Smart Workflows

How to develop your application

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A paradigm shift

In the last decades the approach to computing has changed, not only because of new technologies, but also in its philosophy.

We often hear about:

- DevOps approach and Continuous Integration (CI)
- Microservices
- Internet of Things (IoT) and the Digital Continuum

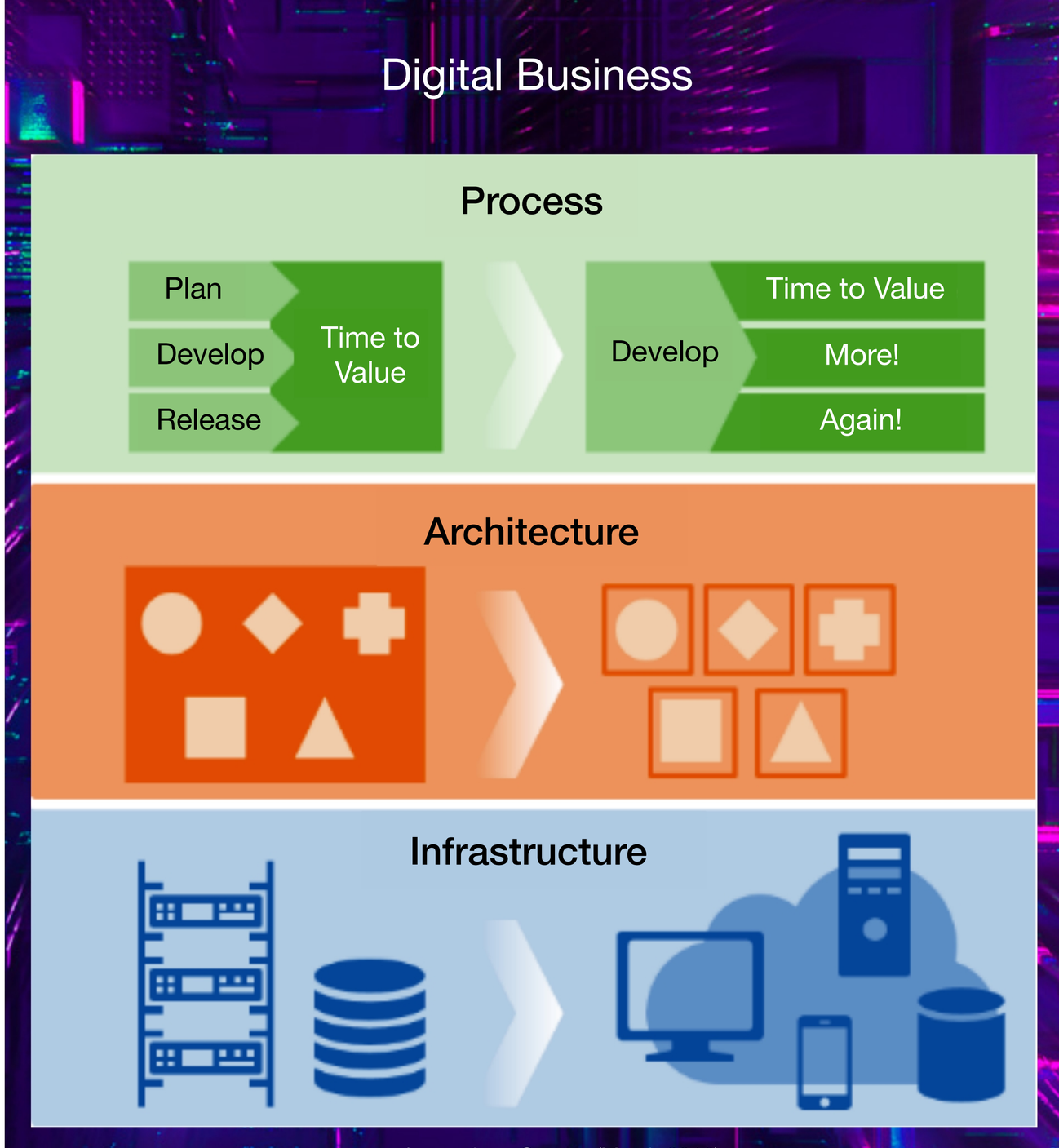


Image from Gartner (March 2016)

