Programming Python

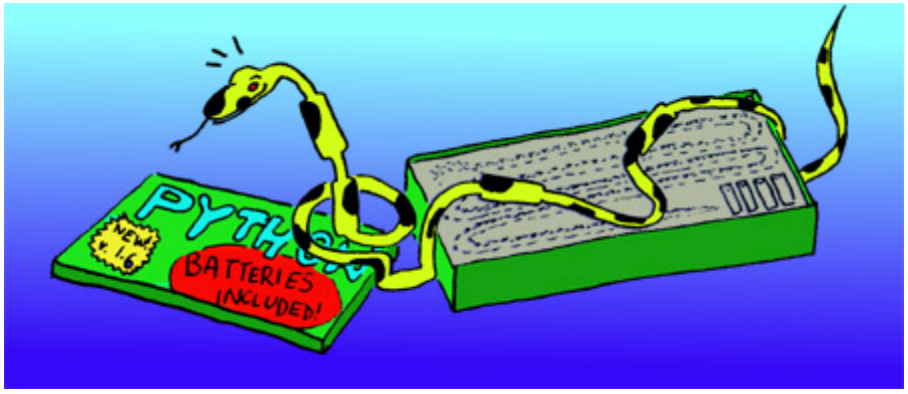
STEP Infotek internal seminar

Seminar contents

- Some introductory matters
- Basic Python (types and statements)
- The Python libraries
- A practical exercise
- Object−oriented programming in Python

Introduction

Getting to know Python



Classifying languages

- Programming languages
  - compiled, statically typed, fast, low−level, useable for big projects
  - C/C++, Java, Ada, Pascal, Eiffel, ...
- Scripting languages
  - interpreted, dynamically typed, slow, high−level, only for ’toy’ projects
  - tcl, Perl, *Basic, Ruby, ...

Classifying Python

- A scripting language
  - interpreted, dynamically typed, slow, high−level
- Useful for both small and large projects
  - CORBA ORB, RDBMS, web browser...
- Syntactically unusual, closest relative is probably ABC

Python features

- High−level data types
- Very extensive standard libraries; can access anything
- Everything is a first−class object
  - classes, functions, modules, ...
- Convenient, readable programming
- OOP without a straitjacket
- Features from functional languages

What does this mean?

- Incredibly rapid development
- Source code is nearly always easily readable
- Perfect for integration tasks
- Can be used for just about anything
- Programming becomes fun!

Where does it come from?

- Christmas 1989, Guido van Rossum creates ABC for Unix/C hackers
- Developed at CWI in Amsterdam in 1990/91, then posted on comp.sources
- Classical open source project
- Development (and Guido) move to CNRI in the US in 1995
- Development moves to BeOpen in 2000

DOCTOR FUN

6 Apr 2000

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Internals

- There are two implementations:
  - the original, written as a C program
  - JPython, a Java re−implementation
- It’s easy to integrate C code into Python as if it were Python code
- Java code can be used as is from JPython as if it were Python

Portability and access

- Python runs anywhere
  - Win32, Unix, Mac, DOS, Amiga, BeOS, VMS, Palm, WinCE, VxWorks
- Integrates with platform−specific extensions on most platforms
- Source code is generally portable unless depends on specific libraries

Python versions

- 1.4 and earlier are totally obsolete now, though code will usually run
- 1.5 is also obsolete, but less so
- 1.6 was just an interim release
- 2.0 introduces many new things
  - Unicode support
  - new language features (GC++)
  - new modules

Hello, world!

- The Python port of the famous hello world program:

```
print "Hello, World!"
```

- Write this line into a file named hello.py
- `python hello.py` runs it

The interpreter

- An excellent programming tool!
- Lets you try things out on the fly
- *Very* useful for playing around with libraries and modules
- *Extremely* useful for debugging
- Use it whenever you wonder how something works!

Python basics

Getting a grip on it

Variables and values

- Variables created by assignment
- `a = 2` creates the variable `a`
- Variables don’t have types
- Values have types
- `type(a)` will give `<type ’int’>`
- `del a` will delete the variable

Numbers

- Mostly work as you would expect
- `(2 + 2) * 6 => 24`
- `2 ** 8 => 256`
- `2.0 / 3.0 => 0.6666667`
- `2 / 3 => 0 !`
- `3 % 2 => 1`

Strings

- "this is a Python string"
- ’so is this’
- str(5 + 5) => ’10’
- "Hi " + "there" => "Hi there"
- "say " + "a" * 3 => "say aaa"
- len("python") => 6

String templates

- `temp = "%s is very %s"`
- `temp % ("Python", "cool") =>`

  `"Python is very cool"`
- A very useful feature for producing text output of all sorts
- Has more fancy capabilities as well

Lists

- `a = [1, 2, 3, 4]`
- `len(a) => 4`
- `a[0] => 1`
- `a[-1] => 4`
- `a[1 : -1] => [2, 3]`
- `a[200]` => error!
- `range(5) => [0, 1, 2, 3, 4]`

List methods

- l.append(value), appends value
- l.reverse(), reverses list
- l.sort(), sorts list
- l.count(value), counts occurrences
- l.index(value), finds index of value
- l.remove(value), removes value

Dictionaries

- *Incredibly* useful feature!
- `lang = {"no" : "Norwegian",`
  `"en" : "English"}`
- `lang["en"] => "English"`
- `lang["hu"] => "Hungarian"`
- `lang.has_key("se") => 0`
- `lang["se"]` => error!

