Lecture 10:
Lists and Sequences

(Sections 10.0-10.2, 10.4-10.6, 10.8-10.13, 12.1, 12.2)

CS 1110

Introduction to Computing Using Python

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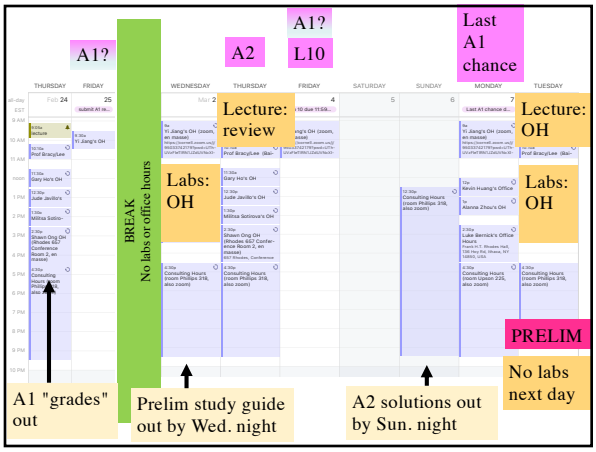

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Today: A1 feedback out, revisions enabled

- Set your CMS notifications to get email when "one of your grades is changed"
- Watch for instruction announcement, but:
  the *expected* first "grade" is **-99999**
  = "there's something we'd like you to fix"
- Revising will change -99999 to -9999 to ... until 10/10!

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Magical traditions: names have power

- **Function:** a genie in a bottle you can **call** on.
  - You put input into the bottle, the genie assigns them "private nicknames" (the **parameter** names)
  - Does "hidden magic"/"scratch work" inside its **call frame** -- the "bottle".
  - Can *delegate* by calling other genies.
- **Call stack:** list of *pending* delegated function calls (to-do list).
- **Object:** can be affected by a function that knows its "secret name", or **id**
  - Created by a special function call "let there be a new Point": **Point(…)**; returns the secret name of new object so you can access it --- *if* you store it somewhere safe (a variable).

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Analogies to ('foreign') languages

- The "dot" (**.**) is like an apostrophe: x.y is like "x's y", or the "y that belongs to x"
- **methods:** functions :: irregular verbs : verbs
  - Different calling syntax: some_string.

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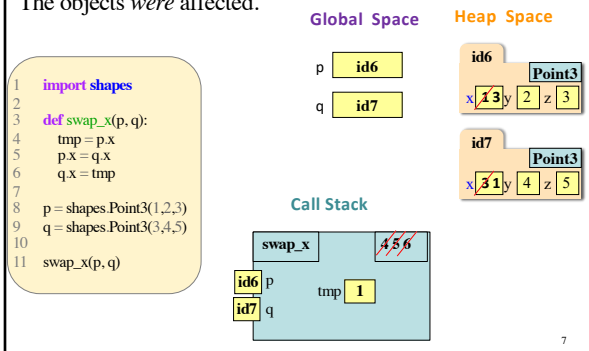
Depicted: when line 6 of swap_x() has been executed, but before function ends (returns None).
The objects *were* affected.



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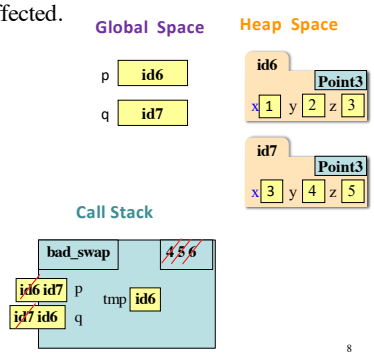
Depicted: when line 6 of bad_swap() has been executed, but before function ends (returns None).
The objects *weren't* affected.

```
1   import shapes
2
3   def bad_swap(p, q):
4       tmp = p
5       p = q
6       q = tmp
7
8   p = shapes.Point3(1,2,3)
9   q = shapes.Point3(3,4,5)
10
11  bad_swap(p, q)
```



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Call stack example (Spring 2021 A2)

```
7     def replace_first(s, target, rep):
8...      """Returns: copy of s with the FIRST instance of target in s
          replaced by rep..."""
16        pos = s.index(target)
17        before = s[:pos]
18...     after = s[pos + len(target):]
20        return before + rep + after
21
22    def replace2(s, target, rep):
23...     """Replace first two occurrences of target in s..."""
27        before = s[:s.index(target)+len(target)]
28        after = s[s.index(target)+len(target):]
29        if s.count(target) > 1:
30            after = replace_first(after, target, rep)
31        else:
32...           WARNING = <does something>
34...     return replace_first(before,target,rep)+after

37    x = "Millissippi"
```

`replace2(x, 'i', 's')`
vs.
`replace2(x, 'ii', 's')`

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Sequences: Lists of Values

String	List
• s = 'abc d'	• x = [5, 6, 5, 9, 15, 23]
0 1 2 3 4 / a b c d	0 1 2 3 4 5 / 5 6 5 9 15 23
• Put characters in quotes	• Put values inside [ ]
▪ Use \' for quote character	▪ Separate by commas
• Access characters with []	• Access **values** with []
▪ s[0] is 'a'	▪ x[0] is 5
▪ s[5] causes an error	▪ x[6] causes an error
▪ s[0:2] is 'ab' (excludes c)	▪ x[0:2] is [5, 6] (excludes 2nd 5)
▪ s[2:] is 'c d'	▪ x[3:] is [9, 15, 23]
• len(s) → 5, length of string	• len(x) → 6, length of list

