git: A Version Control System

(Anybody can make history, but only good devs can (re)write it)

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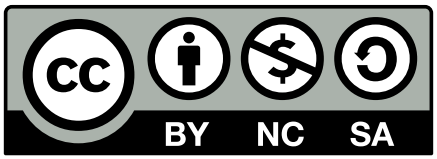

Overview

Overview

Version Control Software (VCS)

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A **Version Control Software** is a tool that:

- Keep a **log of changes** applied on source code.
- Help to **merge your work** with other developers.
- Allow to **navigate within history** of source code versions.

Even when coding alone, a VCS is extremely useful to not be annoyed by tracking different revisions of your software.

A few (famous) VCS:

- `sccs` (1972)
- `rcs` (1982)
- `cvs` (1990)
- `svn` (2000)
- `darcs` (2003)
- `git` (2005)
- `hg` (2005)
- ...

Get used to use a VCS on long term projects !!!

Project History

The **sequence of modifications** bringing you from the start of the project til now.

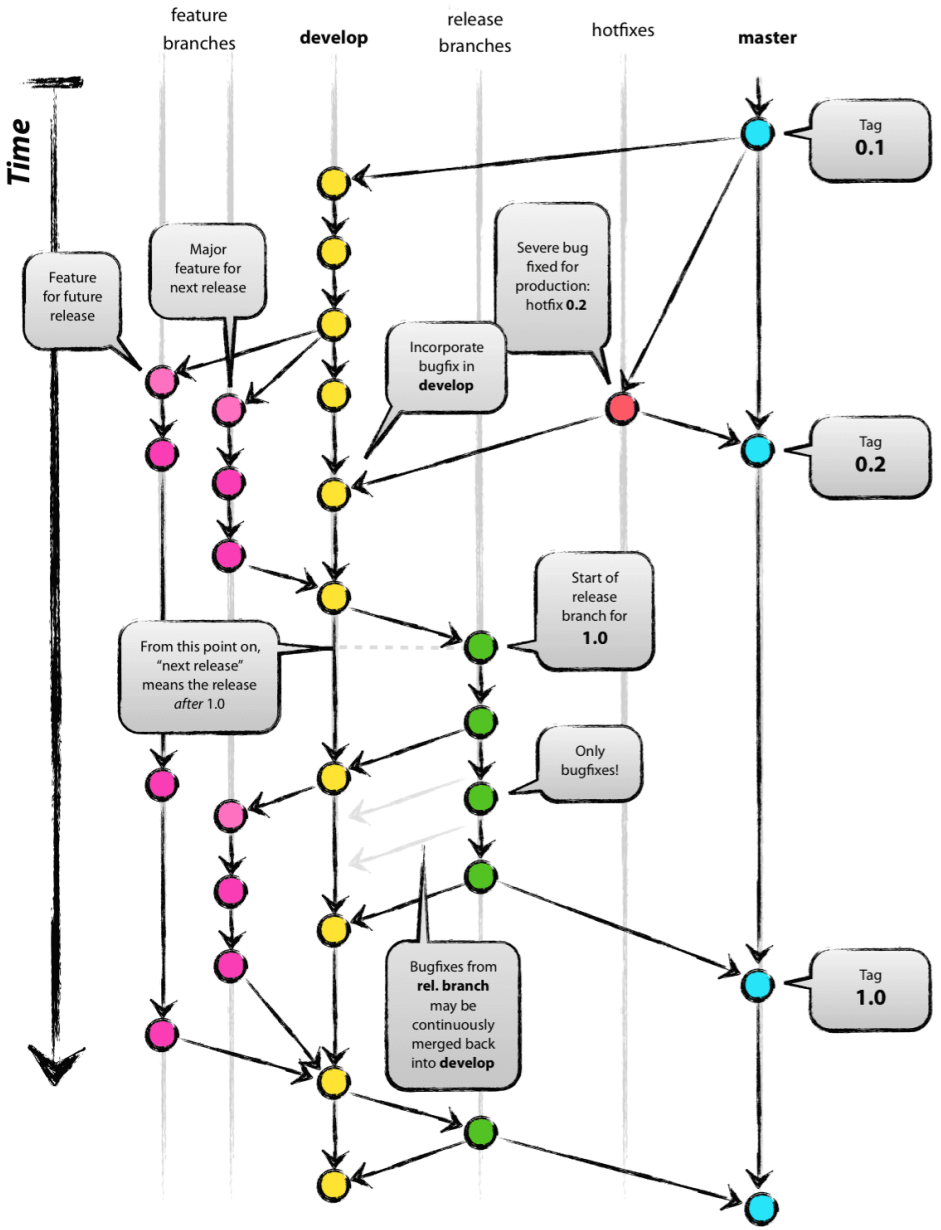
Two distinct **type of approaches**:

- **History cannot be rewritten**
  (`cvs`, `svn`, `hg`, ...)

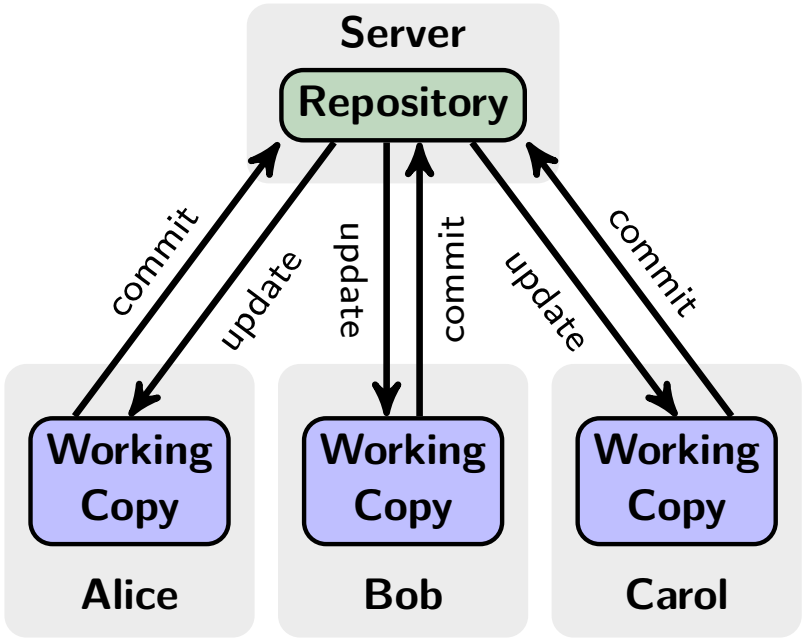
  History represents the chronological order of events, we cannot erase it. Thus, it keeps track of all your mistakes.

- **History is a set of lies agreed upon**
  (`git`, `darcs`, ...)

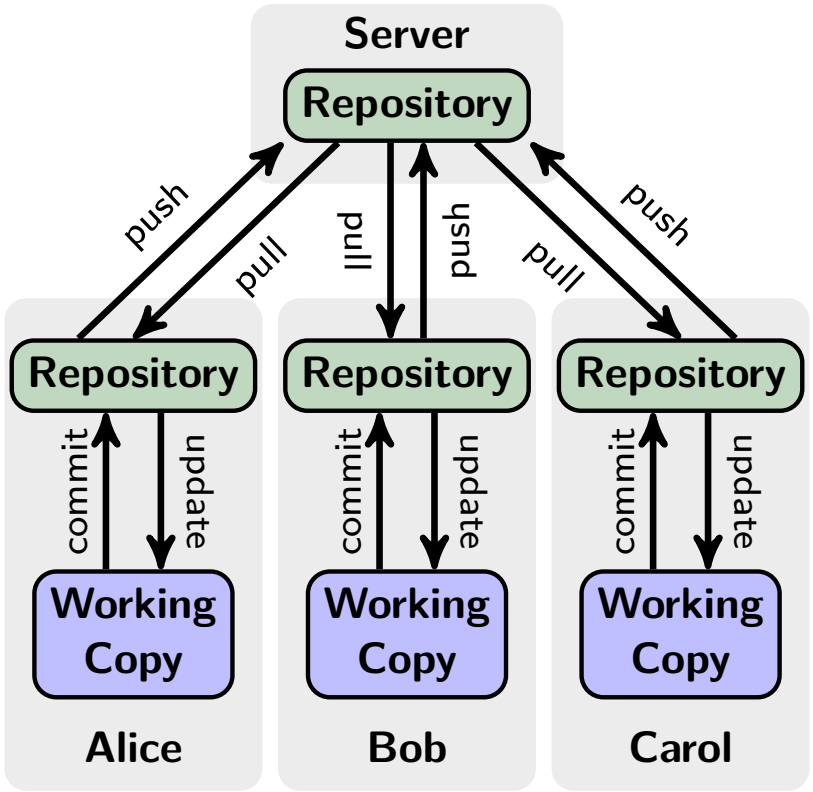
  History tries to show the best logical path from one point to another, we can modify it to make it more understandable.



Centralized vs. Distributed



Centralized Version Control



Distributed Version Control

Repository

Hold the whole history of the project (as a data-base of code).

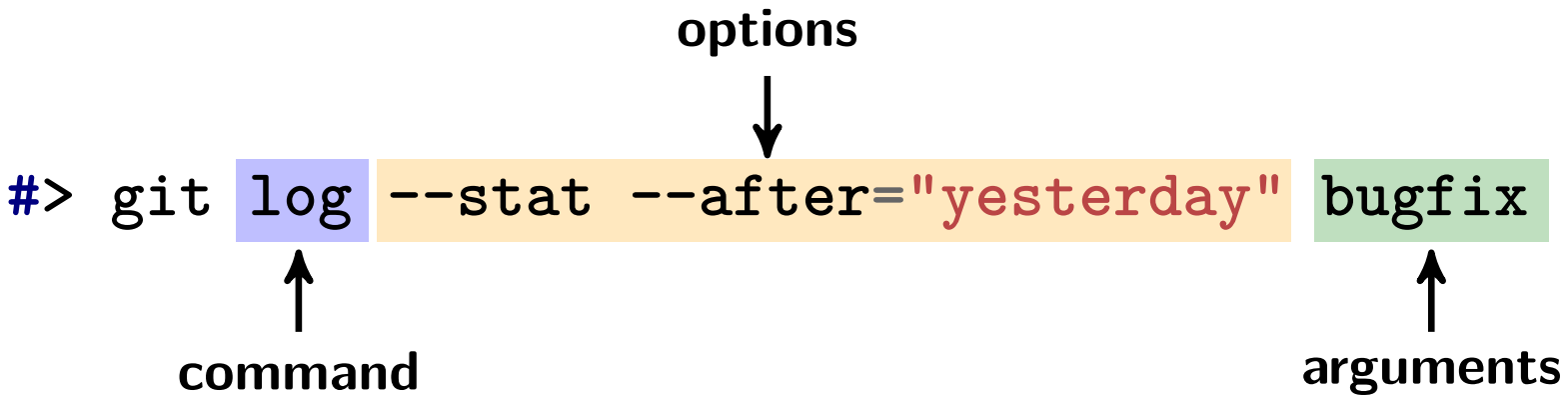
Working Copy

A snapshot of the code taken from the repository on which you can work.

Overview

Overview

Command Syntax



Git main commands

```
add blame branch checkout clone commit
config diff init log merge pull push rebase
remote reset revert rm status tag ...
```

How to Get Help

```
#> git help <command>
#> git <command> --help
#> man git-<command>
```

Help Examples

```
#> git help log
#> git log --help
#> man git-log
```

Overview

Introduce Yourself to git

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First of all, you need to **set your identity** in order to **tag properly your commits** and get **your usual tools** (*e.g.* editor).

You have two options ('global' or 'local').

Global Configuration ('~/.gitconfig' or '~/.config/git/config')

```
#> git config --global user.name "John Doe"
#> git config --global user.email john.doe@u-bordeaux.fr
#> git config --global core.editor emacs
```

Local Configuration ('project/.git/config')

```
#> git config --local user.name "John Doe"
#> git config --local user.email john.doe@email.net
#> git config --local core.editor emacs
```

Where: Local > Global

Playing with Configuration

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Setting Config

```
#> git config section.key1 'value1'
#> git config section.key2 'value2'
#> git config section.subsection.key3 'value3'
#> git config --list
  section.key1=value1
  section.key2=value2
  section.subsection.key3=value3
```

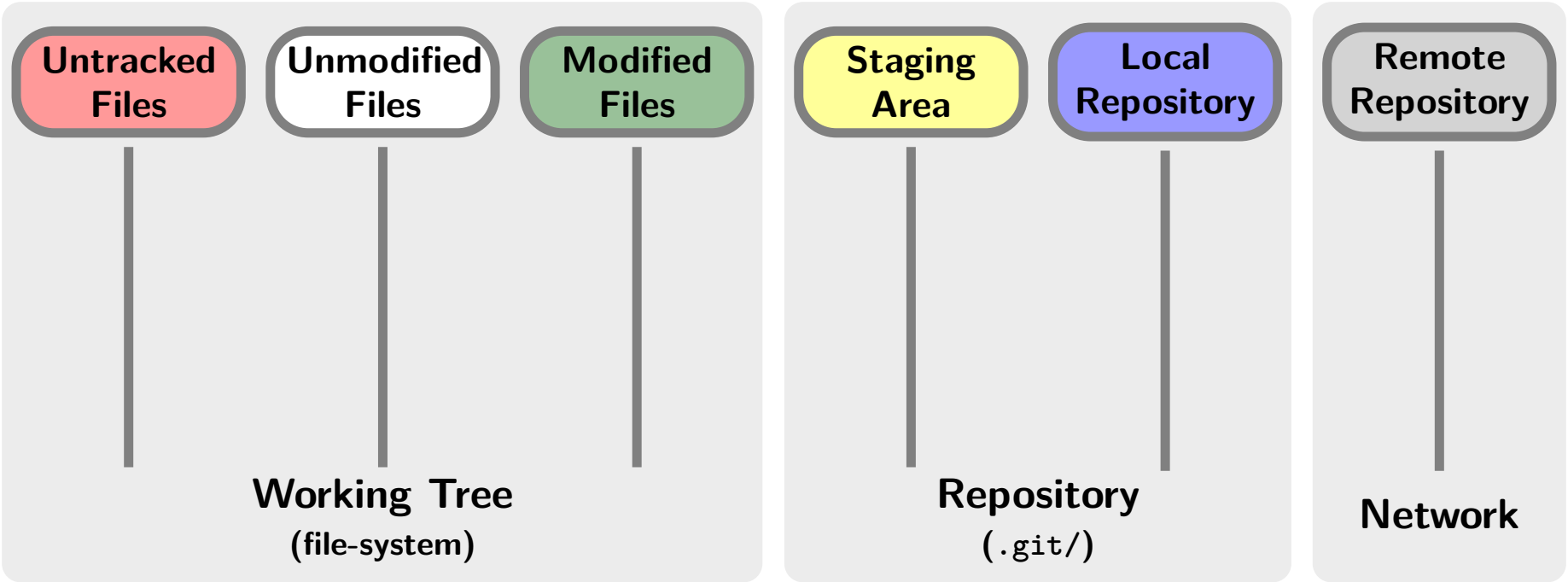
Config File Format

```
# This is a comment
[section]
  key1 = value1 # Another comment
  key2 = value2
[section "subsection"]
  key3 = value3
```

Sections and keys are case-sensitive!

Overview

Files States



Working Tree

- **Untracked Files**: Files that are not tracked by `git` in the working copy.
- **Unmodified Files**: Tracked files that are not modified.
- **Modified Files**: Tracked files that are modified and ready to get staged.

Repository

- **Staging Area** (`.git/index`): Stores all the temporary modifications before committing to the repository.
- **Local Repository** (`.git/objects/`): Hold the whole history of the project with all the modifications.

Network

- **Remote Repository**: A place used to synchronize your repository with other developpers.

'git status': Get Status Information

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Gives the **current status** of all your files which are in the **untracked files**, the **working tree** or the **staging area**.

Untracked Files

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

        README

nothing added to commit but untracked files present (use "git add" to track)
```

Modified Files

```
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:   README

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

Unmodified Files

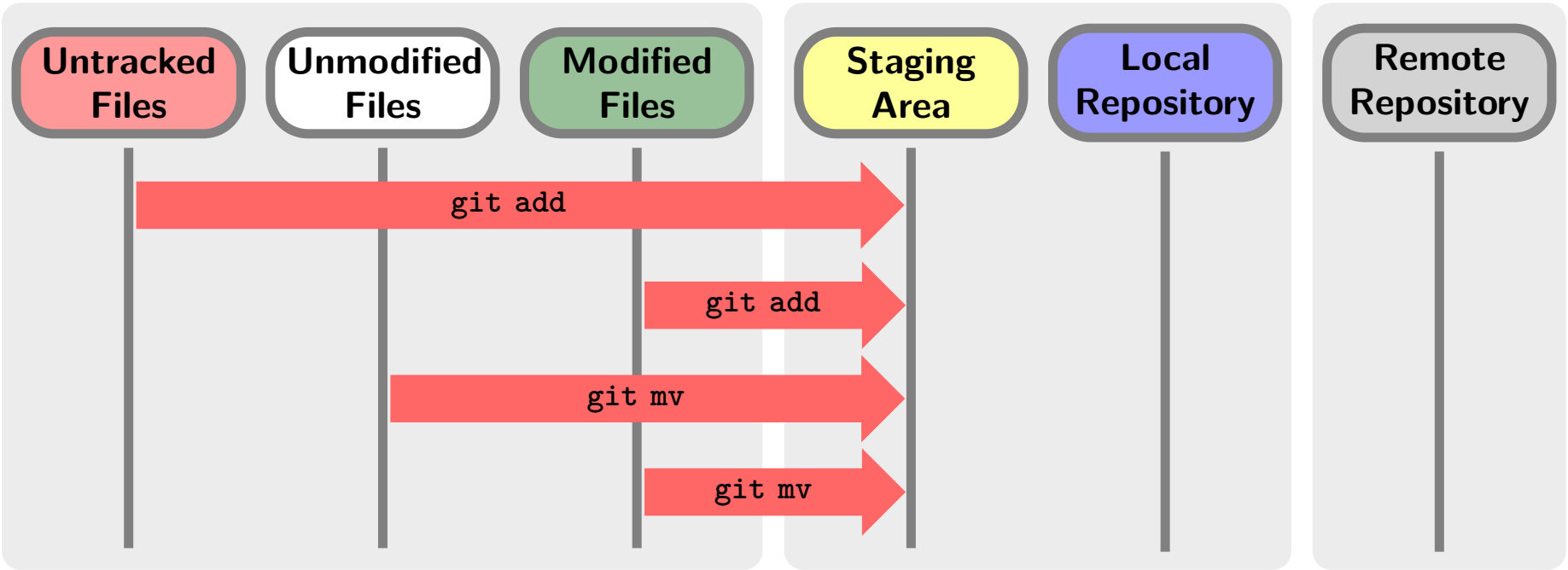
```
nothing to commit, working tree clean
```

Staged Files

```
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        new file:   README
```

Commands: 'add' and 'mv'



Command 'git add FILE'

Used to add an **untracked file** or a **modification on a file** to the **staging area**. Note that moving an untrack file to staging is not the same than moving it from modified files. (Always prefer 'git add --patch' to add modifications to staging)

Command 'git mv FLIE FILE'

Used to rename or move a **tracked file** in the **staging area**.

