

Git It Right: A Complete Cheatsheet

Source Control

Source control is the practice of tracking and managing changes to code. There are two types:

1. In **centralized source control**, a centralized server acts as the ultimate source of truth for a collection of versioned files.
 - *Implications.* An internet connection to the central server is required for most basic operations.
 - *Examples.* **Subversion**, **CVS**
2. **Distributed or decentralized source control** doesn't require a central source of truth and allows for most operations to be local.
 - *Implications.* You can work independently of an internet connection.
 - *Examples.* **Git**, **Mercurial (Hg)**

History of Git: **Git** was developed by **Linus Torvalds**, the creator of **Linux**, to handle the requirements of the **Linux Kernel Project**. It is often used, because...

1. Due to its distributed nature, **Git** can scale massively.
2. **Git** is very fast to execute, since most of its operations are local.
3. Due to its history, it has a very active community.

Git Theory

A **repository** is a collection of version controlled files that are kept together. This includes (a) all the files related to a specific project/application, (b) the history of changes, and (c) any special configurations.

Git states: **Git** has three **local** states.

1. The **working directory state** holds all the project or application files. These files may or may not be managed by **Git**, but **Git** is aware of them.
2. The **staging area state** or **Git index state** is holding area for the queue of changes to be included in your next commit.
3. The **local Git repository state** is a hidden folder called **.git**, which contains your entire local commit history.

Git also has a **remote (repository) state**, which is just another repository with its own three internal states. A specific **Git** command is used to move files between these states. i.e.,

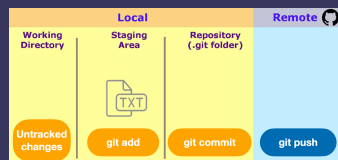


Figure 1: Git states and associated commands. % Source

Git Theory (2)

Where is remote stored?: The remote repo lives on a **version control hosting services** and is accessible via a web-based interface.

- *Examples.* Popular **Git** repository hosting services include **GitHub**, **GitLab**, and **BitBucket**. See [here](#) for more info.
- *Open-source standard.* **GitHub** is considered the standard for hosting open-source projects due to its immense popularity.

Remote hosting services **offer unique functionalities** that are **separate from Git**, including: **access control**, **pull requests**, **issue tracking**, and automation tools like **GitHub Actions**.

Tracking: A **tracked file** is any file that **Git** is aware of and is actively tracking. In other words, any files that aren't new.

Git Command	Description
git ls-files	Returns the list of files tracked by Git
git commit -am "commit message"	Simultaneously add and commit a tracked file
git add .	Recursively add untracked files from current filepath location

Quick Start

Installation: Depends on your OS.

- **MacOS.** Normally, it's pre-installed. Otherwise, use command line developer tools to install it.
- **WindowsOS.** Install the open source **Git for Windows Project**. Make sure to execute your **Git** commands from the **Git Bash**.

Configure: You need to tell **Git** who you are and where the remote repository hosting platform is.

Git Command	Description
git config --global user.name "bellanich"	Set your global username
git config --global user.email "youremail@gmail.com"	Set your global email
git config --global --list	Check your global configs
git config --global pager.branch false	Turn off terminal pager for git branch command

Initialize your project: Here's how to start a new **Git** project.

Git Command	Description
git init my-project-name	Initialize a new empty Git repository
git init	Convert an existing dir into a Git project
git clone git-project-url	Initialize from your code hosting platform of choice
git remote add origin git-project-url	Add a remote reference to your local repository
git push origin main	Force push to main branch (only do for initialization)

Commit History

Introduction: Your **Git** **commit history** is the chronological record of all commits ever made within your **Git** repository, where each commit is a snapshot of your project at a specific point in time.

- *Implications.* The commit messages you make matter. We recommend writing **conventional commits**.

A project's **Git** history is typically **represented as a directed acyclic graph (DAG)** data structure. Use the idea of a **perfect commit** to scope your commits.

How does **Git** commit history work? **Git** doesn't copying entire files in each commit. Rather, it **uses a system of blobs and pointers**.

- **Git** uses **SHA-1 hashing** to create unique identifiers (hashes) for file content and stores
- The hashes are stored as **blobs** (binary large objects) in a database
- **Git** uses pointers to reference the changes made to these blobs in its commit history

Search: Here is how you can search through your **Git** history logs.

