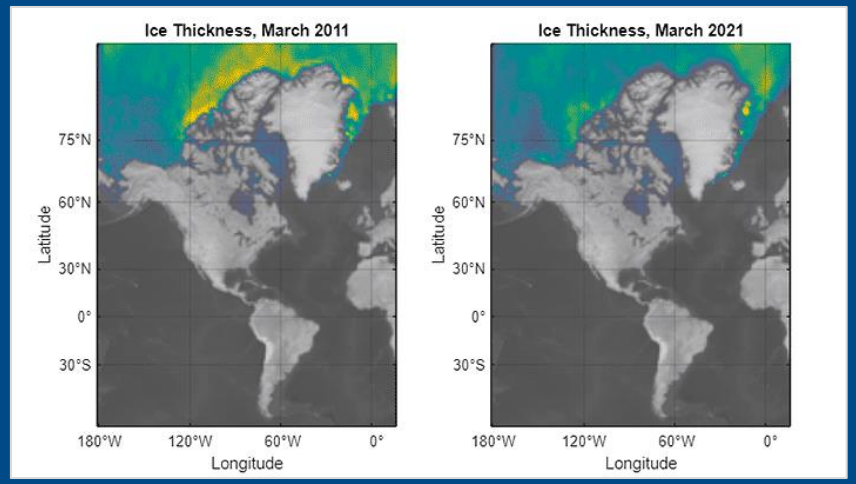
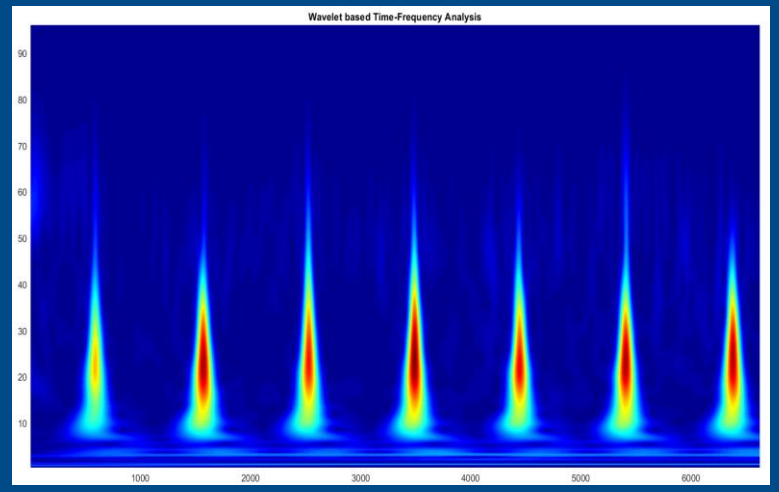
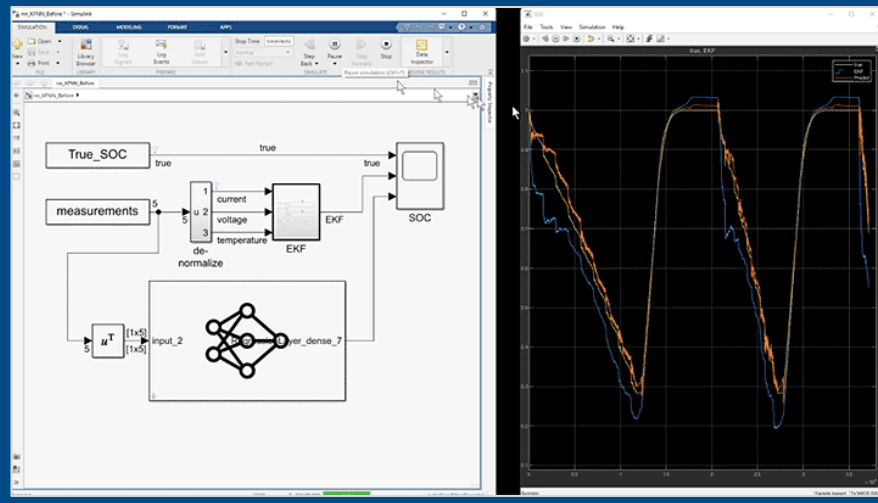
MATLAB with Python

MathWorks®

Why use MATLAB and Python together?





