Leiden University
Medical Center

Code and data management with Git

Combining changes by merging

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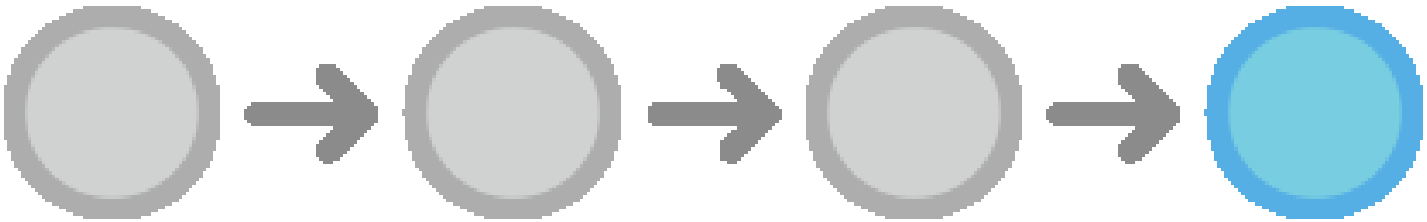
The Git commit graph

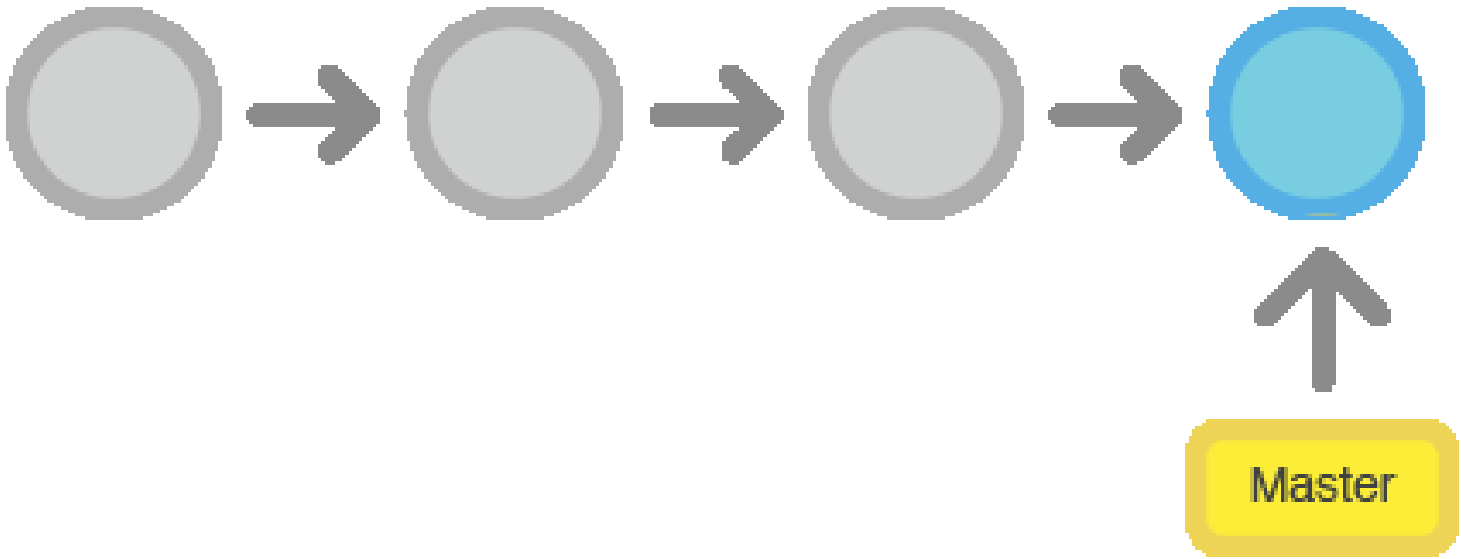
A linear history



- Every commit has a parent.
- *Committing* creates a new commit on top of the current one.

