

# Lesson 3: Python

## Lab 3A: Python

### On Windows, download and install the latest version of Python 3

Open Git Bash, run Python and install/upgrade Python packages with pip

```
MINGW64/c/Users/87945/iot/lesson3
87945@DESKTOP-Q8QCBUA MINGW64 ~
$
bash: '$'\302\226': command not found
87945@DESKTOP-Q8QCBUA MINGW64 ~
$ python -i
Python 3.6.8 (tags/v3.6.8:3c6b436a57, Dec 24 2018, 00:16:47) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> import math
>>> math.sqrt(64)
8.0
>>> exit()
87945@DESKTOP-Q8QCBUA MINGW64 ~
$ python -m pip install --upgrade pip
Collecting pip
  Downloading pip-20.3.1-py2.py3-none-any.whl (1.5 MB)
    | 1.5 MB 3.3 MB/s
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 20.2.4
    Uninstalling pip-20.2.4:
      Successfully uninstalled pip-20.2.4
Successfully installed pip-20.3.1
87945@DESKTOP-Q8QCBUA MINGW64 ~
$ pip install jdcals astral geopy
Collecting astral
  Downloading astral-2.2-py2.py3-none-any.whl (30 kB)
Requirement already satisfied: pytz in c:\users\87945\appdata\local\programs\python\python36\lib\site-packages (from astral) (2020.4)
Collecting geopy
  Downloading geopy-2.0.0-py3-none-any.whl (111 kB)
    | 111 kB ...
Collecting jdcals
  Downloading jdcals-1.4.1-py2.py3-none-any.whl (9.5 kB)
Collecting dataclasses
  Downloading dataclasses-0.8-py3-none-any.whl (19 kB)
Collecting geographiclib<2,=>1.49
  Downloading geographiclib-1.50-py3-none-any.whl (38 kB)
Installing collected packages: geographiclib, dataclasses, jdcals, geopy, astral
Successfully installed astral-2.2 dataclasses-0.8 geographiclib-1.50 geopy-2.0.0 jdcals-1.4.1
87945@DESKTOP-Q8QCBUA MINGW64 ~
$ cd
87945@DESKTOP-Q8QCBUA MINGW64 ~
$ cd iot
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot
$ git pull
fatal: not a git repository (or any of the parent directories): .git
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot
$ cd lesson3
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python julian.py
Calendar Date: 2020-12-04
Julian Date: 2459187.5
Modified Julian Date: 59187.0
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python date_example.py
Date: 2020-12-04
Date: 12-04-20
Day of Week: Friday
Month: December
Year: 2020
95 days after the first day of classes
3 days before the last day of classes
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python datetime_example.py
2020-12-04 16:13:31.328601
2020-12-04 16:13:31.329598
2020-12-04 21:13:31.329598
1607116411.3295984
Fri Dec 4 16:13:31 2020
2020-12-04 16:13:31.329598
2020-12-04 21:13:31.329598
87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python time_example.py
Fri Dec 4 16:13:46 2020
Fri Dec 4 16:13:56 2020
Fri Dec 4 16:14:06 2020
Fri Dec 4 16:14:16 2020
```

```

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python sun.py 'New York'
Information for New York/USA

Timezone: US/Eastern
Latitude: 40.72; Longitude: -74.00

Dawn: 2020-12-04 06:33:14.849334-05:00
Sunrise: 2020-12-04 07:04:25.312334-05:00
Noon: 2020-12-04 11:46:11-05:00
Sunset: 2020-12-04 16:28:20.125961-05:00
Dusk: 2020-12-04 16:59:30.193123-05:00

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python sun.py 'Beijing'
Information for Beijing/China

Timezone: Asia/Harbin
Latitude: 39.92; Longitude: 116.33

Dawn: 2020-12-04 06:49:32.749826+08:00
Sunrise: 2020-12-04 07:20:14.949760+08:00
Noon: 2020-12-04 12:04:51+08:00
Sunset: 2020-12-04 16:49:24.407371+08:00
Dusk: 2020-12-04 17:20:06.228013+08:00

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python sun.py 'New Delhi'
Information for New Delhi/India

Timezone: Asia/Kolkata
Latitude: 28.62; Longitude: 77.22

Dawn: 2020-12-04 06:32:49.756503+05:30
Sunrise: 2020-12-04 06:59:01.793728+05:30
Noon: 2020-12-04 12:11:19+05:30
Sunset: 2020-12-04 17:23:42.763175+05:30
Dusk: 2020-12-04 17:49:54.786880+05:30

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python moon.py
2020-12-04 Moon Phase: 17
2020-12-05 Moon Phase: 18
2020-12-06 Moon Phase: 19
2020-12-07 Moon Phase: 20
2020-12-08 Moon Phase: 21
2020-12-09 Moon Phase: 22
2020-12-10 Moon Phase: 23
2020-12-11 Moon Phase: 24
2020-12-12 Moon Phase: 25
2020-12-13 Moon Phase: 26
2020-12-14 Moon Phase: 27
2020-12-15 Moon Phase: 0
2020-12-16 Moon Phase: 1
2020-12-17 Moon Phase: 2
2020-12-18 Moon Phase: 3
2020-12-19 Moon Phase: 4
2020-12-20 Moon Phase: 5
2020-12-21 Moon Phase: 6
2020-12-22 Moon Phase: 7
2020-12-23 Moon Phase: 8
2020-12-24 Moon Phase: 9
2020-12-25 Moon Phase: 10
2020-12-26 Moon Phase: 10
2020-12-27 Moon Phase: 11
2020-12-28 Moon Phase: 12
2020-12-29 Moon Phase: 13
2020-12-30 Moon Phase: 14
2020-12-31 Moon Phase: 15
2021-01-01 Moon Phase: 16
2021-01-02 Moon Phase: 17

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python coordinates.py 'SC Williams Library'
SC Williams Library, Field House Road, The Shades, Croxton, Hoboken, Hudson County, New Jersey, 07030, United States of America
(40.74480675, -74.02532862031404)

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$ python address.py '40.74480675, -74.02532862031404'
Stevens Institute of Technology, Babbio Drive, The Shades, Croxton, Hoboken, Hudson County, New Jersey, 07030, United States of America
(40.744809599999996, -74.02524356385591)

87945@DESKTOP-Q8QCBUA MINGW64 ~/iot/lesson3
$

