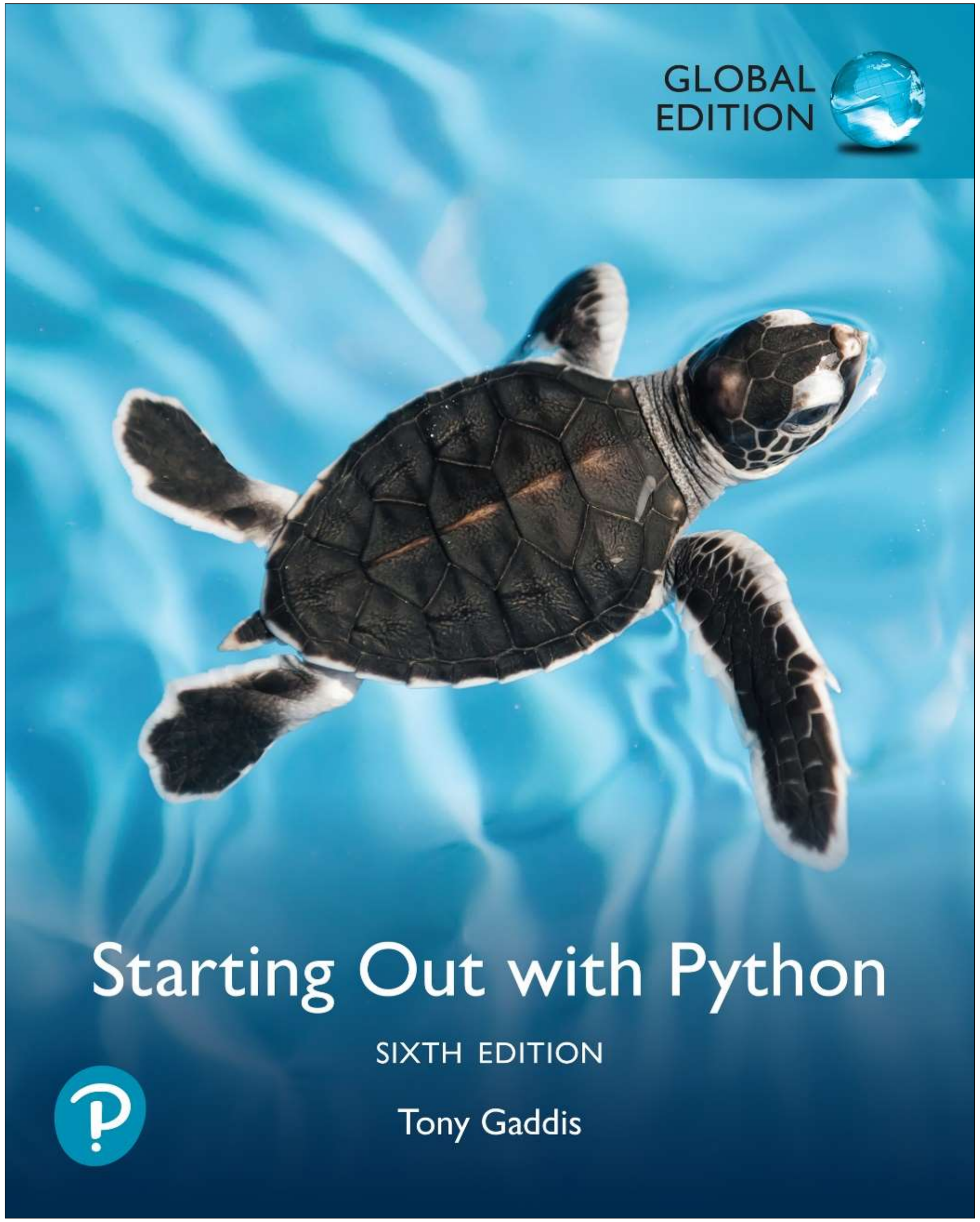
CHAPTER 9

Dictionaries and Sets



Topics

- Dictionaries
- Sets
- Serializing Objects

Dictionaries

- **Dictionary: object that stores a collection of data**
  - Each element consists of a *key* and a *value*
    - Often referred to as *mapping* of key to value
    - Key must be an immutable object
  - To retrieve a specific value, use the key associated with it
  - Format for creating a dictionary

```
dictionary =
            {key1:val1, key2:val2}
```

