# Advanced use of Git

Matthieu Moy

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`http://www-verimag.imag.fr/~moy/cours/formation-git/advanced-git-slides.pdf`

2015

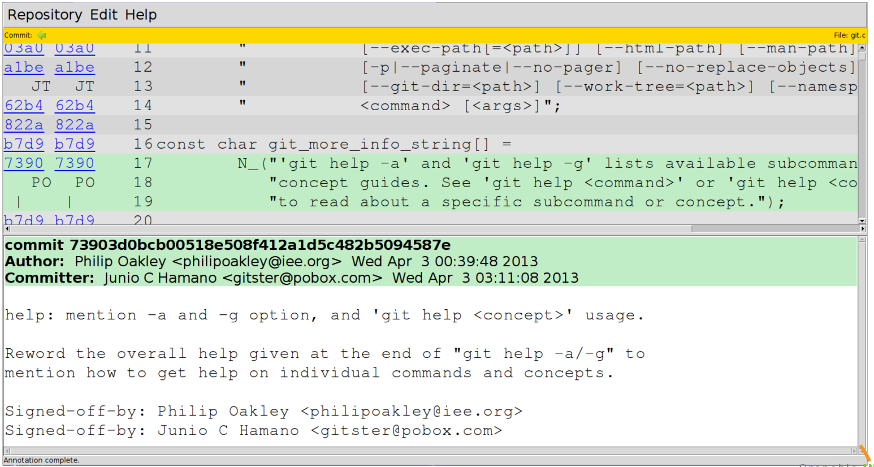
## Goals of the presentation

- Understand why Git is important, and what can be done with it
- Understand how Git works
- Motivate to read further documentation

## Outline

## Git blame: Who did that?

```
git gui blame file
```



```
03a0 03a0   11   "             [--exec-path[=<path>]] [--html-path] [--man-path]
a1be a1be   12   "             [-p|--paginate|--no-pager] [--no-replace-objects]
  JT   JT   13   "             [--git-dir=<path>] [--work-tree=<path>] [--namesp
62b4 62b4   14   "             <command> [<args>]";
822a 822a   15
b7d9 b7d9   16 const char git_more_info_string[] =
7390 7390   17         N_("'git help -a' and 'git help -g' lists available subcomman
  PO   PO   18            "concept guides. See 'git help <command>' or 'git help <co
   |    |   19            "to read about a specific subcommand or concept.");
b7d9 b7d9   20
```

**commit 73903d0bcb00518e508f412a1d5c482b5094587e**
**Author:** Philip Oakley <philipoakley@iee.org> Wed Apr 3 00:39:48 2013
**Committer:** Junio C Hamano <gitster@pobox.com> Wed Apr 3 03:11:08 2013

```
help: mention -a and -g option, and 'git help <concept>' usage.

Reword the overall help given at the end of "git help -a/-g" to
mention how to get help on individual commands and concepts.

Signed-off-by: Philip Oakley <philipoakley@iee.org>
Signed-off-by: Junio C Hamano <gitster@pobox.com>
```

## Bisect: Find regressions

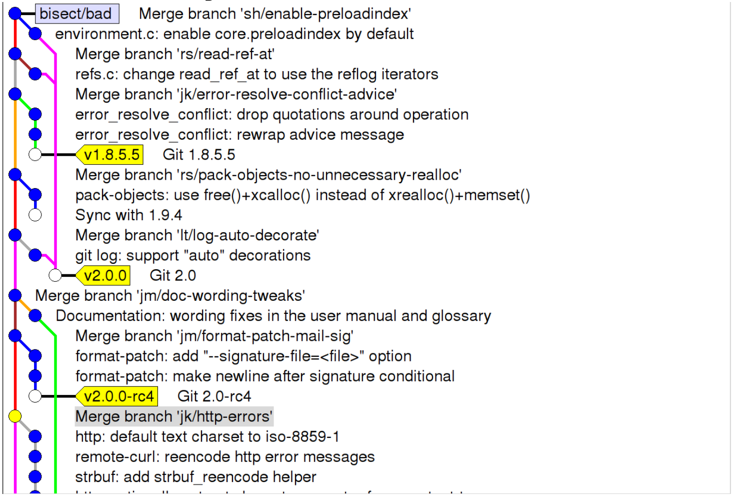
```
$ git bisect start
$ git bisect bad
$ git bisect good v1.9.0
Bisecting: 607 revisions left to test after this (roughly 9 steps
[8fe3ee67adcd2ee9372c7044fa311ce55eb285b4] Merge branch 'jx/i18n'
$ git bisect good
Bisecting: 299 revisions left to test after this (roughly 8 steps
[aa4bffa23599e0c2e611be7012ecb5f596ef88b5] Merge branch 'jc/codin
$ git bisect good
Bisecting: 150 revisions left to test after this (roughly 7 steps
[96b29bde9194f96cb711a00876700ea8dd9c0727] Merge branch 'sh/enabl
$ git bisect bad
Bisecting: 72 revisions left to test after this (roughly 6 steps)
[09e13ad5b0f0689418a723289dca7b3c72d538c4] Merge branch 'as/prett
...
$ git bisect good
```

**60ed26438c909fd273528e67 is the first bad commit**

```
commit 60ed26438c909fd273528e67b399ee6ca4028e1e
```

## Bisect: Binary search

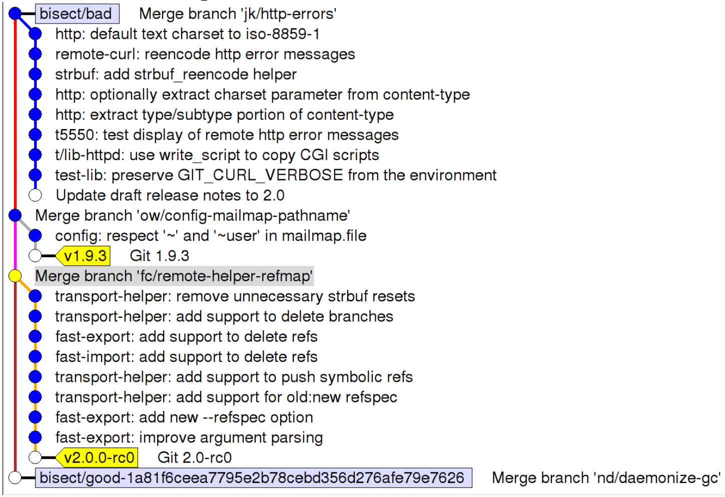
`git bisect visualize`



```
bisect/bad   Merge branch 'sh/enable-preloadindex'
environment.c: enable core.preloadindex by default
Merge branch 'rs/read-ref-at'
refs.c: change read_ref_at to use the reflog iterators
Merge branch 'jk/error-resolve-conflict-advice'
error_resolve_conflict: drop quotations around operation
error_resolve_conflict: rewrap advice message
v1.8.5.5   Git 1.8.5.5
Merge branch 'rs/pack-objects-no-unnecessary-realloc'
pack-objects: use free()+xcalloc() instead of xrealloc()+memset()
Sync with 1.9.4
Merge branch 'lt/log-auto-decorate'
git log: support "auto" decorations
v2.0.0   Git 2.0
Merge branch 'jm/doc-wording-tweaks'
Documentation: wording fixes in the user manual and glossary
Merge branch 'jm/format-patch-mail-sig'
format-patch: add "--signature-file=<file>" option
format-patch: make newline after signature conditional
v2.0.0-rc4   Git 2.0-rc4
Merge branch 'jk/http-errors'
http: default text charset to iso-8859-1
remote-curl: reencode http error messages
strbuf: add strbuf_reencode helper
```

