Hands-on

Introduction to Git

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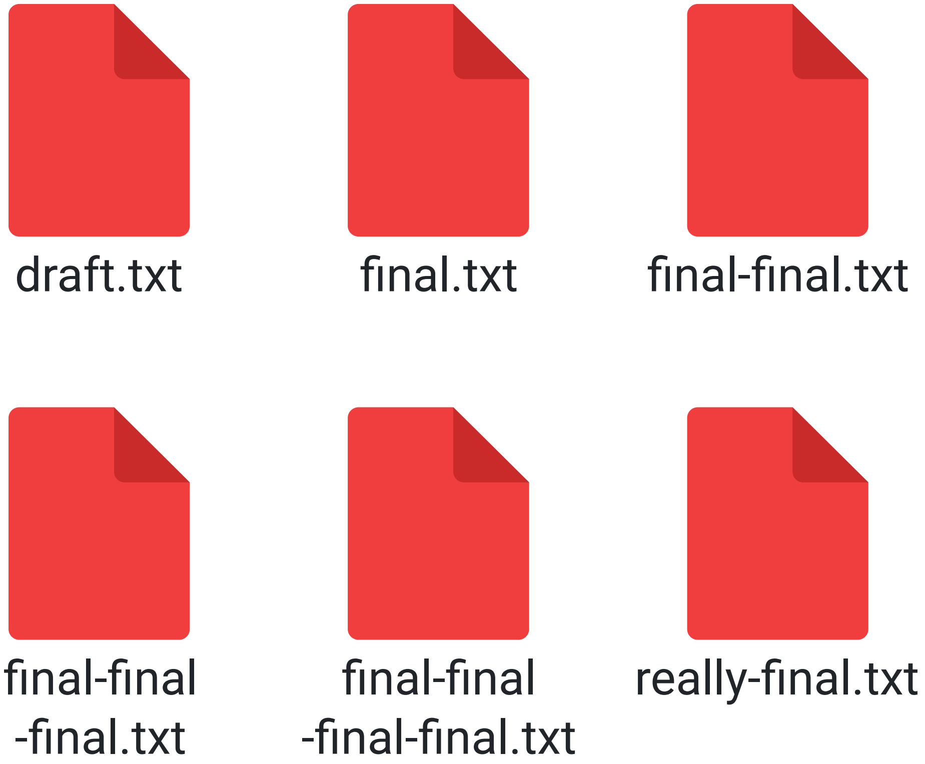
Agenda

- Introduction to version control
- Overview of concepts and terms
- Tutorial section
- Additional topics
- Time for questions

Introduction

Version control

Version control software is used to keep track of **changes** to files over **time**.



Everyone can use it!

- Writers
- Instructors
- Managers
- Scientists and engineers
  - Digital object identifiers (DOI)

Why use version control?

- Collaborate on projects
- Keep historical versions
- Keep copies on remote servers
- Hold editors accountable for changes

Version control software should *not* be used for large backups!

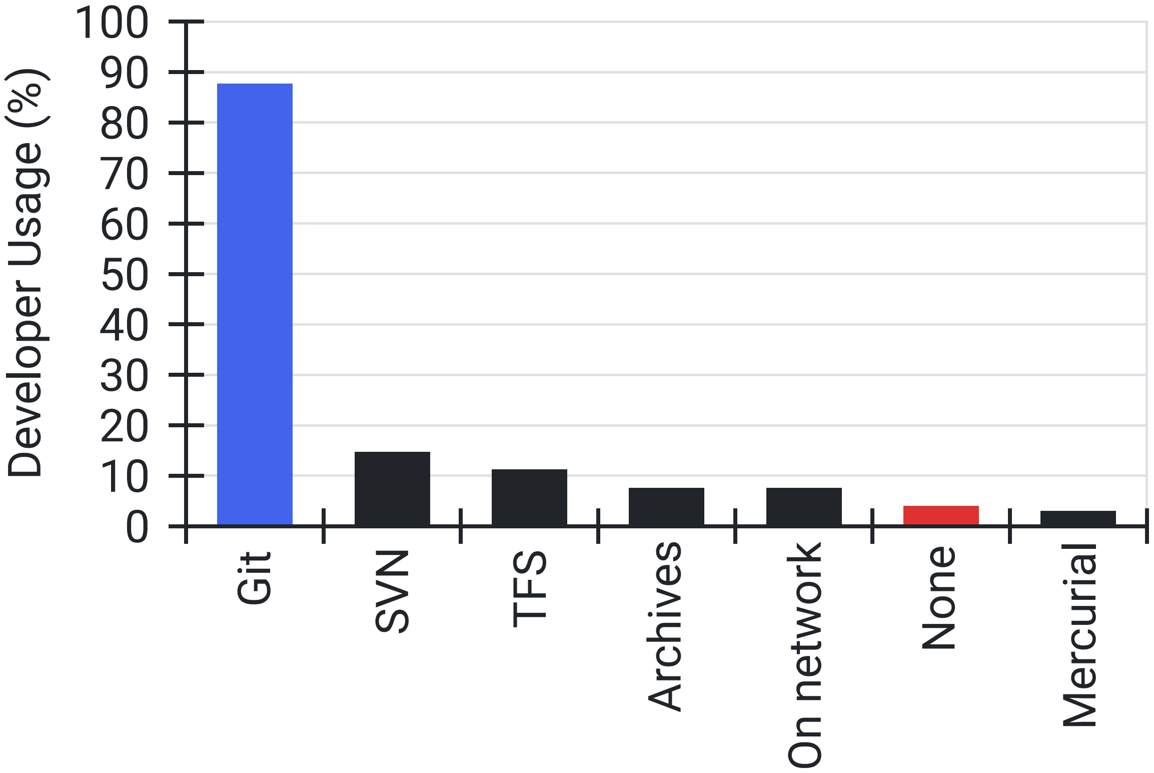
Available software

- Git
- Subversion
- Mercurial
- GNU RCS
- Commercial offerings

Git is the most common by far.

