

# MATLAB as a Service on INFN Cloud

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# Introduction


- Why MATLAB as a Service on INFN Cloud?
- Because:
  - Many scientific collaborations and projects would leverage MATLAB as a powerful framework for their computations and analyses
  - INFN has bought unlimited MATLAB licenses for the current year
  - The most straightforward way to provide INFN users with MATLAB would be adding a related INFN Cloud service to the present Portfolio
- How to provide the service?
  - The majority of INFN Cloud communities exploits Jupyter Notebooks as the main tool to perform computations on a user basis
  - MATLAB can be integrated with Jupyter Notebooks: that seems the ideal solution

# Supported Use Cases - NaaS

- At present, INFN Cloud provides Jupyter Notebooks through JupyterHub

CENTRALISED SERVICES:

NaaS



## Server Options

You are logged in as default user. If you want to enhance your quota please contact us issuing a ticket in servicedesk via email [cloud-support@infn.it](mailto:cloud-support@infn.it) or via portal at <https://servicedesk.cloud.infn.it/>

Select your desired image:

Select your desired number of cores:

Select your desired memory size:

Start

- The INFN Cloud user connects to the Hub through INFN Cloud IAM and:
  - selects a Jupyter Docker image to be downloaded from a public registry
  - selects number of cores and RAM size for the server to be run
  - spawns a Jupyter server based on the selected Docker image

# Supported Use Cases - NaaS


- The Docker image *harbor.cloud.infn.it/jupyter-matlab/naas\_matlab* provides Jupyter Notebook integration for MATLAB and INFN Cloud MinIO buckets

The screenshot displays the JupyterLab interface. On the left, a file browser shows a directory structure: `cloud-storage / scratch`. Below the browser, a list of folders is visible, including `anderlinil`, `andreett`, `barbettimatteo`, `boccali`, and `ciangottini`. A 'New' dropdown menu is open, listing options: 'MATLAB Kernel', 'Python 3 (ipykernel)', 'Text File', 'Folder', 'Terminal', 'Open MATLAB', and '7 minutes ago'. On the right, the MATLAB notebook environment is shown with a toolbar containing icons for 'New Script', 'New Live Script', 'Open', 'Import Data', 'Save Workspace', and 'CODE', 'ENVIRONMENT', 'RESOURCES' tabs. The notebook content area shows a prompt `>>` and a yellow notification banner: 'New to MATLAB? See resources for Getting Started.'

# Supported Use Cases - Jupyter with Persistence

- INFN Cloud also supports Notebooks deployment via Hub on personal VM

Jupyter + Matlab (with persistence for Notebooks)



## Server Options

Select your desired image:

Select your desired memory size:

GPU:

Start

+
📁
↑
↻
🗑️

Filter files by name 🔍

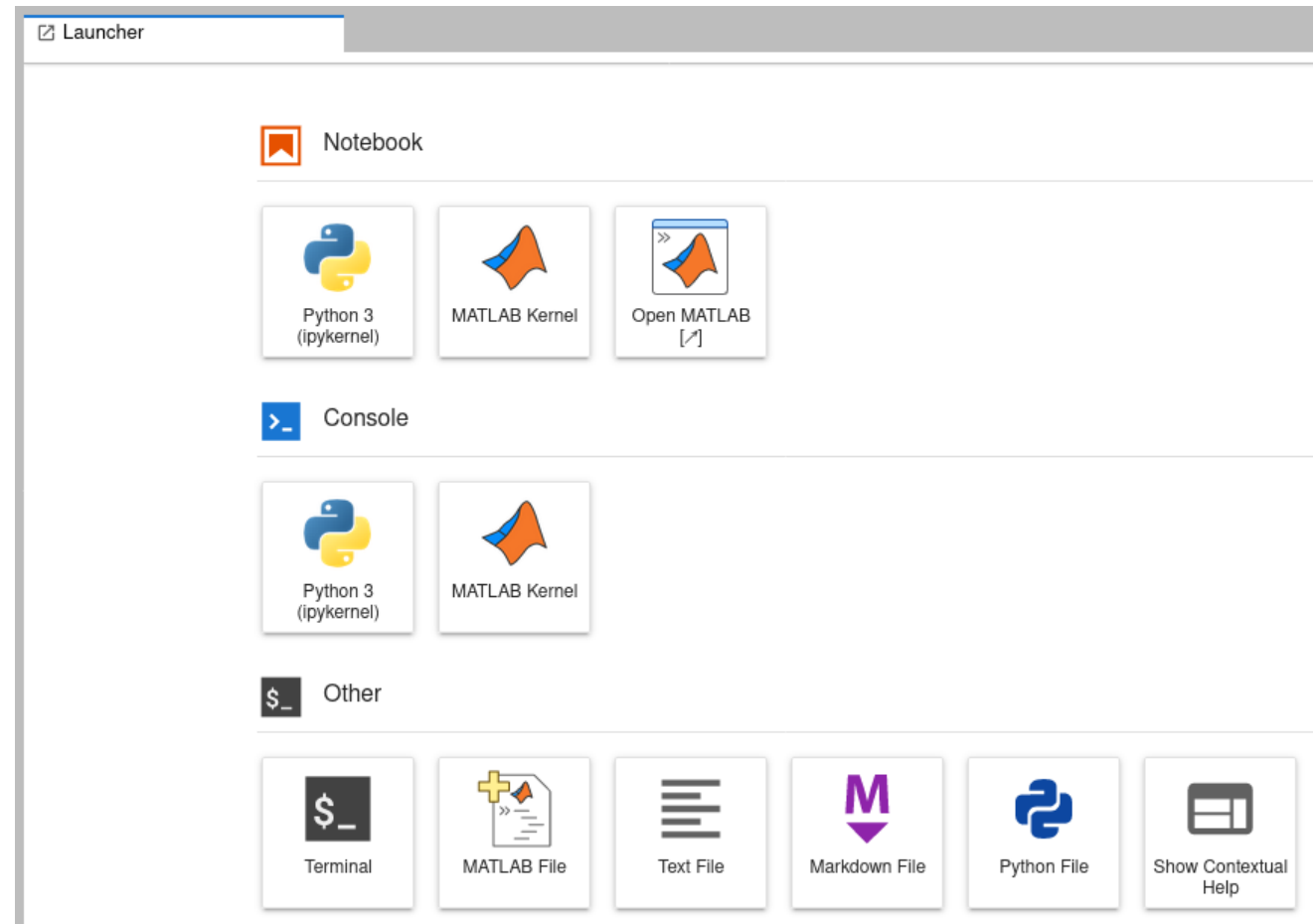
📁 /

Name	Last Modified
📁 fornari	2 minutes ago
📁 scratch	2 minutes ago

- The INFN Cloud user connects to personal Hub via INFN Cloud IAM and:
  - selects a JupyterLab Docker image to be downloaded from a container registry
  - selects RAM size for the server to be run (and GPU if available)
  - spawns a JupyterLab server based on the selected Docker image providing POSIX access to centralized MinIO S3 buckets (personal and scratch)

# MATLAB personal interface for Jupyter

- The Docker image [harbor.cloud.infn.it/jupyter-matlab/jupyter\\_matlab](https://harbor.cloud.infn.it/jupyter-matlab/jupyter_matlab) provides JupyterLab with:
  - MATLAB kernel for Notebook
  - MATLAB kernel for console
  - MATLAB native web interface
  - Python 3 kernel for Notebook
  - Python 3 kernel for console
  - Terminal with shell session
  - File editor for:
    - MATLAB files
    - Markdown files
    - Python files
    - Generic text files



# MATLAB collaborative interface for Jupyter

- The Docker image *harbor.cloud.infn.it/jupyter-matlab/collaborative\_matlab* provides JupyterLab with collaborative editing feature that allows collaboration in real-time between multiple users. It is disabled by default.

