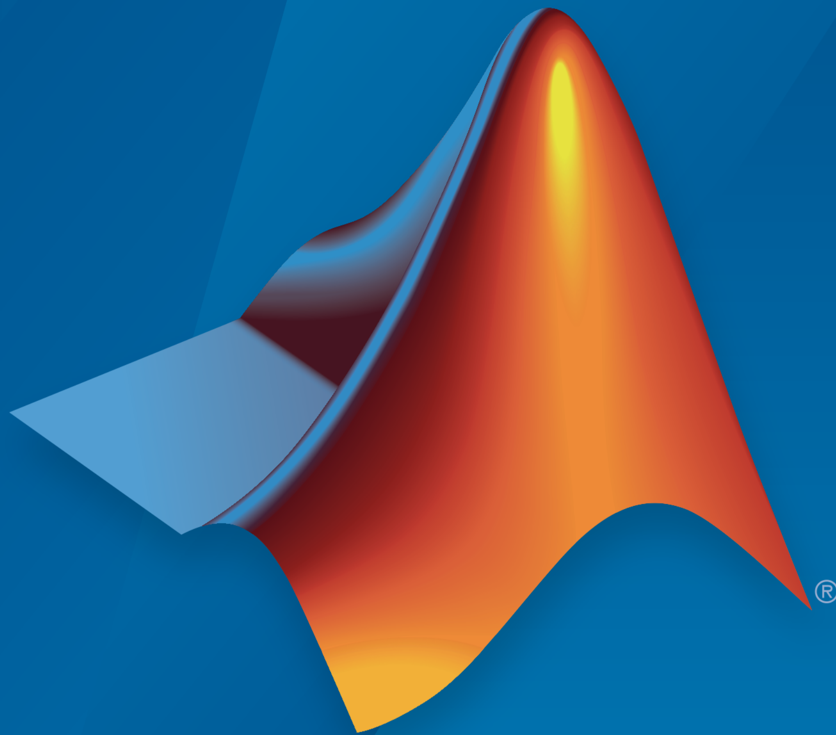
MATLAB® Compiler SDK™

Getting Started Guide



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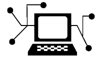

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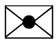

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MATLAB® Compiler SDK™ Getting Started Guide

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Revision History

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Overview of MATLAB Compiler SDK

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MATLAB Compiler SDK Product Description

Build software components from MATLAB programs

MATLAB® Compiler SDK™ extends the functionality of MATLAB Compiler™ to let you build C/C++ shared libraries, Microsoft® .NET assemblies, and Java® classes from MATLAB programs. These components can be integrated with custom applications and then deployed to desktop, web, and enterprise systems.

MATLAB Compiler SDK includes a development version of MATLAB Production Server™ for testing and debugging application code and Excel® add-ins before deploying them to web applications and enterprise systems.

Applications created using software components from MATLAB Compiler SDK can be shared royalty-free with users who do not need MATLAB. These applications use the MATLAB Runtime, a set of shared libraries that enables the execution of compiled MATLAB applications or components.

Key Features

- Packaging of your MATLAB programs as C/C++ shared libraries, Microsoft .NET assemblies, and Java classes
- Royalty-free distribution of software components to users who do not need MATLAB
- Development and test framework for MATLAB Production Server for integration with web and enterprise systems
- Encryption of MATLAB code to protect your intellectual property

Appropriate Tasks for MATLAB Compiler Products

MATLAB Compiler generates standalone applications and Excel add-ins. MATLAB Compiler SDK generates C/C++ shared libraries, deployable archives for use with MATLAB Production Server, Java packages, .NET assemblies, and COM components.

While MATLAB Compiler and MATLAB Compiler SDK let you run your MATLAB application outside the MATLAB environment, it is not appropriate for all external tasks you may want to perform. Some tasks require either the MATLAB Coder™ product or MATLAB external interfaces. Use the following table to determine if MATLAB Compiler or MATLAB Compiler SDK is appropriate to your needs.

MATLAB Compiler Task Matrix

Task	MATLAB Compiler and MATLAB Compiler SDK	MATLAB Coder	MATLAB External Interfaces
Package MATLAB applications for deployment to users who do not have MATLAB	■		
Package MATLAB applications for deployment to MATLAB Production Server	■		
Build non-MATLAB applications that include MATLAB functions	■		
Generate readable, efficient, and embeddable C code from MATLAB code		■	
Generate MEX functions from MATLAB code for rapid prototyping and verification of generated C code within MATLAB		■	
Integrate MATLAB code into Simulink®		■	
Speed up fixed-point MATLAB code		■	

Task	MATLAB Compiler and MATLAB Compiler SDK	MATLAB Coder	MATLAB External Interfaces
Generate hardware description language (HDL) from MATLAB code		■	
Integrate custom C code into MATLAB with MEX files			■
Call MATLAB from C and Fortran programs			■

For information on MATLAB Coder see “MATLAB Coder”.

For information on MATLAB external interfaces see “External Code Integration”.

Deployment Product Terms

A

Add-in — A Microsoft Excel add-in is an executable piece of code that can be actively integrated into a Microsoft Excel application. Add-ins are front-ends for COM components, usually written in some form of Microsoft Visual Basic®.

Application program interface (API) — A set of classes, methods, and interfaces that is used to develop software applications. Typically an API is used to provide access to specific functionality. See `MWArray`.

Application — An end user-system into which a deployed functions or solution is ultimately integrated. Typically, the end goal for the deployment customer is integration of a deployed MATLAB function into a larger enterprise environment application. The deployment products prepare the MATLAB function for integration by wrapping MATLAB code with enterprise-compatible source code, such as C, C++, C# (.NET), F#, and Java code.

Assembly — An executable bundle of code, especially in .NET.

B

Binary — See *Executable*.

Boxed Types — Data types used to wrap opaque C structures.

Build — See *Compile*.

C

Class — A user-defined type used in C++, C#, and Java, among other object-oriented languages, that is a prototype for an object in an object-oriented language. It is analogous to a derived type in a procedural language. A class is a set of objects which share a common structure and behavior. Classes relate in a class hierarchy. One class is a specialization (a *subclass*) of another (one of its *superclasses*) or comprises other classes. Some classes use other classes in a client-server relationship. Abstract classes have no members, and concrete classes have one or more members. Differs from a *MATLAB class*

Compile — In MATLAB Compiler and MATLAB Compiler SDK, to compile MATLAB code involves generating a binary that wraps around MATLAB code, enabling it to execute in various computing environments. For example, when MATLAB code is

compiled into a Java package, a Java wrapper provides Java code that enables the MATLAB code to execute in a Java environment.

COM component — In MATLAB Compiler, the executable back-end code behind a Microsoft Excel add-in. In MATLAB Compiler SDK, an executable component, to be integrated with Microsoft COM applications.

Console application — Any application that is executed from a system command prompt window.

D

Data Marshaling — Data conversion, usually from one type to another. Unless a MATLAB deployment customer is using type-safe interfaces, data marshaling—as from mathematical data types to MathWorks® data types such as represented by the `MWArray` API—must be performed manually, often at great cost.

Deploy — The act of integrating MATLAB code into a larger-scale computing environment, usually to an enterprise application, and often to end users.

Deployable archive — The deployable archive is embedded by default in each binary generated by MATLAB Compiler or MATLAB Compiler SDK. It houses the deployable package. All MATLAB-based content in the deployable archive uses the Advanced Encryption Standard (AES) cryptosystem. See “Additional Details”.

DLL — Dynamic link library. Microsoft's implementation of the shared library concept for Windows®. Using DLLs is much preferred over the previous technology of static (or non-dynamic) libraries, which had to be manually linked and updated.

E

Empties — Arrays of zero (`0`) dimensions.

Executable — An executable bundle of code, made up of binary bits (zeros and ones) and sometimes called a *binary*.

F

Fields — For this definition in the context of MATLAB Data Structures, see *Structs*.

Fields and Properties — In the context of .NET, *Fields* are specialized classes used to hold data. *Properties* allow users to access class variables as if they were accessing member fields directly, while actually implementing that access through a class method.

I

Integration — Combining deployed MATLAB code's functionality with functionality that currently exists in an enterprise application. For example, a customer creates a mathematical model to forecast trends in certain commodities markets. In order to use this model in a larger-scale financial application (one written with the Microsoft .NET Framework, for instance) the deployed financial model must be integrated with existing C# applications, run in the .NET enterprise environment.

Instance — For the definition of this term in context of MATLAB Production Server software, see *MATLAB Production Server Server Instance*.

J

JAR — Java archive. In computing software, a JAR file (or Java ARchive) aggregates many files into one. Software developers use JARs to distribute Java applications or libraries, in the form of classes and associated metadata and resources (text, images, etc.). Computer users can create or extract JAR files using the `jar` command that comes with a Java Development Kit (JDK).

Java-MATLAB Interface — Known as the *JMI Interface*, this is the Java interface built into MATLAB software.

JDK — The *Java Development Kit* is a free Oracle® product which provides the environment required for programming in Java.

JMI Interface — see *Java-MATLAB Interface*.

JRE — *Java Run-Time Environment* is the part of the Java Development Kit (JDK) required to run Java programs. It comprises the Java Virtual Machine, the Java platform core classes, and supporting files. It does not include the compiler, debugger, or other tools present in the JDK™. The JRE™ is the smallest set of executables and files that constitute the standard Java platform.

M

Magic Square — A square array of integers arranged so that their sum is the same when added vertically, horizontally, or diagonally.

MATLAB Runtime — An execution engine made up of the same shared libraries. MATLAB uses these libraries to enable the execution of MATLAB files on systems without an installed version of MATLAB.

