Python for engineers

Fedor Baart

November 19, 2013

Introduction

TU Delft

Deltares
Enabling Delta Life

micore

1 Setting up
- Working environment
- Where to get help?
- Stuff that's easy in python

2 The language
- Data types
- Reflection and namespaces
- Performance

3 Python nice libraries
- Glue
- Plotting
- Gis

4 Python common surprises

5 Excersize

6 Reading

7 Web development

Agenda

Python

16:00	Overview
17:00	General excercises
18:00	Your examples
20:00	Done

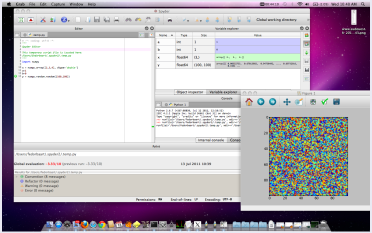
Outline

1. Setting up
   - Working environment
   - Where to get help?
   - Stuff that's easy in python
2. The language
   - Data types
   - Reflection and namespaces
   - Performance
3. Python nice libraries
   - Glue
   - Plotting
   - Gis
4. Python common surprises
5. Excersize

Most popular python IDE (@SO)

15 Spyder

Screenshot



```
# -*- coding: utf-8 -*-
"""
Spyder Editor

This temporary script file is located here:
/Users/fedorbaart/.spyder2/.temp.py
"""
import numpy

x = numpy.array([2,3,4], dtype='double')
a=1
b=0
y = numpy.random.random((100,100))
```

Name	Type	Size	Value
a	int	1	1
b	int	1	0
x	float64	(3,)	array([2., 3., 4.])
y	float64	(100, 100)	array([[0.00332755, 0.67013982, 0.94738492, ..., 0.69732916, 0.1941 ...

```
Python 2.6.7 (r267:88850, Jul 12 2011, 12:18:52)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "copyright", "credits" or "license" for more informatio
>>> runfile(r'/Users/fedorbaart/.spyder2/.temp.py', wdir=r'/
>>> runfile(r'/Users/fedorbaart/.spyder2/.temp.py', wdir=r'/
runfile(r'/Users/fedorbaart/.spyder2/.temp.py', wdir=r'/User
```

/Users/fedorbaart/.spyder2/.temp.py

Global evaluation: -3.33/10 (previous run: -3.33/10) 13 Jul 2011 10:39

Results for /Users/fedorbaart/.spyder2/.temp.py

- Convention (8 messages)
- Refactor (0 message)
- Warning (0 message)
- Error (0 message)

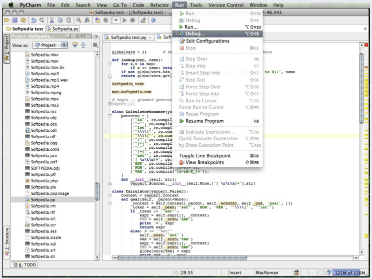
Permissions: RW End-of-lines: LF Encoding: UTF-8

Most popular python IDE (@SO)

4 PyCharm

15 Spyder

Screenshot



```
globalvars = {}

def lookup(map, name):
    for x,v in map:
        if x == name: retu
    if not globalvars.has_                                   to 0):', name
    return globalvars.get(

Softpedia test

mac.softpedia.com

# Begin -- grammar generat
import ...

class CalculatorScanner(ya
    patterns = [
        ('"in"', re.compil
        ('"="', re.compile
        ('"let"', re.compi
        ('"\\\\)"', re.com
        ('"\\\\("', re.com
        ('"/"', re.compile
        ('"[*]"', re.compi
        ('"-"', re.compile
        ('"[+]"', re.compi
        ('"set"', re.compi
        ('[ \r\t\n]+', re.
        ('END', re.compile
        ('NUM', re.compile('[0-9]+')),
        ('VAR', re.compile('[a-zA-Z_]+')),
    ]
    def __init__(self, str):
        yappsrt.Scanner.__init__(self,None,['[ \r\t\n]+'],str)

class Calculator(yappsrt.Parser):
    Context = yappsrt.Context
    def goal(self, _parent=None):
        _context = self.Context(_parent, self._scanner, self._pos, 'goal', [])
        _token = self._peek('"set"', 'NUM', 'VAR', '"\\\\("', '"let"')
        if _token != '"set"':
            expr = self.expr([], _context)
            END = self._scan('END')
            print '=', expr
            return expr
        else: # == '"set"'
            self._scan('"set"')
            VAR = self._scan('VAR')
            expr = self.expr([], _context)
            END = self._scan('END')
            globalvars[VAR] = expr
```

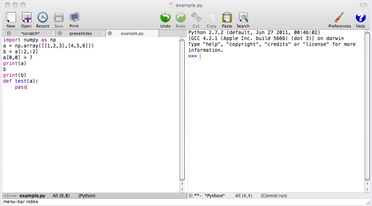
Most popular python IDE (@SO)

3 emacs

4 PyCharm

15 Spyder

Screenshot



```python
import numpy as np
a = np.array([[1,2,3],[4,5,6]])
b = a[:2,:2]
a[0,0] = 7
print(a)
b
print(b)
def test(a):
    pass
```

