Iterables: List, Tuple, Set, Dictionaries

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Introducing lists

- A list is a collection of items, stored in a variable
- Items should be related
- Items could be of different types (objects)

```python
colors = ['red', 'green', 'blue']
print(colors)
['red', 'green', 'blue']
```
Naming a list

• since lists are collection of objects, it is a good practice to give them a plural name

• for a list of color, call the list 'colors'

• for a list of student, call the list 'students'

• in this way a single item in the list will be the singular name ('color'), the entire list will be plural ('colors') - Iteration pattern
Defining a list

A list is a container which holds comma-separated values (items or elements) between square brackets where items or elements don't need all have the same type.

- elements in a list have an index
- list are zero-index: the first element in a list has 0 as index
List indexes

- index counts elements in a list
- if an index has a positive value, it counts from the beginning
- if an index has a negative value, it counts backward
- you can get the element of a list by its index in square brackets
colors = ['red', 'green', 'blue', 'black']

<table>
<thead>
<tr>
<th>item</th>
<th>red</th>
<th>green</th>
<th>blue</th>
<th>black</th>
</tr>
</thead>
<tbody>
<tr>
<td>index (from 0 left)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>index (from -4 right)</td>
<td>-4</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
</tbody>
</table>
colors = ['red', 'green', 'blue', 'black']
color = colors[0]
color
'red'
green_color = colors[-3]
green_color
'green'
green_color = colors[1]
green_color
'green'

Ln: 17 Col: 4
>>> color = colors[5]
Traceback (most recent call last):
  File "<pyshell#20>", line 1, in <module>
    color = colors[5]
IndexError: list index out of range
>>> color = colors[-5]
Traceback (most recent call last):
  File "<pyshell#21>", line 1, in <module>
    color = colors[-5]
IndexError: list index out of range
>>> colors[4]
Traceback (most recent call last):
  File "<pyshell#22>", line 1, in <module>
    colors[4]
IndexError: list index out of range
>>>
Common list operations

Edit element in a list

colors[0] = 'orange'

print(colors)
['orange', 'green', 'blue', 'black']
Common list operations
get the position of an element in list

colors = ['red', 'green', 'blue', 'black']
print(colors.index('green'))
1
>>> print(colors.index('pink'))
Traceback (most recent call last):
  File "<pyshell#43>", line 1, in <module>
    print(colors.index('pink'))
ValueError: 'pink' is not in list

>>>
Common list operations

test if an element is in a list

colors = ['red', 'green', 'blue', 'black']

print('red' in colors)
True

print('orange' in colors)
False
Common list operations

Adding item to the end of a list

colors = ['red', 'green', 'blue', 'black']

colors.append('orange')
print(colors)
['red', 'green', 'blue', 'black', 'orange']
Common list operations

Insert item into a list

we specify the position and everythings from that point is shifted one position to the right

colors = ['red', 'green', 'blue', 'black']

colors.insert(1, 'orange')
print(colors)
['red', 'orange', 'green', 'blue', 'black']
Common list operations

removing item by position

We specify the position and everythings from that point is shifted one position to the right.

colors = ['red', 'green', 'blue', 'black']

del colors[1]
print(colors)
['red', 'blue', 'black']
Common list operations
removing item by value

remove only the first matching value in a list

```
colors = ['red', 'green', 'blue', 'black']

colors.remove('green')
['red', 'blue', 'black']
```
Common list operations

popping item from a list

• remove the last item from the list (with no parameter)

• always it returns the popped item
colors = ['red', 'green', 'blue', 'black']

last_item = colors.pop()
print(last_item)
black
print(colors)
['red', 'green', 'blue']
Common list operations
popping item from a list

- or in a specific position
- **always** it returns the popped item
colors = ['red', 'green', 'blue', 'black']

item = colors.pop(1)
print(item)
green
print(colors)
['red', 'blue', 'black']
Common list operations

number of elements of a list

colors = ['red', 'green', 'blue', 'black']

number_item = len(colors)
print(number_item)
4
Numerical lists

• a list composed by only numbers
• it's not special
• you can use some special function

The range() function is a shortcut to create a numerical list ordered

range(1,11): [1,2,3,4,5,6,7,8,9,10]
The `range()` function returns a list of consecutive integers. The function has one, two or three parameters where last two parameters are optional.

