

Introductory Programming Using Python

Day 2

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[eAttendance]

(SF) Introductory Programming using Python (13 - 14 Aug 2020)



<https://bit.ly/rp-aug20>

Course Material : <https://bit.ly/py-aug20>

(Same link as yesterday)



Programme Day Two

Morning

- Read and writing files
- Copying, moving and deleting files and folders
- Working with Excel
- Image Processing

Afternoon

- Connecting to the Web
- Sending emails
- Creating charts
- Generating PDF



File Paths

Absolute file paths are notated by a **leading forward slash or drive label**.

For example,

/home/example_user/example_directory

or

C:/system32/cmd.exe

An absolute file path describes how to access a given file or directory, starting from the root of the file system.

Relative file paths are notated by a **lack of a leading forward slash**.

For example,

example_directory.

A relative file path is interpreted from the perspective your current working directory. If you use a relative file path from the wrong directory, then the path will refer to a different file than you intend, or it will refer to no file at all..



Read files

```
1 # make sure you have a hello.txt in your current working director
2 # same directory as your python script
3 helloFile = open("hello.txt")
4 content = helloFile.read()
5 print(content)
6 helloFile.close()
7
8 # make sure you have a hello.txt in the specified director
9 # same directory as your python script
10 helloFile = open("hello.txt")
11
12 content = helloFile.readlines()
13 print(content)
14
```

Open() will return a file object which has reading and writing related methods

Pass 'r' (or nothing) to open() to open the file in read mode.

Call read() to read the contents of a file

Call close() when you are done with the file.

- Call readLines() to read the contents of a file

The screenshot shows the Python IDLE interface. At the top, there are tabs for 'Search', 'Stack Data', 'Debug I/O', and 'Python Shell'. The 'Python Shell' tab is active. Below the tabs, a status bar says 'Commands execute without debug. Use arrow keys for history.' On the left, there are search and replace fields with checkboxes for 'Case sensitive', 'Whole words', and 'In Selection'. Below the search fields are buttons for 'Prev', 'Next', 'Replace', 'Place', and 'Option'. In the main window, the Python shell displays the following session:

```
3.7.4 (tags/v3.7.4:e09359112e, Jul 8
Python Type "help", "copyright", "cre
>>> [evaluate file_read_01.py]
THis is also another line
Hello world again

['THis is also another line\n', 'Hello world again\n']
```



Write files

```
1 # make sure you have a hello.txt in your current working director
2 # same directory as your python script
3 helloFile = open("hello.txt", "w")
4 helloFile.write("This is also another line\n")
5 helloFile.close()
6
7 # reopen to display content
8 helloFile = open("hello.txt")
9 print(helloFile.read())
10 helloFile.close()
11
12 # open the file for adding next text
13 helloFile = open("hello.txt", "a")
14 helloFile.write("Hello world again\n")
15 helloFile.close()
16
17 # reopen to display content
18 helloFile = open("hello.txt")
19 print(helloFile.read())
20 helloFile.close()
```

Pass 'w' to open() to open the file in write mode or 'a' for append mode.



Opening a non-existent file in write or append mode will create that file

Call write() to write a string to a file.

Search Stack Data

Search: Replace:
 Case sensitive Whole words In Selection

Previ Ne: eplac place Option:

Debug I/O Python Shell

Commands execute without debug. Use arrow keys for history.

```
3.7.4 (tags/v3.7.4:e09359112e, Jul 8 2019, 19:29:22) [MSC ^  
Python Type "help", "copyright", "credits" or "license" for  
[evaluate file_write..py]  
THis is also another line  
  
THis is also another line  
Hello world again
```



Copy and moving files

```
1 import shutil
2
3 # copy file
4 shutil.copy("folder1/hello.txt", "folder2")
5
6 # recursively copy an entire directory
7 shutil.copytree("folder2", "folder2_backup")
8
9 # move file
10 shutil.move("folder2/hello.txt", "folder2/anotherfolder")
11
12 # move and rename file
13 shutil.move("folder2/anotherfolder/hello.txt", "folder2/anotherfolder/newhello.txt")
14
```

Search Stack Data Debug I/O Python Shell

Search: Commands execute without debug. Use arrow keys for history.

Replace: Options

Case Whole In Selection

>>> [evaluate file_copy_01.py]

- `shutil.copy(src, dst)` – Copy the file `src` to the file or directory `dst`
- `shutil.copytree(src, dst)` - Recursively copy an entire directory tree rooted at `src`.
- `shutil.move(src, dst)` - Recursively move a file or directory (`src`) to another location (`dst`).

<https://docs.python.org/3/library/shutil.html>



Deleting files

```
import os

# error if file do not exist
os.unlink("hello.txt")

# get current working directory
print(os.getcwd())

# delete directory (can only delete empty folder)
os.rmdir("folder3")

import shutil
# delete directory (with content)
# error if folder is not found
shutil.rmtree("folder3")
```

e.g. To delete all .docx file in the current folder

```
import os

for filename in os.listdir():
    if filename.endswith(".docx"):
        print(filename)
        os.unlink(filename)
```

- `os.unlink()` will delete a file
- `os.rmdir()` will delete a folder (but folder must be empty)
- `shutil.rmtree()` will delete a folder and all its contents



Deleting can be dangerous, so do a dry run first

file_delete.py



send2Trash module

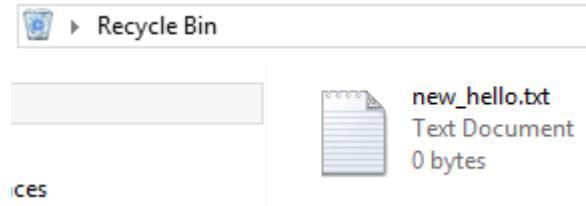
- Install send2trash module using pip.exe
`pip install send2trash`
- `send2trash.send2trash()` will send a file or folder to the recycling bin

```
Administrator: Command Prompt
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\charissa_chua>cd C:\Users\charissa_chua\PycharmProjects\ExerciseTwo\venv\Scripts
C:\Users\charissa_chua\PycharmProjects\ExerciseTwo\venv\Scripts>pip.exe install send2trash
Collecting send2trash
  Using cached https://files.pythonhosted.org/packages/49/46/c3dc27481d1cc57b9385aff41c474ceb7714f79
Installing collected packages: send2trash
Successfully installed send2trash-1.5.0
You are using pip version 10.0.1, however version 18.0 is available.
You should consider upgrading via the 'python -m pip install --upgrade pip' command.

C:\Users\charissa_chua\PycharmProjects\ExerciseTwo\venv\Scripts>
```

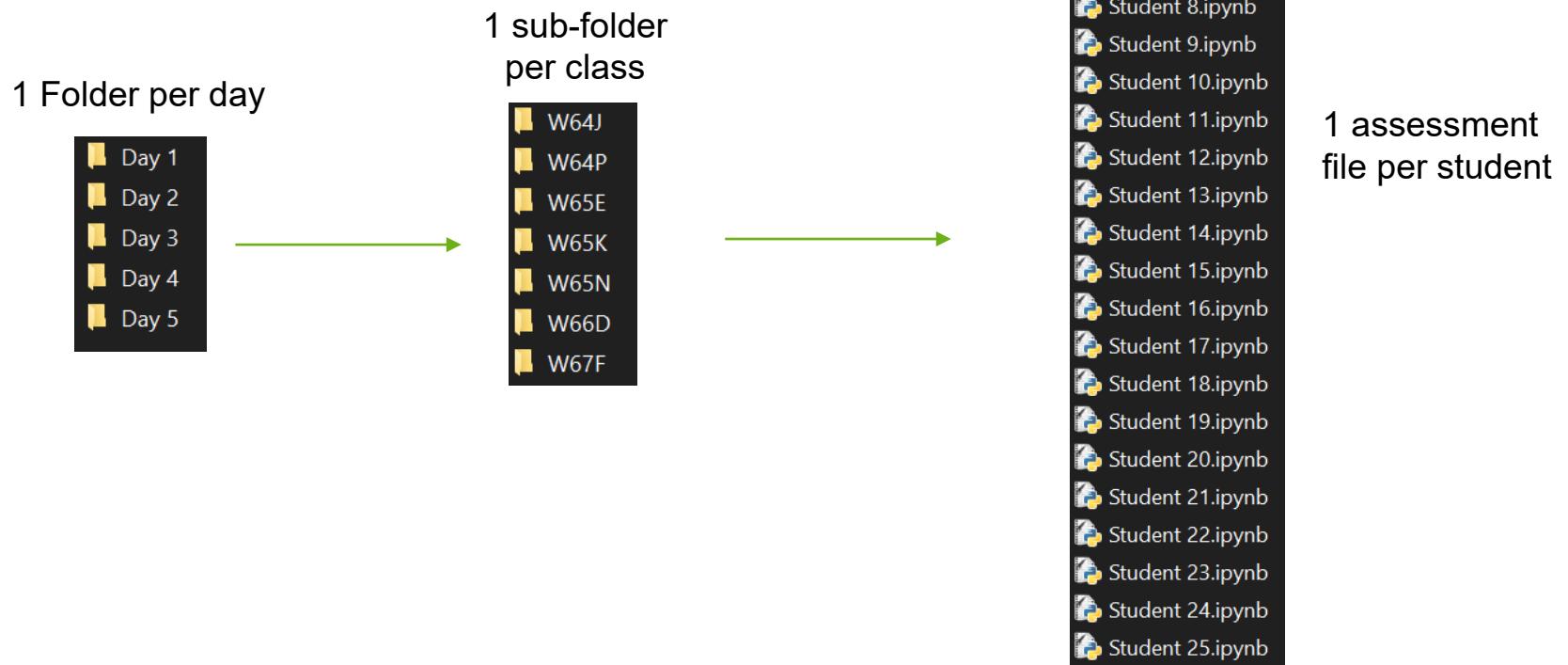
```
>>> import send2trash
>>> send2trash.send2trash("D:\\\\folder2\\\\new_hello.txt")
```





Use Case Sharing

- Generating 600+ students assessment files, organized by day of week and classes folder
 - 5 Days of week
 - ~7 Classes a day
 - ~22+ students per class





Other Use Cases

- System administrators can use these commands to
 - Copy and backup files to other hard-disks
 - Delete folders/ files at fixed schedules
 - End of financial year?
 - End of semester?
- Others use
 - Check timestamp of files, and delete all files created before a certain date



Exercise

- **Write code to achieve the following:**

1. Create a file named: “myfile.txt”.
2. Write the following line of text into the file:
 - Programming is fun!
3. Close the file
4. Create a folder called “myfolder”
 - Use os.mkdir() command
5. Copy myfile.txt to myfolder



Python Package Index

- <https://pypi.org/>
- A repository of software for the Python Programming Language
- Python Installation provides the core libraries needed for the common tasks
 - Additional packages can be found at the website and installed as extension
 - E.g. send2trash, openpyxl, pillow etc
- Installation is easy done with the following command
 - **pip install <software_package>**
- Installed packages can be found at:
 - C:\python38\Lib\site-packages



Using pip install

- **For all windows users by default**
 - Open command prompt
 - pip install <package_name>
- **For Mac User**
 - Open terminal
 - **pip3** install <package_name>
- **For RP staff using RP issued laptop**
 - Open command prompt
 - pip install --user <package_name>