Example: 'add' and 'mv'

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```
#> echo "Hello World!" > REAMDE
#> git add REAMDE
#> git status
No commits yet

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

    new file:   REAMDE

#> git mv REAMDE README
#> git status
No commits yet

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

    new file:   README
```

Example: 'add --patch'

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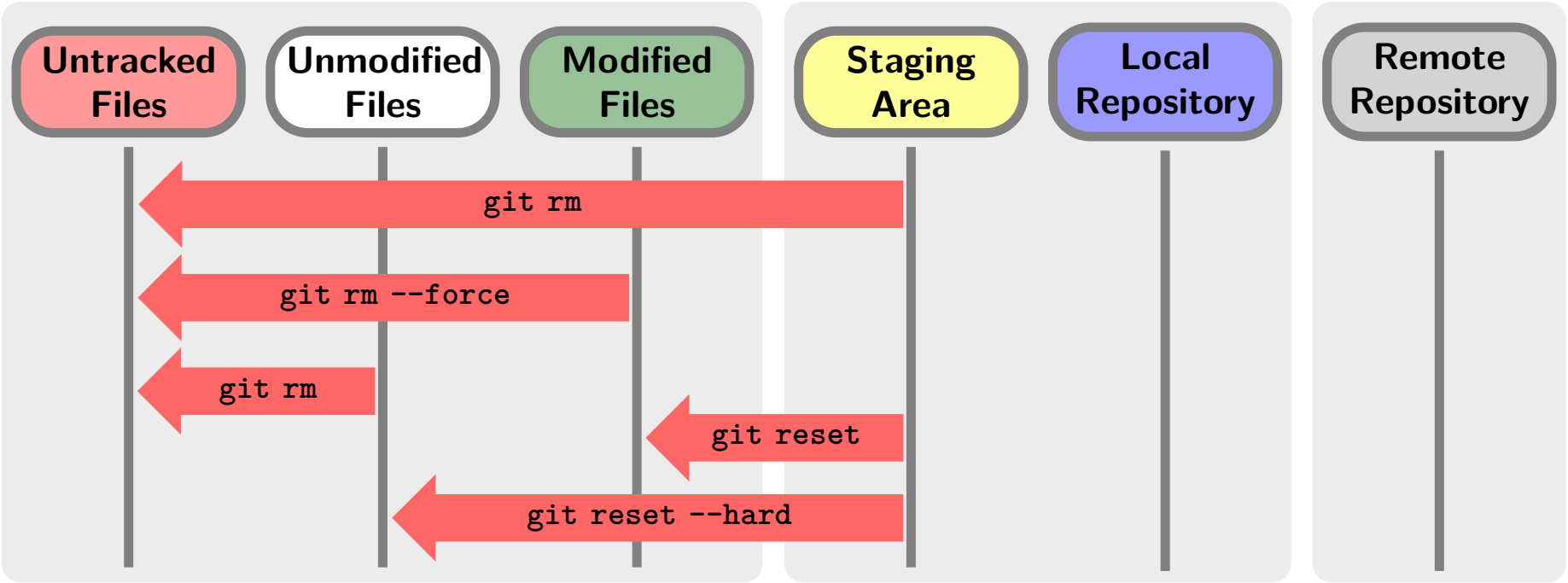
```
#> echo "Hello World!" > README
#> git add README
#> echo "Second line" >> README
#> git add --patch README
diff --git a/README b/README
index 980a0d5..307dca1 100644
--- a/README
+++ b/README
@@ -1 +1,2 @@
 Hello World!
+Second line
Stage this hunk [y,n,q,a,d,e,?]? ?
y - stage this hunk
n - do not stage this hunk
q - quit; do not stage this hunk or any of the remaining ones
a - stage this hunk and all later hunks in the file
d - do not stage this hunk or any of the later hunks in the file
e - manually edit the current hunk
? - print help
@@ -1 +1,2 @@
 Hello World!
+Second line
Stage this hunk [y,n,q,a,d,e,?]? y
```

Commands: 'rm' and 'reset'



Command 'git rm FILE'

Used to **remove a file from the tracked files** (unmodified, modified or staged).

- 'git rm -r DIR/': Recursive removal of the content of a directory.
- 'git rm --cached FILE': Do not delete the file which is removed from the **tracked files**;

Command 'git reset FILE'

Used to **remove changes from the staging area** to the working tree.

- 'git reset --hard': Throw away all the pending changes (you can't get it back!).

Example: 'rm'

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```
#> echo "Hello World!" > README
#> git add README
#> git status
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        new file:   README

#> git rm README
error: the following file has changes staged in the index:
    README
(use --cached to keep the file, or -f to force removal)
#> git rm --cached README
rm 'README'
#> git status
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
```

Example: 'reset'

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```
#> echo "Hello World!" > README
#> git add README
#> git status
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        new file:   README

#> git reset
#> git status
No commits yet

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

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git add README
#> git reset --hard
#> git status
On branch master

No commits yet

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

.gitignore: Ignoring Untracked Files...

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Why Ignore Files?

- You do not want to see these files in 'git status' to have a better understanding of the modifications you did on the code.
- Building the project and editing files produce a lot of intermediate files that are not relevant to be cared upon. These files must be banned from the history because:
  - It blurs the 'status' command a lot;
  - Versionning binary files is inefficient;
  - It breaks Makefile timestamps on files;
  - It breaks merge algorithm;
  - It eats disk space for nothing.

How to Ignore Files?

- Ignore files: '~/.config/git/ignore' (global) or 'project/.gitignore' (local)
- Basic Ignore Format:

```
# This is a comment
# Ignore all files ended by '~'
*~
# Ignore all file named 'core'
core
# Ignore the directory 'images/' and its content
images/
```

Example: .gitignore

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Bad!

```
#> git status
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:   src/project.c

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

        project
        src/module.o
        src/project
        src/project.o

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

Good!

```
#> git status
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:   src/project.c

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

.gitignore

```
*~
*.o
project
src/project
```

Overview

History Logs

```
#> git log
commit 848679e3dc10b6ef13e1d2ea2a5055 (HEAD->master)
Author: John Doe <john.doe@u-bordeaux.fr>
Date:   Mon Nov 19 12:02:05 2018 +0100

  Cleaning and fixing bugs

  - Removed 'project' exec from tracked files
  - Updated the 'clean' target in Makefile
  - Fixing a missing include in 'project.c'

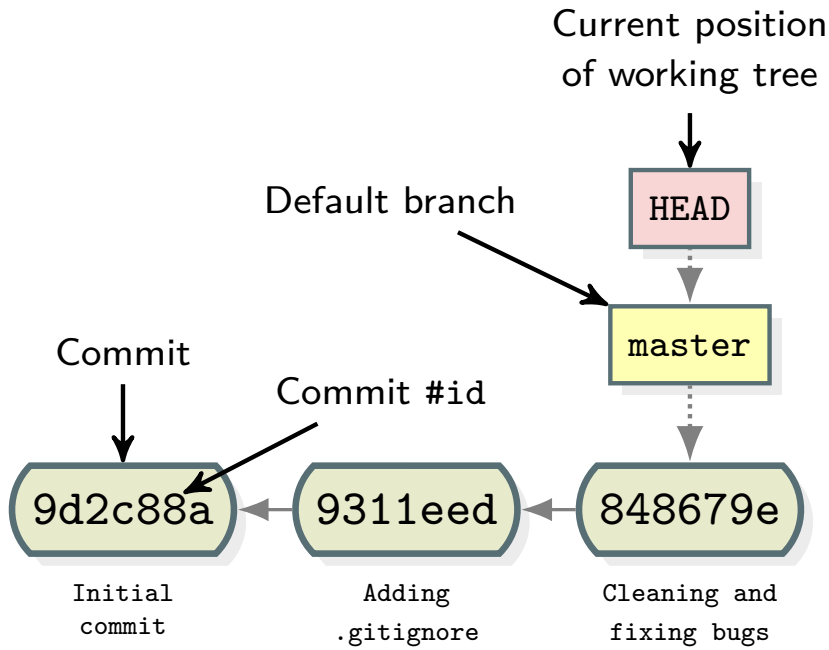
commit 9311eedbc1c00071055abfbd4228bd
Author: John Doe <john.doe@u-bordeaux.fr>
Date:   Mon Nov 19 12:00:13 2018 +0100

    Adding a .gitignore file

commit 9d2c88af92b23131b74bbe6fdcd3f8
Author: John Doe <john.doe@u-bordeaux.fr>
Date:   Mon Nov 19 11:59:19 2018 +0100

    Initial commit
```

```
#> git log --oneline
848679e (HEAD -> master) Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
```



HEAD: Convention to name current position of working tree in history and where:

- `HEAD~1` (`HEAD~`): First ancestor of `HEAD`.
- `HEAD~2` (`HEAD~~`): Second ancestor of `HEAD`.
- `HEAD~n`: n-*th* ancestor of `HEAD`.

9d2c88a: Commit `#id` is obtained by hashing the tree of changes as a Merkle tree with SHA-1 (160-bit).

More Tricks about 'git log'

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```
#> git log --oneline --stat
9311eed (HEAD -> master) Adding a .gitignore file
 .gitignore | 3 +++
 1 file changed, 3 insertions(+)
9d2c88a Initial commit
 Makefile  |  13 ++++++++++++
 project   | Bin 0 -> 1708464 bytes
 project.c |  21 +++++++++++++++++++++
 project.h |   8 ++++++++
 4 files changed, 42 insertions(+)
```

Displays the statistics on changed lines in files

```
#> git log --patch
commit 9311eedbc1c031fe09dbfd0071055abfbd4228bd (HEAD -> master)
Author: John Doe <john.doe@u-bordeaux.fr>
Date:   Mon Nov 19 12:00:13 2018 +0100

    Adding a .gitignore file

diff --git a/.gitignore b/.gitignore
new file mode 100644
index 0000000..b069126
--- /dev/null
+++ b/.gitignore
@@ -0,0 +1,3 @@
+*~
+*.o
+project
```

Displays all the diffs of the commit

Writing Good Log Messages

```
Summarize changes in around 50 characters or less

More detailed explanatory text, if necessary. Wrap it to about 72
characters or so. In some contexts, the first line is treated as the
subject of the commit and the rest of the text as the body. The
blank line separating the summary from the body is critical (unless
you omit the body entirely); various commands like `log`, `shortlog`
and `rebase` can get confused if you run the two together.

Explain the problem that this commit is solving. Focus on why you
are making this change as opposed to how (the code explains that).
Are there side effects or other unintuitive consequences of this
change? Here's the place to explain them.

Further paragraphs come after blank lines.

 - Bullet points are okay, too

 - Typically a hyphen or asterisk is used for the bullet, preceded
   by a single space, with blank lines in between.

If you use an issue tracker, put references at the bottom, like this:

Resolves: #123
See also: #456, #789
```

For more, see: **How to Write a Git Commit Message**, by *Chris Beams*, 2014.
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Optional body

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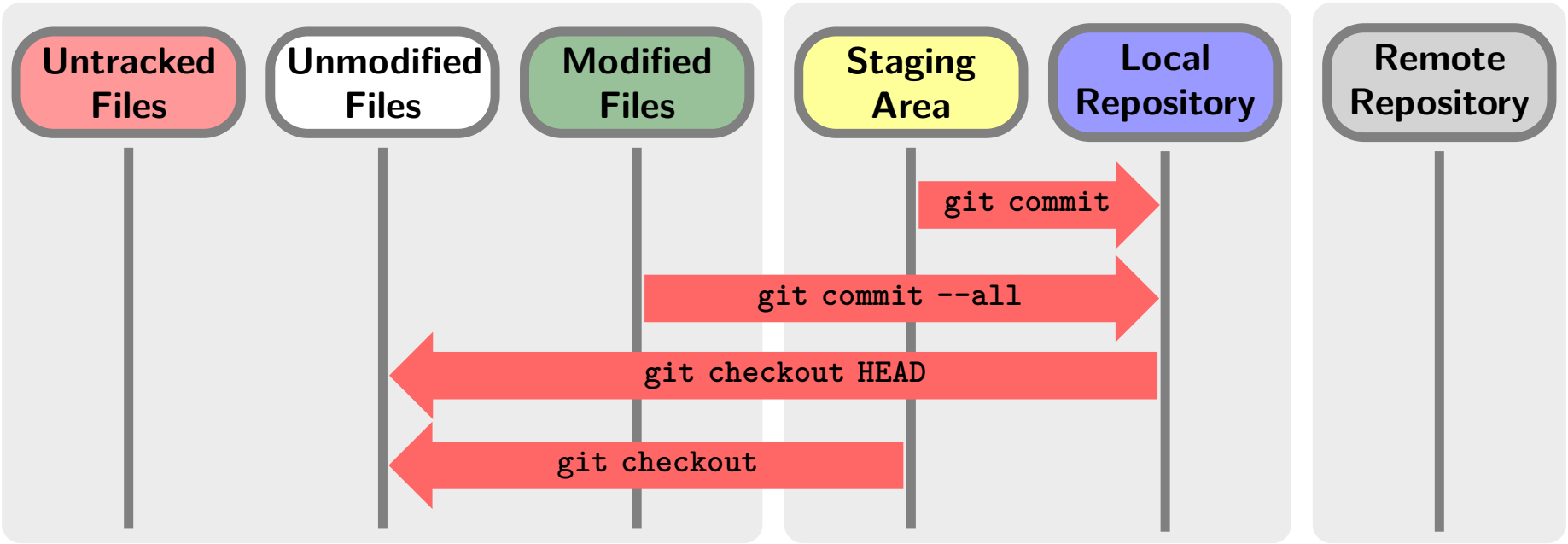
Commands: 'commit' and 'checkout'



Command 'git commit'

Store the content of the staging area in local repository.

- 'git commit --message="My message"': Send the commit with the given message.
- 'git commit --amend': Merge the current commit with the last one.
  (beware, use this only if you haven't pushed to remote!)

Command 'git checkout'

Change current working tree to another state in history or **reset staging area**.

- 'git checkout HEAD~n': Change the working tree to n commits in the past.

Example: 'commit' and 'checkout'

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Adding a README file"
[master 52ee35a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git log --oneline
52ee35a (HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~2
Note: checking out 'HEAD~2'.

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 9311eed Adding a .gitignore file
#> git log --oneline
9311eed (HEAD) Adding a .gitignore file
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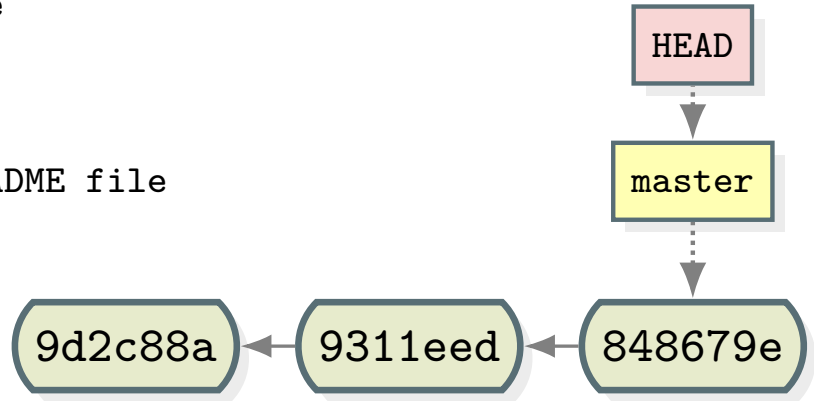

Example: 'commit' and 'checkout'

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#> git commit -m "Adding a README file"
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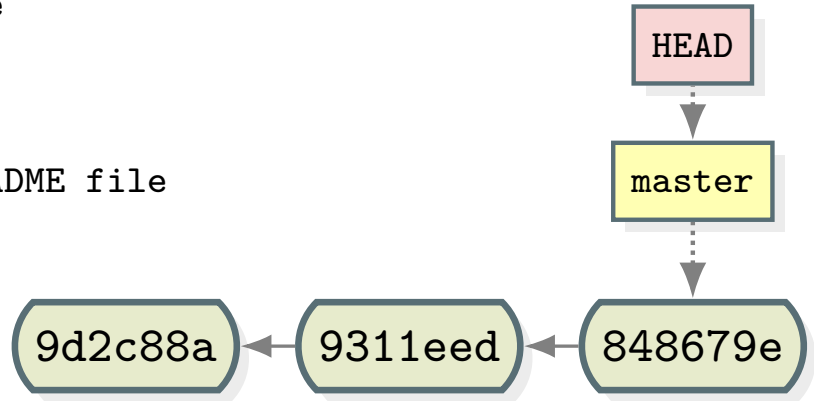

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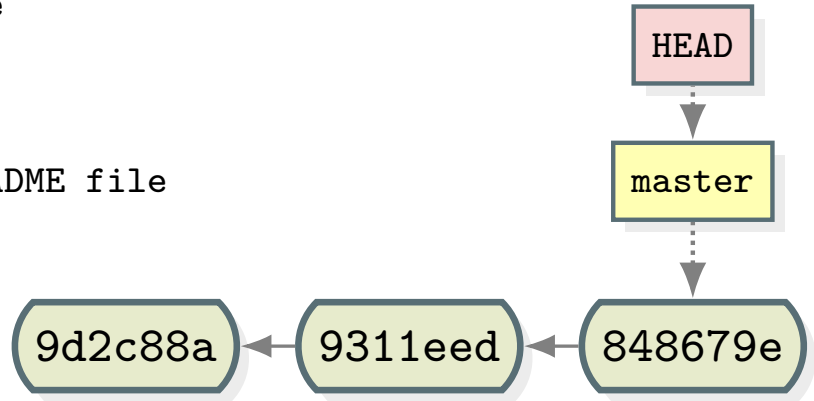

Example: 'commit' and 'checkout'

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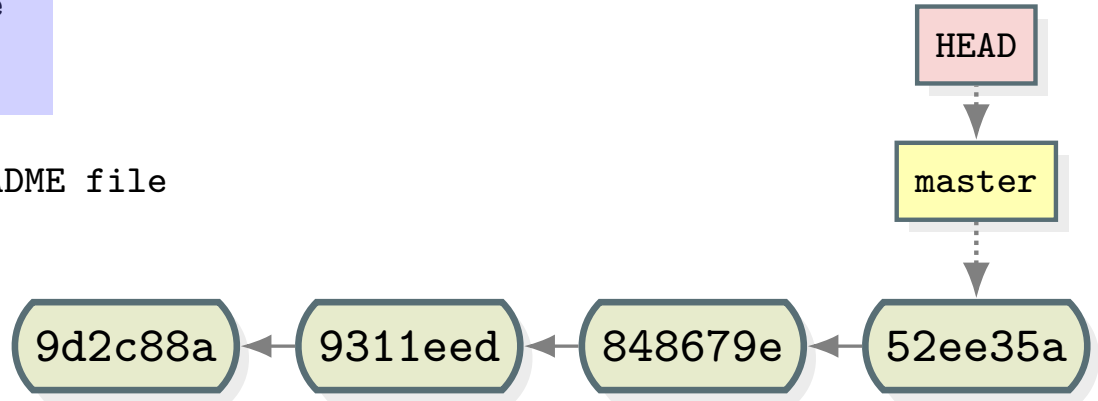
9311eed (HEAD) Adding a .gitignore file
9d2c88a Initial commit
```



Example: 'commit' and 'checkout'

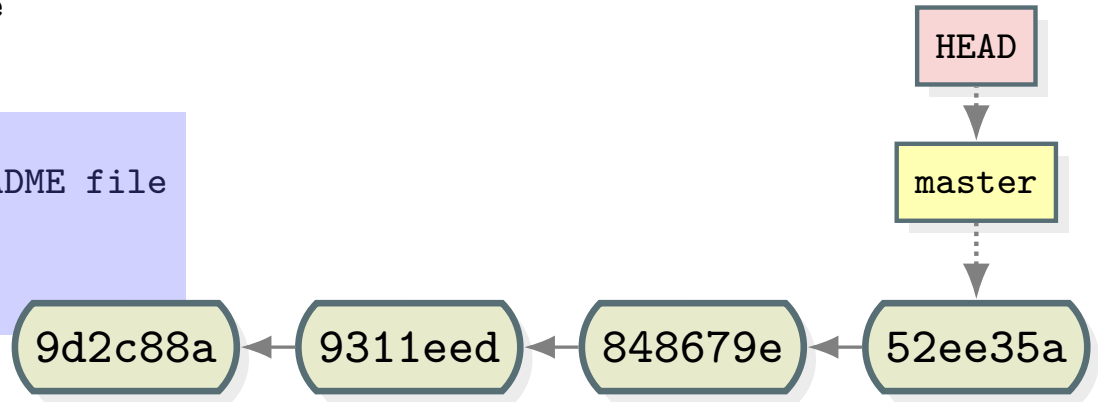
```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Adding a README file"
[master 52ee35a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git log --oneline
52ee35a (HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~2
Note: checking out 'HEAD~2'.

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 9311eed Adding a .gitignore file
#> git log --oneline
9311eed (HEAD) Adding a .gitignore file
9d2c88a Initial commit
```



Example: 'commit' and 'checkout'

université de BORDEAUX

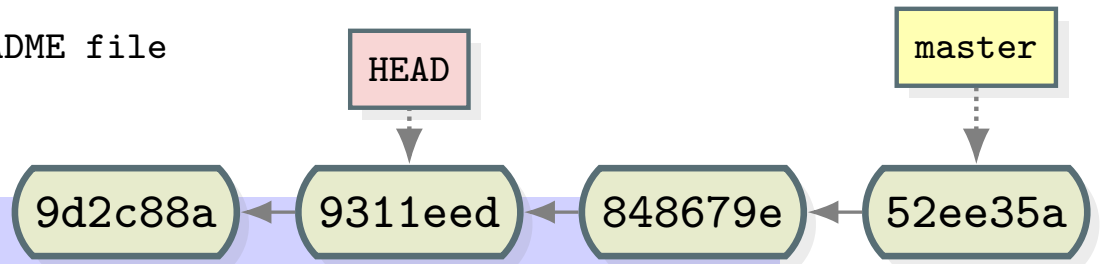
```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Adding a README file"
[master 52ee35a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git log --oneline
52ee35a (HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~2
Note: checking out 'HEAD~2'.

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 9311eed Adding a .gitignore file
#> git log --oneline
9311eed (HEAD) Adding a .gitignore file
9d2c88a Initial commit
```