MATLAB Runtime singleton — See *Shared MATLAB Runtime instance*.

MATLAB Runtime workers — A MATLAB Runtime session. Using MATLAB Production Server software, you have the option of specifying more than one MATLAB Runtime session, using the `--num-workers` options in the server configurations file.

MATLAB Production Server Client — In the MATLAB Production Server software, clients are applications written in a language supported by MATLAB Production Server that call deployed functions hosted on a server.

MATLAB Production Server Configuration — An instance of the MATLAB Production Server containing at least one server and one client. Each configuration of the software usually contains a unique set of values in the server configuration file, `main_config`.

MATLAB Production Server Server Instance — A logical server configuration created using the `mps-new` command in MATLAB Production Server software.

MATLAB Production Server Software — Product for server/client deployment of MATLAB programs within your production systems, enabling you to incorporate numerical analytics in enterprise applications. When you use this software, web, database, and enterprise applications connect to MATLAB programs running on MATLAB Production Server via a lightweight client library, isolating the MATLAB programs from your production system. MATLAB Production Server software consists of one or more servers and clients.

Marshaling — See *Data Marshaling*.

mbuild — MATLAB Compiler SDK command that compiles and links C and C++ source files into standalone applications or shared libraries. For more information, see the `mbuild` function reference page.

`mcc` — The MATLAB command that invokes the compiler. It is the command-line equivalent of using the compiler apps.

Method Attribute — In the context of .NET, a mechanism used to specify declarative information to a .NET class. For example, in the context of client programming with MATLAB Production Server software, you specify method attributes to define MATLAB structures for input and output processing.

`mxArray` interface — The MATLAB data type containing all MATLAB representations of standard mathematical data types.

`MWArray` interface — A proxy to `mxArray`. An application program interface (API) for exchanging data between your application and MATLAB. Using `MWArray`, you marshal data from traditional mathematical types to a form that can be processed and understood by MATLAB data type `mxArray`. There are different implementations of the `MWArray` proxy for each application programming language.

P

Package — The act of bundling the deployed MATLAB code, along with the MATLAB Runtime and other files, into an installer that can be distributed to others. The compiler apps place the installer in the `for_redistribution` subfolder. In addition to the installer, the compiler apps generate a number of lose artifacts that can be used for testing or building a custom installer.

PID File — See *Process Identification File (PID File).*

Pool — A pool of threads, in the context of server management using MATLAB Production Server software. Servers created with the software do not allocate a unique thread to each client connection. Rather, when data is available on a connection, the required processing is scheduled on a *pool*, or group, of available threads. The server configuration file option `--num-threads` sets the size of that pool (the number of available request-processing threads) in the master server process.

Process Identification File (PID File) — A file that documents informational and error messages relating to a running server instance of MATLAB Production Server software.

Program — A bundle of code that is executed to achieve a purpose. Programs usually are written to automate repetitive operations through computer processing. Enterprise system applications usually consist of hundreds or even thousands of smaller programs.

Properties — For this definition in the context of .NET, see *Fields and Properties*.

Proxy — A software design pattern typically using a class, which functions as an interface to something else. For example, `MWArray` is a proxy for programmers who need to access the underlying type `mxArray`.

S

Server Instance — See MATLAB Production Server Server Instance.

Shared Library — Groups of files that reside in one space on disk or memory for fast loading into Windows applications. Dynamic-link libraries (DLLs) are Microsoft's implementation of the shared library concept for Microsoft Windows.

Shared MATLAB Runtime instance — When using MATLAB Compiler SDK, you can create a shared MATLAB Runtime instance, also known as a *singleton*. When you invoke MATLAB Compiler with the `-S` option through the compiler (using either `mcc` or a compiler app), a single MATLAB Runtime instance is created for each COM component or Java package in an application. You reuse this instance by sharing it among all subsequent class instances. Such sharing results in more efficient memory usage and eliminates the MATLAB Runtime startup cost in each subsequent class instantiation. All class instances share a single MATLAB workspace and share global variables in the deployed MATLAB files. MATLAB Compiler SDK creates singletons by default for .NET assemblies. MATLAB Compiler creates singletons by default for the COM components used by the Excel add-ins.

State — The present condition of MATLAB, or the MATLAB Runtime. MATLAB functions often carry state in the form of variable values. The MATLAB workspace itself also maintains information about global variables and path settings. When deploying functions that carry state, you must often take additional steps to ensure state retention when deploying applications that use such functions.

Structs — MATLAB Structures. Structs are MATLAB arrays with elements that you access using textual field designators. Fields are data containers that store data of a specific MATLAB type.

System Compiler — A key part of Interactive Development Environments (IDEs) such as Microsoft Visual Studio®.

T

Thread — A portion of a program that can run independently of and concurrently with other portions of the program. See *pool* for additional information on managing the number of processing threads available to a server instance.

Type-safe interface — An API that minimizes explicit type conversions by hiding the `MWArray` type from the calling application.

W

Web Application Archive (WAR) —In computing, a Web Application Archive is a JAR file used to distribute a collection of `JavaServer` pages, servlets, Java classes, XML files, tag libraries, and static web pages that together constitute a web application.

Webfigure — A MathWorks representation of a MATLAB figure, rendered on the web. Using the WebFigures feature, you display MATLAB figures on a website for graphical

manipulation by end users. This enables them to use their graphical applications from anywhere on the web, without the need to download MATLAB or other tools that can consume costly resources.

Windows Communication Foundation (WCF) — The Windows Communication Foundation™ is an application programming interface in the .NET Framework for building connected, service-oriented, web-centric applications. WCF is designed in accordance with service oriented architecture principles to support distributed computing where services are consumed by client applications.

Examples

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- “Create a .NET Application with MATLAB Code” on page 2-7
- “Create a Java Application with MATLAB Code” on page 2-14
- “Create a Python Application with MATLAB Code” on page 2-19

Create a C/C++ Application with MATLAB Code

This example shows how to create a C/C++ shared library using a MATLAB function. You then integrate it into an application.

1. In MATLAB, examine the MATLAB code that you want to deploy as a shared library.

   a. Open `addmatrix.m`.

   ```
   function a = addmatrix(a1, a2)

   a = a1 + a2;
   ```

   b. At the MATLAB command prompt, enter `addmatrix(1,2)`.

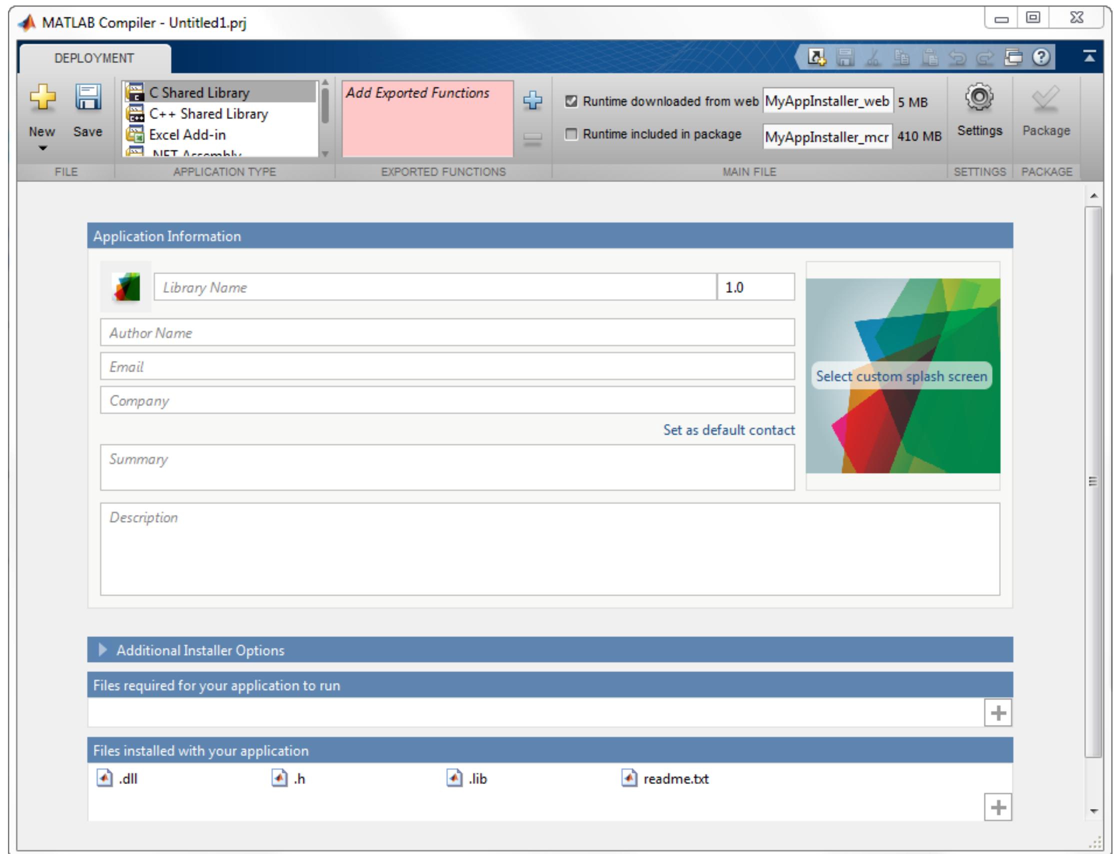
      The output appears as follows:

   ```
   ans =

         3
   ```

2. Open the **Library Compiler** app.

   a. On the toolstrip, select the **Apps** tab.
   b. Click the arrow at the far right of the tab.
   c. Click **Library Compiler**s.



3. In the **Application Type** section of the toolstrip, select **C++ Shared Library** from the list.
4. Specify the MATLAB functions you want to deploy.