More dictionaries

- `lang.keys() => ["no", "en", "hu"]`
- `lang.values() => ["Norw...]`
- `lang.items() => [("no", "N...`
- `len(lang) => 3`
- `lang.get("se", "Unknown") => "Unknown"`

Truth values

- No explicit true and false
- Instead, any value can be evaluated
- 0, "", [], {} are all false
- and, or and not work as usual
- 0 and 1 usually used for false/true
- == is the comparison operator, with <, >, <=, >=

The while loop

```
print "Language? ",
l = raw_input()
while l != "stop":
print lang.get(l, "???")
print "Language? ",
l = raw_input()
```

Break

```
while 1:

print "Language? ",

l = raw_input()

if l == "stop":

break

print lang.get(l, "???")
```

The for loop

```
codes = lang.items()

codes.sort()

for (code, name) in codes:

print "%5s %s" % (code, name)
```

Continue

```
codes = lang.items()

codes.sort()

for (code, name) in codes:

if name == "sv":

continue

print "%5s %s" % (code, name)
```

Functions

```
def get_input():
    print "Language? ",
    return raw_input()


l = get_input()
while l:
    print lang.get(l, "???")
    l = get_input()
```

Parameters

```
def double(x):
return 2 * x


def hello(who = "World"):
print "Hello, %s!" % who
```

An exercise!

- Write a function `verify(str)`
- This function returns true if the first character in str is 1, 2 or 3
- Save it in a file dict.py
- Test it interactively in the interpreter
- Try filter(verify, ["110", "552", "240", "345", "007", "777"])

Modules

- Any Python file can be a module
- `import foo` will locate the foo module and load it in
- Its contents will be available as `foo.bar`
- The PYTHONPATH is where modules are searched for

An essential module

- The string module
- string.split(str, div = " ") => list
- string.join(list, div = " ") => str
- string.find(str, what) => index

Another!

- Write another function in dict.py: interpret_multiline(str)
- This takes a string with several lines separated by \r\n
- It should return a list of the lines
- However, it should stop when a line contains only "."

Tuples

- Used for grouping data
- Perfect for coordinates (x, y)
- Cannot be modified
- Can be accessed just like lists
- Essentially read−only lists
- Much used for grouping in data structures

Conversions

- str(anything)
- int(anything)
- float(anything)
- list(anything)
- tuple(anything)

Yet another!

- split_and_strip takes a string of the form `'name "descr..."'`
- It returns a tuple (name, descr) without the quotes
- Try map(split_and_strip, list_of_strings_of_above_form)

The Python libraries

The batteries

When programming...

- ...always keep the HTML library reference ready
- This *will* save you lots of work

Library categories

- System libraries
- String services
- Operating system interaction
- Internet libraries
- Python language services
- Various
  - multimedia, maths, crypto

System libraries

- __builtin__ The built−in functions
- sys Interpreter information
- gc Garbage collector (2.0)
- pickle Save/load objects
- shelve Pickle database
- pprint Data pretty−printer

String services

- string — Our old friend
- re — Regexps
- struct — Work with binary data
- StringIO — In−memory files
- codecs — String converters (2.0)

OS interaction

- os Files, paths, processes
- time Date and time information
- curses Text screen handling
- getopt Deal with cmdline args
- socket Network access
- *dbm Simple keyed databases

Internet libraries

- Protocols: http, ftp, pop, smtp...
- URLs: urllib, urlparse
- Web: htmllib, cgi, Cookie
- Formats: rfc822, MIME, base64...
- XML:
  - pyexpat (2.0)
  - SAX 2.0 (2.0)

File handling

- open(name, mode) opens a file
- file.read(chars = all)
- file.readline()
- file.readlines()
- file.write(data)
- file.close()

A file example

```
out = open("hello.txt", "w")
out.write("Hello, world!\n")
out.close()

inf = open("hello.txt")
inf.readline() => ’Hello, world!\n’
inf.readline() => ’’
inf.close()
```

sys

- argv cmdline arguments (list)
- exit halts the interpreter
- path Python search path
- version Python version string
- platform platform identifier
- stdin, stderr, stdout

A sys example

```
import sys


print sys.argv
print sys.platform
print sys.version
print sys.path
```

An exercise!

