

# Lecture 13

## Python: containers, loops, script arguments



Course: Practical Bioinformatics (BIOL 4220)  
Instructor: Michael Landis  
Email: [michael.landis@wustl.edu](mailto:michael.landis@wustl.edu)



# Lecture 13 outline

Last time: variables, operators,  
if-statements, functions

This time: Python (2 of 4)

## Python

- containers
- loops
- script arguments

# Containers

**Containers** are variables that store multiple values (often of the same type) called **elements**

Container elements are generally accessed through the **index** operator, `[idx]`

```
>>> # create list called `x`
>>> x = [ 10, 20, 30 ]
>>> # what is the value of `x`?
>>> x
[10, 20, 30]
>>> # access the index-0 element
>>> x[0]
10
```

# Lists

**List** elements are indexed by integers;  
lists can be modified after creation (*mutable*)

```
>>> x = [ 10, 20, 30 ] # create list called `x`
>>> x # what is the value of `x`?
[10, 20, 30]
>>> x[0] = 11 # set value of index-0 element
>>> x[1:3] = [ 22, 33 ] # set values of index-1,2 elements
>>> x[3] = 55 # access the index-3 element
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: list index out of range
>>> x.append(55) # append element to end of list
>>> x.insert(3, 44) # insert value 44 after 3rd index
>>> x
[11, 22, 33, 44, 55]
```

# Tuples

**Tuples** are integer-indexed containers, but unlike lists, their contents cannot be modified (*immutable*)

```
>>> x = ( 10, 20, 30 ) # create tuple called `x`
>>> x                  # what is the value of `x`?
(10, 20, 30)
>>> x[0]
11
>>> x[0] = 11          # set value of index-0 element
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support item assignment
```

# Dictionaries

**Dictionaries** contain *key-value* pairs;  
keys are used to index values

```
>>> x = { 'a':1, 'b':2 } # create dictionary with two key-values
>>> x                    # report value of dictionary
{'a': 1, 'b': 2}
>>> x['a']              # retrieve dictionary value with key 'a'
1
>>> x['c'] = 3          # assign value 3 to key 'c'
>>> x.keys()            # print container of sorted keys
dict_keys(['a', 'b', 'c'])
>>> x.values()          # print container of sorted values
dict_values([1, 2, 3])
>>> x.values()[0]       # dict_values can't be accessed by index!?
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'dict_values' object does not support indexing
>>> list(x.values())[0] # typecast dict_values as list
1
```

## Alternatives for initializing lists and dicts

```
>>> x = [] # creates an empty list
>>> x
[]
>>> x = [0]*10 # creates size-10 list with values 0
>>> x
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
>>> x = {} # creates empty dict
>>> x
{}
>>> x = dict.fromkeys(['a','b'], 0) # creates keys with values 0
{'a': 0, 'b': 0}
```

## Container elements may differ in type

```
>>> x = [ 1, 0.1 ]
>>> x
[1, 0.1]
>>> type(x)
<class 'list'>
>>> type(x[0])
<class 'int'>
>>> type(x[1])
<class 'float'>
>>> x = [ 'a', [ 1, 0.1, {'a':0, 'b':[0]*2} ], False ]
>>> x
['a', [1, 0.1, {'a': 0, 'b': [0, 0]}], False]
```

# for-loops over list elements

Executes code block while iterating  
over each element in a container

```
# create list
x = [ 'a', 'b', 'c', 'd', 'e' ]
# get list length
n = len(x)
# loop over each element in list
for i in x:
    # code block
    s = i + ' (? out of ' + str(n) + ')'
    print(s)

# done
print('...done!')
```

```
a (? out of 5)
b (? out of 5)
c (? out of 5)
d (? out of 5)
e (? out of 5)
...done!
```

*output*

*code*



# for-loops over indices

The *range(n)* function creates a list of integers with values  $[0, 1, \dots, n-1]$

```
# create list
x = [ 'a', 'b', 'c', 'd', 'e' ]
# loop over each integer in range
for i in range(len(x)):
    # code block
    s = x[i] + ' (' + str(i)
    s += 'out of ' + str(len(x)) + ')'
    print(s)

# done
print('...done!')
```

```
a (1 out of 5)
b (2 out of 5)
c (3 out of 5)
d (4 out of 5)
e (5 out of 5)
...done!
```


*output*

# for-loops over dictionary items

Iterate over *(key, value)* **items** in a dictionary

```
# create dictionary
x = {'a':1, 'b':2, 'c':3}
# loop over all items in dictionary, while
# storing key and value for each item
for key,value in x.items():
    # code block
    s = 'key = ' + str(key) + ';'
    s += 'value = ' + str(value)
    print(s)

# done
print('...done!')
```



*code*

```
key = a; value = 1
key = b; value = 2
key = c; value = 3
...done!
```

*output*

# enumerate

The *enumerate(x)* function assigned pairs an index to each iterable element in the container: *(index, value)*

```
# create dictionary
x = [10, 20, 30]
# create loop
for i,v in enumerate(x):
    # code block
    s = 'iteration = ' + str(i) + '; '
    s += 'value = ' + str(v)
    print(s)

# done
print('...done!')
```

code

```
iteration = 0; value = 10
iteration = 1; value = 20
iteration = 2; value = 30
...done!
```

output

# Nested containers and loops

```
# create array of input
x = [[ 1,  4,  9],
      [16, 25, 36],
      [49, 64, 81]]

# create empty array for output
y = []

# iterate over rows
for i,row in enumerate(x):
    # create empty row for results
    y.append([])
    # iterate over column-values
    for j,val in enumerate(row):
        # get square root of input value
        y_ij = int( val**(1/2) )
        # store result in y[i][j]
        y[i].append(y_ij)

# print square roots
print(y)
```

code

Containers may be *nested* as elements within larger containers

For-loops may also be *nested* to process all containers, subcontainers, etc.

```
[[1, 2, 3],
 [4, 5, 6],
 [7, 8, 9]]
```

output

# System arguments

Python programs can accept user arguments through the system argument vector, `sys.argv`

```
# load system library
import sys

# print each argument
print('sys.argv contents:')
for i,v in enumerate(sys.argv):
    print(' ' + str(i) + ' : ' + str(v))

# done
print('...done!')
```

Pass arguments to Python when calling the script from shell

```
$ python example.py 10 20
sys.argv contents:
0 : example.py
1 : 10
2 : 20
...done!
```

# Overview for Lab 13