Sequence is a name we give to both

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Lists Have Methods Similar to String

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

But to get the length of a list you use a function, not a class method:
len(x)
~~x.len()~~

- <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

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Representing Lists

Wrong:

Global Space
x ~~5, 6, 7, -2~~

Correct:

Global Space
x id1

Heap Space
id1 list
0 5
1 7
2 4
3 -2
Indices

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

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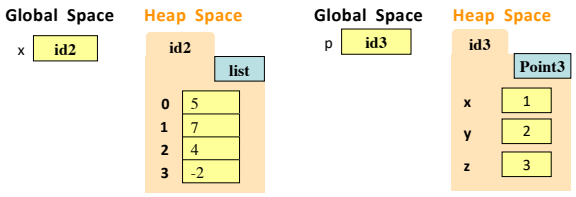
Lists: objects with special syntax (like nouns with "weird" plurals)

List	Objects
• Attributes are indexed	• Attributes are named
▪ Example: x[2]	▪ Example: p.x



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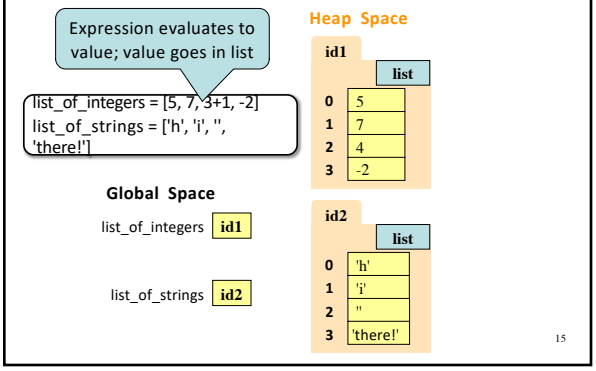
Lists Can Hold Any Type



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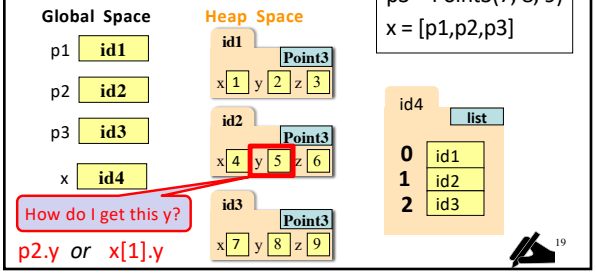
Lists of Objects

- 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]



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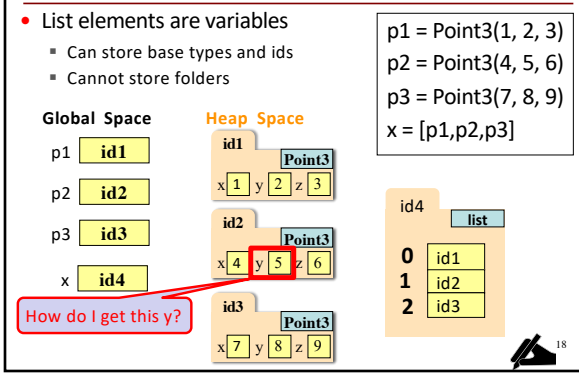
Lists of Objects

- 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]



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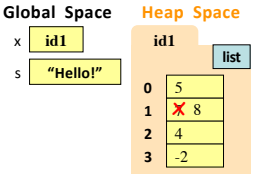
List is *mutable*; strings are not

- **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



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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?

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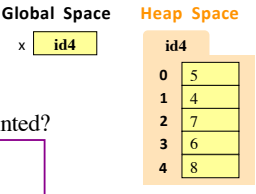
Q2: Swap List Values?

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



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

x = [5, 6, 5, 9]

y = x[1:3]

Global Space: x → id5; y → id6

Heap Space:

id5 (list)

0	5
1	6
2	5
3	9

id6 (list)

0	6
1	5

copy means **new folder**

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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

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A3: 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 **CORRECT**
D: **ERROR**
E: I don't know

Global Space: x → id5; y → id6

Heap Space:

id5 (list)

0	5
1	6
2	5
3	9
4	10

id6 (list)

0	~~6~~ 7
1	5
2	9
3	10

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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

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A4

- Execute the following:

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

- What is x[1]?

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

Global Space: x → id5; y → id5

Heap Space:

id5 (list)

0	5
1	~~6~~ 7
2	5
3	9
4	10

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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

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Returning multiple values

- Can use lists/tuples to **return** multiple values

```
INCHES_PER_FOOT = 12

def to_feet_and_inches(height_in_inches):
    feet = height_in_inches // INCHES_PER_FOOT
    inches = height_in_inches % INCHES_PER_FOOT
    return [feet, inches]

all_inches = 68  # Prof. Bracy wrote this
data= to_feet_and_inches(all_inches)
print(You are “+str(data[0])+” feet, “+str(data[1])+” inches.”)
```

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