Introduction

Overview

JuliaInXL is an extension of Microsoft® Excel® that brings the power of the Julia language and ecosystem to a familiar spreadsheet work environment.

This guide details the installation procedure and usage of the JuliaInXL package for JuliaPro.

Installation

Prerequisites

To install JuliaInXL, the system must meet the following prerequisites

- An appropriate version of Microsoft Windows®:
- Windows 7 SP1, Windows 8, Windows 8.1, Windows 10
- Windows Server 2008 R2, Windows Server 2012, Windows Server 2012 R2, Windows Server 2016
- JuliaPro v1.0.3.1 (Or higher)
- .NET 4.0 (Bundled with the JuliaInXL installer when executed with Administrator privileges)
- Microsoft Excel 2010, 2013, or 2016

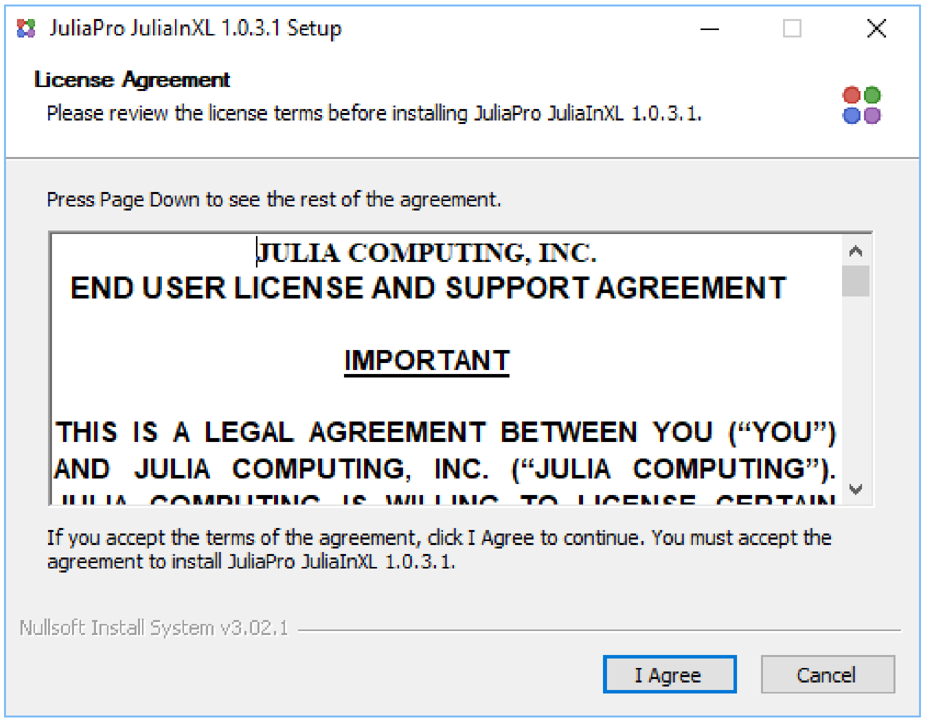
Installing JuliaInXL for JuliaPro

JuliaInXL can be installed only on a Windows machine if Microsoft Excel is installed. Installation of JuliaInXL should be performed with the same set of user privileges as were used when the corresponding version of JuliaPro was installed. Open your JuliaPro IDE and execute following command to begin JuliaInXL installation:

```
Pkg.add("JuliaInXL")
```

Above command will download JuliaInXL installer and initiate the installer, you will be presented with the JuliaInXL Software License Agreement. After reading through the terms mentioned in the agreement, click "I Agree" if you accept the terms of the license and proceed with the installation.

Upon completion of the installer, press close to exit the installer. Once you close the installer, you can come back to your JuliaPro IDE to use JuliaInXL.



JuliaPro JuliaInXL 1.0.3.1 Setup

License Agreement

Please review the license terms before installing JuliaPro JuliaInXL 1.0.3.1.

Press Page Down to see the rest of the agreement.

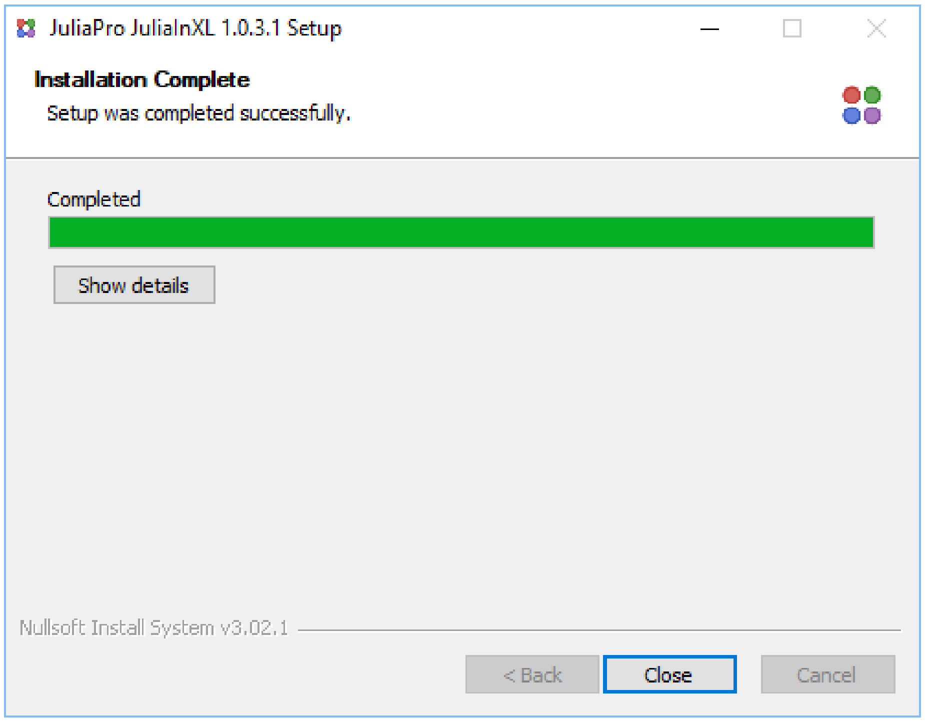
JULIA COMPUTING, INC.
END USER LICENSE AND SUPPORT AGREEMENT

IMPORTANT

THIS IS A LEGAL AGREEMENT BETWEEN YOU ("YOU") AND JULIA COMPUTING, INC. ("JULIA COMPUTING").

If you accept the terms of the agreement, click I Agree to continue. You must accept the agreement to install JuliaPro JuliaInXL 1.0.3.1.

Figure 1:


JuliaPro JuliaInXL 1.0.3.1 Setup

Installation Complete

Setup was completed successfully.

Completed

Nullsoft Install System v3.02.1

Figure 2:

Uninstalling JuliaInXL

Please use “Add/Remove programs” Windows utility to uninstall JuliaInXL.

