Migrate Python from 2.X to 3.X

WHO AM I?

C++ & PYTHON DEVELOPER

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6,5 years in CAD&Numeric simulations

20,5 years in C++

3 years in embedded programming

19,5 years in Python

11,5 years in finance

invivoo
IT & Finance

CONCERNS

SOME NEWS

- 2017

➢ Instagram migrated major part of its code to Python 3

- September 2018

➢ Dropbox announced the end of its migration to Python 3 (they began in 2015)!

TECHNICAL ASPECTS (1/2)

- Support for Python 2.7 will stop soon
  - January the 1st 2020
- Some libraries are no more compliant
  - Django, numpy (2019), etc.
- Python 4
  - Will arrive in the next few years (2023 ?)

TECHNICAL ASPECTS (2/2)

- Asynchronous programming (asyncio)
- Consistency
  - Return generator instead of containers
  - Functional programming

DIFFERENCES (1/3)

	Python 2	Python 3
print	print 'blabla'	print('blabla')

DIFFERENCES (1/3)

	Python 2	Python 3
print	**print** ‘blabla'	**print**(‘blabla’)
raise	**raise** IOError, ‘file error'	**raise** IOError(‘file error’)

DIFFERENCES (1/3)

	Python 2	Python 3
print	**print** 'blabla'	**print**('blabla')
raise	**raise** IOError, 'file error'	**raise** IOError('file error')
long	**long**(myvar) 5/2 = 2	**int**(myvar) 5/2 = 2.5 5//2 = 2

DIFFERENCES (2/3)

	Python 2	Python 3
string	unicode str	str bytes

DIFFERENCES (2/3)

	Python 2	Python 3
string	unicode str	str bytes
dict, map, zip	dict.items(): list dict.keys()[0] dict.iteritems()	dict.items(): dict_items list(dict.keys())[0] dict.items()

DIFFERENCES (3/3)

UNICODE MANAGEMENT

u’toto’

b’titi’

instruction unicode()

method __unicode__()

