

Introduction to Git — Fall 2021

Lecture 5:

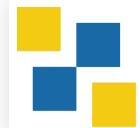
Branches



UMEÅ
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HPC2N



SNIC

Slides: <https://hackmd.io/@hpc2n-git-2021/L5-branches#/>

What is a Git branch?

- A pointer to a commit (ref: named pointer)
- Defined as all points reachable in the commit graph from the named commit (the “tip” of the branch)
- The ref HEAD determines what branch you are on.
- If HEAD is a symbolic ref for an existing branch, then you are “on” that branch.
- If HEAD is a simple ref directly naming a commit by its SHA-1 ID, you are not “on” any branch - you are in “detached HEAD” mode, which happens when you check out some earlier commit to examine.

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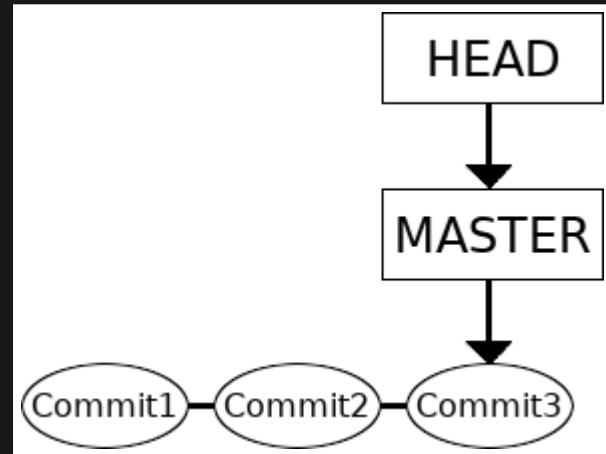
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What is a Git branch?

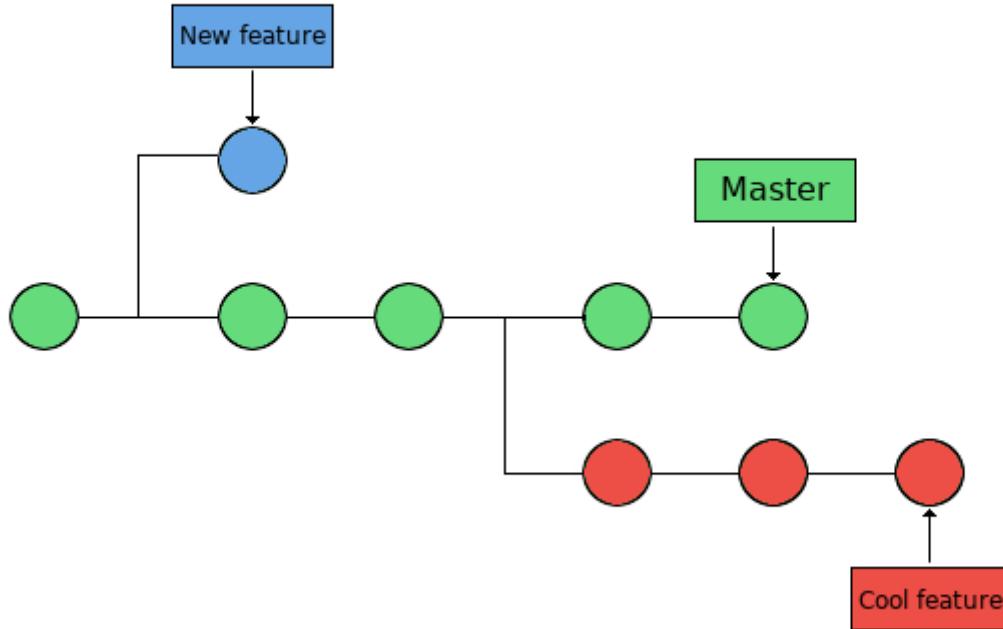
Until now, we have worked with a repository that only have one branch, with the commits done one at a time:



In the above picture, the master branch points to a commit. The current position is HEAD.