Retrieving a Value from a Dictionary

- **Elements in dictionary are unsorted**
- **General format for retrieving value from dictionary: *`dictionary`*`[`*`key`*`]`**
  - If `key` in the dictionary, associated value is returned, otherwise, `KeyError` exception is raised
- **Test whether a key is in a dictionary using the `in` and `not in` operators**
  - Helps prevent `KeyError` exceptions

Adding Elements to an Existing Dictionary

- **Dictionaries are mutable objects**
- **To add a new key-value pair:**

```
dictionary[key] = value
```

  - If key exists in the dictionary, the value associated with it will be changed

Deleting Elements From an Existing Dictionary

- **To delete a key-value pair:**

  `del` ***`dictionary`*****`[`*****`key`*****`]`**

  - If key is not in the dictionary, `KeyError` exception is raised

Getting the Number of Elements and Mixing Data Types

- **`len` function: used to obtain number of elements in a dictionary**
- **Keys must be immutable objects, but associated values can be any type of object**
  - One dictionary can include keys of several different immutable types
- **Values stored in a single dictionary can be of different types**

Creating an Empty Dictionary and Using `for` Loop to Iterate Over a Dictionary

- **To create an empty dictionary:**
  - Use `{}`
  - Use built-in function `dict()`
  - Elements can be added to the dictionary as program executes
- **Use a `for` loop to iterate over a dictionary**
  - General format: `for` *`key`* `in` *`dictionary`*`:`

Some Dictionary Methods

- **`clear` method: deletes all the elements in a dictionary, leaving it empty**
  - Format: `*dictionary*.clear()`
- **`get` method: gets a value associated with specified key from the dictionary**
  - Format: `*dictionary*.get(*key*, *default*)`
    - *`default`* is returned if *`key`* is not found
  - Alternative to `[]` operator
    - Cannot raise `KeyError` exception

Some Dictionary Methods (cont'd.)

- **`items` method: returns all the dictionaries keys and associated values**
  - Format: `dictionary.items()`
  - Returned as a *dictionary view*
    - Each element in dictionary view is a tuple which contains a key and its associated value
    - Use a `for` loop to iterate over the tuples in the sequence
      - Can use a variable which receives a tuple, or can use two variables which receive key and value

Some Dictionary Methods (cont'd.)

- **`keys` method: returns all the dictionaries keys as a sequence**
  - Format: `dictionary.keys()`
- **`pop` method: returns value associated with specified key and removes that key-value pair from the dictionary**
  - Format: `dictionary.pop(key, default)`
    - *`default`* is returned if *`key`* is not found

Some Dictionary Methods (cont'd.)

- **`popitem` method: Returns, as a tuple, the key-value pair that was last added to the dictionary. The method also removes the key-value pair from the dictionary.**
  - Format: `dictionary.popitem()`
  - Key-value pair returned as a tuple
- **`values` method: returns all the dictionaries values as a sequence**
  - Format: `dictionary.values()`
  - Use a `for` loop to iterate over the values

Some Dictionary Methods (cont'd.)

Table 9-1 Some of the dictionary methods

Method	Description
`clear`	Clears the contents of a dictionary.
`get`	Gets the value associated with a specified key. If the key is not found, the method does not raise an exception. Instead, it returns a default value.
`items`	Returns all the keys in a dictionary and their associated values as a sequence of tuples.
`keys`	Returns all the keys in a dictionary as a sequence of tuples.
`pop`	Returns the value associated with a specified key and removes that key-value pair from the dictionary. If the key is not found, the method returns a default value.
`popitem`	Returns, as a tuple, the key-value pair that was last added to the dictionary. The method also removes the key-value pair from the dictionary.
`values`	Returns all the values in the dictionary as a sequence of tuples.

The Dictionary Merge Operator

- **The dictionary merge operator is the `|` symbol**
- **It merges two dictionaries into a single dictionary that is the combination of the two**

```
dict3 = dict1 | dict2
```

- **After this statement, `dict3` will have all the elements of `dict1` and `dict2`**
- **If the same key appears in `dict1` and `dict2`, the new dictionary keeps the value from the dictionary on the right-hand side of the `|` operator (in this case, `dict2`).**

The Dictionary Update Operator

- The dictionary update operator is the `|=` symbol
- It works like the dictionary merge operator, but it assigns the new dictionary to the dictionary variable that appears on the left-hand side of the operator.

```
dict1 |= dict2
```

- This statement merges `dict1` and `dict2`, and assigns the resulting dictionary back to `dict1`

