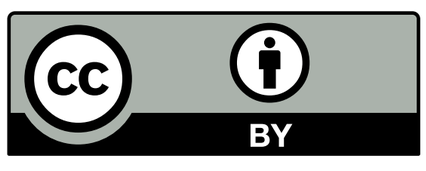
Python

Digital Audio Coding



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Learn Python 2.7

Tutorials

http://docs.python.org/tutorial/

http://www.diveintopython.net

http://tinyurl.com/OCW-python

Scientific Computing

http://tinyurl.com/python-Matlab

http://www.scipy.org/NumPy_for_Matlab_Users

http://mathesaurus.sourceforge.net/matlab-numpy.html

First Program

file hello.py

```
message = "Hello World !"
print message
```

Shell / Console

```
$ python hello.py
Hello World !
```

Python Interpreter

```
>>> import hello
Hello World !
>>> hello.message
'Hello World !'
```

Spyder

```
>>> runfile("hello.py")
Hello World !
>>> message
'Hello World !'
```

Primitive Types

```
>>> length = 411852
>>> frequency = 44.1
>>> magic = "RIFF"
>>> stereo = True
>>> author = None
```


int
float
str
bool
(NoneType)

Containers

Lists

```
>>> items = [4, 5, 6]
>>> items.append(7)
>>> items.insert(0, 3)
>>> items
[3, 4, 5, 6, 7]
>>> items[2]
5
>>> items.pop()
7
```

Dicts

```
>>> p = {"heads": 0.5, "tails": 0.5}
>>> p["edge"] = 0.01
>>> p["heads"] = 0.5 - p["edge"]
>>> p
{'tails': 0.5, 'edge': 0.01, 'heads': 0.49}
>>> p.get("stolen by a magpie", 0.0)
0.0
```

Control Structures

```
if x > 0.0:
    sign = 1
elif x < 0.0:
    sign = -1
else:
    sign = 0
```

```
while not_ready():
    wait(10.0)
```

```
for i in [1, 2, 3, 4, 5]:
    print i
```

SEE ALSO: **pass, continue, break.**

Iteration

```
>>> items = [4, 5, 6]
>>> len(items)
3
>>> for item in items:
...     print item,
4 5 6
```

```
>>> p = {"heads": 0.5, "tails": 0.5}
>>> len(items)
2
>>> for key in p:
...     print key,
heads tails
```

SEE ALSO: **enumerate, zip**

Tests

```
>>> n = 5
>>> 0 < n <= 7
True
>>> one  = n == 1
>>> odd  = bool(n % 2)
>>> odd and not one
True
```

```
>>> numbers = [0, 1, 2, 3]
>>> numbers == [0, 1, 2, 3]
True
>>> numbers is [0, 1, 2, 3]
False
>>> numbers is None or \
...   numbers == []
False
```

Functions

define

```
def fib(n, start=(0, 1)):
    result = []
    a, b = start
    while a < n:
        result.append(a)
        a, b = b, a+b
    return result
```

call

```
>>> numbers = fib(10)
>>> numbers
[0, 1, 1, 2, 3, 5, 8]
>>> numbers = fib(20, start=(5,8))
>>> numbers
[5, 8, 13]
```

Objects

```
>>> complex
<type 'complex'>
>>> c = complex(2.0, 1.0)
>>> c
(2+1j)
>>> c.imag
1.0
>>> c.conjugate()
(2-1j)
```

TYPE / CLASS

CONSTRUCTOR (CALL)

INSTANCE

ATTRIBUTE

METHOD (CALL)

Objects: Definition

```
class complex(object):
  def __init__(self, real=0.0, imag=0.0):
    self.real = real
    self.imag = imag
```

TYPE / CLASS

CONSTRUCTOR

ATTRIBUTES

```
def conjugate(self):
    return complex(self.real, -self.imag)
```

METHOD

```
def __str__(self):
    return "({0} + j{1})".format(self.real, self.imag)
```

METHOD (SPECIAL)

