First Hackathon of Machine Learning
Advanced Level
November 26–28, Padova

Advanced Hackathon
Infrastructure

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SEZIONE DI FIRENZE

ICSC
Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

AI_INFN
Artificial Intelligence technologies for INFN research

Introduction

To practice with the machine learning exercises we want you to access to GPUs in the Cloud.

We have access to resources at:

- CNAF in Bologna
- ReCaS Bari

Thanks to the ***Cloud approach***, the two sites are almost indistinguishable, though the flavor of the GPUs is slightly different.

INFN Cloud
IAM Authentication
INDIGO - DataCloud

NGINX Proxy: https://mlinfn.cloud.cnaf.infn.it

Notebook Notebook Notebook Notebook Notebook Notebook

Docker Docker

Filesystem
Monitoring
Kubernetes Overlay
JupyterHub

Instance

INFN Cloud Infrastructure and Platform

Bare Metal @ CNAF
Bare Metal @ CNAF

NGINX: https://hpc-gpu-8-2-10.recas.ba.infn.it

Notebook Notebook Notebook Notebook Notebook Notebook

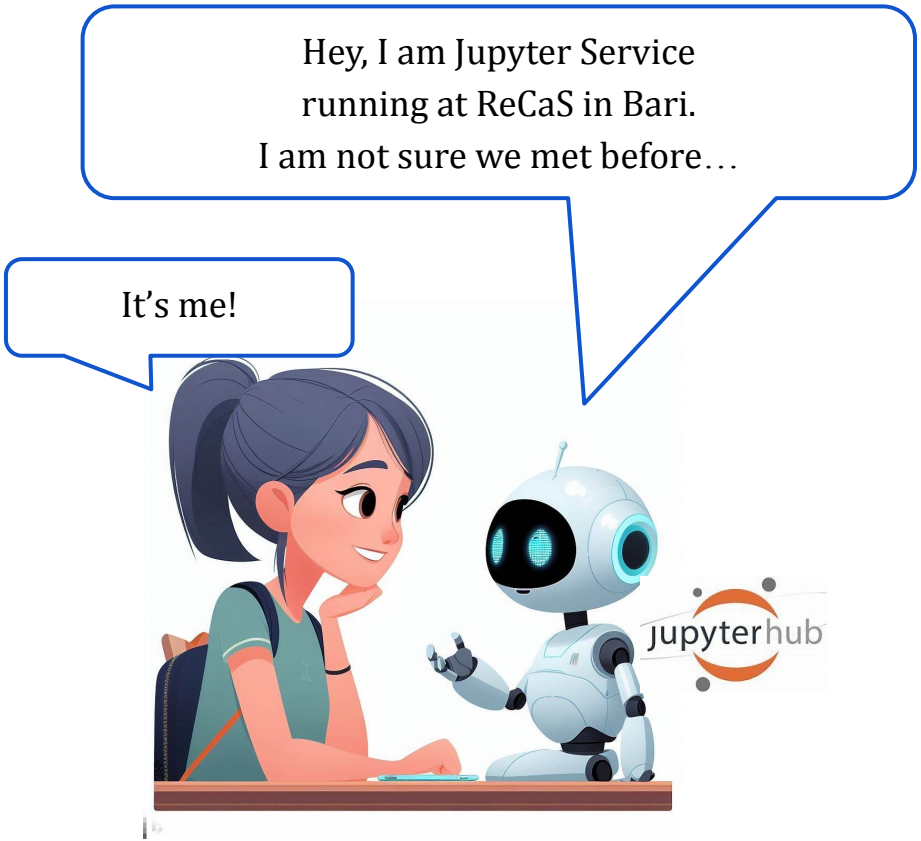
Docker Docker

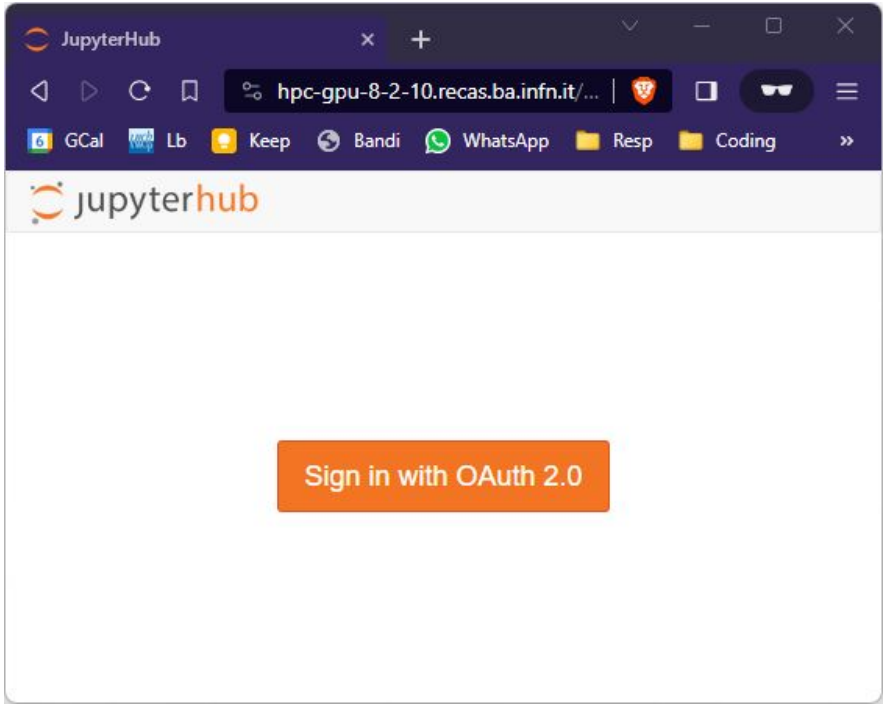
Filesystem
Monitoring
Kubernetes Overlay
JupyterHub