## Bisect: Binary search

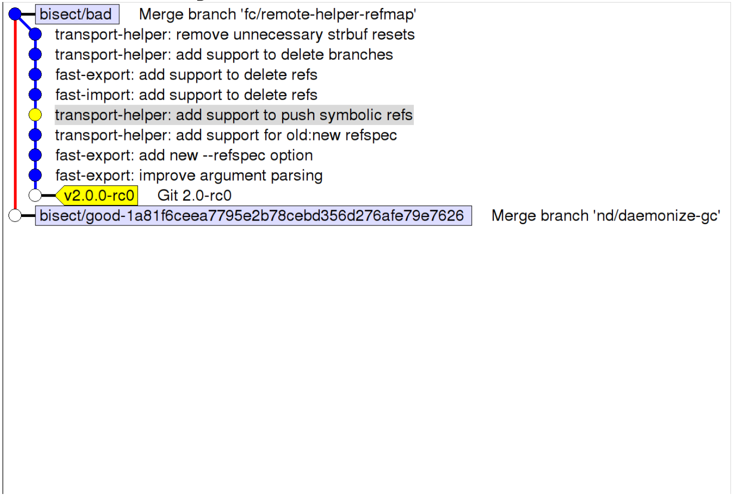
```
git bisect visualize
```



```
bisect/bad   Merge branch 'jk/http-errors'
  http: default text charset to iso-8859-1
  remote-curl: reencode http error messages
  strbuf: add strbuf_reencode helper
  http: optionally extract charset parameter from content-type
  http: extract type/subtype portion of content-type
  t5550: test display of remote http error messages
  t/lib-httpd: use write_script to copy CGI scripts
  test-lib: preserve GIT_CURL_VERBOSE from the environment
  Update draft release notes to 2.0
Merge branch 'ow/config-mailmap-pathname'
  config: respect '~' and '~user' in mailmap.file
  v1.9.3   Git 1.9.3
Merge branch 'fc/remote-helper-refmap'
  transport-helper: remove unnecessary strbuf resets
  transport-helper: add support to delete branches
  fast-export: add support to delete refs
  fast-import: add support to delete refs
  transport-helper: add support to push symbolic refs
  transport-helper: add support for old:new refspec
  fast-export: add new --refspec option
  fast-export: improve argument parsing
  v2.0.0-rc0   Git 2.0-rc0
bisect/good-1a81f6ceea7795e2b78cebd356d276afe79e7626   Merge branch 'nd/daemonize-gc'
```

## Bisect: Binary search

`git bisect visualize`



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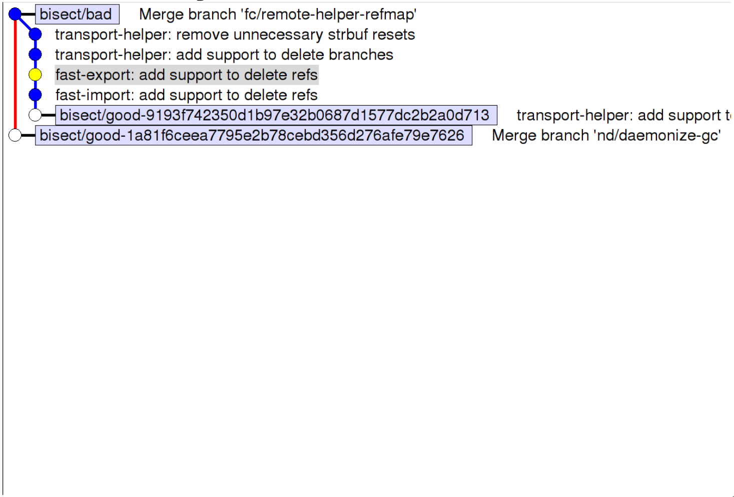

```
bisect/bad    Merge branch 'fc/remote-helper-refmap'
  transport-helper: remove unnecessary strbuf resets
  transport-helper: add support to delete branches
  fast-export: add support to delete refs
  fast-import: add support to delete refs
  bisect/good-9193f742350d1b97e32b0687d1577dc2b2a0d713    transport-helper: add support t
bisect/good-1a81f6ceea7795e2b78cebd356d276afe79e7626    Merge branch 'nd/daemonize-gc'
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## Bisect: Binary search

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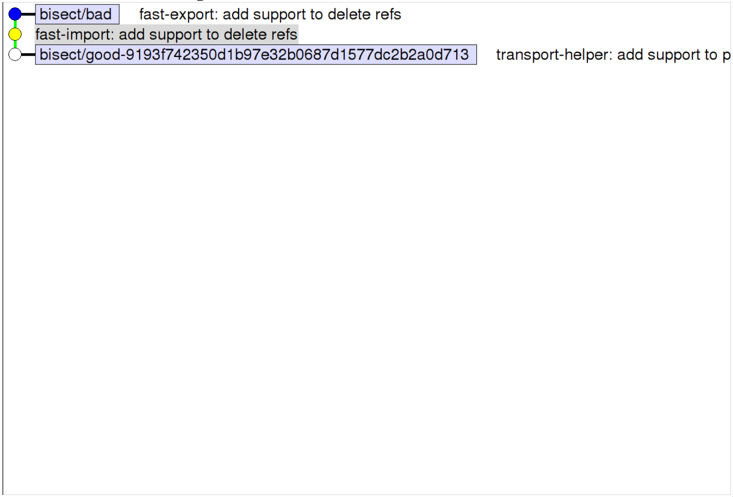