Example: 'commit' and 'checkout'

université de BORDEAUX

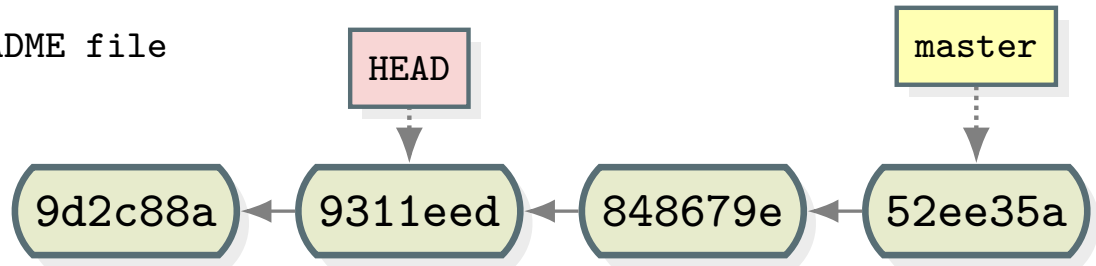
```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Adding a README file"
[master 52ee35a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git log --oneline
52ee35a (HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~2
Note: checking out 'HEAD~2'.

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.

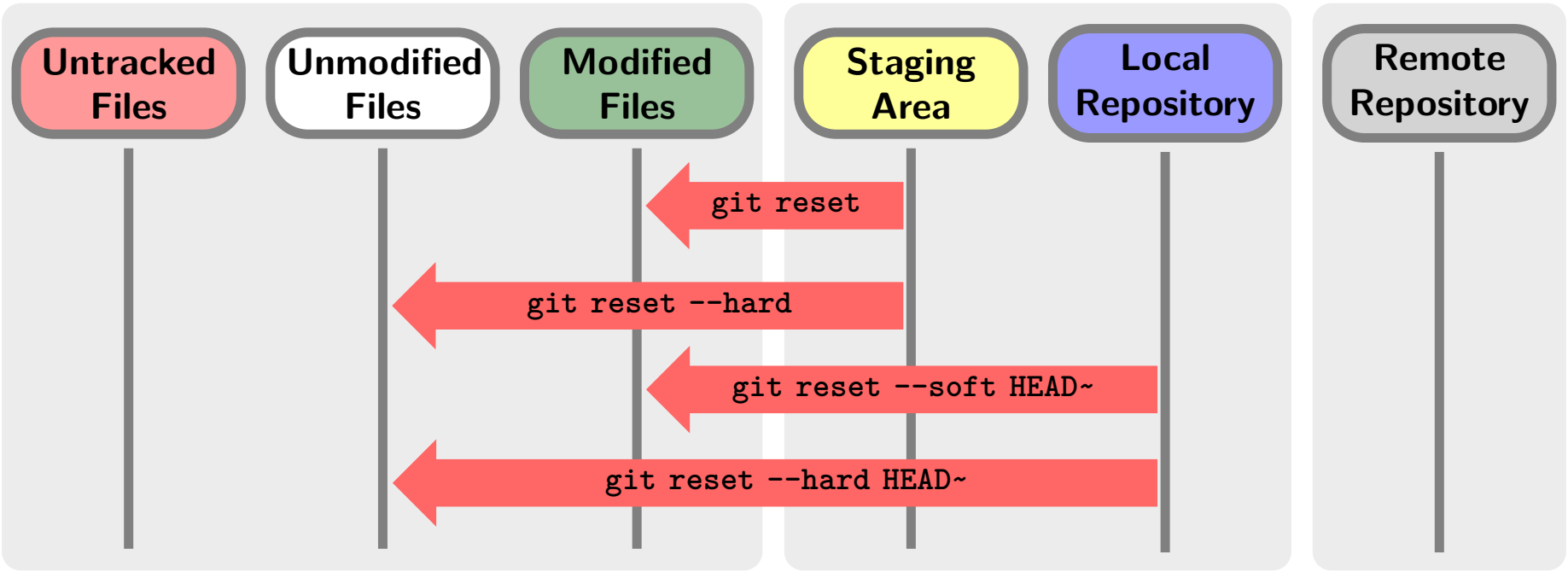
If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -b with the checkout command again. Example:

  git checkout -b <new-branch-name>

HEAD is now at 9311eed Adding a .gitignore file
#> git log --oneline
9311eed (HEAD) Adding a .gitignore file
9d2c88a Initial commit
```



Command: 'reset' (One More Time)



'`git reset`': Move `HEAD` to a specified state in the history.

- '`git reset (--mixed)`' (default): Resets staging area but not working tree. So, it keeps all the changes and they appear in the working tree as they were before '`git add`'.
- '`git reset --soft`': Leave staging area and working tree untouched but move `HEAD` to the given position. This option ensures that you keep all the changes you did since then, they appear in the staging area (but uncommitted).
- '`git reset --hard`': Reset staging area and working tree to the new state. It throws away all the pending changes (you can't get it back!) and return to a clean working tree.

Example: 'checkout' vs. 'reset' (1/2)

université de BORDEAUX

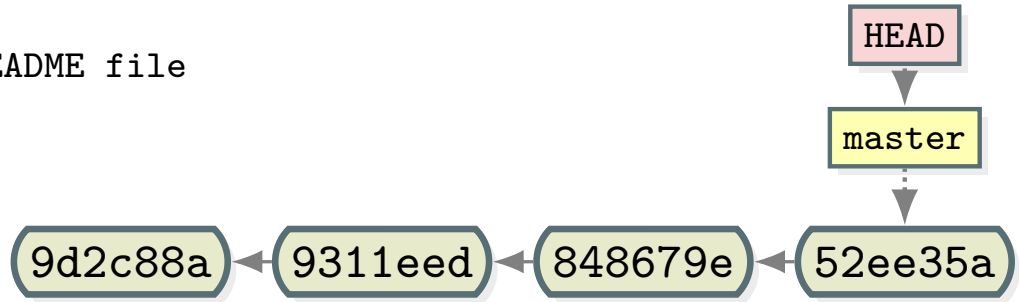
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~
Note: checking out 'HEAD~'.

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 848679e Cleaning and fixing bugs
#> git checkout master
Previous HEAD position was 848679e Cleaning and fixing bugs
Switched to branch 'master'
```



Example: 'checkout' vs. 'reset' (1/2)

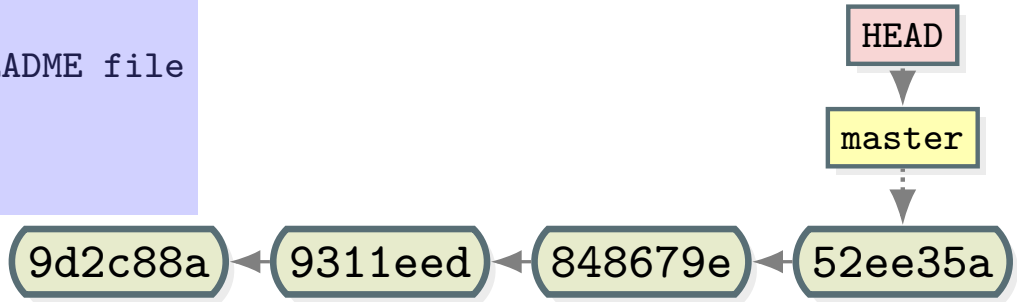
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~
Note: checking out 'HEAD~'.

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 848679e Cleaning and fixing bugs
#> git checkout master
Previous HEAD position was 848679e Cleaning and fixing bugs
Switched to branch 'master'
```



Example: 'checkout' vs. 'reset' (1/2)

université de BORDEAUX

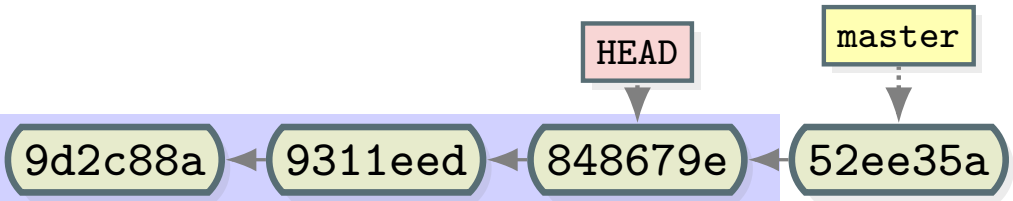
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~
Note: checking out 'HEAD~'.

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 848679e Cleaning and fixing bugs
#> git checkout master
Previous HEAD position was 848679e Cleaning and fixing bugs
Switched to branch 'master'
```



Example: 'checkout' vs. 'reset' (1/2)

université de BORDEAUX

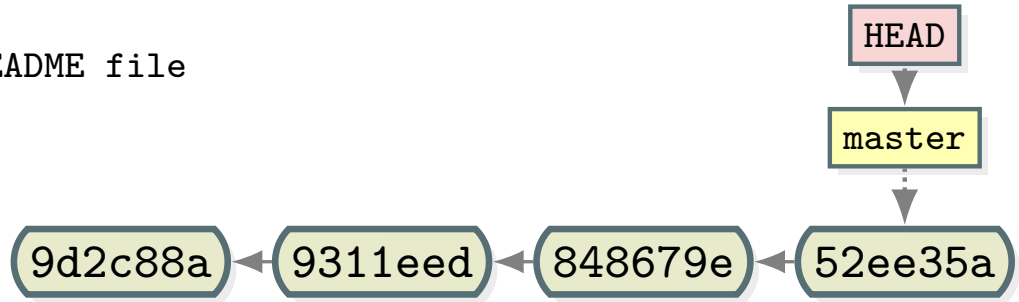
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git checkout HEAD~
Note: checking out 'HEAD~'.

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 848679e Cleaning and fixing bugs
#> git checkout master
Previous HEAD position was 848679e Cleaning and fixing bugs
Switched to branch 'master'
```

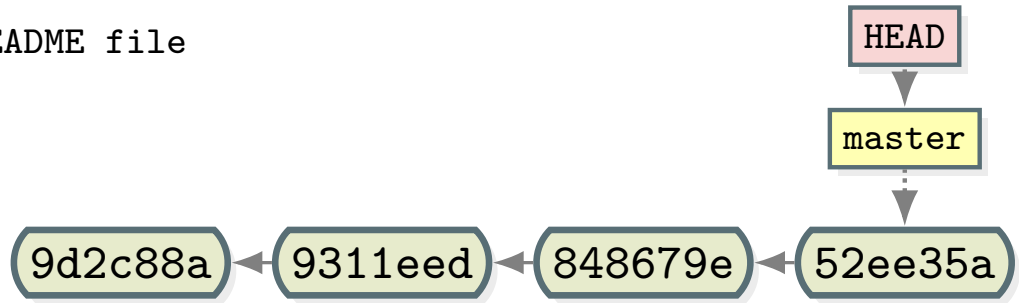


Example: 'checkout' vs. 'reset' (2/2)

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```

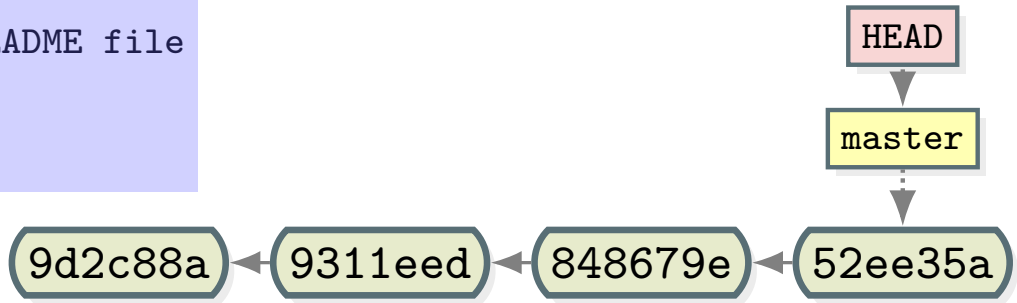


Example: 'checkout' vs. 'reset' (2/2)

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```



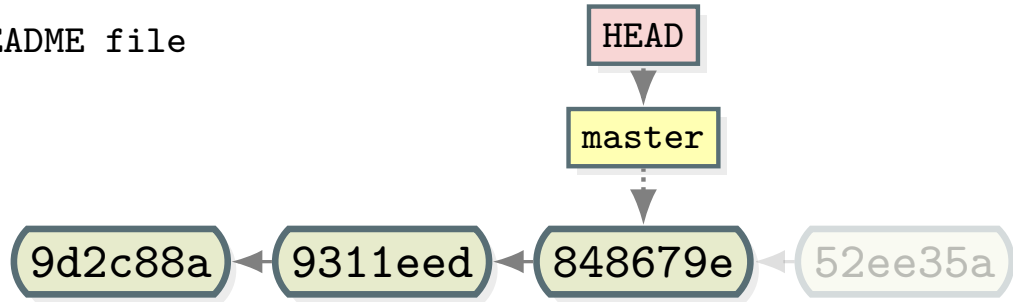
Example: 'checkout' vs. 'reset' (2/2)

université de BORDEAUX

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```



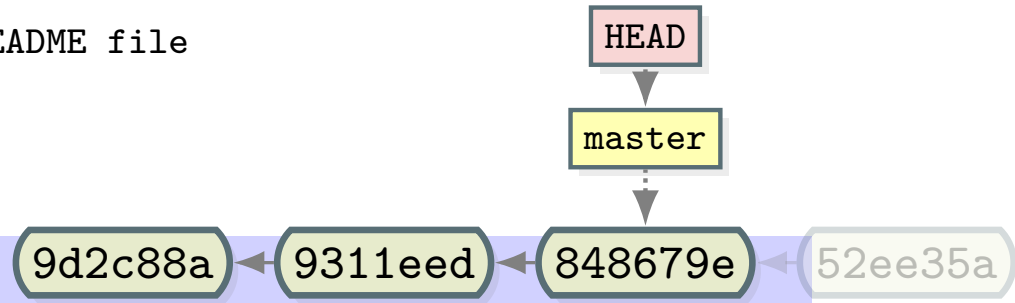
Example: 'checkout' vs. 'reset' (2/2)

université de BORDEAUX

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```



Example: 'checkout' vs. 'reset' (2/2)

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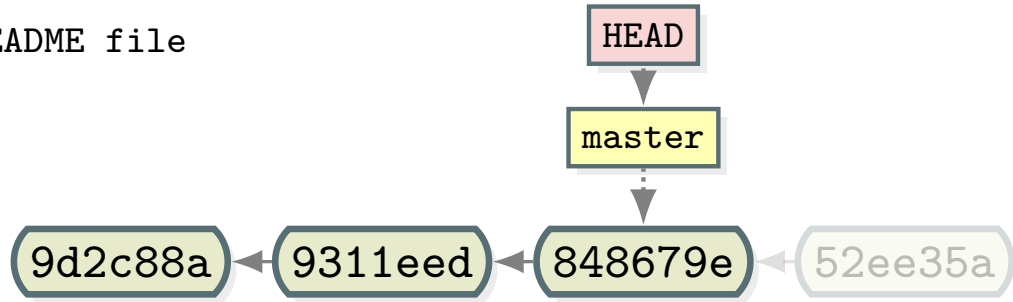
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```

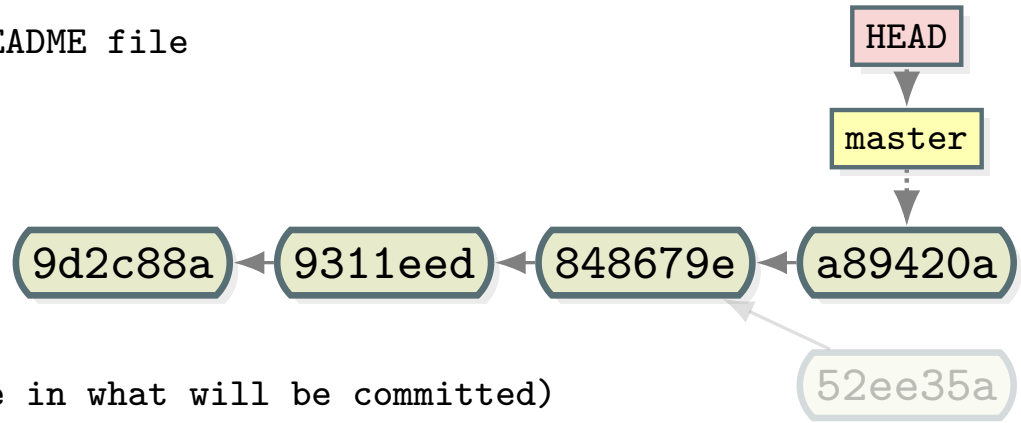


Example: 'checkout' vs. 'reset' (2/2)

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```



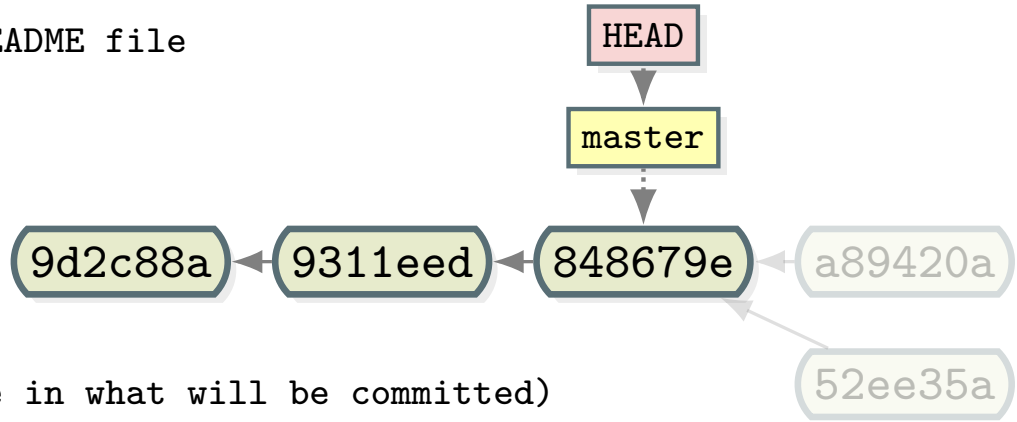
Example: 'checkout' vs. 'reset' (2/2)

université de BORDEAUX

```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```

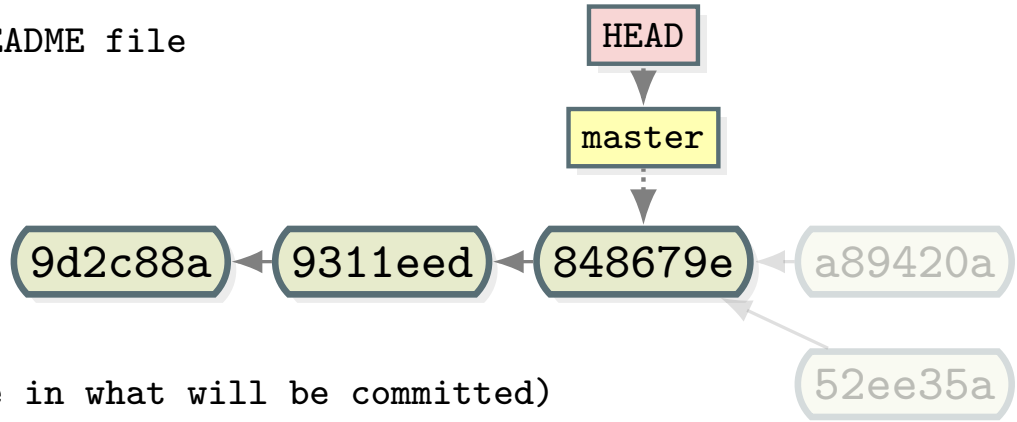


Example: 'checkout' vs. 'reset' (2/2)

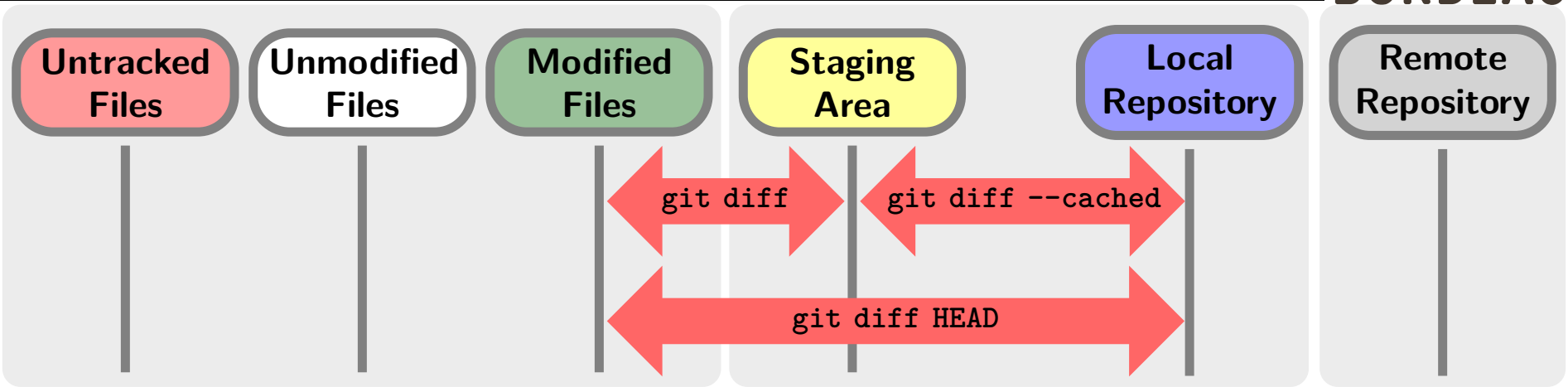
```
#> git log --oneline
52ee35a ((HEAD -> master) Adding a README file
848679e Cleaning and fixing bugs
9311eed Adding a .gitignore file
9d2c88a Initial commit
#> git reset HEAD~
#> git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

        README

nothing added to commit but untracked files present (use "git add" to track)
#> git checkout master
Already on 'master'
#> git add README
#> git commit -m "Adding a README file"
[master a89420a] Adding a README file
 1 file changed, 1 insertion(+)
 create mode 100644 README
#> git reset --hard HEAD~
HEAD is now at 848679e Cleaning and fixing bugs
#> git status
On branch master
nothing to commit, working tree clean
```



Command: 'diff'



'git diff': Show the differences between two states of the history.

- 'git diff': Displays changes between the tracked modified files and the staging area.
- 'git diff --cached': Displays changes between the staging area and current HEAD.
- 'git diff HEAD': Displays changes between the tracked modified files and current HEAD.
- 'git diff HEAD HEAD~': Displays changes between two states (HEAD and its ancestor).