jupyterlab\_collaborative  
true  
enable the jupyter collaborative service

jupyterlab\_collaborative\_image  
harbor.cloud.infn.it/jupyter-matlab/collaborative\_matlab  
Default image for jupyter collaborative service including MATLAB

iam\_groups  
admins/beta-testers admins  
IAM groups for authorization management (comma delimited list of strings)

iam\_admin\_groups  
admins/beta-testers admins  
IAM groups for JupyterHub ADMIN authorization management (comma delimited list of strings)

jupyterhub Home Token Admin Services fornari Logout

Collaborative-Jupyter

## Server Options

Select your desired image:

Select your desired memory size: 1GB

GPU: Not Available

Start

Filter files by name

Name	Last Modified
collaborativefolder	a day ago

# MATLAB license management

- License for MATLAB usage can be obtained by:

- Online License Manager:

- Login with Mathworks account
- Authentication via INFN AAI
- User based license released

Online License Manager | Network License Manager

MathWorks®

Email

fornari@infn.it

By signing in, you agree to our [privacy policy](#).

Next

For more details, see [MATLAB Licensing information](#)

- Network License Manager:

- Provide License Manager hostname and port
- Host based license released

Online License Manager | Network License Manager

License Server Address

port@hostname

Submit

For more details, see [MATLAB Licensing information](#)

INFN CCR - AAI

IT | EN

Username or e-mail

fornari

Password

\*\*\*\*\*

LOGIN

REGISTER

Change or Reset Password - Retrieve Username

X.509 CERTIFICATE

KERBEROS - GSSAPI

**i** Status Information

MATLAB Status: Starting. This may take several minutes.

Licensing: Online License Manager (federico.fornari@cnaif.infn.it)

Start MATLAB Session | Stop MATLAB Session | Sign Out | Feedback | Help

**i** Status Information

MATLAB Status: Starting. This may take several minutes.

Licensing: Network License Manager (27000@lm-matlab.infn.it)

Start MATLAB Session | Stop MATLAB Session | Unset License Server Address | Feedback | Help



# MATLAB web interface and Jupyter kernel

- MATLAB native web interface and Jupyter Notebook kernel can be used to perform computations and produce plots

The screenshot shows the MATLAB web interface with a Jupyter Notebook kernel. The code in the notebook is as follows:

```
[1]: fs = 500000;
dt = 1 / fs;
t = 0:dt:0.004;
sn = [];
for v = t
    sn = [sn, 2 * cos(2 * pi * 1000 * v + pi / 2)];
end
plot(t, sn);
```

The plot shows a sine wave with an amplitude of 2, oscillating between 0 and 4 on the x-axis (scaled by  $10^{-3}$ ).

