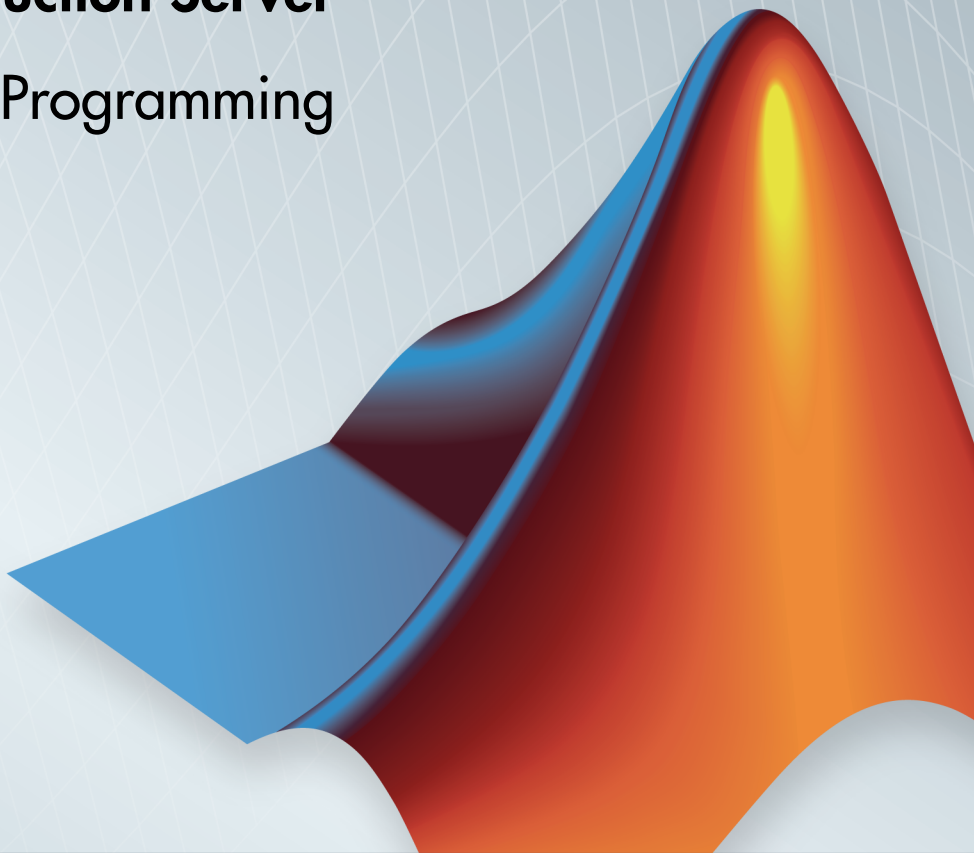


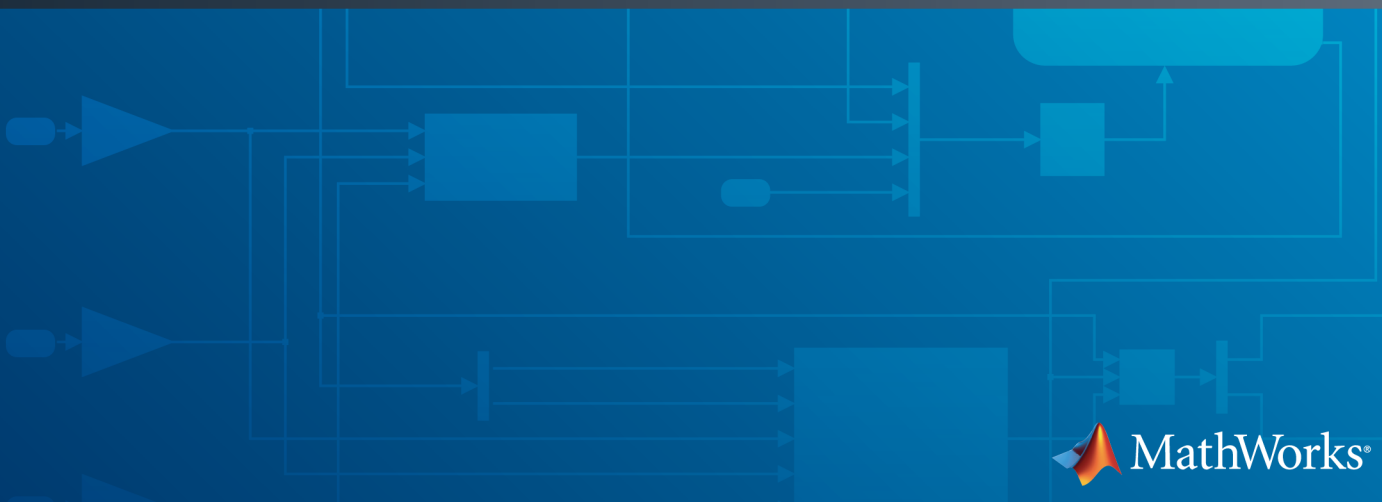
MATLAB[®] Production Server[™]