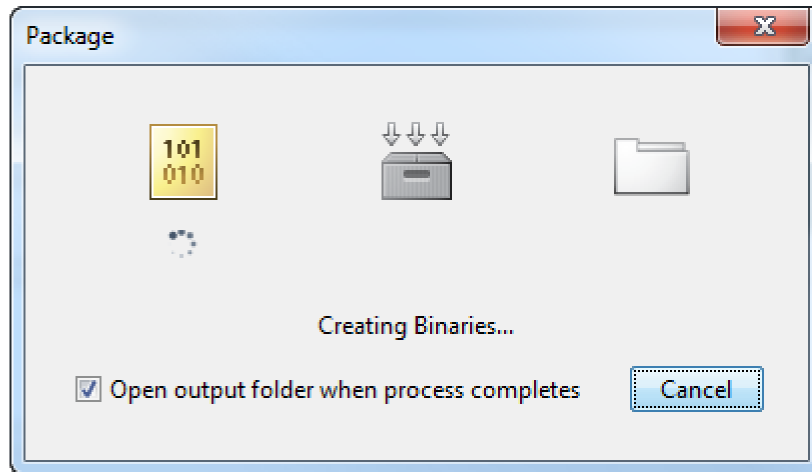
   a. In the **Exported Functions** section of the toolstrip, click the plus button.
   b. In the file explorer that opens, locate and select the `addmatrix.m` file.

      `addmatrix.m` is located in *`matlabroot`*`\extern\examples\compilersdk`.
   c. Click **Open** to select the file and close the file explorer.
5. In the **Packaging Options** section of the toolstrip, verify that the **Runtime downloaded from web** check box is selected.

This option creates an application installer that automatically downloads the MATLAB Runtime and installs it along with the deployed shared library.

6 Click **Package**.

The Package window opens while the library is being generated.



7 Select the **Open output folder when process completes** check box.
8 Click **Close** on the Package window.
9 Verify the contents of the generated output:

- `for_redistribution` — A folder containing the installer to distribute the standalone application
- `for_testing` — A folder containing the raw files generated by the compiler
- `for_redistribution_files_only` — A folder containing only the files needed to redistribute the application
- `PackagingLog.txt` — A log file generated by the compiler.

10 Open the `for_redistribution` folder.
11 Run the installer.
12 In the folder containing the generated shared libraries, create a new file called `addmatrix.cpp`.
13 Using a text editor, open `addmatrix.cpp`.
14 Copy the following into the file.

```
#include "addmatrix.h"
```

```
int run_main(int argc, char **argv)
{
  if (!mclInitializeApplication(NULL,0))
    {
      std::cerr << "could not initialize the application properly"
                << std::endl;
       return -1;
    }
  if( !addmatrixInitialize() )
    {
      std::cerr << "could not initialize the library properly"
                << std::endl;
      return -1;
    }

  try
    {
      // Create input data
      double data[] = {1,2,3,4,5,6,7,8,9};
      mwArray in1(3, 3, mxDOUBLE_CLASS, mxREAL);
      mwArray in2(3, 3, mxDOUBLE_CLASS, mxREAL);
      in1.SetData(data, 9);
      in2.SetData(data, 9);

      // Create output array
      mwArray out;

      // Call the library function
      addmatrix(1, out, in1, in2);

      std::cout << "The value of added matrix is:" << std::endl;
      std::cout << out << std::endl;
    }
  catch (const mwException& e)
    {
      std::cerr << e.what() << std::endl;
      return -2;
    }
  catch (...)
    {
      std::cerr << "Unexpected error thrown" << std::endl;
      return -3;
    }
```

```
  addmatrixTerminate();
  mclTerminateApplication();
  return 0;
}

int main()
{
  mclmcrInitialize();
  return mclRunMain((mclMainFcnType)run_main,0,NULL);
}
```

15 Use `mbuild` to compile and link the application.

```
mbuild addmatrix.cpp addmatrix.lib
```

16 From the system's command prompt, run the application.

```
addmatrix
The value of added matrix is:
     2     8    14
     4    10    16
     6    12    18
```

Create a .NET Application with MATLAB Code

This example shows how to transform a MATLAB function into a .NET assembly and integrate it into an application. The example compiles a MATLAB function, `makesquare`, which computes a magic square, into a .NET assembly named `MagicSquareComp`, which contains the `MLTestClass` class and other files needed to deploy your application.

1 In MATLAB, create the function that you want to deploy as a shared library.

   This example uses the sample function, called `makesquare.m`, included in the *`matlabroot`*`\toolbox\dotnetbuilder\Examples\VS`*`Version`*`\NET\MagicSquareExample\MagicSquareComp` folder, where *`matlabroot`* represents the name of your MATLAB installation folder.

```
function y = makesquare(x)

y = magic(x);
```

   Run the example in MATLAB.

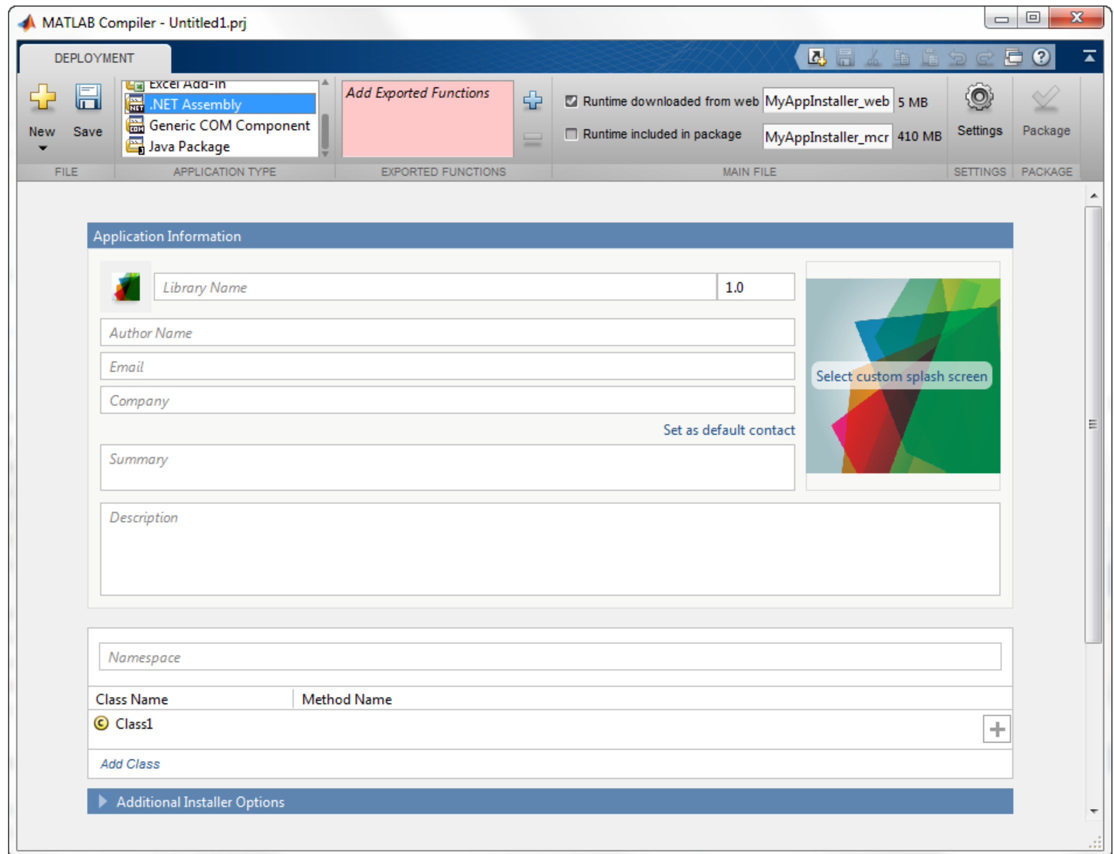
```
makesquare(5)
```

   17241815235714164613202210121921311182529

2 Open the Library Compiler app.

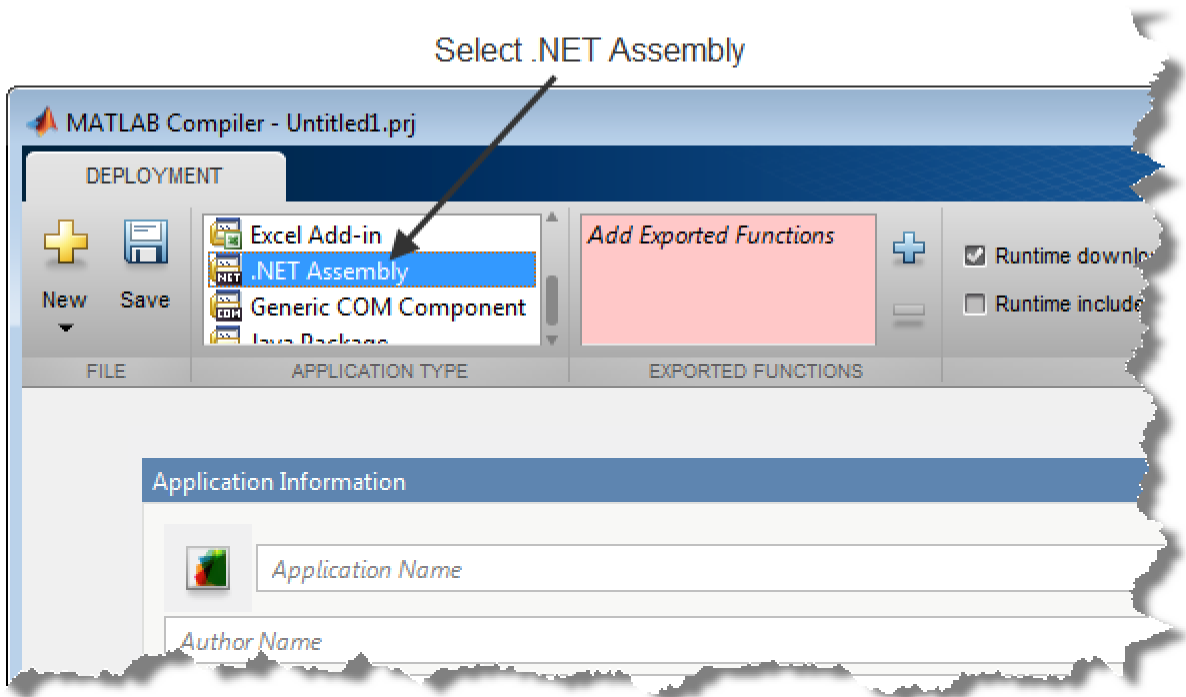
   a On the toolstrip, select the **Apps** tab.
   b Click the arrow at the far right of the tab to open the apps gallery.
   c Click **Library Compiler**.

