http://www.cs.cornell.edu/courses/cs1110/2021sp

Lecture 10: **Lists and Sequences**

(Sections 10.0-10.2, 10.4-10.6, 10.8-10.13)

CS 1110

Introduction to Computing Using Python

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Announcements

- ***Only if*** you cannot write Prelim 1 in person on Mar 30 at 6:30pm Ithaca time or have SDS exam accommodations, do the CMS "assignment" called "Prelim 1 alternate format/time request" (both Parts A & B). Request deadline is Mar 16 11:59pm. Legitimate reasons needed to request online format and/or alternative time
  - Conflicting exam listed on University Evening Prelim Schedule
  - You are not in Ithaca

Tonight

- "Go to" lab weekly!! Stay on track. Great student:staff ratio!
- A2 due Mar 19 at 11:59pm
- Window to submit A1 revisions closes Mar 20 at 11:59pm

Sequences: Lists of Values

String

- s = 'abc d'

0	1	2	3	4
a	b	c		d

- Put characters in quotes
  - Use \' for quote character
- Access characters with []
  - s[0] is 'a'
  - s[5] causes an error
  - s[0:2] is 'ab' (excludes c)
  - s[2:] is 'c d'
- len(s) → 5, length of string

List

- x = [5, 6, 5, 9, 15, 23]

0	1	2	3	4	5
5	6	5	9	15	23

- Put values inside [ ]
  - Separate by commas
- Access **values** with []
  - x[0] is 5
  - x[6] causes an error
  - x[0:2] is [5, 6] (excludes 2nd 5)
  - x[3:] is [9, 15, 23]
- len(x) → 6, length of list

Sequence is a name we give to both

Lists Have Methods Similar to String

```
x = [5, 6, 5, 9, 15, 23]
```

- `<list>.index(<value>)`
  - Return position of the value
  - **ERROR** if value is not there
  - `x.index(9)` evaluates to 3
- `<list>.count(<value>)`
  - Returns number of times value appears in list
  - `x.count(5)` evaluates to 2

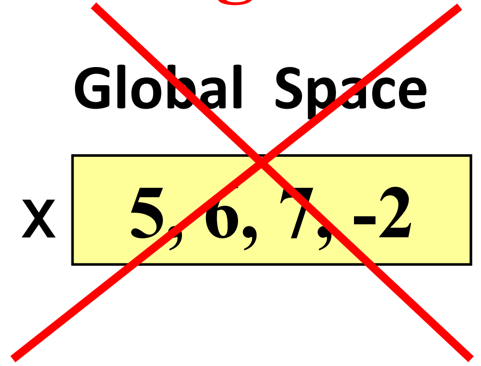
But to get the length of a list you use a function, not a class method:

`len(x)`

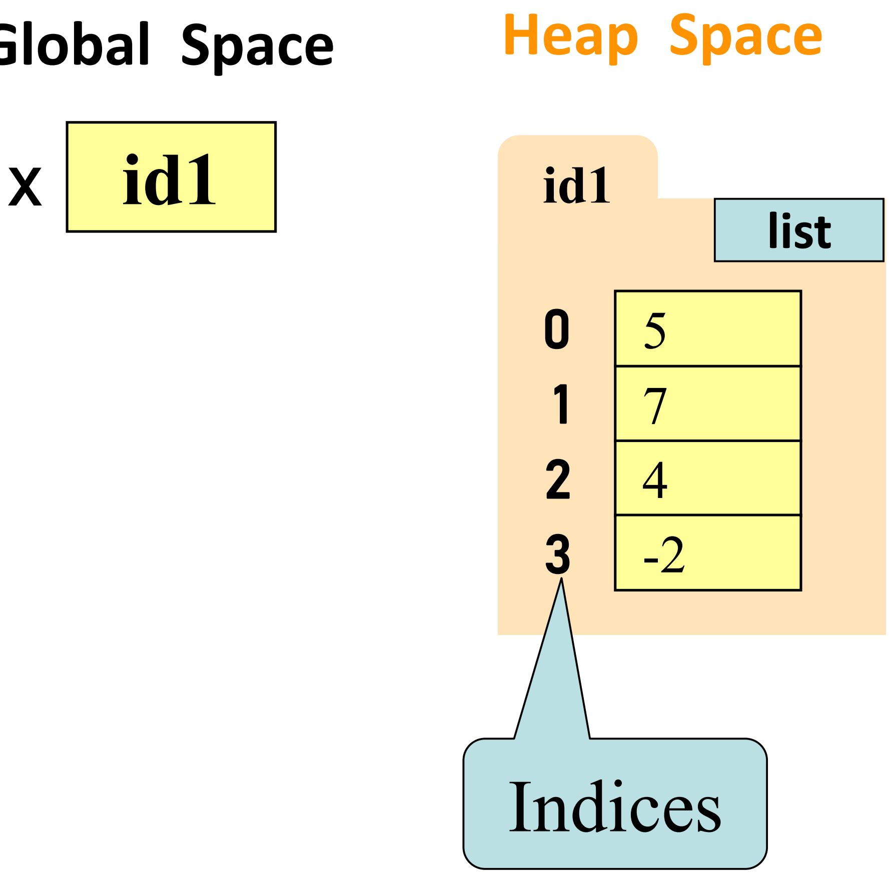
~~`x.len()`~~

Representing Lists

Wrong:



