Modules

Inteligencia Artificial en los Sistemas de Control Autónomo

Objectives

1. Understand the relevance to use modules and packages.
2. Be able to install some widely used Python packages about geospatial software.
3. Be able to apply some modules and packages of both Python Standard Library and others Python Geospatial Libraries.

Table of Contents

Introduction (I)

You loose everything when exit the interpreter

- *Solution*: Write it down in a script

When a script becomes big, it is difficult to maintain

- *Solution*: Split your script in several ones

As you get more scripts, you will need to reuse your functions

- *Solution*: Create a module
- **Module**: A file that contains definitions, functions and classes

If a module is too big, it is too difficult to maintain

- *Solution*: Create a package
- **Package**: A module of modules

Introduction (II)

Why modules?

- **Main function**: Organization.
- **Reuse**: To provide software solutions, that have been proven to work, to solve similar problems.

Using modules

Creation and Implementation

A module is just a Python script with `.py` extension

fibo.py

```
1  def fib(n):
2      """Print a Fibonacci series up to n """
3      a, b = 0, 1
4      while a < n:
5          print(a, end=' ')
6          a, b = b, a+b
7      print()
8
9  def fib2(n):
10     """Print a Fibonacci series up to n """
11     result = [] # Declare a new list
12     a, b = 0, 1
13     while a < n:
14         result.append(a) # Add to the list
15         a, b = b, a+b
16     return result
```

Using modules

Where is it stored?

Accessible and reusable module:

- Set path in the file directory where the module is stored.
- Variable `PYTHONPATH`

Using modules

How do I use them? (I)

```
>>> import fibo
>>> fibo.fib(1000)
1 1 2 3 5 8 13 21 34 55 89 144 233 377 610 987
>>> fibo.fib2(100)
[1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89]
>>> fibo.__name__
'fibo'
>>> fib = fibo.fib
>>> fib(100)
1 1 2 3 5 13 21 34 55 89
```

Using modules

How do I use them? (II)

A module can import other modules

- Name conflicts may arise: Each module has a symbol table
- It means you should invoke it as `modname.itemname`

It is possible to import items directly

- `from module import name1, name2`
- `from module import *`
- It uses the global symbol table (no need to use the modname)

```
>>> from fibo import fib, fib2
>>> fib(100)
1 1 2 3 5 8 13 21 34 55 89 144 233 377 610 987
```

Using modules

How do I use them? (III)

List zip file contents (file.zip must exist. Open in read mode)

```
1  import zipfile
2
3  file = zipfile.ZipFile("file.zip", "r")
4
5  # list filenames
6  for name in file.namelist():
7      print(name)
8      print
9
10 # list file information
11 for info in file.infolist():
12     print(info.filename, info.date_time, info.file_size)
```

Several examples here: `http://pymotw.com/2/PyMOTW-1.132.pdf`

Using modules

How do I use them? (IV)

Error while importing:

- The module does not exist.
- The module name has not been well written.
- The module is not on the search path of Python modules:
  1. By default, it searches in the current directory.
  2. If it does not find it here, it then searches in the directories of the environment variable `PYTHONPATH`.
     - `echo $PYTHONPATH`
     - ```
       import sys
       print sys.path
       ```
  3. If it still does not find, it then searches in the installation directories of Python.
- How can I troubleshoot it?
       ```

Executing modules

Modules as scripts (I)

When a module is imported, its statements are executed

- It declares functions, classes, variables ...
- ... and also executes code
- It serves to initialize the module

Very useful to use modules as programs and libraries

Executing modules

Modules as scripts (II)

fibo2.py

```
1  def fib(n):
2      """Print a Fibonacci series up to n """
3      a, b = 0, 1
4      while a < n:
5          print(a, end=' ')
6          a, b = b, a+b
7      print()
8
9  def fib2(n):
10     """Print a Fibonacci series up to n """
11     result = [] # Declare a new list
12     a, b = 0, 1
13     while a < n:
14         result.append(a) # Add to the list
15         a, b = b, a+b
16     return result
17
18 if __name__ == "__main__":
19     import sys
20     fib(int(sys.argv[1]))
```

```
    (python3 version)
$ python3 fibo2.py 50
1 1 2 3 5 8 13 21 34
```

Compiled Python files

We said Python is an interpreted language

- ... this is almost a lie

Python, as other interpreted languages, has a speed-up trick

- It can use bytecode, just as Java

Bytecode: Intermediate code between machine code and source code

- Faster than source code, slower than machine code.
- It is transparent to the programmer.
- The first time a `.py` file is executed, it is compiled automatically, generating a `.pyc` file.

