

Python Fundamentals (Part3)

Concepts : String, List, Tuple, Dictionary & Set

In this chapter we are going to dive deep into some of the not-so-simple data types of Python.

Strings

What is a String?

A **string** in Python is a sequence of characters enclosed in quotes:

```
str1 = "hello world"
str2 = 'Prime'
```

Strings are **immutable**, meaning once created, their contents can't be changed directly.

len() Function

We can use the built-in `len()` function to print the length of a string:

```
word = 'Prime'
print(len(word))    # 5
```

Concatenation

Just like we add numbers, we can concatenate (i.e. join) strings using the `+` operator.

```
str1 = "Apna"
str2 = "College"

word = str1 + " " + str2    # concatenation
print(word)
```

Loop on Strings

```
s = "Python"
for ch in s:    # ch will store individual chars - 'P', 'y', 't' & so on
    print(ch)
```

Indexing in Strings

Index in a sequence (like strings) represents the position value of individual elements i.e. characters in case of a string. So Indexing lets us access individual characters in a string.

Python follows **Zero-based indexing** i.e. first character is at index `0`.

```
s = "Python"
print(s[0]) # 'P'
print(s[3]) # 'h'
print(s[-1]) # 'n' (negative index: last character)
```

Slicing in Strings

Slicing is a powerful feature of Python that lets us access multiple elements at once. We can do slicing in strings & even on other sequences like lists & tuples.

The general syntax for slicing a string is:

```
string[start : end stop : step]
```

Where:

- **start** - index where the slice starts (inclusive). Defaults to `0` if omitted.
- **stop** - index where the slice ends (exclusive). Defaults to the end of the string if omitted.
- **step** - how many indices to move forward each time. Defaults to `1`.

Example:

```
s = "Python"
print(s[0:2]) # 'Py'
print(s[2:]) # 'thon'
print(s[:3]) # 'Py t'
print(s[::2]) # 'Pto' (every second char)
print(s[::-1]) # 'nohtyP' (reversed string)
```

String Formatting

String formatting is the process of creating **dynamic strings** by inserting values from variables or expressions into a predefined string template. This allows for the construction of flexible and informative output based on changing data.

We have multiple ways to format a string, the most modern 2 are:

1. using the `format()` function
2. using `f-strings`

1. Using `.format()`

In this way we use `{}` as placeholders & pass placeholder replacement values in the format function.

```
name = "Rahul"
age = 25

text = "My name is {} and I am {} years old".format(name, age)
print(text)
```

We can also use positional & named placeholders:

```
"Coordinates: {1}, {0}".format("x", "y") # 'Coordinates: y, x'

"Name: {n}, Age: {a}".format(n="Bob", a=30)
```

2. Using f-strings (Python 3.6+)

F-strings are concise, readable & will be our preferred way going forward.

In f-strings we prefix the string with `f` and put our variable or expressions inside `{}`.

```
name = "Rahul"
age = 25
text = f"My name is {name} and I am {age} years old"
print(text)
```

You can put any valid Python expression inside `{}`:

```
a = 5
b = 10
print(f"sum of {a} & {b} = {a + b}")
print(f"avg of {a} & {b} = {(a + b) / 2}")
```

Lists

What is a List?

- A **list** is a **collection of items** in Python.
- Items in a list are **ordered, changeable (mutable), and can contain duplicates**.
- Lists can hold any data type: numbers, strings, other lists, etc.
- Lists are written using square brackets `[]`

Example:

```
my_list = [1, 2, 3, 4, 5]
print(my_list)
print(type(my_list))    # <class 'list'>

my_list2 = [10, "Hello", 3.14, True, 10]    # heterogenous list
print(my_list2)
```

List Characteristics

1. **Ordered** – Items have a defined order and can be accessed by index.
2. **Mutable** – Items can be changed after the list is created.
3. **Allows duplicates** – Same value can appear more than once.
4. **Heterogeneous** – Can contain different data types.

List Indexing

Index in list is the position value of an item. Index starts from 0.

We can use index to access elements, modify the list or even slice it.

Access Elements

```
my_list = ["apple", "banana", "cherry"]
print(my_list[0])    # apple
print(my_list[1])    # banana
print(my_list[-1])   # cherry (last element)
```

Modify Elements

```
my_list = [1, 2, 3, 4]
my_list[0] = 10
print(my_list)    # [10, 2, 3, 4]
```

Slicing - Slicing in lists is same as slicing in strings.

The general syntax for slicing a list is:

```
list[start:end:step]
```

- **start** - inclusive
- **end** - exclusive
- **step** - optional (default = 1)

```
numbers = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

# Simple Slice
print(numbers[2:5]) # Output: [2, 3, 4]

print(numbers[:4]) # Output: [0, 1, 2, 3] (from start to index 3)
print(numbers[5:]) # Output: [5, 6, 7, 8, 9] (from index 5 to end)
print(numbers[:]) # Output: [0,1,2,3,4,5,6,7,8,9] (copy of the whole list)

# using STEP
print(numbers[::2]) # Output: [0, 2, 4, 6, 8] (every2nd element)
print(numbers[1::3]) # Output: [1, 4, 7] (start at 1, every 3rd element)

# NEGATIVE slice
print(numbers[-5:-2]) # Output: [5, 6, 7] (negative indexing from end)
```

List Methods

We have a lot of useful functions that are associated with lists. Let's have a look at some of them:

1. `len()` - returns the number of elements in a list i.e. length of the list.
2. `append(element)` - adds an elements to the end.
3. `insert(element, idx)` - adds at a specific position.
4. `sort()` - sorts in ascending/alphabetical order.
5. `reverse()` - flips the order of elements.

```
nums = [5, 2, 9]
print(len(nums)) # 3

nums.append(7)
print(nums) # [5, 2, 9, 7]

nums.insert(1, 4)
print(nums) # [5, 4, 2, 9, 7]

nums.sort()
print(nums) # [2, 4, 5, 7, 9]

nums.reverse()
print(nums) # [9, 7, 5, 4, 2]
```

There are many more methods associated with lists. It doesn't make a lot of sense to cover all of them theoretically here, so we'll be covering them whenever we use them in coming chapters.