```
bisect/bad    fast-export: add support to delete refs
fast-import: add support to delete refs
bisect/good-9193f742350d1b97e32b0687d1577dc2b2a0d713    transport-helper: add support to p
```

## Then what?

`git blame` and `git bisect` point you to a commit, then ...

- Dream:
  - The commit is a 50-lines long patch
  - The commit message explains the intent of the programmer
- Nightmare 1:
  - The commit mixes a large reindentation, a bugfix and a real feature
  - The message says “I reindented, fixed a bug and added a feature”
- Nightmare 2:
  - The commit is a trivial fix for the previous commit
  - The message says “Oops, previous commit was stupid”
- Nightmare 3:
  - Bisect is not even applicable because most commits aren’t compilable.

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Which one do you prefer?

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Clean history is important
for software maintainability

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Clean history is as important as comments
for software maintainability

## Two Approaches To Deal With History

Approach 1

“Mistakes are part of history.”

Approach 2

“History is a set of lies agreed upon.”[1]

[1] Napoleon Bonaparte

## Approach 1: Mistakes are part of history

- $\approx$ the only option with Subversion/CVS/...
- History reflects the chronological order of events
- Pros:
  - Easy: just work and commit from time to time
  - Traceability
- But ...
  - Is the actual order of event what you want to remember?
  - When you write a draft of a document, and then a final version, does the final version reflect the mistakes you did in the draft?

## Approach 2: History is a set of lies agreed upon

- Popular approach with modern VCS (Git, Mercurial. . . )
- History tries to show the best logical path from one point to another
- Pros:
  - See above: blame, bisect, ...
  - Code review
  - Claim that you are a better programmer than you really are!

## Another View About Version Control

- 2 roles of version control:
  - For beginners: help the code reach upstream.
  - For advanced users: prevent bad code from reaching upstream.
- Several opportunities to reject bad code:
  - Before/during commit
  - Before push
  - Before merge

## What is a clean history

- Each commit introduce small group of related changes ($\approx$ 100 lines changed max, no minimum!)
- Each commit is compilable and passes all tests (“bisectable history”)
- “Good” commit messages

## Outline

## Outline of this section

2 Clean commits
- Writing good commit messages
- Partial commits with `git add -p`, the index

## Reminder: good comments

- Bad:

```
int i; // Declare i of type int
for (i = 0; i < 10; i++) { ... }
f(i)
```

- Possibly good:

```
int i; // We need to declare i outside the for
       // loop because we'll use it after.
for (i = 0; i < 10; i++) { ... }
f(i)
```

Common rule: if your code isn't clear enough,
rewrite it to make it clearer
instead of adding comments.

## Reminder: good comments

- Bad: What? The code already tells

```
int i; // Declare i of type int
for (i = 0; i < 10; i++) { ... }
f(i)
```

- Possibly good: Why? Usually the relevant question

```
int i; // We need to declare i outside the for
       // loop because we'll use it after.
for (i = 0; i < 10; i++) { ... }
f(i)
```

Common rule: if your code isn't clear enough,
rewrite it to make it clearer
instead of adding comments.

## Good commit messages

- Recommended format:

```
One-line description (< 50 characters)

Explain here why your change is good.
```

- Write your commit messages like an email: subject and body
- Imagine your commit message is an email sent to the maintainer, trying to convince him to merge your code[2]
- Don't use `git commit -m`

[2]Not just imagination, see `git send-email`

## Good commit messages: examples

### From Git's source code

https://github.com/git/git/commit/bde4a0f9f3035d482a80c32b4a485333b9ed4875

```
gitk: Add visiblerefs option, which lists always-shown branches

When many branches contain a commit, the branches used to be shown in
the form "A, B and many more", where A, B can be master of current
HEAD. But there are more which might be interesting to always know about.
For example, "origin/master".

The new option, visiblerefs, is stored in ~/.gitk. It contains a list
of references which are always shown before "and many more" if they
contain the commit. By default it is `"master"', which is compatible
with previous behavior.

Signed-off-by: Max Kirillov <max@max630.net>
Signed-off-by: Paul Mackerras <paulus@samba.org>
```

## Good commit messages: counter-example

### GNU-style changelogs

http://git.savannah.gnu.org/cgit/emacs.git/commit/?id=237adac78268940e77ed19e06c4319af5955d55f

```
Use convenient alists to manage per-frame font driver-specific data.

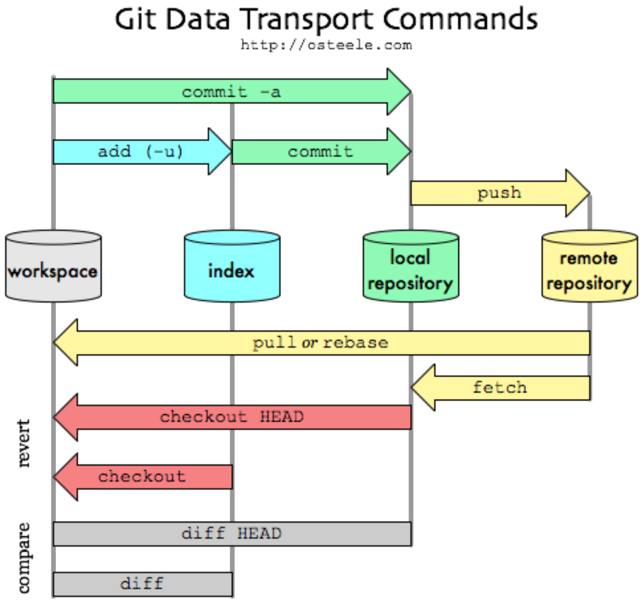
* frame.h (struct frame): Rename font_data_list to...
[HAVE_XFT || HAVE_FREETYPE]: ... font_data, which is a Lisp_Object now.
* font.h (struct font_data_list): Remove; no longer need a special
data type.
(font_put_frame_data, font_get_frame_data) [HAVE_XFT || HAVE_FREETYPE]:
Adjust prototypes.
* font.c (font_put_frame_data, font_get_frame_data)
[HAVE_XFT || HAVE_FREETYPE]: Prefer alist functions to ad-hoc list
management.
* xftfont.c (xftfont_get_xft_draw, xftfont_end_for_frame):
Related users changed.
* ftxfont.c (ftxfont_get_gcs, ftxfont_end_for_frame): Likewise.
Prefer convenient xmalloc and xfree.
```

Not much the patch didn't already say ... (do you understand the problem the commit is trying to solve?)

## Outline of this section

2 Clean commits

- Writing good commit messages
- Partial commits with `git add -p`, the index


Git Data Transport Commands
http://osteele.com
commit -a
add (-u)
commit
push
workspace
index
local repository
remote repository
pull or rebase
fetch
revert
checkout HEAD
checkout
compare
diff HEAD
diff

## The index, or “Staging Area”

- “the index” is where the next commit is prepared
- Contains the list of files and their content
- `git commit` transforms the index into a commit
- `git commit -a` stages all changes in the worktree in the index before committing. You’ll find it sloppy soon.

## Dealing with the index

- Commit only 2 files:

```
git add file1.txt
git add file2.txt
git commit
```

- Commit only some patch hunks:

```
git add -p
(answer yes or no for each hunk)
git commit
```

## git add -p: example

```
$ git add -p
@@ -1,7 +1,7 @@
 int main()
-       int i;
+       int i = 0;
        printf("Hello, ");
        i++;
Stage this hunk [y,n,q,a,d,/,K,g,e,?]? y
```

## git add -p: example

```
$ git add -p
@@ -1,7 +1,7 @@
 int main()
-        int i;
+        int i = 0;
         printf("Hello, ");
         i++;
Stage this hunk [y,n,q,a,d,/,K,g,e,?]? y
@@ -5,6 +5,6 @@

-        printf("i is %s\n", i);
+        printf("i is %d\n", i);

Stage this hunk [y,n,q,a,d,/,K,g,e,?]? n
```

## git add -p: example

```
$ git add -p
@@ -1,7 +1,7 @@
 int main()
-        int i;
+        int i = 0;
         printf("Hello, ");
         i++;
Stage this hunk [y,n,q,a,d,/,K,g,e,?]? y
@@ -5,6 +5,6 @@

-        printf("i is %s\n", i);
+        printf("i is %d\n", i);

Stage this hunk [y,n,q,a,d,/,K,g,e,?]? n
$ git commit -m "Initialize i properly"
[master c4ba68b] Initialize i properly
 1 file changed, 1 insertion(+), 1 deletion(-)
```

## `git add -p`: dangers

- Commits created with `git add -p` do not correspond to what you have on disk
- You probably never tested this commit ...
- Solutions:
  - `git stash -k`: stash what's not in the index
  - `git rebase --exec`: see later
  - (and code review)

## Outline

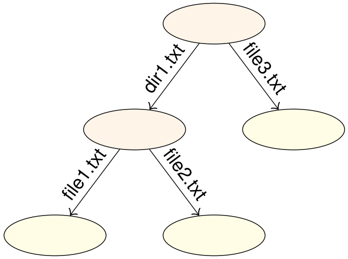
## Why do I need to learn about Git's internal?

- Beauty of Git: very simple data model
  (The tool is clever, the repository format is simple&stupid)
- Understand the model, and the 150+ commands will become simple !

## Outline of this section

## Content of a Git repository: Git objects

| | |
|---|---|
| blob | Any sequence of bytes, represents file content |
| tree | Associates object to pathnames, represents a directory |



## Content of a Git repository: Git objects

| | |
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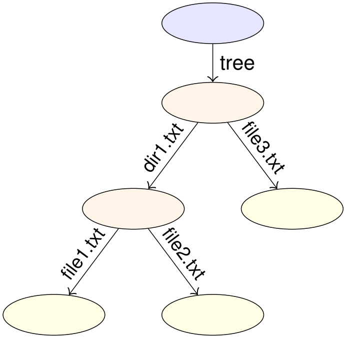
| commit | Metadata + pointer to tree + pointer to parents |



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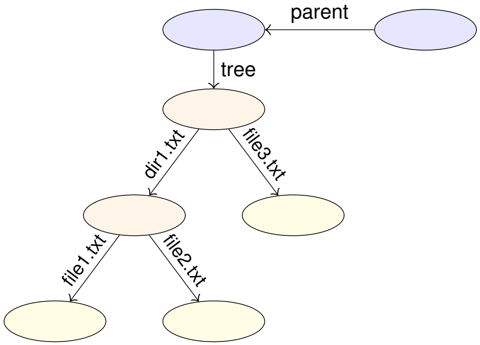

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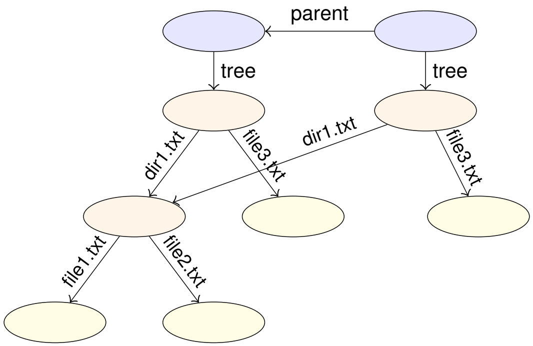

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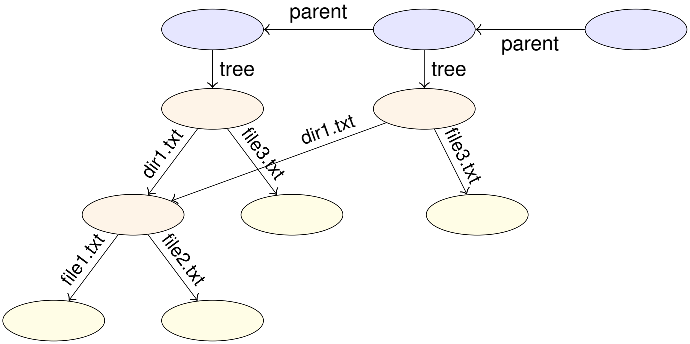

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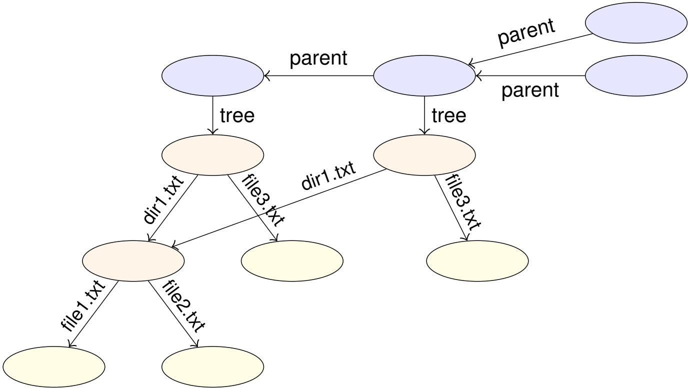

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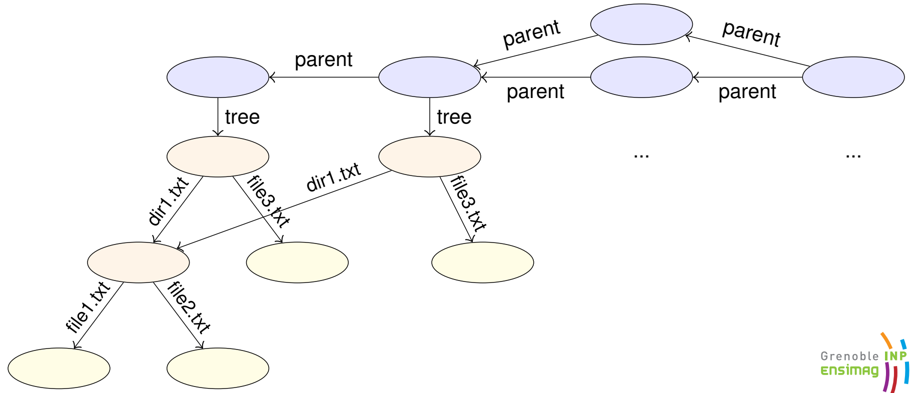


## Git objects: On-disk format