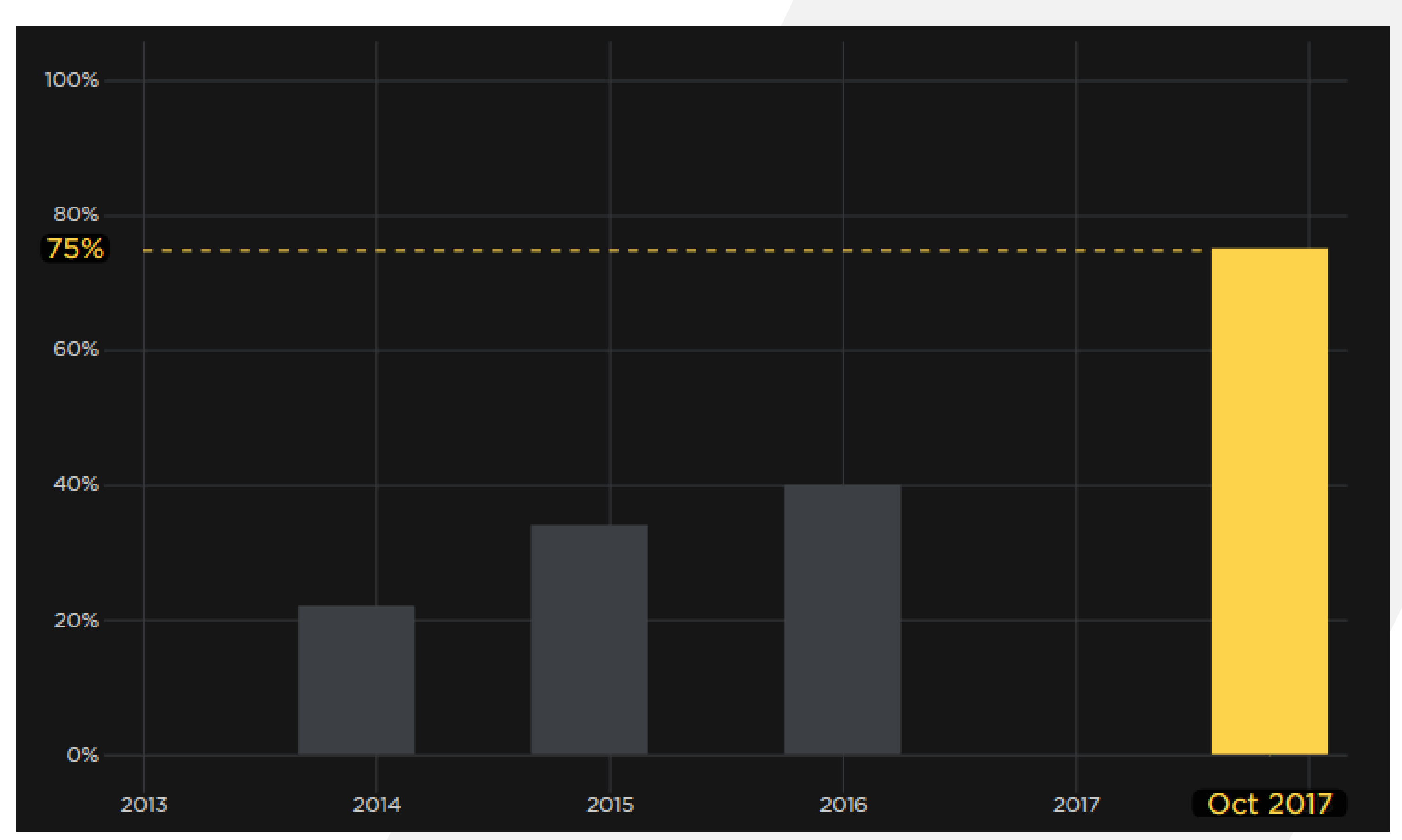
StringIO/BytesIO

FINANCIAL ASPECT

- Migration costs?
  - Heavy costs at short term
  - Few costs at long term

- Costs to keep Python 2?
  - No immediat costs
  - Heavy cost at middle/long term

GOAL...



Python 3	Python 2	
75%	25%	All Python
70%	30%	Web developers
80%	20%	Data scientists

NON-REGRESSION TESTS

HOW TO VALIDATE THE MIGRATION?

- Is the migration a success?
- Are the performances as good as the 2.X version?
- What is the coverage of the tests?
- We need **indicators**!

UNIT TESTS

- Use a unit test for a small part of code testing (As a function).
- Utopic goal: have unit tests for all API.

FUNCTIONAL TESTS (1/2)

- Functional tests are more complex because several API are linked but cover a real service or functionality.

- Objective: cover most of the functionalities as possible. Having a tool to mesure code coverage will be useful.

FUNCTIONAL TESTS (2/2)

- The need to automate tests is increasing with program size

- A functional test could be:
  - A chain of API calls
  - GUI actions (use of UFT/QTP)

PERFORMANCES TESTS

- You need to validate that migration keep the application performances : algorithms used in libraries could be replaced between versions, some conflicts between libraries could appears…

  - Load tests?

COVERAGE TESTS (1/2)

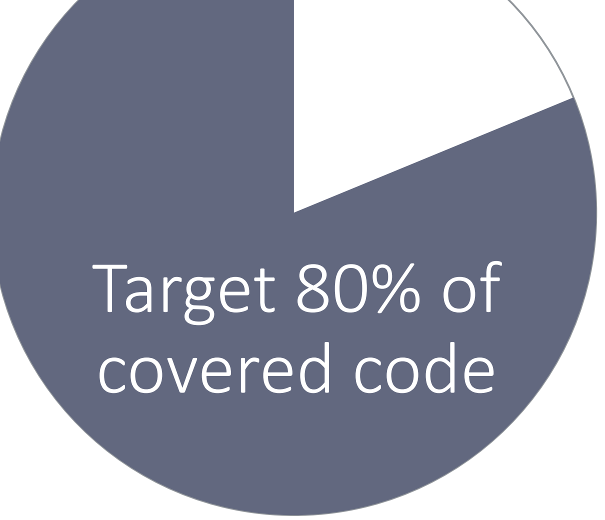
- Knowing the number of lines of codes tested when all the tests are using (unit, functional or performance)

https://coverage.readthedocs.io/en/coverage-4.5.1a

COVERAGE TESTS (2/2)