- `range(a)`: Generates a sequence of numbers from 0 to `a`, excluding `a`, incrementing by 1.
range() function

- range(a, b): Generates a sequence of numbers from a to b excluding b, incrementing by 1.
- range(a, b, c): Generates a sequence of numbers from a to b excluding b, incrementing by c.
**Numerical lists**

**min()**

```python
ages = [22, 38, 33, 50, 9, 16, 28, 11]

youngest = min(ages)
print(youngest)
9
```
Numerical lists

```python
max()

ages = [22, 38, 33, 50, 9, 16, 28, 11]

oldest = max(ages)
print(oldest)
50
```
Numerical lists

`sum()`

```python
ages = [22, 38, 33, 50, 9, 16, 28, 11]

total = sum(ages)
print(total)
207
```
exercise

• calculate the ages' average
• add 3 different ages
• remove the last item
• remove age 22
• recalculate the ages'a average
exercise

- Store the values 'python', 'c', and 'java' in a list. Print each of these values out, using their position in the list.
exercise

- Print a statement about each of these values, using their position in the list. Your statement could simply be, 'A nice programming language is value.'

- Think of something you can store in a list. Make a list with three or four items, and then print a message that includes at least one item from your list. Your sentence could be as simple as, "One item in my list is a ____."
Lists and Looping
accessing all elements in a list

- we use a loop to access all the elements in a list, no matters how many elements the list was composed
- we are able to "use" all the elements in the list with 3 line of code
- A loop is a block of code that repeats itself until it runs out of items to work with or until a certain condition is met
colors = ['red', 'green', 'blue', 'black']

for color in colors:
    print(color)
red
green
blue
black

• the keyword "for" tells Python to get ready to use a loop
• the variable color is a placeholder variable. In this variable, Python will place each item in the list into, one at a time
• when there are no more items in the list, the loop will end
for loop and range function

```python
for a in range(4):
    print(a)
```

0
1
2
3
Enumerating a list

If you want to enumerate a list, you need to add an index variable to hold the current index.

colors = ['red', 'green', 'blue', 'black']

for index, color in enumerate(colors):
    place = str(index)
    print("place: " + place + " color: " + color)

place: 0 color: red
place: 1 color: green
place: 2 color: blue
place: 3 color: black
Lists and Looping
FOR Special keywords

Python allows two **keywords** to be used within a *for* loop: break and continue.

The two keywords have two **different** meanings:

- **Break** used to *immediately* break the loop and exit!
- **Continue** used to skip to the **next** iteration step!
While loop

In Python, also the while loops are permitted.

The while loop runs as long as the condition evaluates to True and execute the code block:

```python
x = 0;
while (x < 5):
    print(x)
    x += 1
```
While loop
infinite loop

```python
x = 10;
while (True):
    print(x)
    x += 1
```
While loop
else statement

else statement is executed when the condition is false

```python
x = 0;
s = 0
while (x < 10):
    s = s + x
    x = x + 1
else:
    print('The sum of first 9 integers : ',s)
```
• Repeat First List, but this time use a loop to print out each value in the list.

• Repeat First List, but this time use a loop to print out your statements. Make sure you are writing the same sentence for all values in your list.

• Repeat First List, but this time use a loop to print out your message for each item in your list. Again, if you came up with different messages for each value in your list, decide on one message to repeat for each value in your list.
Strings as Lists

- Now that you have some familiarity with lists, we can take a second look at strings.
- A string is really a list of characters, so many of the concepts from working with lists behave the same with strings.
Strings as Lists

message = "Hello Lists!"
message_list = list(message)
print(message_list)
['H', 'e', 'l', 'l', 'o', ' ', 'L', 'i', 's', 't', 's', '!' ]
for letter in message:
    print(letter)

Hello

Lists!
Finding substring

A substring is a series of characters that appears in a string

```python
>>> message = "I like cats and dogs"
>>> dog_present = 'dog' in message
>>> print(dog_present)
True
```
>>> message = "I like cats and dogs, but I prefer cats"
>>> first_cat_index = message.find('cats')
>>> print(first_cat_index)
7
>>> last_cat_index = message.rfind("cats")
>>> print(last_cat_index)
35
Replace substrings

You can use replace() function to replace any substring with another substring.

```python
>>> message = "I like cats and dogs, but I prefer cats"
>>> new_message = message.replace("cats","snakes")
>>> print(new_message)
I like snakes and dogs, but I prefer snakes
```
Counting substrings

```python
>>> number_of_cats = message.count('cats')
```

```
>>> print(number_of_cats)
2
```
Splitting strings

```python
>>> words = message.split(' ')
>>> print(words)
['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
```
Slicing a list /1