- python iso.py <standard−number>
- This should print the name of the ISO standard with the given number
- A list of numbers are in input.txt

socket

- socket(AF_INET, SOCK_DSTREAM)
- socket.connect((IP, port))
- socket.send(string)
- socket.recv(max_bytes)
- socket.close()
- gethostbyname(name) => IP

A socket example

```
from socket import *

sock = socket(AF_INET, SOCK_STREAM)

sock.connect((’195.225.9.157’, 79))

sock.send("larsga\r\n")

print sock.recv(1024 * 16)

sock.close()
```

A urllib example

```
from urllib import urlopen

url = "http://www.infotek.no"

inf = urlopen(url)

print inf.read(1024)

inf.close()
```

Important tools

- GUI wxPython, PyGtk, tkInter
- Web Zope, Medusa, PyApache
- Data DBI + database modules
- Strings SPARK
- Python DistUtils, PyUnit

A practical exercise

Making a DICT client

DICT

- A network protocol for talking to dictionary servers (see dict.org)
- Many free implementations with free dictionaries exist
- Both stand−alone and web clients can be found
- Defined in RFC 2229

The concept

- The server has a set of databases (typically webster, jargon & wn)
- Client can ask for specific words in one of these or in all of them
- Client can also search for words
- Much more functionality is also available

The protocol

- Based on simple text commands being sent to the server
- Server responds in clearly defined formats
- Numeric codes are used in responses to indicate the rough meaning of a response

A sample session

```
<= 220 pc-larsga dictd 1.4.9
=> SHOW DATABASES
<= 110 4 databases present
<= web1913 "Webster's Revi..."
<= wn "WordNet (r) 1.6"
<= foldoc "The Free On-line..."
<= jargon "Jargon File..."
<= .
<= 250 ok
=> QUIT
<= 221 bye
```

Some conventions

- Error codes beginning with 1, 2 or 3 signify success
- String lists are terminated by a single line containing only a .
- Lines are terminated by ’\r\n’

Some tips

- Keep receiving until the response contains the terminator
- Use socket.gethostbyname to find the IP address of a machine
- Use the functions you wrote earlier to process the data
- Server is ’pc−larsga.infotek.no’

Suggested steps

- Connect to server (port 2628) and print the welcome message
- Send ’SHOW DATABASES’ and just print the result
- Turn the result into a list
- Try to implement ’DEFINE * word’

Object−oriented programming

Making a class

- Like Java, Python supports object−oriented programming
- Unlike Java, it also supports other styles of programming
- Python’s OOP support has some similarities with Java’s, but rather more with Perl’s

A simple class

```
class Person:
  def __init__(self, given, sur):
    self._given = given
    self._sur = sur

  def get_name(self):
    return self._given + " " + self._sur

  def get_sortname(self):
    return self._sur + ", " + self._given
```

Using the class

```
from person import *
me = Person("Lars Marius", "Garshol")
me.get_name()
  => ’Lars Marius Garshol’
me.get_sortname()
  => ’Garshol, Lars Marius’
```

Inheritance

```
class HungarianPerson(Person):
  def get_name(self):
    return self._sur + " " + \
           self._given
class FrenchPerson(Person):
  def get_name(self):
    return string.uppr(self._sur)+\
           " " + self._given
```

Noteworthy stuff

- Inheritance from more than one class allowed
- Names beginning with __ are protected by mangling
- Names beginning with _ are protected by convention
- Classes and methods are first−class citizens

Exceptions

- A *very* useful feature in handling errors
- C/C++ programs often make every single function return 0/1
- This is ugly and error−prone
- Exceptions provide a far better way

Why exceptions are good

- What to do with errors depends on the context
- Errors often occur in the innermost parts of the code
- These tend not to know about the context at all
- Solution: exceptions
- These can be ’thrown’ by a function back to its callers until someone catches it

An example

```
def bing():
  bong()
def bong():
  bang()
def bang():
  raise HolySmokeError("Whoops!")
try:
  bing()
  print "OK"
except HolySmokeError, e:
  print "ERROR:", e
```

Exceptions are objects

- In Python and Java, exceptions are objects
- This makes it possible to put error information in them
- This information can be used by catchers

Cleanup actions

```
def insert_person(person):
  try:
    db = get_connection()
    db.run(insert_sql % person)
  finally:
    db.release()
```

An exercise

- Write the DICT client as a class
- Define get_databases and get_definition as methods
- Define a DictProtocolError
- Make the client raise this when the server indicates an error

How to go on from here

- Read the appendix to my book
- Read the Python tutorial
- Read ’Learning Python’
- Read the library reference
- Write scripts!
- Attend my Python and XML seminar!