Git & friends

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UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA
High Performance Real Time Lab


They call me 007
0 LINES ADDED
0 LINES MODIFIED
7 MERGE CONFLICTS

What is a version control?

A system that keeps records of your changes

› Allows you to revert any changes and go back to a previous state

Enables collaborative development

› Allows you to know who made what changes and when (with a bug…)

…but not only this!!

› Forces you to follow well-known development flows
  – (Ever heard of DevOps?)
› Provides a set of tools to automate testing, integration and deployment
  – (Ever heard of CI/CD?)
› Provides an easy way to write documentation

Ultimately, let you focus on coding, coding, coding, removing all of (what programmers think is) clutter!

Git

- "Widestly" adopted version control
- Based on distributed repositories
- Created by Linus Torvalds to support Linux kernel development, in 2005

git LISTEN: US

UK:* /ˈgɪt/ US: (git)

definizione | Sinonimi inglesi | in spagnolo | in francese | Coniugatore [IT] | Conjugator [EN] | nel contesto | immagini

WordReference English-Italiano Dictionary © 2022:

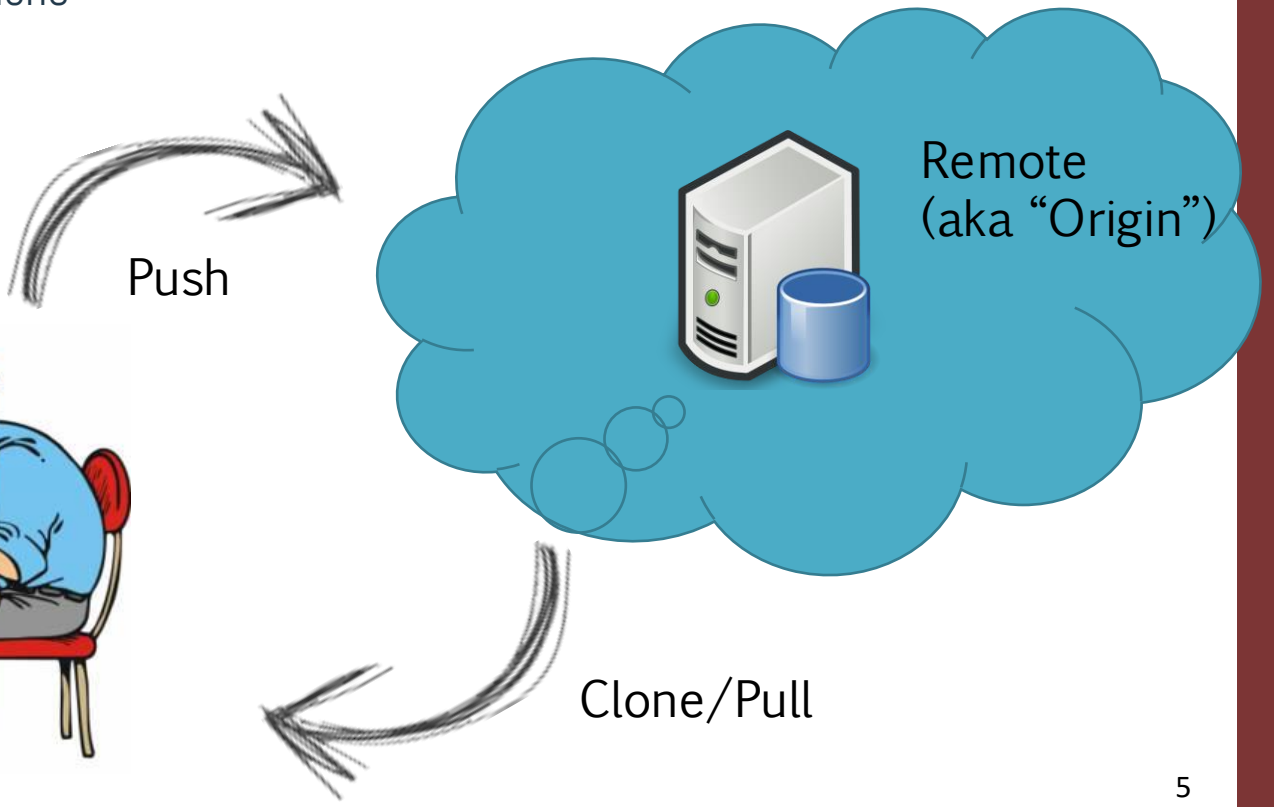
Principal Translations/Traduzioni principali

Inglese		Italiano
git *n*	*UK, pejorative, slang* (contemptible man)	cretino, idiota, scemo *nm* (*colloquiale, offensivo*)
	George is such a git!	

Step 1: let's start simple

"Somewhere"/"on cloud" there is a remote repository with your codebase (called "origin")

- Users clone this repo on their local machine
- …keep their local copy updated by pulling recent changes from the remote
- And push their modifications



https://github.com

The most famous public git repo service

- Free version + payment version
- Acquired by BigM in 2016 (tbc)
- Web console to access

Why do we use this?

- Preview for slides, past exams, code…
- Issues!! You now are a team!
- Let's set up an account

Why GitHub?

- And not, for instance, GitLab.com?
- …or HiPeRT's on-premise GitLab?

Local tools

Baseline: command line tool

- Comes with most of the GNU/Linux distros
- (You can always “apt” it)

Under Win, multiple options

- https://git-scm.com/ - also, with (very ugly) UI
- Use WSL
- Powershell?

Integrated in most commonly used IDEs

- .but, soon, we'll only work on web tools

Let's start!

