An Overview of Python Programming

Lesson 3: Iteration and Lists

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Outline

- Lists
- Tuples & Dictionaries
- Loops

Lists in Python

- Multiple values can be grouped together into lists
- Just use square brackets [ ]
- Values can have different datatypes

```
a = 1.0
b = [ 1, 2, a, 4]
print(b[0])
print(b[2])
print(b)
```

Indexed starting with '0'

```
print(b)
print (b[2] is a)
a = 2
print ( b[2] is a)
print ( b[2] , a)
```

memory management: values copied – once they have to be…

Nested (Multi-dimensional) Lists

- We can have lists of lists:
- Indexing uses two square brackets

```
a = [ 1 , 2]
b = [ 3 , 4]
c = [ a , b , 5 ]
```

Note:

- c[0] and c[1] are 2-element lists
- c[2] is a scalar.

```
print( c[ 0 ] )      # a
print( c[ 1 ] )      # b
print( c[ 0 ][ 0 ] ) # a[0]
print( c[ 0 ][ 1 ] ) # a[1]
print( c[ 1 ][ 0 ] ) # b[0]
print( c[ 1 ][ 1 ] ) # b[1]
print( c[ 2 ] )      # 5
```

Nested Lists: Memory

- Be careful!
- Python **does not** automatically **copy** lists…

```
a = [ 1 , 2 ]
b = [ 3 , 4 ]
c = [ a , b ]
```

```
print( a[ 0 ][ 0 ] , c[ 0 ][ 0 ] )
c[ 0 ][ 0 ] = 4
print( a[ 0 ][ 0 ] , c[ 0 ][ 0 ] )
```

Cloning Lists

- If we want distinct copies, use the slice operator " : "

```
a = [ 1, 2]
b = a
b[0] = 5
print(a[0], b[0])
```

Aliased!

```
a = [ 1, 2]
b = a[:]
b[0] = 5
print( a[0], b[0] )
```

```
a = [ 1, 2]
b = [ 3, 4]
c = [ a[:] , b[:] ]
```

```
print( a[ 0 ][ 0 ] , c[ 0 ][ 0 ] )
c[ 0 ][ 0 ] = 4
print( a[ 0 ][ 0 ] , c[ 0 ][ 0 ] )
```

Sublists

- We can **copy** a portion of a list using the slice operator

```
a = [ 1 , 2 , 3 , 4 , 5 ]
b = a[ 2 : 4 ]
print( len( b ) )
print( b[ 0 ] , b[ 1 ] )
```

len function
returns number of elements in a list

Note:

- b is [a[2] , a[3]]
- b *is not* [a[2], a[3], a[4]]

Lists and functions

- Avoid unwanted side-effects by passing list clones to a function

```
def mod0( a ):
        a[ 0 ] = 2
```

Side Effect

```
b = [ 0 , 0 ]
mod0( b )
print( b )  # [ 0 , 2 ]
```

No Side Effect

```
b = [ 0 , 0 ]
mod0( b[ : ] )
print( b )  # [0, 0]
```

append & del

- The append method grows a list
- The del statement deletes elements or sublists

```
a = [ ]  # init empty list
a.append( 1 )
print( len( a ) ,  a)
a.append( 4 )
print( len( a ) , a)
a.append( 8 )
print( len( a ) , a)
```

```
a = [ 4 , 8 , 12 , 13]
print( a )
del a[ 0 : 2 ]
print( a )
del a[ 0 ]
print( a )
```

List Initialization: Replication

- Occasionally useful to initialize a list with known value
- Use the * operator to replicate values from an existing list or list expression

1-dimensional list

```
a = [ 1 , 2 ]
b = 3 * a
print( b )
```

b is [1, 2, 1, 2, 1, 2]

Nested list

```
a = [ 1 , 2 ]
b = 3*[ a ]
print( b )
```

b is [[1, 2], [1, 2], [1, 2]]

List Initialization: Replication

- Extends naturally to higher dimensions

```
a = [ [ 1 , 2 ] , [ 3 , 4 ] ]
b = 2 * a
print( b )
```

b is [[1, 2], [3, 4], [1, 2], [3, 4]]

```
a = [ [ 1,2], [ 3, 4] ]
b = 2*[a]
print(b)
```

b is [[[1, 2], [3, 4]], [[1, 2], [3, 4]]]

List-like Objects: Tuples

- Similar to Lists, but immutable (can't change values)
- Use ( ) instead of [ ] during creation (only)

```
a = ( 1 , 2 )
print( a[ 0 ] )
a[ 0 ] = 2  # not allowed
```

```
a = ( 1 , 2)
b = ( 3 , 4)
c = [ a , b]
c[ 0 ] = 1        # OK – modifying list c
c[ 1 ][ 0 ] = 2   # not OK – modifying tuple element
```