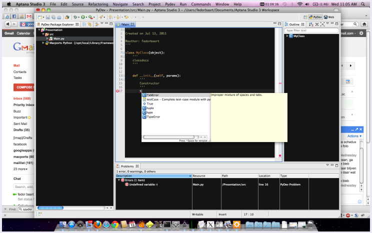
```
Python 2.7.2 (default, Jun 27 2011, 00:46:02)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more
information.
>>> 
```

Working environment

Most popular python IDE (@SO)

2	PyDev
3	emacs
4	PyCharm
15	Spyder

Screenshot



PyDev – Presentation/src/Main.py – Aptana Studio 3 – /Users/fedorbaart/Documents/Aptana Studio 3 Workspace

```
'''
Created on Jul 13, 2011

@author: fedorbaart
'''

class MyClass(object):
    '''
    classdocs
    '''


    def __init__(self, params):
        '''
        Constructor
        '''
        t
```

TabError
testCase – Complete test-case module with py
True
tuple
type
TypeError

Improper mixture of spaces and tabs.

1 error, 0 warnings, 0 others

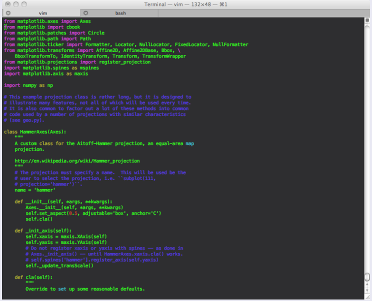
Description	Resource	Path	Location	Type
Errors (1 item)				
Undefined variable: t	Main.py	/Presentation/src	line 16	PyDev Problem

Writable Insert 17 : 10

Most popular python IDE (@SO)

1	vim
2	PyDev
3	emacs
4	PyCharm
15	Spyder

Screenshot

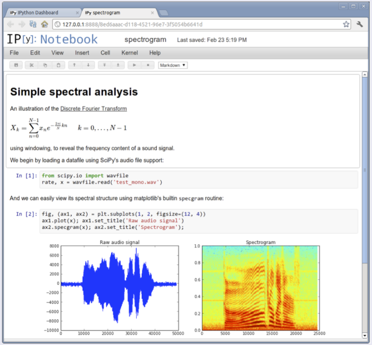


```
from matplotlib.axes import Axes
from matplotlib import cbook
from matplotlib.patches import Circle
from matplotlib.path import Path
from matplotlib.ticker import Formatter, Locator, NullLocator, FixedLocator, NullFormatter
from matplotlib.transforms import Affine2D, Affine2DBase, Bbox, \
    BboxTransformTo, IdentityTransform, Transform, TransformWrapper
from matplotlib.projections import register_projection
import matplotlib.spines as mspines
import matplotlib.axis as maxis

import numpy as np

# This example projection class is rather long, but it is designed to
# illustrate many features, not all of which will be used every time.
# It is also common to factor out a lot of these methods into common
# code used by a number of projections with similar characteristics
# (see geo.py).

class HammerAxes(Axes):
    """
    A custom class for the Aitoff-Hammer projection, an equal-area map
    projection.

    http://en.wikipedia.org/wiki/Hammer_projection
    """
    # The projection must specify a name.  This will be used be the
    # user to select the projection, i.e. ``subplot(111,
    # projection='hammer')``.
    name = 'hammer'

    def __init__(self, *args, **kwargs):
        Axes.__init__(self, *args, **kwargs)
        self.set_aspect(0.5, adjustable='box', anchor='C')
        self.cla()

    def _init_axis(self):
        self.xaxis = maxis.XAxis(self)
        self.yaxis = maxis.YAxis(self)
        # Do not register xaxis or yaxis with spines -- as done in
        # Axes._init_axis() -- until HammerAxes.xaxis.cla() works.
        # self.spines['hammer'].register_axis(self.yaxis)
        self._update_transScale()

    def cla(self):
        """
        Override to set up some reasonable defaults.
```

Most popular python IDE (@SO)

new	ipython notebook
1	vim
2	PyDev
3	emacs
4	PyCharm
15	Spyder

Screenshot



Simple spectral analysis

An illustration of the Discrete Fourier Transform

$$X_k = \sum_{n=0}^{N-1} x_n e^{-\frac{2\pi i}{N}kn} \qquad k = 0, \ldots, N-1$$

using windowing, to reveal the frequency content of a sound signal.

We begin by loading a datafile using SciPy's audio file support:

```
In [1]: from scipy.io import wavfile
        rate, x = wavfile.read('test_mono.wav')
```

And we can easily view its spectral structure using matplotlib's builtin `specgram` routine:

```
In [2]: fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 4))
        ax1.plot(x); ax1.set_title('Raw audio signal')
        ax2.specgram(x); ax2.set_title('Spectrogram');
```

Which version?

Python

- Python 2.7, current default in python xy, enthought python.
- Python 3.x, use this when all your packages are available

How to install?

Windows

- Python x,y
- Enthought Python Distribution

Linux

- yum
- apt-get (some extra ppd)
- emerge

How to install?

OSX

- macports (from source)
- homebrew

Extra modules

- pip install module
- pypi.python.org
- python setup.py install
- `http://www.lfd.uci.edu/~gohlke/pythonlibs/`

Web development

- virtualenv, isolation
- buildout, isolation and deployment
- fabric, deployment

Where to get help?

