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Lecture 8B:

Python: containers, loops, script arguments

Practical Bioinformatics (Biol 4220)
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Lecture 8B outline

1. Containers
2. Loops
3. Script arguments
4. Lab 8A overview

Containers

Containers are variables that store multiple values 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 length-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 with lists

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!')
```

for-loops over indices

The *range(n)* function creates a list of integers with values *[0, 1, ..., 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] + ' (out of ' + str(len(x)) + ')'
    print(s)

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

for-loops over dictionaries

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) + '; value = ' + str(value)
    print(s)

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

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) + '; value = ' + str(v)
    print(s)

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

Nested containers and loops

Contains may be *nested* as elements within larger containers; for-loops may also be *nested* to process all containers, subcontainers, etc.

```
# 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)
```

System arguments

Python programs can user accept arguments into 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 Unix

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

Lab 8B

github.com/WUSTL-Biol4220/home/labs/lab_08B.md