Trademark Usage

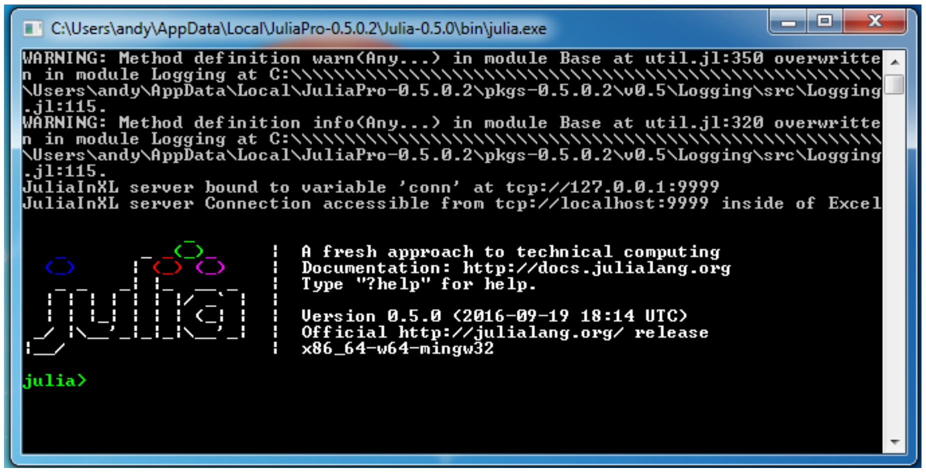
Microsoft®, Windows®, and Excel® are registered trademarks of Microsoft Corporation.

Other names may be trademarks of their respective owners.

Using JuliaInXL for JuliaPro

Julia Office Ribbon Tab

If JuliaInXL was selected as a component to install with your JuliaPro installation, then in most cases a Julia process should launch automatically when starting your Excel session.



C:\Users\andy\AppData\Local\JuliaPro-0.5.0.2\Julia-0.5.0\bin\julia.exe

```
WARNING: Method definition warn(Any...) in module Base at util.jl:350 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
WARNING: Method definition info(Any...) in module Base at util.jl:320 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
JuliaInXL server bound to variable 'conn' at tcp://127.0.0.1:9999
JuliaInXL server Connection accessible from tcp://localhost:9999 inside of Excel

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   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: http://docs.julialang.org
   _ _   _| |_  __ _   |  Type "?help" for help.
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.5.0 (2016-09-19 18:14 UTC)
 _/ |\__'_|_|_|\__'_|  |  Official http://julialang.org/ release
|__/                   |  x86_64-w64-mingw32

julia>
```

Figure 3:

A Julia tab will also be present in the Office Ribbon that contains a number of buttons and text boxes for controlling the connection between Julia and Excel, as well as loading functionality into the current Julia process.

In the current version of JuliaInXL, if your Excel installation has loaded the “Analysis Toolpak - VBA” add-in, then the Julia process does not launch automatically on startup. In this scenario, you must launch the julia.exe process manually using the “Launch Local Julia” button as shown below.

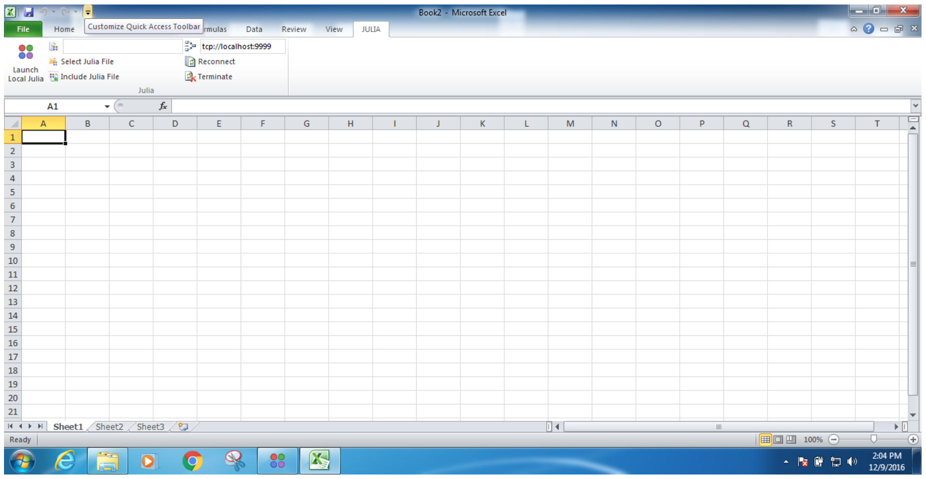
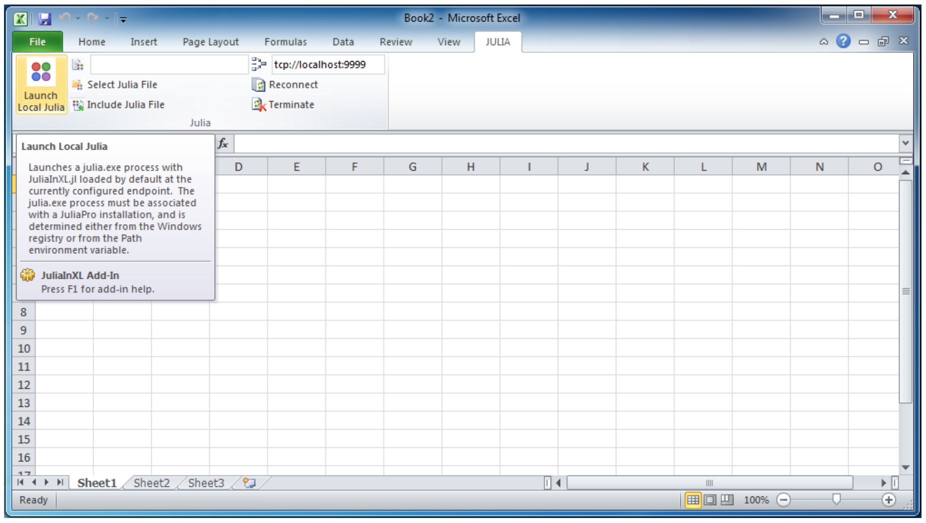


Figure 4:



Launch Local Julia

Launches a julia.exe process with JuliaInXL.jl loaded by default at the currently configured endpoint. The julia.exe process must be associated with a JuliaPro installation, and is determined either from the Windows registry or from the Path environment variable.

JuliaInXL Add-In

Press F1 for add-in help.