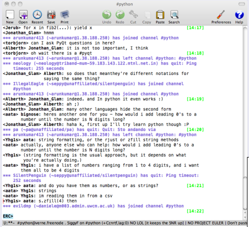
```
help(function) #inline help
pydoc # from command line
pydoc -p 10000 # webserver
```

most python modules have a sphinx doc website:

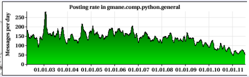
1. docs.python.org
2. docs.scipy.org
3. matplotlib.sourceforge.net
4. readthedocs.org

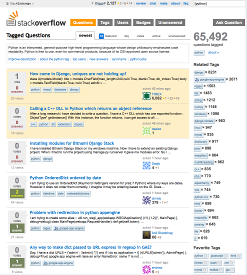
Communities

Python



```
<Jerub> for x in fib2(...): yield x                                    [14:17]
<Jonathan_Glam> hmmm
*** arunkumar413 (~arunkumar@1.38.188.250) has joined channel #python
<torbjorn> can I ask PyQt questions in here?
<Alberth> Jonathan_Glam: it is not too important, I think
<torbjorn> oh wait there is a #pyqt                                     [14:18]
*** arunkumar413 (~arunkumar@1.38.188.250) has left channel #python: #python
*** neology (~neology@triband-mum-59.183.143.122.mtnl.net.in) has quit: Ping
    timeout: 255 seconds
<Jonathan_Glam> Alberth: so does that meanthey're different notations for
                saying the same thing?
*** IllegalEagle (~seppy@unaffiliated/silentpenguin) has joined channel
    #python
*** arunkumar413 (~arunkumar@1.38.188.250) has joined channel #python
<Alberth> Jonathan_Glam: indeed. and In python it even works :)        [14:19]
<Jonathan_Glam> Alberth: ah ;)
<Alberth> Jonathan_Glam: many other languages hide the second form
<aata> bignose: heres another one for you - how would i add leading 0's to a
       number until the number is N digits long?
<Jonathan_Glam> Alberth: haha k, first up I'll try learn python though :P
*** pa (~pa@unaffiliated/pa) has quit: Quit: Sto andando via           [14:20]
*** arunkumar413 (~arunkumar@1.38.188.250) has left channel #python: #python
<Yhgls> aata: string formatting, or the rjust or zfill string methods
<aata> actually, anyone else who can help: how would i add leading 0's to a
       number until the number is N digits long?
<Yhgls> (string formatting is the usual approach, but it depends on what
        you're actually doing.)
<aata> Yhgls: i have a list of numbers ranging from 1 to 4 digits, and i want
       them all to be 4 digits
*** SilentPenguin (~seppy@unaffiliated/silentpenguin) has quit: Ping timeout:
    252 seconds
<Yhgls> aata: and do you have them as numbers, or as strings?          [14:21]
<aata> Yhgls: strings
<aata> Yhgls: im reading them in from a csv
<Yhgls> aata: s.zfill(4) then
*** evildmp (~daniele@m003.admin.uwcm.ac.uk) has joined channel #python
                                                                       [14:22]
ERC>
U:**-  #python@verne.freenode . SiggyF on #python (+Ccnrtf,lag:0) NO LOL [it keeps the SNR up] | NO PROJECT EULER | Don't past
```





Tagged Questions

Python is an interpreted, general-purpose high-level programming language whose design philosophy emphasizes code readability. Python is free to use, even for commercial products, because of its OSI-approved open source license.

improve description | about the python tag | top users | new answers | synonyms | python jobs

1 vote, 0 answers, 20 views — **How come in Django, uniques are not holding up?**
class A(models.Model): title = models.CharField(max_length=240,null=True, blank=True, db_index=True) body = models.TextField(blank=True, null=True) adinfo = ...
python mysql database django — asked 42 mins ago TIMEX 6,082 ●1 ●22 ●79

0 votes, 0 answers, 16 views — **Calling a C++ DLL in Python which returns an object reference**
After a long research i have decided to write a question. I have a C++ DLL which has one exported function : ObjectType* getInstance() With this instance, the function returns, i can get access to all ...
c++ python dll extension ctypes — asked 46 mins ago daalex 1

0 votes, 0 answers, 12 views — **Installing modules for Bitnami Django Stack**
I have installed Bitnami Django Stack on my windows machine. Now I have to extend an existing Django project. When I tried to run the project using manage.py runserver it gave me modules error. So I ...
python django — asked 1 hour ago Saqib 4 ●1

0 votes, 2 answers, 44 views — **Python OrderedDict ordered by date**
I am trying to use an OrderedDict (Raymond Hettingers version for pre2.7 Python) where my keys are dates. However it does not order them correctly, I imagine it may be ordering based on the ID. Does ...
python datetime date ordereddictionary — asked 1 hour ago jamesj 379 ●1 ●7

0 votes, 1 answer, 21 views — **Problem with redirection in python appengine**
I am trying to create some alias :: util.run_wsgi_app(webapp.WSGIApplication([(r"/(.{1,2})", MainPage)], debug=debug) class MainPage(webapp.RequestHandler): def get(self,token): ...
python regex google-app-engine — asked 1 hour ago Anil Shanbhag 66 ●9