Centos7 Operating System

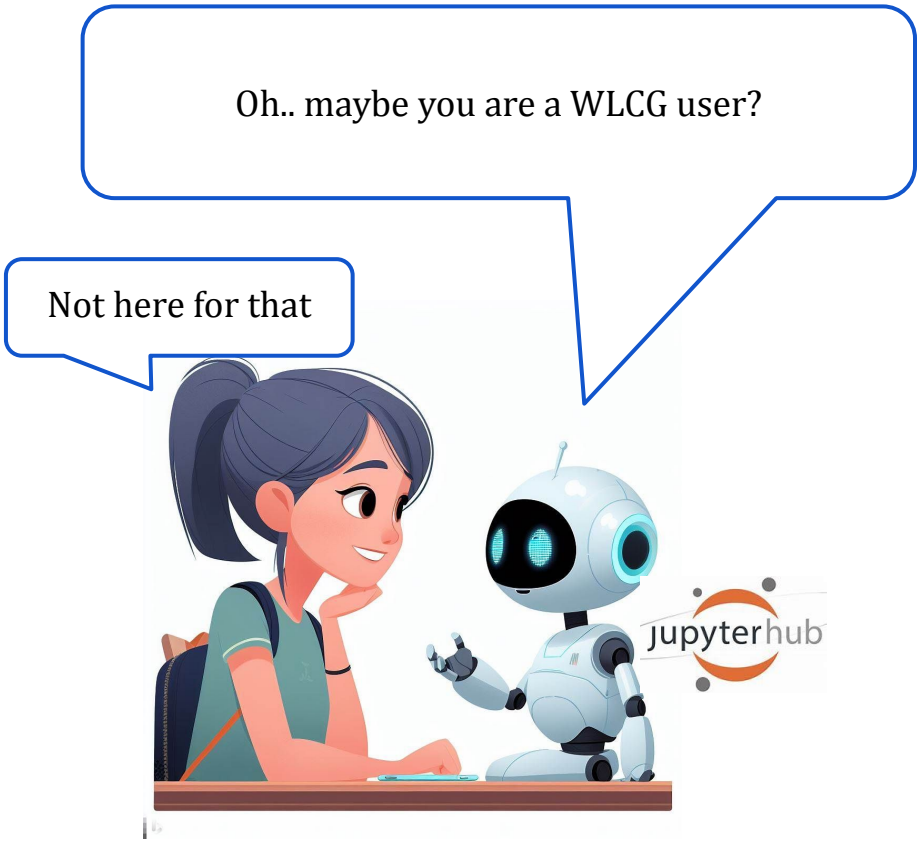
Bare Metal @ ReCaS Bari

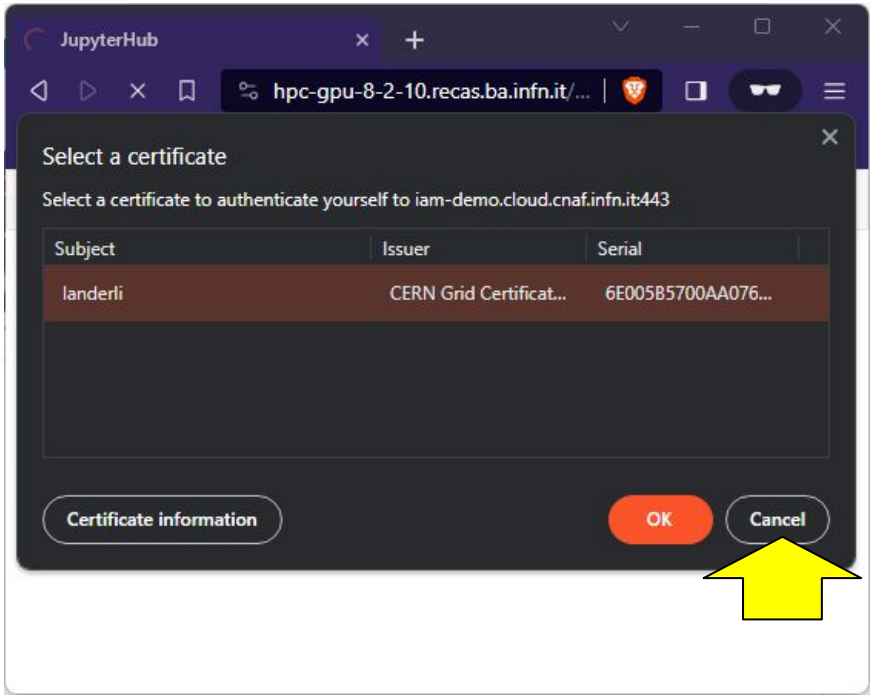
Behind the scenes: *Landing page*



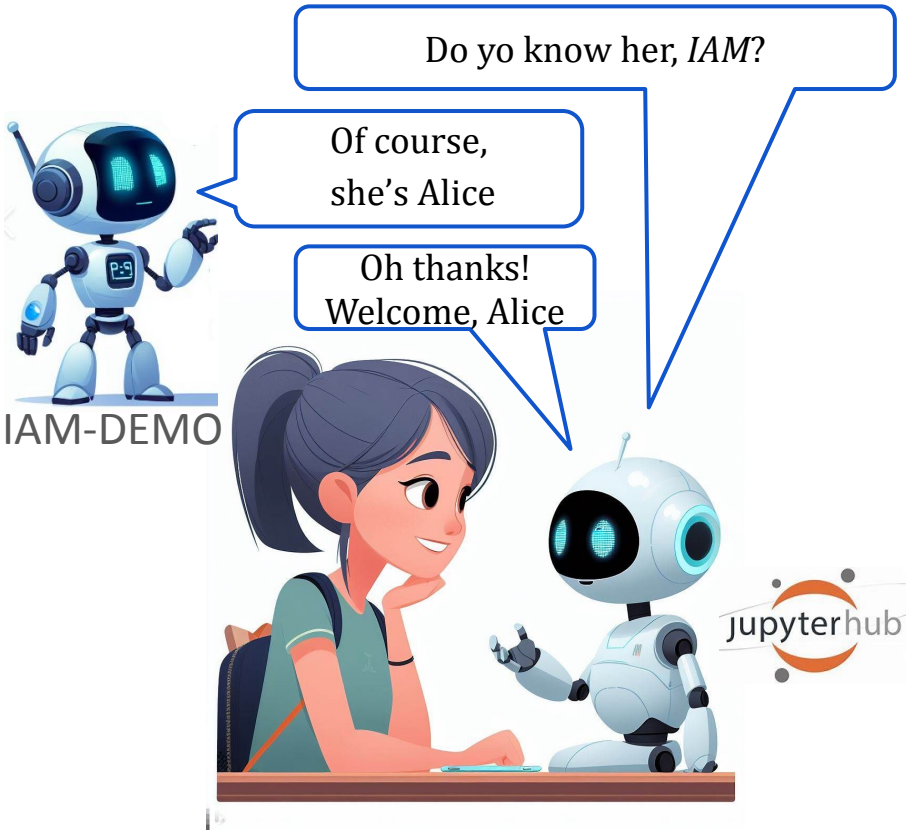


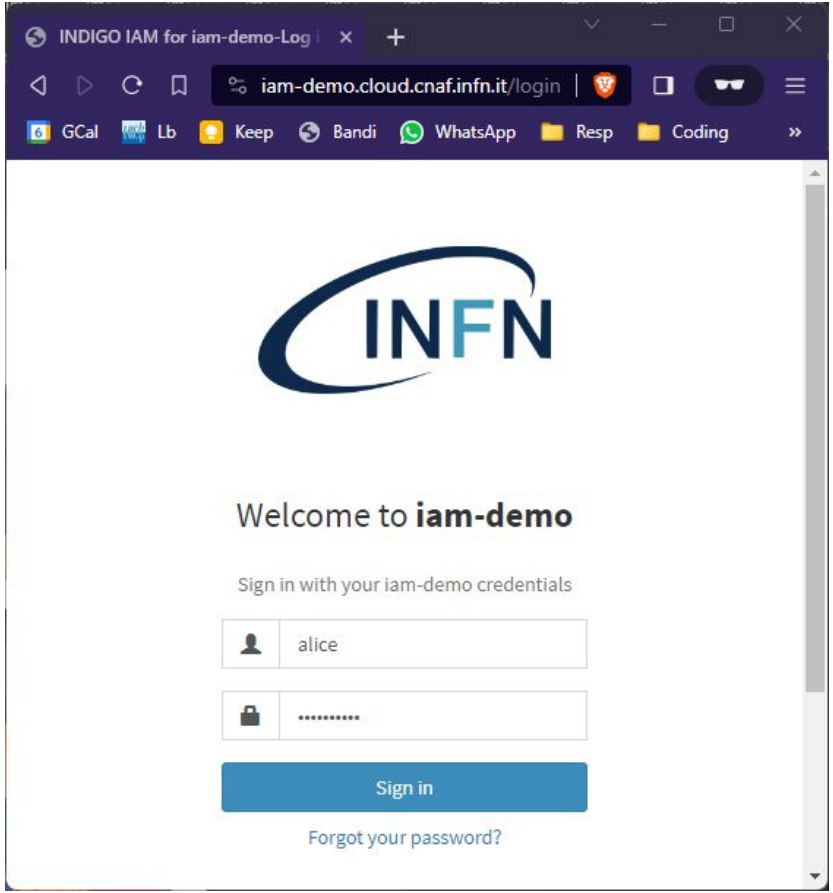
Authentication procedure



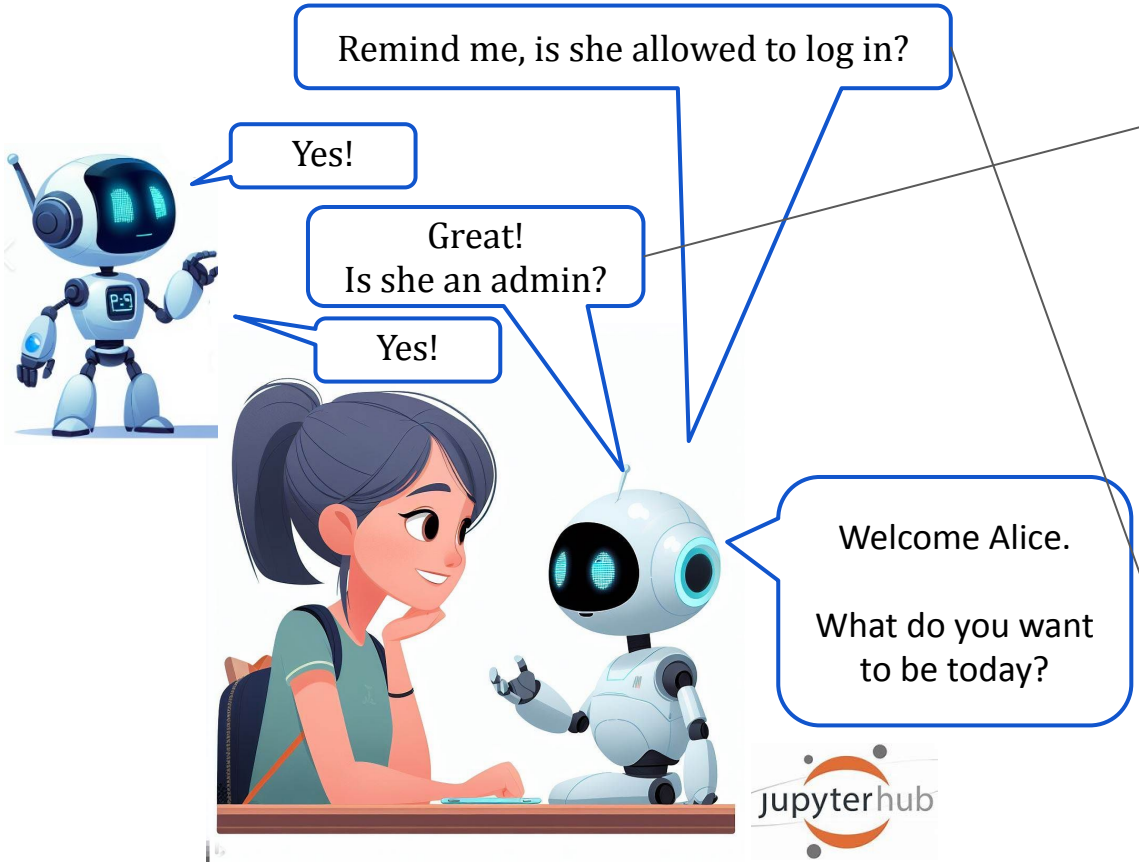


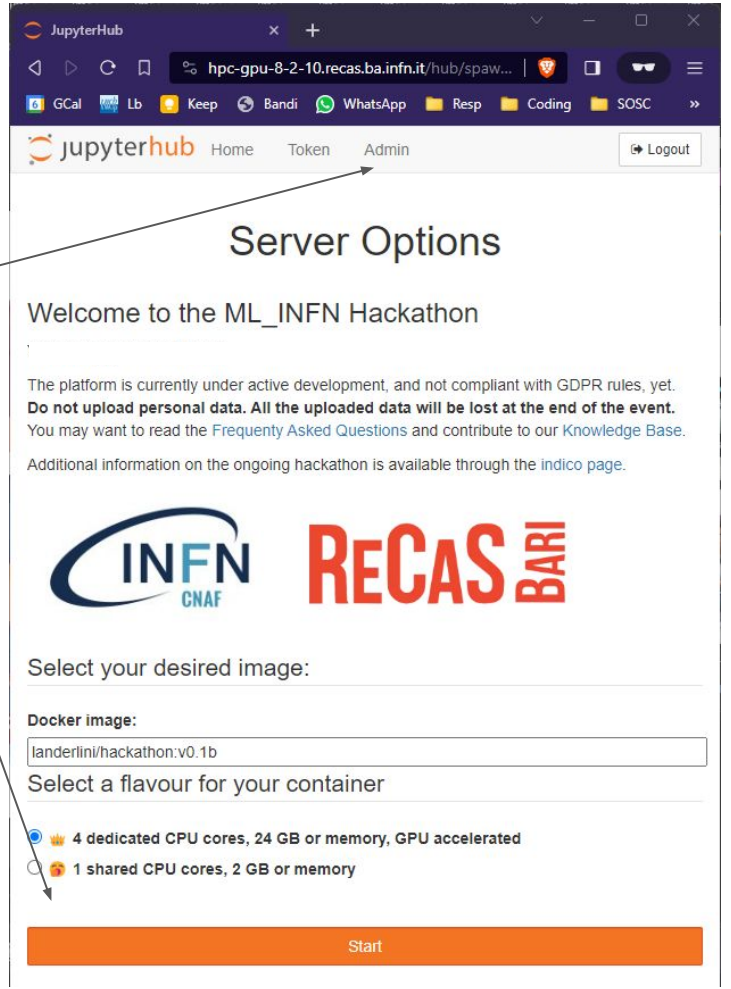