```
$ git log
commit 7a7fb77be431c284f1b6d036ab9aebf646060271
Author: Matthieu Moy <Matthieu.Moy@imag.fr>
Date:   Wed Jul 2 20:13:49 2014 +0200

    Initial commit
$ find .git/objects/
.git/objects/
.git/objects/fc
.git/objects/fc/264b697de62952c9ff763b54b5b11930c9cfec
.git/objects/a4
.git/objects/a4/7665ad8a70065b68fbcfb504d85e06551c3f4d
.git/objects/7a
.git/objects/7a/7fb77be431c284f1b6d036ab9aebf646060271
.git/objects/50
.git/objects/50/a345788a8df75e0f869103a8b49cecdf95a416
.git/objects/26
.git/objects/26/27a0555f9b58632be848fee8a4602a1d61a05f
```

## Git objects: On-disk format

```
$ echo foo > README.txt; git add README.txt
$ git commit -m "add README.txt"
[master 5454e3b] add README.txt
 1 file changed, 1 insertion(+)
 create mode 100644 README.txt
$ find .git/objects/
.git/objects/
.git/objects/fc
.git/objects/fc/264b697de62952c9ff763b54b5b11930c9cfec
.git/objects/a4
.git/objects/a4/7665ad8a70065b68fbcfb504d85e06551c3f4d
.git/objects/59
.git/objects/59/802e9b115bc606b88df4e2a83958423661d8c4
.git/objects/7a
.git/objects/7a/7fb77be431c284f1b6d036ab9aebf646060271
.git/objects/25
.git/objects/25/7cc5642cb1a054f08cc83f2d943e56fd3ebe99
.git/objects/54
.git/objects/54/54e3b51e81d8d9b7e807f1fc21e618880c1ac9
...
```

## Git objects: On-disk format

- By default, 1 object = 1 file
- Name of the file = object unique identifier content
- Content-addressed database:
  - Identifier computed as a hash of its content
  - Content accessible from the identifier
- Consequences:
  - Objects are immutable
  - Objects with the same content have the same identity (deduplication for free)
  - No known collision in SHA1
  - Acyclic (DAG = Directed Acyclic Graph)

## On-disk format: Pack files

```
$ du -sh .git/objects/
68K     .git/objects/
$ git gc
...
$ du -sh .git/objects/
24K     .git/objects/
$ find .git/objects/
.git/objects/
.git/objects/pack
.git/objects/pack/pack-f9cbdc53005a4b500934625d...a3.idx
.git/objects/pack/pack-f9cbdc53005a4b500934625d...a3.pack
.git/objects/info
.git/objects/info/packs
$
```

$\rightsquigarrow$ More efficient format, no conceptual change (objects are still there)

## Exploring the object database

- **`git cat-file -p`** : pretty-print the content of an object

```
$ git log --oneline
5454e3b add README.txt
7a7fb77 Initial commit
$ git cat-file -p 5454e3b
tree 59802e9b115bc606b88df4e2a83958423661d8c4
parent 7a7fb77be431c284f1b6d036ab9aebf646060271
author Matthieu Moy <Matthieu.Moy@imag.fr> 1404388746 +0200
committer Matthieu Moy <Matthieu.Moy@imag.fr> 1404388746 +0200

add README.txt
$ git cat-file -p 59802e9b115bc606b88df4e2a83958423661d8c4
100644 blob 257cc5642cb1a054f08cc83f2d943e56fd3ebe99  README.txt
040000 tree 2627a0555f9b58632be848fee8a4602a1d61a05f  sandbox
$ git cat-file -p 257cc5642cb1a054f08cc83f2d943e56fd3ebe99
foo
$ printf 'blob 4\0foo\n' | sha1sum
257cc5642cb1a054f08cc83f2d943e56fd3ebe99  -
```

## Merge commits in the object database

```
$ git checkout -b branch HEAD^
Switched to a new branch 'branch'
$ echo foo > file.txt; git add file.txt
$ git commit -m "add file.txt"
[branch f44e9ab] add file.txt
 1 file changed, 1 insertion(+)
 create mode 100644 file.txt
$ git merge master
Merge made by the 'recursive' strategy.
 README.txt | 1 +
 1 file changed, 1 insertion(+)
 create mode 100644 README.txt
```

## Merge commits in the object database

```
$ git checkout -b branch HEAD^
$ echo foo > file.txt; git add file.txt
$ git commit -m "add file.txt"
$ git merge master
$ git log --oneline --graph
*   1a7f9ae (HEAD, branch) Merge branch 'master' into branch
|\
| * 5454e3b (master) add README.txt
* | f44e9ab add file.txt
|/
* 7a7fb77 Initial commit
$ git cat-file -p 1a7f9ae
tree 896dbd61ffc617b89eb2380cdcaffcd7c7b3e183
parent f44e9abff8918f08e91c2a8fefe328dd9006e242
parent 5454e3b51e81d8d9b7e807f1fc21e618880c1ac9
author Matthieu Moy <Matthieu.Moy@imag.fr> 1404390461 +0200
committer Matthieu Moy <Matthieu.Moy@imag.fr> 1404390461 +0200

Merge branch 'master' into branch
```

## Snapshot-oriented storage

- A commit represents exactly the state of the project
- A tree represents only the state of the project (where we are, not how we got there)
- Renames are not tracked, but re-detected on demand
- Diffs are computed on demand (e.g. `git diff HEAD HEAD^`)
- Physical storage still efficient

## Outline of this section

## Branches, tags: references

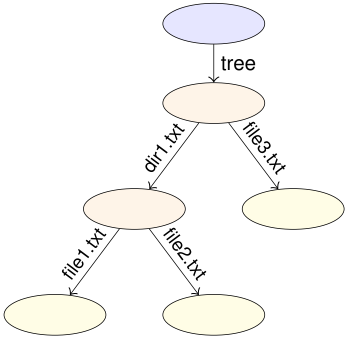
- In Java:

```
String s; // Reference named s
s = new String("foo"); // Object pointed to by s
String s2 = s; // Two refs for the same object
```

- In Git: likewise!

