

Git better

Collaborative project management using *Git* and *GitHub*

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Let's Git it done!

These slides are a brief primer to Git, and how it can help your workflow.

References:

- [Atlassian tutorial](#)
- [GitHub guides](#)
- [Git cheatsheet](#)
- [Git book](#)

Troubleshooting:

- [How to undo \(almost\) anything with Git](#)
- [Git flight rules](#)

Overview

1. Version control with Git
2. Essential concepts
3. History and branching
4. Collaborative development
5. Coding with style
6. Managing a single-user project locally and remotely on GitHub
7. Collaborating on team projects on GitHub
8. Undo (almost) anything with Git

Version control with Git



Git is a distributed version control system for tracking changes in files and coordinating work on those files among multiple people.

Version control (Git, Mercurial, CVS, Subversion, Bitkeeper):

- keep track of changes to text files line-by-line over time;
- easily track what changed between any two versions (text);
- revert any change if needed;
- back up and distribute copies of files;
- collaborate on projects.

Distributed:

- developers keep local copy of entire code and history;
- can make changes offline and asynchronously;
- changes (easily) reconciled later.

Advantages of Git:

- widely used, supported, documented;
- online platforms: [GitHub](#), [Bitbucket](#), [GitLab](#);
- desktop interfaces: shell, [GitHub Desktop](#), [SourceTree](#), [GitKraken](#);
- integration in editors and IDEs: Emacs, Sublime Text, RStudio, XCode, Visual Studio, ...;
- distributed (asynchronous, offline) development;
- easy branching: eg, experimental branches for trying changes);
- easily make complex merges.

Let's Git on the same page

Challenges:

- steep learning curve;
- complex conceptual model;
- cryptic man pages (but good documentation!).
- trivial handling of binary files, images, Office documents;

Requires some workflow changes (see details):

- keep project under single directory (*outside* Dropbox, Google Drive, piCloud, ...!)
- consistency in personal and team coding style (eg, indentation, spacing, line-breaking);
- save and commit changes manually and frequently;
- requires to document code and explain changes.

Essential concepts

Git concepts: What

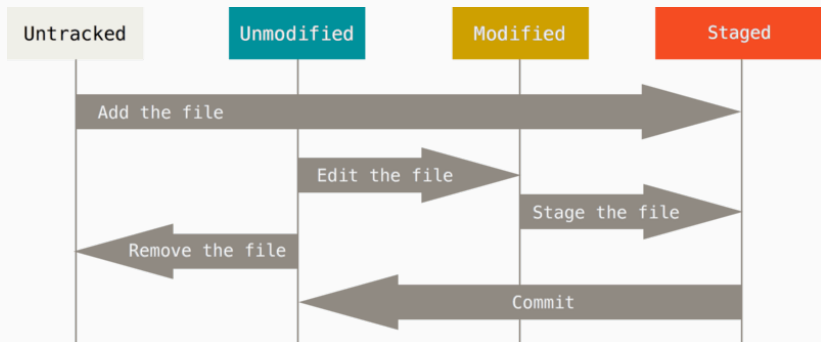
- **repository (repo)**: a collection of files and their history:
 - where the code is kept: under a single root directory;
 - can be **local** (your machine), or distributed across your team or on a **remote** server (eg, GitHub).
- **commit**: a snapshot of your files at a given time:
 - how Git keeps track of changes in code over time and across team;
 - manually **add** one or more files to include to commit them and describe what changed in a message;
 - a permanent record of what changed (**diff**), when, by whom, with respect to what (**parent commit**);
 - a repository is “just a directed acyclic graph of commits”.

Git concepts: Where

Git has a sophisticated model of *where* things happen, based on how frequently you change things:

- **Working directory (working tree, workspace):** the files and sub-directories you can see and work on.
These are visible files stored on your disk.
- **Staging area (index):** where you list files that will go into your next commit.
This is a file in the hidden `.git/` subdirectory on your disk.
- **(local) Repository:** where the commits are stored; ie, it contains the full history of previous versions of the files in the repository, and relevant metadata.
Contained in the hidden `.git/` subdirectory on your disk.
- **(remote) Repository:** a version of the repository hosted elsewhere.
On another computer, or online service like GitHub or Bitbucket.