0 votes, 1 answer, 8 views — **Any way to make dict passed to URL express in regexp in GAE?**
Say, I have a dict URLS = {'admin' : '/admin/(.*)'} and if I do so application = ([(r(URLS['admin']), AdminPage)], debug=True) google app engine will raise an error NameError: name 'r' is not ...
python google-app-engine — asked 1 hour ago andrew 5 ●2

65,492 questions tagged
python about »

Related Tags

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google-app-engine	× 2671
regex	× 1503
list	× 1483
string	× 1212
numpy	× 1148
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multithreading	× 862
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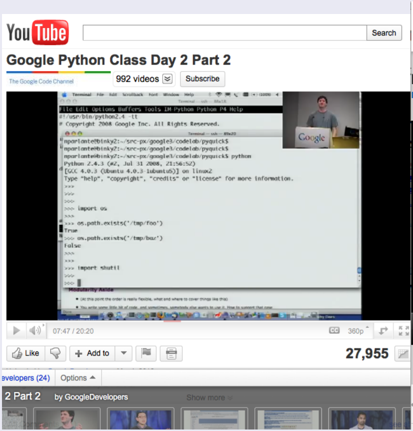
Communities

Python



Google Python Class Day 2 Part 2

The Google Code Channel

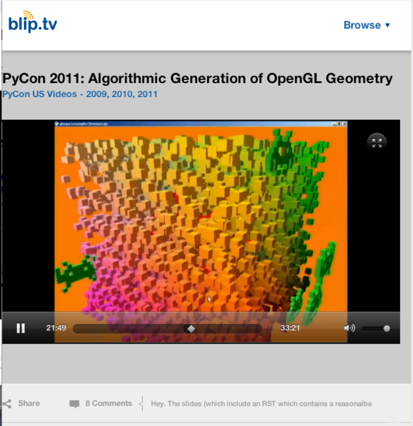
992 videos | Subscribe

```
File Edit Options Buffers Tools IM-Python Python P4 Help
#!/usr/bin/python2.4 -tt
# Copyright 2008 Google Inc. All Rights Reserved.

nparlante@binky2:~/src-px/google3/codelab/pyquick$
nparlante@binky2:~/src-px/google3/codelab/pyquick$
nparlante@binky2:~/src-px/google3/codelab/pyquick$ python
Python 2.4.3 (#2, Jul 31 2008, 21:56:52)
[GCC 4.0.3 (Ubuntu 4.0.3-1ubuntu5)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>>
>>>
>>> import os
>>>
>>> os.path.exists('/tmp/foo')
True
>>> os.path.exists('/tmp/baz')
False
>>>
>>>
>>> import shutil
>>>
>>>
```

Modularity Aside

- (At this point the order is really flexible, what and where to cover things like this)
- You write some little bit of code, and sometimes, somebody else wants to use it. How to support that one



PyCon 2011: Algorithmic Generation of OpenGL Geometry

PyCon US Videos - 2009, 2010, 2011

Hey. The slides (which include an RST which contains a reasonalbe

Stuff that's easy in python

comparisons

```
>>> x = 5
>>> 1 < x < 10
True
>>> 10 < x < 20
False
```

enumerating

```
a = [10, 20, 30, 40, 50]
for index, item in enumerate(a):
  print(index, item)

0 10
1 20
2 30
3 40
4 50
```

swapping

```
>>> a, b = 1, 2
>>> b,a = a,b
>>> a,b
(2, 1)
```

decorating

```python
@cache
def somethingdifficult():
  time.sleep(1000)
```

arguments

```
def point(x, y):
    # do some magic
point(3, 4)
point(3, y=4)
point(x=3, y=4)
a_tuple = (3, 4)
a_dict = {'y': 3, 'x': 2}
draw_point(*point_foo) # pass in each element
draw_point(**point_bar) # pass named elements
```

doctests

```
def add(x, y):
    """
    add 2 numbers
    >>> add(3, 4)
    7
    """
import doctest
doctest.testmod()
```

string formatting

```
"We are at {lat},{lon}".format(lat=52, lon=3)
```

useful collections

```
>>> a = {1,2,3,4}
>>> b = {3,4,5,6}
>>> a | b # Union
{1, 2, 3, 4, 5, 6}
>>> a & b # Intersection
{3, 4}
```

4

string methods

```
>>> "a" in "foobar"
True
>>> ";".join(["foo", "bar"])
"foo;bar"
```

4

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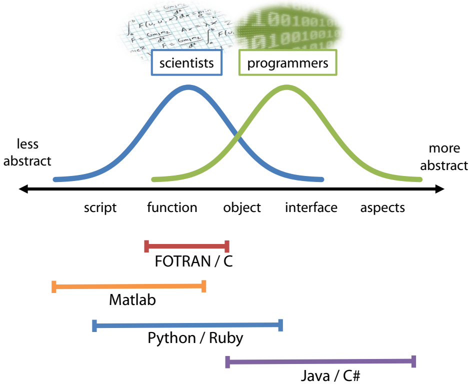
4 Python common surprises

5 Excersize

What aspects are relevant when choosing a language?

- People (What are the other people making?)
- Paradigma (Object Oriented, Procedural, Functional)
- Help (Documentation, community)
- Data types (dict, list, strings, numbers, matrices, vectors)
- Type system (int a = 1 vs a = 1)
- Syntax (Keywords, whitespace, braces)
- Libraries (What can you reuse of others?)