Correct:

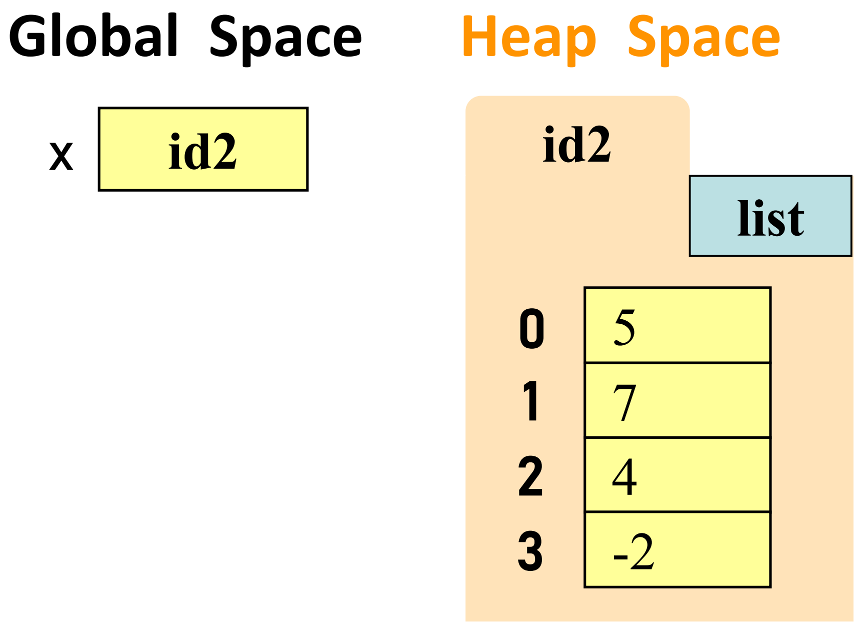


x = [5, 7, 4,-2]

Lists vs. Class Objects

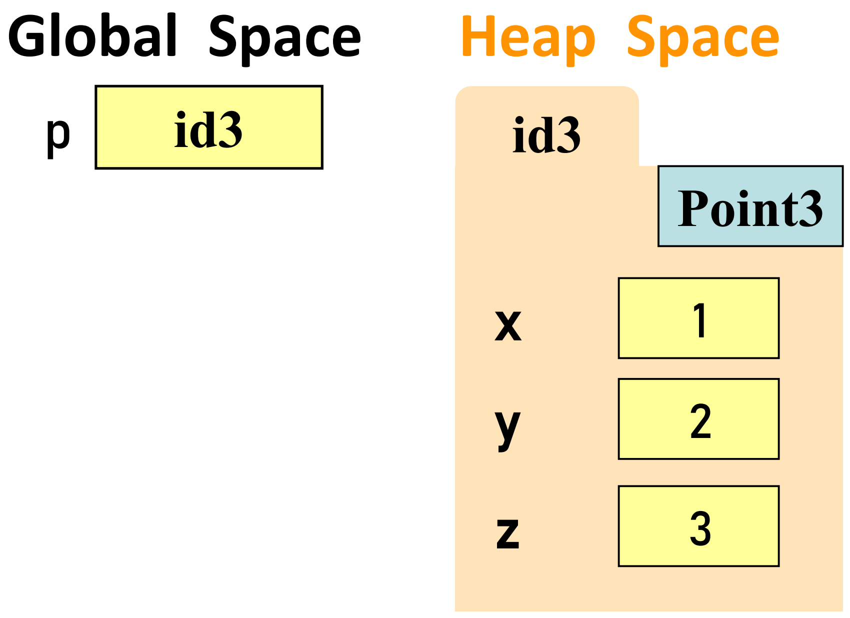
List

- Attributes are indexed
  - Example: x[2]