Python[®] Client Programming

R2014b



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MATLAB[®] Production Server[™] Python[®] Client Programming

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Client Programming

1

MATLAB Production Server Examples	1-2
Create a MATLAB Production Server Python Client	1-3
Create a Python Application That Calls a Deployed Function	1-4
Unsupported MATLAB Data Types for Client and Server Marshaling	1-6

Python Client Development

2

Install the MATLAB Production Server Python Client	2-2
Supported Python Interpreters	2-2
Installation Procedure	2-2
Create Client Connection	2-3
Create a Default Connection	2-3
Configure the Connection Time Out	2-4
Invoke MATLAB Functions that Return a Single Output ...	2-5
Invoke MATLAB Functions that Return Multiple Outputs ..	2-6
Receive the Results as Individual Variables	2-6
Receive the Results as a Single Object	2-6
Handle Function Processing Errors	2-8
HTTP Errors	2-8

MATLAB Runtime Errors	2-9
-----------------------------	-----

Data Handling

3

Passing Data to MATLAB Production Server from Python .	3-2
Handling Data Returned from MATLAB Production Server to Python	3-3
MATLAB Arrays as Python Variables	3-5
Create MATLAB Arrays in Python	3-5
MATLAB Array Attributes and Methods in Python	3-6
Multidimensional MATLAB Arrays in Python	3-7
Index Into MATLAB Arrays in Python	3-7
Slice MATLAB Arrays in Python	3-8
Reshaping MATLAB Arrays in Python	3-9
Use MATLAB Arrays in Python	3-10

API Reference

4

Client Programming

- “MATLAB Production Server Examples” on page 1-2
- “Create a MATLAB Production Server Python Client” on page 1-3
- “Create a Python Application That Calls a Deployed Function” on page 1-4
- “Unsupported MATLAB Data Types for Client and Server Marshaling” on page 1-6

MATLAB Production Server Examples

Additional Client examples for MATLAB Production Server are available in the `client` folder of your MATLAB Production Server.

Create a MATLAB Production Server Python Client

To create a MATLAB Production Server client:

- 1** Install the client run-time files.
See “Install the MATLAB Production Server Python Client” on page 2-2
- 2** In consultation with the MATLAB programmer, agree on the MATLAB function signatures that comprise the services in the application.
- 3** Write the Python code to instantiate a connection to a MATLAB Production Server instance.
See “Create Client Connection” on page 2-3
- 4** Create the required MATLAB data for function inputs and outputs.
See “MATLAB Arrays as Python Variables” on page 3-5.
- 5** Evaluate the MATLAB functions.
See “Invoke MATLAB Functions that Return a Single Output” on page 2-5 or “Invoke MATLAB Functions that Return Multiple Outputs” on page 2-6
- 6** Close the client connection.