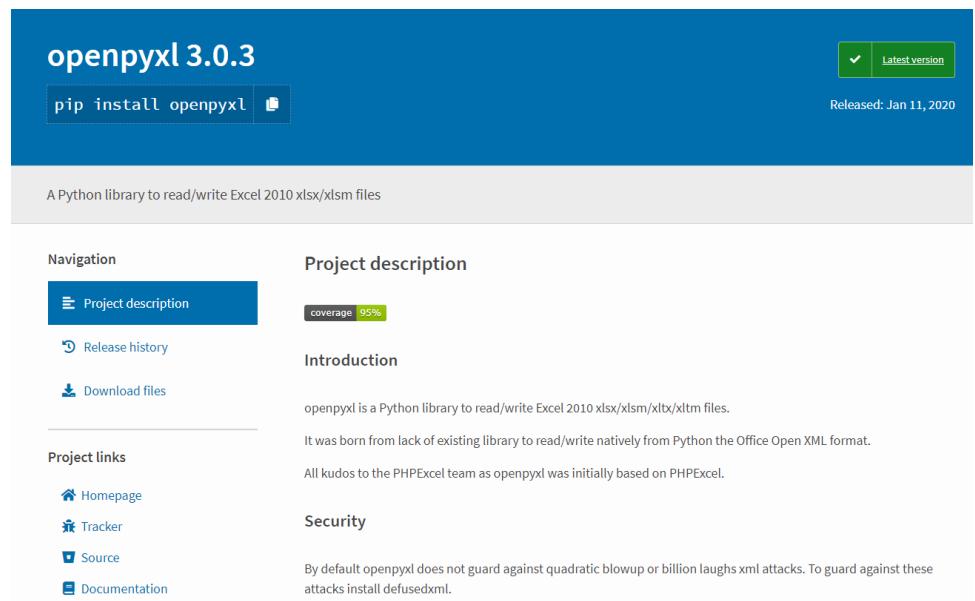
Double-Dash

Excel Spreadsheet Manipulation with Python



Working with Excel

- Install openpyxl module using
“`pip install openpyxl`”
- Full openpyxl documentation:
<https://openpyxl.readthedocs.io/en/stable/index.html>

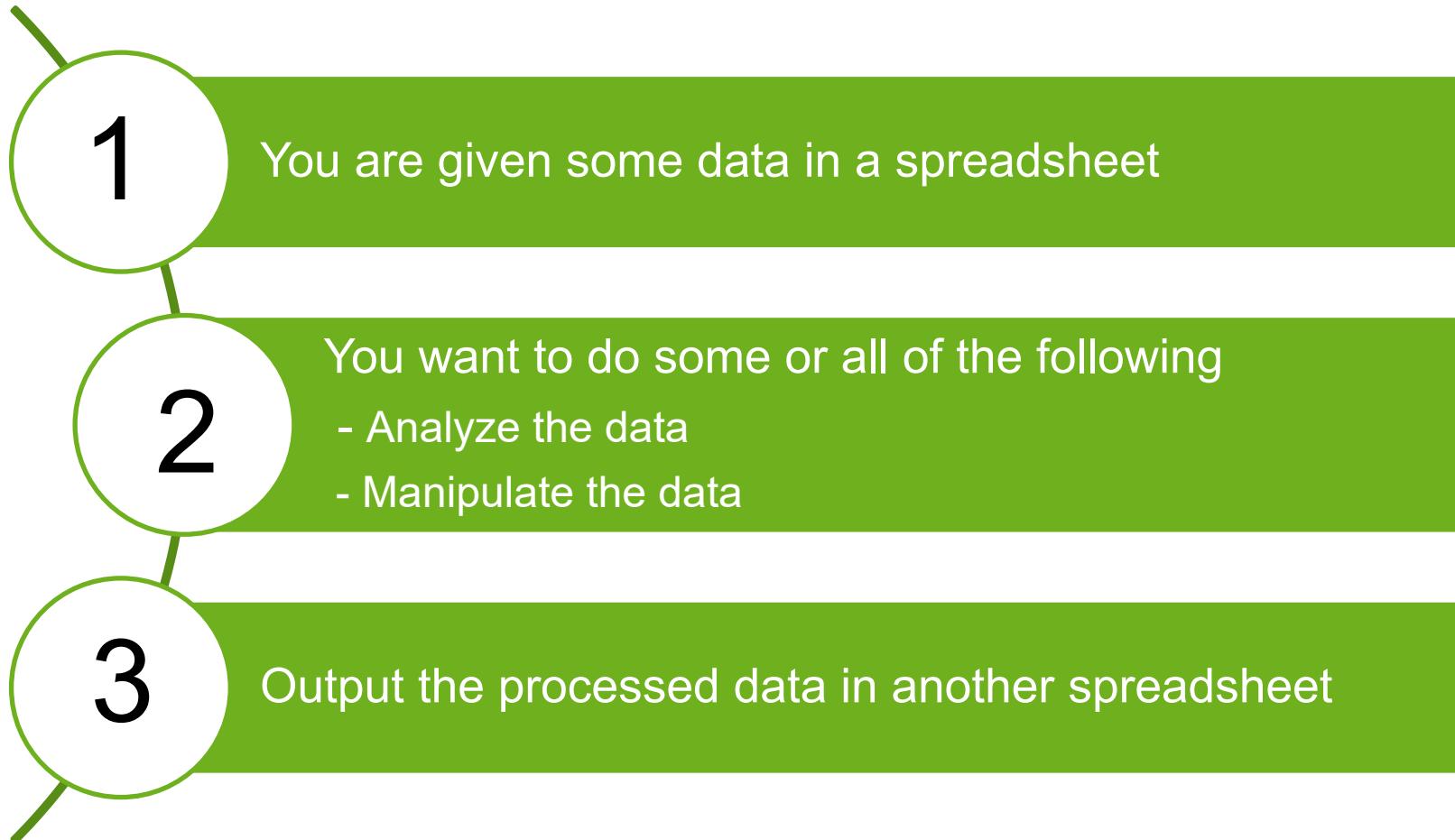


The screenshot shows the PyPI project page for openpyxl 3.0.3. The top header is blue with the text "openpyxl 3.0.3" and a "Latest version" button. Below the header, there's a "pip install openpyxl" button and a "Released: Jan 11, 2020" timestamp. The main content area has a light gray background and contains the following sections:

- Navigation**: Includes links for "Project description", "Release history", and "Download files".
- Project description**: Includes a "coverage 95%" badge and a link to "Introduction".
- Introduction**: A brief description of the library: "openpyxl is a Python library to read/write Excel 2010 xlsx/xlsm/xltx/xltm files. It was born from lack of existing library to read/write natively from Python the Office Open XML format. All kudos to the PHPExcel team as openpyxl was initially based on PHPExcel."
- Project links**: Includes links for "Homepage", "Tracker", "Source", and "Documentation".
- Security**: A note about XML attacks: "By default openpyxl does not guard against quadratic blowup or billion laughs xml attacks. To guard against these attacks install defusedxml."



Typical Workflow for Excel Automation





Reading Excel file

1) Import openpyxl

```
import openpyxl
```

```
workbook = openpyxl.load_workbook("bmi.xlsx")  
sheet=workbook["Sheet1"]
```

2) Load Excel content into "workbook" object by specifying the file name

3) Get the worksheet named "Sheet1"

```
name = sheet.cell(row=2, column=1).value  
weight = sheet.cell(row=2, column=2).value  
height = sheet.cell(row=2, column=3).value
```

4) Get the value of each cell by specifying the row and column

```
print("name:%s \tweight: %d \theight: %f " % (name, weight, height))
```

5) Get the value of each cell by specifying the row and column



Reading Excel file

The typical workflow for reading excel file is to use a **for** loop to go through each row to read the data

```
import openpyxl  
  
workbook = openpyxl.load_workbook("bmi.xlsx")  
sheet=workbook["Sheet1"]  
  
max_row = sheet.max_row # get number of rows  
  
#loop through every row  
for i in range(2, max_row + 1):  
  
    #read cell  
    name = sheet.cell(row=i, column=1).value  
    weight = sheet.cell(row=i, column=2).value  
    height = sheet.cell(row=i, column=3).value  
  
    print("name:%s \tweight: %d \theight: %f " % (name, weight, height))
```

1) Get the number of rows and columns

2) Use For loop to go through every row

3) Extract the status at Column C to check for attendance



Update Excel file

```
import openpyxl

workbook = openpyxl.load_workbook("bmi.xlsx")
sheet=workbook["Sheet1"]

max_row = sheet.max_row # get number of rows

# add a column header for bmi
sheet.cell(row=1, column=4).value = "bmi"

#loop through every row
for i in range(2, max_row + 1):

    #read cell
    name = sheet.cell(row=i, column=1).value
    weight = sheet.cell(row=i, column=2).value
    height = sheet.cell(row=i, column=3).value

    bmi = weight / (height * height)

    sheet.cell(row=i, column=4).value = bmi

    print("name:%s \tBMI: %f" % (name, bmi))

#save the file
workbook.save("bmi_update.xlsx")
```

2) Load file into memory & get the sheet

1) Perform calculation with values taken from the excel files

2) Add comments to cell

5) Save the spreadsheet



Create Excel file

If you have data in nested python list, you can write the data into an excel file.

```
import openpyxl

workbook = openpyxl.Workbook()

#get the default sheet
sheet=workbook["Sheet"]

#create a list of tuples as data source
data = [
    [225.7, 'Gone with the Wind', 'Victor Fleming'],
    [194.4, 'Star Wars', 'George Lucas'],
    [161.0, 'ET: The Extraterrestrial', 'Steven Spielberg']
]

for row in data:
    sheet.append(row)

#save the spreadsheet
workbook.save("movies.xlsx")
```

1) Some data in nested list

2) Using for loop to add each row of data into the excel sheet

3) Save the spreadsheet



Format Excel

```
import openpyxl
from openpyxl.styles import Font, PatternFill, Border, Side

workbook = openpyxl.load_workbook("bmi.xlsx")
sheet=workbook["Sheet1"]

#define the colors to use for styling
BLUE = "0033CC"
LIGHT_BLUE = "E6ECFF"
WHITE = "FFFFFF"

#define styling
header_font = Font(name="Tahoma", size=14, color=WHITE)
header_fill = PatternFill("solid", fgColor=BLUE)

# format header
for row in sheet["A1:c1"]:
    for cell in row:
        cell.font = header_font
        cell.fill = header_fill

#define styling
white_side = Side(border_style="thin", color=WHITE)
blue_side = Side(border_style="thin", color=BLUE)
alternate_fill = PatternFill("solid", fgColor=LIGHT_BLUE)
border = Border(bottom=blue_side, left=white_side, right=white_side)

# format rows
for row_index, row in enumerate(sheet["A2:C3"]):
    for cell in row:
        cell.border = border
        if row_index %2 :
            cell.fill = alternate_fill

workbook.save("bmi_format.xlsx")
```