Version Control Usage

Stack Overflow Developer Survey 2018



The Fundamentals

```
git help command
```

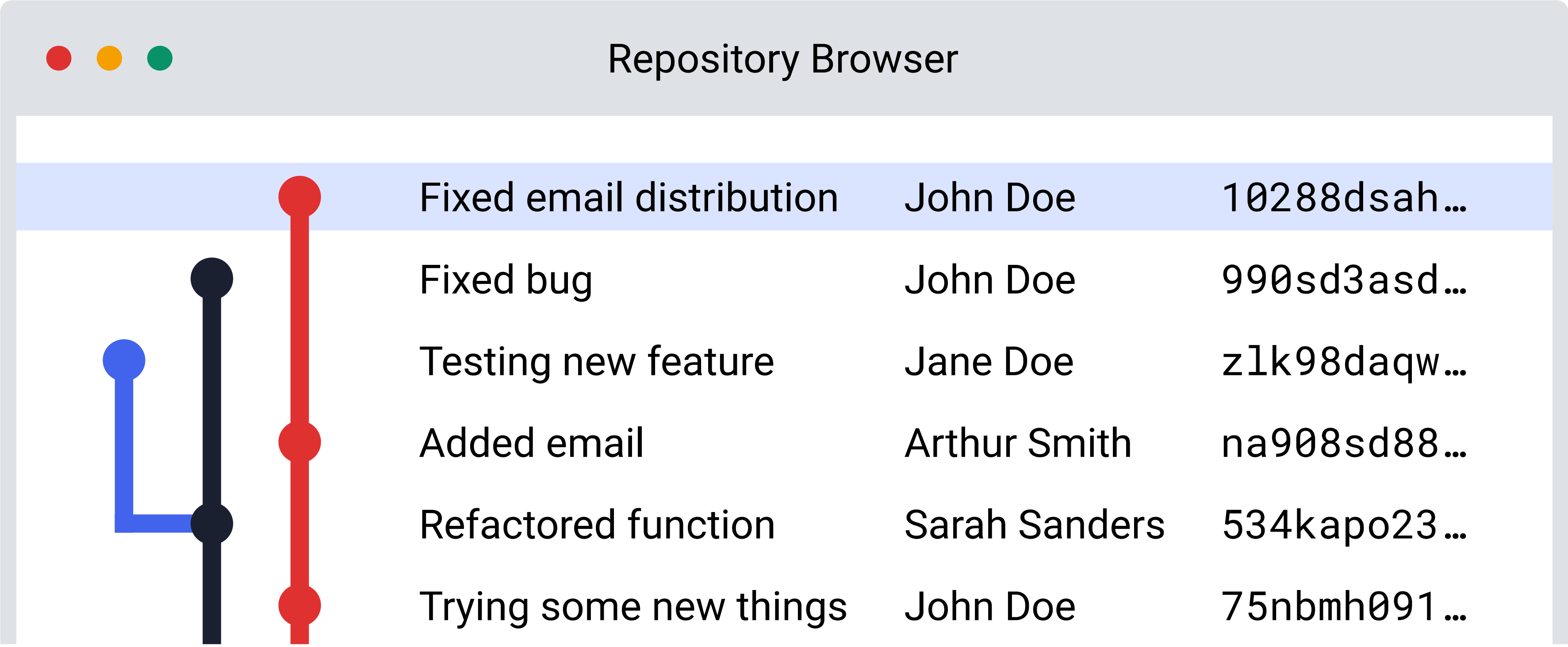
Git packages

- Linux
  - Install with package managers
- macOS
  - Included with Xcode tools
  - Homebrew
- Windows
  - Git Bash

Git is not the same thing as GitHub.

Graphical tools

Graphical software offers much of Git’s functionality without the need to learn commands.



Fixed email distribution	John Doe	10288dsah…
Fixed bug	John Doe	990sd3asd…
Testing new feature	Jane Doe	zlk98daqw…
Added email	Arthur Smith	na908sd88…
Refactored function	Sarah Sanders	534kapo23…
Trying some new things	John Doe	75nbmh091…

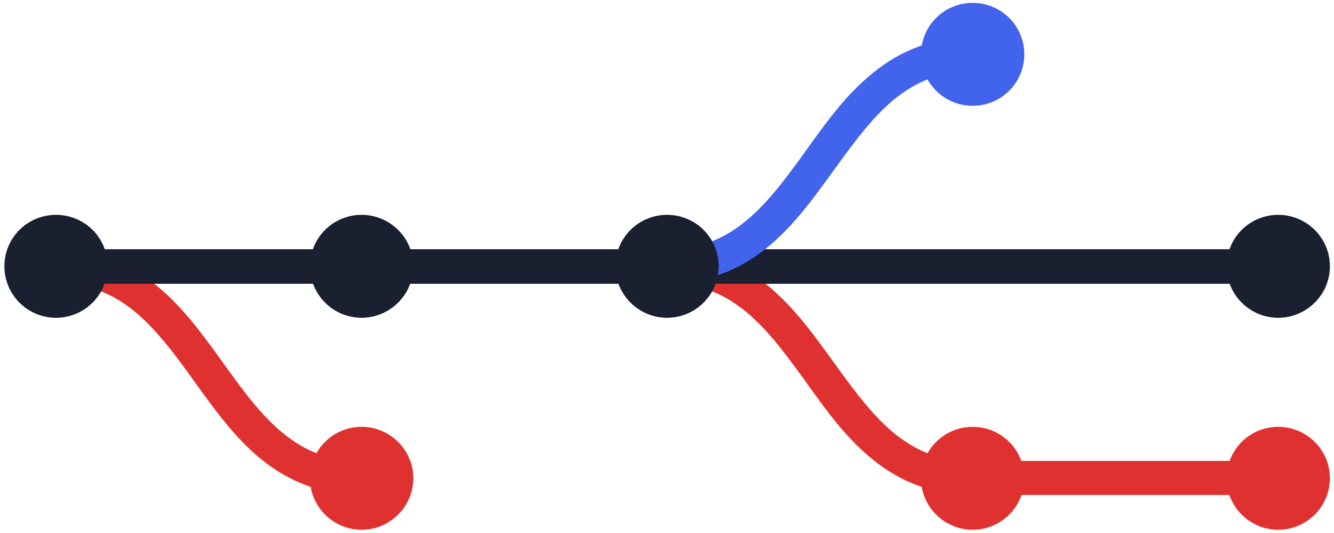
Concepts and Terms

The repository

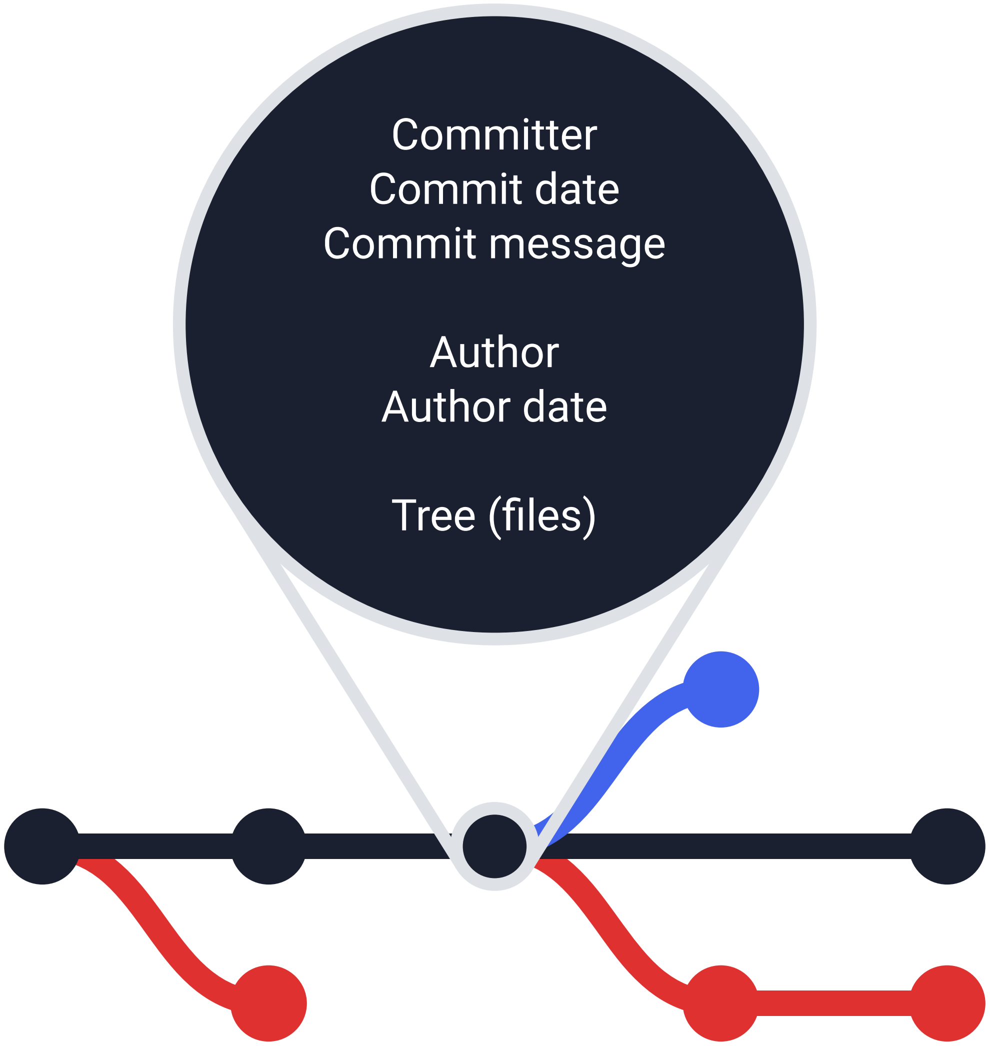
All project files are stored in the repository.