What is a Git branch - basic concepts

Now we want to look at repositories with several branches:



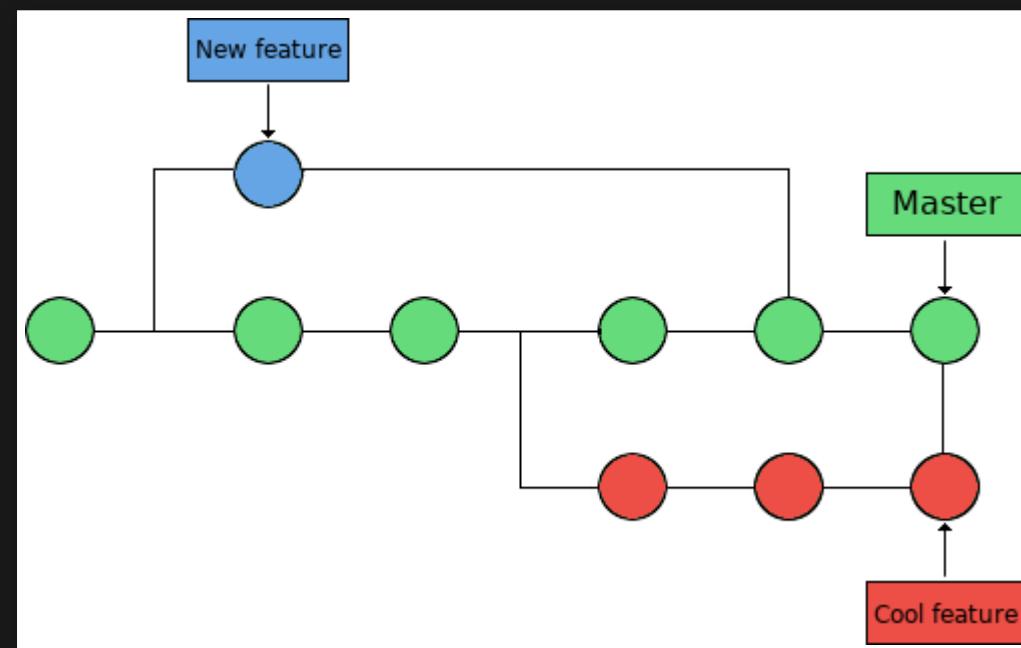
Branches are used to create another line of development. They are “individual projects” within a git repository.

- The branch is the commit and all its parent commits, not just the one we are currently pointing at.

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- The main line of development is usually called the “master” branch.
- Different branches within a repository can have
 - completely different files and folders
 - almost everything the same except for a few lines of code in a file

Usually, a branch is created to work on a new feature. Once the feature is completed, it is merged back with the master branch.



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To create a new branch (called cool-feature in the following):

```
$ git branch cool-feature
```

To move to another branch (switch):

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$ git checkout cool-feature
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Branches: merging, deletion

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- Then merge them:

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- Note: The branch is always merged to the current HEAD.
- First switch to the branch you are merging it to:

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$ git checkout master
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- Then merge them:

```
$ git merge cool-feature
```

- You can now delete the extra branch:

```
$ git branch -d cool-feature
```

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```
$ mkdir my-project; cd my-project/
$ git init
Initialized empty Git repository in /home/bbrydsoe/my-project/.git/
$ touch file.txt
$ git add file.txt
$ git commit -m "Committing the first file"
[master (root-commit) 1006b51] Committing the first file
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 file.txt
```

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```
$ git branch cool-feature
$ git checkout cool-feature
Switched to branch 'cool-feature'
$ echo "This is a text" > file.txt
$ git add file.txt
$ git commit -m "Added text to the first file"
[cool-feature 5bad966] Added text to the first file
 1 file changed, 1 insertion(+)
```