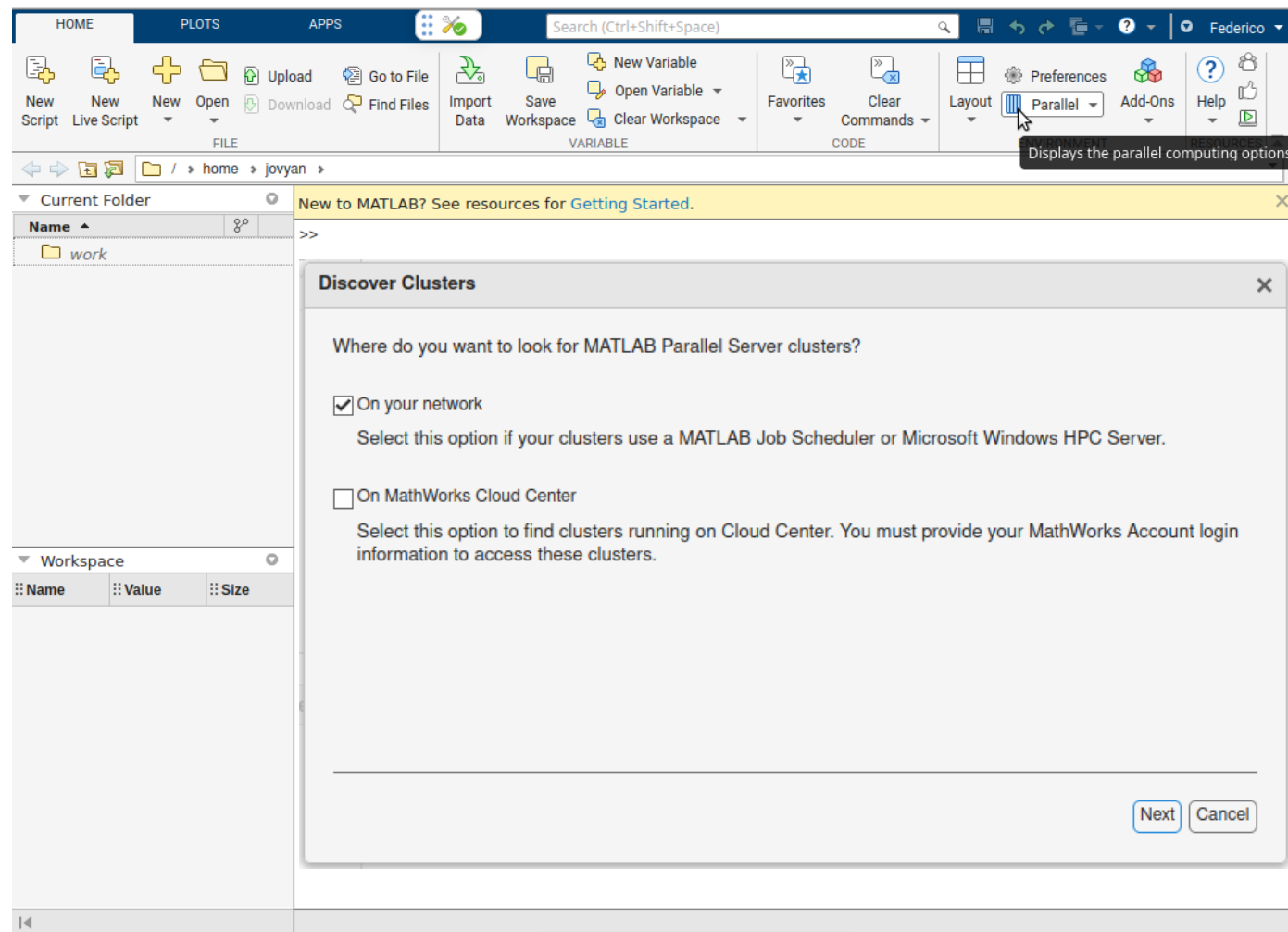
The screenshot shows the MATLAB web interface with a Jupyter Notebook kernel. The code in the notebook is as follows:

```
>> columns = 10000;
>> rows = 1;
>> bins = columns/100;
>> rng(now);
>> list = 100*rand(rows, columns);
>> histogram(list, bins);
>>
```

The plot shows a histogram of random data, with the x-axis ranging from 0 to 100 and the y-axis ranging from 0 to 140.