You will need to make or otherwise acquire a repository to work with Git.

The graph



The commit

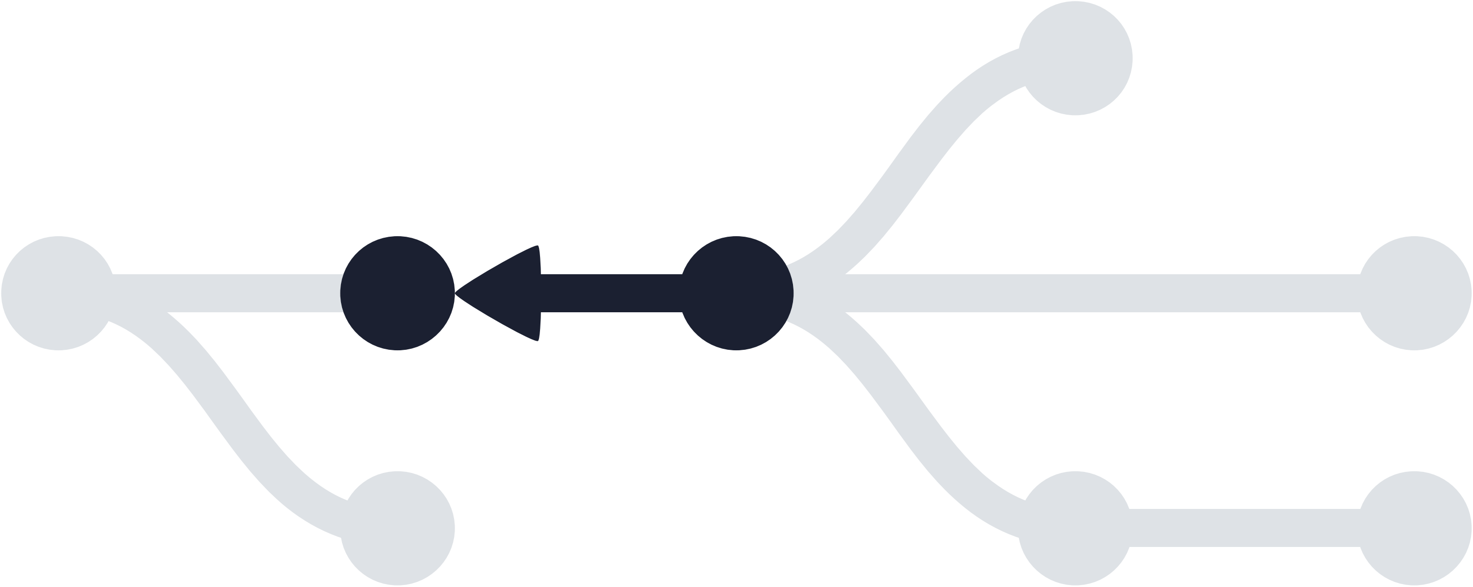


Committer
Commit date
Commit message

Author
Author date

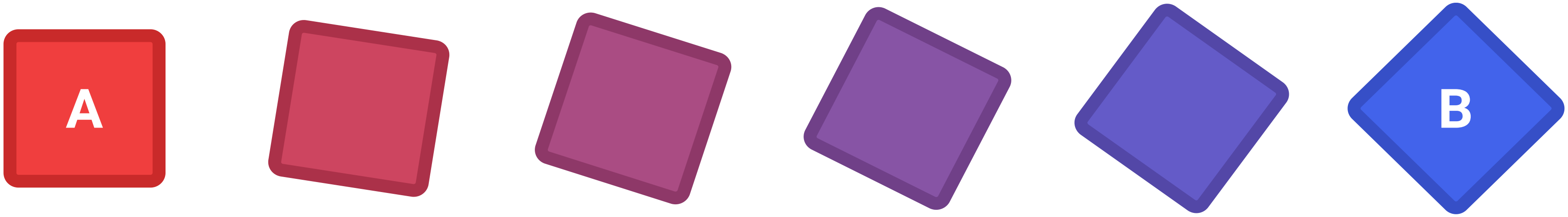
Tree (files)