Infrastructure

Internet of Things (IoT) and the Digital Continuum

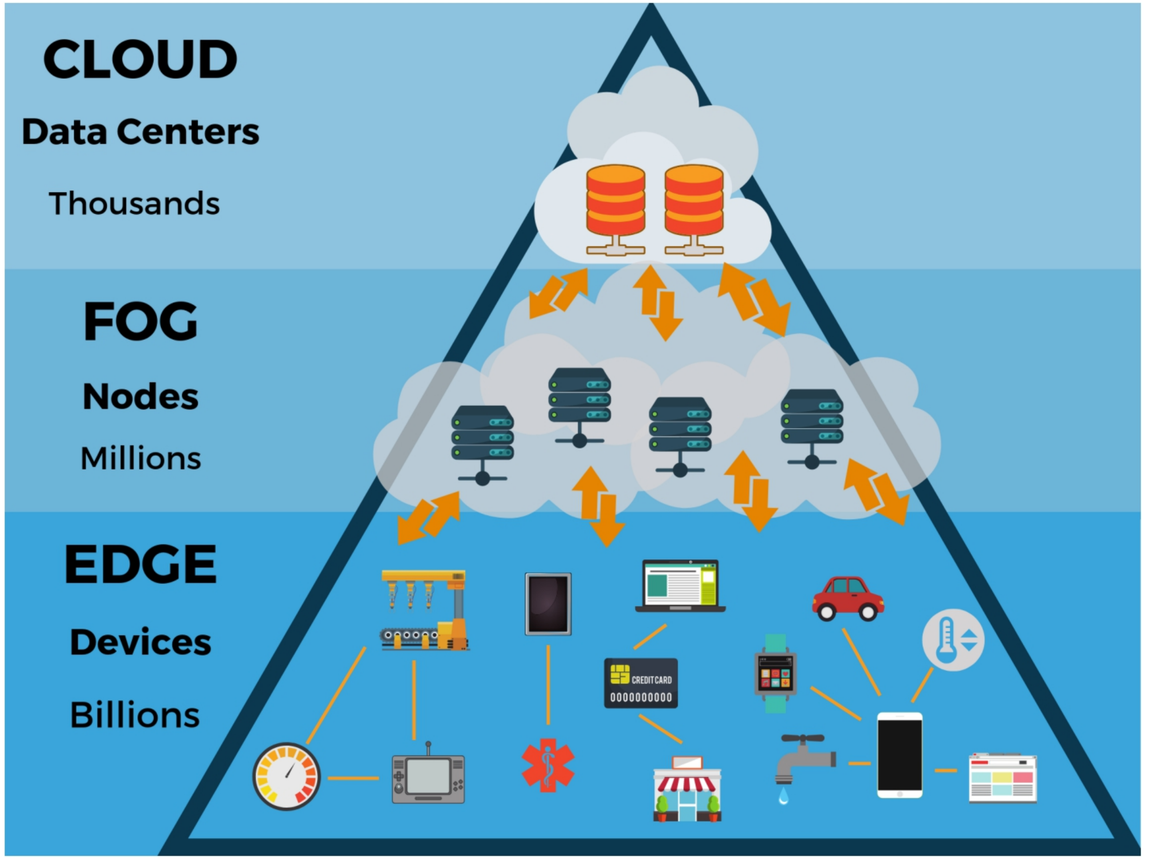
We used to have servers and storage disks…

Now, we still have servers and storage disks, but we also talk about:

- **IoT**, where you generate, store and process data on an amount of objects:

  computers, smartphones, sensors, the washing machine…

- **Digital Continuum**: a design space that creates continuity between elements that exist separately, with the goal to transform data into information as soon as possible.