   Note: You can also call the `libraryCompiler` command.



3 In the **Application Type** section of the toolstrip, select **.NET Assembly** from the list.

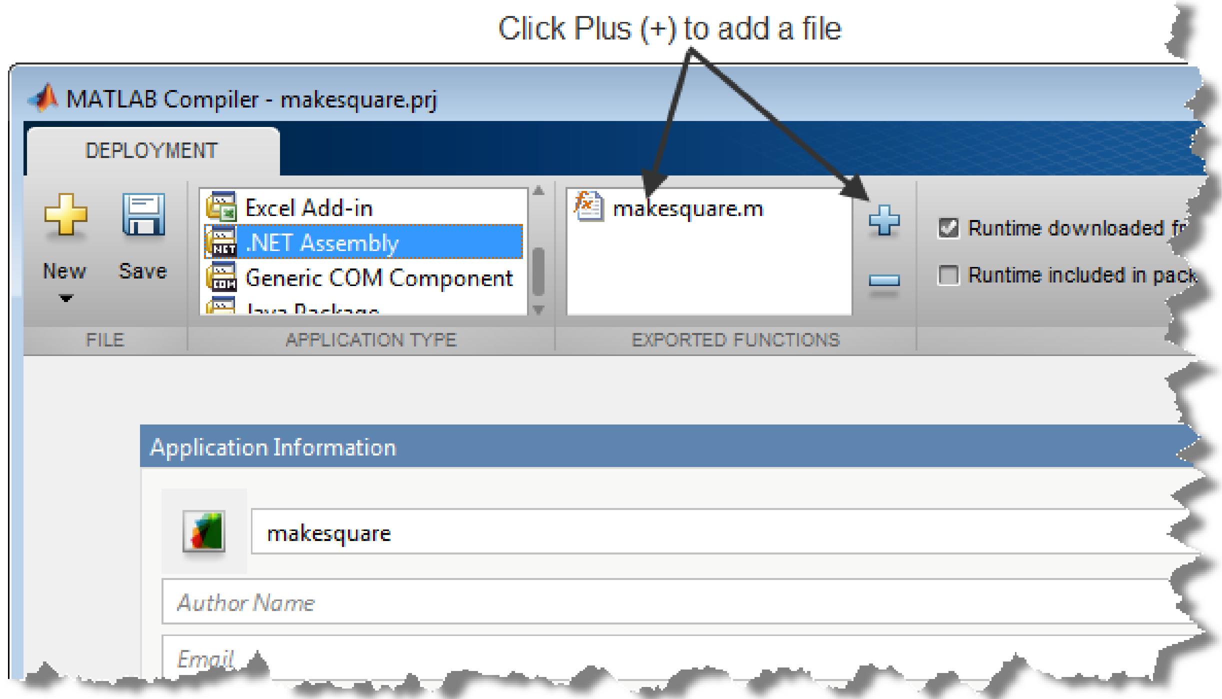
Note: If the **Application Type** section of the toolstrip is collapsed, you can expand it by clicking the down arrow.



4 Specify the MATLAB functions that you want to deploy.

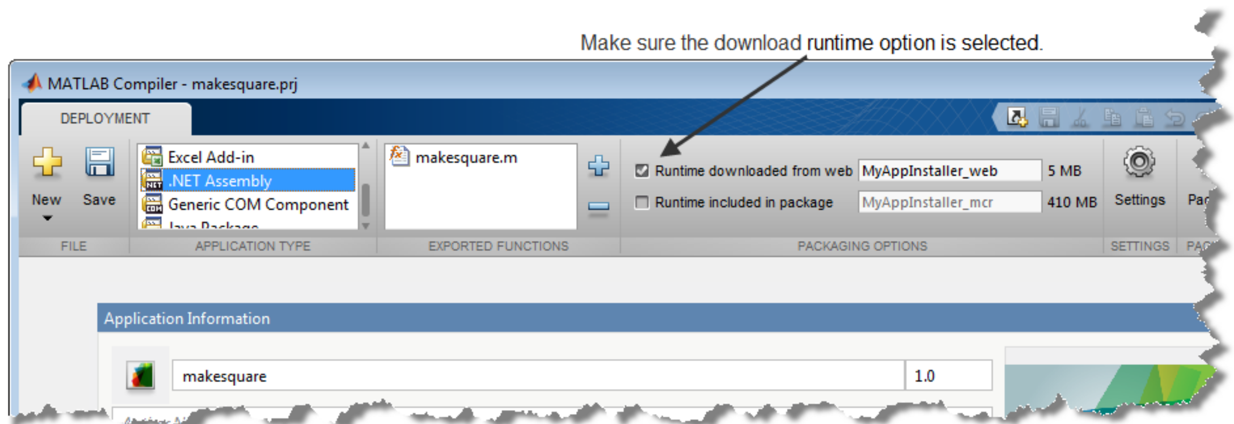
a In the **Exported Functions** section of the toolstrip, click the plus button.
b In the file explorer that opens, locate and select the `makesquare.m` file.
c Click **Open** to select the file and close the file explorer.

The Library Compiler app adds **makesquare.m** to the list of files and a minus button appears under the plus button. The Library Compiler app uses the name of the file as the name of the deployment project file (`.prj`), shown in the title bar, and as the name of the assembly, shown in the first field of the Application Information area. The project file saves all of the deployment settings so that you can re-open the project.



5 In the **Packaging Options** section of the toolstrip, verify that the **Runtime downloaded from web** check box is selected.

This option creates an application installer that automatically downloads the MATLAB Runtime and installs it along with the deployed add-in.



6 In the top field of **Application Information**, replace `makesquare` with `MagicSquareComp`.
7 In the **Class Name** column of the class browser, replace `Class1` with `MLTestClass`.
8 Click **Package**.

The Package window opens while the library is being generated. Select the **Open output folder when process completes** check box. The packaging process generates a self-extracting file that *automatically registers* the DLL and unpacks all deployable deliverables.

9 When the deployment process is complete, a file explorer opens and displays the generated output.

It should contain:

- `for_redistribution` — A folder containing the installer to distribute the generated assembly
- `for_testing` — A folder containing the raw files generated by the compiler
- `for_redistribution_files_only` — A folder containing only the files needed to redistribute the assembly
- `PackagingLog.txt` — A log file generated by the compiler

10 Click **Close** on the Package window.
11 Open the `for_redistribution` folder.
12 Run the installer.
13 Open Microsoft Visual Studio

14 Create a new project.

For this example create a C# Console Application called **MainApp**.

15 Create a reference to your assembly.

The assembly is located in the application folder created when you installed the component. For this example, select `makeSqr.dll`.

16 Create a reference to the `MWArray` API.

The API is located in *`MATLABROOT`*`\toolbox\dotnetbuilder\bin\`*`arch`*`\`*`version`*`\MWArray.dll`.

17 Paste the following code into your main file.

```
using System;
using System.Collections.Generic;
using System.Text;

using MagicSquareComp;
using MathWorks.MATLAB.NET.Arrays;
using MathWorks.MATLAB.NET.Utility;

namespace mainApp
{
    class Program
    {
        static void Main(string[] args)
        {
            MLTestClass obj = null;
            MWNumericArray input = null;
            MWNumericArray output = null;
            MWArray[] result = null;

            try
            {
                obj = new MLTestClass();

                input = 5;
                result = obj.makesquare(1, input);

                output = (MWNumericArray)result[0];
                Console.WriteLine(output);
            }
            catch
```

```
                    {
                        throw;
                    }
                }
            }
        }
```

18 After you finish writing your code, you build and run it with Microsoft Visual Studio.

Create a Java Application with MATLAB Code

This example shows how to create a Java package using a MATLAB function. You can then pass the generated package to the developer, who is responsible for integrating it into an application.

To compile a Java package from MATLAB code:

1. In MATLAB, examine the MATLAB code that want to deploy as a Java package.

   a. Open `makesqr.m`.

   ```
   function y = makesqr(x)

   y = magic(x);
   ```

   b. At the MATLAB command prompt, enter `makesqr(5)`.