Do the following

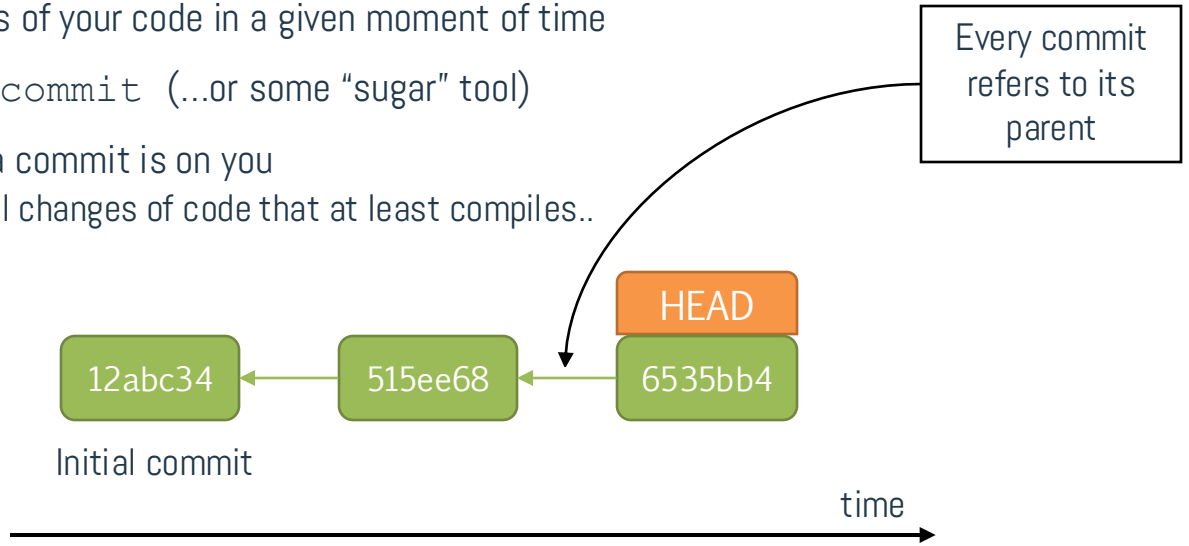
- Create a GitHub account
- Navigate to HiPeRT Lab's page
  - https://github.com/HiPeRT
  - https://github.com/pburgio for older stuff
- Clone the repo
  - We will use git over https, but there are also other protocols

```
$ git clone https://<URL>
```

Basic workflow

A project is a sequence of commits

- They are snapshots of your code in a given moment of time
- Create with `git commit` (...or some "sugar" tool)
- The granularity of a commit is on you
  - Typically, small changes of code that at least compiles..



Commits track incremental changes! (`git diff`)

- Every commit is identified by a hashcode, and has a parent
- Most recent (...) comit is also called HEAD
- It is **mandatory** to add a comment to every commit

`$ git log` to see all information

The git flow

Working with commits

› Before committing, files must be added to the staging area

```
$ git add <file> <file> && git commit
```

..or...

```
$ git commit -a
```

To check the status of your staging area and commits

```
$ git status
```

Watch out

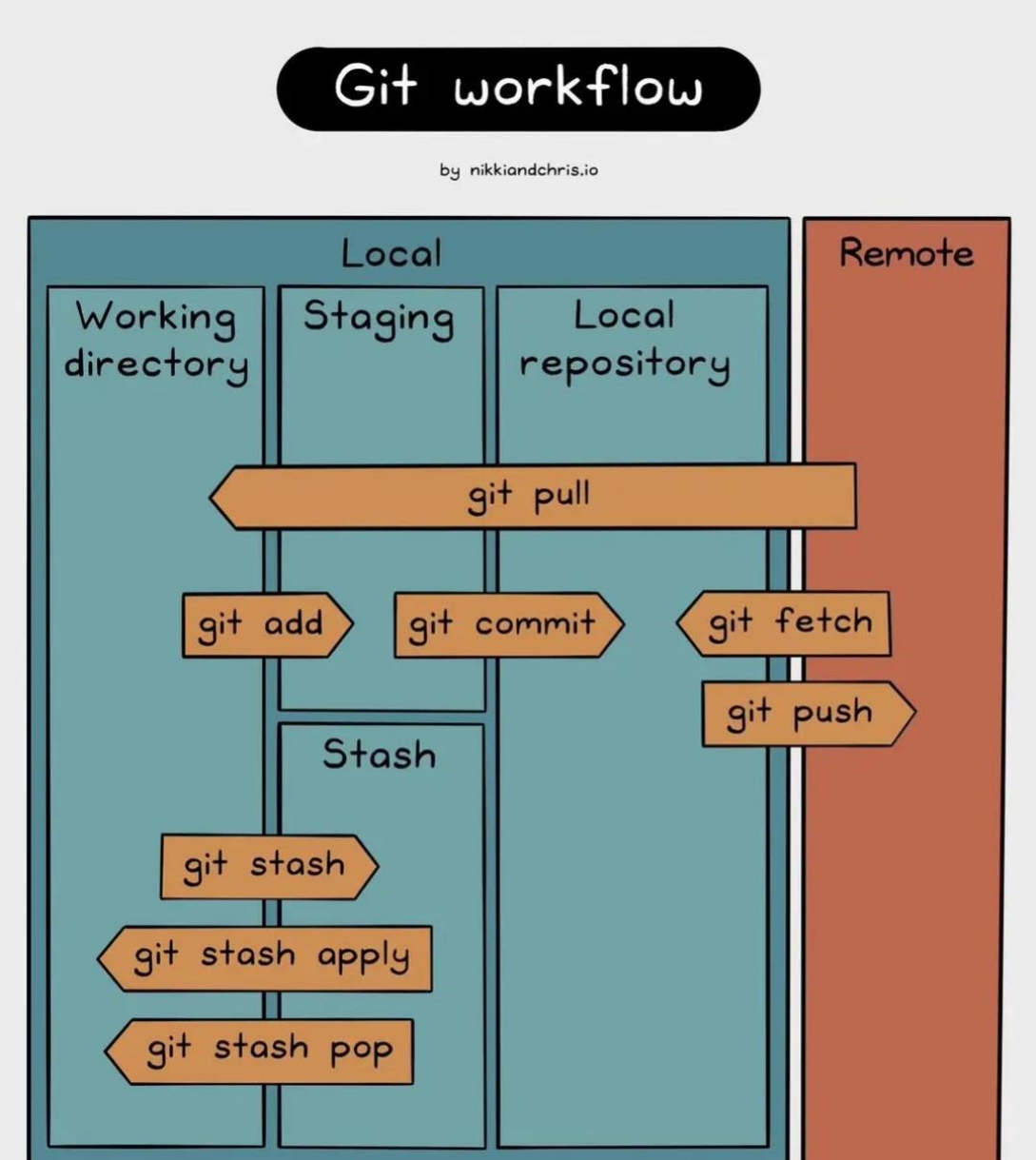
› `-a` options does not apply to new files

› Empty folders are never added by git

› You can always amend a previous commit, if you forgot to add something

```
$ git commit --amend
```

The git flow (cont'd)



The git flow (cont'd)

