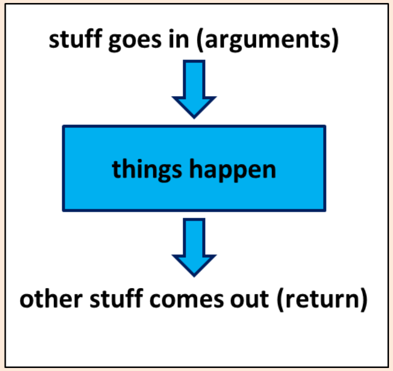
Modules

Genome 559: Introduction to Statistical and Computational Genomics

Elhanan Borenstein

A quick review

- **Functions**:
  - Reusable pieces of code (write once, use many)
  - Take arguments, “do stuff”, and (usually) return a value
  - Use to organize & clarify your code, reduce code duplication



stuff goes in (arguments)

things happen

other stuff comes out (return)

- Defining a function:

```
def <function_name>(<arguments>):
     <function code block>
     <usually return something>
```

- Using (calling) a function:

```
<function defined here>

<my_variable> = function_name(<my_arguments>)
```

A quick review

- Functions have their own namespace
  - Local variables inside the function are invisible outside
- Arguments can be of any type!
  - Number and strings
  - Lists and dictionaries
- Return values can be of any type!
  - Number and strings
  - Lists (as a way to return multiple values)

```
def CalcSumProd(a_list):
    ...
    return [sum, prod]
```

- **Pass-by-reference vs. pass-by-value**
- Default arguments

```
def printMulti(text, n=3):
    ...
```

Modules

- Recall your makeDict function:

```
def makeDict(fileName):
    myFile = open(fileName, "r")
    myDict = {}
    for line in myFile:
        fields = line.strip().split("\t")
        myDict[fields[0]] = float(fields[1])
    myFile.close()
    return myDict
```

- This is in fact a very useful function which you may want to use in many programs!
- So are other functions you wrote (e.g., makeMatrix)

Modules

- A module is a file that contains a collection of **related** functions.
- You have already used several built-in modules:
  - e.g.: sys, math
- Python has numerous standard modules
  - Python Standard Library: (http://docs.python.org/library/)

- **It is easy to create and use your own modules:**
  - **JUST PUT YOUR FUNCTIONS IN A SEPARATE FILE!**

Importing Modules

- To use a module, you first have to import it into your namespace
- To import the entire module:

  `import module_name`

my_prog.py

```
import utils
import sys

Dict1 = utils.makeDict(sys.argv[1])
Dict2 = utils.makeDict(sys.argv[2])

Mtrx = utils.makeMatrix(“blsm.txt”)


…
```

utils.py

```
# This function makes a dictionary
def makeDict(fileName):
   myFile = open(fileName, "r")
   myDict = {}
   for line in myFile:
      fields = line.strip().split("\t")
      myDict[fields[0]] = float(fields[1])
   myFile.close()
   return myDict

# This function reads a 2D matrix
def makeMatrix(fileName):
    < ... >
```

The dot notation

- Why did we use **`utils.makeDict()`** instead of just **`makeDict()`**?

- Dot notation allows the Python interpreter to organize and divide the namespace

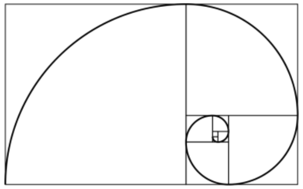
Sample problem #2 from previous class

- Make the following improvements to your function:

1. Add two **optional** arguments that will denote alternative starting values (instead of 0 and 1).
   - fibonacci(10) → [0, 1, 1, 2, 3, 5, 8, 13, 21, 34]
   - fibonacci(10,4) → [4, 1, 5, 6, 11, 17, 28, 45, 73, 118]
   - fibonacci(10,4,7) →[4, 7, 11, 18, 29, 47, 76, 123, 199, 322]

2. Return, in addition to the sequence, also the ratio of the last two elements you calculated (how would you return it?).