```
#> git diff
diff --git a/README b/README
index 980a0d5..2c1251f 100644
--- a/README
+++ b/README
@@ -1 +1,2 @@
 Hello World!
+Added to README
```

Names of the diffed files

Hashes of the diffed commits

Unnecessary trailing whitespaces are marked in red!

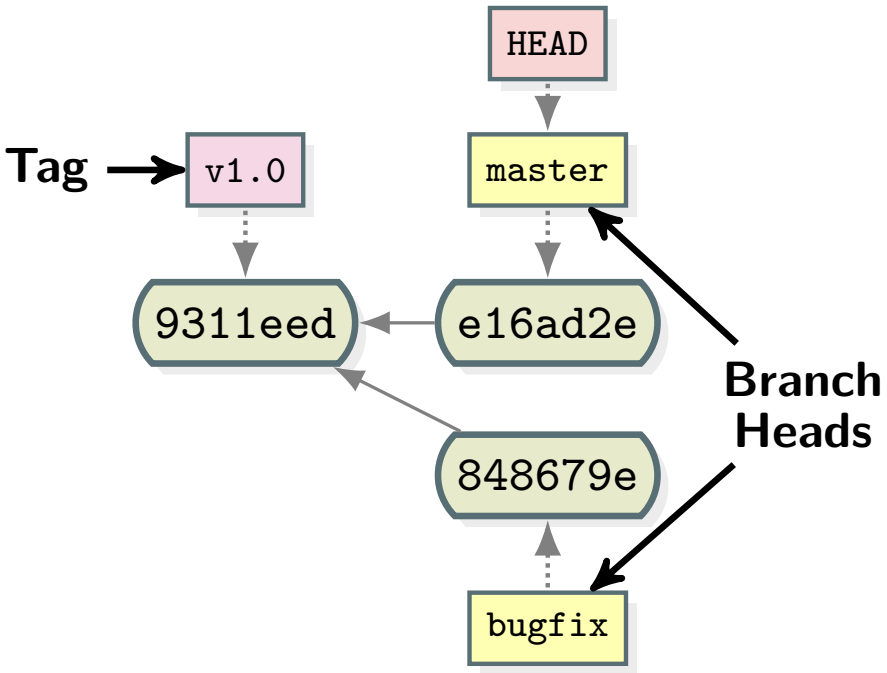
Overview

Branches & Tags

```
#> git log --oneline --graph --all
* e16ad2e (HEAD -> master) Adding a README file
| * 848679e (bugfix) Cleaning and fixing bugs
|/
* 9311eed (tag: v1.0) Initial commit
```

- **Tag**: A label on a commit that will stay forever (except if you delete it).

- **Branch**: Denoted by a label marking the head of the branch. The label will be pushed forward if a new commit occurs on the branch.



Example: Managing Branches and Tags

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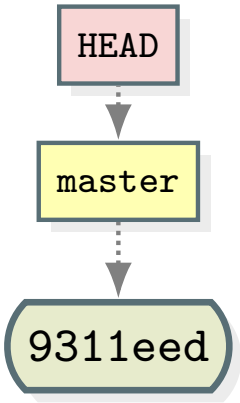
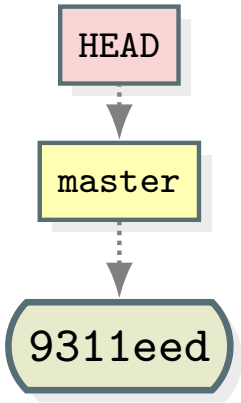
```
#> git  log --oneline
9311eed (HEAD -> master) Initial commit
#> git tag "v1.0"
#> git  log --oneline
9311eed (HEAD -> master, tag: v1.0) Initial commit
#> git checkout -b bugfix
Switched to a new branch 'bugfix'
#> emacs project.c
... Cleaning and fixing bugs ...
#> git commit -a -m "Cleaning and fixing bugs"
[bugfix 848679e] Cleaning and fixing bugs
 1 file changed, 7 insertion(+)
#> git checkout master
Switched to branch 'master'
#> emacs README &
... Adding a README file ...
#> git add README
#> git commit -m "Adding a README file"
[master e16ad2e] Adding a README file
 create mode 100644 README
#> git log --oneline --graph --all
* e16ad2e (HEAD -> master) Adding a README file
| * 848679e (bugfix) Cleaning and fixing bugs
|/
* 9311eed (tag: v1.0) Initial commit
```



Example: Managing Branches and Tags

```
#> git  log --oneline
9311eed (HEAD -> master) Initial commit
#> git tag "v1.0"
#> git  log --oneline
9311eed (HEAD -> master, tag: v1.0) Initial commit
#> git checkout -b bugfix
Switched to a new branch 'bugfix'
#> emacs project.c
... Cleaning and fixing bugs ...
#> git commit -a -m "Cleaning and fixing bugs"
[bugfix 848679e] Cleaning and fixing bugs
 1 file changed, 7 insertion(+)
#> git checkout master
Switched to branch 'master'
#> emacs README &
... Adding a README file ...
#> git add README
#> git commit -m "Adding a README file"
[master e16ad2e] Adding a README file
 create mode 100644 README
#> git log --oneline --graph --all
* e16ad2e (HEAD -> master) Adding a README file
| * 848679e (bugfix) Cleaning and fixing bugs
|/
* 9311eed (tag: v1.0) Initial commit
```



Example: Managing Branches and Tags

université de BORDEAUX

```
#> git  log --oneline
9311eed (HEAD -> master) Initial commit
#> git tag "v1.0"
#> git  log --oneline
9311eed (HEAD -> master, tag: v1.0) Initial commit
#> git checkout -b bugfix
Switched to a new branch 'bugfix'
#> emacs project.c
... Cleaning and fixing bugs ...
#> git commit -a -m "Cleaning and fixing bugs"
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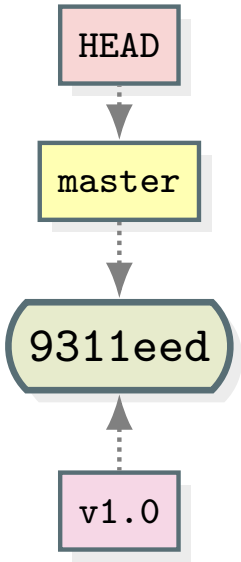

Example: Managing Branches and Tags

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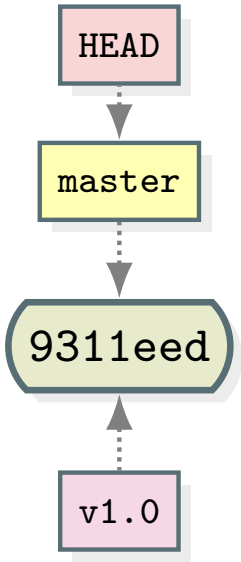

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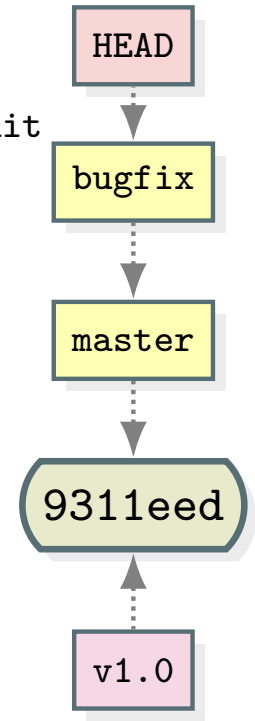

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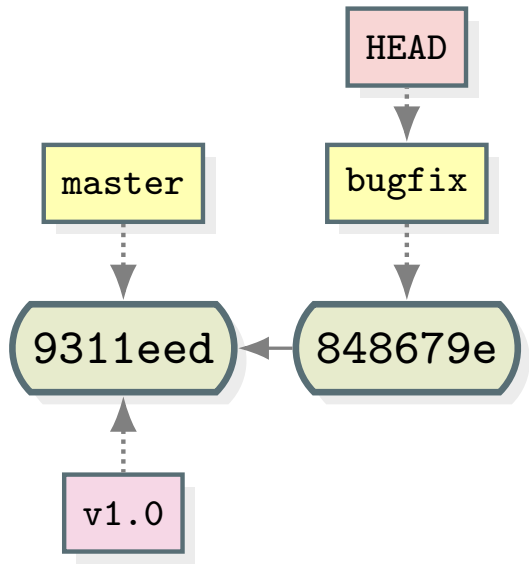

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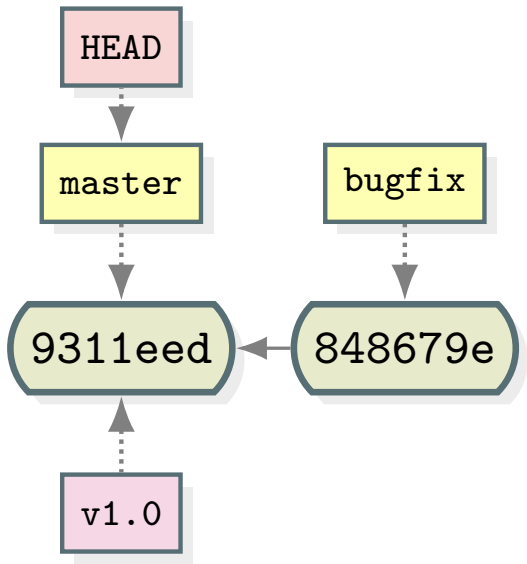

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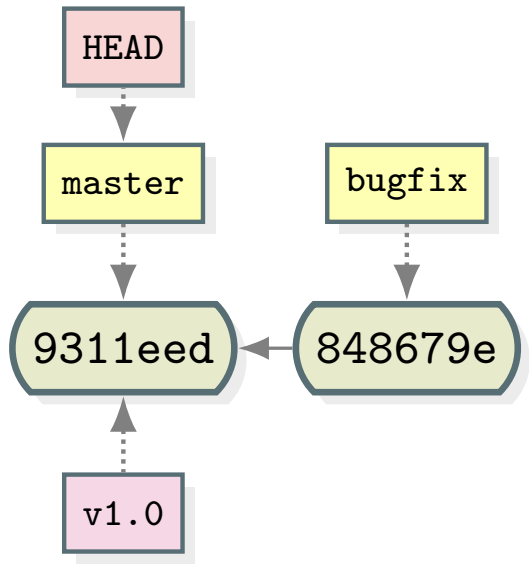

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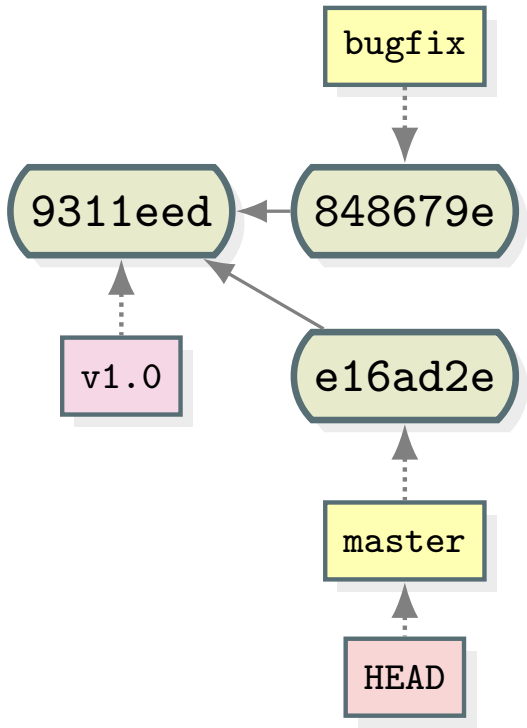

Example: Managing Branches and Tags

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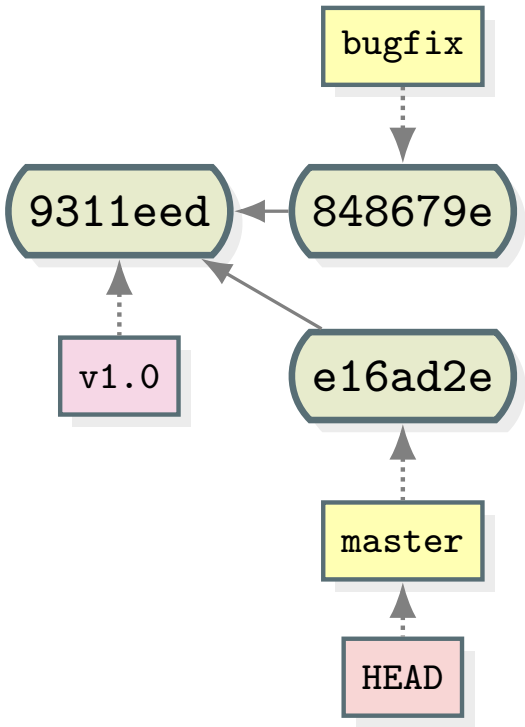

Commands: 'merge' and 'rebase'

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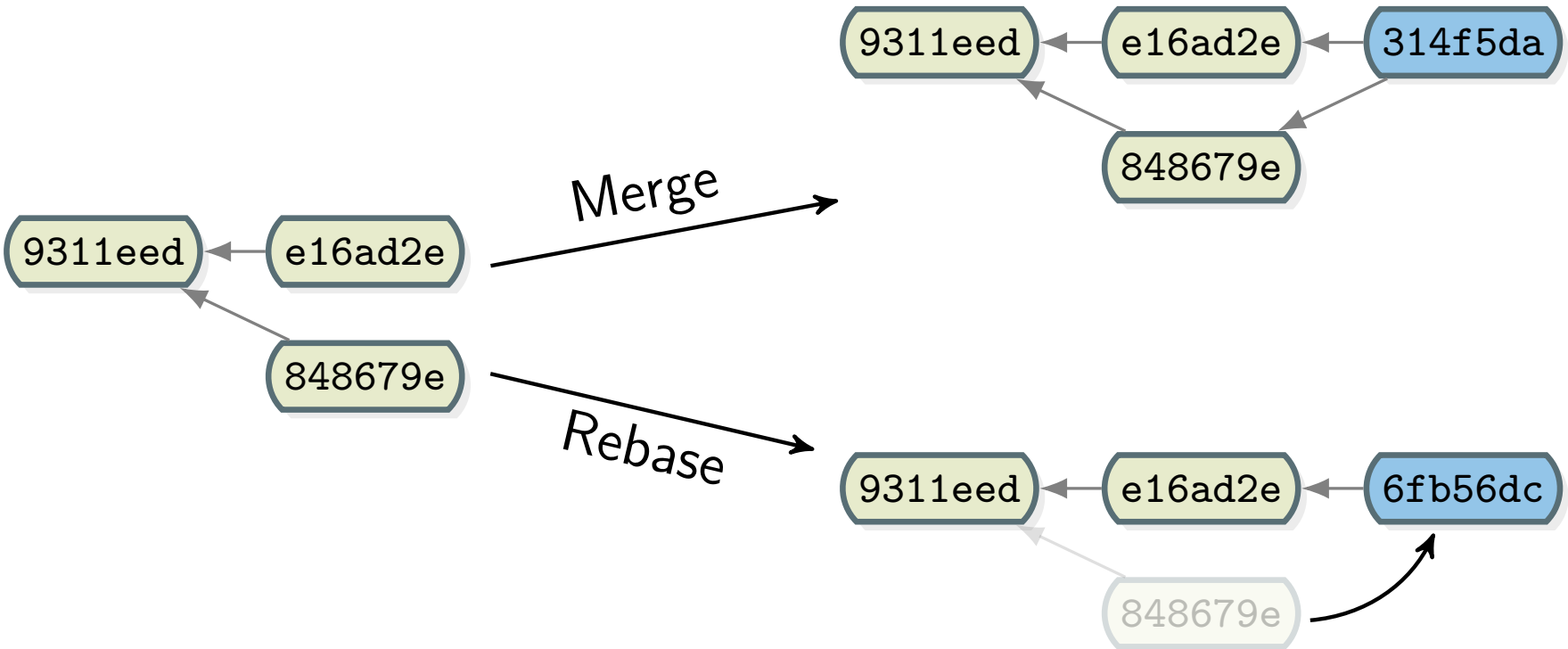
Merge

Merge is a **non-destructive** operation on the history. It is used when the history need to be kept. Typically when incorporating new features in common branches (*e.g.* `master`).

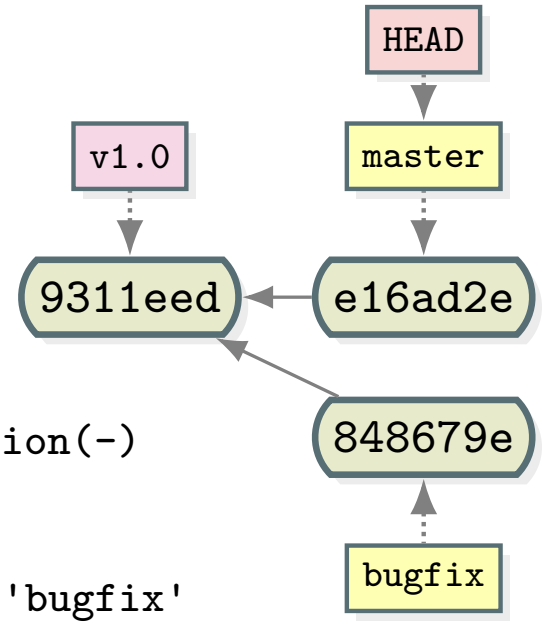


Rebase

An alternative to merge that **rewrite** its own history. It is used to keep your current work-in-progress branches up to date with `master` when updating.