Objects

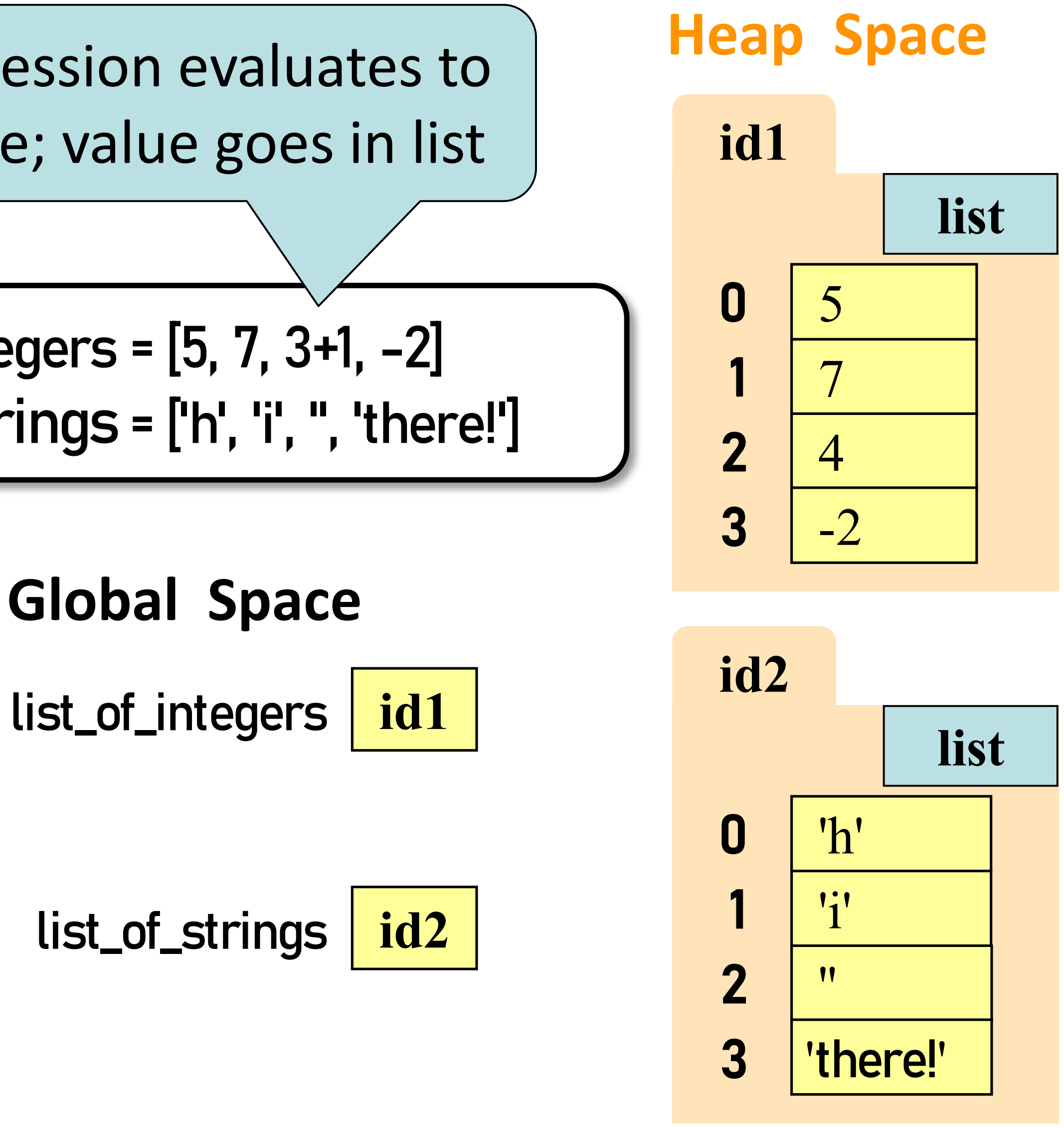
- Attributes are named
  - Example: p.x



Lists Can Hold Any Type

Expression evaluates to value; value goes in list

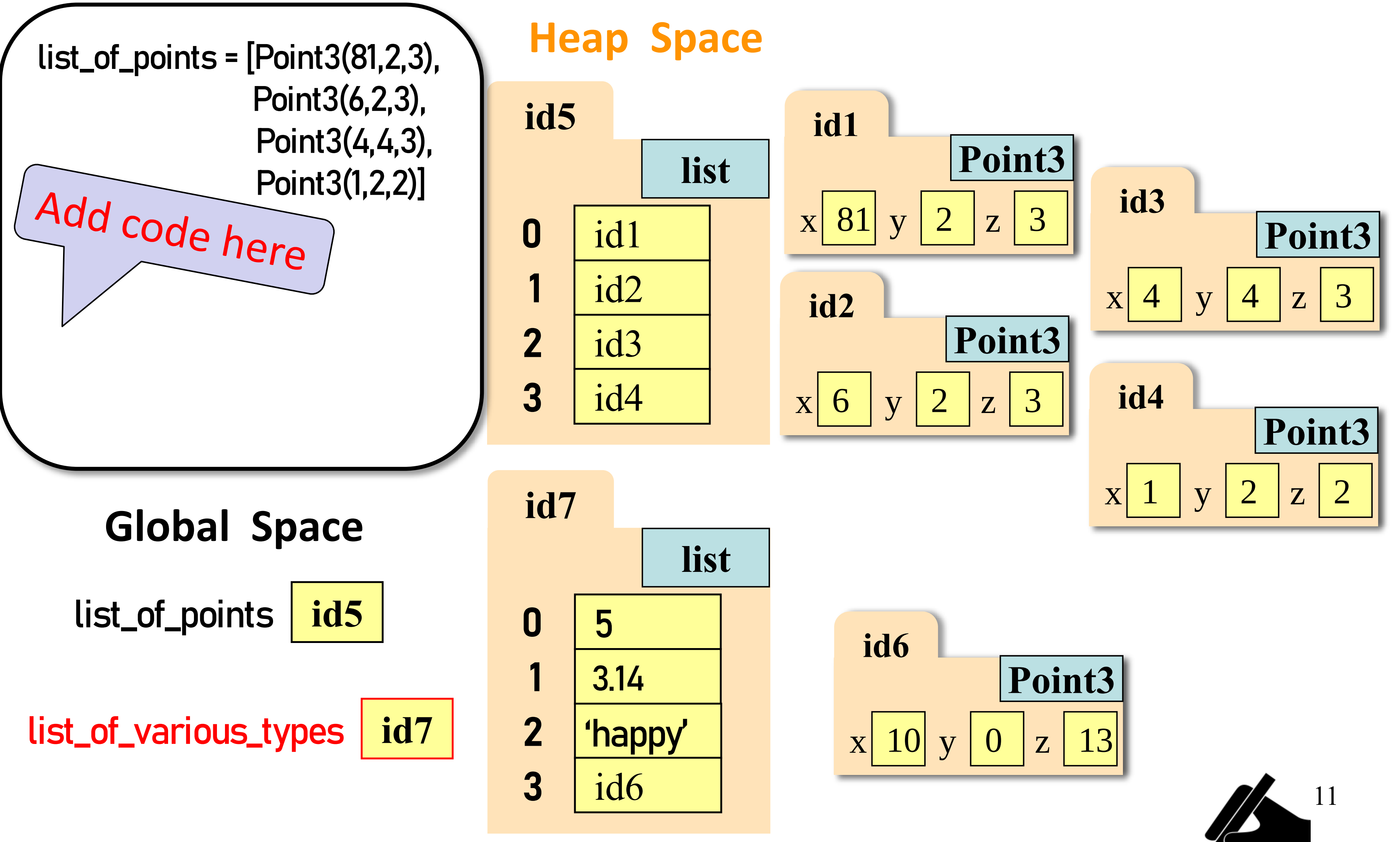
```
list_of_integers = [5, 7, 3+1, -2]
list_of_strings = ['h', 'i', '', 'there!']
```



No Really, Lists Can Hold Any Type!

```
list_of_points = [Point3(81,2,3),
                  Point3(6,2,3),
                  Point3(4,4,3),
                  Point3(1,2,2)]
```

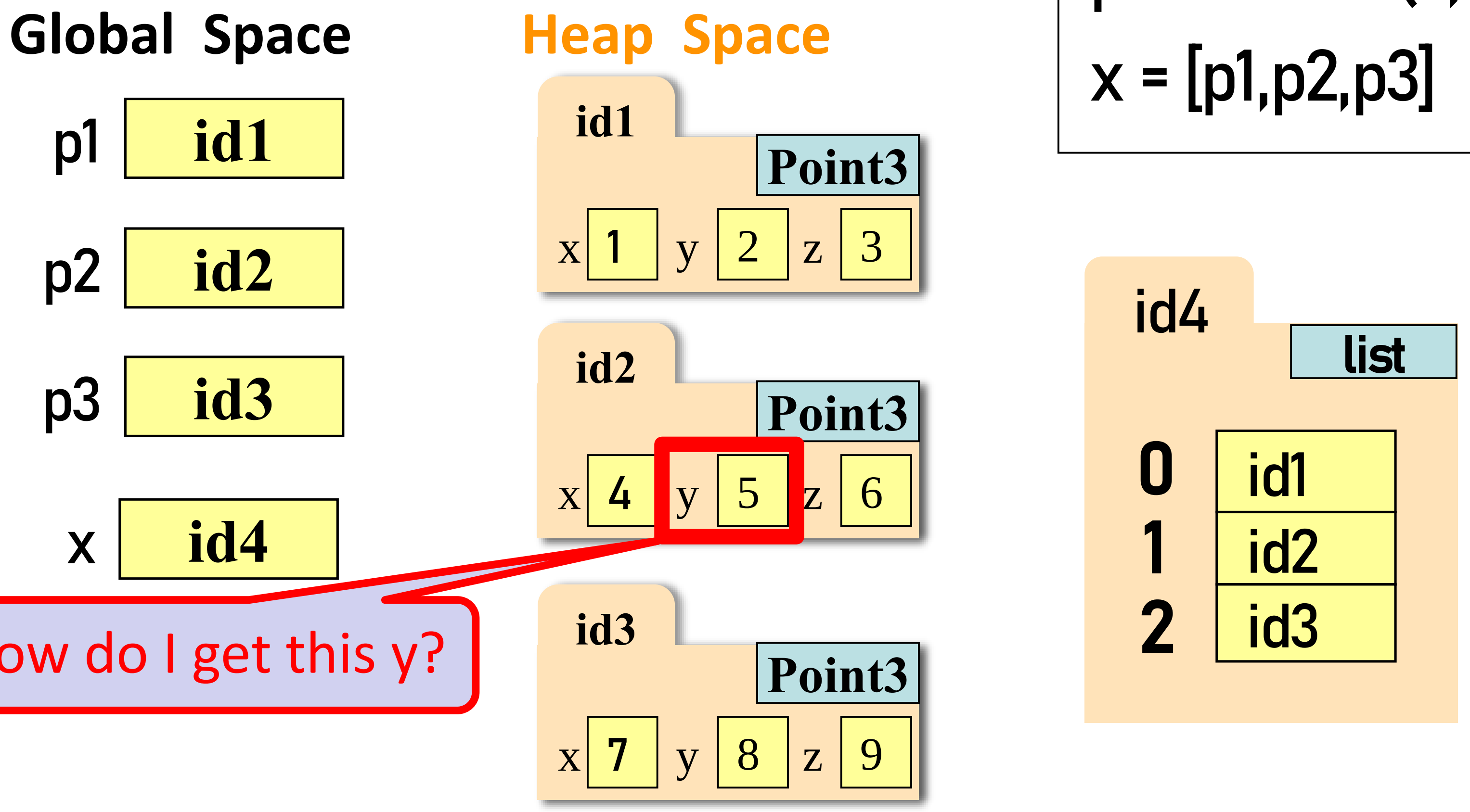
Add code here



Lists of Objects

- List elements are variables
  - Can store base types and ids
  - Cannot store folders

```
p1 = Point3(1, 2, 3)
p2 = Point3(4, 5, 6)
p3 = Point3(7, 8, 9)
x = [p1,p2,p3]
```



How do I get this y?

List is *mutable*; strings are not

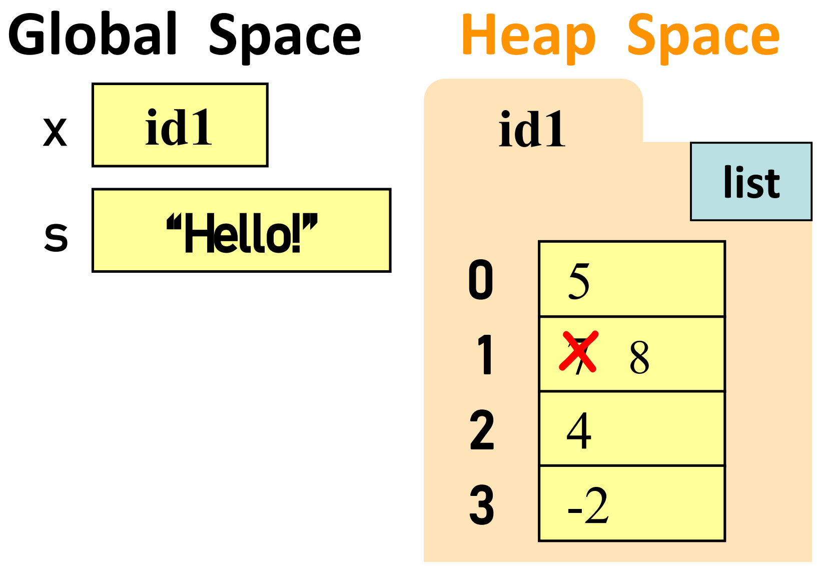
- **Format**:

  <var>[<index>] = <value>

  - Reassign at index
  - Affects folder contents
  - Variable is unchanged

- Strings cannot do this
  - Strings are **immutable**

```
x = [5, 7,4,-2]
x[1] = 8
s = "Hello!"
s[0] = 'J'
TypeError: 'str' object does not
support item assignment
```



List Methods Can Alter the List

`x = [5, 6, 5, 9]`

`y = [15, 16, 15, 19]`

See Python API for more

- `<list>.append(<value>)`
  - Adds a new value to the end of list
  - `x.append(-1)` *changes* the list to `[5, 6, 5, 9, -1]`
- `<list>.insert(<index>,<value>)`
  - Puts value into list at index; shifts rest of list right
  - `y.insert(2,-1)` *changes* the list to `[15, 16, -1, 15, 19]`
- `<list>.sort()`

What do you think this does?

Q1: Insert into list

- Execute the following:

```
>>> x = [5, 6, 5, 9, 10]
>>> x[3] = -1
>>> x.insert(1, 2)
```

- What is `x[4]`?

A: 10
B: 9
C: -1
D: **ERROR**
E: I don't know

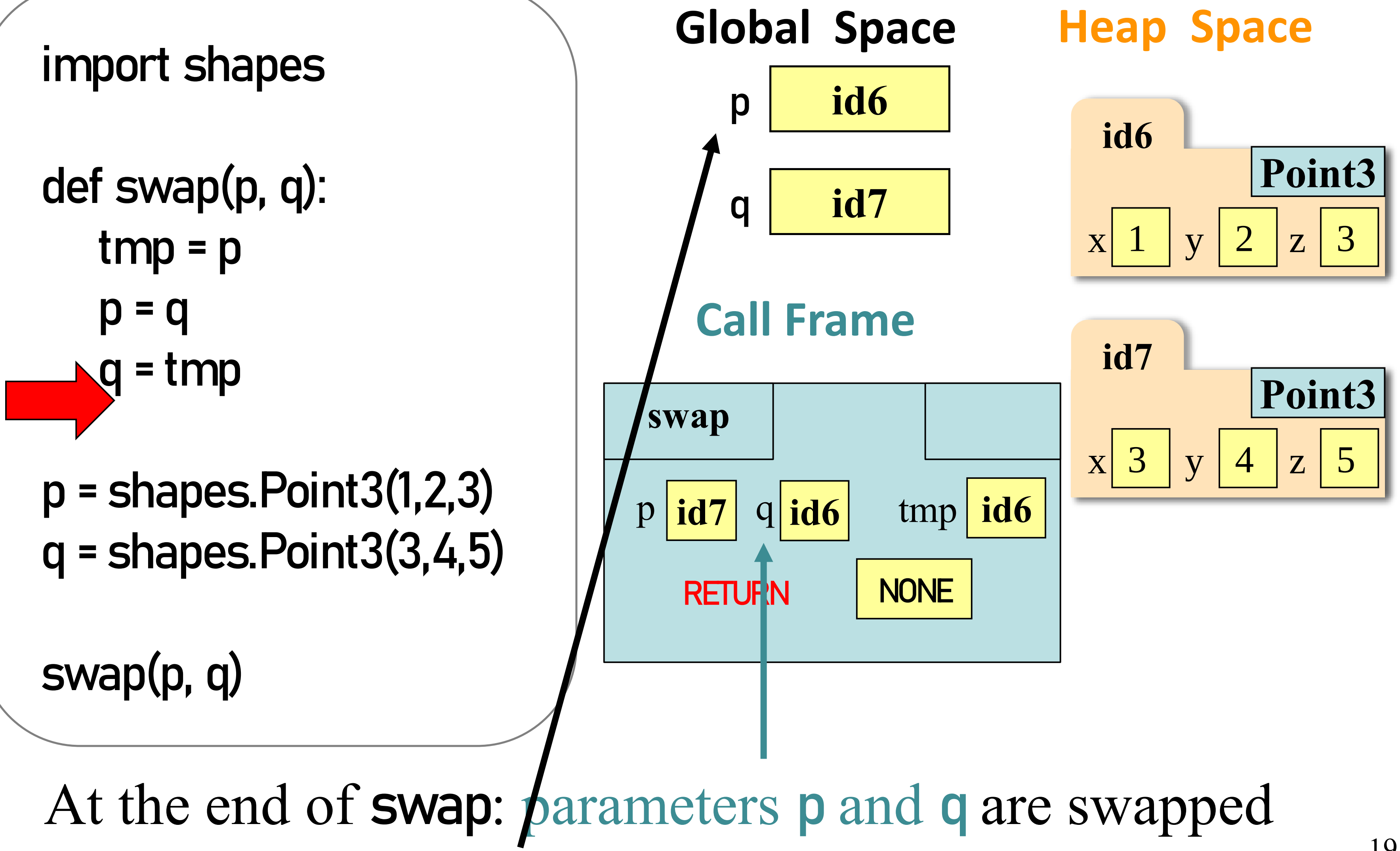
Recall: identifier assignment → no swap

```
import shapes

def swap(p, q):
    tmp = p
    p = q
    q = tmp

p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

swap(p, q)
```



At the end of **swap**: parameters **p** and **q** are swapped
global **p** and **q** are unchanged

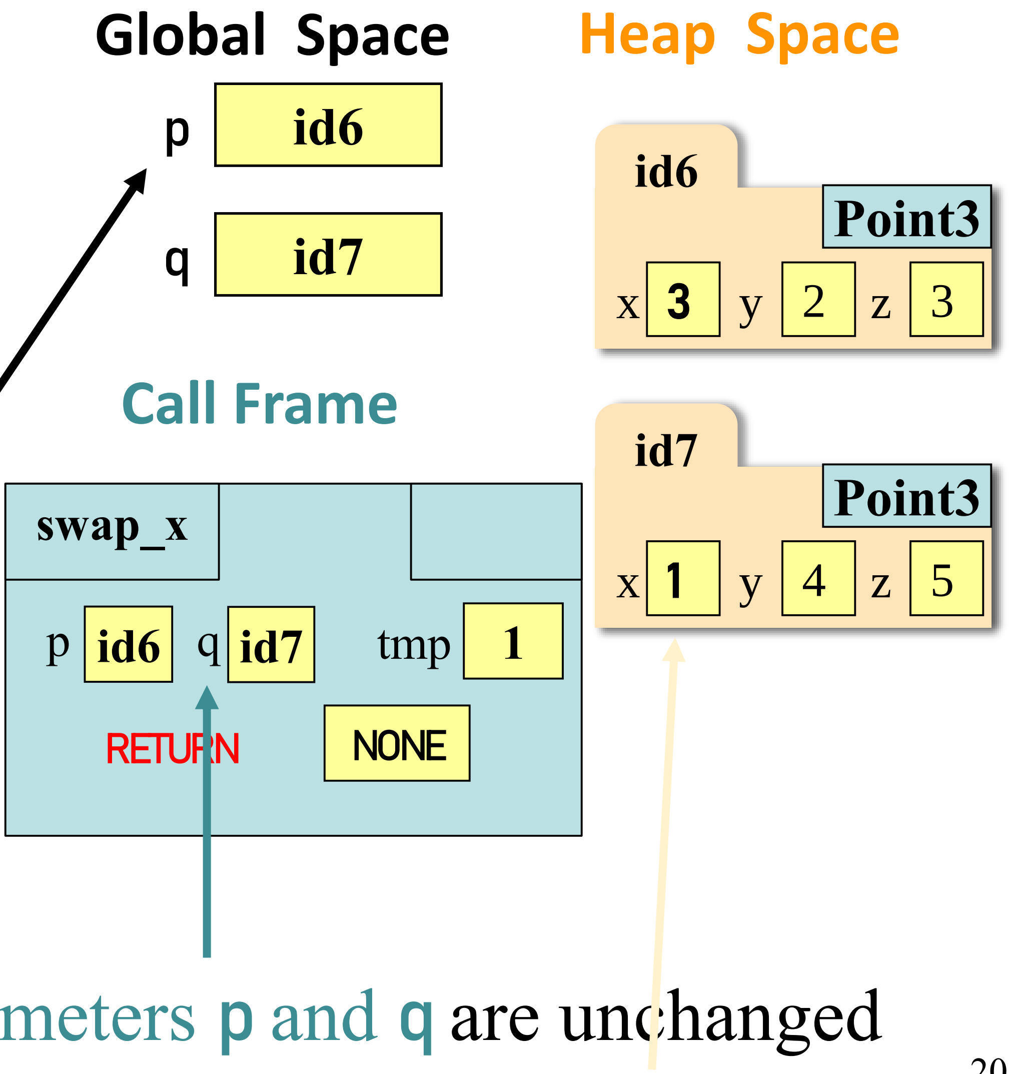
Recall: Attribute Assignment → swap!

```
import shapes

def swap_x(p, q):
    tmp = p.x
    p.x = q.x
    q.x = tmp

p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

swap_x(p, q)
```

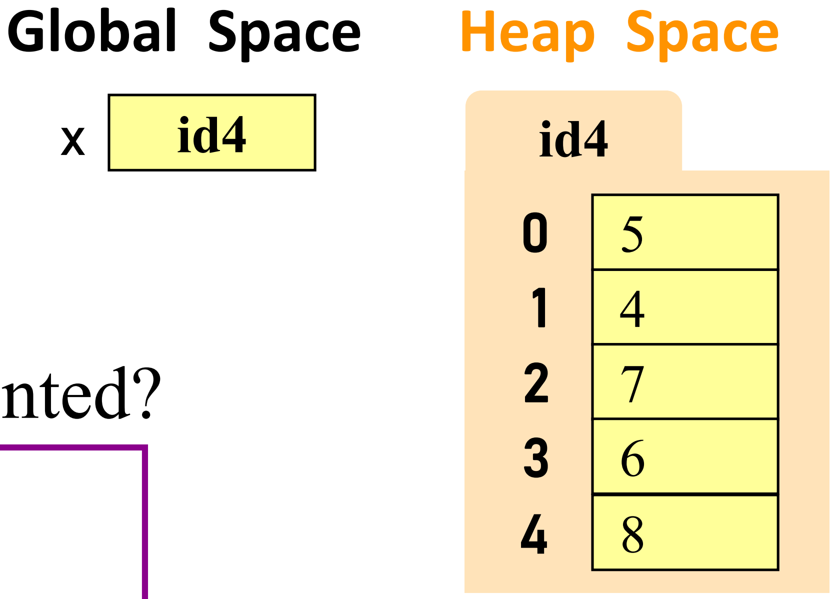


At the end of swap: parameters p and q are unchanged
global p and q are unchanged, attributes x are swapped

Q2: Swap List Values?

```
def swap(b, h, k):
    """Procedure swaps b[h] and b[k] in b
       Precondition: b is a mutable list, h
       and k are valid positions in the list"""
    temp= b[h]
    b[h]= b[k]
    b[k]= temp
```

```
x = [5,4,7,6,8]
swap(x, 3, 4)
print(x[3])
```



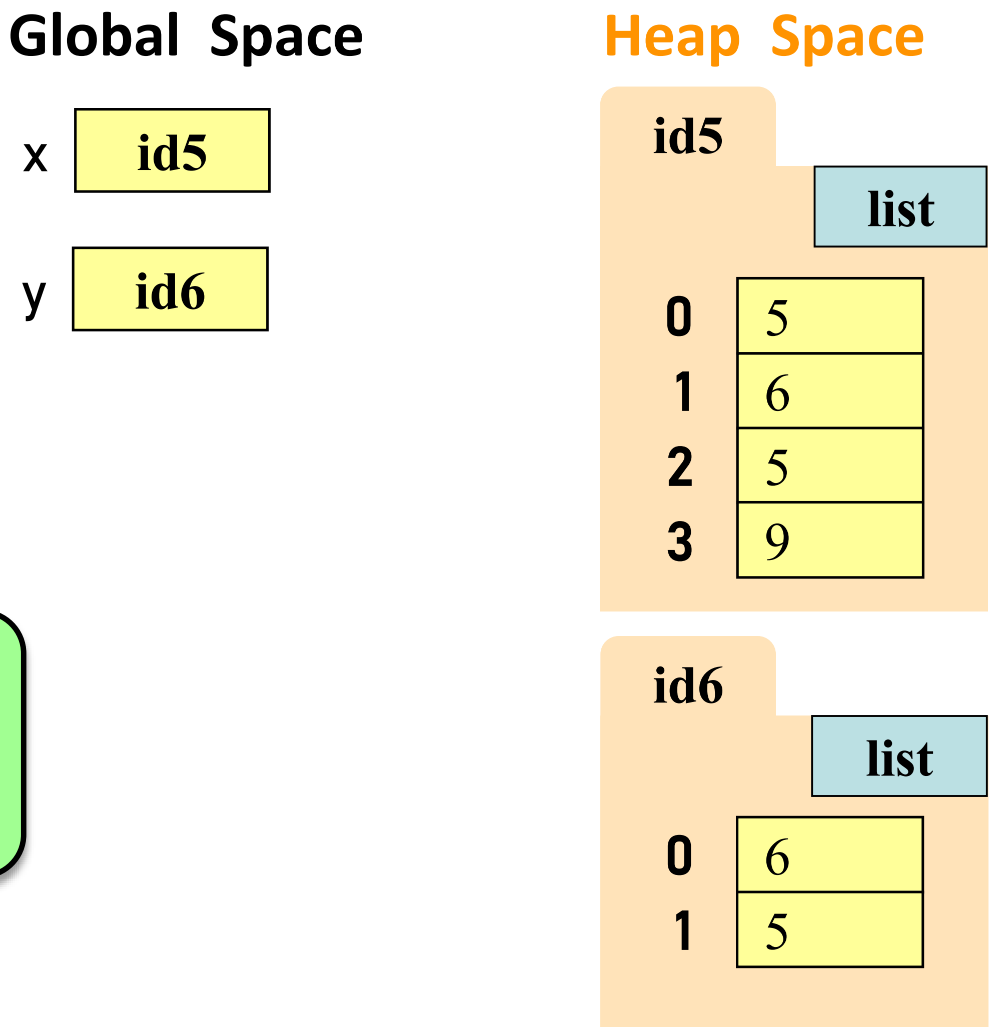
What gets printed?

A: 8
B: 6
C: Something else
D: I don’t know

List Slices Make Copies:
a slice of a list is a new list

```
x = [5, 6, 5, 9]

y = x[1:3]
```



copy means
new folder

Q3: List Slicing

- Execute the following:

```
>>> x = [5, 6, 5, 9, 10]
>>> y = x[1:]
>>> y[0] = 7
```

- What is x[1]?

A: 7
B: 5
C: 6
D: **ERROR**
E: I don't know

Q4

- Execute the following:

```
>>> x = [5, 6, 5, 9, 10]
>>> y = x
>>> y[1] = 7
```

- What is `x[1]`?

A: 7
B: 5
C: 6
D: **ERROR**
E: I don’t know

Things that Work for All Sequences

s = ‘slithy’		x = [5, 6, 9, 6, 15, 5]
s.index(‘s’) → 0	methods	x.index(5) → 0
s.count(‘t’) → 1		x.count(6) → 2
len(s) → 6	built-in fns	len(x) → 6
s[4] → “h”	slicing	x[4] → 15
s[1:3] → “li”		x[1:3] → [6, 9]
s[3:] → “thy”		x[3:] → [6, 15, 5]
s[–2] → “h”		x[–2] → 15
s + ‘ toves’ → “slithy toves”	operators	x + [1, 2] → [5, 6, 9, 6, 15, 5, 1, 2]
s * 2 → “slithyslithy”		x * 2 → [5, 6, 9, 6, 15, 5, 5, 6, 9, 6, 15, 5]
‘t’ in s → True		15 in x → True

Lists and Strings Go Hand in Hand

text.split(<sep>): return a list of words in **text** (separated by **<sep>**, or whitespace by default)

<sep>.join(words): concatenate the items in the list of strings **words**, separated by **<sep>**.

```
>>> text = 'A sentence is just\n a list of words'
>>> words = text.split()
>>> words
['A', 'sentence', 'is', 'just', 'a', 'list', 'of', 'words']
>>> lines = text.split('\n')
>>> lines
['A sentence is just', ' a list of words']
>>> hyphenated = '-'.join(words)
>>> hyphenated
'A-sentence-is-just-a-list-of-words'
>>> hyphenated2 = '-'.join(lines[0].split()+lines[1].split())
>>> hyphenated2
'A-sentence-is-just-a-list-of-words'
```

Turns string into a list of words

Turns string into a list of lines

Combines elements with hyphens

Merges 2 lists, combines elements with hyphens

Tuples (see lesson video)

strings: **immutable** sequences of **characters**	tuples*: **immutable** sequences of **any objects**	lists: mutable sequences of **any objects**

* "tuple" generalizes "pair," "triple," "quadruple," …

- Tuples fall between strings and lists
  - write them with just commas: `42, 4.0, 'x'`
  - often enclosed in parentheses: `(42, 4.0, 'x')`

Use **lists** for:
- long sequences
- homogeneous sequences
- variable length sequences

Use **tuples** for:
- short sequences
- heterogeneous sequences
- fixed length sequences