```

## On Raspberry Pi only

```

pi@Zhaoning: ~
File Edit Tabs Help

pi@Zhaoning:~ $ python3 system_info.py
Free RAM: 99 (3776)
Number of processes: 171
Up time: 4 min
Number of connections: 4
Temperature in C: 54.0
IP-address: 192.168.1.169
CPU speed in MHz: arm_freq=1500

pi@Zhaoning:~ $

```

Run ifconfig on Raspberry Pi (macOS or Linux) or ipconfig on Windows to find IP address

```
pi@Zhaoning:~ $ ifconfig
docker0: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    inet 172.17.0.1 netmask 255.255.0.0 broadcast 172.17.255.255
    ether 02:42:0d:6e:2c:06 txqueuelen 0 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

eth0: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    ether dc:a6:32:2d:15:d4 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 29 bytes 1724 (1.6 KiB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 29 bytes 1724 (1.6 KiB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.1.169 netmask 255.255.255.0 broadcast 192.168.1.255
    inet6 fe80::4326:9bec:9340:666a prefixlen 64 scopeid 0x20<link>
    ether dc:a6:32:2d:15:d5 txqueuelen 1000 (Ethernet)
    RX packets 5469 bytes 590529 (576.6 KiB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2857 bytes 638148 (623.1 KiB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

pi@Zhaoning:~ $
```