Can have lists of tuples

Tuple Assignment

- Useful Python feature
- tuple *expression* 1 = tuple OR tuple expression 2
- values on right mapped 1-to-1 to values on left

```
( a, b, c ) = (1, 2, 3)
```

Create a,b,c and assign them values

```
tmp = a
a = b
b = tmp
```

```
( a , b) = (b , a)
```

Swap values

List-like Objects: Dictionaries

- Key-value pairs
- Key (i.e., the index) must be immutable
- Initialize with { } (not [ ] or ( ))

```
var = { }
var['Apple'] = 43
var[8] = [ 'Orange', 2, 14.0]
```

```
print (var[ 'Apple' ])
```
43

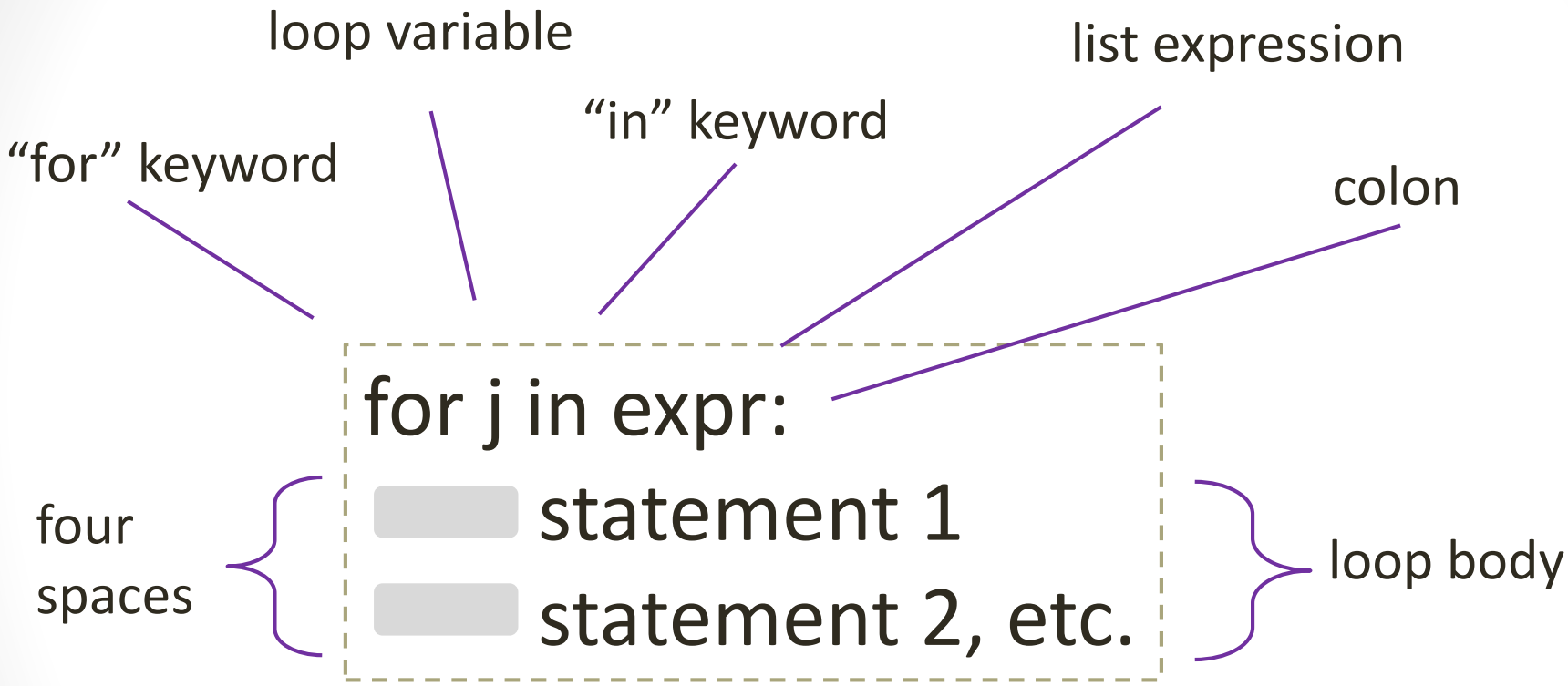
```
print( var[ 8 ] )
```
['Orange', 2, 14.0]

```
print( var[ 8 ][ 2 ] )
```
14.0

