

Principles of Software Construction: Objects, Design, and Concurrency

Software engineering in practice

Teams, branch-based development, and workflows

Josh Bloch

Charlie Garrod

Administrivia

- Homework 4c due tonight
 - Can regain up to 75% of lost Homework 4a credit
 - Directly address TA comments
 - Turn in revised design documents + description of what you changed to Gradescope before Monday night
- No lecture next Tuesday: please vote
- Homework 5 team sign-up deadline Wednesday 5 p.m.
- Midterm exam next Wednesday/Thursday
 - Practice exam released tomorrow
 - Exam review session Monday 6:30-8:30 p.m.
 - Exam released Wednesday night, due Thursday 11:59 p.m.
 - No lecture next Thursday

Key concepts from the past week

Key design principle: Information hiding

- “When in doubt, leave it out.”

Minimize Mutability

- Parameter types should be immutable
 - Eliminates need for defensive copying
- Classes should be immutable unless there's a good reason to do otherwise
 - Advantages: simple, thread-safe, reusable
 - Disadvantage: separate object for each value
- If mutable, keep state-space small, well-defined
 - Make clear when it's legal to call which method

Bad: Date

Good: `java.time.Instant`

“Fail Fast” – prevent failure, or fail quickly, predictably, and informatively

- Ideally, API should make **misuse impossible**
 - Fail at compile time or sooner
- Misuse that’s **statically detectable** is second best
 - Fail at build time, with proper tooling
- Misuse leading to **prompt runtime failure** is third best
 - Fail when first erroneous call is made
 - Method should succeed or have no effect (*failure-atomicity*)
- Misuse that **can lie undetected** is what nightmares are made of
 - Fail at an undetermined place and time in the future

Don't let your output become your de facto API

- Document the fact that output formats may evolve in the future
- Provide programmatic access to all data available in string form

```
org.omg.CORBA.MARSHAL: com.ibm.ws.pmi.server.DataDescriptor; IllegalAccessException minor code: 4942F23E comp
  at com.ibm.rmi.io.ValueHandlerImpl.readValue(ValueHandlerImpl.java:199)
  at com.ibm.rmi.iiop.CDRInputStream.read_value(CDRInputStream.java:1429)
  at com.ibm.rmi.io.ValueHandlerImpl.read_Array(ValueHandlerImpl.java:625)
  at com.ibm.rmi.io.ValueHandlerImpl.readValueInternal(ValueHandlerImpl.java:273)
  at com.ibm.rmi.io.ValueHandlerImpl.readValue(ValueHandlerImpl.java:189)
  at com.ibm.rmi.iiop.CDRInputStream.read_value(CDRInputStream.java:1429)
  at com.ibm.ejs.sm.beans._EJSRemoteStatelessPmiService_Tie._invoke(_EJSRemoteStatelessPmiService_Tie.ja
  at com.ibm.CORBA.iiop.ExtendedServerDelegate.dispatch(ExtendedServerDelegate.java:515)
  at com.ibm.CORBA.iiop.ORB.process(ORB.java:2377)
  at com.ibm.CORBA.iiop.OrbWorker.run(OrbWorker.java:186)
  at com.ibm.ejs.oa.pool.ThreadPool$PooledWorker.run(ThreadPool.java:104)
  at com.ibm.ws.util.CachedThread.run(ThreadPool.java:137)
```

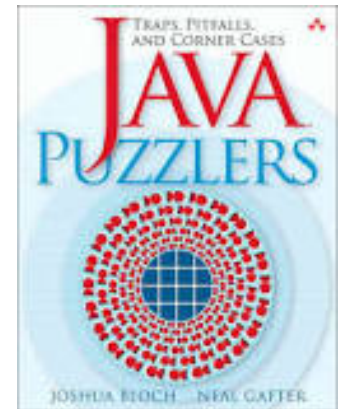
Today: Toward software engineering in practice

- Two puzzlers
- Software engineering for teams
 - Challenges of working as a team
 - Tools and processes for teams
 - Branch-based development, et al.

1. “Time for a Change” (2002)

If you pay \$2.00 for a gasket that costs \$1.10, how much change do you get?

```
public class Change {  
    public static void main(String args[]) {  
        System.out.println(2.00 - 1.10);  
    }  
}
```



What does it print?

- (a) 0.9
- (b) 0.90
- (c) It varies
- (d) None of the above

```
public class Change {  
    public static void main(String args[]) {  
        System.out.println(2.00 - 1.10);  
    }  
}
```

What does it print?

(a) 0.9

(b) 0.90

(c) It varies

(d) None of the above: 0.89999999999999999999

Decimal values can't be represented exactly
by float or double

Another look

```
public class Change {  
    public static void main(String args[]) {  
        System.out.println(2.00 - 1.10);  
    }  
}
```

How do you fix it?

// You could fix it this way...

```
import java.math.BigDecimal;
public class Change {
    public static void main(String args[]) {
        System.out.println(
            new BigDecimal("2.00").subtract(
                new BigDecimal("1.10")));
    }
}
```

Prints 0.90

// ...or you could fix it this way

```
public class Change {
    public static void main(String args[]) {
        System.out.println(200 - 110);
    }
}
```

Prints 90

The moral

- Avoid `float` and `double` where exact answers are required
 - For example, when dealing with money
- Use `BigDecimal`, `int`, or `long` instead

2. “A Change is Gonna Come”



If you pay \$2.00 for a gasket that costs \$1.10, how much change do you get?

```
import java.math.BigDecimal;

public class Change {
    public static void main(String args[]) {
        BigDecimal payment = new BigDecimal(2.00);
        BigDecimal cost = new BigDecimal(1.10);
        System.out.println(payment.subtract(cost));
    }
}
```

What does it print?

- (a) 0.9
- (b) 0.90
- (c) 0.899999999999999999999999
- (d) None of the above

```
import java.math.BigDecimal;

public class Change {
    public static void main(String args[]) {
        BigDecimal payment = new BigDecimal(2.00);
        BigDecimal cost = new BigDecimal(1.10);
        System.out.println(payment.subtract(cost));
    }
}
```


What does it print?

(a) 0.9

(b) 0.90

(c) 0.899999999999999999999999

(d) None of the above:

0.8999999999999999999999991118215802998747
6766109466552734375

Another look

We used the wrong `BigDecimal` constructor.

The spec says:

```
public BigDecimal(double val)
```

Translates a double into a `BigDecimal` which is the **exact decimal representation of the double's binary floating-point value**.

```
import java.math.BigDecimal;
```

```
public class Change {  
    public static void main(String args[]) {  
        BigDecimal payment = new BigDecimal(2.00);  
        BigDecimal cost = new BigDecimal(1.10);  
        System.out.println(payment.subtract(cost));  
    }  
}
```

How do you fix it?

```
import java.math.BigDecimal;
```

Prints 0.90

```
public class Change {  
    public static void main(String args[]) {  
        BigDecimal payment = new BigDecimal("2.00");  
        BigDecimal cost = new BigDecimal("1.10");  
        System.out.println(payment.subtract(cost));  
    }  
}
```

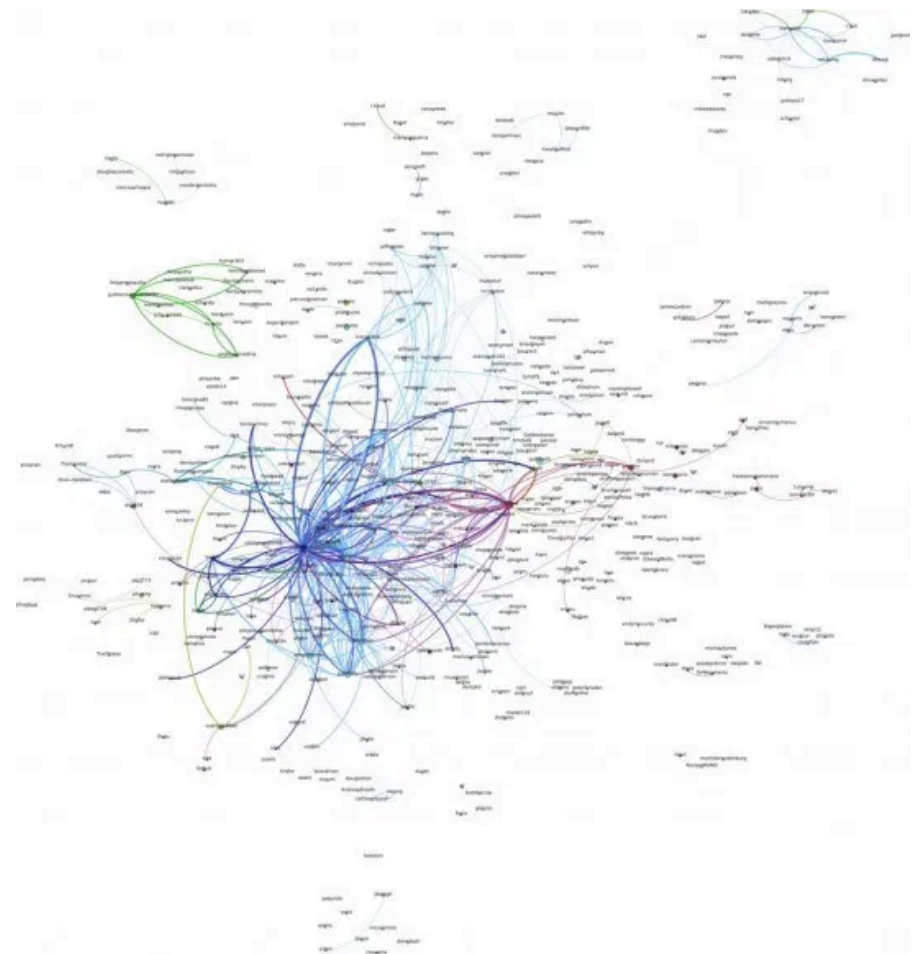
The moral

- Use `new BigDecimal(String)`,
not `new BigDecimal(double)`
- `BigDecimal.valueOf(double)` is better, but not perfect
 - Use it for non-constant values.
- For API designers
 - Make it easy to do the commonly correct thing
 - Make it hard to misuse
 - Make it possible to do exotic things

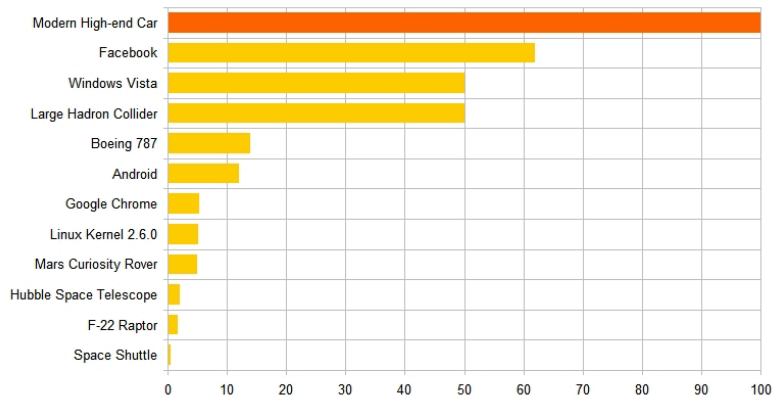
Today: Toward software engineering in practice

- Two puzzlers
- Software engineering for teams
 - Challenges of working as a team
 - Tools and processes for teams
 - Branch-based development, et al.