- According to my experience, with less than 60% of covered code, the chance of having hidden bugs is very important

- A good target is 80% of covered code



GUI TESTS

- Test the GUI
  - Either manual
  - Or use tool like UFT (previous name: QTP)
  - …
- Allow to automate test as if it was done by a user

HUMAN TESTS

- A developer tests the code from a way which corresponds to the implementation he done, a real user tests according to its habits
  - Update GUI controls, click… raise events and code execution and the order of calls can change the behavior
  - human add random part inside tests

PERIMETER

PERIMETER?

ENVIRONMENT

OS

DB

PROCESSOR

PYTHON DISTRIBUTION

TOOLING

WHAT MODULES ARE LOADED? (1/2)

- Standard modules in Python?
- Modules which were developed in intern?
- What are the external modules?

WHAT MODULES ARE LOADED? (2/2)

- How to determine the list of dynamically loaded modules… Available since Python 2.3.

```
import re, itertools

try:
    import baconhameggs
except ImportError:
    pass

try:
    import guido.python.ham
except ImportError:
    pass
```

```
from modulefinder import ModuleFinder

finder = ModuleFinder()
finder.run_script('bacon.py')

print 'Loaded modules:'
for name, mod in finder.modules.iteritems():
    print '%s: ' % name,
    print ','.join(mod.globalnames.keys()[:3])

print '-'*50
print 'Modules not imported:'
print '\n'.join(finder.badmodules.iterkeys())
```

AND THEN: PROBLEMS?...

- Is there module:
  - with ended support or unmigrated?
  - with modified API?
  - licencing changed?
  - library name changed?

NON-PYTHON MODULES

- Problems with C/C++ written modules
  - C++ compiler migration
  - porting C++ libraries
  - tools problems (swig…)
  - licences, etc…

MIGRATION METHODOLOGY

SPLIT IN BUNDLES

- « Divide to reign »: it will be better to migrate small groups of files to minimize interactions.
- Create bundles in using module dependencies (have a graph should be useful), internal or external module…

PORTING EXTERNAL CODE (1/2)

- External code has no dependency with house-made code: start with them will be a good idea.

- Take count of tools:
  - Compiler
  - Integration tools in Python: swig, boost.python, etc.
  - External libraries

PORTING EXTERNAL CODE (2/2)

- Library was ported or not?
- API changed?
- Licensing changed?
- Is there constraints according to the versions of different libraries?
- Is source code available ?

ADD PYTHON 3.X CHANGES INSIDE PYTHON 2.X CODE (1/3)

- from __future__ import division
  - PEP 238: Changing the Division Operator
- from __future__ import print_function
  - PEP 3105: Make print a function

ADD PYTHON 3.X CHANGES INSIDE PYTHON 2.X CODE (2/3)

- from __future__ import absolute_import
  - PEP 328: Imports: Multi-Line and Absolute/Relative
- from __future__ import unicode_literals
  - PEP 3112: Bytes literals in Python 3000

ADD PYTHON 3.X CHANGES INSIDE PYTHON 2.X CODE (3/3)

- Six : six.readthedoc.io

Python 2

```python
from urllib2 import urlopen

my_url = 'http://myurl.net'

try:
    x = urlopen[my_url].read()
    print x
except Exception, e:
    raise IOError, 'Error 404'
```

Python 3

```python
from urllib.request import urlopen

my_url = 'http://myurl.net'

try:
    x = urlopen[my_url].read()
    print(x)
except Exception as e:
    raise IOError('Error 404')
```

Six to add 3.X features in 2.X code

```python
from six.urllib.request import urlopen

my_url = 'http://myurl.net'

try:
    x = urlopen[my_url].read()
    print(x)
except Exception as e:
    raise IOError('Error 404')
```

