

# LIST AND DICTIONARIES 6

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## COMPUTER SCIENCE 61A

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### 1 Lists

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A list is an ordered collection of values. You can have a list of integers, a list of strings, or even a mix of any types of values you want; this means that the list need not be homogenous. You can add and remove items to and from a list them by calling list methods, and you can access elements through the index notation. Let's look at an example:

```
>>> fantasy_team = []
>>> fantasy_team.append("frank gore")
>>> print(fantasy_team)
['frank gore']
>>> fantasy_team.append("calvin johnson")
>>> print(fantasy_team[1])
calvin johnson
>>> fantasy_team.remove("calvin johnson")
>>> fantasy_team[0] = "aaron rodgers"
>>> print(fantasy_team)
['aaron rodgers']
```

Lists can be created using square braces, and likewise, their elements can be accessed via square braces. Just like tuples, lists are zero-indexed. Let's try out some basics.

#### 1.1 Basics

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1. What would Python print?

```
>>> a = [1, 5, 4, 2, 3]
>>> print(a[0], a[-1])

>>> a[4] = a[2] + a[-2]
>>> a

>>> len(a)

>>> 4 in a

>>> a[1] = [a[1], a[0]]
>>> a
```

## 1.2 List methods

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In addition to the indexing operator, lists have many mutating methods, some examples of which are listed here:

1. `append(e1)` → Adds `e1` to the end of the list
2. `index(e1)` → Returns the index of `e1` if it occurs in the list, otherwise errors.
3. `insert(i, e1)` → Insert `e1` at index `i`
4. `remove(e1)` → Removes the first occurrence of `e1` in list, otherwise errors
5. `sort()` → Sorts elements of list *in place*

List methods are called via 'dot notation', as in:

```
>>> fruits = ['apple', 'pineapple']
>>> fruits.append('banana')
```

1. Write a function that removes all instances of an element from a list.

```
def remove_all(e1, lst):
    """Removes all instances of e1 from lst.
    >>> x = [3, 1, 2, 1, 5, 1, 1, 7]
    >>> remove_all(1, x)
    >>> x
    [3, 2, 5, 7]
    """
```

2. Write a function that takes in two values,  $x$  and  $y$ , and a list, and adds as many  $y$ 's to the end of the list as there are  $x$ 's. Do not use the built-in function `count`.

```
def add_this_many(x, y, lst):
    """ Adds y to the end of lst the number of times x occurs in lst.
    >>> lst = [1, 2, 4, 2, 1]
    >>> add_this_many(1, 5, lst)
    >>> lst
    [1, 2, 4, 2, 1, 5, 5]
    """
```

### 1.3 Slicing

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Like tuples, lists also support slicing notation, allowing you to retrieve multiple elements of a list at once. Slicing a list returns a *new* list. Slicing has the following syntax:

```
lst[start:end:interval]
```

where `start`, `end`, and `interval` are integers. The slice includes the element at `start` and every `interval` elements up to but not including the element at `end`. It is legal to omit one or more of `start`, `end`, and `incr`; they default to `0`, `len(lst)`, and `1`, respectively. `start` and `end` can be negative, meaning you count from the end.

```
>>> a = [0, 1, 2, 3, 4, 5, 6]
>>> a[1:4]
[1, 2, 3]
>>> a[1:6:2]
[1, 3, 5]
>>> a[:4] # equivalent to a[0:4]
[0, 1, 2, 3]
>>> a[3:] # equivalent to a[3:len(a)]
[3, 4, 5, 6]
>>> a[1:4:] # equivalent to a[1:4:1] or a[1:4]
[1, 2, 3]
>>> a[-1:]
[6]
```

### 1. What would Python print?

```
>>> a = [3, 1, 4, 2, 5, 3]
```

```
>>> a[:4]
```

```
>>> a
```

```
>>> a[1::2]
```

```
>>> a[:]
```

```
>>> a[4:2]
```

```
>>> a[1:-2]
```

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

### 1.4 For loops

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There are two main methods of looping through lists.

- `for el in lst` → loops through the elements in `lst`
- `for i in range(len(lst))` → loops through the valid, positive indices of `lst`

If you do not need indices, looping over elements is usually more clear. Let's try this out.