Parent commits



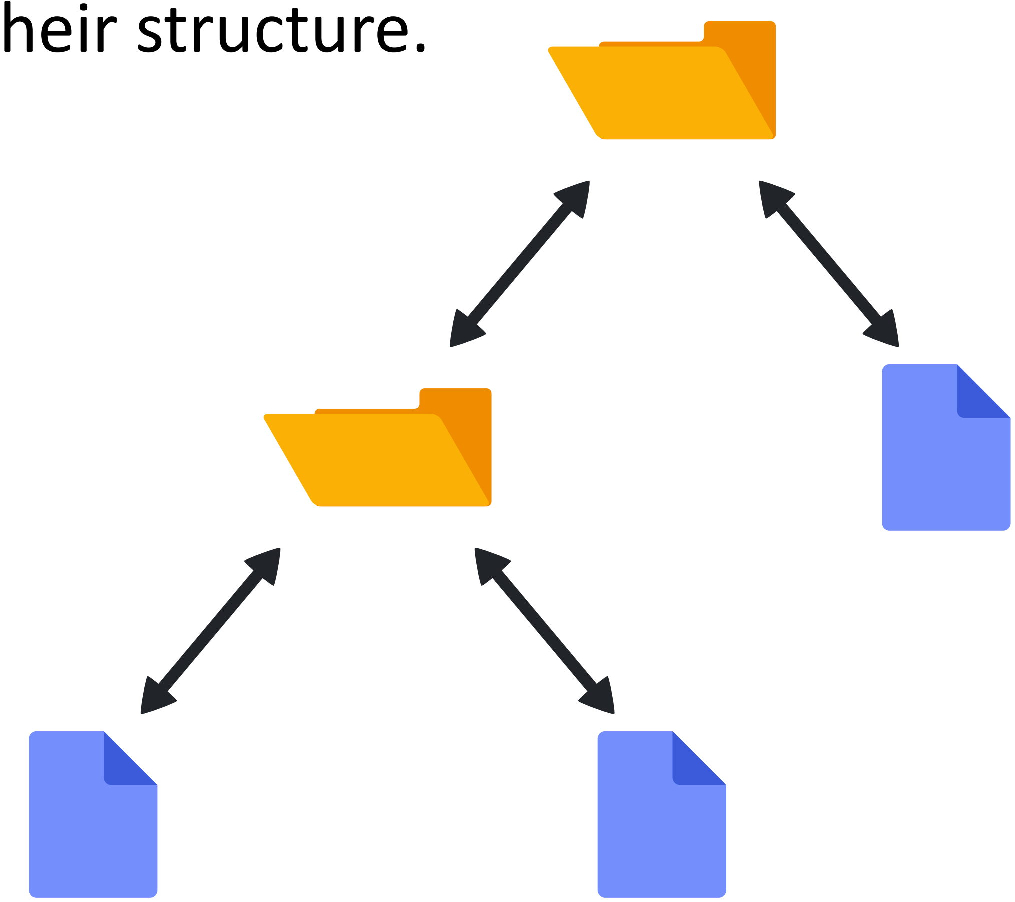
Snapshot storage

Git stores a snapshot of the whole tree on each commit—not just the changes between commits—to make operations faster.



The tree

The tree is the hierarchy of files. The term refers to the project files and their structure.

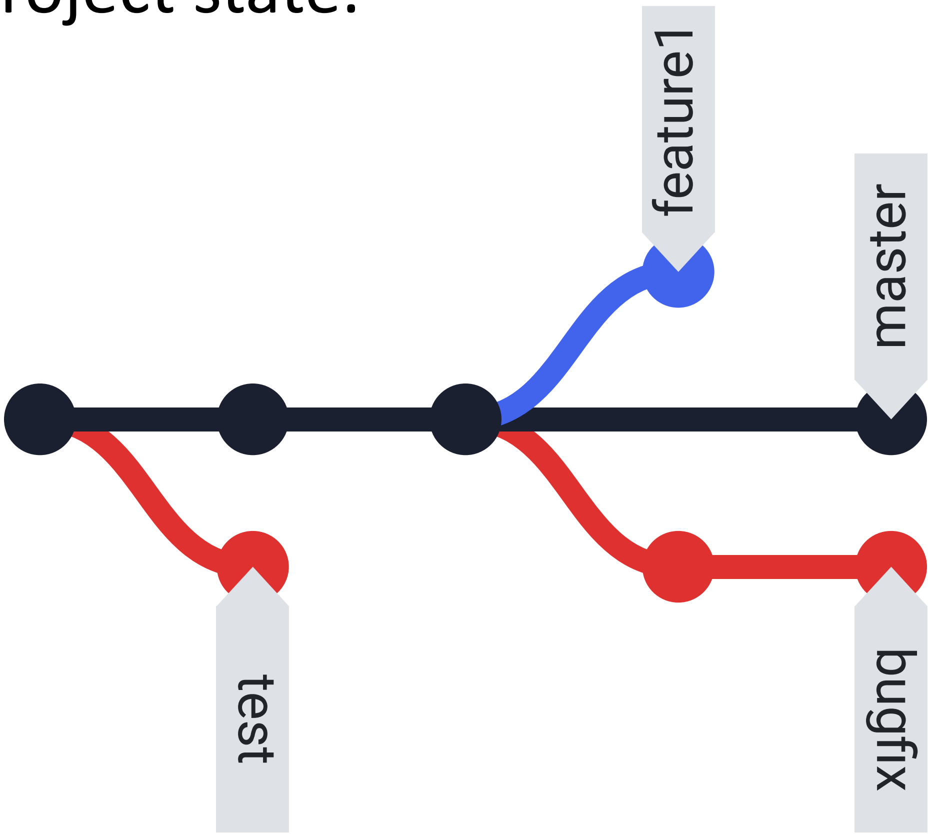


The blob

Files are stored as “blobs,” or “binary large objects.”

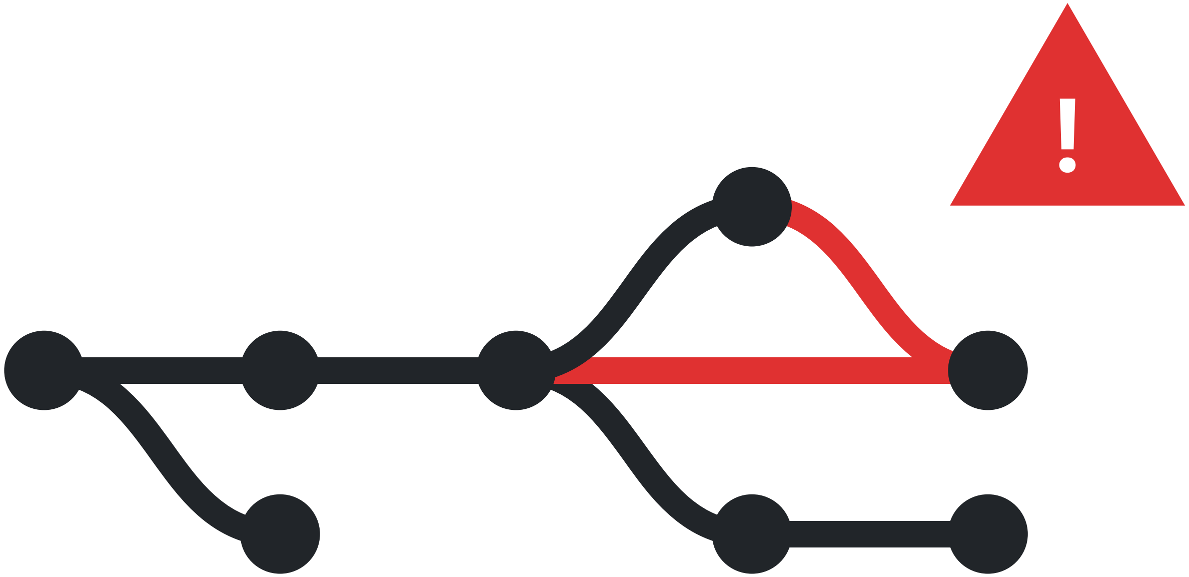
The branch

A branch is a collection of commits that describe a particular project state.



Branching and conflicts

What happens if you try to merge (combine) conflicting branches?



Using Git

Hands-on: Prepare

Connect to a Linux server.

Get a recent version of Git.

- `module load git`
- `apt install git`
- `yum install git`

Check that it works with `git --version`.

Repositories

The repository contains the project information.

- Created in a directory with `git init`
- Cloned from an existing source with `git clone` *`source [destination]`*

See usage on handout.

