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Rewriting History

The previous module on rebasing taught us how to move commits around and perform some basic edits while doing so, but now we're going to really get our hands dirty. We'll learn how to split up commits, revive lost snapshots, and completely rewrite a repository's history to our exact specifications.

Hopefully, this module will get you much more comfortable with the core Git components, as we'll be inspecting and editing the internal makeup of our project.

Download the repository for this module

If you've been following along from the previous module, you already have everything you need. Otherwise, download the zipped Git repository from the above link, uncompress it, and you're good to go.

Create the Red Page

First, let's create a new branch and add a few more HTML pages.

```
git checkout -b new-pages
git branch
```

Notice that we created a new branch and checked it out in a single step by passing the `-b` flag to the `git checkout` command.

Next, create the file `red.html` and add the following content:

```
<!DOCTYPE html>
```

```
<html lang="en">
<head>
  <title>The Red Page</title>
  <link rel="stylesheet" href="style.css" />
  <meta charset="utf-8" />
</head>
<body>
  <h1 style="color: #C00">The Red Page</h1>
  <p>Red is the color of <span style="color: #C00">passion</span>!</p>

  <p><a href="index.html">Return to home page</a></p>
</body>
</html>
```

We'll hold off on committing this page for the moment.

Create the Yellow Page

Create a file called `yellow.html`, which should look like the following.

```
<!DOCTYPE html>
<html lang="en">
<head>
  <title>The Yellow Page</title>
  <link rel="stylesheet" href="style.css" />
  <meta charset="utf-8" />
</head>
<body>
  <h1 style="color: #FF0">The Yellow Page</h1>
  <p>Yellow is the color of <span style="color: #FF0">the sun</span>!</p>

  <p><a href="index.html">Return to home page</a></p>
</body>
</html>
```

Link and Commit the New Pages

Next, we'll link both new pages to the home page. Add the following items to the "Navigation" section in `index.html`:

```
<li style="color: #C00">
  <a href="red.html">The Red Page</a>
</li>
<li style="color: #FF0">
  <a href="yellow.html">The Yellow Page</a>
</li>
```

Then, commit all of these changes in a single snapshot.

```
git add red.html yellow.html index.html
git status
git commit -m "Add new HTML pages"
```

This is an example of a *bad* commit. It performed multiple, unrelated tasks, and it has a relatively generic commit message. Thus far, we haven't really specified when it's appropriate to commit changes, but the general rules are essentially the same as for branch creation:

- Commit a snapshot for each significant addition to your project.
- *Don't* commit a snapshot if you can't come up with a single, specific message for it.

This will ensure that your project has a meaningful commit history, which gives you the ability to see exactly when and where a feature was added or a piece of functionality was broken. However, in practice, you'll often wind up committing several changes in a single snapshot, since you won't always know what constitutes a "well-defined" addition as you're developing a project. Fortunately, Git lets us go back and fix up these problem commits after the fact.

Create and Commit the Green Page

Let's create one more page before splitting that "bad" commit: Add the following HTML to a file called `green.html`.

```
<!DOCTYPE html>
<html lang="en">
<head>
  <title>The Green Page</title>
  <link rel="stylesheet" href="style.css" />
  <meta charset="utf-8" />
</head>
<body>
  <h1 style="color: #0C0">The Green Page</h1>
  <p><span style="color: #0C0">Green</span> is the color of earth.</p>

  <p><a href="index.html">Return to home page</a></p>
</body>
</html>
```

Add a link to `index.html` in the “Navigation” section:

```
<li style="color: #0C0">
  <a href="green.html">The Green Page</a>
</li>
```

And finally, stage the green page and commit the snapshot.

```
git add green.html index.html
git status
git commit -m "Add green page"
```

Begin an Interactive Rebase

The commits introduced in our `new-pages` branch are:

```
4c3027c Add green page
db96c72 Add new HTML pages
```

But, we want these commits to look more like:

```
4c3027c Add green page
9b1a64f Add yellow page
77a1cf1 Add red page
```