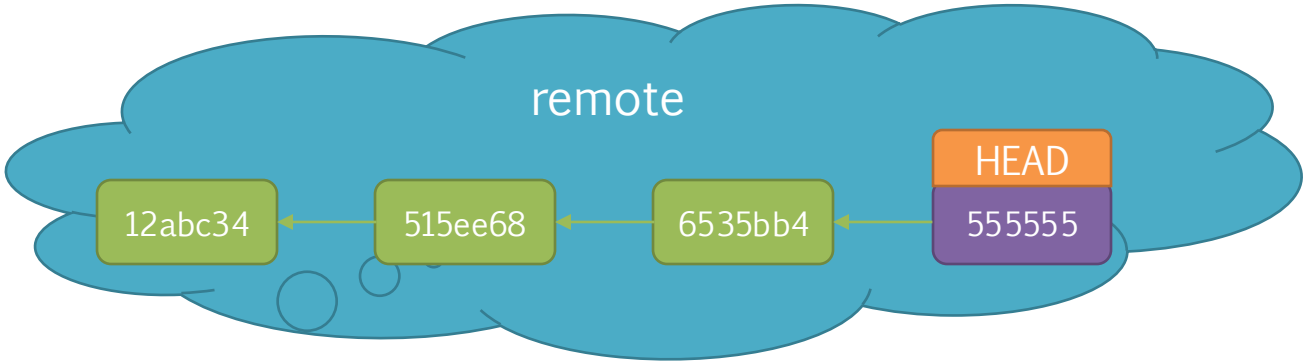
- You can remove/delete files
- Renaming files means deleting + adding

When you're done, transfer files to the remote repo by

```
$ git push [origin] [master]
```

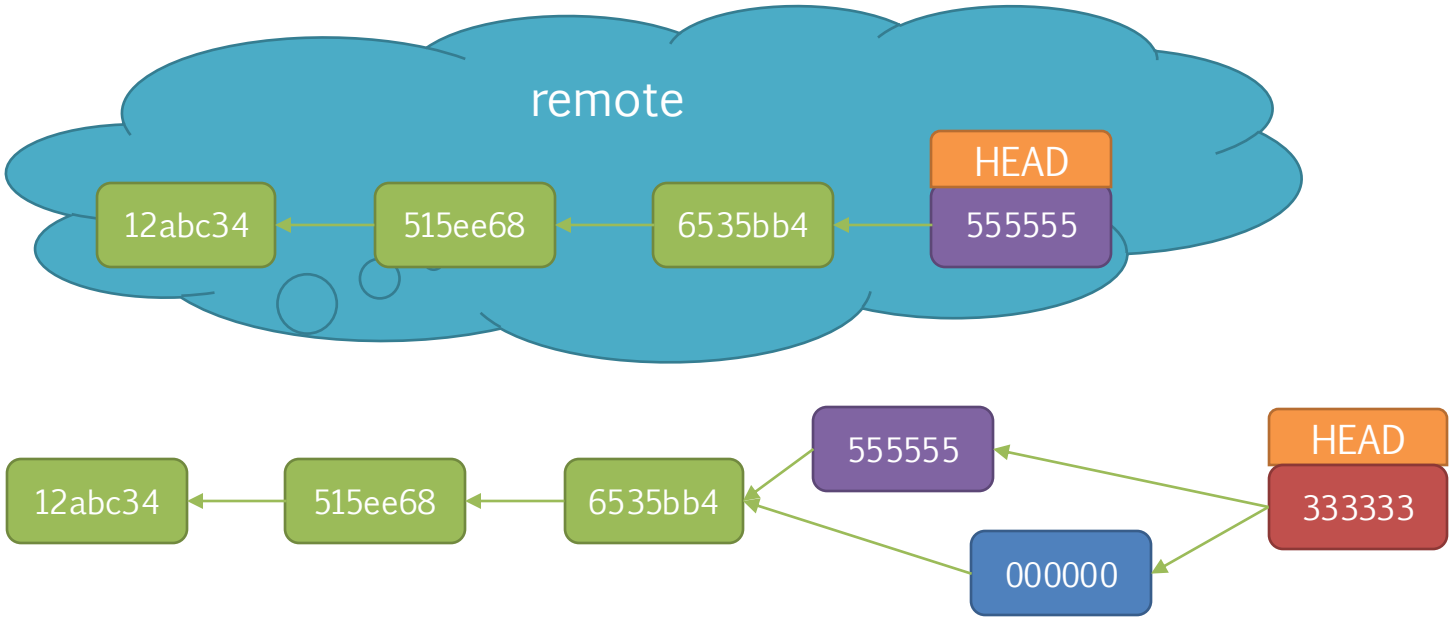
Always make sure you have the latest version!

```
$ git pull [origin] [master]
```



Pulling and auto-merging

- Based on the actual time of commit, local history is updated
- The local codebase is automatically updated (aka: files are merged), including modifications both from local and remote
- A new commit is created



Let's assume this is the most recent of the two

Merge…and conflicts

- It is extremely easy to mess things up, if codebases are significantly different!!!
- Git works at the code line level
  - What if we modify the same code line?
  - Some modern systems track also single words

If there are merge conflicts, the local repo stays in conflicting state

- Until you solve the conflicts locally, and manually merge them
  - Easier if you do it on IDEs
  - Using appropriate flags in the checkout command

Tips & tricks

- Frequently pull changes
- Always make sure your code works by re-running the testing automation
- Create small commits, "packed" by "working area" (ex: one for the code, one for the makefiles, one for the scripts…)
  - This also forces you to keep the workspace clean and well structured!!

Useful commands

Checkout and (hard or soft) reset

› To unstage/delete local modifications and/or commits

Revert

› To switch back to a specific commit

Cherry-pick

› Commits are incremental. They simply trace the difference against parent commit

› You can apply a commit/difference also to any other commit (not only parent)

› By cherry-picking

The history of my project

A typical sw project is structured in quite a rigid way

- A main branch ("master"), containing the latest released version (with full commit history)
- Multiple branches that correspond to specific works/subprojects
- You have total freedom on branches. Company-specific rules apply here
  - "develop", "bugfix/", "hotfix/", "features/", "pb_<SOMETHING>" (initials of the developer)

Once a project is started, you might **never** push onto the master branch

- You typically fork the master, or the "Development" branch, and then issue a pull request
- Which is served by the repo Maintainer
  - Typically a sadist, with very limited empathy and sense of humour
  - Sysadmins are good candidates for this role
- There are access rules and user roles, both at the org and repo level, and also at the branch level, etc

Torvalds is a nice person....