Life cycle of files in a repository: from changes to staging area



Key commands: repository actions

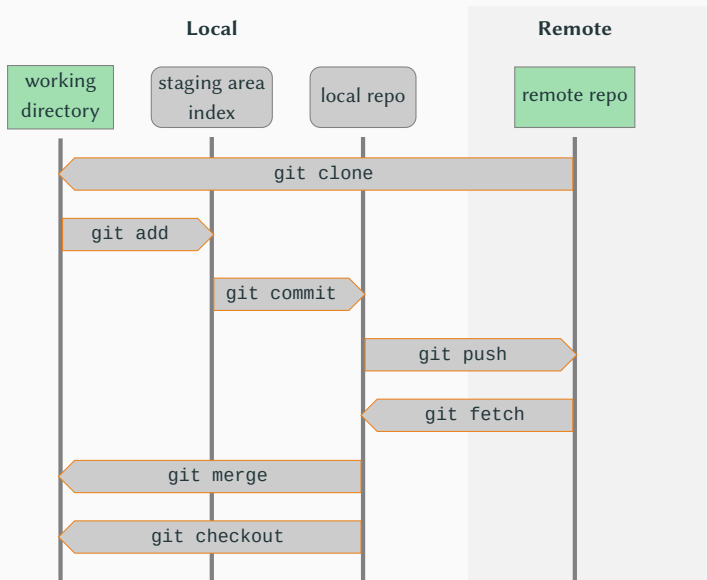
- `git status` (or interface) tells you the state of your repository:
 - which files are **untracked** and not indexed.
 - which files are **modified** with respect to the index/staging area;
 - which files are **staged (indexed)** and ready to be committed;
- `git add` new or modified files to the index.
- `git commit` commits changes in the index.
- `git diff` shows what has changed, wrt index or last commit.
- `git log` shows the history of commits up to this point.
- `git push`: send your local changes to the remote server;
- `git pull` (`git fetch`; `git merge`): get latest changes from remote.
- `git clone`: copy a remote repository on your machine;
- `git init`: start a new repository in empty directory;

Example workflow 1

Solitary development, offline, from scratch

1. create a new empty directory on your computer
2. `git init`: create a Git repository in the directory
3. create, edit, and save some `file.txt` in the directory
4. `git status` shows the file is untracked
5. `git add file.txt` to stage the file
6. `git commit -m "First commit! added file.txt!"`
7. `git status` reports no changes
8. edit the file again, repeat from step (4).

Working with repositories: from changes to commits

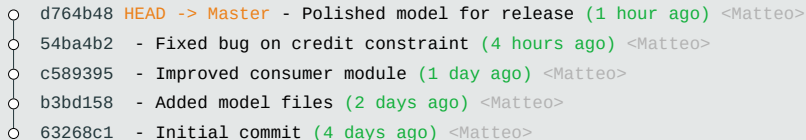


History and branching

History of the repo with **git log**

git log (or the interface) shows the history of commits of the repo:

Log of a solitary development workflow



```
d764b48 HEAD -> Master - Polished model for release (1 hour ago) <Matteo>
54ba4b2 - Fixed bug on credit constraint (4 hours ago) <Matteo>
c589395 - Improved consumer module (1 day ago) <Matteo>
b3bd158 - Added model files (2 days ago) <Matteo>
63268c1 - Initial commit (4 days ago) <Matteo>
```

Note:

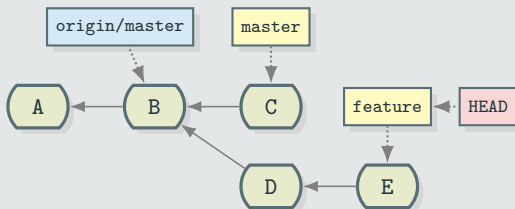
- commits are uniquely identified by a SHA-1 hash (eg, a12b34...);
- commit messages can have two parts:
 - short description (~< 50 characters, above)
 - details after two line break (not shown);
- **HEAD** means “where your next commit would go” (pointer to branch);
- **Master** is the name of the main **branch**

Branches

Branches are sequences of commits, which can trace an alternative history and versions of the code in your repo.