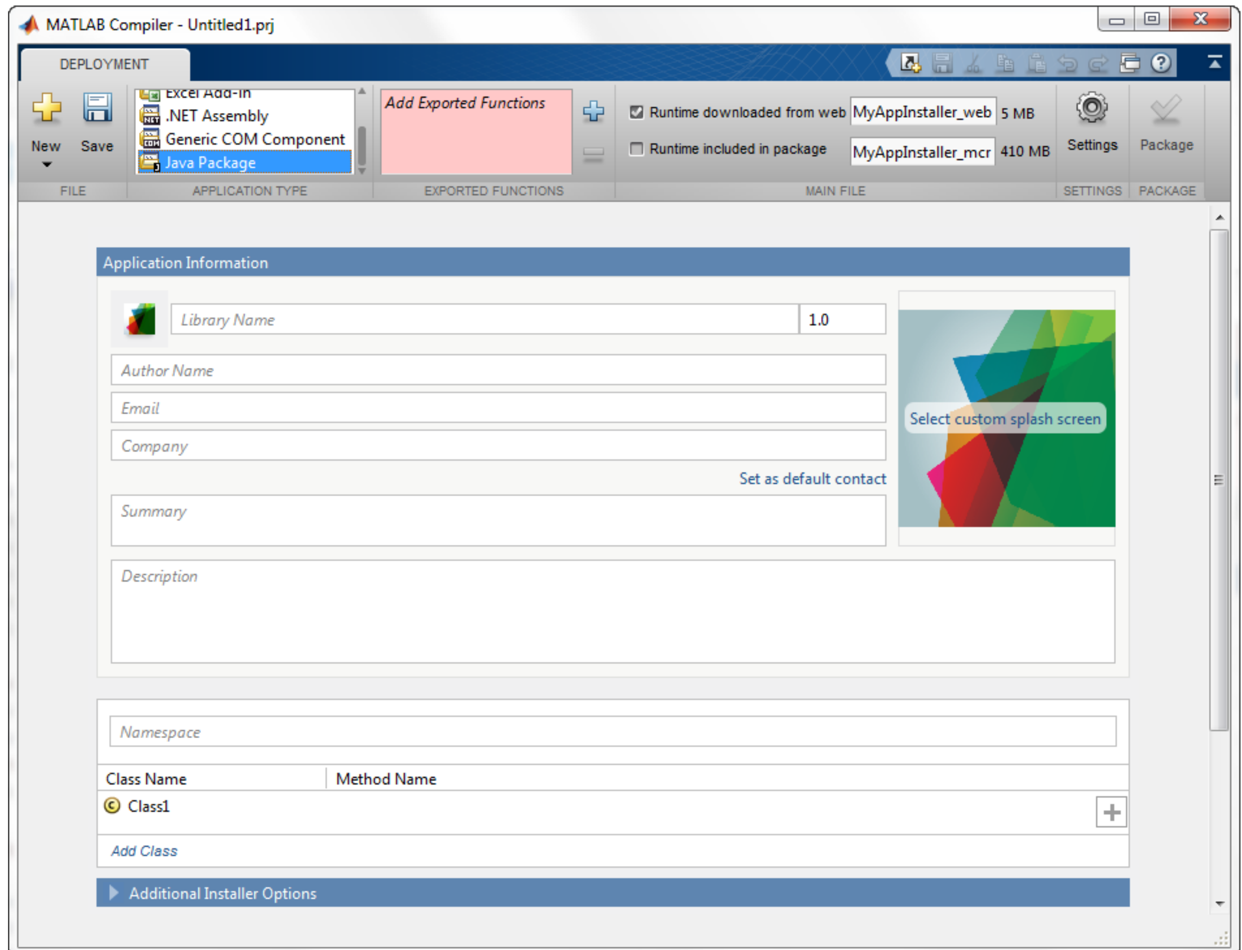
   The output appears as follows:

   ```
   ans =

       17    24     1     8    15
       23     5     7    14    16
        4     6    13    20    22
       10    12    19    21     3
       11    18    25     2     9
   ```

2. Open the **Library Compiler** app.

   a. On the toolstrip, select the **Apps** tab.
   b. Click the arrow at the far right of the tab to open the apps gallery.
   c. Click **Library Compiler**.



3. In the **Application Type** section of the toolstrip, select **Java Package** from the list.
4. Specify the MATLAB functions you want to deploy.

   a. In the **Exported Functions** section of the toolstrip, click the plus button.
   b. In the file explorer that opens, locate and select the `makesqr.m` file.

      `makesqr.m` is located in *`matlabroot`*`\toolbox\javabuilder\Examples\MagicSqaureExample\MagicDemoComp`.
   c. Click **Open** to select the file, and close the file explorer.

makesqr.m is added to the list of exported files and a minus button appears under the plus button. In addition, makesqr is set as:

- the library name
- the package name

5 Verify that the function defined in `makesqr.m` is mapped into `Class1`.

6 In the **Packaging Options** section of the toolstrip, verify that the **Runtime downloaded from web** check box is selected.

This option creates an application installer that automatically downloads the MATLAB Runtime and installs it along with the deployed package.

7 Click **Package**.

8 Select the **Open output folder when process completes** check box.

9 Verify that the generated output contains:

- `for_redistribution` — A folder containing the installer to distribute the package
- `for_testing` — A folder containing the raw generated files to create the installer
- `for_redistribution_files_only` — A folder containing only the files needed to redistribute the package
- `PackagingLog.txt` — A log file generated by the compiler

10 Click **Close** on the Package window.

11 Open the `for_redistribution` folder.

12 Run the installer.

13 In the folder containing the generated JAR files, create a new file called `getmagic.java`.

14 Using a text editor, open `getmagic.java`.

15 Paste the following code into the file.

```
import com.mathworks.toolbox.javabuilder.*;
```

```
import makesqr.*;

class getmagic
{
   public static void main(String[] args)
   {
      MWNumericArray n = null;
      Object[] result = null;
      Class1 theMagic = null;

      if (args.length == 0)
      {
        System.out.println("Error: must input a positive integer");
        return;
      }

      try
      {
         n = new MWNumericArray(Double.valueOf(args[0]),
                                      MWClassID.DOUBLE);

         theMagic = new Class1();

         result = theMagic.makesqr(1, n);
         System.out.println(result[0]);
      }
      catch (Exception e)
      {
         System.out.println("Exception: " + e.toString());
      }
      finally
      {
         MWArray.disposeArray(n);
         MWArray.disposeArray(result);
         theMagic.dispose();
      }
   }
}
```

16 Compile the Java application using `javac`.

```
javac -classpath "mcrroot\toolbox\javabuilder\jar\javabuilder.jar";.\makesqr.jar .\
```

Note: On UNIX® platforms, use colon (`:`) as the class path delimiter instead of semicolon (`;`).

`mcrroot` is the path to where the MATLAB Runtime is installed on your system. If you have MATLAB installed on your system instead, you can use the path to your MATLAB installation.

17 From the system's command prompt, run the application.

```
java -classpath .;"c:\Program Files\MATLAB\MATLAB Compiler Runtime\v82\toolbox\java
    17    24     1     8    15
    23     5     7    14    16
     4     6    13    20    22
    10    12    19    21     3
    11    18    25     2     9
```

You must be sure to place a dot (`.`) in the first position of the class path. If it not, you get a message stating that Java cannot load the class.

Note: On UNIX platforms, use colon (`:`) as the class path delimiter instead of semicolon (`;`).

`mcrroot` is the path to where the MATLAB Runtime is installed on your system. If you have MATLAB installed on your system instead, you can use the path to your MATLAB installation.

Create a Python Application with MATLAB Code

This example shows how to create a Python® package using a MATLAB function. You can then pass the generated package to the developer, who is responsible for integrating it into an application.

To compile a Python package from MATLAB code:

1. In MATLAB, examine the MATLAB code that you want to deploy as a Python package.

   a. Open `makesqr.m`.

   ```
   function y = makesqr(x)

   y = magic(x);
   ```

   b. At the MATLAB command prompt, enter `makesqr(5)`.

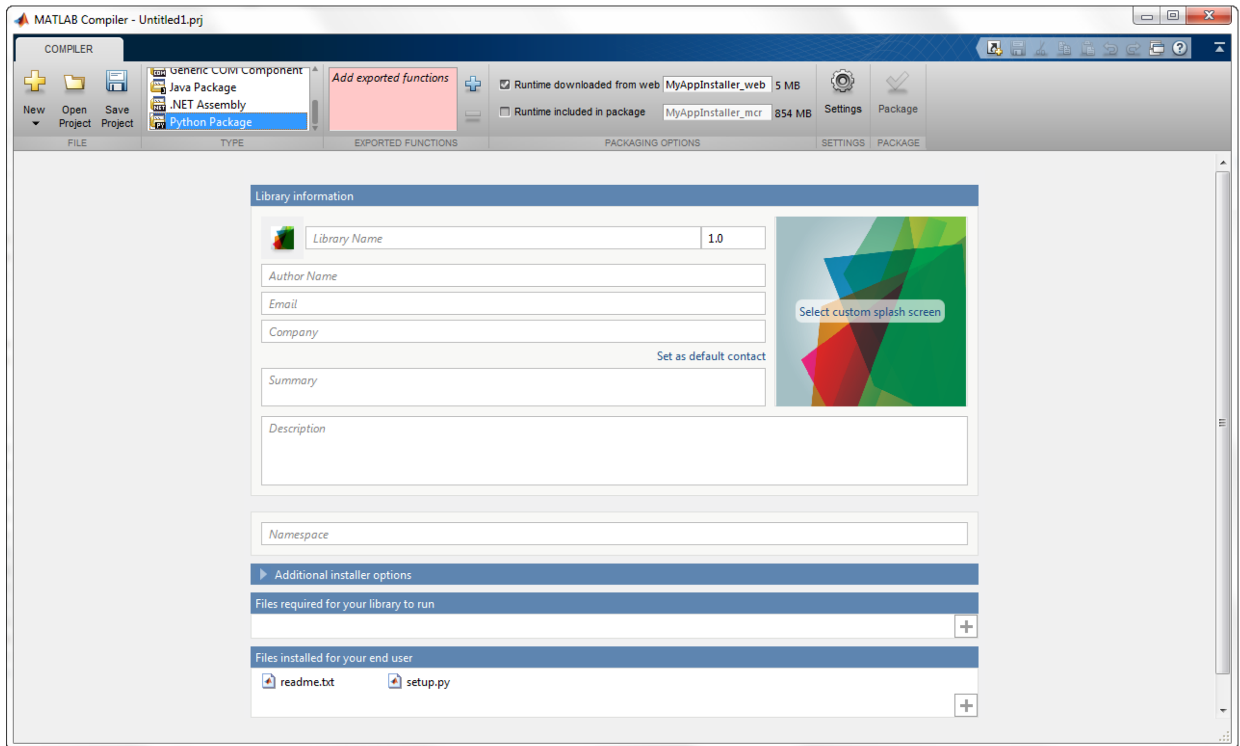
   The output appears as follows:

   ```
   ans =

       17    24     1     8    15
       23     5     7    14    16
        4     6    13    20    22
       10    12    19    21     3
       11    18    25     2     9
   ```

2. Open the **Library Compiler** app.

   a. On the toolstrip, select the **Apps** tab.
   b. Click the arrow at the far right of the tab to open the apps gallery.
   c. Click **Library Compiler**.