```
$ git log -oneline
5454e3b add README.txt
7a7fb77 Initial commit
$ cat .git/HEAD
ref: refs/heads/master
$ cat .git/refs/heads/master
5454e3b51e81d8d9b7e807f1fc21e618880c1ac9
$ git symbolic-ref HEAD
refs/heads/master
$ git rev-parse refs/heads/master
5454e3b51e81d8d9b7e807f1fc21e618880c1ac9
```

## References (refs) and objects



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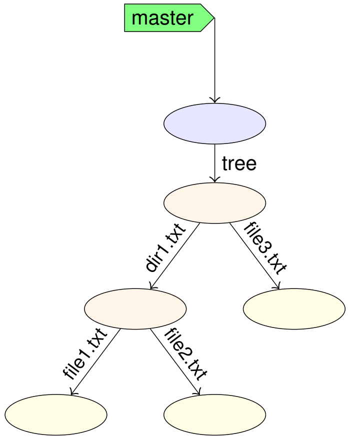

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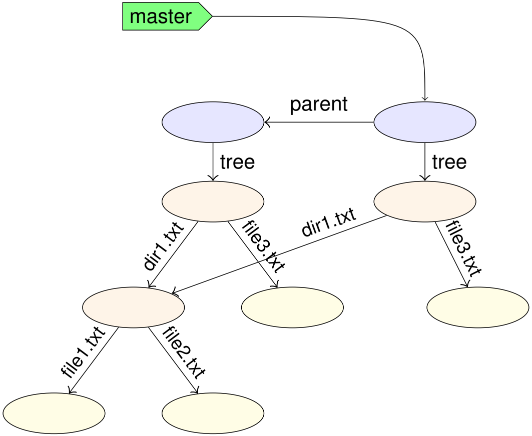

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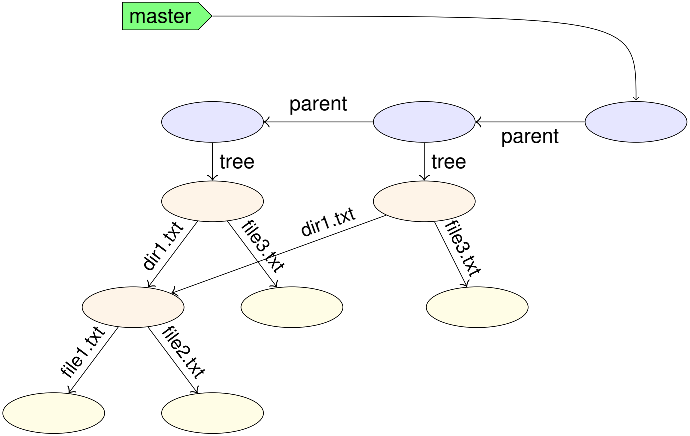

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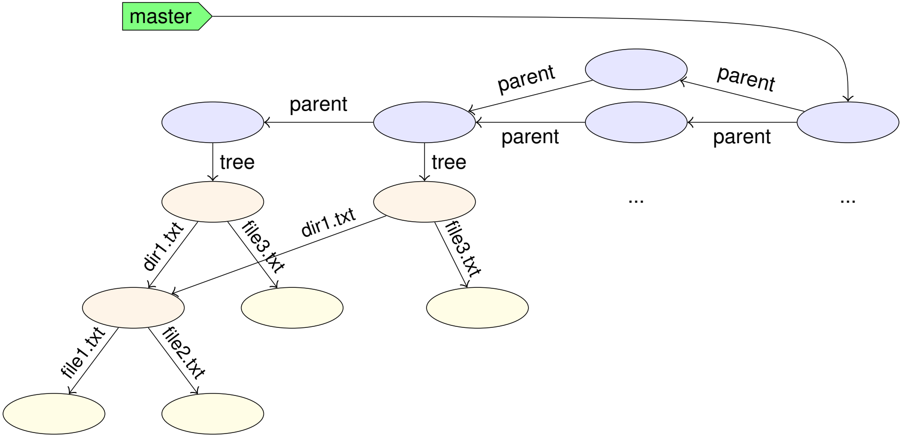

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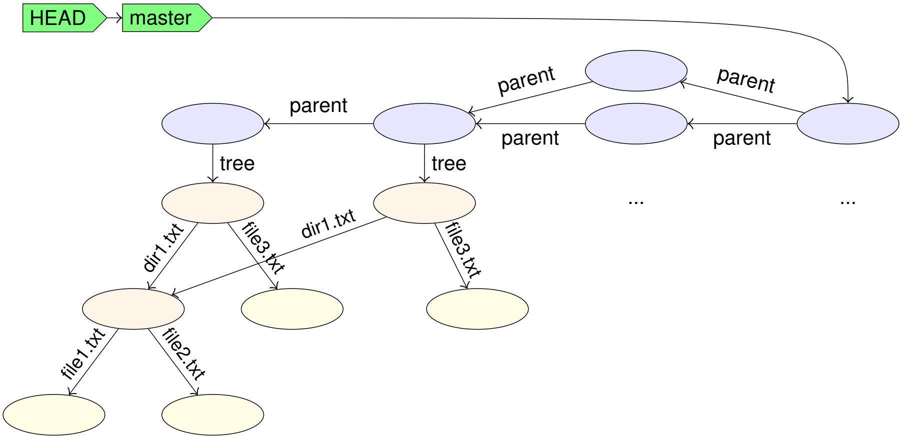
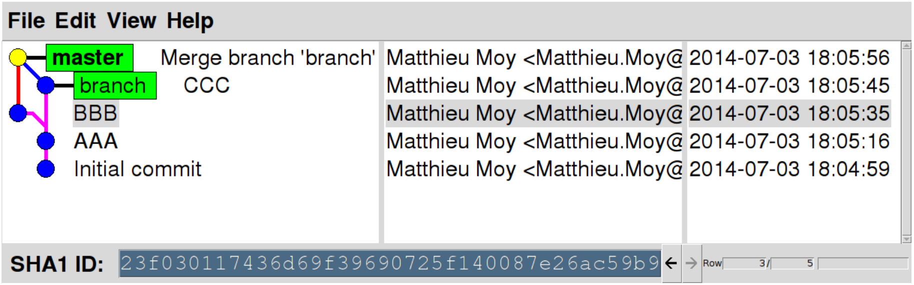


## Sounds Familiar?

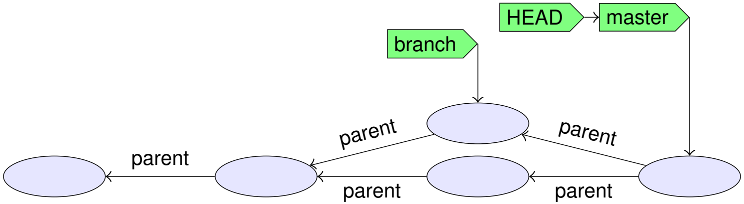


File Edit View Help

| | | |
|---|---|---|
| master Merge branch 'branch' | Matthieu Moy <Matthieu.Moy@ | 2014-07-03 18:05:56 |
| branch CCC | Matthieu Moy <Matthieu.Moy@ | 2014-07-03 18:05:45 |
| BBB | Matthieu Moy <Matthieu.Moy@ | 2014-07-03 18:05:35 |
| AAA | Matthieu Moy <Matthieu.Moy@ | 2014-07-03 18:05:16 |
| Initial commit | Matthieu Moy <Matthieu.Moy@ | 2014-07-03 18:04:59 |

SHA1 ID: 23f030117436d69f39690725f140087e26ac59b9 Row 3/ 5

$\approx$



## Branches, HEAD, tags

- A branch is a ref to a commit
- A lightweight tag is a ref (usually to a commit) (like a branch, but doesn't move)
- Annotated tags are objects containing a ref + a (signed) message
- HEAD is “where we currently are”
  - If HEAD points to a branch, the next commit will move the branch
  - If HEAD points directly to a commit (detached HEAD), the next commit creates a commit not in any branch (warning!)

## Outline

## Example

Implement `git clone -c var=value` : 9 preparation patches, 1 real (trivial) patch at the end!

`https://github.com/git/git/commits/84054f79de35015fc92f73ec4780102dd820e452`

Did the author actually write this in this order?

## Outline of this section

4 Clean local history

- Avoiding merge commits: `rebase` Vs `merge`
- Rewriting history with `rebase -i`

## Merging With Upstream

Question: upstream (where my code should eventually end up) has new code, how do I get it in my repo?

- Approach 1: merge (default with `git pull`)

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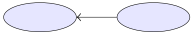

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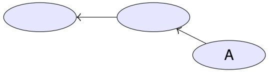

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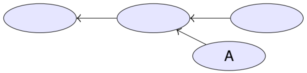

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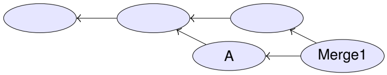

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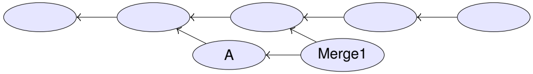

