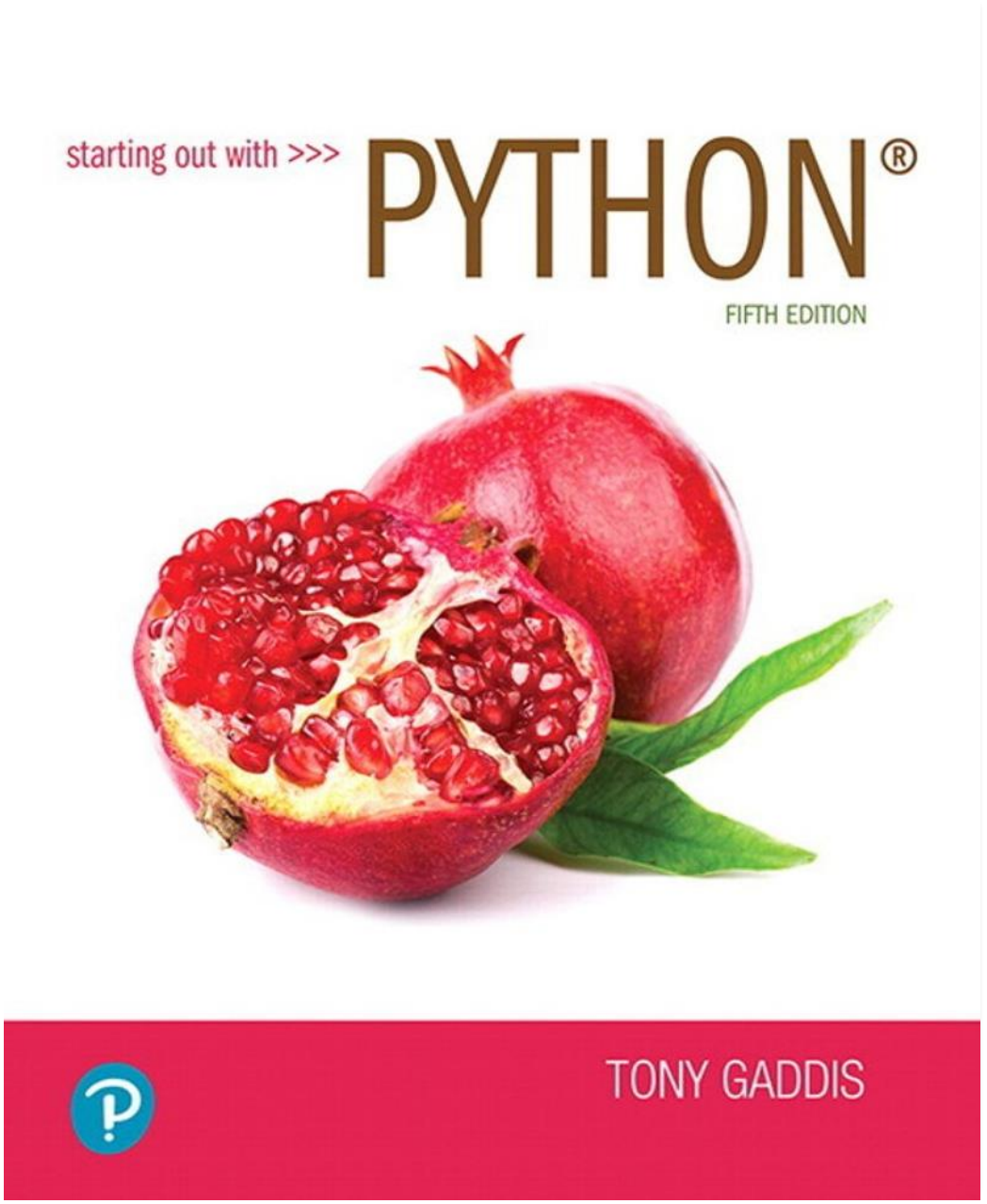
CHAPTER 9

Dictionaries and Sets



Topics

- **Dictionaries**
- **Sets**
- **Serializing Objects**

DNA Count

- **DNA Deoxyribonucleic acid**
  - "The polymer carries genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses. "
- **Part of the building blocks of DNA are 4 nitrogen containing nucleobases**
  - cytosine [C], guanine [G], adenine [A] or thymine [T]