Example: Merging Branches

```
#> git branch
  bugfix
* master
#> git merge bugfix
Removing project
Merge made by the 'recursive' strategy.
 Makefile  |   2 +-
 project   | Bin 17084 -> 0 bytes
 project.c |   2 ++
 3 files changed, 3 insertions(+), 1 deletion(-)
 delete mode 100644 project
#> git log --oneline --graph --all
*   314f5da (HEAD -> master) Merge branch 'bugfix'
|\
| * 848679e (bugfix) Cleaning and fixing bugs
|/
* 9311eed (tag: v1.0) Initial commit
```



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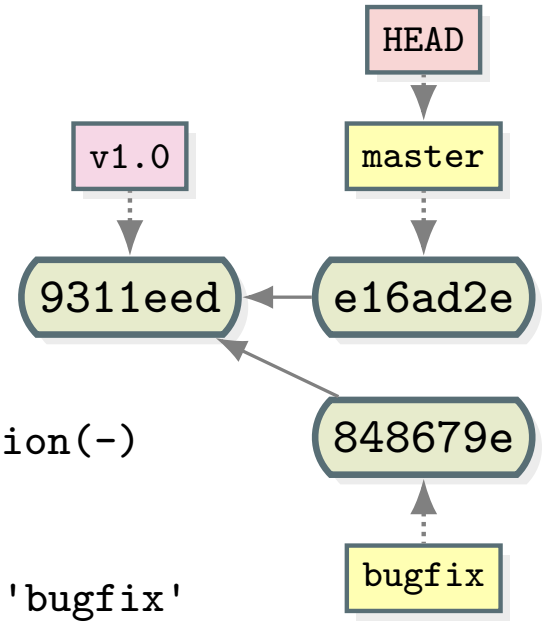

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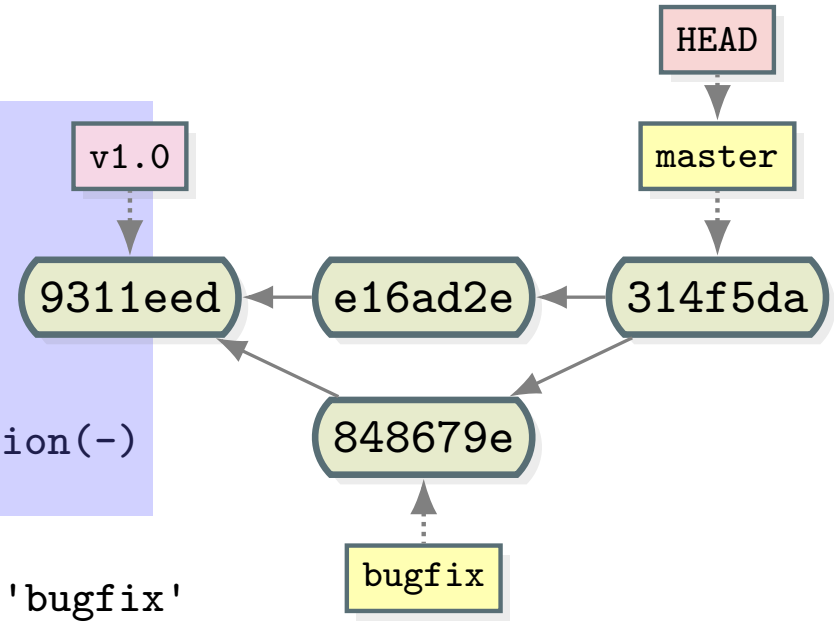

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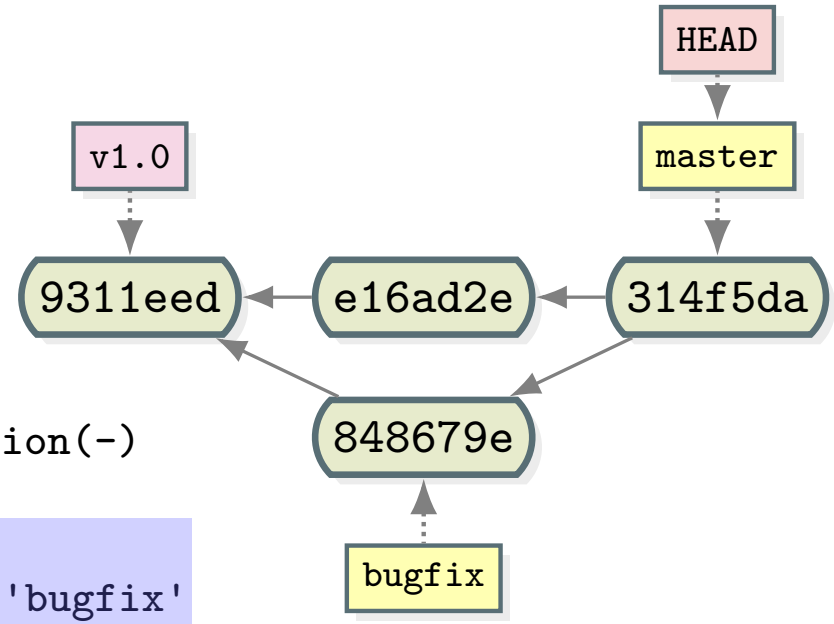
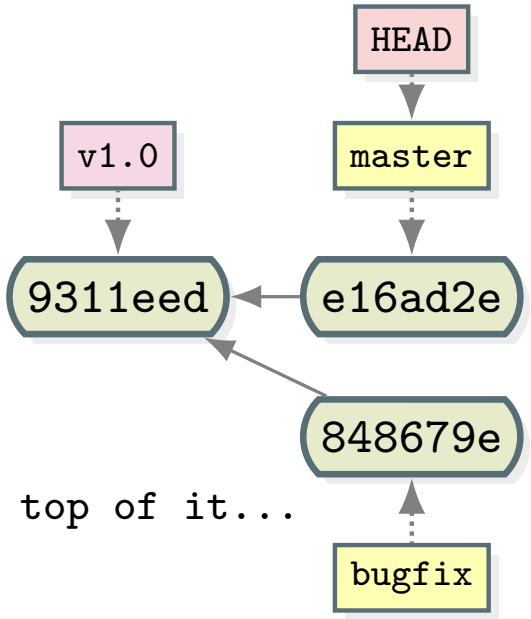


Example: Rebasing Branches

```
#> git branch
  bugfix
* master
#> git checkout bugfix
Switched to branch 'bugfix'
#> git branch
* bugfix
  master
#> git rebase master
First, rewinding head to replay your work on top of it...
Applying: Cleaning and fixing bugs
#> git log --oneline --graph --all
* 6fb56dc (HEAD -> bugfix) Cleaning and fixing bugs
* e16ad2e (master) Adding a README file
* 9311eed (tag: v1.0) Initial commit
```



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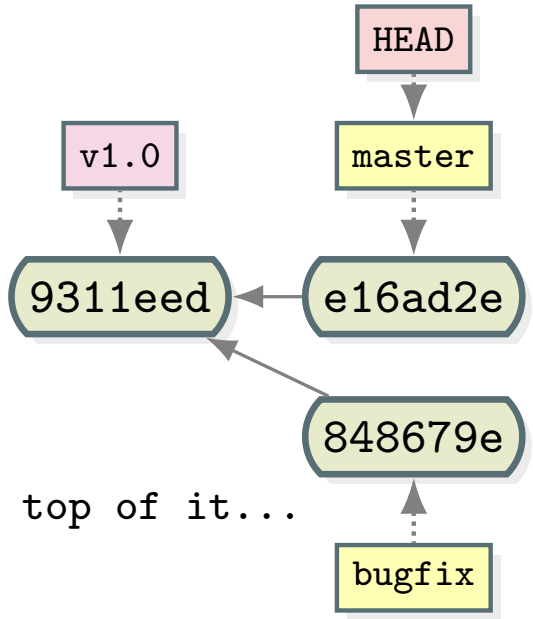

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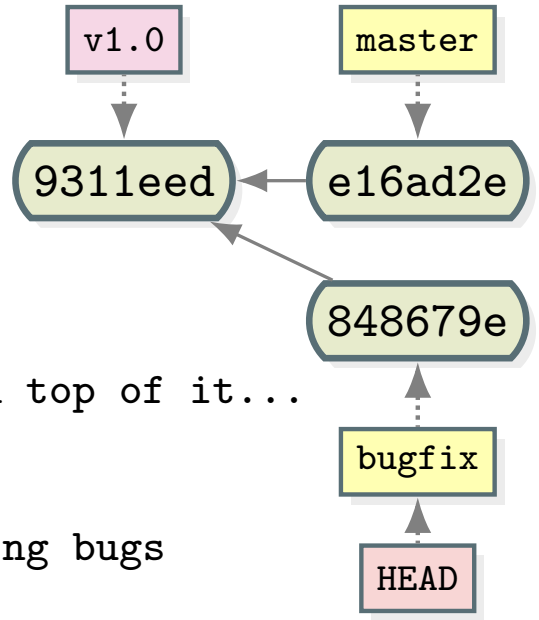

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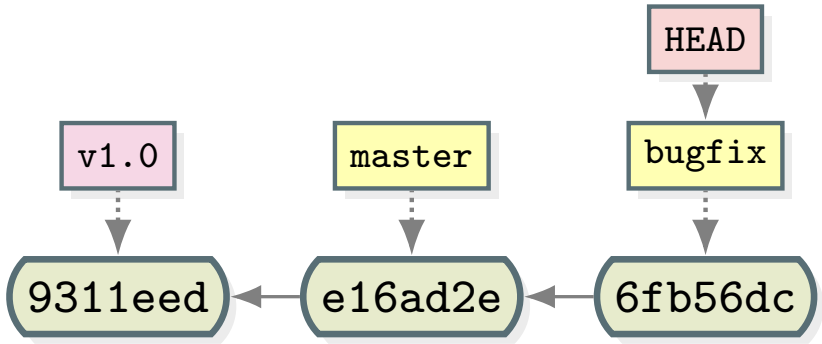

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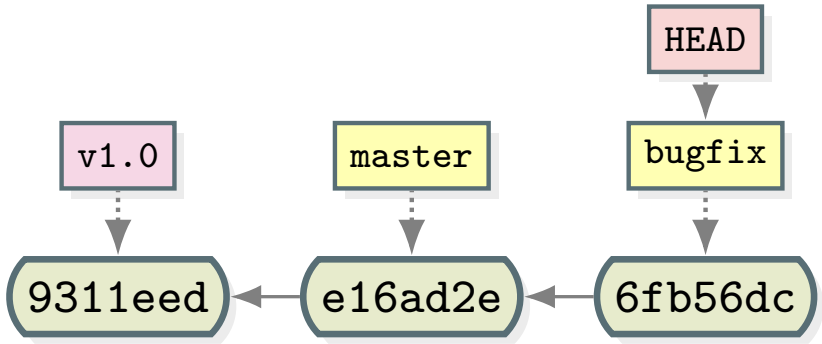

Was it 'HEAD^3~2' or 'HEAD^2~3' ?

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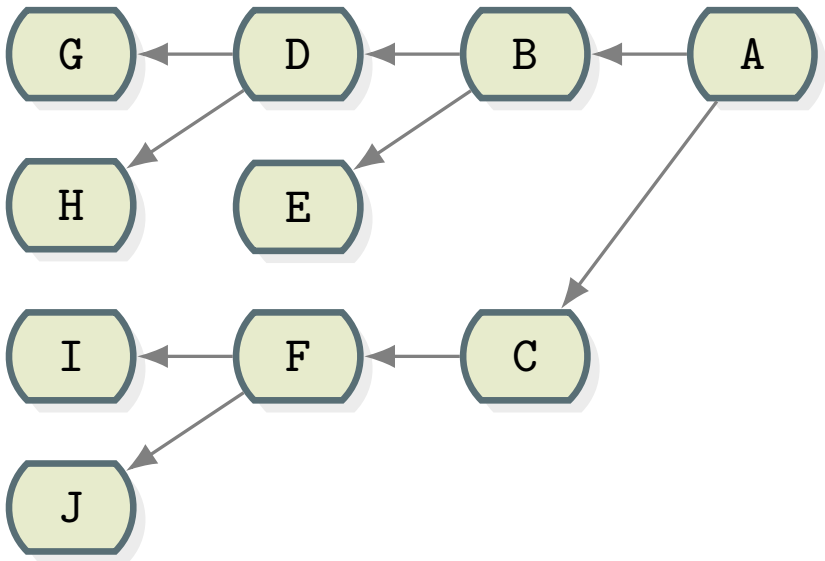
As we can branch now, we cannot cope only with the HEAD~ notation. We need to be able to navigate in a bi-dimensional space, so we need to introduce another HEAD^ notation which allows to select a branch.

Here are a few examples:

- HEAD~2: The first ancestor of the ancestor of HEAD.
- HEAD^3: The third ancestor of HEAD (starting from upper side).

```
A =       = A^0
B = A^    = A^1      = A~1
C = A^2   = A^2
D = A^^   = A^1^1    = A~2
E = B^2   = A^^2
F = B^3   = A^^3
G = A^^^  = A^1^1^1  = A~3
H = D^2   = B^^2     = A^^^2   = A~2^2
I = F^    = B^3^     = A^^3^
J = F^2   = B^3^2    = A^^3^2
```



Overview

What is a Repository?

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A **Git Repository** is a hierarchy of files and directories (working tree) with a hidden `.git/` directory in its top directory (repository data).

A `.git/` directory contains (not exhaustive, see '`gitrepository-layout(5)`'):

```
.git/
  |
  +- branches/       # Deprecated way of storing branches
  +- COMMIT_EDITMSG  # Last commit message
  +- config          # Configuration file (see later)
  +- description     # Used by gitweb to store project description
  +- HEAD            # Pointer on refs/heads to the current branch HEAD
  +- hooks/          # A set of scripts automatically applied on commit/pull/...
  +- index           # Staging area (difference between working tree and HEAD)
  +- info/           # Additional information about the repository
  |  +- exclude      # Locally excluded files (won't be shared as the .gitignore)
  +- objects/        # Contains all the files, commits and trees of your history
  +- refs/           # References are stored in subdirectories of this directory
  |  +- heads/foo    # Records tip-of-the-tree commit objects of branch 'foo'
  |  +- remotes/foo  # Records tip-of-the-tree commit objects of remote 'foo'
  |  +- tags/foo     # Records any object 'foo'
  \- remotes         # URL and default refnames for remote repositories
```

Create a Fresh Repository

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Initialize an empty repository (working tree and .git/)

(Usefull to start a new project with its own history)

```
#> git init my_project/
Initialized empty Git repository in /home/user/my_project/.git/
#> cd  my_project/
#> git status
On branch master
No commits yet
nothing to commit (create/copy files and use "git add" to track)
#> echo "Hello!" > README
#> git add .
#> git commit -m "Initial commit"
[master (root-commit) 1305a7c] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README
```

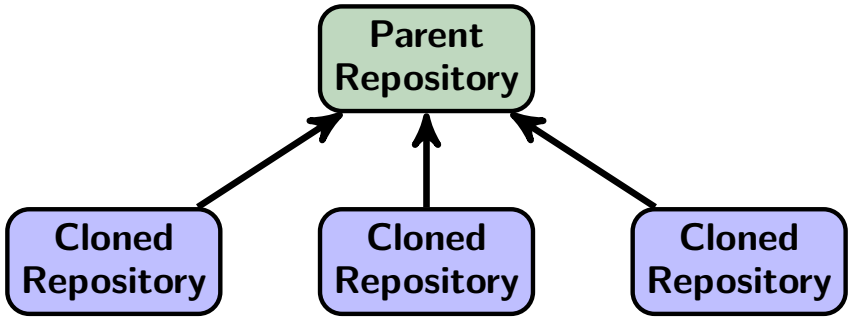
Initialize a '*bare*' repository (no working tree, only history)

(Usefull to store code history on a server to synchronize with others)

```
#> git init --bare my_project/
Initialized empty Git repository in /home/user/my_project/.git/
#> ls my_project/
branches/  config  description  HEAD  hooks/  info/  objects/  refs/
```

Clone an Existing Repository

Clone a repository is **equivalent to create a copy and keep a link towards the parent repository** (configured to 'push' to parent and 'pull' from it).



Copy an existing repository (same file-system)

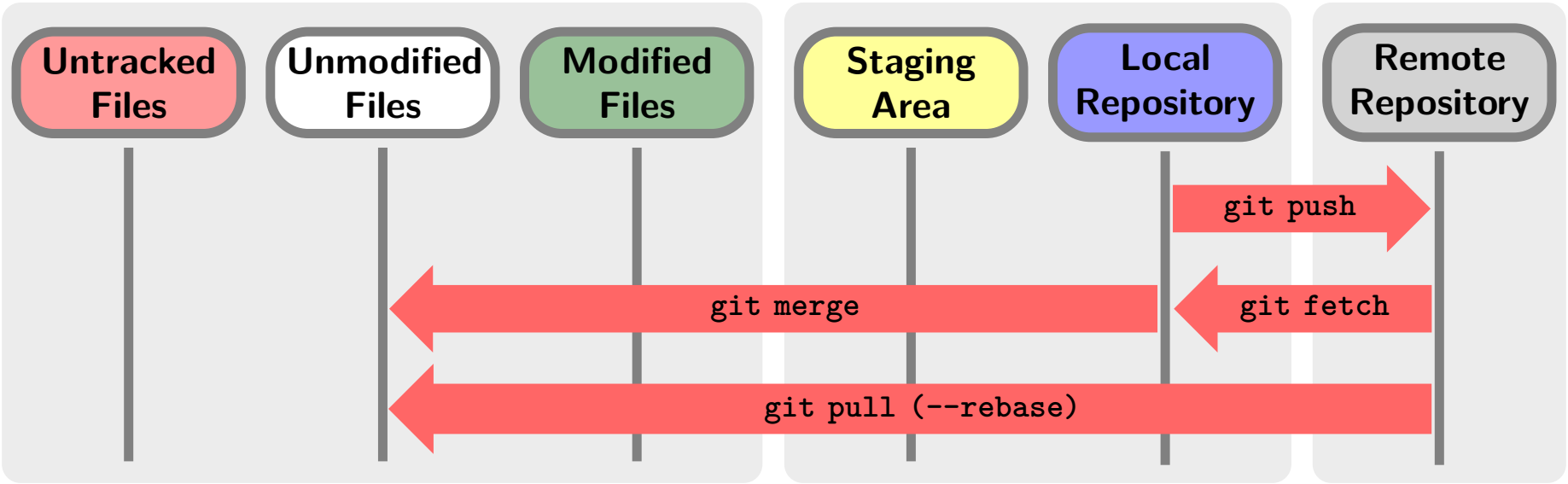
```
#> git clone my_project/ my_project-clone
Cloning into 'my_project-clone'...
done.
```

Copy an existing repository (remote repository through ssh)

```
#> git clone ssh://user@localhost/home/user/my_project my_project-remote
Cloning into 'my_project-remote'...
remote: Enumerating objects: 3, done.
remote: Counting objects: 100% (3/3), done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Receiving objects: 100% (3/3), done.
```

Overview

Synchronize with Remote Repository



- `git push`: Update local repository with the content of a remote repository.
  (`git` refuse to destroy remote objects by default, use '`git push --force`' when needed)
- `git fetch`: Download the history from remote repository to local repository.
- `git merge`: Join two (or more) code histories together.
- `git pull`: Perform a `fecth` and a `merge` at once. Consider this operation as "*dangerous*" and prefer to use `fecth` and `merge` or '`pull --rebase`'.
- `git remote`: Manage the remote repositories of this local repository.