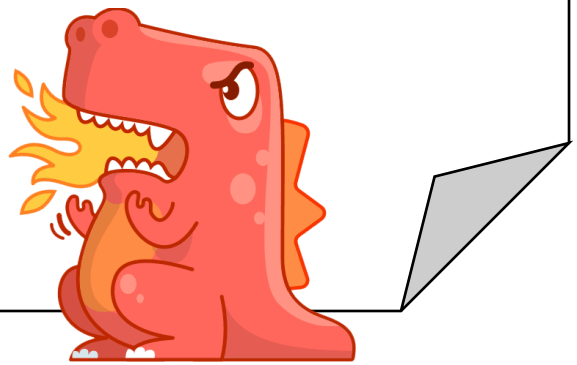
On Sun, Sep 18, 2011 at 1:35 PM, Eric Dumazet <eric.dumazet@gmail.com> wrote:
> [PATCH] tcp: fix build error if !CONFIG_SYN_COOKIE
> commit 946cedccbd7387 (tcp: Change possible SYN flooding
> messages) added a build error if CONFIG_SYN_COOKIE=n

Christ Eric, you clearly didn't even compile-test this one either.
Which is pretty bad, considering that the whole and only *point* of the patch is to make it compile.
The config option is CONFIG_SYN_COOKIES (with an 'S' at the end), but your patch has 'CONFIG_SYN_COOKIE' (without the S).
Which means that now it doesn't compile when syncookies are *enabled*.
I really wanted to release -rc7 today. But no way am I applying these kinds of totally untested patches. Can you guys please get your act Together?

PLEASE?

Stop with the "this might just work" crap. Because -rc7 is just too late to dick around like that.

Linus



...sometimes he really is

```
On Thu, Aug 25, 2011 at 1:21 PM, Arnaud Lacombe
<lacombar@gmail.com> wrote:
> On Thu, Aug 25, 2011 at 4:10 PM, Andy Lutomirski
<luto@mit.edu> wrote:
>>
>> Arnaud, can you test this?
>>
> All good.
>
> Tested-by: Arnaud Lacombe <lacombar@gmail.com>
```

Thanks guys. Applied and pushed out,

Linus

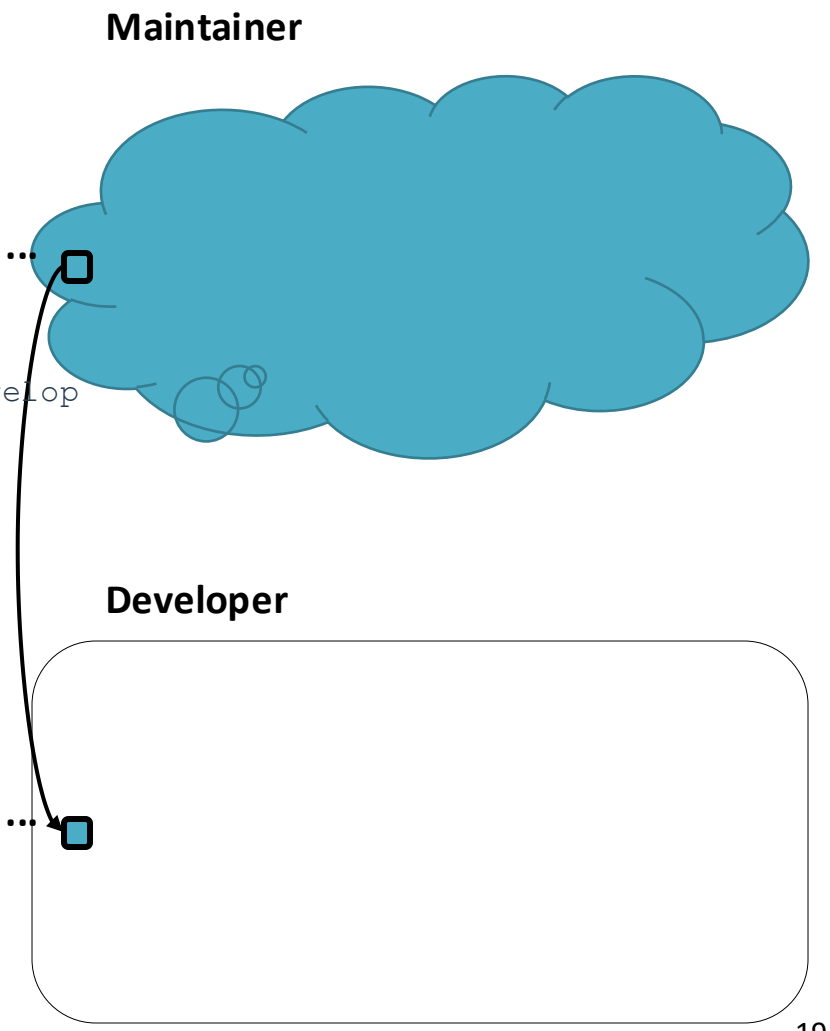
What typically happens…

- Developers clone a branch from an updated repo
  - Typically, you clone Master, or Develop
- Anyway: your starting point

```
$ git clone <SOME_URL>

$ git checkout Develop # Assume it exists

$ git branch MY_LOCAL # Create from the Develop
branch

$ git branch -l # To check

$ git checkout MY_LOCAL # Switch to it
```

You can also do all of these together

```
$ git checkout -b MY_LOCAL
```



Master, or Develop branch

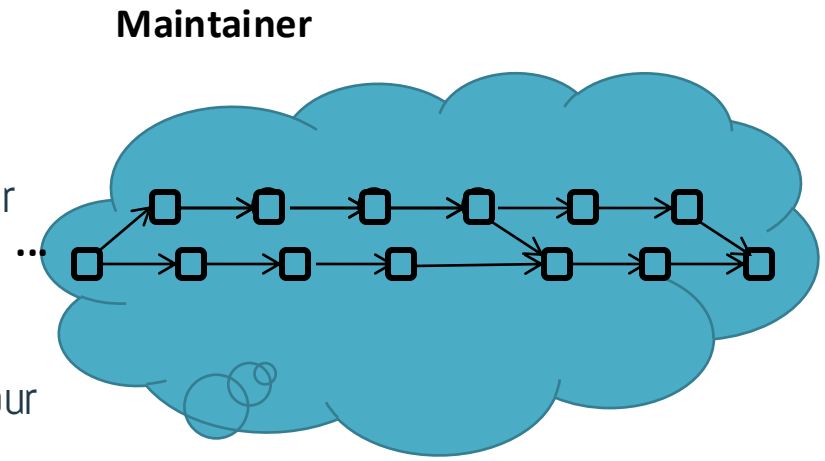
MY_LOCAL branch

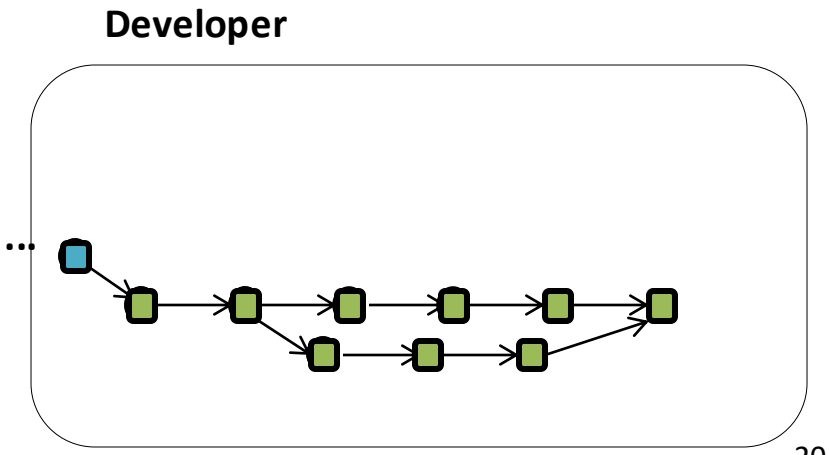
What typically happens…

- Developer starts his work, producing new commits
- In a local branch
- Similarly, remote repo gets some updates for some reason

