

SEQUENCES AND CONTAINERS Solutions

COMPUTER SCIENCE MENTORS 61A

October 3–October 007, 2022

1 Sequences

Sequences are ordered data structures that have length and support element selection. Here are some common types of sequences you'll be dealing with in this class:

- Lists: `[1, [2], 'a', lambda x: 5]`
- Tuples: `(1, (2,), 'a', lambda x: 5)`
- Strings: `'Hello World!'`

While each type of sequence is different, they all share a common interface for manipulating and accessing their data:

- **Item selection:** Use square brackets to select an element at an index:
`(3, 1, 2)[0] → "3", "Hello"[-1] → "o"`
- **Length:** The built-in `len` function returns the length of a sequence:
`len((1, 2)) → 2`
- **Concatenation:** Sequences can be concatenated with the `+` operator, which returns a *new* sequence:
`[1, 2] + [3, 4] → [1, 2, 3, 4]`
- **Membership:** The `in` operator tests for sequence membership:
`1 in (1, 2, 3) → True, 5 not in (1, 2, 3) → True, "apple" in "snapple" → True`
- **Looping:** Sequences can be looped through with `for` loops:

```
>>> for x in [1, 2, 3]:
...     print(x)
1
2
3
```

- **Aggregation:** Common built-in functions—including **sum**, **min**, and **max**—can take sequences and aggregate them into a single value:

```
max((3, 4, 5)) → 5
```

- **Slicing:** Slicing is a way to create a copy of all or part of a sequence. The general syntax for slicing a sequence `seq` is as follows:

```
seq[<start index>:<end index>:<step size>]
```

This evaluates to a new sequence that includes every element starting at `<start index>` and up to and *excluding* `<end index>` in `seq`, taking steps of size `<step size>`.

If we do not supply `<start index>` or `<end index>`, it will start at the beginning of the sequence and include every element up to and including the end of the sequence.

```
>>> lst = [1, 2, 3, 4, 5]
>>> lst[2:]
[3, 4, 5]
>>> lst[:3]
[1, 2, 3]
>>> lst[::-1]
[5, 4, 3, 2, 1]
>>> lst[1::2]
[2, 4]
```

List comprehensions, which only apply to lists, are a concise and powerful method to create a new list from another sequence. The syntax for a list comprehension is

```
[<expression> for <element> in <sequence> if <condition>]
```

We could equivalently write the following:

```
lst = []
for <element> in <sequence>:
    if <condition>:
        lst = lst + [<expression>]
```

The **if** <condition> filter statement is optional. The following list comprehension doubles each odd element of [1, 2, 3, 4]:

```
>>> [i * 2 for i in [1, 2, 3, 4] if i % 2 != 0]
[2, 6]
```

Equivalent in **for** loop syntax:

```
lst = []
for i in [1, 2, 3, 4]:
    if i % 2 != 0:
        lst = lst + [i * 2]
```

1. What would Python display? Draw box-and-pointer diagrams for the following:

```
>>> a = [1, 2, 3]
>>> a
```

```
[1, 2, 3]
```

```
>>> a[2]
```

```
3
```

```
>>> a[-1]
```

```
3
```

```
>>> b = a
>>> a = a + [4, [5, 6]]
>>> a
```

```
[1, 2, 3, 4, [5, 6]]
```

```
>>> b
```

```
[1, 2, 3]
```

```
>>> c = a
>>> a = [4, 5]
>>> a
```

```
[4, 5]
```

```
>>> c
```

```
[1, 2, 3, 4, [5, 6]]
```

```
>>> d = c[3:5]
>>> c[3] = 9
>>> d
```

```
[4, [5, 6]]
```

```
>>> c[4][0] = 7
>>> d
```

```
[4, [7, 6]]
```

```
>>> c[4] = 10
>>> d
```

```
[4, [7, 6]]
```

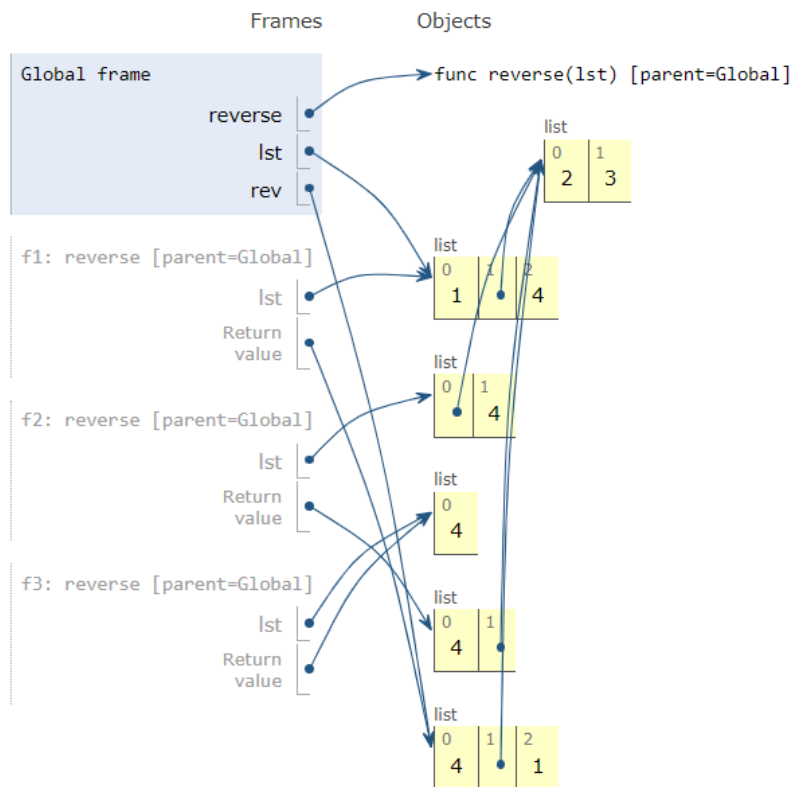
```
>>> c
```

```
[1, 2, 3, 9, 10]
```

2. Draw the environment diagram that results from running the code below.

```
def reverse(lst):
    if len(lst) <= 1:
        return lst
    return reverse(lst[1:]) + [lst[0]]
```

```
lst = [1, [2, 3], 4]
rev = reverse(lst)
```



