

# Lists

Ruth Anderson

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# Lists

- What do we already know about Lists?
- List Operations
  - Creation
  - Querying
  - Modification

# Loop Examples: Where's the list?

```
for num in [2, 4, 6]:  
    print(num)
```

[See in python tutor](#)

```
for i in [1, 2, 3]:  
    print("Hi there!")
```

sequence is a string, NOT a list

```
for char in "happy":  
    print(char)
```

Prints the values  
of sequence

# The range function: returns a list

A typical for loop does not use an explicit list:

```
for i in range (5) :
```

```
... body ...
```

Upper limit  
(*exclusive*)

Produces the list  
[0, 1, 2, 3, 4]

```
range (5) : cycles through [0, 1, 2, 3, 4]
```

Lower limit  
(*inclusive*)

```
range (1 , 5) : cycles through [1, 2, 3, 4]
```

step (distance  
between elements)

```
range (1 , 10 , 2) : cycles through [1, 3, 5, 7, 9]
```

# What is a list?

- A list is an ordered sequence of values

- A list of integers:

[3, 1, 4, 4, 5, 9]

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

- A list of strings:

["Four", "score", "and", "seven", "years"]

|        |         |       |         |         |
|--------|---------|-------|---------|---------|
| 0      | 1       | 2     | 3       | 4       |
| "Four" | "score" | "and" | "seven" | "years" |

- Each value has an **index**
  - Indexing is zero-based (counting starts with zero)
- `len([3, 1, 4, 4, 5, 9])` returns 6

# List Operations

- What operations should a list support efficiently and conveniently?
  - Creation
  - Querying
  - Modification

# 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 ]
```

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

# List Querying

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

Expressions that return parts of lists:

- Single element: `mylist[index]`
  - The single element stored at that location
- Sublist (“slicing”): `mylist[start:end]`
  - the sublist that starts at index `start` and ends at index `end - 1`
  - If `start` is omitted: defaults to 0
  - If `end` is omitted: defaults to `len(mylist)`
  - `mylist[:]` evaluates to the whole list
  - `mylist[0:len(mylist)]` also does

# Indexing and Slicing Examples

```
a = [3, 1, 4, 4, 5, 9]
print(a[0])
print(a[5])
print(a[6])
print(a[-1]) # last element in list
print(a[-2]) # next to last element

print(a[0:2])
print(a[0:-1])
```

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

```
a = [3, 1, 4, 4, 5, 9]
```

What is printed by: `print(a[1:3])`  
[pollev.com/rea](http://pollev.com/rea)

A. [3, 1]

B. [3, 1, 4]

C. [1, 4]

D. [1, 4, 4]

E. [1, 2, 3]

# More List Querying

- Find/lookup in a list

**`x in mylist`**

- Returns True if **`x`** is found in **`mylist`**

**`mylist.index(x)`**

- Return the integer index in the list of the *first item* whose value is **`x`**.
- It is an error if there is no such item.

**`mylist.count(x)`**

- Return the number of times **`x`** appears in the list.

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

# List Querying Examples

```
a = [3, 1, 4, 4, 5, 9]
print(5 in a)
print(16 in a)
print(a.index(4))
print(a.index(16))
print(a.count(4))
print(a.count(16))
```

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

# List Modification

- Insertion
- Removal
- Replacement
- Rearrangement

# List Insertion

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 |
| 3 | 1 | 4 | 4 | 5 | 9 |

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

**Note:** `append`, `extend` and `insert` all return `None`

# List Insertion Examples

```
lst = [1, 2, 3, 4]
lst.append(5)
lst.extend([6, 7, 8])
lst.insert(3, 3.5)
```

What is printed by: `print(lst[2])`

```
lst = [1, 3, 5]
lst.insert(2, [4, 6])
print(lst[2])
```

- A. 4
- B. 5
- C. 3
- D. [4, 6]
- E. IndexError: list index out of range

# List Removal

- `mylist.remove(x)`
  - Remove the first item from the list whose value is **x**
  - It is an error if there is no such item
  - Returns **None**

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.

- `mylist.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.

**Note: `remove` returns `None`**

# List Replacement

- `mylist[index] = newvalue`
- `mylist[start:end] = newsublist`
  - Replaces `mylist[start]... mylist[end - 1]` with `newsublist`
  - Can change the length of the list
- `mylist[start:end] = []`
  - removes `mylist[start]... mylist[end - 1]`
- `mylist[len(mylist):] = L`
  - is equivalent to `a.extend(L)`

# List Removal & Replacement Examples

```
lst = [1, 2, 3, 4, 5, 6, 7]
print(lst.pop())
print(lst.pop(1))
lst.remove(3)
lst[3] = 'blue'
lst[1:3] = [10, 11, 12]
```

# List Rearrangement

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

**Note:** `sort` and `reverse` return **None**

# List Modification Examples

```
lst = [1, 2, 3, 4, 5]
lst.append(7)
lst.extend([8, 9, 3])
lst.insert(2, 2.75)
lst.remove(3)
print(lst.pop())
print(lst.pop(4))
lst[1:5] = [20, 21, 22]
lst2 = [4, 6, 8, 2, 0]
lst2.sort()
lst2.reverse()
lst3 = lst2
lst4 = lst2[:]
lst2[-1]= 17
```

# What will convert a into [1, 2, 3, 4, 5]?

[pollev.com/rea](http://pollev.com/rea)

`a = [1, 3, 5]`

A. `a.insert(1, 2)`

`a.insert(2,4)`

B. `a[1:2] = [2, 3, 4]`

C. `a.extend([2, 4])`

D. `a[1] = 2`

`a[3] = 4`

# 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`

# Exercise: list lookup (Answer #1)

```
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
```

## Exercise: list lookup (Answer #2)

```
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."""  
    for i in range(len(somelist)):  
        if somelist[i] == value:  
            return i  
    return None
```

# 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 = []
```

# Exercise: Convert Units (Answer)

```
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)
```

# More on 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`

# List Slicing Examples

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

```
test_list[2:]
```

```
test_list[:5]
```

```
test_list[-1]
```

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

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

```
test_list[:]
```

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

# Answer: List Slicing Examples

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

|                              |   |
|------------------------------|---|
| <code>test_list[2:]</code>   | From e2 to the end of the list              |
| <code>test_list[:5]</code>   | From beginning up to (but not including) e5 |
| <code>test_list[-1]</code>   | Last element                                |
| <code>test_list[-4:]</code>  | Last four elements                          |
| <code>test_list[:-3]</code>  | Everything except last three elements       |
| <code>test_list[:]</code>    | Get a copy of the whole list                |
| <code>test_list[::-1]</code> | Reverse the list                            |

# 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, **fahr\_to\_cent(-40)**, [3 + 4, 5 \* 6]]

Same tokens "[ ]"  
with two *distinct*  
meanings

List  
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**)

Index  
expression

# 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]]
```