

Advanced Git Operations and Principles

This blog post was organized with the assistance of ChatGPT-4o. The keynote can be found at <https://github.com/lzwjava/Keynotes>.

Undoing Changes

```
$ git commit --amend
$ git add *
$ git status
$ git reset HEAD CONTRIBUTING.md
Unstaged changes after reset:
M CONTRIBUTING.md
$ git status
$ git checkout -- CONTRIBUTING.md
```

- Recommit
- Unstage files
- Discard changes in working directory

Commands

- `git revert`: Revert, re-commit to counteract a previous commit
- `git cherry-pick`: Select specific commits from multiple commits
- `git rebase`

filter-branch

- Remove a file from every commit
- You want to delete it, but it's still in history
- How to delete a file from all commits?

```
$ git filter-branch --tree-filter 'rm -f passwords.txt' HEAD
Rewrite 6b9b3cf04e7c5686a9cb838c3f36a8cb6a0fc2bd (21/21)
Ref 'refs/heads/master' was rewritten
```

Search

```
$ git grep -n gmtime_r
compat/gmtime.c:3:#undef gmtime_r
compat/gmtime.c:8:return git_gmtime_r(timep, &result);
compat/gmtime.c:11:struct tm *git_gmtime_r(const time_t *timep, struct tm *result)
```

```

compat/gmtime.c:16:ret = gmtime_r(timep, result);
compat/mingw.c:606:struct tm *gmtime_r(const time_t *timep, struct tm *result)
compat/mingw.h:162:struct tm *gmtime_r(const time_t *timep, struct tm *result);
date.c:429:if (gmtime_r(&now, &now_tm))
date.c:492:if (gmtime_r(&time, tm)) {
git-compat-util.h:721:struct tm *git_gmtime_r(const time_t *, struct tm *);
git-compat-util.h:723:#define gmtime_r git_gmtime_r
$ git log -SZLIB_BUF_MAX --oneline
e01503b zlib: allow feeding more than 4GB in one go
ef49a7a zlib: zlib can only process 4GB at a time

```

.Git Directory

- config: Project configuration
- info: .gitignore
- objects: All content in Git database
- refs: Pointers to branches
- HEAD: Pointer to the current branch
- index: Staging area information

Git Objects

```

$ git init test
Initialized empty Git repository in /tmp/test/.git/
$ cd test
$ find .git/objects
.git/objects
.git/objects/info
.git/objects/pack
$ find .git/objects -type f

$ echo 'test content' | git hash-object -w --stdin
d670460b4b4aece5915caf5c68d12f560a9fe3e4
$ find .git/objects -type f
.git/objects/d6/70460b4b4aece5915caf5c68d12f560a9fe3e4

```

- hash-object: Command to save data to .git directory
- -w: Write the object, otherwise just return the key
- --stdin: Read from standard input
- d670...: 40-character checksum

- cat-file: Swiss army knife to view Git Object

```
$ git cat-file -p d670460b4b4aece5915caf5c68d12f560a9fe3e4
test content

$ echo 'version 1' > test.txt
$ git hash-object -w test.txt
83baae61804e65cc73a7201a7252750c76066a30
$ echo 'version 2' > test.txt
$ git hash-object -w test.txt
1f7a7a472abf3dd9643fd615f6da379c4acb3e3a
$ find .git/objects -type f
.git/objects/1f/7a7a472abf3dd9643fd615f6da379c4acb3e3a
.git/objects/83/baae61804e65cc73a7201a7252750c76066a30
.git/objects/d6/70460b4b4aece5915caf5c68d12f560a9fe3e4
$ git cat-file -p 83baae61804e65cc73a7201a7252750c76066a30 > test.txt
$ cat test.txt
version 1
$ git cat-file -p 1f7a7a472abf3dd9643fd615f6da379c4acb3e3a > test.txt
$ cat test.txt
version 2
$ git cat-file -t 1f7a7a472abf3dd9643fd615f6da379c4acb3e3a
blob
$ git cat-file -p master^{tree}
100644 blob a906cb2a4a904a152e80877d4088654daad0c859 README
100644 blob 8f94139338f9404f26296befa88755fc2598c289 Rakefile
040000 tree 99f1a6d12cb4b6f19c8655fca46c3ecf317074e0 lib
$ git cat-file -p 99f1a6d12cb4b6f19c8655fca46c3ecf317074e0
100644 blob 47c6340d6459e05787f644c2447d2595f5d3a54b simplegit.rb
Tree Objects

$ git update-index --add --cacheinfo 100644 \
83baae61804e65cc73a7201a7252750c76066a30 test.txt
update-index
```