Create a Python Application That Calls a Deployed Function

This example shows how to write a MATLAB Production Server client using the Python client API. The client application calls the `addmatrix` function you compiled in “Create a Deployable Archive for MATLAB Production Server” and deployed in “Share a Deployable Archive on the Server Instance”.

Create a Python MATLAB Production Server client application:

- 1 Copy the contents of the `MPS_INSTALL\clients\python` folder to your development environment.
- 2 Open a command line,
- 3 Change directories into the folder where you copied the MATLAB Production Server Python client.
- 4 Run the following command.

```
python install_mps.py
```

- 5 Start the Python command line interpreter.
- 6 Enter the following import statements at the Python command prompt.

```
import matlab  
from production_server import client
```

- 7 Open the connection to the MATLAB Production Server instance and initialize the client runtime.

```
client_obj = client.MWHttpClient("http://localhost:9910")
```

- 8 Create the MATLAB data to input to the function.

```
a1 = matlab.double([[1,2,3],[3,2,1]])  
a2 = matlab.double([[4,5,6],[6,5,4]])
```

- 9 Call the deployed MATLAB function.

You must know the following:

- Name of the deployed archive
- Name of the function

```
client_obj.addmatrix.addmatrix(a1,a2)
```

```
matlab.double([[5.0,7.0,9.0],[9.0,7.0,5.0]])
```


The syntax for invoking a function is
`client.archiveName.functionName(arg1, arg2, ..,
[nargout=numOutArgs]).`

- 10** Close the client connection.

```
client_obj.close()
```

Unsupported MATLAB Data Types for Client and Server Marshaling

These data types are not supported for marshaling between MATLAB Production Server instances and clients:

- MATLAB function handles
- Complex (imaginary) data
- Sparse arrays

Python Client Development

- “Install the MATLAB Production Server Python Client” on page 2-2
- “Create Client Connection” on page 2-3
- “Invoke MATLAB Functions that Return a Single Output” on page 2-5
- “Invoke MATLAB Functions that Return Multiple Outputs” on page 2-6
- “Handle Function Processing Errors” on page 2-8

Install the MATLAB Production Server Python Client

In this section...
“Supported Python Interpreters” on page 2-2
“Installation Procedure” on page 2-2

Supported Python Interpreters

The MATLAB Production Server Python client supports Python v. 2.7 (<https://www.python.org/download/releases/2.7.7/>).

Installation Procedure

The MATLAB Production Server Python client provides a standard Python setup script. This script installs the required modules into your Python environment.

- 1 Change into the Python client folder.

UNIX

```
cd MPS_INSTALL/client/python
```

Windows

```
cd MPS_INSTALL\client\python
```

- 2 Run the setup script.

```
python setup.py install
```

Create Client Connection

In this section...

“Create a Default Connection” on page 2-3

“Configure the Connection Time Out” on page 2-4

The connection between a Python client and a MATLAB Production Server instance is encapsulated in a `matlab.production_server.client.MWHttpClient` object. You use the constructor to instantiate the connection between the client and the server.

The `MWHttpClient()` constructor has the following signature:

```
client.MWHttpClient(url[, timeout_ms=timeout])
```

The constructor has the following arguments:

- *url* — URL of the server instance to which the client connects.

Note: The URL contains only the host name and port information of the server instance.

- *timeout_ms* — amount of time, in milliseconds, that the client waits for a response before timing out.

The default time out interval is 2 minutes.

Note: The `MWHttpClient` object is not thread-safe. If you are developing a multithreaded application, create a new `MWHttpClient` object for each thread.