<https://goo.gl/6vPeX9>

3. Write a list comprehension that accomplishes each of the following tasks.

(a) Square all the elements of a given list, `lst`.

```
[x ** 2 for x in lst]
```

(b) Compute the dot product of two lists `lst1` and `lst2`. *Hint:* The dot product is defined as $lst1[0] \cdot lst2[0] + lst1[1] \cdot lst2[1] + \dots + lst1[n] \cdot lst2[n]$. The Python `zip` function may be useful here.

```
sum([x * y for x, y in zip(lst1, lst2)])
```

(c) Return a list of lists such that `a = [[0], [0, 1], [0, 1, 2], [0, 1, 2, 3], [0, 1, 2, 3, 4]]`.

```
a = [[x for x in range(y)] for y in range(1, 6)]
```

(d) Return the same list as above, except now excluding every instance of the number 2: `b = [[0], [0, 1], [0, 1], [0, 1, 3], [0, 1, 3, 4]]`.

```
b = [[x for x in range(y) if x != 2] for y in range(1, 6)]
```

4. Write a function `duplicate_list`, which takes in a list of positive integers and returns a new list with each element `x` in the original list duplicated `x` times.

```
def duplicate_list(lst):  
    """  
    >>> duplicate_list([1, 2, 3])  
    [1, 2, 2, 3, 3, 3]  
    >>> duplicate_list([5])  
    [5, 5, 5, 5, 5]  
    """
```

```
    _____  
  
    for _____:
```

```
        for _____:
```

```
            _____
```

```
    _____
```

```
new_list = []  
for x in lst:  
    for i in range(x):  
        new_list = new_list + [x]  
return new_list
```

2 Dictionaries

Dictionaries are another useful Python data structure that store a collection of items. However, instead of assigning each item a numerical index, each **value** in a dictionary is mapped to by some **key**.

Dictionaries are denoted with curly braces and use much of the syntax—including item selection with square brackets, membership testing with **in**, and length checking with **len**—is the same as that of sequences. Consider the following “Big” example:

```
>>> big_game_wins = {"Cal": 48, "Stanford": 65}
>>> big_game_wins
{"Cal": 48, "Stanford": 65}
>>> big_game_wins["Stanford"]
65
>>> big_game_wins["Cal"]
48
>>> big_game_wins["Cal"] += 1
>>> big_game_wins["Cal"]
49
```

```
>>> list(big_game_wins.keys())
["Cal", "Stanford"]
>>> list(big_game_wins.values())
[49, 65]
```

```
>>> "Cal" in big_game_wins
True
>>> "Tie" in big_game_wins
False
>>> 65 in big_game_wins
False
```

```
>>> big_game_wins["Tie"]
KeyError: Tie
>>> big_game_wins["Tie"] = 11
>>> big_game_wins["Tie"]
11
```


1. Complete the function `snapshot`, which takes a single-argument function `f` and a list `inputs` and returns a “snapshot” of `f` on `inputs`. A “snapshot” is a dictionary where the keys are the provided `inputs` and the values are the corresponding outputs of `f` on each input.

```
def snapshot(f, inputs):  
    """  
    >>> snapshot(lambda x: x**2, [1, 2, 3])  
    {1: 1, 2: 4, 3: 9}  
    """  
  
    snap = _____  
  
    _____:  
  
    _____  
  
    return snap
```

```
def snapshot(f, inputs):  
    snap = {}  
    for input in inputs:  
        snap[input] = f(input)  
    return snap
```

2. A *digraph* is any pair of immediately adjacent letters; for example, “otto” contains three digraphs: “ot”, “tt”, and “to”. Write a function `count_digraphs`, which takes a piece of text and a list of letters `alphabet` and analyzes the frequency of digraphs in `text`. Specifically, `count_digraphs` returns a dictionary whose keys are the valid digraphs of `text` and whose values are the number of times each digraph occurred. (A digraph is valid if it is formed out of letters from the specified `alphabet`.)

```
def count_digraphs(text, alphabet):
    """
    >>> count_digraphs("otto", ['o', 't'])
    {'ot': 1, 'tt': 1, 'to': 1}
    >>> count_digraphs("otto", ['t'])
    {'tt': 1}
    >>> count_digraphs("6161 6", ['6', '1'])
    {'61': 2, '16': 1}
    """

    freq = {}

    _____:

        if _____:

            digraph = _____

            _____

            _____

            _____

            _____

    return freq


def count_digraphs(text, alphabet):
    freq = {}
    for i in range(len(text) - 1):
        if text[i] in alphabet and text[i + 1] in alphabet:
            digraph = text[i] + text[i + 1]
```

```
        if digraph in freq:
            freq[digraph] += 1
        else:
            freq[digraph] = 1
    return freq
```