- there is always a **Master** branch, containing the *main, baseline* version of the code.
- Git makes creating and merging branches quick and easy: it's a great help to the workflow.
- other branches can be created from any commit to *experiment, implement new features, keep diverging versions*.

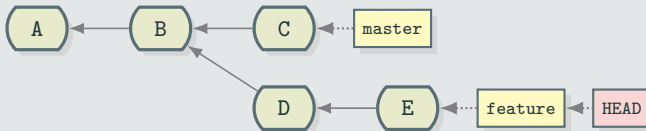
Example history with branches



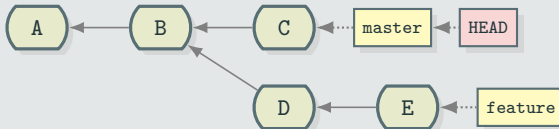
Moving across branches with **git checkout**

git checkout moves **HEAD** on the tree (different branch or earlier commit on the same branch): it shows the files at different commit.

Example switching branches



git checkout master

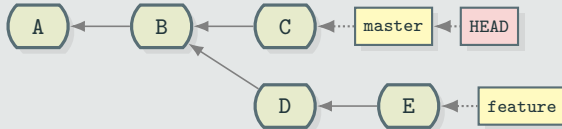


Merging branches with `git merge`

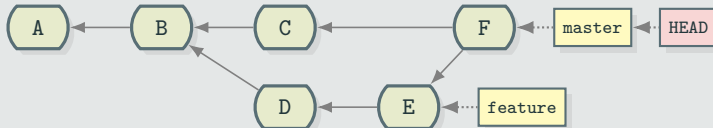
From the `Master` branch, `git merge feature master` creates a new commit combining the two branches.

Merging branches

`git checkout master`



`git merge feature master`



Collaborative development

Collaborating on remote git repositories (GitHub, Bitbucket,...)

Online hosting services like GitHub and Bitbucket provide:

- **remote repository** to back up code;
- **issue tracking** interface: reporting bugs, suggesting improvements;
- **project and team management**: decide who can do what;
- managing contributions (**pull requests**) from team members and third parties;
- place to **host documentation** and **share know-how** on the code;
- venue to **make code public** and **invite collaboration** from anyone.



Collaboration workflow on remote git repositories

The typical workflow within our GitHub *organization* or Bitbucket *team* would be:

1. create a (private/public) repository within the organization.
 - invite collaborators among modelers;
 - nominate administrators, maintainers, access rights, etc.
2. upload (or migrate) existing code on the repository;
3. other modelers clone repository on their machine, replicate and experiment;
4. document existing code; add a README.md explaining what the model does, reference to papers, how to collaborate;
5. document issues, suggest improvements;
6. create branches for developing new versions (features, bugfix,...)
7. merge branches in Master to integrate in the development version.
8. tag specific commits to refer to milestones of the project.

Coding with style

Some matters of style and workflow to collaborate with ease.

- repository as self-contained, dedicated directory of (mostly) code:
 - include **all** relevant files in the repo (libraries, dependencies, ...);
 - in your code, refer to dependencies using relative paths: `./library/`, **not** `/home/user/project_name/library`;
 - exclude unnecessary files (eg, compilation artifacts, large data, useless binary files) using `.gitignore` (see github.com/GitHub/gitignore).
 - keep it **outside** shared folders of Dropbox, Google Drive, piCloud!
- be **consistent** in personal and team coding style: indentation/tabs, spacing, character encoding (UTF-8), line-breaking.
- conform to a language **style guide** (eg, [google.GitHub.io/styleguide/](https://google.github.io/styleguide/));
- **commit early and often**;
- **never commit broken code!** use `git stash` to save it instead.
- commit related files together;
- write meaningful commit messages.
- tag release (baseline, published) versions of your code with `git tag`.

Managing a single-user project locally and remotely on GitHub

Existing project: local and remote repo

Use case: an existing local project in `/<project>/`, as yet untracked by git.

