Advanced Git

IVS demonstration exercise

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April 3, 2024

Prerequisites

- Basic knowledge of Git commands for:
  - creating commits (`git add`, `git commit`)
  - inspecting current state (`git status`, `git diff`)
  - inspecting history (`git log`, `git show`)
  - working with remotes (`git pull`, `git push`)
  - working with branches (`git checkout`, `git branch`)
  - merging branches (`git merge`, `git rebase`)
- Git commands cheatsheet:
  `https://www.atlassian.com/git/tutorials/atlassian-git-cheatsheet`

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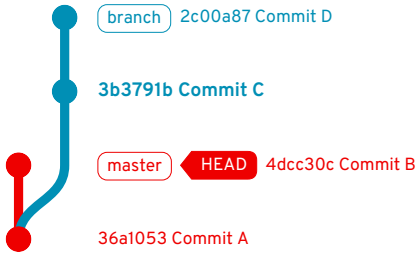


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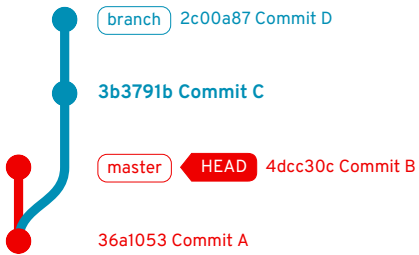


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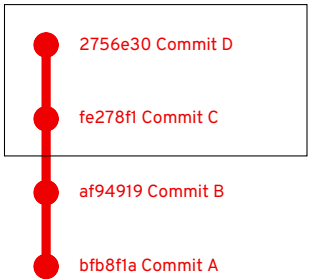

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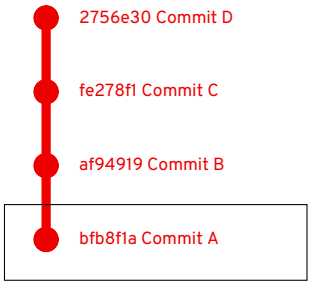

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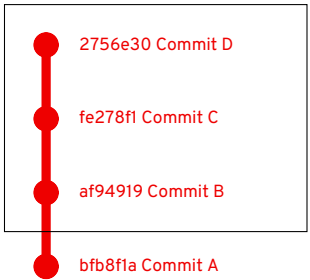

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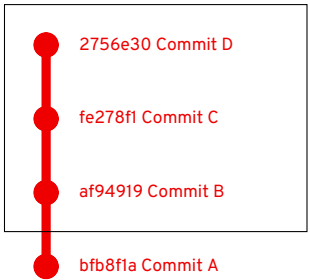
- Hence, `2756e30..af94919^` selects the commit range including *Commit B*
- **Note:** the order of references does not matter. `2756e30..af94919^` = `af94919^..2756e30`

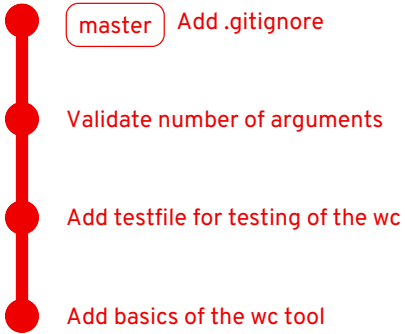


”Advanced” work with Git

Let's start

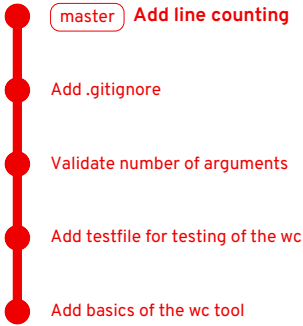
- We'll write a simple tool for counting characters, words, and lines in a file (similar to the `wc` utility)
- We start with a pre-initialized repo containing very basics of the tool: `https://github.com/viktormalik/git-workshop`
- The repo contains:
  - source file `wc.c`
  - testing file `testfile`
  - `Makefile`
  - `.gitignore`