3 In the **Application Type** section of the toolstrip, select **Python Package** from the list.

4 Specify the MATLAB functions you want to deploy.

   a In the **Exported Functions** section of the toolstrip, click the plus button.

   b In the file explorer that opens, locate and select the `makesqr.m` file.

      `makesqr.m` is located in *`matlabroot`*`\toolbox\javabuilder\Examples\MagicSqaureExample\MagicDemoComp`.

   c Click **Open** to select the file, and close the file explorer.

      makesqr.m is added to the list of exported files and a minus button appears under the plus button. In addition, `makesqr` is set as the package name.

5 In the **Packaging Options** section of the toolstrip, verify that the **Runtime downloaded from web** check box is selected.

This option creates an application installer that automatically downloads the MATLAB Runtime and installs it along with the deployed package.

6. Click **Package**.
7. Select the **Open output folder when process completes** check box.
8. Verify that the generated output contains:

   - `for_redistribution` — A folder containing the installer to distribute the package
   - `for_testing` — A folder containing the raw generated files to create the installer
   - `for_redistribution_files_only` — A folder containing only the files needed to redistribute the package
   - `PackagingLog.txt` — A log file generated by the compiler
9. Click **Close** on the Package window.
10. Open a command prompt in the `for_redistribution_files_only` folder.
11. Run the set up script to install the package.

    ```
    python setup.py install
    ```
12. Create a new file called `getmagic.py`.
13. Using a text editor, open `getmagic.py`.
14. Paste the following code into the file.

    ```
    import makesqr
    import matlab

    myMagic = makesqr.initialize()

    myMagic.makesqr(5)

    myMagic.terminate()
    ```
15. From the system's command prompt, run the application.

    ```
    python getmagic.py
    matlab.double([[17.0,24.0,1.0,8.0,15.0],
    [23.0,5.0,7.0,14.0,16.0],[4.0,6.0,13.0,20.0,22.0],
    [10.0,12.0,19.0,21.0,3.0],[11.0,18.0,25.0,2.0,9.0]])
    ```

Note: On Mac OS X you must use the `mwpython` script. The `mwpython` script is located in the *`matlabroot`*`/bin` folder. *`matlabroot`* is the location of your MATLAB installation. For example:

```
mwpython getmagic.py
```

See Also

`mwpython`

Using MATLAB Production Server

- "Create a Deployable Archive for MATLAB Production Server" on page 3-2
- "Create a C# Client" on page 3-6
- "Create a Java Client" on page 3-10
- "Create a C++ Client" on page 3-14
- "Create a Python Client" on page 3-20

Create a Deployable Archive for MATLAB Production Server

This example shows how to create a deployable archive for MATLAB Production Server using a MATLAB function. You can then hand the generated archive to a system administrator who will deploy it into MATLAB Production Server.

To create a deployable archive:

1. In MATLAB, examine the MATLAB code that you want to deploy.

   a. Open addmatrix.m.

   ```
   function a = addmatrix(a1, a2)

   a = a1 + a2;
   ```

   b. At the MATLAB command prompt, enter `addmatrix(1,2)`.

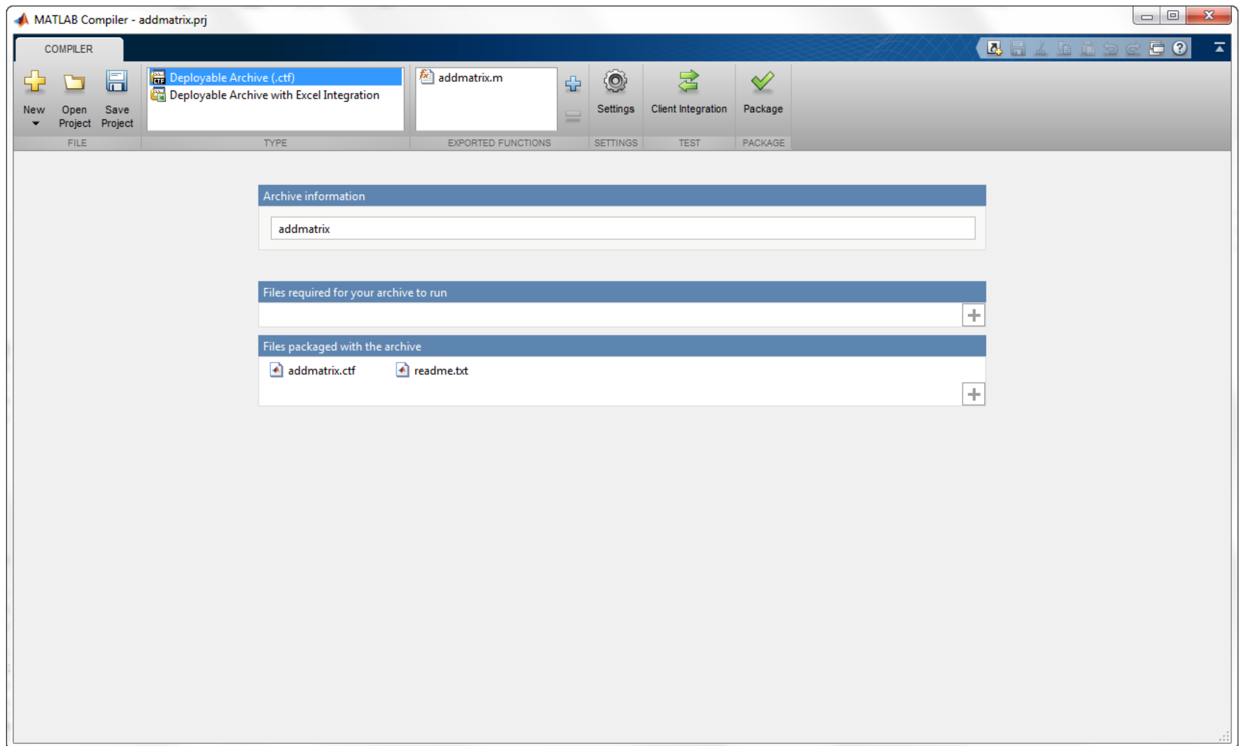
      The output appears as follows:

   ```
   ans =

        3
   ```

2. Open the **Production Server Compiler** app.

   a. On the toolstrip, select the **Apps** tab.
   b. Click the arrow on the far right of the tab to open the apps gallery.
   c. Click **Production Server Compiler**.



3 In the **Application Type** section of the toolstrip, select **Deployable Archive** from the list.

Note: If the **Application Type** section of the toolstrip is collapsed, you can expand it by clicking the down arrow .

---

4 Specify the MATLAB functions you want to deploy.

a In the **Exported Functions** section of the toolstrip, click the plus button.

Note: If the **Exported Functions** section of the toolstrip is collapsed, you can expand it by clicking the down arrow.

---

b Using the file explorer, locate and select the `addmatrix.m` file.

`addmatrix.m` is located in *`matlabroot`*`\extern\examples\compiler`.

c. Click **Open** to select the file and close the file explorer.

   addmatrix.m is added to the field. A minus button will appear below the plus button.

5. Explore the main body of the project window.

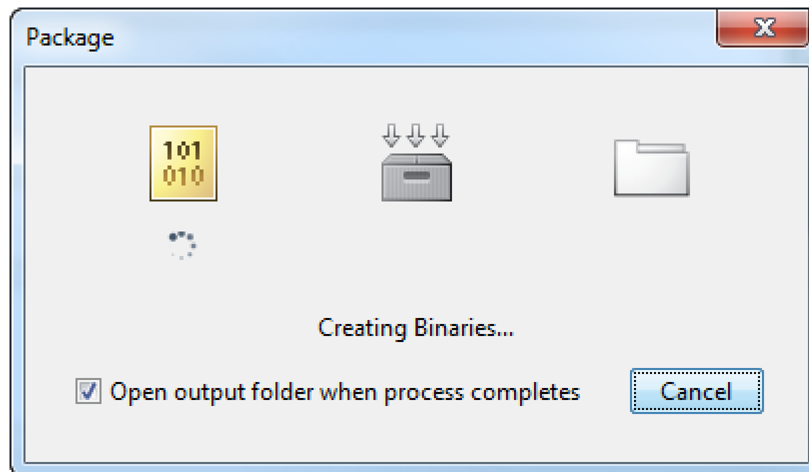
   The project window is divided into the following areas:

   - **Archive Information** — Editable information about the deployed archive.
   - **Files required for your archive to run** — Additional files required by the archive. These files will be included in the generated archive. See "Manage Required Files in Compiler Project".
   - **Files packaged with the archive** — Files that are packaged with your archive. These files include:
     - `readme.txt`
     - `.ctf` file

     See "Specify Files to Install with Application".