Git Command	Description
git log --oneline --graph --decorate	View your entire Git history in a user friendly way
git log --since="3 days ago"	Search for all Git commits made in the last 3 days
git log -- your_filename	Get the history for only a specific file
git log --follow -- your_filename	Include filename changes in your Git history search
git show git_commit_hash	See a given commit's entire content, including: commit message, that commit's git diff results, author, and date

Compare: You can compare (a) what you have and haven't committed in **Git** as well as (b) different points in your commit history.

Git Command	Description
git diff	Compare staged and unstaged changes in your working directory to your last commit.
git diff -- your_filename	Only preview comparisons for a specific file
git diff --staged HEAD	Review the (staged) changes about to be committed
git diff commit_hash1 commit_hash2	Compare two commits
git diff local_branchname origin/remote_branchname	Compare local and remote branches

Repo restructuring can be easily tracked in **Git**.

Git Command	Description
git mv current_filepath new_filepath	Rename your file and get Git to track it in one-go
git rm your_filename	Simultaneously delete and stop tracking a file in one-go

Commit History (2)

Repo restructuring commands: (continued)

Git Command	Description
git add -A	Stages any file renaming or deletions done via your IDE
git checkout --deleted_filename	Undo tracked file deletion

Undo Unwanted Changes

Undo unwanted changes: Once you've committed something, it's in Git forever. However, there are some things that can be undone.

Git Command	Description
git reset HEAD your_filename	Undoes an unwanted git add.
git reflog	View records of time travel, i.e. HEAD resets
git checkout -- your_filename	Reverts a file to its last commit version
git commit --amend -m "new commit message"	Update your Git commit message

Note. The `git reflog` holds records for the last 60 days. After that, it autopurges.

Resets: There are 3 different types of resets in Git.

1. **Soft Reset.** Moves the HEAD and branch pointer to a different commit, but **leaves changes in the staging area**. Undoes a `git commit` while keeping changes made.
2. **Mixed Reset.** Moves the HEAD and branch pointer to a different commit and **clears the staging area**. Default in Git.
3. **Hard Reset.** Same as a mixed reset, except it **also discards all changes in the working dir**. Hence, a destructive operation.

Stashing

Introduction: The `Git stash` command allows you to temporarily save and store changes in your working directory that are not ready to be committed. It stores these changes as a **stack data structure**.

- *When to use?* Whenever you want to save but not commit incomplete work. e.g., switching branches or addressing urgent tasks
- *Best practices.* Save your stash with a specific stash message, especially when working with multiple stashes at once

Git Command	Description
git stash list	Get the list of all stashed changes in your repo
git stash	Stash all tracked changes
git stash -u	Include untracked changes in your stash
git stash show stash@{01}	Shows aggregate file changes for 1st index in Git stash stack
git stash push -m "stash message"	Stash your work with a clear message

Stashing (2)

Move stashes: Eventually, you'll either **(a)** want to delete your stashed work to declutter the stash stack or **(b)** move your stashed work back into the working directory.

Git Command	Description
git stash apply	Applies most recent stash to working directory without deleting it from stash stack
git stash drop	Manually delete most recent stash from stack
git stash pop	Shorthand combination of <code>git stash apply</code> and <code>git stash drop</code>
git stash apply stash@{1}	Apply a specify specific stash to working dir
git stash drop stash@{1}	Delete a specify specific stash from stack
git stash clear	Deletes all stashes

Stash into another branch: You can use git stash to move changes from one branch into another one. Here are the 2 steps:

1. Stash the changes that you want move
2. Use the command `git stash branch new_branch_name` to automatically create a new branch, where your stash is applied. Your stash will also be removed from the stack.

Tagging

Introduction: Git tags are just labels that we can link to a specific commit in our history. There is a 1-to-1 mapping between git tags and commits.

- *Why?* They let us mark significant events or milestones in our repository. e.g., project releases
- *Note.* Tags function like commits. You make them locally and then push to the remote repository.

There are 2 different types of Git tags:

1. **Lightweight tags** are markers on a commit
2. **Annotated tags** have more information than a lightweight tag does. They also contain the tag message, the tag author, and tagging date.

Basic usage: Here are the basic Git tag commands.