1. In the homework, you reversed rlists iteratively and recursively. Let's reverse Python lists *in place*, meaning mutate the passed in list itself, instead of returning a new list. Why is this solution preferred?

```
def reverse(lst):  
    """ Reverses lst in place.  
    >>> x = [3, 2, 4, 5, 1]  
    >>> reverse(x)  
    >>> x  
    [1, 5, 4, 2, 3]  
    """
```

2. Write a function that rotates the elements of a list to the right by  $k$ . Elements should not "fall off"; they should wrap around the beginning of the list. `rotate` should return a new list. To make a list of  $n$  0's, you can do this: `[0] * n`

```
def rotate(lst, k):  
    """ Return a new list, with the same elements  
        of lst, rotated to the right k.  
    >>> x = [1, 2, 3, 4, 5]  
    >>> rotate(x, 3)  
    [3, 4, 5, 1, 2]  
    """
```

## 1.5 Higher order functions

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Many times, we wish an operation to be applied to all elements of a list. Python has methods built in to help us with these tasks:

- `map(fn, lst)` → applies `fn` to each element in `lst`
- `filter(pred, lst)` → keeps those elements in `lst` that satisfy the predicate
- `reduce(accum, lst, zero_value)` → repeatedly calls the accumulator, which takes in two arguments and returns a single value, on elements of `lst`

We can also use higher order functions in *list comprehensions*. List comprehensions are a compact way to apply some operations to a sequence. They look like this:

```
[expression for value in sequence if predicate]
```

where the `if` clause is optional.

1. What would Python print?

```
>>> l_1, l_2 = lambda x: 3*x + 1, lambda x: x % 2 == 0
>>> list(filter(l_2, map(l_1, [1,2,3,4])))
```

```
>>> [x*x - x for x in [1, 2, 3, 4] if x > 2]
```

```
>>> [[y*2 for y in [x, x+1]] for x in [1,2,3,4]]
```

## 2 Dictionaries

Recall that *dictionaries* are data structures that map *keys* to *values*. Dictionaries are usually unordered (unlike real-world dictionaries) – in other words, the key-value pairs are not arranged in the dictionary in any particular order. Let's look at an example:

```
>>> superbowls = {'joe montana': 4, 'tom brady':3, 'joe flacco': 0}
>>> superbowls['tom brady']
3
>>> superbowls['peyton manning'] = 1
>>> superbowls
{'peyton manning': 1, 'tom brady': 3, 'joe flacco': 0, 'joe montana': 4}
>>> superbowls['joe flacco'] = 1
>>> superbowls
{'peyton manning': 1, 'tom brady': 3, 'joe flacco': 1, 'joe montana': 4}
```

Dictionaries are indexed with similar syntax as sequences, only they use keys, which can be any immutable value, not just numbers. Dictionaries themselves are mutable; we can

add, remove, and change entries after creation. There is only one value per key, however, in a dictionary (we call this *injective* or one-to-one).

1. Continuing from above, what would Python print?

```
>>> 'colin kaepernick' in superbowls

>>> len(superbowls)

>>> superbowls['peyton manning'] = superbowls['joe montana']
>>> superbowls[('eli manning', 'giants')] = 2
>>> superbowls[3] = 'cat'
>>> superbowls

>>> superbowls[('eli manning', 'giants')] = \
        superbowls['joe montana'] + superbowls['peyton manning']
>>> superbowls[['steelers', '49ers']] = 11
>>> superbowls
```

Dictionaries in general can be arbitrarily deep, meaning their values can be dictionaries themselves. Let's get practice traversing these deep structures. To do so, we'll need to know a couple more things about dictionaries.

To iterate over a dictionary's keys:

```
for k in d.keys():
    ...
```

and to remove an entry:

```
del dictionary[key]
```

2. Given a dictionary replace all occurrences of *x* as the value with *y*.

```
def replace_all(d, x, y):
    """Replaces all values of x with y.
    >>> d = {1: {2:3, 3:4}, 2:{4:4, 5:3}}
    >>> replace_all(d, 3, 1)
    >>> d
    {1: {2: 1, 3: 4}, 2: {4: 4, 5: 1}}
    """
```

3. Given a (non-nested) dictionary delete all occurrences of a value. You cannot delete items in a dictionary as you are iterating through it.

```
def rm(d, x):
    """Removes all pairs with value x.
    >>> d = {1:2, 2:3, 3:2, 4:3}
    >>> rm(d, 2)
    >>> d
    {2:3, 4:3}
    """
```