6. Click **Package**.

   The Package window opens while the library is being generated.



7. Select the **Open output folder when process completes** check box.

When the deployment process is complete, a file explorer opens and displays the generated output.

8. Verify the contents of the generated output:

   - `for_redistribution` — A folder containing the installer to redistribute the archive to the system administrator responsible for the MATLAB Production Server
   - `for_testing` — A folder containing the raw files generated by the compiler
   - `PackagingLog.txt` — A log file generated by the compiler.

9. Click **Close** on the Package window.

To lean more about MATLAB Production Server see "MATLAB Production Server"

Create a C# Client

This example shows how to call a deployed MATLAB function from a C# application using MATLAB Production Server.

In your C# code, you must:

- Create a Microsoft Visual Studio Project.
- Create a Reference to the Client Run-Time Library.
- Design the .NET interface in C#.
- Write, build, and run the C# application.

This task is typically performed by .NET application programmer. This part of the tutorial assumes you have Microsoft Visual Studio and .NET installed on your computer.

Create a Microsoft Visual Studio Project

1 Open Microsoft Visual Studio.
2 Click **File > New > Project**.
3 In the New Project dialog, select the project type and template you want to use. For example, if you want to create a C# Console Application, select **Windows** in the **Visual C#** branch of the **Project Type** pane, and select the **C# Console Application** template from the **Templates** pane.
4 Type the name of the project in the **Name** field (`Magic`, for example).
5 Click **OK**. Your `Magic` source shell is created, typically named `Program.cs`, by default.

Create a Reference to the Client Run-Time Library

Create a reference in your `MainApp` code to the MATLAB Production Server client run-time library. In Microsoft Visual Studio, perform the following steps:

1 In the Solution Explorer pane within Microsoft Visual Studio (usually on the right side), select the name of your project, `Magic`, highlighting it.
2 Right-click `Magic` and select **Add Reference**.
3 In the Add Reference dialog box, select the **Browse** tab. Browse to the MATLAB Production Server client runtime, installed at

`matlabroot\toolbox\compiler_sdk\mps_client\dotnet`. Select `MathWorks.MATLAB.ProductionServer.Client.dll`.

4. Click **OK**. `MathWorks.MATLAB.ProductionServer.Client.dll` is now referenced by your Microsoft Visual Studio project.

Design the .NET Interface in C#

In this example, you invoke `mymagic.m`, hosted by the server, from a .NET client, through a .NET interface.

To match the MATLAB function `mymagic.m`, design an interface named `Magic`.

For example, the interface for the `mymagic` function:

```
function m = mymagic(in)
    m = magic(in);
```

might look like this:

```
 public interface Magic
        {
          double[,] mymagic(int in1);
        }
```

Note the following:

- The .NET interface has the same number of inputs and outputs as the MATLAB function.
- You are deploying one MATLAB function, therefore you define one corresponding .NET method in your C# code.
- Both MATLAB function and .NET interface process the same types: input type `int` and the output type two-dimensional `double`.
- You specify the name of your deployable archive (`magic`, which resides in your `auto_deploy` folder) in your URL, when you call `CreateProxy` (`"http://localhost:9910/magic"`).

Write, Build, and Run the .NET Application

Create a C# interface named `Magic` in Microsoft Visual Studio by doing the following:

1. Open the Microsoft Visual Studio project, `MagicSquare`, that you created earlier.
2. In `Program.cs` tab, paste in the code below.

Note: The URL value (`"http://localhost:9910/mymagic_deployed"`) used to create the proxy contains three parts:

- the server address (`localhost`).
- the port number (`9910`).
- the archive name (`mymagic_deployed`)

```
using System;
using System.Net;
using MathWorks.MATLAB.ProductionServer.Client;

namespace Magic
{
  public class MagicClass
  {

    public interface Magic
    {
     double[,] mymagic(int in1);
    }

    public static void Main(string[] args)
  {
     MWClient client = new MWHttpClient();
       try
       {
        Magic me = client.CreateProxy<Magic>
                     (new Uri("http://localhost:9910/mymagic_deployed"));
          double[,] result1 = me.mymagic(4);
          print(result1);
       }
       catch (MATLABException ex)
       {
         Console.WriteLine("{0} MATLAB exception caught.", ex);
         Console.WriteLine(ex.StackTrace);
       }
       catch (WebException ex)
       {
         Console.WriteLine("{0} Web exception caught.", ex);
         Console.WriteLine(ex.StackTrace);
       }
       finally
       {
         client.Dispose();
       }
       Console.ReadLine();
   }
```

```
        public static void print(double[,] x)
        {
           int rank = x.Rank;
           int [] dims = new int[rank];

           for (int i = 0; i < rank; i++)
           {
              dims[i] = x.GetLength(i);
           }

           for (int j = 0; j < dims[0]; j++)
           {
              for (int k = 0; k < dims[1]; k++)
              {
                 Console.Write(x[j,k]);
                 if (k < (dims[1] - 1))
                 {
                    Console.Write(",");
                 }
              }
              Console.WriteLine();
            }
          }
        }
     }
```

3 Build the application. Click **Build > Build Solution**.

4 Run the application. Click **Debug > Start Without Debugging**. The program returns the following console output:

```
16,2,3,13
5,11,10,8
9,7,6,12
4,14,15,1
```

Create a Java Client

This example shows how to write a MATLAB Production Server client using the Java client API. In your Java code, you will:

- Define a Java interface that represents the MATLAB function.
- Instantiate a proxy object to communicate with the server.
- Call the deployed function in your Java code.

To create a Java MATLAB Production Server client application:

1. Create a new file called `MPSClientExample.java`.
2. Using a text editor, open `MPSClientExample.java`.
3. Add the following import statements to the file:

   ```
   import java.net.URL;
   import java.io.IOException;
   import com.mathworks.mps.client.MWClient;
   import com.mathworks.mps.client.MWHttpClient;
   import com.mathworks.mps.client.MATLABException;
   ```
4. Add a Java interface that represents the deployed MATLAB function.

   The interface for the `addmatrix` function

   ```
   function a = addmatrix(a1, a2)

   a = a1 + a2;
   ```

   looks like this:

   ```
   interface MATLABAddMatrix {
          double[][] addmatrix(double[][] a1, double[][] a2)
            throws MATLABException, IOException;
      }
   ```

   When creating the interface, note the following:

   - You can give the interface any valid Java name.
   - You must give the method defined by this interface the same name as the deployed MATLAB function.
   - The Java method must support the same inputs and outputs supported by the MATLAB function, in both type and number. For more information about data

type conversions and how to handle more complex MATLAB function signatures, see “Java Client Programming”.

- The Java method must handle MATLAB exceptions and I/O exceptions.

5 Add the following class definition:

```
public class MPSClientExample
{
}
```

This class now has a single main method that calls the generated class.

6 Add the `main()` method to the application.

```
public static void main(String[] args)
{
}
```

7 Add the following code to the top of the `main()` method:

```
double[][] a1={{1,2,3},{3,2,1}};
double[][] a2={{4,5,6},{6,5,4}};
```

These statements initialize the variables used by the application.

8 Instantiate a client object using the `MWHttpClient` constructor.

```
MWClient client = new MWHttpClient();
```

This class establishes an HTTP connection between the application and the server instance.

9 Call the client object’s `createProxy` method to create a dynamic proxy.

You must specify the URL of the deployable archive and the name of your interface `class` as arguments:

```
MATLABAddMatrix m = client.createProxy(new URL("http://localhost:9910/addmatrix"),
                                        MATLABAddMatrix.class);
```

The URL value (`"http://localhost:9910/addmatrix"`) used to create the proxy contains three parts:

- the server address (`localhost`).
- the port number (`9910`).
- the archive name (`addmatrix`)

For more information about the `createProxy` method, see the Javadoc included in the *`matlabroot`*`/toolbox/compiler_sdk/mps_client` folder.

10. Call the deployed MATLAB function in your Java application by calling the public method of the interface.

```
double[][] result = m.addmatrix(a1,a2);
```

11. Call the client object's `close()` method to free system resources.

```
client.close();
```

12. Save the Java file.

The completed Java file should resemble the following:

```
import java.net.URL;
import java.io.IOException;
import com.mathworks.mps.client.MWClient;
import com.mathworks.mps.client.MWHttpClient;
import com.mathworks.mps.client.MATLABException;

interface MATLABAddMatrix
  {
    double[][] addmatrix(double[][] a1, double[][] a2)
         throws MATLABException, IOException;
  }

public class MPSClientExample {

    public static void main(String[] args){

        double[][] a1={{1,2,3},{3,2,1}};
        double[][] a2={{4,5,6},{6,5,4}};

        MWClient client = new MWHttpClient();

        try{
            MATLABAddMatrix m = client.createProxy(new URL("http://localhost:9910/addmatrix"),
                                                    MATLABAddMatrix.class);
            double[][] result = m.addmatrix(a1,a2);

            // Print the magic square

            printResult(result);

        }catch(MATLABException ex){

            // This exception represents errors in MATLAB
               System.out.println(ex);
        }catch(IOException ex){

            // This exception represents network issues.
               System.out.println(ex);
        }finally{

            client.close();
        }
    }
```

```
    private static void printResult(double[][] result){
        for(double[] row : result){
            for(double element : row){
                System.out.print(element + " ");
            }
            System.out.println();
        }
    }
}
```

13 Compile the Java application, using the `javac` command or use the build capability of your Java IDE.

For example, enter the following:

```
javac -classpath "matlabroot\toolbox\compiler_sdk\mps_client\java\mps_client.jar" MPSClientExample.java
```

14 Run the application using the `java` command or your IDE.

For example, enter the following:

```
java -classpath .;"matlabroot\toolbox\compiler_sdk\mps_client\java\mps_client.jar" MPSClientExample
```

The application returns the following at the console:

```
5.0 7.0 9.0
9.0 7.0 5.0
```

Create a C++ Client

This example shows how to write a MATLAB Production Server client using the C 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 C++ MATLAB Production Server client application:

1. Create a file called `addmatrix_client.cpp`.
2. Using a text editor, open `addmatrix_client.cpp`.
3. Add the following include statements to the file:

   ```
   #include <iostream>
   #include <mps/client.h>
   ```

   Note: The header files for the MATLAB Production Server C client API are located in the *`matlabroot`*`/toolbox/compiler_sdk/mps_client/c/include/mps` folder. folder.