- Switch back to the master branch, make some changes

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```
$ git checkout master
Switched to branch 'master'
$ echo "Text to the second file" > second-file.txt
$ git add second-file.txt
$ git commit -m "Added a second file"
[master bdec2cf] Added a second file
 1 file changed, 1 insertion(+)
 create mode 100644 second-file.txt
```

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We now merge the branches and check again

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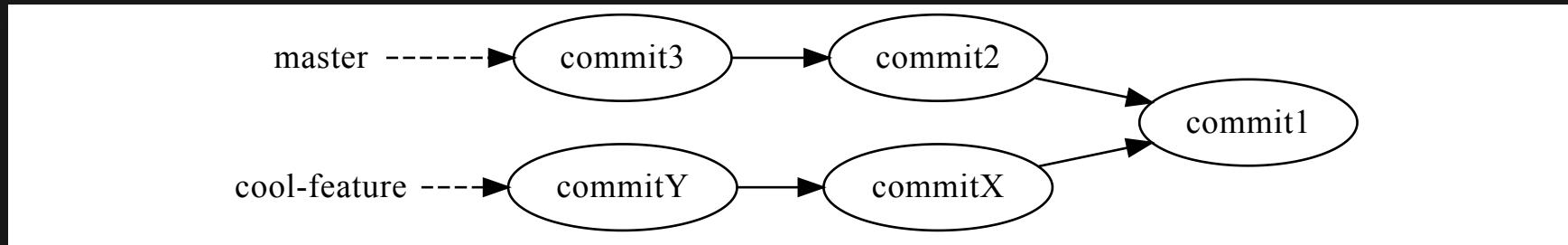
```
$ git merge cool-feature
Merge made by the 'recursive' strategy.
 file.txt | 1 +
 1 file changed, 1 insertion(+)
$ git log --graph --oneline --decorate --all
*   cf3e6b7 (HEAD -> master) Merge branch 'cool-feature'
|\ \
| * 5bad966 (cool-feature) Added text to the first file
* | bdec2cf Added a second file
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```

Now we can delete the new branch we had created, since all the content is now in the master branch.

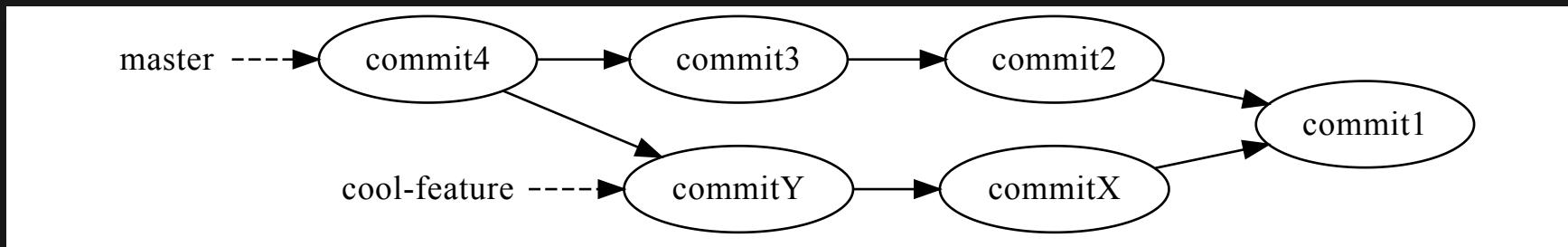
```
$ git branch -d cool-feature  
Deleted branch cool-feature (was 5bad966) .
```

In a somewhat nicer format, it looks like this:

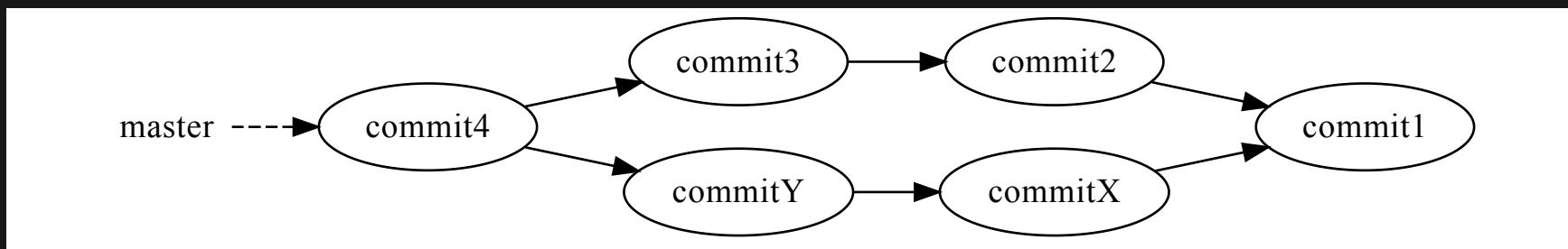
We commit stuff to both branches



Merge ‘cool-feature’ to ‘master’



Delete ‘cool-feature’



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What if there is a conflict?

- You will **not** be allowed to switch to the other branch.
- You must commit or stash any conflicting changes before switching branches.

Example - new file

Here we create a new branch, switch to it, then add a new file. Then we switch back to the master branch without committing the changes:

```
$ git checkout -b cool-feature
Switched to a new branch 'cool-feature'
$ touch newfile.txt
$ git add newfile.txt
$ git checkout master
A     newfile.txt
Switched to branch 'master'
```

Git warns that there is a file added in one branch but not the other, but the switch is allowed.

