COMPSCI 1☺1

Principles of Programming

Lecture 14 – the `in` operator, lists, use `for … in` loops to iterate through the elements of a list

Learning outcomes

At the end of this lecture, students should be able to:

- create a new list
- obtain the length of a list
- use the + operator to concatenate lists
- use the in operator to check if an element is in the list
- iterate through a list using a for…in loop

Recap on for … in range(…) loops

From lecture 13

- the Python range() function is used to define a sequence of values
- a for…in range() loop can be used to implement counter-controlled repetition

```
def print_series(start_num, how_many):
    num = start_num
    for to_add in range(how_many):
        num = num + to_add
        print(num, end=" ")
    print()

def main():
    print_series(2, 8)
    print_series(5, 12)
    print_series(16, 9)

main()
```

```
2 3 5 8 12 17 23 30
5 6 8 11 15 20 26 33 41 50 60 71
16 17 19 22 26 31 37 44 52
```

```
2    3    5    8    12    17    23    30
   +1   +2   +3   +4    +5    +6    +7
```

The membership operator (in)

The operator, 'in', can be used to check if one string is part of another string. True is returned if the element is in the list, False otherwise.

```
def check_first_last(word):
    vowels = "aeiou"
    message1 = "vowel"
    message2 = "non-vowel"
    to_print = word + ": "
    if word[0] in vowels:
        to_print = to_print + message1
    else:
        to_print = to_print + message2
    if word[-1] in vowels:
        to_print = to_print + " … " + message1
    else:
        to_print = to_print + " … " + message2
    print(to_print)
def main():
   check_first_last("ground")
   check_first_last("ouch")
   check_first_last("agree")
```

```
ground: non-vowel … non-vowel
ouch: vowel … non-vowel
agree: vowel … vowel
```

Why lists?

Let's say we want to store the bank balance amount for every student in this class.

```
bank01 = 2000
bank02 = 231
bank03 = 21
bank04 = -3000
….
```

To calculate the total of the first four bank balances?

```
total = bank01 + bank02 + bank03 + bank04
```

To calculate the total of all the bank balances?

```
total = bank01 + bank02 + bank03 + bank04 + bank05 +
                                             bank06 + …
```

Very awkward!

The list data structure

A **list** is an **ordered** sequence of variables (called elements of the list).

Each element of a list has a position in the list, i.e., an **index** number. The index number always starts at 0.

Each element of a list can be accessed using its index number.

An analagy:

A simple variable

8172 Green St

single_home

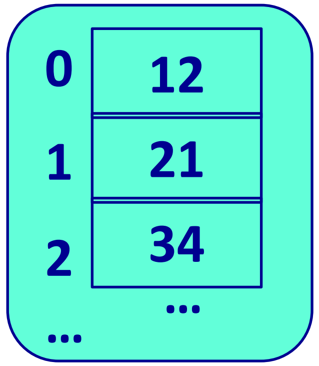
A structure with many variables

3 / 156 Green St

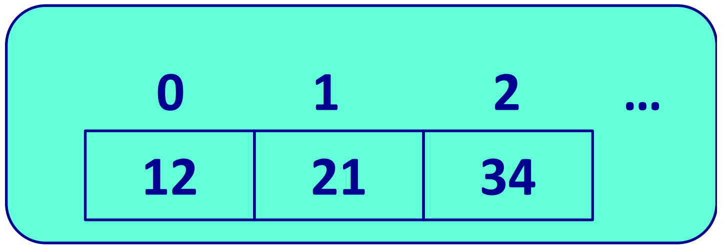
many_homes[0], many_homes[1], many_homes[2], …

Visualising a list data structure

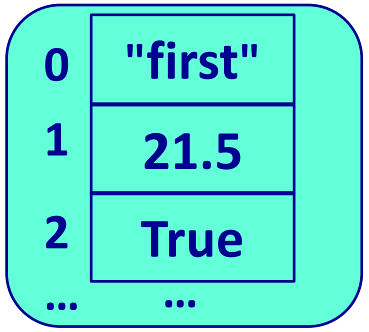
A list can be visualised:



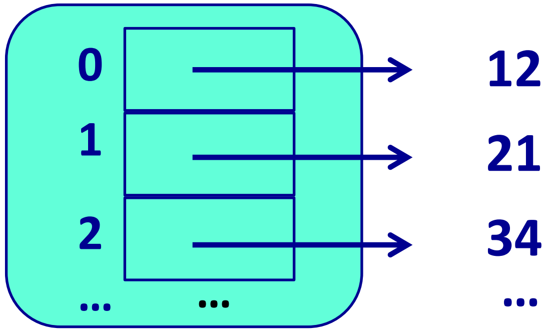
or

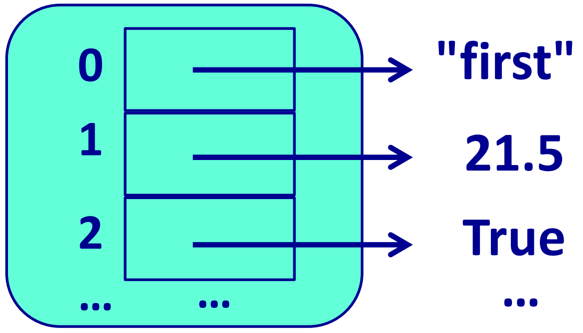


The elements of a list can be of any type, e.g.,



In reality, each element of a list is a reference (see the two diagrams below):

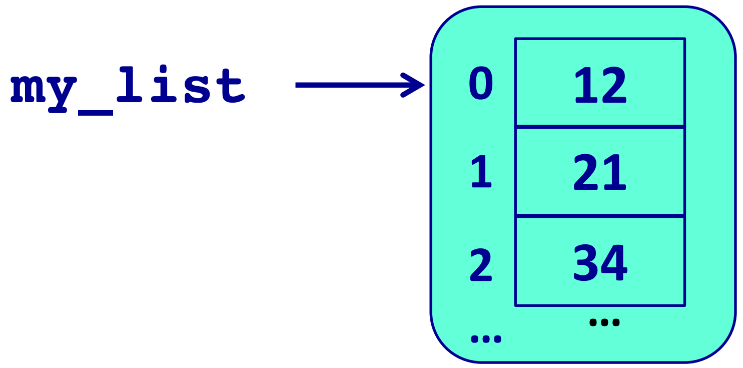




List – use square brackets

Square brackets are used with lists.

For example, for the following list (named `my_list`),

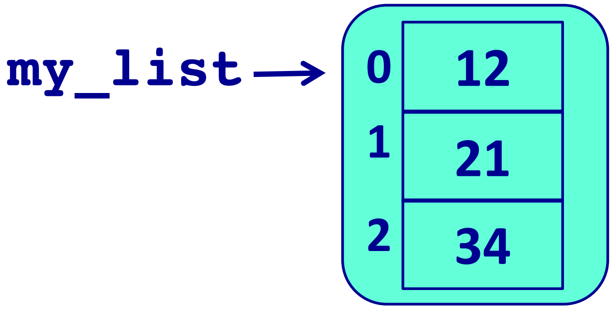


the element at position 1 in the list can be referred to as **`my_list[1]`**, the first element (at position 0 in the list) can be referred to as **`my_list[0]`**, and so on.

Creating a list in Python

Square brackets are used to **create a list** which contains some elements. Each element is separated from the next element using a comma, e.g.,

```
my_list = [12, 21, 34]
```



An **empty list** (contains no elements) can be created:

```
my_list = []
```

Another way to create an empty list is:

```
my_list = list()
```

Note that list is a special word in Python. It refers to the list data structure and it should not be used as a variable name.

Printing a list, the length of a list

Lists can be printed using the `print()` function:

```
my_list = [5, 2, 7, 4, 3, 8, 0, 1, 9, 6, -3]
list1 = []
list2 = ['Try', 'something', 'new']
print(my_list)
print(list1)
print(list2)
```

```
[5, 2, 7, 4, 3, 8, 0, 1, 9, 6, -3]
[]
['Try', 'something', 'new']
```

The **length of a list** is the number of elements currently in the list. The function `len()` can be used to obtain the current length of a list, e.g.,

```
#Continuing from the code above

number_of_elements = len(my_list)
print(number_of_elements)
print(len(list1))
print(len(list2))
```

```
11
0
3
```