Git Command	Description
git tag tag_name	Create a local lightweight tag for most recent commit
git tag tag_name "your tag message"	Create a local annotated tag for most recent commit
git tag tag_name commit_hash "your tag message"	Create a local annotated tag for an older commit
git tag --list	Shows the names of all Git tags within your repo
git show tag_name	Preview the contents of the tagged commit
git tag --delete tag_name	Delete a local tag
git diff tag_name1 tag_name2	Compare 2 different tagged commits

Tagging (2)

Syncing tags: When you push a tag to your remote repository, you also push its associated commit.

Git Command	Description
git push origin tag_name	Push a specific Git tag to remote
git push origin remote_branch_name --tags	Push all Git tags to a specific remote branch
git push origin :tag_name	Delete a tag that you've accidentally pushed to remote

Undoing tags: Let's suppose that you put your git tag on the wrong commit. There are 2 ways to fix it:

1. Delete and recreate your Git tag on the correct commit.
2. Force a git tag change by using the command `git tag -a tag_name -f commit_hash`. This forces the git tag to move from its current commit to a new one.

Branches

Introduction: It's a best practice to create all your changes on feature (or topic) branches, make sure these changes stable, open a **pull request for review**, and then merge into the **main** branch.

- *Note.* You can **protect important branches** via your chosen remote hosting service.

Git Command	Description
git branch	Lists all current local branches
git branch --all	Lists all current local and remote branches
git branch -m old_branch_name new_branch_name	Rename your Git branch
git branch --delete branch_name	Delete a local branch
git push origin --delete branch_name	Delete a remote branch

Merging: Insert the changes from one branch into another as a new commit. You can **squash** multiple commits into one as you merge. This keeps your commit history size manageable.

Main types of merges are:

- A **fast forward merge** happens when one branch is ahead of another. i.e.,

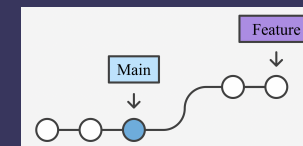


Figure 2: Before fast-forward merge. [Source](#)

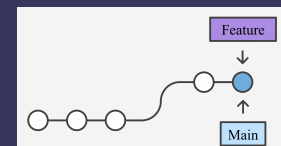


Figure 3: After fast-forward merge. [Source](#)

- A **3-way merge** happens when histories between two branches diverge. This can result in a Git conflict. i.e.,

Branches (2)

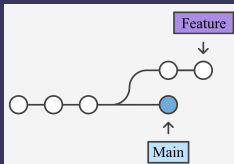


Figure 4: Before 3-way merge. [Source](#)

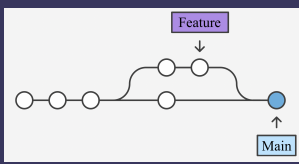


Figure 5: After 3-way merge. [Source](#)

Other **less common merge types** do exist for very specific situations.

Rebasing: rewrite the commit history by "rewinding" the changes from one branch onto another. This means moving commits around.

- **Why?** This lets you maintain a linear project history when your feature and main branches start to diverge. It also eliminates the unnecessary merge commits required by merging.
- **Pull with a rebase.** You can pull changes from `main` into your feature branch as a rebase. This keeps your Git history flat. Use `git pull --rebase origin main`.

The Golden Rule of Rebasing is do **not** rebase on **public branches**.

- **Why?** Branch histories can diverge. This can only be resolved with a merge, which would pollute the commit history.
- **More info.** Check out [this explanation](#).

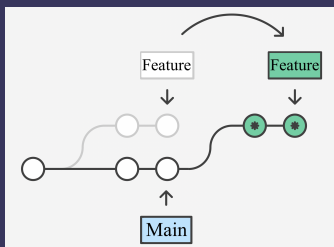


Figure 6: The effects of a git rebase. [Source](#)

Branching strategies: the strategy chosen by a software development teams when writing, merging and deploying code. Here are some noteworthy ones:

1. **GitFlow** allows for parallel development to protect the production code. **Many variants exist**. It has the following types of branches:

Branch	Description
<code>main</code>	The code that's in production
<code>develop</code>	Where developers merge their features into. Branches off of <code>main</code> .
<code>feature</code>	One new feature per branch. Branches off of <code>develop</code> . Merge back once stable.
<code>release</code>	Prepare for a new production release, needs to be merged back into <code>main</code> and <code>develop</code> .
<code>hotfix</code>	Fix a bug that has been discovered and must be resolved (usually from production)

2. In **trunk-based development**, developers merge small, frequent updates to a core "trunk" or `main` branch. You **push directly** into `main` and use `release` branches.