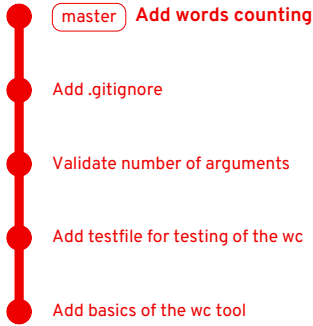
Current status of the repo



Basic team synchronisation

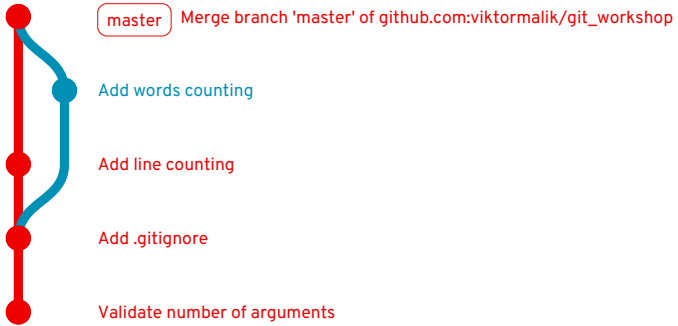
Every member implements a different feature in their *master*





Basic team synchronisation

The second one to push must do a merge (and resolve a merge conflict)



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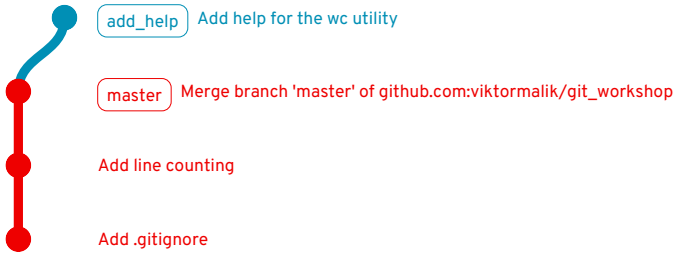
Better team synchronisation

- **This is not a good practice!**
- Always implement new features in **separate branches**.
- Potential merge conflicts should be resolved in the feature branch.
- Ideally, merging into master should be always done using **pull requests**
  - They allow other team members to comment on the changes
  - Changes can be **reviewed** before they get into master
  - Master always contains a working and approved version of the project

Using a feature branch

Let us add help into the tool using a separate branch *add_help*

```
git checkout -b add_help
git commit -m "Add help for the wc utility"
```



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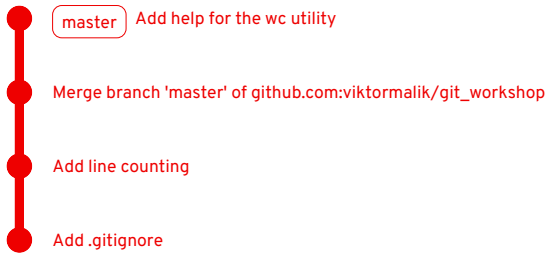
Using a feature branch

Then, we open a **pull request (PR)** from *add_help* to *master*, review it, and merge it using the **“rebase”** strategy.

The state of *master* after the PR is merged:



Moving branches

We start working on a new feature (branch *own-separator*) only to realize that we need to implement something else before. So, we create another branch *option-opt*.

But now, we have two branches pointing to the same commit and we need to **move one backwards**.

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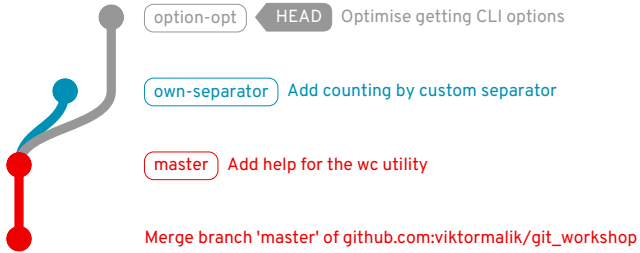
Moving branches

Instead of deleting and re-creating *option-opt*, we can move it **one commit back**:

```
git checkout option-opt
git reset HEAD^
```

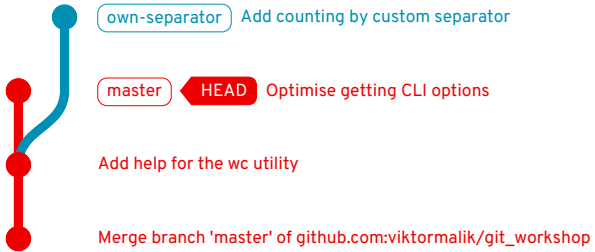
Moving branches

After adding a new commit to *options-opt*:



Moving branches

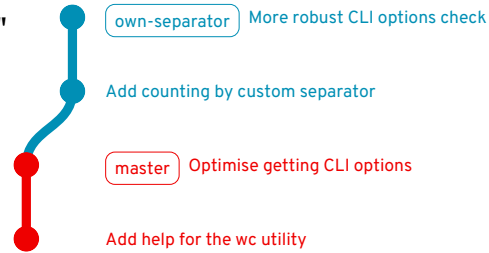
options-opt can be now merged into master while *own-separator* remains a feature branch in development.