DNA Data

- **Massive amounts of work to catalog and decode DNA in organisms has been done.**
- **https://www.kaggle.com/datasets/nageshsingh/dna-sequence-dataset?select=dog.txt**
- **ATGCCACAGCTAGATACATCCACCTGATTTATTATA ATCTTTTCAATATTTCTCACCCTCTTCATCCTATTTC AACTAAAAATTTCAAATCACTACTACCCAGAAAAC CCGATAACCAAATCTGCTAAAATTGCTGGTCAACA TAATCCTTGAGAAAACAAATGAACGAAAATCTATTC GCTTCTTTCGCTGCCCCCTCAATAA**

DNA Counts

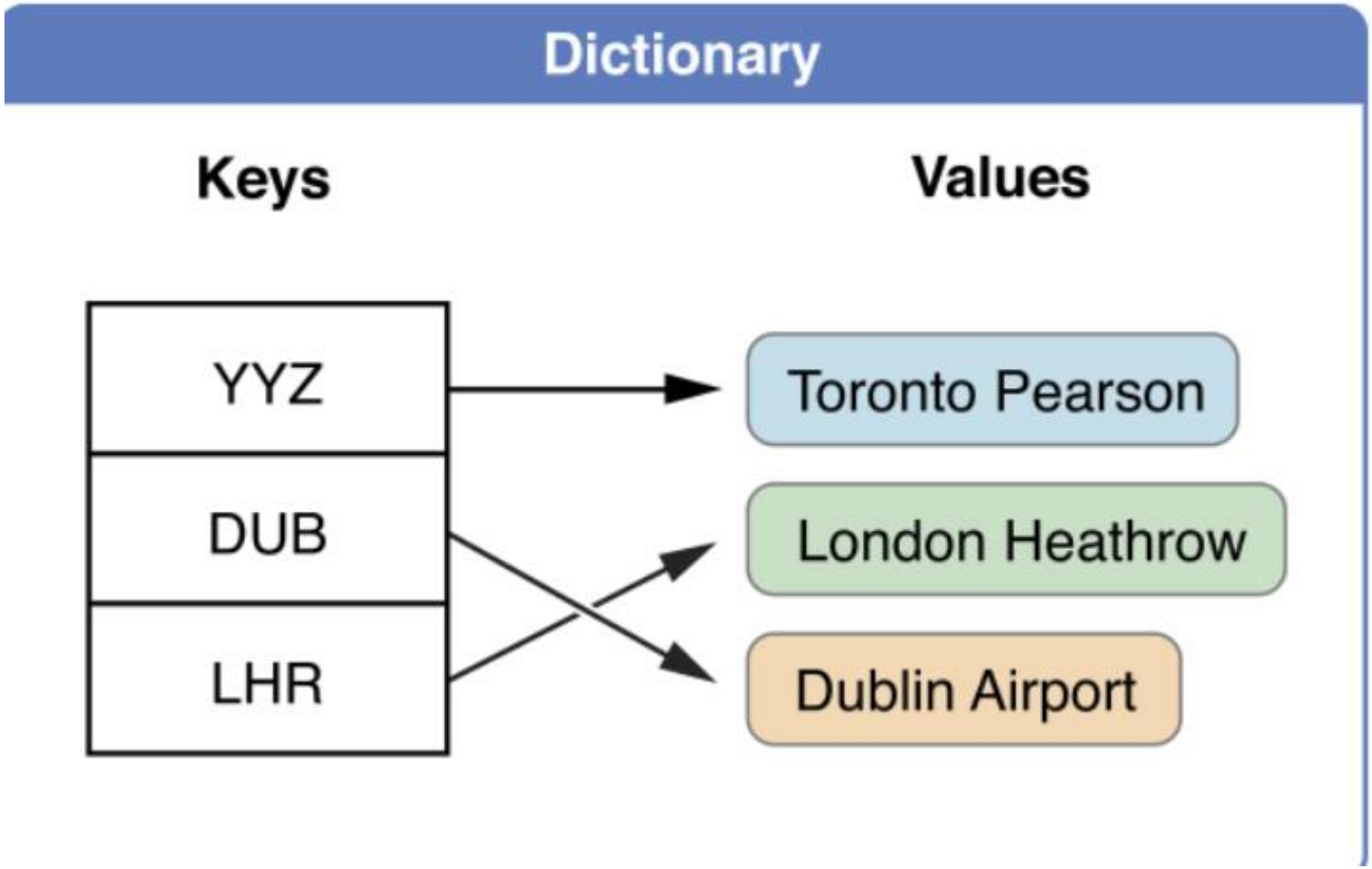
- **Write a function that given a string that represents a portion of DNA returns the frequency of the four nucleobases**
- **cytosine [C], guanine [G], adenine [A] or thymine [T]**