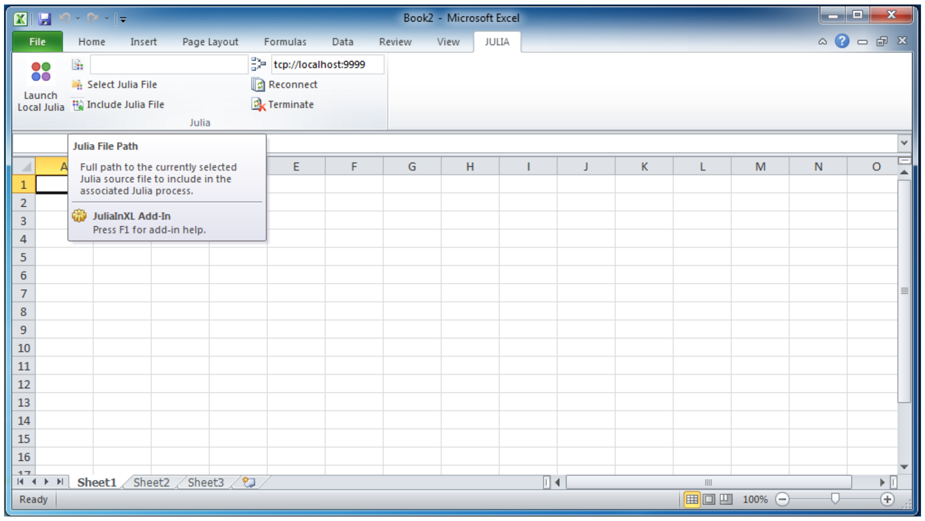
Figure 5:

The “Launch Local Julia” button will launch a new child Julia process, as well as start a JuliaInXL server process that listens on the currently defined TCP endpoint.

When this button is pressed, any current child Julia process is shutdown before launching a new Julia process.

If an execution of `jlcall` has resulted in a `#JuliaNotConnected` error, then either the “Launch Local Julia” button or the “Reconnect” button (described below) can be used to re-establish a connection to a JuliaInXL server process. The “Launch Local Julia” button launches a new julia.exe process, while the “Reconnect” button attempts to connect to a JuliaInXL server in an existing julia.exe process.

Adjacent to the “Launch Local Julia” button is a “Julia File Path” text box for entering the path to a file that can be loaded into the Julia process via the `include` command.



Julia File Path

Full path to the currently selected Julia source file to include in the associated Julia process.

JuliaInXL Add-In
Press F1 for add-in help.

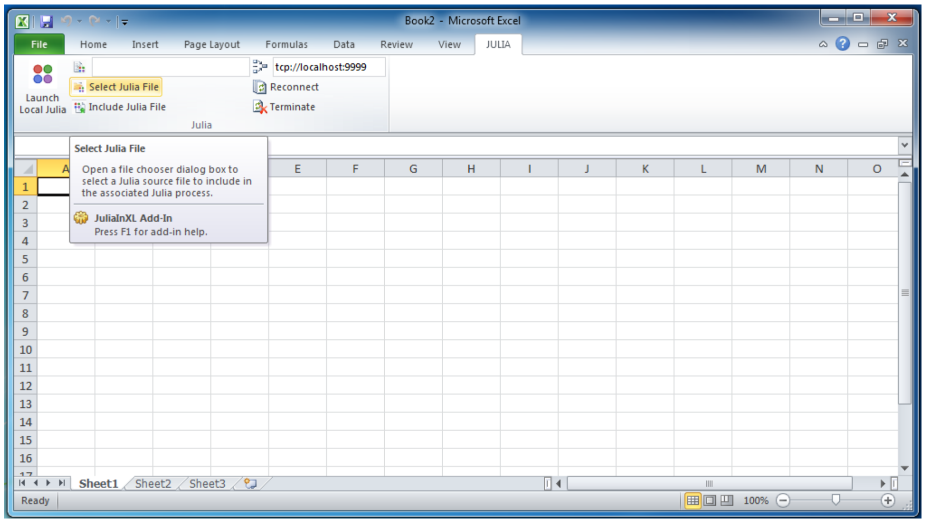
Figure 6:

Below the “Julia File Path”, is a “Select Julia File” button, which launches a file chooser dialog box that allows for browsing to a Julia file that can be loaded into the current Julia process.

Selecting a file using this dialog box only populates the “Julia File Path” text box with the path to the file selected.

With a file selected via the “Select Julia File” button or manually entered into the “Julia File Path” text box, the selected file can be loaded into the Julia process using the “Include Julia File” button.

In the screenshot below, we have included the “sim.jl” file from the “test”

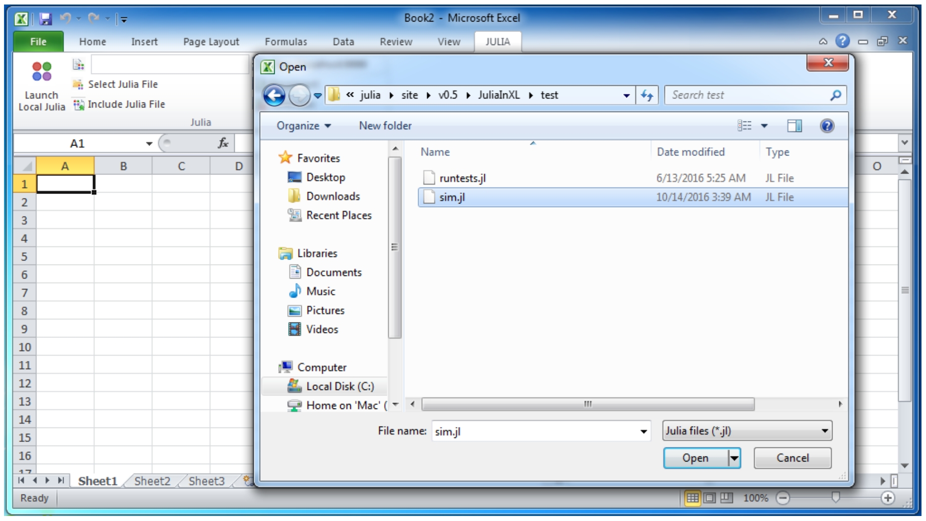


Select Julia File

Open a file chooser dialog box to select a Julia source file to include in the associated Julia process.

JuliaInXL Add-In
Press F1 for add-in help.

Figure 7:



Name	Date modified	Type
runtests.jl	6/13/2016 5:25 AM	JL File
sim.jl	10/14/2016 3:39 AM	JL File

File name: sim.jl
Julia files (*.jl)

Figure 8:

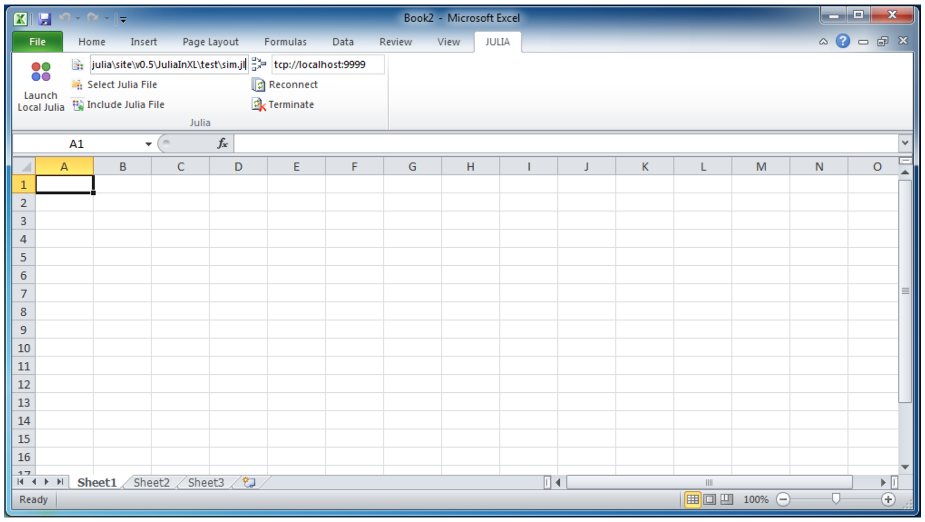
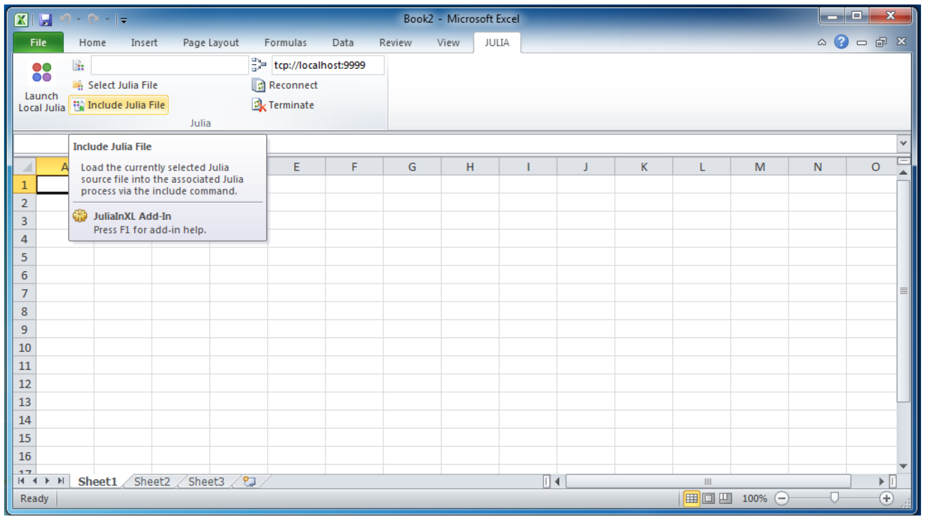


Figure 9:



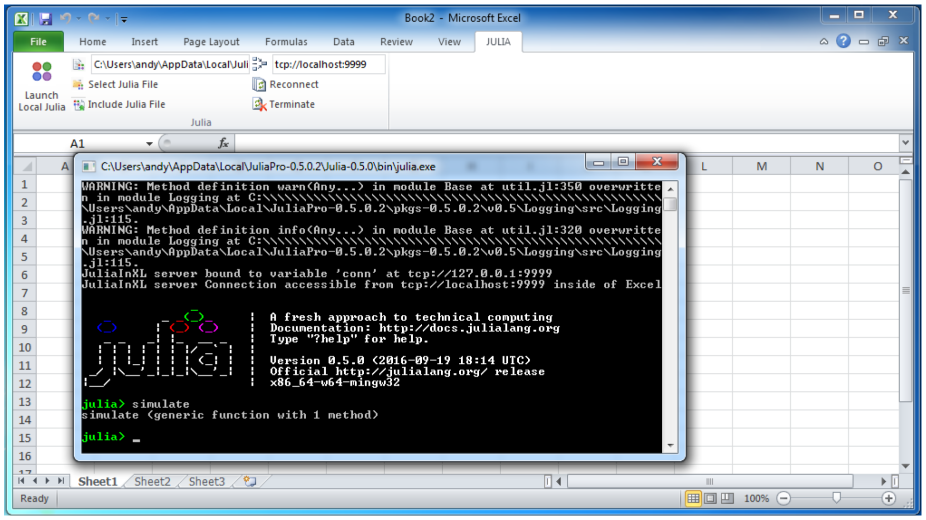
Include Julia File

Load the currently selected Julia source file into the associated Julia process via the include command.

JuliaInXL Add-In
Press F1 for add-in help.

Figure 10:

directory of the JuliaInXL package installation. The `simulate` function defined in `sim.jl` is now available for use from the current Julia process and is callable from Excel via `jlcall` as described in a later section.



```
WARNING: Method definition warn(Any...) in module Base at util.jl:350 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
WARNING: Method definition info(Any...) in module Base at util.jl:320 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
JuliaInXL server bound to variable 'conn' at tcp://127.0.0.1:9999
JuliaInXL server Connection accessible from tcp://localhost:9999 inside of Excel

               _
   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: http://docs.julialang.org
   _ _   _| |_  __ _   |  Type "?help" for help.
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.5.0 (2016-09-19 18:14 UTC)
 _/ |\__'_|_|_|\__'_|  |  Official http://julialang.org/ release
|__/                   |  x86_64-w64-mingw32

julia> simulate
simulate (generic function with 1 method)

julia> _
```

Figure 11:

Adjacent to the “Julia File Path” text box is the “JuliaInXL TCP Endpoint” textbox. This textbox displays the currently configured TCP endpoint to use when Excel connects to a JuliaInXL server.

By default, the endpoint value displayed in this textbox is associated with the value stored in the “JuliaInXL_Default_Endpoint” entry of the JuliaPro Windows registry key.

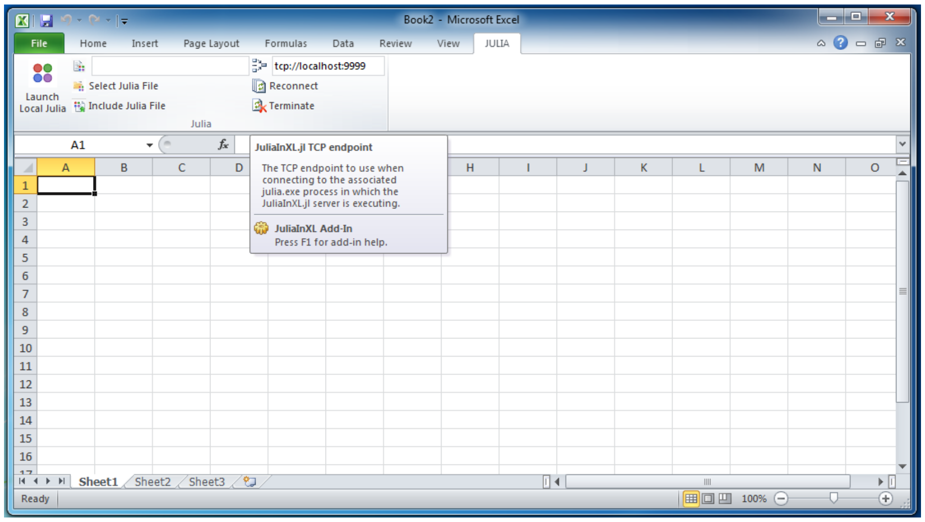
For a “Current User” installation of JuliaPro, this registry key is located at “HKEY_CURRENT_USER\Software\JuliaProfessional\0.5.0.4\”.

For an “All Users” installation of JuliaPro, this registry key is located at “HKEY_LOCAL_MACHINE\Software\JuliaProfessional\0.5.0.4\”.