1) Import necessary functions

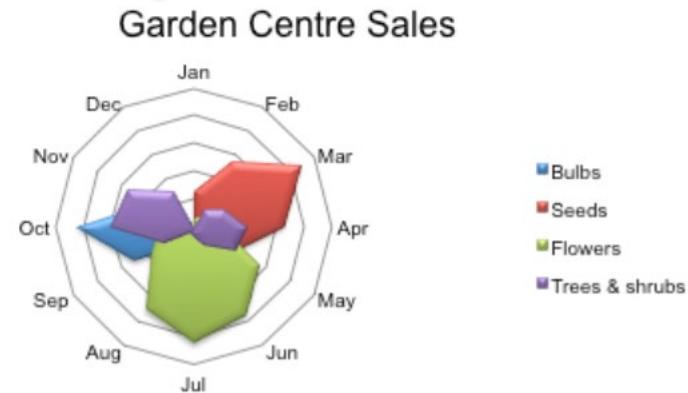
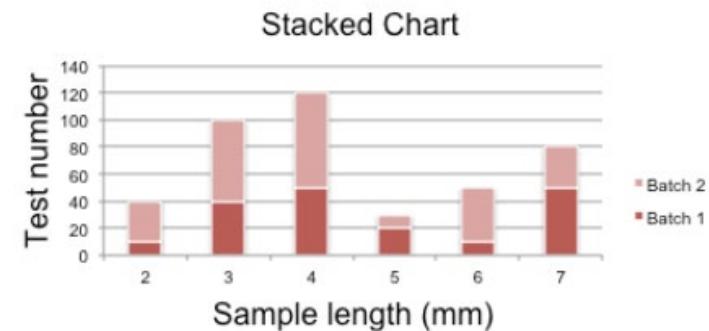
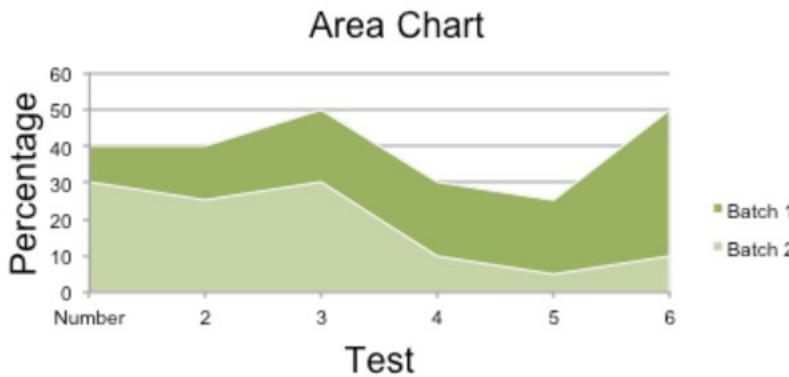
2) Setup colors and styles

3) Loop through cell and set properties



Excel Charts

- Openpyxl supports the creation of many types of charts
 - Area Charts
 - Bar and Column Charts
 - Bubble Charts
 - Line Charts
 - Scatter Charts
 - etc





Create Excel Chart

```
import openpyxl
from openpyxl.chart import BarChart, Reference, Series

workbook = openpyxl.load_workbook("bmi.xlsx")
sheet=workbook["Sheet1"]

chart = BarChart()

labels = Reference(sheet, min_col=1, min_row=2, max_row=3)
data = Reference(sheet, min_col=3, min_row=1, max_row=3)

chart.add_data(data, titles_from_data=True)
chart.set_categories(labels)
chart.title = "Height"

sheet.add_chart(chart, 'E1')
workbook.save('bmi_chart.xlsx')
```

1) Import necessary functions

2) Load the data from excel file

3) Specify the label and the data range

4) Add the chart to the sheet, and save the file in another excel file.



Create Excel Chart

```
import openpyxl
from openpyxl.chart import BarChart, Reference, Series ← 1) Import necessary
functions

workbook = openpyxl.load_workbook("bmi.xlsx")
sheet=workbook["Sheet1"] ← 2) Load the data from excel
file

chart = BarChart()

# first column is used as label, starting from row 2
labels = Reference(sheet, min_col=1, min_row=2, max_row=3) ← 3) Specify the label and
the data range

# first row is used for header, that is why min_row is 1
data = Reference(sheet, min_col=3, min_row=1, max_row=3)

chart.add_data(data, titles_from_data=True)
chart.set_categories(labels) ← 4) Specify values for title x-axis
and y-axis for the chart
chart.title = "Bar Chart"
chart.x_axis.title = "Name"
chart.y_axis.title = "Height"
chart.series[0].SeriesLabel = "height"

sheet.add_chart(chart, 'E1')
workbook.save('bmi_chart.xlsx') ← 5) Add the chart to the
sheet, and save the file
in another excel file.
```



More Explanation on Chart Reference

- Write a script to list read an Excel file and output every even rows to a csv file.

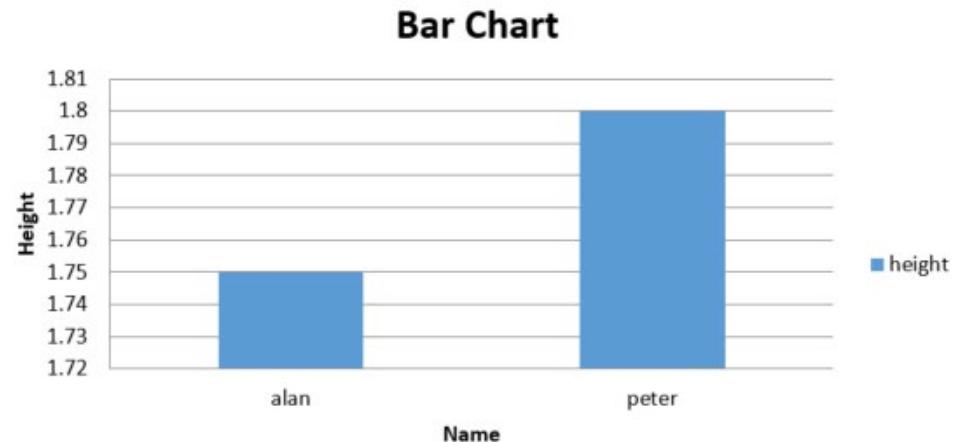
```
data = Reference(sheet, min_col=3,  
min_row=1, max_row=3)
```

| | A | B | C |
|---|-------|--------|--------|
| 1 | name | weight | height |
| 2 | alan | 65 | 1.75 |
| 3 | peter | 70 | 1.8 |



```
min_col = 3 ← height  
Min_col = 2 ← weight
```

```
labels = Reference(sheet, min_col=1  
min_row=2, max_row=3)
```

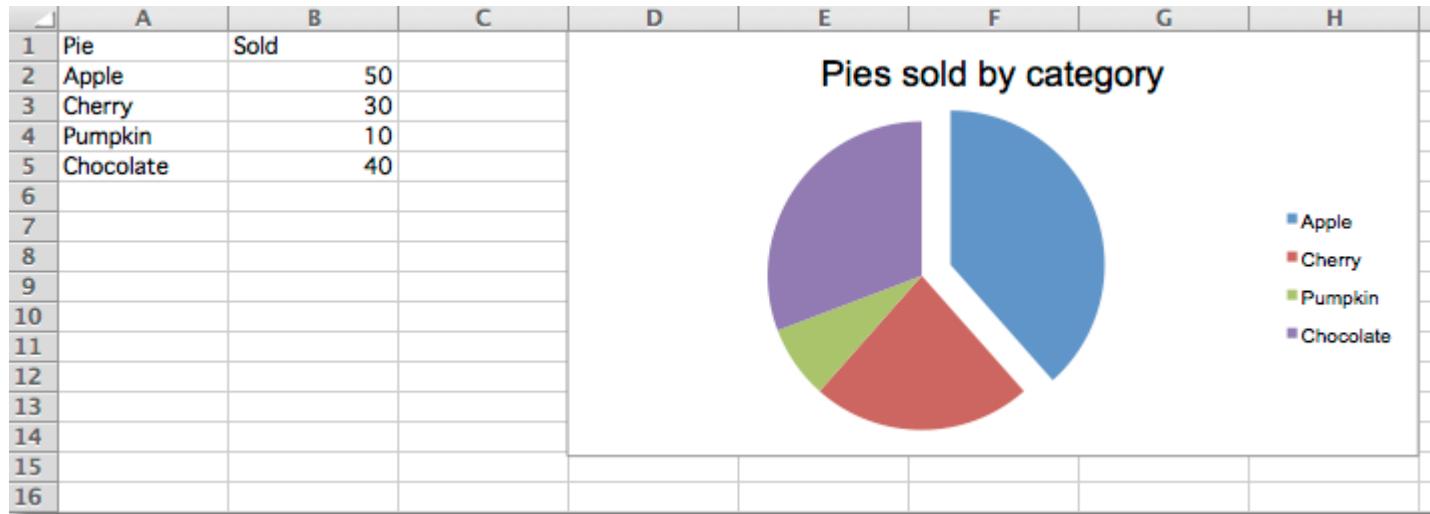




Exercise

- Write code to achieve the following:

1. Refer to the documentation at
<https://openpyxl.readthedocs.io/en/stable/charts/pie.html#id1>
2. Follow the instruction to create the following pie chart.