## Lab 3E: PyPy

```
pi@Zhaoning: ~/iot/lesson3/pyypy
File Edit Tabs Help
pi@Zhaoning:~$ cd ~/iot/lesson3/pyypy
pi@Zhaoning:~/iot/lesson3/pyypy$ gcc -o test test.c
pi@Zhaoning:~/iot/lesson3/pyypy$ time ./test
1000000.000000

real    0m0.026s
user    0m0.025s
sys     0m0.001s
pi@Zhaoning:~/iot/lesson3/pyypy$ time pypy test.py
1000000.0

real    0m7.130s
user    0m0.121s
sys     0m0.165s
pi@Zhaoning:~/iot/lesson3/pyypy$ time python test.py
1000000.0

real    0m1.381s
user    0m0.567s
sys     0m0.021s
pi@Zhaoning:~/iot/lesson3/pyypy$ time python3 test.py
1000000.0

real    0m0.663s
user    0m0.587s
sys     0m0.030s
pi@Zhaoning:~/iot/lesson3/pyypy$ pypy -m cProfile test.py
1000000.0
    1000003 function calls in 3.717 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
1      0.000    0.000    3.717    3.717 test.py:1(<module>)
1000000  1.848    0.000    1.848    0.000 test.py:1(add)
1      1.869    1.869    3.717    3.717 test.py:4(main)
1      0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

pi@Zhaoning:~/iot/lesson3/pyypy$ python -m cProfile test.py
1000000.0
    1000003 function calls in 1.951 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
1      0.000    0.000    1.951    1.951 test.py:1(<module>)
1000000  0.718    0.000    0.718    0.000 test.py:1(add)
1      1.233    1.233    1.951    1.951 test.py:4(main)
1      0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

pi@Zhaoning:~/iot/lesson3/pyypy$ python3 -m cProfile test.py
1000000.0
    1000005 function calls in 1.783 seconds

Ordered by: standard name

ncalls  tottime  percall  cumtime  percall filename:lineno(function)
1      0.000    0.000    1.783    1.783 test.py:1(<module>)
1000000  0.644    0.000    0.644    0.000 test.py:1(add)
1      1.139    1.139    1.783    1.783 test.py:4(main)
1      0.000    0.000    1.783    1.783 {built-in method builtins.exec}
1      0.000    0.000    0.000    0.000 {built-in method builtins.print}
1      0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}

pi@Zhaoning:~/iot/lesson3/pyypy$
```

