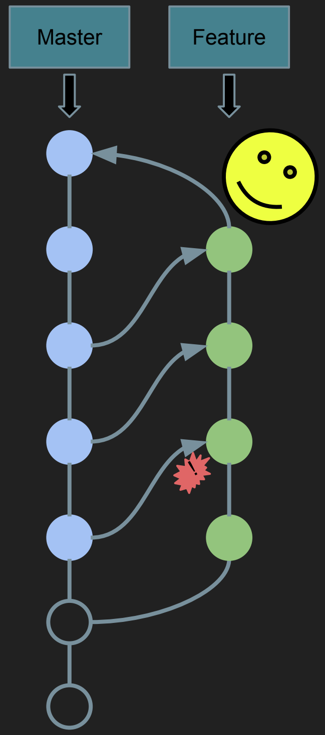
Branching strategies

Personal branches

- Make a branch for your work
- Make a branch for different "features"
- Try to merge/rebase frequently to integrate master changes into your branch.
  Stay in-touch!

Merge or rebase to master when complete.





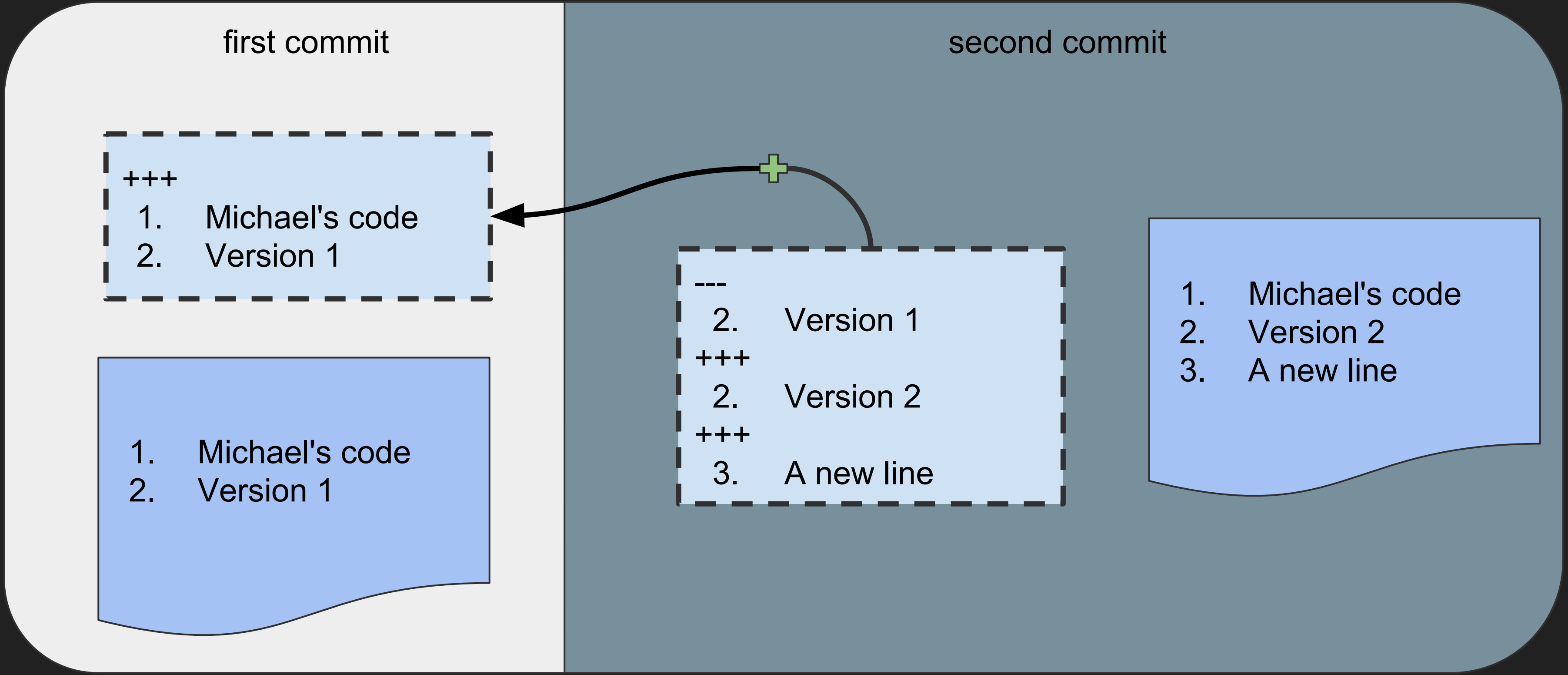
Git Cheatsheet

`git commit -am "comment"`	Make a commit with comment. Add all local changes first.
`git commit --amend`	Rewrite the comment of the previous commit
`git rebase -i HEAD~2`	Squash the last two commits together and edit comments
`git push origin HEAD`	Share current branch with remote repository "origin"
`git pull`	Get current branch from remote repository (default branch)
`git merge otherbranch`	Merge **`otherbranch`** *into* the current branch
`git rebase otherbranch`	Rebase *onto* **`otherbranch`**
`git checkout -b newbranch`	Create **`newbranch`** and check it out one-liner
`git reset --hard HEAD`	Discard all local changes and go back to last commit