Typical Workflow for Excel Automation

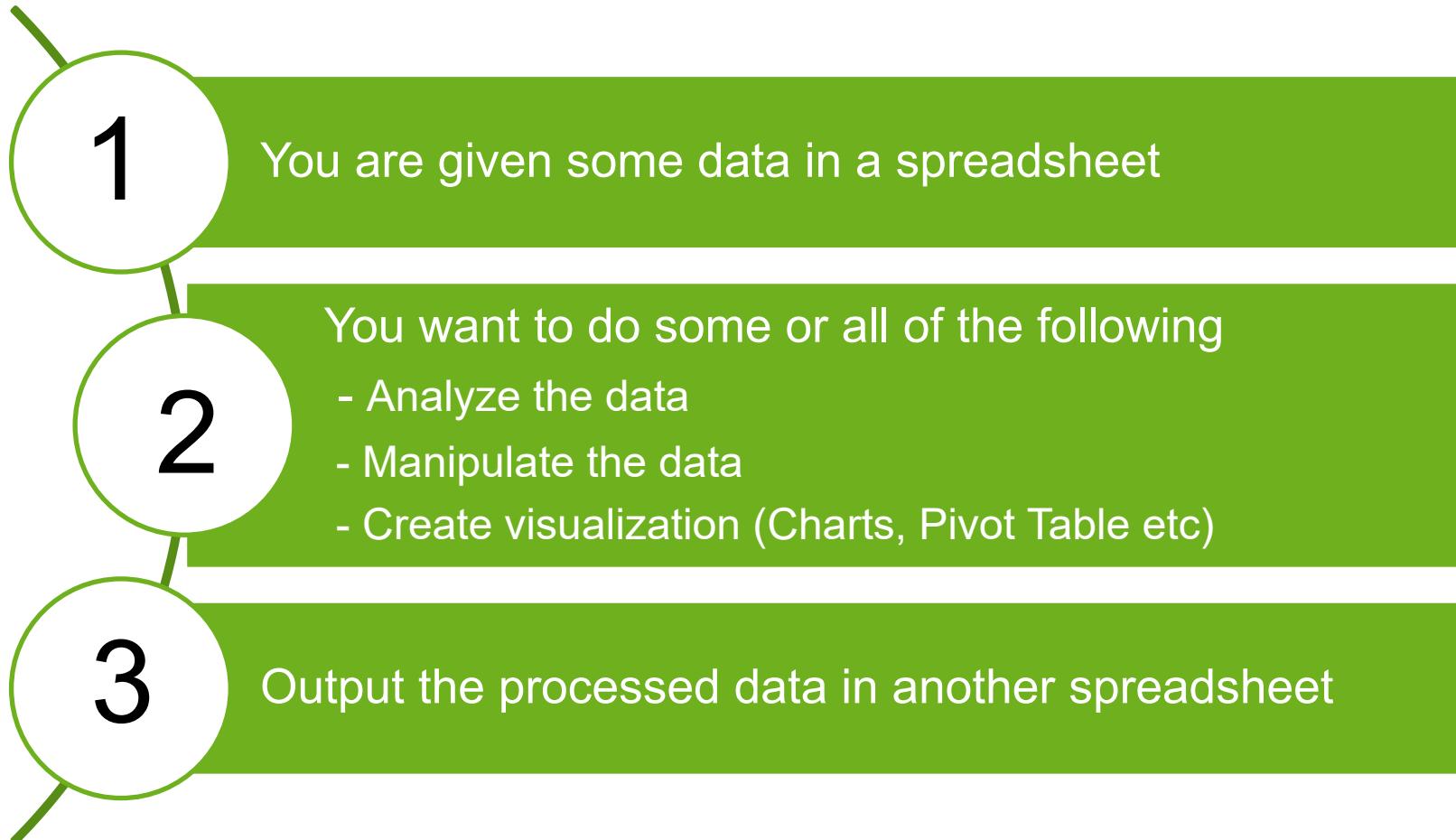


Image Processing with Python



Image Processing

The screenshot shows the official website for Pillow, a Python Imaging Library fork. The header features the Pillow logo (a colorful icon resembling a cross) and the word "pillow". Below the logo is the tagline "The friendly PIL fork". The main content area includes sections for "Welcome", "Code", and "Documentation". The "Welcome" section contains a paragraph about the project's purpose and a link to a "We're here" page. The "Code" section links to GitHub and other CI services. The "Documentation" section links to the ReadTheDocs site. A central image is a vibrant, abstract, multi-colored pattern labeled "Random psychedelic art made with PIL".

Welcome
This is the home of [Pillow](#), the friendly PIL fork. PIL is the [Python Imaging Library](#). If you have ever worried or wondered about the future of PIL, please stop. [We're here](#) to save the day.

Code
Our code is [hosted on GitHub](#), tested on [Travis CI](#), [AppVeyor](#), [Coveralls](#), [Landscape](#) and [released on PyPI](#).

Documentation
Our documentation is [hosted on readthedocs.io](#) and includes [installation instructions](#), [handbook](#), [API reference](#), [release notes](#) and more.

Random psychedelic art made with PIL

For the next section we are going to use the Python Image Library, or in short Pillow.

Install using the following command:
pip install pillow

The documentation is at:

<https://pillow.readthedocs.io/en/stable/handbook/overview.html>



Image Processing

```
import os
from PIL import Image

filename = "img/clungup.jpg"

im = Image.open(filename)
print ("%s - %s" % (im.size, im.mode))

# show the image
im.show()

# close the file
im.close()
```

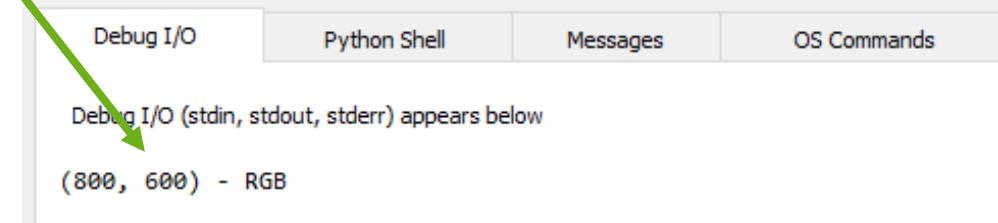


As a start we need to import it:
`import Image`

We can open images with
`im = Image.open(fullname)`

Then we can display the image using
`im.show()`

Print some info about the image using
`im.size` and `im.mode`



```
Debug I/O (stdin, stdout, stderr) appears below
(800, 600) - RGB
```

Size: 800 x 600, Mode: RGB

image_show_info.py



Image Processing

```
import os
from PIL import Image, ImageFilter

filename = "img/clungup.jpg"

im = Image.open(filename)

out = im.filter(ImageFilter.BLUR)

im.show()
out.show()
```



Pillow has many conversion and filters, to use filters we need to extend our import:
`from PIL import Image, ImageFilter`

The way you can apply filters is :
`out = im.filter(ImageFilter.BLUR)`

Try other different filters!



Image processing - filters



```
image = image.filter(ImageFilter.FIND_EDGES)
```



```
image = ImageOps.solarize(image)
```

```
image = ImageOps.grayscale(image)
```



```
image = image.filter(ImageFilter.CONTOUR)
```

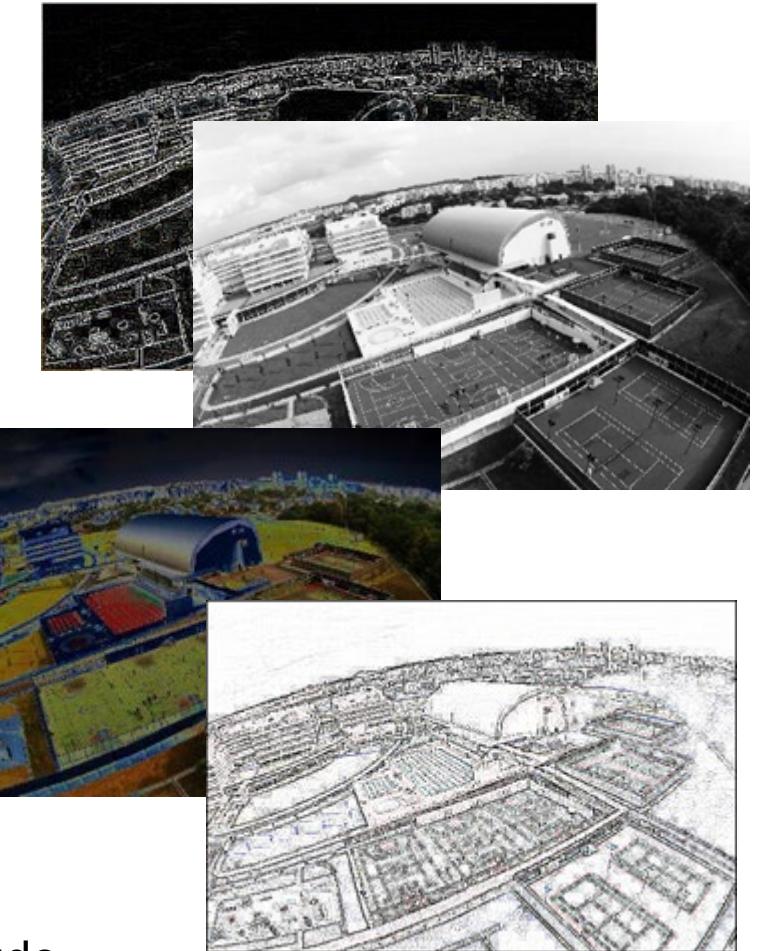


* Remember to include
ImageOps in your import statement



Image processing - filters

```
import os  
from PIL import Image, ImageFilter, ImageOps  
  
filename = "img/clungup.jpg"  
  
im = Image.open(filename)  
  
# Filter  
#out = im.filter(ImageFilter.BLUR)  
#out = im.filter(ImageFilter.FIND_EDGES)  
#out = im.filter(ImageFilter.CONTOUR)  
  
# ImageOps  
out = ImageOps.grayscale(im)  
#out = ImageOps.solarize(im)  
  
im.show()  
out.show()
```



* Remember to include
ImageOps in your import statement



Image Processing - Rotating

Flipping the image horizontally or vertically

```
out = im.transpose(Image.FLIP_LEFT_RIGHT)  
out = im.transpose(Image.FLIP_TOP_BOTTOM)
```

} Flip images

Rotating the image

```
out = im.transpose(Image.ROTATE_90)  
out = im.transpose(Image.ROTATE_180)  
out = im.transpose(Image.ROTATE_270)
```

} Rotate images

Contrast

First add ImageEnhance to our imports:

```
from PIL import Image, ImageFilter,  
ImageEnhance
```

Then:

```
enh = ImageEnhance.Contrast(im)  
out = enh.enhance(1.3)
```

make image brighter by
changing the contrast



Image Processing - Writing

```
import os
from PIL import Image, ImageFilter, ImageOps

filename = "clungup.jpg"

src_folder = "img/"
out_folder = "out/"

im = Image.open(src_folder + filename) # img/clungup.jpg
out = im.filter(ImageFilter.BLUR)

outFilename = out_folder + filename # out/clungup.jpg

out.save(outFilename)
```

You can see the image, but it's not being saved !

All you need to do to save the images in the "out" folder is:
out.save(the name of the output file)



Image processing – Converting

```
>>> fname1 = "holiday.gif"
>>> fname2 = fname1.split(".")[0] + ".jpg"
>>> print(fname2)
holiday.jpg
>>>
```

```
>>> fname1 = "holiday.gif"
>>> f, e = os.path.splitext(fname1)
>>> fname2 = f + ".jpg"
>>> print(fname2)
holiday.jpg
>>>
```

Maybe you want to keep all your photos in the same format.

We have some gif files and maybe you would have bmp or png images.

Pillow understands the output file, and will convert if the output file is different from the input.

| | | |
|-------------|----|-------------|
| fname1 | | fname2 |
| holiday.gif | -> | holiday.jpg |

How can we convert the string holiday.gif to holiday.jpg ?



Image processing – Converting

```
import os
from PIL import Image, ImageFilter, ImageOps

filename = "clungup.jpg"

src_folder = "img/"
out_folder = "out/"

im = Image.open(src_folder + filename) # img/clungup.jpg
out = im.filter(ImageFilter.BLUR)

# split the filename and the extension
f, e = os.path.splitext(filename)

# add the gif extension to the filename
fname2 = f + ".gif"

outFilename = out_folder + fname2 # out/clungup.gif

out.save(outFilename)
```

`os.path.splitext(file)` returns a list.
We are only interested in `f` which is
the first item in the list.



Image processing – Watermark

Create the mark image

You can reduce the size to 100,100

```
mark = Image.open("img\\watermark.png")
mark = mark.resize((100,100))
```

Create a new function called

```
def watermark(im, mark, position):
```

....

It takes the original image, the watermark image and the desired position that we want the watermark to appear. The function will return the result.

We can use this function like:

```
watermark(im, mark, (0, 50)).show()
```

or

```
imOut = watermark(im, mark, (0,50))
imOut.save(fileOut)
```

Maybe you want to leave a small footprint on your images, called watermark.

In this case we can use the \\img\\watermark.png and place it in each image on the bottom right.

Copyright
@RP



Image processing – Watermark

```
from PIL import Image

def watermark(im, mark, position):
    layer = Image.new("RGBA", im.size, (0,0,0,0))
    layer.paste(mark, position)
    return Image.composite(layer, im, layer)

im = Image.open("img\\clungup.jpg")
mark = Image.open("img\\watermark.png")
mark = mark.resize((100,100))
mark.putalpha(128)

out = watermark(im, mark, (0,0))
out.show()
```



First we need to create a new layer with the size of the original image.

Then we paste the watermark image at the desired position and we return the composite.

Finally we merge the image and the layer together and return the result.