(You can push your local branch to back up your work on the cloud)

```
$ git push origin MY_LOCAL
```





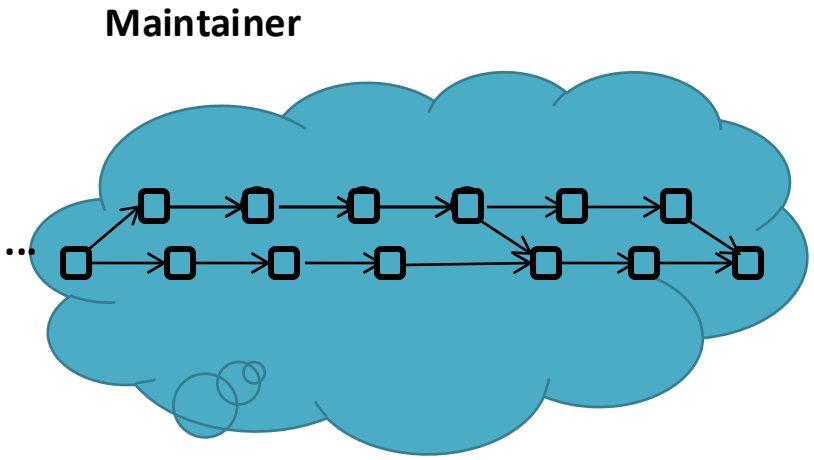
Develop branch

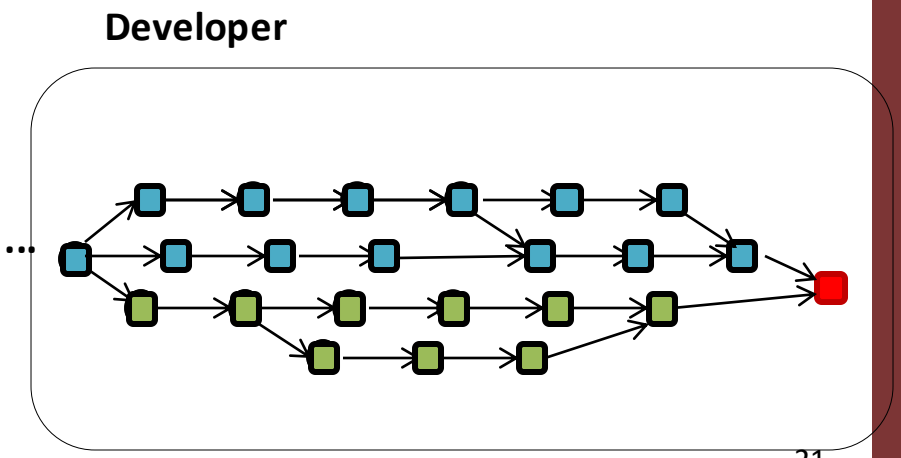
MY_LOCAL branch

What typically happens…

- When developer is ready, he pulls to update with whatever is in the cloud
- He's in charge of "making his commits consistent" with the whole story
- This implies re-testing the whole thing!!

```
$ git pull origin Develop

$ git merge Develop
```





Develop branch

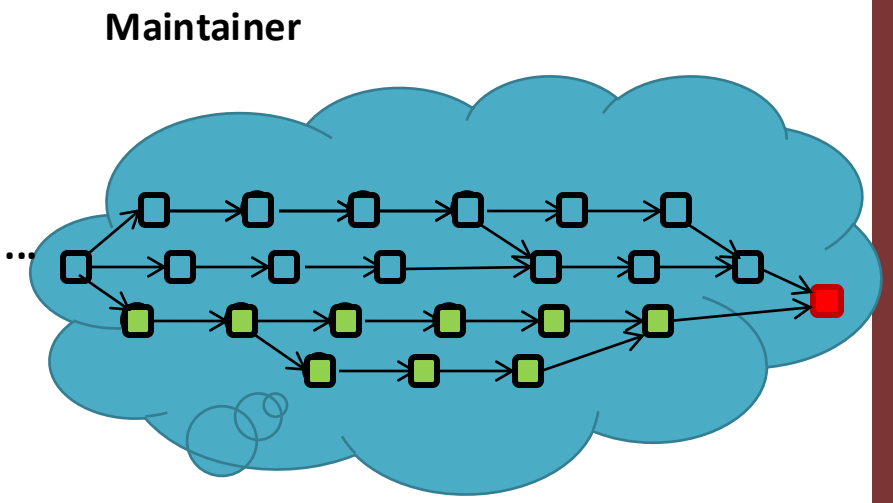
MY_LOCAL branch

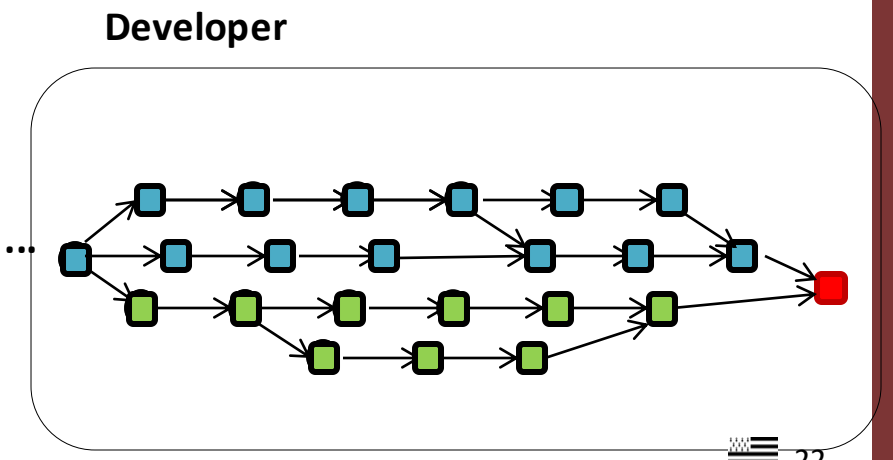
What typically happens…

- After the merge is done, the "final commit" is created
- And then we can push on the cloud
- And issue a pull request
  - By email, or by automated tools

```
$ git push origin MY_LOCAL
```