Create a Default Connection

To create a default connection, provide a value for the server instance URL. The `timeout_ms` argument has a default value and can be left unspecified. This code sample shows how to connect to server instance on a host named `mps_host` using the default timeout of 2 minutes.

```
import matlab
from production_server import client
```

```
my_client = client.MWHttpClient("http://mps_host:9190")
```

Configure the Connection Time Out

You specify the connection time out by providing a value for the `timeout_ms` argument. This code sample specifies a time out of 1 minute.

```
import matlab
from production_server import client

my_client = client.MWHttpClient("http://mps_host:9190", timeout_ms=60000)
```

Invoke MATLAB Functions that Return a Single Output

The connection between a Python client and a MATLAB Production Server instance is encapsulated in a `matlab.production_server.client.MWHttpClient` object. You invoke MATLAB functions directly using the client connection object.

```
result = my_client.archive_name.function_name(in_args)
```

- *my_client* — Name of client connection object
- *archive_name* — Name of the deployable archive hosting the function
- *function_name* — Name of the function to invoke
- *in_args* — Comma-separated list of input arguments

For example, to invoke the MATLAB function `result = mutate(m1, m2, m3)` from the deployable archive `mutations`, you use this code:

```
import matlab
from production_server import client

my_client = client.MWHttpClient("http://localhost:9910")

m1 = matlab.double(...)
m2 = matlab.double(...)
m3 = matlab.double(...)

result = my_client.mutations.mutate(m1,m2,m3)
```

Invoke MATLAB Functions that Return Multiple Outputs

In this section...

“Receive the Results as Individual Variables” on page 2-6

“Receive the Results as a Single Object” on page 2-6

Receive the Results as Individual Variables

The connection between a Python client and a MATLAB Production Server instance is encapsulated in a `matlab.production_server.client.MWHttpClient` object. When you are expecting multiple return values from the server and want each return value saved in a variable, invoke MATLAB functions directly using the client connection object.

```
result1,result2,...resultN = my_client.archive_name.function_name(in_args, nargout=nargs)
```

- *my_client* — Name of client connection object
- *archive_name* — Name of the deployable archive hosting the function
- *function_name* — Name of the function to invoke
- *in_args* — Comma-separated list of input arguments
- *nargs* — Number of results expected from the server

Each left-hand variable is populated with a single return value.

For example, to invoke the MATLAB function `c1,c2= copy(o1,o2)` from the deployable archive `copier`, you use the following code.

```
>>> import matlab
>>> from production_server import client
>>> my_client = client.MWHttpClient("http://localhost:9910")
>>> c1,c2 = my_client.copier.copy("blue",10,nargout=2)
>>> print(c1)
"blue"
>>> print(c2)
10
```

Receive the Results as a Single Object

The connection between a Python client and a MATLAB Production Server instance is encapsulated in a `matlab.production_server.client.MWHttpClient` object. You invoke MATLAB functions directly using the client connection object.


```
results = my_client.archive_name.function_name(in_args, nargout=nargs)
```

- *my_client* — Name of client connection object
- *archive_name* — Name of the deployable archive hosting the function
- *function_name* — Name of the function to invoke
- *in_args* — Comma-separated list of input arguments
- *nargs* — Number of results expected from the server

The left-hand variable is populated by a list containing all of the returned values.

For example, to invoke the MATLAB function `c1,c2= copy(o1,o2)` from the deployable archive `copier`, use this code:

```
>>> import matlab
>>> from production_server import client
>>> my_client = client.MWHttpClient("http:\\localhost:9910")
>>> copies = my_client.copier.copy("blue",10,nargout=2)
>>> print(copies)
["blue",10]
```

Handle Function Processing Errors

In this section...
“HTTP Errors” on page 2-8
“MATLAB Runtime Errors” on page 2-9

The common types of exceptions that can occur when evaluating MATLAB functions include:

- HTTP errors — Handled using the Python `httplib.HTTPException` exception. Common reasons for HTTP errors include:
 - Using an incorrect archive name
 - Using an incorrect function name
 - Timing out before the function finishes evaluating
- MATLAB runtime errors — handled using the `matlab.mpsexception.MATLABException` exception. Occur when the MATLAB runtime generates an error while evaluating a function.

Your client code should handle these errors gracefully.

HTTP Errors

If your client code experiences any issues when sending data to or receiving data from a server instance, an `httplib.HTTPException` exception is raised. A common cause for an HTTP error is a name mismatch between deployed artifacts on the server and the functions called in the client.