Dictionaries

- **Dictionary: data structure that stores a collection of *key-value pairs***
  - Each element consists of a *key* and a *value*
    - Often referred to as *mapping* of key to value
    - Key must be an immutable object
    - A real world dictionary, the words are the keys and the definitions are the values
    - Given the word you can find the value ***quickly***
  - To retrieve a specific value, use the key associated with it
  - Format for creating a dictionary with given values

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

Visualization of Dictionary



- **https://docs.swift.org/swift-book/LanguageGuide/CollectionTypes.html**

Retrieving a Value from a Dictionary

- **Prior to Python 3.7 the keys in a dictionary are in no discernible order from the client's perspective**
- **Python 3.7 and later, dictionaries maintain keys in *insertion order***
- **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
  - if the key doesn't exist this adds the *key-value* pair to the dictionary

Deleting Elements From an Existing Dictionary

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

  d.pop(key)

  - If key is not in the dictionary, `KeyError` exception is raised
  - OR `del` *`dictionary`*`[`*`key`*`]`

Getting the Number of Elements and Mixing Data Types

- **`len` function: used to obtain number of key-value pairs 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. Heterogeneous.
- **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 a randomly selected key-value pair and removes that 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

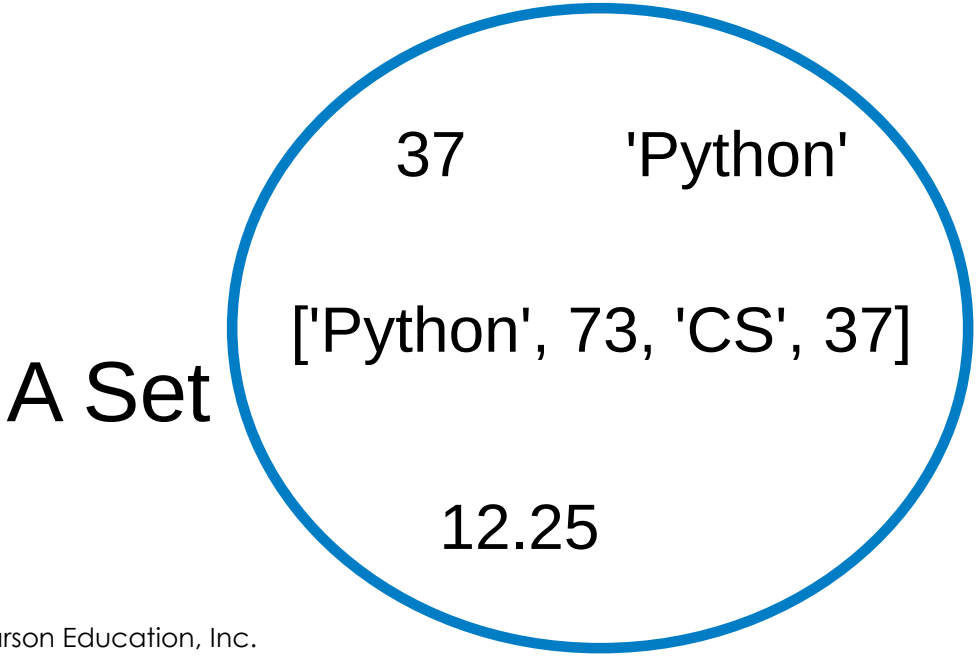
Method	Description
`clear`	Clears the contents of a dictionary.
`get`	Gets the value associated with a specified key. If the key is not found, the method does not raise an exception. Instead, it returns a default value.
`items`	Returns all the keys in a dictionary and their associated values as a sequence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