Authentication



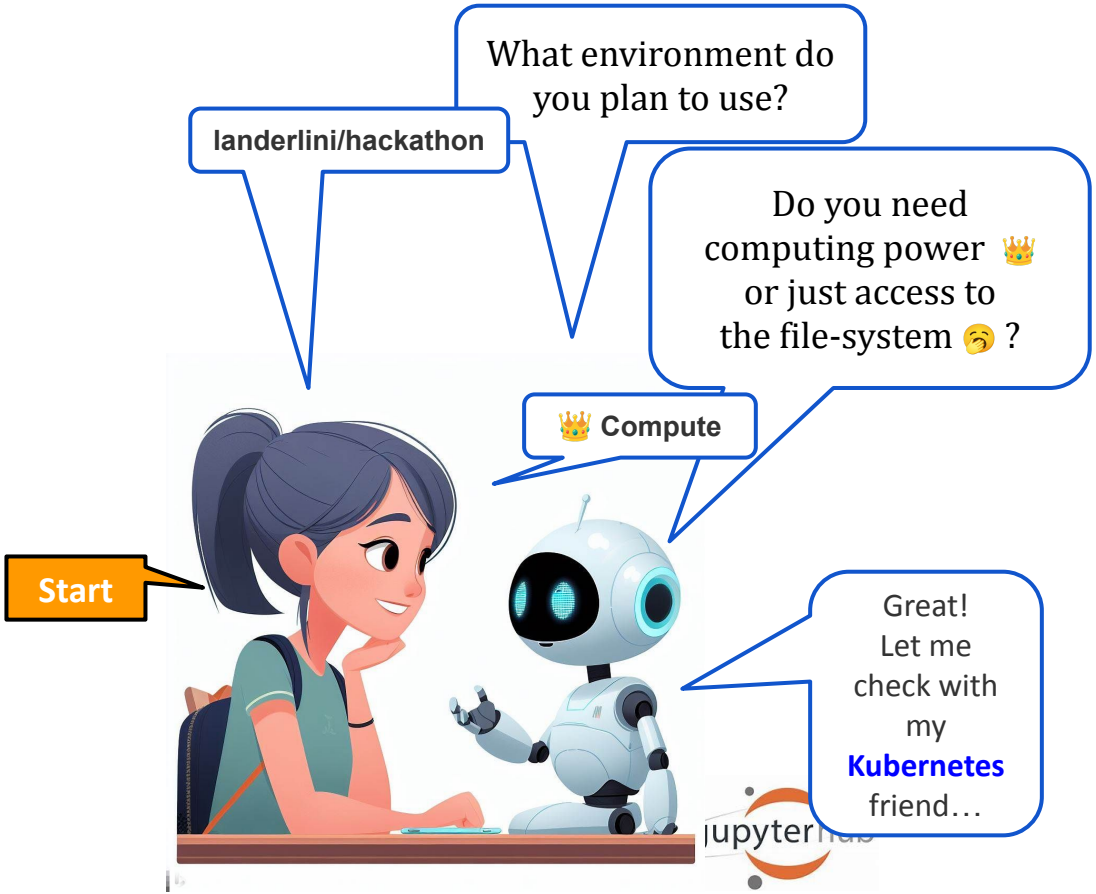


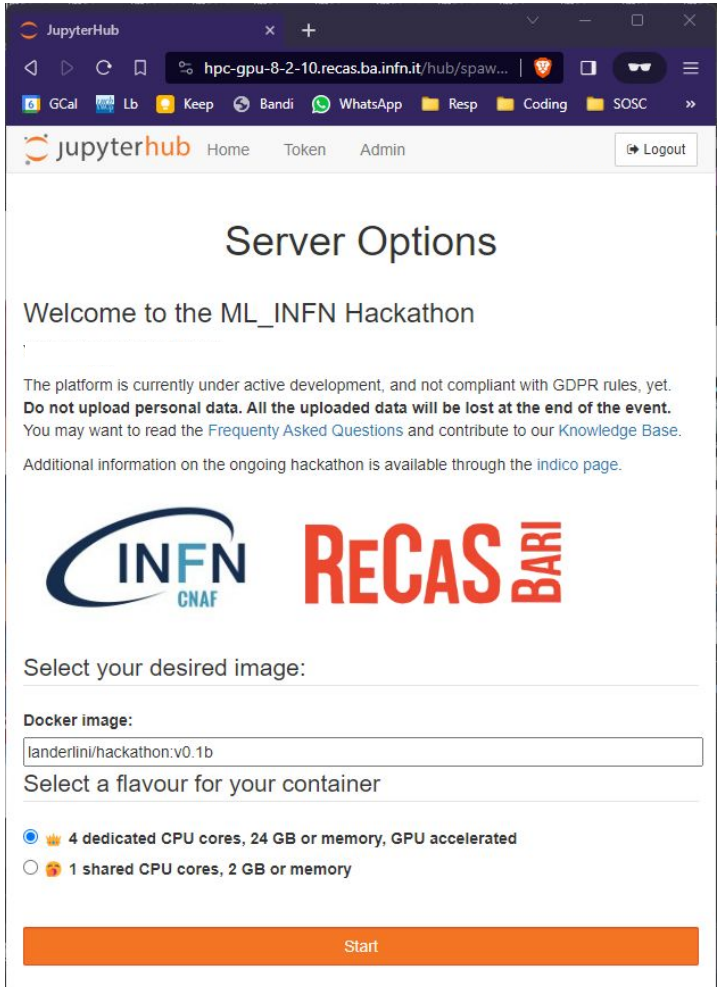
Authorization



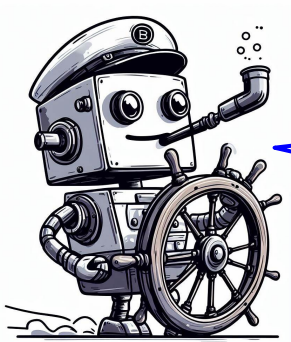


Authorization



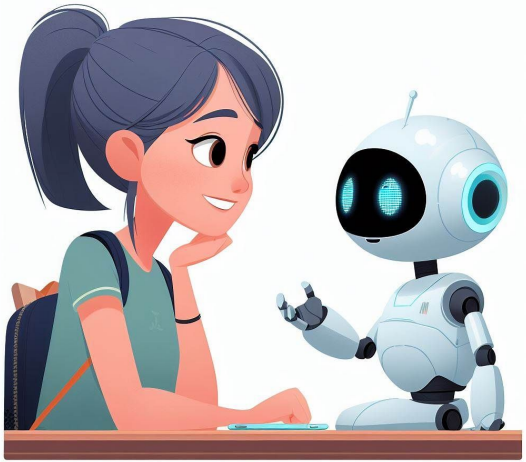


Spawning: *Allocating resources*

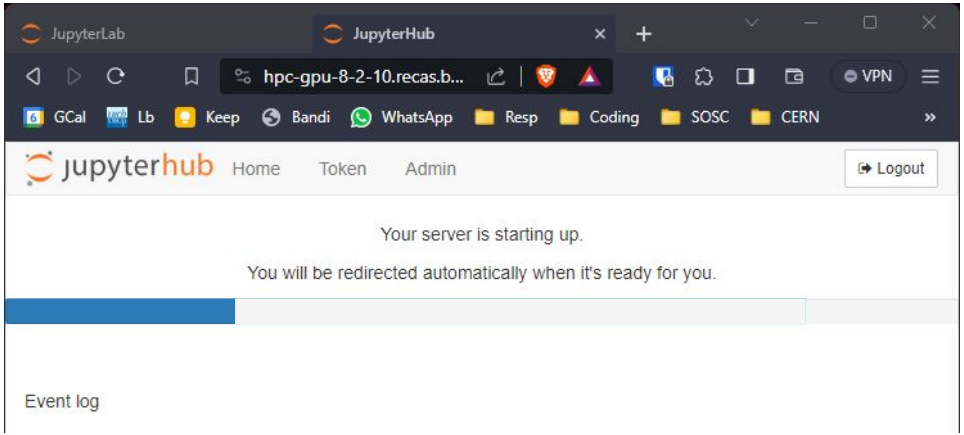


Aye! I have nVidia GPUs, today, and there is an available GPU slot in one of the computing nodes. It's yours!

