CS65: Introduction to Computer Science

Sequence: List

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Topics

- List
  - Quick recap
- List manipulation
  - Appending items in a list
  - List slicing
  - Modifying items in a list
  - Removing an item from a list
  - Other methods/operations
- List of lists
  - Understanding the dimensions
  - Accessing elements
  - Accessing with nested for loops

List

- Sequence is an ordered group of elements (numbers, characters, etc)
- **String** is a type of sequence whose members are characters
  - "Drake University"
  - "cs65:introduction_to_computer_science!"
- **List** is another type of sequence whose members can be numbers, strings, or even another list!
  - ["Drake University", "hello", "world"]
  - [1, 2, 3, 4, 5]

Inserting Items in a List

- Appending elements in an empty list with **. append()** method
  - A method instructs an object to perform some action
  - It is executed by a "**.**" (dot) symbol followed the method name

```
# building list with append() function
num_list = []

num_list.append(2)
print("num_list: ", num_list)
```

```
Shell
>>> %Run lec11.py

  num_list:  [2]
```

Inserting Items in a List

- Appending elements in an empty list with **.append()** method

```
# building list with append() function
num_list = []

num_list.append(2)
print("num_list: ", num_list)

num_list.append(4)
print("num_list: ", num_list)

num_list.append(6)
print("num_list: ", num_list)
```

```
>>> %Run lec11.py

  num_list:  [2]
  num_list:  [2, 4]
  num_list:  [2, 4, 6]
```

Inserting Items in a List Iteratively

- Appending elements in an empty list with **.append()** method iteratively using **for loop**

```
# building list with append function using loop
num_list = []

for i in range(10, 100, 10):
    num_list.append(i)

print("num_list: ", num_list)
```

```
>>> %Run lec11.py
  num_list:  [10, 20, 30, 40, 50, 60, 70, 80, 90]
>>>
```

Inserting Specific Items in a List Iteratively

- Appending odd numbers (from 1 to 20) in an empty list with **.append()** method iteratively using **for loop**

```
# building list with append function using loop
# insert only odd numbers
num_list = []

for num in range(1, 20):

    if (num % 2 != 0):

        num_list.append(num)

print("num_list: ", num_list)
```

```
>>> %Run lec11.py

  num_list:  [1, 3, 5, 7, 9, 11, 13, 15, 17, 19]
```

Exercise 1

- Appending **multiples of 5** in an empty list with **append()** method iteratively using **for loop**
  - Prompt the user to enter two numbers
    - first number is the lower limit, eg, **1**
    - second number is the upper limit, eg, **15**
  - If user enters **1** and **15**, you should append only **5, 10, 15**

```
# building list with append function using loop
# insert only odd numbers
num_list = []

for num in range(1, 20):

    if (num % 2 != 0):

        num_list.append(num)

print("num_list: ", num_list)
```

```
>>> %Run lec11.py
  num_list:  [1, 3, 5, 7, 9, 11, 13, 15, 17, 19]
```

Exercise: my solution

- Appending **multiples of 5** in an empty list with **append()** function iteratively using **for loop**

```
# building list with append function using loop
# insert only multiples of 5
lower_limit = int(input("enter the lower limit: "))
upper_limit = int(input("enter the upper limit: "))

num_list = []


for num in range(lower_limit, upper_limit):

    if (num % 5 == 0):

        num_list.append(num)

print("num_list: ", num_list)
```