Workflow

- initialise a git repo:
 - `cd <project>/`
 - `git init`
- create `.gitignore` file, exclude irrelevant files.
- stage all (relevant) files: `git add .`
- `git status` (is your friend)
- commit changes
`git commit -m "First commit (better late than never)"`

Existing project: local and remote repo (continued)

Workflow (continued)

- create an **empty** remote repo called *<project>* in GitHub:
 - uncheck “Initialize this repository with a README”
 - no gitignore
 - no licence

(You can always add those later; should not commit at this time)

- GitHub project now at <https://github.com/<user>/<project>>; name need not be globally unique (GUID: *<user>/<project>*), but make it **memorable**, **evocative** and **google-able**.
- locally, add remote repo address called “origin”:
`git remote add origin https://github.com/<user>/<project>.git`
- push changes for the first time (creates remote **master** branch) :
`git push -u origin master`

Collaborating on team projects on GitHub

Collaborating on a GitHub project

Use case: working with your team on github.com/<user>/<project>.

Workflow

1. add collaborators from github.com/<user>/<project>/settings/collaboration; they receive and accept invitations to work on the repo.
2. collaborators can access a private repository, clone repository locally and make changes;
3. collaborators can now push commits to repo, including **master**! Protect it from foolishness in [/settings/branches/](https://github.com/<user>/<project>/settings/branches) by requiring **branching** and **pull requests** in order to commit on **master**:
 - **collaborators**—branch → commit(s) → pull request;
 - **repo admin(s)**—evaluate pull requests.

Undo (almost) anything with Git

How to undo (almost) anything with Git

Git allows to undo most actions easily, depending on state of the repo.

Golden rules

- *Don't Panic!* Your code is still there (somewhere).
- working [methodically](#) will prevent (most) mishaps.
- remote commits are there to stay—but you can revert their effects.

See also:

- GitHub's [How to undo \(almost\) anything with Git](#);
- [Stack Overflow](#) (pro tip: there is usually > 1 way to do it).

How to undo (almost) anything with Git: examples

Solutions to **local** (ie, not-yet-pushed) problems:

- undo changes in `<file>` made since last commit: return files to last commit with `git checkout -- <file>`;
- undo changes just committed (eg, typo in message or error in code): fix files, add them and commit again with `--amend` option;
- stop tracking `<file>`: `git rm --cached <file>`; add it to `.gitignore`; commit;
- undo changes in several recent commits: return to last good commit with `git log`, look for `<SHA>` of commit, then `git reset <SHA>`

Solutions to **public** (ie, pushed to remote) problems:

- undo a public commit `<SHA>`: `git revert <SHA>` will create a new commit, that undoes (inverts) the changes introduced by `<SHA>`; this new commit is added to existing (public) history.

Contributing to third-party open-source projects on GitHub

Contributing to third-party repositories on GitHub

GitHub hosts many great projects, mostly managed by volunteers.

Here's how you can help:

- **report issues (bugs):**
 - **first, due diligence:** read documentation, search existing issues, repo Wiki, StackOverflow answers. Is your problem really new or general?
 - describe all the steps needed to reproduce; embed example code in Markdown (eg, [R Minimal Reproducible Example](#));
 - give feedback on proposed solutions.
- **fix issues:** if you can solve an existing issue, fork the repo, work on it, and submit a pull request.
- **documentation:** writing good documentation takes time, and developers may be happy to delegate. Ask how you can help.
- **say thanks:** volunteer development is a thankless task; reach out to thank to the developers on social media.

Further topics

Sharing snippets of code easily with GitHub Gists

GitHub Gists (gist.github.com) are pages to store and share snippets of code. They are light-weight repositories, with an emphasis on showcasing the code itself, and making it easy to copy.

- great for sharing self-contained scripts or config files;
- automatically highlight code and can embed it in third-party websites;
- can be edited online by the author (automatic versioning);
- either public (listed on your profile page, searchable) or private (access with link only);
- can gather comments from everyone.

References to advanced topics

Some useful topics covered in GitHub Guides (guides.github.com):

- [Mastering Markdown](#): all about GitHub-flavoured Markdown, the easiest mark-up language around—used extensively in GitHub READMEs, issues, comments, and around the web;
- [Documenting your projects on GitHub](#): writing great documentation (README, Wiki, pages) for your repo (in Markdown);
- [Making Your Code Citable](#): assign a DOI (Digital Object Identifier) to cite your code in academic publication, using GitHub and [Zenodo](#);
- [GitHub Pages](#): easily build a website from a GitHub repo—for your project or for yourself!