Example: Synchronize with Remotes

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```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```

Example: Synchronize with Remotes

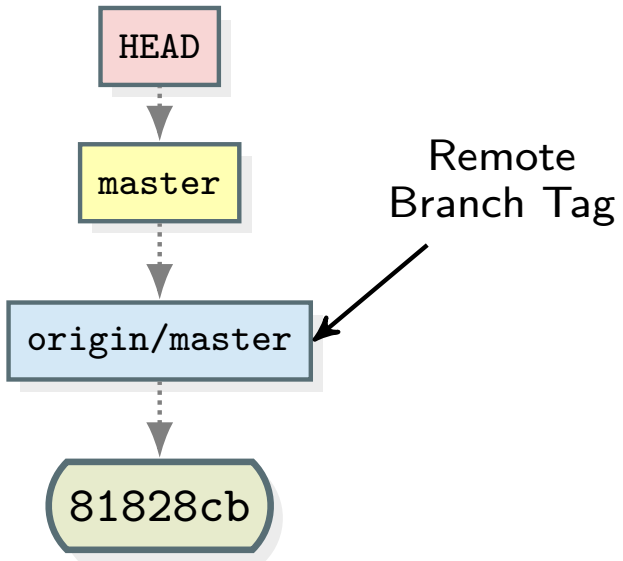
université de BORDEAUX

```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```

Example: Synchronize with Remotes

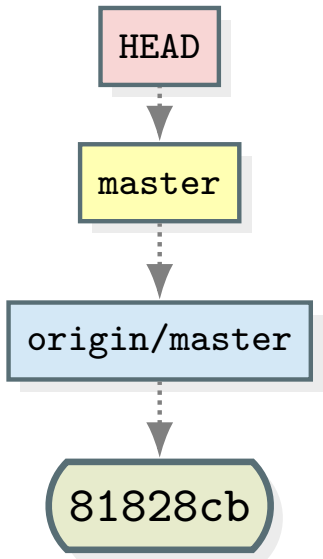
université de BORDEAUX

```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```



Example: Synchronize with Remotes

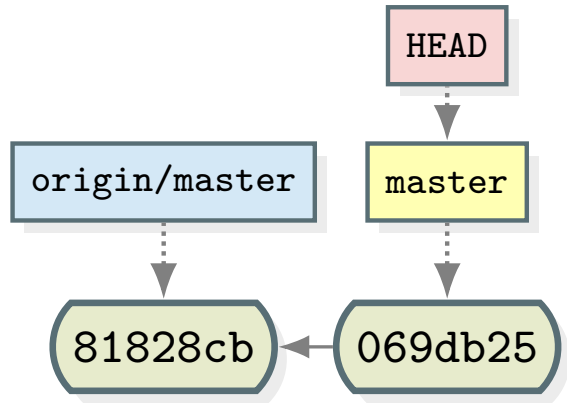
```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```



Example: Synchronize with Remotes

université de BORDEAUX

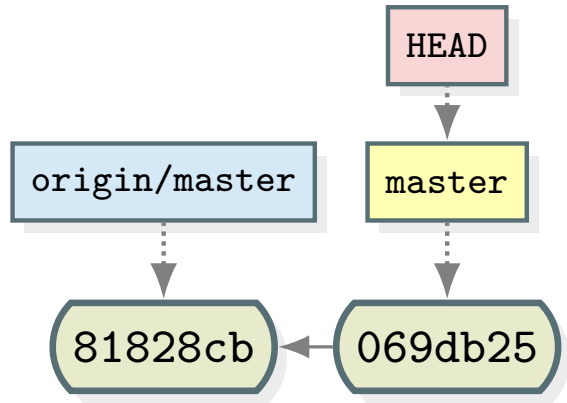
```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```



Example: Synchronize with Remotes

université de BORDEAUX

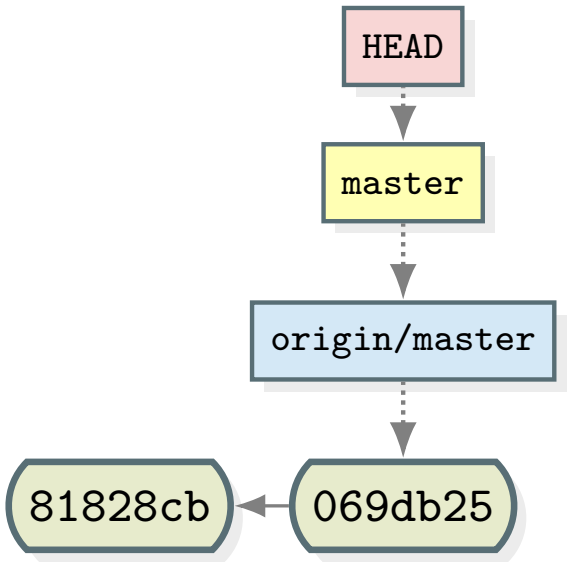
```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```



Example: Synchronize with Remotes

université de BORDEAUX

```
#> git clone my_repo/ my_project
Cloning into 'my_project'...
done.
#> cd my_project/
#> git log --oneline
81828cb (HEAD -> master, origin/master, origin/HEAD) Initial release
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> nano README
#> git commit -a
[master 069db25] Added a line in README file
 1 file changed, 1 insertion(+)
#> git log --oneline
069db25 (HEAD -> master) Added a line in README file
81828cb (origin/master, origin/HEAD) Initial release
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Writing objects: 100% (3/3), 285 bytes | 285.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   81828cb..069db25  master -> master
```



Example: Send Local Branch to Remote

université de BORDEAUX

```
#> git remote -v
origin        /home/user/my_repo/ (fetch)
origin        /home/user/my_repo/ (push)
#> git branch -a
* master
  remotes/origin/HEAD -> origin/master
  remotes/origin/master
#> git checkout -b bugfix
Switched to a new branch 'bugfix'

    ... work and commit on this branch ...

#> git push --set-upstream origin bugfix
Total 0 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      bugfix -> bugfix
Branch 'bugfix' set up to track remote branch 'bugfix' from 'origin'.
#> git branch -a
* bugfix
  master
  remotes/origin/HEAD -> origin/master
  remotes/origin/bugfix
  remotes/origin/master
```

Example: Synchronizing First Commits

université de BORDEAUX

Creating the main repository

```
#> git init --bare my_repo
Initialized empty Git repository in /home/user/my_repo/
```

Cloning the main repository to `project1/`

```
#> git clone my_repo/ project1
Cloning into 'project1'...
warning: You appear to have cloned an empty repository.
done.
```

Cloning the main repository to `project2/`

```
#> git clone my_repo/ project2
Cloning into 'project2'...
warning: You appear to have cloned an empty repository.
done.
```

Example: 'push' (project1)

université de BORDEAUX

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Initial commit"
[master (root-commit) 848679e] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README

#> echo "Second line" >> README
#> git commit -a -m "Second commit"
[master aea37e6] Second commit
 1 file changed, 1 insertion(+)

#> git push
Enumerating objects: 6, done.
Counting objects: 100% (6/6), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (6/6), 471 bytes | 471.00 KiB/s, done.
Total 6 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      master -> master

#> git log --oneline
aea37e6 (HEAD -> master, origin/master, origin/HEAD) Second commit
848679e Initial commit
```

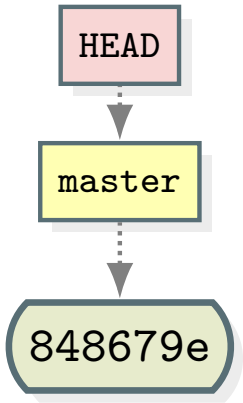
Example: 'push' (project1)

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Initial commit"
[master (root-commit) 848679e] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README

#> echo "Second line" >> README
#> git commit -a -m "Second commit"
[master aea37e6] Second commit
 1 file changed, 1 insertion(+)

#> git push
Enumerating objects: 6, done.
Counting objects: 100% (6/6), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (6/6), 471 bytes | 471.00 KiB/s, done.
Total 6 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      master -> master

#> git log --oneline
aea37e6 (HEAD -> master, origin/master, origin/HEAD) Second commit
848679e Initial commit
```



Example: 'push' (project1)

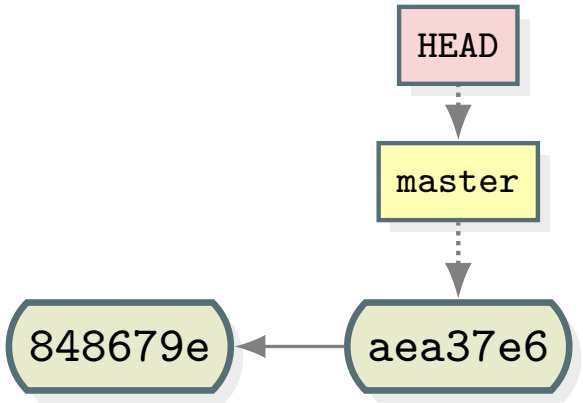
université de BORDEAUX

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Initial commit"
[master (root-commit) 848679e] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README

#> echo "Second line" >> README
#> git commit -a -m "Second commit"
[master aea37e6] Second commit
 1 file changed, 1 insertion(+)

#> git push
Enumerating objects: 6, done.
Counting objects: 100% (6/6), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (6/6), 471 bytes | 471.00 KiB/s, done.
Total 6 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      master -> master

#> git log --oneline
aea37e6 (HEAD -> master, origin/master, origin/HEAD) Second commit
848679e Initial commit
```



Example: 'push' (project1)

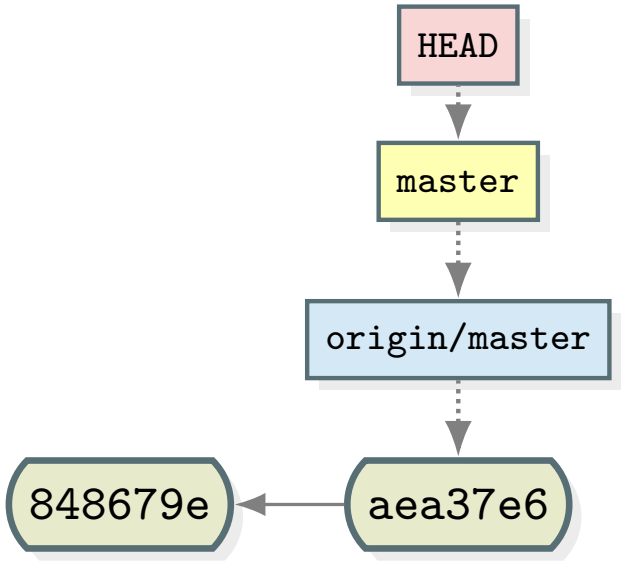
université de BORDEAUX

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Initial commit"
[master (root-commit) 848679e] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README

#> echo "Second line" >> README
#> git commit -a -m "Second commit"
[master aea37e6] Second commit
 1 file changed, 1 insertion(+)

#> git push
Enumerating objects: 6, done.
Counting objects: 100% (6/6), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (6/6), 471 bytes | 471.00 KiB/s, done.
Total 6 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      master -> master

#> git log --oneline
aea37e6 (HEAD -> master, origin/master, origin/HEAD) Second commit
848679e Initial commit
```



Example: 'push' (project1)

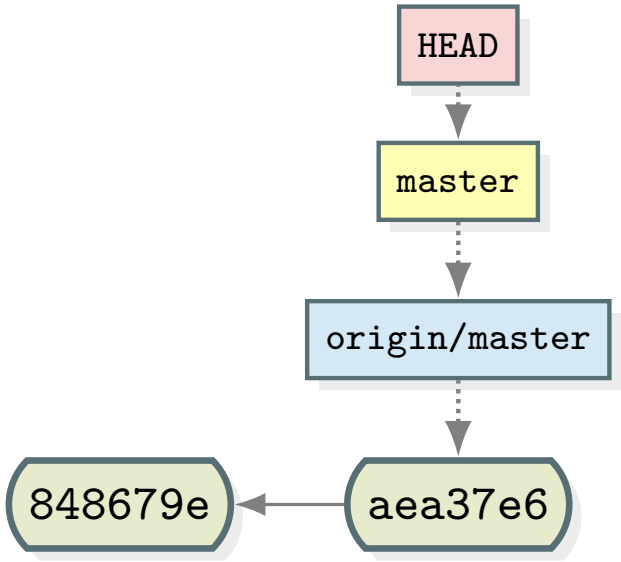
université de BORDEAUX

```
#> echo "Hello World!" > README
#> git add README
#> git commit -m "Initial commit"
[master (root-commit) 848679e] Initial commit
 1 file changed, 1 insertion(+)
 create mode 100644 README

#> echo "Second line" >> README
#> git commit -a -m "Second commit"
[master aea37e6] Second commit
 1 file changed, 1 insertion(+)

#> git push
Enumerating objects: 6, done.
Counting objects: 100% (6/6), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (6/6), 471 bytes | 471.00 KiB/s, done.
Total 6 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
 * [new branch]      master -> master

#> git log --oneline
aea37e6 (HEAD -> master, origin/master, origin/HEAD) Second commit
848679e Initial commit
```



Example: 'push' Attempt (project2)

université de BORDEAUX

```
#> cd project2/

#> echo "John Doe <john.doe@u-bordeaux.fr" > AUTHORS
#> git add AUTHORS
#> git commit -m "Adding first author"
[master 7d385a4] Adding first author
 1 file changed, 1 insertion(+)
 create mode 100644 AUTHORS

#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```

Example: 'push' Attempt (project2)

université de BORDEAUX

```
#> cd project2/

#> echo "John Doe <john.doe@u-bordeaux.fr" > AUTHORS
#> git add AUTHORS
#> git commit -m "Adding first author"
[master 7d385a4] Adding first author
 1 file changed, 1 insertion(+)
 create mode 100644 AUTHORS

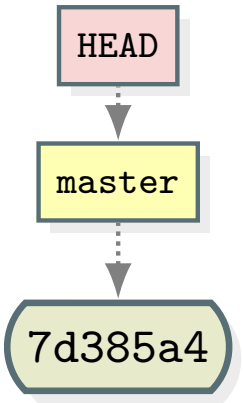
#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: to 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.
```

Example: 'push' Attempt (project2)

```
#> cd project2/

#> echo "John Doe <john.doe@u-bordeaux.fr" > AUTHORS
#> git add AUTHORS
#> git commit -m "Adding first author"
[master 7d385a4] Adding first author
 1 file changed, 1 insertion(+)
 create mode 100644 AUTHORS

#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```

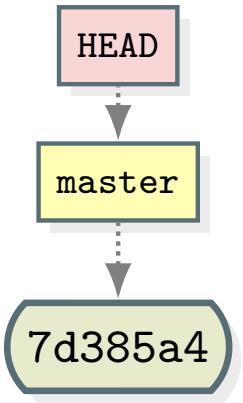


Example: 'push' Attempt (project2)

université de BORDEAUX

```
#> cd project2/

#> echo "John Doe <john.doe@u-bordeaux.fr" > AUTHORS
#> git add AUTHORS
#> git commit -m "Adding first author"
[master 7d385a4] Adding first author
 1 file changed, 1 insertion(+)
 create mode 100644 AUTHORS
```



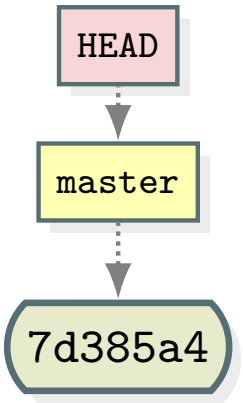

```
#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: 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.
```

Example: 'push' Attempt (project2)

université de BORDEAUX

```
#> cd project2/

#> echo "John Doe <john.doe@u-bordeaux.fr" > AUTHORS
#> git add AUTHORS
#> git commit -m "Adding first author"
[master 7d385a4] Adding first author
 1 file changed, 1 insertion(+)
 create mode 100644 AUTHORS
```




```
#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```

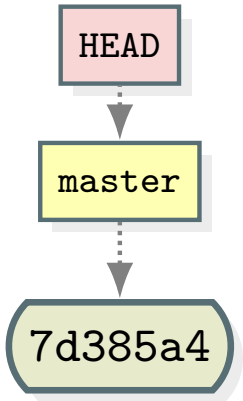
What to do ???

Example: 'pull' Attempt (project2)

```
#> git pull
warning: no common commits
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 1), reused 0 (delta 0)
Unpacking objects: 100% (6/6), done.
From /home/user/my_repo
 * [new branch]      master     -> origin/master
fatal: refusing to merge unrelated histories

#> git log --oneline
7d385a4 (HEAD -> master) Adding first author

#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```

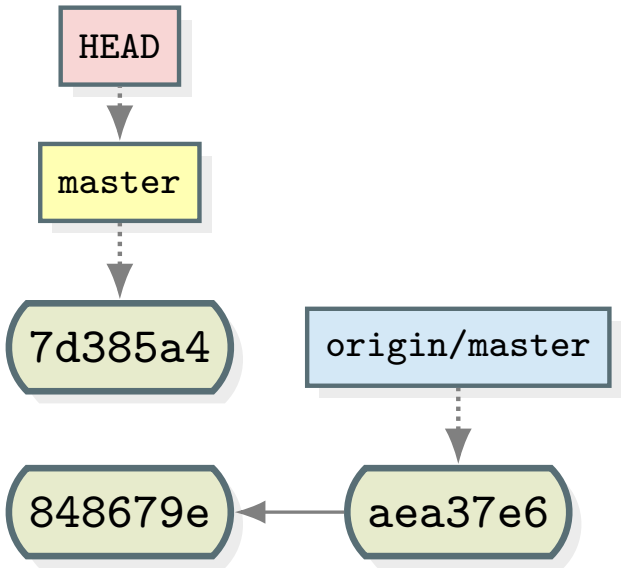


Example: 'pull' Attempt (project2)

```
#> git pull
warning: no common commits
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 1), reused 0 (delta 0)
Unpacking objects: 100% (6/6), done.
From /home/user/my_repo
 * [new branch]      master     -> origin/master
fatal: refusing to merge unrelated histories

#> git log --oneline
7d385a4 (HEAD -> master) Adding first author

#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```

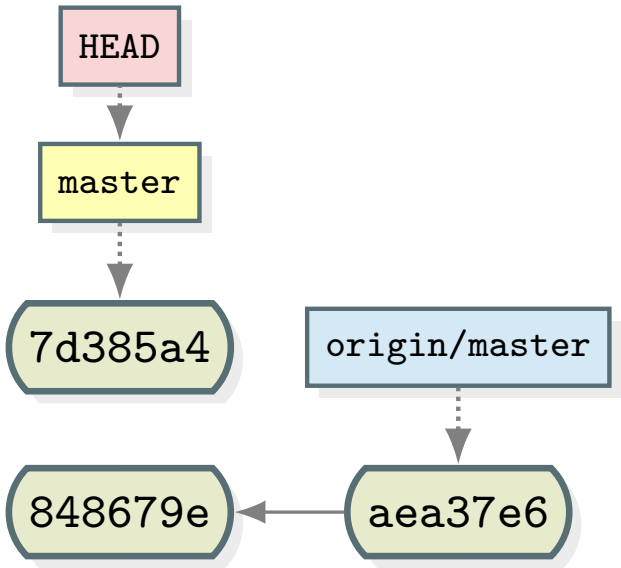


Example: 'pull' Attempt (project2)

```
#> git pull
warning: no common commits
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 1), reused 0 (delta 0)
Unpacking objects: 100% (6/6), done.
From /home/user/my_repo
 * [new branch]      master     -> origin/master
fatal: refusing to merge unrelated histories

#> git log --oneline
7d385a4 (HEAD -> master) Adding first author

#> git push
To /home/user/my_repo/
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to '/home/user/my_repo/'
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.
```



Example: 'pull' Attempt (project2)

```
#> git pull
warning: no common commits
remote: Enumerating objects: 6, done.
remote: Counting objects: 100% (6/6), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 6 (delta 1), reused 0 (delta 0)
Unpacking objects: 100% (6/6), done.
From /home/user/my_repo
 * [new branch]      master     -> origin/master
fatal: refusing to merge unrelated histories

#> git log --oneline
7d385a4 (HEAD -> master) Adding first author

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To /home/user/my_repo/
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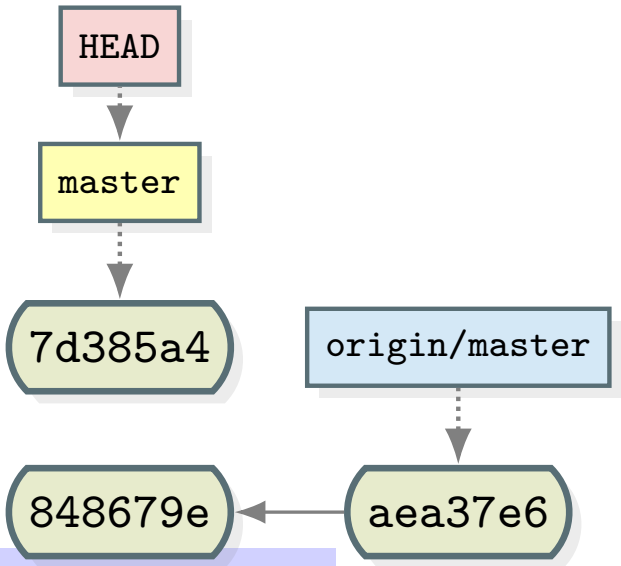

Example: 'pull' Attempt (project2)

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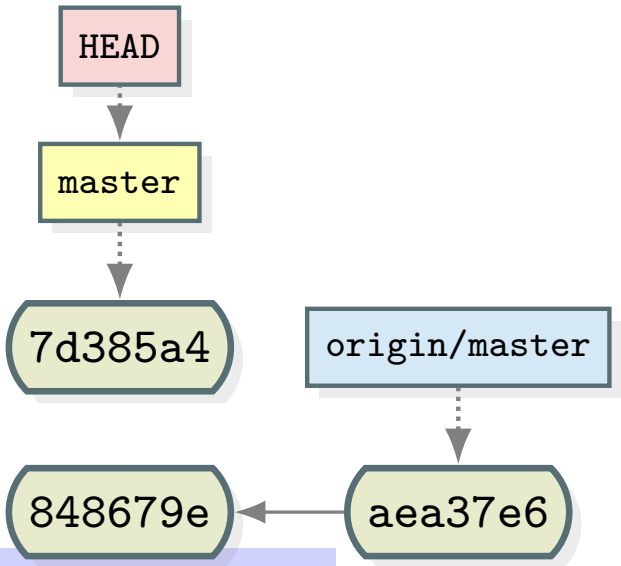


What to do ???

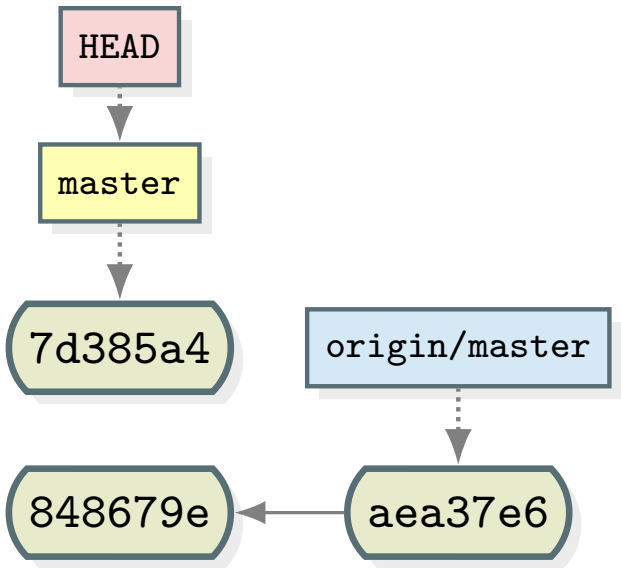
Example: 'pull --rebase' (project2)