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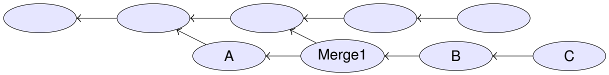

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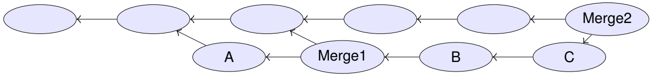

- Drawbacks:
  - Merge1 is not relevant, distracts reviewers (unlike Merge2).

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Question: upstream (where my code should eventually end up) has new code, how do I get it in my repo?

- Approach 2: no merge

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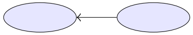

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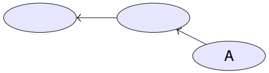

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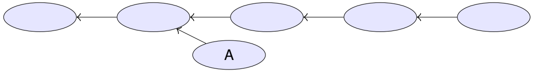

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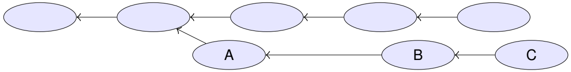

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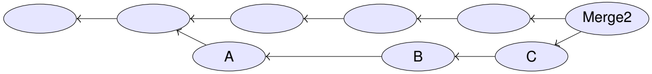
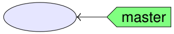


- Drawbacks:
  - In case of conflict, they have to be resolved by the developer merging into upstream (possibly after code review)
  - Not always applicable (e.g. “I need this new upstream feature to continue working”)

## Merging With Upstream

Question: upstream (where my code should eventually end up) has new code, how do I get it in my repo?

- Approach 3: rebase (`git rebase` or `git pull --rebase`)



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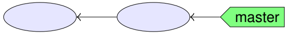

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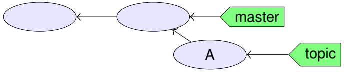

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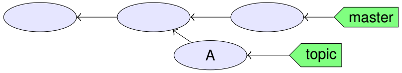

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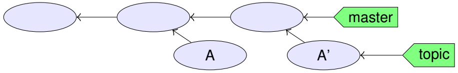

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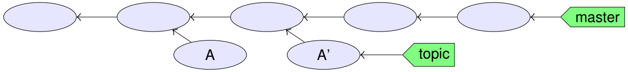

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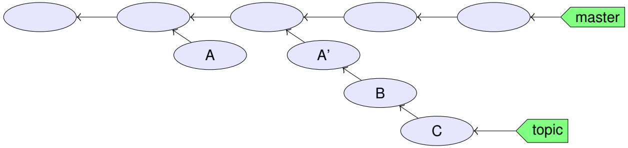

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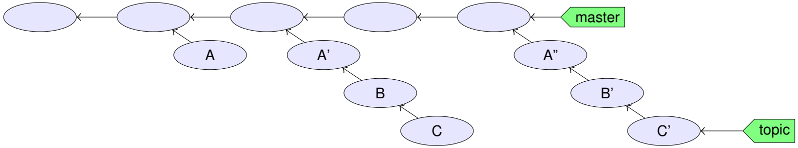

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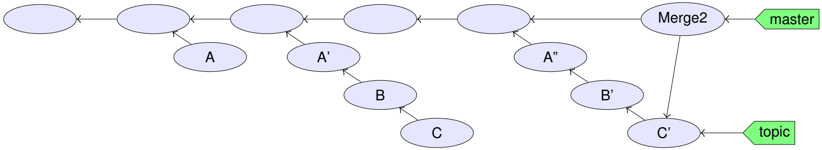

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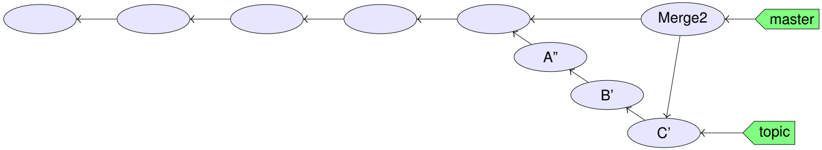

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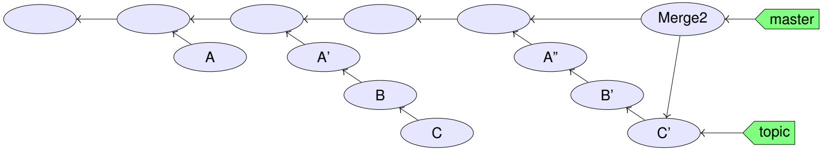


- Drawbacks: rewriting history implies:
  - A', A", B', C' probably haven't been tested (never existed on disk)
  - What if someone branched from A, A', B or C?
  - Basic rule: don't rewrite published history

## Outline of this section

4. Clean local history
   - Avoiding merge commits: `rebase` Vs `merge`
   - Rewriting history with `rebase -i`

## Rewriting history with `rebase -i`

- `git rebase`: take all your commits, and re-apply them onto upstream
- `git rebase -i`: show all your commits, and asks you what to do when applying them onto upstream:

```
pick ca6ed7a Start feature A
pick e345d54 Bugfix found when implementing A
pick c03fffc Continue feature A
pick 5bdb132 Oops, previous commit was totally buggy

# Rebase 9f58864..5bdb132 onto 9f58864
#
# Commands:
#  p, pick = use commit
#  r, reword = use commit, but edit the commit message
#  e, edit = use commit, but stop for amending
#  s, squash = use commit, but meld into previous commit
#  f, fixup = like "squash", but discard this commit's log message
#  x, exec = run command (the rest of the line) using shell
#
# These lines can be re-ordered; they are executed from top to bottom.
#
# If you remove a line here THAT COMMIT WILL BE LOST.
#
# However, if you remove everything, the rebase will be aborted.
#
```

## `git rebase -i` commands (1/2)

| | |
|---|---|
| p, pick | use commit (by default) |
| r, reword | use commit, but edit the commit message<br>Fix a typo in a commit message |
| e, edit | use commit, but stop for amending<br>• Once stopped, use `git add -p`, `git commit -amend`, ... |
| s, squash | use commit, but meld into previous commit |
| f, fixup | like "squash", but discard this commit's log message<br>• Very useful when polishing a set of commits (before or after review): make a bunch of short fixup patches, and squash them into the real commits. No one will know you did this mistake ;-). |

## `git rebase -i` commands (2/2)

x, exec run command (the rest of the line) using shell

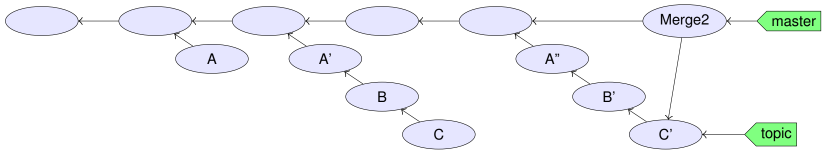
- Example: `exec make check`. Run tests for this commit, stop if test fail.
- Use `git rebase -i -exec 'make check'`[3] to run `make check` for each rebased commit.

[3]Implemented by Ensimag students!

## Outline

## Git's reference journal: the reflog

- Remember the history of local refs.
- $\neq$ ancestry relation.



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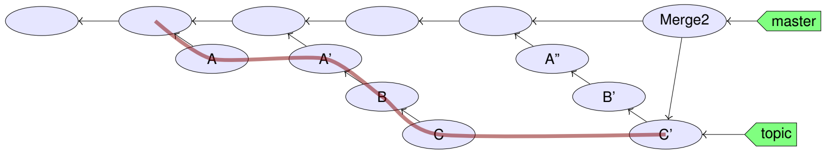

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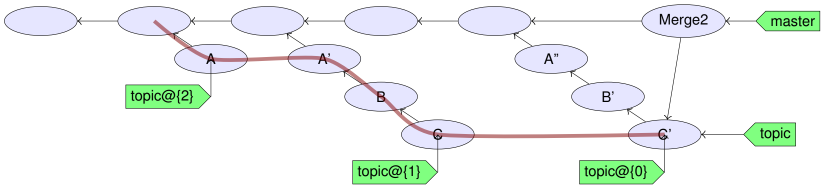

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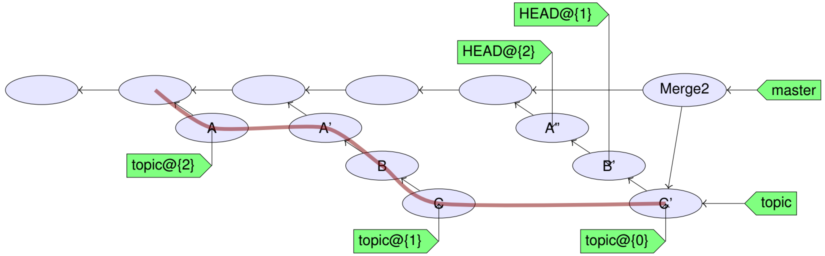


- `ref@{n}`: where *ref* was before the *n* last ref update.
- `ref~n`: the *n*-th generation ancestor of *ref*
- `ref^`: first parent of *ref*
- `git help revisions` for more

## Outline

## Outline of this section

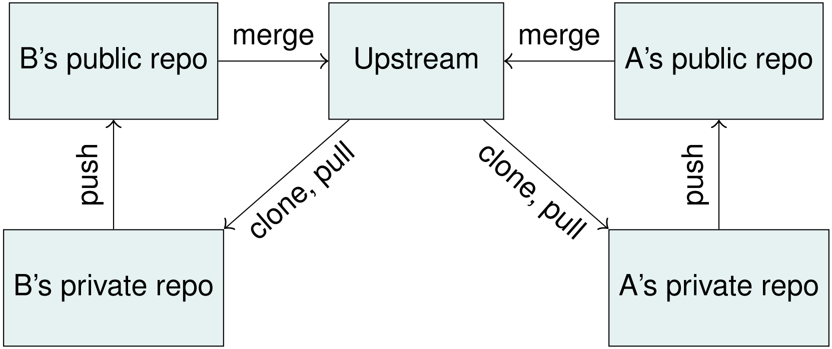
## Centralized workflow

```
do {
   while (nothing_interesting())
      work();
   while (uncommited_changes()) {
      while (!happy) { // git diff --staged ?
         while (!enough) git add -p;
         while (too_much) git reset -p;
      }
      git commit; // no -a
      if (nothing_interesting())
         git stash;
   }
   while (!happy)
      git rebase -i;
} while (!done);
git push; // send code to central repository
```

## Outline of this section

## Triangular Workflow with pull-requests

- Developers pull from upstream, and push to a “to be merged” location
- Someone else reviews the code and merges it upstream



## Outline of this section

## Code Review

- What we'd like:
  1. A writes code, commits, pushes
  2. B does a review
  3. B merges to upstream
- What usually happens:
  1. A writes code, commits, pushes
  2. B does a review
  3. B requests some changes
  4. ... then ?

## Iterating Code Reviews

- At least 2 ways to deal with changes between reviews:
  1. Add more commits to the pull request and push them on top
  2. Rewrite commits (`rebase -i`, . . .) and overwrite the old pull request
     - ★ The resulting history is clean
     - ★ Much easier for reviewers joining the review effort at iteration 2
     - ★ e.g. On Git's mailing-list, 10 iterations is not uncommon.

## Outline

## More Documentation

- http://ensiwiki.ensimag.fr/index.php/Maintenir_un_historique_propre_avec_Git
- http://ensiwiki.ensimag.fr/index.php/Ecrire_de_bons_messages_de_commit_avec_Git