Configuring Git

You should always configure Git in a new repository. Add `--global` to change everywhere.

- `git config user.name "`*`Your Name`*`"`
- `git config user.email "`*`your.name@utah.edu`*`"`
- `git config core.editor `*`editor`*
- `git config commit.template `*`path`*
- `git config user.signingkey `*`gpg_key`*

Hands-on: Make a repository

Create a new repository or clone one from an existing source.

Configure your name and email address (at a minimum) in the new repository.

Editing files

You can edit files in any editor.

Text files work best with Git.

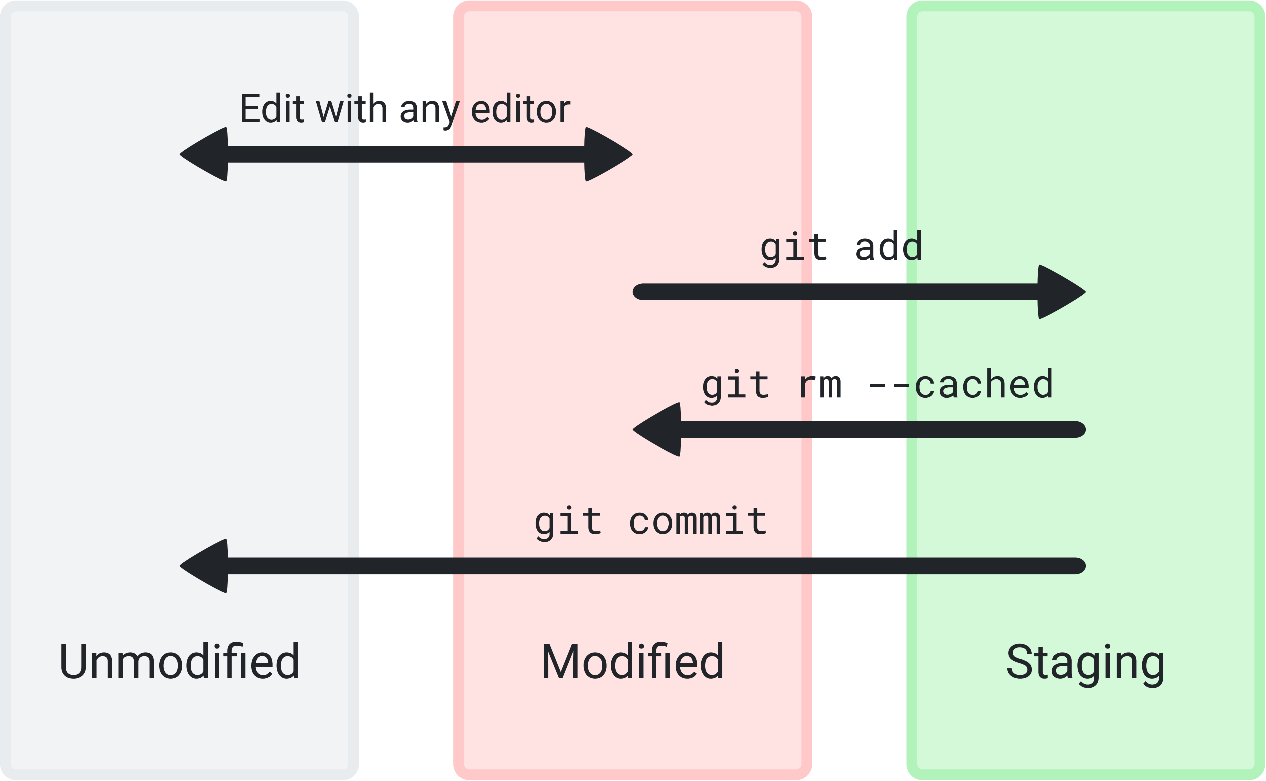
- Consider using text formats for writing
- Binary files like images and word processor documents will not work with comparison tools

Staging files

Git won't “track” *all* your changes.

- By design
- `git add` files to the “index” (“staging area”) before commits to identify desired modifications

Effects of Selected Commands



Edit with any editor

`git add`

`git rm --cached`

`git commit`

Unmodified

Modified

Staging

Commits

Commits only include content from staged files.
(Your files must be in the index.)

- `git commit`
- `git commit -m "Message"`

Commit identification

Commits are hashed with SHA-1. A long string is used to refer to a particular commit.

The string can be shortened where you need to use it; “5203b1d979f05bcd88c28257950f467e1c2396f9” is (probably) the same as “5203b.”

Hands-on: Commits

Modify files with any editor.

Add your changes to the index.

Commit changes (be sure to add a message). Make several commits if you have time!

Logs and differences

View the project history with `git log`.

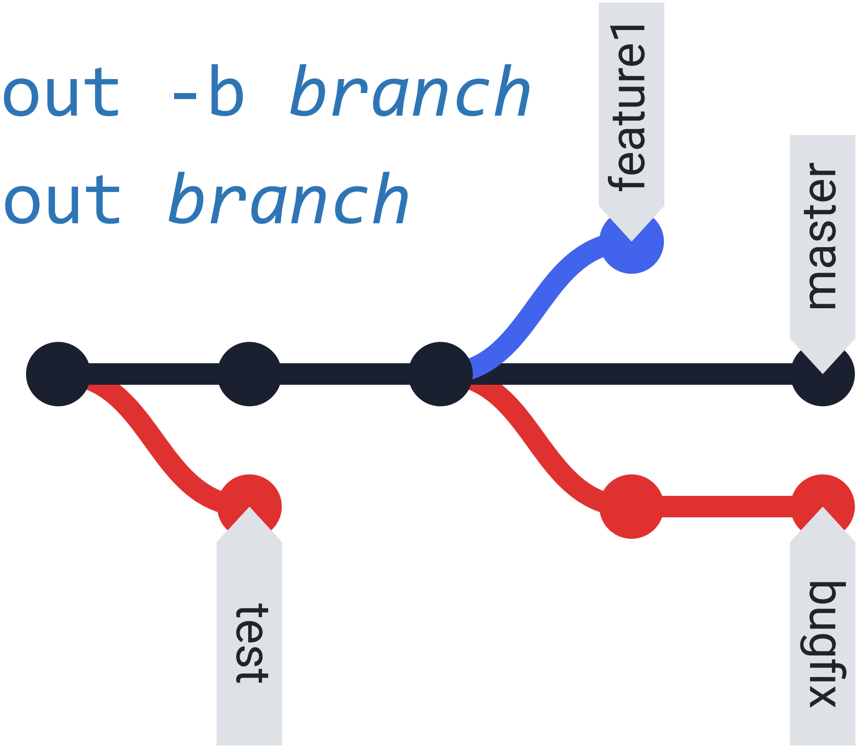
View new changes with `git diff`.

- Add commit identifications to the command
- Without specific commits, this compares the current state to the previous commit

Branches

Branches allow you to have multiple versions of your project simultaneously.