The Git commit graph

The default `master` branch

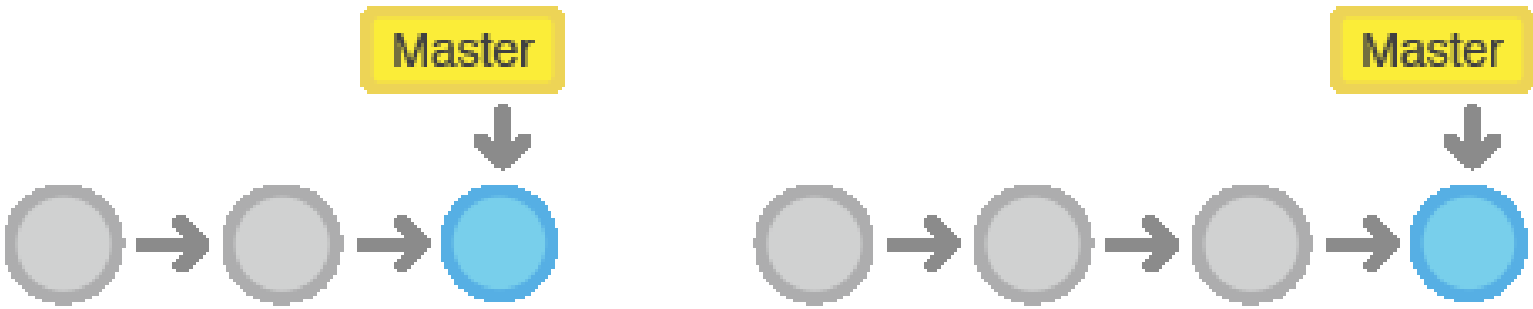


- A *branch* is a pointer to a commit.
- By default there is one branch: `master`.
- `HEAD` is a special pointer, it points to the current branch.

The Git commit graph

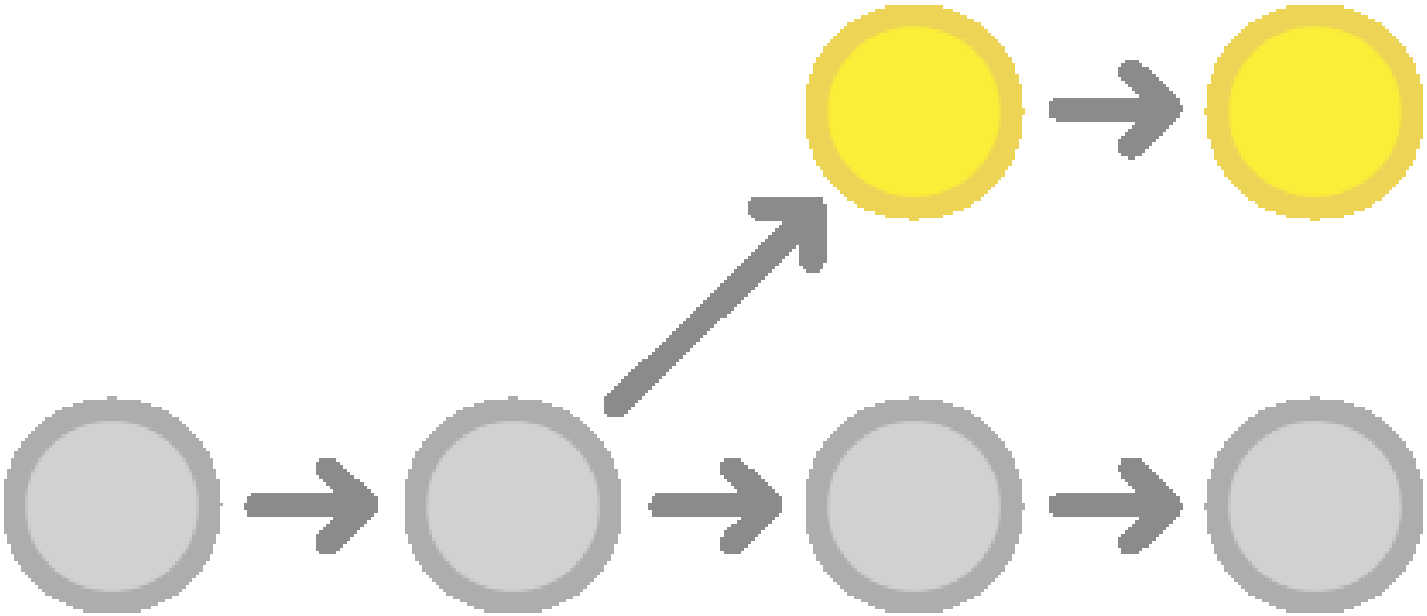
Committing moves the current branch pointer

- Committing moves the current branch to the new commit.
- (Of course, `HEAD` moves with it.)