Content of a module

The dir() function

Very usefull to get an insight to a module

- It returns the names defined in a module
- Without arguments, it returns your names

```
>>> import fibo, sys
>>> dir(fibo)
['__name__', 'fib', 'fib2']
>>> dir()
['__builtins__', ... , '__spec__']
>>> variable = 'Hello'
>>> dir()
['__builtins__', ... , '__spec__', 'variable']
```

Packages

Package concept (I)

If a module gets too big, many problems arise

- Name collisions
- It is good to organize modules in a bigger structure: *Packages*

Packages can be seen as ``dotted module names"

- It is just a module that contains more modules
- Make life easier in big proyects
- The name `A.B` designates a submodule `B` in a package named `A`

Must contain a `__init__.py` file in the root directory

- Executed when the package is imported for the first time

Packages

Package concept (II)

Sound module structure

```
sound/                          Top-level package
      __init__.py               Initialize the sound package
      formats/                  Subpackage for format conversions
              __init__.py
              wavread.py
              wavwrite.py
              aiffread.py
              aiffwrite.py
              auread.py
              auwrite.py
              ...
      effects/                  Subpackage for sound effects
              __init__.py
              echo.py
              surround.py
              reverse.py
              ...
      filters/                  Subpackage for filters
              __init__.py
              equalizer.py
              vocoder.py
              karaoke.py
              ...
```

Packages

Importing a package (I)

Ways to use a package

Import an individual module

- `import sound.effects.echo`
- Use function as `sound.effects.echo.echofilter(input, output)`

Alternative way to import an individual module

- `from sound.effects import echo`
- Use function as `echo.echofilter(input, output)`

Alternative way to import an individual module

- `from sound.effects.echo import echofilter`
- Use function as `echofilter(input, output)`

Packages

Importing a package (II)

Imagine we run `from sound import *`

- In theory, it would import the whole package
- In practice, it would take too much time

There is a convention to avoid waste of resources

- There may be a variable `__all__` defined in `__init__`
- `__all__` contains modules to be imported

sounds/effects/__init__.py

```
__all__ = ["echo", "surround", "reverse"]
```

Packages

Installing packages

Command-line automatic tool: `pip`

- Very similar to `apt-get` in Linux

pip usage

```
$ python -m pip install SomePackage
```

pip alternative usage

```
$ pip3 install SomePackage
```

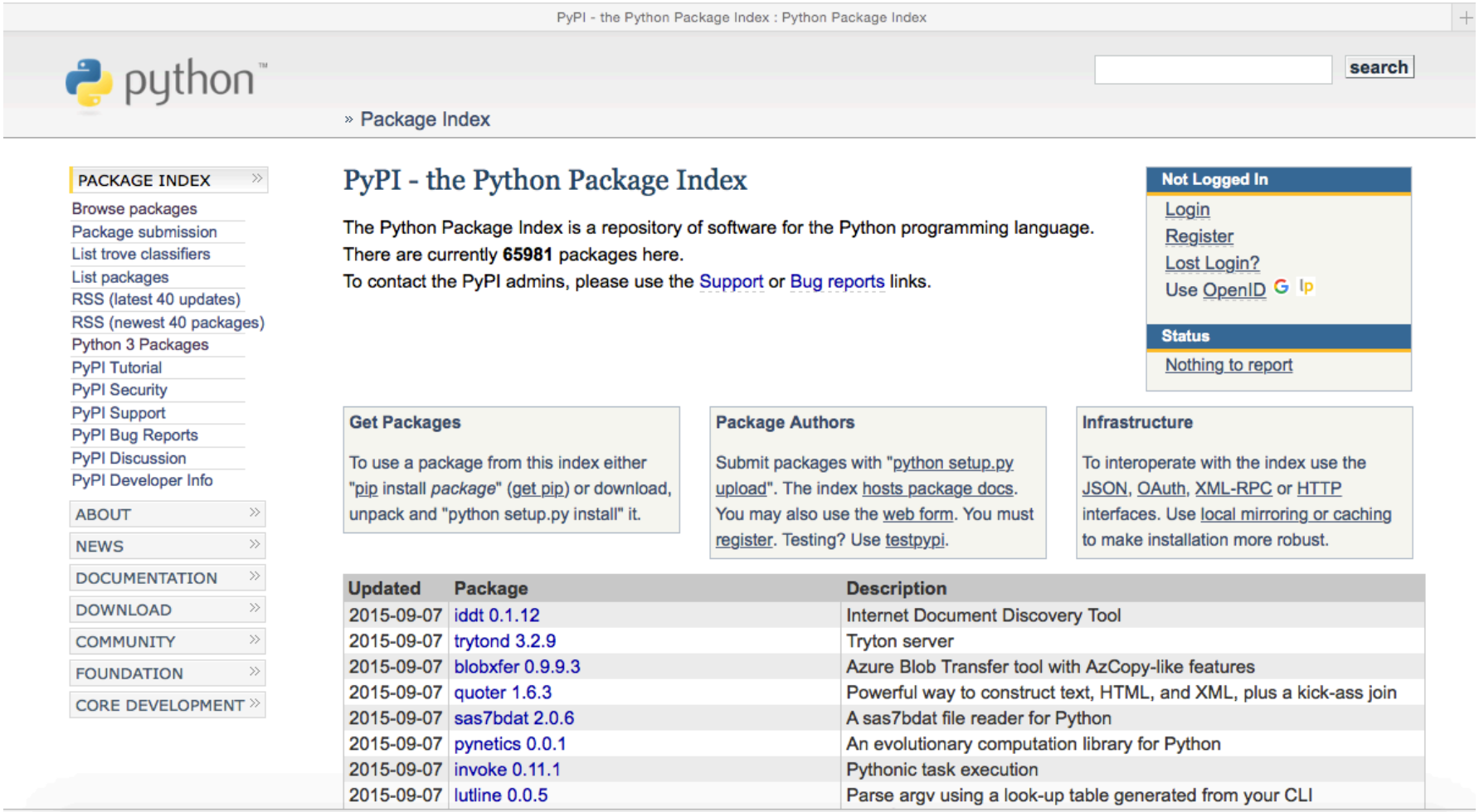
Example of the PIL installation:

```
$ pip3 install Pillow
```