   ---
4. Add the `main()` method to the application.

   ```
   int main ( void )
   {
   }
   ```
5. Initialize the client runtime.

   ```
   mpsClientRuntime* mpsruntime = mpsInitializeEx(MPS_CLIENT_1_1);
   ```
6. Create the client configuration.

   ```
   mpsClientConfig* config;
   mpsStatus status = mpsruntime->createConfig(&config);
   ```
7. Create the client context.

   ```
   mpsClientContext* context;
   status = mpsruntime->createContext(&context, config);
   ```
8. Create the MATLAB data to input to the function.

   ```
   double a1[2][3] = {{1,2,3},{3,2,1}};
   double a2[2][3] = {{4,5,6},{6,5,4}};

   int numIn=2;
   mpsArray** inVal = new mpsArray* [numIn];
   ```

```
inVal[0] = mpsCreateDoubleMatrix(2,3,mpsREAL);
inVal[1] = mpsCreateDoubleMatrix(2,3,mpsREAL);

double* data1 = (double *)( mpsGetData(inVal[0]) );
double* data2 = (double *)( mpsGetData(inVal[1]) );

for(int i=0; i<2; i++)
{
  for(int j=0; j<3; j++)
  {
    mpsIndex subs[] = { i, j };
    mpsIndex id = mpsCalcSingleSubscript(inVal[0], 2, subs);
    data1[id] = a1[i][j];
    data2[id] = a2[i][j];
  }
}
```

9. Create the MATLAB data to hold the output.

```
int numOut = 1;
mpsArray **outVal = new mpsArray* [numOut];
```

10. Call the deployed MATLAB function.

    Specify the following as arguments:

    - client context
    - URL of the function
    - Number of expected outputs
    - Pointer to the `mpsArray` holding the outputs
    - Number of inputs
    - Pointer to the `mpsArray` holding the inputs

```
mpsStatus status = mpsruntime->feval(context,
     "http://localhost:9910/addmatrix/addmatrix",
    numOut, outVal, numIn, (const mpsArray**)inVal);
```

    For more information about the `feval` function, see the reference material included in the *`matlabroot`*`/toolbox/compiler_sdk/mps_client` folder.

11. Verify that the function call was successful using an `if` statement.

```
if (status==MPS_OK)
{
```

```
}
```

12 Inside the `if` statement, add code to process the output.

```
double* out = mpsGetPr(outVal[0]);

for (int i=0; i<2; i++)
{
  for (int j=0; j<3; j++)
  {
    mpsIndex subs[] = {i, j};
    mpsIndex id = mpsCalcSingleSubscript(outVal[0], 2, subs);
    std::cout << out[id] << "\t";
  }
  std::cout << std::endl;
}
```

13 Add an `else` clause to the `if` statement to process any errors.

```
else
{
  mpsErrorInfo error;
  mpsruntime->getLastErrorInfo(context, &error);
  std::cout << "Error: " << error.message << std::endl;
  switch(error.type)
  {
    case MPS_HTTP_ERROR_INFO:
      std::cout << "HTTP: " << error.details.http.responseCode << ": "
          << error.details.http.responseMessage << std::endl;
    case MPS_MATLAB_ERROR_INFO:
      std::cout << "MATLAB: " << error.details.matlab.identifier
          << std::endl;
      std::cout << error.details.matlab.message << std::endl;
    case MPS_GENERIC_ERROR_INFO:
      std::cout << "Generic: " << error.details.general.genericErrorMsg
          << std::endl;
  }

  mpsruntime->destroyLastErrorInfo(&error);
}
```

14 Free the memory used by the inputs.

```
for (int i=0; i<numIn; i++)
  mpsDestroyArray(inVal[i]);
delete[] inVal;
```

15 Free the memory used by the outputs.

```
for (int i=0; i<numOut; i++)
  mpsDestroyArray(outVal[i]);
delete[] outVal;
```

16 Free the memory used by the client runtime.

```
mpsruntime->destroyConfig(config);
mpsruntime->destroyContext(context);
mpsTerminate();
```

17 Save the file.

The completed program should resemble the following:

```
#include <iostream>
#include <mps/client.h>

int main ( void )
{
  mpsClientRuntime* mpsruntime = mpsInitializeEx(MPS_CLIENT_1_1);

  mpsClientConfig* config;
  mpsStatus status = mpsruntime->createConfig(&config);

  mpsClientContext* context;
  status = mpsruntime->createContext(&context, config);

  double a1[2][3] = {{1,2,3},{3,2,1}};
  double a2[2][3] = {{4,5,6},{6,5,4}};

  int numIn=2;
  mpsArray** inVal = new mpsArray* [numIn];
  inVal[0] = mpsCreateDoubleMatrix(2,3,mpsREAL);
  inVal[1] = mpsCreateDoubleMatrix(2,3,mpsREAL);
  double* data1 = (double *)( mpsGetData(inVal[0]) );
  double* data2 = (double *)( mpsGetData(inVal[1]) );
  for(int i=0; i<2; i++)
  {
    for(int j=0; j<3; j++)
    {
      mpsIndex subs[] = { i, j };
      mpsIndex id = mpsCalcSingleSubscript(inVal[0], 2, subs);
      data1[id] = a1[i][j];
      data2[id] = a2[i][j];
    }
  }

  int numOut = 1;
  mpsArray **outVal = new mpsArray* [numOut];

  status = mpsruntime->feval(context,
               "http://localhost:9910/addmatrix/addmatrix",
               numOut, outVal, numIn, (const mpsArray **)inVal);

  if (status==MPS_OK)
  {
    double* out = mpsGetPr(outVal[0]);

    for (int i=0; i<2; i++)
```

```
    {
      for (int j=0; j<3; j++)
      {
        mpsIndex subs[] = {i, j};
        mpsIndex id = mpsCalcSingleSubscript(outVal[0], 2, subs);
        std::cout << out[id] << "\t";
      }
      std::cout << std::endl;
    }
  }
  else
  {
    mpsErrorInfo error;
    mpsruntime->getLastErrorInfo(context, &error);
    std::cout << "Error: " << error.message << std::endl;

    switch(error.type)
    {
    case MPS_HTTP_ERROR_INFO:
      std::cout << "HTTP: "
          << error.details.http.responseCode
          << ": " << error.details.http.responseMessage
          << std::endl;
    case MPS_MATLAB_ERROR_INFO:
      std::cout << "MATLAB: " << error.details.matlab.identifier
          << std::endl;
      std::cout << error.details.matlab.message << std::endl;
    case MPS_GENERIC_ERROR_INFO:
      std::cout << "Generic: "
          << error.details.general.genericErrorMsg
          << std::endl;
    }
    mpsruntime->destroyLastErrorInfo(&error);
  }

  for (int i=0; i<numIn; i++)
    mpsDestroyArray(inVal[i]);
  delete[] inVal;

  for (int i=0; i<numOut; i++)
    mpsDestroyArray(outVal[i]);
  delete[] outVal;

  mpsruntime->destroyConfig(config);
  mpsruntime->destroyContext(context);
  mpsTerminate();
}
```

18 Compile the application.

To compile your client code, the compiler needs access to `client.h`. This header file is stored in *`matlabroot`*`/toolbox/compiler_sdk/mps_client/c/include/mps/`.

To link your application, the linker needs access to the following files stored in :

Files Required for Linking

Windows	UNIX/Linux	Mac OS X
`$arch\lib\mpsclient.lib`	`$arch/lib/libprotobuf.so`	`$arch/lib/libprotobuf.dylib`
	`$arch/lib/libcurl.so`	`$arch/lib/libcurl.dylib`
	`$arch/lib/libmwmpsclient.so`	`$arch/lib/libmwmpsclient.dylib`
	`$arch/lib/libmwcpp11compat.so`	

19 Run the application.

To run your application, add the following files stored in to the application's path:

Files Required for Running

Windows	UNIX/Linux	Mac OS X
`$arch\lib\mpsclient.dll`	`$arch/lib/libprotobuf.so`	`$arch/lib/libprotobuf.dylib`
`$arch\lib\libprotobuf.dll`	`$arch/lib/libcurl.so`	`$arch/lib/libcurl.dylib`
`$arch\lib\libcurl.dll`	`$arch/lib/libmwmpsclient.so`	`$arch/lib/libmwmpsclient.dylib`
	`$arch/lib/libmwcpp11compat.so`	

The client invokes `addmatrix` function on the server instance and returns the following matrix at the console:

```
5.0 7.0 9.0
9.0 7.0 5.0
```

Create a Python Client

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 *`matlabroot`*`\toolbox\compiler_sdk\mps_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 setup.py install
   ```
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()
```