To achieve this, we can use the same interactive rebasing method covered in the previous module, only this time we'll actually *create* commits in the middle of the rebasing procedure.

```
git rebase -i master
```

Change the rebase listing to the following, then save the file and exit the editor to begin the rebase.

```
edit db96c72 Add new HTML pages
pick 4c3027c Add green page
```

Undo the Generic Commit

First, let's take a look at where we are with `git log --oneline`:

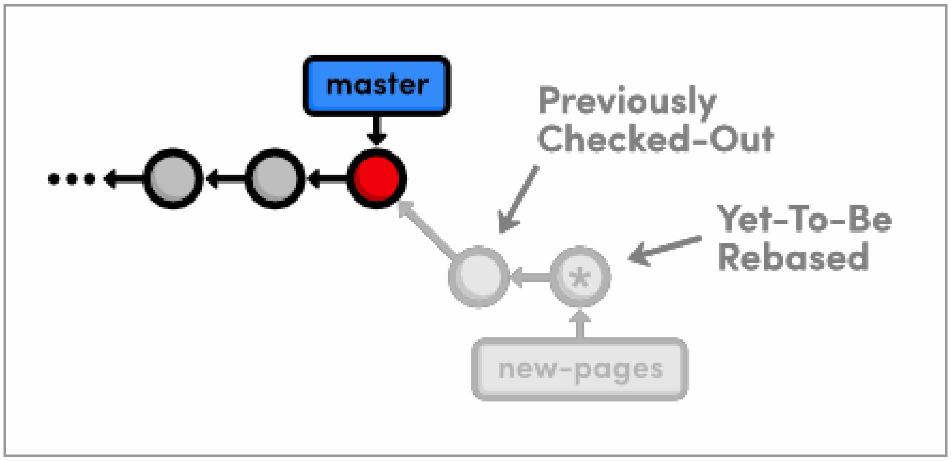
```
db96c72 Add new HTML pages
7070b0e Add link to about section in home page
...
```

When Git encountered the `edit` command in the rebase configuration, it stopped to let us edit the commit. As a result, the green page commit doesn't appear in our history yet. This should be familiar from the previous module. But instead of *amending* the current commit, we're going to completely remove it:

```
git reset --mixed HEAD~1
git log --oneline
git status
```

The `git reset` command moves the checked out snapshot to a new commit, and the

HEAD~1 parameter tells it to reset to the commit that occurs immediately before the current HEAD (likewise, HEAD~2 would refer to second commit before HEAD). In this particular case, HEAD~1 happens to coincide with master. The effect on our repository can be visualized as:



Resetting to HEAD~1

You may recall from Undoing Changes that we used git reset --hard to undo uncommitted changes to our project. The --hard flag told Git to make the working directory look exactly like the most recent commit, giving us the intended effect of removing uncommitted changes.

But, this time we used the --mixed flag to preserve the working directory, which contains the changes we want to separate. That is to say, the HEAD moved, but the working directory remained unchanged. Of course, this results in a repository with uncommitted modifications. We now have the opportunity to add the red.html and yellow.html files to distinct commits.

Split the Generic Commit

Let's start with the red page. Since we only want to commit content that involves the red page, we'll have to manually go in and remove the yellow page's link from the "Navigation" section. In index.html, change this section to match the following:

```
<h2>Navigation</h2>
<ul>
  <li>
    <a href="about/index.html">About Us</a>
  </li>
  <li style="color: #F90">
    <a href="orange.html">The Orange Page</a>
  </li>
  <li style="color: #00F">
    <a href="blue.html">The Blue Page</a>
  </li>
  <li>
    <a href="rainbow.html">The Rainbow Page</a>
  </li>
  <li style="color: #C00">
    <a href="red.html">The Red Page</a>
  </li>
</ul>
```

Now, we can group the red page’s updates into an independent commit.

```
git add red.html index.html
git status
git commit -m "Add red page"
```