The Git commit graph

A non-linear history

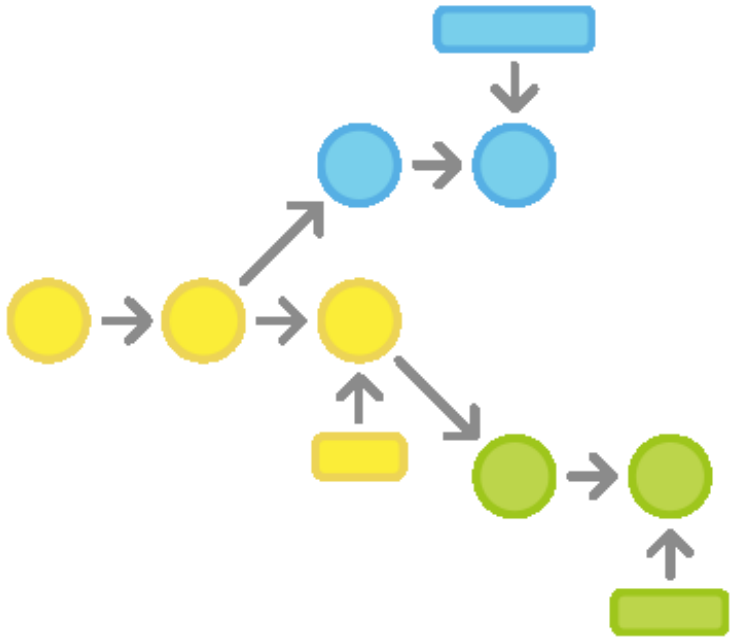


- The commit graph can become non-linear.
- Usually by committing from the same commit twice.

The Git commit graph

Use branches to keep track of different code paths

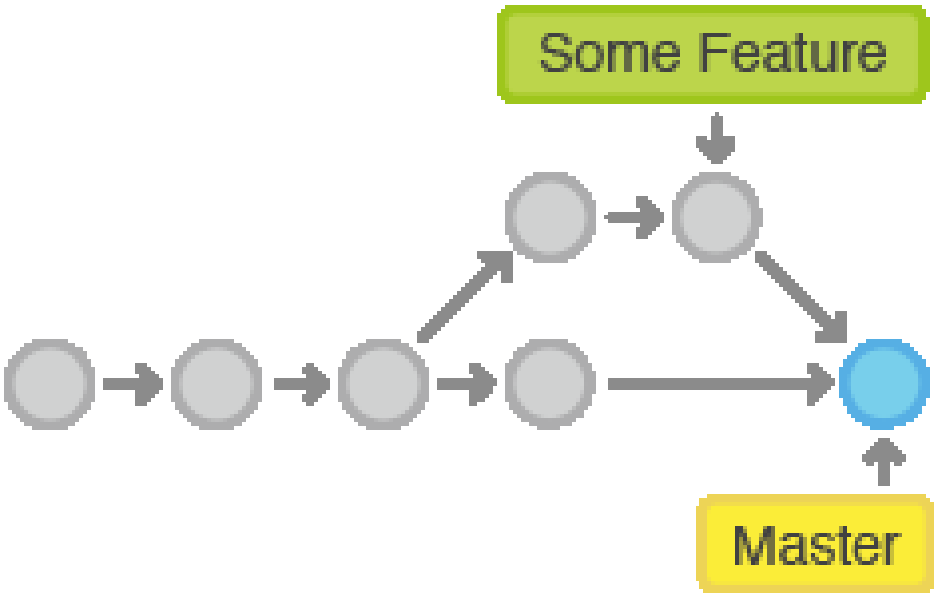
- Branch names are easier to remember than commit hashes.
- Branch names make it clear what commits are about.



The Git commit graph

Different code paths may later join

- Commits from different branches can be brought together.
- We call this *merging*.