3. **Create a module "my_math" and include your function in this module. Import this module into another program and use the function.**



Recall Solution #2 from previous class

```
# Calculate Fibonacci series up to n
def fibonacci(n, start1=0, start2=1):
    fib_seq = [start1, start2];
    for i in range(2,n):
        fib_seq.append(fib_seq[i-1]+fib_seq[i-2])

    ratio = float(fib_seq[n-1])/float(fib_seq[n-2])
    return [fib_seq[0:n], ratio]

seq, ratio = fibonacci(1000)
print "first 10 elements:",seq[0:10]
print "ratio:", ratio
# Will print:
# first 10 elements:[0, 1, 1, 2, 3, 5, 8, 13, 21,34]
# ratio: 1.61803398875
```

Sample problem #2.1

- Now, Create a module “my_math” and include your function in this module. Import this module into another program and use the function.

Solution #2.1

my_math.py

```
# Calculate Fibonacci series up to n
def fibonacci(n, start1=0, start2=1):
    fib_seq = [start1, start2];
    for i in range(2,n):
        fib_seq.append(fib_seq[i-1]+fib_seq[i-2])

    ratio = float(fib_seq[n-1])/float(fib_seq[n-2])
    return [fib_seq[0:n], ratio]
```

my_prog.py

```
import my_math
seq, ratio = my_math.fibonacci(1000)
print "first 10 elements:",seq[0:10]
print "ratio:", ratio
# Will print:
# first 10 elements: [0, 1, 1, 2, 3, 5, 8, 13, 21, 34]
# ratio: 1.61803398875

fib = my_math.fibonacci # creating a local name
print fib(5,12,14)
# Will print:
# [[12, 14, 26, 40, 66], 1.65]
```

Challenge problem

- Write your own sort function!
- Sort elements in ascending order.
- The function should sort the input list **in-place** (i.e. do not return a new sorted list as a return value; the list that is passed to the function should itself be sorted after the function is called).
- As a return value, the function should return the number of elements that were in their appropriate ("sorted") location in the original list.
- You can use any sorting algorithm. Don't worry about efficiency right now.

Challenge solution 1

```
def swap(a_list, k, l):
        temp = a_list[k]
        a_list[k] = a_list[l]
        a_list[l] = temp

def bubbleSort(a_list):
    n = len(a_list)
    a_list_copy = [] # note: why don't we use assignment
    for item in a_list: a_list_copy.append(item)

    # bubble sort
    for i in range(n):
        for j in range(n-1):
            if a_list[j] > a_list[j+1]:
                swap(a_list, j, j+1) # note: in place swapping

    # check how many are in the right place
    count = 0
    for i in range(n):
        if a_list[i] == a_list_copy[i]: count += 1
    return count
```

This is the actual sorting algorithm. Simple!

```
>>> ls = [1, 3, 2, 15, 7, 4, 8, 12]
>>> print bubbleSort(ls)
2
>>> print ls
[1, 2, 3, 4, 7, 8, 12, 15]
```

Challenge solution 1

```
def swap(a_list, k, l):
        temp = a_list[k]
        a_list[k] = a_list[l]
        a_list[l] = temp

def bubbleSort(a_list):
    n = len(a_list)
    a_list_copy = [] # note: why don't we use assignment
    for item in a_list: a_list_copy.append(item)

    # bubble sort
    for i in range(n):
        for j in range(n-1-i):
            if a_list[j] > a_list[j+1]:
                swap(a_list, j, j+1) # note: in place swapping

    # check how many are in the right place
    count = 0
    for i in range(n):
        if a_list[i] == a_list_copy[i]: count += 1
    return count
```

Why is this better?
Why is this working?

```
>>> ls = [1, 3, 2, 15, 7, 4, 8, 12]
>>> print bubbleSort(ls)
2
>>> print ls
[1, 2, 3, 4, 7, 8, 12, 15]
```