```
#> git pull --rebase
First, rewinding head to replay your work on top of it...
Applying: Adding first author

#> git log --oneline
ce2f041 (HEAD -> master) Adding first author
88a843d (origin/master) Second commit
617567 Initial commit

#> git push
Enumerating objects: 4, done.
Counting objects: 100% (4/4), done.
Delta compression using up to 8 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 320 bytes | 320.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   88a843d..7d385a4  master -> master

#> git log --oneline
ce2f041 (HEAD -> master, origin/master, origin/HEAD) Adding first author
dbb0042 Second commit
848679e Initial commit
```



Example: 'pull --rebase' (project2)

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Total 3 (delta 0), reused 0 (delta 0)
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ce2f041 (HEAD -> master, origin/master, origin/HEAD) Adding first author
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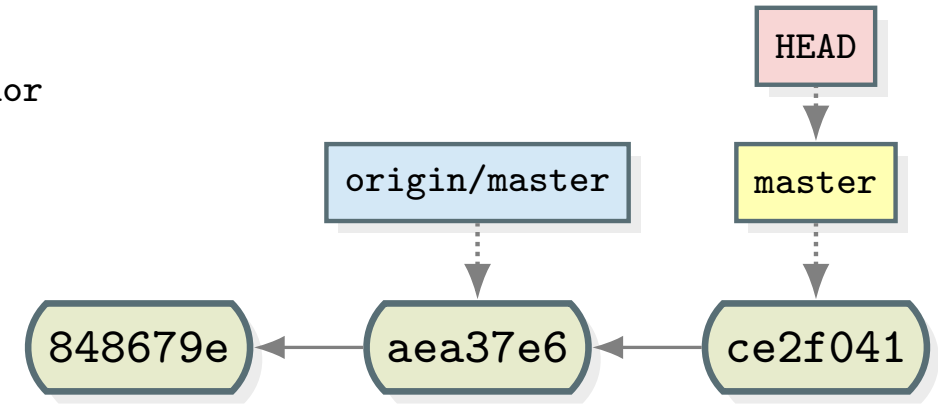

The 'rebase' option push all the new modifications on the top of the history of what you download from the remote repository. It minimize a lot the possibility of a conflict.

Note, also that the hash of the 'Adding first author' commit changed after the rebase!

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To /home/user/my_repo/
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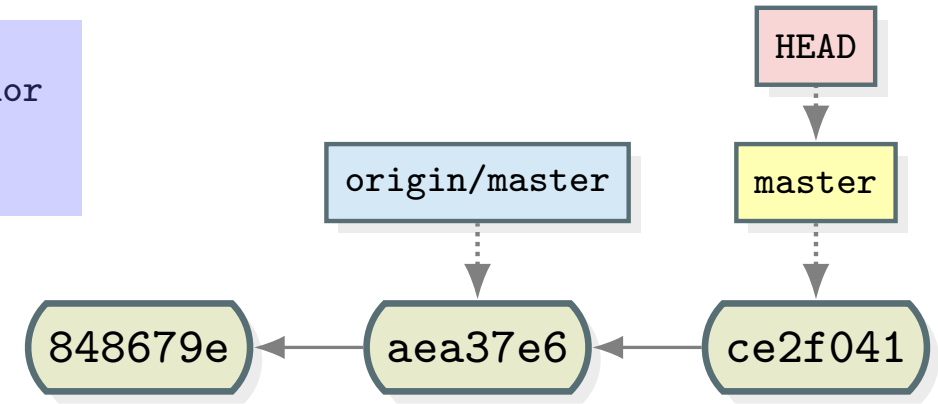

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Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   88a843d..7d385a4  master -> master

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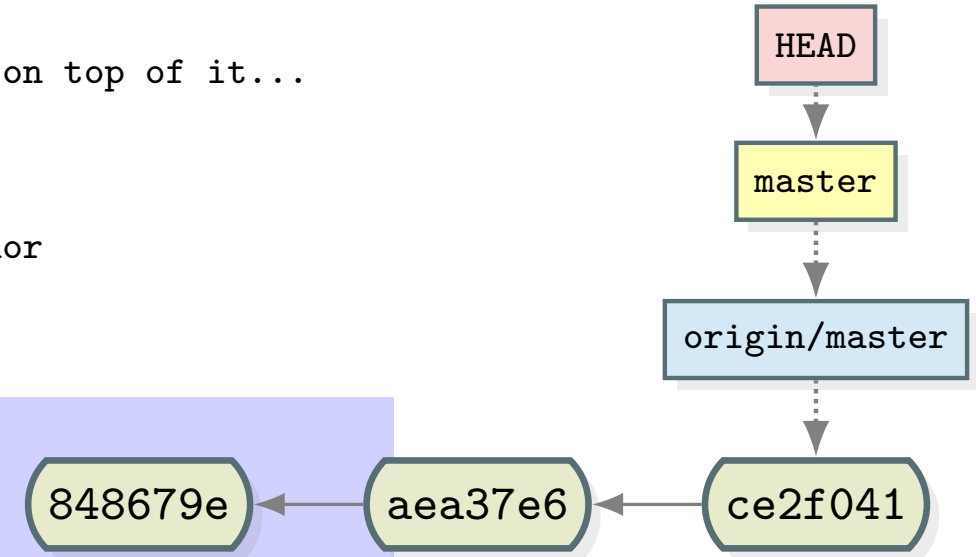

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Example: 'pull --rebase' (project2)

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Writing objects: 100% (3/3), 320 bytes | 320.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   88a843d..7d385a4  master -> master

#> git log --oneline
ce2f041 (HEAD -> master, origin/master, origin/HEAD) Adding first author
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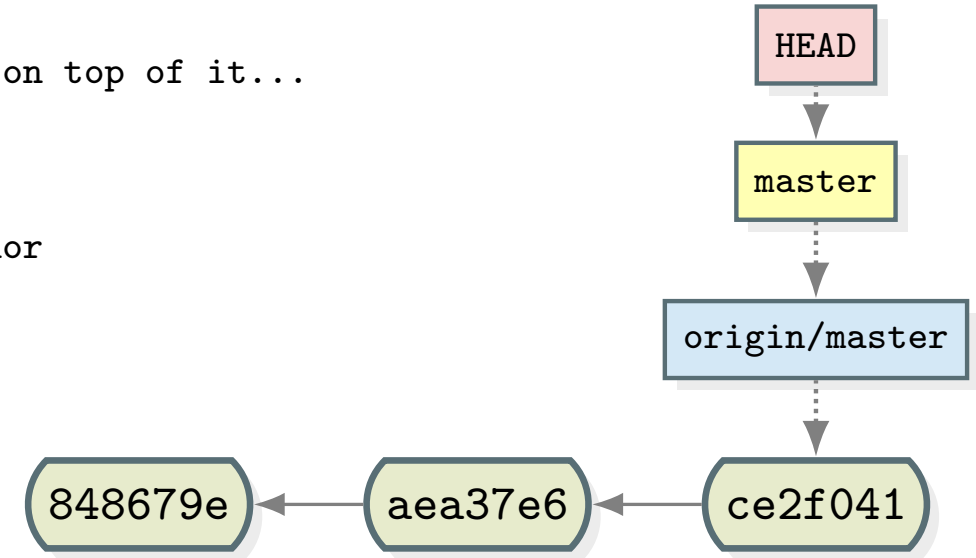
848679e Initial commit
```



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Overview

What is a Conflict?

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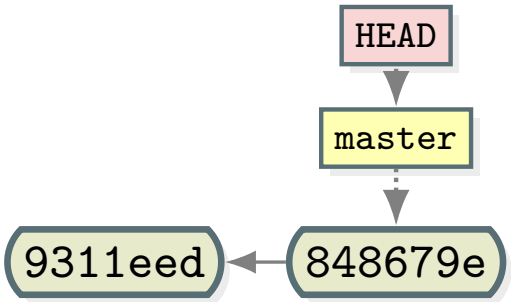
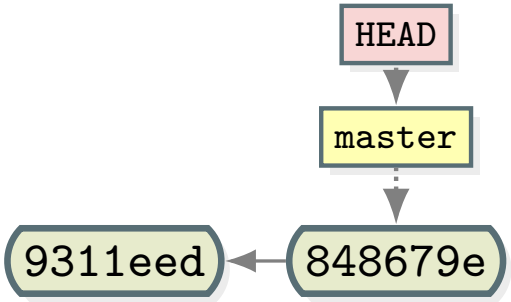
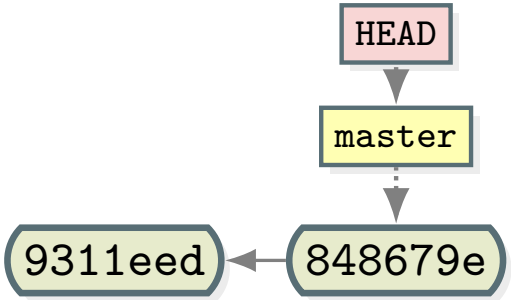
Alice



Repository



Bob



What is a Conflict?

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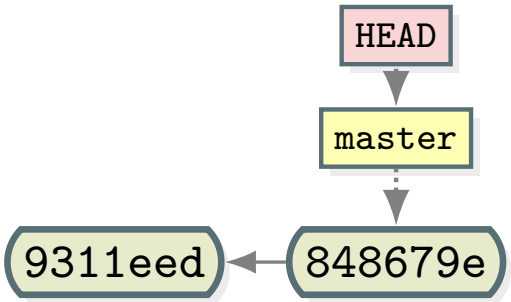

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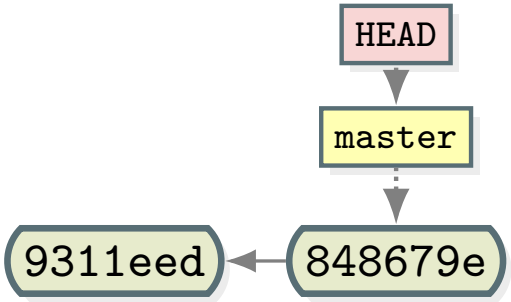

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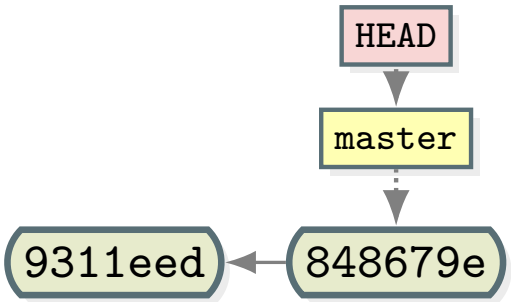

What is a Conflict?

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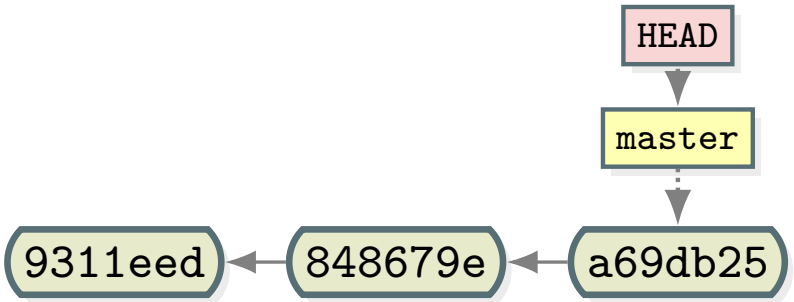
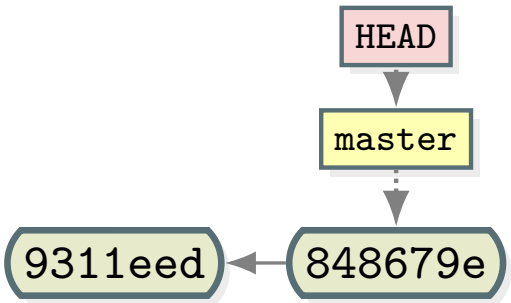


Worked on
`README` at line 1

Repository



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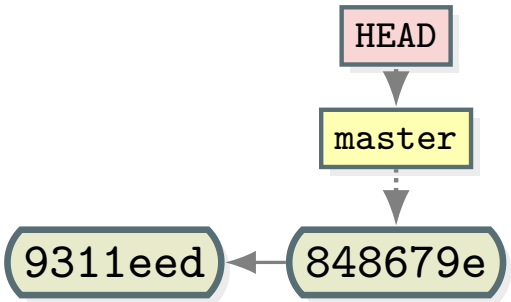

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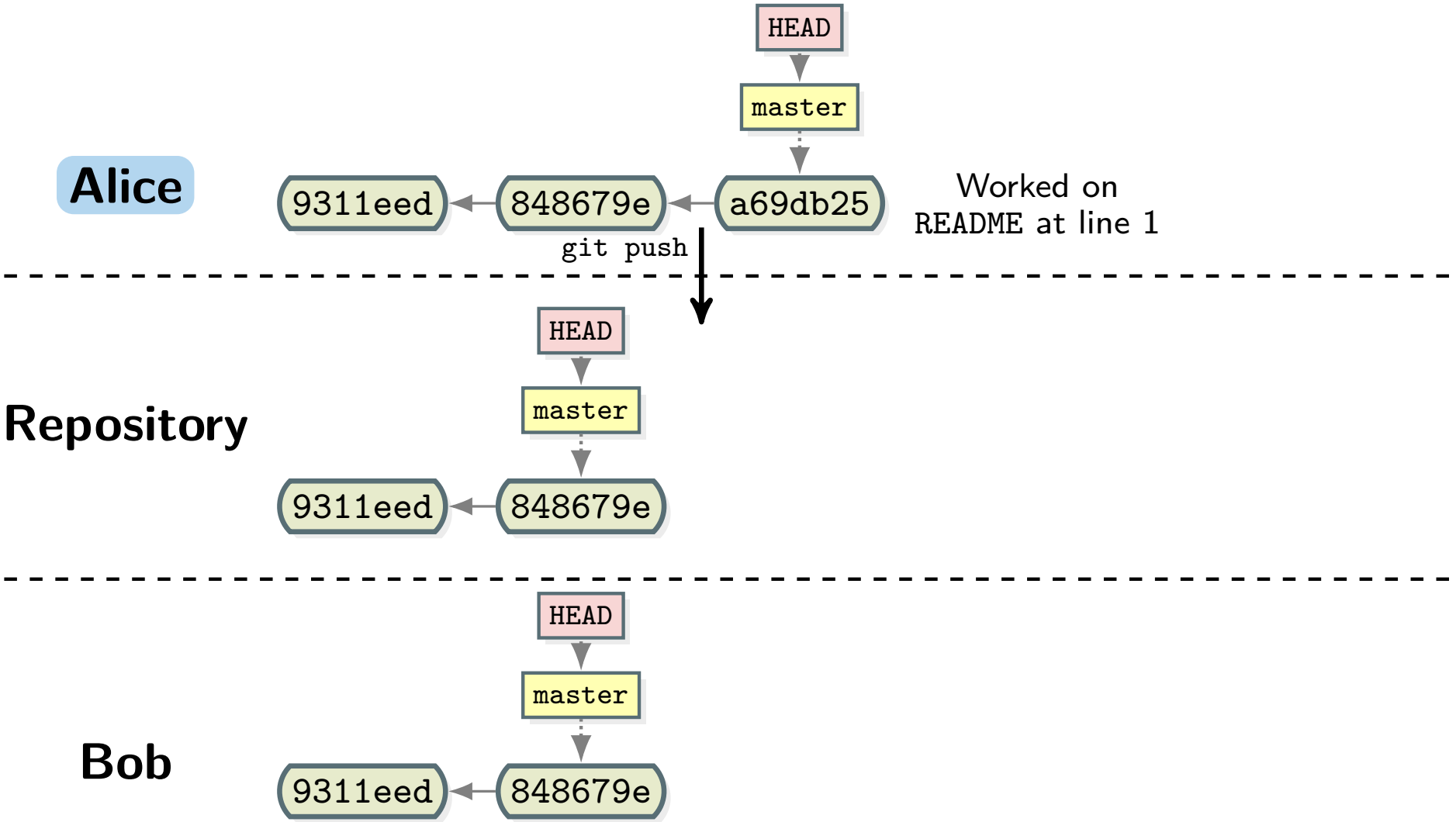

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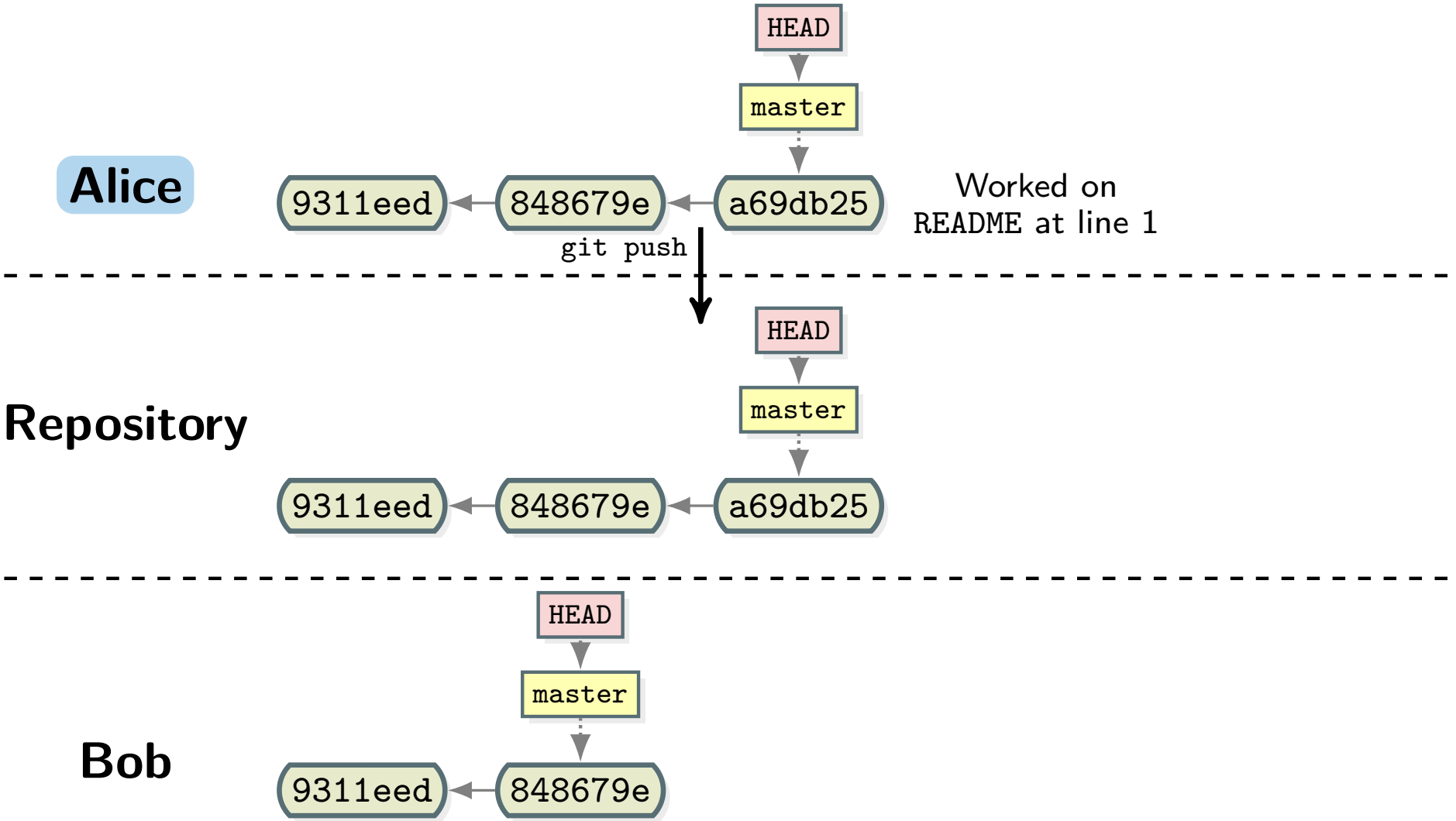

What is a Conflict?