Branches (3)

3. **Ship / Show / Ask** has 3 categories for merges:

Category	Description
Ship	Make a change directly into your mainline. Great for updated docs, simple bug fixes; etc.
Show	Open a Pull Request with your change but merge without waiting for anyone.
Ask	Open a Pull Request and wait for approval before merging

Aliases

Introduction: Rather than adding Git aliases to a `~/ .bashrc` or `~/ .zshrc` file, you can declare them directly in Git.

Git Command	Description
<code>git config --global alias.alias_name "your git command"</code>	Creates a new Git alias. Do not include <code>git</code> in double quotations, since Git automatically adds this.
<code>git config --global --unset alias.alias_name</code>	Globally delete your Git alias

Your alias definition will be saved in your machine's `~/ .gitconfig` file. You can also edit or delete your aliases from here.

Favorite aliases:

Git Alias	Definition
<code>git history</code>	<pre>git config --global alias.history "log --graph --abbrev-commit --decorate --format=format:'%C(bold blue)%h%C(reset) - %C(bold cyan)%aD%C(reset) %C(bold green)(%ar)%C(reset) %C(bold cyan)(committed: %C(d)%C(reset) %C(auto)%d%C(reset)%n'' %C(white)%s%C(reset)%n'' %C(dim white)- %an <%ae> %C(reset) %C(dim white)(committer: %cn <%ce>)%C(reset)'"</pre>

Git Conventions

Repository name conventions: what to keep in mind when naming projects and referencing remote

- **Project names** are expected to be (a) a short and descriptive name, (b) in all lowercase letters, and (c) only use dashes as separators.
- **Remote repository** is referred to as `origin` in Git.

Commits: There are some shorthands to refer to the most recently made commits.

Git Command	Description
<code>HEAD</code>	Shorthand in Git for the last commit
<code>HEAD~</code>	Shorthand for 2nd to last commit.
<code>HEAD~3</code>	Shorthand for 3 commits before current <code>HEAD</code> for linear branch histories
<code>HEAD^3</code>	Traverses a non-linear history , where exact commits back from <code>HEAD</code> depends on branching pattern

Default branch name: In 2020, the Git community moved away from calling the default branch name from `master` to calling it `main`.

- **Why?** The term "master" has an **unsavory connotation** for historical reasons.

Git Conventions (2)

- **Implications.** Some older projects still use `master` as their main branch name, since renaming it is a risky process.

Reasons for keeping `master` as the default in older project include:

- Renaming it to `main` can cause backwards compatibility issues with earlier project releases
- Complicated CI/CD processes can consequently fail in non-obvious ways that are difficult to troubleshoot
- Integrations with third-party tools and services can break

Nonetheless, it is possible to change the default branch name.

Git Command	Description
<code>git branch -m main</code>	Change the default branch name from <code>master</code> → <code>main</code> for a specific repo
<code>git config --global init.defaultBranch main</code>	Change the default branch across all repositories

Naming new branches: **One convention for branch naming** is to have a prefix that states the branch's general purpose. i.e.,

Branch Type	Convention
<code>feature</code>	Branch name is either <code>feat/my-description</code> or <code>feature/my-description</code>
<code>bugfix</code>	Branch name is either <code>fix/my-description</code> or <code>bugfix/my-description</code>
<code>release</code>	Branch name is <code>release/version-number</code>
<code>hotfix</code>	Branch name is <code>hotfix/my-description</code>

Hooks

Introduction: **Git hooks** are ordinary scripts that Git executes whenever a certain events occurs.

- **What language to use?** Git hooks **can be written in any language**; however, they're usually written in **Bash**.
- **Setup.** Hooks are located in the `.git/hooks` directory, which Git automatically populates with sample scripts. Simply remove the `.sample` extension to activate a given hook.
- **Best practice.** Use a hook's reserved filename (rather than renaming it).

Types of hooks: Hooks fall into one of two categories.

1. **Local hooks** are **personal scripts** that allow developers to set up their own local workflow without interfering with a project's global (i.e., remote) configurations.
2. **Server-side hooks** are **centrally managed** scripts that run on the remote repository server. Developers use them to (a) **enforce project-wide standards** and (b) run server-level actions.
 - **Note.** Your ability to implement server-side hooks depends on who manages your remote repository servers. Hosting services usually have some restrictions in place.

See [here](#) for a comprehensive list of local and server-side Git hooks. Each hook has a specific, pre-defined purpose.