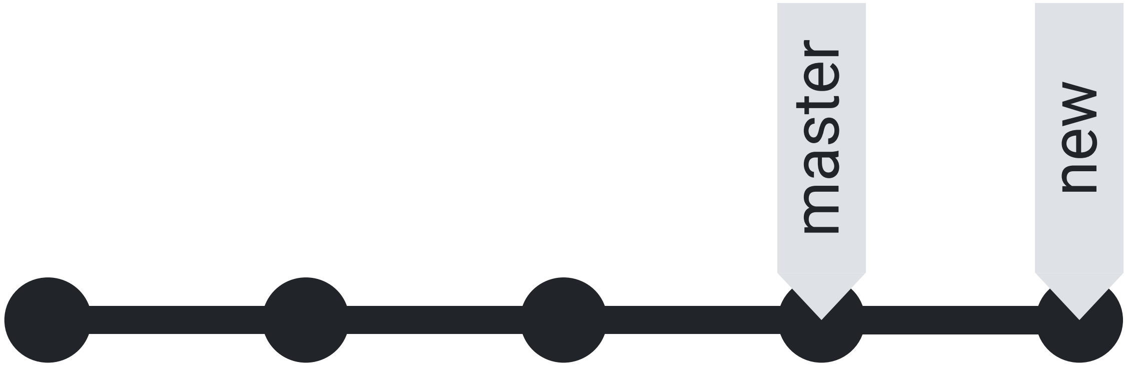
- List with `git branch`
- Create with `git checkout -b` *`branch`*
- Switch with `git checkout` *`branch`*



Hands-on: Branches

Create a new branch.

Modify files on the new branch and make a commit.



Merging branches

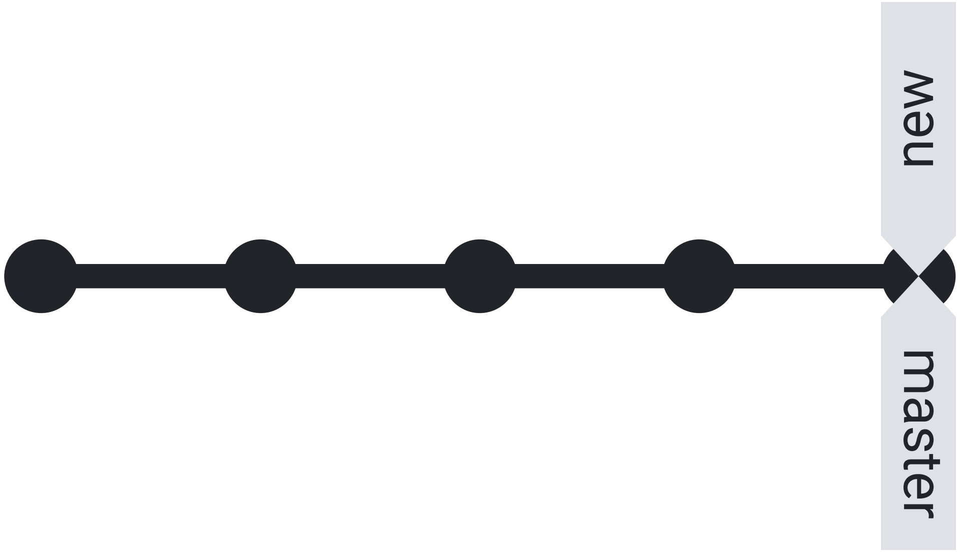
- Switch to the branch you would like to merge *into*
- `git merge source_branch`

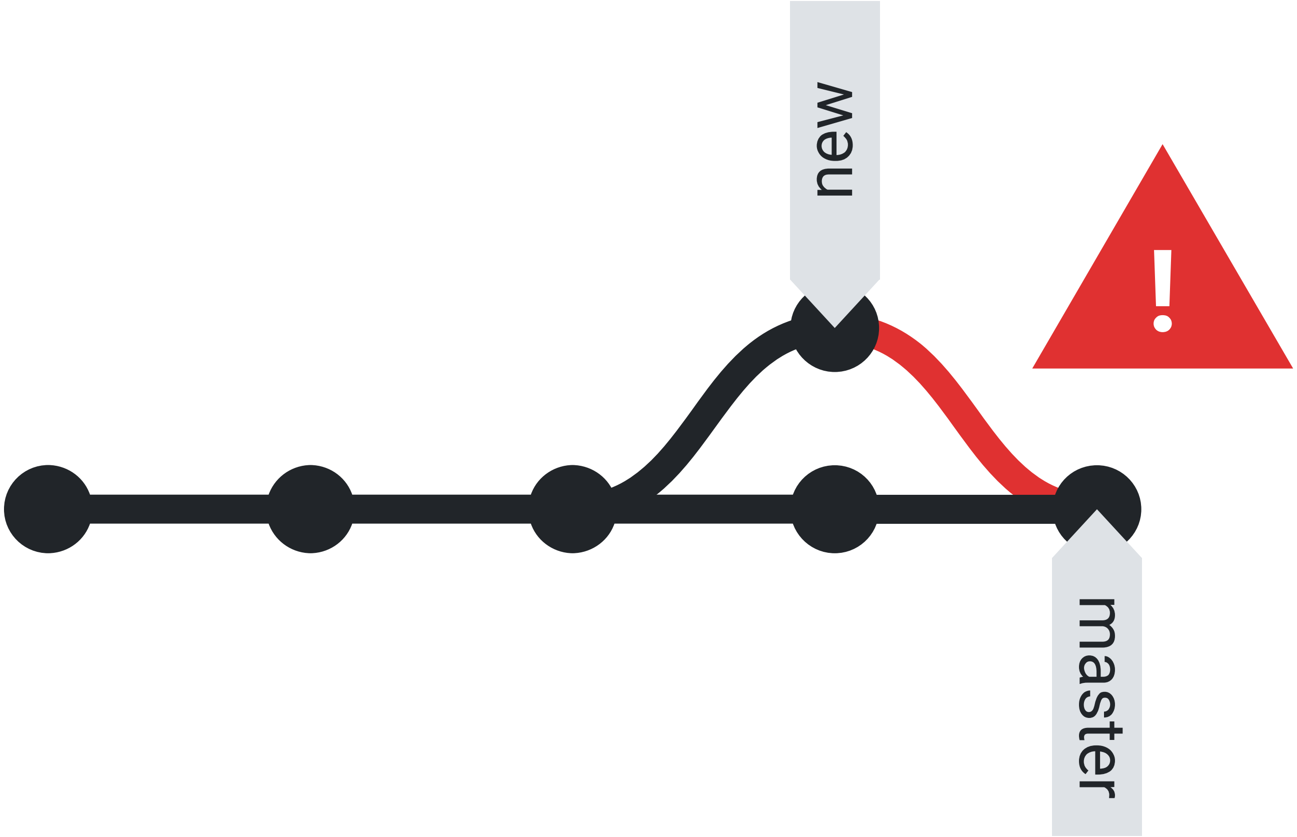
If there are conflicting commits, issues will be identified within files. (More on this later.)

Hands-on: Merging

Switch to the “master” branch.

Merge the changes from the previous exercise (the new branch).




new
!
master

Fixing problems

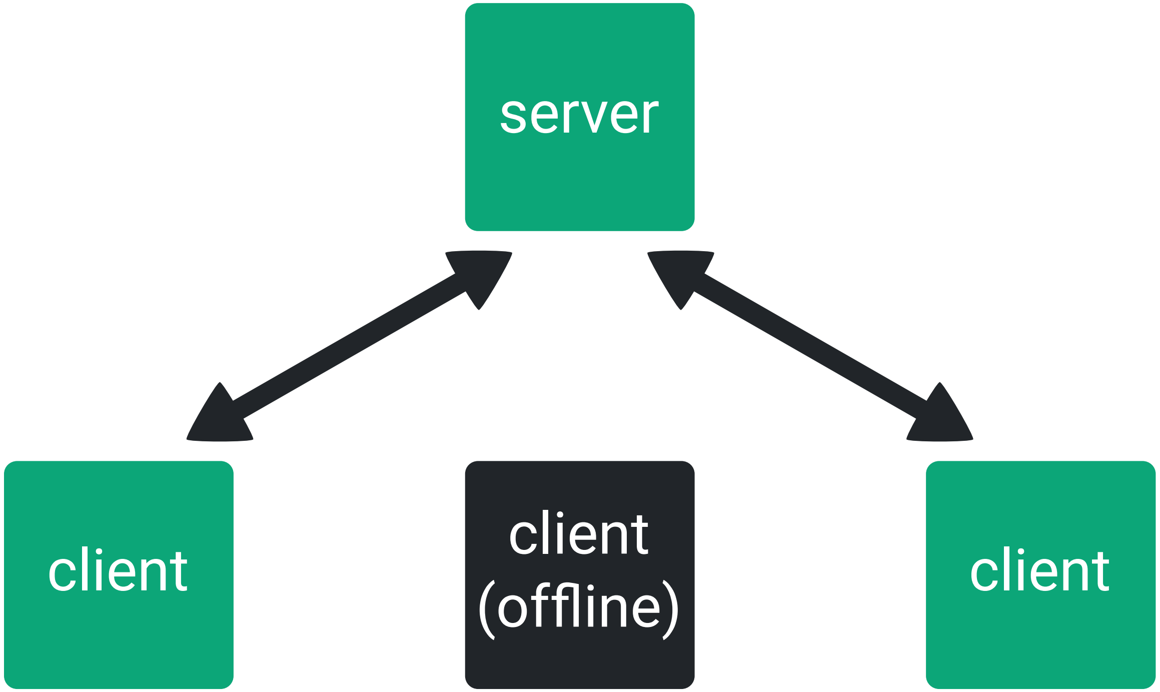
- Fix files with problems
- Create a new commit

```
<<<<<<< HEAD
This is an example of the first version of a file.
=======
This is the second version!
>>>>>>> 57a4c537d0cc429794dfed77d02e5a1bfca9d91b
```

Remote repositories

- Store projects on highly available resources
- Good option for collaborative projects

- The “origin” remote is configured automatically when using `git clone`
  - The primary remote is typically called “origin”
- `git remote add` *`name url`*


server
client
client
(offline)
client

Never store sensitive information on a remote server unless you are certain it is permissible.

Interacting with remotes

Interaction generally consists of uploading and downloading newer versions of the project.

- git push *remote branch*
- git pull *remote branch*

Working with other projects

- *Forks* are copies of a project owned by another user
  - Helps manage project permissions
  - Protects important content
- *Pull* or *merge requests* are used to ask the original project owner to include your changes
  - Generally done on the remote repository host’s website

Conflicts with remotes

- Similar to merge conflicts
- Generally happen when trying to `git push`

1. Pull the current version with `git pull`
2. Resolve issues in files
3. Create a new commit
4. Try to `git push` again

GitLab at CHPC

gitlab.chpc.utah.edu

- Accessible with University credentials
- Create projects that cannot be accessed publicly
- *Not* for sensitive information

Hands-on: Remotes

Create a new project on a remote host (like GitHub or GitLab).

Add the remote to your local repository.

`git push` your project (use `--all` to push tags and all branches).

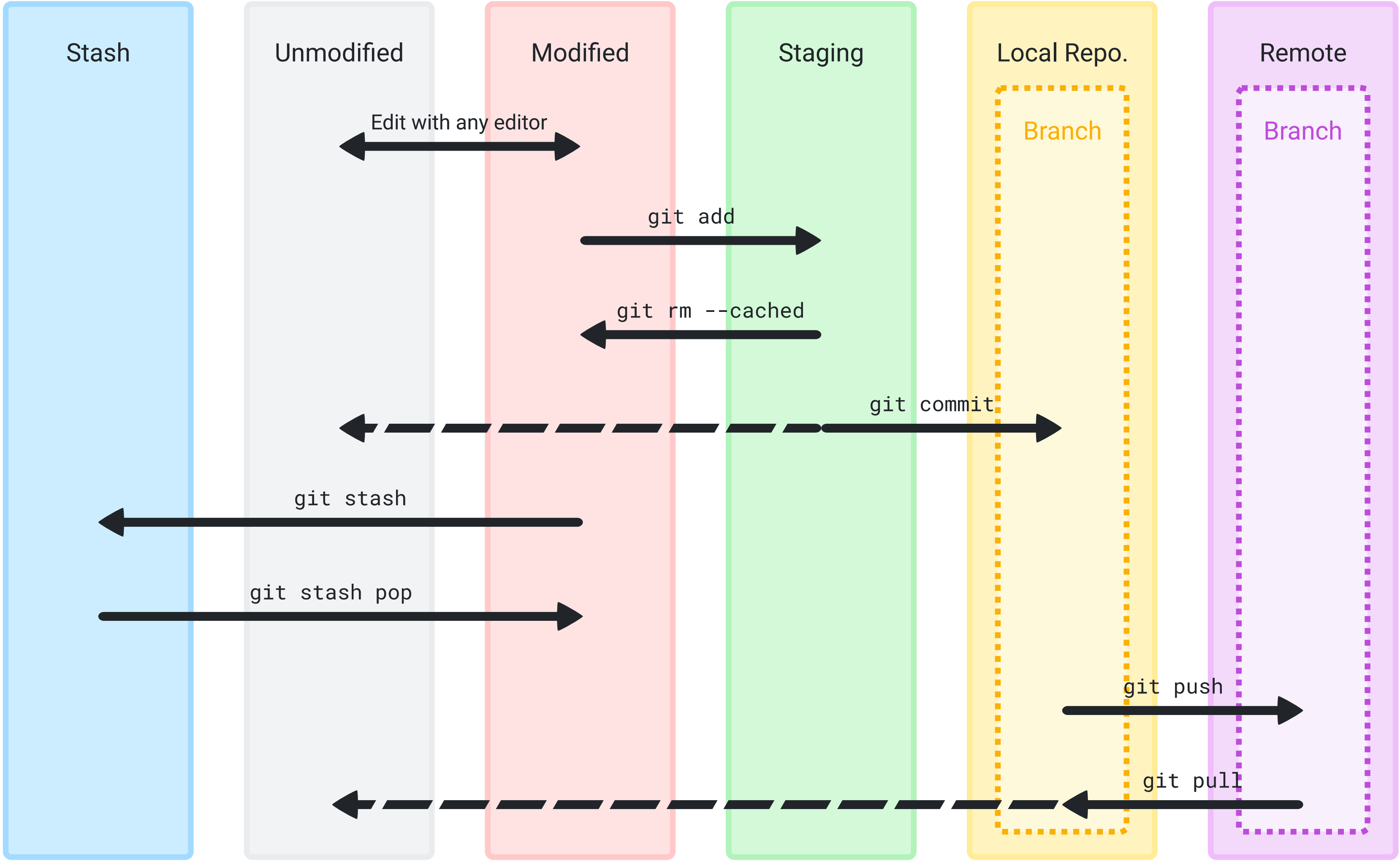
The stash

The stash is used to save the project state without creating a commit.