Dictionary Comprehensions

- **Dictionary comprehension: an expression that reads a sequence of input elements and uses those input elements to produce a dictionary**

Dictionary Comprehensions

- **Example: create a dictionary in which the keys are the integers 1 through 4 and the values are the squares of the keys**

Using a for loop

```
>>> numbers = [1, 2, 3, 4]
>>> squares = {}
>>> for item in numbers:
...     squares[item] = item**2
...
>>> squares
{1: 1, 2: 4, 3: 9, 4: 16}
>>>
```

Using a dictionary comprehension

```
>>> squares = {item:item**2 for item in numbers}
>>> squares
{1: 1, 2: 4, 3: 9, 4: 16}
>>>
```

Dictionary Comprehensions

$$\texttt{squares = \{}\underbrace{\texttt{item:item**2}}_{\text{Result Expression}}\ \underbrace{\texttt{for item in numbers}}_{\text{Iteration Expression}}\texttt{\}}$$

- The iteration expression iterates over the elements of `numbers`
- Each time it iterates, the target variable `item` is assigned the value of an element
- At the end of each iteration, an element containing `item` as the key and `item**2` as the value is added to the new dictionary

Dictionary Comprehensions

- **Example: You have an existing list of strings. Create a dictionary in which the keys are the stings in the list, and the values are the lengths of the strings**

```
>>> names = ['Jeremy', 'Kate', 'Peg']
>>> str_lengths = {item:len(item) for item in names}
>>> str_lengths
{'Jeremy': 6, 'Kate': 4, 'Peg': 3}
>>>
```

Dictionary Comprehensions

- **Example: making a copy of a dictionary**

```
>>> dict1 = {'A':1, 'B':2, 'C':3}
>>> dict2 = {k:v for k,v in dict1.items()}
>>> dict2
{'A': 1, 'B': 2, 'C': 3}
>>>
```

Dictionary Comprehensions

- **You can use an `if` clause in a dictionary comprehension to select only certain elements of the input sequence**
  - Example: A dictionary contains cities and their populations as key-value pairs. Select only the cities with a population greater than 2 million

```
>>> populations = {'New York': 8398748, 'Los Angeles': 3990456,
...                'Chicago': 2705994, 'Houston': 2325502,
...                'Phoenix': 1660272, 'Philadelphia': 1584138}
>>> largest = {k:v for k,v in populations.items() if v > 2000000}
>>> largest
{'New York': 8398748, 'Los Angeles': 3990456, 'Chicago': 2705994,
'Houston': 2325502}
>>>
```

Sets

- **Set: object that stores a collection of data in same way as mathematical set**
  - All items must be unique
  - Set is unordered
  - Elements can be of different data types

Creating a Set

- **<u>`set` function</u>: used to create a set**
  - For empty set, call `set()`
  - For non-empty set, call `set(`*`argument`*`)` where *`argument`* is an object that contains iterable elements
    - e.g., *`argument`* can be a list, string, or tuple
    - If *`argument`* is a string, each character becomes a set element
      - For set of strings, pass them to the function as a list
    - If *`argument`* contains duplicates, only one of the duplicates will appear in the set

Getting the Number of and Adding Elements

- <u>`len` function</u>: returns the number of elements in the set
- Sets are mutable objects
- <u>`add` method</u>: adds an element to a set
- <u>`update` method</u>: adds a group of elements to a set
  - Argument must be a sequence containing iterable elements, and each of the elements is added to the set

Deleting Elements From a Set

- **`remove` and `discard` methods: remove the specified item from the set**
  - The item that should be removed is passed to both methods as an argument
  - Behave differently when the specified item is not found in the set
    - `remove` method raises a `KeyError` exception
    - `discard` method does not raise an exception
- **`clear` method: clears all the elements of the set**

Using the `for` Loop, `in`, and `not in` Operators With a Set

- **A `for` loop can be used to iterate over elements in a set**
  - General format: `for` *`item`* `in` *`set`*`:`
  - The loop iterates once for each element in the set
- **The `in` operator can be used to test whether a value exists in a set**
  - Similarly, the `not in` operator can be used to test whether a value does not exist in a set

Finding the Union of Sets

- **Union of two sets: a set that contains all the elements of both sets**
- **To find the union of two sets:**
  - Use the `union` method
    - Format: `set1.union(set2)`
  - Use the `|` operator
    - Format: `set1 | set2`
  - Both techniques return a new set which contains the union of both sets