People and paradigma



Python

```
>>> x1 = 1 # integer
>>> x2 = 2.0 # float
>>> x3 = "three" # string
>>> x4 = [4,4,4,4] # list
>>> x5 = {5,"five"} # set
>>> x6 = {"six":6} # dictionary
>>> x7 = (4,4,4,4) # tuple
```

Matlab

```
>> x1 = int16(1) % integer (16bit)
>> x2 = 2 % double
>> x3 = "three" % string
>> x7 = {4,4,4,4} % cell
>> %x5 no matlab equivalent
>> x6 = struct('six',6) % not quite the same
>> %x7 no matlab equivalent
```

Data types

Python

```
>>> x1 = 1
>>> x1 == 1
True
>>> x1 + 1
2
>>> x1 + 2.0
3.0
>>> x1 + "three"
... unsupported +: 'int'
    and 'str'
>>> 2 * "three"
'threethree'
>>> x2 = 2.0
>>> x2 * "three"
... can't multiply sequence
     by 'float'
```

Matlab

```
>> x1=1;
>> x1==1;
>> x1+1;
>> x1+2.0;
>> x1+'three'
ans =
   117   105   115   102
         102
>> 2 * 'three'
ans =
   232   208   228   202
         202
>> 2.0*'three'
ans =
   232   208   228   202
         202
```

Data types

Python

```
>>> 9223372036854775807 + 1
9223372036854775808L
>>> 2/3  # 2//3 is explicit
      integer division
0 (0.67 in python3)
```

Matlab

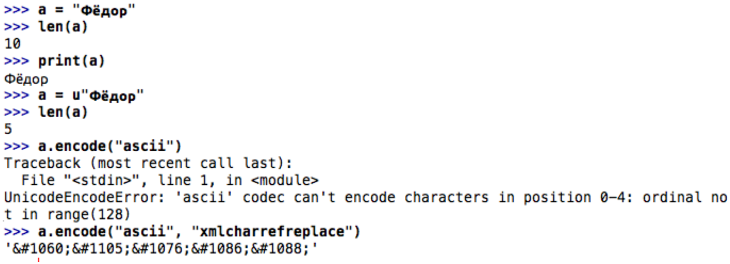
```
>> int64
    (9223372036854775807)+1
ans =
 9223372036854775807
>> int64(2)/int64(3)
ans =
   1
```

Python

```
>>> 2.0.is_integer()
True
>>> 2.5.as_integer_ratio()
(5, 2)
>>> 2.0.imag
0.0
```

Matlab

```
>> isinteger(2.0)
ans =
     0
>> [a,b] = rat(2.5)
a =          b =
     5            2
>> imag(2.0)
ans =
     0
```



```
>>> a = "Фёдор"
>>> len(a)
10
>>> print(a)
Фёдор
>>> a = u"Фёдор"
>>> len(a)
5
>>> a.encode("ascii")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
UnicodeEncodeError: 'ascii' codec can't encode characters in position 0-4: ordinal no
t in range(128)
>>> a.encode("ascii", "xmlcharrefreplace")
'&#1060;&#1105;&#1076;&#1086;&#1088;'
```

Data types

Python

```
>>> x1 = array([[1,2,3],
 [4,5,6]])
>>> x1
array([[1, 2, 3],
       [4, 5, 6]])
>>> x1[0,0]
1
>>> x1[1:,1:]
array([[5, 6]])
```

Matlab

```
>> x1 = [1 2 3; 4 5 6]
x1 =
     1     2     3
     4     5     6
>> x1(1,1)
ans =
     1

>> x1(2:end, 2:end)
ans =
    5     6
```

Data types

Python

```
>>> x1*x1
array([[ 1,  4,  9],
       [16, 25, 36]])
>>> x1.dot(x1.T)
array([[14, 32],
       [32, 77]])
```

3

Matlab

```
>> x1 .* x1
>> x1 * x1
```

Python

```
>>> print(np.zeros((100,100)))
[[ 0.   0.   0.  ...,   0.]
 [ 0.   0.   0.  ...,   0.]   3
...,
 [ 0.   0.   0.  ...,   0.]
 [ 0.   0.   0.  ...,   0.]]
```

Matlab

```
>> zeros(100)

ans =
                                          4
  Columns 1 through 13

     0     0     0     0
     0     0     0     0
     0     0     0     0                  9
```

Python

```
>>> a = np.array([[1,2,3],[4,5,6]])
>>> b = a[:2,:2]
>>> a[0,0] = 7
>>> print(a)
[[7 2 3]
 [4 5 6]]
>>> print(b)
[[7 2]
 [4 5]]
```

Matlab

```
a = [1 2 3; 4 5 6];
b = a(1:2,1:2);
a(1,1) = 7
a =
     7     2     3
     4     5     6
b
b =
     1     2
     4     5
```

Python

```
>>> a = 1
>>> a
1
>>> type(a)
<type 'int'>
```

Matlab

```
>> a = 1

a =


    1
>> whos a
  Name     Class


  a        double
```

Python

```python
import numpy
numpy.array([])
import numpy as np
np.array([])
from numpy import *
array([])
from numpy import array
array([])
```

Matlab

```matlab
% Matlab>7.6 +parallel/+gpu/GPUArray.m
import parallel.gpu.*
GPUArray([])
```