Dictionary Example

- **Use a dictionary to determine which "word" occurs the most in a text.**
- **What will be the keys?**
- **What will be the values?**

Sets

- **Set: object that stores a collection of data in same way as mathematical set**
  - Items are unique, duplicates don’t' exist in a set
  - Set is unordered, from the client's perspective
  - Elements can be of different data types



Creating a Set

- **`set` function: used to create a set**
  - Simple set creation
    - **`set1 = {12, 'Python', 37, 73}`**
  - 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

Creating Data Types

- **List:**
  - `data = [7, 37, 5, 37, 12, 37.5]`
- **List of lists:**
  - `table = [[1, 2], [3, 7], [19, 73]]`
- **String:**
  - `name = 'Python Language'`
- **Tuple:**
  - `tup1 = (37, 'Python', 73, 12, 12)`
- **Dictionary:**
  - `freq_map = {'Python': 3, 'Java': 7}`
- **Set:**
  - `lang_set= {'Python', 'Java', 'C++'}`

Sets are Unordered

- **Unlike the keys of a dictionary (which are a set, no duplicates), the elements in a Python set are unordered from the client's perspective.**

```
>>> lang_set= {'Python', 'Java', 'C++',
...                12, 'Swift', 37, 12}
>>> lang_set
{'Java', 'Python', 37, 'C++', 'Swift', 12}
```

Getting the Number of and Adding Elements

- **`len` function: returns the number of elements in the set**
- **Sets are mutable objects**
- **`add` method: adds an element to a set**
  - What if set already contains that element?
- **`update` method: 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

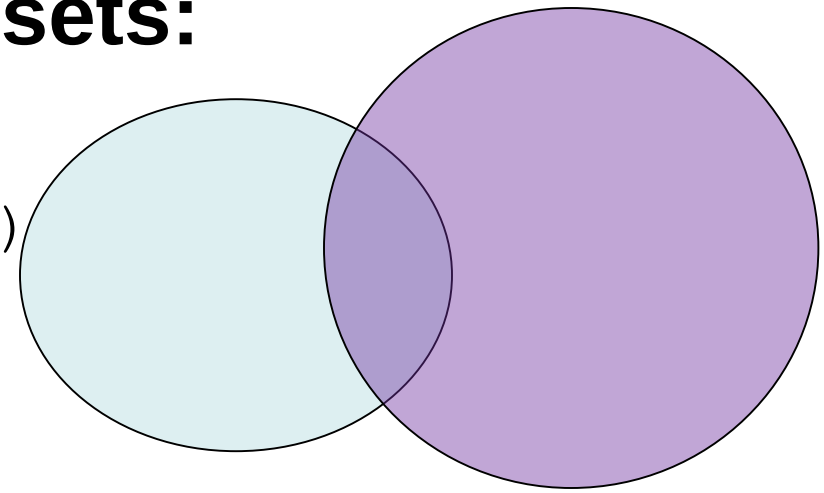
- **`remove` and `discard` methods: remove the specified item from the set**
  - The item that should be removed is passed to both methods as an argument
  - Behave differently when the specified item is not found in the set
    - `remove` method raises a `KeyError` exception
    - `discard` method does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