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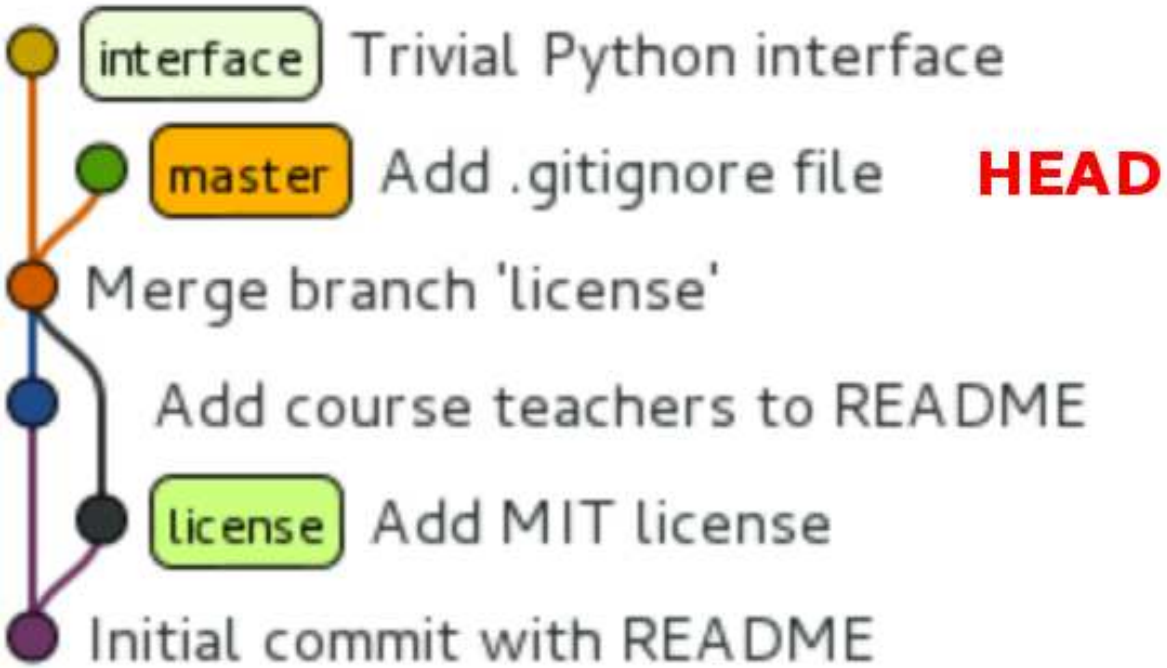
Inspecting the commit graph

An example repository



- Branches `license` and `interface` diverged from `master`.
- Only `license` has been merged back into `master`.
- Current branch is `master`.

Inspecting the commit graph

Showing the current branch: `git status`

```
$ git status
# On branch master
nothing to commit (working directory clean)
```

Remember: you cannot type `git status` enough!

Inspecting the commit graph

The commit log: `git log`

```
$ git log --oneline --decorate
c7f3bd9 (HEAD, master) Add .gitignore file
4a44c4e Merge branch 'license'
64af1ee Add course teachers to README
0fbe3e3 (license) Add MIT license
d1c7fd7 Initial commit with README
```

`--oneline`: Shows commit summary on one line.

`--decorate`: Adds branch information.

Inspecting the commit graph

The commit log as a graph: `git log`

```
$ git log --oneline --decorate --graph --all
* 8fc25c1 (interface) Trivial Python interface
| * c7f3bd9 (HEAD, master) Add .gitignore file
|/
*   4a44c4e Merge branch 'license'
|\
| * 0fbe3e3 (license) Add MIT license
* | 64af1ee Add course teachers to README
|/
* d1c7fd7 Initial commit with README
```

`--graph`: Shows the commit graph.
`--all`: Includes all branches instead of just the current.

Annotated log as an alias

For convenience, we can create an alias for the `git log` command with all the arguments we just used:

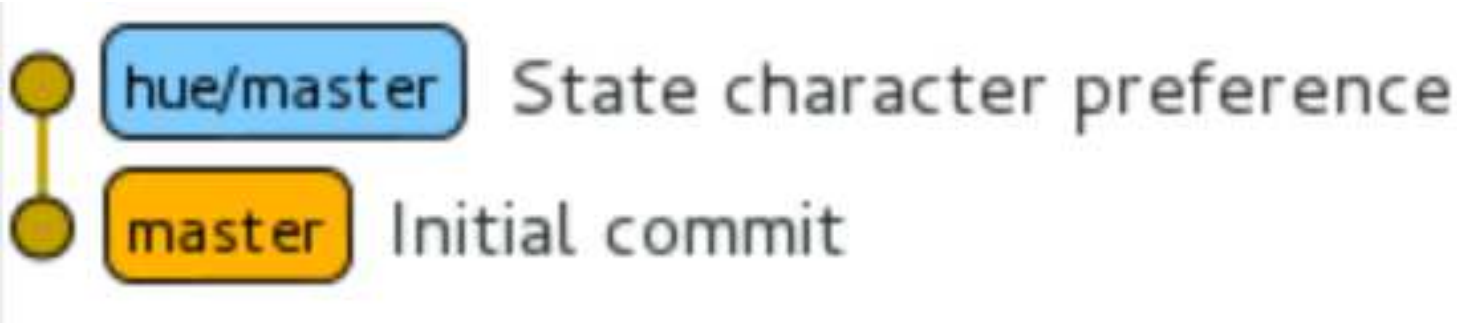
```
$ git config --global alias.l \
    'log --oneline --decorate --graph --all'
$ git l
* 8fc25c1 (interface) Trivial Python interface
| * c7f3bd9 (HEAD, master) Add .gitignore file
|/
*   4a44c4e Merge branch 'license'
...
```

This alias is stored in the `~/.gitconfig` file. You can also edit that file manually.