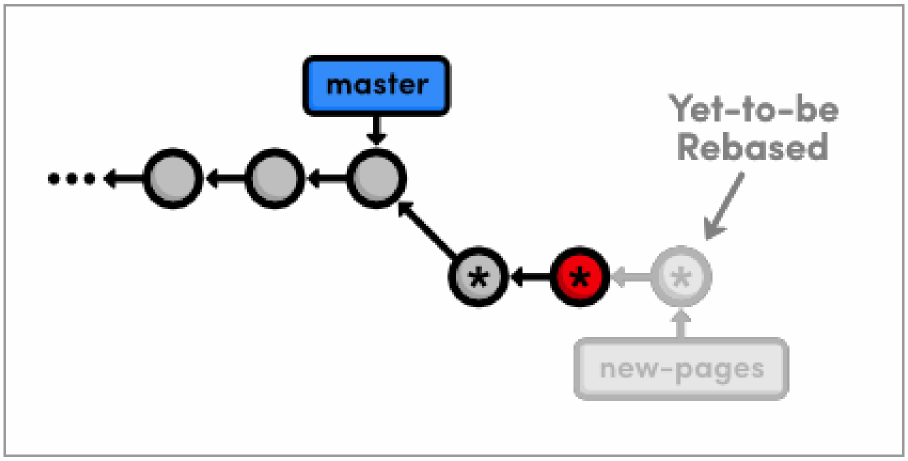
Next up is the yellow page. Go ahead and add it back to the “Navigation” section in `index.html`:

```
<li style="color: #FF0">
  <a href="yellow.html">The Yellow Page</a>
</li>
```

And again, stage and commit the snapshot.

```
git add yellow.html index.html
git status
git commit -m "Add yellow page"
```

We’ve successfully split up the contents of a single commit into two new snapshots, as shown below.



Creating two new commits while rebasing

But, don't forget that the rebase still needs to transfer the green page:

```
git rebase --continue
```

To summarize, we removed the "bad" commit from the current branch with `git reset`, keeping the contained HTML files intact with the `--mixed` flag. Then, we committed them in separate snapshots with the usual `git add` and `git commit` commands. The point to remember is that during a rebase you can add, delete, and edit commits to your heart's content, and the entire result will be moved to the new base.

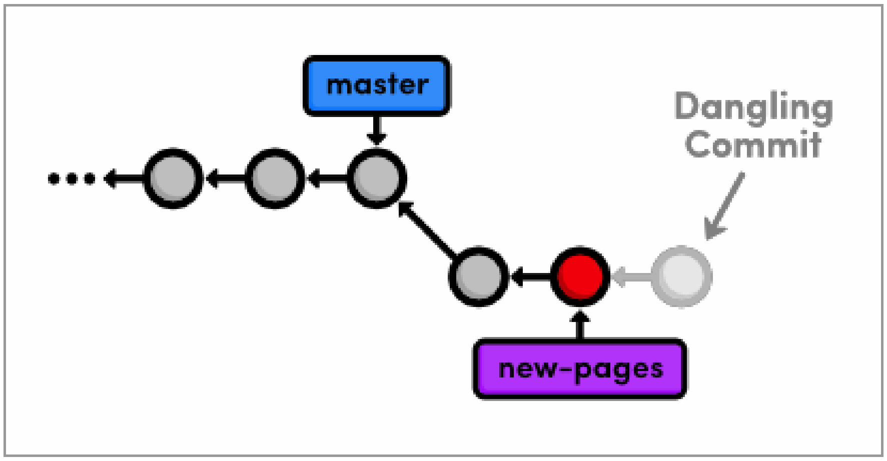
Remove the Last Commit

Next, we're going to "accidentally" remove the green page commit so we can learn how to retrieve it via Git's internal repository data.

```
git reset --hard HEAD~1
git status
git log --oneline
```

This moves the checked-out commit backward by one snapshot, along with the `new-pages` pointer. Note that `git status` tells us that we have nothing to commit, since the `--hard` flag obliterated any changes in the working directory. And of course, the `git log` output shows that the `new-pages` branch no longer contains the green commit.