- update-index: Command to create a tree
- --add: Create index
- --cacheinfo: Read from Git database
- 100644: File mode, normal file; 100755 for executable files; 120000 for symlinks

- 83baae: Previous content, version 1
- \: Split a command into two lines

write-tree

```
$ git write-tree
d8329fc1cc938780ffdd9f94e0d364e0ea74f579
$ git cat-file -p d8329fc1cc938780ffdd9f94e0d364e0ea74f579
100644 blob 83baae61804e65cc73a7201a7252750c76066a30 test.txt
$ git cat-file -t d8329fc1cc938780ffdd9f94e0d364e0ea74f579
tree
```

- write-tree: Write the content of the staging area to Tree Object

read-tree

```
$ echo 'new file' > new.txt
$ git update-index test.txt
$ git update-index --add new.txt
$ git write-tree
0155eb4229851634a0f03eb265b69f5a2d56f341
$ git cat-file -p 0155eb4229851634a0f03eb265b69f5a2d56f341
100644 blob fa49b077972391ad58037050f2a75f74e3671e92 new.txt
100644 blob 1f7a7a472abf3dd9643fd615f6da379c4acb3e3a test.txt
$ git read-tree --prefix=bak d8329fc1cc938780ffdd9f94e0d364e0ea74f579
$ git write-tree
3c4e9cd789d88d8d89c1073707c3585e41b0e614
$ git cat-file -p 3c4e9cd789d88d8d89c1073707c3585e41b0e614
040000 tree d8329fc1cc938780ffdd9f94e0d364e0ea74f579 bak
100644 blob fa49b077972391ad58037050f2a75f74e3671e92 new.txt
100644 blob 1f7a7a472abf3dd9643fd615f6da379c4acb3e3a test.txt
```

Commit Objects

```
$ echo 'first commit' | git commit-tree d8329f
d5ffe1aa4b7b089eee03dccea5e0439ad6d72037
$ git cat-file -p d5ffe1aa4b7b089eee03dccea5e0439ad6d72037
tree d8329fc1cc938780ffdd9f94e0d364e0ea74f579
author lzwjava <lzwjava@gmail.com> 1462090215 +0800
committer lzwjava <lzwjava@gmail.com>
```

1462090215 +0800

first commit

- Hash values differ because creation time and author are different

```
$ echo 'second commit' | git commit-tree 0155eb -p d5ffe1aa4
e946d6367f07de45cac242dca7cd002f5eaa72b1
```

```
$ echo 'third commit' | git commit-tree 3c4e9c -p e946d6
09490bf051c34b3693dfd5c7fb63dfe27b295904
```

```
$ git log --stat 09490
```

```
commit 09490bf051c34b3693dfd5c7fb63dfe27b295904
```

```
Author: lzwjava <lzwjava@gmail.com>
```

```
Date: Sun May 1 16:38:55 2016 +0800
```

third commit

```
bak/test.txt | 1 +
```

```
1 file changed, 1 insertion(+)
```

```
commit e946d6367f07de45cac242dca7cd002f5eaa72b1
```

```
Author: lzwjava <lzwjava@gmail.com>
```

```
Date: Sun May 1 16:37:01 2016 +0800
```

second commit

```
new.txt | 1 +
```

```
test.txt | 2 +- 
```

```
2 files changed, 2 insertions(+), 1 deletion(-)
```

```
commit d5ffe1aa4b7b089eee03dccea5e0439ad6d72037
```

```
Author: lzwjava <lzwjava@gmail.com>
```

```
Date: Sun May 1 16:10:15 2016 +0800
```

first commit

```
test.txt | 1 +
```

```
1 file changed, 1 insertion(+)
```

- commit-tree: First parameter points to blob or tree
- -p: Points to parent node

third commit

second commit

first commit

tree

tree

tree

```
"version 2"
"new file"
"version 1"
09490b
e946d6
d5ffe1 d8329f
0155eb
3c4e9c
83baae
fa49b0
1f7a7a
test.txt
new.txt
test.txt
new.txt
test.txt
bak
```

Branch Principles

```
$ find .git/refs
.git/refs
.git/refs/heads
.git/refs/tags
$ find .git/refs -type f
$ echo "09490bf051c34b3693dfd5c7fb63dfe27b295904" > .git/refs/heads/master
$ git log --pretty=oneline master
09490bf051c34b3693dfd5c7fb63dfe27b295904 third commit
e946d6367f07de45cac242dca7cd002f5eaa72b1 second commit
d5ffe1aa4b7b089eee03dccea5e0439ad6d72037 first commit
$ git update-ref refs/heads/master 09490bf051c34b3693dfd5c7fb63dfe27b295904
$ git update-ref refs/heads/test e946d6367f07de45cac242dca7cd002f5eaa72b1
$ git branch
* master
test
```