Example - modified file

If we make changes to the file in one of the branches but not on the other and do not commit it, then git will again warn:

```
$ echo "Adding some text" >> newfile.txt
$ git add newfile.txt
$ git checkout master
M      newfile.txt
Switched to branch 'master'
```

Git warns that there is a file that is modified in one branch but not the other, but the switch is allowed.

Example - uncommitted, conflicting changes

Assume two branches, “cool-feature” and “morefeatures”

Switch to branch “cool-feature”, add some text to a file, stage the file and commit it:

```
$ git checkout cool-feature
Switched to branch 'cool-feature'
$ echo "add text" >> morefiles.txt
$ git add morefiles.txt
$ git commit -m "Some text"
[cool-feature 469542b] Some text
 1 file changed, 1 insertion(+)
 create mode 100644 morefiles.txt
```

Switch to branch “morefeatures”. Modify the same file, stage the file and commit it. Then try and switch back to the “cool-features” branch:

```
$ git checkout morefeatures
Switched to branch 'morefeatures'
$ echo "Adding yet some more text" >> morefiles.txt
$ git add morefiles.txt
$ git checkout cool-feature
error: Your local changes to the following files would be overwritten by checkout:
      morefiles.txt
Please commit your changes or stash them before you switch branches.
Aborting
```

Now Git complains.

Handling uncommitted changes

So what can we do if there is a conflict?

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- Commit the changes before switching branch
- Stash the uncommitted changes
- Discard the uncommitted changes
- Checkout with Merge

Stashing, example

First do a git status in the branch where you may have uncommitted changes:

```
$ git status
On branch morefeatures
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

    modified:   file.txt
    new file:   morefiles.txt
```

You can see the dirty status.

To fix it, let us use `git stash`:

```
$ git stash  
Saved working directory and index state WIP on morefeatures: 4922606 Some tex
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$ git status  
On branch morefeatures  
nothing to commit, working tree clean
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On branch morefeatures  
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You can now switch branches and work on something else.

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```
$ git clean --dry-run
```

Handling uncommitted changes - merging

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- This will perform a three-way merge between your working tree and the new branch, with the current branch as the base.
- After the merge, you will be on the new branch and the merged result will be in your working tree.
- NOTE: As with any merge, conflicts may result and you will then have to resolve those.

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error: Entry '<fileName>' would be overwritten by merge.  
Cannot merge. (Changes in staging area)
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Cannot merge. (Changes in staging area)
```

- NOTE: Always check that you are on the right branch before merging! You check the branch with `git branch`.

Git can automatically try to merge when you give the command:

```
$ git merge <branch-to-merge-to>
```

while standing on the branch you want to merge to.

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- Fast Forward Merge - the commit history is one straight line. You create a branch, you make some commits there, but no changes to the ‘master’. You then just merge onto the ‘master’. This just moves the pointer for the ‘master’ branch forward in a straight line.

Git has some merge strategies. The most commonly used are:

- Fast Forward Merge - the commit history is one straight line. You create a branch, you make some commits there, but no changes to the ‘master’. You then just merge onto the ‘master’. This just moves the pointer for the ‘master’ branch forward in a straight line.
- Recursive Merge - make a branch and make some commits there, but also make new commits made on the ‘master’. Then, when you want to merge, git will recurse over the branch and create a new merge commit. The merge commit will continue to have two parents.

Merge conflicts, example

Here we create a merge conflict:

```
$ mkdir merge-test
$ cd merge-test/
~/merge-test$ git init
Initialized empty Git repository in /home/bbrydsoe/merge-test/.git/
~/merge-test$ echo "Creating a file with some text to play with." >> myfile.txt
~/merge-test$ git add myfile.txt
~/merge-test$ git commit -m "First commit"
[master (root-commit) 9badcc6] First commit
 1 file changed, 1 insertion(+)
  create mode 100644 myfile.txt
~/merge-test$ git checkout -b mergebranch
Switched to a new branch 'mergebranch'
~/merge-test$ echo "Adding text to the file in order to merge." > myfile.txt
```