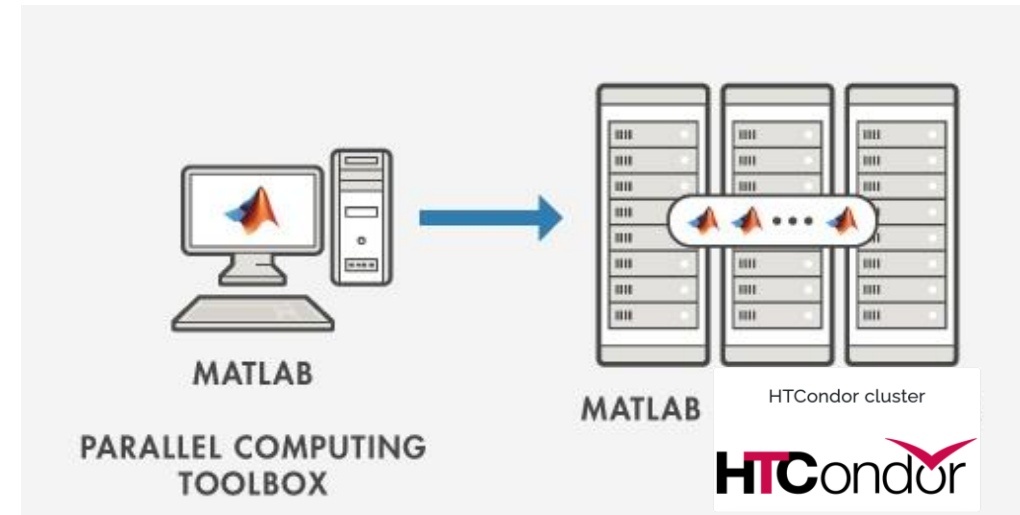
# MATLAB additional Toolboxes

- Additional MATLAB Toolboxes can be installed by building suitable Docker images
- A Dockerfile for MATLAB integration for Jupyter is available at:
  - <https://github.com/mathworks-ref-arch/matlab-integration-for-jupyter.git>
- For example, to install Parallel Computing Toolbox and run parallel jobs on an external batch system:
  - add Parallel\_Computing\_Toolbox to MATLAB\_PRODUCT\_LIST build arg
  - build your Docker image
  - push your image to a public registry



# MATLAB integration with HTCondor - WIP

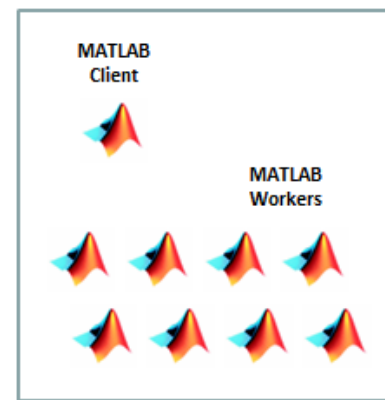
- The possibility to run MATLAB jobs on a HTCondor cluster would easily fit INFN Cloud HTCondor as a Service on Kubernetes
- An INFN Cloud user would spawn his personal HTCondor cluster integrated with MATLAB and submit MATLAB jobs to it via Parallel Computing Toolbox
- Service under development with the collaboration of MathWorks qualified experts



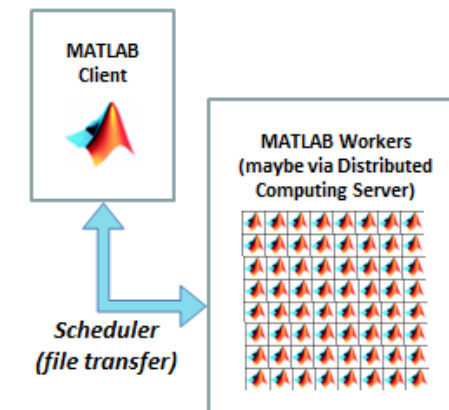
Interactive

- vs. -

Batch-style



*Start local or remote parpool, run PCT commands (scripted)*



*Submit jobs, task functions to local or remote parcluster*

# Conclusions and future plans

- MATLAB is a powerful framework for computations and simulations
- INFN invested relevant economical resources to provide this service
- INFN Cloud users may efficiently exploit MATLAB computing tools through Jupyter Notebooks
- The possibility to run MATLAB batch or interactive jobs on personal distributed computing clusters (HTCondor on K8s) would attract considerable audience among INFN communities
- The integration with heterogeneous computing environments, involving GPU resources, represents a further enhancement

# THANK YOU VERY MUCH!