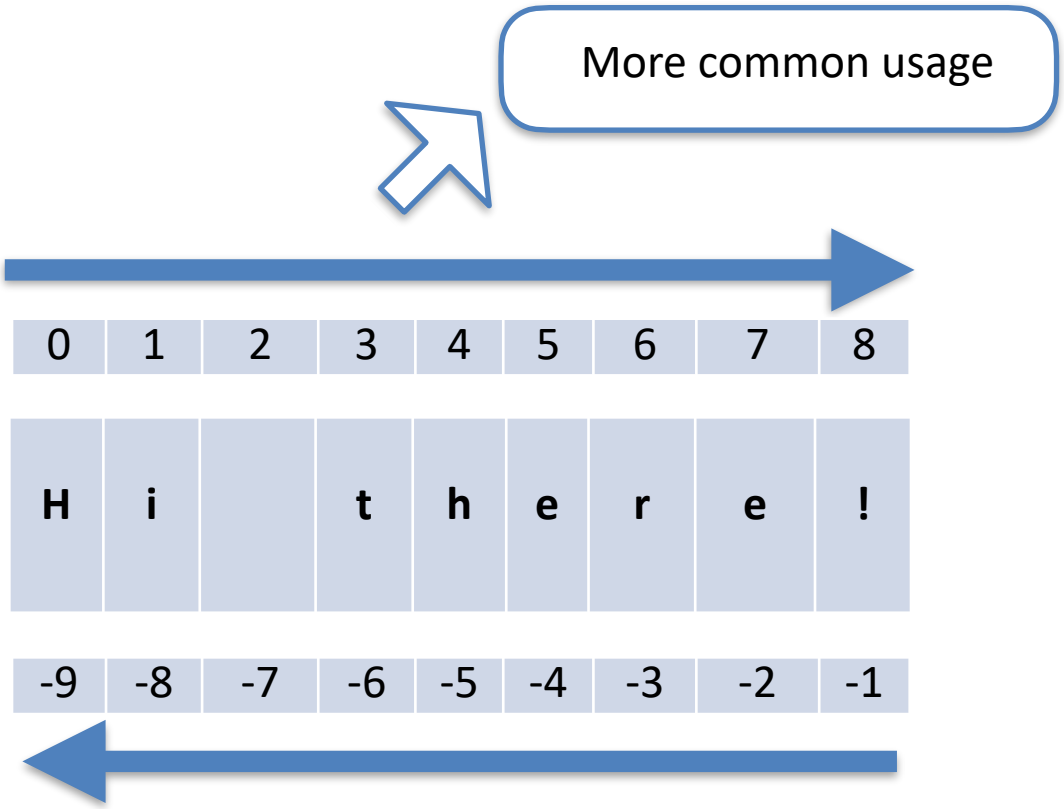
```
>>> %Run lec11.py

  enter the lower limit: 3
  enter the upper limit: 22
  num_list:  [5, 10, 15, 20]

>>> %Run lec11.py

  enter the lower limit: 5
  enter the upper limit: 49
  num_list:  [5, 10, 15, 20, 25, 30, 35, 40, 45]
```

Quick Review: Indexing



Quick Review: Accessing Items using Index

- Use ***variable_name[index]*** access an item in a list

```
75  num_list = [10, -1, -2, -3, 20, -4, 30]
76
77  print("Number at index 0 is ", num_list[0])
78  print("Number at index 1 is ", num_list[1])
79  print("Number at index 4 is ", num_list[4])
80  print("Number at last index is ", num_list[-1])
```

Shell

```
Python 3.7.9 (bundled)
>>> %Run lec11.py

  Number at index 0 is  10
  Number at index 1 is  -1
  Number at index 4 is  20
  Number at last index is  30
```

List Slicing

- Slice is a span of items that are taken from a list (or any sequence)
  - Span is a list containing copies of elements from **start** up to, but not including, **end**
  - Format: *list_variable_name*[**start : end**]
    - **start :** starting index — if not specified 0 is used
    - **end :** end index — if not specified ***len****(list)* is used

List Slicing

- Format: *list_variable_name*[**start : end**]
  - **start :** starting index — if not specified 0 is used
  - **end :** end index — if not specified ***len****(list)* is used

```
num_list = [10, 11, 12, 13, 14, 15]

print("num_list ", num_list)
print("num_list[0] ", num_list[0])
print("num_list[:1] ", num_list[:1])
print("num_list[1:4] ", num_list[1:4])
print("num_list[1:] ", num_list[1:])
```

```
>>> %Run lec12.py

num_list  [10, 11, 12, 13, 14, 15]
num_list[0]  10
num_list[:1]  [10]
num_list[1:4]  [11, 12, 13]
num_list[1:]  [11, 12, 13, 14, 15]
```

