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

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

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

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

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

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

Why lists?
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 + ...
```
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 analogy:

A simple variable
- single_home

A structure with many variables
- many_homes[0], many_homes[1], many_homes[2], ...

List - Square brackets

Square brackets are used with lists. For example, for the following list (named my_list),

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

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.

Visualising a list data structure

A list can be visualised:

```
0 1 2 ...
12 21 34 ...
```
or

```
0 1 2 ...
“first” 21.5 True ...
```

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):

```
0 1 2 ...
12 21 34 ...
```

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:

```python
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)
```

![List printing example](image)

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.,

```python
#Continuing from the code above
number_of_elements = len(my_list)
print(number_of_elements)
print(len(list1))
print(len(list2))
```

![Length calculation example](image)

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.,

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

![List concatenation example](image)

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.,

```python
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)
```

![List population example](image)

The Python 'in' operator

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.,

```python
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 = list(range(1, 5))
    search_feedback(-1, my_list)
    search_feedback(5, my_list)
    main()
```

![In operator example](image)
Accessing elements of a list

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

```python
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()
```

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

```python
def main():
a_list = ['What', 'I', 'didn't', 'expect', 'changed', 'me']
print(a_list[6])
```

Assigning new values to elements of the list

Elements of a list can be assigned new values (square brackets are used with lists.)

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

    print("2.", my_list)

    my_list[0] = my_list[1] + my_list[2]
    length = len(my_list)

    my_list[length - 2] = my_list[length - 1]
    print("3.", my_list)

    my_list[length - 1] = "Bye"
    print("4.", my_list)
main()
```

Visiting each element in the list

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

```python
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()
```

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).

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

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

Complete the function

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.

```python
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()
```

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.

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

```python
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()
```

The highest even number:

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

```python
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()
```

Complete the function

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.

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

```python
print_highest_even_num([11, 91, 95, 83, 93, 28, 31, 23, 16, 40])
```

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.
Complete the function

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`).

```python
def print_xs(a_list):
    pass
```

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

0123456789
X  X  X

Complete the function

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.

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

```python
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

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Summary

In a Python program:
* a list object can be created
* square brackets 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

```python
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]
```