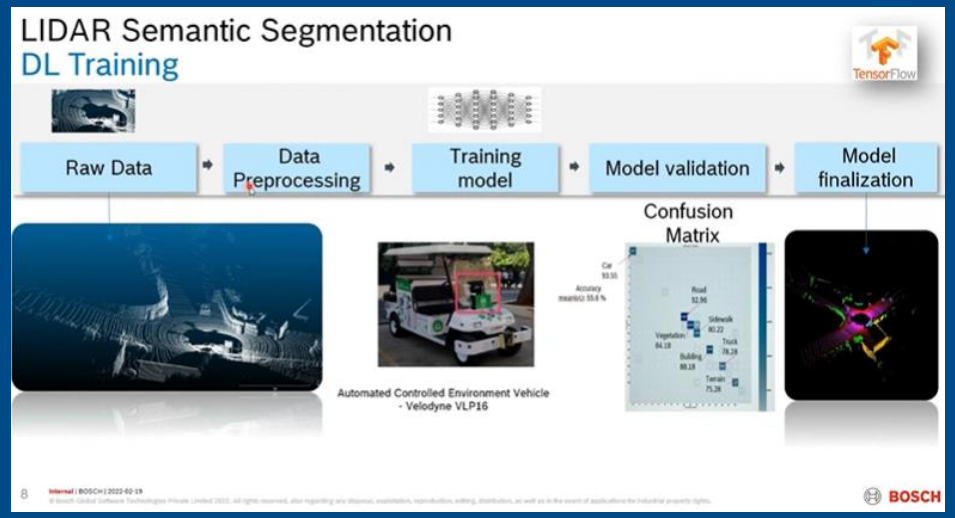


1. Reuse existing code

2. Use functionality from other language

3. Collaborate

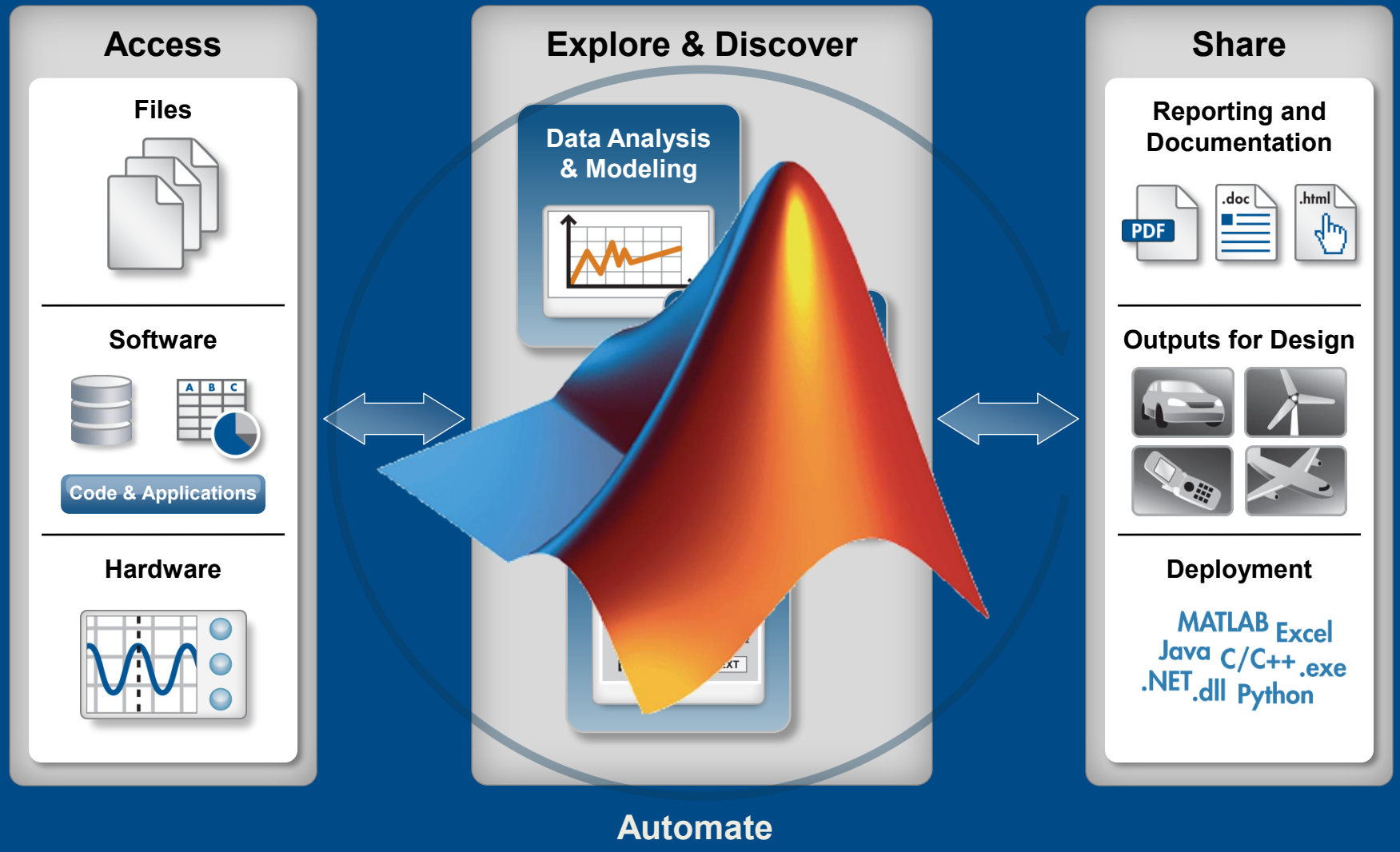
Examples of interoperability in Industry



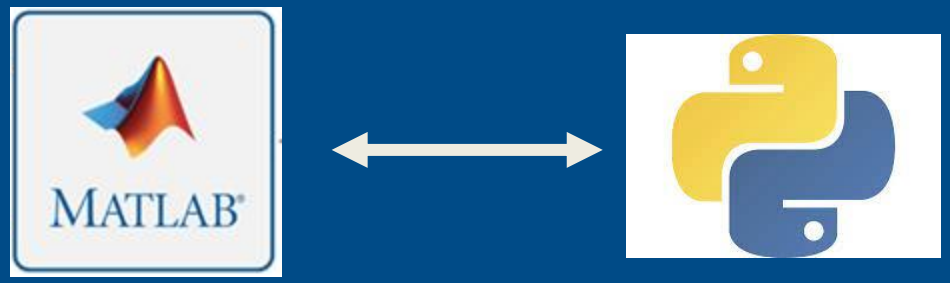
Bosch Designs and Implements a Lidar Point Cloud Classifier with MATLAB and Deep Learning Toolbox

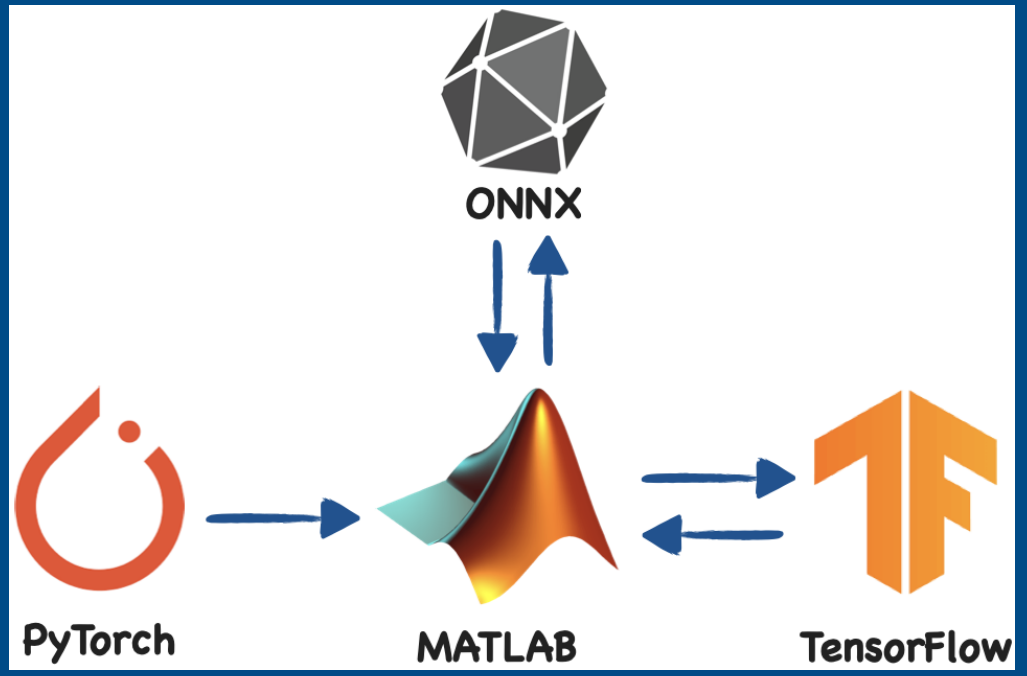
CODA

Data Analysis Workflow



What is interoperability?





I would like to **integrate my colleagues' Python codes** in my MATLAB simulations models, is it possible?

You can call Python code and models directly from MATLAB!

Can I use my colleagues **MATLAB codes and apps** in Python?

Yes! You can import saved MATLAB models, apps and scripts into Python!

Can I build an engineering project using a Python AI algorithm and deploy it to hardware?

Yes! Import the Python model into MATLAB/Simulink and then deploy it to hardware using automated code generation.