Centralised processing

Decentralised pre-processing

Heterogeneous data from smart sensors

Architecture

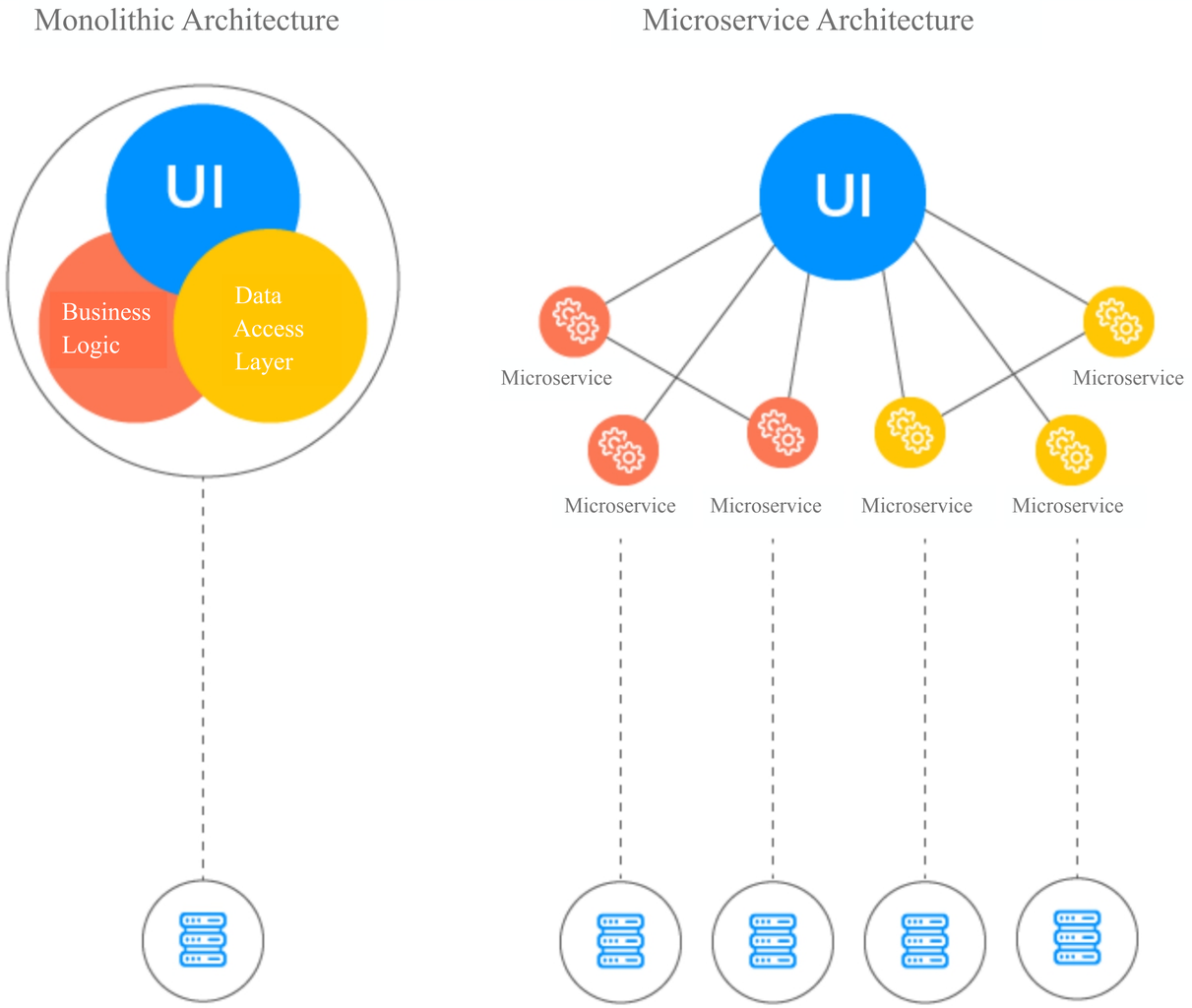
Microservices

The way people structure a complex stack of computing applications has changed.

- **Monolithic architecture:** several “programs” installed on a server. Difficult to understand dependencies, do updates, re-use work done.

- **Microservices:** Service Oriented Architecture (SOA) that structures an application as a collection of loosely coupled services.

    - Makes the application easier to understand, develop and test.
    - Parallelises development.
    - Orchestration layer needed to coordinate operations.



Process

Time to Value

Time to value: from the original idea to have a product available for other people to use or to produce a scientific result.

Before: I have an idea, I write code, I release.

Now: keep time to value as short as possible. Make a change available whenever it is ready and tested, with the possibility to rollback.

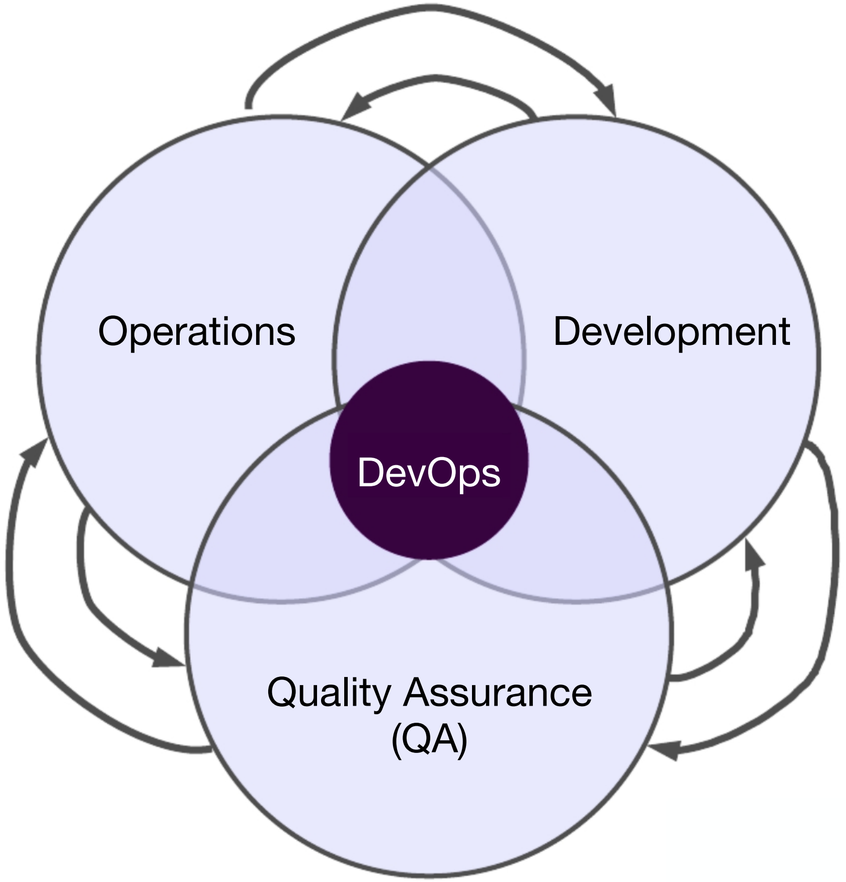
Process

DevOps approach

- DevOps (Development and Operations) is a philosophy and practice focused on agility, collaboration, and automation within IT and development team processes.

- The goal is to **bridge the gap between IT operations and development** to improve communication and collaboration, create more seamless processes, and align strategy and objectives for faster and more efficient delivery.

- **DevOps philosophy principles:**
    - Automation
    - Iteration
    - Self-service
    - Continuous improvement
    - Collaboration
    - Continuous testing

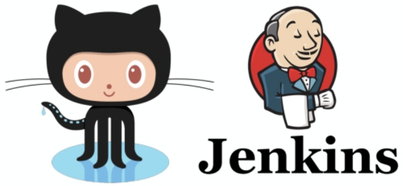


Process

Continuous Integration, Delivery and Deployment

Continuous Integration (CI):

- a software development practice in which developers regularly merge their code changes into a shared repository where those updates are automatically tested
- ensures that the most up-to-date and validated code is always readily available to developers.