Files and Bytes

filename = "07MomentofClarity.mp3"

```
>>> file = open(filename)
```

or

```
>>> url = "http://stereo.lu/grey/" + filename
>>> import urllib
>>> file = urllib.urlopen(url)
```

```
>>> raw = file.read(); file.close()
```

```
>>> raw[0:128]
"ID3\x02\x00\x00\x00\x0fBwTT2\x00\x00\x12\x00Moment
of ClarityTAL\x00\x00\x0f\x00The Grey AlbumTYE\x00\x00\x05
\x002004CM1\x00\x00\x11\x00The STFU Man WCRTRK\x00\x00
\x03\x007\x00TP1\x00\x00\x19\x00Jay-Z + DJ Danger Mouse"
```


```
>>> copy = open("moment-of-clarity.mp3", "w")
>>> copy.write(raw)
>>> copy.close()
```

WAVE Files

(RIFF, Linear 16-bit PCM)

```
>>> import audio.wave as wave
>>> data = wave.read("sound.wav")
>>> data
array([[ 1., 0.99803566, ..., 0.99803566]])
>>> wave.write(data, "sound-copy.wav")
```

```
>>> wave.write([0, 1, 2], "mono.wav")
>>> wave.write([[0, 1, 2], [0, 1, 2]], "stereo.wav")
>>> wave.write([-1.0, 0.0, 1.0], "float.wav")
```

Bit Streams

```
from audio.bitstream import BitStream
```

Create: `stream = BitStream()`

Write: `stream.write(data, type)`

Read: `data = stream.read(type, n)`

```
>>> stream = BitStream()
>>> stream.write(True, bool)
>>> stream.write(False, bool)
>>> stream.write(-128, int8)
>>> stream.write("AB", str)
>>> stream.read(bool, 2)
[True, False]
>>> stream.read(int8, 1)
array([-128], dtype=int8)
>>> stream.read(str, 2)
"AB"
```

stream

```
1
10
1010000000
1010000000010000010100001010000010
1000000001000001010000010
0100000101000010
```

NumPy / Scipy

Scientific Computing in Python

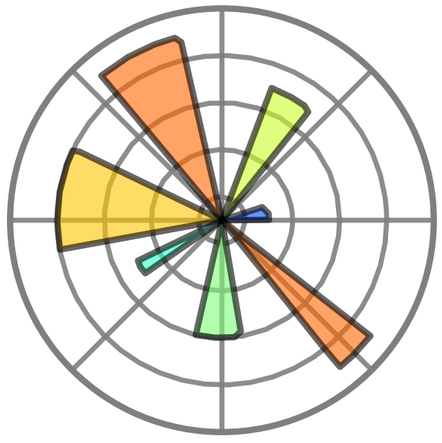
N-dimensional **ARRAY** object

+

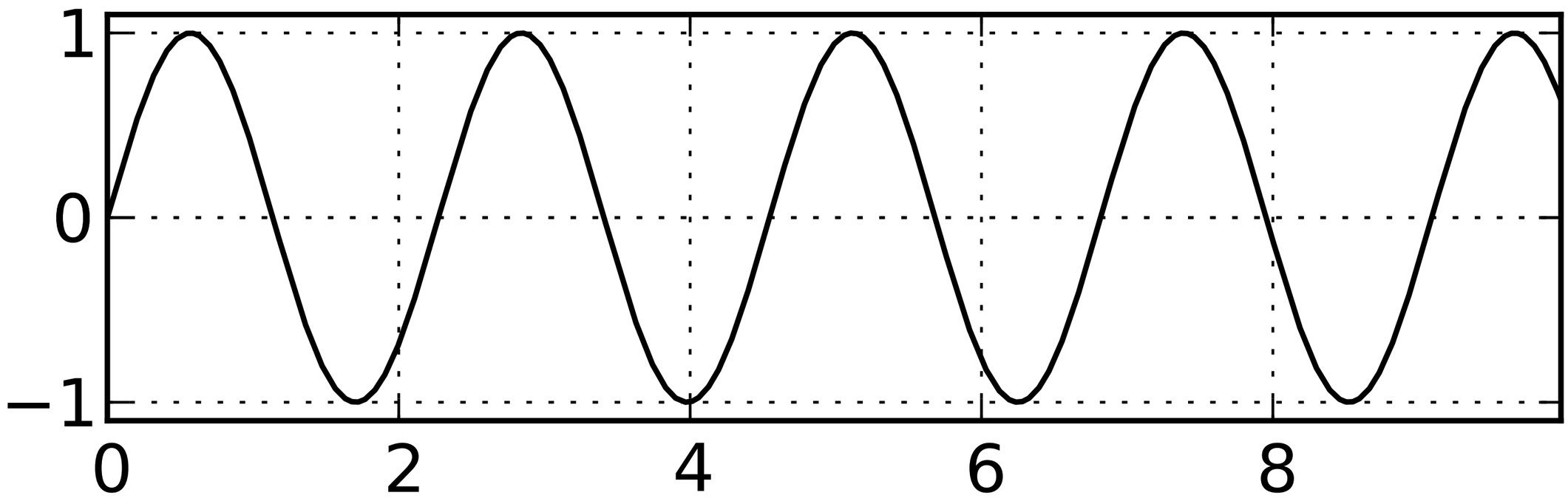
- Linear Algebra,
- Fourier Analysis,
- Random Numbers,
- Optimization,
- etc.