Ways to Interoperate

Python Interface

MATLAB Engine

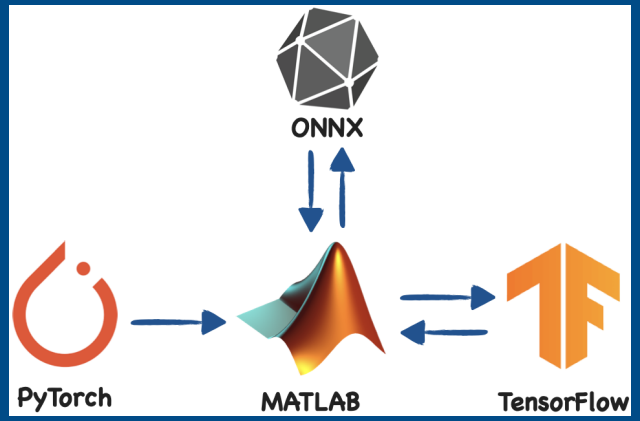
MATLAB-Python Coexecution

TensorFlow Converter

ONNX Converter

PyTorch Converter

Model Exchange



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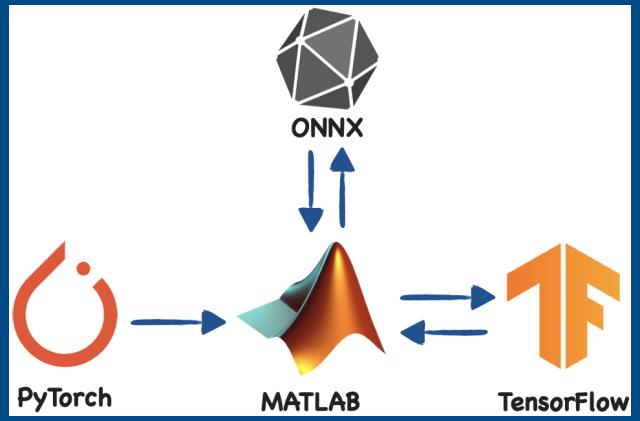
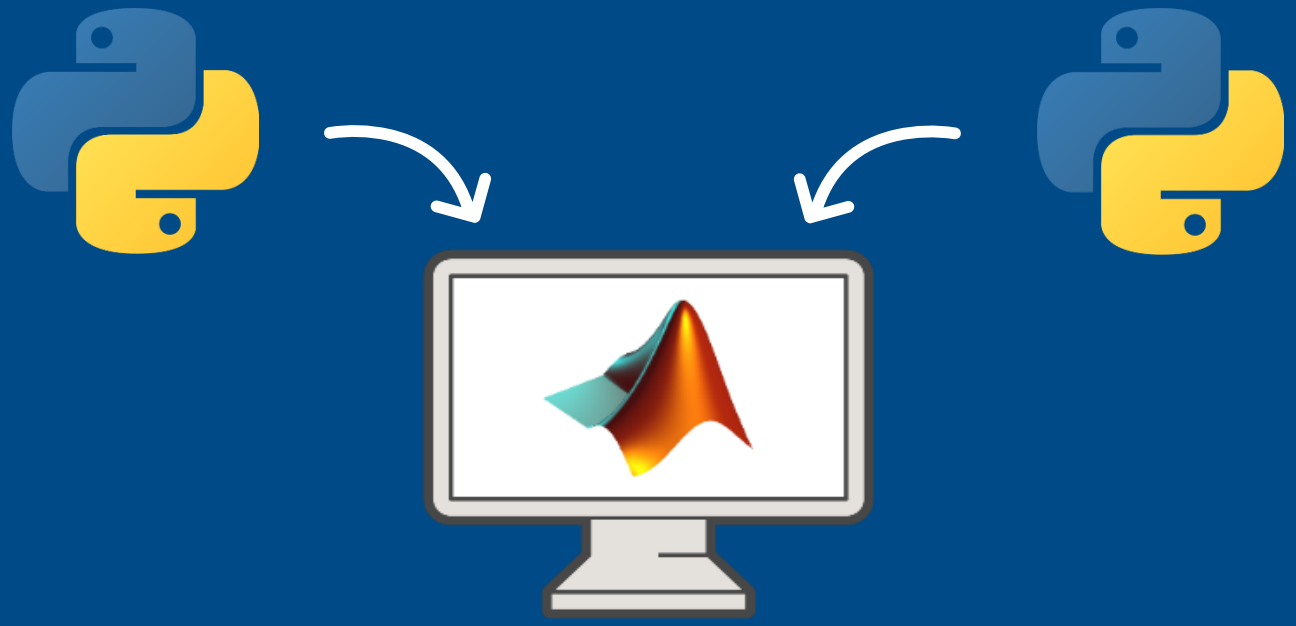
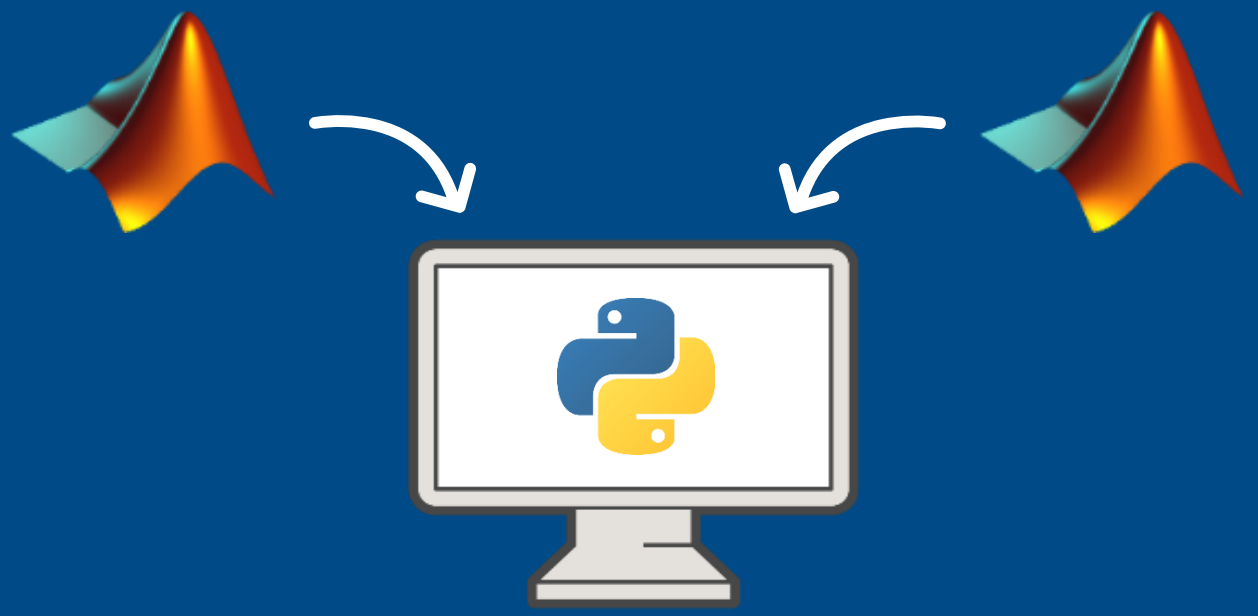


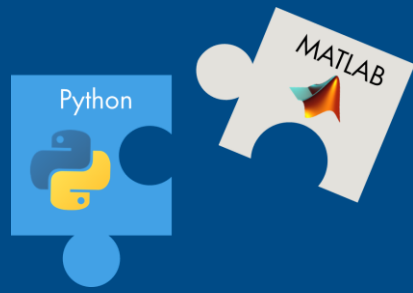


Call Python from MATLAB



Call MATLAB from Python

Call MATLAB from Python
MATLAB Engine API



- Install MATLAB Engine API for Python (from PyPI)