Continuous Delivery:

- code changes are automatically built, tested, and packaged for release into production.

Continuous Deployment:

- every validated change is automatically released to users.

Continuous Monitoring and Feedback.

GitHub

Git

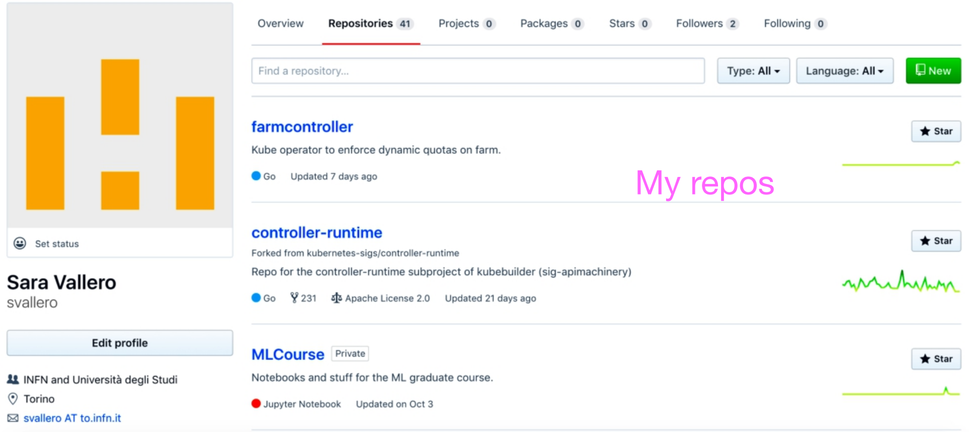
A Version Control System:

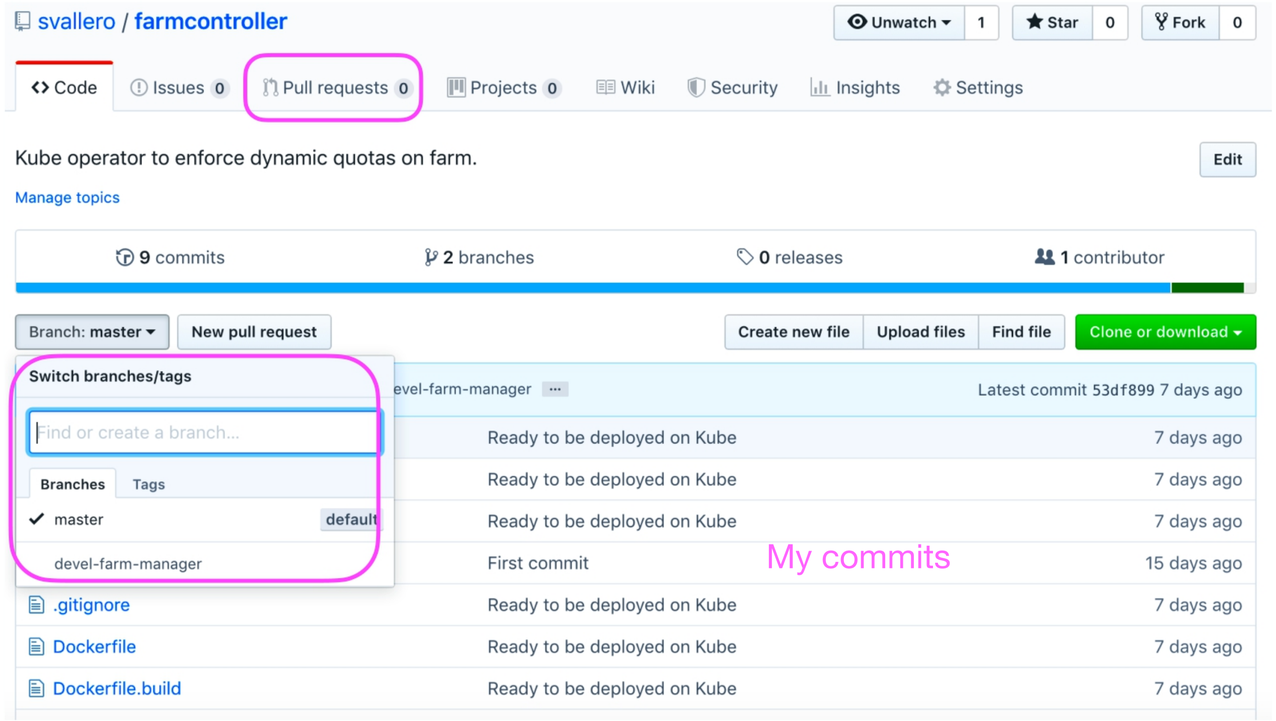
- You make constant changes to the code, releasing new versions
- Keep the revisions straight, storing modifications in a central repository
- Make it easy to collaborate: download/upload new revisions
- Efficient storage of f ile changes
- File integrity checks

The Hub (GitHub)

A Web Platform to:

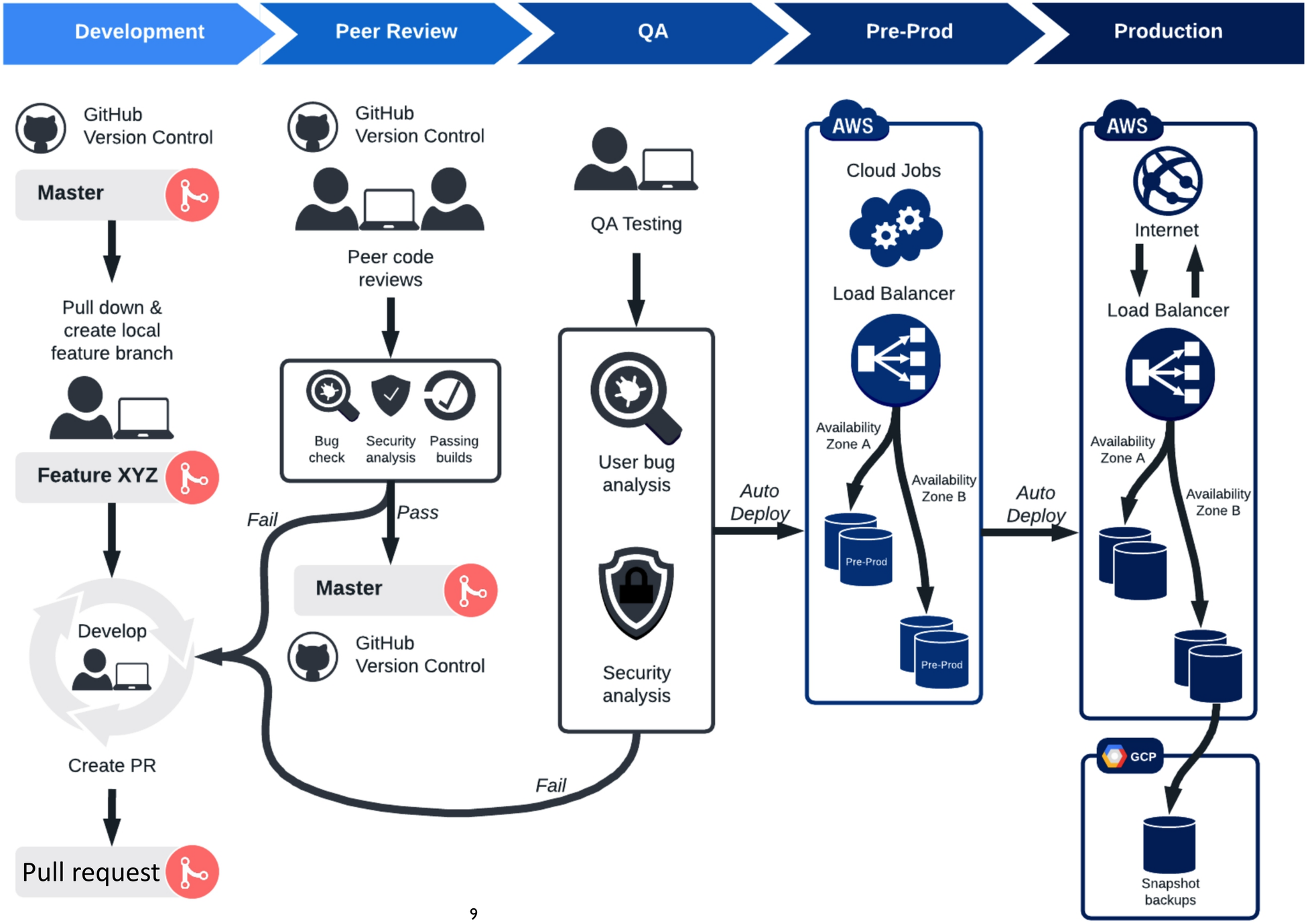
- Store your projects
- Collaborate
- Host your project's documentation
- Implement Continuous Development
- Automatic builds
- WebHooks





DevOps workflow

Atomic commits:
implement a new feature, commit. If something goes wrong you can always go back. Each commit version is working with its own set of features.



The more sophisticated science becomes, the harder it is to communicate results. Papers today are longer than ever and full of jargon and symbols. They depend on chains of computer programs that generate data, and clean up data, and plot data, and run statistical models on data. These programs tend to be both so sloppily written and so central to the results that it's contributed to a replication crisis, or put another way, a failure of the paper to perform its most basic task: to **report what you've actually discovered, clearly enough that someone else can discover it for themselves**.

- James Somers

JupyterHub

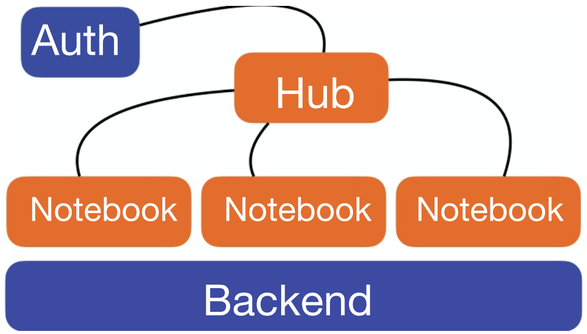
The **Jupyter Notebook** is an open-source web application that allows you to interactively create and share documents that contain:

- visualisations
- narrative text
- live code
- equations

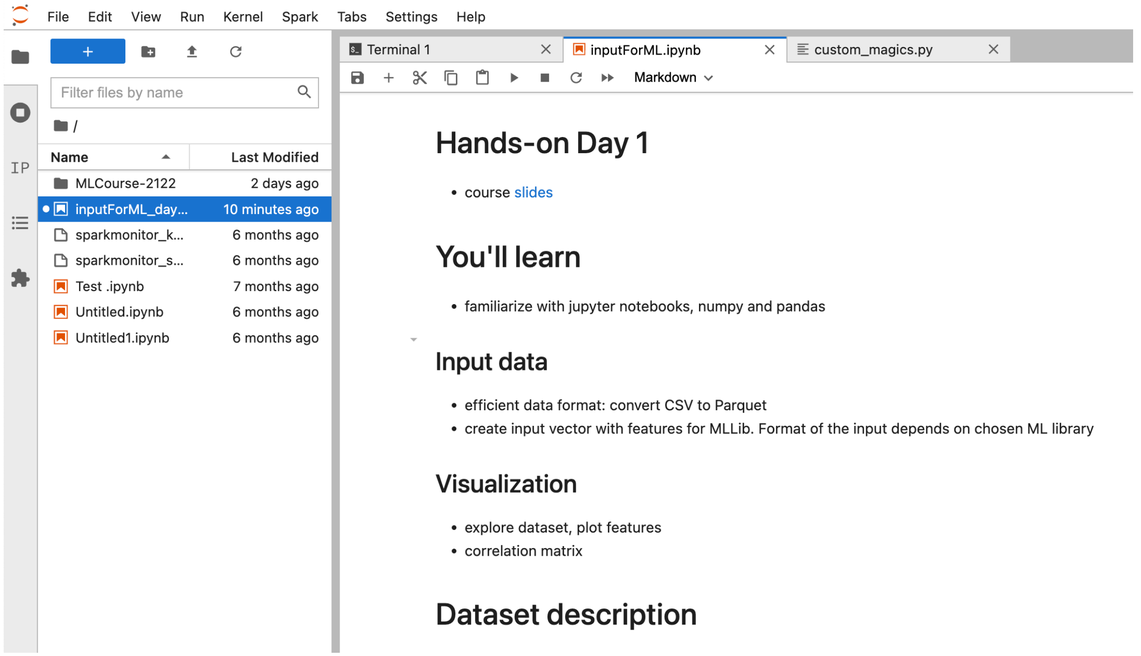
Uses include:

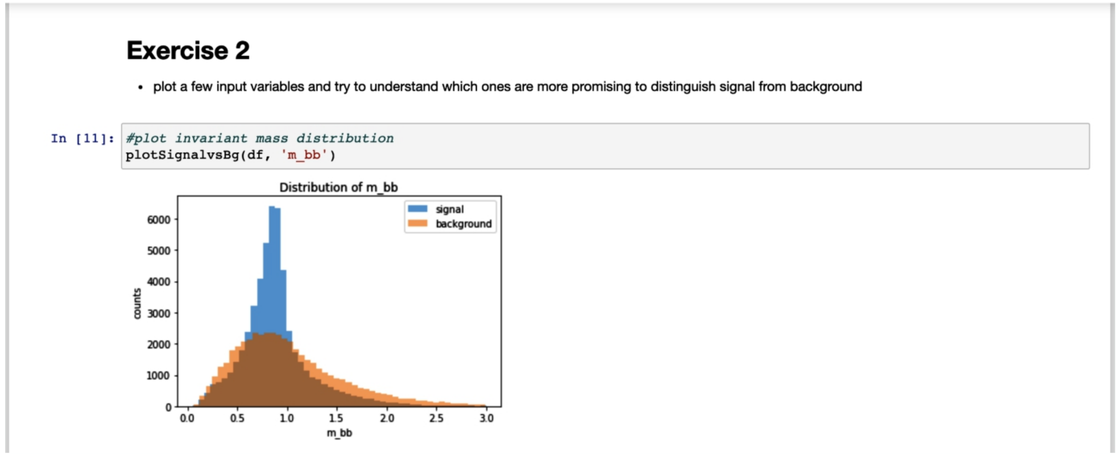
- data cleaning and transformation
- numerical simulation
- statistical modeling
- data visualisation
- machine learning

The JupyterHub
A multi-user version
of the notebook



Multiple language support (kernels)