A subsets of a list are called slices

```python
words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
slice = words[0:3]
>>> for word in slice:
...     print(word)
...
I
like
cats
```
Slicing a list /2

words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
slice = words[2:5]
>>> slice = words[2:5]
>>> for word in slice:
...     print(word)
...     
cats
and
dogs,
Slicing a list /3

words = ['I', 'like', 'cats', 'and', 'dogs,', 'but', 'I', 'prefer', 'cats']
# from 4rd to the end
>>> slice = words[4:]
>>> for word in slice:
...     print(word)
dogs,
but
I
prefer
cats
Slicing strings

>>> message = "I like cats and dogs, but I prefer cats"
>>> first_char = message[0]
>>> last_char = message[-1]
>>> print(first_char, last_char)
I s
>>> first_three = message[0:3]
>>> last_three = message[-3:]
>>> print(first_three, last_three)
I l ats
Exercise

Store the first 10 square numbers in a list.
Make an empty list that will hold our square numbers
>>> squares = []
>>> for number in range(1, 11):
...     new_square = number**2
...     squares.append(new_square)
...
>>> for square in squares:
...     print(square)
...
1
4
9
16
25
36
49
64
81
100
Exercise

• Make a list of the first ten multiples of ten (10, 20, 30...90, 100). Print out your list.

• Make a list of the first ten cubes(1, 8, 27...) using a list. Print them out

• Store five names in a list. Make a second list that adds the phrase "is awesome!" to each name. Print out the new list
Tuples

- Tuples are basically lists that can never be changed
- Tuples are not dynamic
- you cannot modify any element
- Lists are mutable objects and tuple are immutable objects
Defining Tuples

as the lists but use (), non []

```
colors = ('red', 'green', 'blue')
>>> print(colors[0])
red
>>> for color in colors:
...     print("- " + color)
...
- red
- green
- blue
```
Adding an element to a Tuple

If you try to add something to a tuple, you will get an error:

```python
colors = ('red', 'green', 'blue')
colors.append('purple')
```

```
--
AttributeError
Traceback (most recent call last)
<ipython-input-37-ed1dbff53ab2> in <module>()
    1 colors = ('red', 'green', 'blue')
----> 2 colors.append('purple')

AttributeError: 'tuple' object has no attribute 'append'
```
Sets

- unordered collections of distinct objects
- You define a set just like you define a list, but you have to use **braces** "{}" instead of square brackets "[]"
- you can access individual elements (just like you can with a list and tuple)
```python
>>> shapes = {"square", "triangle", "circle"}
>>> for shape in shapes:
...     print(shape)
...
circle
square
triangle
>>> shapes.add("polygon")
>>> shapes
{'polygon', 'circle', 'square', 'triangle'}
>>> shapes2 = set(['circle', 'triangle', 'hexagon'])
{'hexagon', 'circle', 'triangle'}
```
shapes = {'polygon', 'circle', 'square', 'triangle'}
shapes2 = {'hexagon', 'circle', 'triangle'}

>>> shapes.intersection(shapes2)
{'circle', 'triangle'}

>>> shapes.difference(shapes2)
{'polygon', 'square'}

>>> shapes.union(shapes2)
{'hexagon', 'circle', 'polygon', 'square', 'triangle'}
Exercise

3 is a Crowd

• Make a list of names that includes at least 4 people
• Write an if test that prints a message about the room being crowded if there are more three people in your list
• Modify your list so that there are only two people in it. Use one of the methods for removing people from the list
• Run your if test again.
**Exercise**

- Save your program from Three is Crowd under a new name.
- Add an else statement to your tests. If the else statement is run, have it print a message that the room is not very crowded.
Exercise

Six is a Mob

• save the previous program with a new name
• add some names to your list, so that there are at least six people in the list
• modify your tests so that:
  • more 5 people: print a message about there being a mob in the room
  • 3-5 people: print a message about there being crowded
  • 1 or 2 people: print a message about the room not being crowded
  • no people: print a message about the room being empty
Dictionaries