Then you can use it like this:



Use Case I: Batch Resize

1. Find all the files in “img” folder with “.jpg” extension
1. Resize all the file to 60 x 90.
1. Save all the files to the resized folder

```
import os
from PIL import Image, ImageFilter, ImageOps

files = os.listdir('img')
size = 60, 90

for file in files:
    if file.lower().endswith('.jpg'):
        im = Image.open("img/" + file)
        im.thumbnail(size, Image.ANTIALIAS)
        im.save("resized/" + file, "JPEG")
```



Use Case II: Batch Rename

1. Find all the files in “img” folder with “.jpg” extension
1. Copy all the files to the renamed folder
1. Rename all the files with the “s-” prefix.

```
import os
import shutil

files = os.listdir('img')

for file in files:
    if file.lower().endswith('.jpg'):
        shutil.copyfile("img/" + file, "renamed/s-" + file[:-4] + ".jpg")
```

Web Automation with Python



Connecting to the Web

- requests – download files and web pages from the Web

```
pip install requests
```

```
1 import requests  
2  
3 url = "https://api.data.gov.sg/v1/environment/2-hour-weather-forecast"  
4 req = requests.get(url)  
5 print(req.text)
```

Get the required information from the given URL



Economy



Education



Environment



Finance



Health



Infrastructure



Society



Technology



Transport

web_request.py



Connecting to the Web

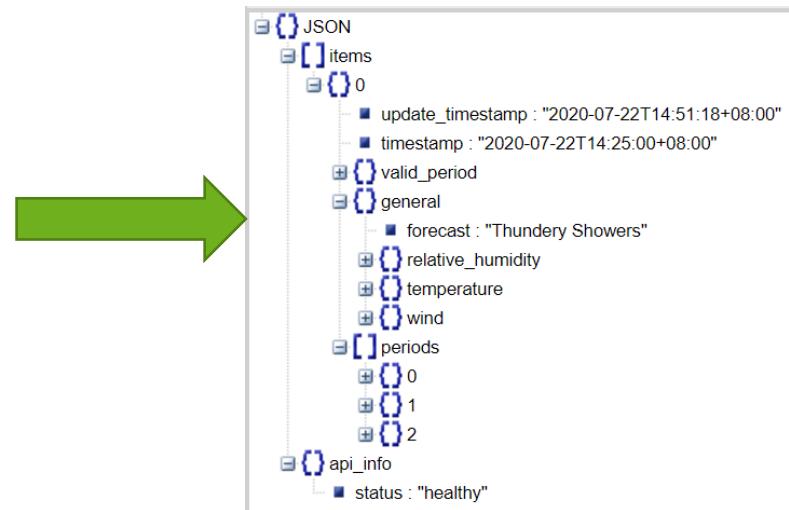
- Data is in JSON format
- Use a JSON formatter tool to present the data in a nicer form

<http://jsonviewer.stack.hu/>

```
import requests

url="https://api.data.gov.sg/v1/environment/24-hour-weather-forecast"
req=requests.get(url)
print(req.text)
```

```
{"items": [{"update_timestamp": "2020-07-22T14:51:18+08:00", "timestamp": "2020-07-22T14:25:00+08:00", "valid_period": {"start": "2020-07-22T12:00:00+08:00", "end": "2020-07-23T12:00:00+08:00"}, "general": {"forecast": "Thunderous Showers", "relative_humidity": {"low": 70, "high": 95}, "temperature": {"low": 22, "high": 30}, "wind": {"speed": {"low": 10, "high": 20}, "direction": "ESE"}}, "periods": [{"start": "2020-07-22T12:00:00+08:00", "end": "2020-07-22T18:00:00+08:00", "regions": [{"west": "Moderate Rain", "east": "Moderate Rain", "central": "Light Rain", "north": "Light Rain"}, {"time": {"start": "2020-07-22T12:00:00+08:00", "end": "2020-07-23T06:00:00+08:00"}, "regions": {"west": "Partly Cloudy (Night)", "east": "Partly Cloudy (Night)", "central": "Partly Cloudy (Night)", "north": "Partly Cloudy (Night)"}]}, {"time": {"start": "2020-07-22T18:00:00+08:00", "end": "2020-07-23T12:00:00+08:00"}, "regions": {"west": "Partly Cloudy (Night)", "east": "Partly Cloudy (Night)", "central": "Partly Cloudy (Night)", "north": "Partly Cloudy (Night)"}]}], "api_info": {"status": "healthy"}}
```





Connecting to the Web

- To work with JSON data, import json first
- Use json.loads() to load the data in JSON format
- Extract and retrieve the required data

```
import json
import requests

url="https://api.data.gov.sg/v1/environment/24-hour-weather-forecast"
req=requests.get(url)

data = json.loads(req.text)

# print update timestamp
update_time = data["items"][0]["update_timestamp"]
print("Update time: " + update_time)

# print forecast
forecast = data["items"][0]["general"]["forecast"]
print("Forecast: " + forecast)
```

Update time: 2020-07-22T14:51:18+08:00
Forecast: Thundery Showers

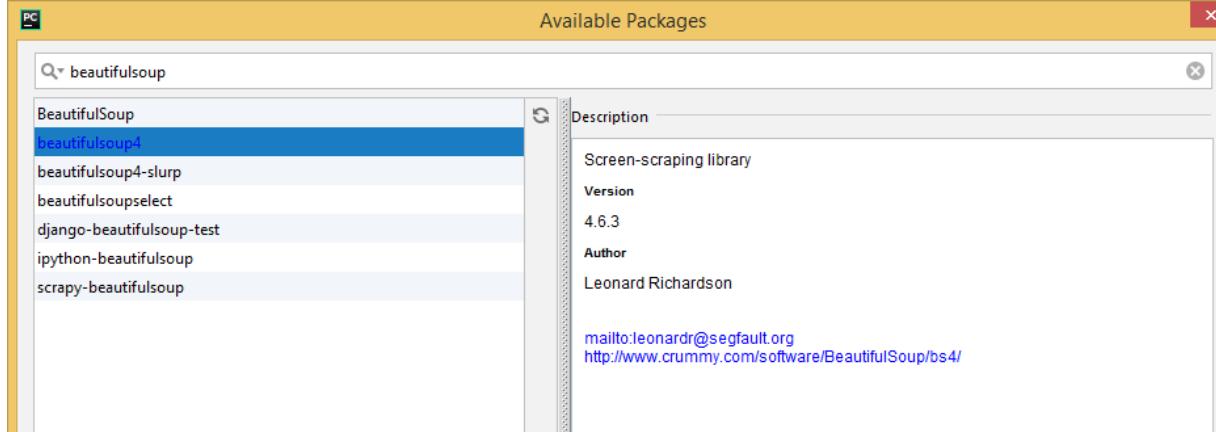


Connecting to the Web

- Beautiful Soup – a third party module that parses HTML (web pages)

Web Scraping – download and process Web content

- Install Beautiful Soup 4 - **pip install beautifulsoup4**





Connecting to the Web

- What's the URL?

<https://www.fortytwo.sg/dining/dining-tables/landon-regular-dining-table-coffee.html>

Enquiries: +65 6777 7667 | Mon - Fri (10am - 6pm)

The screenshot shows a product page for a 'Landon Regular Dining Table Coffee'. The page includes a search bar, user profile, and shopping cart icon. A navigation menu at the top lists categories like Furniture, Bedding & Mattresses, Décor | Essentials, Kitchen | Dining, Lightings | Fans, and Sale. The product details show a dark wood dining table with a rectangular top and four legs. The price is listed as S\$69.90. Other features include a 100 Day Free Returns policy and Free Assembly Included. The page also shows a 'Warranty: 1 Year' and delivery options like Standard Delivery.

FORTYTWO

Search furniture, mattress, home & decor...

Enquiries: +65 6777 7667 | Mon - Fri (10am - 6pm)

New Furniture Bedding & Mattresses Décor | Essentials Kitchen | Dining Lightings | Fans Sale

Home > Dining Room Furniture > Dining Tables > Landon Regular Dining Table Coffee

Landon Regular Dining Table Coffee

Qty: 1

Add to Cart

Add to Wishlist

Email to a Friend

Warranty: 1 Year

Standard Delivery

42EXPR

Free Assembly Included

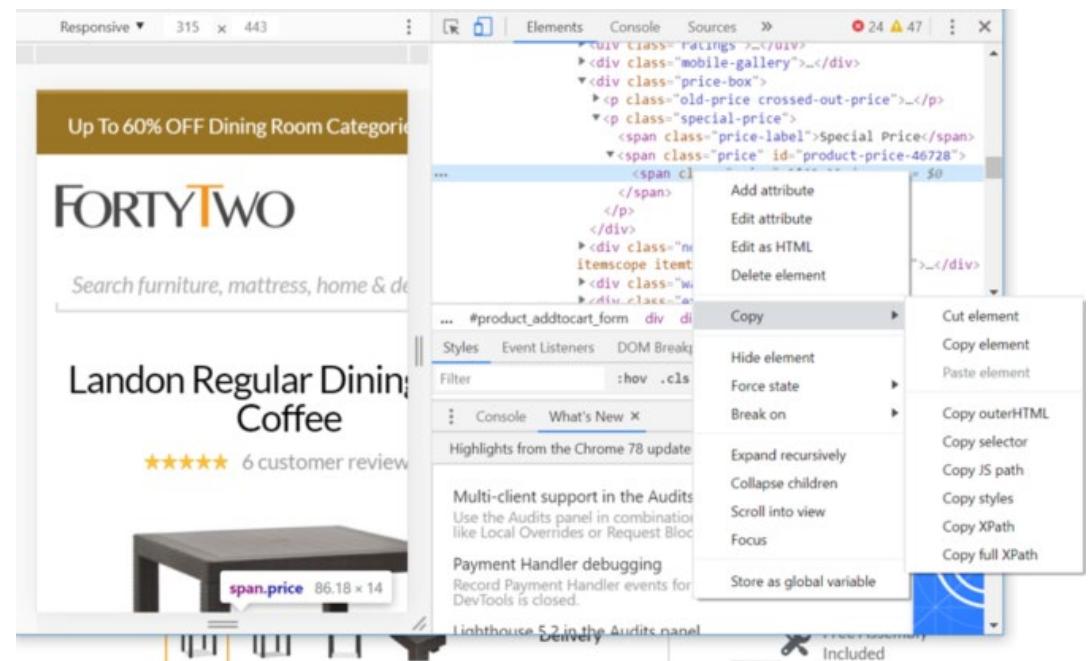


Connecting to the Web

- Get the url

<https://www.fortytwo.sg/dining/dining-tables/landon-regular-dining-table-coffee.html>