Remote branches

In this course, we don't really discuss branches, except:

- Commits from a remote show up as a remote branch.
- Even with only a `master` branch, remotes might still diverge.
- Merging remote branches is just like merging local branches.



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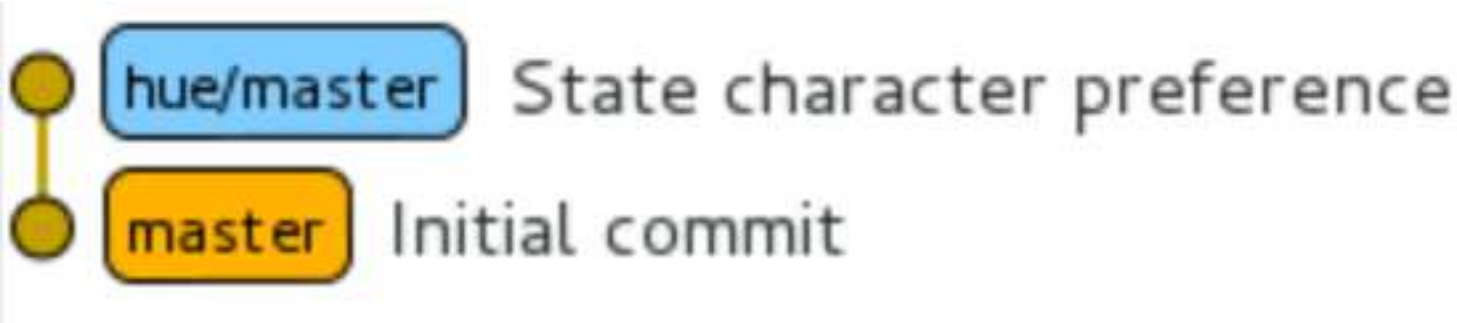
Merging from remotes

An example repository



Branch `master` on `hue` is one commit ahead of our `master` and we have already seen how to merge `hue/master` into `master`:

- `git merge hue/master`
- This was easy: Git just moves `master` (and `HEAD`) to point to `hue/master`.
- It is called a *fast forward merge*.

Merging from remotes

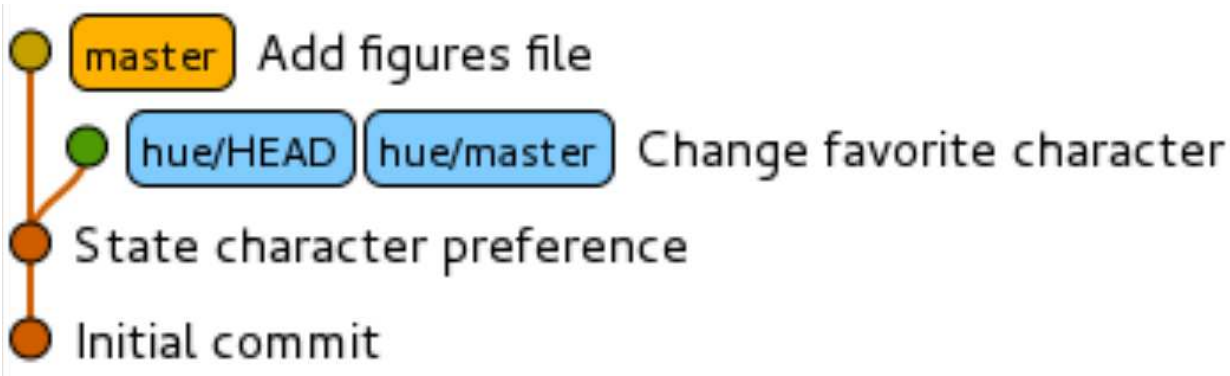
Fast forward merging: `git merge`

If a remote branch is ahead of us, it can be merged easily:

```
$ git merge hue/master
Updating c7f3bd9..251a51b
Fast-forward
testlib.py |    2 +
1 file changed, 2 insertions(+)
```

Merging from remotes

An example repository



Branch `master` on `hue` and our `master` have diverged and merging now seems less straightforward.