CPU and memory are available as well. I will start a **docker** for you.

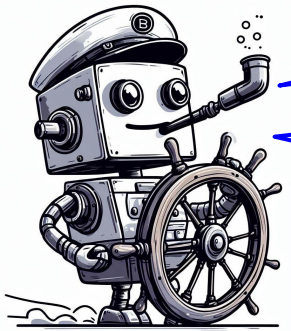


5GB	5GB	5GB	5GB	5GB	5GB	5GB	5GB
	1g.5gb	GPU Instance • Fixed partition of memory and compute • Fixed amount of "other" GPU Engines (depending on size)					
	1 compute	1 compute	1 compute	1 compute	1 compute	1 compute	1 compute

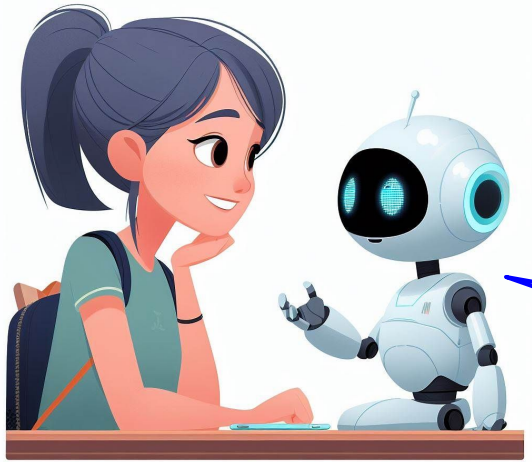


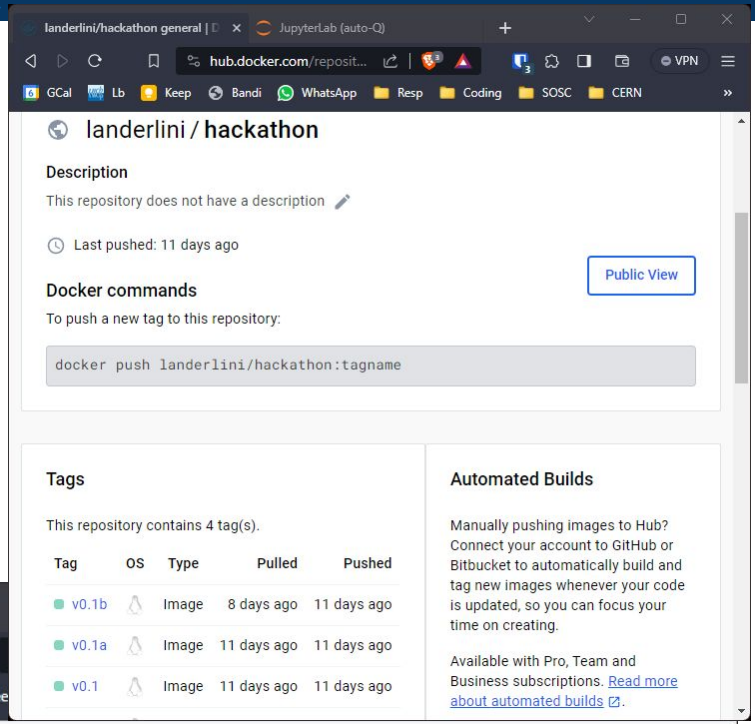
Spawning: *Docker image*

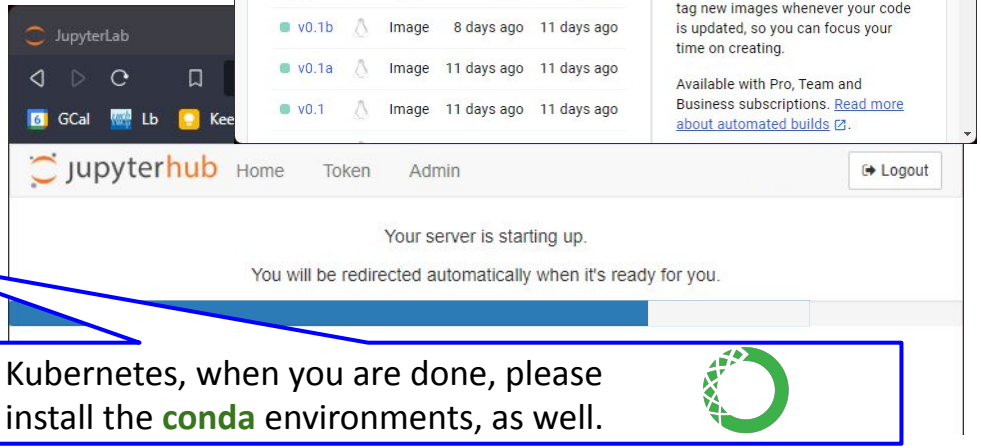
I found the image you requested,
`landerlini/hackathon`, on hub.docker.com
I will download it for you, if needed.



CPU and memory are available as well.
I will start a **docker** for you.