- Helpful if changing state (e.g. testing another user’s commits) with unfinished changes
- Returns to a clean working directory

- `git stash push`
- `git stash pop`

Effects of (More) Commands



Reverting changes

- `git checkout` a previous commit and create a new branch at that point
  - Works best from an unimportant branch
  - Leaves unwanted commits untouched
- `git revert` to create a new commit that returns the project to a different state
  - Keeps unwanted commits in history
- `git reset` to remove commits entirely
  - *Not a good option for shared repositories*
  - May be acceptable if all changes are local

Additional Information

Rewriting history

- Frowned upon; others probably won't like it if you modify anything public
- Can be done with most commands by appending the `-f` flag
- Be *very careful*!

Continuous integration and delivery

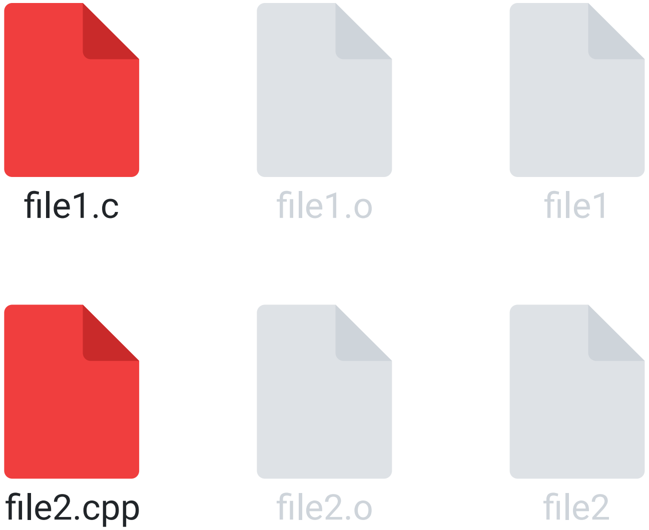
- CI: Merge to primary branch often, complete automated testing
- CD: Similar to CI, but also automates build process

- In theory, release functional software from primary branch at any time
- In the case of “continuous deployment,” successful modifications go directly to end users

.gitignore

Selectively ignore files (with pattern matching) from most commands.

- Makes operations like `git add *` safer
- Helps avoid clutter from compiled binaries and output files



.gitattributes

Attributes of files in repository (improves behavior).

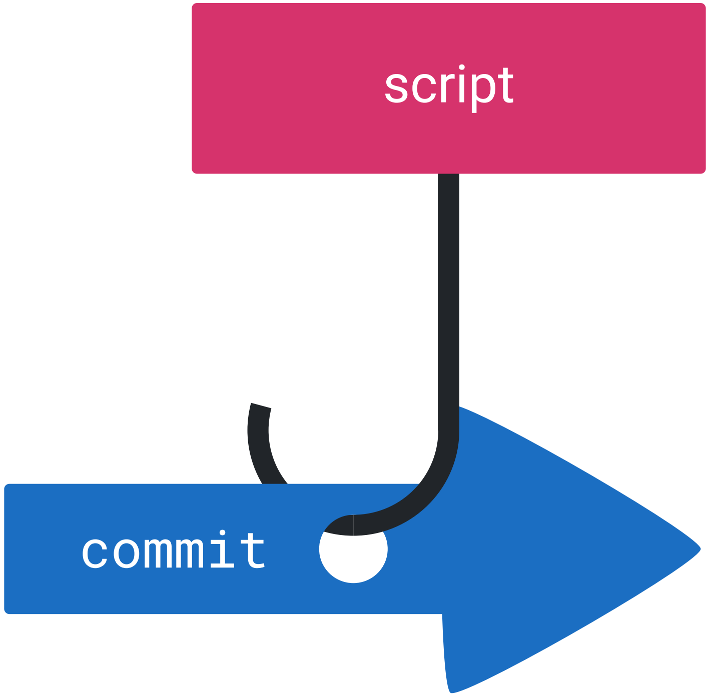
- Identify line endings (Windows, Unix)
- Customize command behavior for certain files
- Mark binary files so they do not appear in `diff` output (most recognized automatically)

Repository information

- The README file is the source of general information on the project
    - Often Markdown
- The LICENSE file contains the license of repository contents
- The CITATION file provides information on citing the project
    - Most common in academic projects

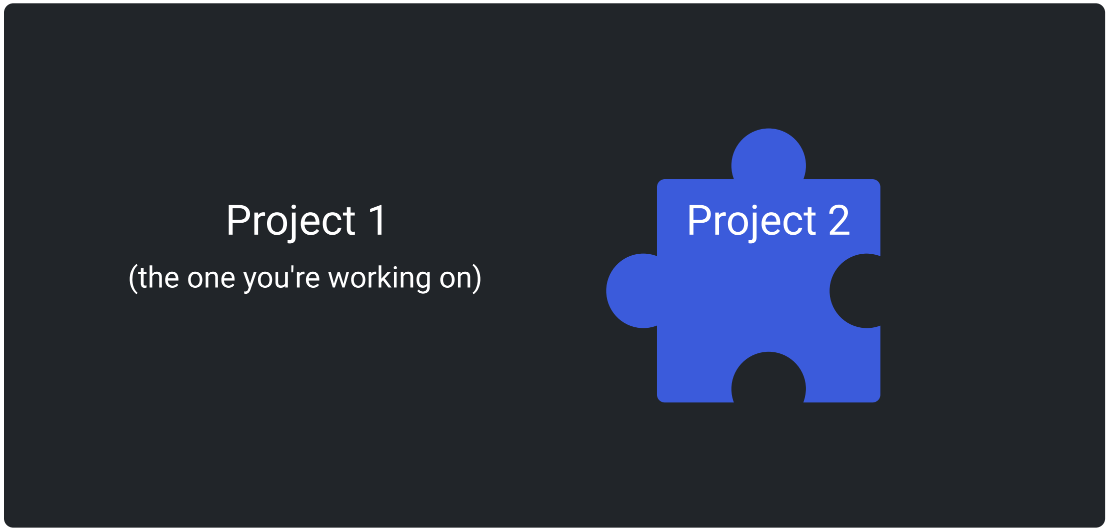
Hooks

- Found in .git/hooks
  - Examples in *.sample
- Run a script conditionally, such as when you run a command
- Interrupts normal workflow



Submodules

- Git repositories inside of Git repositories
- Help simplify project structure
- Reduce redundancy and complexity



Questions or comments?

Thank you for your participation!

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