

# Lists

BBM 101 - Introduction to Programming I

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## What is a List?

- A list is an ordered sequence of values

3	1	4	4	5	9
---	---	---	---	---	---

"Four"	"score"	"and"	"seven"	"years"
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- What operations should a list support efficiently and conveniently?
  - Creation
  - Querying
  - Modification

2

## List Creation

```
a = [ 3, 1, 2*2, 1, 10/2, 10-1 ]
```

3	1	4	1	5	9
---	---	---	---	---	---

```
b = [ 5, 3, 'hi' ]
```

```
c = [ 4, 'a', a ]
```

3

## List Querying

- Extracting part of the list:
  - Single element: `mylist[index]`
  - Sublist ("slicing"): `mylist[startidx : endidx]`
- Find/lookup in a list
  - `elt in mylist`
    - Evaluates to a boolean value
  - `mylist.index(x)`
    - Return the int index in the list of the first item whose value is x. It is an error if there is no such item.
  - `list.count(x)`
    - Return the number of times x appears in the list.

4

## List Mutation

- Insertion
- Removal
- Replacement
- Rearrangement

5

## List Insertion

- `mylist.append(x)`
  - Extend the list by inserting `x` at the end
- `mylist.extend(L)`
  - Extend the list by appending all the items in the argument list
- `mylist.insert(i, x)`
  - Insert an item before the a given position.
  - `a.insert(0, x)` inserts at the front of the list
  - `a.insert(len(a), x)` is equivalent to `a.append(x)`

6

## List Removal

- `list.remove(x)`
  - Remove the first item from the list whose value is `x`
  - It is an error if there is no such item
- `list.pop([i])`
  - Remove the item at the given position in the list, and return it.
  - If no index is specified, `a.pop()` removes and returns the last item in the list.

Notation from the Python Library Reference:  
The square brackets around the parameter, "[i]", means the argument is *optional*.  
It does *not* mean you should type square brackets at that position.

7

## List Replacement

- `mylist[index] = newvalue`
- `mylist[start : end] = newsublist`
  - Can change the length of the list
  - `mylist[ start : end ] = []` removes multiple elements
  - `a[len(a):] = L` is equivalent to `a.extend(L)`

8

## List Rearrangement

- `list.sort()`
  - Sort the items of the list, in place.
  - “in place” means by modifying the original list, not by creating a new list.
- `list.reverse()`
  - Reverse the elements of the list, in place.

9

## How to Evaluate a List Expression

There are two new forms of expression:

- `[a, b, c, d]` **list creation**
  - To evaluate:
    - evaluate each element to a value, from left to right
    - make a list of the values
  - The elements can be arbitrary values, including lists
    - `["a", 3, 3.14*r*r, fahr_to_cen(-40), [3+4, 5*6]]`

Same tokens “`[]`”  
with two *distinct*  
meanings

List  
expression

Index  
expression

- `a[b]` **list indexing or dereferencing**

To evaluate:

- evaluate the list expression to a value
- evaluate the index expression to a value
- if the list value is not a list, execution terminates with an error
- if the element is not in range (not a valid index), execution terminates with an error
- the value is the given element of the list value (counting from **zero**) 10

## List Expression Examples

What does this mean (or is it an error)?

```
["four", "score", "and", "seven", "years"][2]
```

```
["four", "score", "and", "seven", "years"][0,2,3]
```

```
["four", "score", "and", "seven", "years"][[0,2,3]]
```

```
["four", "score", "and", "seven", "years"][[0,2,3][1]]
```

11

## Exercise: List Lookup

```
def index(somelist, value):
```

```
    """Return the position of the first occurrence  
    of the element value in the list somelist.  
    Return None if value does not appear in  
    somelist."""
```

Examples:

```
gettysburg = ["four", "score", "and", "seven",  
              "years", "ago"]  
index(gettysburg, "and") => 2  
index(gettysburg, "years") => 4
```

Fact: `mylist[index(mylist, x)] == x`

12

## Exercise: List Lookup

```
def index(somelist, value):
    """Return the position of the first occurrence
    of the element value in the list somelist.
    Return None if value does not appear in
    somelist."""

    i = 0
    for c in somelist:
        if c == value:
            return i
        i = i + 1
    return None
```

13

## Exercise: Convert Units

```
ctemps = [-40, 0, 20, 37, 100]
# Goal: set ftemps to [-40, 32, 68, 98.6, 212]
# Assume a function celsius_to_fahrenheit exists

ftemps = []
for c in ctemps:
    f = celsius_to_fahrenheit(c)
    ftemps.append(f)
```

14

## List Slicing

`mylist[startindex : endindex]` evaluates to a **sublist** of the original list

– `mylist[index]` evaluates to an **element** of the original list

- Arguments are like those to the **range** function
  - `mylist[start : end : step]`
  - start index is inclusive, end index is exclusive
  - All 3 indices are *optional*
- Can assign to a slice: `mylist[s : e] = yourlist`

15

## List Slicing Examples

```
test_list = ['e0', 'e1', 'e2', 'e3', 'e4', 'e5', 'e6']
```

From e2 to the end of the list:

```
test_list[2:]
```

From beginning up to (but not including) e5:

```
test_list[:5]
```

Last element:

```
test_list[-1]
```

Last four elements:

```
test_list[-4:]
```

Everything except last three elements:

```
test_list[:-3]
```

Reverse the list:

```
test_list[::-1]
```

Get a copy of the whole list:

```
test_list[:]
```

16