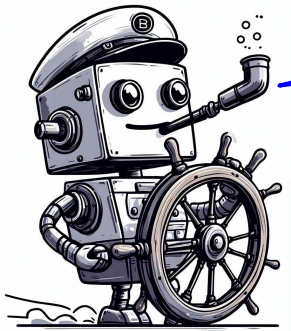


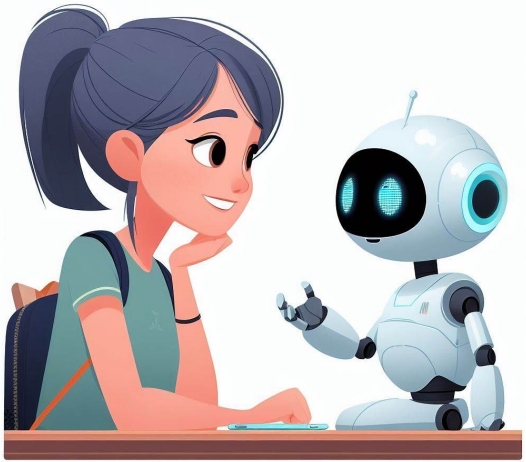
Kubernetes, when you are done, please
install the **conda** environments, as well.

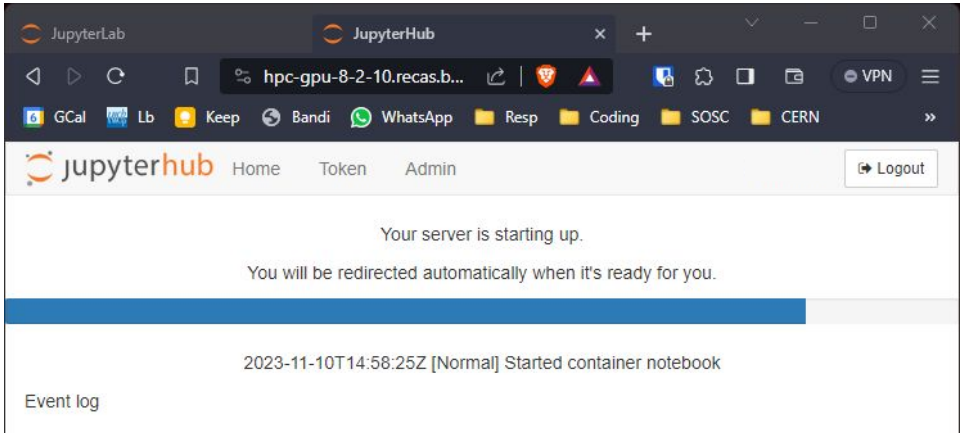
Spawning: *PostStart hook and conda environment*

Aye!
Indeed conda in installed in this image.

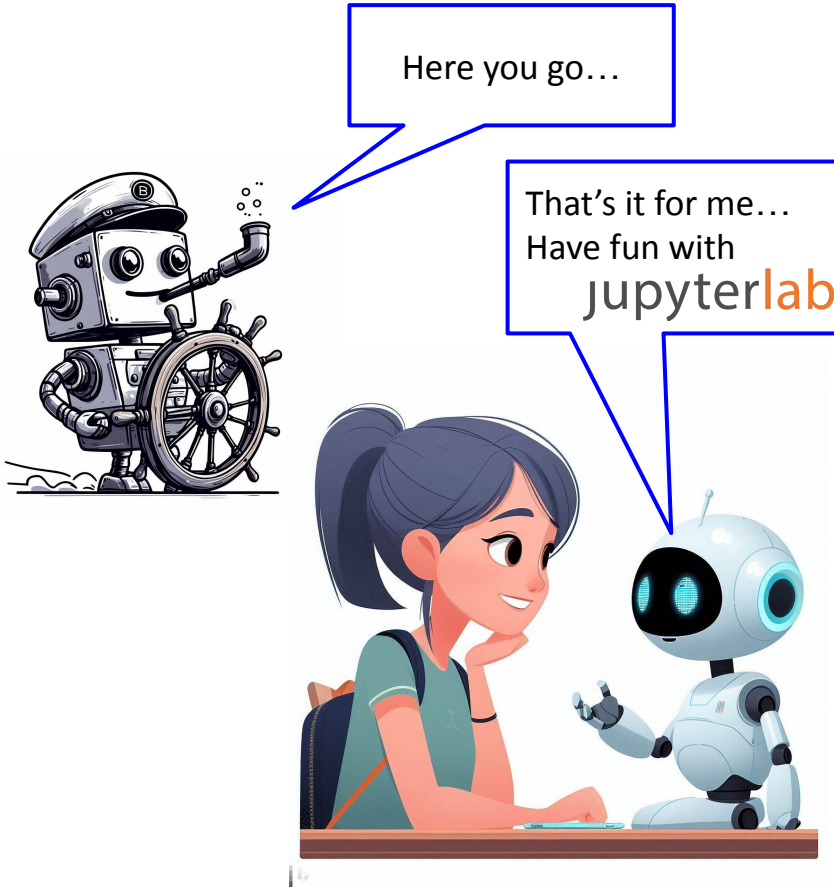
Just one last second…

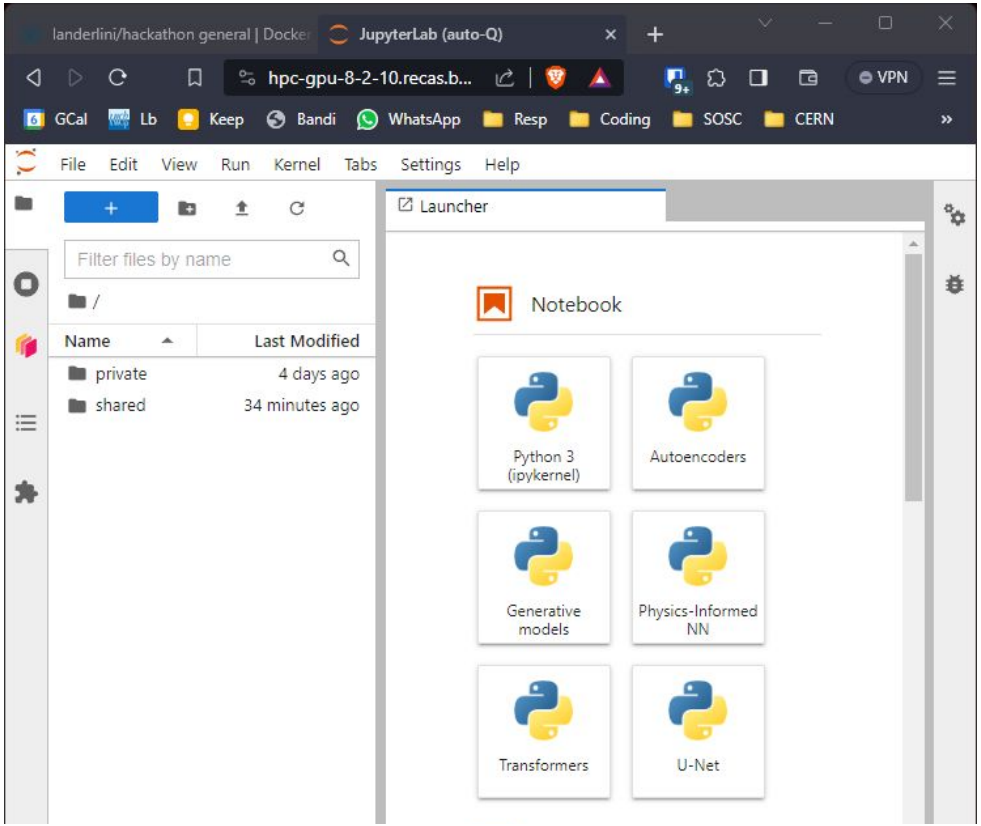






Spawning: *Starting the user interface*





User interface

Available conda environments installed at cluster level and distributed via NFS to the various nodes.