## Lab 3F: Doxygen

```
pi@Zhaoning: ~/demo
File Edit Tabs Help
pi@Zhaoning:~$ sudo apt install doxygen html2text
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libclang1-6.0 libllvm6.0 libxapian30
Suggested packages:
  doxygen-latex doxygen-doc doxygen-gui graphviz xapian-tools
The following NEW packages will be installed:
  doxygen html2text libclang1-6.0 libllvm6.0 libxapian30
0 upgraded, 5 newly installed, 0 to remove and 48 not upgraded.
Need to get 22.5 MB of archives.
After this operation, 91.8 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://raspbrian.mirror.constant.com/raspbian buster/main armhf libllvm6.0 armhf 1:6.0.1-10+rpil [12.5 MB]
Get:2 http://raspbrian.mirror.constant.com/raspbian buster/main armhf libclang1-6.0 armhf 1:6.0.1-10+rpil [5,679 kB]
Get:3 http://raspbrian.mirror.constant.com/raspbian buster/main armhf libxapian30 armhf 1.4.11-1 [959 kB]
Get:4 http://raspbrian.mirror.constant.com/raspbian buster/main armhf doxygen armhf 1.8.13-10 [3,257 kB]
Get:5 http://raspbrian.mirror.constant.com/raspbian buster/main armhf html2text armhf 1.3.2a-24 [76.4 kB]
Fetched 22.5 MB in 5s (4,584 kB/s)
Selecting previously unselected package libllvm6.0:armhf.
(Reading database ... 188856 files and directories currently installed.)
Preparing to unpack .../libllvm6.0_1%3a6.0.1-10+rpil_armhf.deb ...
Unpacking libllvm6.0:armhf (1:6.0.1-10+rpil) ...
Selecting previously unselected package libclang1-6.0:armhf.
Preparing to unpack .../libclang1-6.0_1%3a6.0.1-10+rpil_armhf.deb ...
Unpacking libclang1-6.0:armhf (1:6.0.1-10+rpil) ...
Selecting previously unselected package libxapian30:armhf.
Preparing to unpack .../libxapian30_1.4.11-1_armhf.deb ...
Unpacking libxapian30:armhf (1.4.11-1) ...
Selecting previously unselected package doxygen.
Preparing to unpack .../doxygen_1.8.13-10_armhf.deb ...
Unpacking doxygen (1.8.13-10) ...
Selecting previously unselected package html2text.
Preparing to unpack .../html2text_1.3.2a-24_armhf.deb ...
Unpacking html2text (1.3.2a-24) ...
Setting up libxapian30:armhf (1.4.11-1) ...
Setting up libllvm6.0:armhf (1:6.0.1-10+rpil) ...
Setting up libclang1-6.0:armhf (1:6.0.1-10+rpil) ...
Setting up doxygen (1.8.13-10) ...
Setting up html2text (1.3.2a-24) ...
Processing triggers for libc-bin (2.28-10+rpil) ...
Processing triggers for man-db (2.8.5-2) ...
Processing triggers for mime-support (3.62) ...
pi@Zhaoning:~$ cd ~/demo
pi@Zhaoning:~/demo$ cp ~/lot/lesson3/pyexample.py .
pi@Zhaoning:~/demo$ doxygen -g doxygen.config

Configuration file 'doxygen.config' created.

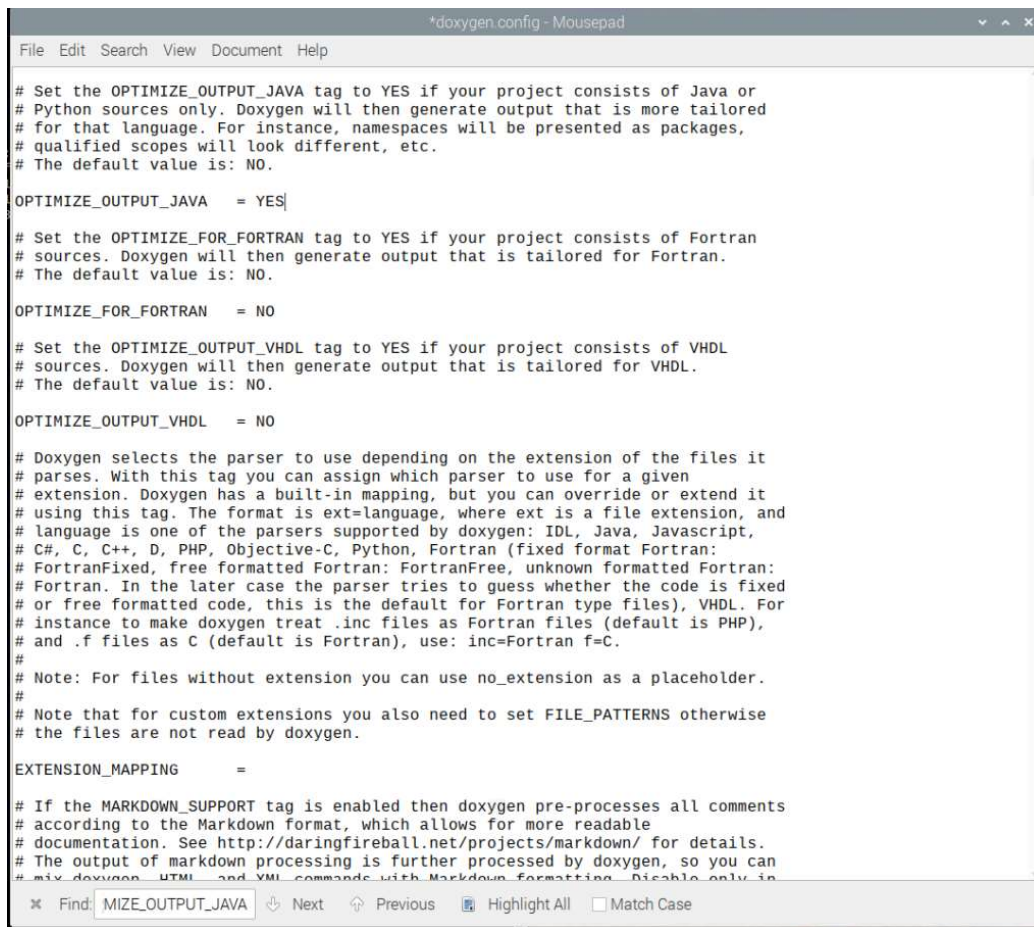
Now edit the configuration file and enter

doxygen doxygen.config

to generate the documentation for your project
pi@Zhaoning:~/demo$ nano doxygen.config
```

PROJECT\_NAME = "pyexample"