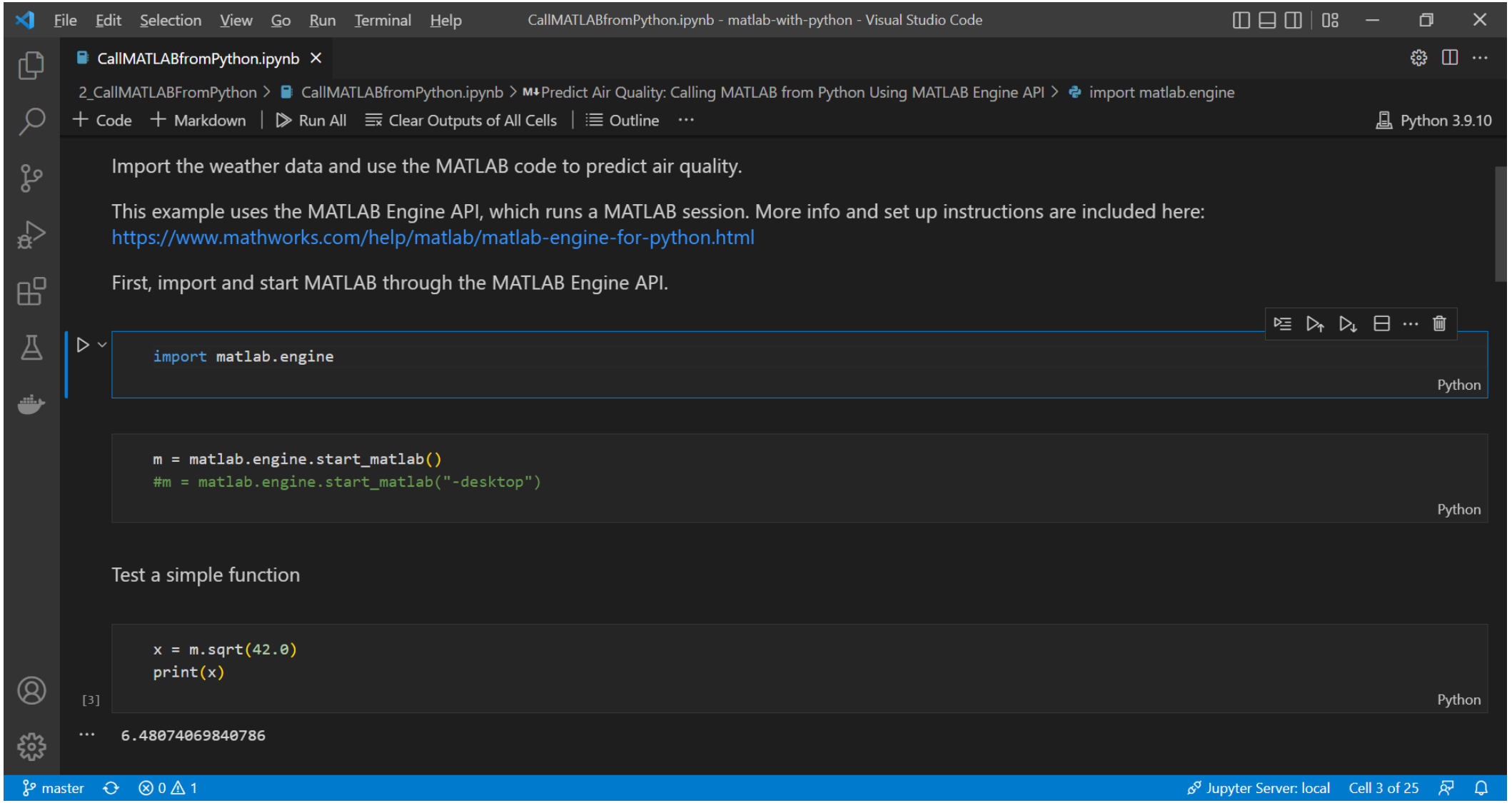
```
$ pip install matlabengine
```

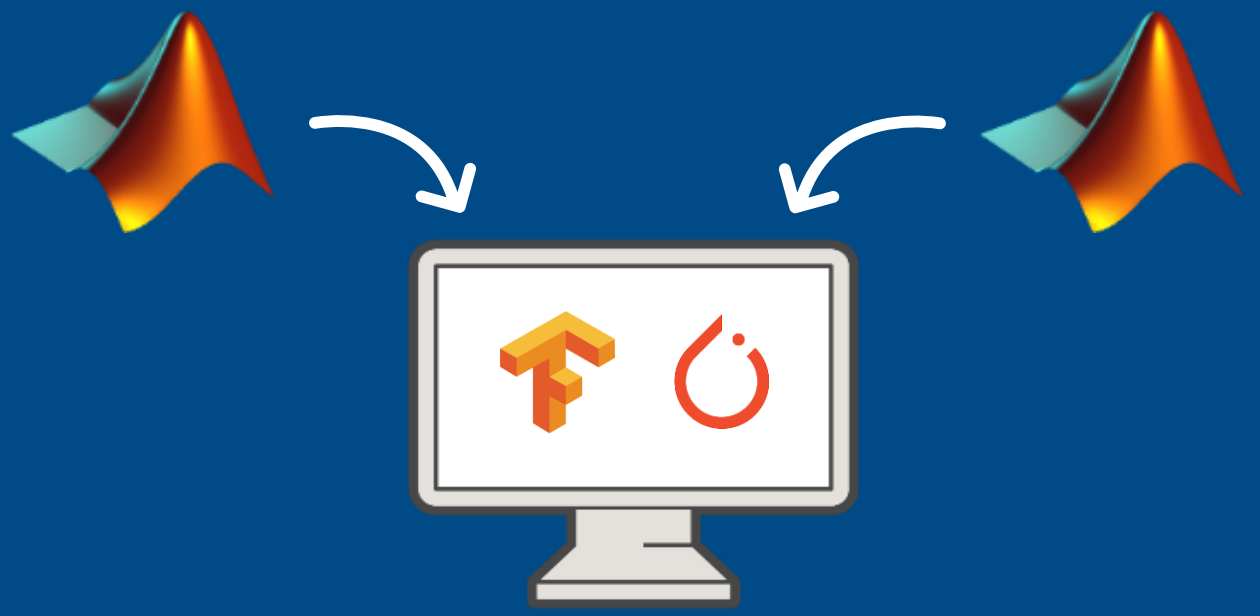
- Start a MATLAB process

```
>>> import matlab.engine
>>> m = matlab.engine.start_matlab()
```

- Call MATLAB functions

```
>>> x = m.sqrt(42.0)
```


File Edit Selection View Go Run Terminal Help
CallMATLABfromPython.ipynb - matlab-with-python - Visual Studio Code
CallMATLABfromPython.ipynb
2_CallMATLABFromPython > CallMATLABfromPython.ipynb > Predict Air Quality: Calling MATLAB from Python Using MATLAB Engine API > import matlab.engine
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline ...
Python 3.9.10
Import the weather data and use the MATLAB code to predict air quality.
This example uses the MATLAB Engine API, which runs a MATLAB session. More info and set up instructions are included here:
https://www.mathworks.com/help/matlab/matlab-engine-for-python.html
First, import and start MATLAB through the MATLAB Engine API.
import matlab.engine
Python
m = matlab.engine.start_matlab()
#m = matlab.engine.start_matlab("-desktop")
Python
Test a simple function
x = m.sqrt(42.0)
print(x)
[3]
Python
6.48074069840786
master
0 1
Jupyter Server: local
Cell 3 of 25



Additional Options

Ways to Interoperate

Python Interface

MATLAB Engine

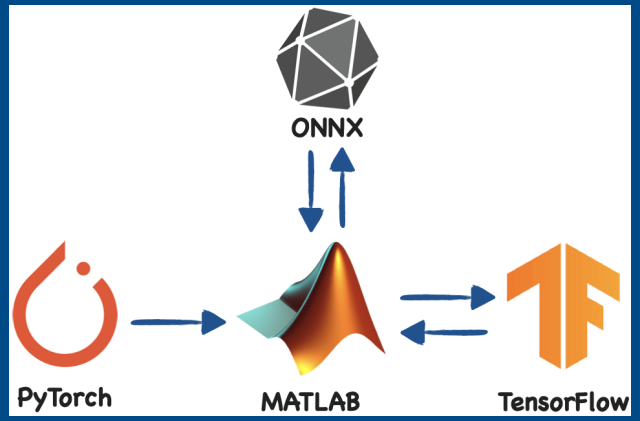
MATLAB-Python Coexecution

TensorFlow Converter

ONNX Converter

PyTorch Converter

Model Exchange

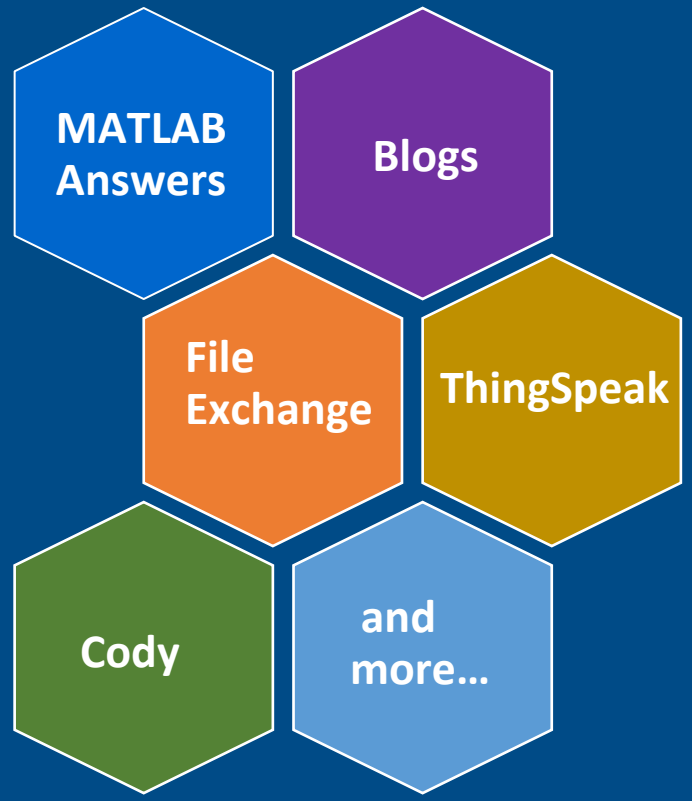


MATLAB Central Community

Every month, over **2 million** MATLAB & Simulink users visit MATLAB Central to get questions answered, download code and improve programming skills.