This behavior is slightly different from the reset we used in the interactive rebase: this time the *branch* moved with the new `HEAD`. Since we were on `(no branch)` during the rebase, there was no branch tip to move. However, in general, `git reset` is used to move branch tips around and optionally alter the working directory via one of its many flags (e.g., `--mixed` or `--hard`).



Removing the most recent commit

The commit that we removed from the branch is now a **dangling commit**. Dangling commits are those that cannot be reached from any branch and are thus in danger of being lost forever.

Open the Reflog

Git uses something called the **reflog** to record every change you make to your repository. Let's take a look at what it contains:

```
git reflog
```

The resulting output should look something like the following. Depending on your version of Git, the messages might be slightly different. You can press Space to scroll through the content or q to exit.

```
9b1a64f HEAD@{0}: reset: moving to HEAD~1
002185c HEAD@{1}: rebase -i (finish): returning to refs/heads/new-pages
002185c HEAD@{2}: rebase -i (pick): Add green page
9b1a64f HEAD@{3}: commit: Add yellow page
77a1cf1 HEAD@{4}: commit: Add red page
```

```
7070b0e HEAD@{5}: reset: moving to HEAD~1
...
```

The above listing reflects our last few actions. For example, the current HEAD, denoted by HEAD@{0}, resulted from reseting HEAD to HEAD~1. Four actions ago, the yellow page was applied during our rebase, as shown in HEAD@{3}.

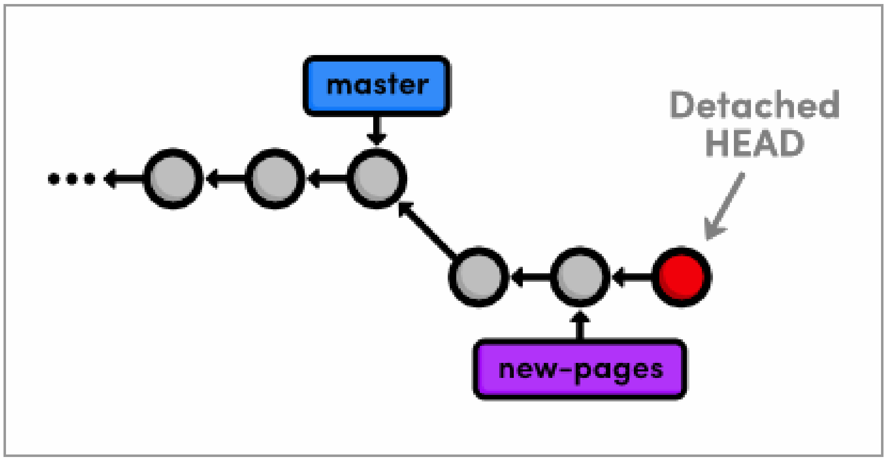
The reflog is a *chronological* listing of our history, without regard for the repository's branch structure. This lets us find dangling commits that would otherwise be lost from the project history.

Revive the Lost Commit

At the beginning of each reflog entry, you'll find a commit ID representing the HEAD after that action. Check out the commit at HEAD@{2}, which should be where the rebase added the green page (change the ID below to the ID from *your* reflog).

```
git checkout 002185c
```

This puts us in a detached HEAD state, which means our HEAD is no longer on the tip of a branch. We're actually in the opposite situation as we were in Undoing Changes when we checked out a commit *before* the branch tip. Now, we're looking at a commit *after* the tip of the branch, but we still have a detached HEAD:

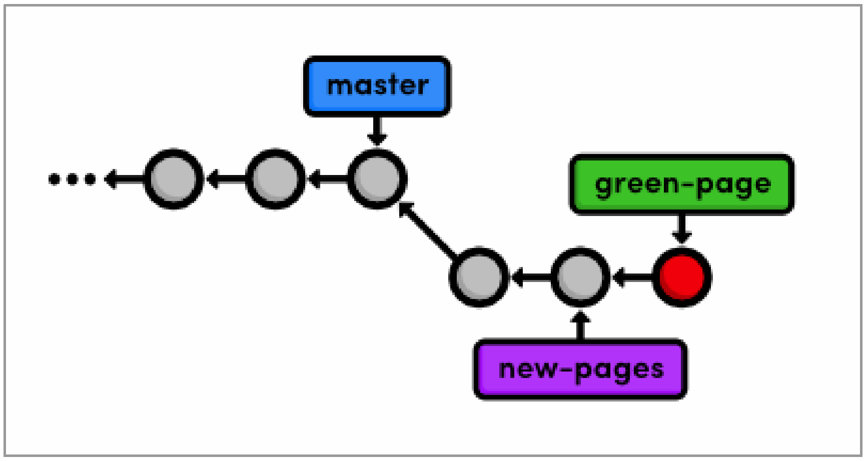


Checking out a dangling commit

To turn our dangling commit into a full-fledged branch, all we have to do is create one:

```
git checkout -b green-page
```

We now have a branch that can be merged back into the project:



Creating a branch from the dangling commit

The above diagram makes it easy to see that the `green-page` branch is an extension of `new-pages`, but how would we figure this out if we weren't drawing out the state of our repository every step of the way?

Filter the Log History

To view the differences between branches, we can use Git's log-filtering syntax.

```
git log new-pages..green-page
```

This will display all commits contained in `green-page` that aren't in the `new-pages` branch. The above command tells us that `green-page` contains one more snapshot than `new-pages`: our dangling commit (although, it's not really dangling anymore since we created a branch for it).

You can also use this syntax to limit the output of `git log`. For example, to display the last 4 commits on the current branch, you could use:

```
git log HEAD~4..HEAD
```

However, this is a bit verbose for such a common task, so Git developers added the

`-n` flag as an easier way to limit output.

```
git log -n 4
```

The `-n 4` parameter tells Git to show only the last four commits from the current `HEAD`, making it the equivalent of the `HEAD~4..HEAD` syntax shown above. Similarly, `-n 3`, `-n 2`, and `-n 1` would display three, two, and one commit, respectively. This feature becomes very useful once a repository grows beyond one screenful of history.

Merge in the Revived Branch

We've revived our lost commit, and now we're ready to merge everything back into the `master` branch. Before we do the merge, let's see exactly what we're merging:

```
git checkout master
git log HEAD..green-page --stat
```

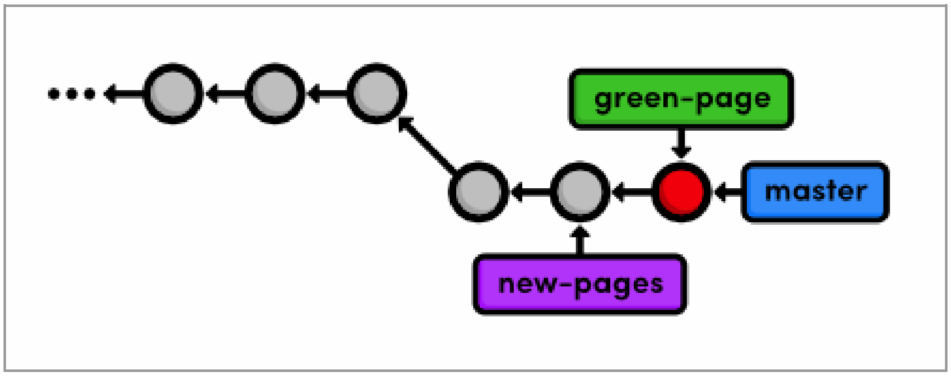
The `git log HEAD..green-page` command shows us only those commits in `green-page` that aren't in `master` (since `master` is the current branch, we can refer to it as `HEAD`). The new `--stat` flag includes information about which files have been changed in each commit. For example, the most recent commit tells us that 14 lines were added to the `green.html` file and 3 lines were added to `index.html`:

```
commit 002185c71e6674915eb75be2afb4ca52c2c7fd1b
Author: Ryan <ryan.example@rypress.com>
Date:   Wed Jan 11 06:49:50 2012 -0600

    Add green page

 green.html |   14 ++++++++++++++
 index.html |    3 +++
 2 files changed, 17 insertions(+), 0 deletions(-)
```

If we didn't already know what was in this new commit, the log output would tell us which files we needed to look at. But, we authored all of these changes, so we can skip right to the merge.

```
git merge green-page
```

The following diagram shows the state of our repository after the merge.