For example, deploying the function `mutate()` in the archive `mutations` the following results in an error because the server instance would not be able to resolve the name of the archive.

```
import httplib
import matlab
from production_server import client

def main()
    my_client = client.MWHttpClient("http://localhost:9190")
```

```

try:
    result = my_client.mutation.mutate("blue",10,12)
    ...
except httpplib.HTTPException as e:
    print e

```

If you deploy the function `mutate()` in the archive `mutations` the following results in an error because the server instance would not be able to resolve the name of the function.

```

import httpplib
import matlab
from production_server import client

def main()
    my_client = client.MWHttpClient("http://localhost:9190")

    try:
        result = my_client.mutations.mutator("blue",10,12)
        ...
    except httpplib.HTTPException as e:
        print e

```

MATLAB Runtime Errors

If an error occurs while the MATLAB runtime is evaluating a function a `matlab.mpsexception.MATLABException` exception is raised. The exception contains the following:

- `m1_error_message` — Error message returned by the MATLAB runtime
- `m1_error_identifier` — MATLAB error ID
- `m1_error_stack` — MATLAB runtime stack

This function catches any MATLAB runtime errors and prints them to the console.

```

from matlab.production_server import client
from matlab.production_server import mpsexceptions
import sys

def main(size):

    my_client = client.MWHttpClient('http://localhost:9190')
    try:

```

```
    data = my_client.magic.mymagic(size)
    print data
except mpsexceptions.MATLABException as e:
    print 'MATLAB Error: ',e

my_client.close()
```

Data Handling

- “Passing Data to MATLAB Production Server from Python” on page 3-2
- “Handling Data Returned from MATLAB Production Server to Python” on page 3-3
- “MATLAB Arrays as Python Variables” on page 3-5
- “Use MATLAB Arrays in Python” on page 3-10

Passing Data to MATLAB Production Server from Python

When you pass data as input arguments to MATLAB functions from Python, MATLAB Production Server converts the data into equivalent MATLAB data types.

Python Input Argument Type	Resulting MATLAB Data Type (scalar unless otherwise noted)
matlab numeric array object (see “MATLAB Arrays as Python Variables” on page 3-5)	Numeric array
float	double
complex	Complex double
int	int32(Windows®) int64(Linux® and Mac)
long ^a	int64
float('nan')	NaN
float('inf')	Inf
bool	logical
str	char
bytearray	uint8 array
bytes	uint8 array
dict	Structure if all keys are strings Not supported otherwise
list	Cell array
set	Cell array
tuple	Cell array
memoryview	Not supported
range	Cell array
None	Not supported
<i>module.type</i>	Not supported

a. long is a data type of Python 2.7 only

Handling Data Returned from MATLAB Production Server to Python

When MATLAB functions return output arguments, MATLAB Production Server converts the data into equivalent Python data types.

MATLAB Output Argument Type (scalar unless otherwise noted)	Resulting Python Data Type
Numeric array	matlab numeric array object (see “MATLAB Arrays as Python Variables” on page 3-5)
double single	float
Complex (any numeric type)	complex
int8 uint8 int16 uint16 int32	int
uint32 int64 uint64	int long
NaN	float('nan')
Inf	float('inf')
logical	bool
char array (1-by-N, N-by-1) char array (M-by-N)	str Not supported
structure	dict
Row or column cell array	list
M-by-N cell array	Not supported
MATLAB handle object (table, containers.Map, categorical array)	Not supported
Other object (e.g., Java [®])	Not supported
Function handle	Not supported

MATLAB Output Argument Type (scalar unless otherwise noted)	Resulting Python Data Type
Sparse array	Not supported
String array	Not supported
Structure array	Not supported

MATLAB Arrays as Python Variables

In this section...