MATLAB Central

Learn | Contribute | Connect



MATLAB Answers: Q&A forum; most questions answered in < **1 hour**

File Exchange: Download code from a huge repository of free code including **tens of thousands** of open source community files

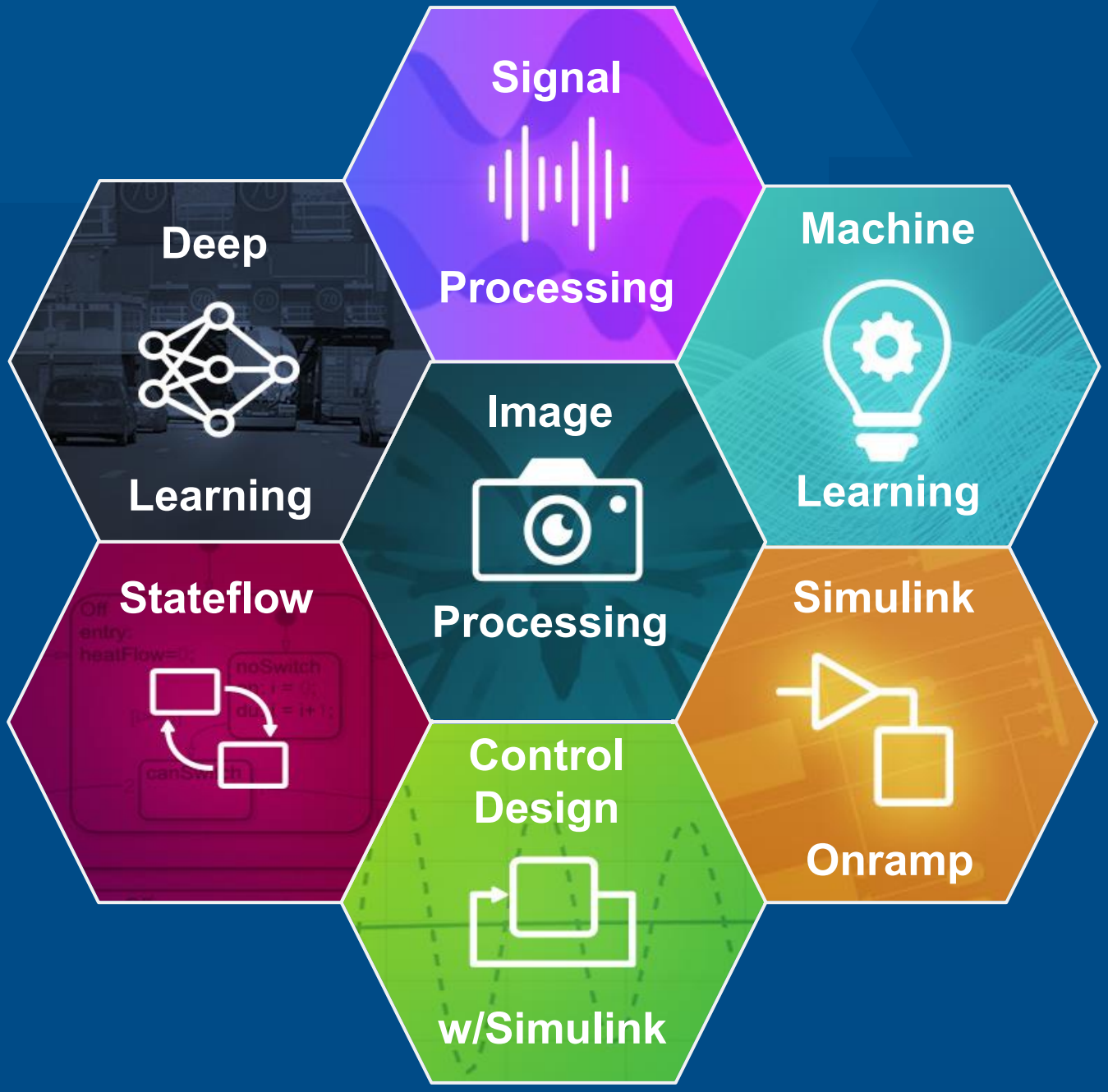
Cody: Sharpen programming skills while having fun

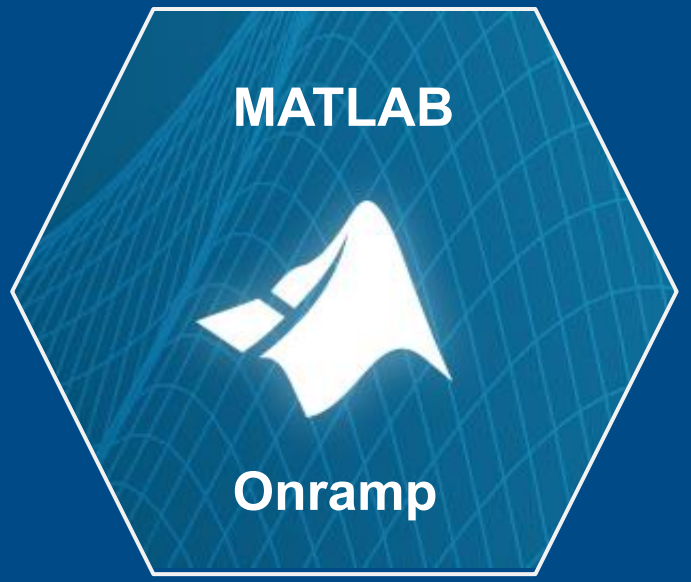
Blogs: Get the inside view from Engineers who build and support MATLAB & Simulink

ThingSpeak: Explore LoT Data

And more for you to explore…

Onramp Courses





MathWorks Engineering Support

Training

Guided Evaluations

Onsite Workshops

Consulting

Technical Support

Support from MathWorks

- Seminar/workshop/training
- MATLAB Community Toolbox support
- Licenses
- Hackathon/event monetary support
- MCT Monetary support
- DCRG Program

Quick Support

Proposal Required

Contact Info & Thank You!