Concatenating lists

The **+ operator** can be used to concatenate (join) two lists. Concatenation returns a **new** list containing the elements of the first list followed by the elements of the second list, e.g.,

```
list1 = ['When', 'all', 'else']
list2 = ['fails,', 'read']
list1 = list1 + list2 +  ['the', 'directions']
print("1.", list1)

my_list = [5, 2, 7]
my_list = my_list + [3, 5]
my_list = my_list + [6, 7]

print("2.", my_list)
```

```
1. ['When', 'all', 'else', 'fails,', 'read', 'the', 'directions']
2. [5, 2, 7, 3, 5, 6, 7]
```

Adding an element to the end of a list - NOT ON THE RECORDING -

The **append(**new_element**)** adds the parameter element to the end of the list.

```
list1 = [10, 20, 30, 40, 50, 55]
list1.append(77)
print("1.", list1)

list1.append(99)
print("2.", list1)

list1.append(44)
print("3.", list1)
```

```
1. [10, 20, 30, 40, 50, 55, 77]
2. [10, 20, 30, 40, 50, 55, 77, 99]
3. [10, 20, 30, 40, 50, 55, 77, 99, 44]
```

Notes:

- **append(**new_element**)** is a method and dot-notation is used to apply this method, i.e.

  `the_list_object.append(element_to_append)`

- This method does NOT create a new list object.

Populating a list using the range() function

The Python `range()` function defines a sequence of integer values within two boundaries (see previous lecture).

The `range()` function can be used to populate a list, e.g.,

```
my_list1 = list(range(5))
print("1.", my_list1)

my_list2 = list(range(10, 20, 3))
print("2.", my_list2)

my_list3 = list(range(10, 4, -2)) + list(range(4, 10, 3))
print("3.", my_list3)
```

```
1. [0, 1, 2, 3, 4]
2. [10, 13, 16, 19]
3. [10, 8, 6, 4, 7]
```

The membership operator (in)

The Python **'in' operator** can be used to test if an element is currently present in a list. `True` is returned if the element is in the list, `False` otherwise e.g.,

```
def search_feedback(num_to_find, a_list):
   if num_to_find in a_list:
      print('It is there')
   elif num_to_find + 1 in a_list or num_to_find - 1 in a_list:
      print('Close!')
   else:
      print('Not even close!')

def main():
   my_list = [1, 2, 3, 4]
   search_feedback(-1, my_list)
   search_feedback(5, my_list)

main()
```

```
Not even close!
Close!
```

Accessing elements of a list

Each element in a list can be accessed using its index value. (Reminder: square brackets are used with lists).

```
def main():
   a_list = ['What', 'I', "didn't", 'expect,', 'changed', 'me']
   phrase = a_list[1] + " " + a_list[4]
   print(phrase)

   phrase = a_list[0] + " " + a_list[4] + " " + a_list[5]
   print(phrase)

main()
```

```
I changed
What changed me
```

Note that accessing an element at an index value which doesn't exist in the list gives an index error:

```
a_list = ['What', 'I', "didn't", 'expect,', 'changed', 'me']
print(a_list[6])
```

```
IndexError: list index out of range
```

Lists are mutable objects. The elements of a list can be updated.

```
def main():
   my_list = [15, 12, 17, 10, 13, 18]
   print("1.", my_list)

   my_list[5] = my_list[5] + my_list[4]
   my_list[0] = my_list[1] + my_list[2]
   my_list[1] = my_list[1] * my_list[3] – 40

   length = len(my_list)
   my_list[length - 2] = my_list[length - 1]
   print("2.", my_list)

   my_list[length - 1] = "Bye"
   print("3.", my_list)

main()
```

```
1. [15, 12, 17,  10,  13,  18]
2. [29, 80, 17,  10,  31,  31]
3. [29, 80, 17,  10,  31,  'Bye']
```

Visiting each element in the list

One way of accessing each element of a list is shown below where each element is printed:

```
def main():
   my_list = ['We', 'are', 'not', 'anticipating', 'any',
                                            'emergencies']
   print(my_list[0])
   print(my_list[1])
   print(my_list[2])
   print(my_list[3])
   print(my_list[4])
   print(my_list[5])

main()
```

```
We
are
not
anticipating
any
emergencies
```

This is not a useful way of visiting each element.

