

Version Control

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What is version control?

- Version control is a tool for **managing changes** in a set of **files**.
- Keeps historical versions.

Why use it?

- Makes **collaborating** on code easier/possible/less violent.
- Helps you **stay organized**.
- Allows you to **track changes** in the code.
- Allows **reproducibility** in the code.
- Allows to maintain multiple versions in **branches**

Types of version control workflows

Centralized

- One authoritative, central remote repository
- Local clones that can check in changes

Examples:

CVS, Subversion (SVN), [GitHub](#), [GitLab](#)

Distributed

- Every clone is a valid, complete repository
- Can clone any repo
- Can pull from any other and resolve differences

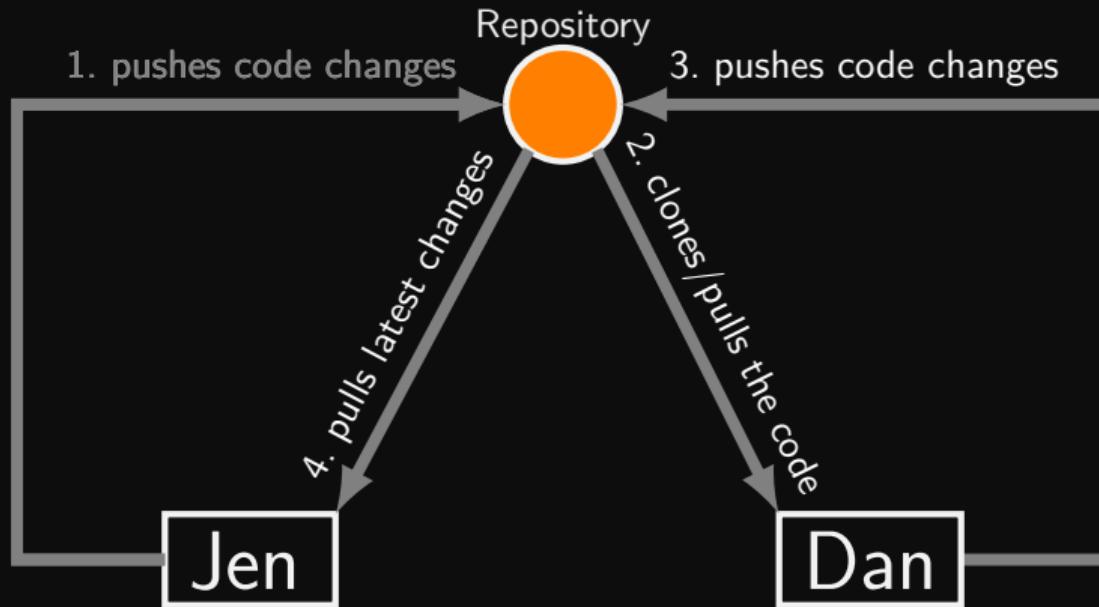
Examples: Git, Mercurial

Seems great and flexible. But people like a central repo for their sanity and for publishing code.

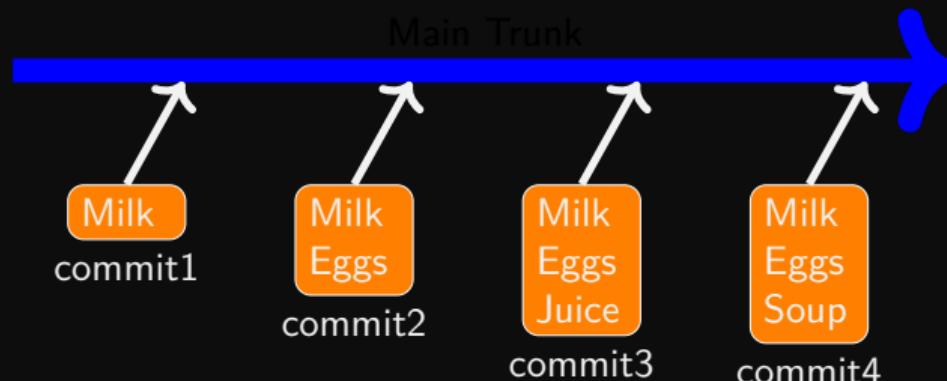
In common

- They are equivalent when you're only working with one, local, repository
- One must be explicit in what file changes are tracked and when versions are committed.
- One can ask for history, and go backwards (and forwards) in time

How does (central) version control work?