Laura Keen – Lkeen@mathworks.com
https://github.com/drLKeen/NIHmatlabpython

Elvira Osuna-Highley – eosunahi@mathworks.com

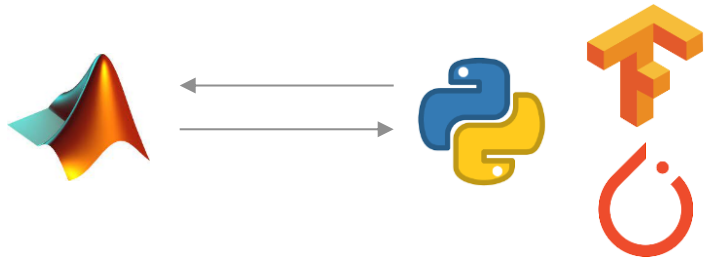
Tim Mathieu – tmathieu@mathworks.com

Matt DiGiandomenico – mdigiand@mathworks.com

MATLAB with Python

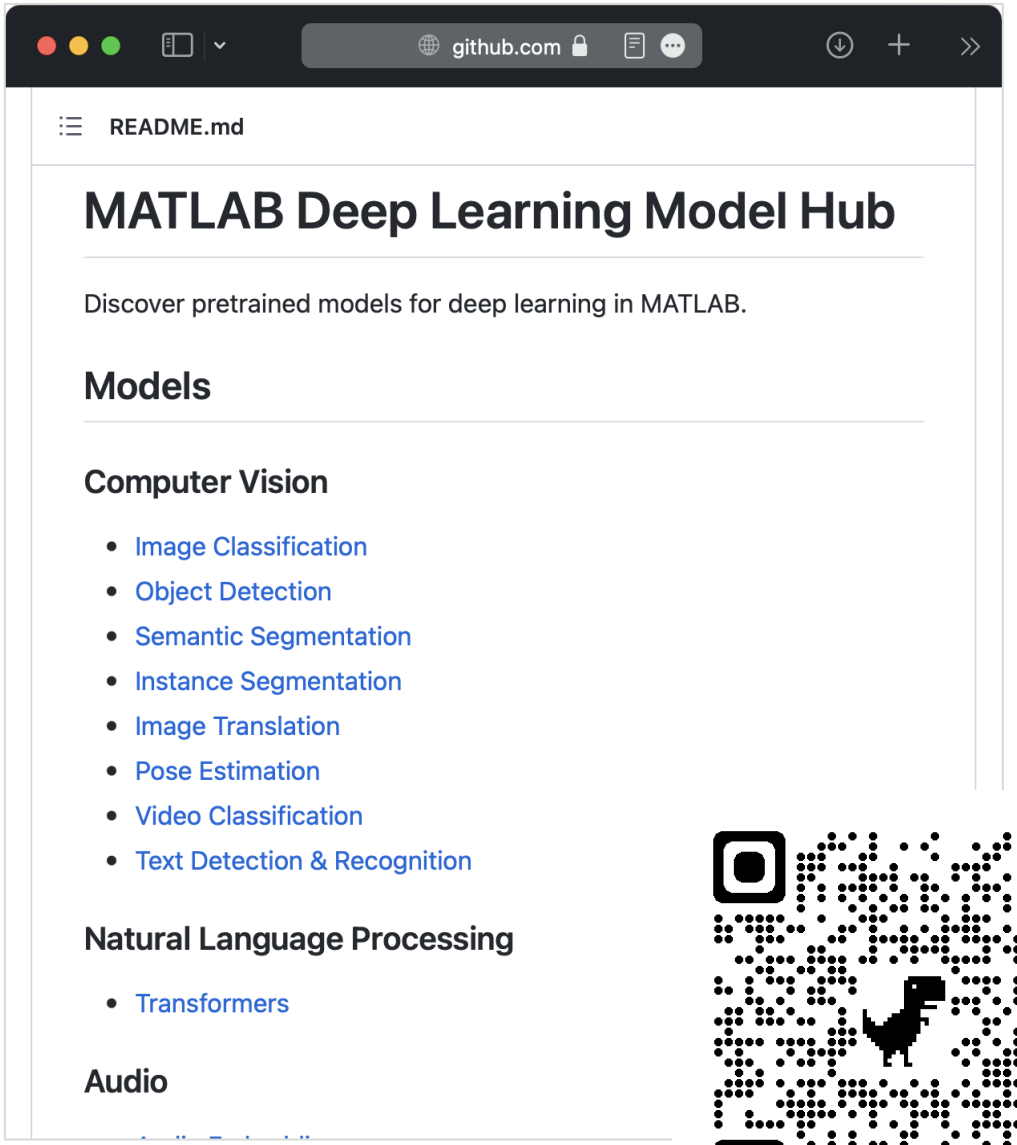
Deep Learning

Co-execution



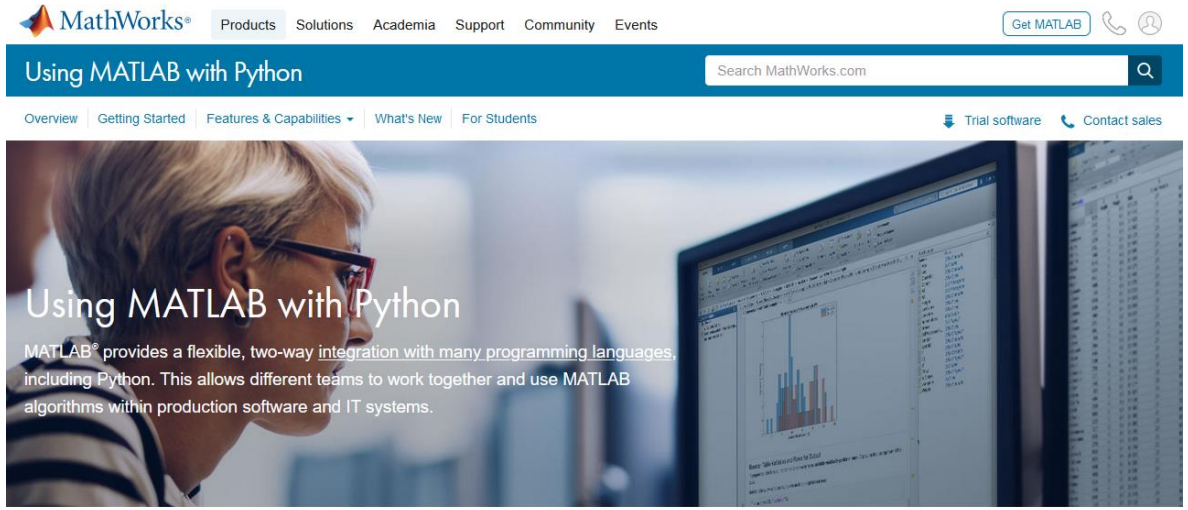
Model import/export

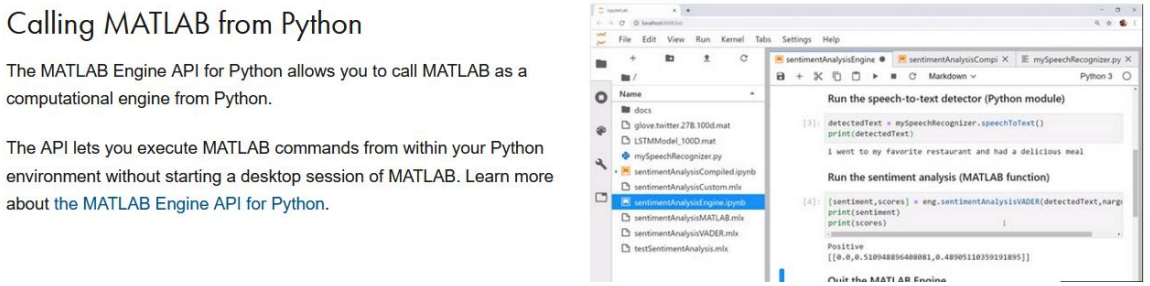
```
>> importTensorFlowNetwork("SavedModel")
>> importONNXNetwork("model.onnx")
>> exportONNXNetwork(net,"model.onnx")
```



https://github.com/matlab-deep-learning/MATLAB-Deep-Learning-Model-Hub

Resources





https://www.mathworks.com/products/matlab/matlab-and-python.html

- Cheatsheet
- Example on GitHub
- Blog post
- Videos
  - Calling Python from MATLAB
  - Calling MATLAB from Python
  - Using MATLAB with Python + Q&A (YouTube live stream recording)
- Documentation
  - Calling Python from MATLAB
  - Calling MATLAB from Python via:
    - MATLAB Engine API
    - MATLAB Compiler SDK
    - MATLAB Production Server
  - Data management:
    - Data type conversions
    - Working with Parquet files
    - MATLAB library for Apache Arrow
  - Deep Learning (TensorFlow, PyTorch, etc)

Cheatsheet

MathWorks®

Accelerating the pace of engineering and science

Using MATLAB® and Python® Together

The ≥ icon provides links to relevant sections of the MATLAB documentation to learn more.