Changing/Replacing Items in a List

- Changing specific items in a list

```
num_list = [10, -1, -2, -3, 20, -4, 30]


print("Before modification num_list is ", num_list)


num_list[1] = 0
num_list[2] = 0
num_list[3] = 0
num_list[4] = 40
```

```
>>> %Run lec12.py

  Before modification num_list is  [10, -1, -2, -3, 20, -4, 30]
  After modification num_list is  [10, 0, 0, 0, 40, -4, 30]
```

Changing/Replacing Items in a List

- Replacing specific items in a list iteratively

- You **must** use index for loop
  - value for loop would modify the variable, it won't modify the list

- **Step 1:** You should find the index/position of an item
- **Step 2:** Use the index to change/modify the value

Recap: **Value** **for** loop vs **Index** **for** loop

- Syntax of **value** **for loop**

```
for var in [10, 20, 30, 40, 50] :
        print(var)
```

- There is another form called **index** **for loop**

```
my_list = [10, 20, 30, 40, 50]
length = len(my_list)
for i in range(length) :
        print( my_list[i] )
```

common practice: index variables are usually **i, j,** or **k**

Changing/Replacing Items in a List

- Replacing all negative numbers in a list with zeros (0s)

```
# modifying list based on a criteria

num_list = [10, -1, -2, -3, 20, -4, 30]

list_size = len(num_list)

print("Before modification num_list is ", num_list)
for i in range(list_size):

    if (num_list[i] < 0):

        #print("Found negative num at index: ", i)

        num_list[i] = 0

print("After modification num_list is ", num_list)
```

```
>>> %Run lec11.py

  Before modification num_list is  [10, -1, -2, -3, 20, -4, 30]
  After modification num_list is  [10, 0, 0, 0, 20, 0, 30]
```

Changing/Replacing Items in a List

- Code simplification
  - Inserting the *len(num_list)* inside the range function

```
# modifying list based on a criteria

num_list = [10, -1, -2, -3, 20, -4, 30]

for i in range(len(num_list)):

    if (num_list[i] < 0):

        #print("Found negative num at index: ", i)

        num_list[i] = 0
```

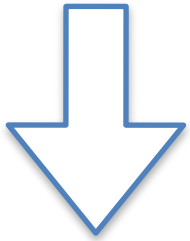
```
>>> %Run lec11.py

  Before modification num_list is  [10, -1, -2, -3, 20, -4, 30]
  After modification num_list is  [10, 0, 0, 0, 20, 0, 30]
```

Exercise 2

- Replacing all negative numbers in a list by making them positives

```
num_list = [10, -1, -2, -3, 20, -4, 30]
```



```
num_list = [10,  1,  2,  3, 20,  4, 30]
```

```
# modifying list based on a criteria
num_list = [10, -1, -2, -3, 20, -4, 30]

for i in range(len(num_list)):
    if (num_list[i] < 0):
        #print("Found negative num at index: ", i)
        num_list[i] = 0
```

```
>>> %Run lec11.py
  Before modification num_list is  [10, -1, -2, -3, 20, -4, 30]
  After modification num_list is  [10, 0, 0, 0, 20, 0, 30]
```

Removing Items from a List

- Remove a specific item from a list <u>using value</u>
  - use ***.remove()*** method

```
# deleting an item from the list

num_list = [10, -1, -2, -3, 20, -4, 30]

print("Initial num_list is ", num_list)

num_list.remove(-1)

print("After removing -1 num_list is ", num_list)

num_list.remove(-2)

print("After removing -2 num_list is ", num_list)
```

```
>>> %Run lec12.py

  Initial num_list is  [10, -1, -2, -3, 20, -4, 30]
  After removing -1 num_list is  [10, -2, -3, 20, -4, 30]
  After removing -2 num_list is  [10, -3, 20, -4, 30]
```