Finding the Intersection of Sets

- **<u>Intersection of two sets</u>: a set that contains only the elements found in both sets**
- **To find the intersection of two sets:**
  - Use the `intersection` method
    - Format: `set1.intersection(set2)`
  - Use the `&` operator
    - Format: `set1 & set2`
  - Both techniques return a new set which contains the intersection of both sets

Finding the Difference of Sets

- **Difference of two sets: a set that contains the elements that appear in the first set but do not appear in the second set**
- **To find the difference of two sets:**
  - Use the `difference` method
    - Format: `set1.difference(set2)`
  - Use the – operator
    - Format: `set1 - set2`

Finding the Symmetric Difference of Sets

- **<u>Symmetric difference of two sets</u>: a set that contains the elements that are not shared by the two sets**
- **To find the symmetric difference of two sets:**
  - Use the `symmetric_difference` method
    - Format: `set1.symmetric_difference(set2)`
  - Use the ^ operator
    - Format: `set1 ^ set2`

Finding Subsets and Supersets

- **Set A is subset of set B if all the elements in set A are included in set B**
- **To determine whether set A is subset of set B**
  - Use the `issubset` method
    - Format: `setA.issubset(setB)`
  - Use the `<=` operator
    - Format: `setA <= setB`

Finding Subsets and Supersets (cont'd.)

- **Set A is superset of set B if it contains all the elements of set B**
- **To determine whether set A is superset of set B**
  - Use the `issuperset` method
    - Format: `setA.issuperset(setB)`
  - Use the `>=` operator
    - Format: `setA >= setB`

Set Comprehensions

- Set comprehension: a concise expression that creates a new set by iterating over the elements of a sequence

- Set comprehensions are written just like list comprehensions, except that a set comprehension is enclosed in curly braces ({}) instead of brackets ([])

Set Comprehensions

- **Example: making a copy of a set**

```
>>> set1 = set([1, 2, 3, 4, 5])
>>> set2 = {item for item in set1}
>>> set2
{1, 2, 3, 4, 5}
>>>
```

Set Comprehensions

- **Example: creating a set that contains the squares of the numbers stored in another set**

```
>>> set1 = set([1, 2, 3, 4, 5])
>>> set2 = {item**2 for item in set1}
>>> set2
{1, 4, 9, 16, 25}
>>>
```

Set Comprehensions

- **Example: copying the numbers in a set that are less than 10**

```
>>> set1 = set([1, 20, 2, 40, 3, 50])
>>> set2 = {item for item in set1 if item < 10}
>>> set2
{1, 2, 3}
>>>
```

Serializing Objects

- Serialize an object: convert the object to a stream of bytes that can easily be stored in a file
- Pickling: serializing an object

Serializing Objects

- **To pickle an object:**
  - Import the `pickle` module
  - Open a file for binary writing
  - Call the `pickle.dump` function
    - Format: `pickle.dump(`*`object, file`*`)`
  - Close the file
- **You can pickle multiple objects to one file prior to closing the file**

Serializing Objects

- **Example**

```
>>> import pickle
>>> phonebook = { 'Chris' : '555-1111',
...               'Katie' : '555-2222',
...               'Joanne' : '555-3333' }
>>> with open('phonebook.dat', 'wb') as output_file:
...     pickle.dump(phonebook, output_file)
...
>>>
```

Serializing Objects

- **<u>Unpickling</u>: retrieving pickled object**
- **To unpickle an object:**
  - Import the `pickle` module
  - Open a file for binary writing
  - Call the `pickle.load` function
    - Format: `pickle.load(`*`file`*`)`
  - Close the file
- **You can unpickle multiple objects from the file**

Serializing Objects

- **Example**

```
>>> import pickle
>>> with open('phonebook.dat', 'rb') as inputfile:
...     pb = pickle.load(inputfile)
...
>>> pb
{'Chris': '555-1111', 'Katie': '555-2222', 'Joanne': '555-3333'}
>>>
```

Summary

- **This chapter covered:**
  - Dictionaries, including:
    - Creating dictionaries
    - Inserting, retrieving, adding, and deleting key-value pairs
    - `for` loops and `in` and `not in` operators
    - Dictionary methods
    - Dictionary operators

Summary (cont'd.)

- **This chapter covered (cont'd):**
  - Sets:
    - Creating sets
    - Adding elements to and removing elements from sets
    - Finding set union, intersection, difference and symmetric difference
    - Finding subsets and supersets
  - Serializing objects
    - Pickling and unpickling objects