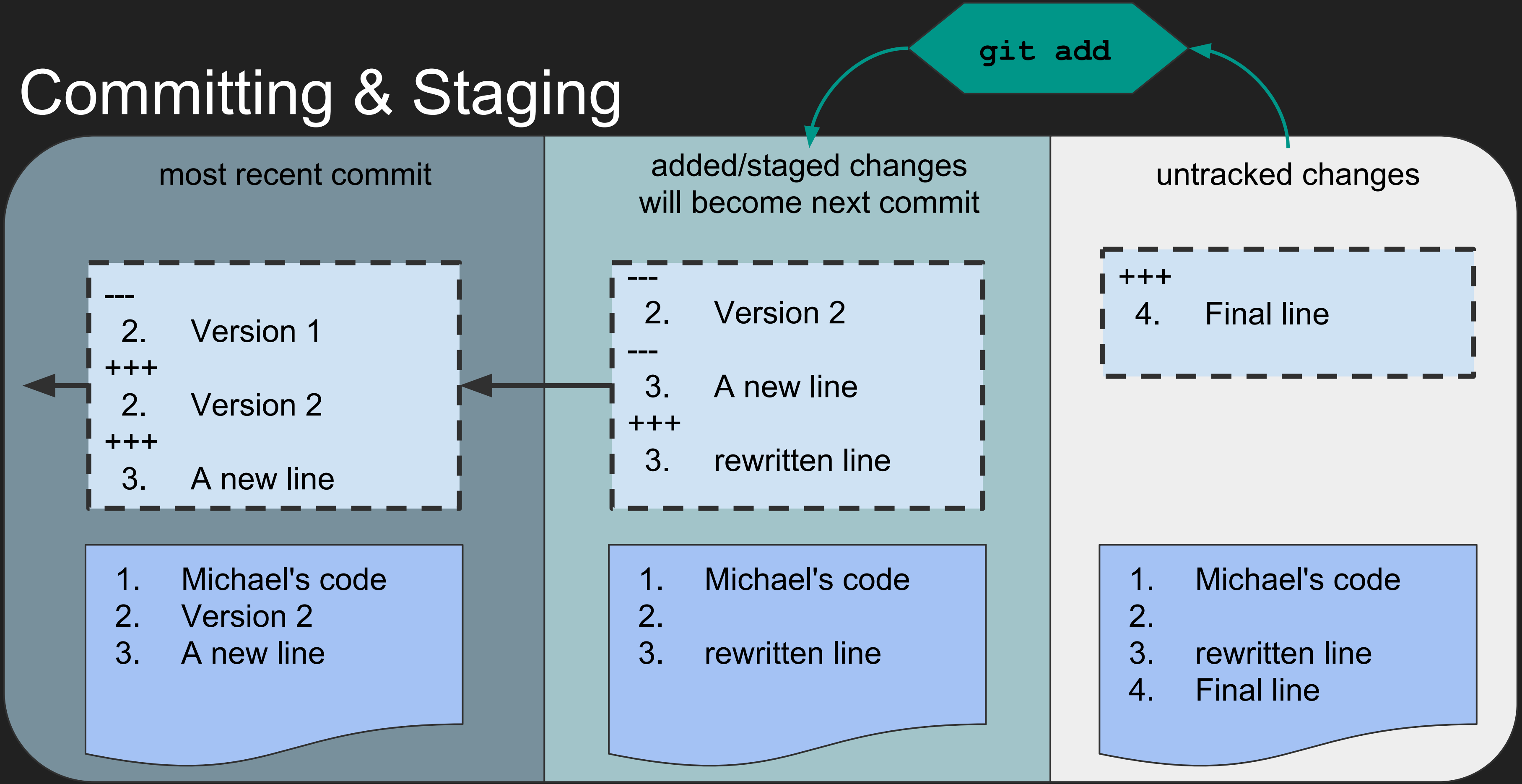
Committing & Staging

```
$ git init
$ printf "Michael's code\nVersion 1\n" > my_file.txt
$ git commit -am "initial commit"
```

