CS 1110:

Introduction to Computing Using Python

Lecture 10

Lists and Sequences

[Andersen, Gries, Lee, Marschner, Van Loan, White]

Lecture 10 Announcements

- Prelim 1
  - **Date:** Tuesday, March 14th, 7:30 pm to 9:00 pm
  - Submit conflicts immediately through CMS
- A2: You must scan or take a picture of your work to submit it through CMS
  - Since you have been warned to submit early, do not expect that we will accept work that does not make it onto CMS on time.
- Set CMS notifications to receive all emails!

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'

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]

Sequences: Lists of Values

String

- s = 'abc d'

0	1	2	3	4
a	b	c		d

- Put characters in quotes
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List

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

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

- Put values inside [ ]
  - mmas
- with []
  - [0] is 5
  - x[6] causes an error
  - x[0:2] is [5, 6] (excludes 2nd 5)
  - x[3:] is [9, 15, 23]

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 you get length of a list with a regular function, not method:

`len(x)`

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	methods	x.count(6) → 2
len(s) → 6	built-in fn.	len(x) → 6
s[4] → "h"	slicing	x[4] → 15
s[1:3] → "li"	slicing	x[1:3] → [6, 9]
s[3:] → "thy"	slicing	x[3:] → [6, 15, 5]
s[–2] → "h"	slicing	x[–2] → 15
s + ' toves' → "slithy toves"	operators	x + [1, 2] → [5, 6, 9, 6, 15, 5, 1, 2]
s * 2 → "slithyslithy"	operators	x * 2 → [5, 6, 9, 6, 15, 5, 5, 6, 9, 6, 15, 5]
't' in s → True	operators	15 in x → True

Difference: Lists Can Hold Any Type

0	1	2	3	4	5
5	6	8	9	15	23

a list of integers

0	1	2	3	4	5	6
‘H’	‘e’	‘l’	‘l’	‘o’	‘ ’	‘World’

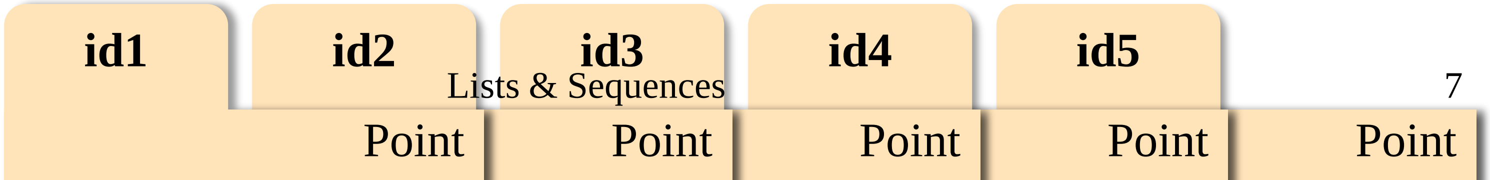
a list of strings

0	1	2	3	4
id1	**id2**	**id5**	**id4**	**id3**

a list of objects of class Point

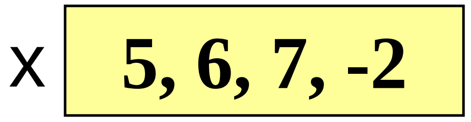
0	1	2	3	4	5	6	7
5	‘a’	‘joy’	24.3	**id1**	**id3**	0	**id2**

a list of values of various types

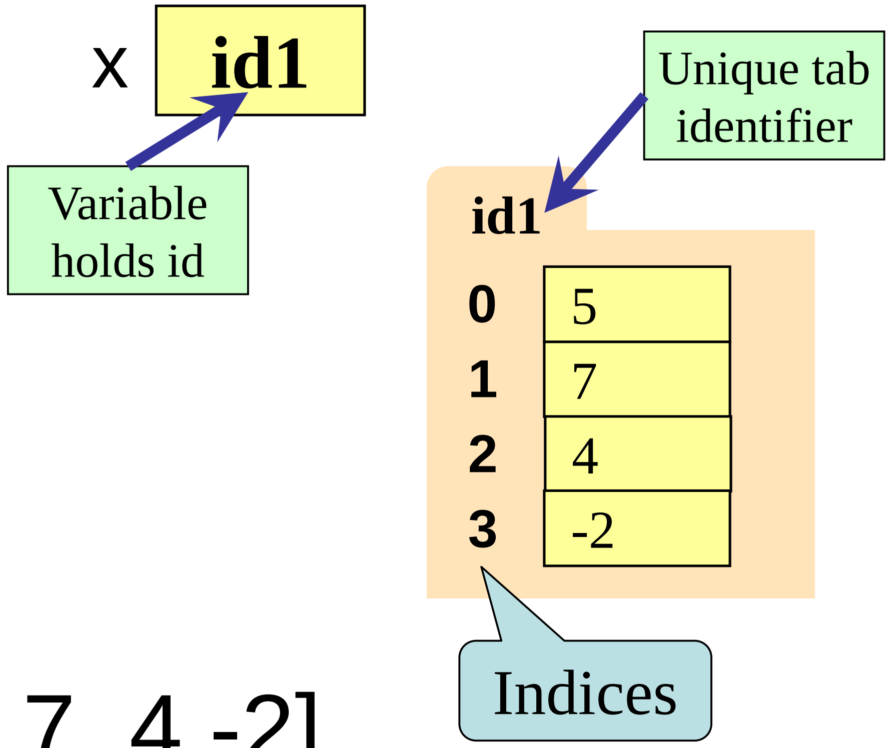


Representing Lists

Wrong



Correct

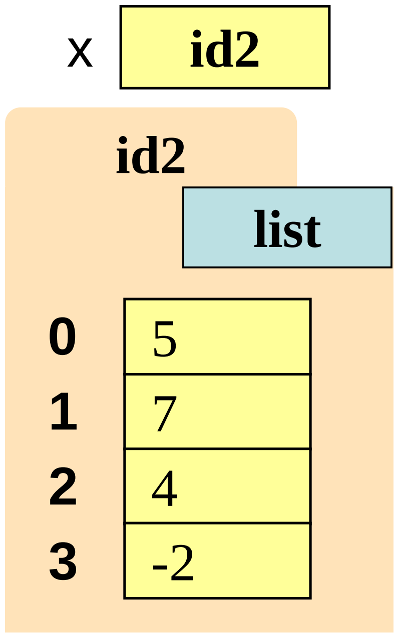


x = [5, 7, 4,-2]

Lists vs. Class Objects

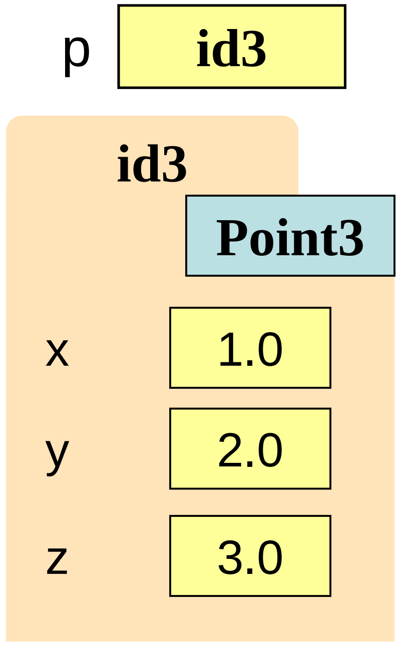
List

- Attributes are indexed
  - Example: x[2]



Objects

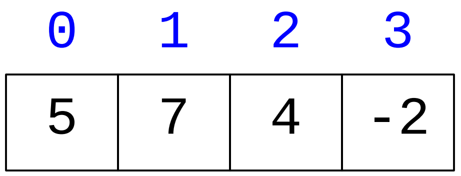
- Attributes are named
  - Example: p.x



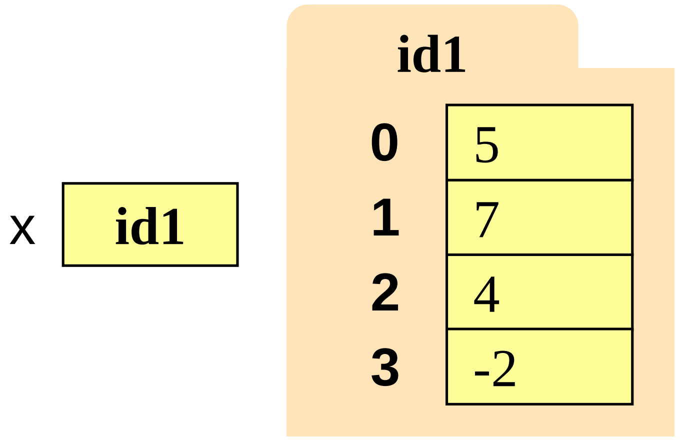
List Assignment

- **Format:**
  <var>[<index>] = <value>
  - Reassign at index
  - Affects folder contents
  - Variable is unchanged

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



- x[1] = 8



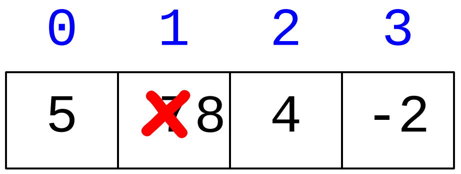
List Assignment

- **Format**:

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

  - Reassign at index
  - Affects folder contents
  - Variable is unchanged
- Strings cannot do this
  - s = 'Hello World!'
  - s[0] = 'J' **ERROR**
  - String are **immutable**

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



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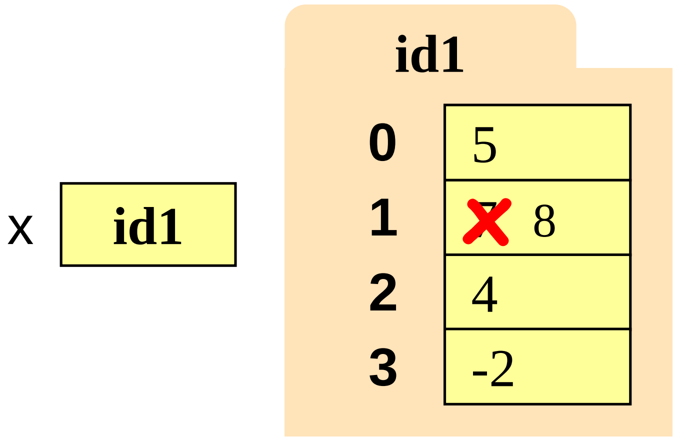


Lists and Expressions

- List brackets [] can contain expressions
- This is a list **expression**
  - Python must evaluate it
  - Evaluates each expression
  - Puts the value in the list
- Example:

```
>>> a = [1+2,3+4,5+6]
>>> a
[3, 7, 11]
```

- Execute the following:

```
>>> a = 5
>>> b = 7
>>> x = [a, b, a+b]
```

- What is x[2]?

```
>>> 12
```

List Methods Can Alter the List

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

See Python API for more

- `<list>.append(<value>)`
  - Procedure, not a fruitful method
  - 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>)`
  - Procedure, not a fruitful method
  - Puts value into list at index; shifts rest of list right
  - `x.insert(2,-1)` changes the list to `[5, 6, -1, 5, 9]`
- `<list>.sort()`

What do you think this does?

Clicker Exercise

- 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

From Before: Attribute Assignment

```
import geom
p = geom.Point3(1.0,2.0,3.0)
q = geom.Point3(3.0,4.0,5.0)
swap_x(p, q)
```

```
def swap_x(p, q):
    t = p.x
    p.x = q.x
    q.x = t
```

swaps `p.x` and `q.x`

```
import geom
p = geom.Point3(1.0,2.0,3.0)
q = geom.Point3(3.0,4.0,5.0)
swap(p, q)
```

```
def swap(p, q):
    t = p
    p = q
    q = t
```

DOES NOT swap global `p` and `q`

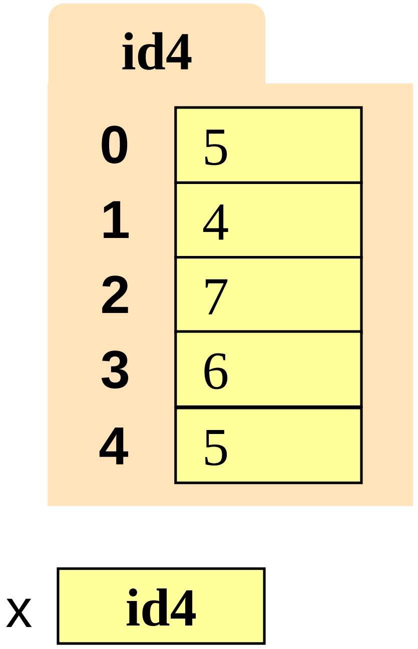
Lists and Functions: Swap

```
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"""
1   temp= b[h]
2   b[h]= b[k]
3   b[k]= temp
```

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

What gets printed?

A: 5
B: 6
C: Something else
D: I don't know



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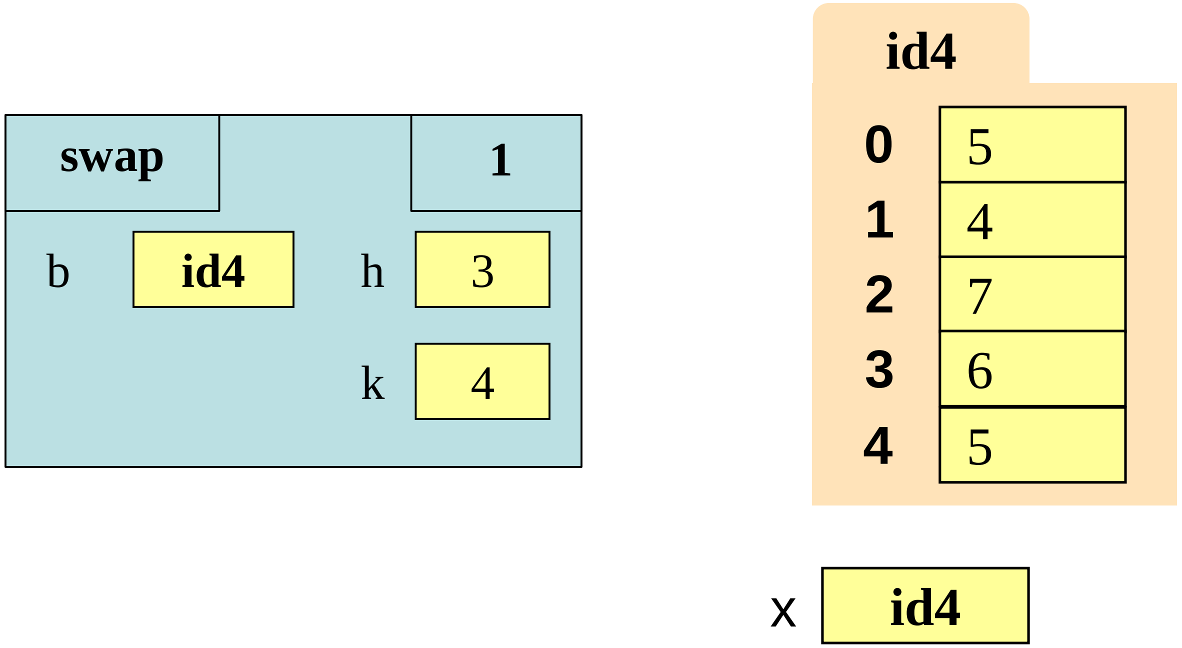

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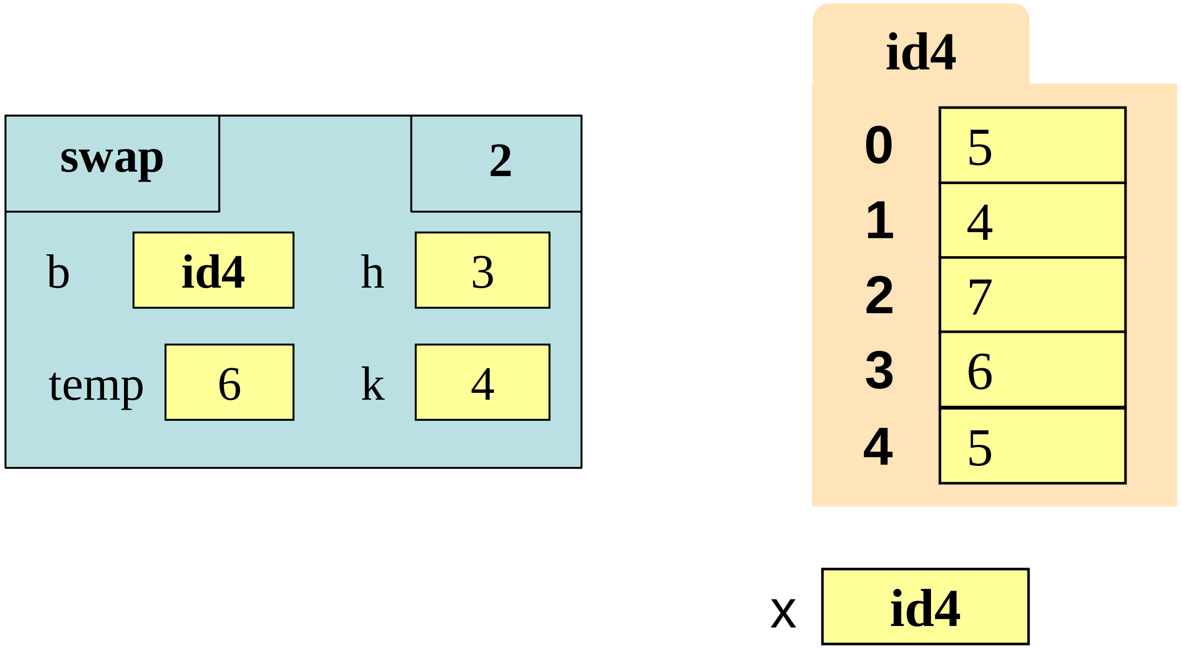

Lists and Functions: Swap

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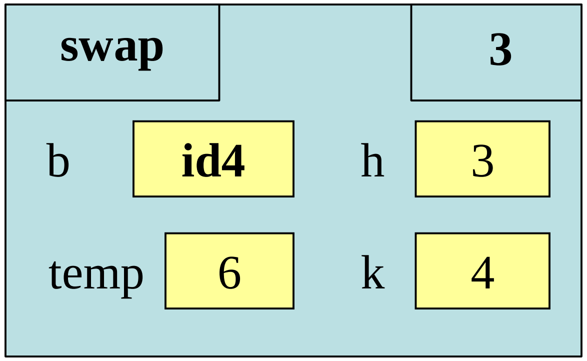

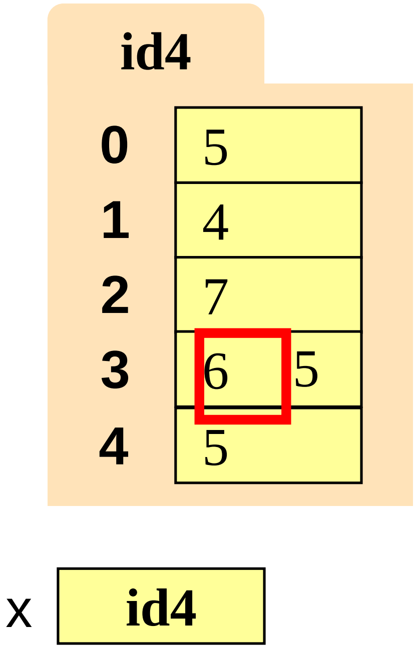

Lists and Functions: Swap

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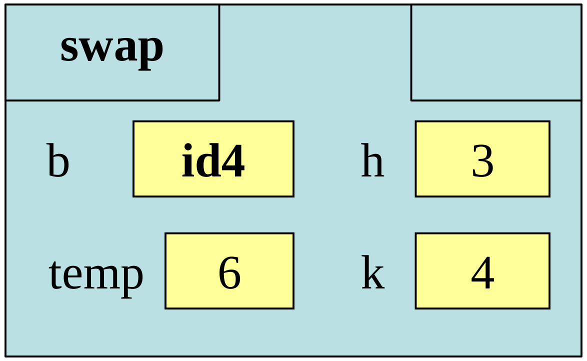
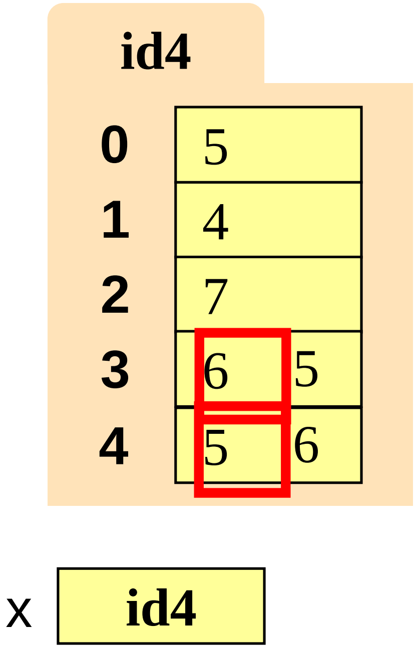
```





Lists and Functions: Swap

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      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
```
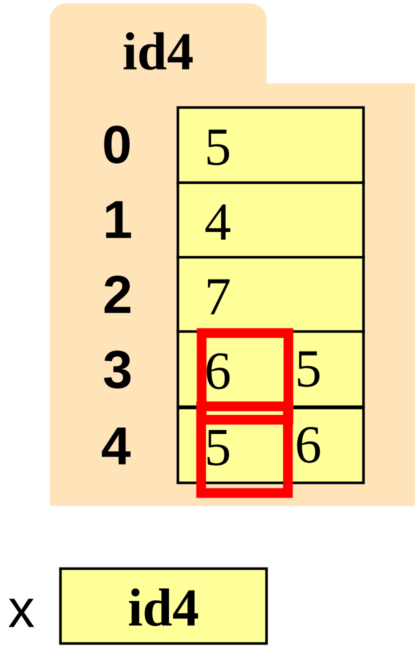

Swaps b[h] and b[k], because parameter b contains name of list.

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

What gets printed?

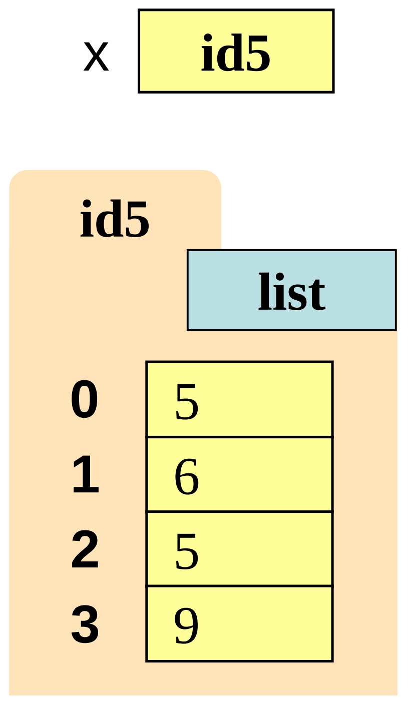
[✓ A: 5]
B: 6
C: Something else
D: I don't know

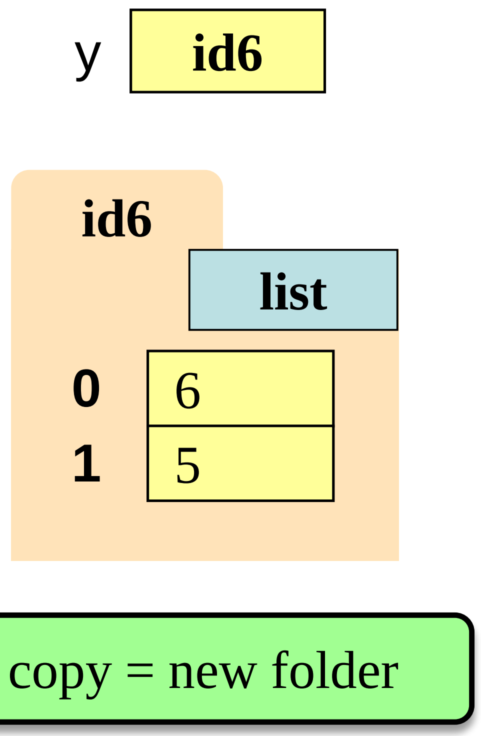


List Slices Make Copies

x = [5, 6, 5, 9]

y = x[1:3]





Clicker Exercises

- 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

- Execute the following:

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

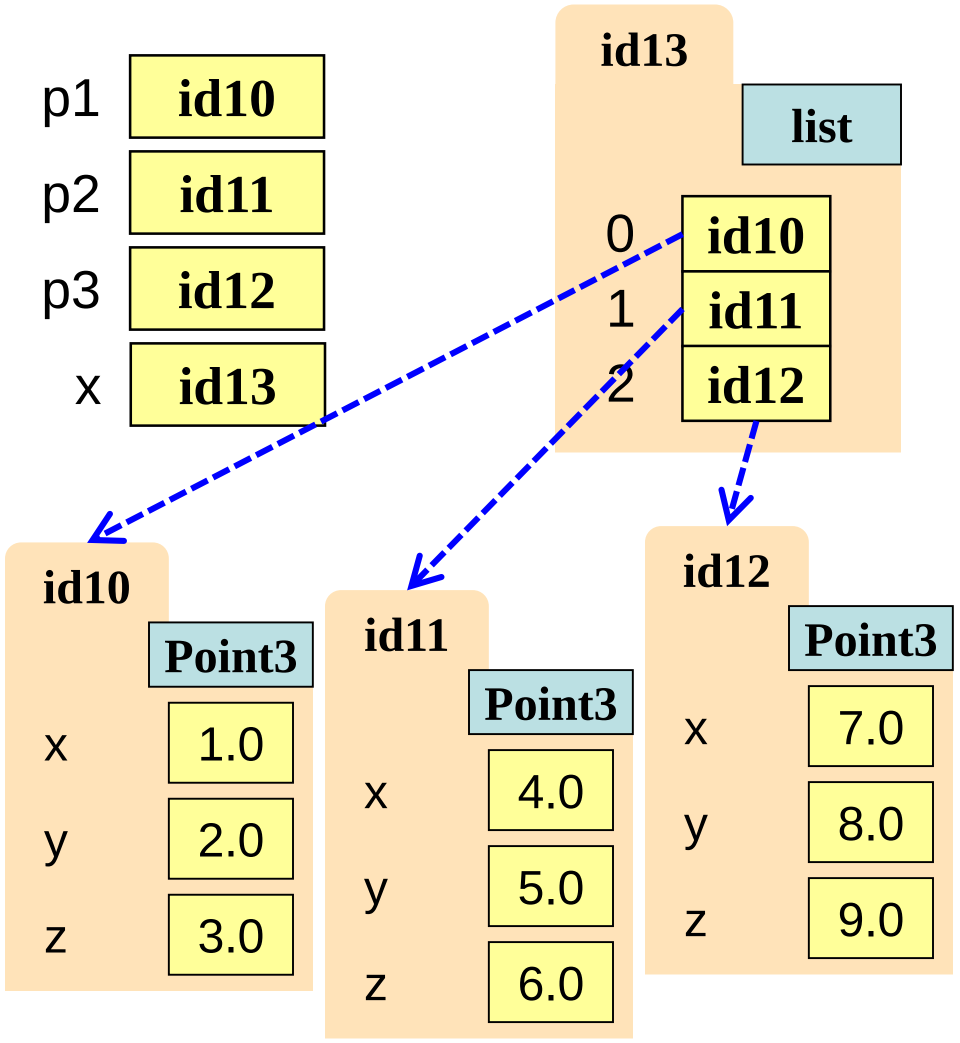
- What is x[1]?

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

Lists of Objects

- List positions are variables
  - Can store base types
  - But cannot store folders
  - Can store folder ids
- Folders linking to folders
  - Top folder for the list
  - Other folders for contents
- Example:

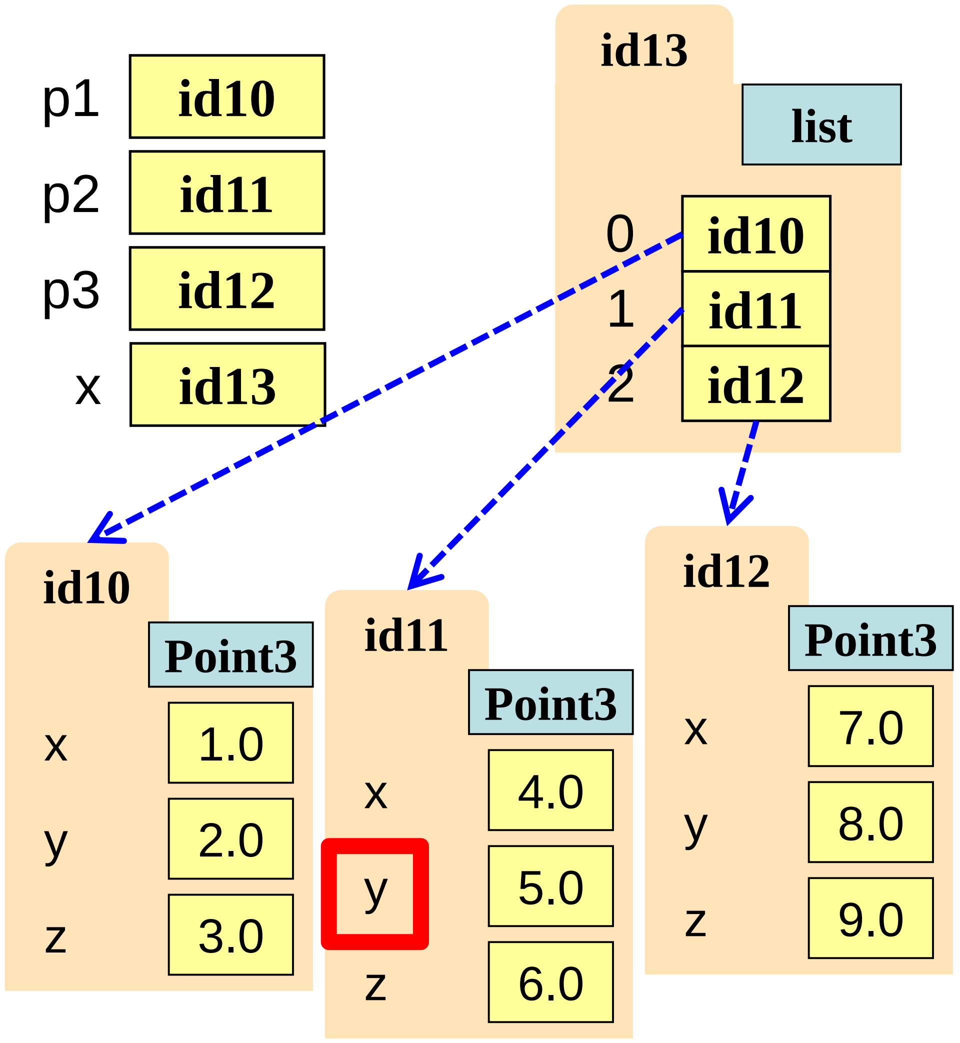
```
>>> p1 = Point3(1.0, 2.0, 3.0)
>>> p2 = Point3(4.0, 5.0, 6.0)
>>> p3 = Point3(7.0, 8.0, 9.0)
>>> x = [p1,p2,p3]
```



Lists of Objects

- Example:

```
>>> p1 = Point3(1.0, 2.0, 3.0)
>>> p2 = Point3(4.0, 5.0, 6.0)
>>> p3 = Point3(7.0, 8.0, 9.0)
>>> x = [p1,p2,p3]
```



- How do I get this y?

```
>>> x[1].y
```

Lists and Strings Go Hand in Hand

text.split(<sep>): return a list of the 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\na list of words'
words = text.split()
lines = text.split('\n')
print '-'.join(words)
print '-'.join(lines[0].split() + lines[1].split())
```

[‘A’, ‘sentence’, ‘is’, ‘just’, ‘a’, …]

returns a list of two strings

‘A-sentence-is-just-a…’

‘A-sentence-is-just a-list-of-words’

Example: Poetry

- Can we “read” a poem and count the number of:
  - characters
  - words
  - lines
  - stanzas

Iteration

- To process a list, you often want to do the same thing to each item in the list. One way to do this:
  - The map function:

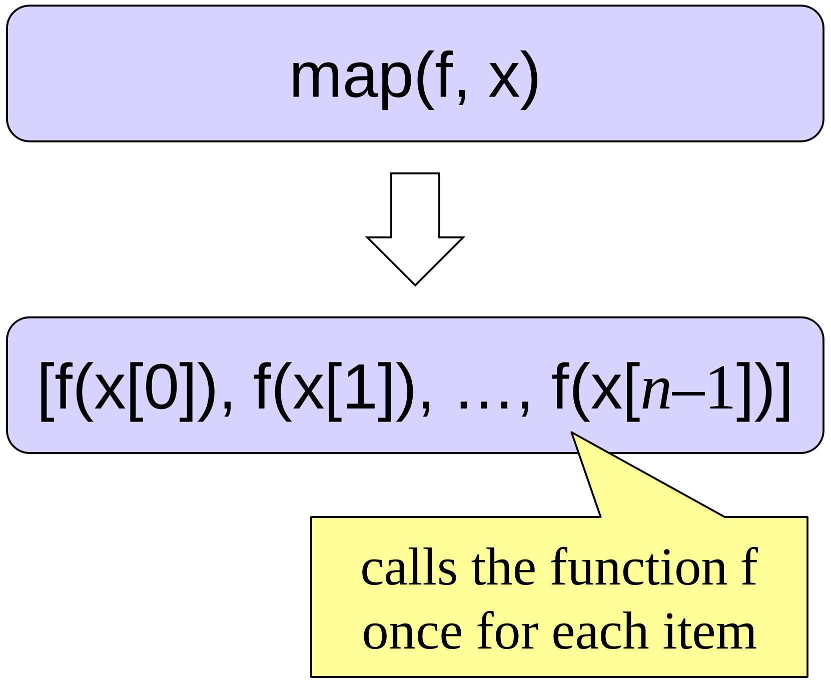
    map(⟨*function*⟩, ⟨*list*⟩)

Call the function once for each item in the list, with the list item as the argument, and put the return values into a list.

The Map Function

- map(⟨*function*⟩, ⟨*list*⟩)
  - Function has to have exactly **1 parameter**
  - Otherwise, get an error
  - Returns a new list
- Does the same thing as

```
def map(f,x):
    result = [] # empty list
    for y in x:
        result.append(f(y))
    return result
```


map(f, x)
[f(x[0]), f(x[1]), …, f(x[n–1])]
calls the function f once for each item

map(len, ['a', 'bc', 'defg'])
returns [1, 2, 4]