For a “Shared Drive” installation of JuliaPro, no Windows registry keys are written on installation, but JuliaInXL will also look to see if an environment variable JULIAINXL_DEFAULT_ENDPOINT has been set.

As shown below, for “Shared Drive” installations, you should both set a value for JULIAINXL_DEFAULT_ENDPOINT, and also ensure that the path to the julia.exe executable included in your JuliaPro installation is included in a Path environment variable for either your system or your current user account.

For connections made to Julia processes executing on the local machine, the hostname included in the provided TCP endpoint should always be “localhost”. On the Julia side, the IP address `127.0.0.1` is used when creating the connection



JuliaInXL.jl TCP endpoint

The TCP endpoint to use when connecting to the associated julia.exe process in which the JuliaInXL.jl server is executing.

JuliaInXL Add-In
Press F1 for add-in help.

Figure 12:

endpoint from which the JuliaInXL server can accept connections. Connections endpoints entered into the "JuliaInXL TCP Endpoint" on the Excel side should use the DNS name associated with an IP address, while on the Julia side the IP address should be used directly.

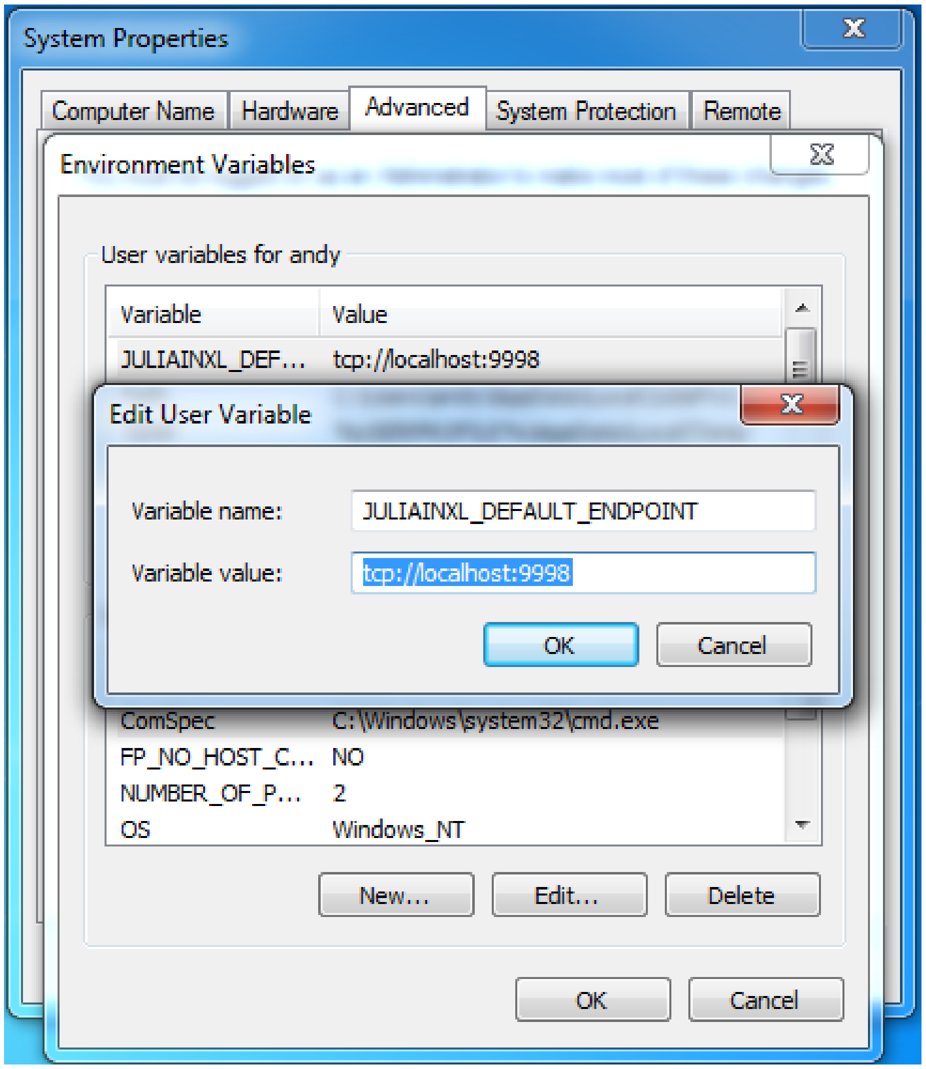
If you wish to configure your JuliaInXL session to connect to a particular JuliaInXL server, possibly on a different machine, then the value of the current endpoint can be changed either manually in the "JuliaInXL TCP Endpoint" text box, through the Windows Registry or via an environment variable.

Using the Windows Registry or an Environment variable allows for the possibility of connecting to a remote JuliaInXL server session as part of an automated workflow that launches Excel and makes use of Julia.

Note that with the current version of JuliaInXL, if the Excel installation has loaded the "Analysis Toolpak - VBA" Add-In, then JuliaInXL cannot be used in the automated workflow described above.

Also note that regardless of the endpoint value (e.g. tcp://hostname:) provided within the Windows Registry, in a JULIAINXL_DEFAULT_ENDPOINT environment variable, entered manually in the "JuliaInXL TCP Endpoint" text box, if a user presses the "Launch Local Julia" button, then the endpoint value in the "JuliaInXL TCP Endpoint" text box will be updated to point to "tcp://localhost:" before launching a new Julia process to create a JuliaInXL server.

Below the "JuliaInXL TCP Endpoint" textbox is the "Reconnect" button. This button resets the TCP client endpoint on the Excel side of the connection, and then attempts to reconnect to the existing JuliaInXL server.


System Properties

Computer Name | Hardware | Advanced | System Protection | Remote

Environment Variables

User variables for andy

Variable	Value
JULIAINXL_DEF...	tcp://localhost:9998

Edit User Variable

Variable name: JULIAINXL_DEFAULT_ENDPOINT

Variable value: tcp://localhost:9998

Variable	Value
ComSpec	C:\Windows\system32\cmd.exe
FP_NO_HOST_C...	NO
NUMBER_OF_P...	2
OS	Windows_NT

Figure 13:

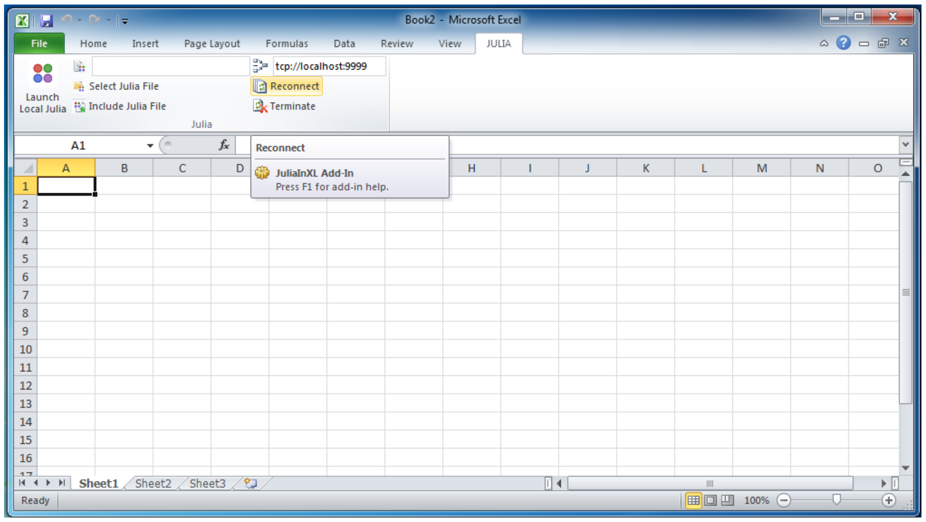


Figure 14:

If an execution of `jlcall` has resulted in a `#JuliaNotConnected` error, then either the "Launch Local Julia" button or the "Reconnect" button (described below) can be used to re-establish a connection to a JuliaInXL server process. The "Launch Local Julia" button launches a new julia.exe process, while the "Reconnect" button attempts to connect to a JuliaInXL server in an existing julia.exe process.

The "Terminate" button disconnects the TCP client endpoint on the Excel side of the connection.

Calling Julia Functions from Excel using `jlcall`

Once the server is started, julia functions can be called from Excel using the `jlcall` worksheet function. The first argument to `jlcall` is a string, which is the name of the registered Julia function to be called. Subsequent arguments to the `jlcall` function are passed as parameters to the Julia function being called. These can be constant literals, or cell references. Arrays can be passed via cell ranges.

If the Julia function returns an array (1d or 2d), then use `jlcall` as an Excel Array function by selecting a range before entering the function, and pressing `Shift+Ctrl+Enter` to finish. Functions exposed to Excel should take floats or strings, or their arrays as arguments. In general, it is a good idea to keep the function arguments as loosely typed as possible. Therefore functions should return integers, floats, or strings; or their arrays. However, arrays of dimensions greater than two are not supported. Note that Excel stores all numbers as 64

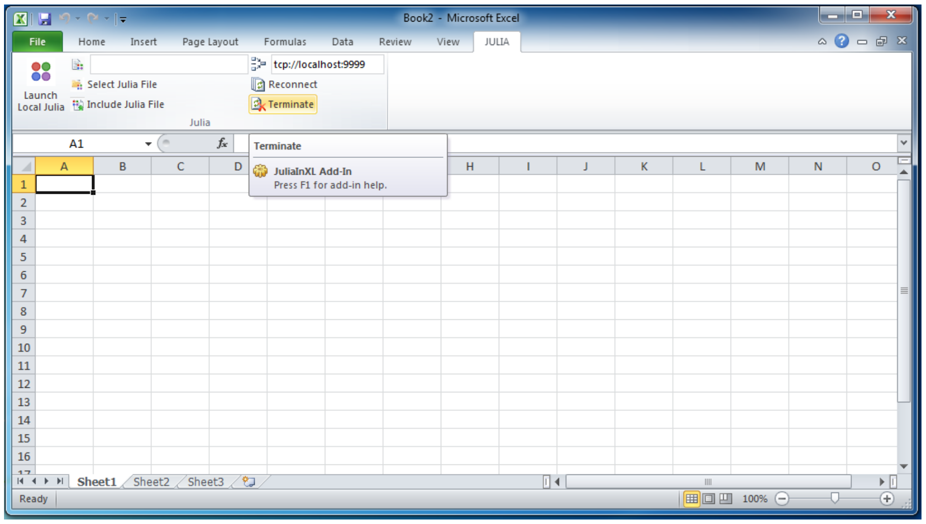


Figure 15:

bit IEEE floats. Therefore, be aware of the possibility of truncation if returning large, or high precision, numbers. Dates are passed in from excel as floating point numbers in its internal encoding (fractional days since 1/1/1900 or 1/1/1904). Thus, they are recieved in Julia functions as floats. They can be converted to Julia DateTime values using the xldate function.

Below we show the initial entry of `jlcall` being called within a cell.

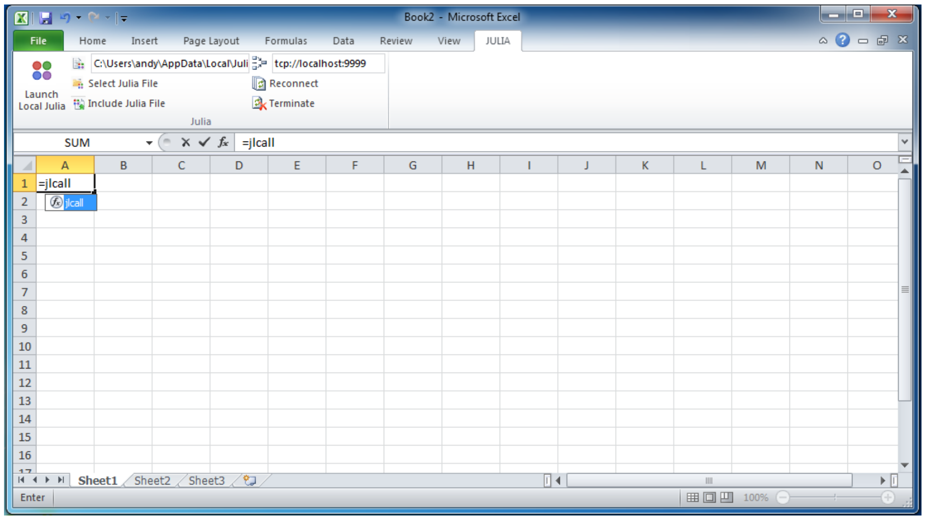
And the completion of that statement calling the `simulate` function from our example.

As well as the corresponding result:

By copying the contents of the cell in which `jlcall` was executed into multiple cells, the original `jlcall` operation can be repeated within multiple cells.

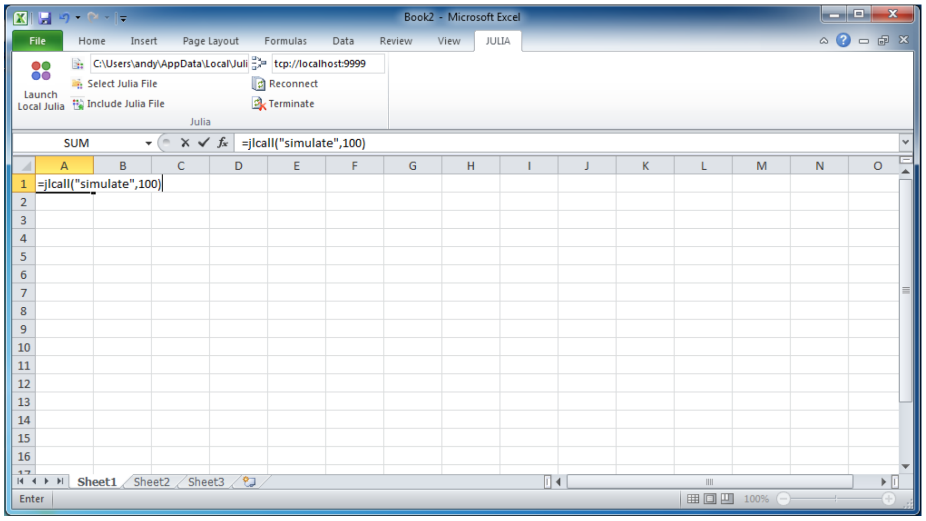
Resolving `#JuliaNotConnected!` error messages

If an execution of `jlcall` has resulted in a `#JuliaNotConnected!` error, then either the "Launch Local Julia" button or the "Reconnect" button (described below) can be used to re-establish a connection to a JuliaInXL server process. The "Launch Local Julia" button launches a new julia.exe process, while the "Reconnect" button attempts to connect to a JuliaInXL server in an existing julia.exe process.