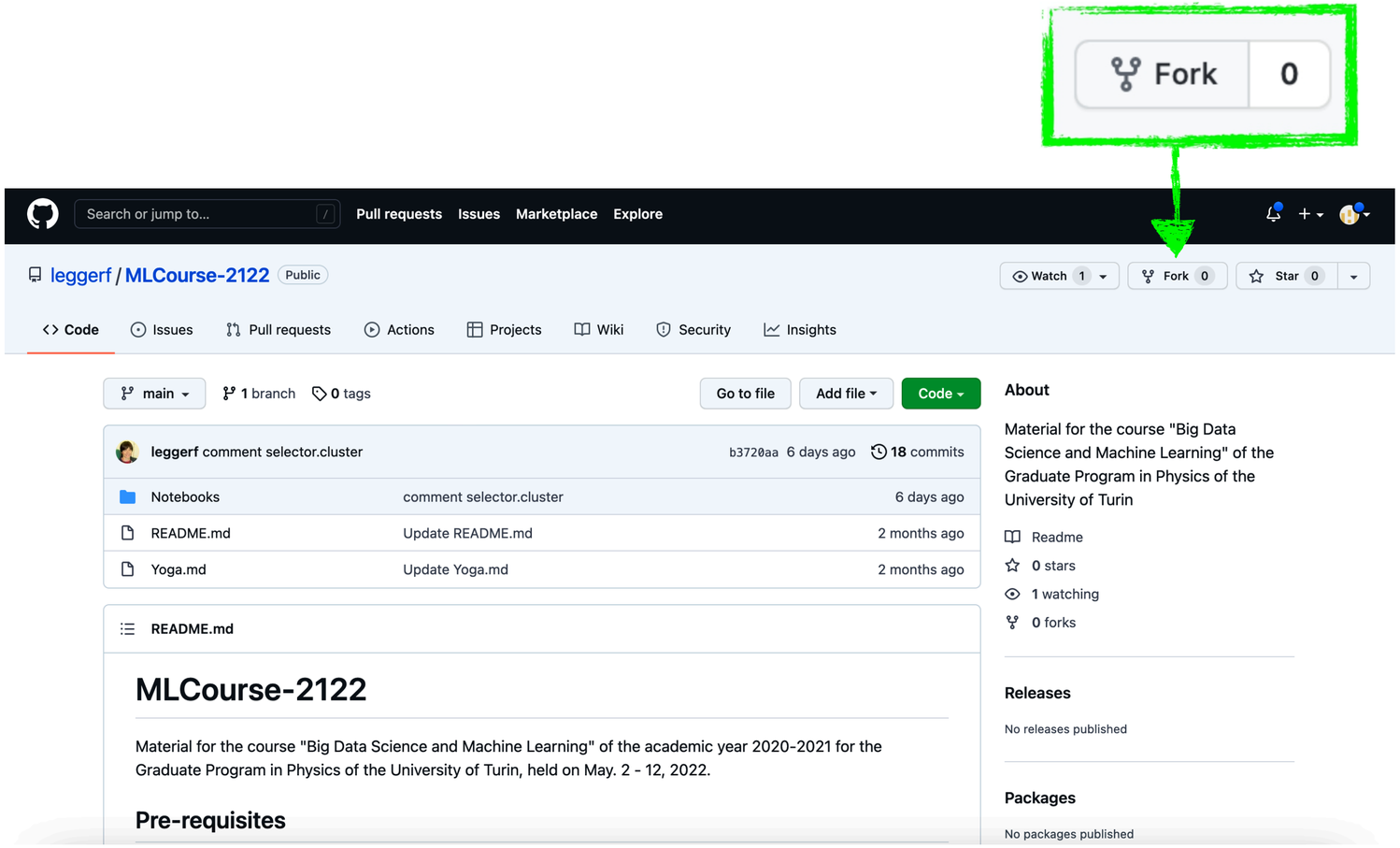


A very simple (and useful) example of DevOps workflow

During the hands-on sessions, you will have a persistent storage to save your Notebooks,
but you can also save them on GitHub!

STEP 1: Fork

- login to GitHub (https://github.com/)
- go to the course repository
  (https://github.com/leggerf/MLCourse-2122)
- fork the repository in your private space