(Remember, you cannot push Master)



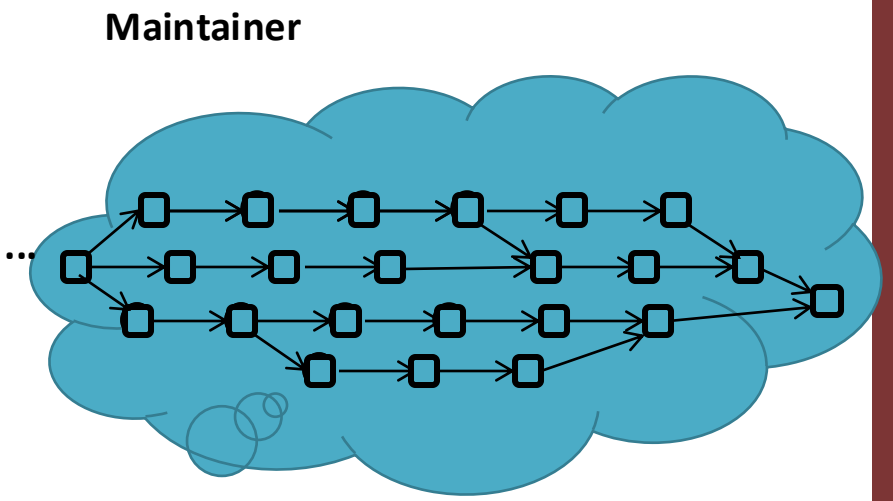


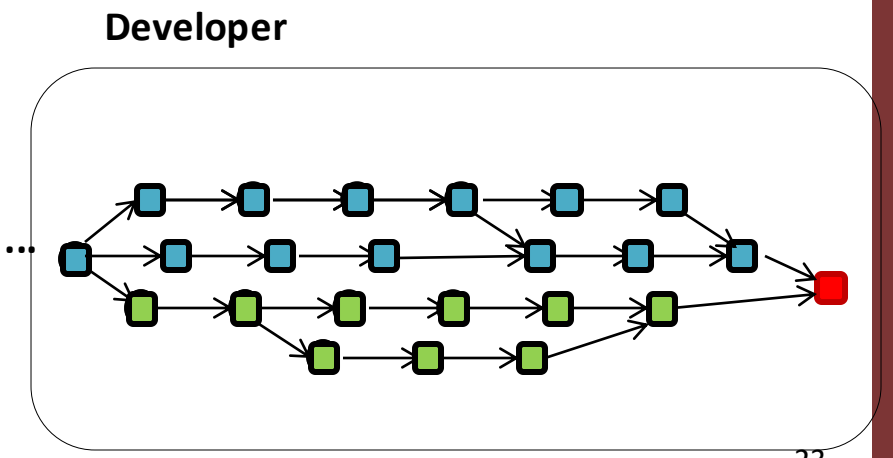
Develop branch

MY_LOCAL branch

What typically happens…

- Request is accepted, and modifications apply to the Develop branch
- Hopefully



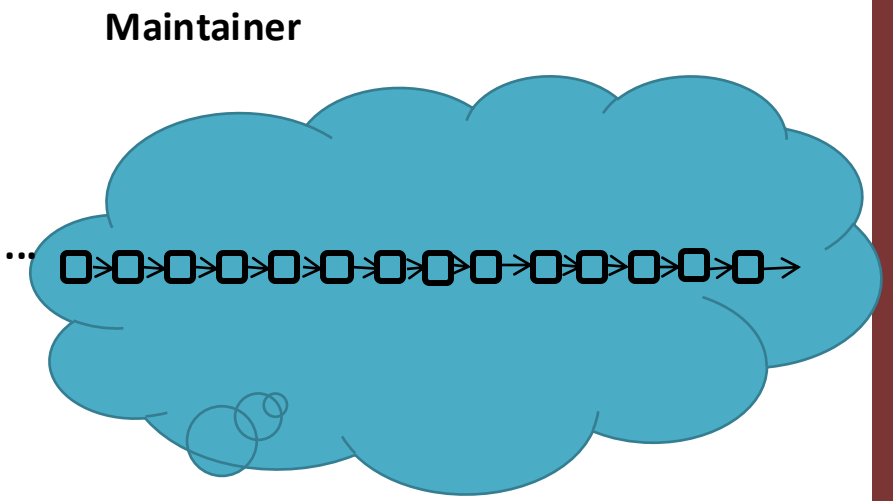


Develop branch

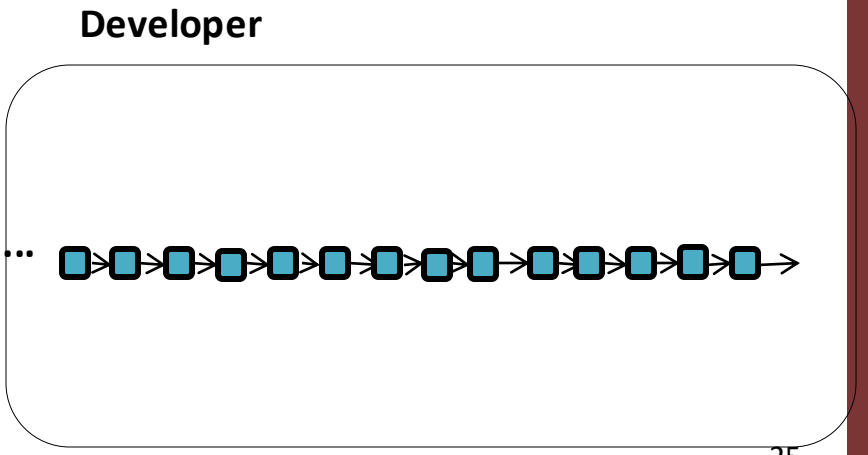
MY_LOCAL branch

What typically happens…

- Typically, the "other" branch is then deleted remotely by mantainer
- The story is now consistent, and a "unique" timeline exist
- We need to pull the Develop branch one more time, to make my local copy consistent (and delete local branch)




```
$ git pull origin Develop
$ git branch –d[D] MY_LOCAL
```



Develop branch

MY_LOCAL branch

Advanced features

Ignore files

Some folders and files are not useful for your projects!

- `.vscode`
- ROS2: `install/ build/ log/` ...