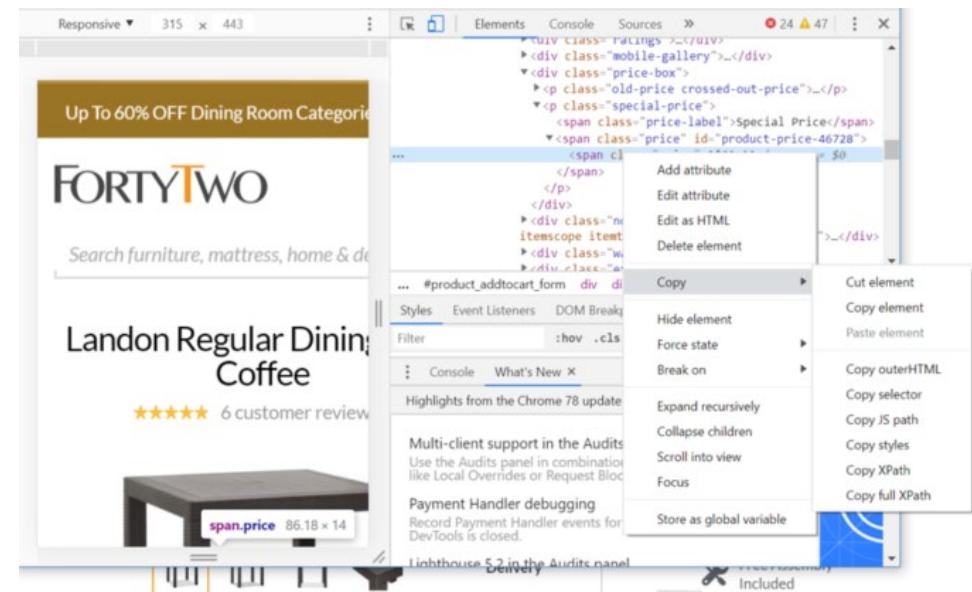
- Select the element to extract, right-click "Inspect"
- Right-click "Copy" "Copy selector"





Connecting to the Web

- Get the url
- Select the element to extract, right-click "Inspect"
- Right-click "Copy" → "Copy selector"

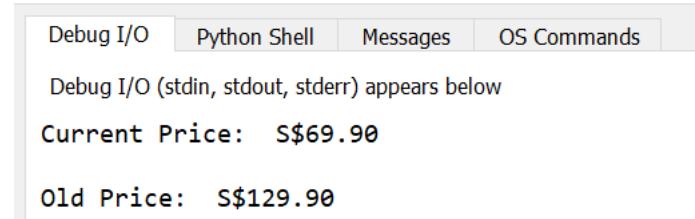


```
import bs4
import requests

requestObj = requests.get("https://www.fortytwo.sg/dining/dining-tables/landon-regular-dining-table-coffee.html")
requestObj.raise_for_status()
soup = bs4.BeautifulSoup(requestObj.text, 'html.parser')

elements = soup.select("#product-price-46728") # $69.90
print("Current Price: " + elements[0].text)

elements = soup.select("#old-price-46728") # $129.90
print("\nOld Price: " + elements[0].text)
```

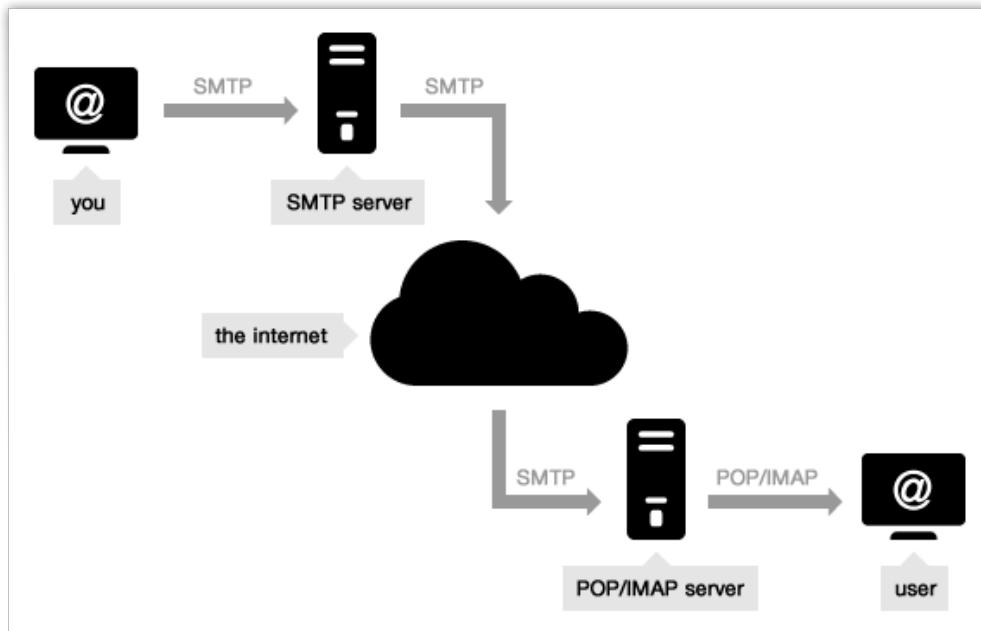


web_scrap.py

Email Automation with Python



Send Email



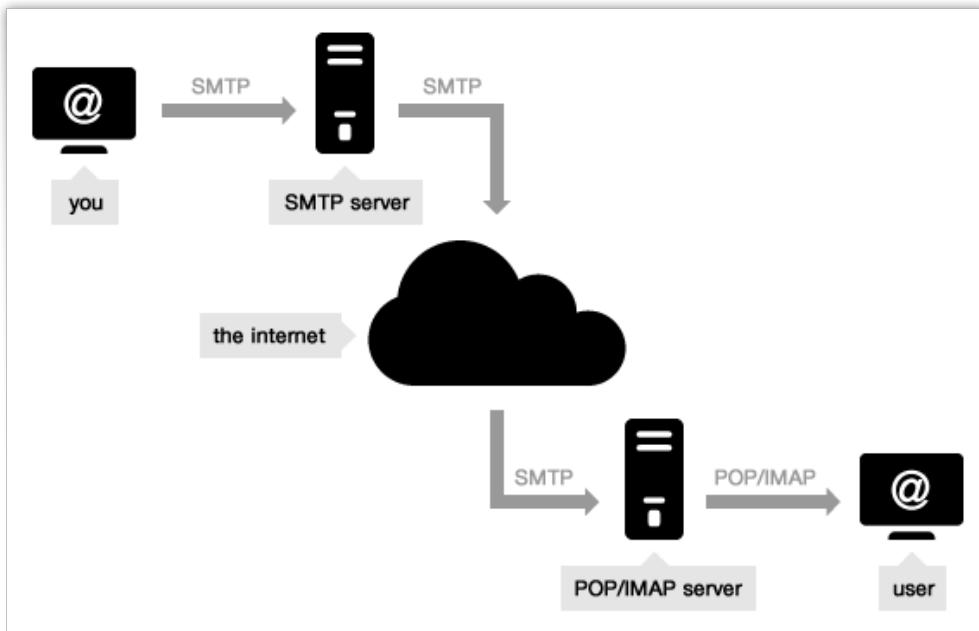
- SMTP (Simple Mail Transfer Protocol) is used for sending and delivering from a client to a server via port 25, 465 or 587: it's the **outgoing server**.
- IMAP and POP are two methods to access email. IMAP is the recommended method when you need to check your emails from several different devices, such as a phone, laptop, and tablet.

<https://www.mailgun.com/blog/which-smtp-port-understanding-ports-25-465-587/>

<https://serversmtp.com/what-is-smtp-server/>



Send Email



- **Note:** The SMTP servers used when you send your emails- Hotmail, Gmail , Yahoo Mail – are **shared among users**
- Common providers establish some **strict limits** on the number of emails you can send (e.g. Yahoo's restriction is 100 emails per hour).
- If you plan to send a bulk email or set up an email campaign you should opt for a professional outgoing email server like turboSMTP,
- which guarantees a controlled IP and ensure that all your messages reach their destination.



Send Email using Gmail

| | |
|---|--|
| Incoming Mail (IMAP) Server | imap.gmail.com Requires SSL: Yes Port: 993 |
| Outgoing Mail (SMTP) Server | smtp.gmail.com Requires SSL: Yes Requires TLS: Yes (if available) Requires Authentication: Yes Port for SSL: 465 Port for TLS/STARTTLS: 587 |
| Full Name or Display Name | Your name |
| Account Name, User name, or Email address | Your full email address |
| Password | Your Gmail password |

Note: If you are using your office network, most port numbers, including 587, may be blocked.



Send Email using Gmail

- Import `smtplib` module
- Specify Gmail email & password, receiver's email address, email title & content
- Connect to SMTP server using Port 587
- Call `starttls()` to enable encryption for your connection
- Login using email and password
- Call `sendmail()`
- Call `quit()` to disconnect from the SMTP server

```
import smtplib

sender_email_address = "your_email_address@gmail.com"
sender_email_password = "xxxxxxxxxxxxxx"
receiver_email_address = "another_email_address@gmail.com"
email_title_content = "Subject: Sending Email Using Python\nThis is a test email."

email_title_content = "Subject: Sending Email Using Python\nThis is a test email."
```

➤ The start of the email body must begin with "Subject:" for the subject line. The "\n" newline character separates the subject line from the main body content.

```
print("Trying to connect to Gmail SMTP server")
smtpObj = smtplib.SMTP("smtp.gmail.com", 587)
smtpObj.starttls()

print("Connected. Logging in...")
smtpObj.login(sender_email_address, sender_email_password)

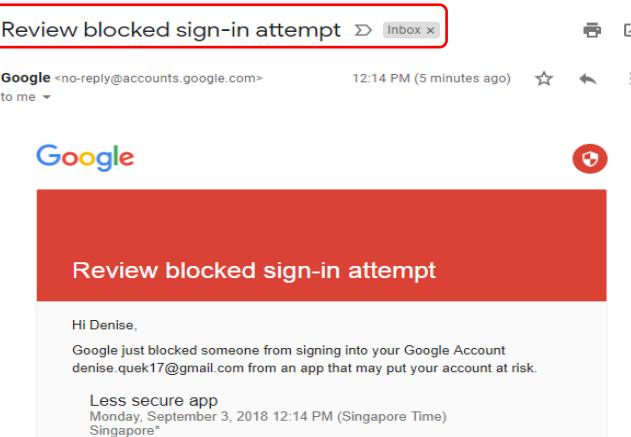
smtpObj.sendmail(sender_email_address, receiver_email_address, email_title_content)
print("Email sent successfully...")

smtpObj.quit()
```



Send Email using Gmail

- Google may block attempted sign-in from unknown devices that don't meet their security standards!



```
C:\Users\denise_quek\AppData\Local\Programs\Python\Python37\python.exe D:/CET_Python/Denise/TestEmail.py
Trying to connect to Gmail SMTP server
Connected. Logging in...
Traceback (most recent call last):
  File "D:/CET_Python/Denise/TestEmail.py", line 13, in <module>
    smtpObj.login(sender_email_address, sender_email_password)
  File "C:\Users\denise_quek\AppData\Local\Programs\Python\Python37\lib\smtplib.py", line 730, in login
    raise last_exception
  File "C:\Users\denise_quek\AppData\Local\Programs\Python\Python37\lib\smtplib.py", line 721, in login
    initial_response_ok=initial_response_ok)
  File "C:\Users\denise_quek\AppData\Local\Programs\Python\Python37\lib\smtplib.py", line 642, in auth
    raise SMTPAuthenticationError(code, resp)
smtplib.SMTPAuthenticationError: (534, b'5.7.9 Application-specific password required. Learn more at\n5.7.9')

Process finished with exit code 1
```



Send Email using Gmail

Steps To Create Google App Password

Step 1: Login to Gmail. Go to Account □ Signing in to Google

Step 2: Make sure that 2-Step Verification is on

Step 3: Create an App password

[← App passwords](#)

App passwords let you sign in to your Google Account from apps on devices that don't support 2-Step Verification. You'll only need to enter it once so you don't need to remember it. [Learn more](#)

You don't have any app passwords.