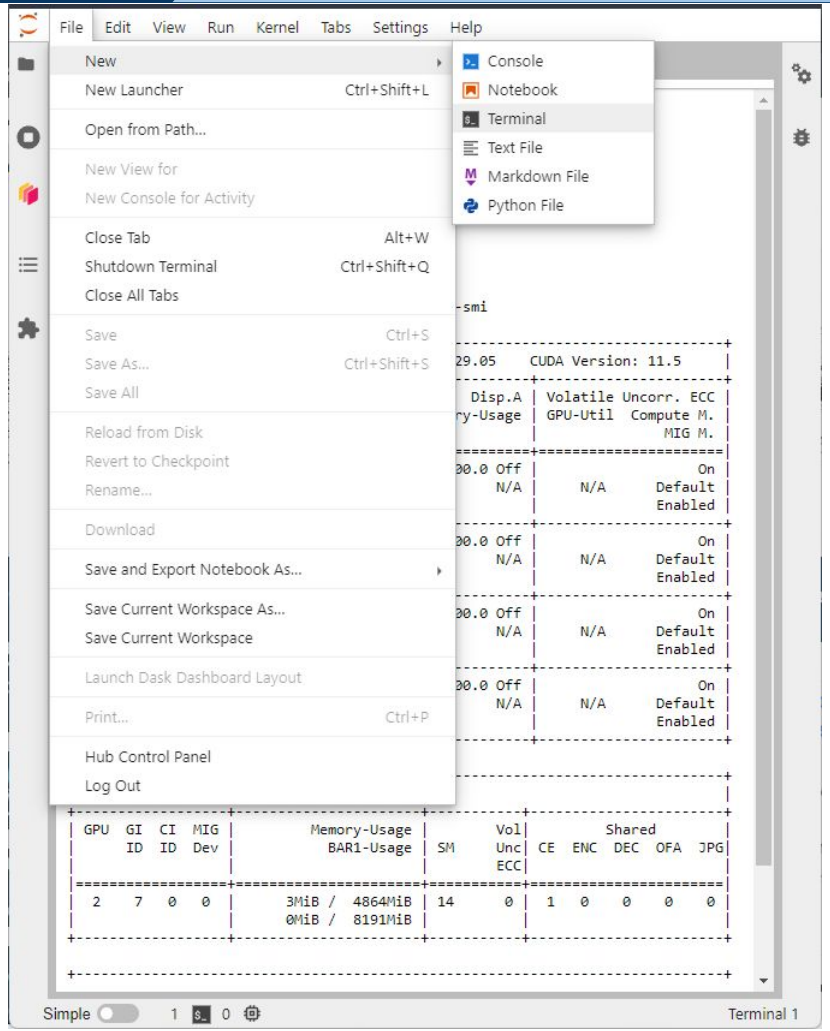
Will use `cvmfs` one day, eventually.

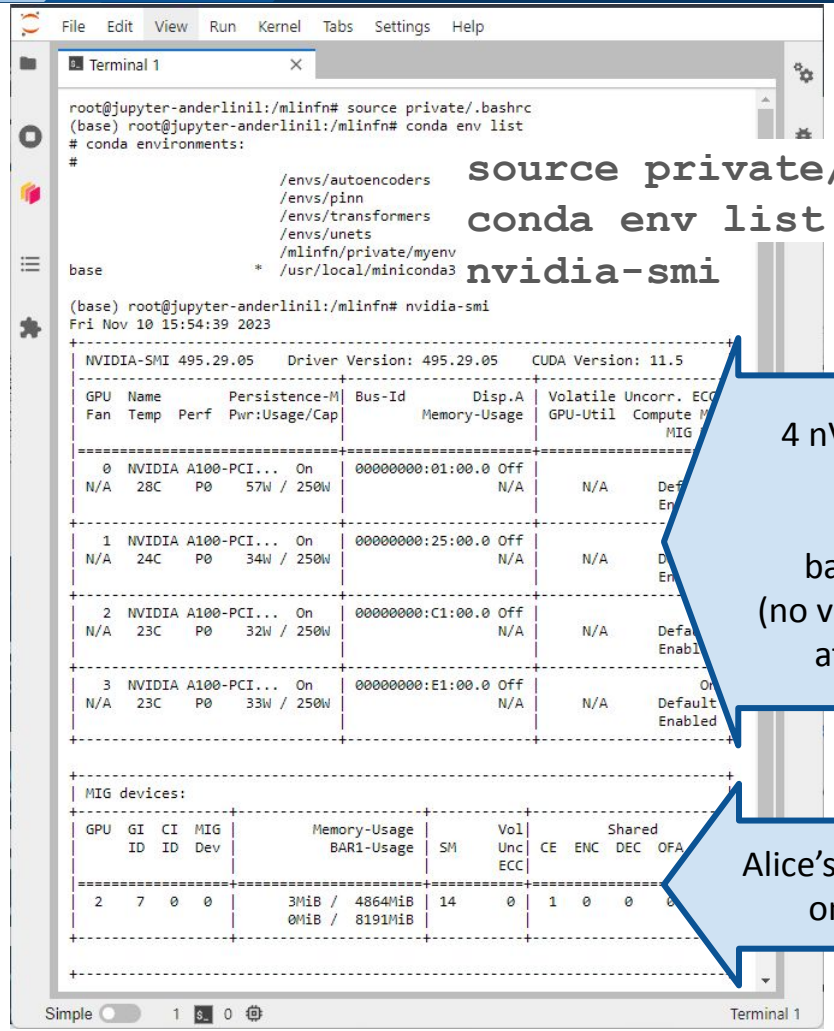
Dask dashboard

A door towards scalability (not for this hackathon)

Cluster volumes `mount`ed here

Everyhere else is "*Ephemeral Filesystem*"
Any data will be lost when the container is turned off






```
source private/.bashrc
conda env list
nvidia-smi
```

4 nVidia A100 GPUs in the bare metal (no virtualization at ReCaS)

Alice's MIG device on GPU 2

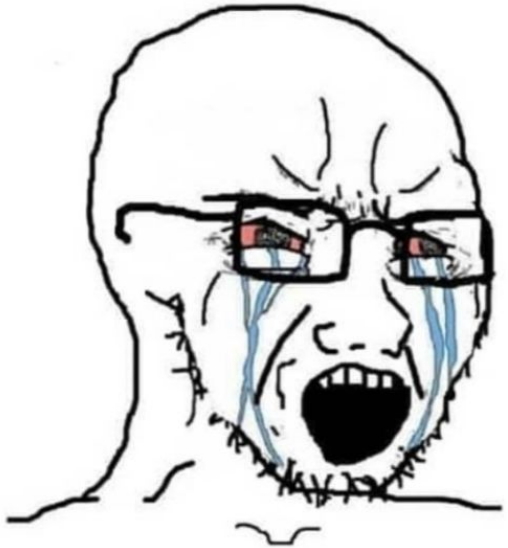
But I need MY VERY SPECIAL PACKAGES!