```
~/merge-test$ git add myfile.txt
~/merge-test$ git commit -m "Changed the content of myfile.txt"
[mergebranch 41b0e36] Changed the content of myfile.txt
 1 file changed, 1 insertion(+), 1 deletion(-)
~/merge-test$ git checkout master
Switched to branch 'master'
~/merge-test$ echo "Put more text to the file" >> myfile.txt
~/merge-test$ git add myfile.txt
bbrydsoe@enterprise-a:~/merge-test$ git commit -m "Added more text"
[master c17e479] Added more text
 1 file changed, 1 insertion(+)
~/merge-test$ git merge mergebranch
Auto-merging myfile.txt
CONFLICT (content): Merge conflict in myfile.txt
Automatic merge failed; fix conflicts and then commit the result.
```

So Git complains

We can get some more information with the `git status` command:

```
~/merge-test$ git status
On branch master
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: myfile.txt

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

Looking inside the file myfile.txt:

```
~/merge-test$ cat myfile.txt
<<<<< HEAD
Creating a file with some text to play with.
Put more text to the file
=====
Adding text to the file in order to merge.
>>>>> mergebranch
```

Some “conflict dividers” have been added.

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- To identify conflicting files: `git status`
- To get a list of commits that conflict between the branches: `git log --merges`
- Find differences between states of a repository/files: `git diff`
- Reset conflicted files to a known good state: `git reset`

Resolving merge conflicts

- The most direct way to resolve the conflict is editing the file yourself.
- When this has been done, you can repeat the merge with:

```
$ git merge --continue <branch-to-merge>
```

Commands to help:

- To identify conflicting files: `git status`
- To get a list of commits that conflict between the branches: `git log --merge`
- Find differences between states of a repository/files: `git diff`
- Reset conflicted files to a known good state: `git reset`

If you made a mistake when you resolved a conflict and have completed the merge before realizing, you can roll back to the commit before the merge was done with the command `git reset --hard`.

Workflow - merge goes well

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Success!

Rebasing

- Rebasing is the process of moving or combining a sequence of commits to a new base commit.

Rebasing

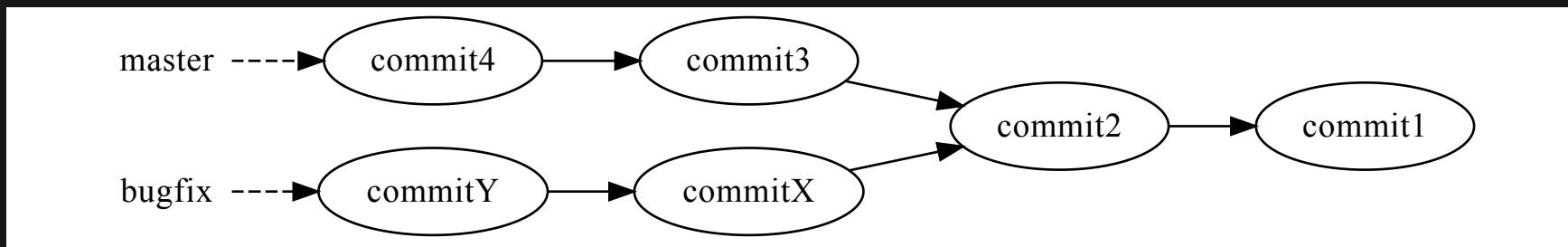
- Rebasing is the process of moving or combining a sequence of commits to a new base commit.
- It solves the same problem as git merge. The commands are both used to integrate changes from one branch into another branch, however the way they do it is very different.

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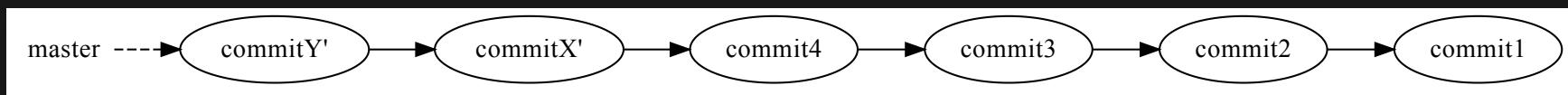
- Rebasing is the process of moving or combining a sequence of commits to a new base commit.
- It solves the same problem as git merge. The commands are both used to integrate changes from one branch into another branch, however the way they do it is very different.
- When you do a rebase, all the changes will be compressed together in a single “patch” which is then “applied” - rebasing creates new commits on the other branch for each commit in the original branch.