Committing & Staging

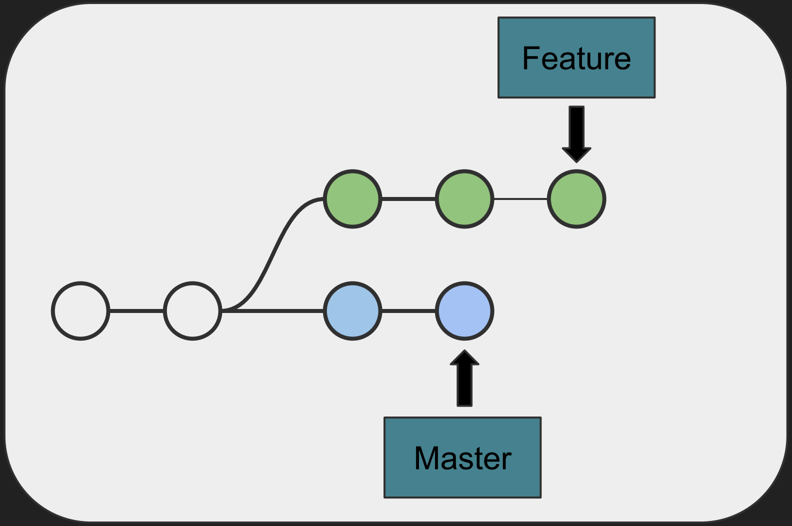


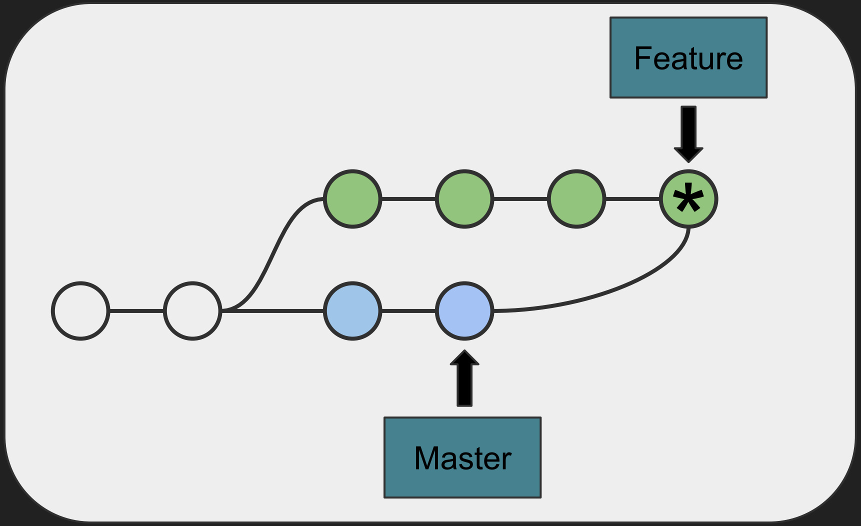
Committing & Staging



Merging

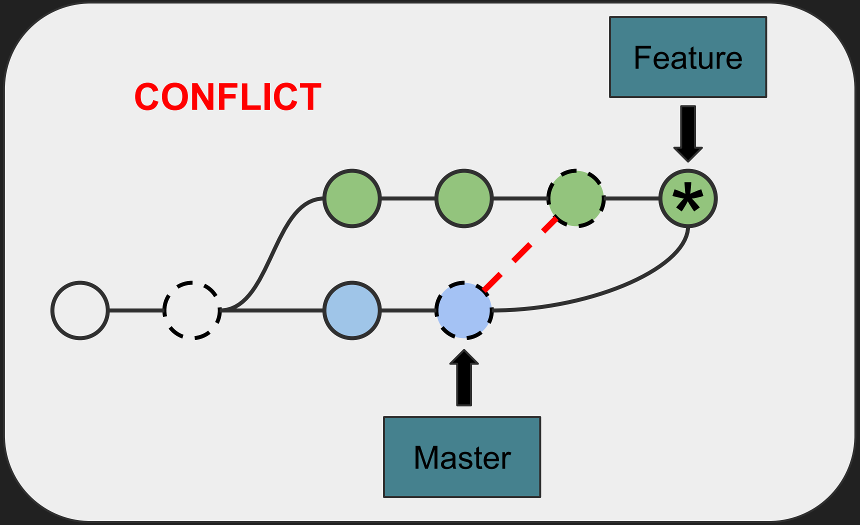
```
$ git checkout Feature
$ git merge Master
```





Merging Conflicts

```
* a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (14 minutes ago) (HEAD -> master)
|           changed to 'main line'
| * b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (15 minutes ago) (feature)
|/          changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (26 minutes ago)
            initial commit
```



```
$ git checkout feature
$ git merge master
Auto-merging my_file.txt
CONFLICT (content): Merge conflict in my_file.txt
Automatic merge failed; fix conflicts and then commit the
result.


$ git status
On branch feature
You have unmerged paths.
  (fix conflicts and run "git commit")

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

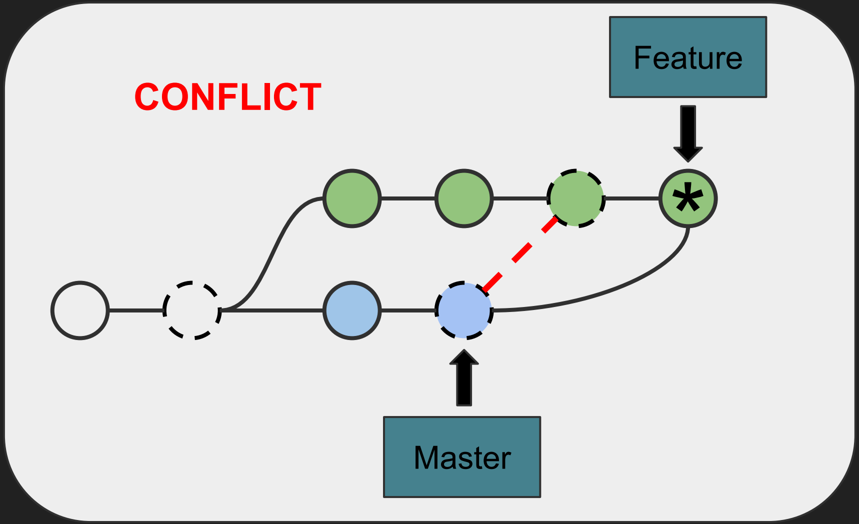
        both modified:   my_file.txt
```

Merging Conflicts

```
* a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (14 minutes ago) (HEAD -> master)
|           changed to 'main line'
| * b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (15 minutes ago) (feature)
|/          changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (26 minutes ago)
            initial commit
```

```
$ cat my_file.txt

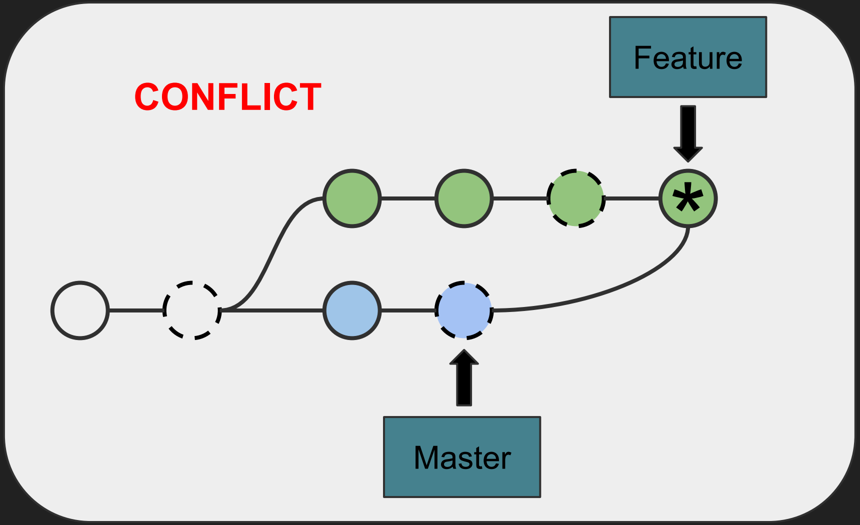
<<<<<<< HEAD
only line
=======
main line
>>>>>>> master
```



Current changes under "<"

Other branch changes above ">"

Merging Conflicts



```
* a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (14 minutes ago) (HEAD -> master)
|           changed to 'main line'
| * b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (15 minutes ago) (feature)
|/          changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (26 minutes ago)
            initial commit

$ echo only main line > my_file.txt
$ git add my_file.txt
$ git status
On branch feature
All conflicts fixed but you are still merging.
  (use "git commit" to conclude merge)

Changes to be committed:

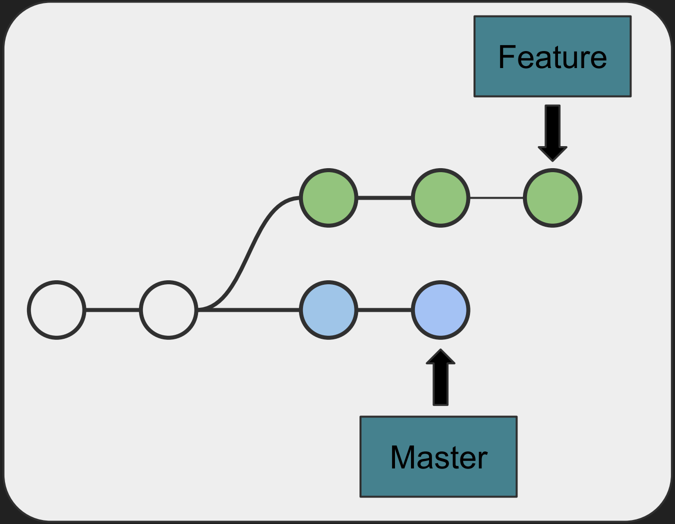
        modified:   my_file.txt
$ git commit -m "resolved conflict"

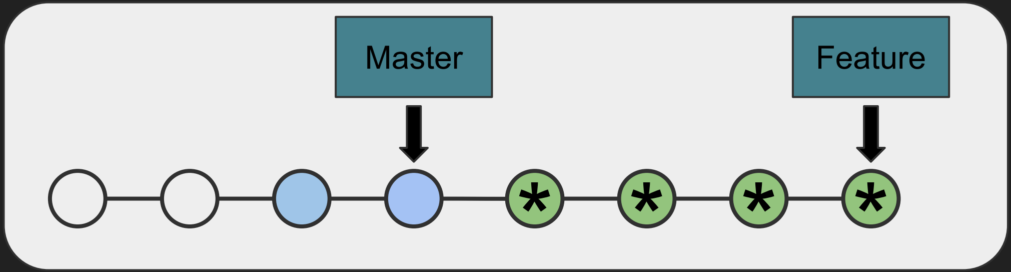

*   e481b10 - Sun, 13 Mar 2016 19:45:21 -0700 (6 seconds ago) (HEAD -> feature)
|\            resolved conflict
| * a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (56 minutes ago) (master)
| |           changed to 'main line'
* | b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (56 minutes ago)
|/            changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (68 minutes ago)
            initial commit
```