- **<u>Heads up!</u>** the size of the list will change! Be careful when you are removing items using for loop

Removing Items from a List

- Remove a specific item from a list using value
  - use ***.remove()*** method

```
num_list = [10, -2, -2, -2, 20, -4, 30]

num_list.remove(-2)
num_list.remove(-2)
num_list.remove(-2)
print("After removing all -2s num_list is ", num_list)
```

```
>>> %Run lec12.py
  After removing all -2s num_list is  [10, 20, -4, 30]
```

- **Heads up!** If the item is not in the list, you will get an error

Removing Items from a List

- Remove a specific item from a list using index
  - use ***.pop()*** method

```
# deleting an item from the list using .pop() method
num_list = [10, -1, -2, -3, 20, -4, 30]
print("Initial num_list is ", num_list)
num_list.pop(0)
print("After removing item at index 0 num_list is ", num_list)
num_list.pop(1)
print("After removing item at index 1 num_list is ", num_list)
```

```
>>> %Run lec12.py
  Initial num_list is  [10, -1, -2, -3, 20, -4, 30]
  After removing item at index 0 num_list is  [-1, -2, -3, 20, -4, 30]
  After removing item at index 1 num_list is  [-1, -3, 20, -4, 30]
```

Removing Items from a List

- Remove a specific item from a list using index
  - use ***del*** keyword

```
# deleting an item from the list

num_list = [10, -1, -2, -3, 20, -4, 30]

print("Initial num_list is ", num_list)

del num_list[0]

print("After removing item at index 0 num_list is ", num_list)

del num_list[1]

print("After removing item at index 1 num_list is ", num_list)
```

```
>>> %Run lec12.py

  Initial num_list is  [10, -1, -2, -3, 20, -4, 30]
  After removing item at index 0 num_list is  [-1, -2, -3, 20, -4, 30]
  After removing item at index 1 num_list is  [-1, -3, 20, -4, 30]
```

Other Useful List Operations

- **Sort** the list items in ascending order

```
num_list = [10,  1,  2,  3, 20,  4, 30]

num_list.sort()
```

```
>>> %Run lec12.py

  Before sorting the items list is  [10, 1, 2, 3, 20, 4, 30]
  After sorting the items list is [1, 2, 3, 4, 10, 20, 30]
```

- **Sum** of elements in the list

```
total = sum(num_list)

print("Sum of list items is ", total)
```

```
 Sum of list items is  70
```

Other Useful List Operations

operation	meaning	result type
x in s	checks if an item in s equals x	bool
x not in s	checks if no items in s equal x	bool
s + t	concatenation (two sequences)	same seq. type
s*n (or: n*s)	n shallow copies of s, concatenated	same seq. type
s.count(x)	find # items in s equal to x	int (#matches)
s.index(x)	find index of first x in s (if not found, crashes)	int

Other Useful List Operations

- **list1 + list2** produces new list by concatenating list2 to end of list1
- **min(list)** finds the elements in the list with the smallest value
- **max(list)** finds the elements in the list with the largest value

operation	meaning	returned value
s.append(x)	add x as a single value at end of s.	None value
s.extend(t)	individually append each item of sequence t to the end of s.	None value
s.insert(i,x)	make space (push other spots to the right), put x value at location i.	None value
s.pop(i)	remove value at index i from sequence; return the value that was there	item that was at index i
s.remove(x)	find first occurrence of x, remove it.	None
s.reverse()	reverse the ordering of items.	None

Other Useful Slicing Operations

operation	meaning
s[i] = x	replace ith item of s with x
s[i:j] = t	replace slice i:j with sequence t. (lengths needn't match!)
s[i:j:k] = t	replace slice i:j:k with sequence t. (lengths *must* match!)
del s[i]	remove ith item from s.
del s[i:j]	remove slice i:j from s.
del s[i:j:k]	remove slice i:j:k from s.