Python

```
>>> dir(1)
['__abs__', ..., 'bit_length', '
     conjugate',
'denominator', ...]
>>> inspect.getfile(inspect)
'/opt/local/.../python2.7/inspect.pyc'
>>> def a(a=1):
...  pass
>>> inspect.getcallargs(a)
{'a': 1}
>>> getframeinfo(currentframe())
Traceback(filename='<stdin>', lineno=1,
     ...)
```

Matlab

```
% no equivalent to dir (I think)
>> which which
built-in (/Applications/MATLAB_R2011a.
     app/toolbox/matlab/general/which)
>> ?object % only for objects
>> dbstack % only in debugging?
```

Exercise

1. Find out the methods of a string object
2. Use the split method to split up the string "1;2;3"

Python

Startup do nothing and shutdown time.

```
$time python -c"pass"
real      0m0.038s
user      0m0.022s
sys       0m0.012s
```

Matlab

Startup do nothing and shutdown time.

```
$ time matlab -r exit                    1
real      1m8.891s
user      0m11.889s (2s with
   -nodesktop -nojvm)
sys       0m3.184s
```

Other languages

C: 0.000s, Java: 0.3s, Perl 0.001s, Bash 0.001s

Python

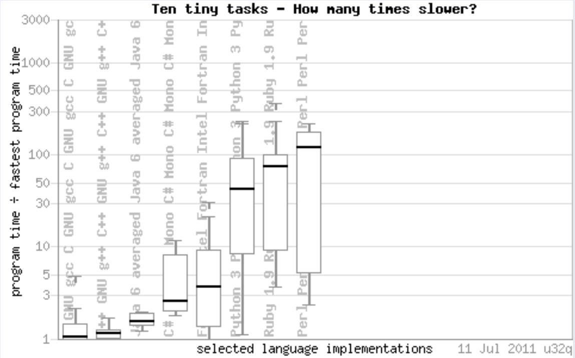
```
>>> setupcode = """
import numpy
x=numpy.zeros((1000,1000))
"""
>>> timeit.timeit('a=x.dot(
    x)',setupcode, number
    =10)
1.5948209762573242
```

Matlab

```
>> x=zeros(1000);
>> tic;for i=1:10;a=x*x;end
    ;toc
Elapsed time is 1.796690
    seconds.
```

Performance shootout

Benchmark (10 different problems)



shootout.alioth.debian.org

Laplace equation

Benchmark using different python techniques (500x500 grid for 100)

- Python: 1500.0s
- Python + NumPy: 29.3s
- Matlab: 29.0s
- Weave 2.3, 4.3, 9.5s
- Fortran 77: 2.9s
- Cython: 2.5s
- Pure C++: 2.16s

`www.scipy.org/PerformancePython`

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- Gis

4 Python common surprises

5 Excersize

- glue (mlabwrap: matlab, ctypes: dll's, fwrap: fortran90)
- plotting (2d: matplotlib, 3d: mayavi, graphs: networkx)
- gis (gdal: data + operations, pyproj: projections)
- data (pydap+netcdf: scientific, sqlalchemy: relational)

Talking to matlab

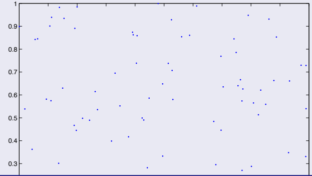
```
>>> import numpy
>>> from mlabwrap import mlab                                            2
>>> X = numpy.random.random((500,500))
>>> mlab.imshow(X)
array([[ 174.00366211]])
```

Talking to a dll

```
>>> import ctypes
>>> libfm = ctypes.CDLL('libdflow_fm.so')
>>> libfm.init()
>>> libfm.update()
>>> libfm.get_double_parameter("t")
0.1
>>> libfm.finalize()
```

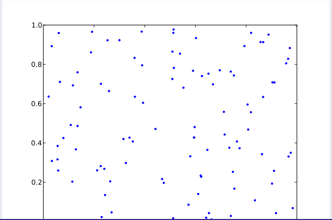
Matlab

```
>> h = plot(
    random('unif',0,1,1,100)
        ,
    random('unif',0,1,1,100)
        ,
    '.')
h =
  174.0028
>> saveas(h,'plot1matlab.
    pdf')
```

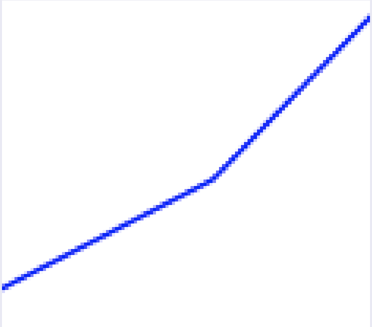


Python

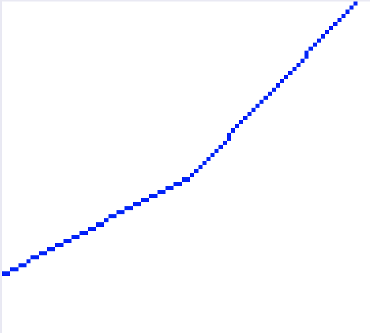
```
>>> plt.plot(random.uniform
    (0,1,100),
                random.uniform
                    (0,1,100),
                '.')
>>> plt.savefig('
    plot1python.pdf')
```