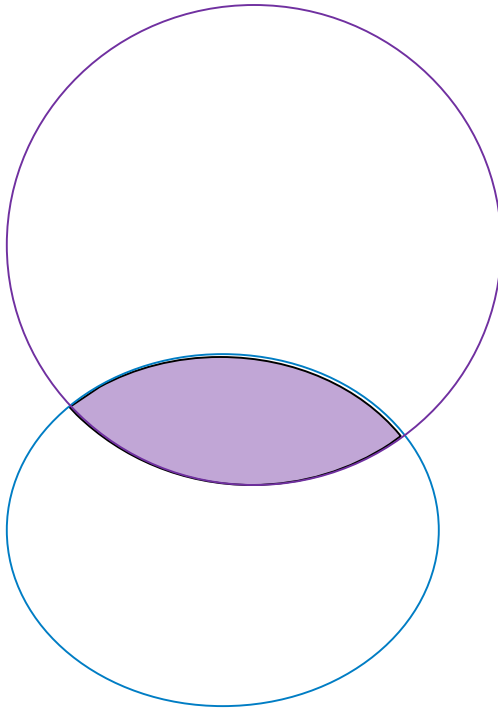
Finding the Union of Sets

- **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



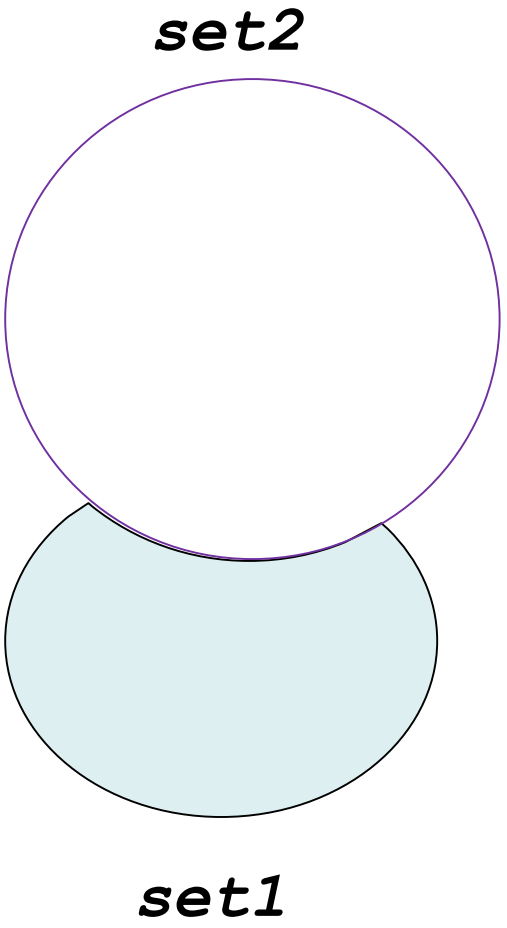
Finding the Intersection of Sets

- **Intersection of two sets: 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



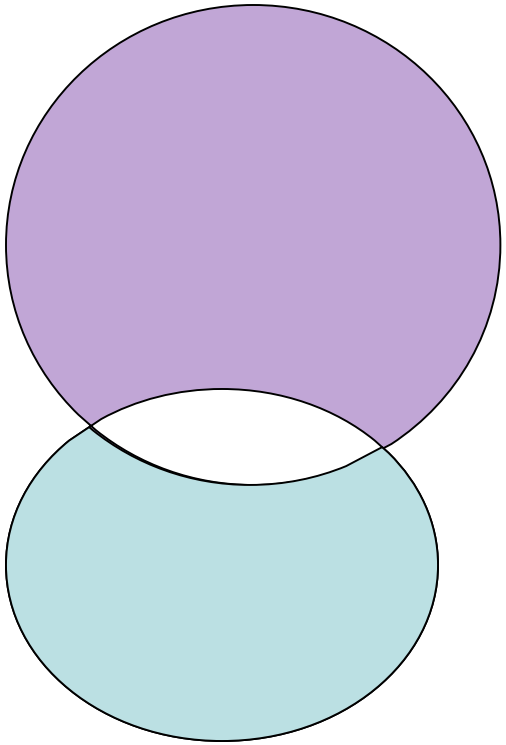
Finding the Difference of Sets

- **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

- **Symmetric difference of two sets: 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`*

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 (cont'd.)

- **To pickle an object:**
  - Import the `pickle` module
  - Open a file for binary writing, 'wb' option
  - 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 (cont'd.)

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