“Create MATLAB Arrays in Python” on page 3-5

“MATLAB Array Attributes and Methods in Python” on page 3-6

“Multidimensional MATLAB Arrays in Python” on page 3-7

“Index Into MATLAB Arrays in Python” on page 3-7

“Slice MATLAB Arrays in Python” on page 3-8

“Reshaping MATLAB Arrays in Python” on page 3-9

The `matlab` Python package provides array classes to represent arrays of MATLAB numeric types as Python variables. MATLAB arrays can be passed as input arguments to functions called with MATLAB Production Server and returned as output arguments from functions called with MATLAB Production Server.

Create MATLAB Arrays in Python

You can create MATLAB numeric arrays in a Python session by calling constructors from the `matlab` Python package (for example, `matlab.double`, `matlab.int32`). The name of the constructor indicates the MATLAB numeric type. You can pass MATLAB arrays as input arguments to functions called with the MATLAB Engine for Python. When a MATLAB function returns a numeric array as an output argument, MATLAB Production Server returns the array to Python.

You can initialize the array with an optional `initializer` input argument that contains numbers. The `initializer` argument must be a Python sequence type such as a list or a tuple. The optional `size` input argument sets the size of the initialized array. To create multidimensional arrays specify `initializer` to contain multiple sequences of numbers, or specify `size` to be multidimensional. You can create a MATLAB array of complex numbers by setting the optional `is_complex` keyword argument to `True`. The `mlarray` module provides the MATLAB array constructors listed in the table.

Class from <code>matlab</code> Package	Constructor Call in Python	MATLAB Numeric Type	
<code>matlab.double</code>	<code>matlab.double(initializer)</code>	Double precision	<code>complex=False</code>
<code>matlab.single</code>	<code>matlab.single(initializer)</code>	Single precision	<code>complex=False</code>
<code>matlab.int8</code>	<code>matlab.int8(initializer)</code>	8-bit signed integer	<code>complex=False</code>

Class from matlab Package	Constructor Call in Python	MATLAB Numeric Type
<code>matlab.int16</code>	<code>matlab.int16(initializ</code>	16-bit signed integer
<code>matlab.int32</code>	<code>matlab.int32(initializ</code>	32-bit signed integer
<code>matlab.int64^a</code>	<code>matlab.int64(initializ</code>	64-bit signed integer
<code>matlab.uint8</code>	<code>matlab.uint8(initializ</code>	8-bit unsigned integer
<code>matlab.uint16</code>	<code>matlab.uint16(initiali</code>	16-bit unsigned integer
<code>matlab.uint32</code>	<code>matlab.uint32(initiali</code>	32-bit unsigned integer
<code>matlab.uint64^b</code>	<code>matlab.uint64(initiali</code>	64-bit unsigned integer
<code>matlab.logical</code>	<code>matlab.logical(initial</code>	Logical

- a. In Python 2.7 on Windows, `matlab.int64` is converted to `int32` in MATLAB. Also, MATLAB cannot return an `int64` array to Python.
- b. In Python 2.7 on Windows, `matlab.uint64` is converted to `uint32` in MATLAB. Also, MATLAB cannot return a `uint64` array to Python.
- c. Logicals cannot be made into an array of complex numbers.

When you create an array with N elements, the size is 1-by-N because it is a MATLAB array.

```
import matlab
A = matlab.int8([1,2,3,4,5])
print(A.size)
```

(1, 5)

The initializer is a Python list containing five numbers. The MATLAB array size is 1-by-5, indicated by the tuple (1,5).