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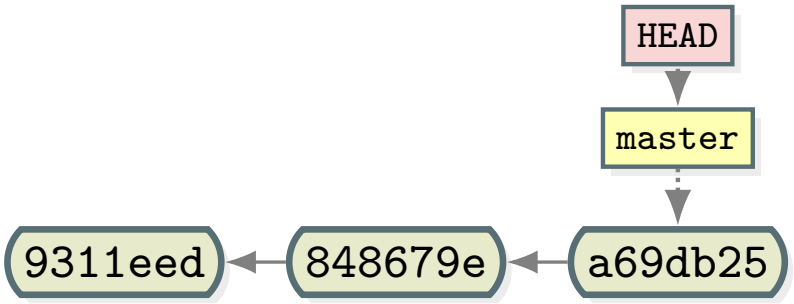

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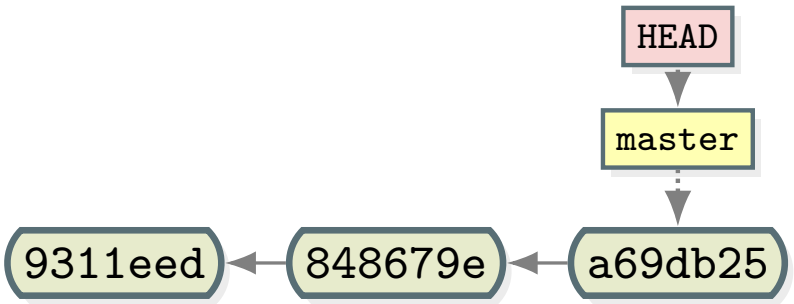

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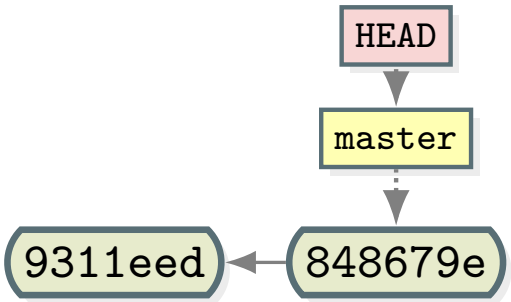

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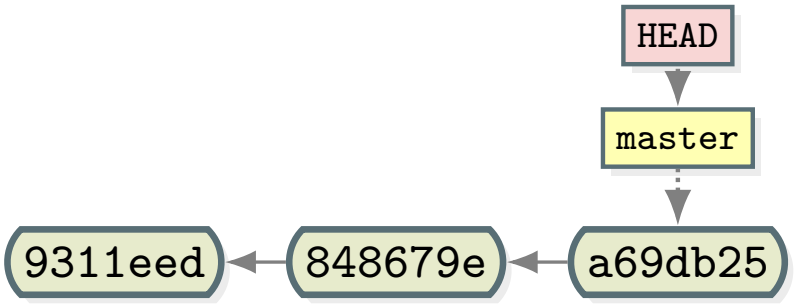

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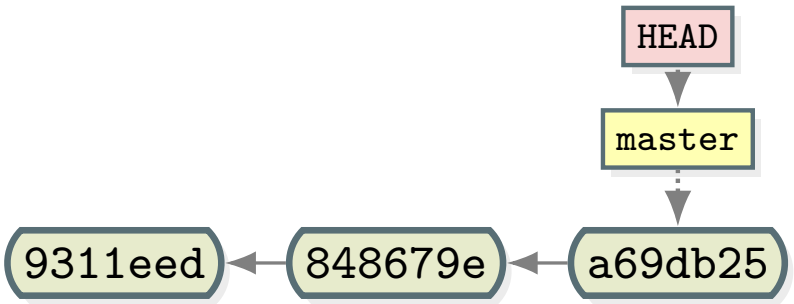

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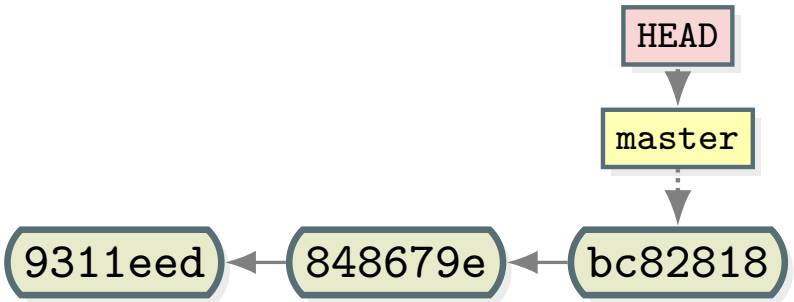

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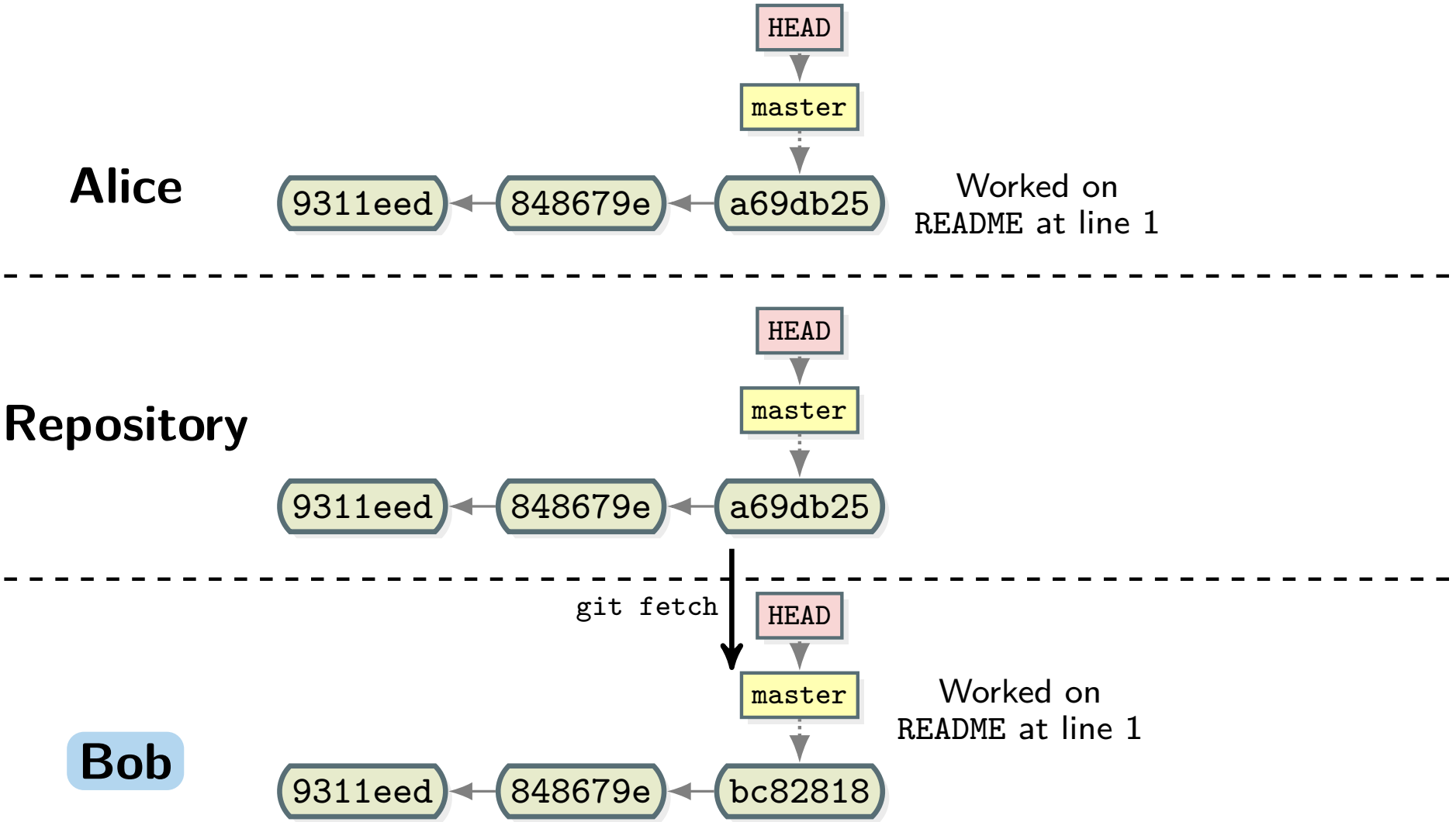

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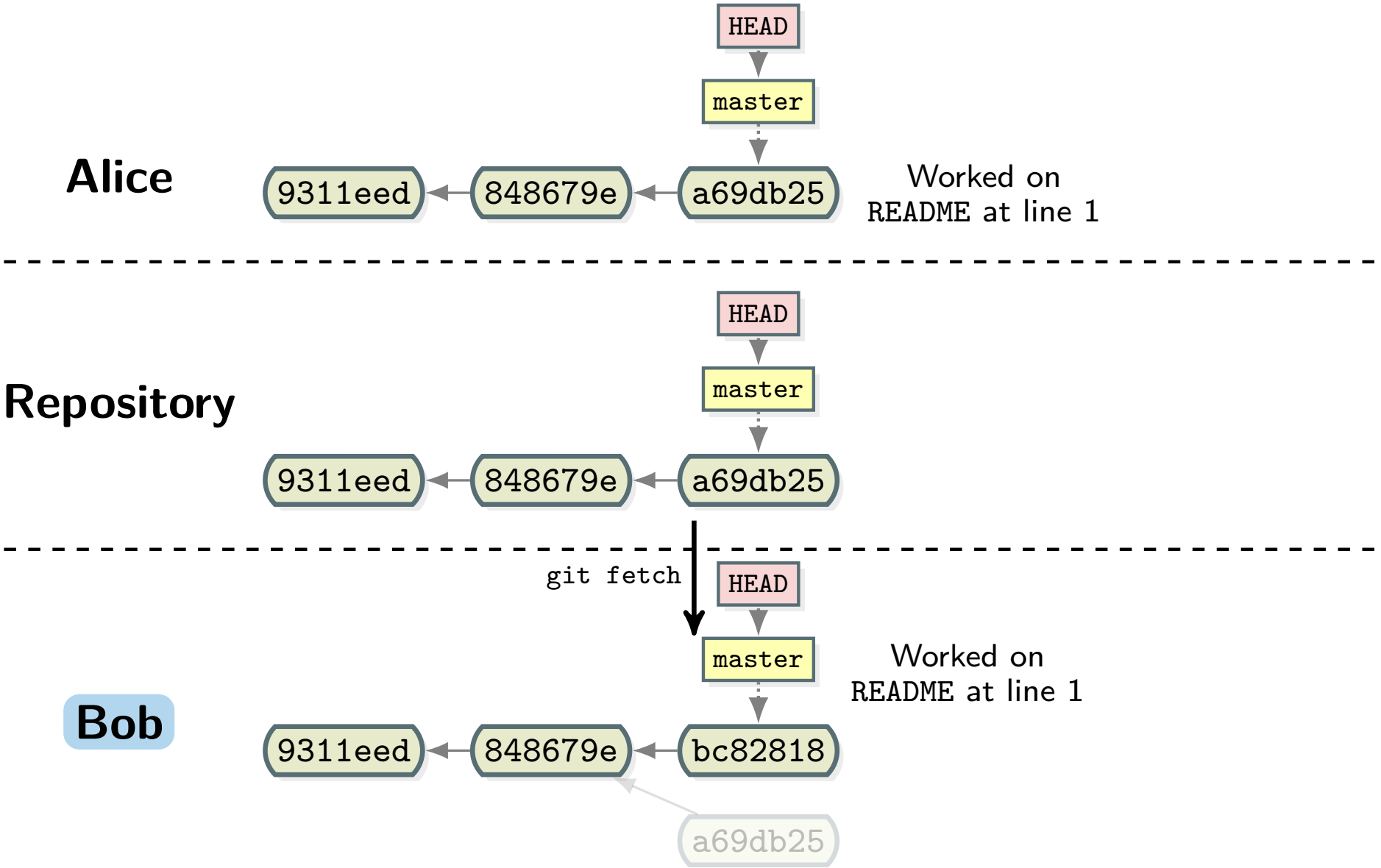

What is a Conflict?

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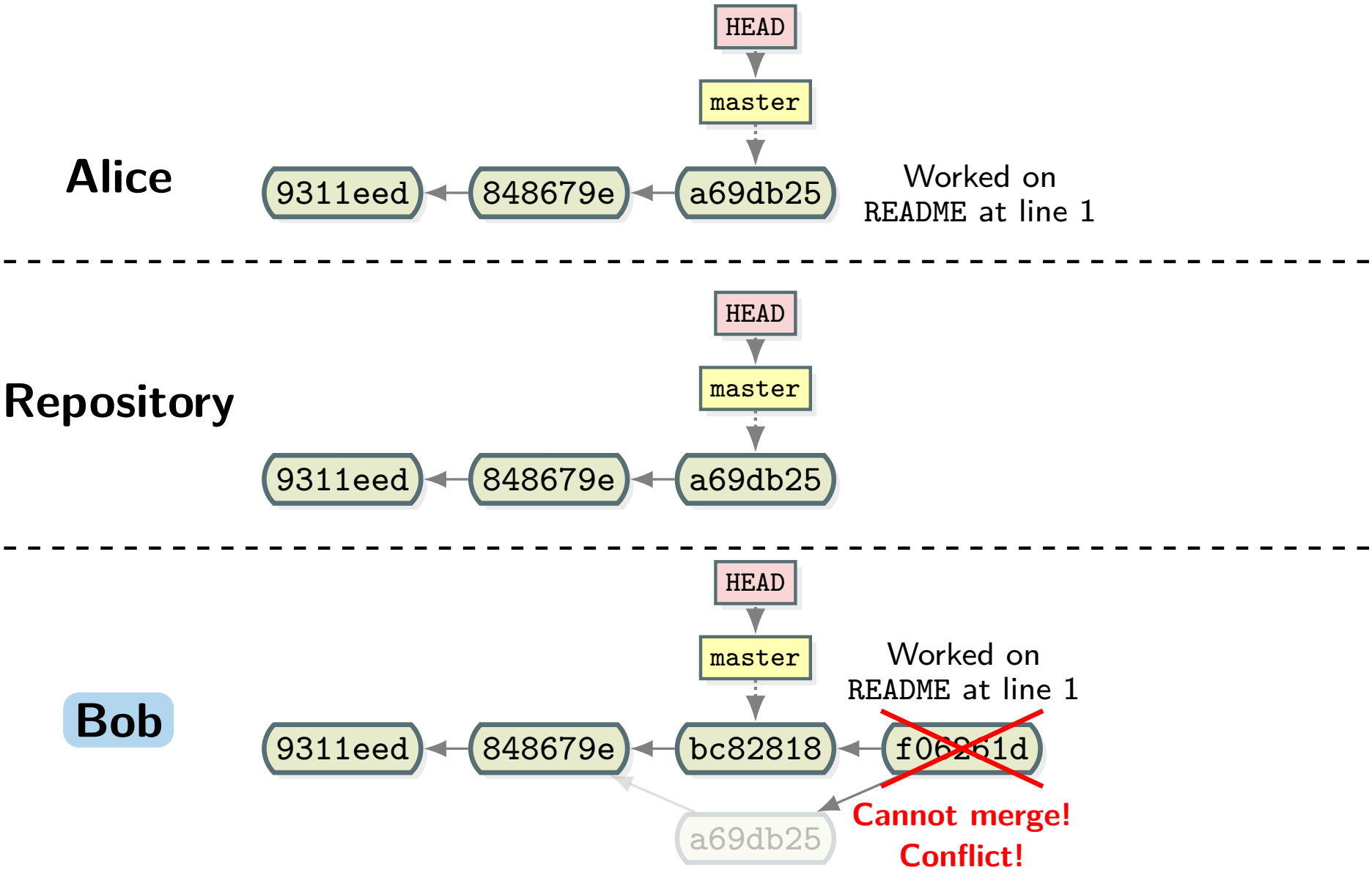

Example: Solving Conflicts (1/4)

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Making a Change on README in project1

```
echo "My change1" >> README
#> git commit -a -m "Added a line to the README file"
[master 26caa4e] Added a line to the README file
 1 file changed, 1 insertion(+)
#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Delta compression using up to 8 threads
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 334 bytes | 334.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   0d4a3a1..26caa4e  master -> master
```

Making a Change on README in project2

```
#> echo "My change2" >> README
#> git commit -a -m "Added a line to the README file too"
[master 3e0eb0f] Added a line to the README file too
 1 file changed, 1 insertion(+)
```

Example: Solving Conflicts (2/4)

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Still in project2

```
#> git pull
remote: Enumerating objects: 5, done.
remote: Counting objects: 100% (5/5), done.
remote: Total 3 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (3/3), done.
From /home/user/my_repo
   0d4a3a1..26caa4e  master     -> origin/master
Auto-merging README
CONFLICT (content): Merge conflict in README
Automatic merge failed; fix conflicts and then commit the result.

#> git status
Your branch and 'origin/master' have diverged,
and have 2 and 1 different commits each, respectively.
  (use "git pull" to merge the remote branch into yours)

You have unmerged paths.
  (fix conflicts and run "git commit")
  (use "git merge --abort" to abort the merge)

Unmerged paths:
  (use "git add <file>..." to mark resolution)
        both modified:   README
no changes added to commit (use "git add" and/or "git commit -a")
```

Now, we have a conflict on README in project2!

Example: Solving Conflicts (3/4)

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Solving the conflict

```
#> git diff
diff --cc README
index 789f05d,3ae2ab8..0000000
--- a/README
+++ b/README
@@@ -1,3 -1,3 +1,7 @@@
  Hello World!
  Second line
++<<<<<<< HEAD
 +My change1
++=======
+ My change2
++>>>>>>> Added a line to the README file too

#> nano README

#> git diff
diff --cc README
index 789f05d,3ae2ab8..0000000
--- a/README
+++ b/README
@@@ -1,3 -1,3 +1,4 @@@
  Hello World!
  Second line
 +My change1
+ My change2
```

Resolve Conflicts (4/4)

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Commit and Push

```
#> git commit -a
[master 536aa05] Merge branch 'master' of /home/user/my_repo

#> git push
Enumerating objects: 5, done.
Counting objects: 100% (5/5), done.
Delta compression using up to 8 threads
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 342 bytes | 342.00 KiB/s, done.
Total 3 (delta 0), reused 0 (delta 0)
To /home/user/my_repo/
   26caa4e..baf2f20  master -> master
```

Conflict is solved, committed and pushed to remote!

Overview

Safe Push Process

Verify your Work

```
#> git status
#> git log --oneline --graph --all
```

Put unfinished work aside

```
#> git stash
#> git stash list
#> git stash pop
#> git stash drop
```

Merge last updates first

```
#> git fetch
#> git pull --rebase
... solve possible conflict ...
#>  git commit
```

Finally `push`

```
#> git push
```

Overview

Managing Remotes

Listing all Remotes

```
#> git remote
origin
#> git remote --verbose
origin    /home/user/project/ (fetch)
origin    /home/user/project/ (push)
```

Add/Rename/Remove a Remote

```
#> git remote add wip git@git.server.org:wip/project.git
#> git remote rename wip wip-new
#> git remote remove wip-new
```

Get Information about a Remote

```
#> git remote show origin
* remote origin
  Fetch URL: /home/user/project/
  Push  URL: /home/user/project/
  HEAD branch: master
  Remote branches:
    master tracked
  Local branches configured for 'git pull':
    master merges with remote master
  Local refs configured for 'git push':
    master pushes to master (up to date)
```

Example: Keep-up with Upstream

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Adding a new remote toward upstream

```
#> git remote add upstream git@github.com:user/project.git
#> git remote -v
origin    git@github.com:user/project.git (fetch)
origin    git@github.com:user/project.git (push)
upstream  git@github.com:foo/project.git (fetch)
upstream  git@github.com:foo/project.git (push)
```

Updating `master` with `upstream`

```
#> git fetch upstream master
#> git checkout master
#> git merge upstream/master
#> git push
```

Rebasing work-in-progress on top of `master`

```
#> git checkout my_branch
#> git rebase master
#> git push --force
```

Overview

Cleaning Local Database

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A few commands useful to clean-up and compress your objects data-base in your repository:

```
# Verifies connectivity and validity of objects in repository
git fsck --full

# Manage reflog information and set it to 'expire'
git reflog expire --expire=now --all

# Pack unpacked objects in a repository
git repack -adl

# Cleanup unnecessary files and optimize local repository and
# prune all unreachable objects from the object database
git gc --prune=now --aggressive
```

Overview

Good Practices...

1. Don't panic!
2. Know, practice and read about `git`!
3. On doubt, back-up your repository before trying!
4. Avoid conflicts at any price!
5. Commit early and commit often!
6. One commit for one thing, no more!
7. Be meaningful on your commit messages!
8. Branch as much as possible!
9. Choose one workflow and stick to it!
10. Keep up with remote project and others!

References

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  `https://marklodato.github.io/visual-git-guide/`

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  `https://learngitbranching.js.org/`

- **Visualizing Git** (Visualization Tool)

  `http://git-school.github.io/visualizing-git/`

- **Git Internals**, by Scott Chacon (2013)

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  `https://github.com/Jubobs/gitdags/wiki`

Questions?