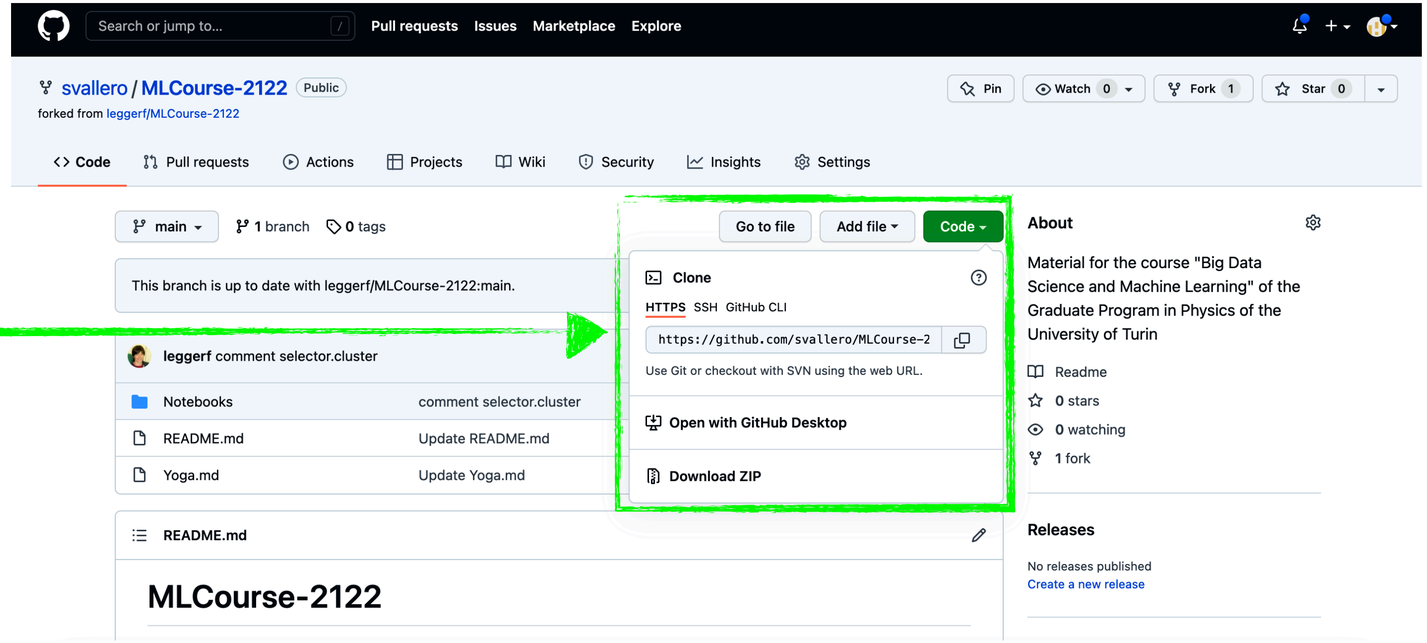
STEP 2: Clone

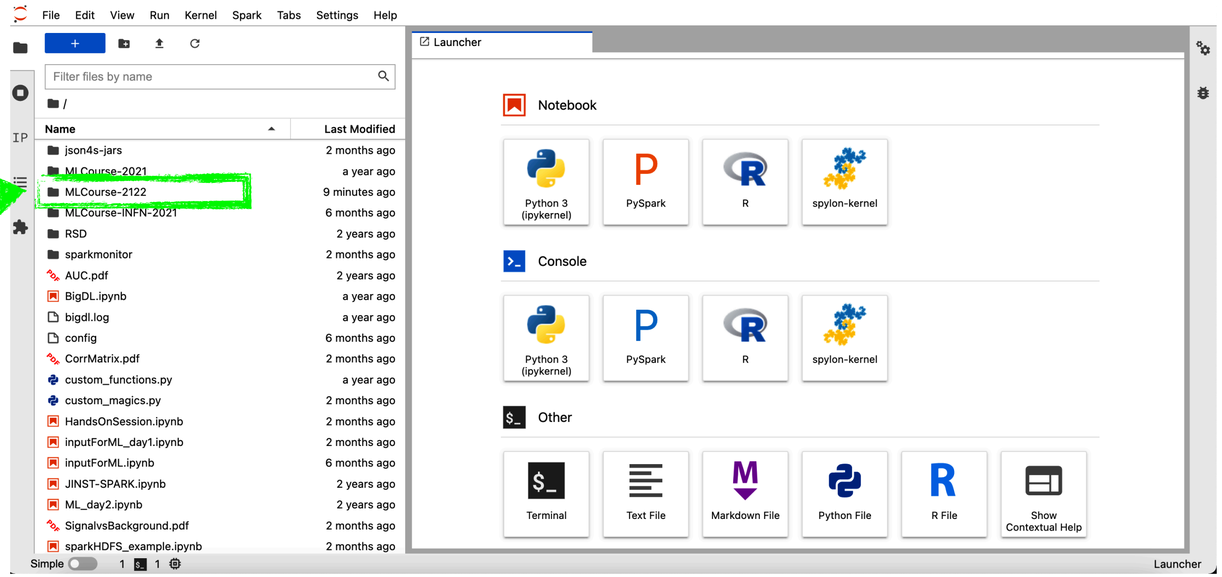
- You have been redirected to your private Fork of the repository
- Copy the Clone URL
- Clone your repository using the command line:

$ git clone https://github.com/yourusername/MLCourse-2122.git

(This will be executed in a Jupyter Terminal as explained in the upcoming hands-on session)

- You should now have a directory called: MLCourse-2122
- The directory is available in your JupyterHub space!





STEP 3: Status

- Browse the directory and start a Notebook.
- Make local modifications to the Notebooks (i.e. solve the exercises) and save them
- Now you can go back to the terminal and see what happened…

$ git status

```
On branch main
Your branch is up to date with 'origin/main'.

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   inputForML.ipynb

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        Notebooks/Day1/.ipynb_checkpoints/

no changes added to commit (use "git add" and/or "git commit -a")
```

This is the file you have changed and you want to *commit*.

These are the files that will not go in the repository unless you explicitly add them (and you don't want to do that).

STEP 4: Commit

- Add your changes
- Commit your changes
(remember the atomic commits)
- Check the status
- So far you made only local modifications

STEP 5: Push and Pull

- Send your changes to the central repository: **git push**
- Get the latest version of the code, including changes made by others: **git pull**

$ git add Notebooks/Day1/inputForML.ipynb
$ git status
On branch main
Your branch is up to date with 'origin/main'.

Changes to be committed:
 (use "git restore --staged < file>..." to unstage)
	modified: Notebooks/Day1/inputForML.ipynb

Untracked files:
 (use "git add < file>..." to include in what will be committed)
	Notebooks/Day1/.ipynb_checkpoints/

$ git commit -m “All exercises solved”
[main 942ef43] All exercises solved
1 file changed, 7354 insertions(+), 22 deletions(-)

$ git status
On branch main
Your branch is ahead of 'origin/main' by 1 commit.
 (use "git push" to publish your local commits)
...

To take home

- DevOps approach for fast time to value
- Version Control System (Git) to book-keep code changes and ease collaboration
- Make your workflow understandable and reproducible (Notebooks)