

Programming workshop: a very brief introduction

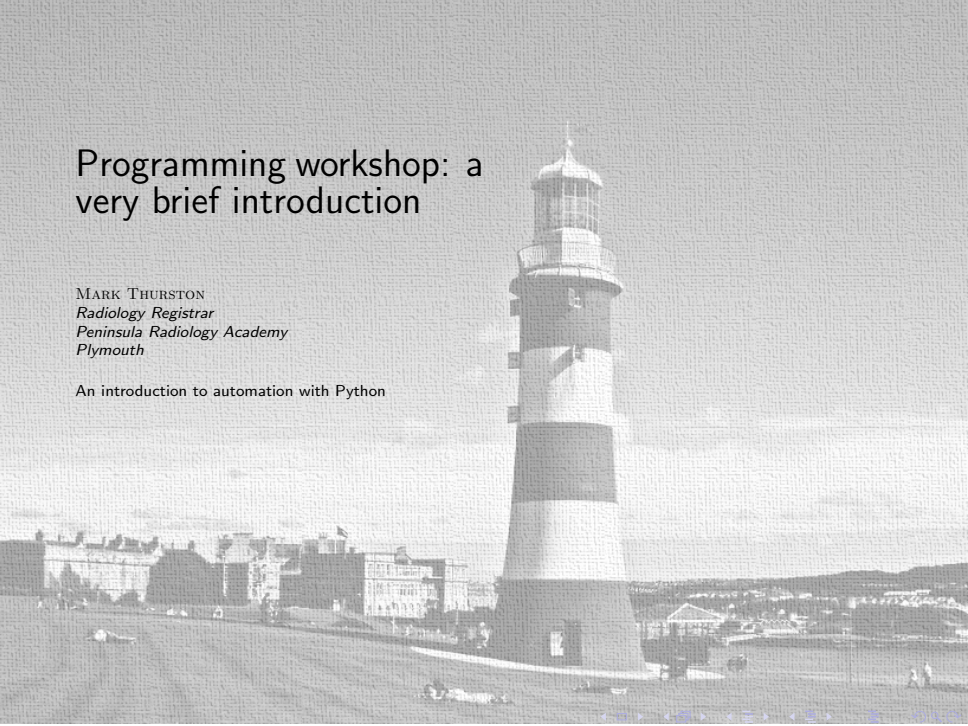
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An introduction to automation with Python



Aims and objectives

By the end of this session, you will be able to:

- ▶ Part 1: Theory
 - ▶ understand basic terms
 - ▶ have a good idea of some tasks that are possible
 - ▶ know where to learn more, if you are interested
- ▶ Part 2: Practice
 - ▶ set up a Python environment
 - ▶ run some pre-written example programs
 - ▶ Write your own simple example programs
- ▶ questions welcome throughout

Why?

how are these skills useful or relevant to me?

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- ▶ make your life easier: automate repetitive and boring tasks
 - ▶ get a new angle on a problem
 - ▶ some simple problems are impossible without very basic programming skills
 - ▶ master your research and audit data
 - ▶ useful in understanding and implementing emerging radiology technologies
 - ▶ AI, radiomics
 - ▶ knowledge enables you to navigate the hype – useful at conferences and as a consultant
 - ▶ interesting and fun :) – especially if you enjoy learning new things

Definitions: programming language

“formal language that specifies a set of instructions that can be used to produce various kinds of output”

- ▶ like any language:
 - ▶ spelling
 - ▶ grammatical rules
 - ▶ common useage
 - ▶ skill level – basic to mastery
 - ▶ the basics can still be put to very good use
 - ▶ mastery may take a lifetime
- ▶ categorisation
 - ▶ high level (Python, Java, etc) vs. lower level (C, assembly) vs. low level (machine code)
 - ▶ by programming paradigm: imperative (procedural, object orientated), declarative (functional, logical), symbolic

Definitions: Python

"The Python philosophy rejects exuberant syntax in favor of a simpler, less-cluttered grammar."

- ▶ based on the *ABC language* — optimised for ease of learning
 - ▶ "Simplicity is the ultimate sophistication" — William Gaddis
- ▶ open source:
 - ▶ *Python Software Foundation Licence (PSFL)*
 - ▶ BSD style licence
- ▶ massive community
 - ▶ loads of extra functionality available as modules
 - ▶ domains include data processing, artificial intelligence, image recognition
 - ▶ help is easily available online for free if you get stuck

Definitions: abstraction

"Ignore the characteristics that we don't need in order to concentrate on those that we do."

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- ▶ in general:
 - ▶ divide a programming problem into simpler, analogous pieces
 - ▶ solve the problem by combining solutions to simpler pieces
 - ▶ Application Programming Interface (API)
 - ▶ a set of clearly defined methods of communication between various software components

```
def drive_car(location):  
    <precise instructions>
```

```
drive_car("50.376289", -4.143841")
```

```
drive_car("51.509865", -0.118092")
```

Basic language syntax: hello world

your first program

“The only way to learn a new programming language is by writing programs in it. The first program to write is the same for all languages: Print the words: *hello, world* ... With these mechanical details mastered, everything else is comparatively easy.”