No TensorBoard, no machine learning!!!!!!

I cannot work without VS Code!!!!!!!!!!!!!!!!

You are in the Cloud, man.

Just customize things.



Customization layers *(in the hands-on in a minute)*

Custom conda environments:

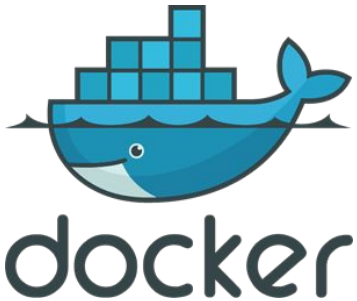
If you just need custom software, but the user interface is fine →

For example, installing TensorBoard

Custom Docker image:

If you need a custom user interface or anything does not fit in conda →

For example, installing VS code

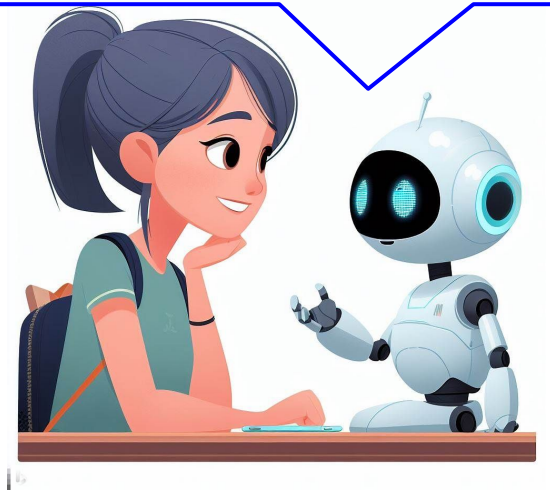


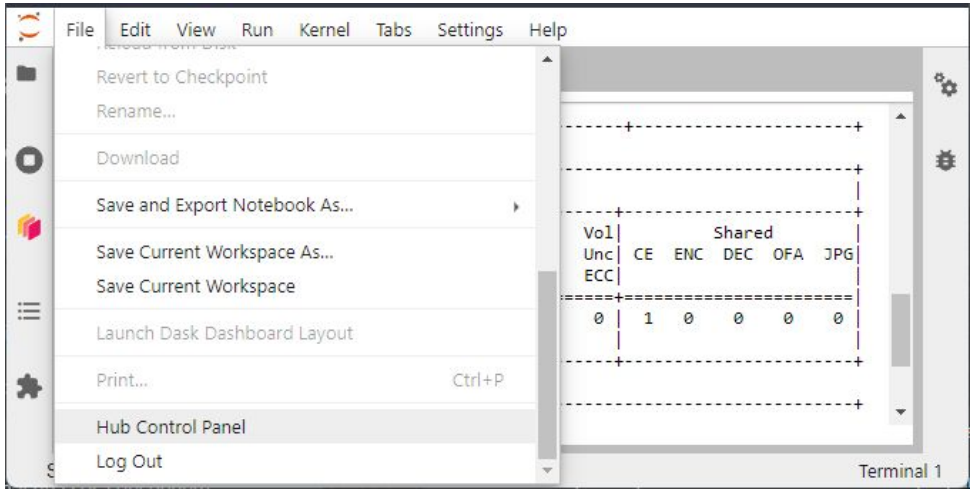
Culling: *Starting the user interface*

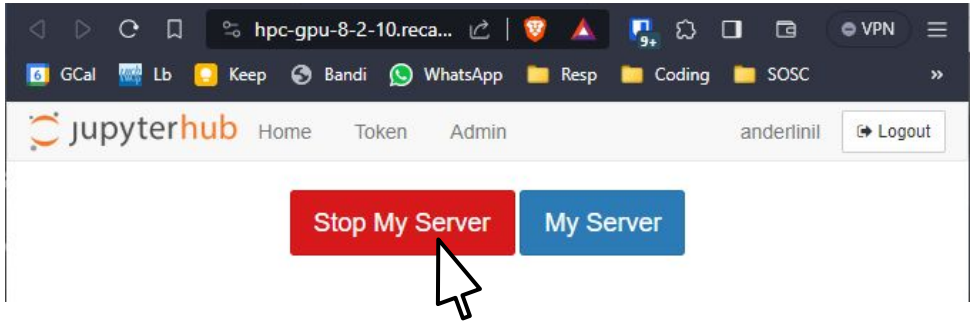
Ah, one last thing…

If I don't see you around for a while (few hours), **I will destroy your container** to free the resources for others. Be prepared.

But please, consider **freeing resources yourself** when you are done







And what about *scaling?*

Once you have your custom environment, running your custom software in your custom Docker container, **it is time for you to *scale up.***

You will want to run the same code, in a non-interactive way, multiple times, possibly in parallel.

This comes with two complications:

- ***economic***: a single GPU to enable development has a negligible cost *wrt.* your salary. The cost of hundreds of GPUs processing buggy workloads while you sleep is unacceptable.
- ***competition and arbitration****:* policies for a **fair share** of the resources must be formulated and implemented.

The future…

ICSC
Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

terabit

AI_INFN
Artificial Intelligence technologies for INFN research

The Fifth Scientific Committee of INFN (CSN5) has recently funded a *three-year project* to evolve ML_INFN facing these complications:

- Enhance our ability of using ALL (or at least most) resources in the Cloud if not employed otherwise (opportunistic usage), including FPGAs and Quantum Processors.
- Develop an infrastructure (*monitoring, batch system* and *user-support*) to enable implementing ***extensive usage*** **and** ***fair share*** **of resources** accessible to **multiple scientific communities** for hardware-accelerated machine-learning workloads.
- The European projects ICSC and Terabit are providing resources to develop and commission the whole thing.

Summary

- **JupyterHub** on **Kubernetes** is the door for **ML** and **Data Analysis** tasks in the Cloud.
- Resources available in **different servers in the same site** can be transparently combined and accessed as a single cluster (e.g. CNAF).
- The **same platform che be deployed in very different scenarios** (*e.g.* CNAF on VMs and ReCaS on bare metal) providing very similar user experience.
- Users can **customize their development environment** with the tools they are used to (e.g. ***conda*** *environments*) or Cloud-native solutions (e.g. ***Docker*** *containers*).
- In the coming months it will become possible to **scale up** to multiple instances accessing resources otherwise unused possibly from remote computing centers.

DISCLAIMER

*Please, consider yourselves as **beta testers of this novel setup** and be patient if something will need hot fixes during the hackathon.*