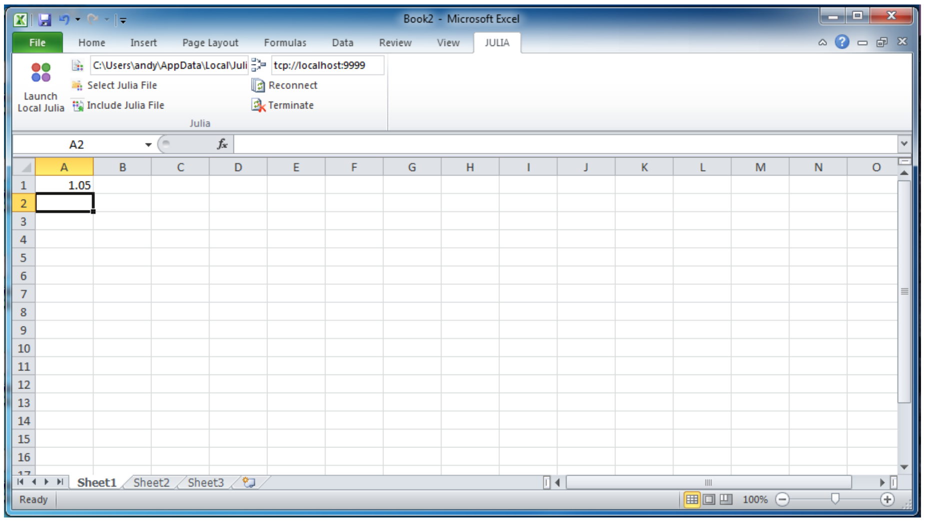
```
=jlcall
```

Figure 16:



```
=jlcall("simulate",100)
```

Figure 17:



C:\Users\andy\AppData\Local\Juli

tcp://localhost:9999

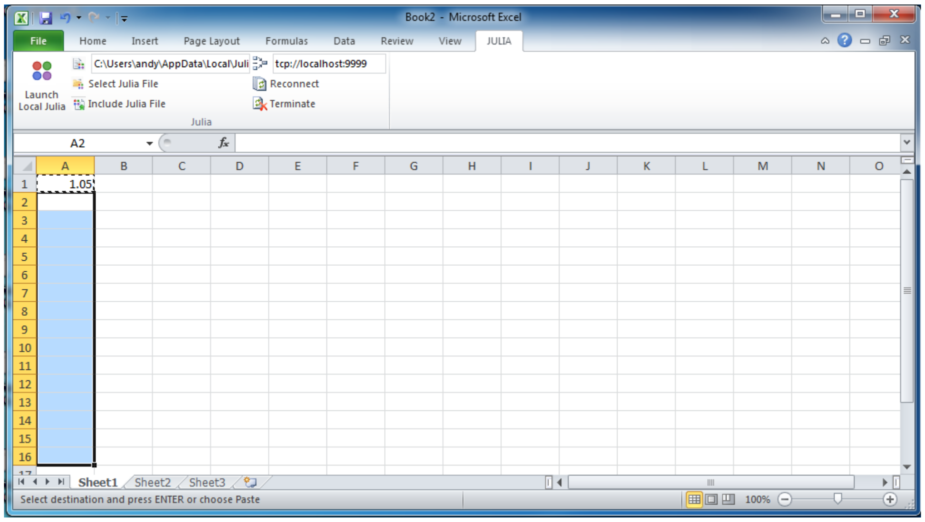
A2

1.05

Ready

100%

Figure 18:



C:\Users\andy\AppData\Local\Juli

tcp://localhost:9999

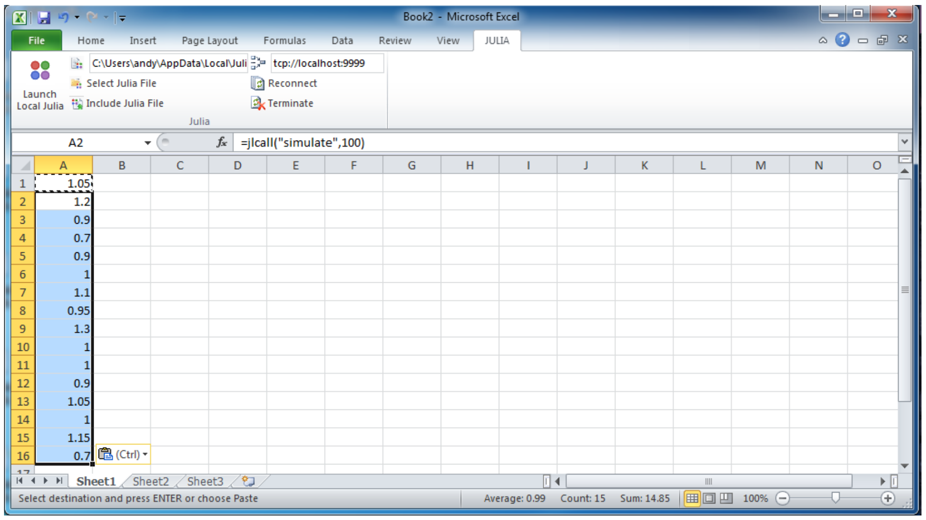
A2

1.05

Select destination and press ENTER or choose Paste

100%

Figure 19:



C:\Users\andy\AppData\Local\Juli

tcp://localhost:9999

A2 =jlcall("simulate",100)

	A
1	1.05
2	1.2
3	0.9
4	0.7
5	0.9
6	1
7	1.1
8	0.95
9	1.3
10	1
11	1
12	0.9
13	1.05
14	1
15	1.15
16	0.7

Select destination and press ENTER or choose Paste

Average: 0.99 Count: 15 Sum: 14.85 100%

Figure 20:

Resolving `#JuliaEmptyCell!` error messages

The `jlcall` function does not currently accept arguments whose inputs are cells or cell ranges that contain empty cells. To resolve a `#JuliaEmptyCell!` error, the input cells or cell ranges must be modified such that they contain a value of some type.