OPTIMIZE\_OUTPUT\_JAVA = YES



```
*doxygen.config - Mousepad
File Edit Search View Document Help

# Set the OPTIMIZE_OUTPUT_JAVA tag to YES if your project consists of Java or
# Python sources only. Doxygen will then generate output that is more tailored
# for that language. For instance, namespaces will be presented as packages,
# qualified scopes will look different, etc.
# The default value is: NO.

OPTIMIZE_OUTPUT_JAVA = YES

# Set the OPTIMIZE_FOR_FORTRAN tag to YES if your project consists of Fortran
# sources. Doxygen will then generate output that is tailored for Fortran.
# The default value is: NO.

OPTIMIZE_FOR_FORTRAN = NO

# Set the OPTIMIZE_OUTPUT_VHDL tag to YES if your project consists of VHDL
# sources. Doxygen will then generate output that is tailored for VHDL.
# The default value is: NO.

OPTIMIZE_OUTPUT_VHDL = NO

# Doxygen selects the parser to use depending on the extension of the files it
# parses. With this tag you can assign which parser to use for a given
# extension. Doxygen has a built-in mapping, but you can override or extend it
# using this tag. The format is ext=language, where ext is a file extension, and
# language is one of the parsers supported by doxygen: IDL, Java, Javascript,
# C#, C, C++, D, PHP, Objective-C, Python, Fortran (fixed format Fortran:
# FortranFixed, free formatted Fortran: FortranFree, unknown formatted Fortran:
# Fortran. In the later case the parser tries to guess whether the code is fixed
# or free formatted code, this is the default for Fortran type files), VHDL. For
# instance to make doxygen treat .inc files as Fortran files (default is PHP),
# and .f files as C (default is Fortran), use: inc=Fortran f=C.
#
# Note: For files without extension you can use no_extension as a placeholder.
#
# Note that for custom extensions you also need to set FILE_PATTERNS otherwise
# the files are not read by doxygen.

EXTENSION_MAPPING =

# If the MARKDOWN_SUPPORT tag is enabled then doxygen pre-processes all comments
# according to the Markdown format, which allows for more readable
# documentation. See http://daringfireball.net/projects/markdown/ for details.
# The output of markdown processing is further processed by doxygen, so you can
# mix doxygen, HTML and XML commands with Markdown formatting. Disable only in
# mix doxygen, HTML and XML commands with Markdown formatting. Disable only in

Find: MIZE_OUTPUT_JAVA Next Previous Highlight All Match Case
```

```
pi@Zhaoning: ~/demo/html
File Edit Tabs Help
Adding xrefitems...
Sorting member lists...
Computing dependencies between directories...
Generating citations page...
Counting data structures...
Resolving user defined references...
Finding anchors and sections in the documentation...
Transferring function references...
Combining using relations...
Adding members to index pages...
Generating style sheet...
Generating search indices...
Generating example documentation...
Generating file sources...
Generating file documentation...
Generating page documentation...
Generating group documentation...
Generating class documentation...
Generating namespace index...
Generating docs for namespace pyexample
/home/pi/demo/pyexample.py:8: warning: Member func() (function) of namespace pyexample is not documented.
Generating docs for compound pyexample::PyClass...
Generating graph info page...
Generating directory documentation...
Generating index page...
Generating page index...
Generating module index...
Generating namespace index...
Generating namespace member index...
Generating annotated compound index...
Generating alphabetical compound index...
Generating hierarchical class index...
Generating graphical class hierarchy...
Generating member index...
Generating file index...
Generating file member index...
Generating example index...
Finalizing index lists...
Writing tag file...
Running dot...
sh: 1: dot: not found
error: Problems running dot: exit code=127, command='dot', arguments='"/home/pi/demo/html/graph_legend.dot" -Tpng -o "/home/pi/demo/html/graph_legend.png"'
Running dot for graph 1/1
lookup cache used 5/65536 hits=7 misses=5
finished...
pi@Zhaoning:~/demo $ cd html
pi@Zhaoning:~/demo/html $ html2text annotated.html

pyexample

Class List
Here are the classes, structs, unions and interfaces with brief descriptions:
[detail level 12]
*PyexampleDocumentation for this module
CPyClass Documentation for a class
=====
Generated by [doxygen] 1.8.13
```