- Save a pointer reference
- update-ref: Modify or add a reference

```

third commit
second commit
first commit
tree
tree
tree
  "version 2"
  "new file"
  "version 1"
09490b
e946d6
d5ffe1 d8329f
0155eb
3c4e9c
83baae
fa49b0
1f7a7a
test.txt
new.txt
test.txt
new.txt
test.txt
bak
refs/heads/master
refs/heads/test

$ cat .git/HEAD
ref: refs/heads/master
$ git symbolic-ref HEAD
refs/heads/master
$ git symbolic-ref HEAD refs/heads/test
$ cat .git/HEAD
ref: refs/heads/test

symbolic-ref

Tag Principles

$ git update-ref refs/tags/v1.0 e946d6367f07de45cac242dca7cd002f5eaa72b1

```

```
$ git tag
v1.0
$ git tag -a v1.1 e946d6367f07de45cac242dca7cd002f5eaa72b1 -m 'test tag'
$ cat .git/refs/tags/v1.1
2766532f03289bc5e158629a8b3faffa5f80b8b6
$ git cat-file -p 276653
object e946d6367f07de45cac242dca7cd002f5eaa72b1
type commit
tag v1.1
tagger lzwjava <lzwjava@gmail.com> 1462103203 +0800
test tag
```

Remotes

```
$ git remote add origin git@github.com:schacon/simplegit-progit.git
$ git push origin master
Counting objects: 11, done.
Compressing objects: 100% (5/5), done.
Writing objects: 100% (7/7), 716 bytes, done.
Total 7 (delta 2), reused 4 (delta 1)
To git@github.com:schacon/simplegit-progit.git
a11bef0..ca82a6d master -> master
$ cat .git/refs/remotes/origin/master
ca82a6dff817ec66f44342007202690a93763949
```

- Stored in refs/remotes directory
- Difference between remotes and branches is that remotes are read-only
- Can git checkout, but HEAD does not change, so commit cannot change remote references

```
$ curl https://raw.githubusercontent.com/mojombo/grit/master/lib/grit/repo.rb > repo.rb
$ git checkout master
$ git add repo.rb
$ git commit -m 'added repo.rb'
[master 484a592] added repo.rb
3 files changed, 709 insertions(+), 2 deletions(-)
delete mode 100644 bak/test.txt
create mode 100644 repo.rb
rewrite test.txt (100%)
$ git cat-file -p master^{tree}
```



```

100644 blob fa49b077972391ad58037050f2a75f74e3671e92 new.txt
100644 blob 033b4468fa6b2a9547a70d88d1bbe8bf3f9ed0d5 repo.rb
100644 blob e3f094f522629ae358806b17daf78246c27c007b test.txt
$ git cat-file -s 033b4468fa6b2a9547a70d88d1bbe8bf3f9ed0d5
22044
$ echo '# testing' >> repo.rb
$ git commit -am 'modified repo a bit'
[master 2431da6] modified repo.rb a bit
1 file changed, 1 insertion(+)
$ git cat-file -p master^{tree}
100644 blob fa49b077972391ad58037050f2a75f74e3671e92 new.txt
100644 blob b042a60ef7dff760008df33cee372b945b6e884e repo.rb
100644 blob e3f094f522629ae358806b17daf78246c27c007b test.txt
$ git cat-file -s b042a60ef7dff760008df33cee372b945b6e884e
22054
$ git gc
Counting objects: 18, done.
Delta compression using up to 8 threads.
Compressing objects: 100% (14/14), done.
Writing objects: 100% (18/18), done.
Total 18 (delta 3), reused 0 (delta 0)
$ find .git/objects -type f
$ git verify-pack -v .git/objects/pack/pack-978e03944f5c581011e6998cd0e9e30000905586.idx

```

Refspec

```

$ git remote add origin https://github.com/schacon/simplegit-progit
[remote "origin"]
url = https://github.com/schacon/simplegit-progit
fetch = +refs/heads/*:refs/remotes/origin/*
$ git log origin/master
$ git log remotes/origin/master
$ git log refs/remotes/origin/master
fetch = +refs/heads/master:refs/remotes/origin/master
[remote "origin"]
url = https://github.com/schacon/simplegit-progit
fetch = +refs/heads/master:refs/remotes/origin/master

```

```
fetch = +refs/heads/qa/*:refs/remotes/origin/qa/*
```

```
push = refs/heads/master:refs/heads/qa/master
```

- <src>:<dst>
- refs/remotes: Local position

```
https://github.com/schacon/simplegit-progit
```

```
https://github.com/schacon/simplegit-progit
```

References

- Pro Git