http://www.scipy.org/more_about_SciPy

Matplotlib



```
from pylab import *
f = 440.0; df = 44100.0; dt = 1.0 / df
t = r_[0.0:0.01: dt]; x = sin(2*pi*f*t)
plot(1000*t, x)
```



http://matplotlib.sourceforge.net/

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urce Run Tools View ?

/home/boisgera/DISKS/VOYAGER/SANDBOX/ACSAN

a/DISKS/VOYAGER/SANDBOX/ACSAN/filter_banks.py

filter_banks.py | perceptual.py | resample.py

```
-8

u"Sébastien Boisgérault <Sebastien.Boisgerault@mines-paristech.fr>"
 "trunk"

port *


pe low-pass filter to prepare for 32-filter banks,
 the appropriate matrices,
se filter bank implementation and check inverse (perfect reco.)
a real signal. Performance issues ?
nt basic noise injection, say 8-bit / sample (would be 352 kb/sec,

ll that, couple with noise mask model:
eger approx. of the optimal bit number, non-pow
oding)

ith "resample". Put in 'filter' module ?
fc, T=1.0):

filter factory

s
-

ilter cutoff frequency.
 optional
eference sampling period, defaults to 1.0.



on
alls `h(n)` returns an array of length `n`.


 T
<= fr <= 0.5:
ate  = "invalid cutoff frequency fc={0}: "
ate += "0 <= fc <= 0.5*T={1} does not hold."
ge = template.format(fc, 0.5*T)
 ValueError(message)

nt((n + 0.5) / 2)
2 * fr * numpy.sinc(2 * fr * numpy.arange(-p, p+1))
% 2 != 1:
```

Outline

- filter_banks
- low_pass

Object inspector

Object convolve

convolve(a, v, mode='full')
Function of numpy.core.numeric module

Returns the discrete, linear convolution of two one-dimensional sequences.

The convolution operator is often seen in signal processing, where it models the effect of a linear time-invariant system on a sig
theory, the sum of two independent random variables is distributed according to the convolution of their individual distributions.

Parameters

a : (N,) array_like
First one-dimensional input array.
v : (M,) array_like
Second one-dimensional input array.
mode : {'full', 'valid', 'same'}, optional

'full':
By default, mode is 'full'. This returns the convolution at each point of overlap, with an output shape of (N+M-
of the convolution, the signals do not overlap completely, and boundary effects may be seen.
'same':
Mode same returns output of length `max(M, N)`. Boundary effects are still visible.
'valid':
Mode valid returns output of length `max(M, N) - min(M, N) + 1`. The convolution product is only given for p
signals overlap completely. Values outside the signal boundary have no effect.

See Also

array
Discrete, linear convolution of a and v.