(More info)

Packages

What has been developed?



`os` module

Functions to manipulate files and processes

- **Functions for managing files and paths**: `os.path`
- **Create directories**. Example: `os.mkdir('data')`
- **Current working directory**: `os.getcwd()`
- **Moving to a certaing directory**. Example: `os.chdir('data')`
- **Value of an environment variable**. Example: `os.chdir(os.environ['HOME'])`
- **Rename a file**. Example: `os.rename('fich1.py', 'palindrome.py')`
- **Deleting a file**. Example: `os.remove('practica1.py')`
- **List the files in the current directory**. Example: `os.listdir(os.curdir)`
- **List the files in a certain directory**. Example: `os.listdir('c:\\data')`
- **Call operating system (execute OS services)**. Example: `os.kill`, `os.execv`, etc.

`sys` module

It provides access to some variables maintained by the interpreter (at execution environment) and the functions that interact with the interpreter.

- **List the arguments passed to script on the command line:** `sys.argv`
- **Python output.** `sys.exit`
- **Files for access to input, output and standard error of the interpreter:** `sys.stdin`, `sys.stdout`, `sys.stderr`, respectively.

sys module

Example

example_sys.py

```
import sys

# datos introducidos por teclado
data = sys.argv[:]

print 'data =   ', data

print "%d arguments were passed to the script %s: " \
          %(len(sys.argv) - 1, sys.argv[0])
for arg in sys.argv[1:]:
    print "  %s" % arg
```

`time` module (I)

- It provides functions related to the measurement of time.
- Python provides the date and time of three ways:
  - Tuple: year-month-day-hour-min-sec-dayweek-day year-x (*tup*)
  - String (*str*)
  - Total of seconds since an origin (*sec*)

`time` module (II)

- **Current time:** `time()`
- **Time elapsed since the start of the execution.** `clock()`
- **Pause n seconds.** `sleep()`
- **GMT.** `gmtime()`
- **Local time.** `localtime()`
- **Convert the tuple to a character string.** `asctime()`
- **Convert the tuple to a string.** `strftime()`
- **Convert the tuple to seconds.** `mktime()`
- **Convert the seconds to a string.** `ctime()`
- **Convert the string to a tuple.** `strptime()`
- ...

`time` module (III)

Example

example_time.py

```
#!/usr/bin/python
import time;

localtime = time.localtime(time.time())
print "Local current time :", localtime
```

Output:

```
Local current time: Fri Nov 20 20:45:34 2015
```

Cool code examples

Example 1: Open a web browser

browser.py

```
import webbrowser

url = input('Give me an URL: ')

webbrowser.open(url)
```

Cool code examples

Example 2: Create a thumbnail

thumbnail.py

```
from PIL import Image

size = (128, 128)
saved = "africa.jpg"

im = Image.open("africa.tif")
im.thumbnail(size)
im.save(saved)
im.show()
```

(Source)

africa.jpg

Cool code examples

Example 3: List a directory contents

dir.py

```
import os

os.system("clear")

path = input("Specify a folder >> ")

for root, dirs, files in os.walk(path):
    print(root)
    print("--------------------")
    print(dirs)
    print("--------------------")
    print(files)
    print("--------------------")
```

(Source)

Cool code examples

Example 4: Send an email with Gmail

gmail.py

```
"""The first step is to create an SMTP object,
each object is used for connection
with one server."""

import smtplib
server = smtplib.SMTP('smtp.gmail.com', 587)

# Next, log in to the server
server.login("youremailusername", "password")

# Send the mail
msg = "\nHello!" # /n separates the message from the headers
server.sendmail("you@gmail.com", "target@example.com", msg)
```

(Source)

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