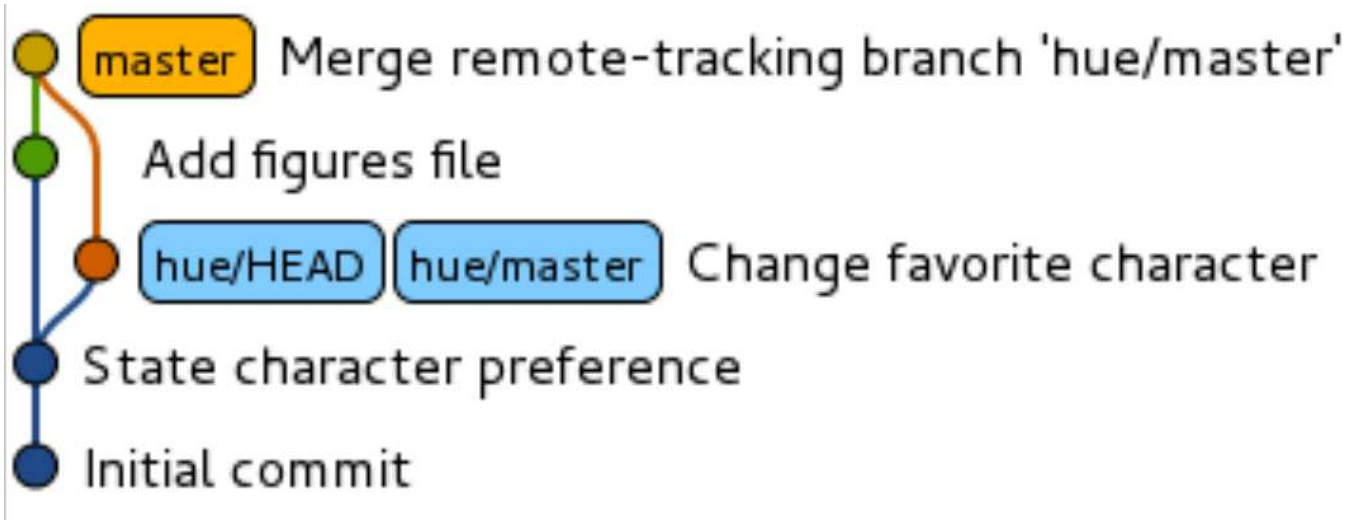
- `git merge hue/master`
- Git will create a new commit in which it combines both changes.
- It is called a *three-way merge*.
- The *merge commit* has two parents.

Merging from remotes

Three-way merging: `git merge`

Let's merge the remote work on `master` back into our local `master`:

```
$ git merge hue/master
Merge made by the 'recursive' strategy.
 FACTS.md | 2 +-
 1 file changed, 1 insertion(+), 1 deletion(-)
```

