Lists Advanced

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[x for x in y]

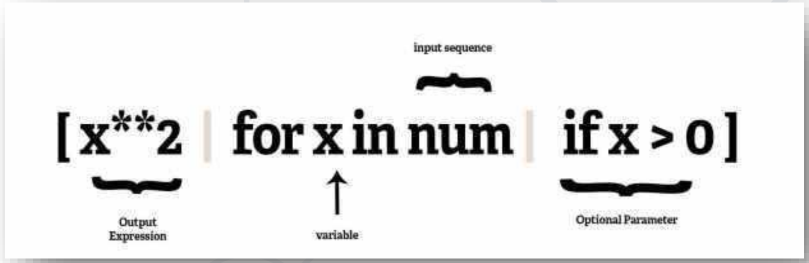
List Comprehensions

What is Comprehension?

- Comprehensions provide us with a **short** way to **construct** new **sequences**
- They allow **sequences** to be built from other sequences
- They require less **memory**
- They have shorter **syntax** and better **performance**

Structure

- A list comprehension consists of the following parts:
  - an **input sequence**
  - a **variable** representing members of the input sequence
  - an **optional predicate** expression
  - an **output expression** producing elements in the output list



$$[\underbrace{x^{**}2}_{\text{Output Expression}} \mid \text{for } \underset{\substack{\uparrow \\ \text{variable}}}{x} \text{ in } \overbrace{\text{num}}^{\text{input sequence}} \mid \underbrace{\text{if } x > 0}_{\text{Optional Parameter}}]$$

List Comprehensions

- Creating a list using the **range** function

Output Expression

```
x = [num for num in range(5)]
# [0, 1, 2, 3, 4]
```

Variable

- Getting the square values of numbers in a list

```
nums = [1, 2, 3, 4]
squares = [x**2 for x in nums]
# [1, 4, 9, 16]
```

Input Sequence

List Comprehensions

- Using **if** statement in a list comprehension

```
nums = [1, 2, 3, 4, 5, 6]
evens = [num for num in nums if num % 2 == 0]
# [2, 4, 6]
```

Optional Parameter

- Using **if-else** statements in a list comprehension

```
nums = [1, 2, 3, 4, 5, 6]
filtered = [True if x % 2 == 0 else False for x in nums]
# [False, True, False, True, False, True]
```

Problem: No Vowels

- Write a program that receives a **text** and **removes** all the **vowels** from it
- Print the **new text string** after removing the vowels
- The **vowels** that should be considered are '**a**', '**o**', '**u**', '**e**', '**i**'

```
ILovePython
```

→

```
LvPythn
```

Solution: No Vowels

```python
text = input()
vowels = ['a', 'u', 'e', 'i', 'o', 'A', 'U', 'E', 'I', 'O']
no_vowels = ''.join([x for x in text if x not in vowels])
print(no_vowels)
```

List Methods

Adding Elements

- Using the **append()** method

```
my_list = [1, 2, 3]
my_list.append(4) # [1, 2, 3, 4]
```

Add single element at the end

- Using the **extend()** method

```
my_list = [1, 2, 3]
my_list.extend([4, 5]) # [1, 2, 3, 4, 5]
```

Add multiple elements at the end

- Using the **insert()** method

```
my_list = [1, 2, 3]
my_list.insert(1, 4) # [1, 4, 2, 3]
```

Add single element at a specific index

Removing Elements

- Using the `clear()` method

```
my_list = [1, 2, 3]
my_list.clear() # []
```

Removes all elements

- Using the `pop()` method

```
my_list = [1, 2, 3]
number = my_list.pop(0) # [2, 3]; number -> 1
```

Removes element by index and returns it

- Using the `remove()` method

```
my_list = [1, 2, 3]
my_list.remove(1) # [2, 3]
```

Removes by value (first occurrence)

Problem: Trains

- You will receive how many wagons the train has
- Until you receive "**End**", you will get some of the commands:
  - **add {people}** -> adds the people in the last wagon
  - **insert {index} {people}** -> adds the people at the given wagon
  - **leave {index} {people}** -> removes the people from the wagon