Object inspector | Variable explorer | File explorer

Python 1

```
Python 2.6.6 (r266:84292, Sep 15 2010, 15:52:39)
Type "copyright", "credits" or "license" for more information.

IPython 0.10 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object'. ?object also works, ?? prints more.

  Welcome to pylab, a matplotlib-based Python environment.
  For more information, type 'help(pylab)'.

In [1]:
```

Console | History log

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

M17x: ~/... [/home/boisgera/DI... Spyder

Spyder

http://packages.python.org/spyder/

array = data + shape + type

```
>>> a0 = array(1.0)
>>> a1 = array([1, 2,3])
>>> a2 = array([[1.0+1.0j], [1.0-1.0j]])
```

```
>>> shape(a0)
()
>>> shape(a1)
(3,)
>>> shape(a2)
(2, 1)
```

```
>>> a0.dtype
dtype('float64')
>>> a1.dtype
dtype('int32')
>>> a2.dtype
dtype('complex128')
```

Transform Array Shape

reshape

```
>>> reshape(a0, (1,1))
array([[ 1.]])
>>> reshape(a1, (3,1))
array([[1],
       [2],
       [3]])
>>> reshape(a2, (2,))
array([ 1.+1.j,  1.-1.j])
```

flatten

```
>>> ravel(a0)
array([ 1.])
>>> ravel(a1)
array([1, 2, 3])
>>> ravel(a2)
array([ 1.+1.j,  1.-1.j])
```

Transform Array Data Type

create

```
>>> a0 = array(1, dtype=float64)
>>> a1 =  array([int8(1), int16(2), int32(3)])
>>> a2 = array([1.0, 1.0]) + 1j * array([1.0, -1.0])
```

convert

```
>>> a0.astype(int8)
array(1, dtype=int8)
>>> a1.astype(float32)
array([ 1.,  2.], dtype=float32)
```

```
>>> a2.astype(uint16)
array([[1],
       [1]], dtype=uint16)
```

array: build from blocks

basic arrays

```
>>> zeros((1,2))
array([[ 0.,  0.]])
>>> ones((3,))
array([ 1.,  1.,  1.])
>>> arange(5)
array([0, 1, 2, 3, 4])
```

```
>>> arange(0, 6, 2)
array([0, 2, 4])
>>> linspace(0.0, 1.0, 3)
array([ 0. ,  0.5,  1. ])
>>> logspace(-1, 1, 3)
array([  0.1,   1. ,  10. ])
```

```
>>> identity(2)
array([[ 1.,  0.],
       [ 0.,  1.]])
>>> eye(2,k=1)
array([[ 0.,  1.],
       [ 0.,  0.]])
```

concatenate

```
>>> r_[zeros(2), ones(2), 2*ones(2)]
array([ 0.,  0.,  1.,  1.,  2.,  2.])
>>> c_[zeros(2), ones(2), 2*ones(2)]
array([[ 0.,  1.,  2.],
       [ 0.,  1.,  2.]])
```

array: indexing + slicing

```
>>> a = zeros((2,2))
>>> a[0, 1] = 1.0
>>> a[1, :] = [1.0, 2.0]
>>> a
array([[ 0.,  1.],
       [ 1.,  2.]])
>>> a[1, 1]
2.0
>>> a[0, :]
array([ 0.,  1.])
```

```
>>> a = arange(10)
>>> a[1 : 9 : 2]
array([1, 3, 5, 7])
>>> a[ : : -1]
array([9, 8, 7, 6, 5, 4, 3, 2, 1, 0])
>>> a[3 : -3]
array([3, 4, 5, 6])
>>> a[[0, 1, 3, 6, 9]]
array([0, 1, 3, 6, 9])
>>> a[a>5]
array([6, 7, 8, 9])
```

array: ufuncs + linear algebra

```
>>> sin([0, pi/2])
array([ 0.000...,  1.000...])
>>> exp(arange(3))
array([ 1.      ,  2.718...,  7.389... ])
>>> array([0.0, 1.0]) + ones(2)
array([ 1.,  2.])
>>> array([0.0, 1.0]) * ones(2)
array([ 0.,  1.])
>>> floor([0.0, 0.5, 1.0])
array([ 0.,  0.,  1.])
```

```
>>> A = array([[1,2], [3,4]])
>>> x = array([-1, 1])
>>> dot(A, x)
array([1, 1])
>>> dot(x, A)
array([2, 2])
>>> dot(x, x)
2
>>> dot(A, ones((2,2)))
array([[ 3.,  3.],
       [ 7.,  7.]])
```