Select the app and device you want to generate the app password for.

Mail Windows Computer

Generated app password

Your app password for Windows Computer

[View your app password](#)

How to use it

1. Open the "Mail" app.
2. Open the "Settings" menu.
3. Select "Accounts" and then select your Google Account.
4. Replace your password with the 16-character password shown above.

Just like your normal password, this app password grants complete access to your Google Account. You won't need to remember it, so don't write it down or share it with anyone.

[Learn more](#)



Send Email using Gmail

Screenshot of the Google Account Security settings page.

The left sidebar shows navigation links: Home, Personal info, Data & personalisation, **Security** (highlighted with a red box), People & sharing, Payments & subscriptions, Help, and Send feedback.

The main content area is titled "Security" and describes settings to keep the account secure.

Security issues found

Protect your account now by resolving these issues



[Secure account](#)

Signing in to Google



Last changed 10 Jan 2018

2-Step Verification On

App passwords 1 password

Ways that we can verify that it's you

These can be used to make sure that it's really you



Show all X



Send Email using Gmail

- Replace your actual password with the App password

```
import smtplib

sender_email_address = "your_email_address@gmail.com"
sender_email_password = "xxxxxxxxxxxxxx"
receiver_email_address = "another_email_address@gmail.com"
email_title_content = "Subject: Sending Email Using Python\nThis is a test email."
```

- Run your email program

```
C:\Users\denise quek\AppData\Local\Programs\Python\Python37\python.exe D:/CET_Python/Denise/TestEmail.py
Trying to connect to Gmail SMTP server
Connected. Logging in...
Email sent successfully...

Process finished with exit code 0
```



Use Case: Send emails to students

- Send email to students who were absent

| | A | B | C |
|---|---------|--------------------------|---------|
| 1 | Student | Email | Status |
| 2 | Alicia | code.musically@gmail.com | Present |
| 3 | Bryan | code.musically@gmail.com | Present |
| 4 | Carol | code.musically@gmail.com | Absent |
| 5 | David | code.musically@gmail.com | Absent |
| 6 | Evelyn | code.musically@gmail.com | Present |
| 7 | | | |


```
1 #! python3
2
3 import openpyxl, smtplib
4
5 def sendEmail(name, emailTo):
6     email_body = "Subject: Your attendance. \nDear %s, \nYou were absent for class.\n" %(name)
7
8     smtpObj = smtplib.SMTP("smtp.gmail.com", 587)
9     smtpObj.starttls()
10    smtpObj.login("code.musically@gmail.com", "xxxxxxxxxxxx")
11    smtpObj.sendmail('code.musically@gmail.com', emailTo, email_body)
12
13    smtpObj.quit()
```



Use Case: Send Emails to Students

- Open an Excel file
- Send email to students who were absent

```
16     workbook = openpyxl.load_workbook("D:\\CET_Python\\students_attendance.xlsx")
17     sheet = workbook["Sheet1"]
18
19     max_row = sheet.max_row
20     max_column = sheet.max_column
21
22     for i in range(1, max_row+1):
23
24         attendance = sheet.cell(row=i, column=3).value
25
26         if attendance == "Absent":
27             name = sheet.cell(row=i, column=1).value
28             email = sheet.cell(row=i, column=2).value
29
30             print(name + " is absent.")
31             sendEmail(name, email)
32             print("Email sent to " + email)
33             print()
34
```

Generate PDF Report with Python



PDF

PyPDF

Search docs

Project Home

Home

- FPDF for Python
- Main features
- Installation
- Support
- ProjectHome
- Reference manual
- Tutorial
- Tutorial (Spanish translation)
- FAQ (Frequently asked questions)
- Python 3
- Templates
- Unicode
- Web2Py framework
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- Reference manual
- accept_page_break
- add_font
- add_link
- add_page
- alias_nb_pages
- cell
- close
- dashed_line

Docs » Project Home » Home

Edit on GitHub

FPDF for Python

PyPDF is a library for PDF document generation under Python, ported from PHP (see FPDF: "Free"-PDF, a well-known PDFlib-extension replacement with many examples, scripts and derivatives).

Latest Released Version: 1.7 (August 15th, 2012) - Current Development
Version: 1.7.1

Fork me on GitHub

Main features

- Easy to use (and easy to extend)
- Many simple examples and scripts available in many languages
- No external dependencies or extensions (optionally PIL for GIF support)
- No installation, no compilation or other libraries (DLLs) required
- Small and compact code, useful for testing new features and teaching

This repository is a fork of the library's original port by Max Pat, with the following enhancements:

- Python 2.5 to 3.4+ support (see [Python3 support](#))
- [Unicode](#) (UTF-8) TrueType font subset embedding (Central European, Cyrillic, Greek, Baltic, Thai, Chinese, Japanese, Korean, Hindi and almost any other language in the world) New! based on [sPDFL GPL3 PHP version from Ian Back](#)
- Improved installers (setup.py, py2exe, PyPI) support
- Barcode 128f5 and code39, QR code coming soon ...
- PNG, GIF and JPG support (including transparency and alpha channel) New!
- Exceptions support, other minor fixes, improvements and PEP8 code cleanups
- Port of the [Tutorial](#) and [ReferenceManual](#) (Spanish translation available)

FPDF original features:

- Install fpdf
 - pip install fpdf

<https://pyfpdf.readthedocs.io/en/latest/Tutorial/index.html>



PDF – Basic document

```
import fpdf

#create a new pdf
document = fpdf.FPDF()

#define font and color for title and add the first page
document.set_font("Times","B", 14)
document.set_text_color(19,83,173)
document.add_page()

#write the title of the document
document.cell(0,5,"PDF Test Document")
document.ln()

#write a long paragraph
document.set_font("Times", "", 11)
document.set_text_color(0)
document.multi_cell(0,10, "This is an example of a long paragraph. \n" * 10)
document.ln()

#save the document
document.output("pdf_report.pdf")
```

- Import fpdf
- Create a new pdf document
- Add page
- Add text
- Save file

PDF Test Document
This is an example of a long paragraph.
This is an example of a long paragraph.



PDF – adding images

```
import fpdf

#create a new pdf
document = fpdf.FPDF()

#define font and color for title and add the first page
document.set_font("Times","B", 14)
document.set_text_color(19,83,173)
document.add_page()

#add a image
document.image("rp_logo.png", x=10, y=5, w=23)

document.set_y(40);

#write the title of the document
document.cell(0,5,"PDF Test Document")
document.ln()

#write a long paragraph
document.set_font("Times", "", 11)
document.set_text_color(0)
document.multi_cell(0,5, "This is an example of a long paragraph. " * 10)
document.ln()

#save the document
document.output("pdf_report.pdf")
```

- Import fpdf
- Create a new pdf document
- Add page
- Add text, logo
- Save file



PDF Test Document

This is an example of a long paragraph. This is an example of a long paragraph.



PDF – Adding password

```
import fpdf
import PyPDF2

#create a new pdf
document = fpdf.FPDF()

#define font and color for title and add the first page
document.set_font("Times","B", 14)
document.set_text_color(19,83,173)
document.add_page()

#write the title of the document
document.cell(0,5,"PDF Test Document")
document.ln()

#save the document
document.output("pdf_report_before_pw.pdf")

#save the document into a new password protected/encrypted pdf
pdffile = open(r"pdf_report_before_pw.pdf", "rb")
pdfReader = PyPDF2.PdfFileReader(pdffile)
pdfWriter = PyPDF2.PdfFileWriter()
for pageNum in range(pdfReader.numPages):
    pdfWriter.addPage(pdfReader.getPage(pageNum))

pdfWriter.encrypt('123') ←
resultPDF = open(r"pdf_report_after_pw.pdf", "wb")
pdfWriter.write(resultPDF)
resultPDF.close()
pdffile.close()
```

- pip install PyPDF2

Password is 123

<https://pythonhosted.org/PyPDF2/>



Use Cases

- Automation:
 - Generation of reports with data from spreadsheet or database
 - Generation of Course Certificates in PDF format
 - Password protection of banking statement in PDF file

Charting/Visualisation with Python



Charting

pip install matplotlib

Full documentation:
<https://matplotlib.org/>

The screenshot shows the Matplotlib 3.0.2 gallery page. At the top, the Matplotlib logo is displayed with the text "Version 3.0.2". Below the logo, there is a navigation bar with links: "home | examples | tutorials | API | docs »" on the left and "modules | index" on the right. A yellow banner in the top right corner says "fork me on GitHub". The main content area is titled "Gallery" and contains a brief introduction: "This gallery contains examples of the many things you can do with Matplotlib. Click on any image to see the full image and source code." It also mentions "For longer tutorials, see our [tutorials page](#). You can also find [external resources](#) and a [FAQ](#) in our [user guide](#)".

Lines, bars and markers

The gallery is organized into a grid of plots. Each plot has a title below it:

- Arctest
- Stacked Bar Graph
- Barchart
- Horizontal bar chart
- Broken Barb
- Plotting categorical variables
- Plotting the coherence of two signals
- CSD Demo

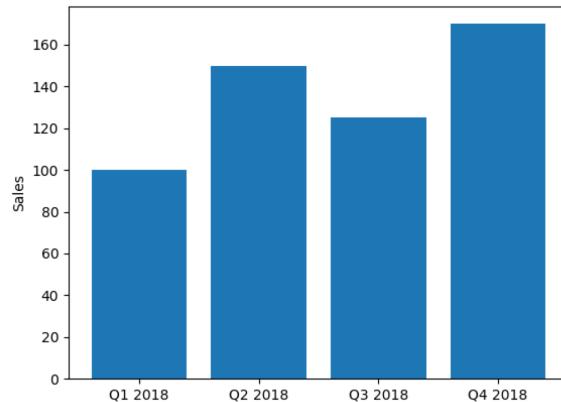
On the right side of the page, there is a sidebar with a "Quick search" input field and a "Table of Contents" section. The "Table of Contents" lists various categories of plots:

- Gallery
- Lines, bars and markers
- Images, contours and fields
- Subplots, axes and figures
- Statistics
- Pie and polar charts
- Text, labels and annotations
- Pyplot
- Color
- Shapes and collections
- Style sheets
- Axes Grid
- Axis Artist
- Showcase
- Animation
- Event handling
- Front Page
- Miscellaneous
- 3D plotting
- Our Favorite Recipes
- Scales
- Specialty Plots
- Ticks and spines
- Units
- Embedding Matplotlib in



Charting

```
1 import matplotlib.pyplot as plt
2
3 #set up values
4 VALUES = [100,150,125,170]
5 POS = [0,1,2,3]
6 LABELS = ['Q1 2018','Q2 2018','Q3 2018','Q4 2018']
7
8 #set up the chart
9 plt.bar(POS,VALUES)
10 plt.xticks(POS, LABELS)
11 plt.ylabel('Sales')
12
13 #to display the chart
14 plt.show()
```