Software engineering is inherently collaborative



Software Size (million Lines of Code)

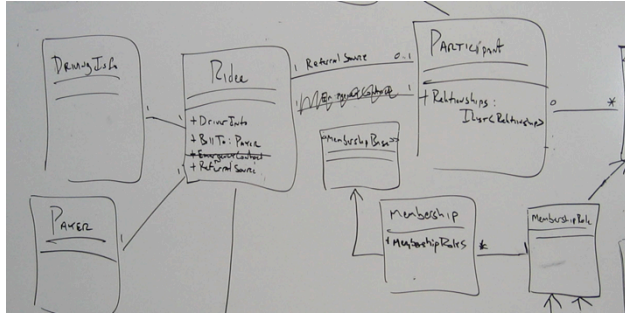


Challenges of working as a team:

Challenges of working as a team: **Aligning expectations**

- How does the team make decisions?
- How do you divide the work?
- Does the team share the same goals and incentives?
- What happens when work isn't completed as expected?
- When do team members like to work?
- What other commitments do your team members have?
- Where will you get the work done?
- ...

Decide what to build, then design the API



```
// A collection of elements (root of the collection hierarchy)
public interface Collection<E> {

    // Ensures that collection contains o
    boolean add(E o);

    // Removes an instance of o from collection, if present
    boolean remove(Object o);

    // Returns true iff collection contains o
    boolean contains(Object o) ;

    // Returns number of elements in collection
    int size() ;

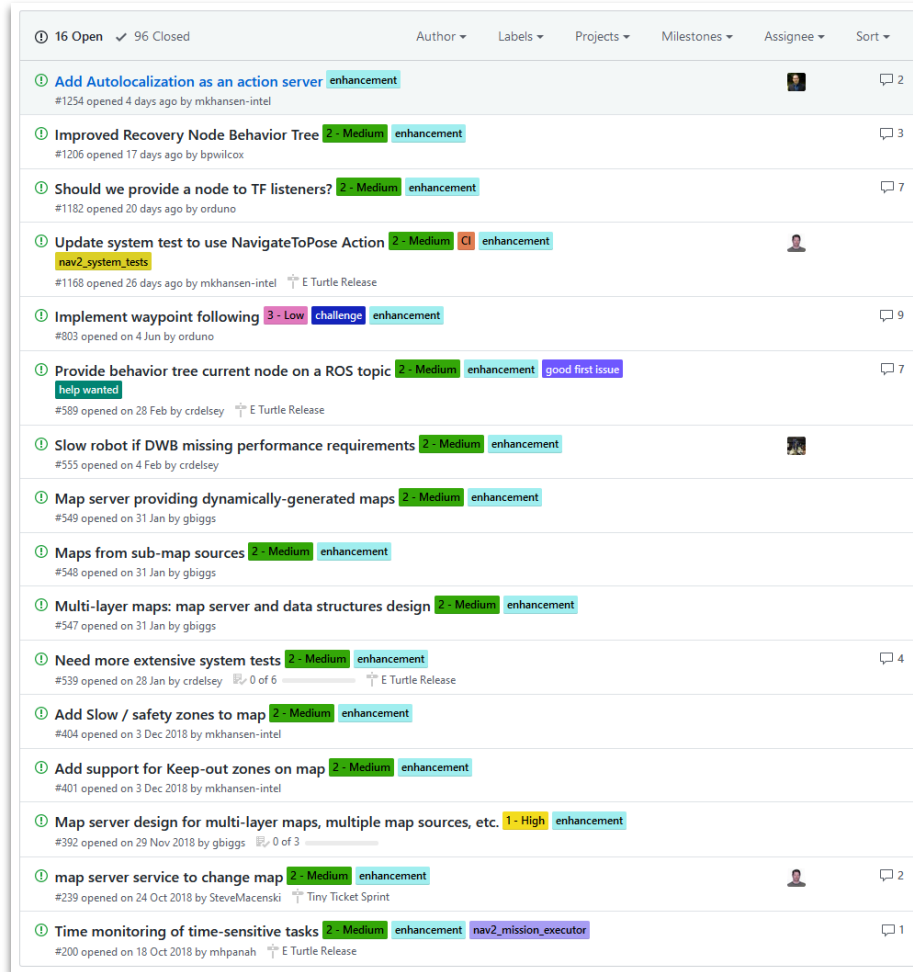
    // Returns true if collection is empty
    boolean isEmpty();

    ... // Remainder omitted
}
```

Basic Process:

- (1) Determine minimal feature set
- (2) Draw UML on a whiteboard.
- (3) Sketch out your API on paper
- (4) Write example code
- (5) Review
- (6) Repeat

Break up tasks into GitHub Issues

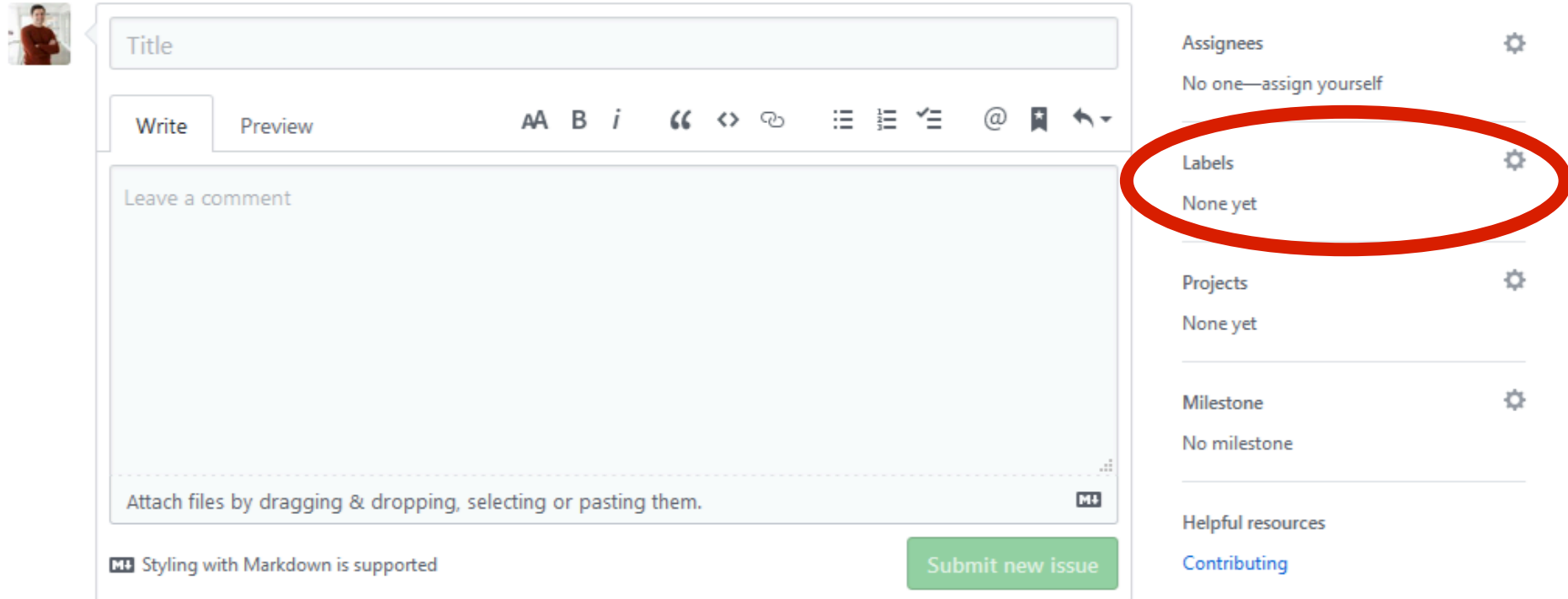



Issues can represent both tasks and bugs that need to be fixed.

Issues should be:

- a *reasonable* chunk of work
- focused and cohesive

Break up tasks into GitHub Issues





 Title

Write Preview


AA B i “ <> @ [List Icons] [Checkmark] [Link] [Star] [Refresh]


Leave a comment


Attach files by dragging & dropping, selecting or pasting them. 


 Styling with Markdown is supported

Submit new issue

Assignees 
No one—assign yourself

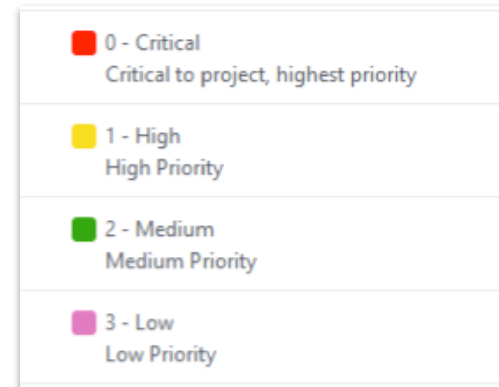
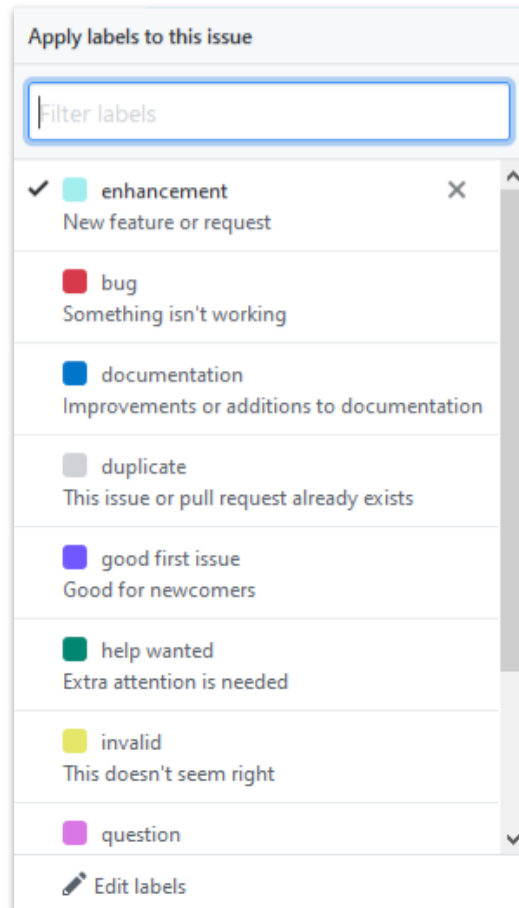
Labels 
None yet

Projects 
None yet

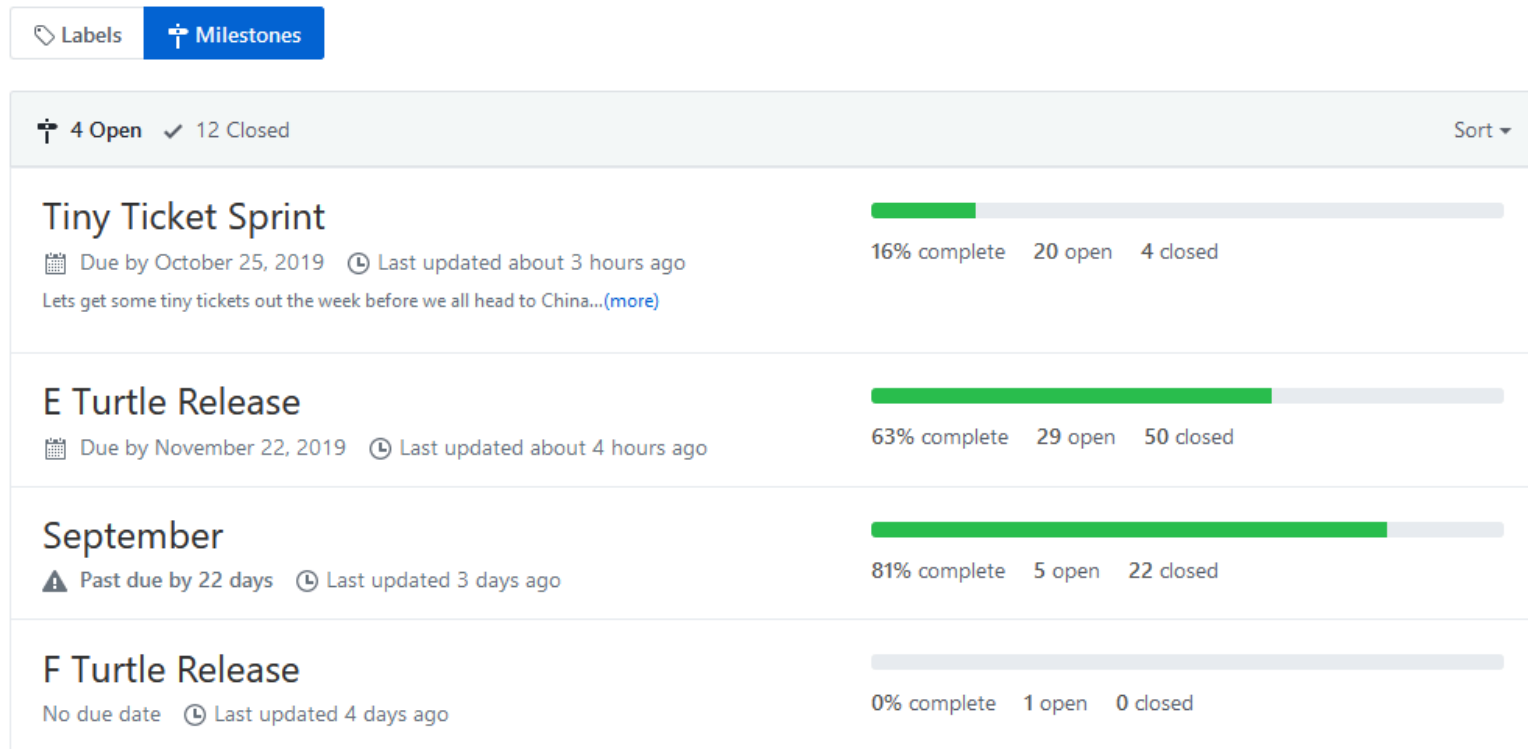
Milestone 
No milestone

Helpful resources
[Contributing](#)

Use labels to indicate priority and differentiate bugs from features



Consider using milestones (e.g., HW5a, HW5b)

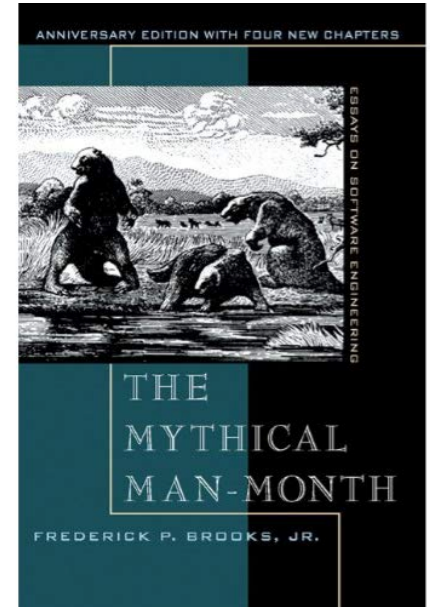


How does a large software project
get to be one year late?

How does a large software project
get to be one year late?

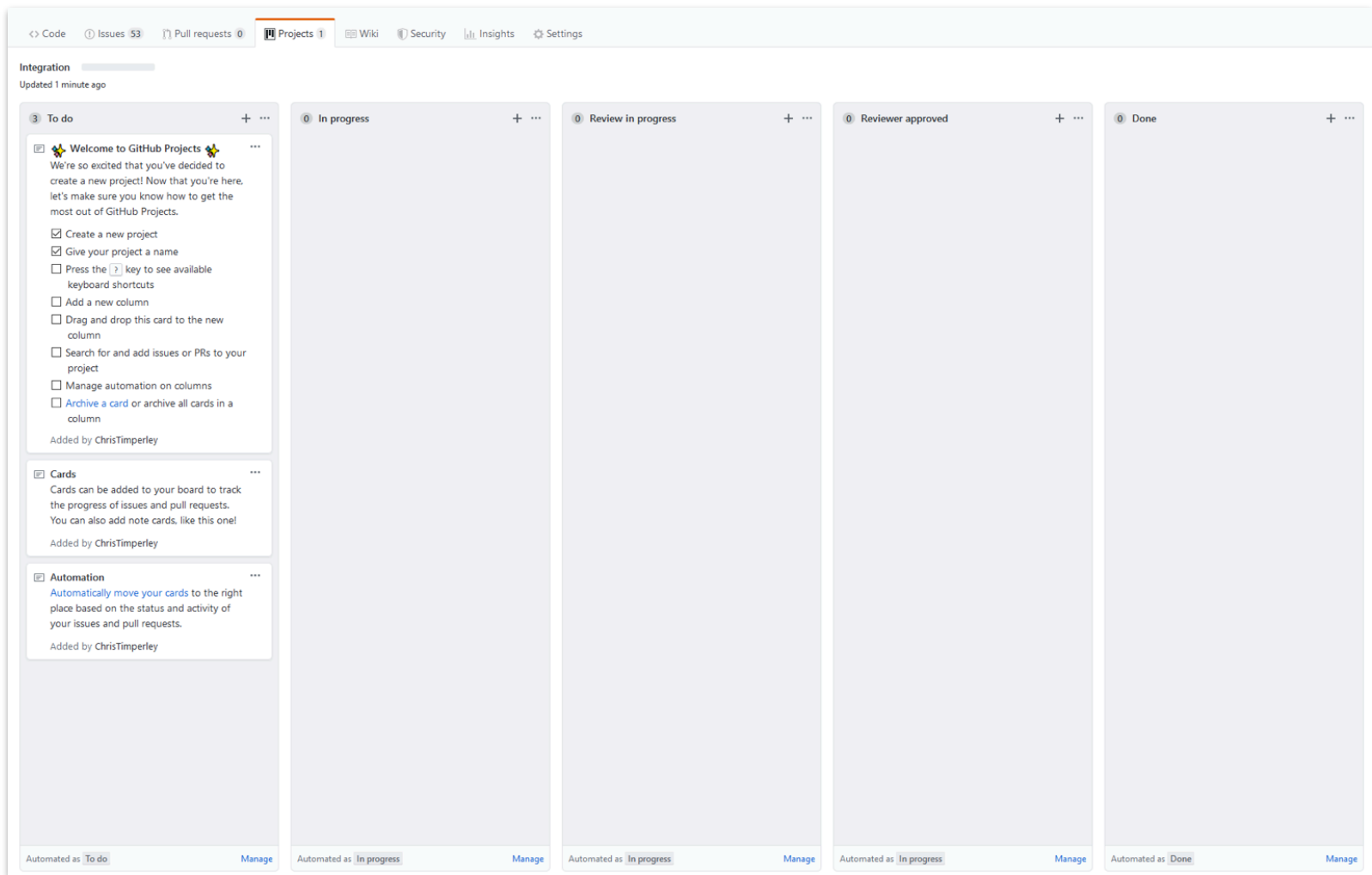
One day at a time.

— Fred Brooks, *The Mythical Man-Month*



https://en.wikipedia.org/wiki/The_Mythical_Man-Month

Use a simple Kanban board to measure progress

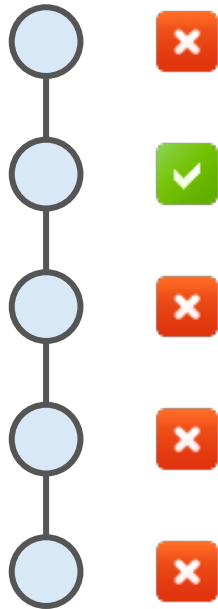


Use a simple Kanban board to measure progress

The screenshot displays a Trello board titled "Magic8ee - Development" with a progress bar at the top. The board is organized into four columns: "Backlog", "To Do", "In progress", and "Done". Each column contains a list of tasks, each represented by a card. The cards include details such as task descriptions, issue IDs, assignees, and labels. For example, in the "Backlog" column, tasks include "Create Docker image for project" and "Throw errors for missing dependencies". The "To Do" column has tasks like "Colombia shapelite (impls.json)" and "Fix 'file_lines' issue". The "In progress" column shows tasks such as "Add contributing guidelines" and "Determine where to begin writing tests". The "Done" column lists completed tasks like "Rename test suite" and "Refactor WebglLayer.js". A search bar and "Add cards" button are located at the top right. A "Add column" button is visible on the right side of the board. At the bottom of each column, there is a "Manage" link and an "Automated as" label.

Column	Task	Issue ID	Assignee	Labels
Backlog	Create Docker image for project	magic8ee-admin-server#10	flory?	enhancement, priority:low
	Throw errors for missing dependencies	magic8ee-admin-server#12	flory?	enhancement, help wanted, priority:crit
	Curling results in empty response, server crashes	magic8ee-admin-server#5	flory?	bug, help wanted, priority:crit
	Serve aggregations by admin level	magic8ee-open-api#22	mikefab	
	Base API in Swagger Spec Has Extra /	magic8ee-open-api#28	sherbida	
	Use arguments to overwrite default configurations	magic8ee-admin-server#24	carlosdiaz	enhancement
	Return hasProbsData in API response for schools	magic8ee-open-api#24	ayana217	
To Do	Colombia shapelite (impls.json) should be fetched from api rather than be required in react app.	magic8ee-map#26	mikefab	
	Fix "file_lines" issue in react-app/src/public/lib.js	magic8ee-map#50	flory?	bug
	Comment and refactor code in action-select-country.js	magic8ee-map#40	mikefab	
In progress	Add contributing guidelines placeholder (closes #22)	magic8ee-open-api#42	flory?	enhancement
	Determine where to begin writing tests and refactoring	magic8ee-map#34	mikefab	
	Map relationships between apps, maps, and abuse resources.	magic8ee#15	mikefab	in progress, internal organization, priority:crit
Done	Rename test suite (run-tests.sh), add comments	magic8ee-open-api#41	flory?	enhancement
	Refactor WebglLayer.js	magic8ee-map#51	flory?	bug
	Create production/staging dev deployment slots for Mobility Mapping	magic8ee#16	mikefab	enhancement, internal organization, priority:crit
	Set up automatic CI testing for new pull requests	magic8ee#6	flory?	enhancement, priority:high
	Add loading spinner to mobility map	magic8ee-map#17	mikefab	
	Add spinner mobility	magic8ee-map#54	carlosdiaz	enhancement
	Add CodeClimate maintainability + test coverage checks to CI	magic8ee-open-api#43	flory?	enhancement

Single-branch development doesn't scale to teams



Master

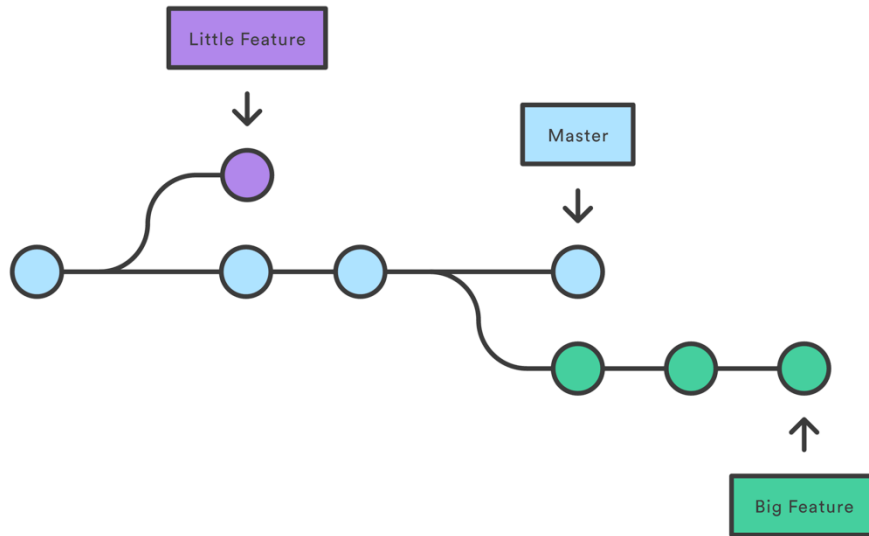
```
merge_conflict — bash — 80x24
bash python bash bash
Your branch is up-to-date with 'origin/master'.
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working directory)

        modified:   index.html

no changes added to commit (use "git add" and/or "git commit -a")
dhcp-10-101-250-155:merge_conflict SUYEONSON$ git add index.html
dhcp-10-101-250-155:merge_conflict SUYEONSON$ git commit -m 'tryna make a merge conflict'
[master ee28024] tryna make a merge conflict
1 file changed, 1 deletion(-)
dhcp-10-101-250-155:merge_conflict SUYEONSON$ git push
To git@github.com:suyeonson/merge_conflict.git
! [rejected]        master -> master (fetch first)
error: failed to push some refs to 'git@github.com:suyeonson/merge_conflict.git'
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.
dhcp-10-101-250-155:merge_conflict SUYEONSON$
```

build failure

Use simple **branch-based** development



Commits on Oct 20, 2019

Added file checking methods to FileSystem (#28) ...

ChrisTimperley committed yesterday ✓

Verified



da32e4a



Commits on Oct 19, 2019

Implemented basic filesystem API (#27) ...

ChrisTimperley committed 2 days ago ✓

Verified



73d331e



Added workaround for shell calls without both stdout and stderr (#26) ...

ChrisTimperley committed 2 days ago ✓

Verified



06aa050



Added Container class for holding Docker container details (#24) ...

ChrisTimperley committed 3 days ago ✓

Verified



05c61e8



Commits on Oct 13, 2019

Added DockerDaemon for maintaining connections to daemon (fixes #21) ...

ChrisTimperley committed 8 days ago ✓

Verified



79ad8e7



Added environ method to Shell (#20) ...

ChrisTimperley committed 9 days ago ✓

Verified



4494af4



Added basic popen to shell (fixes #6) (#19) ...

ChrisTimperley committed 9 days ago ✓

Verified



c779374



Add encoding and text parameters to Shell commands (fixes #9) (#17) ...

ChrisTimperley committed 9 days ago ✓

Verified



cef114c



Create a new branch for each feature.

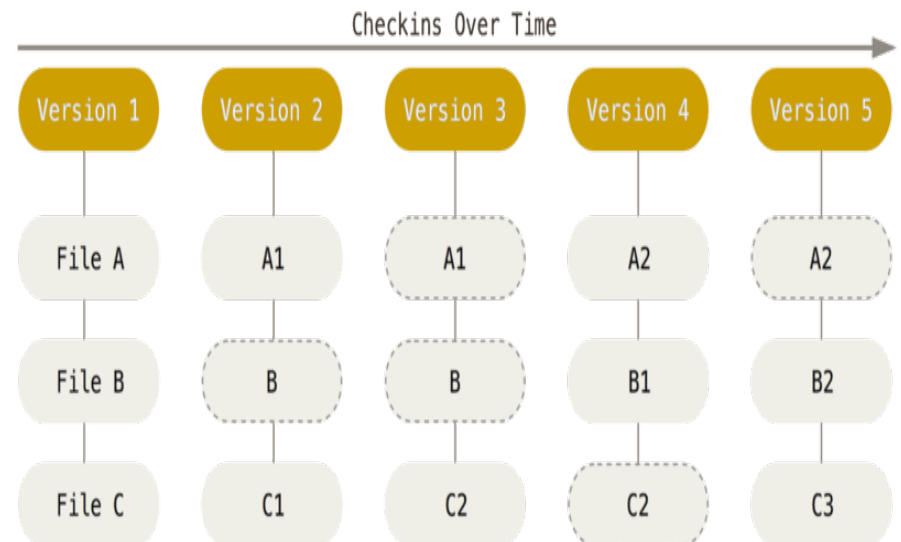
- allows parallel development
- no dealing with half-finished code
- no merge conflicts!

Every commit to “master” should pass your CI checks.

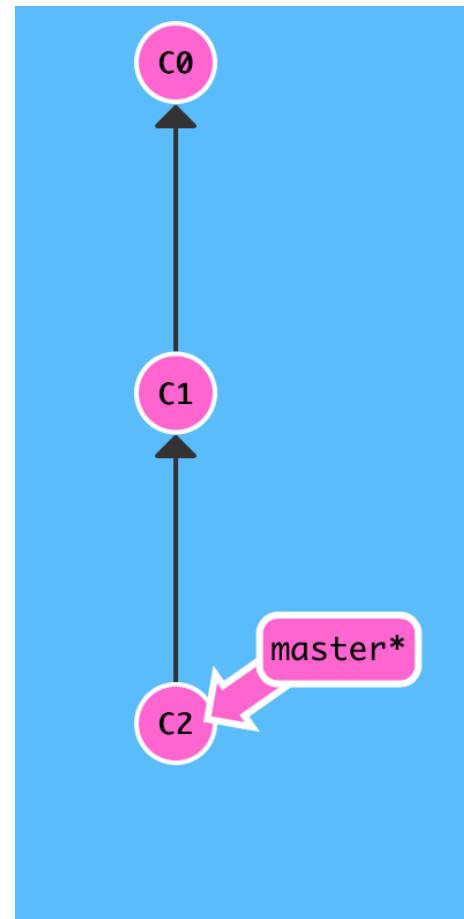
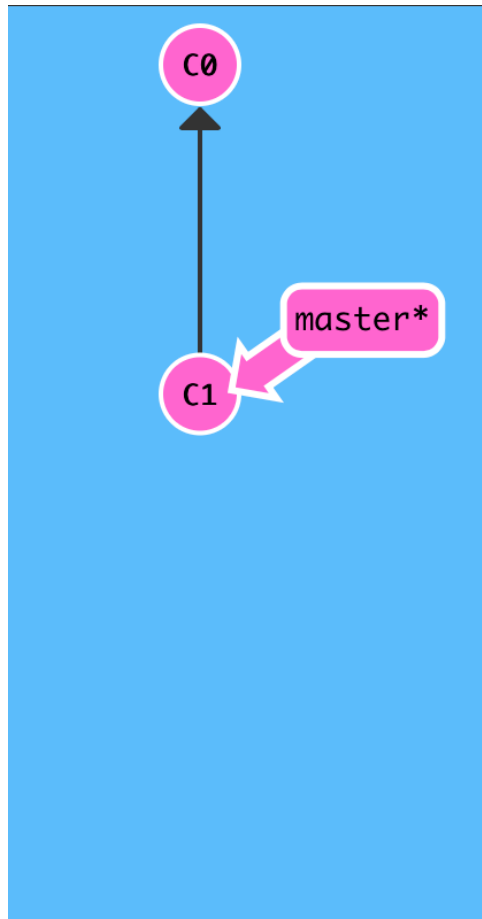
build passing

Git, practically

- Git stores each version as a snapshot
- If files have not changed, only a link to the previous file is stored
- Each version is referred by the SHA-1 hash of the contents

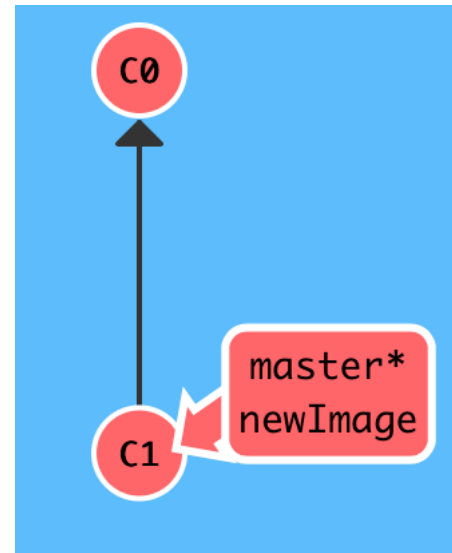
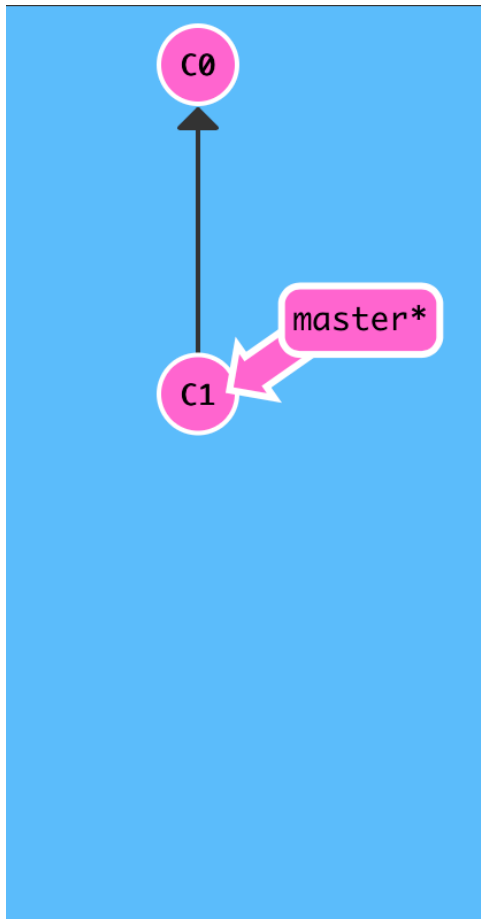


git commit

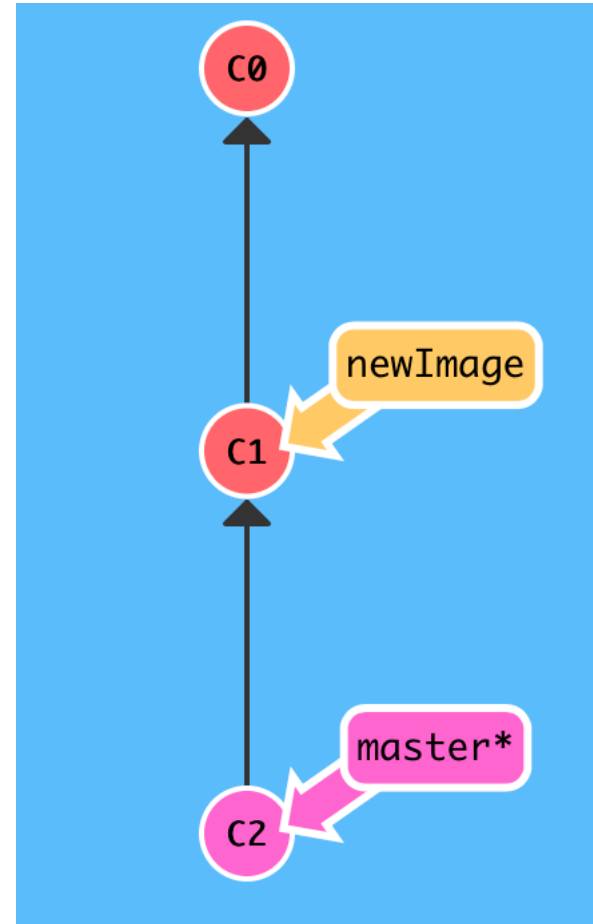
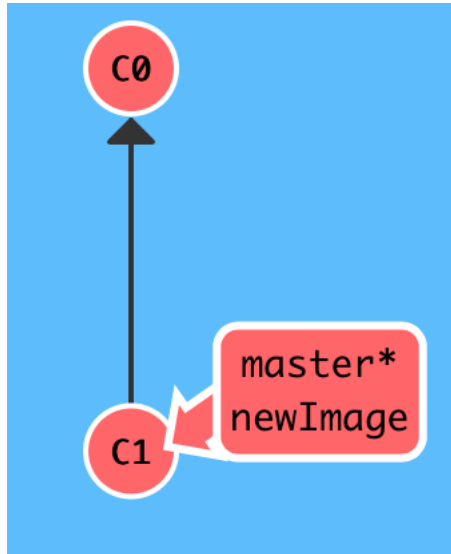


Graphics by <https://learngitbranching.js.org>

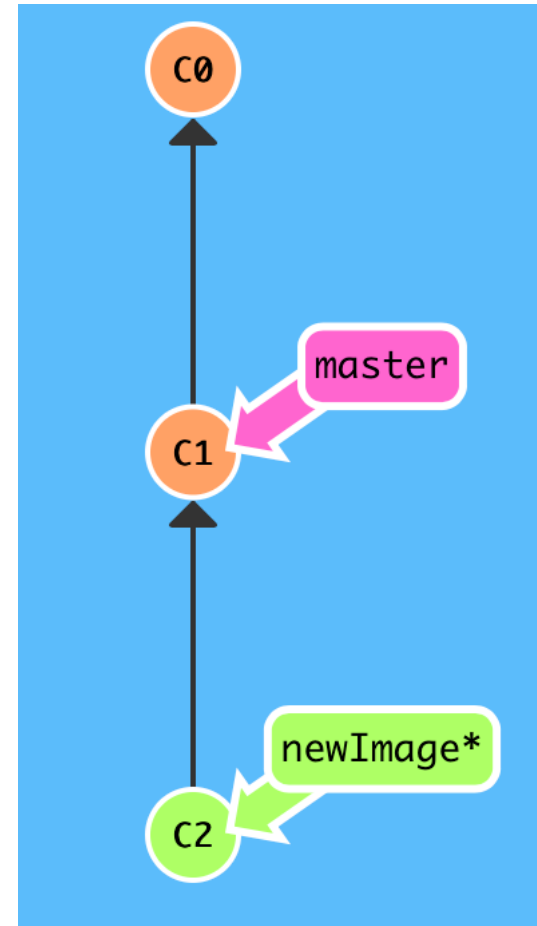
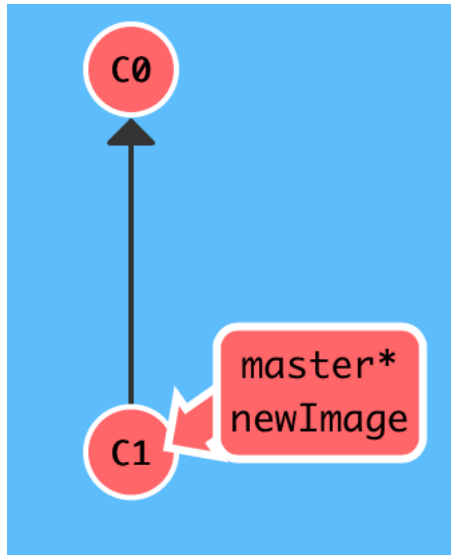
git branch newImage



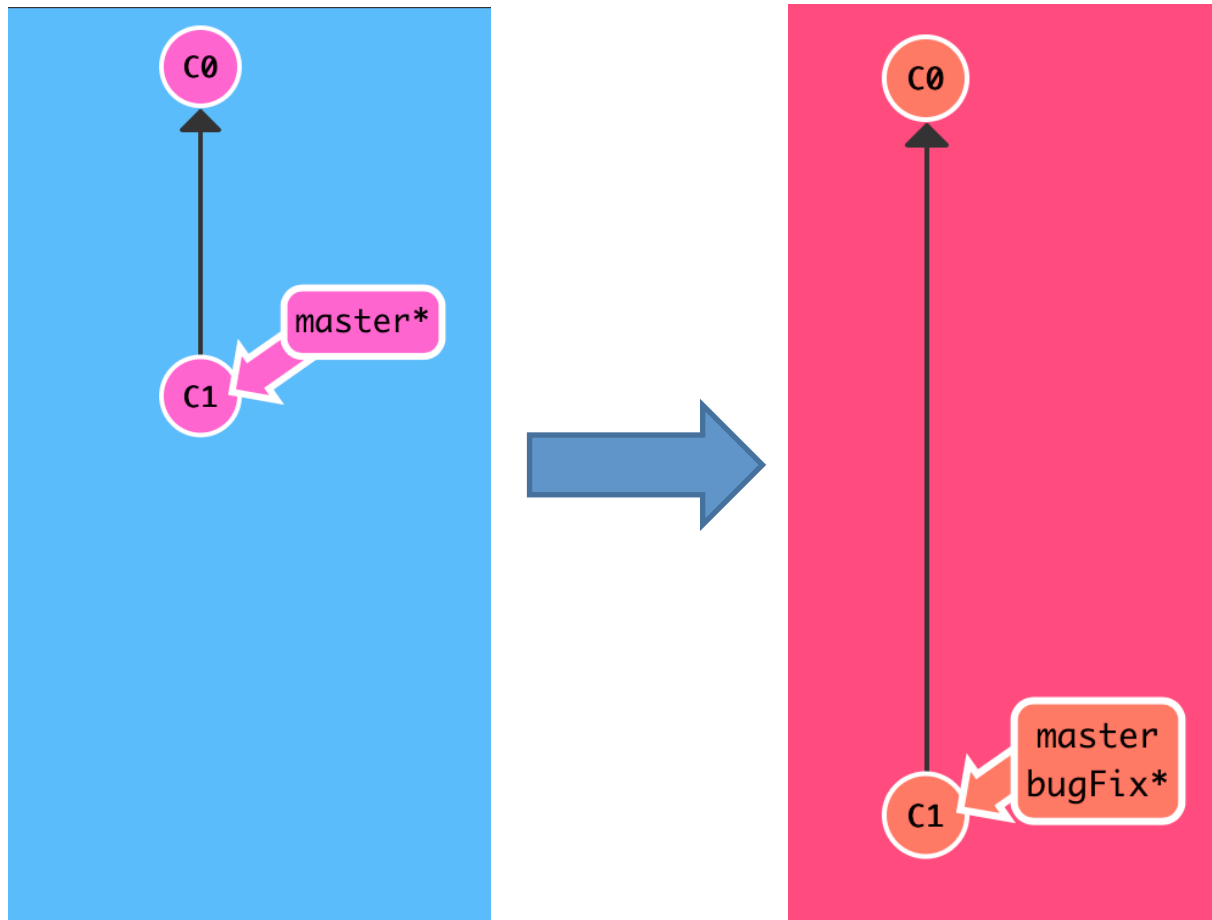
git commit



`git checkout newImage; git commit`

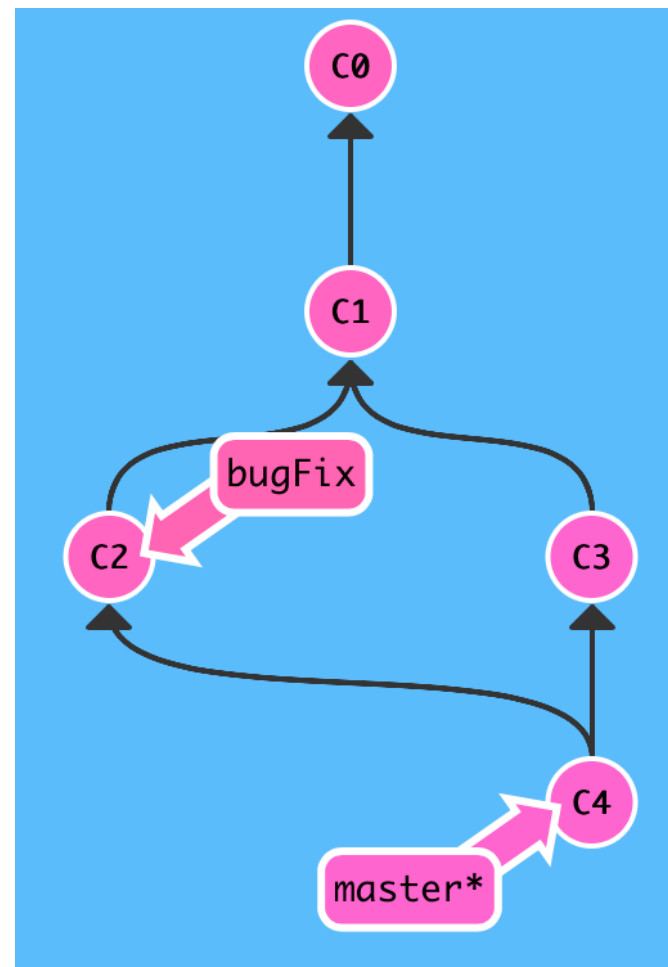
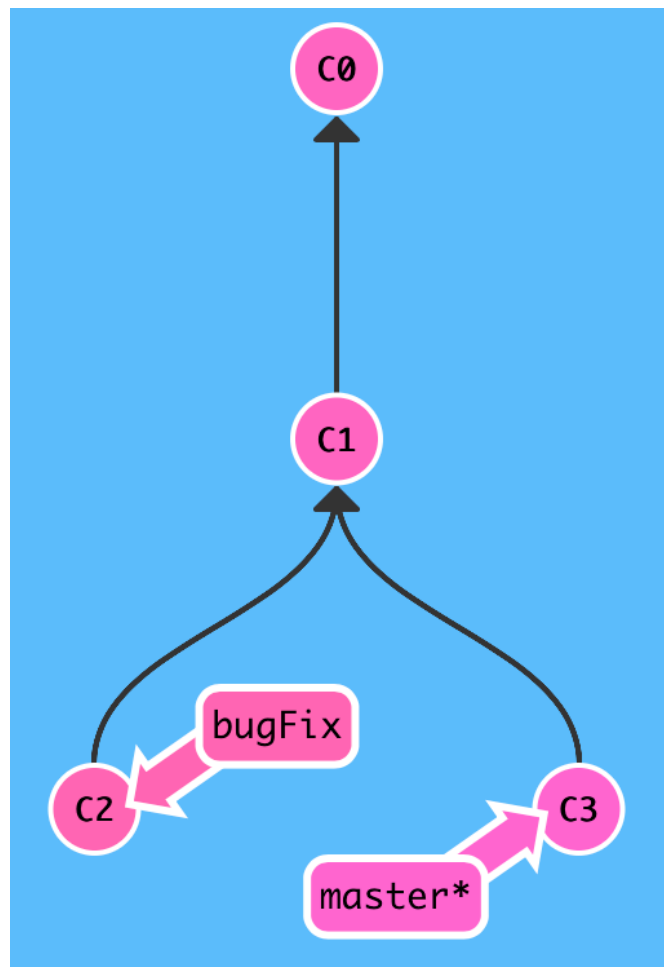


Activity: Make a new branch named bugFix and switch to that branch

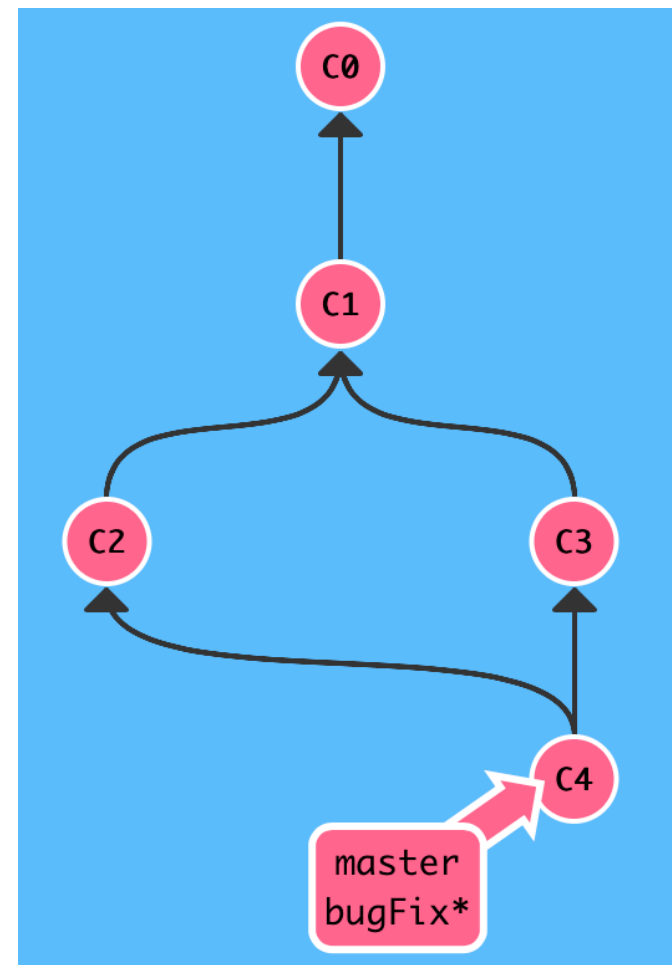
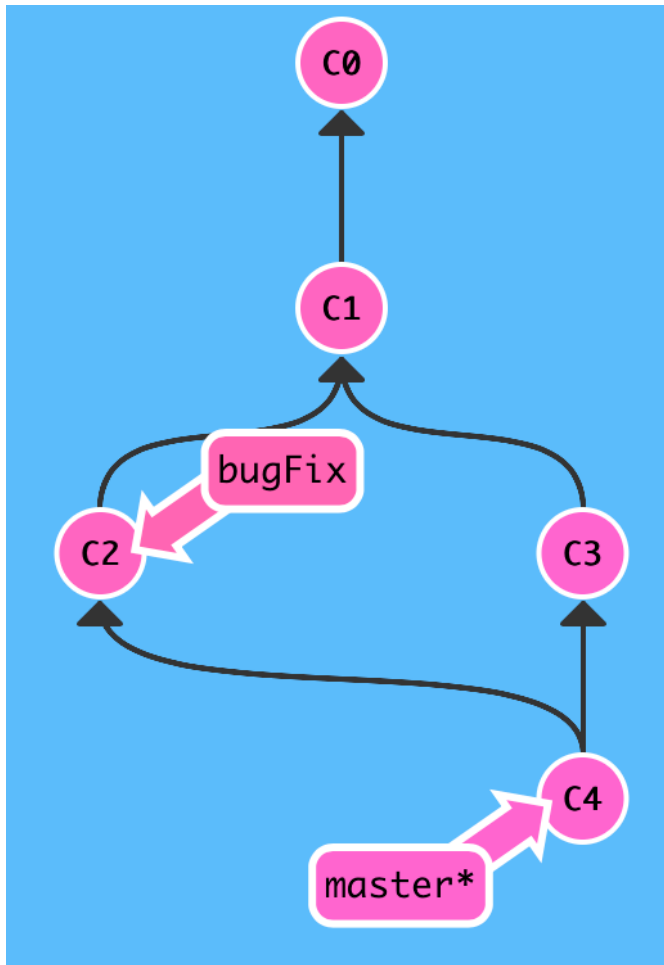


Three ways to move work around between branches

1) git merge bugFix (into master)

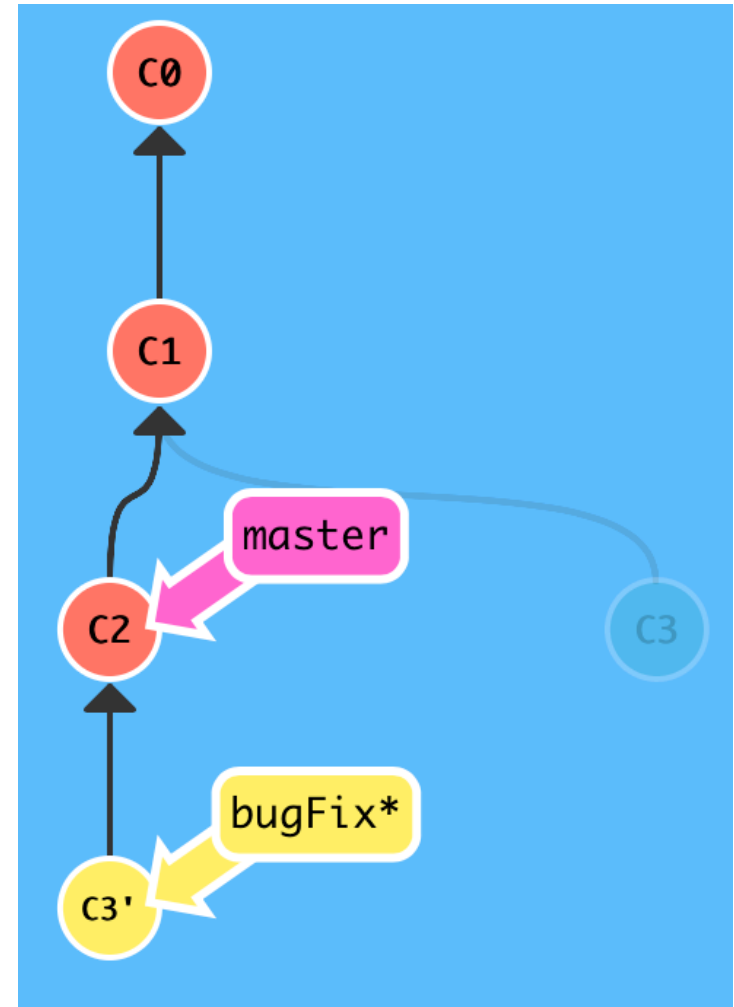
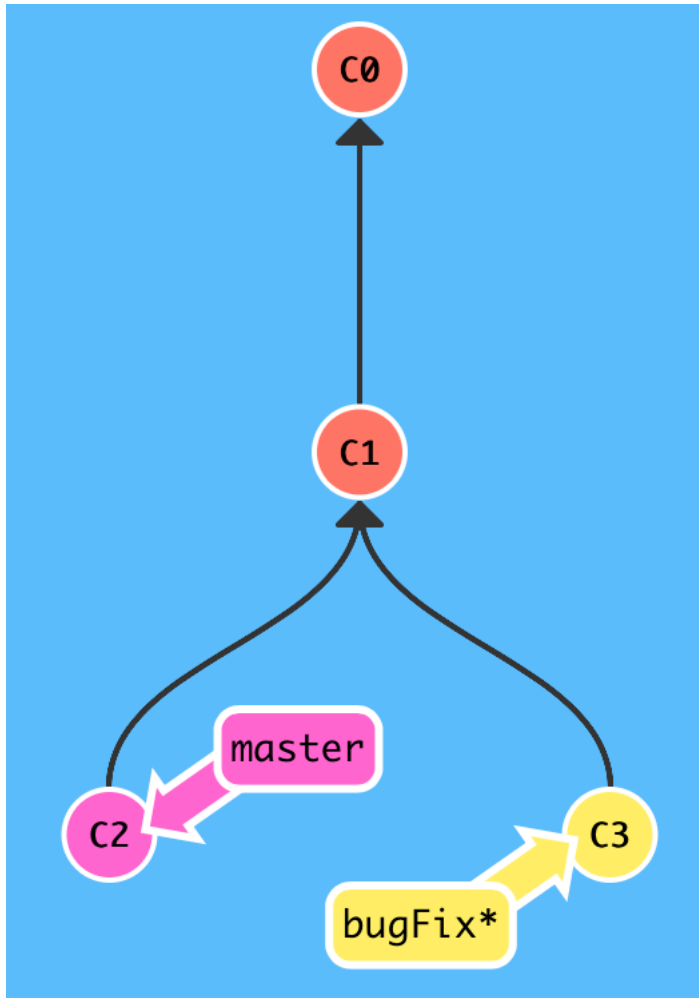


`git checkout bugfix; git merge master (into bugFix)`



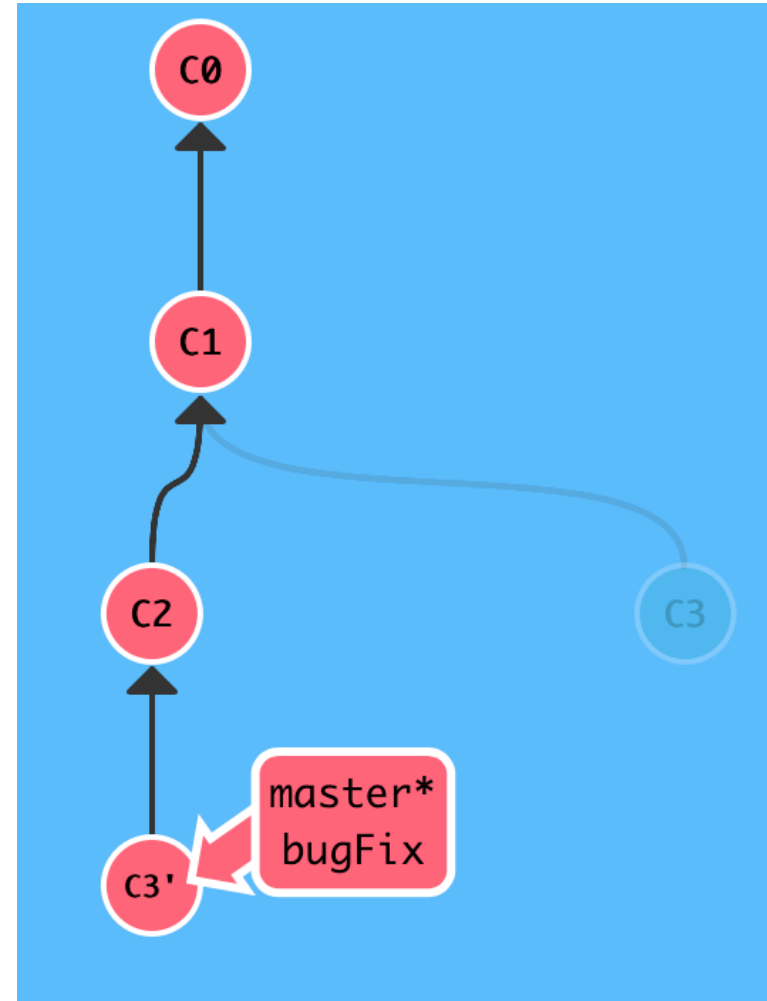
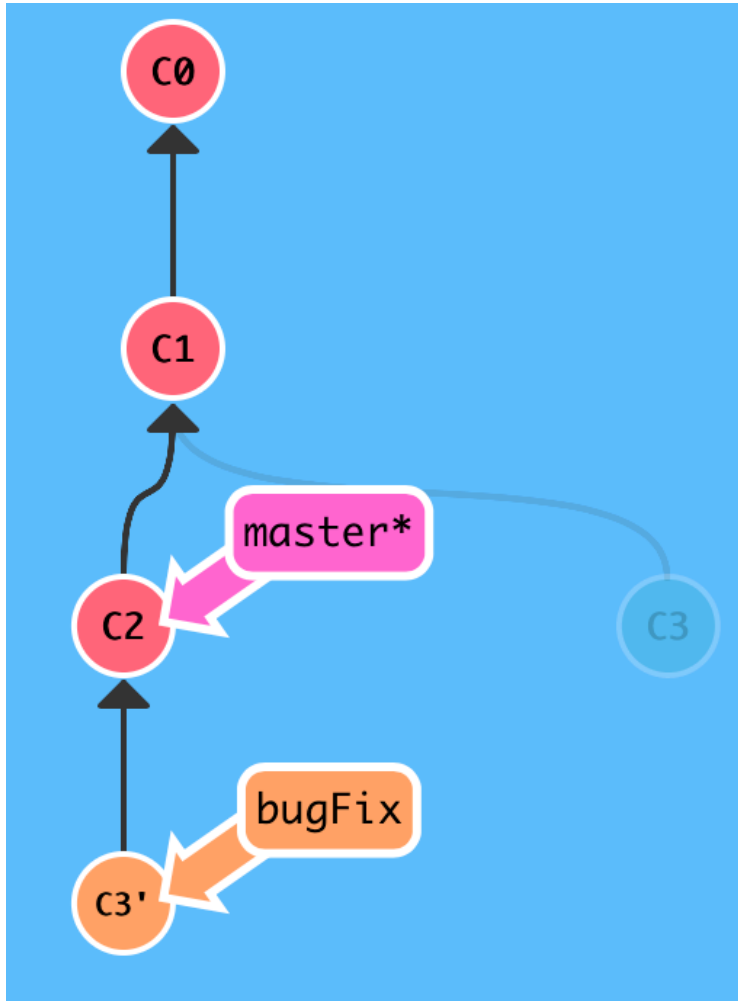
Move work from bugFix directly onto master

2) git rebase master



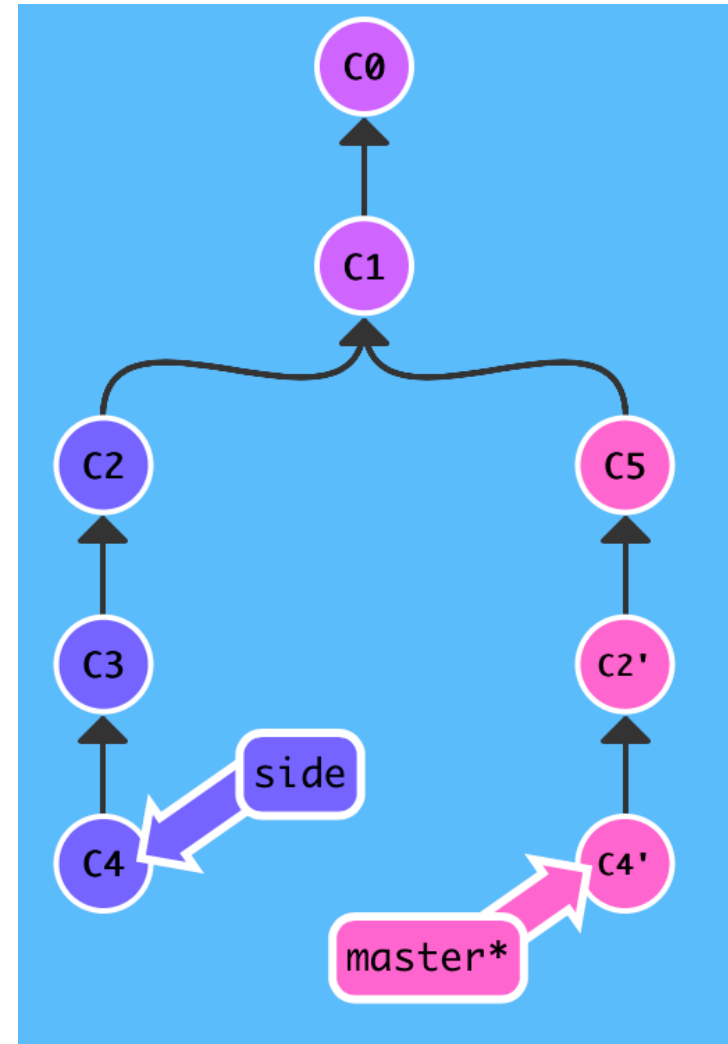
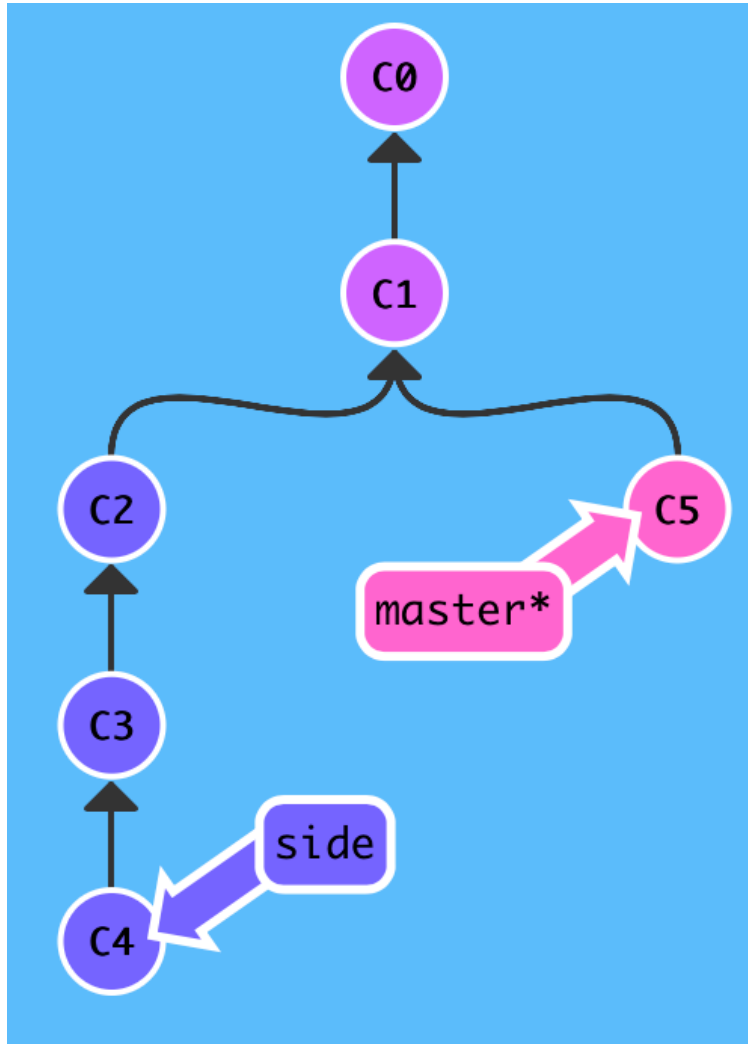
But master hasn't been updated, so:

`git checkout master; git rebase bugFix`

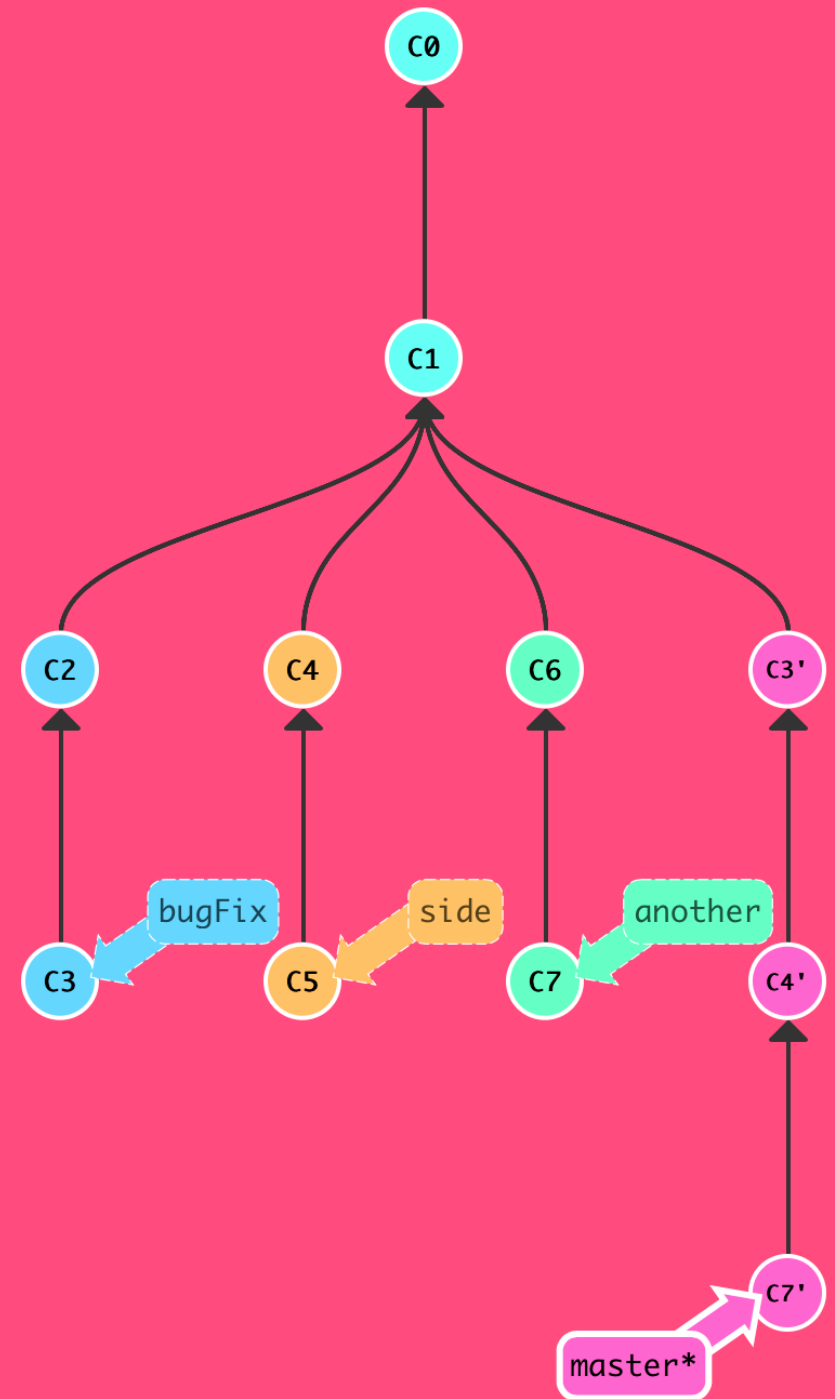
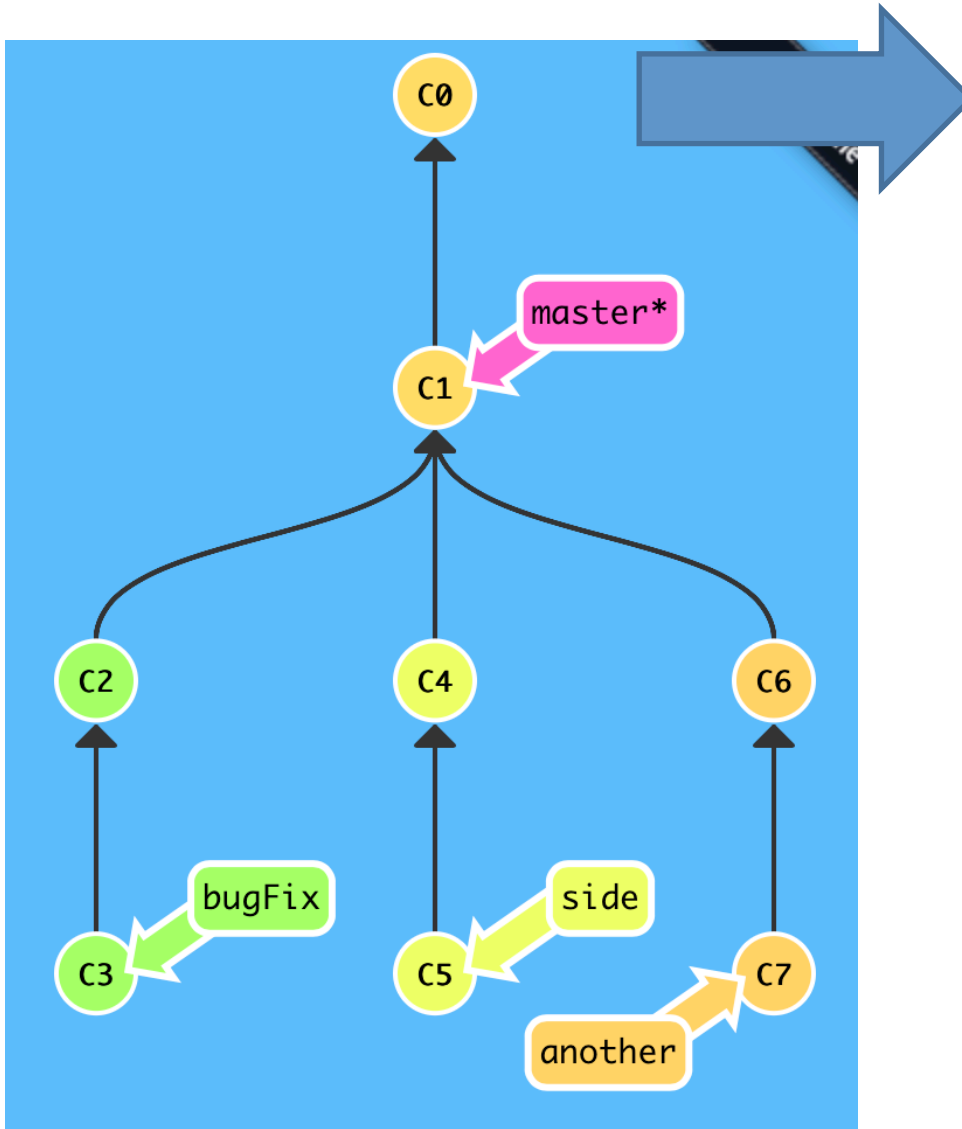


Copy a series of commits below current location

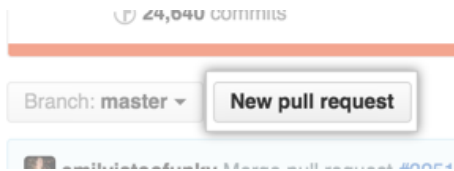
3) `git cherry-pick C2 C4`



Activity:

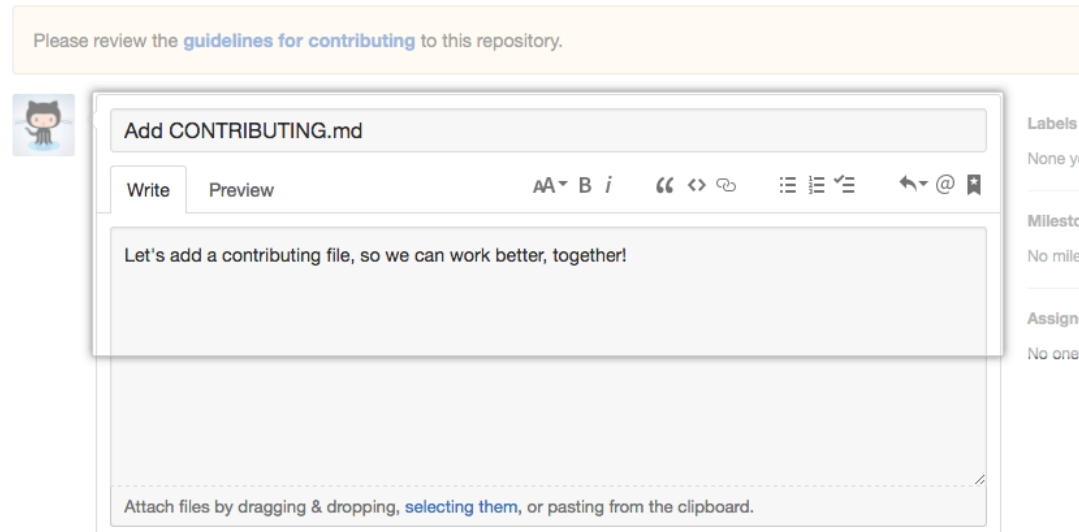
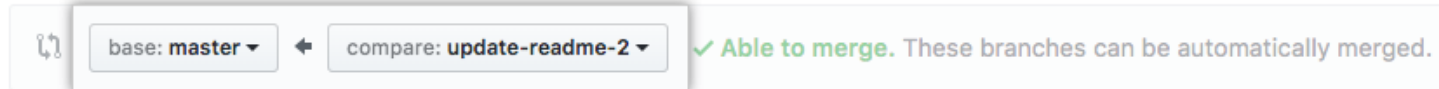


Use GitHub **pull requests** to review and merge changes



Open a pull request

Create a new pull request by comparing changes across two branches. If you need to, you can also [compare across forks](#).



<https://help.github.com/en/github/collaborating-with-issues-and-pull-requests/creating-a-pull-request>

Ask your teammates to review your pull request

Reviewers



Suggestions



octocat

Request



octocat requested changes 3 minutes ago

[View changes](#)

This is looking good. I left a few comments that should be addressed before this gets merged. 🐱

templates/issue_template.md

... @@ -0,0 +1 @@

1 +### Testing multiple templates



octocat 3 minutes ago

Could we use the template from the styleguide here for consistency?

16 - We're all authors :star:

16 + We're all authors :star: :stars:



lecoursen 4 hours ago • edited ▾

I think this is too many emojis.



octocat 4 hours ago • edited ▾

I agree. I'll remove one.



Reply...

Resolve conversation

Bonus tip: Automatically close issues in commits/PRs

Add encoding and text parameters to Shell commands (fixes #9) (#17) ...



ChrisTimperley committed 11 days ago ✓

Use any of the following words:

- close #N, closes #N, closed #N
- fix #N, fixes #N, fixed #N
- resolve #N, resolves #N, resolved #N

Summary

- Identify and discuss risks within your team
 - Get to know your teammates, and agree on your process
- Use standard tools to improve your process
- Please vote!