Using Java Collections

EECS2030 B: Advanced
Object Oriented Programming
Fall 2019

CHEN-WEI WANG

Learning Outcomes

Understand:

- Method Header
- Parameters vs. Arguments
- Self-Exploration of Java API

Application Programming Interface (API)

- Each time before you start solving a problem:
  - As a ***beginner***, crucial to implement **everything** by yourself.
  - As you get more ***experienced***, first check to see if it is already solved by one of the library classes or methods.
    Rule of the Thumb: DO NOT REINVENT THE WHEEL!
- An *Application Programming Interface (API)* is a collection of *programming facilities* for *reuse* and building your applications.
- Java API contains a library of *classes* (e.g., `Math`, `ArrayList`, `HashMap`) and *methods* (e.g., `sqrt`, `add`, `remove`):

  `https://docs.oracle.com/javase/8/docs/api/`
- To use a library class, put a corresponding `import` statement:

```
import java.util.ArrayList;
class MyClass {
  ArrayList<String> myList;
  ... /* call methods on myList */
}
```


Classes vs. Methods

- A *method* is a ***named*** block of code *reusable* by its name.
  e.g., As a user of the `sqrt` method (from the `Math` class):
  - Implementation code of `sqrt` is *hidden* from you.
  - You only need to know how to *call* it in order to use it.
  - A *non-static method* must be called using a context object.
    e.g., Illegal to call `ArrayList.add("Suyeon")`. Instead:

```
ArrayList<String> list = new ArrayList<String>();
list.add("Suyeon")
```

  - A *static method* can be called using the name of its class.
    e.g., By calling `Math.sqrt(1.44)`, you are essentially *reusing* a block of code, *hidden* from you, that will be executed and calculate the square root of the input value you supply (i.e., `1.44`).
- A *class* contains a collection of *related* methods.
  e.g., The `Math` *class* supports *methods* related to more advanced mathematical computations beyond the simple arithmetical operations we have seen so far (i.e., `+`, `-`, `*`, `/`, and `%`).

Parameters vs. Arguments

- *Parameters* of a *method* are its *input variables* that you read from the API page.

  e.g., `double pow(double a, double b)` has:
  - two parameters `a` and `b`, both of type `double`
  - one output/return value of type `double`
- *Arguments* of a *method* are the specific *input values* that you supply/pass in order to use it.

  e.g., To use the `pow` method to calculate 3.4^5, we call it by writing `Math.pow(3.4, 5)`.
- *Argument values* must conform to the corresponding *parameter types*.

  e.g., `Math.pow("three point four", "5")` is an invalid call!

Header of a Method

Header of a *method* informs users of the *intended usage*:
- *Name* of method
- List of *inputs* (a.k.a. *parameters*) and their types
- Type of the *output* (a.k.a. *return type*)
  - Methods with the `void` return type are mutators.
  - Methods with non-`void` return types are accessors.

e.g. In Java API, the **Method Summary** section lists *headers* and descriptions of methods.

Example Method Headers: ArrayList Class

An ArrayList acts like a "resizable" array (indices start with 0).

`int`	**`size`**`()` Returns the number of elements in this list.
`boolean`	**`add`**`(E e)` Appends the specified element to the end of this list.
`void`	**`add`**`(int index, E element)` Inserts the specified element at the specified position in this list.
`boolean`	**`contains`**`(Object o)` Returns `true` if this list contains the specified element.
`E`	**`remove`**`(int index)` Removes the element at the specified position in this list.
`boolean`	**`remove`**`(Object o)` Removes the first occurrence of the specified element from this list, if it is present.
`int`	**`indexOf`**`(Object o)` Returns the index of the first occurrence of the specified element in this list, or -1 if this list does not contain the element.
`E`	**`get`**`(int index)` Returns the element at the specified position in this list.

Generic Parameters: ArrayList Class (1)

- Consider the API of `ArrayList`:

```
1 class ArrayList<E> {
2   boolean add(E e)
3   E remove(int index)
4   E get(int index)
5 }
```

  - **L1** ***declares*** a generic parameter `E`, denoting the type of values stored in the array list.
  - All other occurrences of `E` at **L2**, **L3**, and **L4** refer to whatever `E` is ***instantiated*** by some caller.
- A caller of `ArrayList` may ***instantiate*** `E` to any known class:

```
1 ArrayList<String> list1 = new ArrayList<String>();
2 ArrayList<Point> list2 = new ArrayList<Point>();
```

Generic Parameters: ArrayList Class (2)

A caller of `ArrayList` may ***instantiate*** `E` to any known class:

```
1 ArrayList<String> list1 = new ArrayList<String>();
2 ArrayList<Point> list2 = new ArrayList<Point>();
```

- **L1** instantiate `E` to `String`, as if the following class was declared:

```
class ArrayList {
  boolean add(String e)
  String remove(int index)
  String get(int index)
}
```

- **L2** instantiate `E` to `Point`, as if the following class was declared:

```
class ArrayList {
  boolean add(Point e)
  Point remove(int index)
  Point get(int index)
}
```