- Install matplotlib
- Prepare data
- Create bar graph
- Display the chart

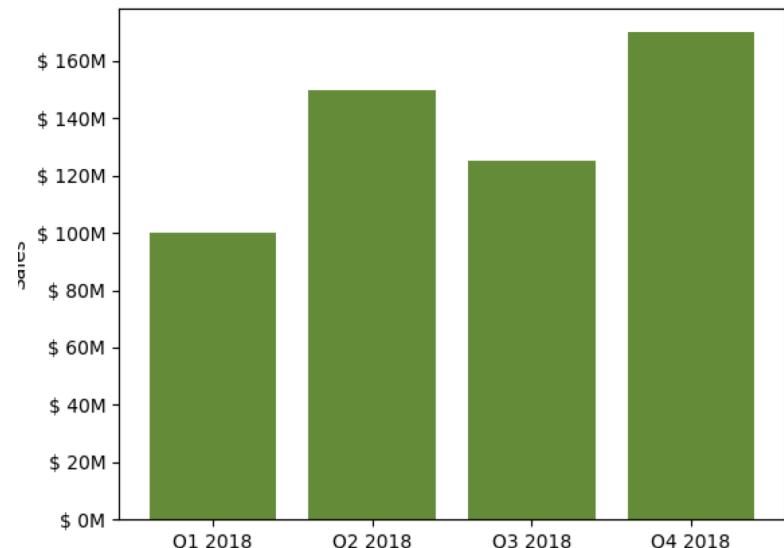
https://matplotlib.org/api/_as_gen/matplotlib.pyplot.bar.html



Charting - Formatting

```
1 import matplotlib.pyplot as plt
2 from matplotlib.ticker import FuncFormatter
3
4 def value_format(value, position):
5     return '$ {}'.format(int(value))
6
7 # set up values
8 VALUES = [100, 150, 125, 170]
9 POS = [0,1,2,3]
10 LABELS = ['Q1 2018', 'Q2 2018', 'Q3 2018', 'Q4 2018']
11
12 # set up the chart
13 # Colors can be specified in multiple formats, as
14 # described in https://matplotlib.org/api/colors_api.html
15 # https://xkcd.com/color/rgb/
16 plt.bar(POS,VALUES, color='xkcd:moss green')
17 plt.xticks(POS, LABELS)
18 plt.ylabel('Sales')
19
20 # retrieve the current axes and apply formatter |
21 axes = plt.gca()
22 axes.yaxis.set_major_formatter(FuncFormatter(value_format))
23
24 # to display the chart
25 plt.show()
```

- Install matplotlib
- Prepare data
- Customise graph options
- Create bar graph
- Display the chart



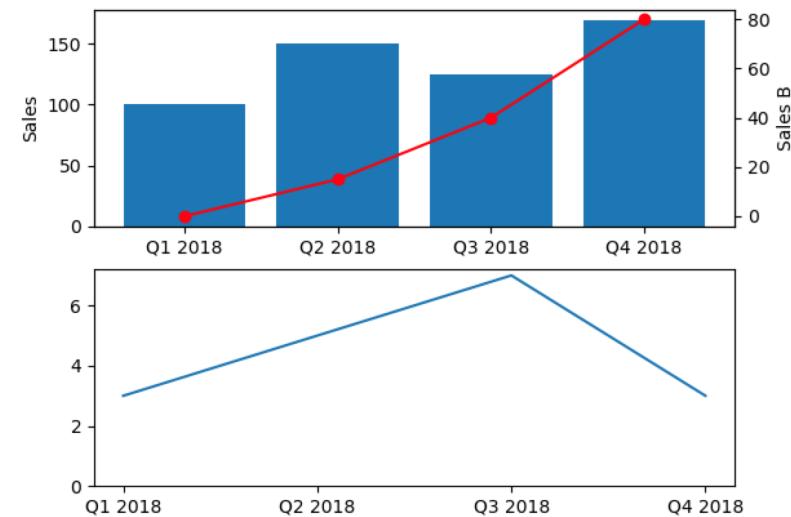


Charting - Subplots

```
1 import matplotlib.pyplot as plt
2
3 #set up values
4 VALUESA = [100,150,125,170]
5 VALUESB = [0,15,40,80]
6 VALUESC = [3,5,7,3]
7 POS = [0,1,2,3]
8 LABELS = ['Q1 2018','Q2 2018','Q3 2018','Q4 2018']
9
10 # Create the first plot
11 plt.subplot(2,1,1) ←
12
13 #create a bar graph with information about VALUESA
14 plt.bar(POS,VALUESA)
15 plt.ylabel('Sales')
16
17 #create a different Y axis, and add information
18 #about VALUESB as a line plot
19 plt.twinx()
20 plt.plot(POS,VALUESB,'o-',color='red')
21 plt.xticks(POS, LABELS)
22 plt.ylabel('Sales B')
23 plt.xticks(POS, LABELS)
24
25 #create another subplot and fill it iwth VALUESC
26 plt.subplot(2,1,2)
27 plt.plot(POS, VALUESC)
28 plt.gca().set_ylim(bottom=0)
29 plt.xticks(POS,LABELS)
30
31 plt.show()
```

- Multiple charts

2 rows, 1 column, index starting from 1)



https://matplotlib.org/api/_as_gen/matplotlib.pyplot.subplot.html

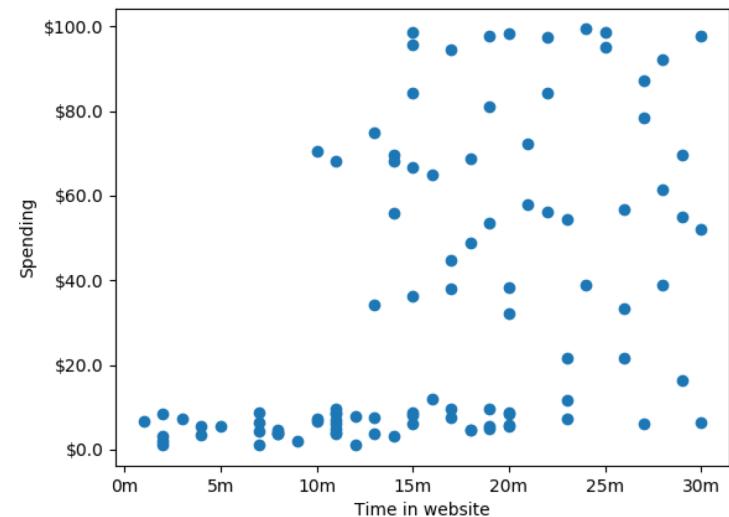


Charting – Scatter Plot

```
1 import csv
2 import matplotlib.pyplot as plt
3 from matplotlib.ticker import FuncFormatter
4
5 def format_minutes(value, pos):
6     return '{}m'.format(int(value))
7
8 def format_dollars(value, pos):
9     return '${}'.format(value)
10
11 # read data from csv
12 fp = open("scatter.csv","r", newline='')
13 reader = csv.reader(fp)
14 data = list(reader)
15
16 data_x=[]
17 data_y=[]
18 for x, y in data:
19     data_x.append(float(x))
20     data_y.append(float(y))
21
22 plt.scatter(data_x, data_y)
23
24 plt.gca().xaxis.set_major_formatter(FuncFormatter(format_minutes))
25 plt.xlabel('Time in website')
26 plt.gca().yaxis.set_major_formatter(FuncFormatter(format_dollars))
27 plt.ylabel('Spending')
28
29 plt.show()
```

- To save a plot:
plt.savefig(*filename*)

- Save the plot before you display





End of Day 2

This concludes the Introduction to Python,
I hope you enjoyed it.

Thank you !

QUESTIONS ?





TRAQOM survey

- **Link sent by SSG via Email or SMS**
- **Message looks like:**
*“You’ve completed a course supported by SSG. PIs complete the TRAQOM survey at this link:
<https://traqom.azcentric.com/xxxxx>”*
- **Do let us know if you have not received**
- **Please complete the survey found in the link**



Where to go from here ?

Getting started step by step

<http://www.python.org/about/gettingstarted/>

Run through the python tutorials:

<http://docs.python.org/tutorial/index.html>

Keep the API doc under your pillow:

<http://docs.python.org/library/index.html>

Advanced examples:

<https://diveintopython3.problemsolving.io/>



Where to go from here ?

MOOC:
DataCamp
<https://www.datacamp.com/>

The screenshot shows the DataCamp website's search results page for "python". At the top, there's a purple banner with the text "Subscribe now. Save 50% on DataCamp and skill up. Offer ends in 04 days 04 hrs 56 mins 51 secs". Below the banner, the search bar shows "python". The main heading says "57 results for 'python'". There are six course cards displayed in two rows of three:

- Intro to Python for Data Science**: Master the basics of data analysis in Python. Expands your skill set by learning scientific computing with numpy. 4 hours. Instructor: FILIP SCHOUWENAARS, Data Science Instructor at DataCamp.
- Intermediate Python for Data Science**: Level up your data science skills by creating visualizations using matplotlib and manipulating data frames with Pandas. 4 hours. Instructor: FILIP SCHOUWENAARS, Data Science Instructor at DataCamp.
- Python Data Science Toolbox (Part 1)**: Learn the art of writing your own functions in Python, as well as key concepts like scoping and error handling. 3 hours. Instructor: HUGO BOVNE-ANDERSON, Data Scientist at DataCamp.
- Deep Learning in Python**: Learn the fundamentals of neural networks and how to build deep learning models using Keras 2.0. 4 hours.
- Supervised Learning with scikit-learn**: Learn how to build and train models and evaluate how well they perform on unseen data. 4 hours.
- pandas Foundations**: A course card with a placeholder image and a brief description.

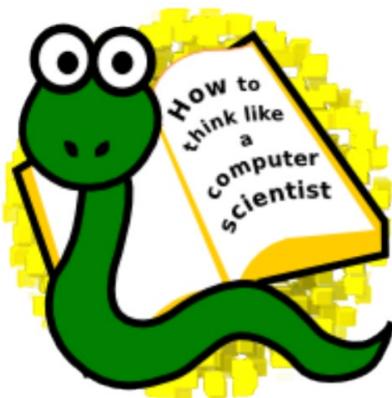
Edx
<https://www.edx.org/learn/python>

Udemy
<https://www.udemy.com/topic/python/>

The screenshot shows the edX website's homepage during Cyber Monday. At the top, there's a banner with the text "Accelerate your future. Learn anytime, anywhere." and a "Find courses" button. Below the banner is a search bar with the placeholder "What do you want to learn?". The footer features logos for MIT, Harvard University, Berkeley, The University of Texas System, The Hong Kong Polytechnic University, and The University of British Columbia. A large "CYBER MONDAY" graphic is on the right. A promotional banner in the center says "THE COUNTDOWN IS ON! Get 15% off your purchase." with a "Start Exploring" button. Below the banner is a "Popular Subjects" section.



Where to go from here ?



How to think like a computer scientist is an introduction to Python programming for beginners. It starts with basic concepts of programming, and is carefully designed to define all terms when they are first used and to develop each new concept in a logical progression. Larger pieces, like recursion and object-oriented programming are divided into a sequence of smaller steps and introduced over the course of several chapters.

How to think like a computer scientist is a Free Book. It is available under the [GNU Free Documentation License](#), which means that you are free to copy, distribute, and modify it, as long as derivative works of the document must themselves be free in the same sense.

<https://buildmedia.readthedocs.org/media/pdf/howtothink/latest/howtothink.pdf>

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- <https://www.rp.edu.sg/soi/lifelong-learning>

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+ [Artificial Intelligence for Techies - A Hands-On Approach \(1 day Beginner\)](#)

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- Using outsystems.com platform
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- Next run: 21 – 22 Sep 2020