Basic Change Commits (Local)

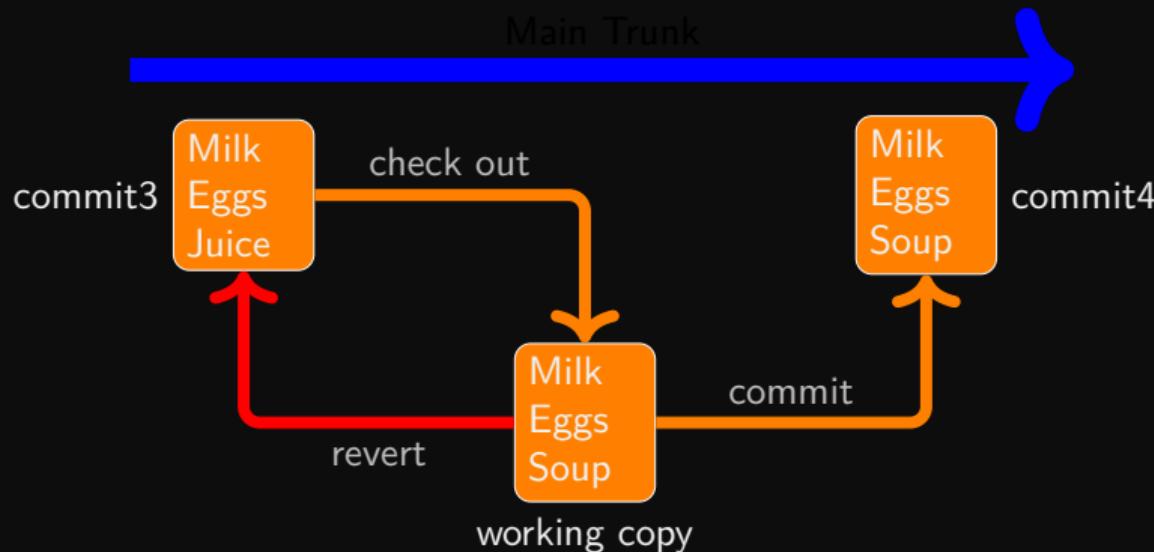


Commits store ***differences*** in the file.

Files that are not changed are not stored again.

Yet commits act as snapshots when you check them out.

Checkout and edit



You do not have direct access to the repo.

Instead, you checkout a working copy.

Once you are happy with your changes in the working copy,
you prepare stage and then apply the commit.

Version control: git

There are many types and approaches to version control.

Here we will introduce one implementation: `git`.

<https://git-scm.com>

There are a few things we will cover in order to get started with git:

- ① How to get git;
- ② How to initialize a git repository;
- ③ How to select files to be committed;
- ④ How to commit them to the repository;
- ⑤ The difference between the repo and working copies;
- ⑥ How to roll back to an older version;
- ⑦ How to inspect an older version;
- ⑧ How to delete files from the repository;
- ⑨ Where to find more information.



1. First things first: getting git

- Linux Desktop
 - ▶ `sudo dnf/.../apt-get install git`
- MacOS
 - ▶ Xcode
 - ▶ fink/macports/homebrew
 - ▶ git OSX installer
- Windows (MobaXterm)
 - ▶ MobaXterm: `apt-get install git`
 - ▶ <https://gitforwindows.org>
- SciNet clusters (Teach, Trillium, ...)
 - ▶ Git is already installed.



2. Setup your git identity

The first time you use git, it complains if it can't identify who you are!

Best to set **identify your global self** to git:

```
$ git config --global user.email "rzon@scinet.utoronto.ca"  
$ git config --global user.name "Ramses van Zon"
```

Then git will mark any commits you make with your user name and email.

