

Python - Data Structures

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Data Structures in Python

- Essential components of programming
- Help manage and organize data effectively
- Python has built-in and user-defined data structures

Types of Data Structures in Python

1. Primitive Data Structures

- Integers, Floats, Strings, Booleans

2. Non-Primitive Data Structures

- Lists, Tuples, Sets, Dictionaries
- User-defined structures

Lists

- Ordered, mutable, allows duplicate elements
- Defined with square brackets `[]`
- Common methods: `append()` , `extend()` , `insert()` , `pop()` , `remove()` ,

```
# Example
fruits = ["apple", "banana", "cherry"]

fruits.append("orange") # ["apple", "banana", "cherry", "orange"]

fruits.extend(["mango", "grape"]) # ["apple", "banana", "cherry", "orange", "mango", "grape"]

fruits.insert(1, "blueberry") # ["apple", "blueberry", "banana", "cherry", "orange", "mango", "grape"]

fruits.pop(2) # ["apple", "blueberry", "orange", "mango", "grape"]

fruits.remove("banana") # ["apple", "blueberry", "banana", "orange", "mango", "grape"]

fruits.reverse() # ['grape', 'mango', 'orange', 'banana', 'blueberry', 'apple']
```

Tuples

- Ordered, immutable, allows duplicate elements
- Defined with parentheses `()`
- Suitable for fixed data collections

```
# Example
coordinates = (10, 20, 30) # X ,Y, Z

coordinates.index(10) # returns: 1

coordinates[0:2] # sliced: 20, 30

coordinates = coordinates * 3 # (10, 20, 30, 10, 20, 30, 10, 20, 30)

len(coordinates) # 9
```

Sets

- Unordered, mutable, does not allow duplicates
- Defined with curly braces `{}` or `set()`
- Common methods: `add()`, `remove()`, `union()`, `intersection()`

```
# Example
unique_numbers = {1, 2, 3, 4}#

unique_numbers.add(5) # {1, 2, 3, 4, 5}

unique_numbers.update([6, 7, 8]) # {1, 2, 3, 4, 5, 6, 7, 8}

unique_numbers.remove(3) # {1, 2, 4, 5, 6, 7, 8}

unique_numbers.discard(9) # No error if not there unlike .remove

unique_numbers.clear() # set() is now empty.
```

Dictionaries

- Key-value pairs, unordered, mutable
- Defined with curly braces `{key: value}`
- Useful for storing related data

```
# Example
server_info = {
    "hostname": "server01",
    "ip_address": "192.168.1.10",
    "status": "active",
    "cpu_load": 73.5,
    "services": ["httpd", "sshd", "mysql"]
}

server_info["hostname"] # Output: "server01"

server_info.get("uptime", "Not Available") # Output: "Not Available" (if key not present)

server_info["disk_usage"] = 85.2 # server_info now contains disk_usage

server_info["disk_usage"].pop(0) # "httpd" removed from "services"

server_info.keys() # Output: dict_keys(["hostname", "status", "cpu_load", "services"])

server_info.values() # Output: dict_values(["server01", "active", 73.5, ["sshd", "mysql"]])
```

Comparison of Data Structures

| Feature | List | Tuple | Set | Dictionary |
|--------------------|--|-------------------------------|-------------------------------------|-------------------------------|
| Ordered | Yes | Yes | No | No |
| Mutable | Mutable | Yes | No | Yes |
| Duplicate | Duplicate | Allowed | Allowed | Not Allowed |
| ===== | ===== | ===== | ===== | ===== |
| Memory Usage | Medium | Low | Medium | High |
| Access Time | $O(1)$ for index-based access | $O(1)$ for index-based access | $O(1)$ average for membership check | $O(1)$ average for key access |
| Insert/Delete Time | $O(n)$ average (insert at end $O(1)$) | Not Applicable $O(1)$ | average for add/remove | $O(1)$ average for add/remove |