Rebasing feature branches

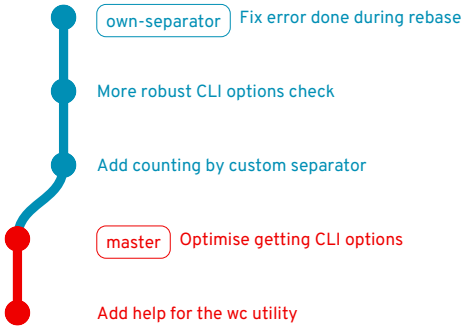
We add more commits to the feature branch and then **rebase** it onto *master* (to avoid creation of a merge commit). This introduces a **merge conflict** which we need to resolve using a **mergetool** (we're using `meld`).

```
git checkout own-separator
git commit -m "More robust ..."
git rebase master
[... merge conflict ...]
git mergetool
```



Rebasing feature branches

We made a mistake during the rebase, which we had to fix with an additional commit.



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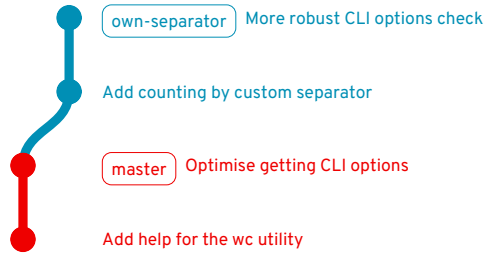
Rebasing feature branches

It is possible to merge the “fix commit” into one of the previous commits using **interactive rebase** (`git rebase -i master`):

Opens up an interactive editor:

```
pick Add counting by custom separator
fixup Fix error done during rebase
pick More robust CLI options check
```

This merges the second (originally last) commit into the first one:



Interactive rebase

- One of the most important Git features in the modern pull request-based workflow.
- Allows to **edit**, **reorder**, **merge (squash)**, or **drop** commits.
- **Rewrites history** – should be only used on feature branches.
- **Never rewrite history of master!**
  - Other developers would not be able to do `git pull`.

How to rewrite commit history

Option 1: edit commits via interactive rebase

Running interactive rebase and selecting `edit` for the relevant commits:

```
pick c853f71 unify whitespaces (replace t by 4 spaces)
pick 4fe8acb extend gitignore: added .test-playground
pick 1b7ccf1 Add just comments into the code
edit e94003b Improve processing of the cmdline parameters
pick b5917e8 cmdline parsing: filename is not positional anymore
pick 43b6520 Check the input file has been opened
```

How to know the right commits? Use `git blame`.

How to rewrite commit history

Option 2: using fixup commits

Commit with the `--fixup` option:

```
$ git log --oneline -3
43b6520 Check the input file has been opened
b5917e8 cmdline parsing: filename is not positional anymore
e94003b Improve processing of the cmdline parameters
$ git commit --fixup e94003b
$ git commit --fixup b5917e8
```

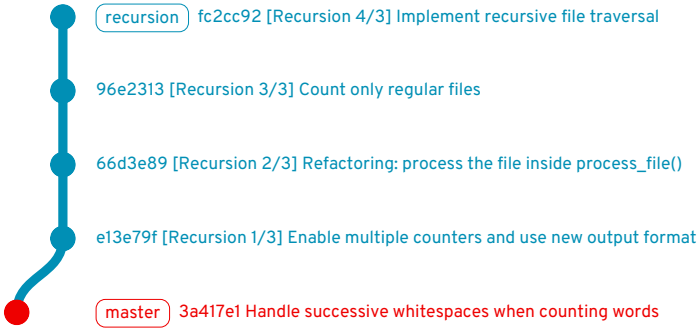
Now, using interactive rebase with `--autosquash` will take care of everything:

```
git rebase master --interactive --autosquash
```

Copying commits from other branches

It is possible to **copy commits** from other branches (e.g. commits implementing useful features from co-workers feature branches) using `git cherry-pick`.