You can also set other preferences, e.g.

```
$ git config --global init.defaultBranch main
```

This ensures any initial branch will be called 'main' (instead of the default 'master').



2. Create a local git repository

The first thing to do is [initialize a repository](#) for your code.

```
$ mkdir code # if there is no code yet  
  
$ cd code  
  
$ git init --initial-branch main # creates a repository for this directory, in the 'main' branch  
Initialized empty Git repository in /home/.../code/.git/
```

This created a [.git](#) directory in the current directory.

[.git](#) **is** your [local repository](#) (currently empty).

The current directory contains the [working copy](#) (currently empty even if there are files in it) .

Note: You cannot see the .git directory with ls unless you give the -a option, i.e.

```
$ ls -a  
. . . .git  
$
```

Adding and committing to a git repo

3. Adding files to the repository

You have to **add** files to the hidden *staging area*:

```
$ echo "some data" > file1.txt
$ cp file1.txt file2.txt
$ cp file1.txt file3.txt
$ ls
file1.txt file2.txt file3.txt

$ git add file1.txt file2.txt # leave out file3.txt for now
```

4. Commiting to the repo

```
$ git commit -m "First commit for my repository"
[main (root-commit) dd9d139] First commit for my repository
 2 files changed, 2 insertions(+)
 create mode 100644 file1.txt
 create mode 100644 file2.txt
```

Note: The working directory is not automatically tracked!

5. Comparing working files with the repo copy

Let's update some data and see how can we compare it with the already committed files...

```
$ echo "some more data" >> file1.txt
```

```
$ git diff file1.txt
diff --git a/file1.txt b/file1.txt
index 4268632..fdd9353 100644
--- a/file1.txt
+++ b/file1.txt
@@ -1 +1,2 @@
 some data
+some more data
```

We're satisfied and want to add this change:

```
$ git add file1.txt
$ git commit -m "updating data due to ..."
```

Files already in the repo are “tracked” and we can commit the changes with one command:

```
$ git commit -a -m "updating data due to ..."
```

Always add a descriptive message!(the examples above are bad!)

Git status report

Review what has been done in the repo: `git log`



```
$ git log
commit b0292f6e3a820856f1d29b5aee2acdc4fd9e73c9 (HEAD -> main)
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:50:01 2022 -0500
```

updating data due to ...

```
commit dd9d13999ac5073089e6ea4282b0c78854256bc1
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:49:02 2022 -0500
```

First commit for my repository

Detailed git status report

Detailed review what has been done: `git log --stat`



Commits are in **reverse** chronological order.

Each commit has a hexadecimal hash.

b0292f6e3a820856f1d29b5aee2acdc4
dd9d13999ac5073089e6ea4282b0c78

```
$ git log --stat
commit b0292f6e3a820856f1d29b5aee2acdc4fd9e73c9 (HEAD -> main)
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:50:01 2022 -0500
```

 updating data due to ...

```
file1.txt | 1 +
1 file changed, 1 insertion(+)
```

```
commit dd9d13999ac5073089e6ea4282b0c78854256bc1
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:49:02 2022 -0500
```

 First commit for my repository

```
file1.txt | 1 +
file2.txt | 1 +
2 files changed, 2 insertions(+)
```

Git working and staging area status

To check the status of files in the working and staging area, use



```
$ git status
On branch main
Untracked files:
  (use "git add <file>..." to include in what will be committed)
    file3.txt

nothing added to commit but untracked files present (use "git add" to include them)
```

Kowalski, status report

Look what happens if we add a file

```
$ git add file3.txt
$ git status
On branch main
Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
    new file:   file3.txt
```

6. Rollback

If you have edited files but something broke and you have not yet committed, you can bring the working copy back to the most recent commit:

```
$ git reset --hard
```

Rolling back to a specific previous version, you can be done with a [hard reset](#):

```
$ git reset dd9d13999ac5073089e6ea4282b0c78854256bc1 --hard
```

This erases the part of the history after dd9d13999ac5073089e6ea4282b0c78854256bc1!