Fast-forwarding `master` *to the* `green-page` *branch*

Note that the `green-page` branch already contains all the history of `new-pages`, which is why we merged the former instead of the latter. If this wasn't the case, Git would complain when we try to run the following command.

```
git branch -d new-pages
```

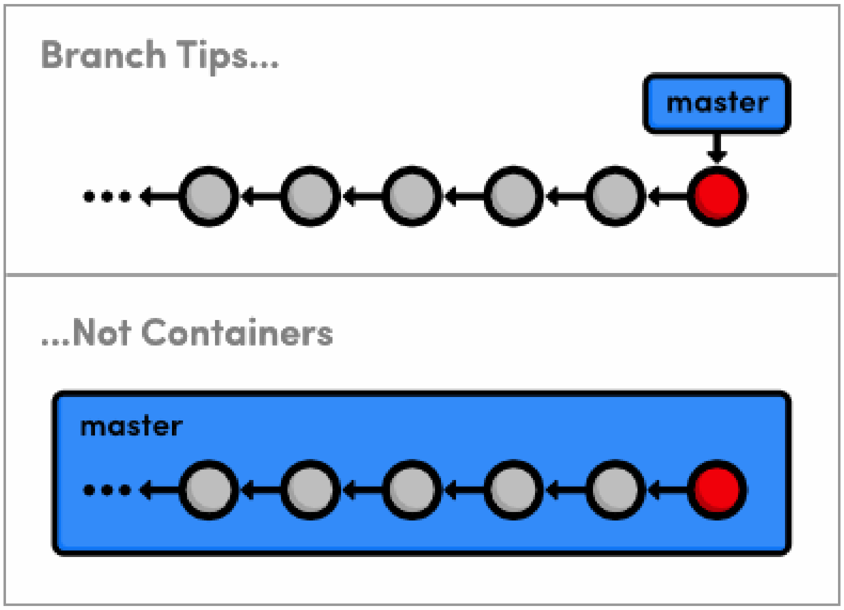
We can go ahead and delete the green page branch, too.

```
git branch -d green-page
```

Conclusion

This module took an in-depth look at rebasing, resetting, and the reflog. We learned how to split old commits into one or more new commits, and how to revive "lost" commits. Hopefully, this has given you a better understanding of the interaction between the working directory, the stage, branches, and committed snapshots. We also explored some new options for displaying our commit history, which will become an important skill as our project grows.

We did a lot of work with branch tips this module. It's important to realize that Git uses the *tip* of a branch to represent the *entire branch*. That is to say, a branch is actually a pointer to a single commit—not a container for a series of commits. This idea has been implicitly reflected in our diagrams:



Branch tips, not containers

The history is represented by the parent of each commit (designated by arrows), not the branch itself. So, to request a new branch, all Git has to do is create a reference to the current commit. And, to add a snapshot to a branch, it just has to move the branch reference to the new commit. An understanding of Git's branch representation should make it easier to wrap your head around merging, rebasing, and other kinds of branch manipulation.

We'll revisit Git's internal representation of a repository in the final module of this tutorial. But now, we're finally ready to discuss multi-user development, which happens to rely entirely on Git branches.

Quick Reference

`git reflog`
Display the local, chronological history of a repository.

`git reset --mixed HEAD~<n>`
Move the `HEAD` backward `<n>` commits, but don't change the working directory.

`git reset --hard HEAD~<n>`
Move the `HEAD` backward `<n>` commits, and change the working directory to match.

`git log <since>..<until>`
Display the commits reachable from `<until>` but not from `<since>`. These parameters can be either commit ID's or branch names.

`git log --stat`
Include extra information about altered files in the log output.

Continue to *Remotes* ›