MATLAB Array Attributes and Methods in Python

All MATLAB arrays created with `matlab` package constructors have the attributes and methods listed in the table below:

Attribute or Method	Purpose
<code>size</code>	Size of array returned as a tuple
<code>reshape(size)</code>	Reshape the array as specified by the sequence <code>size</code>

Multidimensional MATLAB Arrays in Python

In Python, you can create multidimensional MATLAB arrays of any numeric type. Use two Python lists of floats to create a 2-by-5 MATLAB array of doubles.

```
import matlab
A = matlab.double([[1,2,3,4,5], [6,7,8,9,10]])
print(A)
```

```
[[1.0,2.0,3.0,4.0,5.0],[6.0,7.0,8.0,9.0,10.0]]
```

The `size` attribute of `A` shows it is a 2-by-5 array.

```
print(A.size)
```

```
(2, 5)
```

Index Into MATLAB Arrays in Python

You can index into MATLAB arrays just as you can index into Python lists and tuples.

```
import matlab
A = matlab.int8([1,2,3,4,5])
print(A[0])
```

```
[1,2,3,4,5]
```

The size of the MATLAB array is `(1,5)`; therefore, `A[0]` is `[1,2,3,4,5]`. Index into the array to get 3.

```
print(A[0][2])
```

```
3
```

Python indexing is zero-based. When you access elements of MATLAB arrays in a Python session, use zero-based indexing.

This example shows how to index into a multidimensional MATLAB array.

```
A = matlab.double([[1,2,3,4,5], [6,7,8,9,10]])
print(A[1][2])
```

```
8.0
```

Slice MATLAB Arrays in Python

You can slice MATLAB arrays just as you can slice Python lists and tuples.

```
import matlab
A = matlab.int8([1,2,3,4,5])
print(A[0][1:4])
```

```
[2,3,4]
```

You can assign data to a slice. This example shows an assignment from a Python list to the array.

```
A = matlab.double([[1,2,3,4],[5,6,7,8]])
A[0] = [10,20,30,40]
print(A)
```

```
[[10.0,20.0,30.0,40.0],[5.0,6.0,7.0,8.0]]
```

You can assign data from another MATLAB array, or from any Python iterable that contains numbers.

You can specify slices for assignment, as shown in this example.

```
A = matlab.int8([1,2,3,4,5,6,7,8])
A[0][2:4] = [30,40]
A[0][6:8] = [70,80]
print(A)
```

```
[[1,2,30,40,5,6,70,80]]
```

Note: Slicing MATLAB arrays behaves differently from slicing a Python list. Slicing a MATLAB array returns a view instead of a shallow copy.

Given a MATLAB array and a Python list with the same values, assigning a slice results in different results.

```
>>>mlarray = matlab.int32([[1,2],[3,4],[5,6]])
>>>py_list = [[1,2],[3,4],[5,6]]
>>>mlarray[0] = mlarray[0][::-1]
>>>py_list[0] = py_list[0][::-1]
>>>mlarray[0]
matlab.int32([[2,2],[3,4],[5,6]])
```

```
>>>py_list  
[[2,1],[3,4],[5,6]]
```

Reshaping MATLAB Arrays in Python

You can reshape a MATLAB array in Python with the `reshape` method. The input argument, `size`, must be a sequence that does not change the number of elements in the array. Use `reshape` to change a 1-by-9 MATLAB array to 3-by-3.

```
import matlab  
A = matlab.int8([1,2,3,4,5,6,7,8,9])  
A.reshape((3,3))  
print(A)  
  
[[1,4,7],[2,5,8],[3,6,9]]
```

Use MATLAB Arrays in Python

This example shows how to use MATLAB arrays in Python.

The `matlab` package provides new Python data types, to create arrays that can be passed to MATLAB functions. The `matlab` package can create arrays of any MATLAB numeric or logical type from Python sequence types. Multidimensional MATLAB arrays are supported.

Create a MATLAB array in Python and call a MATLAB function on it.

```
import matlab
from production_server import client
client_obj = client.MWHttpClient("http://localhost:9910")
x = matlab.double([1,4,9,16,25])
print(client_obj.myArchive.sqrt(x))
```

```
[[1.0,2.0,3.0,4.0,5.0]]
```

In this example you can use `matlab.double` to create an array of doubles given a Python list that contains numbers. You can call a MATLAB function such as `sqrt` on `x`, and the return value is another `matlab.double` array.

