Python and NumPy

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No Declaration

```python
a = 1
print a
```

```
1
```

```python
print b
```

```
NameError
Traceback (most recent call last)
<ipython-input-2-ab3a5d8f1075> in <module>()
----> 1 print b

NameError: name 'b' is not defined
```
Everything is an object

```python
a = 1
print a
a = 'abc'
print a
a = [1, 2, 3]
print a
```

```
1
abc
[1, 2, 3]
```
Numbers are immutable

```python
a = 1
b = a
b += a
print(a, b)
```

1 2
Strings

```python
a = 'hello'
print a
b = a + ' ' + 'world'
print b
print b.index('o')
print b.count('o')
print b[6:8]
print b[6:]
print b[0:10:2]
print b*2
```

```
print 'There are %d bananas' % 3
print 'There are %d bananas and %d apples' % (3, 10)
print 'There are {} bananas and {} apples'.format(7, 5)
```

There are 3 bananas
There are 3 bananas and 10 apples
There are 7 bananas and 5 apples

```python
x = 'abc'
y = x
y += 'd'
print x, y
print len(x)
print str(123)
```

abc abcd
3
123
Lists

```python
a = [1, 'any', -3.0]
b = ['object', 'can', ['be', 'added'], 'to', 'list']
c = a + b
print(c)
print(c[2:4])
print(c[0] + c[2], c[-3][1])
x = a
x += ['lists are mutable']
print(a)
print(x)
```

```
[1, 'any', -3.0, 'object', 'can', ['be', 'added'], 'to', 'list']
[-3.0, 'object']
-2.0 added
[1, 'any', -3.0, 'lists are mutable']
[1, 'any', -3.0, 'lists are mutable']
```
Tuples

- Tuples are immutable versions of lists
- One strange point is the format to make a tuple with one element

```python
x = 10
a = (1, 2, x)
print a
b = a
b += ('abc',)
print a, b

(1, 2, 10)
(1, 2, 10, 'abc')
```
Dictionaries

• Key-Value structure

```python
a = {1: 'hello', 'two': 42, 'blah': [1, 2, 3]}
print a[1], a['two']
print 'two' in a
a['two'] = 2
print a['two']
a['three'] = 3
del a[1]
del a['blah']
print a

hello 42
True
2
{'three': 3, 'two': 2}
```
import random

a = random.random()  # random value 0 ~ 1
b = random.random()
print a, b

if a < 0.3 and b >= 0.8:
    s = 'pororo'
elif a > b or a > 0.9:
    s = 'pikachu'
elif not a*b < 0.5:
    s = 'elsa'
else:
    s = 'stitch'

print s
print len(s) <= 4

0.265674050893 0.936769174654
pororo
False
my_list = []
for i in xrange(10):
    my_list.append(i)
print my_list
print [v*2 for v in my_list]
print {'key is ' + str(v): 'value is ' + str(v**2) for v in my_list[4:7]}

[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 2, 4, 6, 8, 10, 12, 14, 16, 18]
{'key is 6': 'value is 36', 'key is 5': 'value is 25', 'key is 4': 'value is 16'}
Functions

```python
def sum_over(some_list):
    a = 0
    for v in some_list:
        a += v
    return a

print [k for k in xrange(10, 20)]
print sum_over(xrange(10, 20))

def what_is_happening():
    print a

what_is_happening()

[10, 11, 12, 13, 14, 15, 16, 17, 18, 19]
145
19```
Functions (cont.)

```python
def f(a, b = 2, c = 3):
    return a + b + c

print f(1)
print f(1, -1)
print f('a', 'b', 'c')
```

```python
def fibo(n, fin):
    if fin(n):
        return 1
    else:
        return fibo(n - 1, fin) + fibo(n - 2, fin)

def fin(n):
    return n <= 1

print fibo(10, fin)
```

6
3
abc

89
Lambda

```python
f = lambda x,y : x + y
print f(2, 3)

foo = [2, 18, 9, 22, 17, 24, 8, 12, 27]
print filter(lambda x: x % 3 == 0, foo)

print map(lambda w: len(w), 'It is raining cats and dogs'.split())
```

5
[18, 9, 24, 12, 27]
[2, 2, 7, 4, 3, 4]
With

```python
# set things up
f = open("x.txt")
try:
    # do something with data
    data = f.read()
finally:
    f.close()

with open("x.txt") as f:
    data = f.read()
    # do something with data
```
NumPy

- NumPy is the fundamental package for scientific computing with Python. It contains among other things:
  - a powerful N-dimensional array object
  - sophisticated (broadcasting) functions
  - useful linear algebra, Fourier transform, and random number capabilities
Basic

```python
import numpy as np

A = np.array([[1, 2], [3, 4]])
B = np.array([[1, 0], [0, 1]])  # identity matrix
print(A.shape)
print(A.ndim)
print(A + B - 1)
print(A* B)
print(np.dot(A, B))
```

```
(2, 2)
2
[[1 1]
 [2 4]]
[[1 0]
 [0 4]]
[[1 2]
 [3 4]]
```
Broadcasting

```python
import numpy as np

A = np.array([[1, 2], [3, 4]])
v = np.array([1, 2])  # vector
print(v.shape)
print(A + v)
print(np.log(A))
```

```plaintext
(2,)
[[2 4]
 [4 6]]
[[ 0.       0.69314718]
 [5.91526741 1.38629436]]
```
Indexing

```python
import numpy as np

v = np.arange(10)*3
print(v[1])
print(v[[1]])
print(v[[0, 2, 4]])
idx = np.arange(10)
np.random.shuffle(idx)
print(v[idx[0:3]]) # randomly selects three values in 'v'
```

3
[3]
[ 0  6 12]
[ 3  9 21]
Indexing

```python
import numpy as np

A = np.arange(100).reshape(4, 5, 5)
print A[0]
print A[0, 0:4, 0:2]
print A[0, 2, :]

[[ 0  1  2  3  4]
 [ 5  6  7  8  9]
 [10 11 12 13 14]
 [15 16 17 18 19]
 [20 21 22 23 24]]

[[ 0  1]
 [ 5  6]
 [10 11]
 [15 16]]

[10 11 12 13 14]
```
Indexing with Boolean Arrays

```python
import numpy as np

a = np.arange(6).reshape(2,3)
b = a > 3
print(b)
print(a[b])

a[b] = -1
print(a)
```

[[False False False]
 [False True True]]
[4 5]
[[ 0  1  2]
 [ 3 -1 -1]]
Sum

```python
import numpy as np
A = np.arange(24).reshape(2, 3, 4)
print A.sum()
print A.sum(axis=0)
print A.sum(axis=1)
print A.sum(axis=2)
```

```python
import numpy as np
A = np.arange(24).reshape(2, 3, 4)
print A[::, 0, 0]
print A[0, ::, 0]
print A[0, 0, :]
```

```
[ 0 12]
[ 0  4  8]
[ 0  1  2  3]
```
There are so many things to learn!!

• Good Luck! 😊