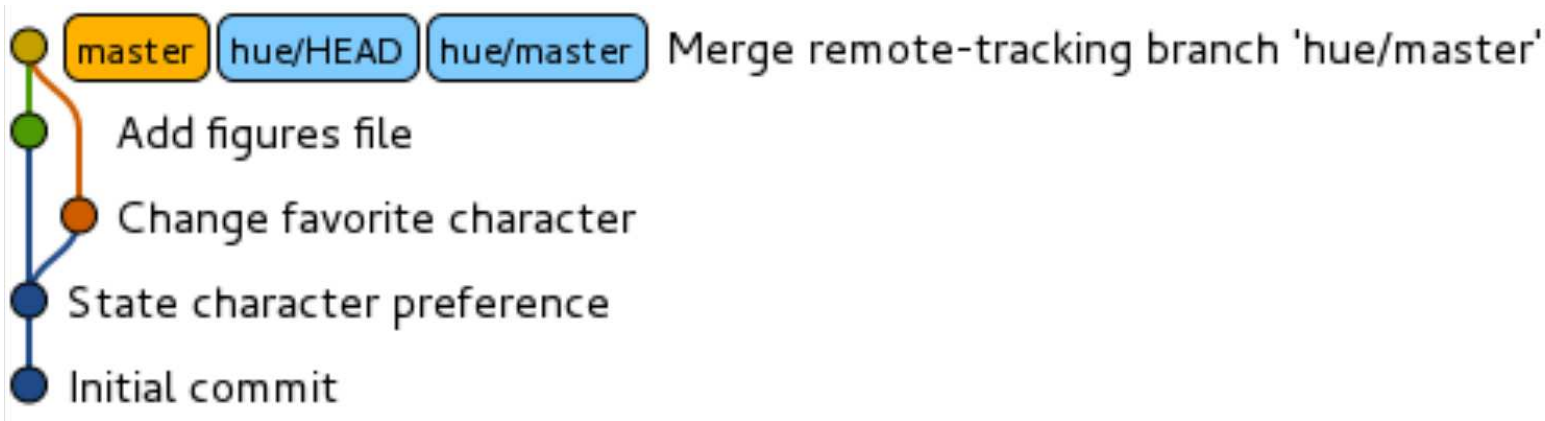


Merging from remotes

The other way around

`git push` also does an implicit `git merge` on the remote.

- We send our local commits to the remote.
- They are merged into the remote branch.
- But only if this is a fast-forward merge.
- Diverging commits *cannot be pushed directly*.



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Merge conflicts

Git is pretty good at merging:

- The changes might have been in different files.
- Or in different parts of the same file.
- Git tries to figure out a sensible result.

Merge conflicts

Git is pretty good at merging:

- The changes might have been in different files.
- Or in different parts of the same file.
- Git tries to figure out a sensible result.

Sometimes this is not possible:

- The changes might be incompatible.
- When we try `git merge`, Git gives up.
- This situation is called a *merge conflict*.

Setting the stage (1/3)

```
* 5edaf08 (hue/master, hue/HEAD) State character
| * f1ef19c (HEAD, master) State character prefer
|/
* 1f6d2ab Initial commit
```

We'd like to merge branch `hue/master` into `master`.

Setting the stage (2/3)

The last commit on `master`:

```
f1ef19c State character preference
diff --git a/FACTS.md b/FACTS.md
index de15194..ef40359 100644
--- a/FACTS.md
+++ b/FACTS.md
@@ -1,2 +1,4 @@
Facts about television series
==============================
+
+My favorite character is Eric Cartman.
```

Setting the stage (3/3)

The last commit on `hue/master`:

```
$ git show --oneline hue/master
5edaf08 State character preference
diff --git a/FACTS.md b/FACTS.md
index de15194..5e69508 100644
--- a/FACTS.md
+++ b/FACTS.md
@@ -1,2 +1,4 @@
Facts about television series
==============================
+
+My favorite character is Milhouse.
```

Creating a merge conflict

```
$ git merge hue/master
Auto-merging FACTS.md
CONFLICT (content): Merge conflict in FACTS.md
Automatic merge failed; fix conflicts and then
commit the result.

$ git status
# On branch master
# Unmerged paths:
#   (use "git add/rm <file>.." as appropriate to
#    mark resolution)
#
#               both modified:      FACTS.md
#
no changes added to commit (use "git add" and/or
"git commit -a")
```

Resolving a merge conflict (1/2)

```
$ cat FACTS.md
Facts about television series
==============================

<<<<<<< HEAD
My favorite character is Eric Cartman.
=======
My favorite character is Milhouse.
>>>>>>> hue/master
```

What we had is under `HEAD`, what `hue/master` had is above `hue/master`.

Resolving a merge conflict (1/2)

```
$ cat FACTS.md
Facts about television series
==============================

<<<<<<< HEAD
My favorite character is Eric Cartman.
=======
My favorite character is Milhouse.
>>>>>>> hue/master
```

What we had is under `HEAD`, what `hue/master` had is above `hue/master`.

```
$ nano FACTS.md
```

Resolving a merge conflict (2/2)

We resolve the conflict by hand.

```
$ cat FACTS.md
Facts about television series
==============================

My favorite characters are Eric Cartman
and Milhouse.
```

Resolving a merge conflict (2/2)

We resolve the conflict by hand.

```
$ cat FACTS.md
Facts about television series
==============================

My favorite characters are Eric Cartman
and Milhouse.
```

And can now finish the merge commit.

```
$ git add FACTS.md
$ git commit
[master 1e496cb] Merge remote-tracking branch
'hue/master'
```

Aborting a merge

If you don't feel like resolving the merge conflict, you can go back with `git merge --abort`.

```
$ git merge hue/master
Auto-merging FACTS.md
CONFLICT (content): Merge conflict in FACTS.md
Automatic merge failed; fix conflicts and then
commit the result.
```

```
$ git merge --abort
```

```
$ git status
# On branch master
nothing to commit (working directory clean)
```