To go to the previous version in the repo:

```
$ git reset HEAD^ --hard
```

HEAD is the last commit in the history, HEAD[^] the one before that, HEAD^{^^} the one before that etc.

Without the --hard option, only the repo in .git is updated, but the files in the working directory would not have been restored.

Note: Actually all the commits are still there in the repo, but without references to it, so they are effectively gone (and eventually deleted).

Reverting changes – Reset, Checkout, and Revert

```
git reset <Commit>          # Throw away changes after Commit (consider '--hard')
git restore --staged <file> # Unstage a file i.e. undo an 'add'
git checkout <Commit>        # Inspect old commit
git checkout <Branch>        # Switch between branches
git checkout <File>          # Discard changes in the working directory
git revert <Commit>          # Create a new commit that undoes the given commit
```

By the way: nobody pretends git command are intuitive.

7. Inspecting a specific previous version

To look at a previous commit temporarily, use the commit hash and do

```
$ git checkout dd9d13999ac5073089e6ea4282b0c78854256bc1
```

This does not update the main branch. To continue working on the main branch, do:

```
$ git checkout main
```

8. Removing repository files

Let's look at what we've done so far.

```
# git log
commit b0292f6e3a820856f1d29b5aee2acdc4fd9e73c9 (HEAD -> main)
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:50:01 2022 -0500
        updating data due to ...

commit dd9d13999ac5073089e6ea4282b0c78854256bc1
Author: Ramses van Zon <rzon@scinet.utoronto.ca>
Date:   Thu Jan 27 09:49:02 2022 -0500
        First commit for my repository
$
```

If you want to delete a file in the working copy and the repo, use `git rm`:

```
$ git rm file2.txt # let git do it!
$ git commit -m "Remove file2.txt"
[main f1af560] removed file2.txt
 1 file changed, 1 deletion(-)
 delete mode 100644 file2.txt
$
```

9. Tips and more information on git

- Commit often.
- Include sensible commit messages.
- It's easy to forget to add files, check with "git status".
- Do not commit log files, executables, object files, etc..

Self-paced course

- <https://scinet.courses/1382>

Tutorials

- <https://www.vogella.com/tutorials/Git/article.html>
- <https://www.atlassian.com/git/tutorials>

Remote repositories

Remote repositories

- Git is a distributed version control system.
- You can **clone** a repo anywhere to copy it elsewhere.
- Each clone is a full-fledged repo with full history.
- You can **push** and **pull** the state of one repo to another.
- You do not have to have one centralized, authoritative repo, but often, that is still convenient.
- Clones can live on remote computers or in the cloud (e.g. github, gitlab)
- Git can interact with remote repos using ssh (as well in other ways).
- Remote repos often don't need a working directory, they can be **bare** .git repos.

Remote repositories: Clone, pull, push

➊ Setup a remote repo on a cluster

```
local> ssh USERNAME@teach.scinet.utoronto.ca
teach> mkdir repo
teach> cd repo
teach> git init --initial-branch main
teach> git config receive.denyCurrentBranch updateInstead
teach> echo "hello" > world.txt
teach> git add world.txt
teach> git commit -m 'hello world'
teach> exit
```

➋ Clone it on your local computer:

```
local> git clone USERNAME@teach.scinet.utoronto.ca:repo
local> cd repo
local> echo "more" >> file1.txt
local> echo "most" >> file2.txt
local> git add file1.txt file2.txt
local> git commit -m "Added files"
```

➌ Update the repo in teach:

```
local> git push -u origin main
```

Check:

```
local> ssh USR@teach.scinet.utoronto.ca
teach> cd repo
teach> git reset --hard
teach> ls
world.txt file1.txt file2.txt
```

➍ Make changes on teach

```
teach> echo "even more data" >> file1.txt
teach> git add file1.txt
teach> git commit -m 'More data added'
```

➎ Update repo locally:

```
local> git pull
```