Defining global variables via `jlsetvar`

If you wish to assign a value to a variable within the current Julia process, a `global` variable can be created through the use of the `jlsetvar` function in Excel.

`jlsetvar` accepts two arguments, where the first argument is a text string for the name of the variable to be created and the second argument is a numeric value, a string value, or a cell reference or cell range whose contents are numbers or strings.

Executing a Julia expression via `jleval`

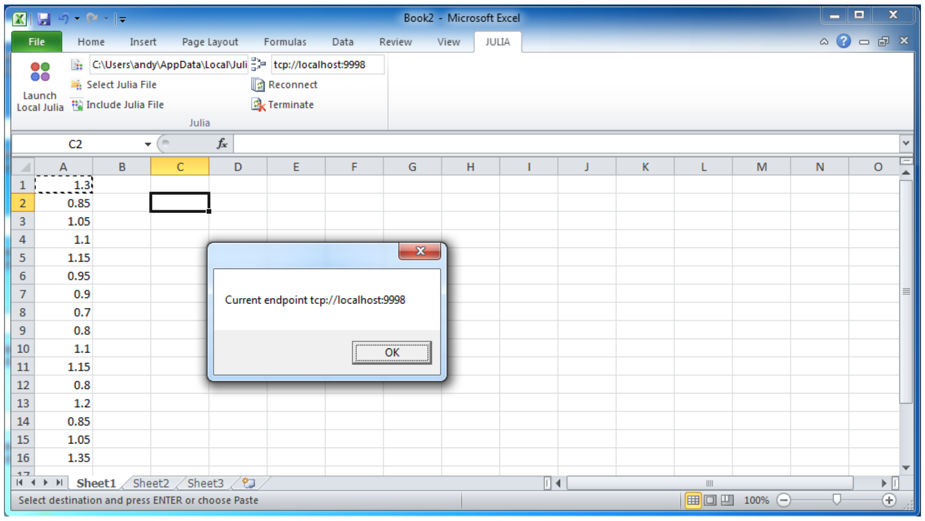
If you wish to define a Julia expression to be evaluated in the Julia process hosting the JuliaInXL server, the `jleval` function accepts a single string argument whose contents must be able to be evaluated by the julia function:

```
parse_and_eval(arg) = eval(parse(arg::String))
```

Connecting to a separate JuliaInXL server

As mentioned previously, one can connect a single Excel session to different Julia sessions by changing the port number within the Julia Office Ribbon tab.

Below is an example of changing the port number of the current Julia session from the default 9999 port to 9998.



C:\Users\andy\AppData\Local\Juli

tcp://localhost:9998

C2

	A
1	1.3
2	0.85
3	1.05
4	1.1
5	1.15
6	0.95
7	0.9
8	0.7
9	0.8
10	1.1
11	1.15
12	0.8
13	1.2
14	0.85
15	1.05
16	1.35

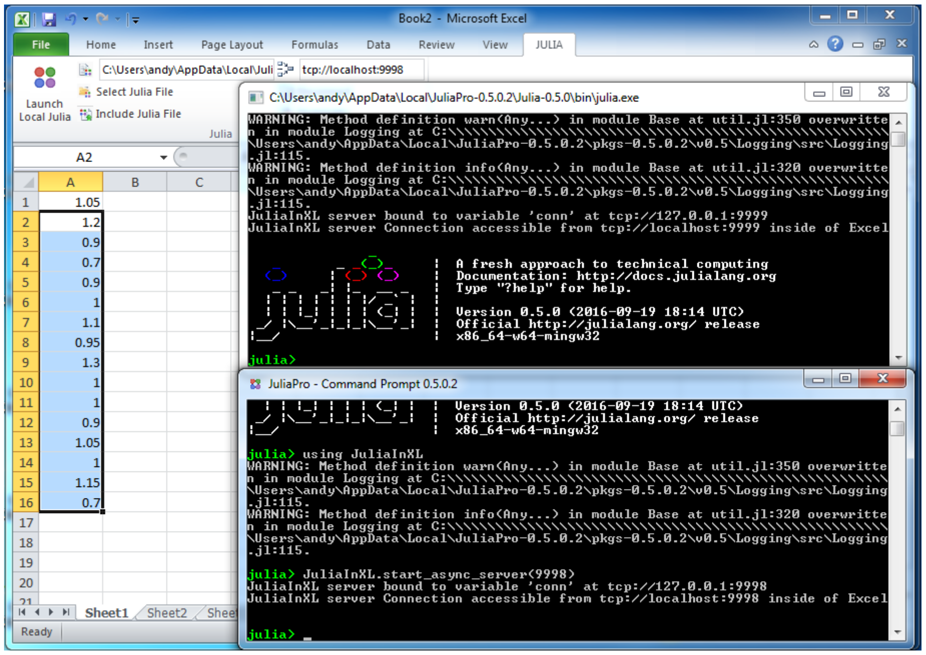
Current endpoint tcp://localhost:9998

OK

Select destination and press ENTER or choose Paste

Figure 21:

And then connecting that same Excel session to a separate Julia session where a different connection object has been associated with the new port number.



	A	B	C
1	1.05		
2	1.2		
3	0.9		
4	0.7		
5	0.9		
6	1		
7	1.1		
8	0.95		
9	1.3		
10	1		
11	1		
12	0.9		
13	1.05		
14	1		
15	1.15		
16	0.7		

C:\Users\andy\AppData\Local\JuliaPro-0.5.0.2\Julia-0.5.0\bin\julia.exe

```
WARNING: Method definition warn(Any...) in module Base at util.jl:350 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
WARNING: Method definition info(Any...) in module Base at util.jl:320 overwritte
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\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
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JuliaInXL server bound to variable 'conn' at tcp://127.0.0.1:9999
JuliaInXL server Connection accessible from tcp://localhost:9999 inside of Excel

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   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: http://docs.julialang.org
   _ _   _| |_  __ _   |  Type "?help" for help.
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.5.0 (2016-09-19 18:14 UTC)
 _/ |\__'_|_|_|\__'_|  |  Official http://julialang.org/ release
|__/                   |  x86_64-w64-mingw32

julia>
```

JuliaPro - Command Prompt 0.5.0.2

```
  | | |_| | | | (_| |  |  Version 0.5.0 (2016-09-19 18:14 UTC)
 _/ |\__'_|_|_|\__'_|  |  Official http://julialang.org/ release
|__/                   |  x86_64-w64-mingw32

julia> using JuliaInXL
WARNING: Method definition warn(Any...) in module Base at util.jl:350 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.
WARNING: Method definition info(Any...) in module Base at util.jl:320 overwritte
n in module Logging at C:\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
\Users\andy\AppData\Local\JuliaPro-0.5.0.2\pkgs-0.5.0.2\v0.5\Logging\src\Logging
.jl:115.

julia> JuliaInXL.start_async_server(9998)
JuliaInXL server bound to variable 'conn' at tcp://127.0.0.1:9998
JuliaInXL server Connection accessible from tcp://localhost:9998 inside of Excel

julia> _
```

Figure 22: