Lecture 7

Lists (& Sequences)

Announcements For This Lecture

Readings

- Chapter 10 (lists)
- Fri will cover for-loops

Assignment 1

- Due **Thursday**
  - Due *before* midnight
  - Submit something…

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

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- s = 'abc d'

0	1	2	3	4
a	b	c		d

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

0	1	2	3	4	5
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- 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 Strings

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

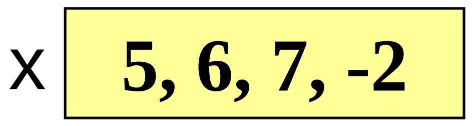
- index(value)
  - Return position of the value
  - **ERROR** if value is not there
  - x.index(9) evaluates to 3
- count(value)
  - Returns number of times value appears in list
  - x.count(5) evaluates to 2

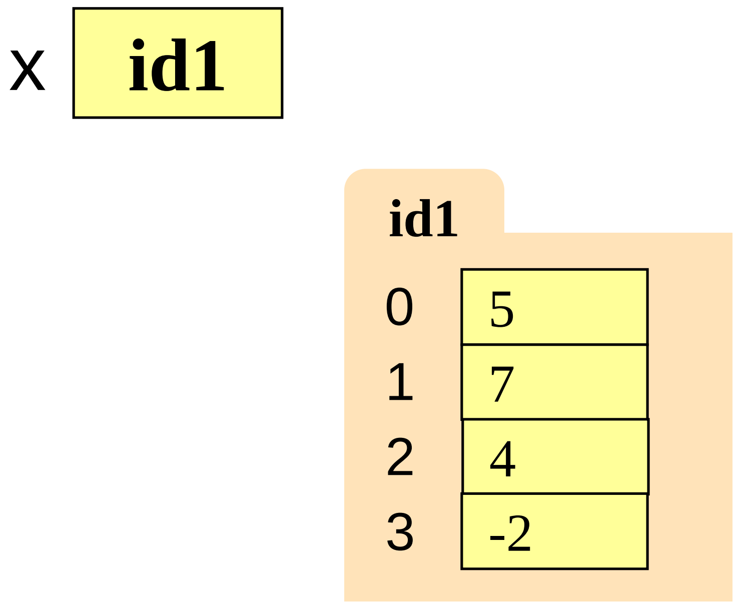
But you get length of a list with a regular function, not method:

len(x)

Representing Lists

Wrong	Correct





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

Representing Lists

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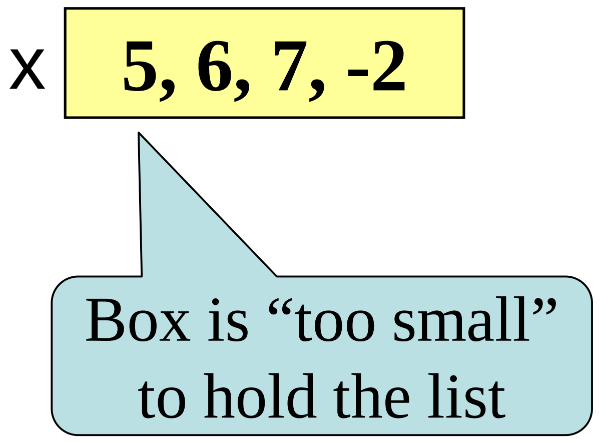

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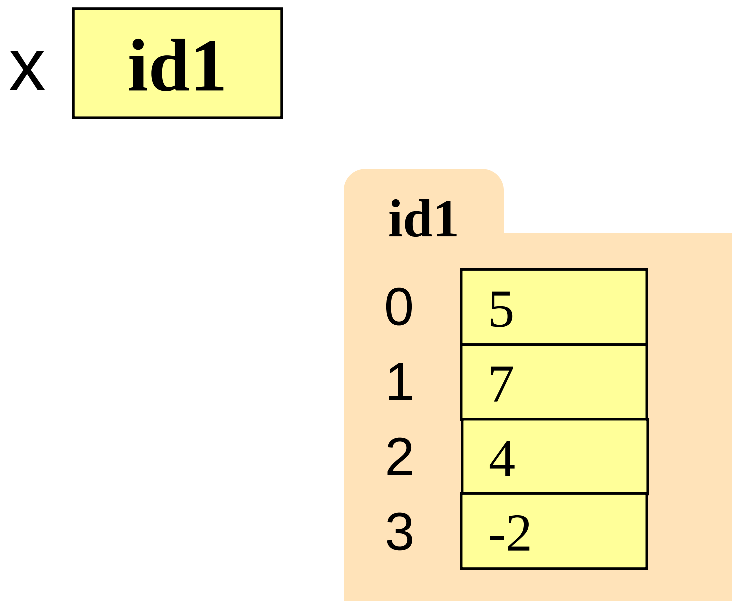

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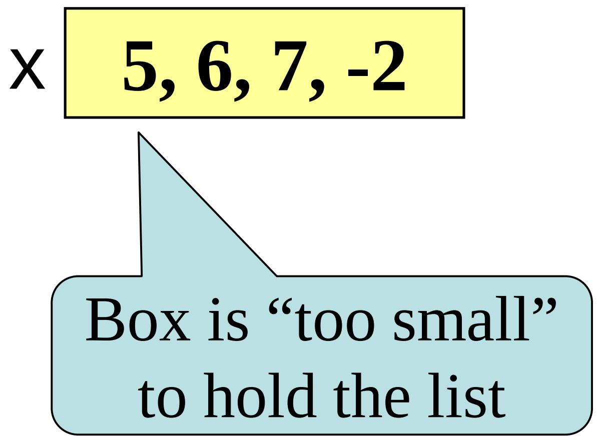

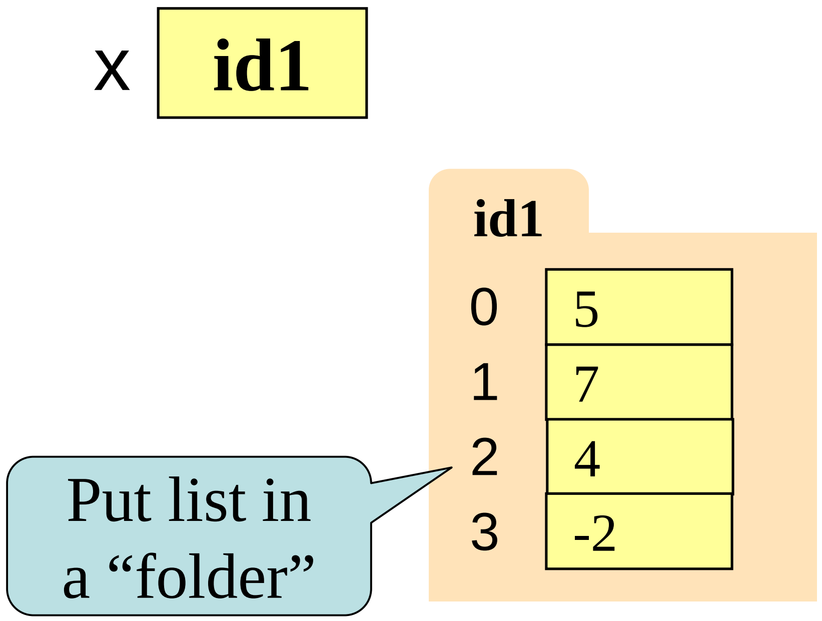

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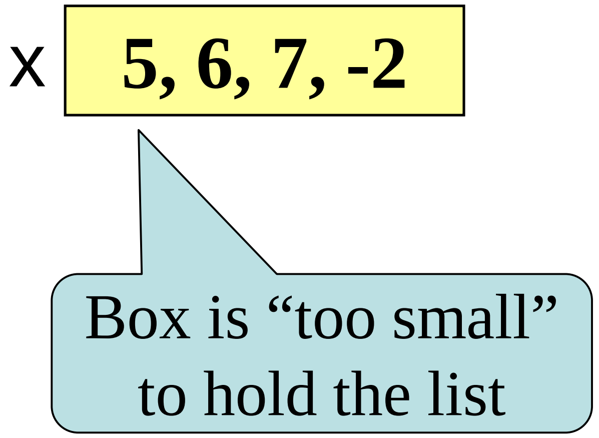

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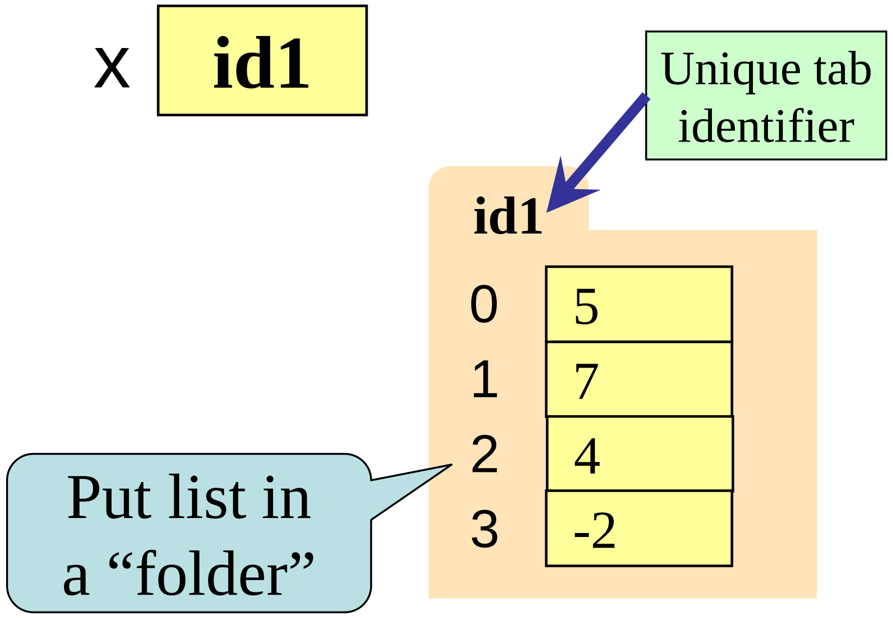

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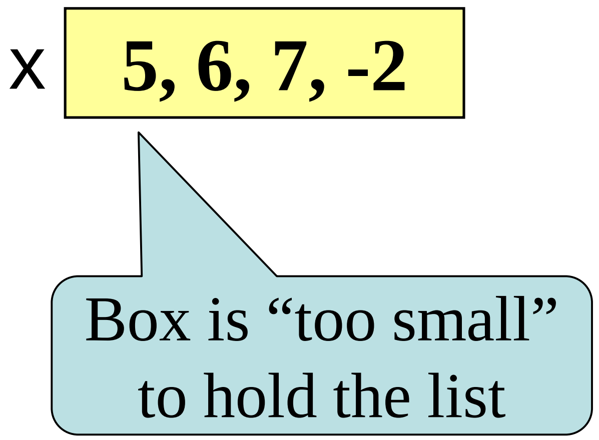

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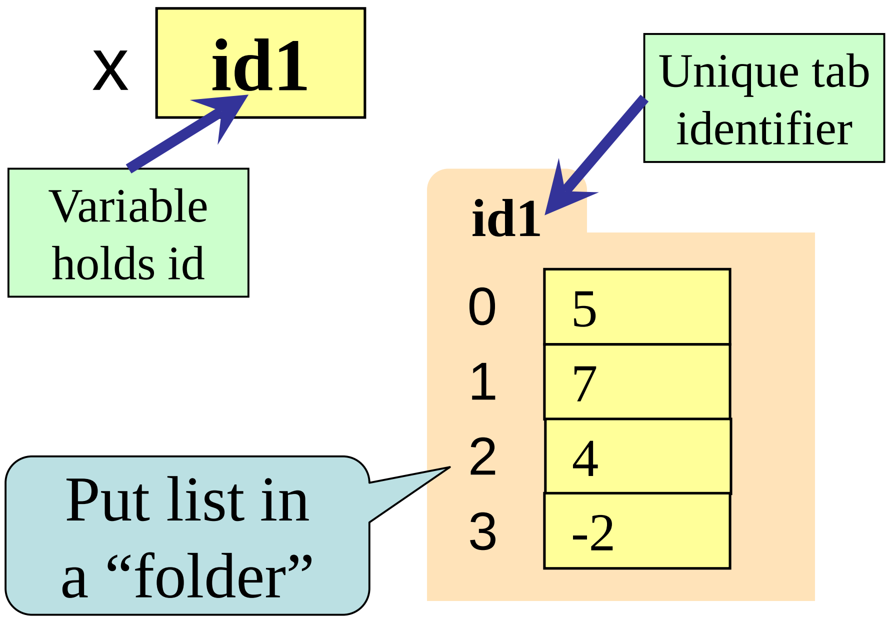


x = [5, 7, 4,-2]

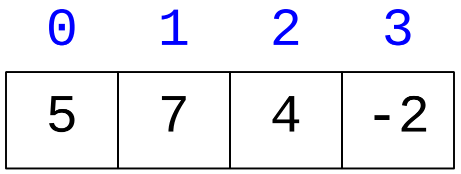
Modifying List Contents

- **List assignment**:

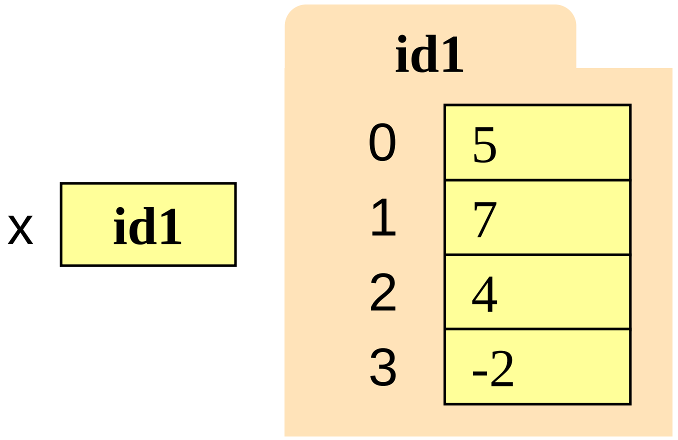
  <var>[<index>] = <value>

  - 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]



- x[1] = 8



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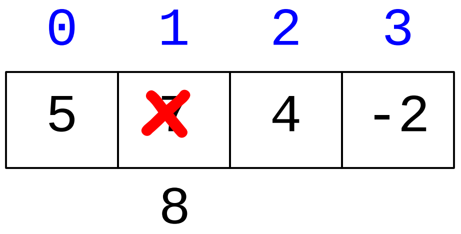

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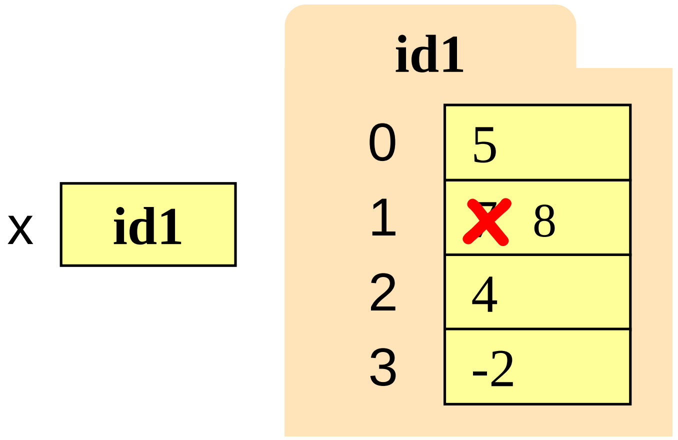


Exercise: List Assignment

- Assignment copies id into y

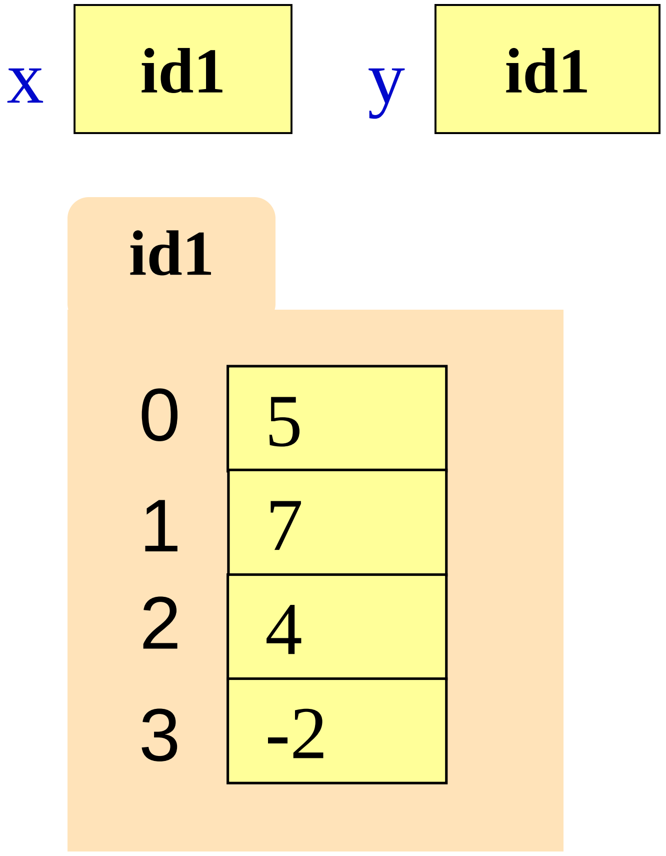
```
>>> x = [5, 7, 4, -2]
>>> y = x
```

- Execute the assignments:

```
>>> x[2] = 8
>>> y[2] = 3
```

- What is value of x[2]?

A: 8
B: 3
C: **id1**
D: I don't know



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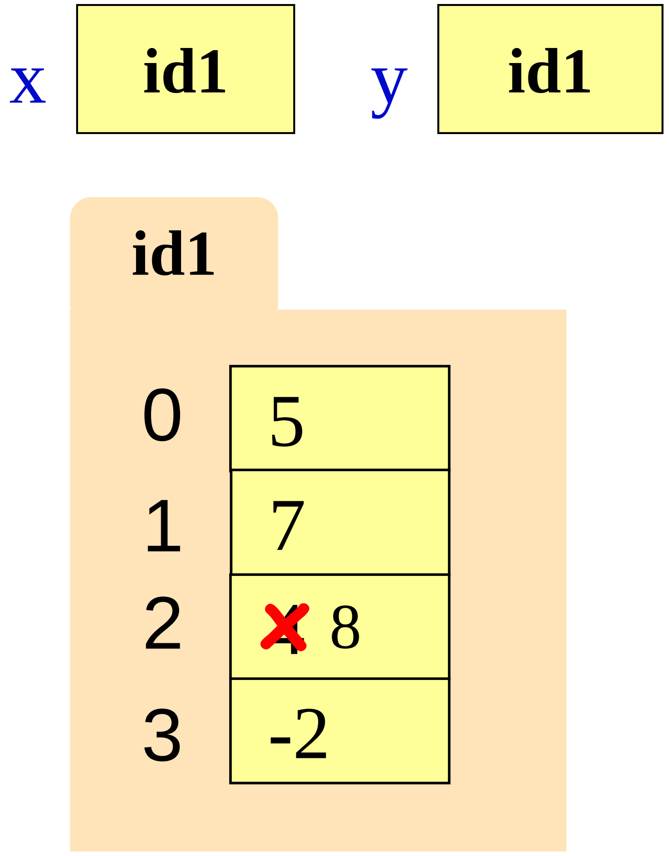

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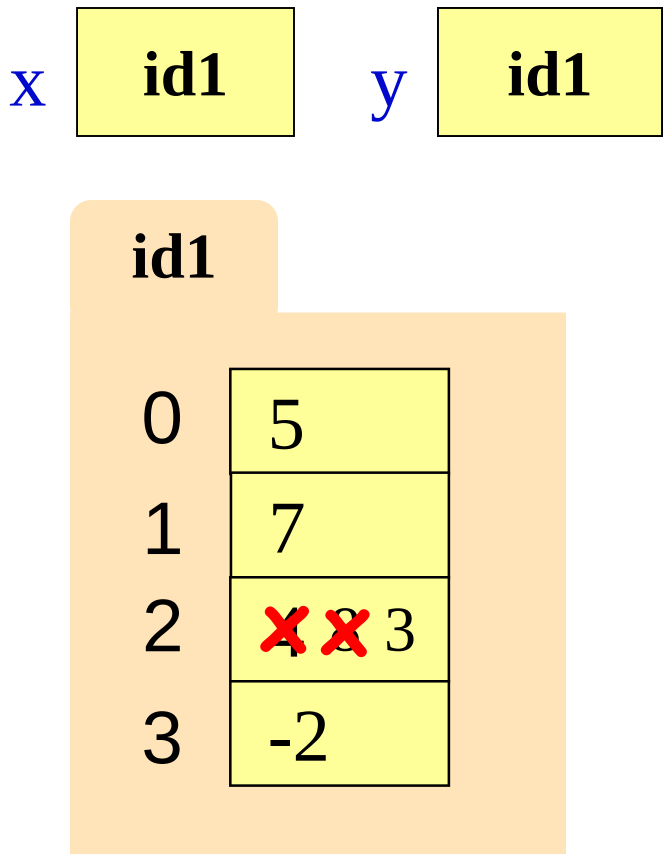


List Methods Can Alter the List

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

See Python API for more

- append(value)
  - A **procedure method**, 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]
- insert(index, value)
  - Put the value into list at index; shift rest of list right
  - x.insert(2,-1) changes the list to [5, 6, -1, 5, 9,]
- sort()

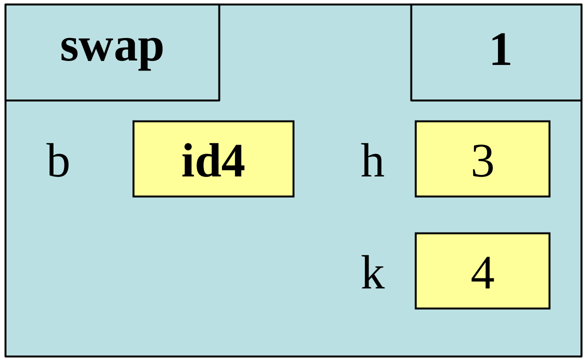
What do you think this does?

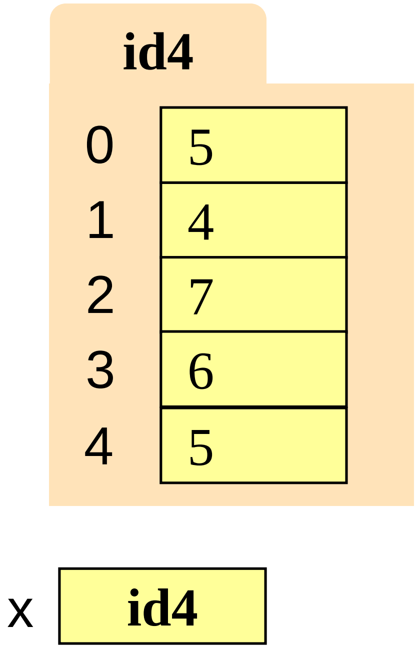
Lists and Functions: Swap

```
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
```

```
swap(x, 3, 4)
```

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





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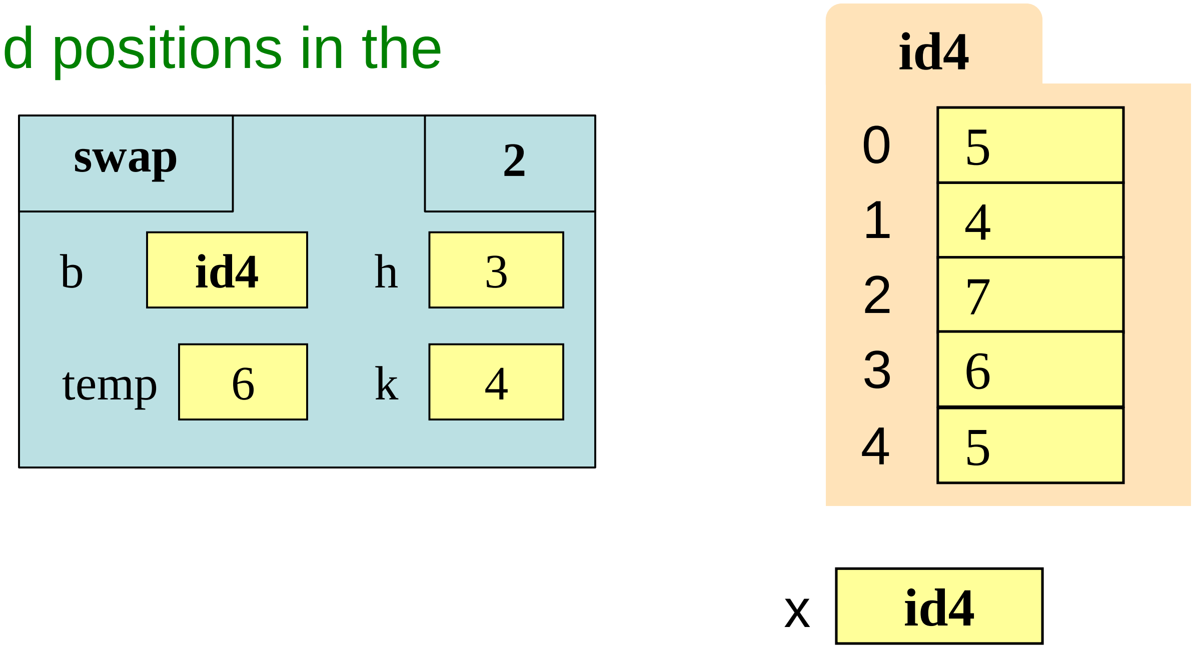

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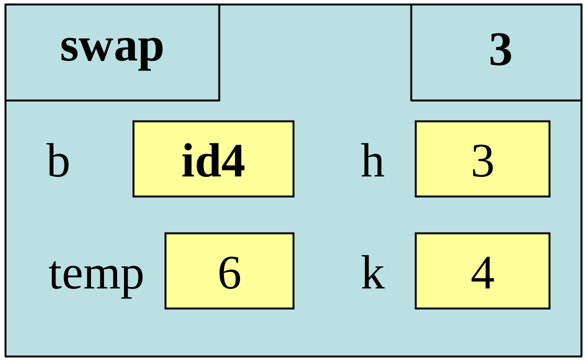

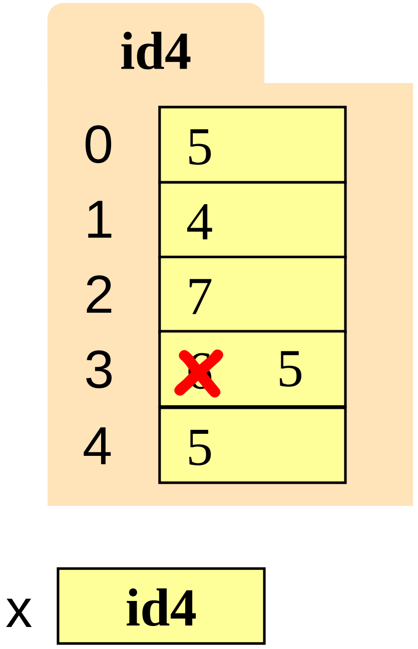

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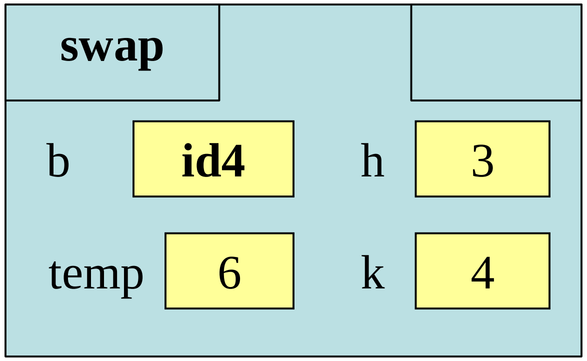

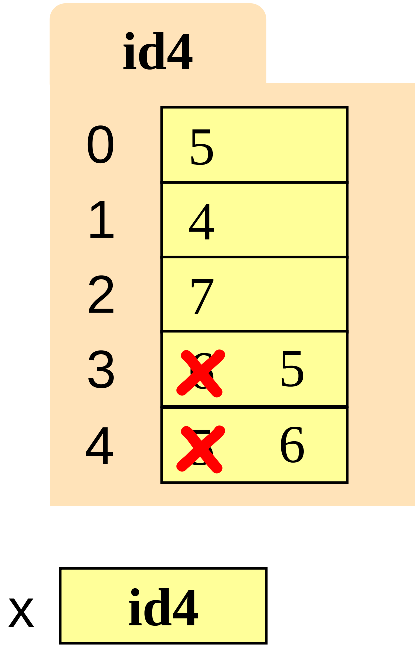

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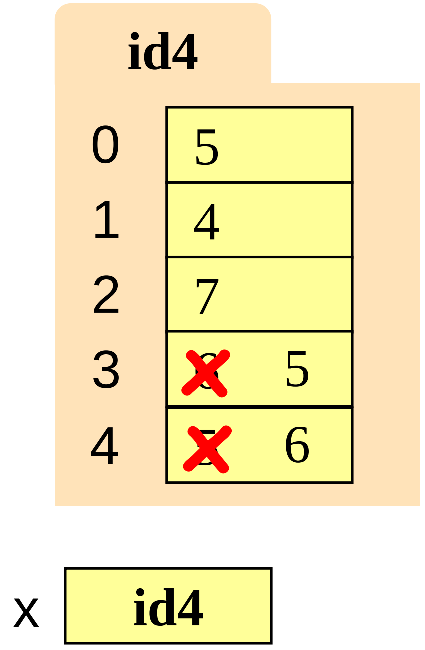
ERASE WHOLE FRAME



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Frame is erased, but folder is not

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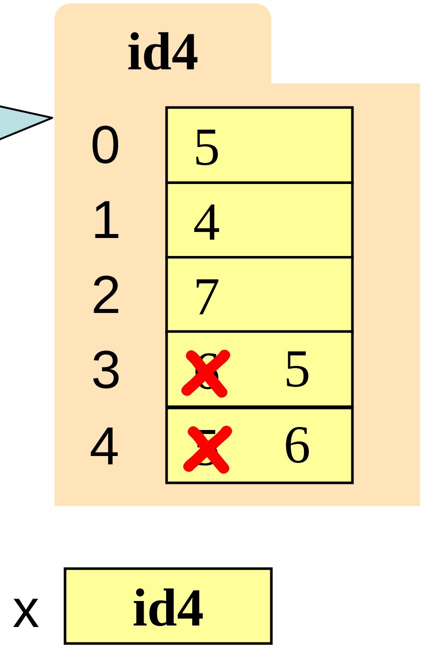
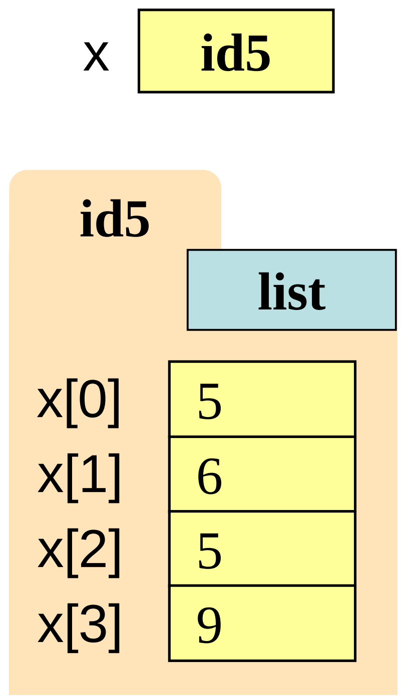
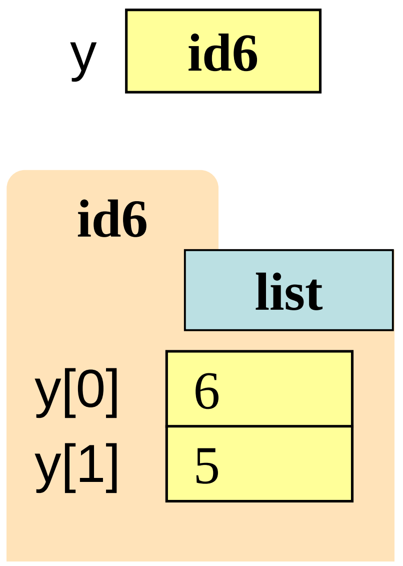


List Slices Make Copies

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

```
y = x[1:3]
```





copy = new folder

Exercise Time

- 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

Exercise Time

- Execute the following:

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

- What is x[4]?

$\boxed{-1}$

- 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

Exercise Time

- Execute the following:

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

- What is x[4]?

-1

- Execute the following:

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

- What is x[1]?

6

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]?

A: 'a+b'
B: 12
C: 57
D: **ERROR**
E: I don’t know

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- Example:

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- Execute the following:

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

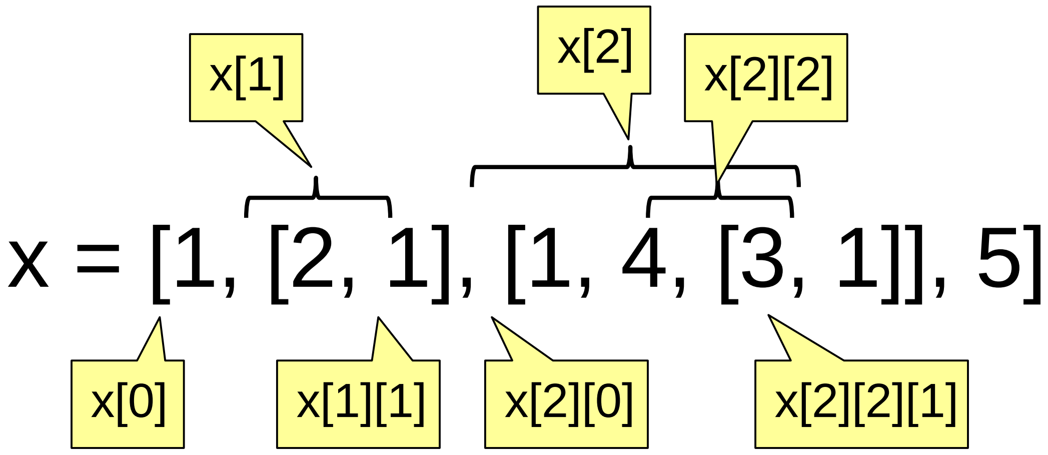
- What is x[2]?

$\boxed{12}$

Nested Lists

- Lists can hold any objects
- Lists are objects
- Therefore lists can hold other lists!

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



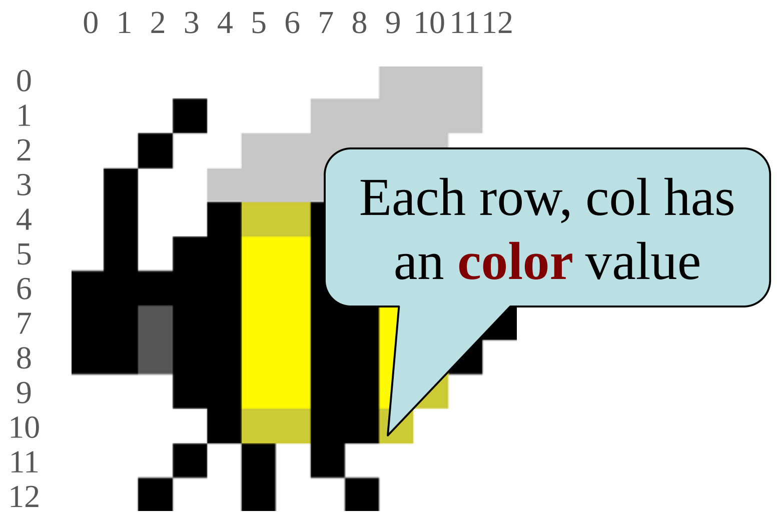
Two Dimensional Lists

Table of Data

	0	1	2	3
0	5	4	7	3
1	4	8	9	7
2	5	1	2	3
3	4	1	2	9
4	6	7	8	0

Each row, col has a value

Images



Store them as lists of lists (**row-major order**)

d = [[5,4,7,3],[4,8,9,7],[5,1,2,3],[4,1,2,9],[6,7,8,0]]

Overview of Two-Dimensional Lists

- Access value at row 3, col 2:

  d[3][2]

- Assign value at row 3, col 2:

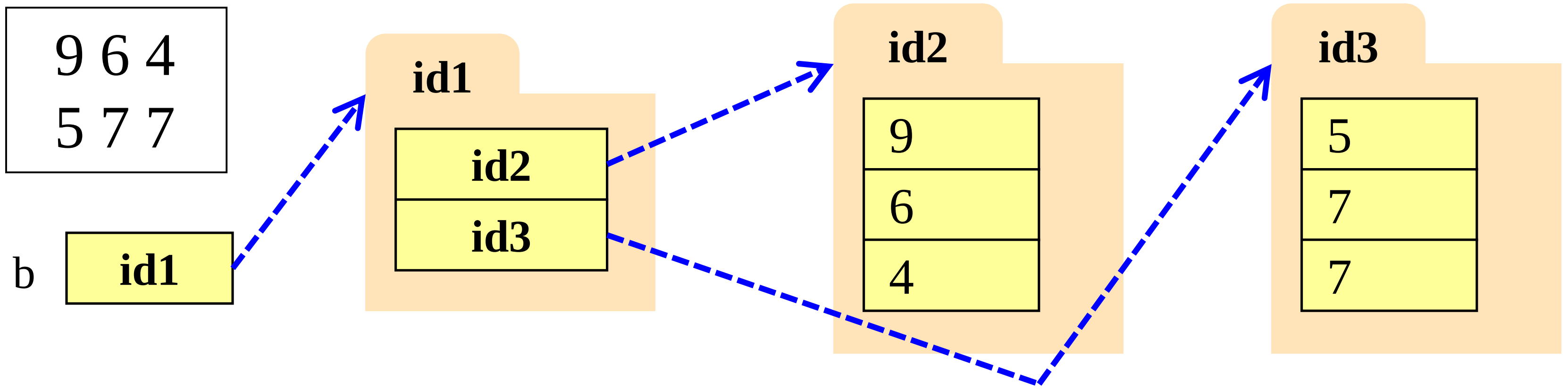
  d[3][2] = 8

- **An odd symmetry**
  - Number of rows of d: len(d)
  - Number of cols in row r of d: len(d[r])

$$\text{d} \quad \begin{array}{c|cccc|} & 0 & 1 & 2 & 3 \\ \hline 0 & 5 & 4 & 7 & 3 \\ 1 & 4 & 8 & 9 & 7 \\ 2 & 5 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 & 9 \\ 4 & 6 & 7 & 8 & 0 \\ \hline \end{array}$$

How Multidimensional Lists are Stored

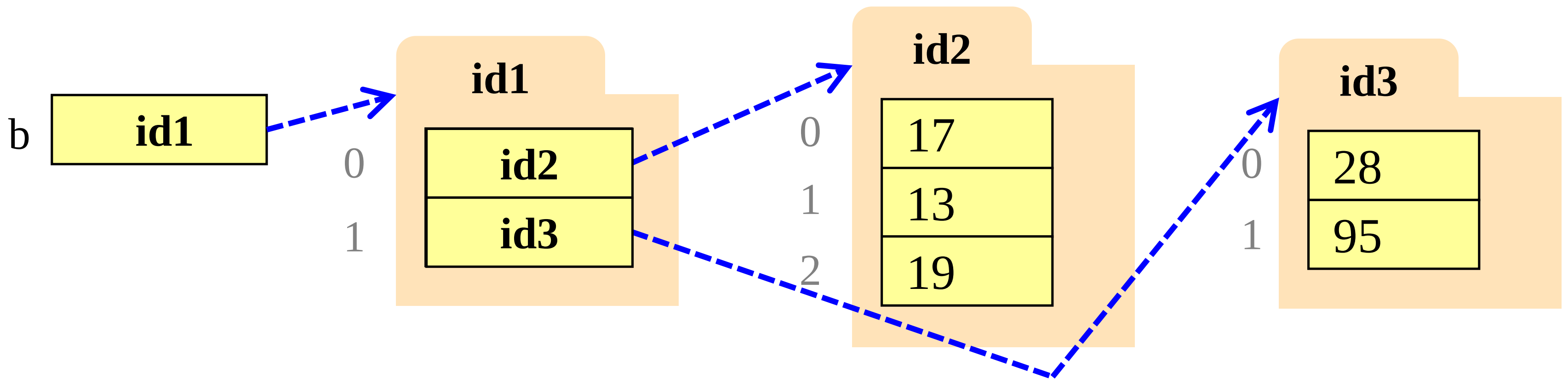
- b = [[9, 6, 4], [5, 7, 7]]



- b holds name of a one-dimensional list
  - Has len(b) elements
  - Its elements are (the names of) 1D lists
- b[i] holds the name of a one-dimensional list (of ints)
  - Has len(b[i]) elements

Ragged Lists: Rows w/ Different Length

- b = [[17,13,19],[28,95]]

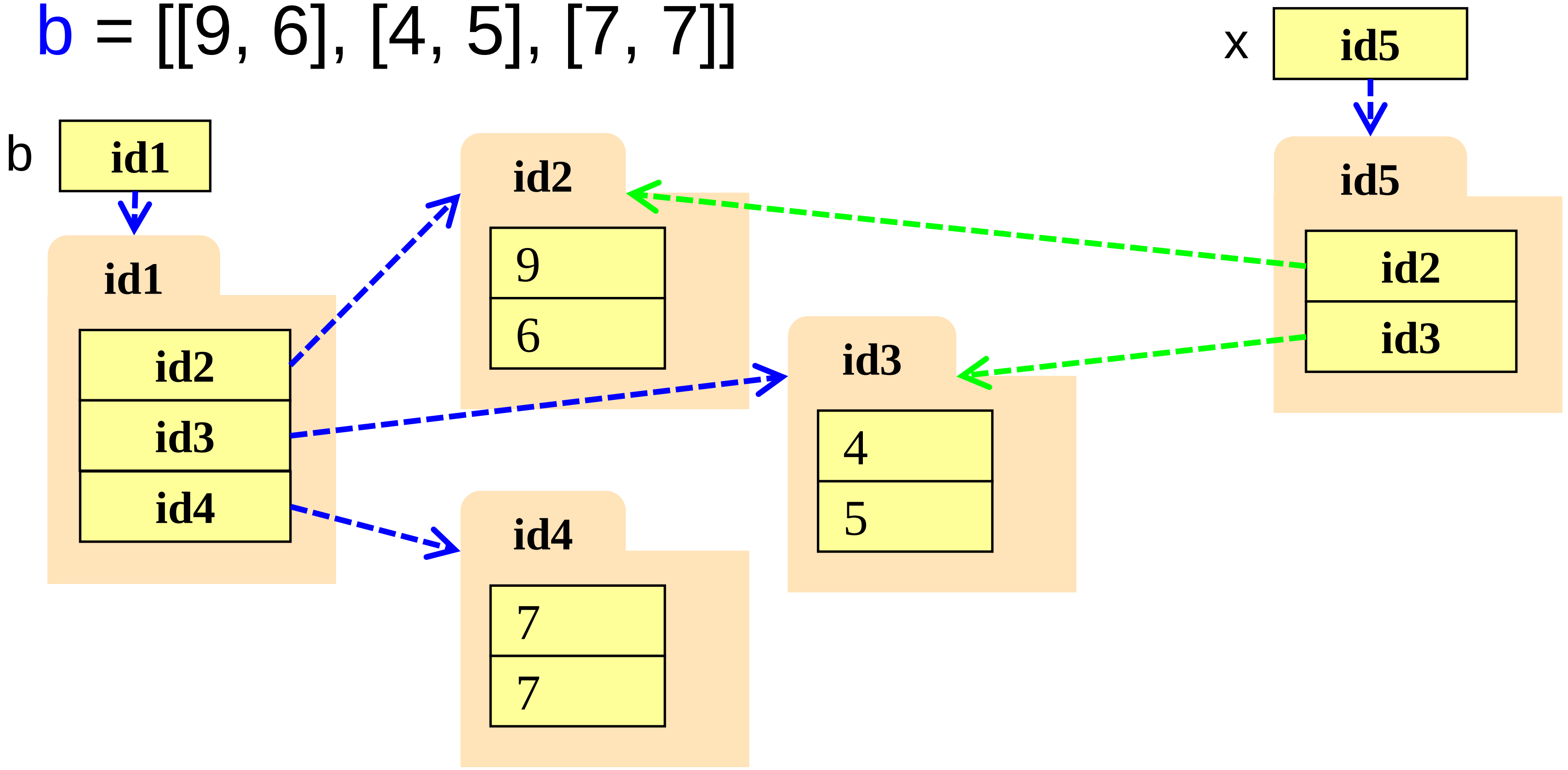


- Will see applications of this later

Slices and Multidimensional Lists

- Only "top-level" list is copied.
- Contents of the list are not altered
- b = [[9, 6], [4, 5], [7, 7]]

x = b[:2]



Slices and Multidimensional Lists

- Create a nested list

  `>>> b = [[9,6],[4,5],[7,7]]`

- Get a slice

  `>>> x = b[:2]`

- Append to a row of x

  `>>> x[1].append(10)`

- x now has nested list

  `[[9, 6], [4, 5, 10]]`

- What are the contents of the list (with name) in b?

A: [[9,6],[4,5],[7,7]]
B: [[9,6],[4,5,10]]
C: [[9,6],[4,5,10],[7,7]]
D: [[9,6],[4,10],[7,7]]
E: I don’t know