What if there were 100000 elements in the list?

Visiting each element in the list

The **for…in** structure can be used to iterate through each element in the list (in their index order from 0 to the end of the list).

```
def main():
   my_list =  ['No', 'keyboard', 'detected.', 'Press', 'F1',
                                                'to', 'continue']
   for element in my_list:
       print(element)

main()
```

```
No
keyboard
detected.
Press
F1
to
continue
```

```
for item in my_list:
    print(item)
```

```
for word in my_list:
    print(word)
```

Both these loops on the left do exactly the same job as the loop above.

Using lists - example

The following program visits each element of a list. The loop variable (`item` in this code) is assigned a reference to **each element** of the list in turn.

```
def count_items(a_list, max_allowed):
   count = 0
   for item in a_list:
       if item < max_allowed:
           count = count + 1
   return count

def main():
   my_list = list()
   for count in range(500):
      num = random.randrange(1, 500)
      my_list = my_list + [num]

   print(count_items(my_list, 250), "elements are under 250")

main()
```

```
238 elements are under 250
```

Complete the function 1

Complete the following function which is passed a list of `ints` as a parameter and returns a **new list** in which each element is the squared value of the element in the original list.

```
import random
def get_list_of_squares(a_list):




def main():
   my_list = list()
   for count in range(10):
      my_list = my_list + [random.randrange(1, 10)]
   print("1.", get_list_of_squares(my_list))
   print("2.", my_list)

main()
```

```
1. [64, 64, 9, 36, 81, 64, 36, 64, 4, 1]
2. [8, 8, 3, 6, 9, 8, 6, 8, 2, 1]
```

Complete the function 2

Complete the `print_xs()` function which prints a line of characters: an "X" is printed if the corresponding element of the parameter list is `True`, otherwise a space is printed (see the output of the example below where the elements in indexes 0, 3 and 5 are `True`).

```
def print_xs(a_list):





def main():
   print("0123456789")
   my_list = [True, False, False, True, False, True]
   print_xs(my_list)

main()
```

```
0123456789
X  X X
```

Complete the function 3

Complete the `start_with_vowel_count()` function which returns the number of words in the list which start with a vowel. Assume each word in the list has at least one letter.

```
def start_with_vowel_count(a_list):
    vowels = "aeiouAEIOU"









def main():
    my_list = ['Nobody', 'goes', 'to', 'that', 'restaurant',
                        'because', 'it', 'is', 'too', 'crowded']
    vowel_starters = start_with_vowel_count(my_list)
    print("Start with a vowel", vowel_starters)
main()
```

```
Start with a vowel: 2
```

Complete the function 4

Complete the following function which prints the largest even number in the parameter list. You can assume that there is at least one element in the list. If the list contains no even numbers message1 is printed.

```
import random
def print_highest_even_num(a_list):
  message1 = "There are no even numbers in this list."
  message2 = "The highest even number:"


def main():
  my_list = list()
  for count in range(0, 10):
     my_list = my_list + [random.randrange(10, 100)]
  print("1.", my_list)
  print_highest_even_num(my_list)

main()
```

```
1. [11, 91, 95, 83, 93, 28, 31, 23, 16, 40]
The highest even number: 40
```

```
1. [73, 87, 89, 69, 23, 25, 67, 21, 31, 73]
There are no even numbers in this list.
```

Summary

In a Python program:

- a list object can be created
- square brackets are are part of the notation used with list
- the length of a list can be obtained using the len() functions
- the + operator is used to concatenate two lists
- the 'in' operator is used to check if an element is in the list
- we can iterate through the elements of a list using a for…in loop

Examples of Python features used in this lecture

```
def print_section():
    a_list = ['What', 'I', "didn't", 'expect,',
                                               'changed', 'me']
    phrase = a_list[1], a_list[4]
    print(phrase)
    phrase = a_list[0], a_list[4], a_list[5]
    print(phrase)


def get_list_of_squares(a_list):
    count = 0
    square_list = []
    for item in a_list:
        square_list = square_list  + [item * item]
    return square_list

def create_list_of_randoms():
    my_list = list()
    for i in range(500):
        num = random.randrange(1, 500)
        my_list = my_list  + [num]
```