TOOLS (1/2)

- 2to3

```
mathilde@pc-moi~ 2to3 example.py
RefactoringTool: Refactored example.py
--- example.py (original)
+++ example.py (refactored)
@@ -1,9 +1,9 @@

- from urllib2 import urlopen
+ from urllib.request import urlopen

my_url = “http://pythonprogramming.net”
```

```
try:
x = urlopen[my_url].read()
-     print x
-except Exception, e:
-     raise IOError, "Error 404"
+     print(x)
+except Exception as e:
+     raise IOError("Error 404")

RefactoringTool: Files that need to be modified:
RefactoringTool: example.py
```

TOOLS (2/2)

- 2to6
  - Based on 2to3
  - For compilancy between 2 and 3
  - Add __future__, six

REFACTORING

REFACTORING (1/6)

- listdir vs scandir

```python
PATH = "C:\\Tools\\Anaconda3"
def nb_file_listdir( path, ext ):
    nb = 0
    for name in listdir( path ):
        fname = F"{path}\\{name}"
        if isdir( fname ):
            nb += nb_file_listdir( fname, ext )
        else:
            r, e = splitext( name )
            if e.lower() == ext:
                nb += 1
    return nb
print( nb_file_listdir( PATH, ".py" ) )
```

```python
PATH = "C:\\Tools\\Anaconda3"
def nb_file_scandir( path, ext ):
    nb = 0
    for entry in scandir( path ):
        if entry.is_dir():
            nb += nb_file_scandir( entry.path, ext )
        else:
            r, e = splitext( entry.name )
            if e.lower() == ext:
                nb += 1
    return nb
print( nb_file_scandir( PATH, ".py" ) )
```

Fonction/Module	Appel	Durée totale	Durée locale
nb_file_listdir	18214	7.14 sec	212.04 ms
nb_file_scandir	18214	1.54 sec	572.59 ms

REFACTORING (2/6)

- Use generators

```
def frange( a, b, n ):
    h = ( b - a ) / n
    for i in range( n+1 ):
        yield a + i * h

for x in frange( 0, 1, 10 ):
    print( x )
```

```
a = 0
b = 1
n = 10
h = ( b - a ) / n
for x in ( a + i * h for i in range( n+1 ) ):
    print( x )
```

REFACTORING (3/6)

- Comprehension containers

```python
A = [ 1, 2, 3, 4 ]
B = {}
for x in A:
    B[ str( x ) ] = x
```

```python
A = [ 1, 2, 3, 4 ]
B = { str( x ): x for x in A }
```

- String format

```
name = ‘‘Toto’’

‘‘My name is %s’’ % ( name ) # since 1.x

‘‘My name is {}’’.format( name ) # since 2.0

f‘‘My name is {name}’’ # since 3.6
```

REFACTORING (5/6)

- JIT compiler: numba

```python
def fib1( n ):
    if n < 2:
        return n
    return fib1( n - 1 ) + fib1( n - 2)
print( fib1( 35 ) )
```

```python
from numba import jit
@jit
def fib2( n ):
    if n < 2:
        return n
    return fib2( n - 1 ) + fib2( n - 2)

print( fib2( 35 ) )
```

Fonction/Module	Durée totale	Durée locale
fib1	5.52 sec	5.52 sec
_find_and_load	353.08 ms	2.87 ms
_handle_fromlist	342.76 ms	1.54 ms
_compile_for_args	119.95 ms	7.76 us
fib2	69.17 ms	69.17 ms
jit	23.36 ms	10.93 us

REFACTORING (6/6)

- Cache strategy

```
from functools import lru_cache as cache

@cache( maxsize=None )
def fib(n):
    if n<2:
        return n
    return fib(n-1) + fib(n-2)

x = [ fib(i) for i in range( 35 ) ]
print(x)
```

TO CONCLUDE

AND NOW...

- Migrations are like children: each of them is different
- Split in steps...
  - After each step, TEST!!!!
- You will have difficulties but keep hope.

ENABLER

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