Rebase

Same type of merge issues, but this time for each commit.

```
* e43b215 - Sun, 13 Mar 2016 20:20:15 -0700 (1 second ago) (HEAD -> second-feature)
|           perfect documentation
* d6a7512 - Sun, 13 Mar 2016 20:19:30 -0700 (46 seconds ago)
|           the best one-liner
| *   e481b10 - Sun, 13 Mar 2016 19:45:21 -0700 (35 minutes ago) (master)
|/|             resolved conflict
* | a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (2 hours ago)
| |           changed to 'main line'
| * b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (2 hours ago)
|/            changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (2 hours ago)
            initial commit
```



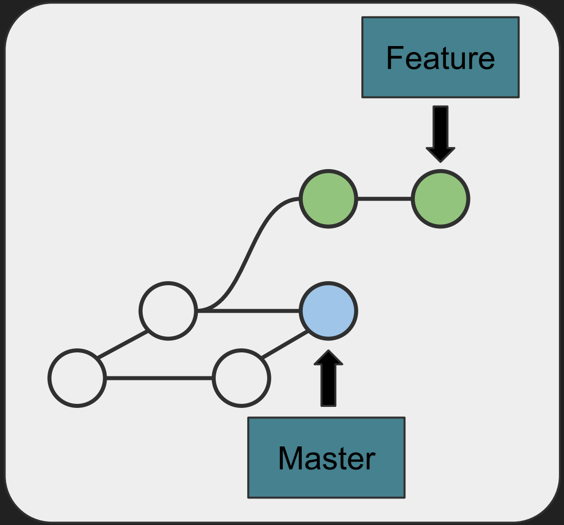


Rebase

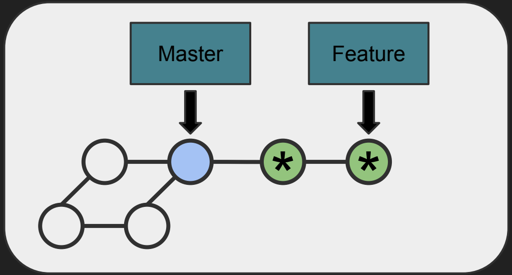
```
$ git rebase master
...
CONFLICT (content): Merge conflict in my_file.txt
Failed to merge in the changes.
...
When you have resolved this problem, run "git rebase
--continue".

$ git status
rebase in progress; onto e481b10
You are currently rebasing branch 'second-feature' on
'e481b10'.
  (fix conflicts and then run "git rebase --continue")
  (use "git rebase --skip" to skip this patch)
  (use "git rebase --abort" to check out the original branch)
```

```
$ echo the best one-liner > my_file.txt
$ git add my_file.txt
$ git rebase --continue
Applying: the best one-liner
Applying: perfect documentation
$ cat my_file.txt
the best one-liner
#perfect documentation
$
```



```
* e43b215 - Sun, 13 Mar 2016 20:20:15 -0700 (1 second ago) (HEAD -> second-feature)
|           perfect documentation
* d6a7512 - Sun, 13 Mar 2016 20:19:30 -0700 (46 seconds ago)
|           the best one-liner
| *   e481b10 - Sun, 13 Mar 2016 19:45:21 -0700 (35 minutes ago) (master)
|/|             resolved conflict
* | a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (2 hours ago)
| |           changed to 'main line'
| * b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (2 hours ago)
|/            changed to 'only line'
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (2 hours ago)
            initial commit
```



```
* e275ba7 - Sun, 13 Mar 2016 20:20:15 -0700 (14 minutes ago) (HEAD -> second-feature)
|           perfect documentation - Michael Stewart
* 9189b89 - Sun, 13 Mar 2016 20:19:30 -0700 (15 minutes ago)
|           the best one-liner - Michael Stewart
*   e481b10 - Sun, 13 Mar 2016 19:45:21 -0700 (49 minutes ago) (master)
|\            resolved conflict - Michael Stewart
| * a9e6f14 - Sun, 13 Mar 2016 18:49:36 -0700 (2 hours ago)
| |           changed to 'main line' - Michael Stewart
* | b5a065f - Sun, 13 Mar 2016 18:49:09 -0700 (2 hours ago)
|/            changed to 'only line' - Michael Stewart
* ccac72d - Sun, 13 Mar 2016 18:37:56 -0700 (2 hours ago)
            initial commit
```

git help

```
usage: git [--version] [--help] [-C <path>] [-c name=value]

These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
   clone      Clone a repository into a new directory
   init       Create an empty Git repository or reinitialize an
existing one

examine the history and state (see also: git help revisions)
   bisect     Find by binary search the change that introduced a bug
   grep       Print lines matching a pattern
   log        Show commit logs
   show       Show various types of objects
   status     Show the working tree status

...
```

```
$ git help branch
GIT-BRANCH(1)      Git Manual        GIT-BRANCH(1)

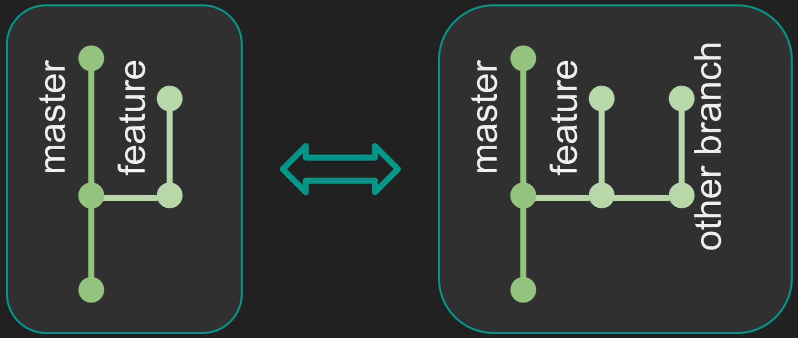
NAME
       git-branch - List, create, or delete branches

SYNOPSIS
       git branch [--color[=<when>] | --no-color] [-r | -a]
               [--list] [-v [--abbrev=<length> | --no-abbrev]]
               [--column[=<options>] | --no-column]
               [(--merged | --no-merged | --contains) [<commit>]]
[<pattern>...]
       git branch [--set-upstream | --track | --no-track] [-l] [-f]
<branchname> [<start-point>]
       git branch (--set-upstream-to=<upstream> | -u <upstream>)
[<branchname>]
       git branch --unset-upstream [<branchname>]
       git branch (-m | -M) [<oldbranch>] <newbranch>
       git branch (-d | -D) [-r] <branchname>...
       git branch --edit-description [<branchname>]
```

Synchronizing between repositories

Everything so far could have been done in one repository on one machine.

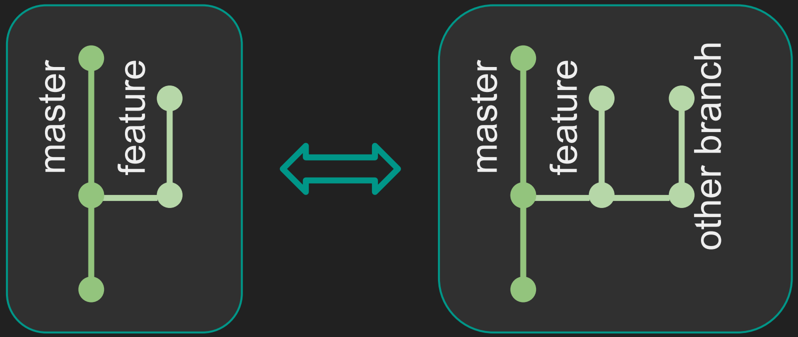
If merge and branch strategies are followed, there will never be a conflict on push/pull



```
$ git branch
  R-correllation-analysis
  big-network-issue-query
* master
$ git branch -a
  R-correllation-analysis
  big-network-issue-query
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/big-network-issue-query
  remotes/origin/master
  remotes/origin/refactor-feature-tables
  remotes/origin/try-extracting-zone
```

Synchronizing between repositories

Everything so far could have been done in one repository on one machine.



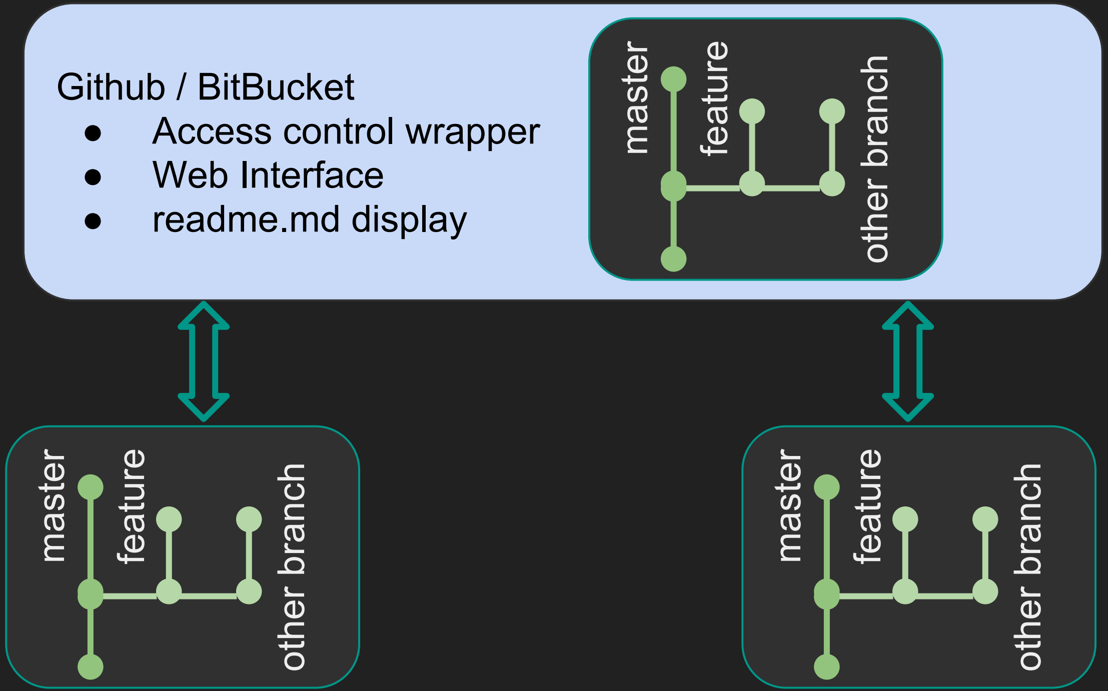
How do local branches correspond to remotes?

`git clone` sets up sane defaults for "tracking":

- 'origin' is name of remote source
- remote branches tracked with same name
    - fetch & pull will update these

Configure this manually …if you *really* have to.

Synchronizing between repositories



Github / BitBucket

- Access control wrapper
- Web Interface
- readme.md display

Git Anti-Cheatsheet

`git {push|pull} --force`	Push or pull *destructively* . Use with caution!

I don't know these well:

`git stash ...`	Store changes as a diff, independent of commits/branches
`git tag ...`	Create a reference without making a new branch

Configuration

Some mandatory to function
Some very helpful to function

Three levels of configuration

- System
  - `git config --system ...`
- Global
  - `git config --global ...`
- Repository
  - `git config ...`

Repository overrides Global

Global overrides System

Configuration tips: cache passwords

Via StackOverflow

Git 1.7.9+

```
git config --global credential.helper cache
```

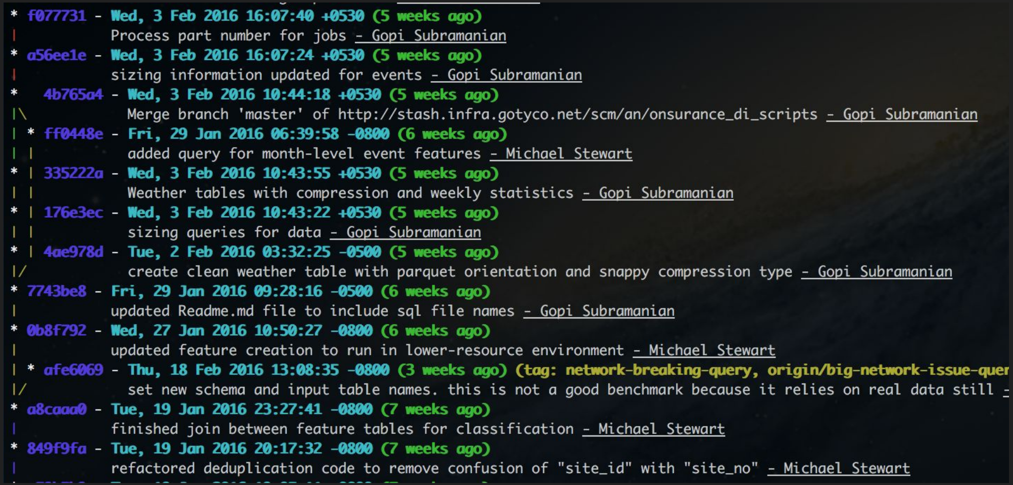
Mac Homebrew

```
git config --global credential.helper osxkeychain
```

```
michael@di-dev-gw1 12:54:44 $ git fetch
Password for 'you':
michael@di-dev-gw1 12:55:01 $ git config --global credential.helper cache
michael@di-dev-gw1 12:55:49 $ git fetch
Password for 'you':
michael@di-dev-gw1 12:55:55 $ git fetch
michael@di-dev-gw1 12:55:57 $
```

Configuration tips: `~/.gitconfig`

```
# This is Git's "global" configuration file.
[user]
	name = Michael Stewart
	email = mikestewart@tycoint.com
[credential]
	helper = osxkeychain
[core]
	editor = vim
[alias]
graph = log --graph --abbrev-commit --decorate --format=format:'%C(bold blue)%h%C(reset) - %C(bold cyan)%aD%C(reset) %C(bold green)(%ar)%C(reset)%C(bold yellow)%d%C(reset)%n''          %C(white)%s%C(reset) %C(dim white)- %an%C(reset)' --all
```



```
* f077731 - Wed, 3 Feb 2016 16:07:40 +0530 (5 weeks ago)
|           Process part number for jobs - Gopi Subramanian
* a56ee1e - Wed, 3 Feb 2016 16:07:24 +0530 (5 weeks ago)
|           sizing information updated for events - Gopi Subramanian
*   4b765a4 - Wed, 3 Feb 2016 10:44:18 +0530 (5 weeks ago)
|\            Merge branch 'master' of http://stash.infra.gotyco.net/scm/an/onsurance_di_scripts - Gopi Subramanian
| * ff0448e - Fri, 29 Jan 2016 06:39:58 -0800 (6 weeks ago)
| |           added query for month-level event features - Michael Stewart
* | 335222a - Wed, 3 Feb 2016 10:43:55 +0530 (5 weeks ago)
| |           Weather tables with compression and weekly statistics - Gopi Subramanian
* | 176e3ec - Wed, 3 Feb 2016 10:43:22 +0530 (5 weeks ago)
| |           sizing queries for data - Gopi Subramanian
* | 4ae978d - Tue, 2 Feb 2016 03:32:25 -0500 (5 weeks ago)
|/            create clean weather table with parquet orientation and snappy compression type - Gopi Subramanian
* 7743be8 - Fri, 29 Jan 2016 09:28:16 -0500 (6 weeks ago)
|           updated Readme.md file to include sql file names - Gopi Subramanian
* 0b8f792 - Wed, 27 Jan 2016 10:50:27 -0800 (6 weeks ago)
|           updated feature creation to run in lower-resource environment - Michael Stewart
| * afe6069 - Thu, 18 Feb 2016 13:08:35 -0800 (3 weeks ago) (tag: network-breaking-query, origin/big-network-issue-quer
|/            set new schema and input table names. this is not a good benchmark because it relies on real data still -
* a8caaa0 - Tue, 19 Jan 2016 23:27:41 -0800 (7 weeks ago)
|           finished join between feature tables for classification - Michael Stewart
* 849f9fa - Tue, 19 Jan 2016 20:17:32 -0800 (7 weeks ago)
|           refactored deduplication code to remove confusion of "site_id" with "site_no" - Michael Stewart
```