Create a multidimensional array. The `magic` function returns a 2-D array to Python scope.

```
a = client_obj.myArchive.magic(6)
print(a)
```

```
[[35.0,1.0,6.0,26.0,19.0,24.0],[3.0,32.0,7.0,21.0,23.0,25.0],[31.0,9.0,2.0,22.0,27.0,20.0],
```

Call the `tril` function to get the lower triangular portion of `a`.

```
b = client_obj.myArchive.tril(a)
print(b)
```

```
[[35.0,0.0,0.0,0.0,0.0,0.0],[3.0,32.0,0.0,0.0,0.0,0.0],[31.0,9.0,2.0,0.0,0.0,0.0],[8.0,0.0,0.0,0.0,0.0,0.0],
```

API Reference

matlab.production_server.client.MWHttpClient

Package: matlab.production_server

Python object encapsulating a connection to a MATLAB Production Server instance

Description

The `matlab.production_server.client.MWHttpClient` class creates a connection object that encapsulates the connection between the client and a MATLAB Production Server instance. Once the connection is created, you can dynamically call all of the MATLAB functions hosted on the server instance.

Construction

```
my_client = MWHttpClient(url,[timeout_ms=timeout_ms])
```

Input Arguments

url — URL of the server instance to connect to

string

URL of the server instance to which the client connects specified as a string. This server instance hosts the MATLAB functions which the client can evaluate.

timeout_ms — number of milliseconds the client waits for a response from the server instance

120000 (default)

Number of milliseconds the client waits for a response from the server instance specified as an integer.

Methods

close

Close the connection to MATLAB Production Server instance and release the resources used by the connection

<archive>.<func>

Call a MATLAB function from a Python client

Exceptions

HTTPException

Raised if there is a problem communicating with the server instance.

MATLABException

Raised if a function call fails to execute.

TypeError

Raised if the specified timeout value is not a positive `int` or `long`.

ValueError

Raised if the specified timeout value is less than zero.

Related Examples

- “Create a Default Connection” on page 2-3
- “Configure the Connection Time Out” on page 2-4
- “Invoke MATLAB Functions that Return a Single Output” on page 2-5
- “Invoke MATLAB Functions that Return Multiple Outputs” on page 2-6

close

Class: matlab.production_server.client.MWHttpClient

Package: matlab.production_server

Close the connection to MATLAB Production Server instance and release the resources used by the connection

Syntax

```
my_client.close()
```

Description

`my_client.close()` closes the connection between the client and the server instance. It also frees any resources being used by the connection.

Examples

Disconnect a Python Client from a Server Instance

```
import matlab
from production_server import client

my_client = client.MWHttpClient("http://mps_host:9190")
my_client.close()
```

`<archive>.<func>`

Class: `matlab.production_server.client.MWHttpClient`

Package: `matlab.production_server`

Call a MATLAB function from a Python client

Syntax

```
results = my_client.<archive>.<func>(in_args, nargsout=nargs)
```

Description

`results = my_client.<archive>.<func>(in_args, nargsout=nargs)` evaluates the specified function, *func*, hosted in the deployed archive, *archive*, and returns the results.

Input Arguments

`in_args` — input arguments to the function being evaluated

Input arguments to the named MATLAB function, specified as positional arguments. The client API passes all positional arguments to the MATLAB function.

`nargs` — number of output values expected from the server instance

1 (default)

Number of output arguments from the named MATLAB function, specified as an integer. Set to the number of output arguments when you call a MATLAB function which returns multiple arguments. The client will process up to the specified number of output arguments. If you specify 2 and the function returns 3 values, the client will only receive the first two values.

Output Arguments

results — output values from the function

One or more output arguments from a MATLAB function, returned as one or more Python variables or as a list.

Exceptions

HTTPException

Raised if there is a problem communicating with the server instance.

MATLABException

Raised if a function call fails to execute.

Related Examples

- “Invoke MATLAB Functions that Return a Single Output” on page 2-5
- “Invoke MATLAB Functions that Return Multiple Outputs” on page 2-6