Call Python in MATLAB

Access settings and status of Python interpreter:

```
>> pe = pyenv
```

Specify version to use:

```
>> pe = pyenv("Version",3.7)
```

Call Python modules and functions:

```
py.module_name.function_name
```

```
>> py.math.sqrt(42)
```

Pass keyword arguments

Use pyargs to pass keyword arguments

```
>>> foo(5,bar=42)
>> py.foo(5,pyargs('bar',42))
```

Reload modules

Reload the module after making updates:

```
>> py.importlib.reload(module)
```

Call MATLAB in Python

Install MATLAB Engine API for Python ≥

Run `setup.py` from an OS command window

```
$ cd [matlabroot]/extern/engines/python
$ python setup.py install
```

Call MATLAB functions

Import the module and start the engine

```
>>> import matlab.engine
>>> eng =
    matlab.engine.start_matlab()
```

Call functions through the engine

```
>>> x = eng.sqrt(42.0)
```

Capture multiple outputs

```
>>> x = eng.gcd(42.0,8.0,nargout=3)
```

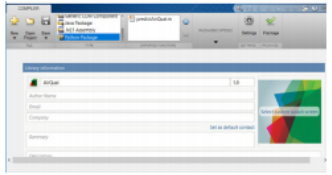
Stop the engine

```
>>> eng.exit()
```

Create Python Package

Package MATLAB functions ≥

Use the Library Compiler App to create a Python package for MATLAB functions



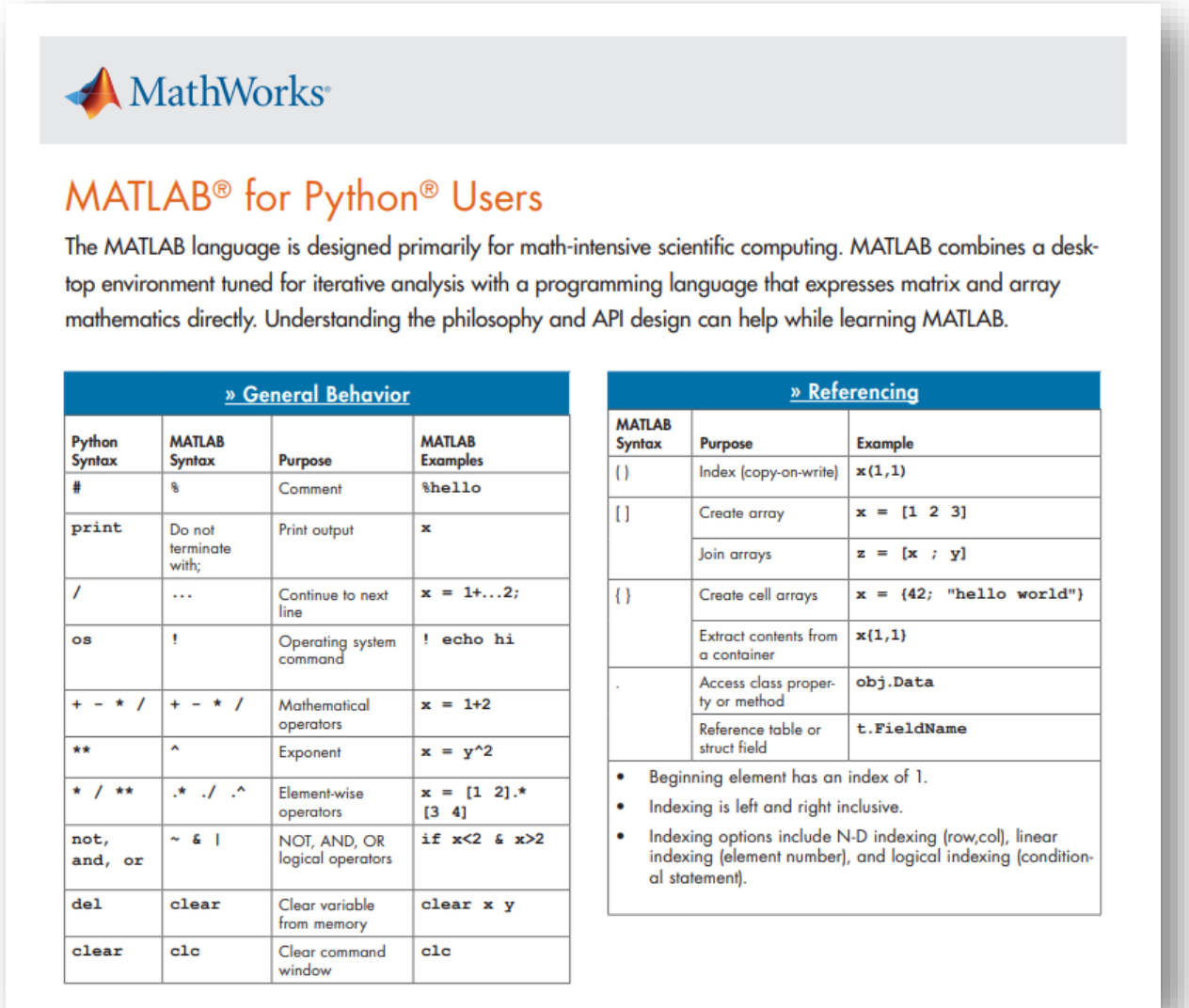
Invoke MATLAB functions from the Python package

```
>>> import PackageName
>>> pkg =
PackageName.initialize()
>>> result = pkg.foo()
```

Close package

```
>>> pkg.terminate()
```

NEW MATLAB for Python Users Cheat Sheet



MathWorks

MATLAB® for Python® Users

The MATLAB language is designed primarily for math-intensive scientific computing. MATLAB combines a desktop environment tuned for iterative analysis with a programming language that expresses matrix and array mathematics directly. Understanding the philosophy and API design can help while learning MATLAB.