So, why adding them to the repo?

Add `.gitignore` file in your repo (or in some subfolder)..

- Specify files to ignore
- Can use wildcards
- Comments start with **#**

```
# Ignore VSCode local configurations
.vscode/*

# Ignore ROS2 temp folders
install/*
logs/*
build/*

# Ignore specific file
i_love_maneskin.txt
```

Remember to commit your `.gitignore` file!

Submodules

You can include a git repo as part of another git repo!

› Mantainability, scalability, etc…

Syntax

› ..from the folder where you want to include…

› `$ git submodule add <REPO-URL>`

› It will create a `.gitmodules` file in the root folder

```
[submodule "my_module"]
          path = src/my_module
          url = https://github.com/something/my_module.git
```

Where:

› `url` can also be relative

› You will also need to commit the `.gitmodules` file

› Update with `$ git submodules update –init --recursive`

Verifying your identity

You might have noticed that on first commit, Git requested you to set your identity, locally

› By "simply" setting a global, **unchecked**, name/email tuple

```
$ git commit -m "my first commit"
Author identity unknown

*** Please tell me who you are.

Run

  git config --global user.email "you@example.com"
  git config --global user.name "Your Name"

to set your account's default identity.
Omit --global to set the identity only in this repository.
```

› **PROBLEM**: you can not guarantee the identity of the committer!!

```
pol@polso:/media/pol/DATA/Unimore/Workspace/ProgSW$ git log
commit 76944a4a8516ab6aba1eafc8b8ed594a7b112127 (HEAD -> master, origin/master, origin/HEAD)
Author: Paolo Burgio <paolo.burgio@gmail.com>
Date:   Mon Feb 23 13:02:54 2026 +0100

    Added 00 and 01

commit 5c85984b70972af134a26cd0f6f7cf9278e0b54b
Author: Paolo Burgio <paolo.burgio@gmail.com>
Date:   Mon Feb 23 13:02:45 2026 +0100

    Updated README.md; fix in FAQ.md
```

Digital signature

Use the GNU Privacy Guard (GPG) - https://www.gnupg.org/

Step 1: Generate a signing key

```
$ gpg --gen-key
```

...and check

```
$ gpg --list-keys
/home/pol/.gnupg/pubring.kbx
----------------------------
pub   ed25519 2026-02-25 [SC] [expires: 2029-02-24]
      0123456789ABCDEF
uid           [ultimate] Paolo Burgio <paolo.burgio@gmail.com>
sub   cv25519 2026-02-25 [E] [expires: 2029-02-24]
```

Step 2: Let Git know that you want to sign it with this key

```
$ git config --global user.signingkey 0123456789ABCDEF
```

Digital signature (cont'd)

Step 3: Sign your commits (use the `-S` flag)

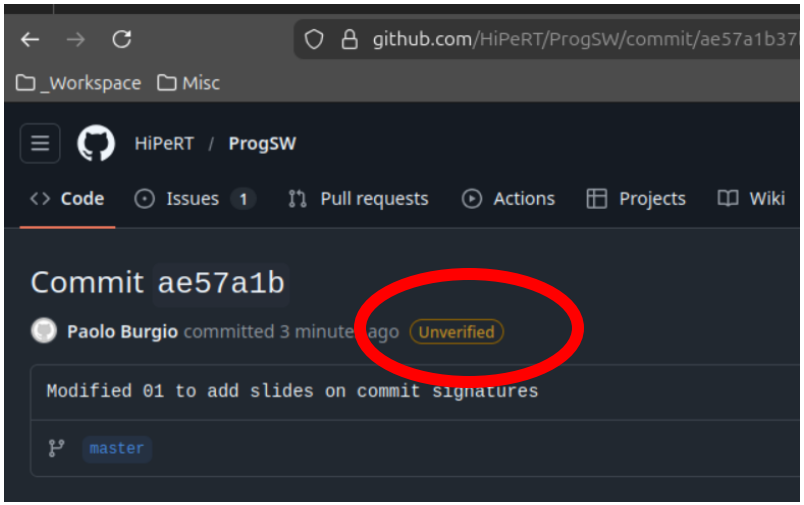
```
$ git commit -S -m 'Modified 01 to add slides on commit signatures'
```

Then you will see a validated commit with `--show-signature` flag to `git log` command

```
pol@polso:/media/pol/DATA/Unimore/Workspace/ProgSW$ git log --show-signature
commit 760b8f793882f21fc3a37f47f15bcba2efd341c5 (HEAD -> master)
gpg: Signature made Wed 25 Feb 2026 10:12:36 AM CET
gpg:                using EDDSA key BFC0E4C47D0CF20DAF25299DE75EC7494789458D
gpg: Good signature from "Paolo Burgio <paolo.burgio@gmail.com>" [ultimate]
Author: Paolo Burgio <paolo.burgio@gmail.com>
Date:   Wed Feb 25 10:12:36 2026 +0100

    Modified 01 to add slides on commit signatures
```

NOTE: GitHub double checks your identity using your email

...but I haven't registered your GPG key in your GitHub account (which matches your email)