Python



Matlab

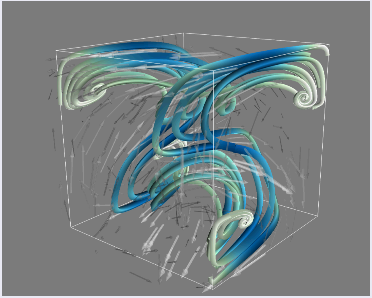


3d plotting

```
import numpy as np
x, y, z = np.mgrid[0:1:20j,
     0:1:20j, 0:1:20j]

u =     np.sin(np.pi*x) * np
    .cos(np.pi*z)
v = -2*np.sin(np.pi*y) * np
    .cos(2*np.pi*z)
w = np.cos(np.pi*x)*np.sin(
    np.pi*z) +
     np.cos(np.pi*y)*np.sin
         (2*np.pi*z)
mlab.quiver3(u,v,w)
mlab.flow(u,v,w)
```

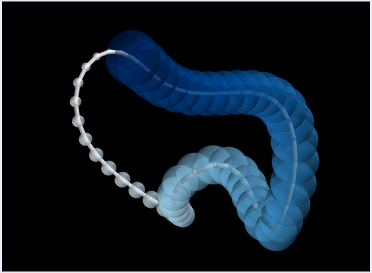
Mayavi plot



networkx

```
import networkx as nx
H = nx.cycle_graph(50)
G = nx.
    convert_node_labels_to_int
    (H)
# layout in 3d
pos = nx.spring_layout(G,
    dim=3)
mlab.points3d( ... )
mlab.pipeline.tube( ... )
```

Networkx plot using mayavi



networkx.lanl.gov

Python with GDAL

```
>>> dataset = ogr.Open('test.kml')
>>> layer = dataset[0]
>>> feature = layer[0]
>>> geometry = feature.geometry()
>>> geometry.GetPoint()
(-122.0822035425683, 37.42228990140251,
     0.0)
>>> geometry.Buffer(3.0).ExportToKML()
'<Polygon>
 <outerBoundaryIs><LinearRing>
   <coordinates>
    -119.082203542568294,37.422289901402507

      ...
```

KML

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml
     /2.2">
  <Placemark>
    <name>Simple placemark</name>
    <description>Attached to the ground.
          Intelligently places itself
       at the height of the underlying
            terrain.</description>
    <Point>
      <coordinates>
           -122.0822035425683,37.422289901402
           </coordinates>
    </Point>
  </Placemark>
</kml>
```

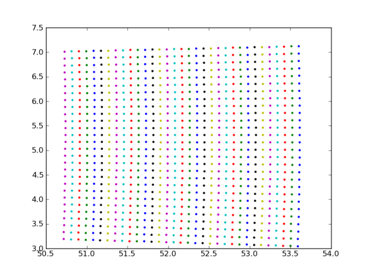
Pyproj

```
from pyproj import Geod
old = Geod(ellps='bessel')
new = Geod(ellps='WGS84')
ams_lat = 52.35
ams_lon = 4.917
nyc_lat = 40.+(47./60.)
nyc_lon = -73.-(58./60.)
args = ams_lon,ams_lat,nyc_lon,nyc_lat
az12,az21, olddist = old.inv(*args) # 5872 km
az12,az21, newdist = new.inv(*args) # 5873 km
```

Python

```
url =
'http://opendap.deltares.nl/thredds/
     dodsC/opendap/tno/ahn100m/mv100.nc
     '
import pydap.client
ds = pydap.client.open_url(url)
ds.keys()
['x', 'y', 'longitude', 'latitude', '
     epsg', 'wgs84', 'depth']
lat = ds['latitude']['latitude']
lon = ds['longitude']['longitude']
depth = ds['depth']['depth']
plt.plot(lat[::100,::100], lon
     [::100,::100], '.')
```

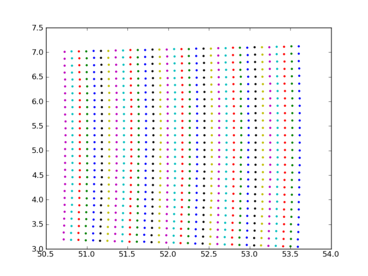
ahn lat/lon



Python

```
lat100 = lat[::100,::100]
lon100 = lon[::100,::100]
idx = reduce(np.logical_and, [
  lat100 < 52.8,
  lat100 > 52.6,
  lon100 > 5.7,
  lon100 < 6.1])
xidx, yidx = np.where(idx)
xslice = slice(xidx.min()*100,xidx.max()
     *100)
yslice = slice(yidx.min()*100,yidx.max()
     *100)
noplat = lat[xslice, yslice]
noplon = lon[xslice, yslice]
nopdep = depth[xslice, yslice]
```

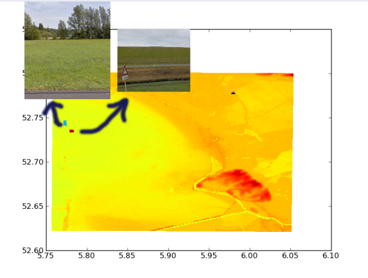
ahn lat/lon



Python