Loops on Lists

We use the classical `for` loop to traverse the entire list element-wise.

The most common way is using a loop in lists is to print elements.

```
numbers = [10, 20, 30, 40, 50]

for num in numbers:
    print(num)
```

Linear Search

A linear search checks each element one by one to find a target (x).

```
numbers = [5, 12, 7, 3, 18, 9]
x = 18
idx = 0

for num in numbers:
    if num == target:
        print(f"{x} found at index={idx}")
        break
    idx += 1
    idx += 1
```

In the above code, we are assuming that `x` always exists in the list.

Tuples

What is a Tuple?

A **tuple** in Python is an ordered, immutable collection of items.

Example:

```
tup = (10, 20, 30)

print(tup)
print(type(tup)) # < class 'tuple'>

empty_tuple = () # empty_tuple

single_element_tuple = (42,)
```

Tuple Characteristics

1. Ordered
2. **Immutable** – Items cannot be changed after the tuple is created.

3. Allows duplicates
4. Heterogeneous



Tuples are very similar to lists. Some of the differences are that tuples are immutable & because of this immutability they are also faster.

Indexing & Slicing (Same as Lists)

```
t = (10, 20, 30, 40)

print(t[0])    # 10
print(t[-1])   # 40
print(t[1:3])  # (20, 30)
```

Loops on Tuples (Same as Lists)

```
t = (10, 20, 30, 40)

for val in t:
    print(val)
```

Using loops to calculate **sum** of all elements in the tuple:

```
t = (5, 15, 25)

sum = 0
for val in t:
    sum += val

print("Sum:", sum)
```

Tuple Methods

Let's have a look at some of tuple methods:

1. `index(val)` - returns index of first occurrence for any val
2. `count(val)` - returns total count of occurrence for any val

```
t = (1, 2, 2, 3, 5)

print(t.index(2)) # 1
print(t.count(2)) # 3
```

Dictionaries

What is a Dictionary?

A dictionary is an unordered, mutable collection of **key-value pairs**.

Example:

```
my_dict = {  
    "name": "Shradha",  
    "age": 30,  
    "city": "Delhi"  
}
```

Dictionary Characteristics

1. Dictionary Keys must be **unique**
2. Dictionary Keys must be **immutable** (e.g., strings, numbers, tuples)
3. Dictionary is mutable.
4. Dictionary values can be anything (lists, other dictionaries, etc.)
5. Unordered (although in modern Python, dictionaries preserve insertion order)

Accessing values (using key & `[]`)

```
student = {"name": "Bob", "age": 20}  
print(student["name"]) # Bob
```

Dictionary Methods

Let's have a look at some of the important dictionary methods:

1. `keys()` - returns all keys
2. `values()` - returns all values
3. `items()` - returns key-value pairs as tuples
4. `get(key)` - a safer way to access value of a particular key. Instead of throwing an error it returns `None` if key doesn't exist
5. `update(new_item)` - adds a new item to the dictionary

```
d = {  
    "name": "Shradha",  
    "subjects": ["math", "science", "physics"],  
    "cgpa": 9.5  
}  
  
print(d.keys()) # dict_keys  
print(d.values()) # dict_values  
print(d.items()) # dict_items  
  
print(d.get("cgpa2")) # return None as no such key as "cgpa2"  
  
new_item = {"city": "Delhi"}  
print(d.update(new_item))  
print(d)
```


Loops on Dictionary

We can loop through using key-pair values:

```
d = {  
    "name": "Shradha",  
    "subjects": ["math", "science", "physics"],  
    "cgpa": 9.5  
}  
  
for key, value in d.items():  
    print(key, value)
```

Sets

What is a Set?

A set is an unordered collection of **unique elements**.

Example:

```
my_set = {1, 2, 2, 2, 3}  
  
print(my_set)           # {1, 2, 3}  
print(type(my_set))     # set  
print(len(my_set))      # 3  
  
empty_set = set()
```

Set Characteristics

1. Sets can only have **unique** elements.
2. They are **unordered** - no indexing or slicing.
3. They are **mutable** - we can add or remove elements.
4. Set elements must be **immutable** (like strings, numbers, tuples).



Sets are often used when we need uniqueness or mathematical set operations.

Set Methods

Let's have a look at some of the important set methods:

1. `add(val)` - adds an element to set
2. `remove(val)` - removes an element (raises error if not found)
3. `clear()` - removes all elements
4. `pop()` - removes and returns a random element (since sets are unordered)
5. `s1.union(s2)` - returns new union (union is collection of all unique values in both sets)
6. `s1.intersection(s2)` - returns new union (intersection is collection of all common & unique values in both sets)

```
s = {10, 20, 30}

s.add(40)      # {10, 20, 30, 40}
print(s)

s.remove(10)   # {20, 30, 40}
print(s)

print(s.pop()) # can be any value

s.clear()
print(s)      # set() - empty set

# Union & Intersection
A = {1, 2, 3}
B = {3, 4, 5}

print(A.union(B))      # {1, 2, 3, 4, 5}
print(A.intersection(B)) # {3}
```

| *Keep learning & Keep exploring!*