- Store information that is connected in some way
- key:value pairs
- no order

```python
dictionary = {'key1': 'value1',
              'key2': 'value2',
              'key3': 'value3',
            }
```
programming_language = { 'python': "Guido van Rossum",
'perl': "Larry Wall",
'c': "Kerninghan and Ritchie",
}

print(programming_language)
{"python": "Guido van Rossum",
/perl": "Larry Wall",
'c": "Kerninghan and Ritchie"}
Iteration

for key, value in programming_language.items():
    print("name: " + key)
    print("author: " + value)

name: python
author: Guido van Rossum

name: perl
author: Larry Wall

name: c
author: Kerningham and Ritchie
Looping all the keys

```python
for key in programming_language.keys():
    print("name: " + key)
name: python
name: perl
name: c

# default iteration schema: by key
for key in programming_language:
    print("name: " + key)
name: python
name: perl
name: c
```
Looping all the values

for value in programming_language.values():
    print("author: " + value)
author: Guido van Rossum
author: Larry Wall
author: Kerninghan and Ritchie
Adding an element

```python
programming_language['ruby']="Yukihiro 'Matz' Matsumoto"

for key, value in programming_language.items():
    print("name: " + key)
    print("author: " + value)

name: python
author: Guido van Rossum
name: perl
author: Larry Wall
name: c
author: Kerninghan and Ritchie
name: ruby
author: Yukihiro 'Matz' Matsumoto
```
Modify the value of an item

```
programming_language['ruby'] = "Matz"
for key, value in programming_language.items():
    print("name: " + key)
    print("author: " + value)
name: python
author: Guido van Rossum
name: perl
author: Larry Wall
name: c
author: Kerninghan and Ritchie
name: ruby
author: Matz
```
Removing an element

def programming_language['perl']
    for key, value in programming_language.items():
        print("name: " + key)
        print("author: " + value)

name: python
author: Guido van Rossum

name: c
author: Kerninghan and Ritchie

name: ruby
author: Matz
Popping an element

programming_language.pop('ruby')
'Matz'

for key, value in programming_language.items():
    print("name: " + key)
    print("author: " + value)

name: python
author: Guido van Rossum
name: c
author: Kernighan and Ritchie
Nesting Structures

Lists in a Dictionary

- You can use lists as value of your dictionary
- You cannot use lists as keys
- But you can use tuples as keys and int ...
# This program stores people's favorite numbers, and displays them.
favorite_numbers = {'eric': [3, 11, 19, 23, 42],
                    'ever': [2, 4, 5],
                    'willie': [5, 35, 120],
               }

# Display each person's favorite numbers.
print("Eric's favorite numbers are:")
print(favorite_numbers['eric'])

print("\nEver's favorite numbers are:")
print(favorite_numbers['ever'])

print("\nWillie's favorite numbers are:")
print(favorite_numbers['willie'])

Eric's favorite numbers are:
[3, 11, 19, 23, 42]

Ever's favorite numbers are:
[2, 4, 5]

Willie's favorite numbers are:
[5, 35, 120]
Dictionary in dictionary
# This program stores information about pets. For each pet, we store the kind of animal, the owner's name, and the breed.

```python
cats = {'willie': {'kind': 'dog', 'owner': 'eric', 'vaccinated': True},
        'walter': {'kind': 'cockroach', 'owner': 'eric', 'vaccinated': False},
        'peso': {'kind': 'dog', 'owner': 'chloe', 'vaccinated': True},
}

# Let's show all the information for each pet.
print("Here is what I know about Willie:"
print("kind: " + cats['willie']['kind']
print("owner: " + cats['willie']['owner'])
print("vaccinated: " + str(cats['willie']['vaccinated'])))

print("Here is what I know about Walter:"
print("kind: " + cats['walter']['kind']
print("owner: " + cats['walter']['owner'])
print("vaccinated: " + str(cats['walter']['vaccinated'])))

print("Here is what I know about Peso:"
print("kind: " + cats['peso']['kind']
print("owner: " + cats['peso']['owner'])
print("vaccinated: " + str(cats['peso']['vaccinated'])))
```

Here is what I know about Willie:
kind: dog
owner: eric
vaccinated: True

Here is what I know about Walter:
kind: cockroach
owner: eric
vaccinated: False

Here is what I know about Peso:
kind: dog
owner: chloe
vaccinated: True
Matrix and sparse matrix

```python
code
matrix = [[1, 5, 6], [7, 8, 9]]
matrix[1][2]
9
matrix[0][1]
5

sparse_matrix = {}
sparse_matrix[0] = {1: 12.5, 23: 25.5}
sparse_matrix[1] = {3: 13.5, 15: 1.6}
sparse_matrix
{0: {1: 12.5, 23: 25.5}, 1: {3: 13.5, 15: 1.6}}
```