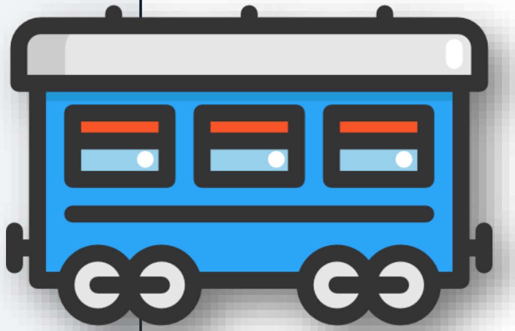
```
3
add 20
insert 0 15
leave 0 5
End
```

```
[10, 0, 20]
```

Solution: Trains

```
train_length = int(input())
train = [0] * train_length
command = input()
while command != "End":
    tokens = command.split(" ")
    key_word = tokens[0]
    if key_word == "add":
        # Implement
    # Add the other cases
    command = input()
print(train)
```

Generate list with same values



Problem: Todo List

- You will be receiving to-do notes until you get the command **"End"**
- The notes will be in the format: **"{priority}-{note}"**
- Return the list of to-do notes sorted by priority (**ascending**)
- Hint: use the **pop()** and the **insert()** methods

```
2-Walk the dog
1-Drink coffee
6-Dinner
5-Work
End
```

```
['Drink coffee', 'Walk the dog', 'Work', 'Dinner']
```

Solution: Todo List

```python
notes = [0] * 10
while True:
    command = input()
    if command == "End":
        break
    tokens = command.split("-")
    priority = int(tokens[0]) - 1
    note = tokens[1]
    notes.pop(priority)
    notes.insert(priority, note)
# Add only the elements that are not 0
```

Creating list with 10 zeros

More Useful Methods

- Using the **count()** method

```
my_list = [1, 2, 3, 2, 2]
my_list.count(2) # 3
```

Finds all occurrences in a list

- Using the **index()** method

```
my_list = [1, 2, 3, 2, 2]
last = my_list.index(2) # 1
```

Finds the index of the first occurrence

- Using the **reverse()** method

```
my_list = [1, 2, 3]
my_list.reverse() # [3, 2, 1]
```

Reverses the elements

Problem: Palindrome Strings

- You will receive words separated by a **single space** and a **palindrome**
- Print a list containing **all** the **palindromes**
- Print the number of **occurrences** of the **palindrome** in the format: "`Found palindrome {number} times`"

```
wow father mom wow shirt stats
wow
```

```
['wow', 'mom', 'wow', 'stats']
Found palindrome 2 times
```

Solution: Palindrome Strings

```python
strings = input().split(" ")
searched_palindrome = input()
palindromes = []
for word in strings:
    if word == "".join(reversed(word)):
        palindromes.append(word)
print(f"{palindromes}")
print(f"Found palindrome
{palindromes.count(searched_palindrome)} times")
```

Reversed returns iterator object, so we join it to a string

Advanced Functions

Using Lambda Operators

sorted() Function

- Sorts the elements of a list in **ascending** order

```
numbers_list = [6, 2, 1, 4, 3, 5]
sorted_numbers = sorted(numbers_list)
# [1, 2, 3, 4, 5, 6]
```

- Sorts the elements of a list in **descending** order

```
numbers_list = [6, 2, 1, 4, 3, 5]
sorted_numbers = sorted(numbers_list, key=lambda x: -x)
# [6, 5, 4, 3, 2, 1]
```

Problem: Sorting Names

- Write a program that reads a single **string** with **names** separated by comma and space "**,** "
- Sort the names by their **length** in **descending order**
  - If 2 or more names have the **same length**, sort them in **ascending order** (alphabetically)
- Print the resulting list

```
Ali, Marry, Kim, Teddy, Monika, John
```

```
["Monika", "Marry", "Teddy", "John", "Ali", "Kim"]
```

map() Function

- Use it to convert a list of **strings** to a list of **integers**

```
strings_list = ["1", "2", "3", "4"]
numbers_list = list(map(int, strings_list)) # [1, 2, 3, 4]
```