Rebasing - illustration

Branch ‘bugfix’ was branched from ‘master’



Rebasing ‘bugfix’ to the ‘master’ branch



Rebasing - continued

Assume a master branch and the branch “cool-features” and that you want to rebase the branch “cool-features” onto the master branch:

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Rebasing - continued

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- apply each change in turn

Rebasing vs. Fast-forward merge

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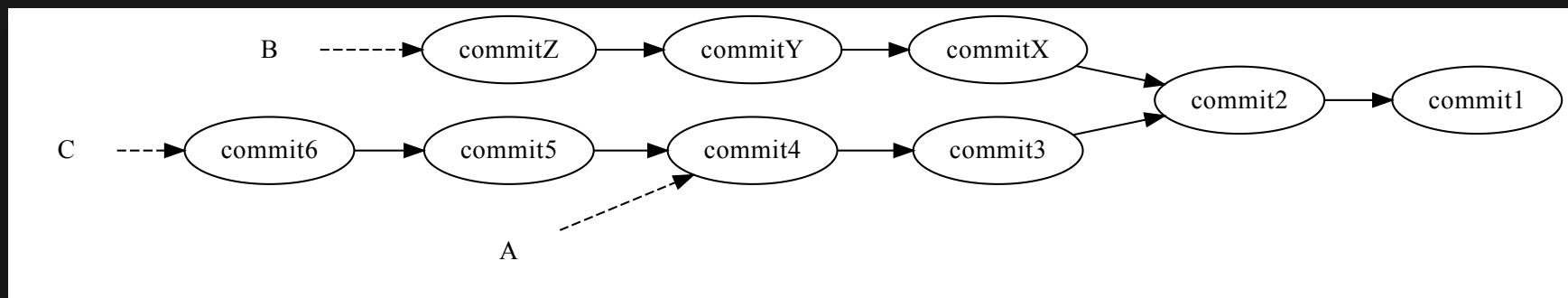
Start

Rebasing vs. Fast-forward merge

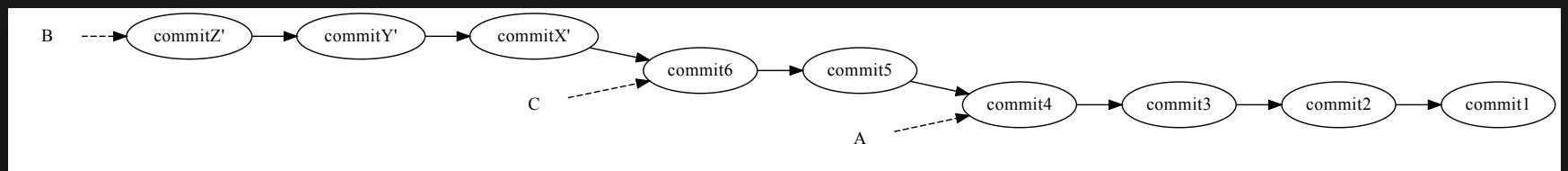
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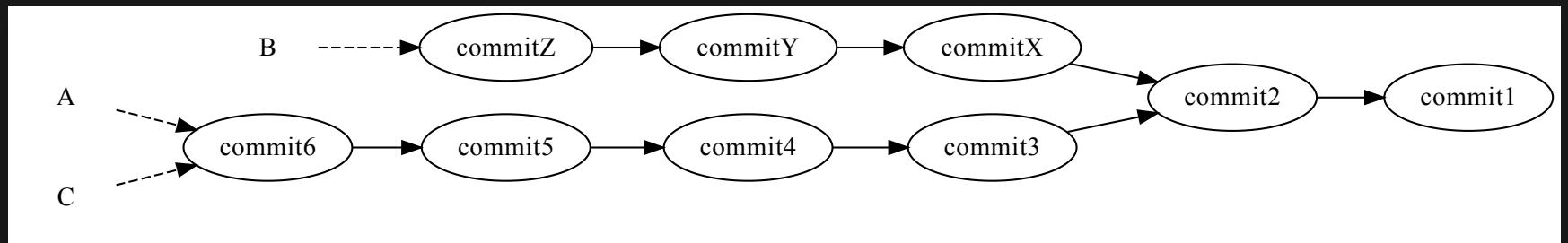
Start



Rebase B onto C



FF merge C into A:



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```
$ git checkout <branch>
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Now you execute the cherry-picking:

```
$ git cherry-pick <hash>
```

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