Setting up GPG in GitHub

1. First, you need to dump it

```
$ gpg --export --armor paolo.burgio@gmail.com
-----BEGIN PGP PUBLIC KEY BLOCK-----
SOMETHINGSOMETHINGSOMETHINGSOMETHINGSOMETHINGSOMETHING
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SOMETHING
-----END PGP PUBLIC KEY BLOCK-----
```
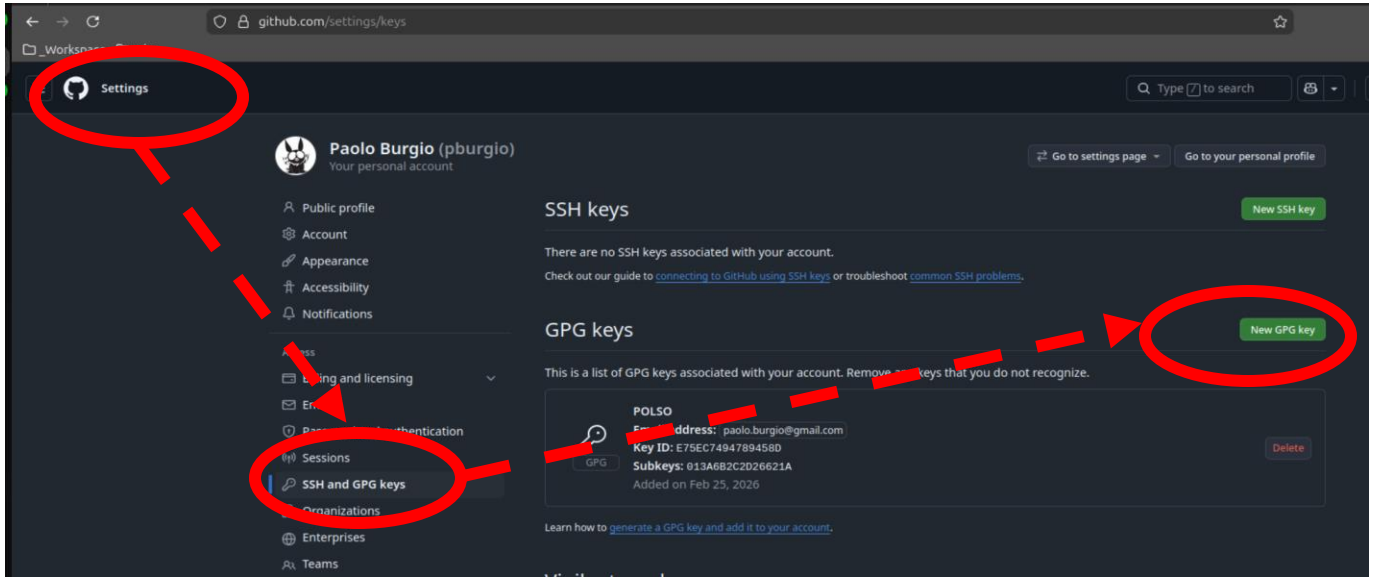
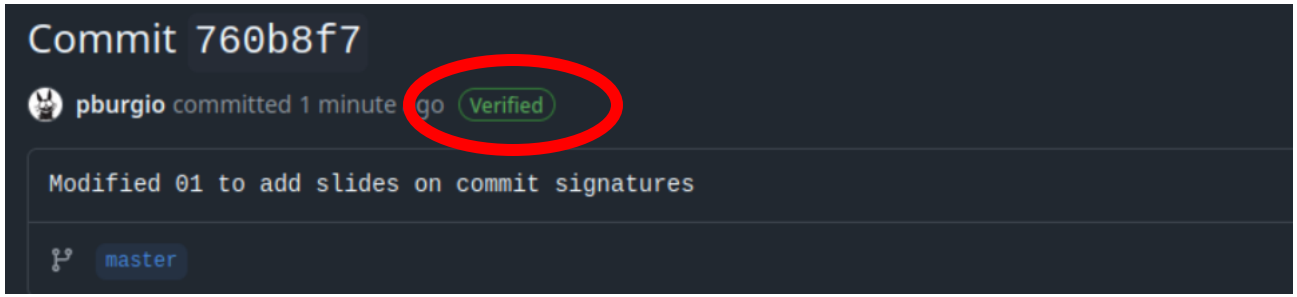

Setting up GPG in GitHub (cont'd)

2. Import it in the GitHub setting page



...and now....



*NOTE: this is GitHub specific!

Multiple repos for release/nitghtly work

You can add as many remote repos you want

- Origin is the one you cloned from
- Typically a *private* one for nightly builds

In Git philosophy, all repos are equal!

- Each of them has a mantainer

Origin (created by default when you clone)

```
$ git remote –v # To list them
$ git remote add <name> <url>
```

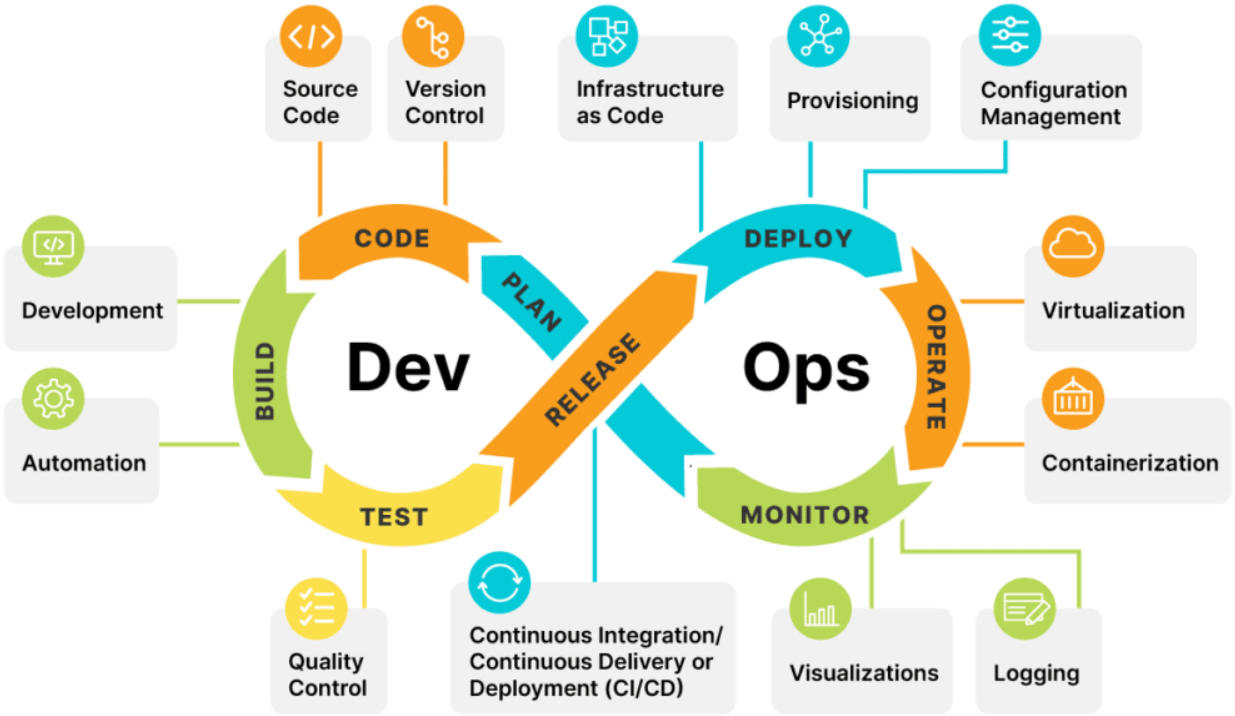
repo1

pburgio

Code like a pro: Continuous Integration, Continuous Deployment

Git enables workflows to automate build, testing, docs...

- Not covered in the course
- ..a seminar, maybe?



https://itbox.id/blog/devops-adalah

References

Course website

- http://hipert.unimore.it/people/paolob/pub/ProgSW/index.html

My contacts

- paolo.burgio@unimore.it
- http://hipert.mat.unimore.it/people/paolob/

Resources

- https://git-scm.com/
- https://docs.github.com