Returns int(x) for each element x in the list

- It **applies a function** to **every item** of an iterable

```
numbers_list = [1, 2, 3, 4]
doubled_list = list(map(lambda x: x*2, numbers_list))
# [2, 4, 6, 8]
```

- It returns an **iterator object**, so you need to convert it **into a list**

filter() Function

- Use it to filter elements that fulfill a given condition

```
numbers_list = [1, 2, 3, 4, 5, 6]
even_numbers = list(filter(lambda x: x % 2 == 0, numbers_list))
# [2, 4, 6]
```

Filter all the even numbers

- The lambda should return either **True** or **False**
- It returns an **iterator object**, so you need to convert it **into a list**

Problem: Even Numbers

- Write a program that reads a single **string** with **numbers** separated by comma and space "**,** "
- Print the **indices** of all **even numbers**

```
3, 2, 1, 5, 8
```
→
```
[1, 4]
```

```
2, 4, 6, 9, 10
```
→
```
[0, 1, 2, 4]
```

Solution: Even Numbers

```python
# Convert the list of strings into a list of numbers
number_list = list(map(int, input().split(", ")))
# Find all the even numbers' indices
found_indices_or_no = map(
    lambda x: x if number_list[x] % 2 == 0 else 'no',
    range(len(number_list)))
# Filter only the indices
even_indices = list(filter(lambda a: a != 'no', found_indices_or_no))
print(even_indices)
```

Problem: The Office

- Read the problem description here

```
1 2 3 4 2 1
3
```

```
Score 2/6. Employees are not happy!
```

```
2 3 2 1 3 3
4
```

```
Score: 3/6. Employees are happy!
```

Solution: The Office

```
employees = input().split(" ")
happiness_factor = int(input())
employees = # Use map to multiply each element with the factor
filtered = # Use filter to get all the numbers >= than the average
if len(filtered) >= len(employees) / 2:
    print(f"Score: {len(filtered)}/{len(employees)}. Employees are happy!")
else:
    print(f"Score: {len(filtered)}/{len(employees)}. Employees are not happy!")
```

Additional List Manipulations

Swapping List Elements

- You can use the following syntax to swap two or more list elements

```
nums = [1, 2, 3]
nums[0], nums[1], nums[2] = nums[2], nums[0], nums[1]
# 1 swaps with 3
# 2 swaps with 1
# 3 swaps with 2
```

- The **first** element on the **left** swaps with the **first** on the **right**, etc.

Concatenating Lists

- You can use the "+" operator to join two lists

```
nums_list_1 = [1, 2, 3]
nums_list_2 = [4, 5, 6]
final_list = nums_list_1 + nums_list_2
print(final_list) # [1, 2, 3, 4, 5, 6]
```

- Always the second list is added at the end of the first

The set() Function

- You can use the **set()** function to extract only the unique elements from a list

```
numbers = [1, 2, 2, 3, 1, 4, 5, 4]
unique_numbers = list(set(numbers)) # [1, 2, 3, 4, 5]
```

- The **set()** function returns a **set** with the unique values
- You will learn more about **sets** in the advanced python module

The reduce() Function

- The **`reduce()`** function in Python implements a mathematical technique commonly known as **folding** or **reduction**
  - **Applies** a function (or callable) to the **first two items** in an iterable, generating a **partial result**
  - **Uses** that **partial result**, together with the **third item** in the iterable, to generate another **partial result**
  - **Repeats** the process until the iterable is exhausted, ultimately returning a **single cumulative value**

The reduce() Function

- This function is defined in the "**functools**" module

```
from functools import reduce

list = [1, 3, 5, 6, 2]

sum = reduce(lambda a, b: a + b, list)  # 17

max = reduce(lambda a, b: a if a > b else b, list)  # 6
```

Using reduce to compute the sum of the list

Using reduce to compute the maximum element from the list

Summary

- We learned:
  - Some additional **methods** that can be used with lists
  - Some basic **lambda** functionality
  - How to **swap** list elements

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