– Kernighan and Ritchie (“K&R”), 1978

- ▶ the interpreter: `python3`
- ▶ saving the file and running as a script: the “*shebang*”
- ▶ the print function: prints objects to a specified place (in our case, the screen *stdout*)

```
print( *objects, sep=' ', end='\n',  
       file=sys.stdout, flush=False)
```

Basic language syntax: comments and docstrings

ensure maximum readability... for others (and yourself)

- ▶ a `#` character makes the interpreter ignore the rest of the line
- ▶ at the start of a function definition, a *docstring* describes the function

```
def test_function():  
    '''Runs a test.'''  
    print("Testing... 1, 2, 3")  
  
# run the test  
test_function()
```


Basic language syntax: variables & data

data are the fundamental building blocks of any program

- ▶ variables allow storage of data by a name
- ▶ be careful how you name them!
 - ▶ clear and concise names: easy to read, descriptive
 - ▶ don't clash with other names in use (including language reserved keywords)
 - ▶ Python style guide recommendation: variable names should be lowercase, with words separated by underscores as necessary to improve readability. Uppercase global variable names.

```
my_var = "value"  
denominator = 7  
GLOBAL_VARIABLES = "all_caps"
```

Basic language syntax: lists, iterables

a list is a type of sequence

- ▶ an iterable is an object with multiple elements:
 - ▶ including *lists*, *tuples*, *sets*
- ▶ accessing multiple times can allow you to perform an operation on every element

```
body_parts = ["hand", "elbow", "shoulder"]  
months = ("Jan", "Feb", "Mar", ...)  
empty_list = list()
```

```
>>> print(months[0]) # 0-indexed  
Jan
```

Basic language syntax: Boolean statements

True, False, 1, 0

- ▶ Boolean algebra named after George Boole, 1815 – 1864
- ▶ the lowest construct that a computer understands
- ▶ the return value from a test statement is either True or False

```
>>> 1 == 1
```

```
True
```

```
>>> 10 <= 0
```

```
False
```

Basic language syntax: conditional statements

perform a different action depending on the result of a test

- ▶ control which part of the program is activated, depending on a test

```
if <statement>:
    <indented code block>
elif <another statement>:
    <indented code>
else:
    <more code>

<statement> == True # activates
<statement> == False # skips
```

Basic language syntax: loops

repeat a process over and over until a condition is met

- ▶ *iteration*: perform an operation on multiple elements
 - ▶ each file in a directory
 - ▶ each DICOM image in a list
- ▶ in Python — *for loop* and *while loop*:

```
for item in <iterable>:  
    <code block>
```

```
while <condition>:  
    <code block>
```

Basic language syntax: user input

store data to operate on

How do I get data in to my program?

- ▶ *stdin*: "standard input"
- ▶ *args*: command line arguments

```
# get some standard input
user_input = input()
```

```
# prints all the items in the argument vector
import sys
for item in sys.argv:
    print(item)
```

Basic language syntax: using external modules

add features to your program

- ▶ allows you to take advantage of built in and community contributed external code
- ▶ pip: tool to collect and install external modules from internet repository — minimal effort required

```
# use the os module to find all the files
```

```
import os
```

```
files = os.walk('.')
```

```
# install a new python module
```

```
$ pip3 install tensorflow
```

Designing your program: drawing board

think about the process

“Computer science is no more about computers than astronomy is about telescopes.”

– Dijkstra

- ▶ paper and pen
- ▶ get the steps right before you start and the rest will be easy
- ▶ the programming language syntax is of secondary importance

For example, your digital camera has produced a directory of files named IMG_3624.JPG etc... You would prefer them named Greece2018_xxx.jpg

Think about the steps that would be required for this:

1. select the appropriate directory location
 - ▶ either hard-coded or user-selectable
 - ▶ can you trust the user to enter a valid location?
2. build a list of all the items you want renamed
3. go through each item, performing the rename operation
 - ▶ format for renaming? a counter might be needed
4. exit

Possibilities: remove all duplicate patients from a spreadsheet

Automate a boring task

1. Precisely define the task: how do you define a duplicate row?
2. import the data to Python using the help of an external module
 - ▶ method depends on the format of the data – *Excel, comma separated value file*
3. loop through all the records removing those that fit (or don't fit) the criteria
4. write to a new file
5. exit

Possibilities: find all phone numbers in a text document

Regular expressions

1. What does a phone number look like?
 - ▶ country code [optional], area code, number
 - ▶ may include dashes or spaces
2. Design a pattern (*regular expression*) that fits the above
3. Test it, looking for false positives and false negatives

Modules: useful extensions

A few selected modules out of hundreds

- ▶ *Tensorflow*: open source machine learning library from Google
- ▶ *Pandas, numpy*: data analysis toolkits
- ▶ *Requests*: allows you to get webpages and text from the web into your program
- ▶ *Scrapy*: scrape data from the web
- ▶ *wxpython*: build a graphical program

Resources: books

Learning resources available on the internet

- ▶ Automate the boring stuff with Python:
`https://automatetheboringstuff.com/`
- ▶ Another free online tutorial:
`https://python-textbok.readthedocs.io/en/1.0/`

- ▶ Massive open online courses: some free, some cost
 - ▶ EdX:
`https://www.edx.org/course?search_query=python`
 - ▶ Coursera: `https://www.coursera.org/courses?languages=en&query=python&userQuery=python`
 - ▶ Udacity: `https://eu.udacity.com/`
 - ▶ udemy `https://www.udemy.com/`

Resources: practice to improve your skills

Thousands of resources are available

- ▶ coding websites
 - ▶ <https://www.hackerrank.com/domains/python>
 - ▶ <https://www.codecademy.com/tracks/python>
- ▶ open access data
 - ▶ <https://data.gov.uk/>
- ▶ read other code on <https://github.com>
- ▶ contribute to an open source project
 - ▶ Horos
 - ▶ Orthanc
 - ▶ OpenCV
 - ▶ Python

- ▶ Stackoverflow:
`https://stackoverflow.com/tags/python/info`
- ▶ Internet relay chat: `#python` on `irc.freenode.net`
- ▶ Mailing lists:
`https://www.python.org/community/lists/`

- ▶ basic definitions and background
- ▶ language syntax
 - ▶ variables
 - ▶ control structures
 - ▶ user input
- ▶ program design
- ▶ some uses
- ▶ help and resources