CS 241: Systems Programming
Lecture 23. Advanced Git

Fall 2025

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Roadmap

Review of Git branches, merging, and rebasing

Conflict markers and resolution

Collaborative development using GitHub, specifically, pull requests

Branches

Visualize a project's development as initially a *linked list* of commits

When a development track splits, a new branch is created

- This gives us a *tree* of commits

In Git, a branch is actually just a pointer to a leaf in the tree of development

Two or more branches can be merged together

- This gives a *graph* of commits

Why might you create a branch?

A. Fixing a specific bug

B. Adding a new feature

C. Creating a development branch so the code in your main branch always compiles and works correctly

D. All of the above

Git branching

List all branches in the project

- `git branch`

Create a new branch

- `git branch <branchname>`

Switch to a branch

- `git checkout <branchname>`

Create and immediately switch

- `git checkout –b <branchname>`

Delete a branch

- `git branch –d <branchname>`

Using branches

Create and switch to a branch

```
$ git branch working

$ git checkout working
M  README
Switched to branch 'working'

$ git branch
  main
* working
```

Stashing

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Working tree should be clean when switching branches

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Save/hide changes you're not ready to commit with `git stash`

- Pushes changes onto a stash stack

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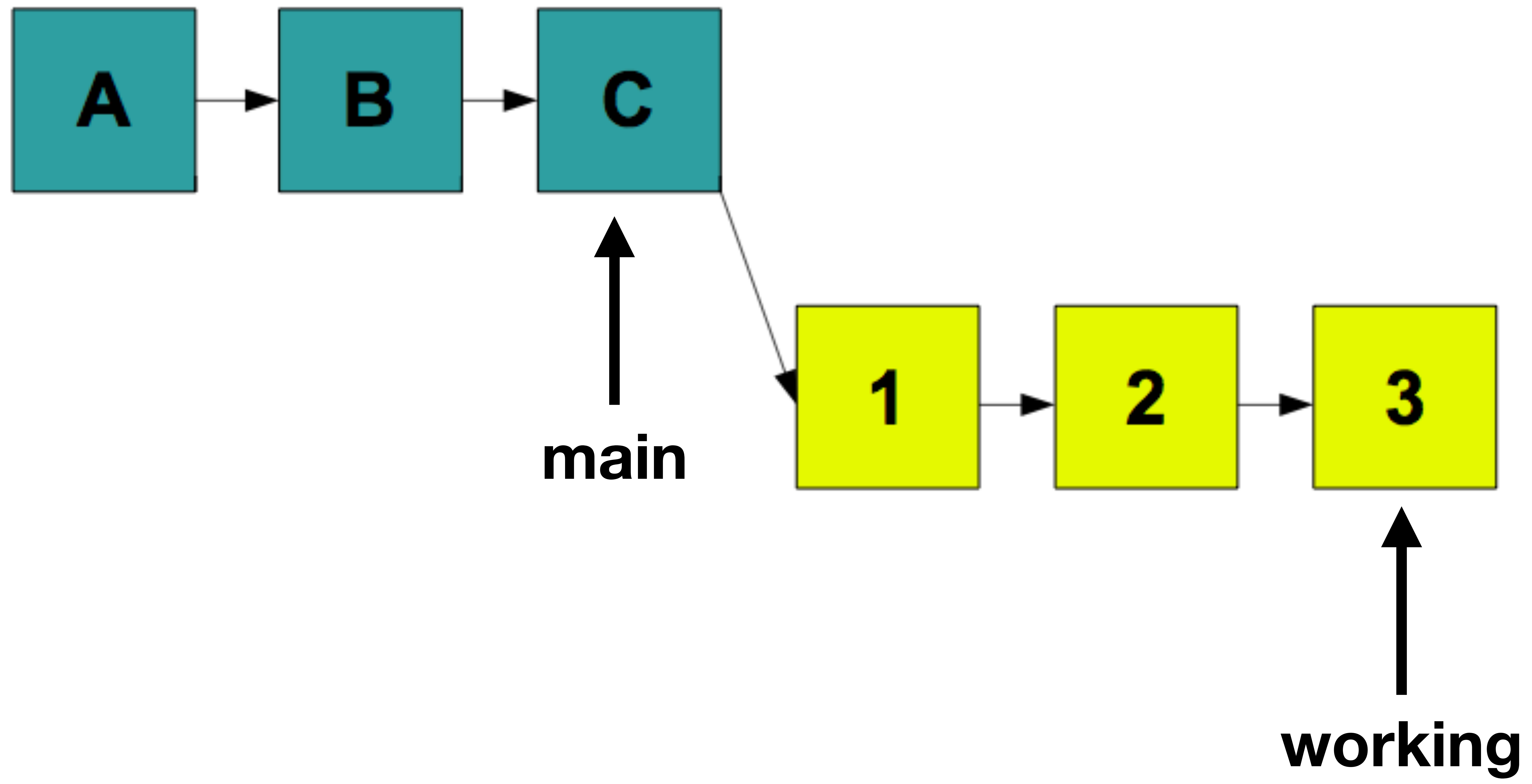
Working tree should be clean when switching branches

Save/hide changes you're not ready to commit with `git stash`

- Pushes changes onto a stash stack

Recover changes later with `git stash pop`

Using branches



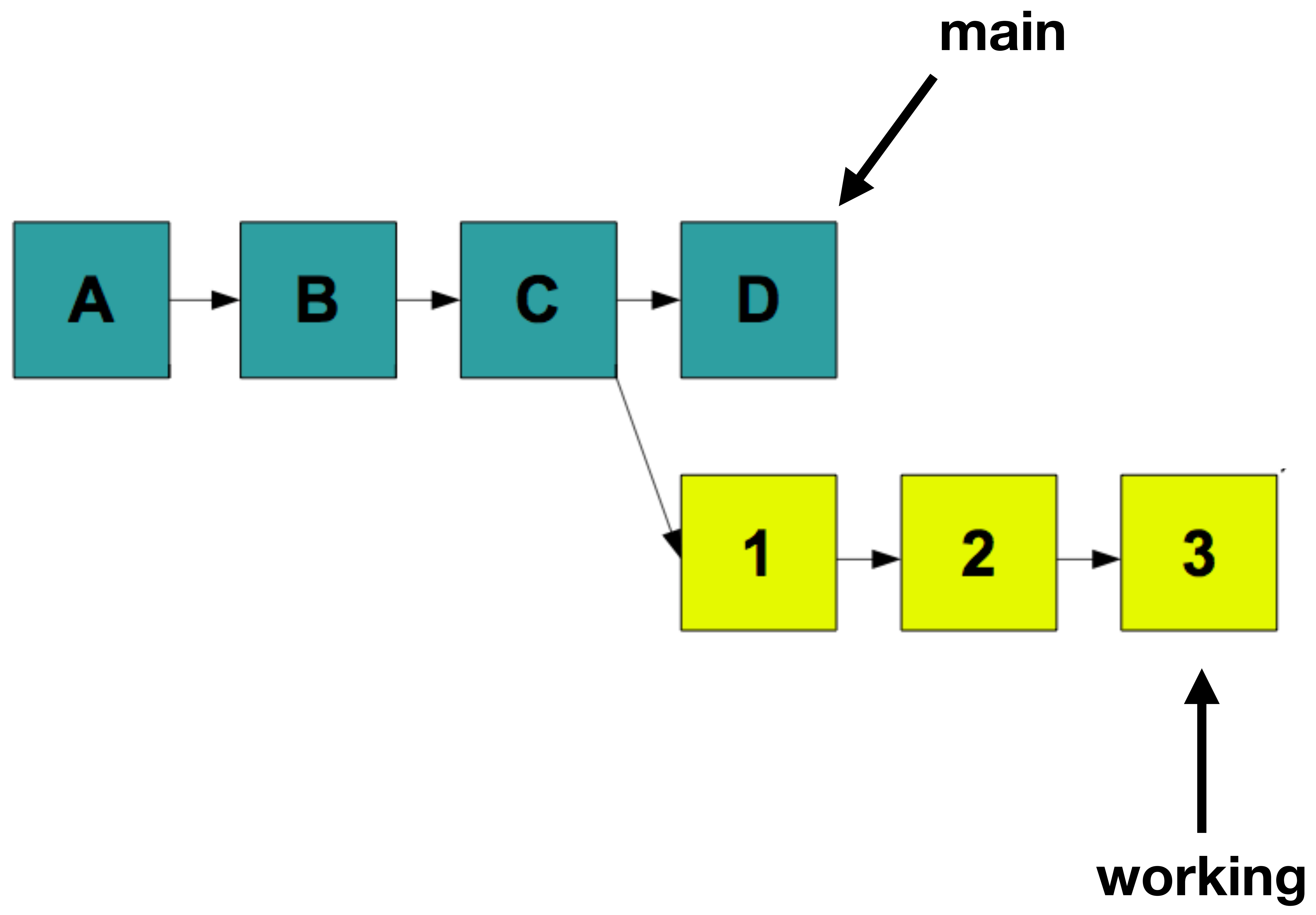
Using branches

Integrate changes back into **main**

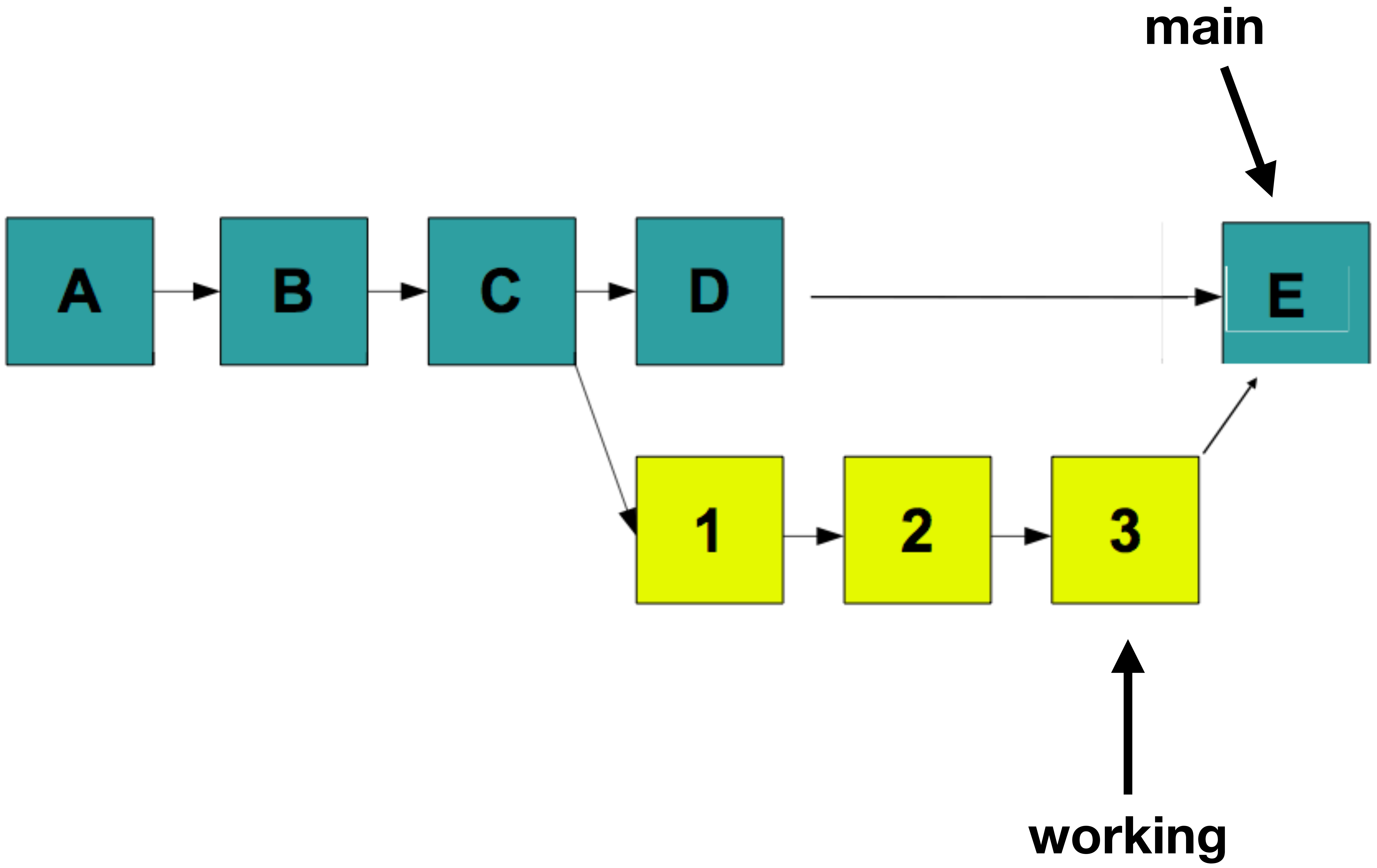
```
$ git checkout main
Switched to branch ‘main'

$ git merge working
Merge made by the 'recursive' strategy.
 newfile.txt | 1 +
 1 file changed, 1 insertion(+)
 create mode 100644 newfile.txt
```

Before git merge



After git merge



Merged history

```
*   cdd07b2 - (HEAD, main) Merge branch
'working'
|\
| * 1ccf9e7 - (working) Added a new file
* | 3637a76 - Second change
* | cf98d00 - First change
|/
* cf31a23 - Updated README to 2.0
* 2a8fc15 - Initial commit
```

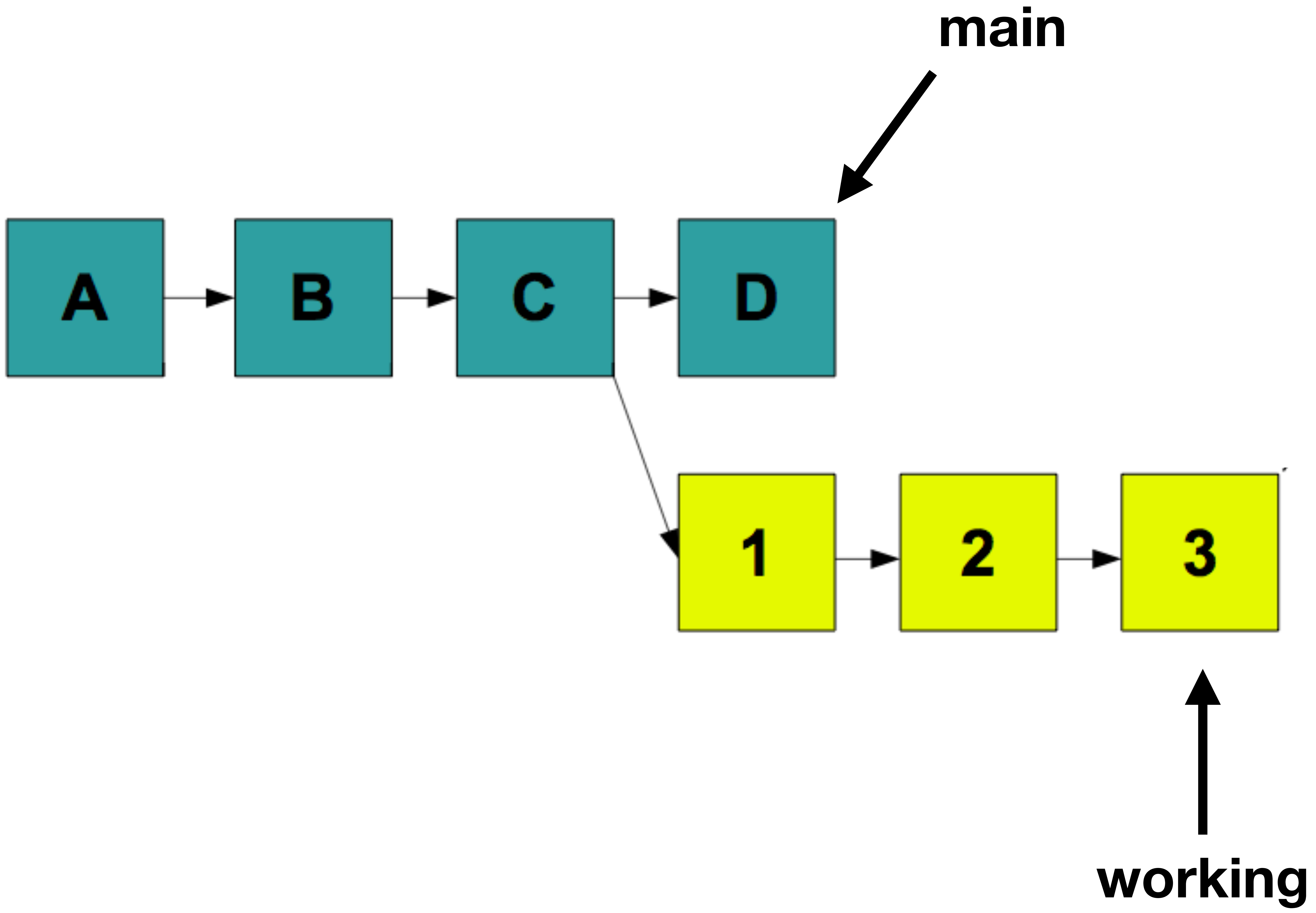
Rebasing

Like merging, rebasing transfers changes from one branch to another

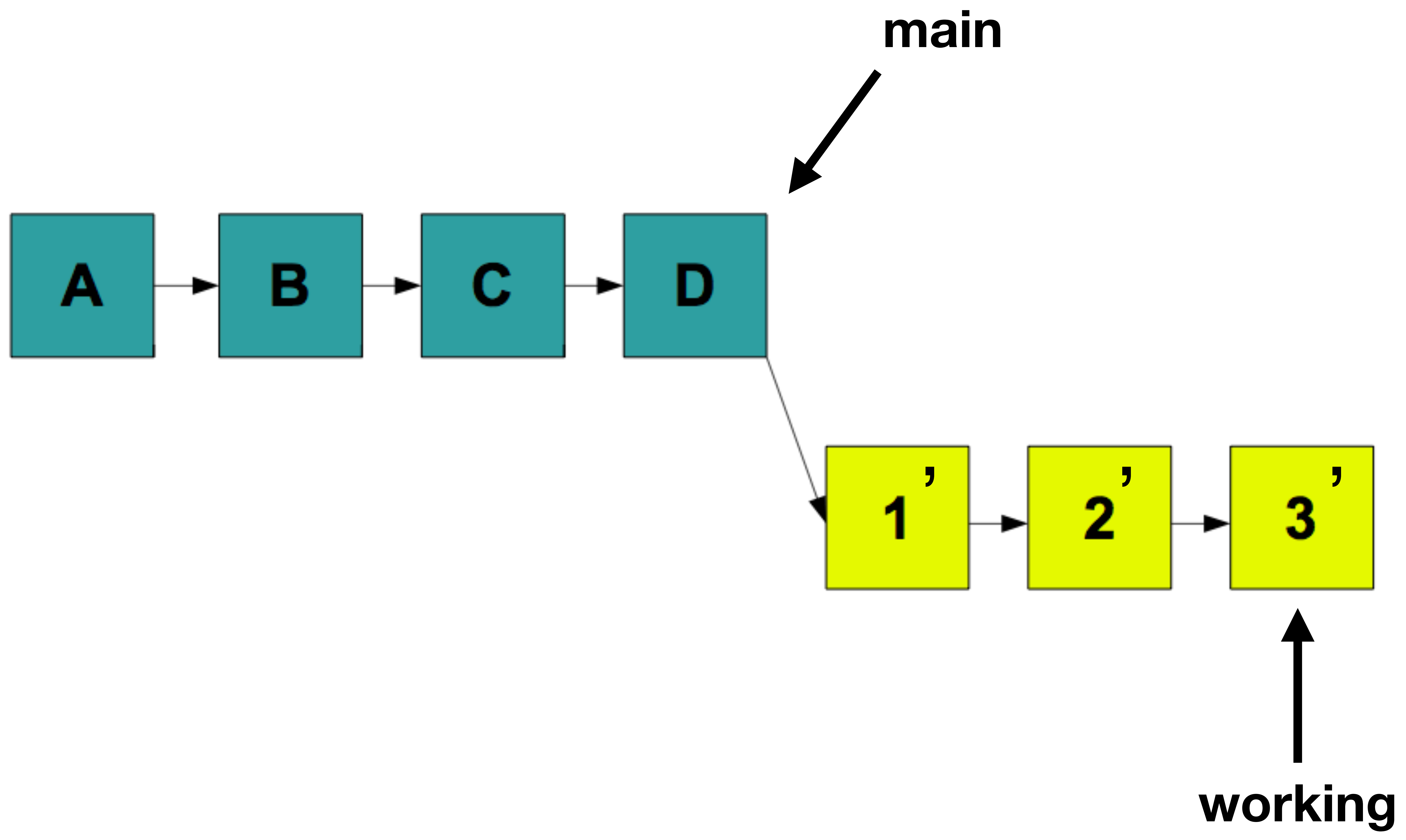
Does not create a new commit

Replays changes from current branch onto head of other branch

Before git rebase



After git rebase



git rebase

Powerful tool

Can change the commit order

Merge/split commits

Make fixes in earlier commits
- DO NOT DO ON PUSHED CHANGES OR PUBLIC BRANCHES

```
$ git rebase —i main
```

Why is it a bad idea to do git rebase on a public project?

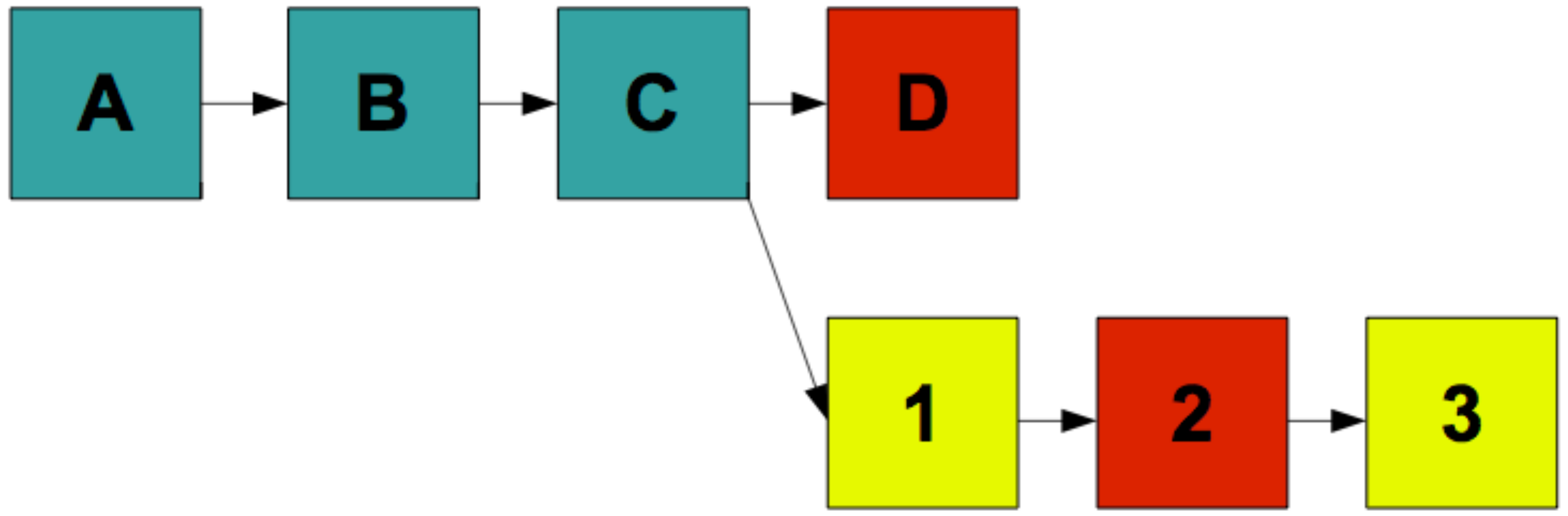
A. If someone else is doing work based on a commit you rebase, it will be hard for them to merge their work

B. Git rebase rewrites history, making it hard for other developers to understand what happened in past commits

C. It can create a situation where different developers are working with different commit histories of the same project

D. All of the above

Conflicts



Git conflict markers

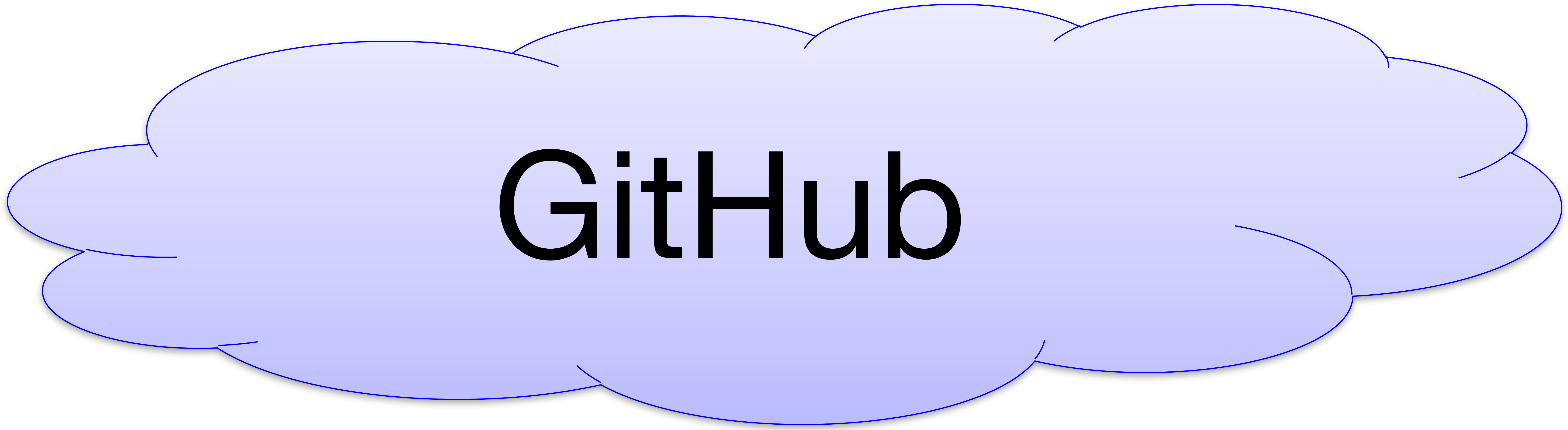
```
$ cat foo.c
<<<<<<< HEAD
current content
=======
branch content
>>>>>>> newbranch
$ vim foo.c
$ git add foo.c
$ git rebase --continue
```

Pull requests with Github

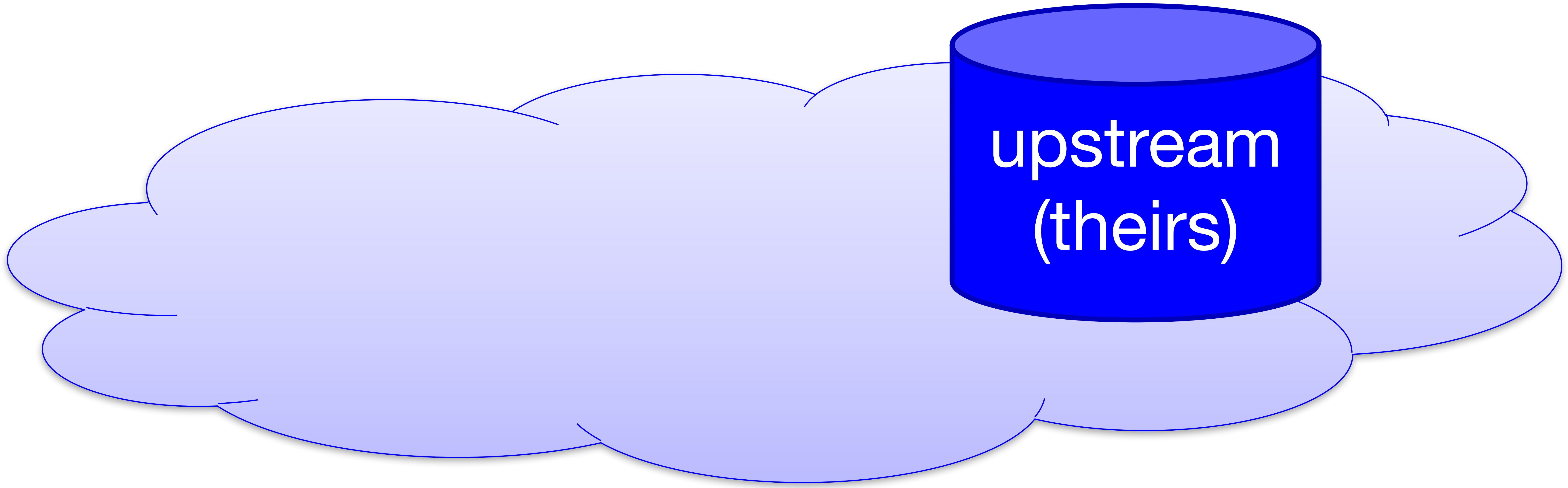
Contributing changes to repositories on Github

Requests the owner of the code integrate your changes

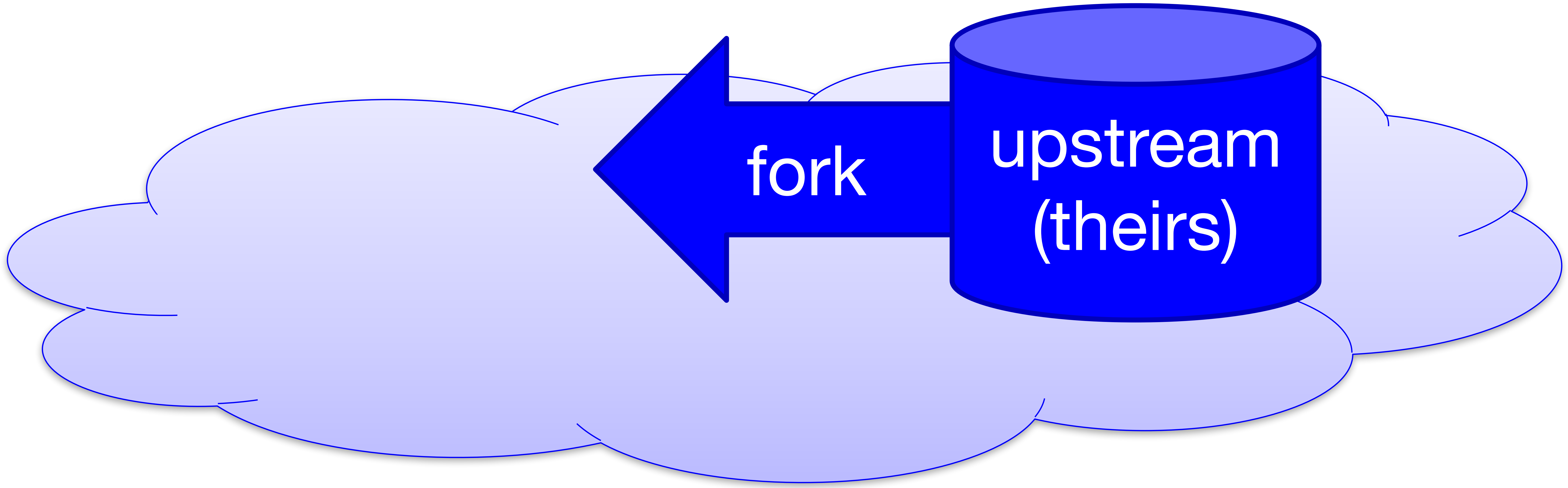
Setup



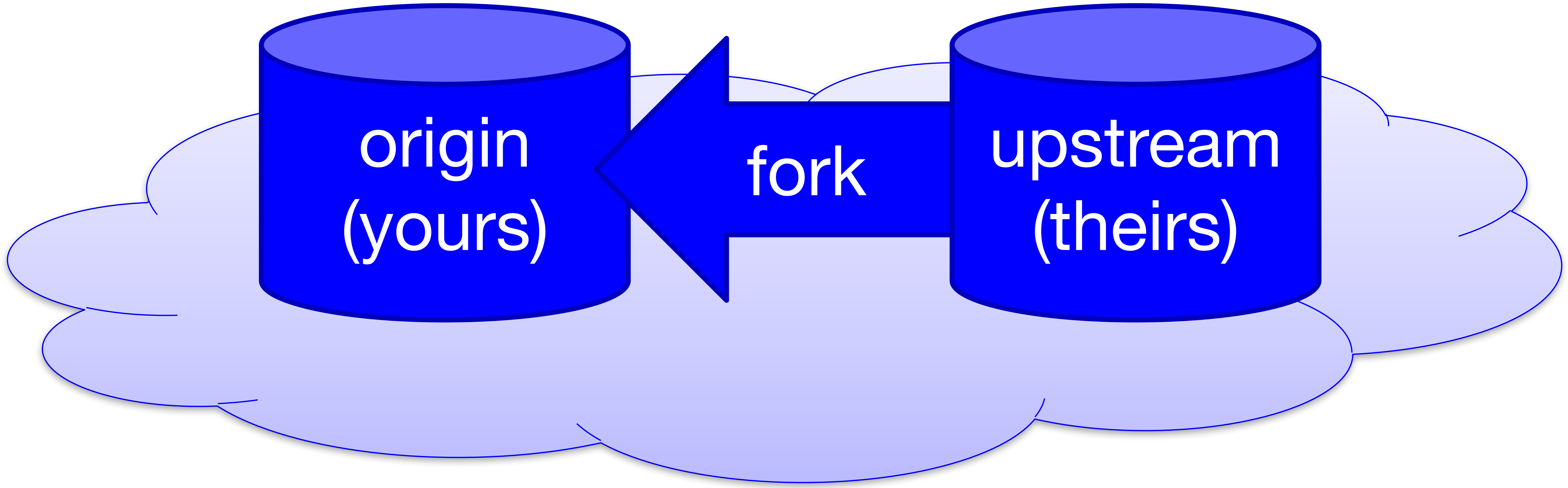
Setup



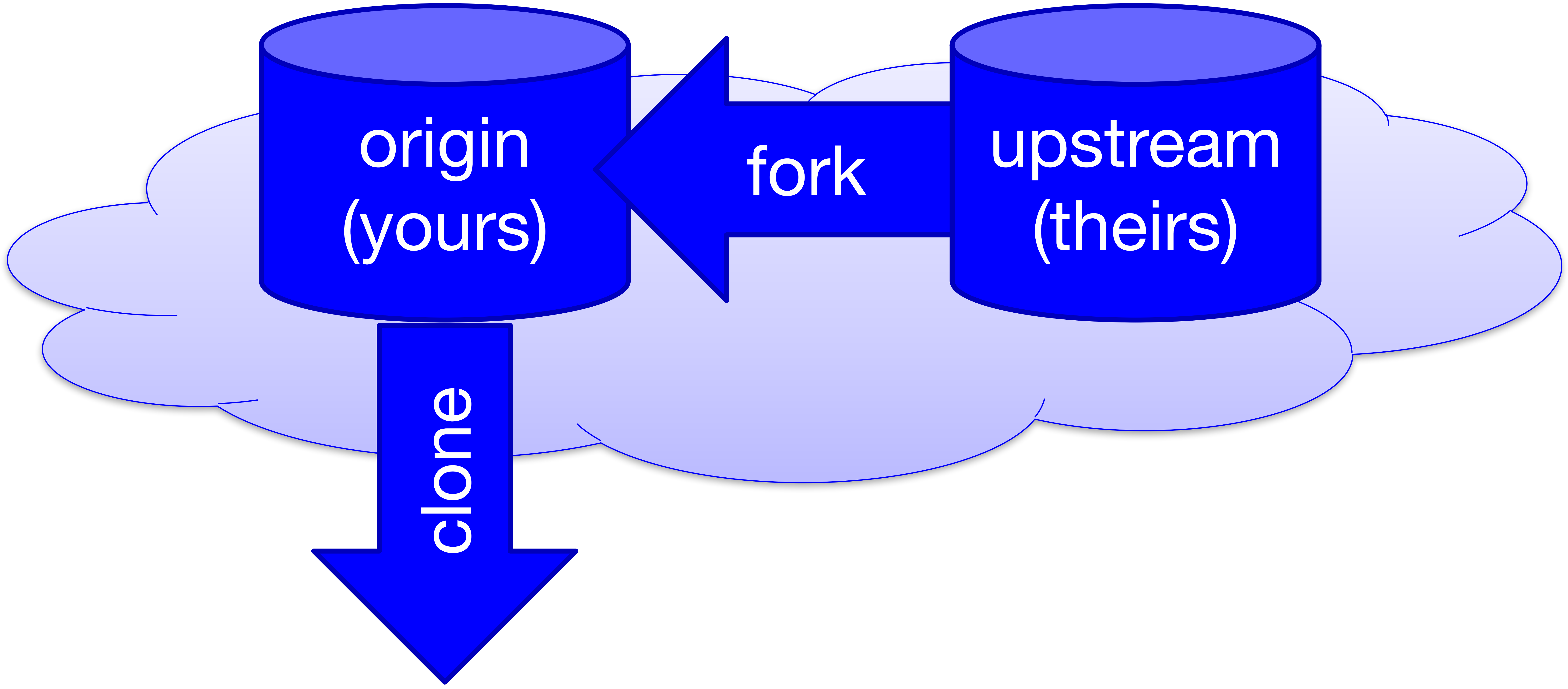
Setup



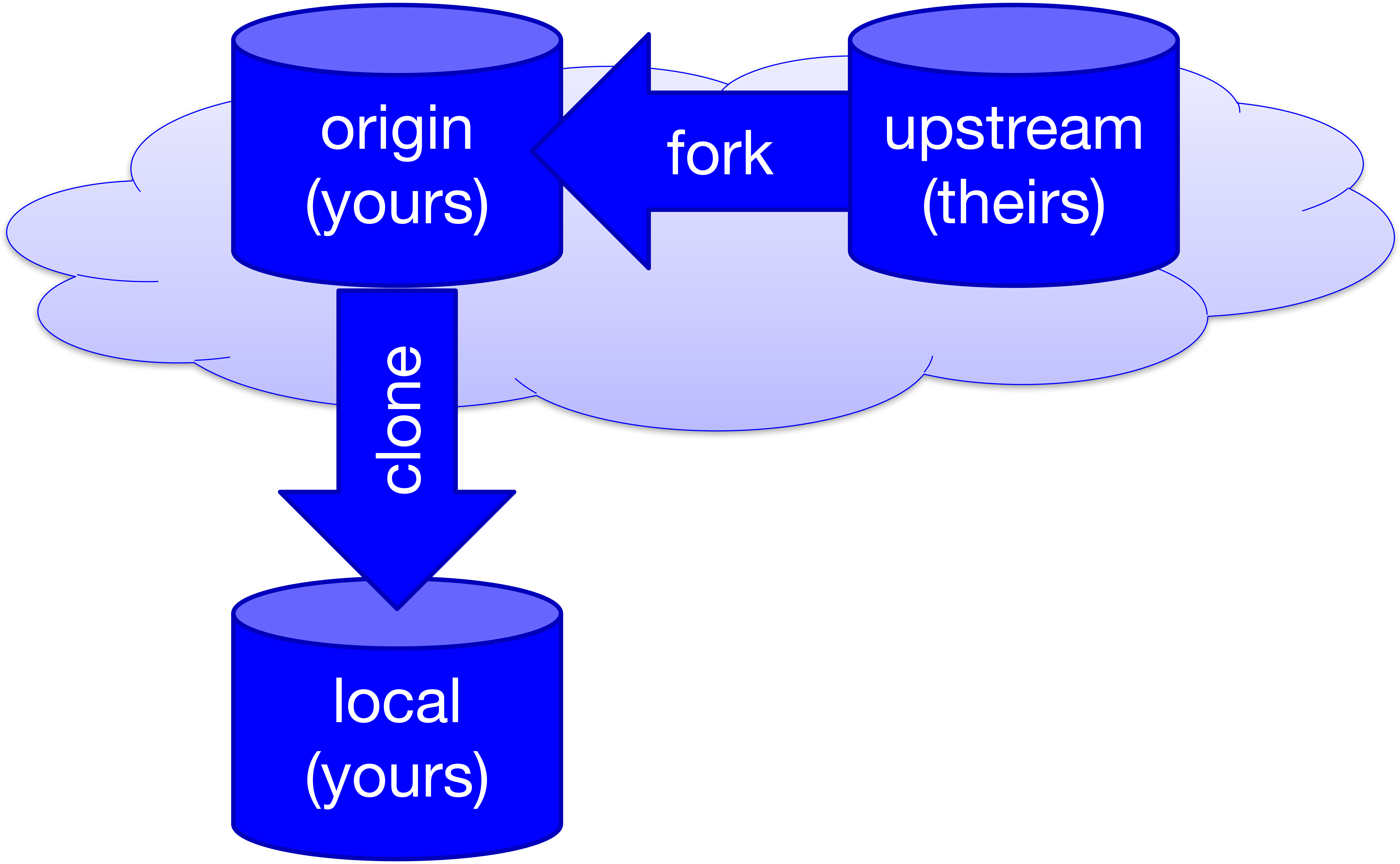
Setup



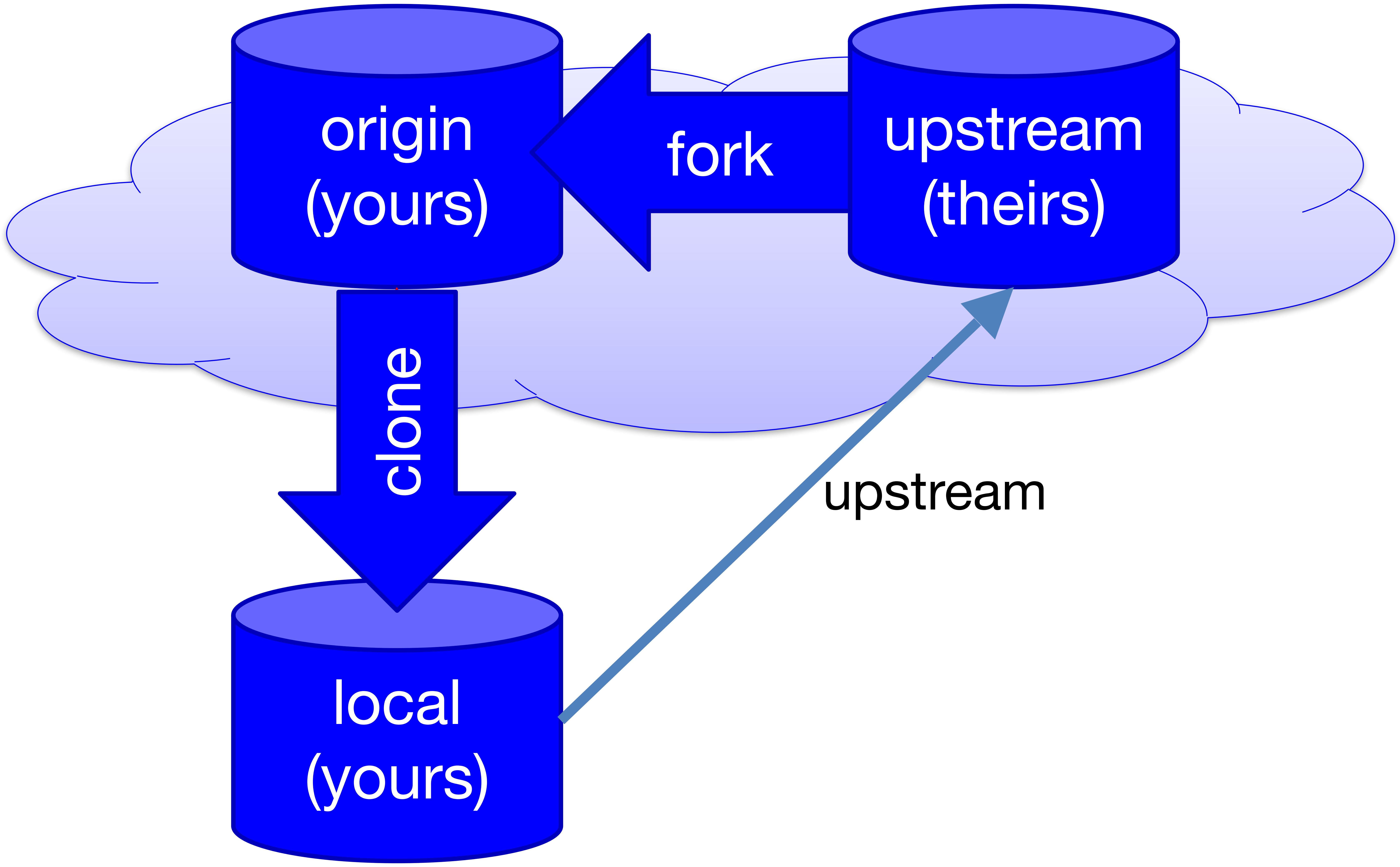
Setup



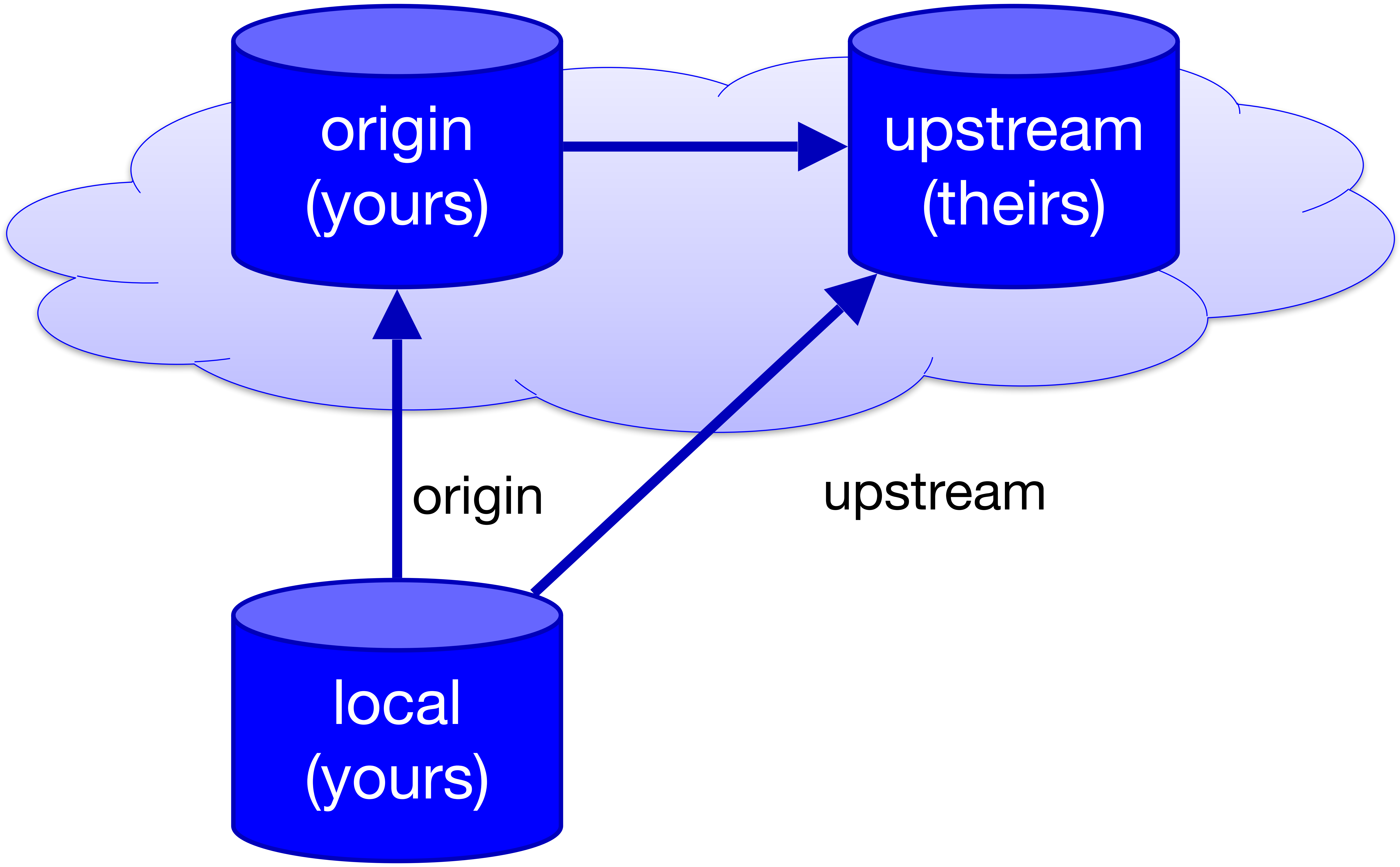
Setup



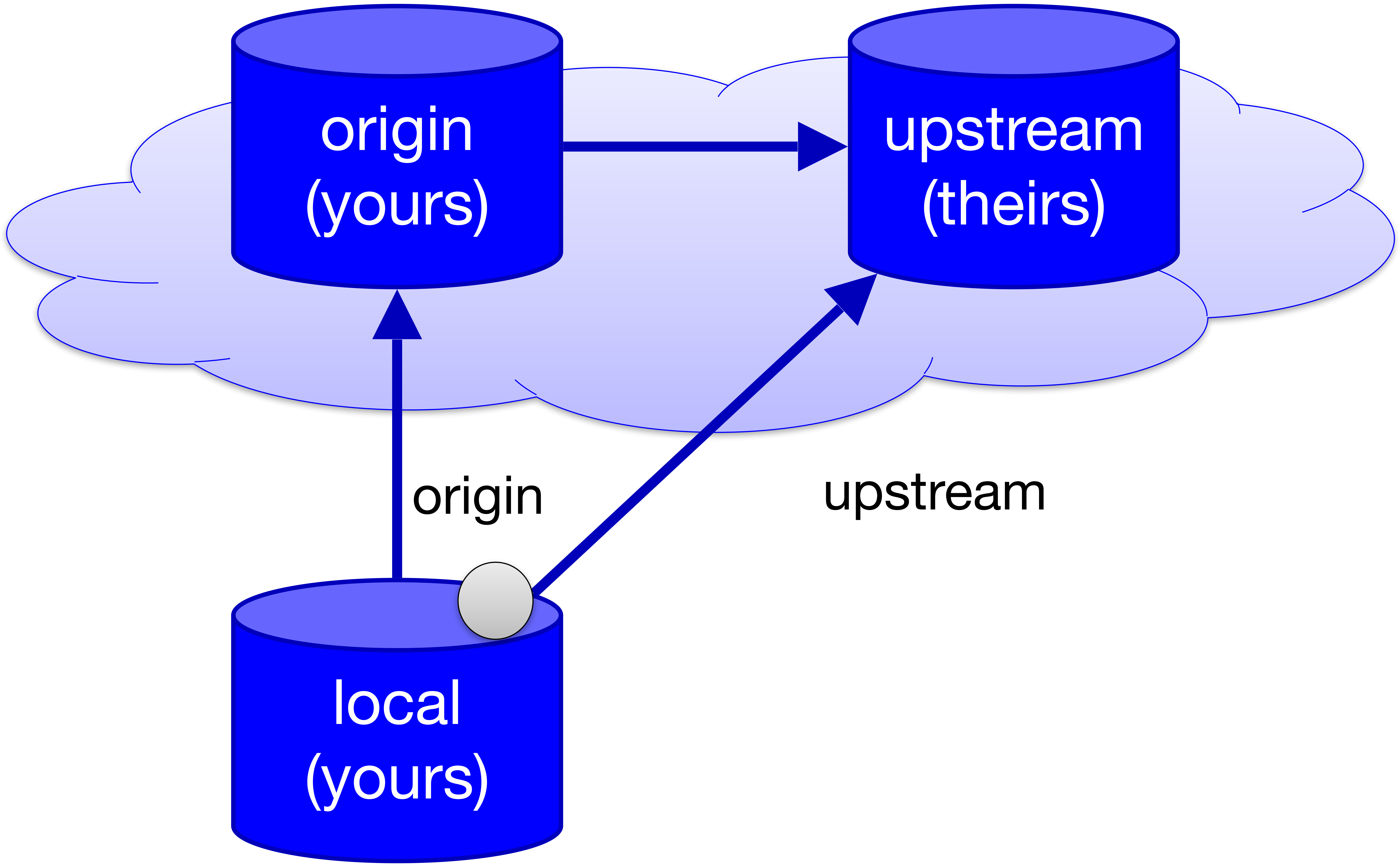
Setup


origin
(yours)
fork
upstream
(theirs)
clone
upstream
local
(yours)

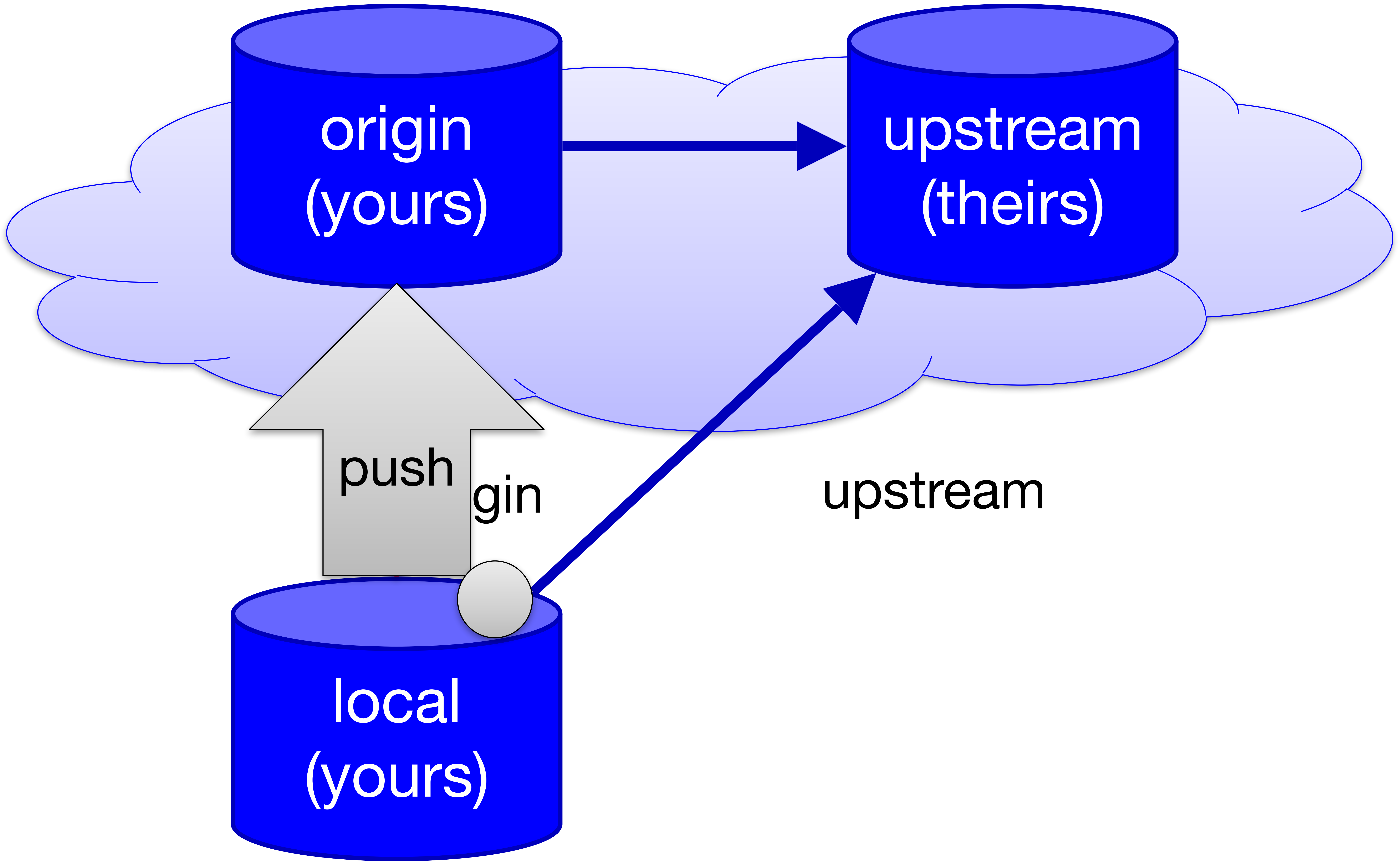
Setup



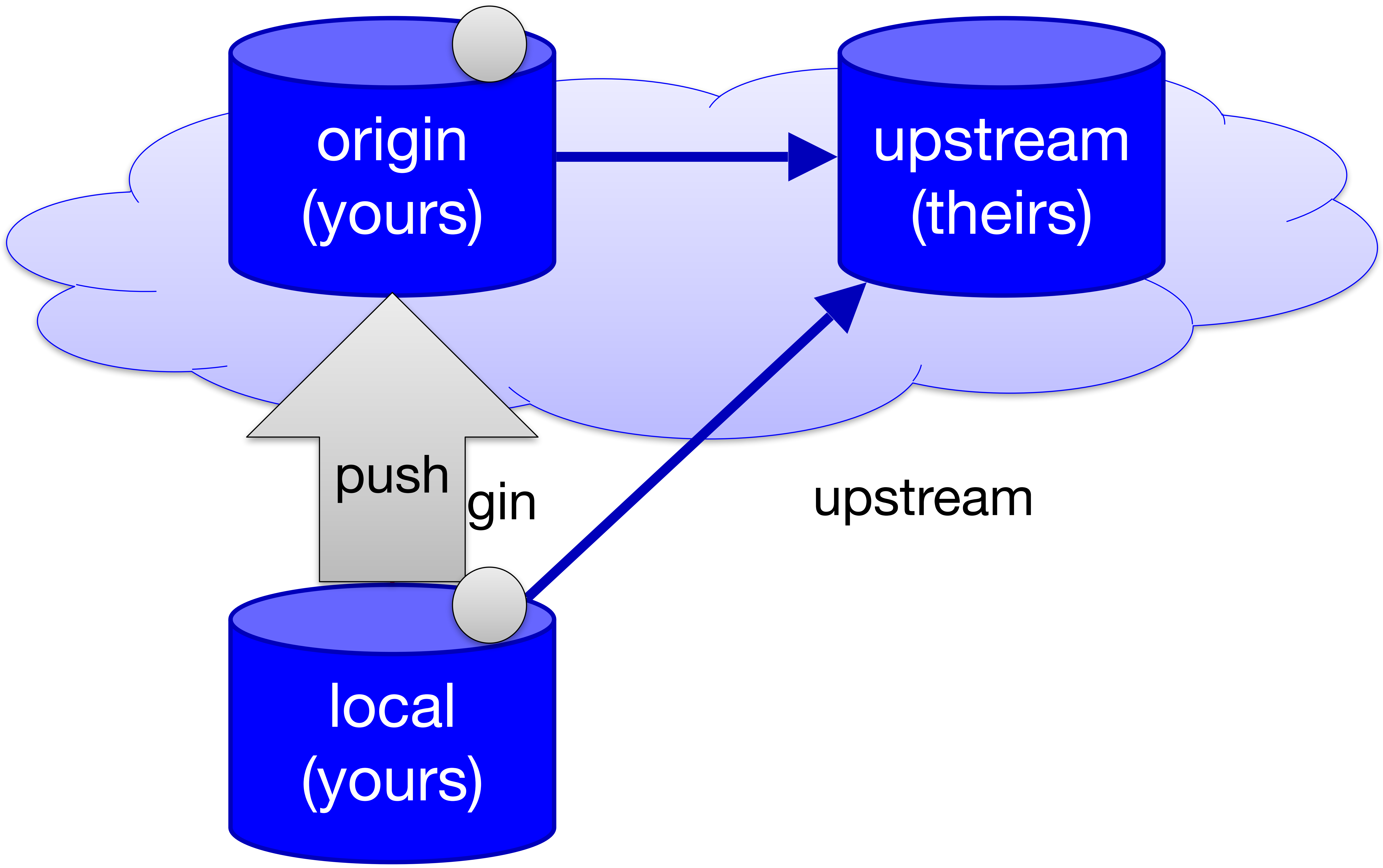
Contribute Changes



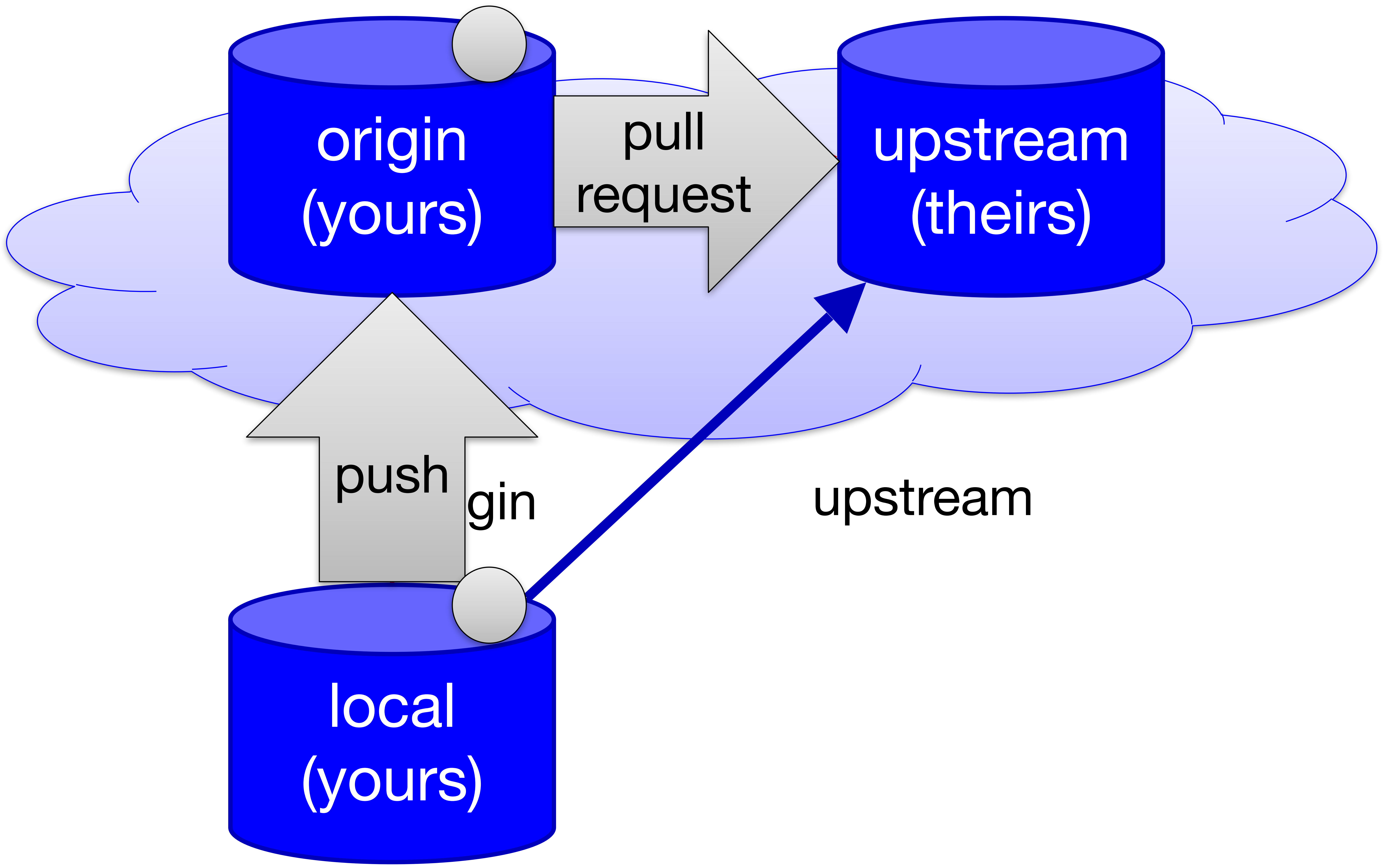
Contribute Changes



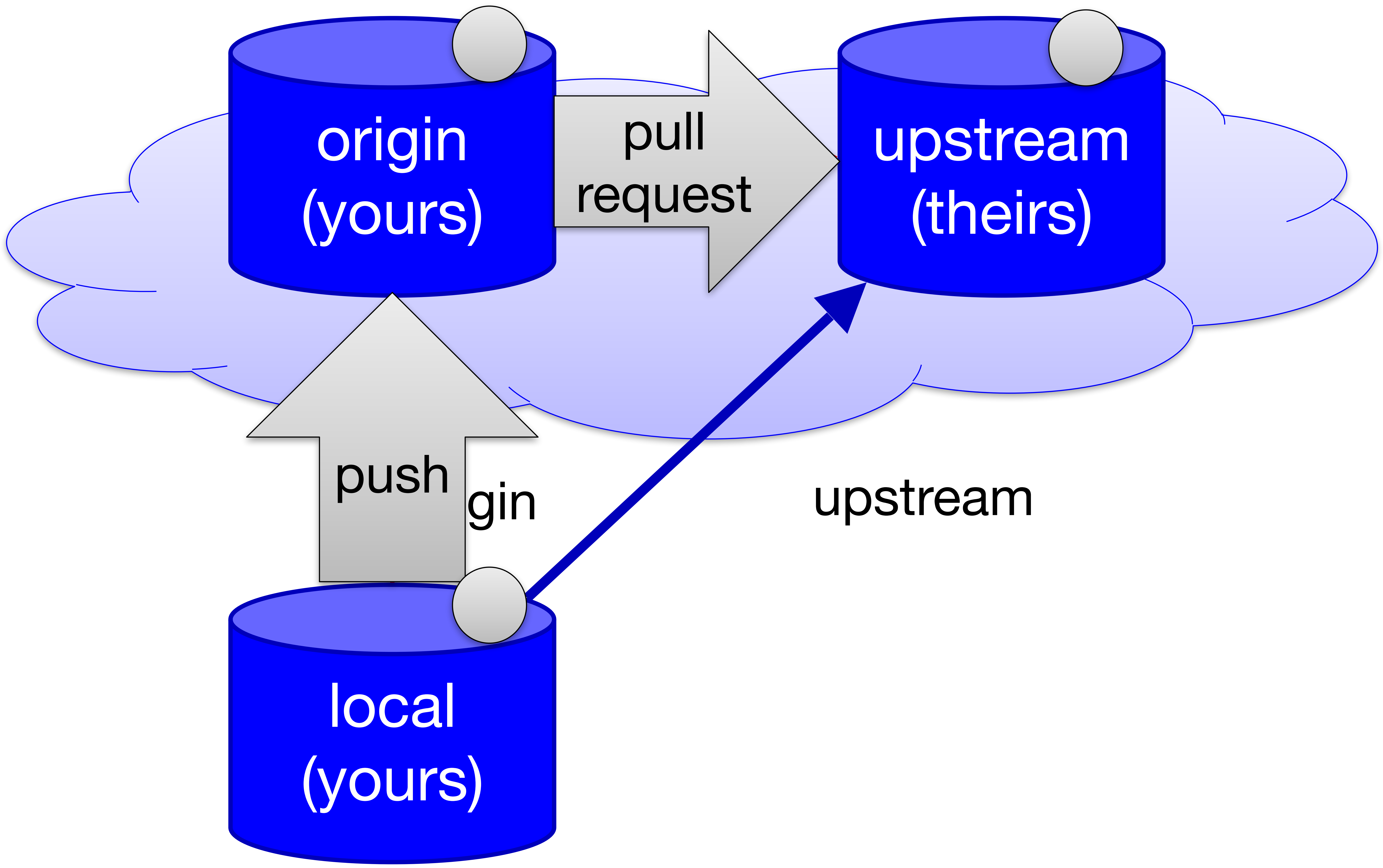
Contribute Changes



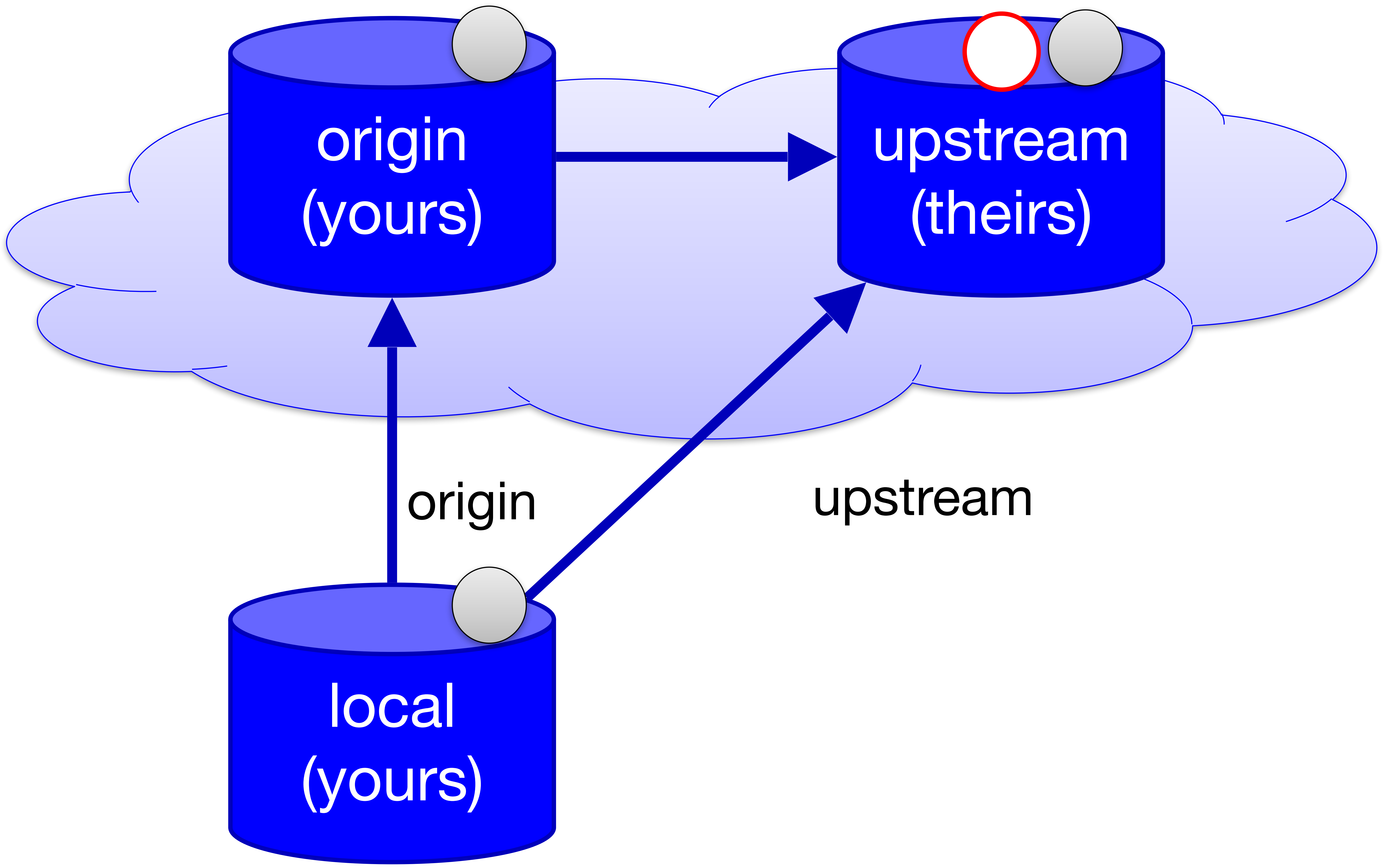
Contribute Changes



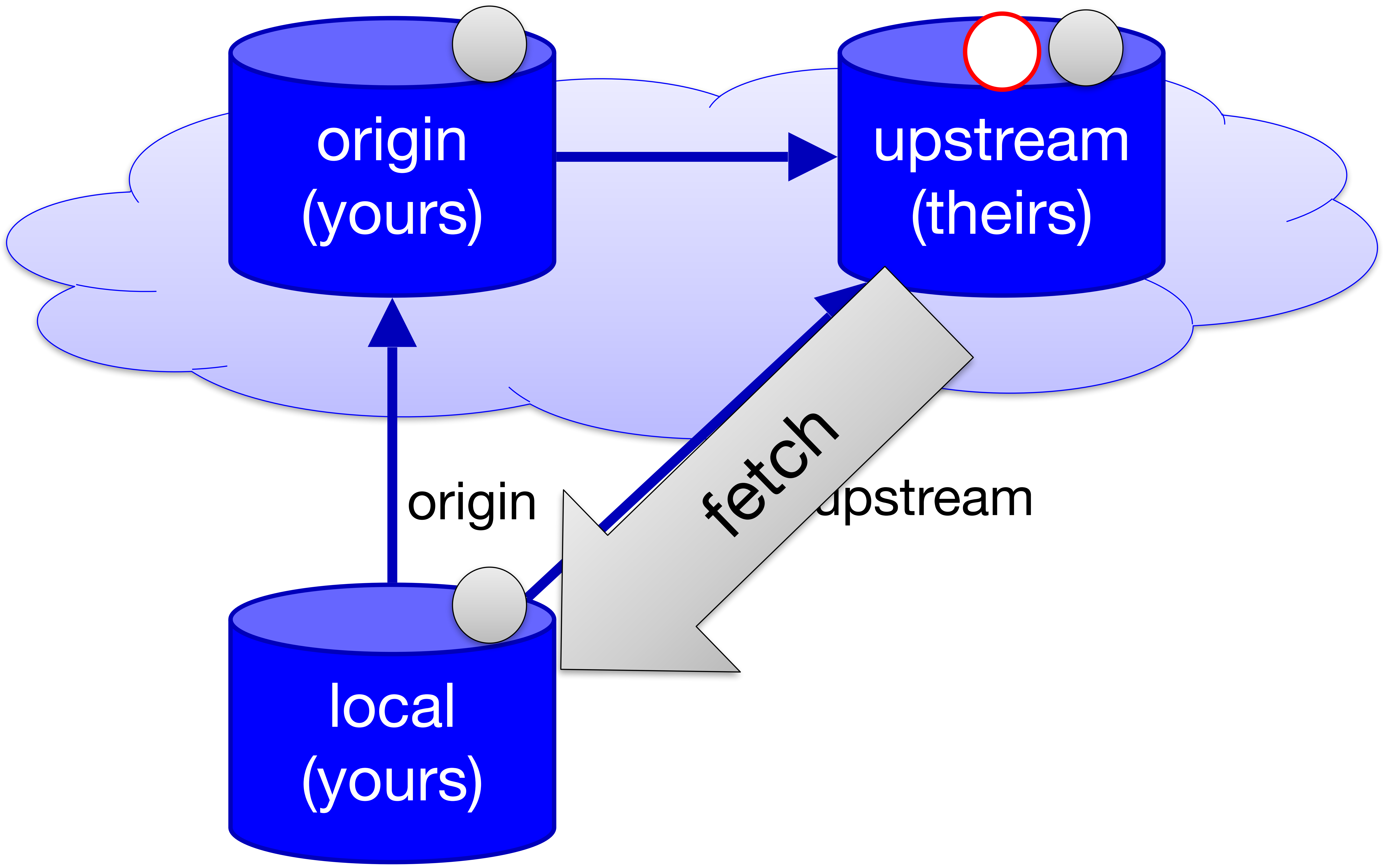
Contribute Changes



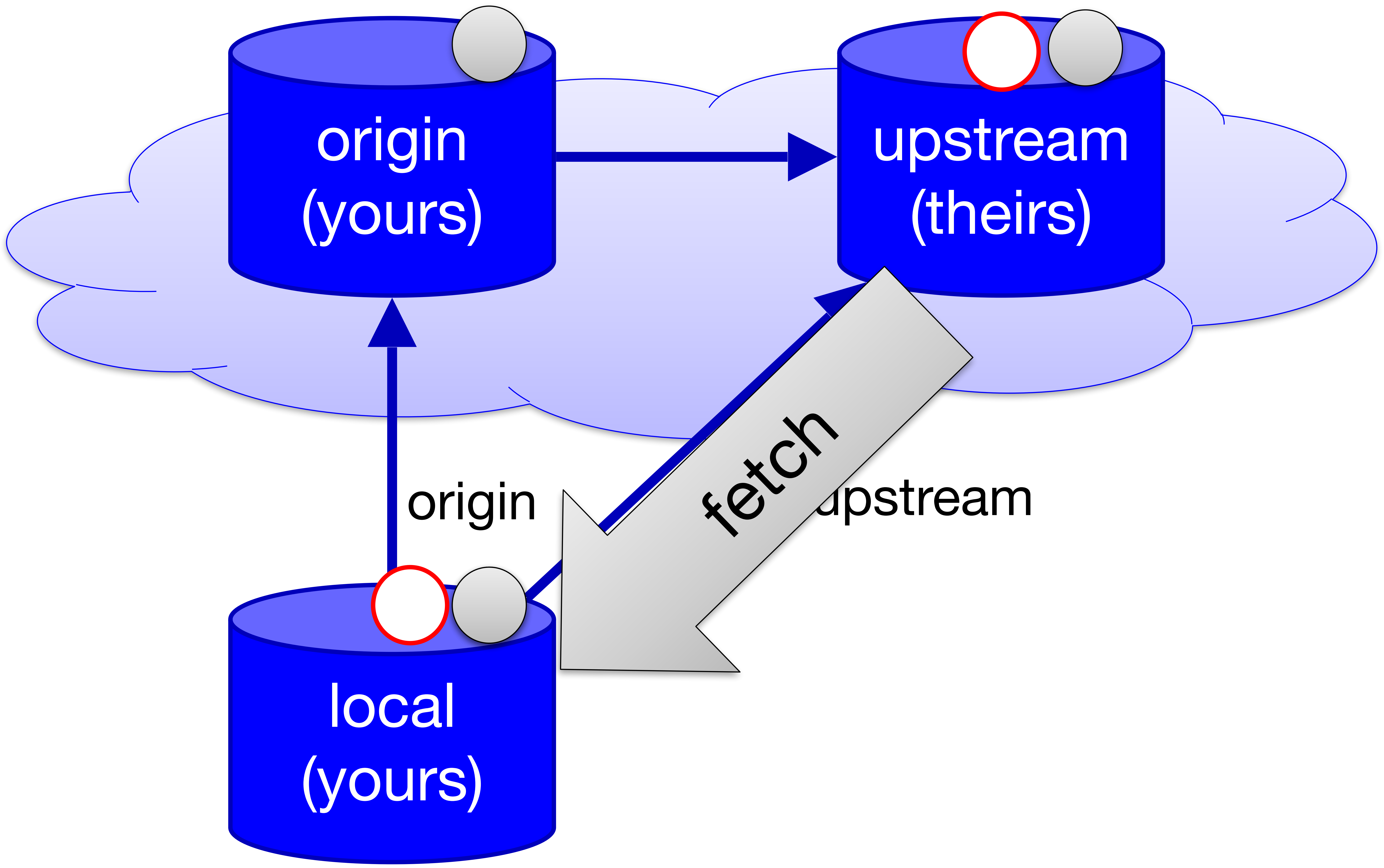
Integrate Changes



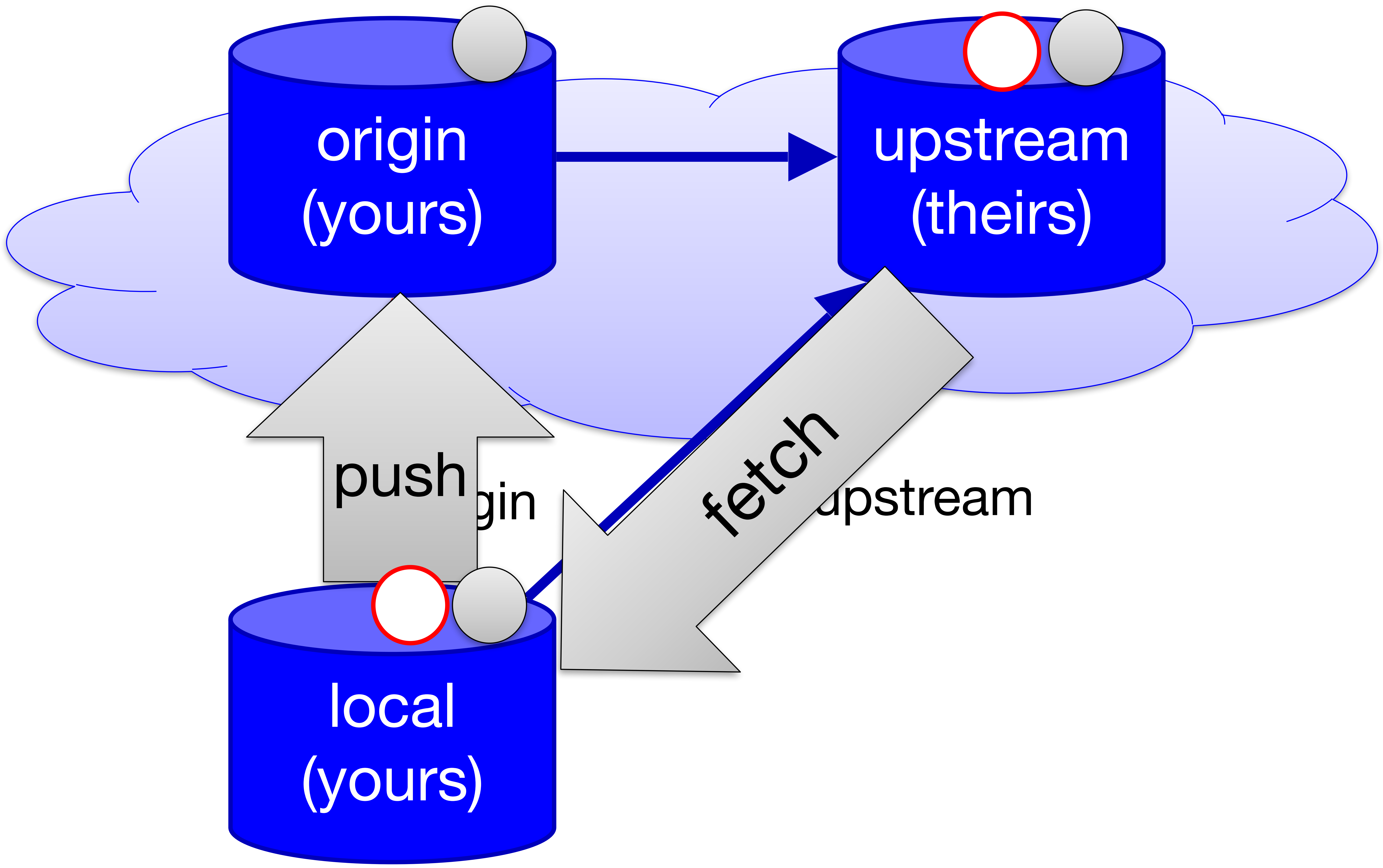
Integrate Changes



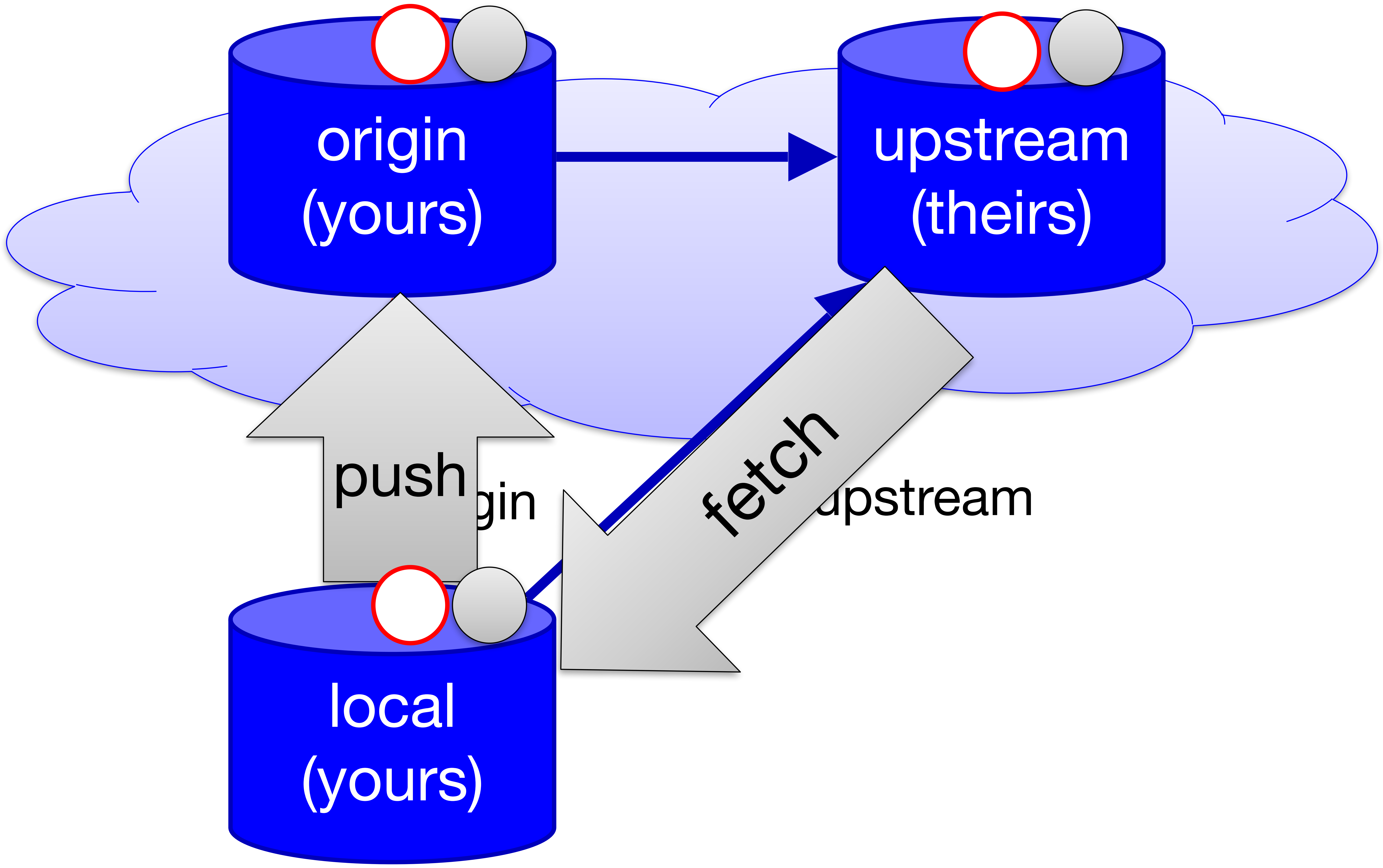
Integrate Changes



Integrate Changes



Integrate Changes



You want to contribute code to the Github project `fancy/project` (`fancy` is the name of the owner, `project` is the name of the repo). You fork the repo (producing `student/project`), commit your changes, and push to `student/project`. Next, you make a pull request for `fancy/project`.

Which statement is true?

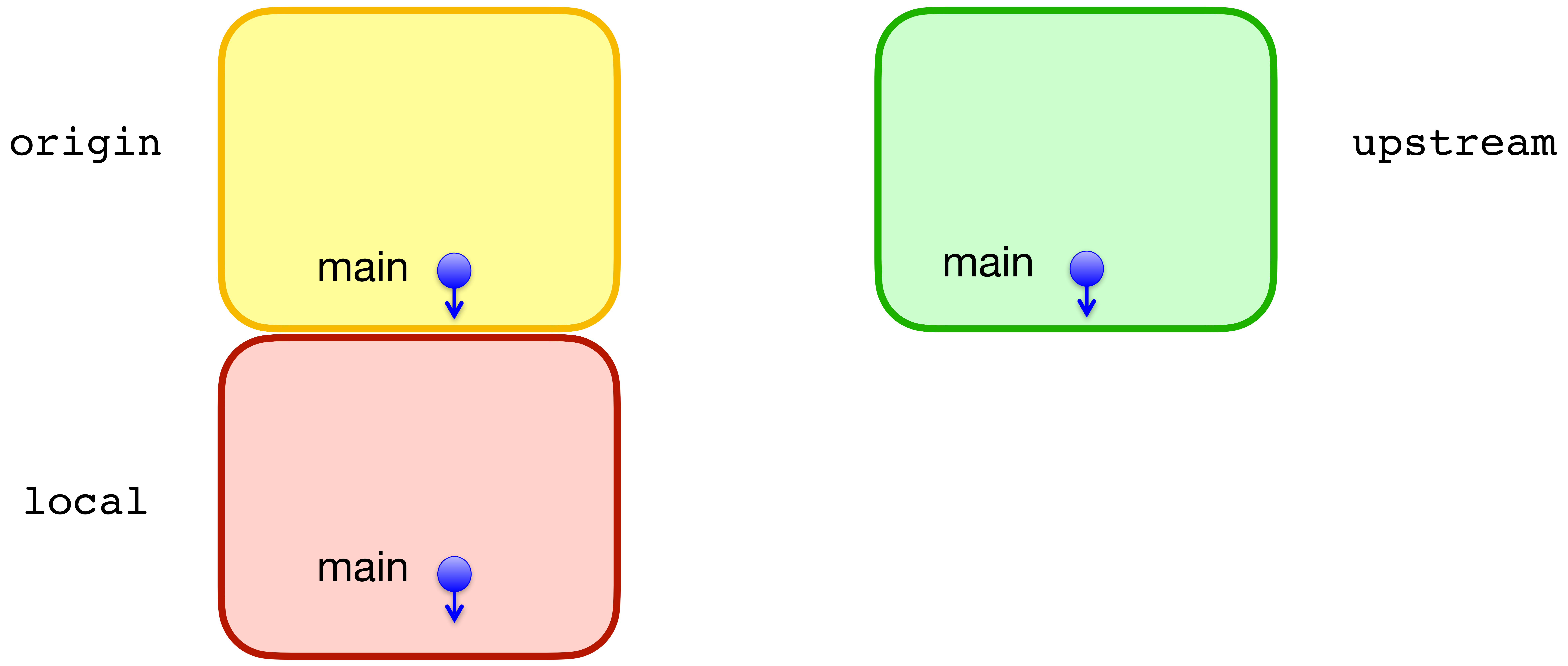
A. Your code is now integrated into `fancy/project` via merging

B. Your code is now integrated into `fancy/project` via rebasing

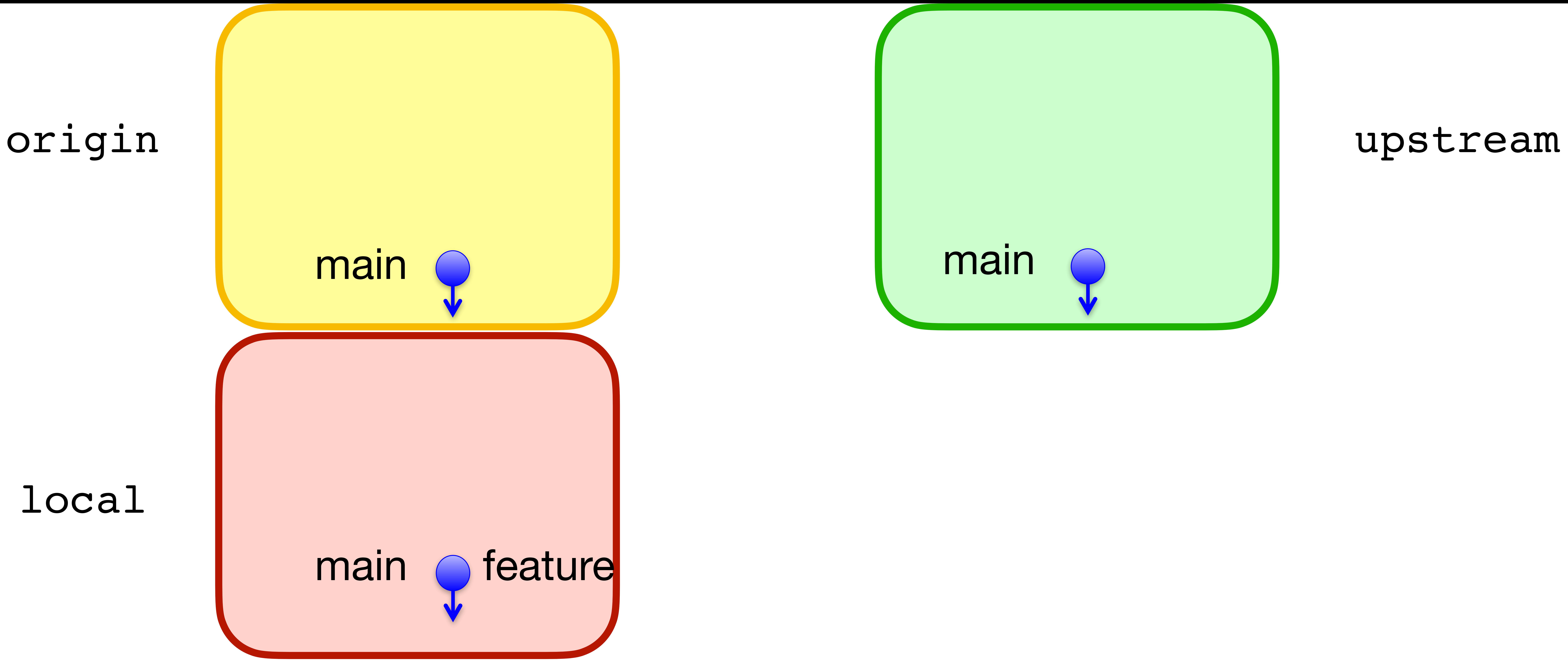
C. You have requested that your code be integrated into `fancy/project`, but no changes have been made

D. You cannot make any additional commits until the pull request has been accepted

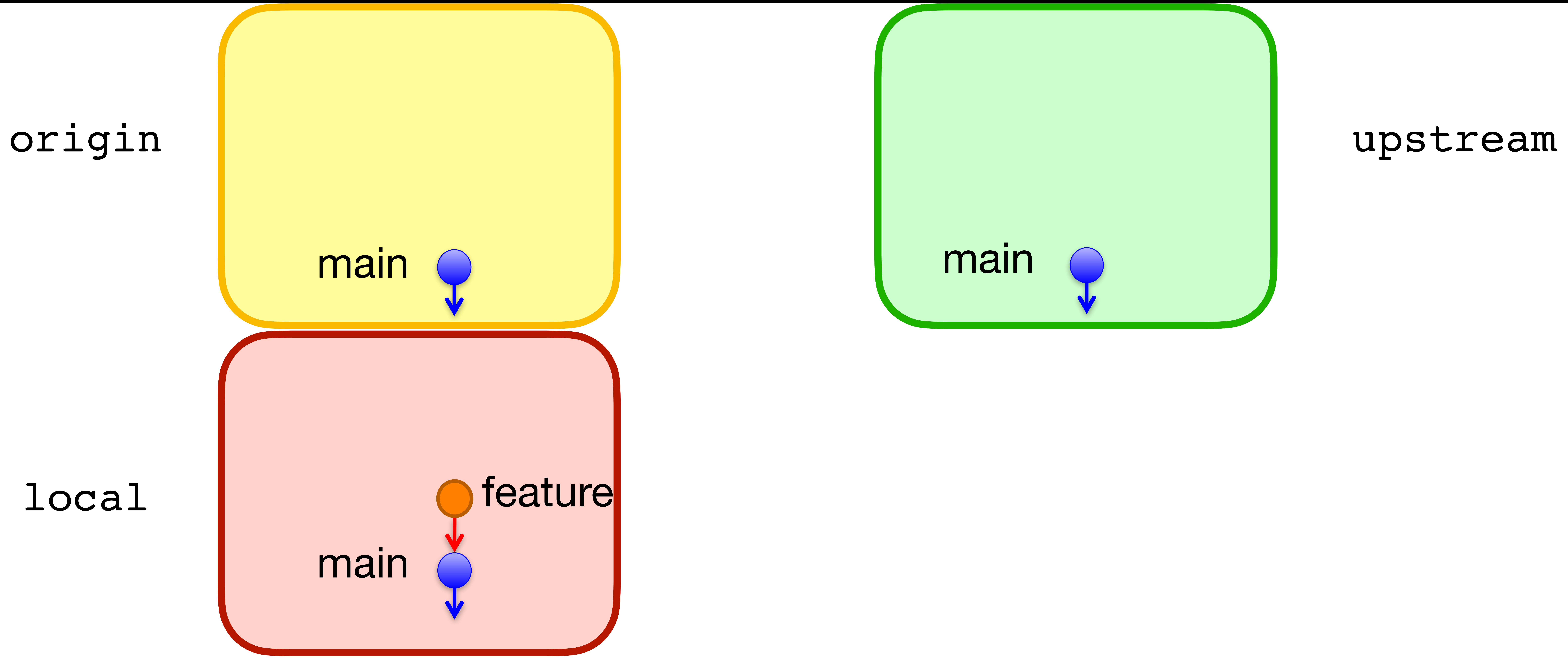
Branches



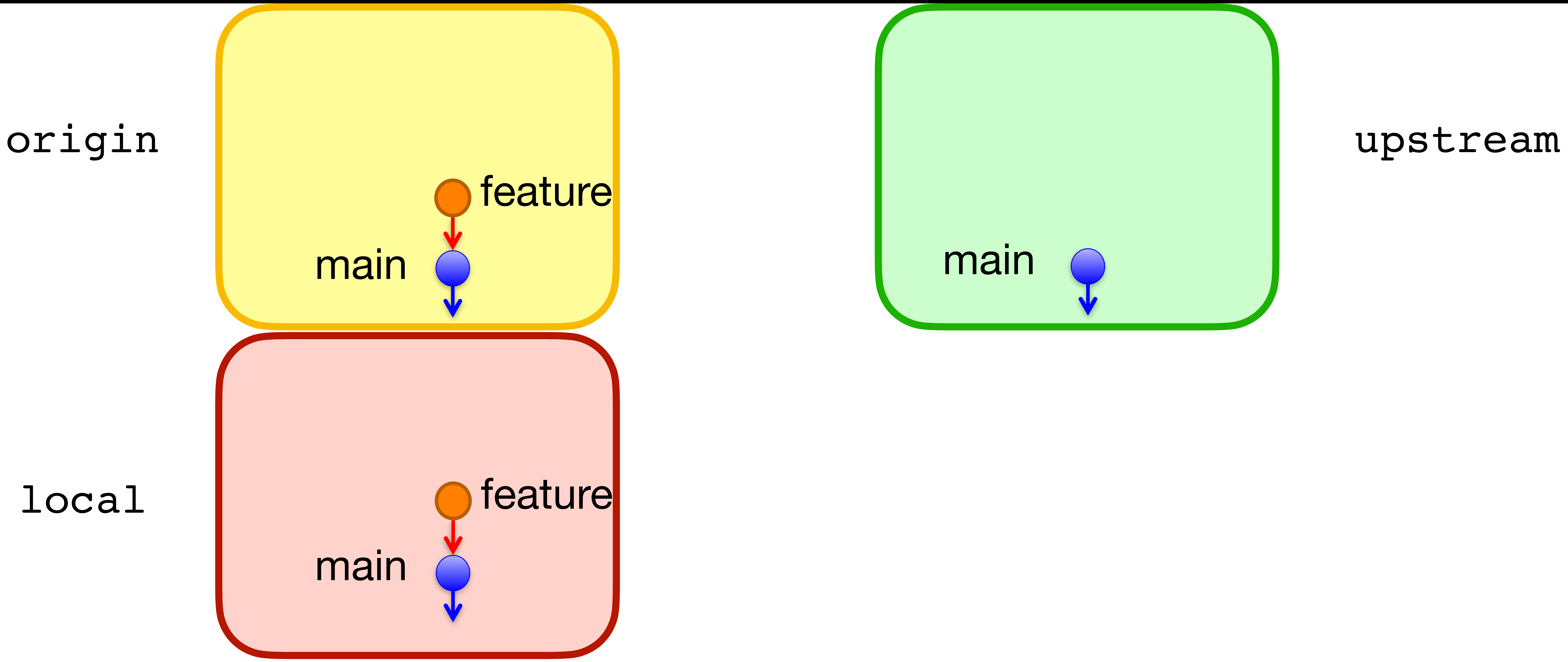
$ git checkout -b feature

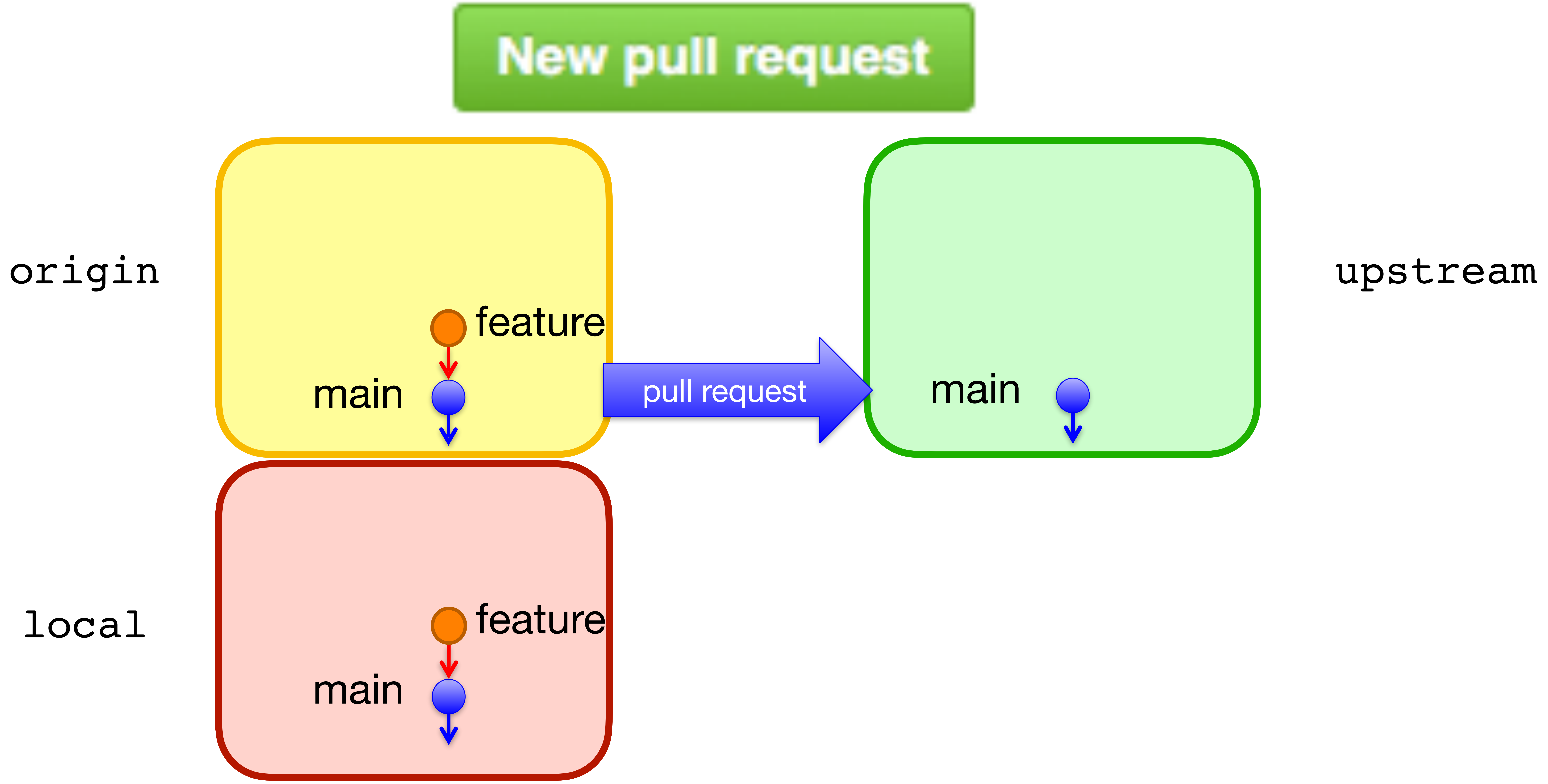


$ git commit

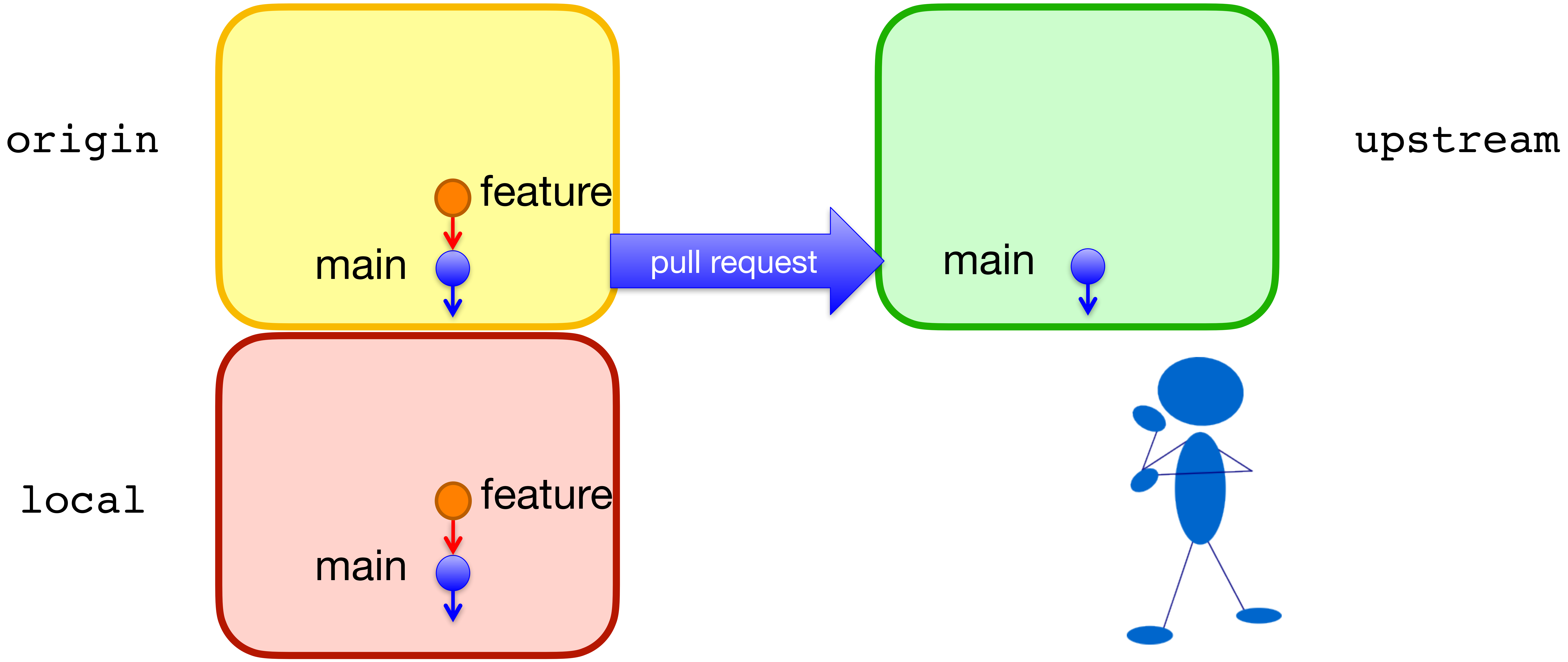


```
$ git push -u origin feature
```

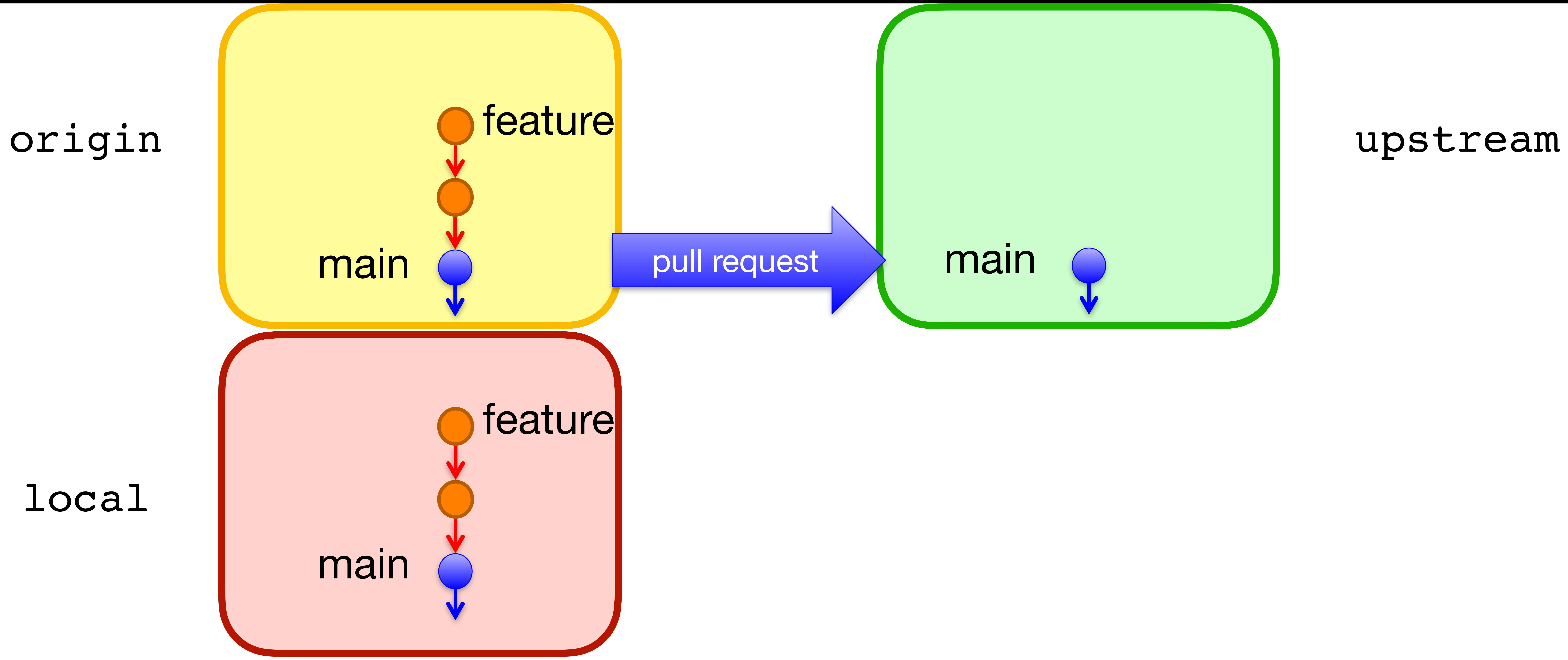



New pull request
origin
feature
main
pull request
main
upstream
local
feature
main

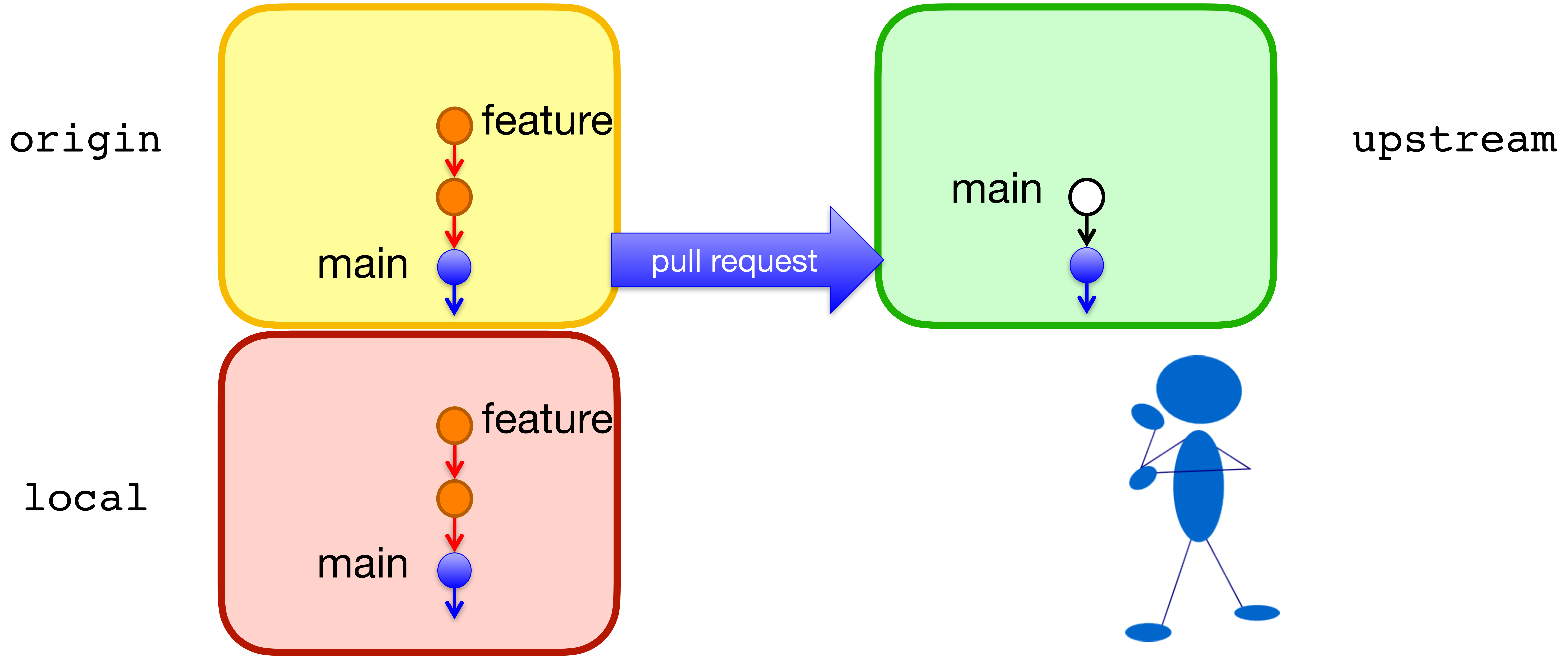
Great idea, now can you do it more like this?



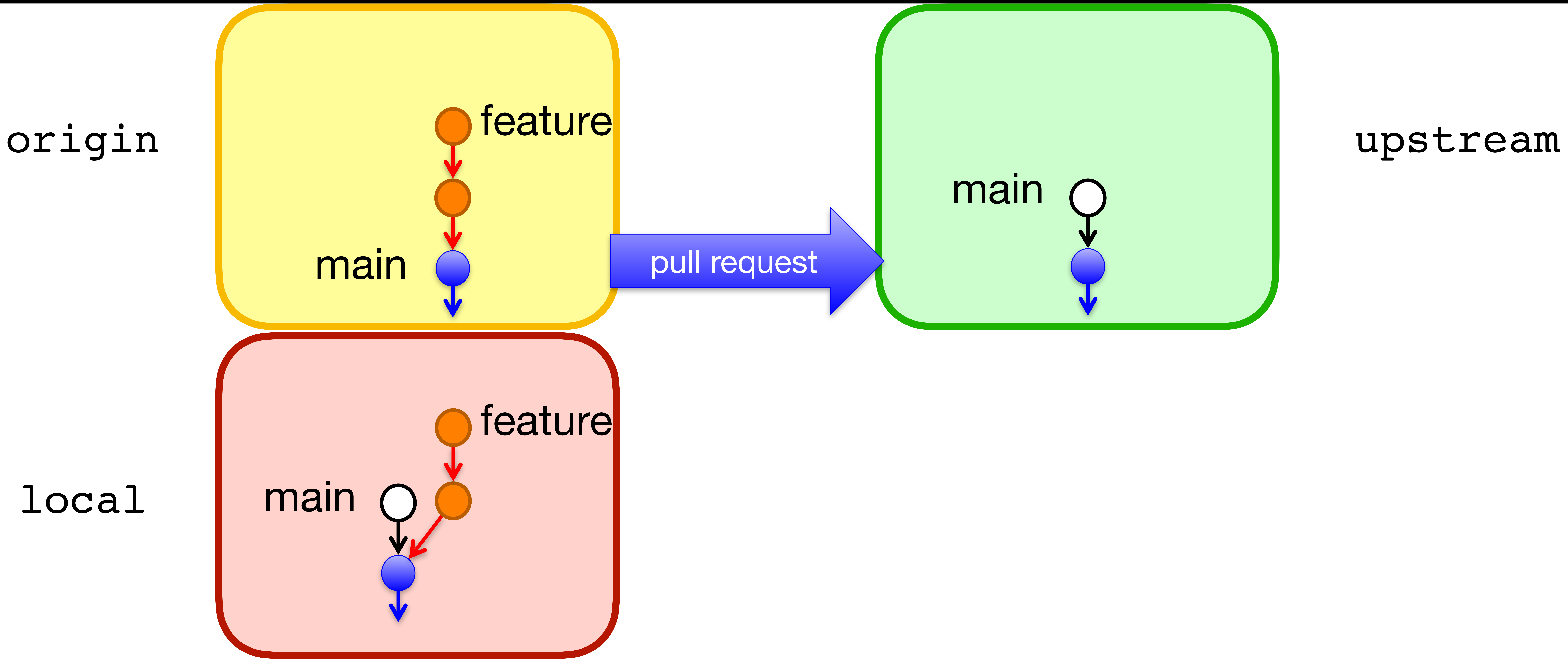
```
$ git commit
$ git push
```



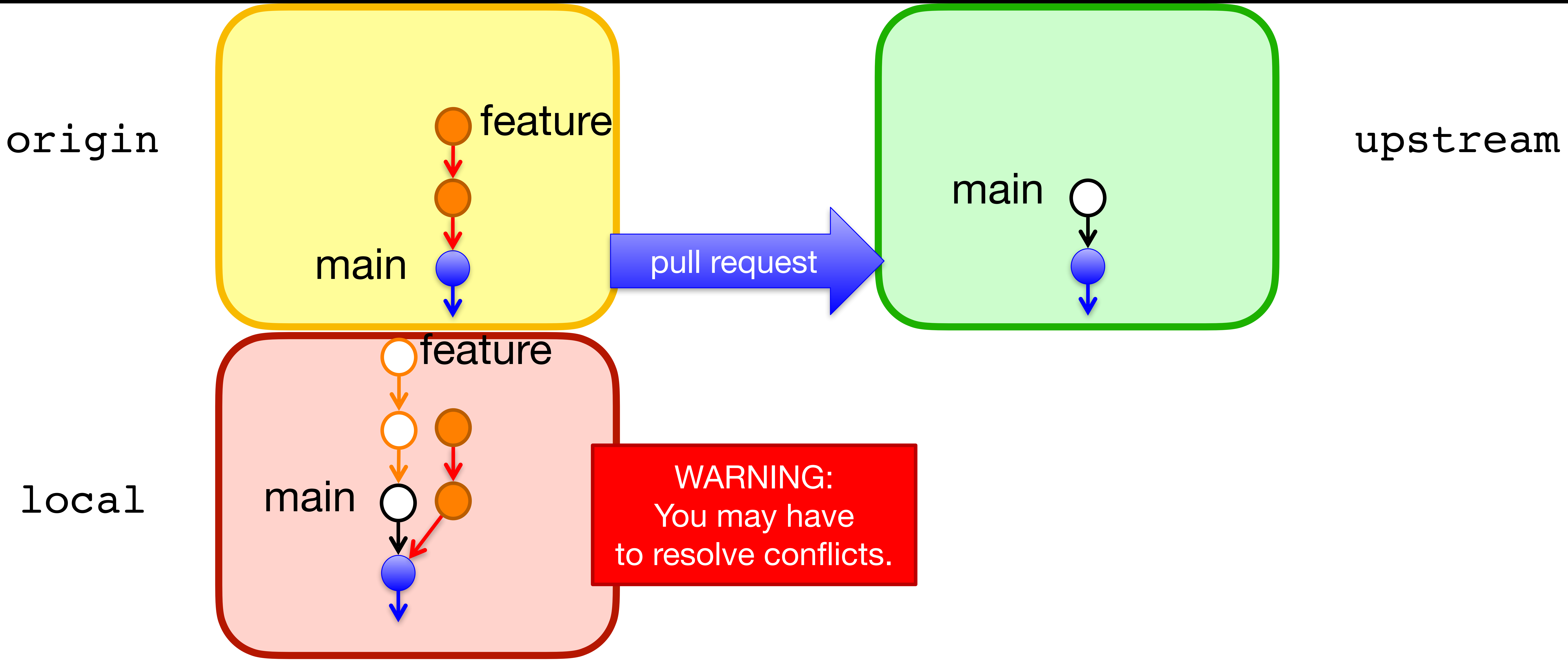
Awesome, but please update with new changes in main



```
$ git remote add upstream https://github.com/…
$ git fetch upstream main:main
```

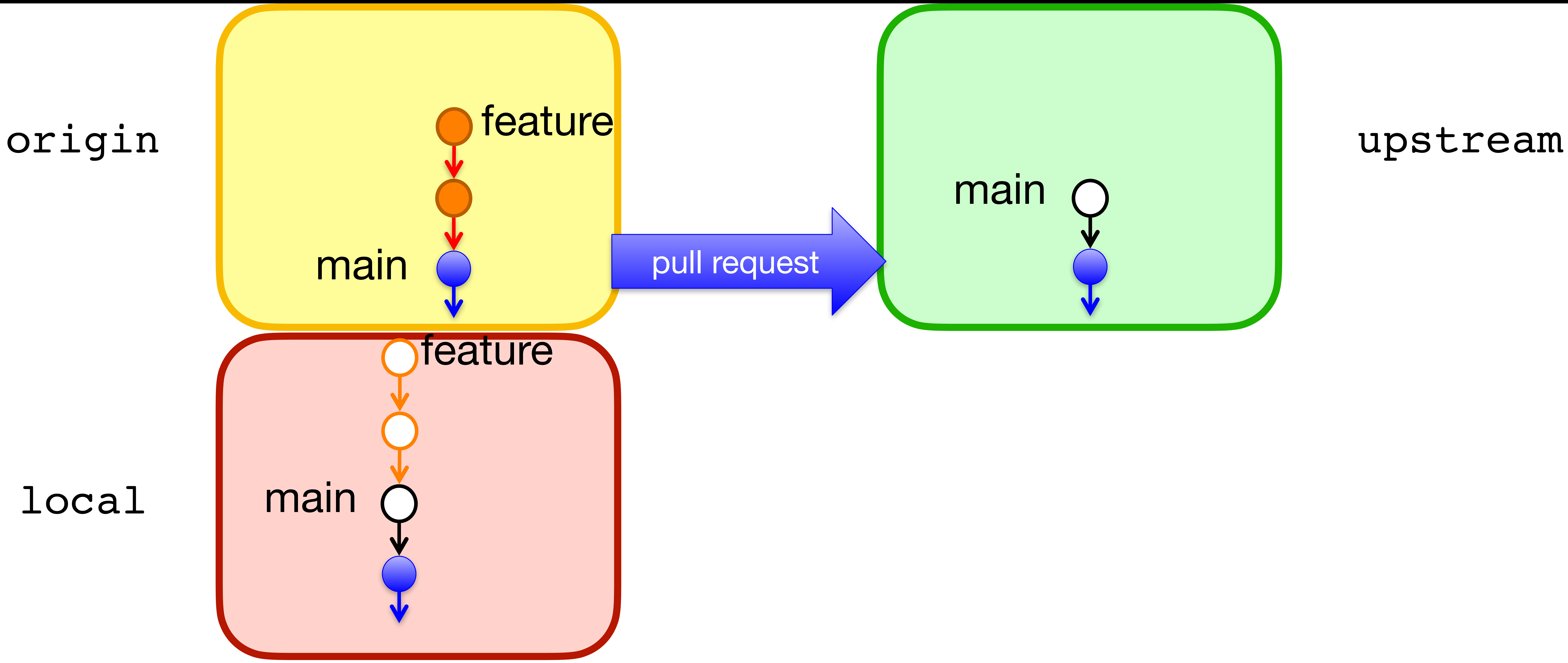


$ git rebase main

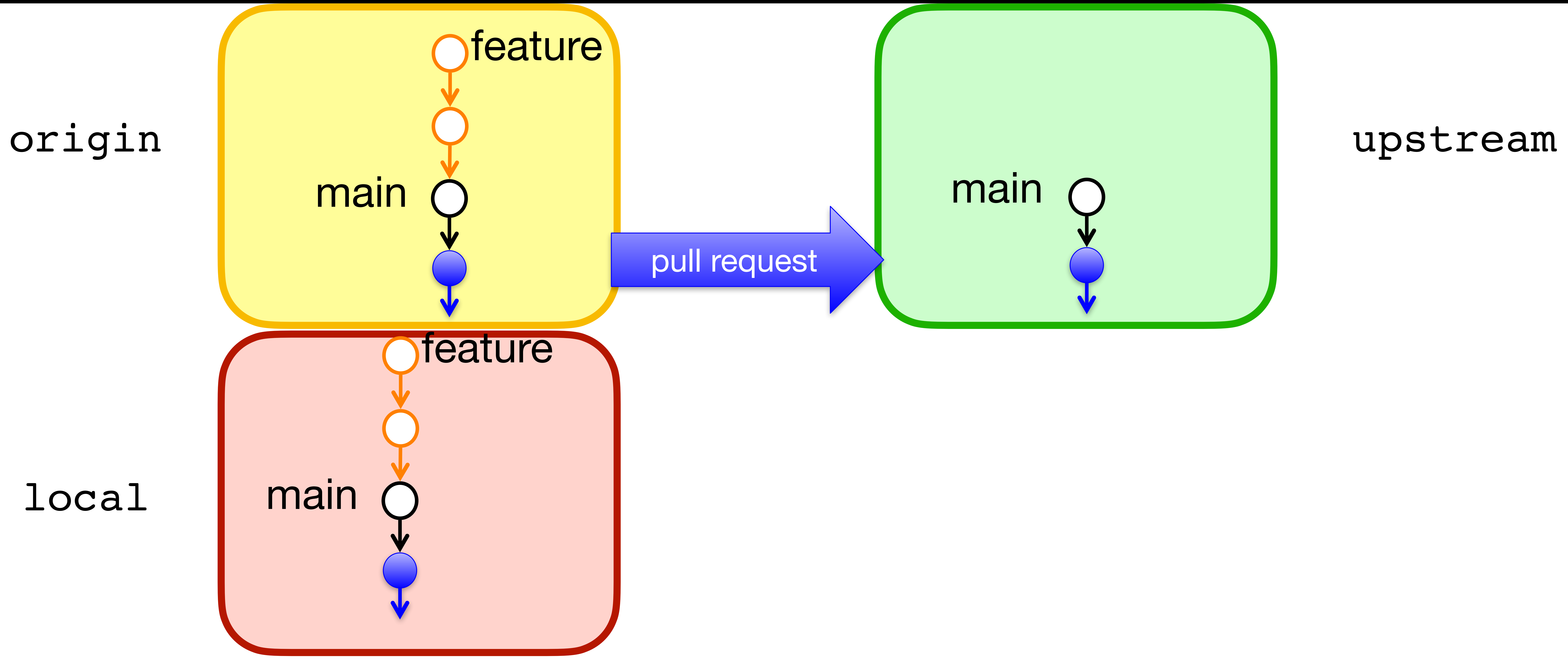


WARNING:
You may have
to resolve conflicts.

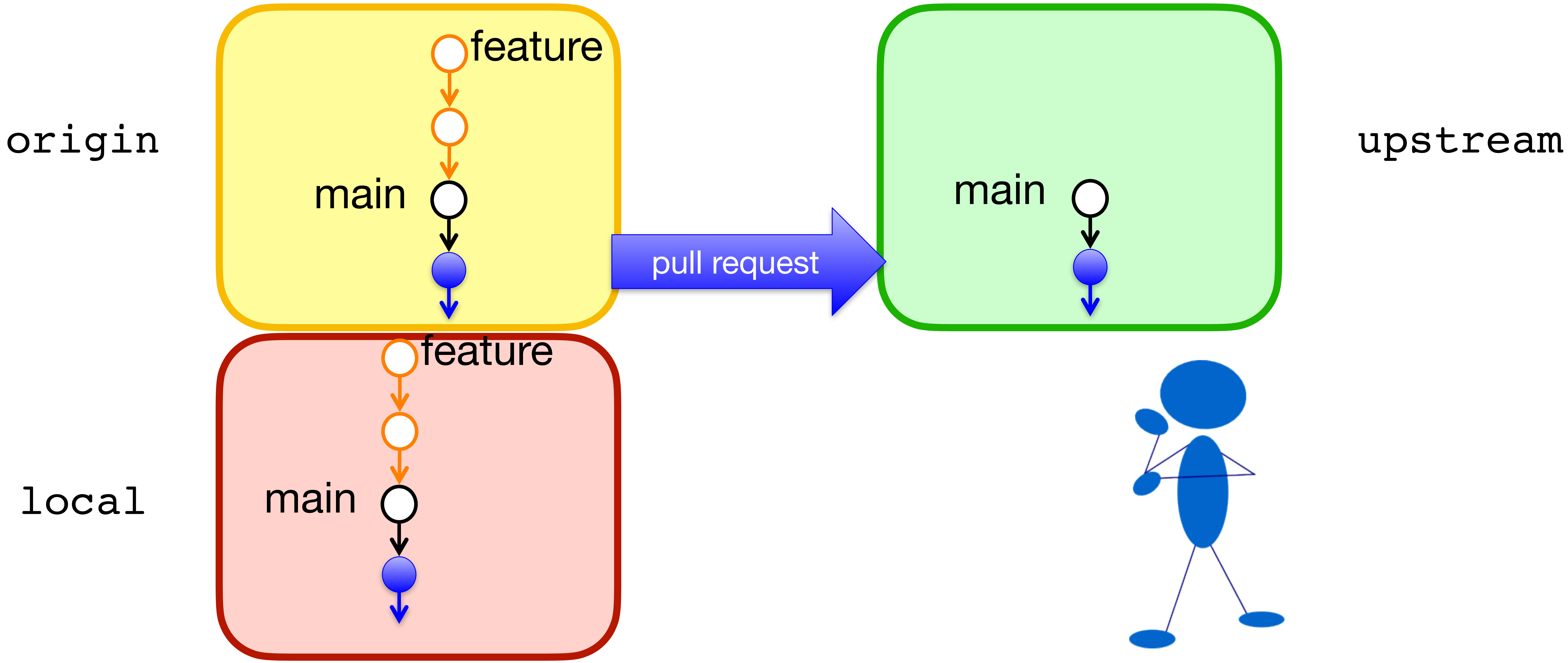
$ git rebase main



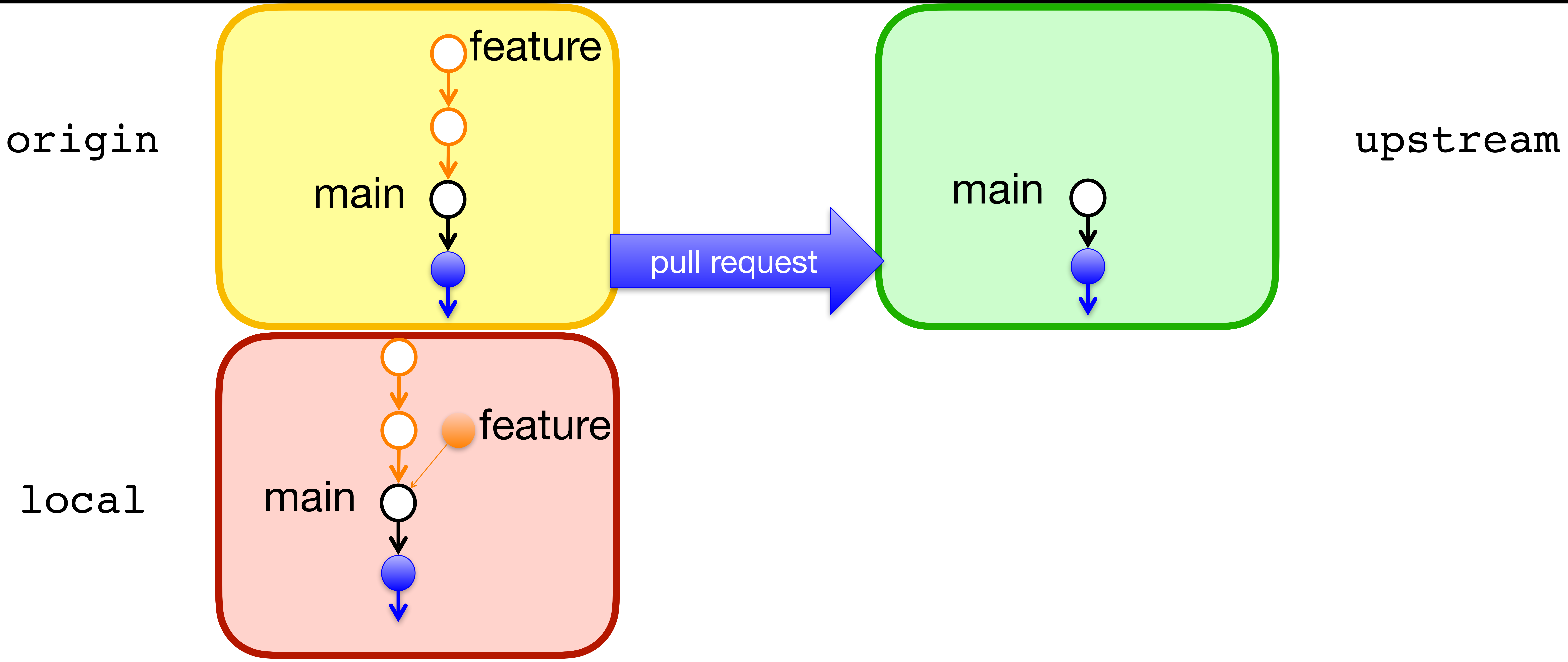
```
$ git push -f origin main feature
```



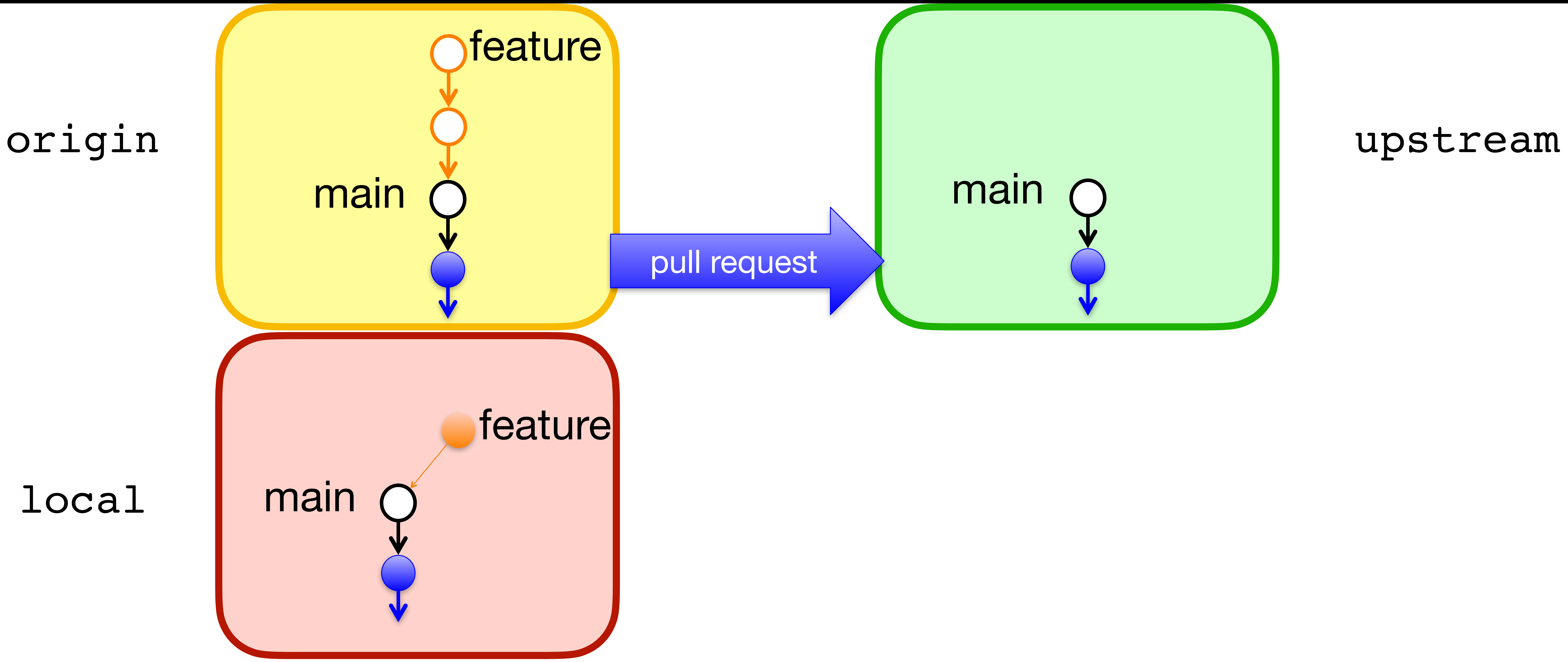
Great. Please squash your commits.



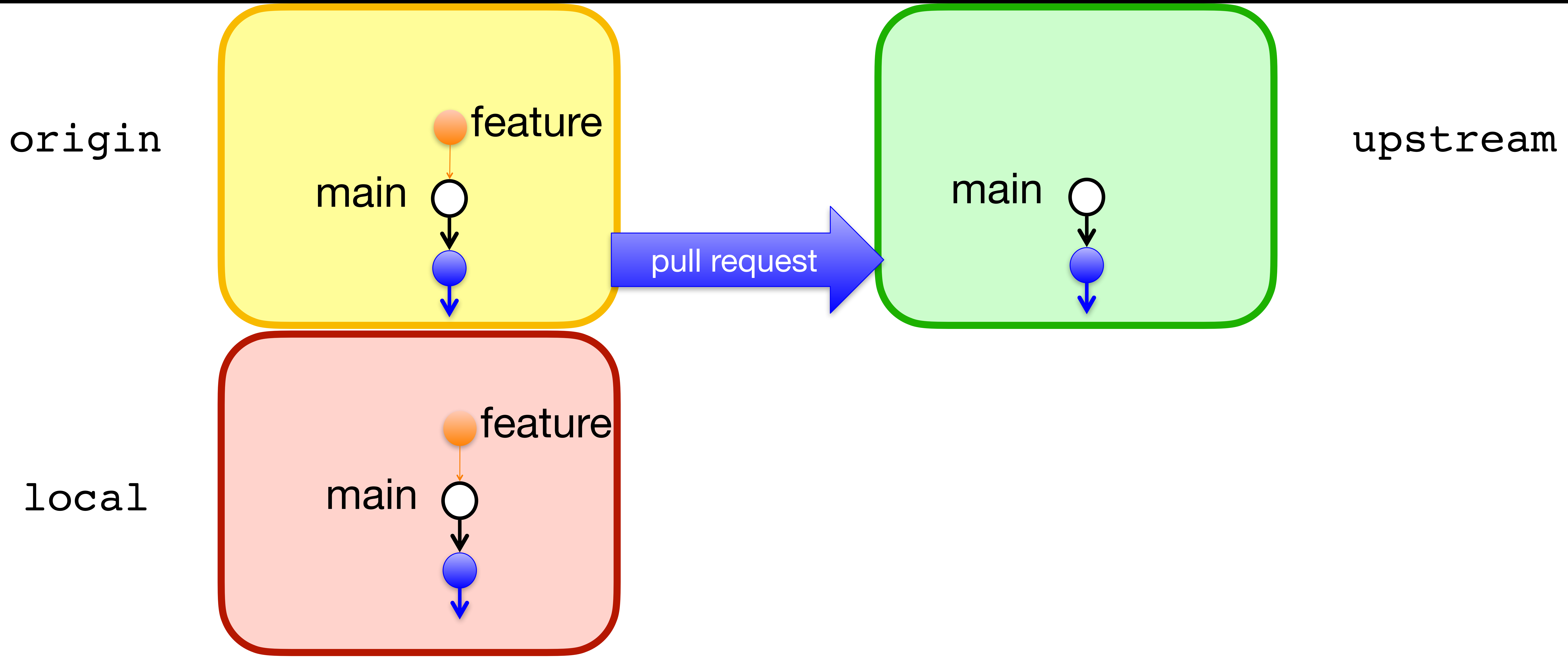
`$ git rebase –i main`



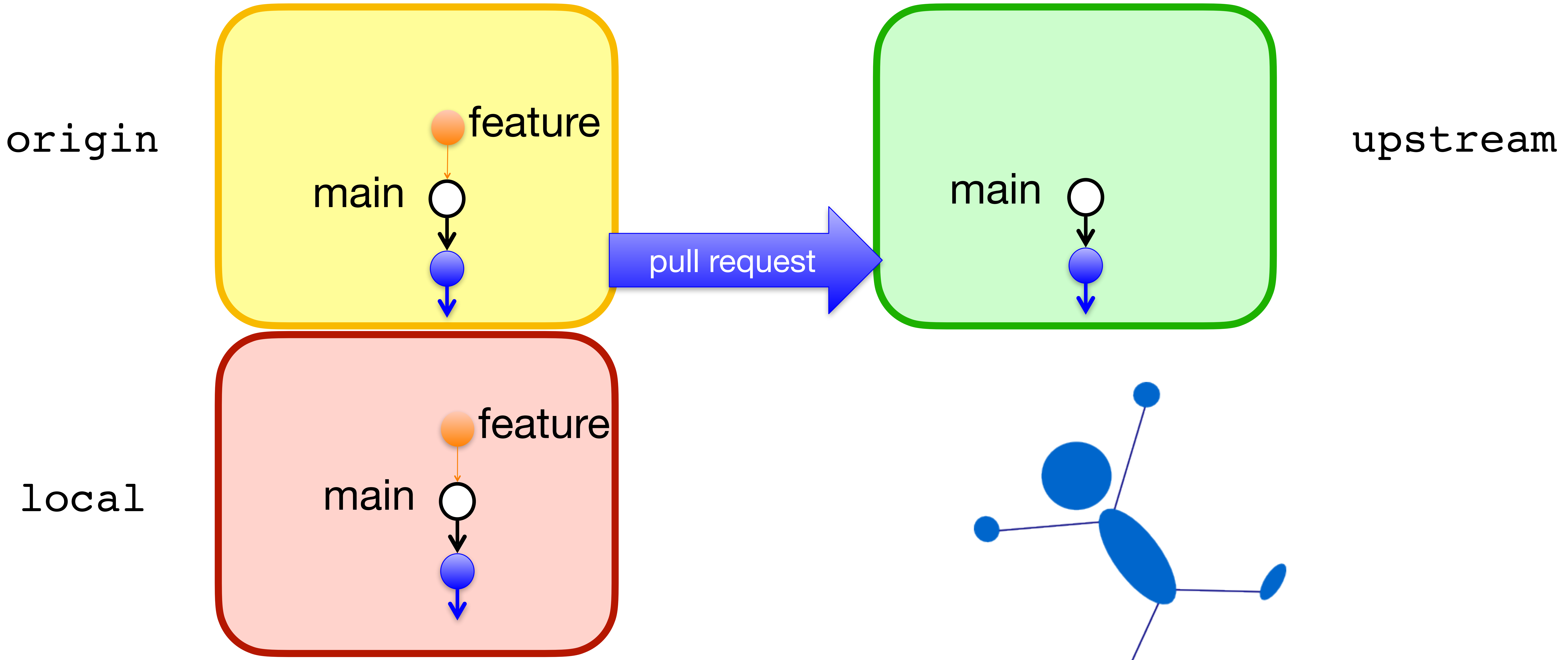
$ git rebase –i main

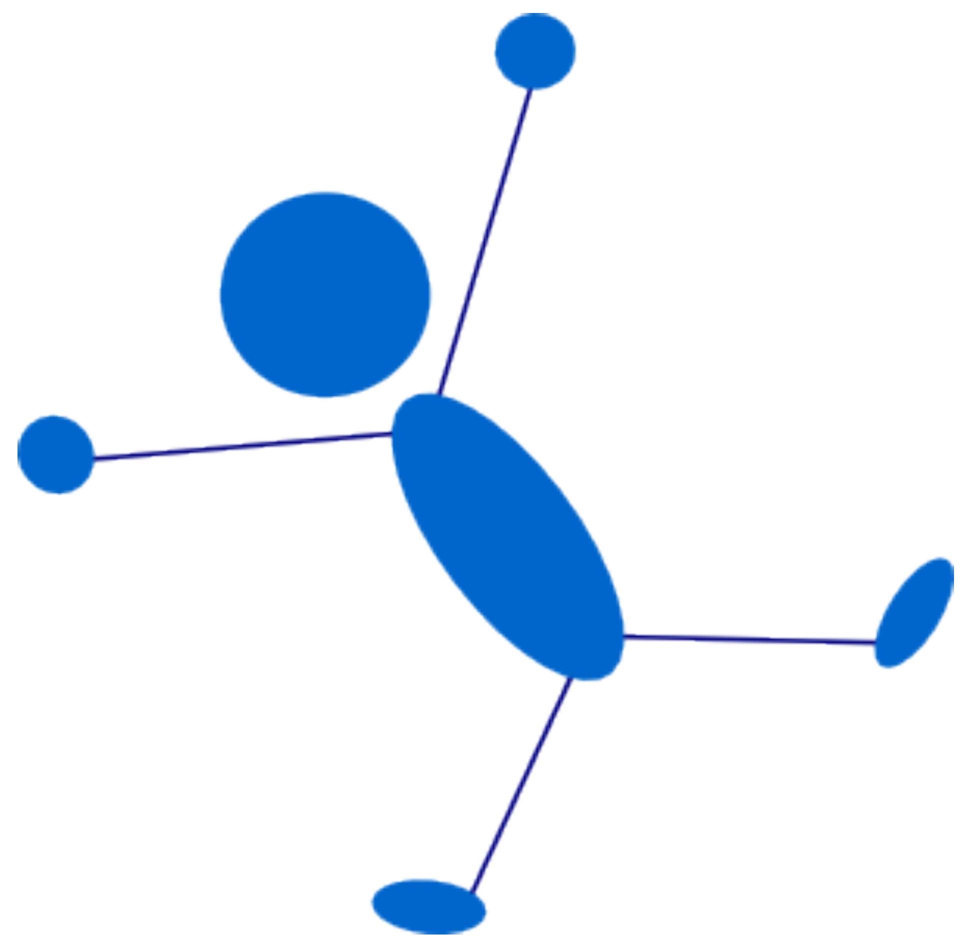


```
$ git push -f origin feature
```

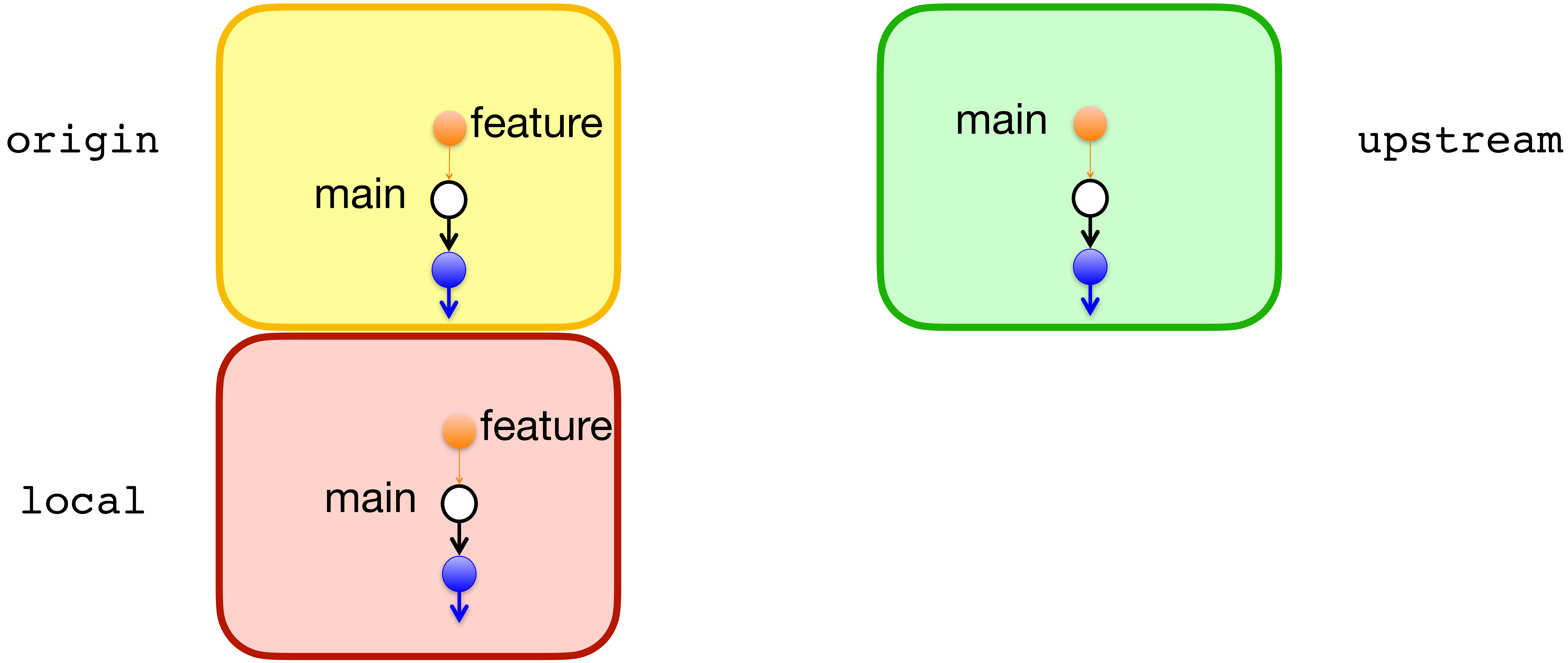


Perfect, I accept!

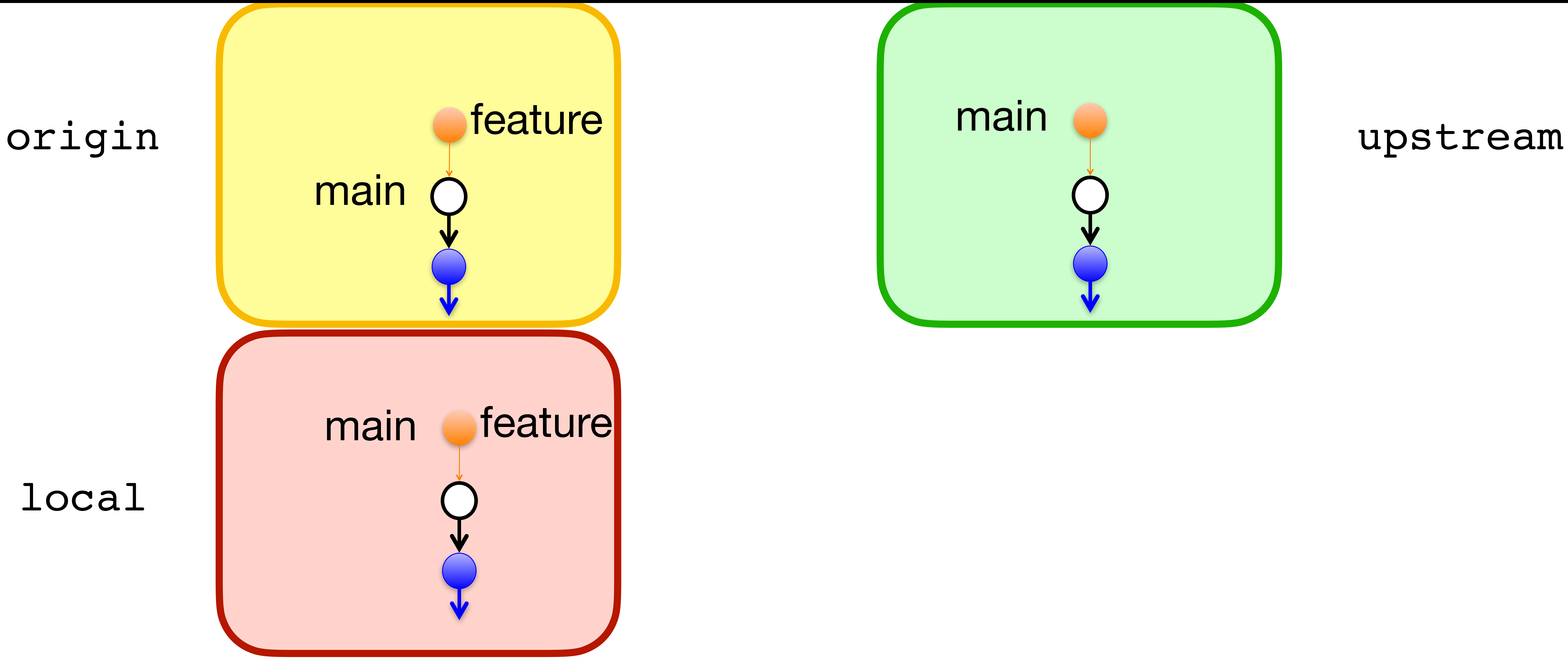




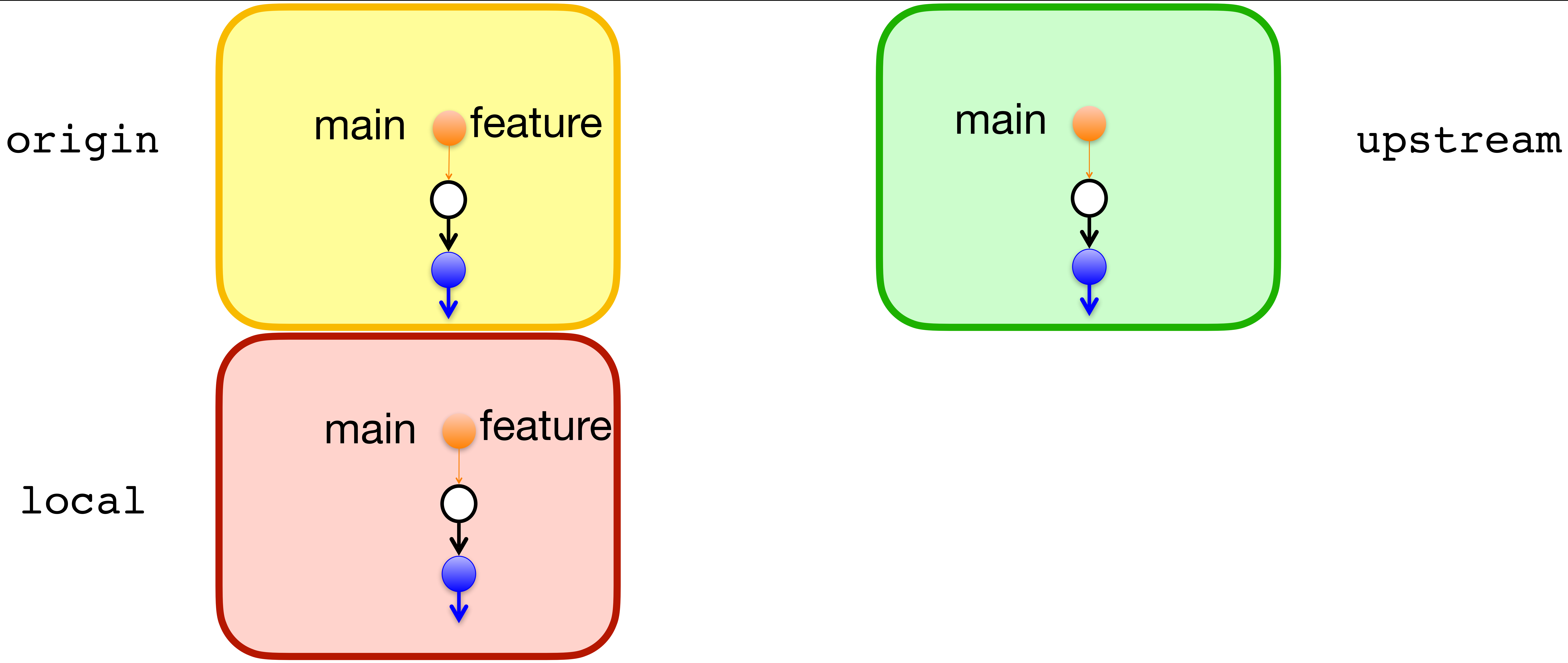
Time to Clean Up



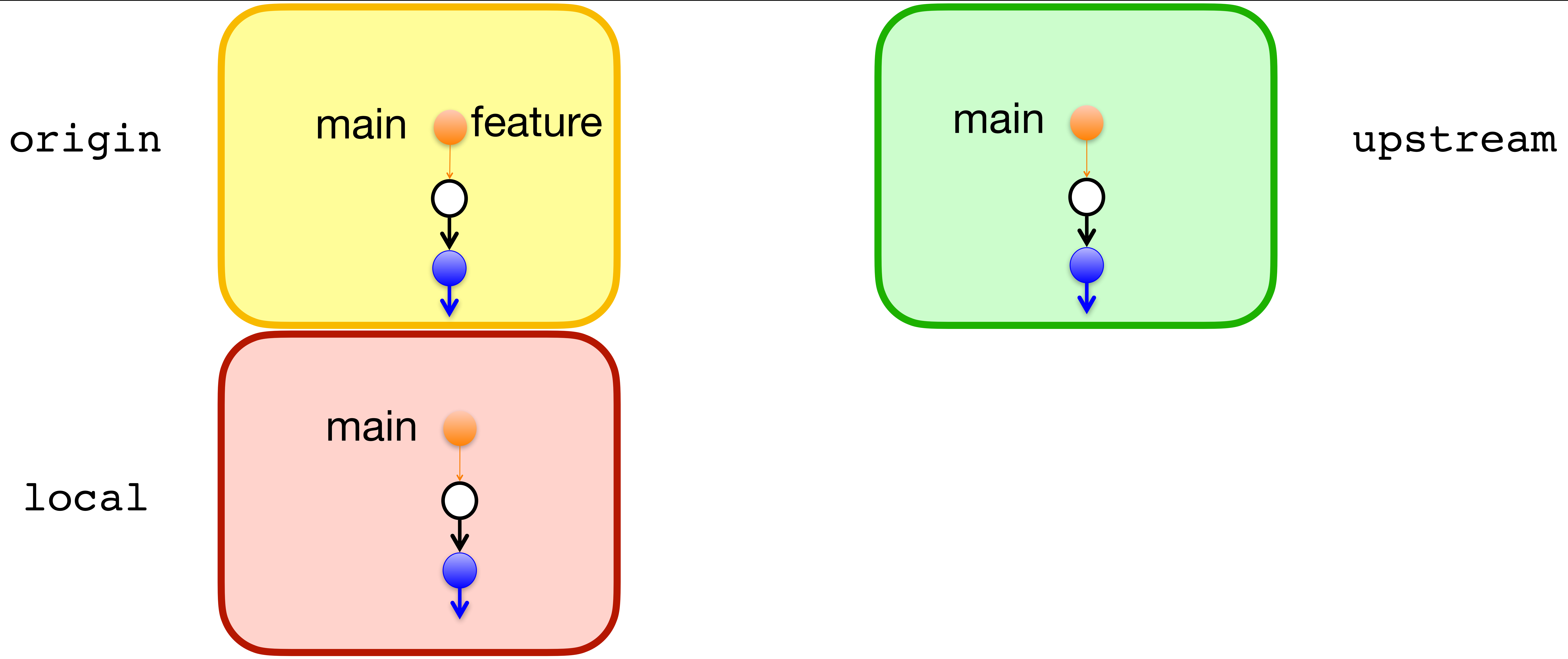
```
$ git fetch upstream main:main
```



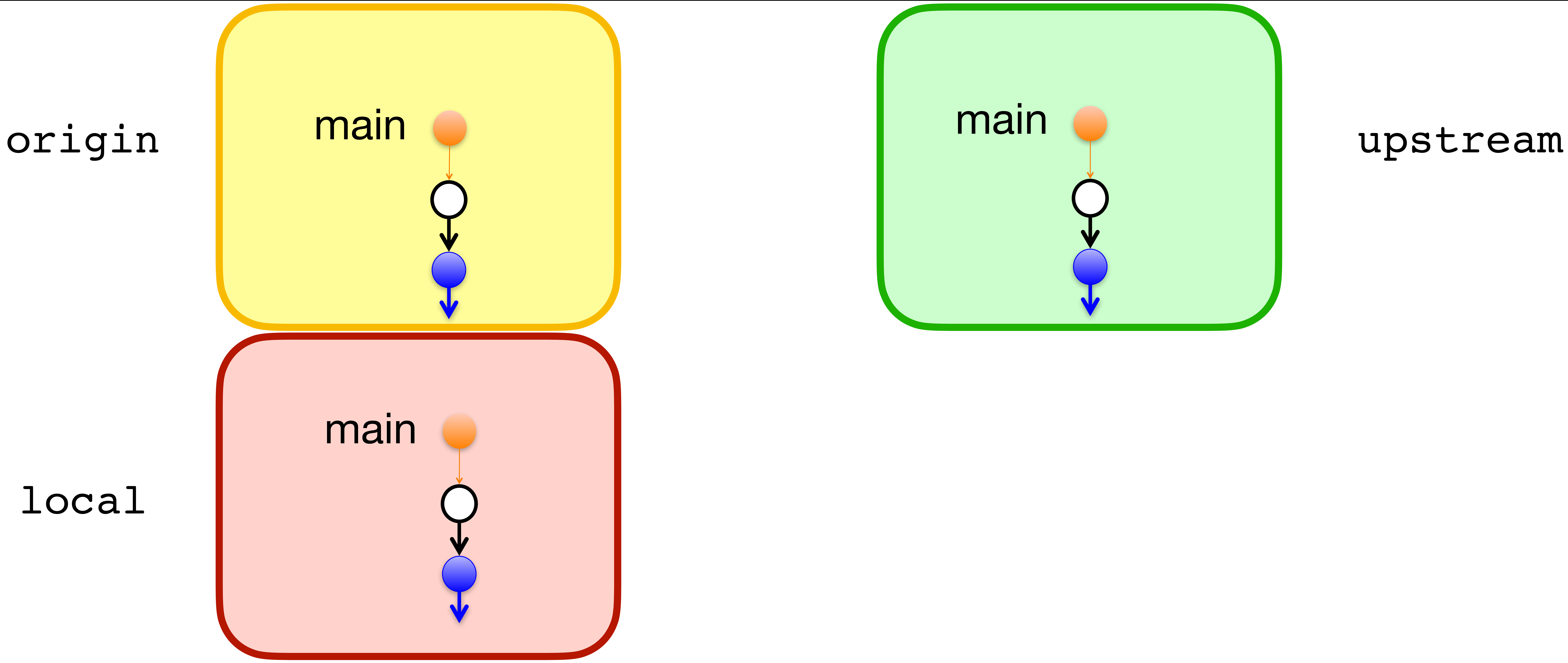
```
$ git push origin main
```



```
$ git checkout main
$ git branch -d feature
```



`$ git push origin -d feature`



After a PR is accepted, Github will ask you if you want to delete your feature branch. If you say yes, which branches get deleted?

A. `feature` — the branch named feature in your local repo

B. `origin/feature` — the branch named feature in your remote repo

C. `upstream/feature` — the branch named feature in their remote repo

D. `feature` and `origin/feature`

E. `feature`, `origin/feature`, and `upstream/feature`

Now that `origin/feature` has been deleted, how do you delete `feature`?

A. $ git delete feature

B. $ git delete -b feature

C. $ git branch -d feature

D. $ git push origin -d feature

E. I would google "delete a git branch" and then click on https://stackoverflow.com/questions/2003505/how-do-i-delete-a-git-branch-locally-and-remotely like every other programmer