» General Behavior

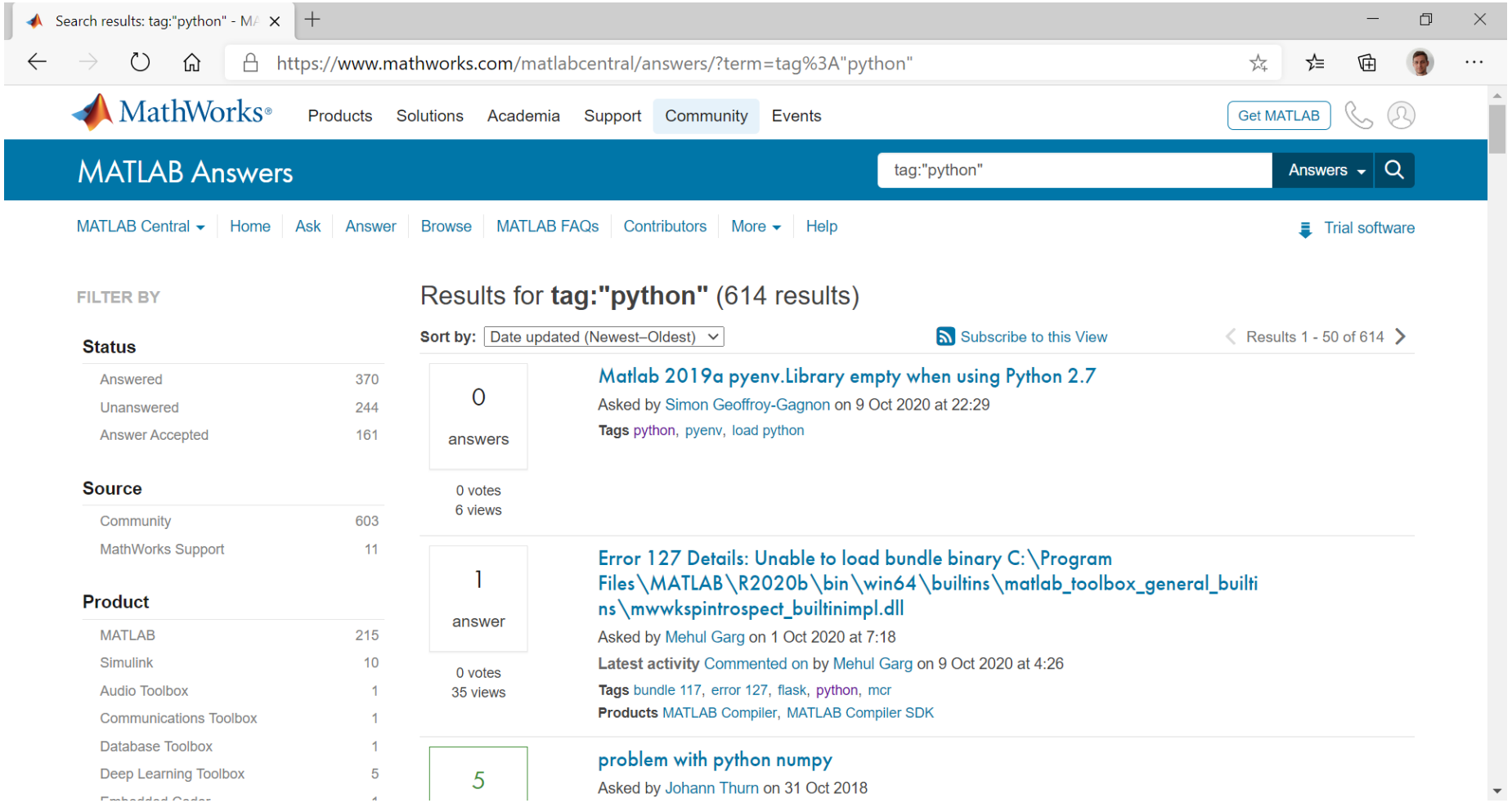
Python Syntax	MATLAB Syntax	Purpose	MATLAB Examples
#	%	Comment	%hello
print	Do not terminate with;	Print output	x
/	...	Continue to next line	x = 1+...2;
os	!	Operating system command	! echo hi
+ - * /	+ - * /	Mathematical operators	x = 1+2
**	^	Exponent	x = y^2
* / **	.* ./ .^	Element-wise operators	x = [1 2].* [3 4]
not, and, or	~ & |	NOT, AND, OR logical operators	if x<2 & x>2
del	clear	Clear variable from memory	clear x y
clear	clc	Clear command window	clc

» Referencing

MATLAB Syntax	Purpose	Example
( )	Index (copy-on-write)	x(1,1)
[ ]	Create array	x = [1 2 3]
	Join arrays	z = [x ; y]
{ }	Create cell arrays	x = {42; "hello world"}
	Extract contents from a container	x{1,1}
.	Access class property or method	obj.Data
	Reference table or struct field	t.FieldName

- Beginning element has an index of 1.
- Indexing is left and right inclusive.
- Indexing options include N-D indexing (row,col), linear indexing (element number), and logical indexing (conditional statement).

MATLAB Answers – tag:"python"



https://www.mathworks.com/matlabcentral/answers/?term=tag%3A%22python%22

Python libraries in MATLAB (1)
Directly call Python® functionality from MATLAB®

Using Python Libraries

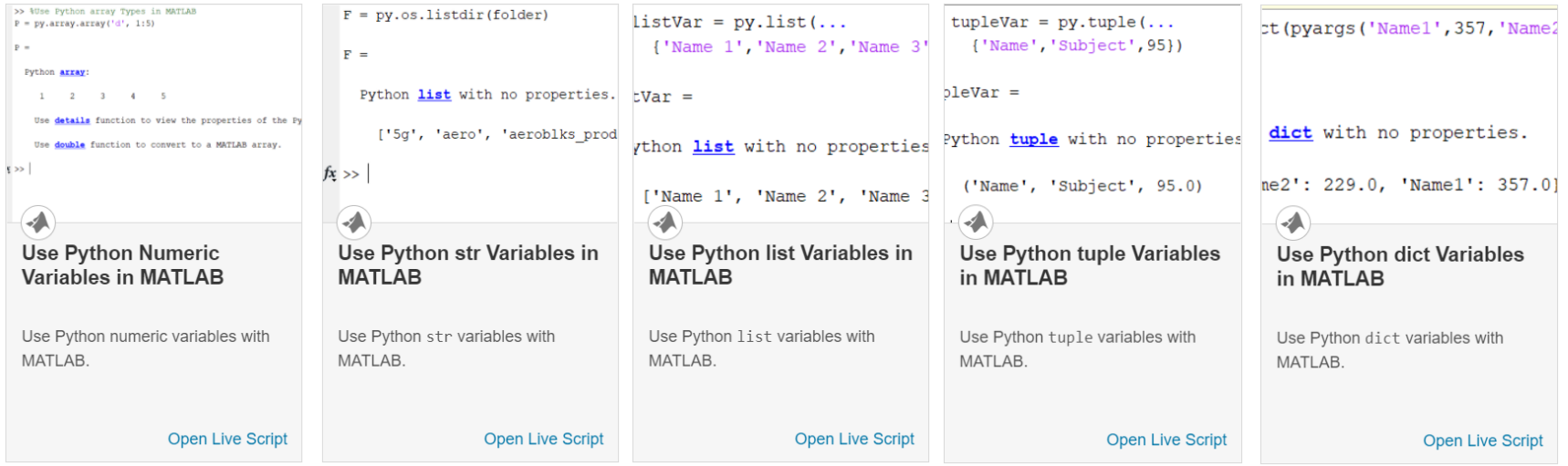
- **Access Python Modules from MATLAB - Getting Started**
  - How to create and use a Python object in MATLAB.
- **Configure Your System to Use Python**
  - How to verify you have installed a supported version of Python.
- **Call User-Defined Python Module**
  - Create a Python module used by examples in this documentation.
- **Understand Python Function Arguments**
  - Python method syntax which might be unfamiliar to MATLAB users.
- **Advanced Topics**
  - Code pattern differences you should be aware of.
- **Out-of-Process Execution of Python Functionality**
  - Execute Python scripts in processes that are separate from the MATLAB process.
- **Reload Out-of-Process Python Interpreter**
  - Reload out-of-process Python interpreter without restarting MATLAB.

https://www.mathworks.com/help/matlab/call-python-libraries.html

Python libraries in MATLAB (2)
Directly call Python® functionality from MATLAB®

Passing Data

- **MATLAB to Python Data Type Mapping**
  - How MATLAB converts MATLAB data into compatible Python data types.
- **Access Elements in Python Container Types**
  - A Python container is typically a sequence type (`list` or `tuple`) or a mapping type (`dict`).
- **Pass Python Function to Python map Function**
  - This example shows how to display the length of each word in a list.



Additional resources

Resources

- General:
  - https://www.mathworks.com/products/matlab/matlab-and-python.html
- Python from MATLAB:
  - https://www.mathworks.com/help/matlab/call-python-libraries.html
- MATLAB from Python:
  - MATLAB Engine API:
    - https://www.mathworks.com/help/matlab/matlab-engine-for-python.html
  - MATLAB Compiler SDK:
    - https://www.mathworks.com/help/compiler_sdk/python_packages.html
  - Data type conversions:
    - https://www.mathworks.com/help/matlab/python-data-types.html
- Example:
  - https://github.com/mathworks/matlab-with-python