Case Study: Using an ArrayList

```
1  import java.util.ArrayList;
2  public class ArrayListTester {
3    public static void main(String[] args) {
4      ArrayList<String> list = new ArrayList<String>();
5      println(list.size());
6      println(list.contains("A"));
7      println(list.indexOf("A"));
8      list.add("A");
9      list.add("B");
10     println(list.contains("A")); println(list.contains("B")); println(list.contains("C"));
11     println(list.indexOf("A")); println(list.indexOf("B")); println(list.indexOf("C"));
12     list.add(1, "C");
13     println(list.contains("A")); println(list.contains("B")); println(list.contains("C"));
14     println(list.indexOf("A")); println(list.indexOf("B")); println(list.indexOf("C"));
15     list.remove("C");
16     println(list.contains("A")); println(list.contains("B")); println(list.contains("C"));
17     println(list.indexOf("A")); println(list.indexOf("B")); println(list.indexOf("C"));
18
19     for(int i = 0; i < list.size(); i ++) {
20       println(list.get(i));
21     }
22   }
23 }
```


Example Method Headers: HashTable Class

A HashTable acts like a two-column table of (searchable) keys and values.

int	**size**() Returns the number of keys in this hashtable.
boolean	**containsKey**(**Object** key) Tests if the specified object is a key in this hashtable.
boolean	**containsValue**(**Object** value) Returns true if this hashtable maps one or more keys to this value.
V	**get**(**Object** key) Returns the value to which the specified key is mapped, or null if this map contains no mapping for the key.
V	**put**(**K** key, **V** value) Maps the specified key to the specified value in this hashtable.
V	**remove**(**Object** key) Removes the key (and its corresponding value) from this hashtable.

Generic Parameters: Hashtable Class (1)

- Consider the API of `Hashtable`:

```
1 class Hashtable<K, V> {
2   V put(K key, V value)
3   V get(Object key)
4 }
```

  - **L1** ***declares*** two generic parameters `K` and `V`, denoting types of keys and values stored in the hash table.
  - All other occurrences of `K` and `V` at **L2**, **L3**, and **L4** refer to whatever `K` and `V` are ***instantiated*** by some caller.

- A caller of `ArrayList` may ***instantiate*** `E` to any known class:

```
1 Hashtable<String, Integer> t1 = new Hashtable<String, Integer>();
2 Hashtable<Integer, String> t2 = new Hashtable<Integer, String>();
```

Generic Parameters: Hashtable Class (2)

A caller of `Hashtable` may ***instantiate*** `K` and `V` to any known classes:

```
1 Hashtable<String, Integer> t1 = new Hashtable<String, Integer>();
2 Hashtable<Integer, String> t2 = new Hashtable<Integer, String>();
```

- **L1** instantiate `K` and `V` to, respectively, `String` and `Integer`, as if the following class was declared:

```
class Hashtable {
  Integer put(String key, Integer value)
  Integer get(Object key)
}
```

- **L2** instantiate `K` and `V` to, respectively, `Integer` and `String`, as if the following class was declared:

```
class Hashtable {
  String put(Integer key, String value)
  String get(Object key)
}
```


Case Study: Using a HashTable

```
1  import java.util.Hashtable;
2  public class HashTableTester {
3    public static void main(String[] args) {
4      Hashtable<String, String> grades = new Hashtable<String, String>();
5      System.out.println("Size of table: " + grades.size());
6      System.out.println("Key Alan exists: " + grades.containsKey("Alan"));
7      System.out.println("Value B+ exists: " + grades.containsValue("B+"));
8      grades.put("Alan", "A");
9      grades.put("Mark", "B+");
10     grades.put("Tom", "C");
11     System.out.println("Size of table: " + grades.size());
12     System.out.println("Key Alan exists: " + grades.containsKey("Alan"));
13     System.out.println("Key Mark exists: " + grades.containsKey("Mark"));
14     System.out.println("Key Tom exists: " + grades.containsKey("Tom"));
15     System.out.println("Key Simon exists: " + grades.containsKey("Simon"));
16     System.out.println("Value A exists: " + grades.containsValue("A"));
17     System.out.println("Value B+ exists: " + grades.containsValue("B+"));
18     System.out.println("Value C exists: " + grades.containsValue("C"));
19     System.out.println("Value A+ exists: " + grades.containsValue("A+"));
20     System.out.println("Value of existing key Alan: " + grades.get("Alan"));
21     System.out.println("Value of existing key Mark: " + grades.get("Mark"));
22     System.out.println("Value of existing key Tom: " + grades.get("Tom"));
23     System.out.println("Value of non-existing key Simon: " + grades.get("Simon"));
24     grades.put("Mark", "F");
25     System.out.println("Value of existing key Mark: " + grades.get("Mark"));
26     grades.remove("Alan");
27     System.out.println("Key Alan exists: " + grades.containsKey("Alan"));
28     System.out.println("Value of non-existing key Alan: " + grades.get("Alan"));
29       }
30 }
```


Tutorial Videos

- Use of `ArrayList`:

https://www.youtube.com/watch?v=SJjZM2DKA3M&index=2&list=PL5dxAmCmjv_4rOxjfTfIxNp42vO8SnT8n

- Use of `HashMap`:

https://www.youtube.com/watch?v=_PV7dP5aIMg&list=PL5dxAmCmjv_4rOxjfTfIxNp42vO8SnT8n&index=3

- iPad Notes:

https://www.eecs.yorku.ca/~jackie/teaching/tutorials/notes/Tutorial%20on%20Java%20Collections.pdf

Index (1)