The *recursion* branch:



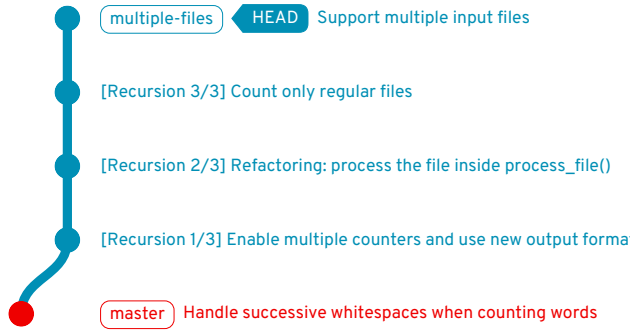
Copying commits from other branches

Now, let's create a new branch *multiple-files*, cherry-pick the first three commits from *recursion*, and add a new commit on top:

```
git checkout -b multiple-files
git cherry-pick e13e79f^..96e2313
git commit -m "Support ..."
```

Equivalent cherry-pick range:

```
recursion@{4}..recursion@{1}
```



Copying commits from other branches

Finally, we rewrite the cherry-picked commits:

```
edit 9abab39 [Recursion 1/3] Enable multiple counters and use new ...
reword 2c403cc [Recursion 2/3] Refactoring: process the file inside ...
reword f85bb09 [Recursion 3/3] Count only regular files
pick Support multiple input files
```

Then, we try to rebase `recursion` on top of `multiple-files`:

```
git checkout recursion
git rebase multiple-files
[... merge conflict during applying [Recursion 1/3] ...]
```

Git tried to apply the first commit from *recursion* (`e13e79f`) but the commit is already in *multiple-files*. Git failed to recognise that since we altered the commit.
The solution is to use **`git rebase --skip`** for such commits.

Hunting bugs in Git history

- We often discover a bug that was certainly introduced **somewhere in the Git history**.
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- The process can be **automated** using a script that returns 0 on success and a non-zero result on failure.

Git tips and tricks

Cloning repositories with a long history

- If a repo has a long history, it may take long time to clone it.
- If the entire history is no needed, it is possible to use a **shallow copy**:
  `git clone --max-depth N`
- Try it with the Linux kernel:
  `git clone --max-depth 1 https://github.com/torvalds/linux`

Signing commits

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- To resolve this problem, Git offers **signing commits** using GPG keys.
- GitHub offers a nice tutorial on how to setup commit signing: `https://help.github.com/en/github/authenticating-to-github/signing-commits`

Setup your environment

There are various possibilities on how to ease your life with Git:

- **Git prompt**
  - It is possible to setup Bash prompt such that it shows the current branch, state of the directory, etc.
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- **Use tools for history inspection**
  - There is a number of tools for an easier history traversal
  - E.g. **tig**, gitk, ...

Git and IDEs/Editors

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- **VSCode**
  - Highlight added/changed/removed lines
  - Git blame for each line
  - Commit, push, pull etc.

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Overcome The Doorway Effect of switching to your terminal, examples:

- **VSCode**
  - Highlight added/changed/removed lines
  - Git blame for each line
  - Commit, push, pull etc.
- **Vim**
  - **git-gutter**
    - Display line status on the side
  - **vim-fugitive**
    - Full fledged TUI for Git right in your Vim
    - Commit, push, pull etc.
    - `<Esc>:G-cciExample commit<Esc>:x-`

Setup your environment

- **Command aliases**
  - Many Git commands are quite long (or have many options).
  - It is possible to setup short aliases for most commonly used commands.
  - Git offers a way to set aliases:

    ```
    git config --global alias.co checkout
    ...
    ```

    or edit `$HOME/.gitconfig`:

    ```
    [alias]
     co = checkout
     ...
    ```
  - An alternative is to setup aliases via shell

Keep your repo clean

- Delete merged/obsolete branches (locally)
  - `git branch -d` doesn't always work (especially with rebases)
  - `git branch -D` works but be careful not to delete something important
- Same applies for remote branches
  - `git push --delete <remote> <branch>`
  - or enable auto-delete branch on your PRs
  - or use GitHub/GitLab/...web UI
- `git prune` removes unreachable objects (branches, tags, etc.)

Other interesting git commands

- `git difftool` – open mergetool for a specific commit and file
- `git worktree` – checkout a branch into a directory
- `git submodule` – embed another git repository
- `git grep` – grep the entire repository
- `git describe` – find tags related to commit
- `git reflog` – the last recovery option when you break your repo

Useful links

- Atlassian Advanced Git Tutorials
  `https://www.atlassian.com/git/tutorials/advanced-overview`
- GitHub Guides
  `https://guides.github.com`
- GitHub Help
  `https://help.github.com/en/github`

TL;DR

What you should take out of this talk:

- Learn and practice **interactive rebase**
- **Read what Git tells you**, there are often good hints (e.g. for undoing things)
- Keep *master* in good shape

Thank you for the attention!

Your feedback is welcome!

`https://forms.gle/rtxQATGqyct9rNM77`