```
plt.pcolormesh(noplon,
    noplat, nopdep)
```

ahn lat/lon

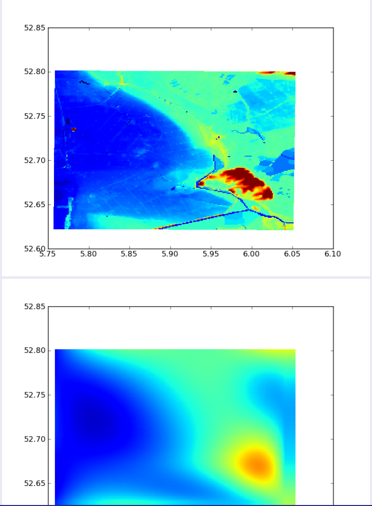


Can we use a rough height map

```
from scipy.interpolate import bisplrep,
     bisplev
roughdep = nopdep[::10,::10]
roughlat = noplat[::10,::10]
roughlon = noplon[::10,::10]
f = bisplrep(roughlon,roughlat,roughdep)
# expects increasing x and y
newdep = bisplev(noplon[:,0], noplat
      [0,::-1], f)[:,::-1].T
plt.pcolormesh(noplon[:,0], noplat[0,:],
      newdep, vmin=-5,vmax=5)
```

4

ahn 100/1000



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```
>>> "%s=%s" % (str(3*0.3),repr(3*0.3))
'0.9=0.8999999999999999'
```

```
x = 1.0 / 3
y = 0.333333333333
print x  #: 0.333333333333
print y  #: 0.333333333333
print x == y  #: False

repr prints too many digits:

print repr(x)  #: 0.33333333333333331
print repr(y)  #: 0.33333333333300003
print x == 0.3333333333333333  #: True
```

```
>>> def a(a=[]):
...     a.append(1)
...     print(a)
...
>>> a()
[1]
>>> a()
[1, 1]
```

```
>>> 01
1
>>> 07
7
>>> 08
  File "<stdin>", line 1
    08
     ^
SyntaxError: invalid token
```

```
>>> a=[[1,2,3]]*3
[[1, 2, 3],
 [1, 2, 3],
 [1, 2, 3]]
>>> a[0][0] = 2
[[4, 2, 3],
 [4, 2, 3],
 [4, 2, 3]]
```

```
>>> i = 1
>>> ++i                                   2
1
>>> i
1
```

```
a = 1
    a = 2
```

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Reading FM output

```
import netCDF4
% open dataset
ds = netCDF4.Dataset('fm.nc')
% inspect (dir, import inspect, ? in ipython, help)
```

Reading FM output

```
import netCDF4
# open dataset
ds = netCDF4.Dataset(’fm.nc’)
# inspect (dir, import inspect, ? in ipython, help)
# Read nodes
netnodex = ds.variables[’NetNode_x’][:]
netnodey = ds.variables[’NetNode_y’][:]
netnodez = ds.variables[’NetNode_z’][:]
netelemnode = ds.variables[’NetElemNode’][:]
netlink = ds.variables[’NetLink’][:]
```

Reading FM output

```
import matplotlib.pyplot as plt

# create figure with 1 axis
fig, ax = plt.subplots(1,1)
# plot on the axis
ax.plot(netnodex ,netnodey,'k.')
# Or plt.plot(...), or just plot(...)
```

Reading FM output

```
# Create split locations
splitidx = np.cumsum(np.r_[self.celltypes()][:-1])

# Convert to 1d filled idx
# Convert from 1 based to 0 based
idx = netelemnode[(~netelemnode.mask)]-1

# Split the netelemnodes by polygons
# x coordinate of cell polygon
xpoly = np.array(np.split(netnodex[idx], splitidx))
ypoly = np.array(np.split(netnodey[idx], splitidx))
zpoly = np.array(np.split(netnodez[idx], splitidx))
# combine all coordinates into a 3,ncell array
cellxycoords = np.concatenate([xpoly[:,np.newaxis],
    ypoly[:,np.newaxis],zpoly[:,np.newaxis]],1)
# transpose (not sure why I do it like this?)
cellcoords = [np.c_[xyz[0],xyz[1], xyz[2]] for xyz
```

Reading FM output

```
# We now have a list of polygons
cells = matplotlib.collections.PolyCollection(
    cellcoords)
# which we can add
ax.add_collection(cells)
# and rescale
ax.autoscale()
```

Reading FM output

```python
grid = UGrid.fromfile(filename)
cellcoords = [xy[:,:2] for xy in grid.cellcoords()]
fig, ax = plt.subplots(1,1)
ax.plot(grid.netnodex ,grid.netnodey,'k.')
cells = matplotlib.collections.PolyCollection(
    cellcoords)
ax.add_collection(cells)
ax.autoscale()
```

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Static and docs

- **tools** Html/css/js editor, apache, wiki, cms
- **goal** Serve non changing information

Batch

tools Templates, scripts, teamcity, matlab/python/R, apache

goal Produce semi-static (incidental changes) hard to produce content

Dynamic

tools	Python, Web application framework (pyramid), Database (OpenDAP, Postgis)
goal	Generate dynamic content (plots, kml, services)

Dynamic

interaction	expose functions
speed	response less than 0.01s
sessions	per user information

Excercise

`http://docs.pylonsproject.org/projects/pyramid/en/latest/`

Excercise

1. Install
2. Creating a pyramid project
3. Make a viewer for a dataset on opendap.deltares.nl