Configuration tips: `./.git/config`

```
# This is a config file for a particular repository. It isn't tracked in the repository's version control!
[core]
	repositoryformatversion = 0
	filemode = true
	bare = false
	logallrefupdates = true
	ignorecase = true
	precomposeunicode = true
[remote "origin"]
	url = http://mikestewart_i@stash.infra.gotyco.net/scm/an/mastermind_di_scripts.git
	fetch = +refs/heads/*:refs/remotes/origin/*
[branch "master"]
	remote = origin
	merge = refs/heads/master
[branch "big-network-issue-query"]
	remote = origin
	merge = refs/heads/big-network-issue-query
```

Configuration tips: `./.gitignore`

```
# This is a list of files to ignore. Typically you include files your IDE creates that others won't want.
# This file is tracked within the repository's version control.
# many convenient defaults are available online e.g. Github or via Eclipse IDE

.Rproj.user
.Rhistory
.RData
*.Rproj
```

GUIs

- Ungit
- SourceTree
- Github Desktop
- Most IDEs

They will do much of this for you, and you won't have to remember or learn.

Version control problems (pedantic details) "Diffing"

a.k.a. Longest common subsequence problem

(applications in bioinformatics, Gnu `diff`, version control)

NP-hard problem

```
Roses are red

Violets are blue

Git is easier for one than for two
```

```
Roses are red

Violets are dumb

I'm a manly man!

I don't need flowers!
```

Version control problems (pedantic details) "Diffing"

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```

Version control problems (pedantic details) "Diffing"

```
SELECT *

FROM yourtable

WHERE true;
```

```
SELECT goodfield

FROM mytable

WHERE true;
```

Δ_1:

- line 1, delete '*'
- line 1, add 'goodfield'
- line 2, delete 'yourtable'
- line 2, add 'mytable'

Δ_2:

- line 1, delete '*\nFROM yourtable'
- line 1, add 'goodfield\n FROM mytable'

Which delta is more efficient to store?
Which delta is faster to identify?

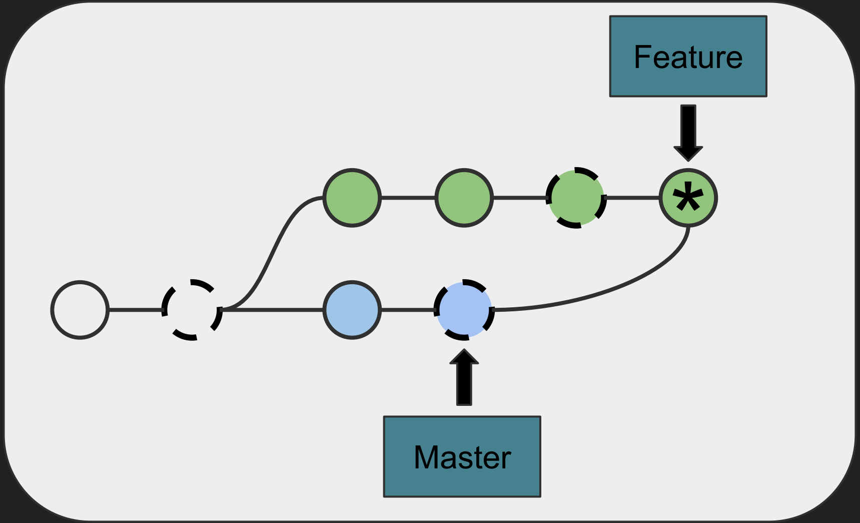
Version control problems (pedantic details) "Diffing"

```
Roses are red
Violets are blue
Git is easier for one than for two
```

```
Roses are red
Violets are dumb
I'm a manly man!
I don't need flowers!
```

Git just treats lines as atomic units, throwing out the whole line.
Trade off: better diffing execution time for more space used to store deltas.

Version control problems (pedantic details) Merging



Git: "resolve these conflicts"

```
<<<<<<< HEAD
=======
>>>>>>> master

<<<<<<< HEAD
same line
=======
same line
>>>>>>> master
```

Which 3-way merge was that, again?

Recommended reading

The **`git help`** commands

- interactive support right at your fingertips
- **`git help <command>`** for separate manual pages
- Try **`git help workflows`**

Atlassian Git Tutorial on Merging and Rebasing

- Well written. I copied their diagrams.

Official Git Documentation

- Great details

Oh Shit Git