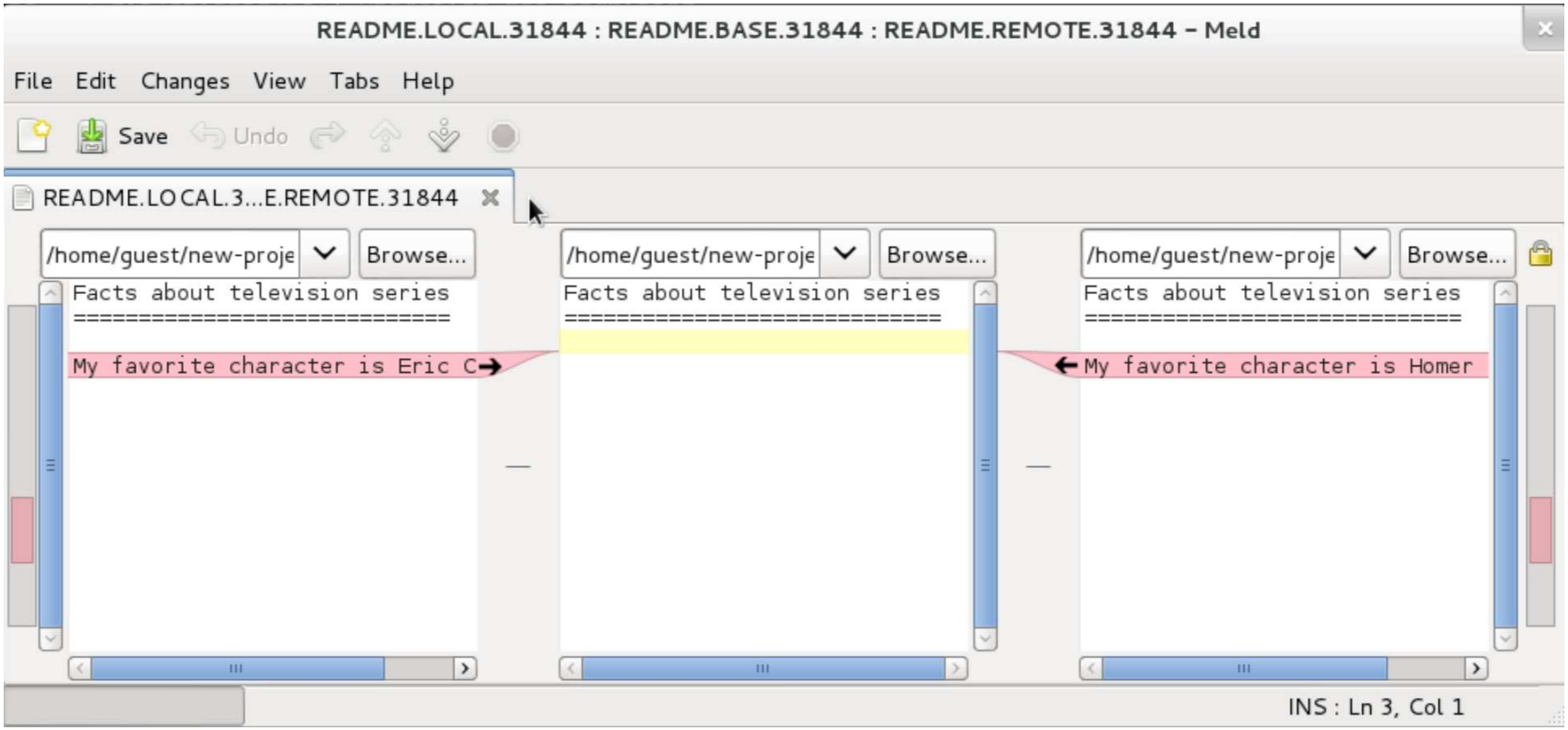
Resolving conflicts with `git mergetool`

We can also use graphical merge tools such as *Meld*.

```
$ git mergetool
merge tool candidates: meld opendiff kdiff3 ...
Merging:
FACTS.md

Normal merge conflict for 'FACTS.md':
  {local}: modified file
  {remote}: modified file
Hit return to start merge resolution tool (meld):
```

Meld example



Tools like Meld provide an editable three-way diff.

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http://git-scm.com/book
https://www.atlassian.com/git