Loops in Python

- Three commonly used loop constructs:
  - for
  - while
  - enumerate

For Loop Syntax



For each element in expr:

- Assign its value to j
- Execute statements in loop body

For Loop Examples

- Try these:

```
a = [1,2,3]
for j in a:
        print(j)
```

```
a = (1,2,3)
for j in a:
        print(j)
```

```
a = [ [1,2] , [3,4] ]
for j in a:
        print(j)
```

```
a = ['Peter', 'Paul', 'Mary']
for j in range(3):
        print( j )
        print( a[ j ] )
```

range function

- range(n)
  - Integer sequence 0 through n-1
- range(m,n)
  - Integer sequence m through n-1

Nesting Loops

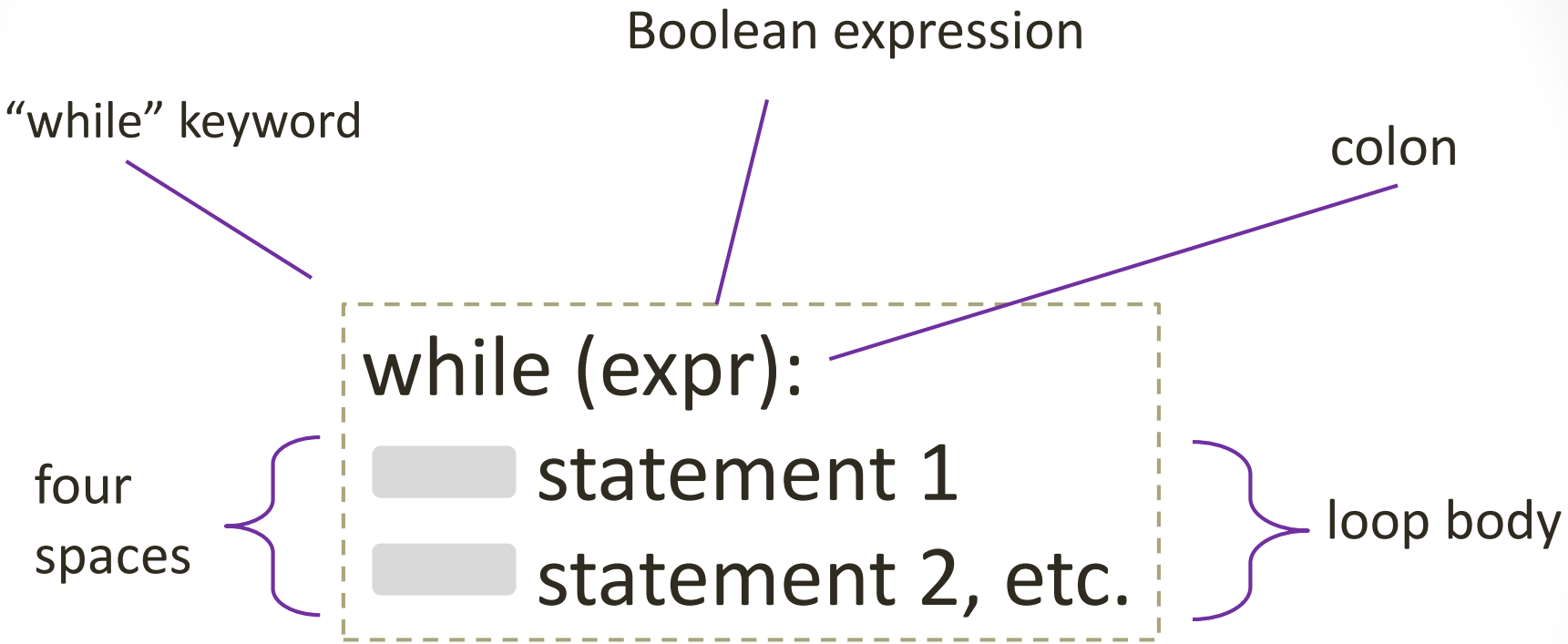
- Just like in any other language…
- Try this

```
a = [ [ 1 , 2 , 0] , [ 3 , 4 , 7] ]
alen = len(a)
for j in range(alen):
        jlen = len(a[ j ])
        for k in range(jlen):
                print( j , k , ' : ', a[ j ][ k ] )
```

Exercise 1: For Loops

- Write a function that:
  - Accepts a single parameter, assumed to be a list of numbers
  - Returns the sum of those numbers
- Be sure to use a for loop
- Hint: don’t forget about the len function

While Loop Syntax



As long as expr is True:

- Execute statements in loop body

While Loop Examples

- Try these:

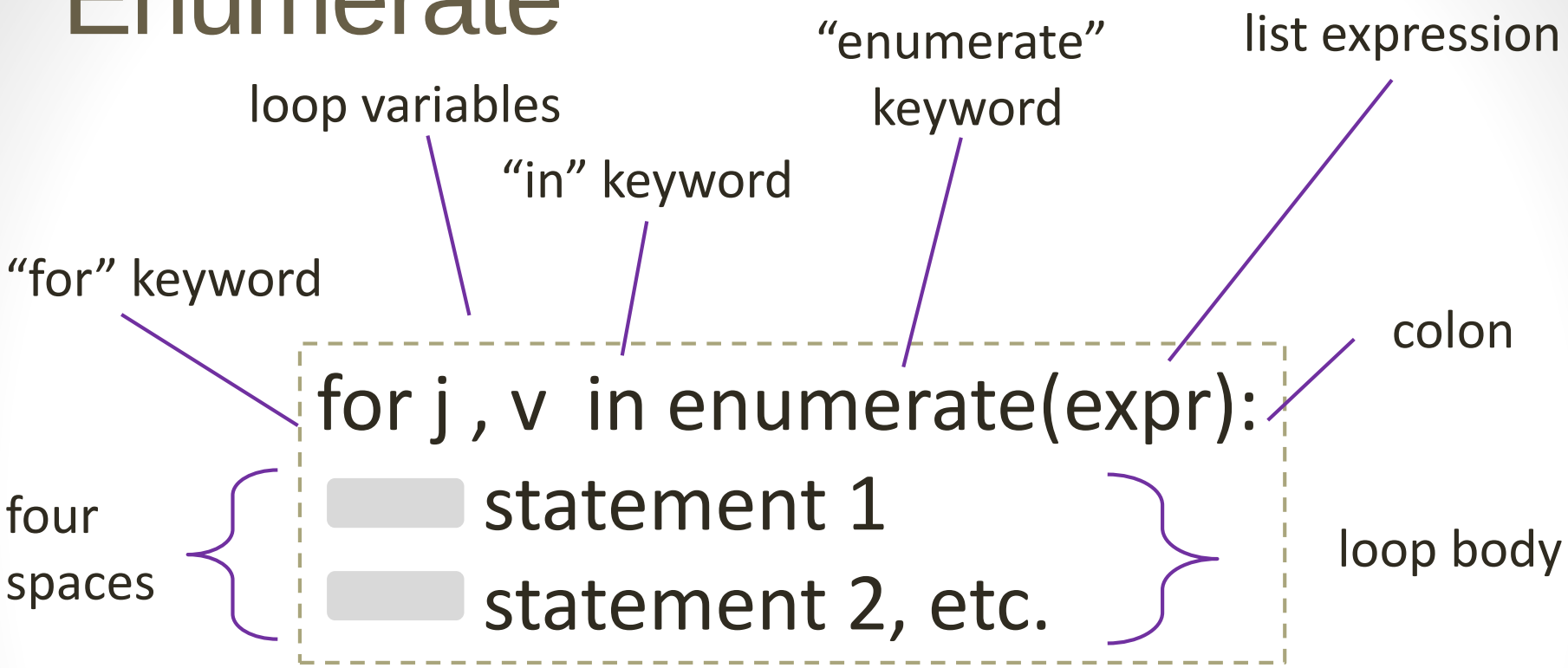
```
a = [ 1 , 2 , 3 ]
j = 0
n = len( a )
while( j < n ):
        print( a[ j ] )
        j += 1
```

```
a = [ [ 1 , 2 ] , [ 3 , 4 ] ]
n = len( a )
j = 0
while ( j <  n ):
        print( a[ j ] )
        for b in a[ j ]:
                print( b )
        j += 1
```

Exercise 2: While Loops

- Write a function that:
  - Accepts two list parameters *a* and *b*
  - Returns the sum of a[j]*b[j] for all elements j in a and b.
  - Replaces b[j] with b[j]*a[j] as a *side effect*
- Be sure to use a while loop

Enumerate



For each element in expr:

- Assign its value to v
- Assign a value of 0 through len(expr)-1 to j
- Execute statements in loop body

Enumeration Example

- Try this:

```
a = [ ‘John’ , 45.0 , 85 ]
for j, v in enumerate(a):
        print( j, v )
```

Exercise 3: Enumerate

- Write a function that:
  - Accepts a single parameter, assumed to contain a list of string values
  - Returns a list of string values with their element index appended.
  - For example:
    - Input = [‘Hello’ , ‘There’]
    - Return value = [‘Hello 0’, ‘There 1’]
- Be sure to use enumerate